IDL Reference Guide

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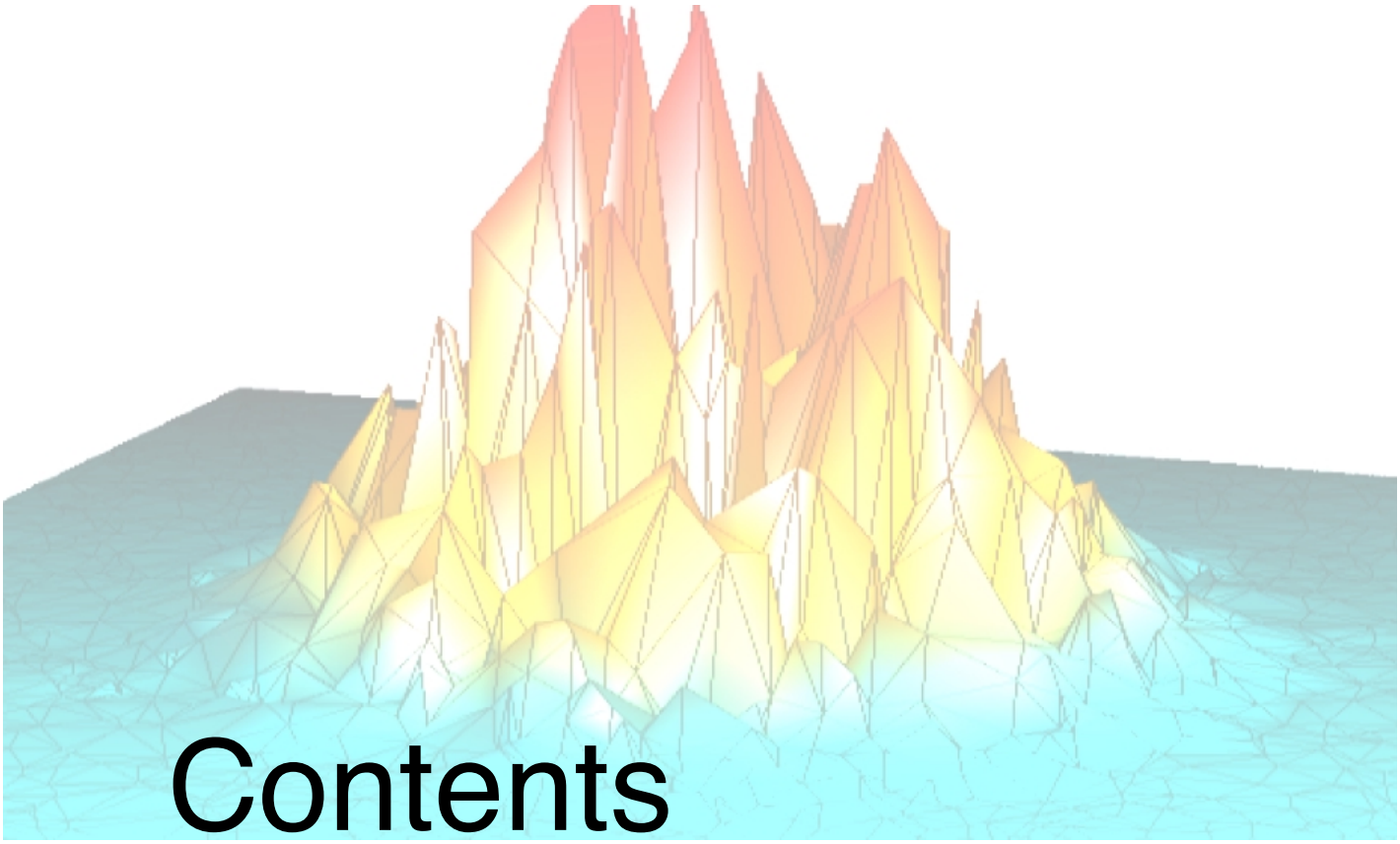
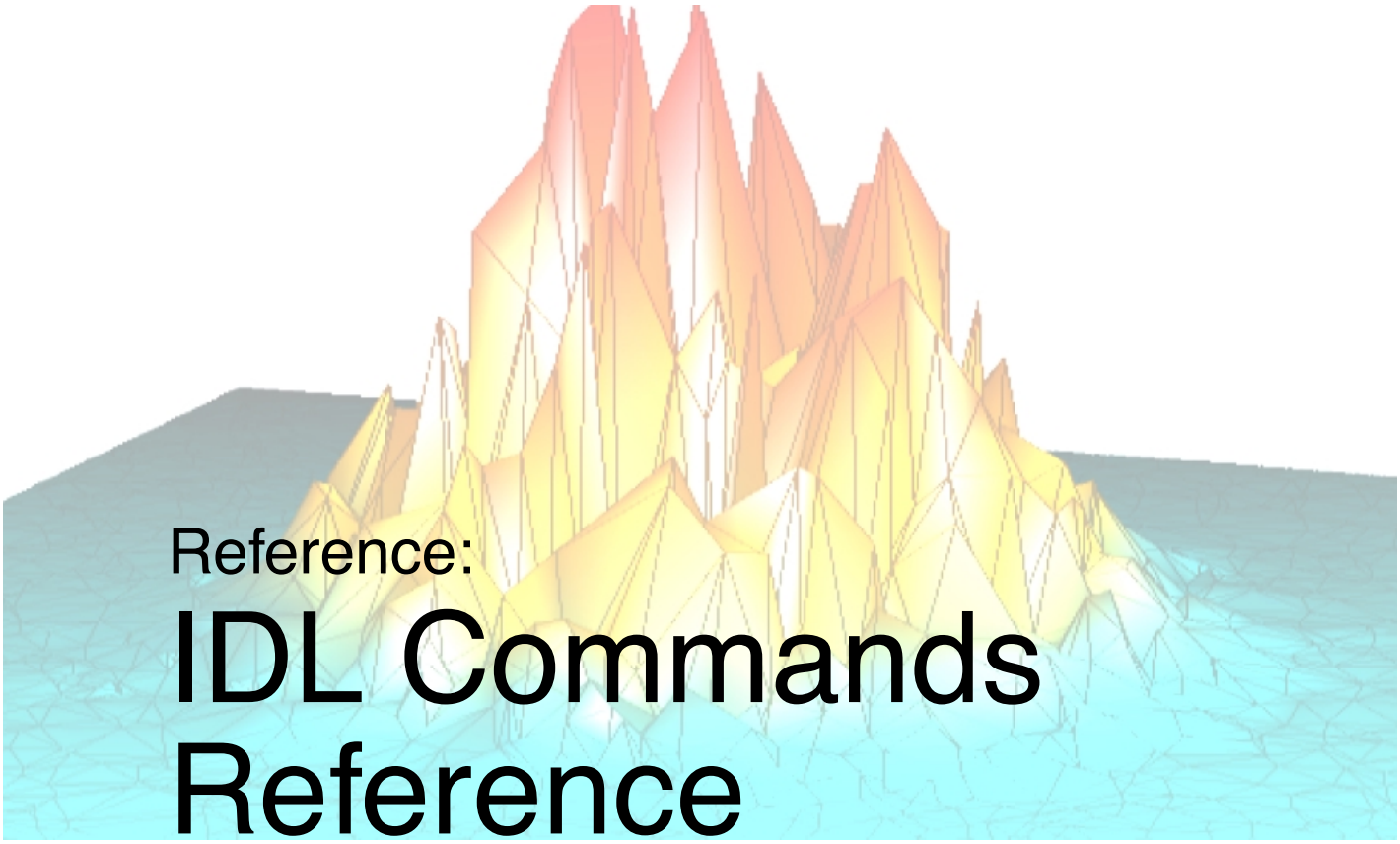
Acknowledgments



Contents



Reference: IDL Commands Reference

This reference is a complete listing of all built-in IDL functions, procedures, statements, executive commands, and objects, collectively referred to as "commands." Every IDL language element that can be used either at the command line or in a program is listed alphabetically. A description of each routine follows its name.

Note

Descriptions of Scientific Data Formats routines (CDF_*, EOS_*, HDF_*, and NCDF_* routines) can be found in the *Scientific Data Formats* book.

Routines written in the IDL language are noted as such, and the location of the `.pro` file within the IDL distribution is specified. You may wish to inspect the IDL source code for some of these routines to gain further insight into their inner workings.

Conventions used in this reference guide are described below.

IDL Syntax

The following table lists the elements used in IDL syntax listings:

Element	Description
[ ] (Square brackets)	Indicates that the contents are optional. Do not include the brackets in your call.
[ ] (Italicized square brackets)	Indicates that the square brackets are part of the statement (used to define an array).
Argument	Arguments are shown in italics, and must be specified in the order listed.
KEYWORD	Keywords are all caps, and can be specified in any order. For functions, all arguments and keywords must be contained within parentheses.
/KEYWORD	Indicates a boolean keyword.
Italics	Indicates arguments, expressions, or statements for which you must provide values.
{ } (Braces)	• Indicates that you must choose one of the values they contain • Encloses a list of possible values, separated by vertical lines (|) • Encloses useful information about a keyword • Defines an IDL structure (this is the only case in which the braces are included in the call).
| (Vertical lines)	Separates multiple values or keywords.
[, $Value_1$, ... , $Value_n$]	Indicates that any number of values can be specified.
[, $Value_1$, ... , $Value_8$]	Indicates the maximum number of values that can be specified.

Table 1: Elements of IDL Syntax

Elements of Syntax

Square Brackets ([ ])

- Content between square brackets is optional. Pay close attention to the grouping of square brackets. Consider the following examples:

  ROUTINE_NAME, *Value1* [, *Value2*] [, *Value3*]: You must include *Value1*. You do not have to include *Value2* or *Value3*. *Value2* and *Value3* can be specified independently.

  ROUTINE_NAME, *Value1* [, *Value2*, *Value3*]: You must include *Value1*. You do not have to include *Value2* or *Value3*, but you must include both *Value2* and *Value3*, or neither.

  ROUTINE_NAME [, *Value1* [, *Value2*]]: You can specify *Value1* without specifying *Value2*, but if you specify *Value2*, you must also specify *Value1*.

- Do not include square brackets in your statement unless the brackets are italicized. Consider the following syntax:

  Result = KRIG2D(*Z* [, *X*, *Y*] [, BOUNDS=*[xmin*, *ymin*, *xmax*, *ymax]*])

  An example of a valid statement is:

  R = KRIG2D(Z, X, Y, BOUNDS=[0,0,1,1])

- Note that when [, $Value_1$, ... , $Value_n$] is listed, you can specify any number of arguments. When an explicit number is listed, as in [, $Value_1$, ... , $Value_8$], you can specify only as many arguments as are listed.

Braces ({ })

- For certain keywords, a list of the possible values is provided. This list is enclosed in braces, and the choices are separated by a vertical line (|). Do not include the braces in your statement. For example, consider the following syntax:

  LIVE_EXPORT [, QUALITY={0 | 1 | 2}]

  In this example, you must choose either 0, 1, or 2. An example of a valid statement is:

  LIVE_EXPORT, QUALITY=1

- Braces are used to enclose the allowable range for a keyword value. Unless otherwise noted, ranges provided are inclusive. Consider the following syntax:

Result = CVTTOBM(*Array* [, THRESHOLD=*value*{0 to 255}])

An example of a valid statement is:

Result = CVTTOBM(A, THRESHOLD=150)

- Braces are also used to provide useful information about a keyword. For example:

  [, LABEL=*n*{label every *n*th gridline}]

  Do not include the braces or their content in your statement.

- Certain keywords are prefaced by X, Y, or Z. Braces are used for these keywords to indicate that you must choose one of the values it contains. For example, [{X | Y}RANGE=*array*] indicates that you can specify either XRANGE=*array* or YRANGE=*array*.

- Note that in IDL, braces are used to define structures. When defining a structure, you *do* want to include the braces in your statement.

Italics

- Italicized words are arguments, expressions, or statements for which you must provide values. The value you provide can be a numerical value, such as 10, an expression, such as DIST(100), or a named variable. For keywords that expect a string value, the syntax is listed as KEYWORD=*string*. The value you provide can be a string, such as 'Hello' (enclosed in single quotation marks), or a variable that holds a string value.

- The italicized values that must be provided for keywords are listed in the most helpful terms possible. For example, [, XSIZE=*pixels*] indicates that the XSIZE keyword expects a value in pixels, while [, ORIENTATION=*ccw_degrees_from_horiz*] indicates that you must provide a value in degrees, measured counter-clockwise from horizontal.

Procedures

IDL procedures use the following general syntax:

PROCEDURE_NAME, *Argument* [, *Optional_Argument*]

where PROCEDURE_NAME is the name of the procedure, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter to the procedure.

Functions

IDL functions use the following general syntax:

Result = FUNCTION_NAME(*Argument* [, *Optional_Argument*])

where *Result* is the returned value of the function, FUNCTION_NAME is the name of the function, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter. Note that all arguments and keyword arguments to functions should be supplied *within* the parentheses that follow the function's name.

Functions do not always have to be used in assignment statements (i.e., `A=SIN(10.2)`), they can be used just like any other IDL expression. For example, you could print the result of `SIN(10.2)` by entering the command:

```
PRINT, SIN(10.2)
```

Arguments

The "Arguments" section describes each valid argument to the routine. Note that these arguments are positional parameters that must be supplied in the order indicated by the routine's syntax.

Named Variables

Often, arguments that contain values upon return from the function or procedure ("output arguments") are described as accepting "named variables". A named variable is simply a valid IDL variable name. This variable *does not* need to be defined before being used as an output argument. Note, however that when an argument calls for a named variable, only a named variable can be used—sending an expression causes an error.

Keywords

The "Keywords" section describes each valid keyword argument to the routine. Note that keyword arguments are formal parameters that can be supplied in any order.

Keyword arguments are supplied to IDL routines by including the keyword name followed by an equal sign ("=") and the value to which the keyword should be set. The value can be a value, an expression, or a *named variable* (a named variable is simply a valid IDL variable name).

Note

If you set a keyword equal to an *undefined* named variable, IDL will quietly ignore the value.

For example, to produce a plot with diamond-shaped plotting symbols, the PSYM keyword should be set to 4 as follows:

```
PLOT, FINDGEN(10), PSYM=4
```

Note the following when specifying keywords:

- Certain keywords are boolean, meaning they can be set to either 0 or 1. These keywords are switches used to turn an option on and off. Usually, setting such keywords equal to 1 causes the option to be turned on. Explicitly setting the keyword to 0 (or not including the keyword) turns the option off. In the syntax listings in this reference, all keywords that are preceded by a slash can be set by prefacing them by the slash. For example, SURFACE, DIST(10), /SKIRT is a shortcut for SURFACE, DIST(10), SKIRT=1. To turn the option back off, you must set the keyword equal to 0, as in SURFACE, DIST(10), SKIRT=0.

  In rare cases, a keyword's default value is 1. In these cases, the syntax is listed as KEYWORD=0, as in SLIDE_IMAGE [, *Image*] [, CONGRID=0]. In this example, CONGRID is set to 1 by default. If you specify CONGRID=0, you can turn it back on by specifying either /CONGRID or CONGRID=1.

- Some keywords are used to obtain values that can be used upon return from the function or procedure. These keywords are listed as KEYWORD=*variable*. Any valid variable name can be used for these keywords, and the variable does not need to be defined first. Note, however, that when a keyword calls for a named variable, only a named variable can be used—sending an expression causes an error.

  For example, the WIDGET_CONTROL procedure can return the user values of widgets in a named variable using the GET_UVALUE keyword. To return the user value for a widget ID (contained in the variable `mywidget`) in the variable `userval`, you would use the command:

  ```
  WIDGET_CONTROL, mywidget, GET_UVALUE = userval
  ```

  Upon return from the procedure, `userval` contains the user value. Note that `userval` did not have to be defined before the call to WIDGET_CONTROL.

- Some routines have keywords that are mutually exclusive, meaning only one of the keywords can be present in a given statement. These keywords are

grouped together, and separated by a vertical line. For example, consider the following syntax:

PLOT, [*X*,] *Y* [, /DATA | , /DEVICE | , /NORMAL]

In this example, you can choose either DATA, DEVICE, or NORMAL, but not more than one. An example of a valid statement is:

PLOT, SIN(A), /DEVICE

- Keywords can be abbreviated to their shortest unique length. For example, the XSTYLE keyword can be abbreviated to XST because there are no other keywords in IDL that begin with XST. You cannot shorten XSTYLE to XS, however, because there are other keywords that begin with XS, such as XSIZE.

.COMPILE

The .COMPILE command compiles and saves procedures and programs in the same manner as .RUN. If one or more filenames are specified, the procedures and functions contained therein are compiled *but not executed*. If you enter this command at the Command Input Line of the IDLDE and the files are not yet open, IDL opens the files within Editor windows and compiles the procedures and functions contained therein.

See RESOLVE_ROUTINE for a way to invoke the same operation from within an IDL routine, and RESOLVE_ALL for a way to automatically compile all user-written or library functions called by all currently-compiled routines.

If the -f flag is specified, File is compiled from the source stored temporarily in TempFile rather than on disk in File itself. This allows you to make changes to File (in an IDLDE editor window, for example), store the modified source into the temporary file (IDLDE does it automatically), compile, and test the changes without overwriting the original code stored in File.

Note

.COMPILE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.COMPILE [$File_1$, ..., $File_n$]

.COMPILE -f *File TempFile*

.CONTINUE

The .CONTINUE command continues execution of a program that has stopped because of an error, a stop statement, or a keyboard interrupt. IDL saves the location of the beginning of the last statement executed before an error. If it is possible to correct the error condition in the interactive mode, the offending statement can be re-executed by entering .CONTINUE. After STOP statements, .CONTINUE continues execution at the next statement. The .CONTINUE command can be abbreviated; for example, .C. Execution of a program interrupted by typing Ctrl+C also can be resumed at the point of interruption with the .CONTINUE command.

Note

.CONTINUE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.CONTINUE

.EDIT

The .EDIT command opens files in IDL Editor windows when called from the Command Input Line of the IDLDE. This functionality is only available on the Windows and Motif platforms. Note that filenames are separated by spaces, not commas.

Note

.EDIT is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.EDIT $File_1$ [$File_2$ ... $File_n$]

.FULL_RESET_SESSION

The .FULL_RESET_SESSION command does everything .RESET_SESSION does, plus the following:

- Removes all system routines installed via LINKIMAGE or a DLM.
- Removes all structure definitions installed via a DLM.
- Removes all message blocks added by DLMs.
- Unloads all sharable libraries loaded into IDL via CALL_EXTERNAL, LINKIMAGE, or a DLM.
- Re-initializes all DLMs to their unloaded initial state.

Note

The VMS operating system does not support unloading sharable libraries. Therefore, .FULL_RESET_SESSION is identical to .RESET_SESSION under VMS, and these extra steps are not performed.

Note

.FULL_RESET_SESSION is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.FULL_RESET_SESSION

.GO

The .GO command starts execution at the beginning of a previously-compiled main program.

Note

.GO is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.GO

.OUT

The .OUT command continues executing statements in the current program until it returns.

Note

.OUT is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.OUT

.RESET_SESSION

The .RESET_SESSION command resets much of the state of an IDL session without requiring the user to exit and restart the IDL session.

.RESET_SESSION does the following:

- Returns current execution point to $MAIN$ (RETALL).
- Removes all breakpoints.
- Closes all files except the standard 3 units, the JOURNAL file (if any), and any files in use by graphics drivers.
- Destroys/Removes the following:
  - All local variables in $MAIN$.
  - All widgets. Exit handlers are not called.
  - All windows and pixmaps for the current window system graphics device are closed. No other graphics state is reset.
  - All common blocks.
  - All handles
  - All user defined system variables
  - All pointer and object reference heap variables.
  - Object destructors are not called.
  - All user defined structure definitions.
  - All user defined object definitions.
  - All compiled user functions and procedures, including the main program ($MAIN$), if any.

The following are not reset:

- The current values of intrinsic system variables are retained.
- The saved commands and output log are preserved.
- Graphics drivers are not reset to their full uninitialized state. However, all windows and pixmaps for the current window system device are closed.
- The following files are not closed:

- Stdin (LUN 0)
- Stdout (LUN -1)
- Stderr (LUN -2)
- The journal file (!JOURNAL) if one is open.
- Any files in use by graphics drivers (e.g. PostScript).

- Dynamically loaded graphics drivers (LINKIMAGE) are not removed, nor are any dynamic sharable libraries containing such drivers, even if the same library was also used for another purpose such as CALL_EXTERNAL, LINKIMAGE system routines, or DLMs. See the .FULL_RESET_SESSION executive command to unload dynamic libraries.

Note

.RESET_SESSION is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.RESET_SESSION

.RETURN

The .RETURN command continues execution of a program until encountering a RETURN statement. This is convenient for debugging programs since it allows the whole program to run, stopping before returning to the next-higher program level so you can examine local variables.

Also see the RETURN command.

Note

.RETURN is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.RETURN

.RNEW

The .RNEW command compiles and saves procedures and functions in the same manner as .RUN. In addition, all variables in the main program unit, except those in common blocks, are erased. The -T and -L filename switches have the same effect as with .RUN.

Note

.RNEW is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.RNEW [$File_1$, ..., $File_n$]

To save listing in a file: .RNEW -L *ListFile.lis* $File_1$ [, $File_2$, ..., $File_n$]

To display listing on screen: .RNEW -T $File_1$ [, $File_2$, ..., $File_n$]

Example

Some statements using the .RUN and .RNEW commands are shown below.

Statement	Description
`.RUN`	Accept a program from the keyboard. Retain the present variables.
`.RUN myfile`	Compile the file myfile.pro. If it is not found in the current directory, try to find it in the directory search path.
`.RUN -T A, B, C`	Compile the files a.pro, b.pro and c.pro. List the files on the terminal.

Table 2: Examples using .RUN and .RNEW

Statement	Description
`.RNEW -L myfile.lis myfile, yourfile`	Erase all variables and compile the files myfile.pro and yourfile.pro. Produce a listing on myfile.lis.

Table 2: Examples using .RUN and .RNEW

.RUN

The .RUN command compiles procedures, functions, and/or main programs in memory. Main programs are executed immediately. The command can be followed by a list of files to be compiled. Filenames are separated by blanks, tabs, or commas.

If a file specification is included in the command, IDL searches for the file first in the current directory, then in the directories specified by the system variable !PATH. See "Executing Program Files" in Chapter 2 of *Using IDL* for more information on IDL's search strategy.

If a main program unit is encountered, execution of the program will begin after all files have been read if there were no errors. The values of all of the variables are retained. If the file isn't found, input is accepted from the keyboard until a complete program unit is entered.

Files containing IDL procedures, programs, and functions are assumed to have the file extension (suffix) `.pro`. Files created with the SAVE procedure are assumed to have the extension `.sav`. See "Preparing and Running Programs" in Chapter 2 of *Using IDL* for further information.

Note

.RUN is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.RUN [$File_1$, ..., $File_n$]

To save listing in a file: .RUN -L *ListFile.lis* $File_1$ [, $File_2$, ..., $File_n$]

To display listing on screen: .RUN -T $File_1$ [, $File_2$, ..., $File_n$]

Note

Subsequent calls to .RUN compile the procedure again.

Using .RUN to Make Program Listings

The command arguments -T for terminal listing or -L filename for listing to a named file can appear after the command name and before the program filenames to produce a numbered program listing directed to the terminal or to a file.

For instance, to see a listing on the screen as a result of compiling a procedure contained in a file named `analyze.pro`, use the following command:

```
.RUN -T analyze
```

To compile the same procedure and save the listing in a file named `analyze.lis`, use the following command:

```
.RUN -L analyze.lis analyze
```

In listings produced by IDL, the line number of each statement is printed at the left margin. This number is the same as that printed in IDL error statements, simplifying location of the statement causing the error.

Note

If the compiled file contains more than one procedure or function, line numbering is reset to "1" each time the end of a program segment is detected.

Each level of block nesting is indented four spaces to the right of the preceding block level to improve the legibility of the program's structure.

.SKIP

The .SKIP command skips one or more statements and then executes a single step. It is useful for continuing over a program statement that caused an error. If the optional argument n is present, it gives the number of statements to skip; otherwise, a single statement is skipped. Note that .SKIP does not skip *into* a called routine.

For example, consider the following program segment:

```
...... ... ...
OPENR, 1, 'missing'
READF, 1, xxx, ..., ...
... ... ...
```

If the OPENR statement fails because the specified file does not exist, program execution will halt with the OPENR statement as the current statement. Execution can not be resumed with the executive command .CONTINUE because it attempts to re-execute the offending OPENR statement, causing the same error. The remainder of the program can be executed by entering .SKIP, which skips over the incorrect OPEN statement.

Note

.SKIP is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.SKIP [*n*]

.STEP

The .STEP command executes one or more statements in the current program starting at the current position, stops, and returns control to the interactive mode. This command is useful in debugging programs. The optional argument *n* indicates the number of statements to execute. If *n* is omitted, a single statement is executed.

Note

.STEP is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.STEP [*n*] or .S [*n*]

.STEPOVER

The .STEPOVER command executes one or more statements in the current program starting at the current position, stops, and returns control to the interactive mode. Unlike .STEP, if .STEPOVER executes a statement that calls another routine, the called routine runs until it ends before control returns to interactive mode. That is, a statement calling another routine is treated as a single statement.

The optional argument n indicates the number of statements to execute. If n is omitted, a single statement (or called routine) is executed.

Note

.STEPOVER is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.STEPOVER [*n*] or .SO [*n*]

.TRACE

The .TRACE command continues execution of a program that has stopped because of an error, a stop statement, or a keyboard interrupt.

Note

.TRACE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

Syntax

.TRACE

A_CORRELATE

The A_CORRELATE function computes the autocorrelation *Px*(*L*) or autocovariance *Rx*(*L*) of a sample population *X* as a function of the lag *L*.

$$P_x(L) = P_x(-L) = \frac{\sum_{k=0}^{N-L-1} (x_k - \bar{x})(x_{k+L} - \bar{x})}{\sum_{k=0}^{N-1} (x_k - \bar{x})^2}$$

$$R_x(L) = R_x(-L) = \frac{1}{N} \sum_{k=0}^{N-L-1} (x_k - \bar{x})(x_{k+L} - \bar{x})$$

where $\bar{x}$ is the mean of the sample population $x = (x_0, x_1, x_2, \ldots, x_{N-1})$.

Note

This routine is primarily designed for use in 1-D time-series analysis. The mean is subtracted before correlating. For image processing, methods based on FFT should be used instead if more than a few tens of points exist. For example:

```
Function AutoCorrelate, X
   Temp = FFT(X,-1)
   RETURN, FFT(Temp * CONJ(Temp), 1)
END
```

This routine is written in the IDL language. Its source code can be found in the file `a_correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = A_CORRELATE(*X*, *Lag* [, /COVARIANCE] [, /DOUBLE])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Lag

An *n*-element integer vector in the interval [-(*n*-2), (*n*-2)], specifying the signed distances between indexed elements of *X*.

Keywords

COVARIANCE

Set this keyword to compute the sample autocovariance rather than the sample autocorrelation.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define an n-element sample population:
X = [3.73, 3.67, 3.77, 3.83, 4.67, 5.87, 6.70, 6.97, 6.40, 5.57]
; Compute the autocorrelation of X for LAG = -3, 0, 1, 3, 4, 8:
lag = [-3, 0, 1, 3, 4, 8]
result = A_CORRELATE(X, lag)
PRINT, result
```

IDL prints:

```
0.0146185   1.00000   0.810879   0.0146185   -0.325279   -0.151684
```

See Also

CORRELATE, C_CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

ABS

The ABS function returns the absolute value of its argument.

Syntax

Result = ABS(*X*)

Arguments

X

The value for which the absolute value is desired. If *X* is of complex type, ABS returns the magnitude of the complex number:

$$\sqrt{\text{Real}^2 + \text{Imaginary}^2}$$

If X is of complex type, the result is returned as the corresponding floating point type. For all other types, the result has the same type as *X*. If *X* is an array, the result has the same structure, with each element containing the absolute value of the corresponding element of *X*.

ABS applied to any of the unsigned integer types results in the unaltered value of X being returned.

Example

To print the absolute value of -25, enter:

```
PRINT, ABS(-25)
```

IDL prints:

```
25
```

ACOS

The ACOS function returns the angle, expressed in radians, whose cosine is *X* (i.e., the arc-cosine). The range of ACOS is between 0 and π.

Syntax

Result = ACOS(*X*)

Arguments

X

The cosine of the desired angle in the range (-1 ≤ *X* ≤ 1). If *X* is double-precision floating, the result of ACOS is also double-precision. *X* cannot be complex. All other types are converted to single-precision floating-point and yield floating-point results. If *X* is an array, the result has the same structure, with each element containing the arc-cosine of the corresponding element of *X*.

Example

To find the arc-cosine of 0.707 and store the result in the variable B, enter:

```
B = ACOS(0.707)
```

See Also

COS

ADAPT_HIST_EQUAL

The ADAPT_HIST_EQUAL function performs adaptive histogram equalization, a form of automatic image contrast enhancement. The algorithm is described in Pizer et. al., “Adaptive Histogram Equalization and its Variations.”, Computer Vision, Graphics and Image Processing, 39:355-368. Adaptive histogram equalization involves applying contrast enhancement based on the local region surrounding each pixel. Each pixel is mapped to an intensity proportional to its rank within the surrounding neighborhood. This method of automatic contrast enhancement has proven to be broadly applicable to a wide range of images and to have demonstrated effectiveness.

Syntax

Result = ADAPT_HIST_EQUAL (*Image* [, CLIP=*value*] [, NREGIONS=*nregions*] [, TOP=*value*])

Return Value

The result of the function is a byte image with the same dimensions as the input image parameter.

Arguments

Image

A two-dimensional array representing the image for which adaptive histogram equalization is to be performed. This parameter is interpreted as unsigned 8-bit data, so be sure that the input values are properly scaled into the range of 0 to 255.

Keywords

CLIP

Set this keyword to a nonzero value to clip the histogram by limiting its slope to the given CLIP value, thereby limiting contrast. For example, if CLIP is set to 3, the slope of the histogram is limited to 3. By default, the slope and/or contrast is not limited. Noise over-enhancement in nearly homogeneous regions is reduced by setting this parameter to values larger than 1.0.

NREGIONS

Set this keyword to the size of the overlapped tiles, as a fraction of the largest dimensions of the image size. The default is 12, which makes each tile 1/12 the size of the largest image dimension.

TOP

Set this keyword to the maximum value of the scaled output array. The default is 255.

Example

The following code snippet reads a data file in the `examples/data` subdirectory of the IDL distribution containing a cerebral angiogram, and then displays both the original image and the adaptive histogram equalized image:

```
OPENR, 1, FILEPATH('cereb.dat', $
   SUBDIRECTORY=['examples','data'])

;Image size = 512 x 512
a = BYTARR(512,512, /NOZERO)

;Read it
READU, 1, a
CLOSE, 1

; Reduce size of image for comparison
a = CONGRID(a, 256,256)

;Show original
TVSCL, a, 0

;Show processed
TV, ADAPT_HIST_EQUAL(a, TOP=!D.TABLE_SIZE-1), 1
```

See Also

H_EQ_CT, H_EQ_INT, HIST_2D, HIST_EQUAL, HISTOGRAM

ALOG

The ALOG function returns the natural logarithm of *X*. The result has the same structure as *X*.

Syntax

Result = ALOG(*X*)

Arguments

X

The value for which the natural log is desired. The result of ALOG is double-precision floating if *X* is double-precision, and complex if *X* is complex. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers, the definition of the ALOG function is:

ALOG(*x*) = *COMPLEX*(log |*x*|, atan *x*)

Example

To print the natural logarithm of 5, enter:

```
PRINT, ALOG(5)
```

IDL prints:

```
1.60944
```

See Also

ALOG10

ALOG10

The ALOG10 function returns the logarithm to the base 10 of *X*. This function operates in the same manner as the ALOG function.

Syntax

Result = ALOG10(*X*)

Arguments

X

The value for which the base 10 log is desired.

Example

To find the base 10 logarithm of 5 and store the result in the variable L, enter:

```
L = ALOG10(5)
```

See Also

ALOG

AMOEBA

The AMOEBA function performs multidimensional minimization of a function *Func*(*x*), where *x* is an *n*-dimensional vector, using the downhill simplex method of Nelder and Mead, 1965, *Computer Journal*, Vol 7, pp 308-313.

The downhill simplex method is not as efficient as Powell's method, and usually requires more function evaluations. However, the simplex method requires only function evaluations—not derivatives—and may be more reliable than Powell's method.

If the minimum is found, AMOEBA returns an *n*-element vector corresponding to the function's minimum value. If a minimum within the given tolerance is not found within the specified number of iterations, AMOEBA returns a scalar value of -1. Results are returned with the same precision (single- or double-precision floating-point) as is returned by the user-supplied function to be minimized.

This routine is written in the IDL language. Its source code can be found in the file `amoeba.pro` in the `lib` subdirectory of the IDL distribution. AMOEBA is based on the routine `amoeba` described in section 10.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = AMOEBA(*Ftol* [, FUNCTION_NAME=*string*]
[, FUNCTION_VALUE=*variable*] [, NCALLS=*value*] [, NMAX=*value*]
[, P0=*vector*, SCALE=*vector* | , SIMPLEX=*array*])

Arguments

Ftol

The fractional tolerance to be achieved in the function value—that is, the fractional decrease in the function value in the terminating step. If the function you supply returns a single-precision result, *Ftol* should never be less than your machine's floating-point precision—the value contained in the EPS field of the structure returned by the MACHAR function. If the function you supply returns a double-precision floating-point value, Ftol should not be less than your machine' double-precision floating-point precision. See MACHAR for details.

Keywords

FUNCTION_NAME

Set this keyword equal to a string containing the name of the function to be minimized. If this keyword is omitted, AMOEBA assumes that an IDL function named “FUNC” is to be used.

The function to be minimized must be written as an IDL function and compiled prior to calling AMOEBA. This function must accept an *n*-element vector as its only parameter and return a scalar single- or double precision floating-point value as its result.

See the *Example* section below for an example function.

FUNCTION_VALUE

Set this keyword equal to a named variable that will contain an (*n*+1)-element vector of the function values at the simplex points. The first element contains the function minimum.

NCALLS

Set this keyword equal to a named variable that will contain a count of the number of times the function was evaluated.

NMAX

Set this keyword equal to a scalar value specifying the maximum number of function evaluations allowed before terminating. The default is 5000.

P0

Set this keyword equal to an *n*-element single- or double-precision floating-point vector specifying the initial starting point. Note that if you specify P0, you must also specify SCALE.

For example, in a 3-dimensional problem, if the initial guess is the point [0,0,0], and you know that the function’s minimum value occurs in the interval:

```
-10 < X[0] < 10, -100 < X[1] < 100, -200 < X[(2] < 200,
```

specify: P0=[0,0,0] and SCALE=[10, 100, 200].

Alternately, you can omit P0 and SCALE and specify SIMPLEX.

SCALE

Set this keyword equal to a scalar or *n*-element vector containing the problem's characteristic length scale for each dimension. SCALE is used with P0 to form an initial (*n*+1) point simplex. If all dimensions have the same scale, set SCALE equal to a scalar.

If SCALE is specified as a scalar, the function's minimum lies within a distance of SCALE from P0. If SCALE is an N-dimensional vector, the function's minimum lies within the Ndim+1 simplex with the vertices P0, P0 + [1,0,...,0] * SCALE, P0 + [0,1,0,...,0] * SCALE, ..., and P0+[0,0,...,1] * SCALE.

SIMPLEX

Set this keyword equal to an *n* by *n*+1 single- or double-precision floating-point array containing the starting simplex. After AMOEBA has returned, the SIMPLEX array contains the simplex enclosing the function minimum. The first point in the array, SIMPLEX[*,0], corresponds to the function's minimum. This keyword is ignored if the P0 and SCALE keywords are set.

Example

Use AMOEBA to find the slope and intercept of a straight line that fits a given set of points, minimizing the maximum error. The function to be minimized (FUNC, in this case) returns the maximum error, given p[0] = intercept, and p[1] = slope.

```
; First define the function FUNC:
FUNCTION FUNC, P
COMMON FUNC_XY, X, Y
RETURN, MAX(ABS(Y - (P[0] + P[1] * X)))
END

; Put the data points into a common block so they are accessible to
; the function:
COMMON FUNC_XY, X, Y

; Define the data points:
X = FINDGEN(17)*5
Y = [ 12.0,  24.3,  39.6,  51.0,  66.5,  78.4,  92.7, 107.8, $
    120.0, 135.5, 147.5, 161.0, 175.4, 187.4, 202.5, 215.4, 229.9]

; Call the function. Set the fractional tolerance to 1 part in
; 10^5, the initial guess to [0,0], and specify that the minimum
; should be found within a distance of 100 of that point:
R = AMOEBA(1.0e-5, SCALE=1.0e2, P0 = [0, 0], FUNCTION_VALUE=fval)

; Check for convergence:
```

```
IF N_ELEMENTS(R) EQ 1 THEN MESSAGE, 'AMOEBA failed to converge'

; Print results:
PRINT, 'Intercept, Slope:', r, $
       'Function value (max error): ', fval[0]
```

IDL prints:

```
Intercept, Slope:      11.4100      2.72800
Function value:       1.33000
```

See Also

POWELL

ANNOTATE

The ANNOTATE procedure starts an IDL widget program that allows you to interactively annotate images and plots with text and drawings. Drawing objects include lines, arrows, polygons, rectangles, circles, and ellipses. Annotation files can be saved and restored, and annotated displays can be written to TIFF or PostScript files. The Annotation widget will work on any IDL graphics window or draw widget.

This routine is written in the IDL language. Its source code can be found in the file `annotate.pro` in the `lib` subdirectory of the IDL distribution.

Using the Annotation Widget

Before calling the Annotation widget, plot or display your data in an IDL graphics window or draw widget. Unless you specify otherwise (using the DRAWABLE or WINDOW keywords), annotations will be made in the current graphics window.

For information on using the Annotation widget, click on the widget's "Help" button.

Syntax

ANNOTATE [, COLOR_INDICES=*array*] [, DRAWABLE=*widget_id* | , WINDOW=*index*] [, LOAD_FILE=*filename*] [/TEK_COLORS]

Arguments

This procedure has no required arguments.

Keywords

COLOR_INDICES

An array of color indices from which the user can choose colors. For example, to allow the user to choose 10 colors, spread evenly over the available indices, set the keyword as follows:

```
COLOR_INDICES = INDGEN(10) * (!D.N_COLORS-1) / 9
```

If neither TEK_COLORS or COLOR_INDICES are specified, the default is to load 10 colors, evenly distributed over those available.

DRAWABLE

The widget ID of the draw widget for the annotations. Do not set both DRAWABLE and WINDOW. If neither WINDOW or DRAWABLE are specified, the current window is used.

LOAD_FILE

The name of an annotation format file to load after initialization.

TEK_COLORS

Set this keyword and the Tektronix color table is loaded starting at color index TEK_COLORS(0), with TEK_COLORS(1) color indices. The Tektronix color table contains up to 32 distinct colors suitable for graphics. If neither TEK_COLORS or COLOR_INDICES are specified, the default is to load 10 colors, evenly distributed over those available.

WINDOW

The window index number of the window to receive the annotations. Do not set both DRAWABLE and WINDOW. If neither WINDOW or DRAWABLE are specified, the current window is used.

Example

```
; Output an image in the current window:
TVSCL, HANNING(300,200)
; Annotate it:
ANNOTATE
```

See Also

PLOTS, XYOUTS

ARG_PRESENT

The ARG_PRESENT function returns a nonzero value if the following conditions are met:

- The argument to ARG_PRESENT was passed as a plain or keyword argument to the current routine by its caller, and
- The argument to ARG_PRESENT is a named variable into which a value will be copied when the current routine exits.

In other words, ARG_PRESENT returns TRUE if the value of the specified variable will be passed back to the caller. This function is useful in user-written procedures that need to know if the lifetime of a value they are creating extends beyond the current routine's lifetime. This can be important for two reasons:

1. To avoid expensive computations that the caller is not interested in.
2. To prevent heap variable leakage that would result if the routine creates pointers or object references and assigns them to arguments that are *not* passed back to the caller.

Syntax

Result = ARG_PRESENT(*Variable*)

Arguments

Variable

The variable to be tested.

Example

Suppose that you are writing an IDL procedure that has the following procedure definition line:

```
PRO myproc, RET_PTR = ret_ptr
```

The intent of the RET_PTR keyword is to pass back a pointer to a new pointer heap variable. The following command could be used to avoid creating (and possibly losing) a pointer if no named variable is provided by the caller:

```
IF ARG_PRESENT(ret_ptr) THEN BEGIN
```

The commands that follow would only be executed if `ret_ptr` is supplied and will be copied into a variable in the scope of the calling routine.

See Also

KEYWORD_SET, N_ELEMENTS, N_PARAMS

ARRAY_EQUAL

The ARRAY_EQUAL function is a fast way to compare data for equality in situations where the index of the elements that differ are not of interest. This operation is much faster than using TOTAL(A NE B), because it stops the comparison as soon as the first inequality is found, an intermediate array is not created, and only one pass is made through the data. For best speed, ensure that the operands are of the same data type.

Arrays may be compared to scalars, in which case each element is compared to the scalar. For two arrays to be equal, they must have the same number of elements. If the types of the operands differ, the type of the least precise is converted to that of the most precise, unless the NO_TYPECONV keyword is specified to prevent it. This function works on all numeric types and strings.

Syntax

Result = ARRAY_EQUAL(*Op1* , *Op2* [, /NO_TYPECONV])

Return Value

Returns 1 (true) if, and only if, all elements of *Op1* are equal to *Op2*; returns 0 (false) at the first instance of inequality.

Arguments

Op1, Op2

The variables to be compared.

Keywords

NO_TYPECONV

By default, ARRAY_EQUAL converts operands of different types to a common type before performing the equality comparison. Set NO_TYPECONV to disallow this implicit type conversion. If NO_TYPECONV is specified, operands of different types are never considered to be equal, even if their numeric values are the same.

Example

```
; Return True (1) if all elements of a are equal to a 0 byte:
IF ARRAY_EQUAL(a, 0b) THEN ...
; Return True (1) if all elements of a are equal all elements of b:
IF ARRAY_EQUAL(a, b) THEN ...
```

ARROW

The ARROW procedure draws one or more vectors with arrow heads.

This routine is written in the IDL language. Its source code can be found in the file `arrow.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

ARROW, *X0*, *Y0*, *X1*, *Y1* [, /DATA | , /NORMALIZED] [, HSIZE=*length*] [, COLOR=*index*] [, HTHICK=*value*] [, /SOLID] [, THICK=*value*]

Arguments

X0, Y0

Arrays or scalars containing the coordinates of the tail end of the vector or vectors. Coordinates are in DEVICE coordinates unless otherwise specified.

X1,Y1

Arrays or scalars containing the coordinates of the arrowhead end of the vector or vectors. *X1* and *Y1* must have the save number of elements as *X0* and *Y0*.

Keywords

DATA

Set this keyword if vector coordinates are DATA coordinates.

NORMALIZED

Set this keyword if vector coordinates are NORMALIZED coordinates.

HSIZE

Use this keyword to set the length of the lines used to draw the arrowhead. The default is 1/64th the width of the display (!D.X_SIZE / 64.). If the HSIZE is positive, the value is assumed to be in device coordinate units. If HSIZE is negative, the arrowhead length is set to the vector length * ABS(HSIZE). The lines are separated by 60 degrees to make the arrowhead.

COLOR

The color of the arrow. The default is the highest color index.

HTHICK

The thickness of the arrowheads. The default is 1.0.

SOLID

Set this keyword to make a solid arrow, using polygon fills, looks better for thick arrows.

THICK

The thickness of the body. The default is 1.0.

Examples

Draw an arrow from (100,150) to (300,350) in DEVICE units:

```
ARROW, 100, 150, 300, 350
```

Draw a sine wave with arrows from the line Y = 0 to SIN(X/4):

```
X = FINDGEN(50)
Y = SIN(x/4)
PLOT, X, Y
ARROW, X, REPLICATE(0,50), X, Y, /DATA
```

See Also

ANNOTATE, PLOTS, VELOVECT

ASCII_TEMPLATE

The ASCII_TEMPLATE function presents a graphical user interface (GUI) which generates a template defining an ASCII file format. Templates are IDL structure variables that may be used when reading ASCII files with the READ_ASCII routine. See READ_ASCII for details on reading ASCII files.

This routine is written in the IDL language. Its source code can be found in the file `ascii_template.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = ASCII_TEMPLATE([*Filename*] [, BROWSE_LINES=*lines*] [, CANCEL=*variable*] [, GROUP=*widget_id*])

Arguments

Filename

A string containing the name of a file to base the template on. If *Filename* is not specified, a dialog allows you to choose a file.

Keywords

BROWSE_LINES

Set this keyword equal to the number of lines that will be read in at a time when the "Browse" button is selected. The default is 50 lines.

CANCEL

Set this keyword to a named variable that will contain the byte value 1 if the user clicked the "Cancel" button, or 0 otherwise.

GROUP

The widget ID of an existing widget that serves as "group leader" for the ASCII_TEMPLATE graphical user interface. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

Example

Use the following command to generate a template structure from the file "myFile":

```
myTemplate = ASCII_TEMPLATE(myFile)
```

See Also

READ_ASCII, BINARY_TEMPLATE

ASIN

The ASIN function returns the angle, expressed in radians, whose sine is *X* (i.e., the arc-sine). The range of ASIN is between -π/2 and π/2. Rules for the type and structure of the result are the same as those given for the ACOS function.

Syntax

Result = ASIN(*X*)

Arguments

X

The sine of the desired angle, -1 ≤ *X* ≤ 1.

Example

To print the arc-sine of 0.707, enter:

```
PRINT, ASIN(0.707)
```

IDL prints:

```
0.785247
```

See Also

SIN

ASSOC

The ASSOC function associates an array structure with a file. It provides a basic method of random access input/output in IDL. An *associated variable*, which stores this association, is created by assigning the result of ASSOC to a variable. This variable provides a means of mapping a file into vectors or arrays of a specified type and size.

Note

Unformatted data files generated by FORTRAN programs under UNIX contain an extra long word before and after each logical record in the file. ASSOC does not interpret these extra bytes but considers them to be part of the data. This is true even if the F77_UNFORMATTED keyword is specified in the OPEN statement. Therefore, ASSOC should not be used with such files. Instead, such files should be processed using READU and WRITEU. An example of using IDL to read such data is given in "Using Unformatted Input/Output" in Chapter 8 of *Building IDL Applications*.

Note

Associated file variables cannot be used for output with files opened using the COMPRESS keyword to OPEN. This is due to the fact that it is not possible to move the current file position backwards in a compressed file that is currently open for writing. ASSOC is allowed with compressed files opened for input only. However, such operations may be slow due to the large amount of work required to change the file position in a compressed file.

Effective use of ASSOC requires the ability to rapidly position the file to arbitrary positions. In general, files that require random access may not be good candidates for compression. If this is necessary however, such files can be processed using READU and WRITEU.

Syntax

Result = ASSOC(*Unit*, *Array_Structure* [, *Offset*] [, /PACKED])

Arguments

Unit

The IDL file unit to associate with *Array_Structure*.

Array_Structure

An expression of the data type and structure to be associated with *Unit* are taken from *Array_Structure*. The actual value of *Array_Structure* is not used.

Offset

The offset in the file to the start of the data in the file. For stream files, and RMS (VMS) block mode files, this offset is given in bytes. For RMS record-oriented files, the offset is specified in records. Offset is useful for dealing with data files that contain a descriptive header block followed by the actual data.

Keywords

PACKED

When ASSOC is applied to structures, the default action is to map the actual definition of the structure for the current machine, including any holes required to properly align the fields. (IDL uses the same rules for laying out structures as the C language). If the PACKED keyword is specified, I/O using the resulting variable instead works in the same manner as READU and WRITEU, and data is moved one field at a time and there are no alignment gaps between the fields.

Example

Suppose that the file `images.dat` holds 5 images as 256-element by 256-element arrays of bytes. Open the file for reading and create an associated variable by entering:

```
OPENR, 1, 'images.dat' ;Open the file as file unit 1.
A = ASSOC(1, BYTARR(256, 256)) ;Make an associated variable.
```

Now A[0] corresponds to the first image in the file, A[1] is the second element, etc. To display the first image in the file, you could enter:

```
TV, A[0]
```

The data for the first image is read and then displayed. Note that the data associated with A[0] is not held in memory. It is read in every time there is a reference to A[0]. To store the image in the memory-resident array B, you could enter:

```
B = A[0]
```

See Also

OPEN, READU

ATAN

The ATAN function returns the angle, expressed in radians, whose tangent is *X* (i.e., the arc-tangent). If two parameters are supplied, the angle whose tangent is equal to *Y*/*X* is returned. The range of ATAN is between -π/2 and π/2 for the single argument case, and between -π and π if two arguments are given.

Syntax

Result = ATAN(*X*)

or

Result = ATAN(*Y*, *X*)

Arguments

X

The tangent of the desired angle.

Y

An optional argument. If this argument is supplied, ATAN returns the angle whose tangent is equal to *Y*/*X*. If both arguments are zero, the result is undefined.

Example

To find the arc-tangent of 0.707 and store the result in the variable B, enter:

```
B = ATAN(0.707)
```

The following code defines a function that converts Cartesian coordinates to polar coordinates. It returns “r” and “theta” given an “x” and “y” position:

```
;Define function TO_POLAR that accepts X and Y as arguments:
FUNCTION TO_POLAR, X, Y

;Return the distance and angle as a two-element array:
RETURN, [SQRT(X^2 + Y^2), ATAN(Y, X)]

END
```

See Also

TAN, TANH

AXIS

The AXIS procedure draws an axis of the specified type and scale at a given position. The new scale is saved for use by subsequent overplots if the SAVE keyword parameter is set. By default, AXIS draws an X axis. The XAXIS, YAXIS, and ZAXIS keywords can be used to select a specific axis type and position.

Syntax

AXIS [, *X* [, *Y* [, *Z*]]] [, /SAVE] [, XAXIS={0 | 1} | YAXIS={0 | 1} | ZAXIS={0 | 1 | 2 | 3}] [, /XLOG] [, /YNOZERO] [, /YLOG] [, /ZLOG]

Graphics Keywords: [, CHARSIZE=*value*] [, CHARTHICK=*integer*]
[, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*]
[, /NODATA] [, /NOERASE] [, SUBTITLE=*string*] [, /T3D] [, TICKLEN=*value*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left*, *right]*]
[, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}RANGE=*[min*, *max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

Arguments

X, Y, and Z

Scalars giving the starting coordinates of the new axis. If no coordinates are specified, the axis is drawn in its default position as given by the [XYZ]AXIS keyword. When drawing an X axis, the *X* coordinate is ignored, similarly the *Y* and *Z*

arguments are ignored when drawing their respective axes (i.e., new axes will always point in the correct direction).

Keywords

SAVE

Set this keyword to indicate that the scaling to and from data coordinates established by the call to AXIS is to be saved in the appropriate axis system variable, !X, !Y, or !Z. If this keyword is not present, the scaling is not changed.

XAXIS

Set this keyword to draw an X axis. If the *X* argument *is not* present, setting XAXIS equal to 0 draws an axis under the plot window with the tick marks pointing up, and setting XAXIS equal to one draws an axis above the plot window with the tick marks pointing down. If the *X* argument *is* present, the X axis is positioned accordingly, and setting XAXIS equal to 0 or 1 causes the tick marks to point up or down, respectively.

XLOG

Set this keyword to specify a logarithmic X axis

YAXIS

Set this keyword to draw a Y axis. If the *Y* argument *is not* present, setting YAXIS equal to 0 draws an axis on the left side of the plot window with the tick marks pointing right, and setting YAXIS equal to one draws an axis on the right side of the plot window with the tick marks pointing left. If the *Y* argument *is* present, the Y axis is positioned accordingly, and setting YAXIS equal to 0 or 1 causes the tick marks to point right or left, respectively.

Note

The YAXIS keyword must be specified in order use any Y* graphics keywords. See the note under "Graphics Keywords Accepted" on page 93 for more information.

YLOG

Set this keyword to specify a logarithmic Y axis.

YNOZERO

Set this keyword to inhibit setting the minimum Y axis value to zero when the Y data are all positive and non-zero, and no explicit minimum Y value is specified (using

YRANGE, or !Y.RANGE). By default, the Y axis spans the range of 0 to the maximum value of Y, in the case of positive Y data. Set bit 4 in !Y.STYLE to make this option the default.

ZAXIS

Set this keyword to draw a Z axis. If the *Z* argument is *not* present, setting ZAXIS has the following meanings:

- 0 = lower (front) right, with tickmarks pointing left
- 1 = lower (front) left, with tickmarks pointing right
- 2 = upper (back) left, with tickmarks pointing right
- 3 = upper (back) right, with tickmarks pointing left

If the *Z* argument *is* present, the Z axis is positioned accordingly, and setting ZAXIS equal to 0 or 1 causes the tick marks to point left or right, respectively.

Note that AXIS uses the 3D plotting transformation stored in the system variable field !P.T.

Note

The ZAXIS keyword must be specified in order use any Z* graphics keywords. See the note under Graphics Keywords Accepted for more information.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above.

Note

In order for the Y* or Z* graphics keywords to work with the AXIS procedure, the corresponding YAXIS or ZAXIS keyword must be specified. For example, the following code will *not* draw a title for the Y axis:

```
AXIS, YTITLE ='Y-axis Title'
```

To use the YTITLE graphics keyword, you must specify the YAXIS keyword to AXIS:

```
AXIS, YAXIS = 0, YTITLE ='Y-axis Title'
```

Because the AXIS procedure draws an X axis by default, it is not necessary to specify the XAXIS keyword in order to use the X* graphics keywords.

CHARSIZE, CHARTHICK, COLOR, DATA, DEVICE, FONT, NODATA, NOERASE, NORMAL, SUBTITLE, T3D, TICKLEN, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

Example

The following example shows how the AXIS procedure can be used with normal or polar plots to draw axes through the origin, dividing the plot window into four quadrants:

```
; Make the plot, polar in this example, and suppress the X and Y
; axes using the XSTYLE and YSTYLE keywords:
PLOT, /POLAR, XSTYLE=4, YSTYLE=4, TITLE='Polar Plot', r, theta

; Draw an X axis, through data Y coordinate of 0. Because the XAXIS
; keyword parameter has a value of 0, the tick marks point down:
AXIS,0,0,XAX=0,/DATA

; Similarly, draw the Y axis through data X = 0. The tick marks
; point left:
AXIS,0,0,0,YAX=0,/DATA
```

See Also

LABEL_DATE, PLOT

BAR_PLOT

The BAR_PLOT procedure creates a bar graph. This routine is written in the IDL language. Its source code can be found in the file `bar_plot.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

BAR_PLOT, *Values* [, BACKGROUND=*color_index*] [, BARNAMES=*string_array*] [, BAROFFSET=*scalar*] [, BARSPACE=*scalar*] [, BARWIDTH=*value*] [, BASELINES=*vector*] [, BASERANGE=*scalar*{0.0 to 1.0}] [, COLORS=*vector*] [, /OUTLINE] [, /OVERPLOT] [, /ROTATE] [, TITLE=*string*] [, XTITLE=*string*] [, YTITLE=*string*]

Arguments

Values

A vector containing the values to be represented by the bars. Each element in *Values* corresponds to a single bar in the output.

Keywords

BACKGROUND

A scalar that specifies the color index to be used for the background color. By default, the normal IDL background color is used.

BARNAMES

A string array, containing one string label per bar. If the bars are vertical, the labels are placed beneath them. If horizontal (rotated) bars are specified, the labels are placed to the left of the bars.

BAROFFSET

A scalar that specifies the offset to be applied to the first bar, in units of “nominal bar width”. This keyword allows, for example, different groups of bars to be overplotted on the same graph. If not specified, the default offset is equal to BARSPACE.

BARSPACE

A scalar that specifies, in units of “nominal bar width”, the spacing between bars. For example, if BARSPACE is 1.0, then all bars will have one bar-width of space between them. If not specified, the bars are spaced apart by 20% of the bar width.

BARWIDTH

A floating-point value that specifies the width of the bars in units of “nominal bar width”. The nominal bar width is computed so that all the bars (and the space between them, set by default to 20% of the width of the bars) will fill the available space (optionally controlled with the BASERANGE keyword).

BASELINES

A vector, the same size as *Values*, that contains the base value associated with each bar. If not specified, a base value of zero is used for all bars.

BASERANGE

A floating-point scalar in the range 0.0 to 1.0, that determines the fraction of the total available plotting area (in the direction perpendicular to the bars) to be used. If not specified, the full available area is used.

COLORS

A vector, the same size as *Values*, containing the color index to be used for each bar. If not specified, the colors are selected based on spacing the color indices as widely as possible within the range of available colors (specified by !D.N_COLORS).

OUTLINE

If set, this keyword specifies that an outline should be drawn around each bar.

OVERPLOT

If set, this keyword specifies that the bar plot should be overplotted on an existing graph.

ROTATE

If set, this keyword indicates that horizontal rather than vertical bars should be drawn. The bases of horizontal bars are on the left, “Y” axis and the bars extend to the right.

TITLE

A string containing the main title for the bar plot.

XTITLE

A string containing the title for the X axis.

YTITLE

A string containing the title for the Y axis.

Example

By using the overplotting capability, it is relatively easy to create stacked bar charts, or different groups of bars on the same graph.

The following example creates a two-dimensional array of 5 columns and 8 rows, and creates a plot with 5 bars, each of which is a “stacked” composite of 8 sections.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Load color table:
LOADCT, 5

;Make axes black:
!P.COLOR=0

;Create 5-column by 8-row array:
array = INDGEN(5,8)

;Create a 2D array, equal in size to array, that has identical
;color index values across each row to ensure that the same item is
;represented by the same color in all bars:
colors = INTARR(5,8)
FOR I = 0, 7 DO colors[*,I]=(20*I)+20

;With arrays and colors defined, create stacked bars (note that
;the number of rows and columns is arbitrary):

;Scale range to accommodate the total bar lengths:
!Y.RANGE = [0, MAX(array)]
nrows = N_ELEMENTS(array[0,*])
base = INTARR(nrows)
FOR I = 0, nrows-1 DO BEGIN
   BAR_PLOT, array[*,I], COLORS=colors[*,I], BACKGROUND=255, $
      BASELINES=base, BARWIDTH=0.75, BARSPACE=0.25, OVER=(I GT 0)
   base = array[*,I]
ENDFOR

;To plot each row of array as a clustered group of bars within the
;same graph, use the BASERANGE keyword to restrict the available
```

```
;plotting region for each set of bars, where NCOLS is the number of
;columns in array. (In this example, each group uses the same set
;of colors, but this could easily be changed.):

ncols = N_ELEMENTS(array[*,0])
FOR I = 0, nrows-1 DO BEGIN
   BAR_PLOT, array[*,I], COLORS=colors[*,I], BACKGROUND=255, $
      BARWIDTH=0.75, BARSPACE=0.25, BAROFFSET=I*(1.4*ncols), $
      OVER=(I GT 0), BASERANGE=0.12
ENDFOR
```

See Also

PLOT, PSYM Graphics Keyword

BEGIN...END

The BEGIN...END statement defines a block of statements. A block of statements is a group of statements that is treated as a single statement. Blocks are necessary when more than one statement is the subject of a conditional or repetitive statement. For more information on using BEGIN...END and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

BEGIN

statements

END | ENDIF | ENDELSE | ENDFOR | ENDREP | ENDWHILE

The END identifier used to terminate the block should correspond to the type of statement in which BEGIN is used. The following table lists the correct END identifiers to use with each type of statement.

Statement	END Identifier	Example

ELSE BEGIN	ENDELSE	`IF (0) THEN A=1 ELSE BEGIN`
		`  A=2`
		`ENDELSE`

FOR *variable=init*, *limit* DO BEGIN	ENDFOR	`FOR i=1,5 DO BEGIN`
		`  PRINT, array[i]`
		`ENDFOR`

IF *expression* THEN BEGIN	ENDIF	`IF (0) THEN BEGIN`
		`  A=1`
		`ENDIF`

REPEAT BEGIN	ENDREP	`REPEAT BEGIN`
		`  A = A * 2`
		`ENDREP UNTIL A GT B`

WHILE *expression* DO BEGIN	ENDWHILE	`WHILE NOT EOF(1) DO BEGIN`
		`  READF, 1, A, B, C`
		`ENDWHILE`

LABEL: BEGIN	END	`LABEL1: BEGIN`
		`  PRINT, A`
		`END`

Table 3: Types of END Identifiers

Statement	END Identifier	Example

case_expression: BEGIN	END	`CASE name OF`
		`'Moe': BEGIN`
		`  PRINT, 'Stooge'`
		`  END`
		`ENDCASE`

switch_expression: BEGIN	END	`SWITCH name OF`
		`'Moe': BEGIN`
		`  PRINT, 'Stooge'`
		`  END`
		`ENDSWITCH`

Table 3: Types of END Identifiers

Note

CASE and SWITCH also have their own END identifiers. CASE should always be ended with ENDCASE, and SWITCH should always be ended with ENDSWITCH.

BESELI

The BESELI function returns the I Bessel function of order *N* for the argument *X*. The BESELI function is adapted from "SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers", W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

Syntax

Result = BESELI(*X*, *N*)

Return Value

If *X* is double-precision, the result is double precision, otherwise the argument is converted to floating-point and the result is floating-point.

Arguments

X

The expression for which the I Bessel function is required. The result will have the same dimensions as *X*.

N

The order of the I Bessel function to calculate. *N* should be greater than or equal to 0 and less than 20, and can be either an integer or a real number.

Keywords

None

Example

The following example plots the I and K Bessel functions for orders 0, 1 and 2:

```
X = FINDGEN(40)/10

;Plot I and K Bessel Functions:
PLOT, X, BESELI(X, 0), MAX_VALUE=4, $
   TITLE = 'I and K Bessel Functions'
OPLOT, X, BESELI(X, 1)
OPLOT, X, BESELI(X, 2)
OPLOT, X, BESELK(X, 0), LINESTYLE=2
OPLOT, X, BESELK(X, 1), LINESTYLE=2
```

```
OPLOT, X, BESELK(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [.18, .45, .95, 1.4, 1.8, 2.4]
ycoords = [2.1, 2.1,  2.1, 1.8, 1.6, 1.4]
labels = ['!8K!X!D0','!8K!X!D1','!8K!X!D2','!8I!X!D0',
   '!8I!X!D1','!8I!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

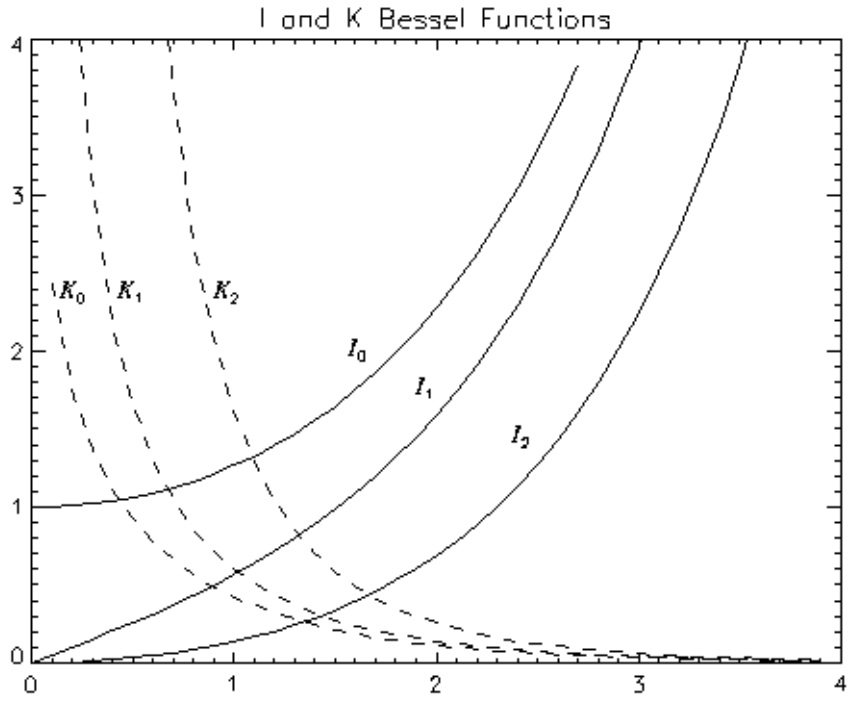


Figure 1: I and K Bessel Functions.

See Also

BESELJ, BESELK, BESELY

BESELJ

The BESELJ function returns the J Bessel function of order *N* for the argument *X*. The BESELJ function is adapted from "SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers", W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

Syntax

Result = BESELJ(*X*, *N*)

Return Value

If *X* is double-precision, the result is double precision, otherwise the argument is converted to floating-point and the result is floating-point.

Arguments

X

The expression for which the J Bessel function is required. The result has the same dimensions as *X*.

N

The order of the J Bessel function to calculate. *N* should be greater than or equal to 0 and less than 20, and can be either an integer or a real number.

Keywords

None

Example

The following example plots the J and Y Bessel functions for orders 0, 1, and 2:

```
X = FINDGEN(100)/10

;Plot J and Y Bessel Functions:
PLOT, X, BESELJ(X, 0), TITLE = 'J and Y Bessel Functions'
OPLOT, X, BESELJ(X, 1)
OPLOT, X, BESELJ(X, 2)
OPLOT, X, BESELY(X, 0), LINESTYLE=2
OPLOT, X, BESELY(X, 1), LINESTYLE=2
OPLOT, X, BESELY(X, 2), LINESTYLE=2
```

```
;Annotate plot:
xcoords = [1, 1.66, 3, .7, 1.7, 2.65]
ycoords = [.8, .62,.52, -.42, -.42, -.42]
labels = ['!8J!X!D0','!8J!X!D1','!8J!X!D2','!8Y!X!D0',
   '!8Y!X!D1','!8Y!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

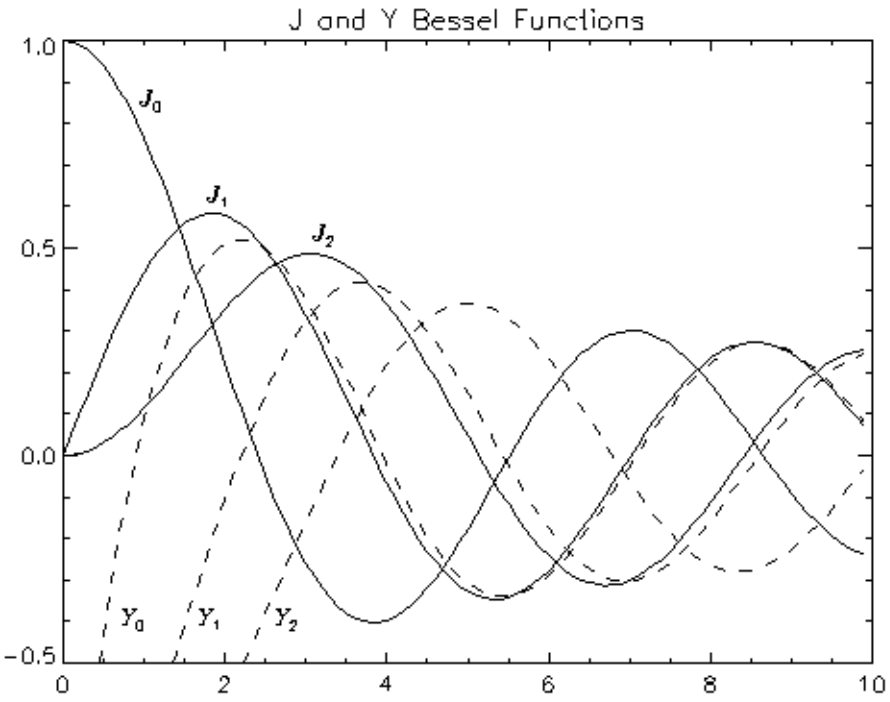


Figure 2: The J and Y Bessel Functions.

See Also

BESELI, BESELK, BESELY

BESELK

The BESELK function returns the K Bessel function of order *N* for the argument *X*. The BESELK function is adapted from "SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers", W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

Syntax

Result = BESELK(*X*, *N*)

Return Value

If *X* is double-precision, the result is double precision, otherwise the argument is converted to floating-point and the result is floating-point.

Arguments

X

The expression for which the K Bessel function is required. The result will have the same dimensions as *X*.

N

The order of the K Bessel function to calculate. *N* should be greater than or equal to 0 and less than 20, and can be either an integer or a real number.

Keywords

None

Example

The following example plots the I and K Bessel functions for orders 0, 1 and 2:

```
X = FINDGEN(40)/10

;Plot I and K Bessel Functions:
PLOT, X, BESELI(X, 0), MAX_VALUE=4, $
   TITLE = 'I and K Bessel Functions'
OPLOT, X, BESELI(X, 1)
OPLOT, X, BESELI(X, 2)
OPLOT, X, BESELK(X, 0), LINESTYLE=2
OPLOT, X, BESELK(X, 1), LINESTYLE=2
```

```
OPLOT, X, BESELK(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [.18, .45, .95, 1.4, 1.8, 2.4]
ycoords = [2.1, 2.1,  2.1, 1.8, 1.6, 1.4]
labels = ['!8K!X!D0','!8K!X!D1','!8K!X!D2','!8I!X!D0',
   '!8I!X!D1','!8I!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

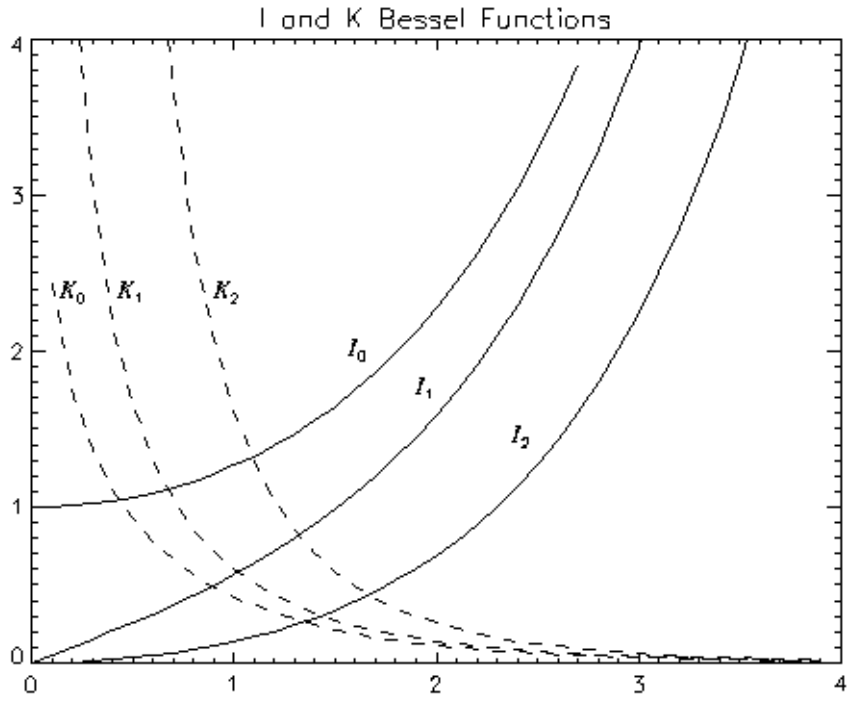


Figure 3: I and K Bessel Functions.

See Also

BESELI, BESELJ, BESELY

BESELY

The BESELY function returns the Y Bessel function of order *N* for the argument *X*. The BESELY function is adapted from "SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers", W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

Syntax

Result = BESELY(*X*, *N*)

Return Value

If *X* is double-precision, the result is double precision, otherwise the argument is converted to floating-point and the result is floating-point.

Arguments

X

The expression for which the Y Bessel function is required. *X* must be greater than 0. The result has the same dimensions as *X*.

N

The order of the Y Bessel function to calculate. *N* should be greater than or equal to 0 and less than 20, and can be either an integer or a real number.

Keywords

None.

Example

The following example plots the J and Y Bessel functions for orders 0, 1, and 2:

```
X = FINDGEN(100)/10

;Plot J and Y Bessel Functions:
PLOT, X, BESELJ(X, 0), TITLE = 'J and Y Bessel Functions'
OPLOT, X, BESELJ(X, 1)
OPLOT, X, BESELJ(X, 2)
OPLOT, X, BESELY(X, 0), LINESTYLE=2
OPLOT, X, BESELY(X, 1), LINESTYLE=2
OPLOT, X, BESELY(X, 2), LINESTYLE=2
```

```
;Annotate plot:
xcoords = [1, 1.66, 3, .7, 1.7, 2.65]
ycoords = [.8, .62,.52, -.42, -.42, -.42]
labels = ['!8J!X!D0','!8J!X!D1','!8J!X!D2','!8Y!X!D0',
   '!8Y!X!D1','!8Y!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

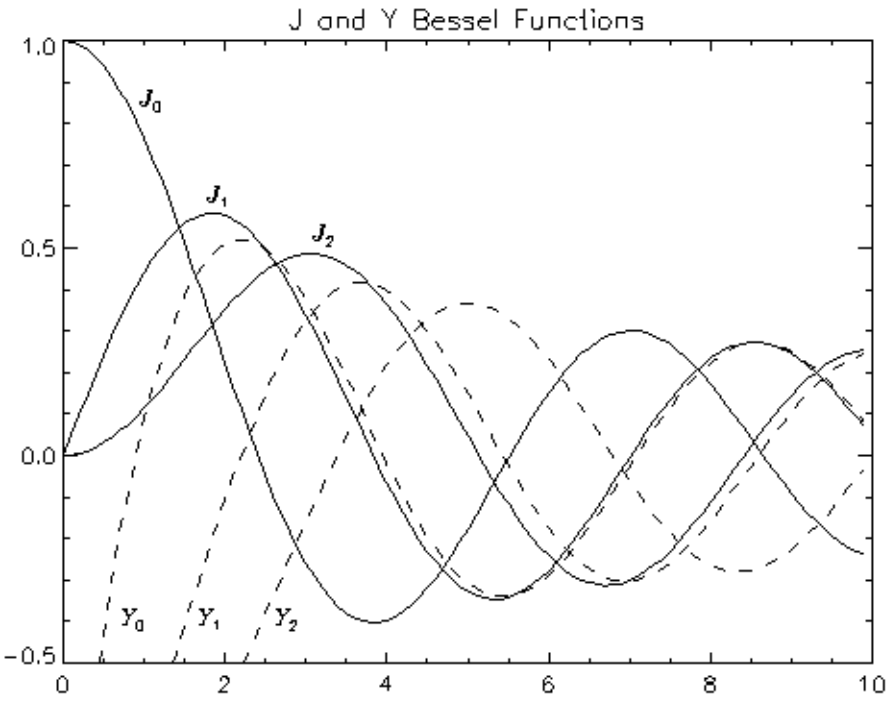


Figure 4: The J and Y Bessel Functions.

See Also

BESELI, BESELJ, BESELK

BETA

The BETA function returns the value of the beta function B(*Z, W*). This routine is written in the IDL language. Its source code can be found in the file `beta.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = BETA(*Z*, *W* [, /DOUBLE])

Arguments

Z, W

The point at which the beta function is to be evaluated. *Z* and *W* can be scalar or array.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To evaluate the beta function at the point (1.0, 1.1) and print the result:

```
PRINT, BETA(1.0, 1.1)
```

IDL prints:

```
0.909091
```

The exact solution is:

((1.00 * .95135077) / (1.10 * .95135077)) = 0.909091.

See Also

GAMMA, IBETA, IGAMMA, LNGAMMA

BILINEAR

The BILINEAR function uses a bilinear interpolation algorithm to compute the value of a data array at each of a set of subscript values. The function returns a two-dimensional interpolated array of the same type as the input array.

This routine is written in the IDL language. Its source code can be found in the file `bilinear.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = BILINEAR(*P, IX, JY*)

Arguments

P

A two-dimensional data array.

IX and JY

Arrays containing the X and Y "virtual subscripts" of *P* for which to interpolate values. *IX* and *JY* can be either of the following:

- One-dimensional, *n*-element floating-point arrays of subscripts to look up in *P*. One-dimensional arrays will be converted to two-dimensional arrays in such a way that *IX* contains *n* identical rows and *JY* contains *n* identical columns.
- Two-dimensional, *n*-element floating-point arrays that uniquely specify the X subscripts (the *IX* array) and the Y subscripts (the *JY* array) of the points to be computed from the input array *P*.

In either case, *IX* must satisfy the expressions

```
0 <= MIN(IX) < N0  and 0 < MAX(IX) <= N0
```

where `N0` is the total number of columns in the array *P*. *JY* must satisfy the expressions

```
0 <= MIN(JY) < M0  and 0 < MAX(JY) <= M0
```

where `M0` is the total number of rows in the array *P*.

It is better to use two-dimensional arrays for *IX* and *JY* because the algorithm is somewhat faster. If *IX* and *JY* are specified as one-dimensional, the returned two-

dimensional arrays *IX* and *JY* can be re-used on subsequent calls to take advantage of the faster 2D algorithm.

Example

Create a 3 x 3 floating point array *P*:

```
P = FINDGEN(3,3)
```

Suppose we wish to find the value of a point half way between the first and second elements of the first row of *P*. Create the subscript arrays *IX* and *JY*:

```
IX = 0.5 ;Define the X subscript.
JY = 0.0 ;Define the Y subscript.
Z = BILINEAR(P, IX, JY) ;Interpolate.
PRINT, Z ;Print the value at the point IX,JY within P.
```

IDL prints:

```
0.500000
```

Suppose we wish to find the values of a 2 x 2 array of points in *P*. Create the subscript arrays *IX* and *JY*:

```
IX = [[0.5, 1.9], [1.1, 2.2]] ;Define the X subscripts.
JY = [[0.1, 0.9], [1.2, 1.8]] ;Define the Y subscripts.
Z = BILINEAR(P, IX, JY) ;Interpolate.
PRINT, Z ;Print the array of values.
```

IDL prints:

```
0.800000    4.60000
4.70000     7.40000
```

See Also

INTERPOL, INTERPOLATE, KRIG2D

BIN_DATE

The BIN_DATE function converts a standard form ASCII date/time string to a binary string. The function returns a six-element integer array where:

- Element 0 is the year (e.g., 1994)
- Element 1 is the month (1-12)
- Element 2 is the day (1-31)
- Element 3 is the hour (0-23)
- Element 4 is minutes (0-59)
- Element 5 is seconds (0-59)

This routine is written in the IDL language. Its source code can be found in the file `bin_date.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = BIN_DATE(*Ascii_Time*)

Arguments

Ascii_Time

A string containing the date/time to convert in standard ASCII format. If this argument is omitted, the current date/time is used. Standard form is a 24 character string:

```
DOW MON DD HH:MM:SS YYYY
```

where DOW is the day of the week, MON is the month, DD is the day of month, HH:MM:SS is the time in hours, minutes, second, and YYYY is the year.

See Also

CALDAT, JULDAY, SYSTIME

BINARY_TEMPLATE

The BINARY_TEMPLATE function presents a graphical user interface which allows the user to interactively generate a template structure for use with READ_BINARY.

The graphical user interface allows the user to define one or more fields in the binary file. The file may be big, little, or native byte ordering.

Individual fields can be edited by the user to define the dimensionality and type of data to be read. Where necessary, fields can be defined in terms of other previously defined fields using IDL expressions. Fields can also be designated as “Verify”. When a file is read using a template with “Verify” fields, those fields will be checked against a user defined value supplied via the template.

Syntax

Template = BINARY_TEMPLATE ([*Filename*] [, CANCEL=*variable*] [, GROUP=*widget_id*] [, N_ROWS=*rows*] [, TEMPLATE=*variable*])

Arguments

Filename

A scalar string containing the name of a binary file which may be used to test the template. As the user interacts with the BINARY_TEMPLATE graphical user interface, the user’s input will be tested for correctness against the binary data in the file. If *filename* is not specified, a dialog allows the user to choose the file.

Keywords

CANCEL

Set this keyword to a named variable that will contain the byte value 1 if the user clicked the “Cancel” button, or 0 otherwise.

GROUP

The widget ID of an existing widget that serves as “group leader” for the BINARY_TEMPLATE interface. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

N_ROWS

Set this keyword to the number of rows to be visible in the BINARY_TEMPLATE's table of fields.

Note

The N_ROWS keyword is analogous to the WIDGET_TABLE and the Y_SCROLL_SIZE keywords.

TEMPLATE

Set this keyword to a named variable that will contain the template structure gererated by BINARY_TEMPLATE. This variable can then be specified for the TEMPLATE keyword to READ_BINARY.

Note

A greater than (">") or less than ("<") symbol can appear in the BINARY_TEMPLATE's "New Field" and the "Modify Field" dialogs where the offset value is displayed. The presence of either symbol indicates that the supplied offset value is "relative" from the end of the previous field or from the initial position in the file. Greater than means offset forward. Less than means offset backward. ">0" and "<0" are synonymous and mean "offset zero bytes". The user can delete these special symbols (thereby indicating that their corresponding offset value is not "relative") by typing over them in the "New Field" or "Modify Field" dialogs where the offset value is displayed.

See Also

READ_BINARY, ASCII_TEMPLATE

BINDGEN

The BINDGEN function returns a byte array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = BINDGEN(D_1, ...,D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create a four-element by four-element byte array, and store the result in the variable A, enter:

```
A = BINDGEN(4,4)
```

Each element in A holds the value of its one-dimensional subscript. That is, if you enter the command:

```
PRINT, A
```

IDL prints the result:

```
  0   1   2   3
  4   5   6   7
  8   9  10  11
 12  13  14  15
```

See Also

CINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

BINOMIAL

The BINOMIAL function computes the probability that in a cumulative binomial (Bernoulli) distribution, a random variable *X* is greater than or equal to a user-specified value *V*, given *N* independent performances and a probability of occurrence or success *P* in a single performance:

$$\text{Probability}(X \geq V) = \sum_{x=V}^{N} \frac{N!}{x!(N-x)!} P^{x} (1-P)^{(N-x)}$$

This routine is written in the IDL language. Its source code can be found in the file `binomial.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = BINOMIAL(*V*, *N*, *P* [, /DOUBLE] [, /GAUSSIAN])

Arguments

V

A non-negative integer specifying the minimum number of times the event occurs in *N* independent performances.

N

A non-negative integer specifying the number of performances.

P

A non-negative single- or double-precision floating-point scalar or array, in the interval [0.0, 1.0], that specifies the probability of occurrence or success of a single independent performance.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

GAUSSIAN

Set this keyword to use the Gaussian approximation, by using the normalized variable $Z = (V - NP)/\mathrm{SQRT}(NP(1 - P))$.

Note

The Gaussian approximation is useful when N is large and neither P nor $(1–P)$ is close to zero, where the binomial summation may overflow. If GAUSSIAN is not explicitly set, and the binomial summation overflows, then BINOMIAL will automatically switch to using the Gaussian approximation.

Examples

Compute the probability of obtaining at least two 6s in rolling a die four times. The result should be 0.131944.

```
result = BINOMIAL(2, 4, 1.0/6.0)
```

Compute the probability of obtaining exactly two 6s in rolling a die four times. The result should be 0.115741.

```
result = BINOMIAL(2, 4, 1./6.) - BINOMIAL(3, 4, 1./6.)
```

Compute the probability of obtaining three or fewer 6s in rolling a die four times. The result should be 0.999228.

```
result = BINOMIAL(0, 4, 1./6.) - BINOMIAL(4, 4, 1./6.)
```

See Also

CHISQR_PDF, F_PDF, GAUSS_PDF, T_PDF

BLAS_AXPY

The BLAS_AXPY procedure updates an existing array by adding a multiple of another array. It can also be used to update one or more one-dimensional subvectors of an array according to the following vector operation:

$$Y = aX + Y$$

where a is a scale factor and X is an input vector.

BLAS_AXPY can be faster and use less memory than the usual IDL array notation (e.g. `Y=Y+A*X`) for updating existing arrays.

Note

BLAS_AXPY is much faster when operating on entire arrays and rows, than when used on columns or higher dimensions.

Syntax

BLAS_AXPY, *Y*, *A*, *X* [, *D1*, *Loc1* [, *D2*, *Range*]]

Arguments

Y

The array to be updated. *Y* can be of any numeric type. BLAS_AXPY does not change the size and type of *Y*.

A

The scaling factor to be multiplied with *X*. *A* may be any scalar or one-element array that IDL can convert to the type of *X*. BLAS_AXPY does not change *A*.

X

The array to be scaled and added to array *Y*, or the vector to be scaled and added to subvectors of *Y*.

D1

An optional parameter indicating which dimension of *Y* is to be updated.

Loc1

A variable with the same number of elements as the number of dimensions of *Y*. The *Loc1* and *D1* arguments together determine which one-dimensional subvector (or subvectors, if *D1* and *Range* are provided) of *Y* is to be updated.

D2

An optional parameter, indicating in which dimension of *Y* a group of one-dimensional subvectors are to be updated. *D2* should be different from *D1*.

Range

A variable containing *D2* indices indicating where to put one-dimensional updates of *Y*.

Example

```
;A seed value needs to be defined:
seed = 5L

;Create a multidimensional array:
A = FINDGEN(40, 90, 10)

;Create a random update:
B = RANDOMU(seed, 40, 90, 10)

;Add a multiple of B to A.(i.e., A = A + 4.5*B ):
BLAS_AXPY, A, 4.5, B

;Add a constant to a subvector of A
;(i.e. A[*,4,9] = A[*,4,9] + 4.3):
BLAS_AXPY, A, 1., REPLICATE(4.3, 40), 1, [0,4,9]

;Create a vector update:
C = FINDGEN(90)

;Add C to a group of subvectors of A
;( i.e. A[ 9,*,*] = A[ 9,*,*] + C):
BLAS_AXPY, A, 1., C, 2, [9,0,0], 3, LINDGEN(10)
```

See Also

REPLICATE_INPLACE

BLK_CON

The BLK_CON function computes a “fast convolution” of a digital signal and an impulse-response sequence. It returns the filtered signal.

This routine is written in the IDL language. Its source code can be found in the file `blk_con.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = BLK_CON(*Filter*, *Signal* [, B_LENGTH=*scalar*] [, /DOUBLE])

Return Value

This function returns a vector with the same length as *Signal*. If either of the input arguments are double-precision or the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

Filter

A *P*-element floating-point vector containing the impulse-response sequence of the digital filter.

Signal

An *n*-element floating-point vector containing the discrete signal samples.

Keywords

B_LENGTH

A scalar specifying the *block length* of the subdivided signal segments. If this parameter is not specified, a near-optimal value is chosen by the algorithm based upon the length *P* of the impulse-response sequence. If *P* is a value less than 11 or greater than 377, then B_LENGTH must be specified.

B_LENGTH must be greater than the filter length, *P*, and less than the number of signal samples.

DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

Example

```
; Create a filter of length P = 32:
filter = REPLICATE(1.0,32);Set all points to 1.0
filter(2*INDGEN(16)) = 0.5;Set even points to 0.5

; Create a sampled signal with random noise:
signal = SIN((FINDGEN(1000)/35.0)^2.5)
noise = (RANDOMU(SEED,1000)-.5)/2.
signal = signal + noise

; Convolve the filter and signal using block convolution:
result = BLK_CON(filter, signal)
```

See Also

CONVOL

BOX_CURSOR

The BOX_CURSOR procedure emulates the operation of a variable-sized box cursor (also known as a “marquee” selector).

Warning

BOX_CURSOR does not function properly when used within a draw widget. See the BUTTON_EVENTS and MOTION_EVENTS keywords in WIDGET_DRAW.

This routine is written in the IDL language. Its source code can be found in the file `box_cursor.pro` in the `lib` subdirectory of the IDL distribution.

Using BOX_CURSOR

Once the box cursor has been realized, hold down the left mouse button to move the box by dragging. Hold down the middle mouse button to resize the box by dragging. (The corner nearest the initial mouse position is moved.) Press the right mouse button to exit the procedure and return the current box parameters.

On machines with only two mouse buttons, hold down the left and right buttons simultaneously to resize the box.

Syntax

BOX_CURSOR, [*X0*, *Y0*, *NX*, *NY* [, /INIT] [, /FIXED_SIZE]] [, /MESSAGE]

Arguments

X0, Y0

Named variables that will contain the coordinates of the lower left corner of the box cursor.

NX, NY

Named variables that will contain the width and height of the cursor, in pixels.

Keywords

INIT

If this keyword is set, the arguments *X0*, *Y0*, *NX*, and *NY* contain the initial position and size of the box.

FIXED_SIZE

If this keyword is set, *NX* and *NY* contain the initial size of the box. This size may not be changed by the user.

MESSAGE

If this keyword is set, IDL prints a message describing operation of the cursor.

See Also

Routines: CURSOR

Keywords to DEVICE: "CURSOR_CROSSHAIR" on page 2319, "CURSOR_IMAGE" on page 2320, "CURSOR_STANDARD" on page 2320, "CURSOR_XY" on page 2321

BREAK

The BREAK statement provides a convenient way to immediately exit from a loop (FOR, WHILE, REPEAT), CASE, or SWITCH statement without resorting to GOTO statements.

Note

BREAK is an IDL statement. For information on using statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

BREAK

Example

This example exits the enclosing WHILE loop when the value of i hits 5.

```
I = 0
WHILE (1) DO BEGIN
   i = i + 1
   IF (i eq 5) THEN BREAK
ENDWHILE
```

BREAKPOINT

The BREAKPOINT procedure allows you to insert and remove breakpoints in programs for debugging. A breakpoint causes program execution to stop after the designated statement is executed. Breakpoints are specified using the source file name and line number. For multiple-line statements (statements containing "$", the continuation character), specify the line number of the last line of the statement.

You can insert breakpoints in programs without editing the source file. Enter the following:

```
HELP, /BREAKPOINT
```

to display the breakpoint table which gives the index, module and source file locations of each breakpoint.

Syntax

BREAKPOINT [, *File*], *Index* [, AFTER=*integer*] [, /CLEAR]
[, CONDITION='*expression*'] [, /DISABLE] [, /ENABLE] [, /ONCE] [, /SET]

Arguments

File

An optional string argument that contains the name of the source file. Note that if *File* is not in the current directory, the full path name must be specified even if *File* is in one of the directories specified by !PATH.

Index

The line number at which to clear or set a breakpoint.

Keywords

AFTER

Set this keyword equal to an integer *n*. Execution will stop only after the *n*th time the breakpoint is hit. For example:

```
BREAKPOINT, /SET, 'test.pro', 8, AFTER=3
```

sets a breakpoint at the eighth line of the file `test.pro`, but only stops execution after the breakpoint has been encountered three times.

CLEAR

Set this keyword to remove a breakpoint. The breakpoint to be removed is specified either by index, or by the source file and line number. Use command `HELP, /BREAKPOINT` to display the indices of existing breakpoints. For example:

```
; Clear breakpoint with an index of 3:
BREAKPOINT, /CLEAR, 3

; Clear the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
BREAKPOINT, /CLEAR, 'test.pro',8
```

CONDITION

Set this keyword to a string containing an IDL expression. When a breakpoint is encountered, the expression is evaluated. If the expression is true (if it returns a non-zero value), program execution is interrupted. The expression is evaluated in the context of the program containing the breakpoint. For example:

```
BREAKPOINT, 'myfile.pro', 6, CONDITION='i gt 2'
```

If i is greater than 2 at line 6 of `myfile.pro`, the program is interrupted.

DISABLE

Set this keyword to disable the specified breakpoint, if it exists. The breakpoint can be specified using the breakpoint index or file and line number:

```
; Disable breakpoint with an index of 3:
BREAKPOINT, /DISABLE, 3

; Disable the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
BREAKPOINT, /DISABLE, 'test.pro',8
```

ENABLE

Set this keyword to enable the specified breakpoint if it exists. The breakpoint can be specified using the breakpoint index or file and line number:

```
; Enable breakpoint with an index of 3:
BREAKPOINT, /ENABLE, 3

; Enable the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
BREAKPOINT, /ENABLE, 'test.pro',8
```

ONCE

Set this keyword to make the breakpoint temporary. If ONCE is set, the breakpoint is cleared as soon as it is hit. For example:

```
BREAKPOINT, /SET, 'file.pro', 12, AFTER=3, /ONCE
```

sets a breakpoint at line 12 of `file.pro`. Execution stops when line 12 is encountered the third time, and the breakpoint is automatically cleared.

SET

Set this keyword to set a breakpoint at the designated source file line. If this keyword is set, the first input parameter, *File* must be a string expression that contains the name of the source file. The second input parameter must be an integer that represents the source line number.

For example, to set a breakpoint at line 23 in the source file `xyz.pro`, enter:

```
BREAKPOINT, /SET, 'xyz.pro', 23
```

BROYDEN

The BROYDEN function solves a system of *n* nonlinear equations (where $n \geq 2$) in *n* dimensions using a globally-convergent Broyden's method. The result is an *n*-element vector containing the solution.

BROYDEN is based on the routine `broydn` described in section 9.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = BROYDEN(*X*, *Vecfunc* [, CHECK=*variable*] [, /DOUBLE] [, EPS=*value*] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLF=*value*] [, TOLMIN=*value*] [, TOLX=*value*])

Arguments

X

An *n*-element vector (where $n \geq 2$) containing an initial guess at the solution of the system.

Vecfunc

A scalar string specifying the name of a user-supplied IDL function that defines the system of non-linear equations. This function must accept a vector argument *X* and return a vector result.

For example, suppose we wish to solve the following system:

$$\begin{bmatrix} 3x - \cos(yz) - 1/2 \\ x^2 - 81(y + 0.1)^2 + \sin(z) + 1.06 \\ e^{-xy} + 20z + \frac{10\pi - 3}{3} \end{bmatrix} = 0$$

To represent this system, we define an IDL function named BROYFUNC:

```
FUNCTION broyfunc, X
   RETURN, [3.0 * X[0] - COS(X[1]*X[2]) - 0.5,$
   X[0]^2 - 81.0*(X[1] + 0.1)^2 + SIN(X[2]) + 1.06,$
   EXP(-X[0]*X[1]) + 20.0 * X[2] + (10.0*!PI - 3.0)/3.0]
END
```

Keywords

CHECK

BROYDEN calls an internal function named `fmin()` to determine whether the routine has converged to a local rather than a global minimum (see *Numerical Recipes*, section 9.7). Use the CHECK keyword to specify a named variable which will be set to 1 if the routine has converged to a local minimum or to 0 if not. If the routine does converge to a local minimum, try restarting from a different initial guess to obtain the global minimum.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

Set this keyword to a number close to machine accuracy, used to remove noise from each iteration. The default is 10^{-7} for single precision, and 10^{-14} for double precision.

ITMAX

Use this keyword to specify the maximum allowed number of iterations. The default is 200.

STEPMAX

Use this keyword to specify the scaled maximum step length allowed in line searches. The default value is 100.0.

TOLF

Set the convergence criterion on the function values. The default value is 1.0×10^{-4}.

TOLMIN

Set the criterion for deciding whether spurious convergence to a minimum of the function `fmin()` has occurred. The default value is 1.0×10^{-6}.

TOLX

Set the convergence criterion on *X*. The default value is 1.0×10^{-7}.

Example

We can use BROYDEN to solve the non-linear system of equations defined by the BROYFUNC function above:

```
;Provide an initial guess as the algorithm's starting point:
X = [-1.0, 1.0, 2.0]

;Compute the solution:
result = BROYDEN(X, 'BROYFUNC')

;Print the result:
PRINT, result
```

IDL prints:

```
      0.500000  -1.10731e-07  -0.523599
```

The exact solution (to eight-decimal accuracy) is [0.5, 0.0, -0.52359877].

See Also

FX_ROOT, FZ_ROOTS, NEWTON

BYTARR

The BYTARR function returns a byte vector or array.

Syntax

Result = BYTARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, BYTARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed (array elements contain random values) and BYTARR executes faster.

Example

To create B as a 3 by 3 by 5 byte array where each element is set to zero, enter:

```
B = BYTARR(3, 3, 5)
```

See Also

COMPLEXARR, DBLARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

BYTE

The BYTE function returns a result equal to *Expression* converted to byte type. If *Expression* is a string, each string is converted to a byte vector of the same length as the string. Each element of the vector is the character code of the corresponding character in the string. The BYTE function can also be used to extract data from *Expression* and place it in a byte scalar or array without modification, if more than one parameter is present. See "Type Conversion Functions" on page 49 for details.

Syntax

Result = BYTE(*Expression*[, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to type byte.

Offset

The byte offset from the beginning of *Expression*. Specifying this argument allows fields of data extracted from *Expression* to be treated as byte data without conversion.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

Example

If the variable A contains the floating-point value 10.0, it can be converted to byte type and saved in the variable B by entering:

```
B = BYTE(A)
```

See Also

COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

BYTEORDER

The BYTEORDER procedure converts integers between host and network byte ordering or floating-point values between the native format and XDR (IEEE) format. This routine can also be used to swap the order of bytes within both short and long integers. If the type of byte swapping is not specified via one of the keywords below, bytes within short integers are swapped (even and odd bytes are interchanged).

The size of the parameter, in bytes, must be evenly divisible by two for short integer swaps, and by four for long integer swaps. BYTEORDER operates on both scalars and arrays. The parameter must be a variable, not an expression or constant, and may not contain strings. The contents of *Variable* are overwritten by the result.

Network byte ordering is “big endian”. That is, multiple byte integers are stored in memory beginning with the most significant byte.

Syntax

BYTEORDER, *Variable*$_1$, ..., *Variable*$_n$ [, /DTOVAX] [, /DTOXDR] [, /FTOVAX] [, /FTOXDR] [, /HTONL] [, /HTONS] [, /L64SWAP] [, /LSWAP] [, /NTOHL] [, /NTOHS] [, /SSWAP] [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, /VAXTOD] [, /VAXTOF] [, /XDRTOD] [, /XDRTOF]

VMS keywords: [, /DTOGFLOAT] [, /GFLOATTOD]

Arguments

Variable$_n$

A named variable (not an expression or constant) that contains the data to be converted. The contents of *Variable* are overwritten by the new values.

Keywords

DTOVAX

Set this keyword to convert native (IEEE) double-precision floating-point format to VAX D float format. See “Note On IEEE to VAX Format Conversion” on page 136.

DTOXDR

Set this keyword to convert native double-precision floating-point format to XDR (IEEE) format.

FTOVAX

Set this keyword to convert native (IEEE) single-precision floating-point format to VAX F float format. See "Note On IEEE to VAX Format Conversion" on page 136.

FTOXDR

Set this keyword to convert native single-precision floating-point format to XDR (IEEE) format.

HTONL

Set this keyword to perform host to network conversion, longwords.

HTONS

Set this keyword to perform host to network conversion, short integers.

L64SWAP

Set this keyword to perform a 64-bit swap (8 bytes). Swap the order of the bytes within each 64-bit word. For example, the eight bytes within a 64-bit word are changed from (B_0, B_1, B_2, B_3 B_4, B_5, B_6, B_7), to (B_7, B_6, B_5, B_4, B_3, B_2, B_1, B_0).

LSWAP

Set this keyword to perform a 32-bit longword swap. Swap the order of the bytes within each longword. For example, the four bytes within a longword are changed from (B_0, B_1, B_2, B_3), to (B_3, B_2, B_1, B_0).

NTOHL

Set this keyword to perform network to host conversion, longwords.

NTOHS

Set this keyword to perform network to host conversion, short integers.

SSWAP

Set this keyword to perform a short word swap. Swap the bytes within short integers. The even and odd numbered bytes are interchanged. This is the default action, if no other keyword is set.

SWAP_IF_BIG_ENDIAN

If this keyword is set, the BYTEORDER request will only be performed if the platform running IDL uses "big endian" byte ordering. On little endian machines, the BYTEORDER request quietly returns without doing anything. Note that this

keyword does not refer to the byte ordering of the input data, but to the computer hardware.

SWAP_IF_LITTLE_ENDIAN

If this keyword is set, the BYTEORDER request will only be performed if the platform running IDL uses "little endian" byte ordering. On big endian machines, the BYTEORDER request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

VAXTOD

Set this keyword to convert VAX D float format to native (IEEE) double-precision floating-point format. See "Note On IEEE to VAX Format Conversion" on page 136.

Note

If you have VAX G float format data, see the "VMS-Only Keywords" on page 135.

VAXTOF

Set this keyword to convert VAX F float format to native (IEEE) single-precision floating-point format. See "Note On IEEE to VAX Format Conversion" on page 136.

Note

If you have VAX G float format data, see the "VMS-Only Keywords" on page 135.

XDRTOD

Set this keyword to convert XDR (IEEE) format to native double-precision floating-point.

XDRTOF

Set this keyword to convert XDR (IEEE) format to native single-precision floating-point.

VMS-Only Keywords

DTOGFLOAT

Set this keyword to convert native (IEEE) double-precision floating-point format to VAX G float format. Note that IDL does not support the VAX G float format via any other mechanism. See "Note On IEEE to VAX Format Conversion" on page 136.

GFLOATTOD

Set this keyword to convert VAX G float format to native (IEEE) double-precision floating-point format. Note that IDL does not support the VAX G float format via any other mechanism.

Note On IEEE to VAX Format Conversion

Translation of floating-point values from the IDL's native (IEEE) format to the VAX formats and back (IEEE to VAX to IEEE) is not a completely reversible operation, and should be avoided when possible. There are many cases where the recovered values will differ from the original, including:

- The VAX floating point format lacks support for the IEEE special values (NaN, Infinity). Hence, their special meaning is lost when they are converted to VAX format and cannot be recovered.
- Differences in precision and range can also cause information to be lost in both directions.

Research Systems recommends using IEEE/VAX conversions only to read existing VAX format data, and strongly recommends that all new files be created using the IEEE format.

See Also

SWAP_ENDIAN

BYTSCL

The BYTSCL function scales all values of *Array* that lie in the range (*Min* ≤ *x* ≤ *Max*) into the range (0 ≤ *x* ≤ *Top*). The returned result has the same structure as the original parameter and is of byte type.

Syntax

Result = BYTSCL(*Array* [, MAX=*value*] [, MIN=*value*] [, /NAN] [, TOP=*value*])

Arguments

Array

The array to be scaled and converted to bytes.

Keywords

MAX

Set this keyword to the maximum value of *Array* to be considered. If MAX is not provided, *Array* is searched for its maximum value. All values greater or equal to MAX are set equal to TOP in the result.

Note

The data type of the value specified for MAX should match the data type of the input array. Since MAX is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

MIN

Set this keyword to the minimum value of *Array* to be considered. If MIN is not provided, *Array* is searched for its minimum value. All values less than or equal to MIN are set equal to 0 in the result.

Note

The data type of the value specified for MIN should match the data type of the input array. Since MIN is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" on page 434 for more information on IEEE floating-point values.)

TOP

Set this keyword to the maximum value of the scaled result. If TOP is not specified, 255 is used. Note that the minimum value of the scaled result is always 0.

Example

BYTSCL is often used to scale images into the appropriate range for 8-bit displays. As an example, enter the following commands:

```
; Create a simple image array:
IM = DIST(200)

; Display the array as an image:
TV, IM

; Scale the image into the full range of bytes (0 to 255) and
; re-display it:
IM = BYTSCL(IM)

; Display the new image:
TV, IM
```

See Also

BYTE, TVSCL

C_CORRELATE

The C_CORRELATE function computes the cross correlation *Pxy*(*L*) or cross covariance *Rxy*(*L*) of two sample populations *X* and *Y* as a function of the lag *L*

$$P_{xy}(L) = \begin{cases} \dfrac{\sum_{k=0}^{N-L-1} (x_{k+L} - \bar{x})(y_k - \bar{y})}{\sqrt{\left[\sum_{k=0}^{N-1} (x_k - \bar{x})^2\right]\left[\sum_{k=0}^{N-1} (y_k - \bar{y})^2\right]}} & \text{For } L < 0 \\ \dfrac{\sum_{k=0}^{N-L-1} (x_k - \bar{x})(y_{k+L} - \bar{y})}{\sqrt{\left[\sum_{k=0}^{N-1} (x_k - \bar{x})^2\right]\left[\sum_{k=0}^{N-1} (y_k - \bar{y})^2\right]}} & \text{For } L \geq 0 \end{cases}$$

$$R_{xy}(L) = \begin{cases} \dfrac{1}{N} \sum_{k=0}^{N-L-1} (x_{k+L} - \bar{x})(y_k - \bar{y}) & \text{For } L < 0 \\ \dfrac{1}{N} \sum_{k=0}^{N-L-1} (x_k - \bar{x})(y_{k+L} - \bar{y}) & \text{For } L \geq 0 \end{cases}$$

where $\bar{x}$ and $\bar{y}$ are the means of the sample populations $x = (x_0, x_1, x_2, \ldots, x_{N-1})$ and $y = (y_0, y_1, y_2, \ldots, y_{N-1})$, respectively.

This routine is written in the IDL language. Its source code can be found in the file `c_correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = C_CORRELATE(*X*, *Y*, *Lag* [, /COVARIANCE] [, /DOUBLE])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *n*-element integer, single-, or double-precision floating-point vector.

Lag

A scalar or *n*-element integer vector in the interval [-(*n*-2), (*n*-2)], specifying the signed distances between indexed elements of *X*.

Keywords

COVARIANCE

Set this keyword to compute the sample cross covariance rather than the sample cross correlation.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define two n-element sample populations:
X = [3.73, 3.67, 3.77, 3.83, 4.67, 5.87, 6.70, 6.97, 6.40, 5.57]
Y = [2.31, 2.76, 3.02, 3.13, 3.72, 3.88, 3.97, 4.39, 4.34, 3.95]

; Compute the cross correlation of X and Y for LAG = -5, 0, 1, 5,
; 6, 7:
lag = [-5, 0, 1, 5, 6, 7]
result = C_CORRELATE(X, Y, lag)
PRINT, result
```

IDL prints:

```
-0.428246   0.914755   0.674547  -0.405140  -0.403100  -0.339685
```

See Also

A_CORRELATE, CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

CALDAT

The CALDAT procedure computes the month, day, year, hour, minute, or second corresponding to a given Julian date. The inverse of this procedure is JULDAY.

Note

The Julian calendar, established by Julius Caesar in the year 45 BCE, was corrected by Pope Gregory XIII in 1582, excising ten days from the calendar. The CALDAT procedure reflects the adjustment for dates after October 4, 1582. See the example below for an illustration.

This routine is written in the IDL language. Its source code can be found in the file `caldat.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CALDAT, *Julian*, *Month* [, *Day* [, *Year* [, *Hour* [, *Minute* [, *Second*]]]]]

Arguments

Julian

A numeric value or array that specifies the Julian Day Number (which begins at noon) to be converted to a calendar date.

Note

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

Month

A named variable that, on output, contains the number of the desired month (1 = January, ..., 12 = December).

Day

A named variable that, on output, contains the number of the day of the month (1-31).

Year

A named variable that, on output, contains the number of the desired year (e.g., 1994).

Hour

A named variable that, on output, contains the number of the hour of the day (0-23).

Minute

A named variable that, on output, contains the number of the minute of the hour (0-59).

Second

A named variable that, on output, contains the number of the second of the minute (0-59).

Examples

In 1582, Pope Gregory XIII adjusted the Julian calendar to correct for its inaccuracy of slightly more than 11 minutes per year. As a result, the day following October 4, 1582 was October 15, 1582. CALDAT follows this convention, as illustrated by the following commands:

```
CALDAT, 2299160, Month, Day, Year
PRINT, Month, Day, Year
```

IDL prints:

```
10    4    1582
```

Warning

You should be aware of this discrepancy between the original and revised Julian calendar reckonings if you calculate dates before October 15, 1582.

Be sure to distinguish between *Month* and *Minute* when assigning variable names. For example, the following code would cause the Minute value to be the same as the Month value:

```
;Find date corresponding to Julian day 2529161.36:
CALDAT, 2529161.36, M, D, Y, H, M, S
PRINT, M, D, Y, H, M, S
```

IDL prints:

```
7           4        2212          18           7      0.00000000
```

Instead, use something like:

```
CALDAT, 2529161.36, Month, Day, Year, Hour, Minute, Second
PRINT, Month, Day, Year, Hour, Minute, Second
```

You can use arrays for the *Julian* argument:

```
CALDAT,FINDGEN(4)+2449587L, m, d, y
PRINT, m, d, y
```

IDL prints:

```
           8           8           8           8
          22          23          24          25
        1994        1994        1994        1994
```

See Also

BIN_DATE, JULDAY, SYSTIME

CALENDAR

The CALENDAR procedure displays a calendar for a month or an entire year on the current plotting device. This IDL routine imitates the UNIX `cal` command.

This routine is written in the IDL language. Its source code can be found in the file `calendar.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CALENDAR [[, *Month*] , *Year*]

Arguments

Month

The number of the month for which a calendar is desired (1 is January, 2 is February, ..., 12 is December). If called without arguments, CALENDAR draws a calendar for the current month.

Year

The number of the year for which a calendar should be drawn. If YEAR is provided without MONTH, a calendar for the entire year is drawn. If called without arguments, CALENDAR draws a calendar for the current month.

Example

```
; Display a calendar for May, 1995.
CALENDAR, 5, 1995
```

See Also

SYSTIME

CALL_EXTERNAL

The CALL_EXTERNAL function calls a function in an external sharable object and returns a scalar value. Parameters can be passed by reference (the default) or by value. See Chapter 7, "CALL_EXTERNAL" in the *External Development Guide* for examples.

CALL_EXTERNAL is supported under all operating systems supported by IDL, although there are system specific details of which you must be aware. This function requires no interface routines and is much simpler and easier to use than the LINKIMAGE procedure. However, CALL_EXTERNAL performs no checking of the type and number of parameters. Programming errors are likely to cause IDL to crash or to corrupt your data.

Warning

Input and output actions should be performed within IDL code, using IDL's built-in input/output facilities, or by using the internal IDL_Message() function. Performing input or output from external code, especially to the user console or tty (e.g. using `printf()` or equivalent functionality in other languages to send text to stdout) may create errors or generate unexpected results.

CALL_EXTERNAL supports the IDL Portable Convention, a portable calling convention that works on all platforms. This convention passes two arguments to the called routine, an argument count (`argc`) and an array of arguments (`argv`). On non-VMS systems, this is the only available convention. Under VMS, the VMS LIB$CALLG convention is also available. This convention, which is the default under VMS, uses the VMS LIB$CALLG runtime library routine to call functions without requiring a special (`argc`, `argv`) convention.

On UNIX, VMS, and Windows platforms, but not the Macintosh, CALL_EXTERNAL also offers a feature called Auto Glue that can greatly simplify use of the CALL_EXTERNAL portable convention if you have the appropriate C compiler installed on your system. Auto glue automatically writes the glue function required to convert the (argc, argv) arguments to the actual function call, and then compiles and loads the glue function transparently. If you want IDL to simply write the glue function for you, but not compile it, the WRITE_WRAPPER keyword can be used.

The result of the CALL_EXTERNAL function is a scalar value returned by the external function. By default, this is a scalar long (32-bit) integer. This default can be changed by specifying one of the keywords described below that alter the result type.

Syntax

Result = CALL_EXTERNAL(*Image*, *Entry* [, P_0, ..., P_{N-1}] [, /ALL_VALUE]
[, /B_VALUE | , /D_VALUE | , /F_VALUE | , /I_VALUE | , /L64_VALUE |
, /S_VALUE | , /UI_VALUE | , /UL_VALUE | , /UL64_VALUE] [, /CDECL]
[, RETURN_TYPE=*value*] [, /UNLOAD] [, VALUE=*byte_array*]
[, WRITE_WRAPPER=*wrapper_file*])

VMS keywords: [, DEFAULT=*string*] [, /PORTABLE] [, /VAX_FLOAT]

Auto Glue keywords: [, /AUTOGLUE] [, CC=*string*]
[, COMPILE_DIRECTORY=*string*] [, EXTRA_CFLAGS=*string*]
[, EXTRA_LFLAGS=*string*] [, /IGNORE_EXISTING_GLUE] [, LD=*string*]
[, /NOCLEANUP] [, /SHOW_ALL_OUTPUT] [, /VERBOSE]

Arguments

Image

The name of the file, which must be a sharable image (VMS), sharable library (UNIX and Macintosh), or DLL (Windows), which contains the routine to be called.

Under VMS the full interpretation of this argument is discussed in "VMS CALL_EXTERNAL and LIB$FIND_IMAGE_SYMBOL" on page 156.

Entry

A string containing the name of the symbol in the library which is the entry point of the routine to be called.

P_0, ..., P_{N-1}

The parameters to be passed to the external routine. All array and structure arguments are passed by reference (address). The default is to also pass scalars by reference, but the ALL_VALUE or VALUE keywords can be used to pass them by value. Care must be taken to ensure that the type, structure, and passing mechanism of the parameters passed to the external routine match what it expects. There are some restrictions on data types that can be passed by value, and the user needs to be aware of how IDL passes strings. Both issues discussed in further detail below.

Keywords

ALL_VALUE

Set this keyword to indicate that all parameters are passed by value. There are some restrictions on data types that should be considered when using this keyword, as discussed below.

B_VALUE

If set, this keyword indicates that the called function returns a byte value.

CDECL

The Microsoft Windows operating system has two distinct system defined standards that govern how routines pass arguments: `stdcall`, which is used by much of the operating system as well as languages such as Visual Basic, and `cdecl`, which is used widely for programming in the C language. These standards differ in how and when arguments are pushed and removed from the system stack. The standard used by a given function is determined when the function is compiled, and can usually be controlled by the programmer. If you call a function using the wrong standard (e.g. calling a `stdcall` function as if it were `cdecl`, or the reverse), you could get incorrect results, corrupted memory, or you could crash IDL. Unfortunately, there is no way for IDL to know which convention a given function uses; this information must be supplied by the user of CALL_EXTERNAL. If the CDECL keyword is present, IDL will use the `cdecl` convention to call the function. Otherwise, `stdcall` is used.

DEFAULT

This keyword is ignored on non-VMS platforms. Under VMS, it is a string containing the default device, directory, file name, and file type information for the file that contains the sharable image. See “VMS CALL_EXTERNAL and LIB$FIND_IMAGE_SYMBOL” on page 156 for additional information.

D_VALUE

If set, this keyword indicates that the called function returns a double-precision floating value.

F_VALUE

If set, this keyword indicates that the called function returns a single-precision floating value.

I_VALUE

If set, this keyword indicates that the called function returns an integer value.

L64_VALUE

If set, this keyword indicates that the called function returns a 64-bit integer value.

PORTABLE

Under VMS, causes CALL_EXTERNAL to use the IDL Portable calling convention for passing arguments to the called function instead of the default VMS LIB$CALLG convention. Under other operating systems, only the portable convention is available, so this keyword is quietly ignored. The details of these calling conventions are described in "Calling Convention" on page 152.

If you are using the IDL Portable calling convention, the AUTO_GLUE or WRITE_WRAPPER keywords are available to simplify the task of matching the form in which IDL passes the arguments to the interface of your target function.

RETURN_TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of the IDL type codes.

S_VALUE

If set, this keyword indicates that the called function returns a pointer to a null-terminated string.

UI_VALUE

If set, this keyword indicates that the called function returns an unsigned integer value.

UL_VALUE

If set, this keyword indicates that the called function returns an unsigned long integer value.

UL64_VALUE

If set, this keyword indicates that the called function returns an unsigned 64-bit integer value.

UNLOAD

Normally, IDL keeps *Image* loaded in memory after the call to CALL_EXTERNAL completes. This is done for efficiency—loading a sharable object can be a slow

operation. Setting the UNLOAD keyword will cause IDL to unload *Image* after the call to it is complete. This is useful if you are debugging code in *Image*, as it allows you to iterate on your code without having to exit IDL between tests. It can also be a good idea if you do not intend to make any subsequent calls to routines within *Image*.

If IDL is unable to unload the sharable object, it will issue an error to that effect. In addition to any operating system reported problem that might occur, there are 2 situations in which IDL cannot perform the UNLOAD operation:

- If the sharable library has been used for any other purpose in addition to CALL_EXTERNAL (e.g. LINKIMAGE).
- The VMS operating system does not offer a mechanism for unloading sharable objects from a running program. Use of the UNLOAD keyword under VMS will therefore cause an error to be issued.

VALUE

A byte array, with as many elements as there are optional parameters, indicating the method of parameter passing. Arrays are always passed by reference. If parameter P_i is a scalar, it is passed by reference if VALUE[*i*] is 0; and by value if it is non-zero. There are some restrictions on data types that should be considered when using this keyword, as discussed below.

VAX_FLOAT (VMS Only)

If specified, all data passed to the called function is first converted to VAX F (single) or D (double) floating point formats. On return, any data passed by reference is converted back to the IEEE format used by IDL. This feature allow you to call code compiled to work with earlier versions of IDL, which used the old VAX formats.

The default setting for this keyword is FALSE, unless IDL was started with the VAX_FLOAT startup option, in which case the default is TRUE. See "Command Line Options" in Chapter 4 of *Using IDL* for details on this qualifier. You can change this setting at runtime using the VAX_FLOAT function.

WRITE_WRAPPER

If set, WRITE_WRAPPER supplies the name of a file for CALL_EXTERNAL to create containing the C function required to convert the (`argc`, `argv`) interface used by the CALL_EXTERNAL portable calling convention to the interface of the target function. If WRITE_WRAPPER is specified, CALL_EXTERNAL writes the specified file, but does not attempt to actually call the function specified by Entry. The result from CALL_EXTERNAL is an integer 0 in this case, and has no special meaning. Use of WRITE_WRAPPER implies the PORTABLE keyword.

Note

This is similar to Auto Glue only in that CALL_EXTERNAL writes a function on your behalf. Unlike auto glue, WRITE_WRAPPER does not attempt to compile the resulting function or to use it. You might want to use WRITE_WRAPPER to generate IDL interfaces for an external library in cases where you intend to combine the interfaces with other code or otherwise modify it before using it with IDL.

Auto Glue Keywords (UNIX, VMS, and Windows)

Auto Glue, discussed in the section "Auto Glue" on page 153, offers a simplified way to use the CALL_EXTERNAL portable calling convention. The following keywords control its use. Many of these keywords correspond to the same keywords to the MAKE_DLL procedure, and are covered in more detail in the documentation for that routine.

AUTO_GLUE

Set this keyword to enable the CALL_EXTERNAL Auto Glue feature. Use of AUTO_GLUE implies the PORTABLE keyword.

CC

If present, a template string to be used in generating the C compiler command(s) to compile the automatically generated glue function. For a more complete description of this keyword, see MAKE_DLL.

COMPILE_DIRECTORY

Specifies the directory to use for creating the necessary intermediate files and the final glue function sharable library. For a more complete description of this keyword, see MAKE_DLL.

EXTRA_CFLAGS

If present, a string supplying extra options to the command used to execute the C compiler. For a more complete description of this keyword, see MAKE_DLL.

EXTRA_LFLAGS

If present, a string supplying extra options to the command used to execute the linker. For a more complete description of this keyword, see MAKE_DLL.

IGNORE_EXISTING_GLUE

Normally, if Auto Glue finds a pre-existing glue function, it will use it without attempting to build it again. Set IGNORE_EXISTING_GLUE to override this caching behavior and force CALL_EXTERNAL to rebuild the glue function sharable library.

LD

If present, a template string to be used in generating the linker command to build the glue function sharable library. For a more complete description of this keyword, see MAKE_DLL.

NOCLEANUP

If set, CALL_EXTERNAL will not remove intermediate files generated in order to build the glue function sharable library after the library has been built. This keyword can be used to preserve information for debugging in case of error, or for additional information on how Auto Glue works. For a more complete description of this keyword, see MAKE_DLL.

SHOW_ALL_OUTPUT

Auto Glue normally produces no output unless an error prevents successful building of the glue function sharable library. Set SHOW_ALL_OUTPUT to see all output produced by the process of building the library. For a more complete description of this keyword, see MAKE_DLL.

VERBOSE

If set, VERBOSE causes CALL_EXTERNAL to issue informational messages as it carries out the task of locating, building, and executing the glue function. For a more complete description of this keyword, see MAKE_DLL.

Note On IEEE to VAX Format Conversion

Translation of floating-point values from the IDL's native (IEEE) format to the VAX format and back (IEEE to VAX to IEEE) is not a completely reversible operation, and should be avoided when possible. There are many cases where the recovered values will differ from the original, including:

- The VAX floating point format lacks support for the IEEE special values (NaN, Infinity). Hence, their special meaning is lost when they are converted to VAX format and cannot be recovered.

- Differences in precision and range can also cause information to be lost in both directions.

Research Systems recommends using IEEE/VAX conversions only to read existing VAX format data, and strongly recommends that all new files be created using the IEEE format.

String Parameters

IDL represents strings internally as IDL_STRING descriptors, which are defined in the C language as:

```
typedef struct {
  unsigned short slen;
  unsigned short stype;
  char *s;
} IDL_STRING;
```

To pass a string by reference, IDL passes the address of its IDL_STRING descriptor. To pass a string by value the string pointer (the `s` field of the descriptor) is passed. Programmers should be aware of the following when manipulating IDL strings:

- Called code should treat the information in the passed IDL_STRING descriptor and the string itself as read-only, and should not modify these values.
- The `slen` field contains the length of the string without including the NULL termination that is required at the end of all C strings.
- The `stype` field is used internally by IDL to know keep track of how the memory for the string was obtained, and should be ignored by CALL_EXTERNAL users.
- `s` is the pointer to the actual C string represented by the descriptor. If the string is NULL, IDL represents it as a NULL (0) pointer, not as a pointer to an empty null terminated string. Hence, called code that expects a string pointer should check for a NULL pointer before dereferencing it.

These issues are examined in greater detail in the IDL *External Development Guide*.

Calling Convention

CALL_EXTERNAL supports two distinct calling conventions for calling user-supplied routines. The primary convention is the IDL Portable convention, which is supported on all platforms. The second is the VMS LIB$CALLG convention which is only available under VMS.

Portable

The portable interface convention passes all arguments as elements of an array of C void pointers (void *). The C language prototype for a user function called this way looks like one of the following:

```
RET_TYPE xxx(int argc, void *argv[])
```

Where RET_TYPE is one of the following: `UCHAR`, `short`, `IDL_UINT`, `IDL_LONG`, `IDL_ULONG`, `IDL_LONG64`, `IDL_ULONG64`, `float`, `double`, or `char *`. The return type used must agree with the type assumed by CALL_EXTERNAL as specified via the keywords described above.

`Argc` is the number of arguments, and the vector `argv` contains the arguments themselves, one argument per element. Arguments passed by reference map directly to these (`void *`) pointers, and can be cast to the proper type and then dereferenced directly by the called function. Passing arguments by value is allowed, but since the values are passed in (`void *`) pointers, there are some limitations and restrictions on what is possible:

- Types that are larger than a pointer cannot be passed by value, and CALL_EXTERNAL will issue an error if this is attempted. This limitation applies only to the standard portable calling convention. Auto Glue does not have this limitation, and is able to pass such variables by value.
- Integer values can be easily passed by value. IDL widens any of the integer types to the C int type and they are then converted to a (void *) pointer using a C cast operation.
- There is no C language-defined conversion between pointers and floating point types, so IDL copies the data for the value directly into the pointer element. Although such values can be retrieved by the called routine with the correct C casting operations, this is inconvenient and error prone. It is best to pass non-integer data by reference.

Auto Glue

Auto Glue is an extension to the IDL Portable Calling Convention that makes it easier to use. It is supported under UNIX, VMS, and Microsoft Windows, but not on the Macintosh at this time.

The portable calling convention requires your function to use the IDL defined (`argc`, `argv`) interface for passing arguments. However, functions not explicitly written for use with CALL_EXTERNAL do not have this interface. VMS users can solve this problem by using the LIB$CALLG calling convention described in the following

section, but that method only works under VMS and has other limitations as well. A common solution using the portable convention is for the IDL user to write a glue function that interfaces between IDL and the actual function. The entire purpose of this glue function, which is usually very simple, is to convert the IDL (argc, argv) method of passing parameters to a form acceptable to the desired function. Writing this wrapper function is easy for programmers that understand the C language, the system C compiler and linker, and how sharable libraries work on their target operating system. However, it is also tedious and error prone, and can be difficult for users that do not already have these skills.

Auto Glue uses the MAKE_DLL procedure to automate the process of using glue code to call functions via the CALL_EXTERNAL portable calling convention. Since it depends so closely on MAKE_DLL, an understanding of how MAKE_DLL works is necessary to fully understand Auto Glue. As with MAKE_DLL, Auto Glue requires that your system have a suitable C compiler installed. Please refer to the documentation for MAKE_DLL.

Auto Glue maintains a cache of previously built glue functions, and will reuse them on subsequent requests, even between IDL sessions. The process works as follows:

- CALL_EXTERNAL finds a suitable glue function by performing the following steps in order, stopping after the first one that works. Glue function libraries can be recognized by their name, which starts with the prefix `idl_ce`, and end with the proper suffix for a sharable library on the target system (most UNIX: `.so`, AIX: `.a`, HP-UX: `.sl`, VMS: `.exe`, Windows: `.dll`).

1. Look for a `ce_glue` subdirectory within the IDL distribution `bin` subdirectory for the current platform. If this directory exists, it looks there for a sharable library containing the appropriate glue function.

Note

For customer security reasons, the `ce_glue` subdirectory does not exist in the IDL distribution as shipped by RSI, and IDL does not use it to create glue functions. However, if an individual site creates this directory and places glue library files within it, IDL will use them. Multiple IDL sessions on a given system can all share these same glue files, even when run by different users on a multi-user system. If you keep your IDL distribution on a network based file server shared by multiple clients, and if you provide a sufficient selection of glue files, it is possible that your users will not require a locally installed C compiler to use Auto Glue.

If you do create the `ce_glue` subdirectory on a multi-user system, we recommend that you make it along with all files contained within belong to the

owner of the IDL distribution, and apply file protections that prevent non-privileged users from creating files in the directory or modifying them.

2. Look in the directory given by the COMPILE_DIRECTORY keyword, or if COMPILE_DIRECTORY is not present, in the directory given by the !MAKE_DLL.COMPILE_DIRECTORY system variable for the appropriate glue function.
3. If this step is reached, there is no pre-existing glue function available. CALL_EXTERNAL will create one in the same directory searched in the previous step by generating a C language file containing the needed glue function, and then compiling and linking it into a sharable library using the functionality of the MAKE_DLL procedure.

- IDL loads the sharable library containing the glue function found in the previous step, as well as the library you specified with the Image argument.
- CALL_EXTERNAL calls the glue function, causing your function to be called with the correct parameters.

The first time CALL_EXTERNAL encounters the need for a glue function that does not already exist, it will automatically build it, and then use it without any external indication that this has happened. You may notice a brief hesitation in IDL's execution as it waits for this process to occur. Once a glue function exists, IDL can load it immediately on subsequent calls (even in unrelated later IDL sessions), and no delay will occur.

Example: Using Auto Glue To Call System Library Routines

Under Sun Solaris, there is a function in the system math library called hypot() that computes the length of the hypotenuse of a right-angled triangle:

```
sqrt(x*x + y*y)
```

This function has the C prototype:

```
double hypot(double x, double y)
```

The following IDL function uses Auto Glue to call this routine:

```
FUNCTION HYPOT, X, Y
   ; Use the 32-bit or the 64-bit math library?
   LIBM=(!VERSION.MEMORY_BITS EQ 64) $
      ? '/usr/lib/sparcv9/libm.so' : '/usr/lib/libm.so'
   RETURN, CALL_EXTERNAL(LIBM, 'hypot', double(x), double(y), $
      /ALL_VALUE, /D_VALUE, /AUTO_GLUE)
END
```

VMS LIB$CALLG

The LIB$CALLG calling convention is built directly upon the VMS LIB$CALLG runtime library function. This function allows calling functions with a natural interface without requiring a special (`argc`, `argv`) convention. In FORTRAN, a typical routine might be declared:

```
INTEGER *4 FUNCTION XXX(P1, P2, ..., PN)
```

As with the Portable convention described above, the return type for the function must be one of the following types: `UCHAR`, `short`, `IDL_UINT`, `IDL_LONG`, `IDL_ULONG`, `IDL_LONG64`, `IDL_ULONG64`, `float`, `double`, or `char *`.

It is possible to pass arguments of any data type by reference, but there are some limitations and restrictions on passing arguments by value. Unfortunately, the interface to LIB$CALLG was designed explicitly for the VAX hardware architecture, and does not provide sufficient information to the operating system to pass all data types by value properly on ALPHA Risc CPUs which pass arguments in registers as well as on the system stack. To the best of our knowledge, Compaq (formerly Digital Equipment Corporation) has no plans to supply an updated version of LIB$CALLG that does not have these limitations. Therefore, this calling convention has the following restrictions on ALPHA/VMS:

- A single or double-precision floating-point argument can only be passed by value if it is one of the first six arguments to the function.
- Single- and double-precision complex arguments cannot be passed by value.

The LIB$CALLG calling convention is the default for VMS IDL because it was the original convention supported on that platform, and because it allows calling routines that do not adhere to the (`argc`, `argv`) style interface required by the portable convention. The Portable convention, described above, can be used under VMS by setting the PORTABLE keyword. If you are writing external code to be used under operating systems other than VMS, using the portable interface simplifies cross platform development.

VMS CALL_EXTERNAL and LIB$FIND_IMAGE_SYMBOL

The VMS implementation of CALL_EXTERNAL uses the system runtime library function LIB$FIND_IMAGE_SYMBOL to perform the dynamic linking. This function has a complicated interface in which the name of the library to be linked is given in two separate arguments. We encourage VMS users wishing to use CALL_EXTERNAL to read and fully understand the documentation for LIB$FIND_IMAGE_SYMBOL in order to understand how it is used by IDL. The

following discussion assumes that you have a copy of the LIB$FIND_IMAGE_SYMBOL documentation available to consult as you read.

LIB$FIND_IMAGE_SYMBOL uses an argument called *filename* to specify the name of the sharable library or executable to be loaded. This means that none of the file specification punctuation characters (`:`, `[`, `<`, `;`, `.`) are allowed. Filename can also be a logical name, in which case its translated value is the name of the file to be loaded. The translation of such a logical name is allowed to contain additional file specification information. VMS uses this information to find the file to load, using SYS$SHARE as the default location if a location is not specified via a logical name. Alternatively, the user can supply the *image-name* argument, which is used as a default file specification to fill in the parts of the file specification not contained in filename. IDL uses the following rules, in the order listed, to determine how to call LIB$FIND_IMAGE_SYMBOL:

1. If CALL_EXTERNAL is called with both the Image argument and DEFAULT keyword, Image is passed to LIB$FIND_IMAGE_SYMBOL as filename, and DEFAULT is passed as image-name. Both are passed directly to the function without any interpretation.
2. If DEFAULT is not present and Image does not contain a file specification character (`:`, `[`, `<`, `;`, `.`) then it is passed to LIB$CALL_IMAGE_SYMBOL as it's filename argument without any further interpretation.
3. If DEFAULT is not present and Image contains a file specification character, then IDL examines it and locates the filename part. The filename part is passed to LIB$FIND_IMAGE_SYMBOL as filename and the entire string from Image is passed as *image-name*.

This means that although LIB$CALL_IMAGE_SYMBOL has a complicated interface, the CALL_EXTERNAL user can supply a simple file specification for Image and it will be properly loaded by IDL. Full control of LIB$CALL_IMAGE_SYMBOL is still available for those who require it.

Important Changes Since IDL 5.0

The current version of CALL_EXTERNAL differs from IDL versions up to and including IDL 5.0 in a few ways that are important to users moving code to the current version:

- Under Windows, CALL_EXTERNAL would pass IDL strings by value no matter how the ALL_VALUE or VALUE keywords were set. This was inconsistent with all the other platforms and created unnecessary confusion. IDL now uses these keywords to decide how to pass strings on all platforms.

Windows users with existing code that expects strings to be passed by value without having specified it via one of these keywords will need to adjust their use of CALL_EXTERNAL or their code.

- VMS IDL through version 5.0 was only capable of using the LIB$CALLG calling convention. Newer versions can also use the portable convention.
- Older versions of IDL would quietly pass by value arguments that are larger than a pointer without issuing an error when using the portable calling convention. Although this might work on some hardware, it is error prone and can cause IDL to crash. IDL now issues an error in this case. Programmers with existing code moving to a current version of IDL should change their code to pass such data by reference.

Example

See Chapter 7, "CALL_EXTERNAL" in the *External Development Guide*.

See Also

LINKIMAGE, VAX_FLOAT

CALL_FUNCTION

CALL_FUNCTION calls the IDL function specified by the string *Name*, passing any additional parameters as its arguments. The result of the called function is passed back as the result of this routine.

Although not as flexible as the EXECUTE function, CALL_FUNCTION is much faster. Therefore, CALL_FUNCTION should be used in preference to EXECUTE whenever possible.

Syntax

Result = CALL_FUNCTION(*Name* [, P_1, ..., P_n])

Arguments

Name

A string containing the name of the function to be called. This argument can be a variable, which allows the called function to be determined at runtime.

P_i

The arguments to be passed to the function given by *Name*. These arguments are the positional and keyword arguments documented for the called function, and are passed to the called function exactly as if it had been called directly.

Example

The following command indirectly calls the IDL function SQRT (the square root function) with an argument of 4 and stores the result in the variable R:

```
R = CALL_FUNCTION('SQRT', 4)
```

See Also

CALL_PROCEDURE, CALL_METHOD, EXECUTE

CALL_METHOD

CALL_METHOD calls the object method specified by *Name*, passing any additional parameters as its arguments. CALL_METHOD can be used as either a function or a procedure, depending on whether the called method is a function or procedure.

Although not as flexible as the EXECUTE function, CALL_METHOD is much faster. Therefore, CALL_METHOD should be used in preference to EXECUTE whenever possible.

Syntax

CALL_METHOD, *Name*, *ObjRef*, [, P_1, ..., P_n]

or

Result = CALL_METHOD(*Name*, *ObjRef*, [, P_1, ..., P_n])

Arguments

Name

A string containing the name of the method to be called. This argument can be a variable, which allows the called method to be determined at runtime.

ObjRef

A scalar object reference that will be passed to the method as the *Self* argument.

P_i

The arguments to be passed to the method given by *Name*. These arguments are the positional and keyword arguments documented for the called method, and are passed to the called method exactly as if it had been called directly.

See Also

CALL_FUNCTION, CALL_PROCEDURE, EXECUTE

CALL_PROCEDURE

CALL_PROCEDURE calls the procedure specified by *Name*, passing any additional parameters as its arguments.

Although not as flexible as the EXECUTE function, CALL_PROCEDURE is much faster. Therefore, CALL_PROCEDURE should be used in preference to EXECUTE whenever possible.

Syntax

CALL_PROCEDURE, *Name* [, P_1, ..., P_n]

Arguments

Name

A string containing the name of the procedure do be called. This argument can be a variable, which allows the called procedure to be determined at runtime.

P_i

The arguments to be passed to the procedure given by *Name*. These arguments are the positional and keyword arguments documented for the called procedure, and are passed to the called procedure exactly as if it had been called directly.

Example

The following example shows how to call the PLOT procedure indirectly with a number of arguments. First, create a dataset for plotting by entering:

```
B = FINDGEN(100)
```

Call PLOT indirectly to create a polar plot by entering:

```
CALL_PROCEDURE, 'PLOT', B, B, /POLAR
```

A “spiral” plot should appear.

See Also

CALL_FUNCTION, CALL_METHOD, EXECUTE

CASE

The CASE statement selects one, and only one, statement for execution, depending on the value of an expression. This expression is called the case selector expression. Each statement that is part of a CASE statement is preceded by an expression that is compared to the value of the selector expression. CASE executes by comparing the CASE expression with each selector expression in the order written. If a match is found, the statement is executed and control resumes directly below the CASE statement.

The ELSE clause of the CASE statement is optional. If included, it matches any selector expression, causing its code to be executed. For this reason, it is usually written as the last clause in the CASE statement. The ELSE statement is executed only if none of the preceding statement expressions match. If an ELSE clause is not included and none of the values match the selector, an error occurs and program execution stops.

The BREAK statement can be used within CASE statements to force an immediate exit from the CASE.

In this CASE statement, only one clause is selected, and that clause is the first one whose value is equal to the value of the case selector expression.

Tip

Each clause is tested in order, so it is most efficient to order the most frequently selected clauses first.

CASE is similar to the SWITCH statement. For more information on using CASE and other IDL program control statements, as well as the differences between CASE and SWITCH, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

CASE *expression* OF

expression: *statement*

...

expression: *statement*

[ELSE: *statement*]

ENDCASE

Example

This example illustrates how the CASE statement, unlike SWITCH, executes only the one statement that matches the case expression:

```
x=2

CASE x OF
   1: PRINT, 'one'
   2: PRINT, 'two'
   3: PRINT, 'three'
   4: PRINT, 'four'
ENDCASE
```

IDL Prints:

```
two
```

CATCH

The CATCH procedure provides a generalized mechanism for the handling of exceptions and errors within IDL. Calling CATCH establishes an error handler for the current procedure that intercepts all errors that can be handled by IDL, excluding non-fatal warnings such as math errors.

When an error occurs, each active procedure, beginning with the offending procedure and proceeding up the call stack to the main program level, is examined for an error handler. If an error handler is found, control resumes at the statement after the call to CATCH. The index of the error is returned in the argument to CATCH. The !ERROR_STATE system variable is also set. If no error handlers are found, program execution stops, an error message is issued, and control reverts to the interactive mode. A call to ON_IOERROR in the procedure that causes an I/O error supersedes CATCH, and takes the branch to the label defined by ON_IOERROR.

This mechanism is similar, but not identical to, the `setjmp/longjmp` facilities in C and the `catch/throw` facilities in C++.

Error handling is discussed in more detail in Chapter 17, “Controlling Errors” in *Building IDL Applications*.

Syntax

CATCH, *Variable* [, /CANCEL]

Arguments

Variable

A named variable in which the error index is returned. When an error handler is established by a call to CATCH, *Variable* is set to zero. If an error occurs, *Variable* is set to the error index, and control is transferred to the statement after the call to CATCH. The error index is also returned in the CODE field of the !ERROR_STATE system variable, i.e., !ERROR_STATE.CODE.

Keywords

CANCEL

Set this keyword to cancel the error handler for the current procedure. This cancellation does not affect other error handlers that may be established in other active procedures.

Example

The following procedure illustrates the use of CATCH:

```
PRO CATCH_EXAMPLE

   ; Define variable A:
   A = FLTARR(10)

   ; Establish error handler. When errors occur, the index of the
   ; error is returned in the variable Error_status:
   CATCH, Error_status

   ;This statement begins the error handler:
   IF Error_status NE 0 THEN BEGIN
      PRINT, 'Error index: ', Error_status
      PRINT, 'Error message: ', !ERROR_STATE.MSG
      ; Handle the error by extending A:
      A=FLTARR(12)
   ENDIF

   ; Cause an error:
   A[11]=12

   ; Even though an error occurs in the line above, program
   ; execution continues to this point because the event handler
   ; extended the definition of A so that the statement can be
   ; re-executed.
   HELP, A
END
```

Running the ABC procedure causes IDL to produce the following output and control returns to the interactive prompt:

```
Error index:         -144
Error message:
Attempt to subscript A with <INT (      11)> is out of range.
A               FLOAT     = Array[12]
```

See Also

!ERROR_STATE, ON_ERROR, ON_IOERROR, Chapter 17, “Controlling Errors” in *Building IDL Applications*.

CD

The CD procedure is used to set and/or change the current working directory. This routine changes the working directory for the IDL session and any child processes started from IDL during that session after the directory change is made. Under UNIX, CD does not affect the working directory of the process that started IDL. The PUSHD, POPD, and PRINTD procedures provide a convenient interface to CD.

Syntax

CD [, *Directory*] [, CURRENT=*variable*]

Arguments

Directory

A scalar string specifying the path of the new working directory. If *Directory* is specified as a null string, the working directory is changed to the user's home directory (UNIX and VMS) or to the directory specified by !DIR (Windows and Macintosh). If this argument is not specified, the working directory is not changed.

Keywords

CURRENT

If CURRENT is present, it specifies a named variable into which the current working directory is stored as a scalar string. The returned directory is the working directory before the directory is changed. Thus, you can obtain the current working directory and change it in a single statement:

```
CD, new_dir, CURRENT=old_dir
```

Note

On Windows and UNIX, the return value of the CURRENT keyword does not include a directory separator at the end of the string. On Macintosh, the return value of the CURRENT keyword includes an appended ':' character on the end of the string, and on VMS, the return value of the CURRENT keyword includes an appended ']' character on the end of the string.

Examples

Windows

To change drives:

```
CD, 'C:'
```

To specify a full path:

```
CD, 'C:\MyData\January'
```

To change from the `C:\MyData` directory to the `C:\MyData\January` directory:

```
CD, 'January'
```

To go back up a directory, use "..". For example, if the current directory is `C:\MyData\January`, you could go up to the `C:\MyData` directory with the following command:

```
CD, '..'
```

If the current directory is `C:\MyData\January`, you could change to the `C:\MyData\February` directory with the following command:

```
CD, '..\February'
```

Unix

To specify a full path:

```
CD, '/home/data/'
```

To change to the `january` subdirectory of the current directory:

```
CD, 'january'
```

To go back up a directory, use "..". For example, if the current directory is `/home/data/january`, you could go up to the `/home/data/` directory with the following command:

```
CD, '..'
```

If the current directory is `/home/data/january`, you could change to the `/home/data/february` directory with the following command:

```
CD, '../february'
```

Macintosh

To change drives, provide a path that begins with a volume name:

```
CD, 'Macintosh volume:'
```

To specify a full path, separate the folders with colons.

```
CD, 'Macinotsh volume:My Data Folder:January:'
```

To specify a partial path from the current folder, begin your path with a colon. For example, to change to the “January” subfolder of the current folder, use:

```
CD, ':January:'
```

To go back up the folder hierarchy, use a leading colon and then add one colon for each level you want to go up. For example, if the current folder is `Macinotsh volume:My Data Folder:January:`, you would go up to the folder `Macinotsh volume:My Data Folder:` with the following command:

```
CD, '::'
```

To go up two folders, use:

```
CD, ':::'
```

You can append a new folder path after a series of colons to go back up the folder hierarchy and then down into a subfolder. For example, to go from the folder `Macinotsh volume:My Data Folder:January:` to the folder `Macinotsh volume:My Data Folder:Febuary:`, use the following command:

```
CD, '::Febuary:'
```

You cannot specify multiple colons in the middle of a path—they must appear at the beginning of the path specifier.

VMS

To change to the `data` subdirectory of the current directory:

```
CD, '[.data]'
```

See Also

PUSHD, POPD

CDF Routines

See "Alphabetical Listing of CDF Routines" in the *Scientific Data Formats* manual.

CEIL

The CEIL function returns the closest integer greater than or equal to its argument.

Syntax

Result = CEIL(*X* [, /L64])

Return Value

If the input value *X* is integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is a 32-bit longword integer with the same structure as *X*.

Arguments

X

The value for which the ceiling function is to be evaluated. This value can be any numeric type (integer, floating, or complex).

Keywords

L64

If set, the result type is 64-bit integer regardless of the input type. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

Example

To print the ceiling function of 5.1, enter:

```
PRINT, CEIL(5.1)
; IDL prints:
6
```

To print the ceiling function of 3000000000.1, the result of which is too large to represent in a 32-bit integer:

```
PRINT, CEIL(3000000000.1D, /L64)
; IDL prints:
3000000001
```

See Also

COMPLEXROUND, FLOOR, ROUND

CHEBYSHEV

The CHEBYSHEV function returns the forward or reverse Chebyshev polynomial expansion of a set of data. Note: Results from this function are subject to roundoff error given discontinuous data.

This routine is written in the IDL language. Its source code can be found in the file `chebyshev.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CHEBYSHEV(*D*, *N*)

Arguments

D

A vector containing the values at the zeros of Chebyshev polynomial.

N

A flag that, if set to -1, returns a set of Chebyshev polynomials. If set to +1, the original data is returned.

See Also

FFT, WTN

CHECK_MATH

The CHECK_MATH function returns and clears the accumulated math error status.

Syntax

Result = CHECK_MATH([, MASK=*bitmask*] [, /NOCLEAR] [, /PRINT])

Return Value

The returned value is the sum of the bit values (described in the following table) of the accumulated errors. Note that not all machines detect all errors.

Value	Condition
0	No errors detected since the last interactive prompt or call to CHECK_MATH
1	Integer divided by zero
2	Integer overflow
16	Floating-point divided by zero
32	Floating-point underflow
64	Floating-point overflow
128	Floating-point operand error. An illegal operand was encountered, such as a negative operand to the SQRT or ALOG functions, or an attempt to convert to integer a number whose absolute value is greater than $2^{31} - 1$

Table 4: Math Error Status Values

Note that each type of error is only represented once in the return value—any number of “Integer divided by zero” errors will result in a return value of 1.

The math error status is cleared (reset to zero) when CHECK_MATH is called, or when errors are reported. Math errors are reported either never, when the interpreter returns to an interactive prompt, or after execution of each IDL statement, depending on the value of the !EXCEPT system variable (see “!EXCEPT” on page 2426). See “Examples” below for further discussion.

Keywords

MASK

If present, the mask of exceptions to check. Otherwise, all exceptions are checked. Exceptions that are pending but not specified by MASK are not reported, and not cleared. Set this keyword equal to the sum of the bit values for each exception to be checked. For a list of the bit values corresponding to various exceptions, see CHECK_MATH.

NOCLEAR

If set, CHECK_MATH returns the pending exceptions (as specified via the MASK keyword) and clears them from its list of pending exceptions. If NOCLEAR is set, the exceptions are not cleared and remain pending.

PRINT

Set this keyword to print an error message to the IDL command log if any accumulated math errors exist. If this keyword is not present, CHECK_MATH executes silently.

Examples

To simply check and clear the accumulated math error status using all the defaults, enter:

```
PRINT, CHECK_MATH()
```

IDL prints the accumulated math error status code and resets to zero.

CHECK_MATH and !EXCEPT

Because the accumulated math error status is cleared when it is reported, the behavior and appropriate use of CHECK_MATH depends on the value of the system variable !EXCEPT.

- If !EXCEPT is set equal to 0, math exceptions are not reported automatically, and thus CHECK_MATH will always return the error status accumulated since the last time it was called.
- If !EXCEPT is set equal to 1, math exceptions are reported when IDL returns to the interactive command prompt. In this case, CHECK_MATH will return appropriate error codes when used *within* an IDL procedure, but will always return zero when called at the IDL prompt.

- If !EXCEPT is set equal to 2, math exceptions are reported after each IDL statement. In this case, CHECK_MATH will return appropriate error codes only when used *within an IDL statement*, and will always return zero otherwise.

For example:

```
;Set value of !EXCEPT to zero.
!EXCEPT=0

;Both of these operations cause errors.
PRINT, 1./0., 1/0
```

IDL prints:

```
Inf    1
```

The special floating-point value Inf is returned for 1./0. There is no integer analogue to the floating-point Inf.

```
;Check the accumulated error status.
PRINT, CHECK_MATH()
```

IDL prints:

```
      17
```

CHECK_MATH reports floating-point and integer divide-by-zero errors.

```
;Set value of !EXCEPT to one.
!EXCEPT=1

;Both of these operations cause errors.
PRINT, 1./0., 1/0
```

IDL prints:

```
Inf    1
% Program caused arithmetic error: Integer divide by 0
% Program caused arithmetic error: Floating divide by 0
```

This time IDL also prints error messages.

```
;Check the accumulated error status.
PRINT, CHECK_MATH()
```

IDL prints:

```
      0
```

The status was reset.

However, if we do not allow IDL to return to an interactive prompt before checking the math error status:

```
;Set value of !EXCEPT to one.
!EXCEPT=1

;Call to CHECK_MATH happens before returning to the
;IDL command prompt.
PRINT, 1./0., 1/0 & PRINT, CHECK_MATH()
```

IDL prints:

```
Inf    1
17
```

In this case, the math error status code (17) is printed, but because the error status has been cleared by the call to CHECK_MATH, no error messages are printed when IDL returns to the interactive command prompt. Finally,

```
;Set value of !EXCEPT to two.
!EXCEPT=2

;Call to CHECK_MATH happens before returning to the
;IDL command prompt.
PRINT, 1./0., 1/0 & PRINT, CHECK_MATH()
```

IDL prints:

```
Inf       1
% Program caused arithmetic error: Integer divide by 0
% Program caused arithmetic error: Floating divide by 0
% Detected at  $MAIN$
           0
```

Errors are printed before executing the CHECK_MATH function, so CHECK_MATH reports no errors. However, if we include the call to CHECK_MATH in the first PRINT command, we see the following:

```
;Call to CHECK_MATH is part of a single IDL statement.
PRINT, 1./0., 1/0, CHECK_MATH()
```

IDL prints:

```
Inf    1    17
```

Printing Error Messages

The following code fragment prints abbreviated names of errors that have occurred:

```
;Create a string array of error names.
ERRS = ['Divide by 0', 'Underflow', 'Overflow', $
```

```
        'Illegal Operand']

;Get math error status.
J = CHECK_MATH()
FOR I = 4, 7 DO IF ISHFT(J, -I) AND 1 THEN $

;Check to see if an error occurred and print the corresponding
;error message.
   PRINT, ERRS(I-4), ' Occurred'
```

Testing Critical Code

Example 1

Assume you have a critical section of code that is likely to produce an error. The following example shows how to check for errors, and if one is detected, how to repeat the code with different parameters.

```
; Clear error status from previous operations, and print error
; messages if an error exists:
JUNK = CHECK_MATH(/PRINT)

; Disable automatic printing of subsequent math errors:
!EXCEPT=0

;Critical section goes here.
AGAIN: ...

; Did an arithmetic error occur? If so, print error message and
; request new values:
IF CHECK_MATH() NE 0 THEN BEGIN
PRINT, 'Math error occurred in critical section.'

; Get new parameters from user:
READ, 'Enter new values.',...

; Enable automatic printing of math errors:
!EXCEPT=2

;And retry:
GOTO, AGAIN
ENDIF
```

Example 2

This example demonstrates the use of the MASK keyword to check for a specific error, and the NOCLEAR keyword to prevent exceptions from being cleared:

```
PRO EXAMPLE2_CHECKMATH
```

```
    PRINT, 1./0
    PRINT, CHECK_MATH(MASK=16,/NOCLEAR)
    PRINT, CHECK_MATH(MASK=2,/NOCLEAR)

END
```

IDL prints:

```
Inf
16
0
% Program caused arithmetic error: Floating divide by 0
```

See Also

FINITE, ISHFT, MACHAR, "!VALUES" on page 2423, "!EXCEPT" on page 2426, "Math Errors" in Chapter 17 of *Building IDL Applications*

CHISQR_CVF

The CHISQR_CVF function computes the cutoff value *V* in a Chi-square distribution with *Df* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `chisqr_cvf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CHISQR_CVF(*P*, *Df*)

Arguments

P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

Df

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the Chi-square distribution.

Example

Use the following command to compute the cutoff value in a Chi-square distribution with three degrees of freedom such that the probability that a random variable X is greater than the cutoff value is 0.100. The result should be 6.25139.

```
PRINT, CHISQR_CVF(0.100, 3)
```

IDL prints:

```
6.25139
```

See Also

CHISQR_PDF, F_CVF, GAUSS_CVF, T_CVF

CHISQR_PDF

The CHISQR_PDF function computes the probability *P* that, in a Chi-square distribution with *Df* degrees of freedom, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `chisqr_pdf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CHISQR_PDF(*V*, *Df*)

Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *V* and *Df*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

Arguments

V

A scalar or array that specifies the cutoff value(s).

Df

A positive scalar or array that specifies the number of degrees of freedom of the Chi-square distribution.

Examples

Use the following command to compute the probability that a random variable X, from the Chi-square distribution with three degrees of freedom, is less than or equal to 6.25. The result should be 0.899939.

```
result = CHISQR_PDF(6.25, 3)
PRINT, result
```

IDL prints:

```
0.899939
```

Compute the probability that a random variable X from the Chi-square distribution with three degrees of freedom, is greater than 6.25. The result should be 0.100061.

```
PRINT, 1 - chisqr_pdf(6.25, 3)
```

IDL prints:

```
0.100061
```

See Also

BINOMIAL, CHISQR_CVF, F_PDF, GAUSS_PDF, T_PDF

CHOLDC

Given a positive-definite symmetric *n* by *n* array *A*, the CHOLDC procedure constructs its Cholesky decomposition $A = LL^T$, where *L* is a lower triangular array and L^T is the transpose of *L*.

CHOLDC is based on the routine `choldc` described in section 2.9 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

CHOLDC, *A*, *P* [, /DOUBLE]

Arguments

A

An *n* by *n* array. On input, only the upper triangle of *A* need be given. On output, *L* is returned in the lower triangle of *A*, except for the diagonal elements, which are returned in the vector *P*.

P

An *n*-element vector containing the diagonal elements of *L*.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

See "CHOLSOL" on page 182.

See Also

CHOLSOL

CHOLSOL

The CHOLSOL function returns an *n*-element vector containing the solution to the set of linear equations Ax = b, where A is the positive-definite symmetric array returned by the CHOLDC procedure.

CHOLSOL is based on the routine `cholsl` described in section 2.9 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = CHOLSOL(*A*, *P*, *B* [, /DOUBLE])

Arguments

A

An *n* by *n* positive-definite symmetric array, as output by CHOLDC. Only the lower triangle of *A* is accessed.

P

The diagonal elements of the Cholesky factor *L*, as computed by CHOLDC.

B

An *n*-element vector containing the right-hand side of the equation.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To solve a positive-definite symmetric system Ax = b:

```
;Define the coefficient array:
A = [[ 6.0, 15.0, 55.0], $
   [15.0, 55.0, 225.0], $
   [55.0, 225.0, 979.0]]

;Define the right-hand side vector B:
B = [9.5, 50.0, 237.0]
```

```
;Compute Cholesky decomposition of A:
CHOLDC, A, P

;Compute and print the solution:
PRINT, CHOLSOL(A, P, B)
```

IDL prints:

```
  -0.499998  -1.00000  0.500000
```

The exact solution vector is [-0.5, -1.0, 0.5].

See Also

CHOLDC, CRAMER, GS_ITER, LU_COMPLEX, LUSOL, SVSOL, TRISOL

CINDGEN

The CINDGEN function returns a complex, single-precision, floating-point array with the specified dimensions. Each element of the array has its real part set to the value of its one-dimensional subscript. The imaginary part is set to zero.

Syntax

Result = CINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create C, a 4-element vector of complex values with the real parts set to the value of their subscripts, enter:

```
C = CINDGEN(4)
```

See Also

BINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

CIR_3PNT

The CIR_3PNT procedure returns the radius and center of a circle, given 3 points on the circle. This is analogous to finding the circumradius and circumcircle of a triangle; the center of the circumcircle is the point at which the three perpendicular bisectors of the triangle formed by the points meet.

This routine is written in the IDL language. Its source code can be found in the file `cir_3pnt.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CIR_3PNT, *X*, *Y*, *R*, *X0*, *Y0*

Arguments

X

A three-element vector containing the X-coordinates of the points.

Y

A three-element vector containing the Y-coordinates of the points.

R

A named variable that will contain the radius of the circle. The procedure returns 0.0 if the points are co-linear.

X0

A named variable that will contain the X-coordinate of the center of the circle. The procedure returns 0.0 if the points are co-linear.

Y0

A named variable that will contain the Y-coordinate of the center of the circle. The procedure returns 0.0 if the points are co-linear.

Example

```
X = [1.0, 2.0, 3.0]
Y = [1.0, 2.0, 1.0]
CIR_3PNT, X, Y, R, X0, Y0
PRINT, 'The radius is: ', R
PRINT, 'The center of the circle is at: ', X0, Y0
```

See Also

PNT_LINE, SPH_4PNT

CLOSE

The CLOSE procedure closes the file units specified as arguments. All open files are also closed when IDL exits.

Syntax

CLOSE[, $Unit_1$, ..., $Unit_n$] [, /ALL] [, EXIT_STATUS=*variable*] [, /FILE] [, /FORCE]

Arguments

$Unit_i$

The IDL file units to close.

Keywords

ALL

Set this keyword to close all open file units. In addition, any file units that were allocated via GET_LUN are freed.

EXIT_STATUS

Set this keyword to a named varible that will contain the exit status reported by a UNIX child process started via the UNIT keyword to SPAWN. This value is the exit value reported by the process by calling EXIT, and is analogous to the value returned by $? under most UNIX shells. If used with any other type of file, 0 is returned. EXIT_STATUS is not allowed in conjunction with the ALL or FILE keywords.

FILE

Set this keyword to close all file units from 1 to 99. File units greater than 99, which are associated with the GET_LUN and FREE_LUN procedures, are not affected.

FORCE

Overrides the IDL file output buffer and forces the file to be closed no matter what errors occur in the process.

IDL buffers file output for performance reasons. If it is not possible to properly flush this data when a file close is requested, an error is normally issued and the file remains open. An example of this might be that your disk does not have room to write the remaining data. This default behavior prevents data from being lost. To override

it and force the file to be closed no matter what errors occur in the process, specify FORCE.

Example

If file units 1 and 3 are open, they can both be closed at the same time by entering the command:

```
CLOSE, 1, 3
```

See Also

OPEN

CLUST_WTS

The CLUST_WTS function computes the weights (the cluster centers) of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples. The result is an *m*-column, N_CLUSTERS-row array of cluster centers.

This routine is written in the IDL language. Its source code can be found in the file `clust_wts.pro` in the `lib` subdirectory of the IDL distribution.

For more information on cluster analysis, see:

Everitt, Brian S. *Cluster Analysis*. New York: Halsted Press, 1993. ISBN 0-470-22043-0

Syntax

Result = CLUST_WTS(*Array* [, /DOUBLE] [, N_CLUSTERS=*value*] [, N_ITERATIONS=*integer*] [, VARIABLE_WTS=*vector*])

Arguments

Array

An *m*-column, *n*-row array of any data type except string, single- or double-precision complex.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

N_CLUSTERS

Set this keyword equal to the number of cluster centers. The default is to compute *n* cluster centers.

N_ITERATIONS

Set this keyword equal to the number of iterations used when in computing the cluster centers. The default is to use 20 iterations.

VARIABLE_WTS

Set this keyword equal to an *m*-element vector of floating-point variable weights. The elements of this vector are used to give greater or lesser importance to each variable (each column) in determining the cluster centers. The default is to give all variables equal weighting using a value of 1.0.

Example

See "CLUSTER" on page 191.

See Also

CLUSTER, "Multivariate Analysis" in Chapter 16 of *Using IDL*.

CLUSTER

The CLUSTER function computes the classification of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples. The classification is based upon a cluster analysis of sample-based distances. The result is a 1-column, *n*-row array of cluster number assignments that correspond to each sample.

This routine is written in the IDL language. Its source code can be found in the file `cluster.pro` in the `lib` subdirectory of the IDL distribution.

For more information on cluster analysis, see:

Everitt, Brian S. *Cluster Analysis*. New York: Halsted Press, 1993. ISBN 0-470-22043-0

Syntax

Result = CLUSTER(*Array*, *Weights* [, /DOUBLE] [, N_CLUSTERS=*value*])

Arguments

Array

An M-column, N-row array of type float or double.

Weights

An array of weights (the cluster centers) computed using the CLUST_WTS function. The dimensions of this array vary according to keyword values.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

N_CLUSTERS

Set this keyword equal to the number of clusters. The default is based upon the row dimension of the *Weights* array.

Example

```
; Define an array with 4 variables and 10 observations:
array = $
[[ 1.5, 43.1, 29.1,  1.9], $
 [24.7, 49.8, 28.2, 22.8], $
 [30.7, 51.9,  7.0, 18.7], $
 [ 9.8,  4.3, 31.1,  0.1], $
 [19.1, 42.2,  0.9, 12.9], $
 [25.6, 13.9,  3.7, 21.7], $
 [ 1.4, 58.5, 27.6,  7.1], $
 [ 7.9,  2.1, 30.6,  5.4], $
 [22.1, 49.9,  3.2, 21.3], $
 [ 5.5, 53.5,  4.8, 19.3]]

; Compute the cluster weights, using two distinct clusters:
weights = CLUST_WTS(array, N_CLUSTERS=2)

; Compute the classification of each sample:
result = CLUSTER(array, weights, N_CLUSTERS=2)

; Print each sample (each row) of the array and its corresponding
; cluster assignment:
FOR k = 0, N_ELEMENTS(result)-1 DO PRINT, $
array[*,k], result(k), FORMAT = '(4(f4.1, 2x), 5x, i1)'
```

IDL prints:

```
 1.5  43.1  29.1   1.9       1
24.7  49.8  28.2  22.8       0
30.7  51.9   7.0  18.7       0
 9.8   4.3  31.1   0.1       1
19.1  42.2   0.9  12.9       0
25.6  13.9   3.7  21.7       0
 1.4  58.5  27.6   7.1       1
 7.9   2.1  30.6   5.4       1
22.1  49.9   3.2  21.3       0
 5.5  53.5   4.8  19.3       0
```

See Also

CLUST_WTS, PCOMP, STANDARDIZE, "Multivariate Analysis" in Chapter 16 of *Using IDL*.

COLOR_CONVERT

The COLOR_CONVERT procedure converts colors to and from the RGB (Red Green Blue), HLS (Hue Lightness Saturation), and HSV (Hue Saturation Value) color systems. A keyword parameter indicates the type of conversion to be performed (one of the keywords must be specified). The first three parameters contain the input color triple(s) which may be scalars or arrays of the same size. The result is returned in the last three parameters, O_0, O_1, and O_2. RGB values are bytes in the range 0 to 255.

Hue is measured in degrees, from 0 to 360. Saturation, Lightness, and Value are floating-point numbers in the range 0 to 1. A Hue of 0 degrees is the color red. Green is 120 degrees. Blue is 240 degrees. A reference containing a discussion of the various color systems is: Foley and Van Dam, *Fundamentals of Interactive Computer Graphics*, Addison-Wesley Publishing Co., 1982.

Syntax

COLOR_CONVERT, I_0, I_1, I_2, O_0, O_1, O_2 {, /HLS_RGB | , /HSV_RGB | , /RGB_HLS | , /RGB_HSV}

Arguments

I_0, I_1, I_2

The input color triple(s). These arguments may be either scalars or arrays of the same length.

O_0, O_1, O_2

The variables to receive the result. Their structure is copied from the input parameters.

Keywords

HLS_RGB

Set this keyword to convert from HLS to RGB.

HSV_RGB

Set this keyword to convert from HSV to RGB.

RGB_HLS

Set this keyword to convert from RGB to HLS.

RGB_HSV

Set this keyword to convert from RGB to HSV.

Example

The command:

```
COLOR_CONVERT, 255, 255, 0, h, s, v, /RGB_HSV
```

converts the RGB color triple (255, 255, 0), which is the color yellow at full intensity and saturation, to the HSV system. The resulting hue in the variable h is 60.0 degrees. The saturation and value, s and v, are set to 1.0.

See Also

HLS, HSV

COLOR_QUAN

The COLOR_QUAN function quantizes a TrueColor image and returns a pseudo-color image and palette to display the image on standard pseudo-color displays. The output image and palette can have from 2 to 256 colors.

COLOR_QUAN solves the general problem of accurately displaying decomposed, TrueColor images, that contain a palette of up to 2^{24} colors, on pseudo-color displays that can only display 256 (or fewer) simultaneous colors.

Syntax

Result = COLOR_QUAN(*Image_R*, *Image_G*, *Image_B*, *R*, *G*, *B*)

or

Result = COLOR_QUAN(*Image*, *Dim*, *R*, *G*, *B*)

Keywords: [, COLORS=*integer*{2 to 256}] [, CUBE={2 | 3 | 4 | 5 | 6} | , GET_TRANSLATION=*variable* [, /MAP_ALL]] [, /DITHER] [, ERROR=*variable*] [, TRANSLATION=*vector*]

Note that the input image parameter can be passed as either three, separate color-component arrays (*Image_R*, *Image_G*, *Image_B*) or as a three-dimensional array containing all three components, *Image*, and a scalar, *Dim*, indicating the dimension over which the colors are interleaved.

Using COLOR_QUAN

One of two color quantization methods can be used:

- Method 1 is a statistical method that attempts to find the N colors that most accurately represent the original color distribution. This algorithm uses a variation of the Median Cut Algorithm, described in “Color Image Quantization for Frame Buffer Display”, from *Computer Graphics*, Volume 16, Number 3 (July, 1982), Page 297. It repeatedly subdivides the color space into smaller and smaller rectangular boxes, until the requested number of colors are obtained.

  The original colors are then mapped to the nearest output color, and the original image is resampled to the new palette with optional Floyd-Steinberg color dithering. The resulting pseudo-color image and palette are usually a good approximation of the original image.

The number of colors in the output palette defaults to the number of colors supported by the currently-selected graphics output device. The number of colors can also be specified by the COLOR keyword parameter.

- Method 2, selected by setting the keyword parameter CUBE, divides the three-dimensional color space into equal-volume cubes. Each color axis is divided into CUBE segments, resulting in $CUBE^3$ volumes. The original input image is sampled to this color space using Floyd-Steinberg dithering, which distributes the quantization error to adjacent pixels.

  The CUBE method has the advantage that the color tables it produces are independent of the input image, so that multiple quantized images can be viewed simultaneously. The statistical method usually provides a better-looking result and a smaller global error.

COLOR_QUAN can use the same color mapping for a series of images. See the descriptions of the GET_TRANSLATION, MAP_ALL, and TRANSLATION keywords, below.

Arguments

Image_R, Image_G, Image_B

Arrays containing the red, green, and blue components of the decomposed TrueColor image. For best results, the input image(s) should be scaled to the range of 0 to 255.

Image

A three-dimensional array containing all three components of the TrueColor image.

Dim

A scalar that indicates the method of color interleaving in the *Image* parameter. A value of 1 indicates interleaving by pixel: (3, *n*, *m*). A value of 2 indicates interleaving by row: (*n*, 3, *m*). A value of 3 indicates interleaving by image: (*n*, *m*, 3).

R, G, B

Three output byte arrays containing the red, green, and blue components of the output palette.

Keywords

COLORS

The number of colors in the output palette. This value must be at least 2 and not greater than 256. The default is the number of colors supported by the current graphics output device.

CUBE

If this keyword is set, the color space is divided into $CUBE^3$ volumes, to which the input image is quantized. This result is always Floyd-Steinberg dithered. The value of CUBE can range from 2 to 6; providing from $2^3 = 8$, to $6^3 = 216$ output colors. If this keyword is set, the COLORS, DITHER, and ERROR keywords are ignored.

DITHER

Set this keyword to dither the output image. Dithering can improve the appearance of the output image, especially when using relatively few colors.

ERROR

Set this optional keyword to a named variable. A measure of the quantization error is returned. This error is proportional to the square of the Euclidean distance, in RGB space, between corresponding colors in the original and output images.

GET_TRANSLATION

Set this keyword to a named variable in which the mapping between the original RGB triples (in the TrueColor image) and the resulting pseudo-color indices is returned as a vector. Do not use this keyword if CUBE is set.

MAP_ALL

Set this keyword to establish a mapping for all possible RGB triples into pseudo-color indices. Set this keyword only if GET_TRANSLATION is also present. Note that mapping all possible colors requires more compute time and slightly degrades the quality of the resultant color matching.

TRANSLATION

Set this keyword to a vector of translation indices obtained by a previous call to COLOR_QUAN using the GET_TRANSLATION keyword. The resulting image is quantized using this vector.

Example

The following code segment reads a TrueColor, row interleaved, image from a disk file, and displays it on the current graphics display, using a palette of 128 colors:

```
;Open an input file:
OPENR, unit, 'XXX.DAT', /GET_LUN

;Dimensions of the input image:
a = BYTARR(512, 3, 480)

;Read the image:
READU, unit, a

;Close the file:
FREE LUN, unit

;Show the quantized image. The 2 indicates that the colors are
;interleaved by row:
TV, COLOR_QUAN(a, 2, r, g, b, COLORS=128)

;Load the new palette:
TVLCT, r, g, b
```

To quantize the image into 216 equal-volume color cubes, replace the call to COLOR_QUAN with the following:

```
TV, COLOR_QUAN(a, 2, r, g, b, CUBE=6)
```

See Also

PSEUDO

COLORMAP_APPLICABLE

The COLORMAP_APPLICABLE function determines whether the current visual class supports the use of a colormap, and if so, whether colormap changes affect pre-displayed Direct Graphics or if the graphics must be redrawn to pick up colormap changes.

This routine is written in the IDL language. Its source code can be found in the file `colormap_applicable.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = COLORMAP_APPLICABLE(*redrawRequired*)

Return Value

The function returns a long value of 1 if the current visual class allows modification of the color table, and 0 otherwise.

Arguments

redrawRequired

A named variable to retrieve a value indicating whether the visual class supports automatic updating of graphics. The value is 0 if the graphics are updated automatically, or 1 if the graphics must be redrawn to pick up changes to the colormap.

Keywords

None.

Example

To determine whether to redisplay an image after a colormap change:

```
result = COLORMAP_APPLICABLE(redrawRequired)
IF ((result GT 0) AND (redrawRequired GT 0)) THEN BEGIN
   my_redraw
ENDIF
```

COMFIT

The COMFIT function fits the paired data {*xi*, *yi*} to one of six common types of approximating models using a gradient-expansion least-squares method. The result is a vector containing the model parameters a_0, a_1, a_2, etc.

This routine is written in the IDL language. Its source code can be found in the file `comfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = COMFIT(*X*, *Y*, *A* {, /EXPONENTIAL | , /GEOMETRIC | , /GOMPERTZ | , /HYPERBOLIC | , /LOGISTIC | , /LOGSQUARE} [, SIGMA=*variable*] [, WEIGHTS=*vector*] [, YFIT=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *n*-element integer, single-, or double-precision floating-point vector.

A

A vector of initial estimates for each model parameter. The length of this vector depends upon the type of model selected.

Keywords

Note

One of the following keywords specifying a type of model must be set when using COMFIT. If you do not specify a model, IDL will display a warning message when COMFIT is called.

EXPONENTIAL

Set this keyword to compute the parameters of the exponential model.

$$y = a_0 a_1^x + a_2$$

GEOMETRIC

Set this keyword to compute the parameters of the geometric model.

$$y = a_0 x^{a_1} + a_2$$

GOMPERTZ

Set this keyword to compute the parameters of the Gompertz model.

$$y = a_0 a_1^{a_2 x} + a_3$$

HYPERBOLIC

Set this keyword to compute the parameters of the hyperbolic model.

$$y = \frac{1}{a_0 + a_1 x}$$

LOGISTIC

Set this keyword to compute the parameters of the logistic model.

$$y = \frac{1}{a_0 a_1^{x} + a_2}$$

LOGSQUARE

Set this keyword to compute the parameters of the logsquare model.

$$y = a_0 + a_1 \log(x) + a_2 \log(x)^2$$

SIGMA

Set this keyword to a named variable that will contain a vector of standard deviations for the computed model parameters.

WEIGHTS

Set this keyword equal to a vector of weights for Y_i. This vector should be the same length as *X* and *Y*. The error for each term is weighted by $WEIGHTS_i$ when computing the fit. Frequently, $WEIGHTS_i = 1.0/\sigma^2_i$, where σ is the measurement error or standard deviation of Y_i (Gaussian or instrumental weighting), or WEIGHTS = 1/Y (Poisson or statistical weighting). If WEIGHTS is not specified, $WEIGHTS_i$ is assumed to be 1.0.

YFIT

Set this keyword to a named variable that will contain an *n*-element vector of y-data corresponding to the computed model parameters.

Example

```
; Define two n-element vectors of paired data:
X = [ 2.27, 15.01, 34.74, 36.01, 43.65, 50.02, 53.84, 58.30, $
     62.12, 64.66, 71.66, 79.94, 85.67, 114.95]
Y = [ 5.16, 22.63, 34.36, 34.92, 37.98, 40.22, 41.46, 42.81, $
     43.91, 44.62, 46.44, 48.43, 49.70, 55.31]

; Define a 3-element vector of initial estimates for the logsquare
; model:
A = [1.5, 1.5, 1.5]

; Compute the model parameters of the logsquare model, A[0], A[1],
; & A[2]:
result = COMFIT(X, Y, A, /LOGSQUARE)
```

The result should be the 3-element vector: [1.42494, 7.21900, 9.18794].

See Also

CURVEFIT, LADFIT, LINFIT, LMFIT, POLY_FIT, SVDFIT

COMMON

The COMMON statement creates a common block.

Note

For more information on using COMMON, see Chapter 3, "Constants and Variables" in *Building IDL Applications*.

Syntax

COMMON *Block_Name*, $Variable_1$, ..., $Variable_n$

COMPILE_OPT

The COMPILE_OPT statement allows the author to give the IDL compiler information that changes some of the default rules for compiling the function or procedure within which the COMPILE_OPT statement appears.

Research Systems recommends the use of

```
COMPILE_OPT IDL2
```

in all new code intended for use in a reusable library. We further recommend the use of

```
COMPILE_OPT idl2, HIDDEN
```

in all such routines that are not intended to be called directly by regular users (e.g. helper routines that are part of a larger package).

Note

For information on using COMPILE_OPT, see Chapter 12, "Procedures and Functions" in *Building IDL Applications*.

Syntax

COMPILE_OPT opt_1 [, opt_2, ..., opt_n]

Arguments

opt_n

This argument can be any of the following:

- **IDL2** — A shorthand way of saying:

  ```
  COMPILE_OPT DEFINT32, STRICTARR
  ```

- **DEFINT32** — IDL should assume that lexical integer constants default to the 32-bit type rather than the usual default of 16-bit integers. This takes effect from the point where the COMPILE_OPT statement appears in the routine being compiled and remains in effect until the end of the routine. The

following table illustrates how the DEFINT32 argument changes the interpretation of integer constants:

Constant	Normal Type	DEFINT32 Type
Without type specifier:		
`42`	INT	LONG
`'2a'x`	INT	LONG
`42u`	UINT	ULONG
`'2a'xu`	UINT	ULONG
With type specifier:		
`0b`	BYTE	BYTE
`0s`	INT	INT
`0l`	LONG	LONG
`42.0`	FLOAT	FLOAT
`42d`	DOUBLE	DOUBLE
`42us`	UINT	UINT
`42ul`	ULONG	ULONG
`42ll`	LONG64	LONG64
`42ull`	ULONG64	ULONG64

Table 5: Examples of the effect of the DEFINT32 argument

- **HIDDEN** — This routine should not be displayed by HELP, unless the FULL keyword to HELP is used. This directive can be used to hide helper routines that regular IDL users are not interested in seeing.

  A side-effect of making a routine hidden is that IDL will not print a “Compile module” message for it when it is compiled from the library to satisfy a call to it. This makes hidden routines appear built-in to the user.

- **OBSOLETE** — If the user has !WARN.OBS_ROUTINES set to True, attempts to compile a call to this routine will generate warning messages that this routine is obsolete. This directive can be used to warn people that there may be better ways to perform the desired task.

- **STRICTARR** — While compiling this routine, IDL will not allow the use of parentheses to index arrays, reserving their use only for functions. Square brackets are then the only way to index arrays. Use of this directive will prevent the addition of a new function in future versions of IDL, or new libraries of IDL code from any source, from changing the meaning of your code, and is an especially good idea for library functions.

  Use of STRICTARR can eliminate many uses of the FORWARD_FUNCTION definition.

Note

STRICTARR has no effect on the use of parentheses to reference structure tags using the tag index, which is not an array indexing operation. For example, no syntax error will occur when compiling the following code:

```
COMPILE_OPT STRICTARR
mystruct = {a:0, b:1}
byindex_0 = mystruct.(0)
```

For more on referencing structure tags by index, see "Advanced Structure Usage" in Chapter 6 of *Building IDL Applications*.

COMPLEX

The COMPLEX function returns complex scalars or arrays given one or two scalars or arrays. If only one parameter is supplied, the imaginary part of the result is zero, otherwise it is set to the value of the *Imaginary* parameter. Parameters are first converted to single-precision floating-point. If either or both of the parameters are arrays, the result is an array, following the same rules as standard IDL operators. If three parameters are supplied, COMPLEX extracts fields of data from *Expression*.

Syntax

Result = COMPLEX(*Real* [, *Imaginary*])

or

Result = COMPLEX(*Expression*, *Offset*, Dim_1 [, ..., Dim_8])

Arguments

Real

Scalar or array to be used as the real part of the complex result.

Imaginary

Scalar or array to be used as the imaginary part of the complex result.

Expression

The expression from which data is to be extracted.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as complex data. See the description in Chapter 3, "Constants and Variables" of *Using IDL* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such

cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

Create a complex array from two integer arrays by entering the following commands:

```
; Create the first integer array:
A = [1,2,3]

; Create the second integer array:
B = [4,5,6]

; Make A the real parts and B the imaginary parts of the new
; complex array:
C = COMPLEX(A, B)

; See how the two arrays were combined:
PRINT, C
```

IDL prints:

```
( 1.00000, 4.00000)( 2.00000, 5.00000)
( 3.00000, 6.00000)
```

The real and imaginary parts of the complex array can be extracted as follows:

```
; Print the real part of the complex array C:
PRINT, 'Real Part: ', FLOAT(C)

; Print the imaginary part of the complex array C:
PRINT, 'Imaginary Part: ', IMAGINARY(C)
```

IDL prints:

```
Real Part:         1.00000   2.00000   3.00000
Imaginary Part:    4.00000   5.00000   6.00000
```

See Also

BYTE, CONJ, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

COMPLEXARR

The COMPLEXARR function returns a complex, single-precision, floating-point vector or array.

Syntax

Result = COMPLEXARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters may be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, COMPLEXARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed, and COMPLEXARR executes faster.

Example

To create an empty, 5-element by 5-element, complex array C, enter:

```
C = COMPLEXARR(5, 5)
```

See Also

DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

COMPLEXROUND

The COMPLEXROUND function rounds real and imaginary components of a complex array and returns the resulting array. If the array is double-precision complex, then the result is also double-precision complex.

This routine is written in the IDL language. Its source code can be found in the file `complexround.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = COMPLEXROUND(*Input*)

Arguments

Input

The complex array to be rounded.

Example

```
X = [COMPLEX(1.245, 3.88), COMPLEX(9.1, 0.3345)]
PRINT, COMPLEXROUND(X)
```

IDL prints:

```
(   1.00000,   4.00000)(   9.00000,   0.00000)
```

See Also

ROUND

COMPUTE_MESH_NORMALS

The COMPUTE_MESH_NORMALS function computes normal vectors for a set of polygons described by the input array. The return value is a 3 x *M* array containing a unit normal for each vertex in the input array.

Syntax

Result = COMPUTE_MESH_NORMALS(*fVerts*[, *iConn*])

Arguments

fVerts

A 3 x *M* array of vertices.

iConn

A connectivity array (see the POLYGONS keyword to IDLgrPolygon::Init). If no *iConn* array is provided, it is assumed that the vertices in *fVerts* constitute a single polygon.

Keywords

None.

COND

The COND function returns the condition number of an *n* by *n* real or complex array *A* by explicitly computing NORM(A)·NORM(A^{-1}). If *A* is real and A^{-1} is invalid (due to the singularity of *A* or floating-point errors in the INVERT function), COND returns -1. If *A* is complex and A^{-1} is invalid (due to the singularity of *A*), calling COND results in floating-point errors.

This routine is written in the IDL language. Its source code can be found in the file `cond.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = COND(*A* [, /DOUBLE])

Arguments

A

An *n* by *n* real or complex array.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define a complex array A:
A = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3, 1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)], $
     [COMPLEX(1, 1), COMPLEX(0, 1), COMPLEX(1, 5)]]

; Compute the condition number of the array using internal
; double-precision arithmetic:
PRINT, COND(A, /DOUBLE)
```

IDL prints:

```
5.93773
```

See Also

DETERM, INVERT

CONGRID

The CONGRID function shrinks or expands the size of an array by an arbitrary amount. CONGRID is similar to REBIN in that it can resize a one, two, or three dimensional array, but where REBIN requires that the new array size must be an integer multiple of the original size, CONGRID will resize an array to any arbitrary size. (REBIN is somewhat faster, however.) REBIN averages multiple points when shrinking an array, while CONGRID just resamples the array.

The returned array has the same number of dimensions as the original array and is of the same data type.

This routine is written in the IDL language. Its source code can be found in the file `congrid.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CONGRID(*Array*, *X*, *Y*, *Z* [, CUBIC=*value*{-1 to 0}] [, /INTERP] [, /MINUS_ONE])

Arguments

Array

A 1-, 2-, or 3-dimensional array to resize. *Array* can be any type except string or structure.

X

The new X-dimension of the resized array. *X* must be an integer or a long integer, and must be greater than or equal to 2.

Y

The new Y-dimension of the resized array. If the original array has only 1 dimension, *Y* is ignored. If the original array has 2 or 3 dimensions *Y* MUST be present.

Z

The new Z-dimension of the resized array. If the original array has only 1 or 2 dimensions, *Z* is ignored. If the original array has 3 dimensions then *Z* MUST be present.

Keywords

CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm. This keyword has no effect when used with 3-dimensional arrays.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than ω_0, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used. Note that cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

INTERP

Set this keyword to force CONGRID to use linear interpolation when resizing a 1- or 2-dimensional array. CONGRID automatically uses linear interpolation if the input array is 3-dimensional. When the input array is 1- or 2-dimensional, the default is to employ nearest-neighbor sampling.

MINUS_ONE

Set this keyword to prevent CONGRID from extrapolating one row or column beyond the bounds of the input array. For example, if the input array has the dimensions (*i, j*) and the output array has the dimensions (*x, y*), then by default the array is resampled by a factor of (*i*/*x*) in the X direction and (*j*/*y*) in the Y direction. If

MINUS_ONE is set, the array will be resampled by the factors (*i*-1)/(*x*-1) and (*j*-1)/(*y*-1).

Example

Given `vol` is a 3-D array with the dimensions (80, 100, 57), resize it to be a (90, 90, 80) array

```
vol = CONGRID(vol, 90, 90, 80)
```

See Also

REBIN

CONJ

The CONJ function returns the complex conjugate of *X*. The complex conjugate of the real-imaginary pair (*x*, *y*) is (*x*, -*y*). If *X* is not complex, a complex-valued copy of *X* is used.

Syntax

Result = CONJ(*X*)

Arguments

X

The value for which the complex conjugate is desired. If *X* is an array, the result has the same structure, with each element containing the complex conjugate of the corresponding element of *X*.

Example

Print the conjugate of the complex pair (4.0, 5.0) by entering:

```
PRINT, CONJ(COMPLEX(4.0, 5.0))
```

IDL prints:

```
( 4.00000, -5.00000)
```

See Also

CINDGEN, COMPLEX, COMPLEXARR, DCINDGEN, DCOMPLEX, DCOMPLEXARR

CONSTRAINED_MIN

The CONSTRAINED_MIN procedure solves nonlinear optimization problems of the following form:

Minimize or maximize gp(X), subject to:

$$glb_i \le g_i(X) \le gub_i \qquad \text{for } i = 0,...,nfuns-1,\ i \ne p$$

$$xlb_j \le x_j \le xub_j \qquad \text{for } j = 0,...,nvars-1$$

X is a vector of *nvars* variables, x_0 ,...,x_{nvars}-*1*, and *G* is a vector of *nfuns* functions g_0 ,...,g_{nfuns}-*1*, which all depend on *X*. Any of these functions may be nonlinear. Any of the bounds may be infinite and any of the constraints may be absent. If there are no constraints, the problem is solved as an unconstrained optimization problem. The program solves problems of this form by the Generalized Reduced Gradient Method. See References 1-4.

CONSTRAINED_MIN uses first partial derivatives of each function g_i with respect to each variable x_j. These are automatically computed by finite difference approximation (either forward or central differences).

CONSTRAINED_MIN is based on an implementation of the GRG algorithm supplied by Windward Technologies, Inc. See Reference 11.

Syntax

CONSTRAINED_MIN, *X*, *Xbnd*, *Gbnd*, *Nobj*, *Gcomp*, *Inform* [, ESPTOP=*value*] [, LIMSER=*value*] [, /MAXIMIZE] [, NSTOP=*value*] [, REPORT=*filename*] [, TITLE=*string*]

Arguments

X

An *nvars*-element vector. On input, *X* contains initial values for the variables. On output, *X* contains final values of the variable settings determined by CONSTRAINED_MIN.

Xbnd

Bounds on variables. *Xbnd* is an *nvars x 2* element array.

- *Xbnd[j,0]* is the lower bound for variable *x[j]*.
- *Xbnd[j,1]* is the upper bound for variable *x[j]*.

- Use -1.0e30 to denote no lower bound and 1.0e30 for no upper bound.

Gbnd

Bounds on constraint functions. *Gbnd* is an *nfuns x 2* element array.

- *Gbnd[i,0]* is the lower bound for function *g[i]*.
- *Gbnd[i,1]* is the upper bound for function *g[i]*.
- use -1.0e30 to denote no lower bound and 1.0e30 for no upper bound.

Bounds on the objective function are ignored; set them to 0.

Nobj

Index of the objective function.

Gcomp

A scalar string specifying the name of a user-supplied IDL function. This function must accept an *nvars*-element vector argument *x* of variable values and return an *nfuns*-element vector *G* of function values.

Inform

Termination status returned from CONSTRAINED_MIN.

***Inform* value**	**Message**
0	Kuhn-Tucker conditions satisfied. This is the best possible indicator that an optimal point has been found.
1	Fractional change in objective less than EPSTOP for NSTOP consecutive iterations. See Keywords below. This is not as good as *Inform*=0, but still indicates the likelihood that an optimal point has been found.
2	All remedies have failed to find a better point. User should check functions and bounds for consistency and, perhaps, try other starting values.

Table 6: Inform argument values

Inform value	Message
3	Number of completed 1-dimensional searches exceeded LIMSER. See Keywords below. User should check functions and bounds for consistency and, perhaps, try other starting values. It might help to increase LIMSER. Use LIMSER=*larger_value* to do this.
4	Objective function is unbounded. CONSTRAINED_MIN has observed dramatic change in the objective function over several steps. This is a good indication that the objective function is unbounded. If this is not the case, the user should check functions and bounds for consistency.
5	Feasible point not found. CONSTRAINED_MIN was not able to find a feasible point. If the problem is believed to be feasible, the user should check functions and bounds for consistency and perhaps try other starting values.
6	Degeneracy has been encountered. The point returned may be close to optimal. The user should check functions and bounds for consistency and perhaps try other starting values.
7	Noisy and nonsmooth function values. Possible singularity or error in the function evaluations.
8	Optimization process terminated by user request.
9	Maximum number of function evaluations exceeded.
–1	Fatal Error. Some condition, such as *nvar*s < 0, was encountered. CONSTRAINED_MIN documented the condition in the report and terminated. In this case, the user needs to correct the input and rerun CONSTRAINED_MIN.
–2	Fatal Error. The report file could not be opened. Check the filename specified via the REPORT keyword, and make sure you have write privileges to the specified path.

Table 6: Inform argument values

Inform value	Message
–3	Fatal Error. Same as *Inform* = –1. In this case, the REPORT keyword was not specified. Specify the REPORT keyword and rerun CONSTRAINED_MIN, then check the report file for more detail on the error.

Table 6: Inform argument values

Keywords

EPSTOP

Set this keyword to specify the CONSTRAINED_MIN convergence criteria. If the fractional change in the objective function is less than EPSTOP for NSTOP consecutive iterations, the program will accept the current point as optimal. CONSTRAINED_MIN will accept the current point as optimal if the Kuhn-Tucker optimality conditions are satisfied to EPSTOP. By default, EPSTOP = 1.0e-4.

LIMSER

If the number of completed one dimensional searches exceeds LIMSER, CONSTRAINED_MIN terminates and returns inform = 3. By default: LIMSER = 10000.

MAXIMIZE

By default, the CONSTRAINED_MIN procedure performs a minimization. Set the MAXIMIZE keyword to perform a maximization instead.

NSTOP

Set this keyword to specify the CONSTRAINED_MIN convergence criteria. If the fractional change in the objective function is less than EPSTOP for NSTOP consecutive iterations, CONSTRAINED_MIN will accept the current point as optimal. By default, NSTOP = 3.

REPORT

Set this keyword to specify a name for the CONSTRAINED_MIN report file. If the specified file does not exist, it will be created. Note that if the file cannot be created, no error message will be generated. If the specified file already exists, it will be overwritten. By default, CONSTRAINED_MIN does not create a report file.

TITLE

Set this keyword to specify a title for the problem in the CONSTRAINED_MIN report.

Example

This example has 5 variables {X0, X1, ..., X4}, bounded above and below, a quadratic objective function {G3}, and three quadratic constraints {G0, G1, G2}, with both upper and lower bounds. See the Himmelblau text [7], problem 11.

Minimize:

G3 = 5.3578547X2X2 + 0.8356891X0X4 + 37.293239X0 - 40792.141

Subject to:

0 < G0 = 85.334407 + 0.0056858X1X4 + 0.0006262X0X3 - 0.0022053X2X4 < 92

90 < G1 = 80.51249 + 0.0071317X1X4 + 0.0029955X0X1 + 0.0021813X2X2 < 110

20 < G2 = 9.300961 + 0.0047026X2X4 + 0.0012547X0X2 + 0.0019085X2X3 < 25

and,

78 < X0 < 102

33 < X1 < 45

27 < X2 < 45

27 < X3 < 45

27 < X4 < 45

This problem is solved starting from X = {78, 33, 27, 27, 27} which is infeasible because constraint G2 is not satisfied at this point.

The constraint functions and objective function are evaluated by HMBL11:

```
; Himmelblau Problem 11
; 5 variables and 4 functions
FUNCTION HMBL11, x

g = DBLARR(4)
g[0] = 85.334407 + 0.0056858*x[1]*x[4] + 0.0006262*x[0] $
   *x[3] - 0.0022053*x[2]*x[4]
g[1] = 80.51249 + 0.0071317*x[1]*x[4] + 0.0029955*x[0] $
   *x[1] + 0.0021813*x[2]*x[2]
g[2] = 9.300961 + 0.0047026*x[2]*x[4] + 0.0012547*x[0]* $
   x[2] + 0.0019085*x[2]*x[3]
```

```
g[3] = 5.3578547*x[2]*x[2] + 0.8356891*x[0]*x[4] $
   + 37.293239*x[0] - 40792.141
RETURN, g
END

; Example problem for CONSTRAINED_MIN
; Himmelblau Problem 11
; 5 variables and 3 constraints
; Constraints and objective defined in HMBL11
xbnd   = [[78, 33, 27, 27, 27], [102, 45, 45, 45, 45]]
gbnd   = [[0, 90, 20, 0], [92, 110, 25, 0 ]]
nobj   = 3
gcomp  = 'HMBL11'
title  = 'IDL:  Himmelblau 11'
report = 'hmbl11.txt'
x      = [78, 33, 27, 27, 27]
CONSTRAINED_MIN, x, xbnd, gbnd, nobj, gcomp, inform, $
   REPORT = report, TITLE = title
g = HMBL11(x)
; Print minimized objective function for HMBL11 problem:
PRINT, g[nobj]
```

References

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3. Abadie, J. and Carpentier, J. “Generalization of the Wolfe Reduced Gradient Method to the Case of Nonlinear Constraints”, in Optimization, R. Fletcher (ed.), Academic Press London; 1969, pp. 37-47.

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5. Powell, M.J.D., “Restart Procedures for the Conjugate Gradient Method,” Mathematical Programming, Vol. 12, No. 2, April 1977, pp. 241-255.

6. Colville, A.R., “A Comparative Study of Nonlinear Programming Codes,” I.B.M. T.R. no. 320-2949 (1968).

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8. Fletcher, R., “A New Approach to Variable Metric Algorithms”, Computer Journal, Vol. 13, 1970, pp. 317-322.

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11. Windward Technologies, GRG2 Users’s Guide, 1997.

CONTINUE

The CONTINUE statement provides a convenient way to immediately start the next iteration of the enclosing FOR, WHILE, or REPEAT loop.

Note

Do not confuse the CONTINUE statement described here with the .CONTINUE executive command. The two constructs are not related, and serve completely different purposes.

Note

CONTINUE is not allowed within CASE or SWITCH statements. This is in contrast with the C language, which does allow this.

For more information on using CONTINUE and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

CONTINUE

Example

This example presents one way (not necessarily the best) to print the even numbers between 1 and 10.

```
FOR I = 1,10 DO BEGIN
   ; If odd, start next iteration:
   IF (I AND 1) THEN CONTINUE
   PRINT, I
ENDFOR
```

CONTOUR

The CONTOUR procedure draws a contour plot from data stored in a rectangular array or from a set of unstructured points. Both line contours and filled contour plots can be created. Note that outline and fill contours cannot be drawn at the same time. To create a contour plot with both filled contours and outlines, first create the filled contour plot, then add the outline contours by calling CONTOUR a second time with the OVERPLOT keyword.

Contours can be smoothed by using the MIN_CURVE_SURF function on the contour data before contouring.

Using various keywords, described below, it is possible to specify contour levels, labeling, colors, line styles, and other options. CONTOUR draws contours by searching for each contour line and then following the line until it reaches a boundary or closes.

Smoothing Contours

The MIN_CURVE_SURF function can be used to smoothly interpolate both regularly and irregularly sampled surfaces before contouring. This function replaces the older SPLINE keyword to CONTOUR, which was inaccurate and is no longer supported. MIN_CURVE_SURF interpolates the entire surface to a relatively fine grid before drawing the contours.

Syntax

CONTOUR, *Z* [, *X*, *Y*] [, C_CHARSIZE=*value*] [, C_CHARTHICK=*integer*]
[, C_COLORS=*vector*] [, C_LABELS=*vector*{each element 0 or 1}]
[, C_LINESTYLE=*vector*] [{, /FILL | , /CELL_FILL} |
[, C_ANNOTATION=*vector_of_strings*] [, C_ORIENTATION=*degrees*]
[, C_SPACING=*value*]] [, C_THICK=*vector*] [, /CLOSED] [, /DOWNHILL]
[, /FOLLOW] [, /IRREGULAR] [, LEVELS=*vector*] [, NLEVELS=*integer*{1 to 60}]
[, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /OVERPLOT]
[{, /PATH_DATA_COORDS, PATH_FILENAME=*string*, PATH_INFO=*variable*,
PATH_XY=*variable*} | , TRIANGULATION=*variable*] [, /PATH_DOUBLE]
[, /XLOG] [, /YLOG] [, /ZAXIS] [, /ZLOG]

Graphics Keywords: Accepts all graphics keywords accepted by PLOT except for: LINESTYLE, PSYM, SYMSIZE. See "Graphics Keywords Accepted" on page 235.

Arguments

Z

A one- or two-dimensional array containing the values that make up the contour surface. If arguments *X* and *Y* are provided, the contour is plotted as a function of the (X, Y) locations specified by their contents. Otherwise, the contour is generated as a function of the two-dimensional array index of each element of *Z*.

If the IRREGULAR keyword is set, X, Y, and Z are treated as vectors. Each point has a value of Z*i* and a location of (X*i*, Y*i*)

This argument is converted to double-precision floating-point before plotting. Plots created with CONTOUR are limited to the range and precision of double-precision floating-point values.

X

A vector or two-dimensional array specifying the X coordinates for the contour surface. If *X* is a vector, each element of *X* specifies the X coordinate for a column of *Z* (e.g., X[0] specifies the X coordinate for Z[0,*]). If X is a two-dimensional array, each element of X specifies the X coordinate of the corresponding point in Z (i.e., X_{ij} specifies the X coordinate for Z_{ij}).

Y

A vector or two-dimensional array specifying the Y coordinates for the contour surface. If *Y* a vector, each element of *Y* specifies the Y coordinate for a row of Z (e.g., Y[0] specifies the Y coordinate for Z[*,0]). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in Z (Y_{ij} specifies the Y coordinate for Z_{ij}).

Keywords

C_ANNOTATION

The label to be drawn on each contour. Usually, contours are labeled with their value. This parameter, a vector of strings, allows any text to be specified. The first label is used for the first contour drawn, and so forth. If the LEVELS keyword is specified, the elements of C_ANNOTATION correspond directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. If there are more contour levels than elements in C_ANNOTATION, the remaining levels are labeled with their values.

Use of this keyword implies use of the FOLLOW keyword.

Note

This keyword has no effect if the FILL or CELL_FILL keyword is set (i.e., if the contours are drawn with solid-filled or line-filled polygons).

Example

To produce a contour plot with three levels labeled “low”, “medium”, and “high”:

```
CONTOUR, Z, LEVELS = [0.0, 0.5, 1.0], $
   C_ANNOTATION = ['low', 'medium', 'high']
```

C_CHARSIZE

The size of the characters used to annotate contour labels. Normally, contour labels are drawn at 3/4 of the size used for the axis labels (specified by the CHARSIZE keyword or !P.CHARSIZE system variable. This keyword allows the contour label size to be specified directly. Use of this keyword implies use of the FOLLOW keyword.

C_CHARTHICK

The thickness of the characters used to annotate contour labels. Set this keyword equal to an integer value specifying the line thickness of the vector drawn font characters. This keyword has no effect when used with the hardware drawn fonts. The default value is 1. Use of this keyword implies use of the FOLLOW keyword.

C_COLORS

The color index used to draw each contour. This parameter is a vector, converted to integer type if necessary. If there are more contour levels than elements in C_COLORS, the elements of the color vector are cyclically repeated.

Example

If C_COLORS contains three elements, and there are seven contour levels to be drawn, the colors $c_0, c_1, c_2, c_0, c_1, c_2, c_0$ will be used for the seven levels. To call CONTOUR and set the colors to [100,150,200], use the command:

```
CONTOUR, Z, C_COLORS = [100,150,200]
```

C_LABELS

Specifies which contour levels should be labeled. By default, every other contour level is labeled. C_LABELS allows you to override this default and explicitly specify the levels to label. This parameter is a vector, converted to integer type if necessary. If the LEVELS keyword is specified, the elements of C_LABELS correspond

directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. Setting an element of the vector to zero causes that contour label to not be labeled. A nonzero value forces labeling.

Use of this keyword implies use of the FOLLOW keyword.

Example

To produce a contour plot with four levels where all but the third level is labeled:

```
CONTOUR, Z, LEVELS = [0.0, 0.25, 0.75, 1.0], $
   C_LABELS = [1, 1, 0, 1]
```

C_LINESTYLE

The line style used to draw each contour. As with C_COLORS, C_LINESTYLE is a vector of line style indices. If there are more contour levels than line styles, the line styles are cyclically repeated. See "LINESTYLE" on page 2405 for a list of available styles.

Note

The cell drawing contouring algorithm draws all the contours in each cell, rather than following contours. Since an entire contour is not drawn as a single operation, the appearance of the more complicated linestyles will suffer. Use of the contour following method (selected with the FOLLOW keyword) will give better looking results in such cases.

Example

To produce a contour plot, with the contour levels directly specified in a vector V, with all negative contours drawn with dotted lines, and with positive levels in solid lines:

```
CONTOUR, Z, LEVELS = V, C_LINESTYLE = (V LT 0.0)
```

C_ORIENTATION

If the FILL keyword is set, this keyword can be set to the angle, in degrees counterclockwise from the horizontal, of the lines used to fill contours. If neither C_ORIENTATION nor C_SPACING are specified, the contours are solid filled.

C_SPACING

If the FILL keyword is set, this keyword can be used to control the distance, in centimeters, between the lines used to fill the contours.

C_THICK

The line used to draw each contour level. As with C_COLORS, C_THICK is a vector of line thickness values, although the values are floating point. If there are more contours than thickness elements, elements are repeated. If omitted, the overall line thickness specified by the THICK keyword parameter or !P.THICK is used for all contours.

CELL_FILL

Set this keyword to produce a filled contour plot using a "cell filling" algorithm. Use this keyword instead of FILL when you are drawing filled contours over a map, when you have missing data, or when contours that extend off the edges of the contour plot. CELL_FILL is less efficient than FILL because it makes one or more polygons for each data cell. It also gives poor results when used with patterned (line) fills, because each cell is assigned its own pattern. Otherwise, this keyword operates identically to the FILL keyword, described below.

Tip

In order for CONTOUR to fill the contours properly when using a map projection, the X and Y arrays (if supplied) must be arranged in increasing order. This ensures that the polygons generated will be in counterclockwise order, as required by the mapping graphics pipeline.

Warning

Do not draw filled contours over the poles on Cylindrical map projections. In this case, the polar points map to lines on the map, and the interpolation becomes ambiguous, causing errors in filling. One possible work-around is to limit the latitudes to the range of -89.9 degrees to + 89.9 degrees, avoiding the poles.

CLOSED

Set this keyword to a nonzero value to close contours that intersect the plot boundaries. After a contour hits a boundary, it follows the plot boundary until it connects with its other boundary intersection. Set CLOSED=0 along with PATH_INFO and/or PATH_XY to return path information for contours that are not closed.

DOWNHILL

Set this keyword to label each contour with short, perpendicular tick marks that point in the “downhill” direction, making the direction of the grade readily apparent. If this keyword is set, the contour following method is used in drawing the contours.

FILL

Set this keyword to produce a filled contour plot. The contours are filled with solid or line-filled polygons. For solid polygons, use the C_COLOR keyword to specify the color index of the polygons for each contour level. For line fills, use C_ORIENTATION, C_SPACING, C_COLOR, C_LINESTYLE, and/or C_THICK to specify attributes for the lines.

If the current device is not a pen plotter, each polygon is erased to the background color before the fill lines are drawn, to avoid superimposing one pattern over another.

Contours that are not closed can not be filled because their interior and exterior are undefined. Contours created from data sets with missing data may not be closed; many map projections can also produce contours that are not closed. Filled contours should not be used in these cases.

Note

If the current graphics device is the Z-buffer, the algorithm used when the FILL keyword is specified will not work when a Z value is also specified with the graphics keyword ZVALUE. In this situation, use the CELL_FILL keyword instead of the FILL keyword.

FOLLOW

In IDL version 5, CONTOUR always uses a line-following method. The FOLLOW keyword remains available for compatibility with existing code, but is no longer necessary. As in previous versions of IDL, setting FOLLOW will cause CONTOUR to draw contour labels.

IRREGULAR

Set this keyword to indicate that the input data is irregularly gridded. Setting IRREGULAR is the same as performing an explicit triangulation. That is:

```
CONTOUR, Z, X, Y, /IRREGULAR
```

is the same as

```
TRIANGULATE, X, Y, tri   ;Get triangulation
CONTOUR, Z, X, Y, TRIANGULATION=tri
```

ISOTROPIC

Set this keyword to force the scaling of the X and Y axes to be equal.

Note

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 2407 for more information.

LEVELS

Specifies a vector containing the contour levels drawn by the CONTOUR procedure. A contour is drawn at each level in LEVELS.

Example

To draw a contour plot with levels at 1, 100, 1000, and 10000:

```
CONTOUR, Z, LEVELS = [1, 100, 1000, 10000]
```

To draw a contour plot with levels at 50, 60, ..., 90, 100:

```
CONTOUR, Z, LEVELS = FINDGEN(6) * 10 + 50
```

MAX_VALUE

Data points with values above this value are ignored (i.e., treated as missing data) when contouring. Cells containing one or more corners with values above MAX_VALUE will have no contours drawn through them. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

MIN_VALUE

Data points with values less than this value are ignored (i.e., treated as missing data) when contouring. Cells containing one or more corners with values below MIN_VALUE will have no contours drawn through them. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

NLEVELS

The number of equally spaced contour levels that are produced by CONTOUR. If the LEVELS parameter, which explicitly specifies the value of the contour levels, is

present, this keyword has no effect. If neither parameter is present, approximately six levels are drawn. NLEVELS should be a positive integer.

OVERPLOT

Set this keyword to make CONTOUR “overplot”. That is, the current graphics screen is not erased, no axes are drawn and the previously established scaling remains in effect. You must explicitly specify either the values of the contour levels or the number of levels (via the NLEVELS keyword) when using this option, unless geographic mapping coordinates are in effect.

PATH_DATA_COORDS

Set this keyword to cause the output contour positions to be measured in data units rather than the default normalized units. This keyword is useful only if the PATH_XY or PATH_FILENAME keywords are set.

PATH_DOUBLE

Set this keyword to indicate that the PATH_FILENAME, PATH_INFO, and PATH_XY keywords should return vertex and contour value information as double-precision floating-point values. The default is to return this information as single-precision floating-point values.

PATH_FILENAME

Specifies the name of a file to contain the contour positions. If PATH_FILENAME is present, CONTOUR does not draw the contours, but rather, opens the specified file and writes the coordinates of the contours, into it. The file consists of a series of logical records containing binary data. Each record is preceded with a header structure defining the contour as follows:

If the PATH_DOUBLE keyword is not set:

```
{CONTOUR_HEADER, TYPE:0B, HIGH:0B, LEVEL:0, NUM:0L, VALUE:0.0}
```

If the PATH_DOUBLE keyword is set:

```
{CONTOUR_DBL_HEADER, TYPE:0B, HIGH:0B, LEVEL:0, NUM:0L,
VALUE:0.0D}
```

The fields are:

Field	Description
TYPE	A byte that is zero if the contour is open, and one if it is closed.
HIGH	A byte that is 1 if the contour is closed and above its surroundings, and is 0 if the contour is below. This field is meaningless if the contour is not closed.
LEVEL	A short integer with value greater or equal to zero (It is an index into the LEVELS array).
NUM	The longword number of data points in the contour.
VALUE	The contour value. If the PATH_DOUBLE keyword is not set, this is a single-precision floating-point value; if the PATH_DOUBLE keyword is set, this is a double-precision floating-point value.

Table 7: CONTOUR Fields

Following the header in each record are NUM X-coordinate values followed by NUM Y-coordinate values. By default, these values are specified in normalized coordinates unless the PATH_DATA_COORDS keyword is set.

PATH_INFO

Set this keyword to a named variable that will return path information for the contours. This information can be used, along with data stored in a variable named by the PATH_XY keyword, to trace closed contours. To get PATH_INFO and PATH_XY with contours that are not closed, set the CLOSED keyword to 0. If PATH_INFO is present, CONTOUR does not draw the contours, but rather records the path information in an array of structures of the following type:

If the PATH_DOUBLE keyword is not set:

```
{CONTOUR_PATH_STRUCTURE, TYPE:0B, HIGH_LOW:0B, $
   LEVEL:0, N:0L, OFFSET:0L, VALUE:0.0}
```

If the PATH_DOUBLE keyword is set:

```
{COUNTOUR_DBL_PATH_STRUCTURE, TYPE:0B, HIGH_LOW:0B, LEVEL:0,
   N: 0L, OFFSET:0L, VALUE:0.0D}
```

The fields are:

Field	Description
TYPE	A byte that is zero if the contour is open, and one if it is closed. In the present implementation, all contours are closed.
HIGH_LOW	A byte that is 1 if the contour is above its surroundings, and is 0 if the contour is below.
LEVEL	A short integer indicating the index of the contour level, from zero to the number of levels minus one.
N	A long integer indicating the number of XY pairs in the contour's path.
OFFSET	A long integer that is the offset into the array defined by PATH_XY, representing the first XY coordinate for this contour.
VALUE	The contour value. If the PATH_DOUBLE keyword is not set, this is a single-precision floating-point value; if the PATH_DOUBLE keyword is set, this is a double-precision floating-point value.

Table 8: PATH_INFO Fields

See the examples section below for an example using the PATH_INFO and PATH_XY keywords to return contour path information.

PATH_XY

Set this keyword to a named variable that returns the coordinates of a set of closed polygons defining the closed paths of the contours. This information can be used, along with data stored in a variable named by the PATH_INFO keyword, to trace closed contours. To get PATH_XY and PATH_INFO with contours that are not closed, set the CLOSED keyword to 0. If PATH_XY is present, CONTOUR does not draw the contours, but rather records the path coordinates in the named array. If the PATH_DOUBLE keyword is not set, the array will contain single-precision floating point values; if the PATH_DOUBLE keyword is set, the array will contain double-precision floating point values. By default, the values in the array are specified in normalized coordinates unless the PATH_DATA_COORDS keyword is set.

See the examples section below for an example using the PATH_INFO and PATH_XY keywords to return contour path information.

TRIANGULATION

Set this keyword to a variable that contains an array of triangles returned from the TRIANGULATE procedure. Providing triangulation data allows you to contour irregularly gridded data directly, without gridding.

XLOG

Set this keyword to specify a logarithmic X axis.

YLOG

Set this keyword to specify a logarithmic Y axis.

ZAXIS

Set this keyword to draw a Z axis for the CONTOUR plot. CONTOUR draws no Z axis by default. This keyword is of use only if a three-dimensional transformation is established.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above.

BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

Examples

Example 1

This example creates a contour plot with 10 contour levels where every other contour is labeled:

```
;Create a simple dataset to plot:
Z = DIST(100)

;Draw the plot:
CONTOUR, Z, NLEVELS=10, /FOLLOW, TITLE='Simple Contour Plot'
```

Example 2

This example shows the use of polygon filling and smoothing.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Create a surface to contour (2D array of random numbers):
A = RANDOMU(seed, 5, 6)

;Smooth the dataset before contouring:
B = MIN_CURVE_SURF(A)

;Load discrete colors for contours:
TEK_COLOR

;Draw filled contours:
CONTOUR, B, /FILL, NLEVELS=5, C_COLOR=INDGEN(5)+2

;Overplot the contour lines with tickmarks:
CONTOUR, B, NLEVELS=5, /DOWNHILL, /OVERPLOT
```

Alternatively, we could draw line-filled contours by replacing the last two commands with:

```
CONTOUR, B, C_ORIENTATION=[0, 22, 45]

CONTOUR, B, /OVERPLOT, NLEVELS=5
```

Example 3

The following example saves the closed path information of a set of contours and plots the result:

```
; Create a 2D array of random numbers:
A = RANDOMU(seed, 8, 10)

; Smooth the dataset before contouring:
B = MIN_CURVE_SURF(A)

; Compute contour paths:
CONTOUR, B, PATH_XY=xy, PATH_INFO=info
FOR I = 0, (N_ELEMENTS(info) - 1 ) DO BEGIN
   S = [INDGEN(info(I).N), 0]

; Plot the closed paths:
   PLOTS, xy(*,INFO(I).OFFSET + S ), /NORM
ENDFOR
```

Example 4

This example contours irregularly-gridded data without having to call TRIGRID. First, use the TRIANGULATE procedure to get the Delaunay triangulation of your data, then pass the triangulation array to CONTOUR:

```
;Make 50 normal X, Y points:
x = RANDOMN(seed, 50)
y = RANDOMN(seed, 50)

;Make the Gaussian:
Z = EXP(-(x^2 + y^2))

;Get triangulation:
TRIANGULATE, X, Y, tri

;Draw the contours:
CONTOUR, Z, X, Y, TRIANGULATION = tri
```

See Also

IMAGE_CONT, SHADE_SURF, SHOW3, SURFACE

CONVERT_COORD

The CONVERT_COORD function transforms one or more sets of coordinates to and from the coordinate systems supported by IDL. The result of the function is a (3, *n*) vector containing the (*x, y, z*) components of the n output coordinates.

The input coordinates *X* and, optionally, *Y* and/or *Z* can be given in data, device, or normalized form by using the DATA, DEVICE, or NORMAL keywords. The default input coordinate system is DATA. The keywords TO_DATA, TO_DEVICE, and TO_NORMAL specify the output coordinate system.

If the input points are in 3D data coordinates, be sure to set the T3D keyword.

Warning

For devices that support windows, CONVERT_COORD can only provide valid results if a window is open and current. Also, CONVERT_COORD only applies to Direct Graphics devices.

Syntax

Result = CONVERT_COORD(*X* [, *Y* [, *Z*]] [, /DATA | , /DEVICE | , /NORMAL] [, /DOUBLE][, /T3D] [, /TO_DATA | , /TO_DEVICE | , /TO_NORMAL])

Arguments

X

A vector or scalar argument providing the X components of the input coordinates. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, `X[0,*]` are taken as the X values, `X[1,*]` are taken as the Y values, and, if present, `X[2,*]` are taken as the Z values.

Y

An optional argument providing the Y input coordinate(s).

Z

An optional argument providing the Z input coordinate(s).

Keywords

DATA

Set this keyword if the input coordinates are in data space (the default).

DEVICE

Set this keyword if the input coordinates are in device space.

DOUBLE

Set this keyword to indicate that the returned coordinates should be double-precision. If this keyword is not set, the default is to return single-precision coordinates (unless double-precision arguments are input, in which case the returned coordinates will be double-precision).

NORMAL

Set this keyword if the input coordinates are in normalized space.

T3D

Set this keyword if the 3D transformation !P.T is to be applied.

TO_DATA

Set this keyword if the output coordinates are to be in data space.

TO_DEVICE

Set this keyword if the output coordinates are to be in device space.

TO_NORMAL

Set this keyword if the output coordinates are to be in normalized space.

Example

Convert, using the currently established viewing transformation, 11 points along the parametric line $x = t, y = 2t, z = t^2$, along the interval [0, 1] from data coordinates to device coordinates:

```
; Establish a valid transformation matrix:
SURFACE, DIST(20), /SAVE

; Make a vector of X values:
X = FINDGEN(11)/10.
```

```
; Convert the coordinates. D will be a (3,11) element array:
D = CONVERT_COORD(X, 2*X, X^2, /T3D, /TO_DEVICE)
```

See Also

CV_COORD

CONVOL

The CONVOL function convolves an array with a kernel, and returns the result. Convolution is a general process that can be used for various types of smoothing, signal processing, shifting, differentiation, edge detection, etc. The CENTER keyword controls the alignment of the kernel with the array and the ordering of the kernel elements. If CENTER is explicitly set to 0, convolution is performed in the strict mathematical sense, otherwise the kernel is centered over each data point.

Syntax

Result = CONVOL(*Array*, *Kernel* [, *Scale_Factor*] [, /CENTER] [, /EDGE_WRAP] [, /EDGE_TRUNCATE])

Using CONVOL

Assume R = CONVOL(A, K, S), where *A* is an *n*-element vector, *K* is an *m*-element vector (*m* < *n*), and *S* is the scale factor. If the CENTER keyword is omitted or set to 1:

$$R_t = \begin{cases} \frac{1}{S}\sum_{i=0}^{m-1} A_{t+i-m/2}K_i & \text{if} \quad m/2 \le t < n - m/2 \\ 0 & \text{otherwise} \end{cases}$$

where the value *m*/2 is determined by *integer division*. This means that the result of the division is the largest *integer* value less than or equal to the fractional number.

If CENTER is explicitly set to 0:

$$R_t = \begin{cases} \frac{1}{S}\sum_{i=0}^{m-1} A_{t-i}K_i & \text{if} \quad t \ge m - 1 \\ 0 & \text{otherwise} \end{cases}$$

In the two-dimensional, zero CENTER case where *A* is an *m* by *n*-element array, and *K* is the *l* by *l* element kernel; the result *R* is an *m* by *n*-element array:

The centered case is similar, except the *t*-*i* and *u*-*j* subscripts are replaced by *t*+*i*-*l*/2 and *u*+*j*-*l*/2.

$$R_{t,u} = \begin{cases} \frac{1}{S}\sum_{i=0}^{l-1}\sum_{j=0}^{l-1} A_{t-i,u-j}K_{i,j} & \text{if } t \geq l-1 \text{ and } u \geq l-1 \\ 0 & \text{otherwise} \end{cases}$$

Arguments

Array

An array of any basic type except string. The result of CONVOL has the same type and dimensions as *Array*.

If the *Array* parameter is of byte type, the result is clipped to the range of 0 to 255. Negative results are set to 0, and values greater than 255 are set to 255.

Kernel

An array of any type except string. If the type of *Kernel* is not the same as *Array*, a copy of *Kernel* is made and converted to the appropriate type before use. The size of the kernel dimensions must be smaller than those of *Array*.

Scale_Factor

A scale factor that is divided into each resulting value. This argument allows the use of fractional kernel values and avoids overflow with byte or integer arguments. If omitted, a scale factor of 1 is used.

Keywords

CENTER

Set or omit this keyword to center the kernel over each array point. If CENTER is explicitly set to zero, the CONVOL function works in the conventional mathematical sense. In many signal and image processing applications, it is useful to center a symmetric kernel over the data, thereby aligning the result with the original array.

Note that for the kernel to be centered, it must be symmetric about the point K(FLOOR(*m*/2), where *m* is the number of elements in the kernel.

EDGE_WRAP

Set this keyword to make CONVOL compute the values of elements at the edge of *Array* by "wrapping" the subscripts of *Array* at the edge. For example, if CENTER is set to zero:

$$R_t = \left\{ \frac{1}{S} [\sum_{i=0}^{m-1} A_{((t-i) \bmod (n))} K_i] \right.$$

where *n* is the number of elements in *Array*. The mod operator in the formula above is defined as `a mod b = a - b * floor(a/b)`. For example, -1 mod 5 is 4. If neither EDGE_WRAP nor EDGE_TRUNCATE is set, CONVOL sets the values of elements at the edges of *Array* to zero.

EDGE_TRUNCATE

Set this keyword to make CONVOL compute the values of elements at the edge of *Array* by repeating the subscripts of *Array* at the edge. For example, if CENTER is set to zero:

$$R_t = \left\{ \frac{1}{S} \sum_{i=0}^{m} A_{((t-i) > 0 < (n-1))} K_i \right.$$

where *n* is the number of elements in *Array*. The "<" and ">" operators in the above formula return the smaller and larger of their operands, respectively. If neither EDGE_WRAP nor EDGE_TRUNCATE is set, CONVOL sets the values of elements at the edges of *Array* to zero.

Example

Convolve a vector of random noise and a one-dimensional triangular kernel and plot the result. Create a simple vector as the original dataset and plot it by entering:

```
A = RANDOMN(SEED, 100) & PLOT, A
```

Create a simple kernel by entering:

```
K = [1, 2, 3, 2, 1]
```

Convolve the two and overplot the result by entering:

```
OPLOT, CONVOL(A, K, TOTAL(K))
```

See Also

BLK_CON

COORD2TO3

The COORD2TO3 function returns a three-element vector containing 3D data coordinates given the normalized X and Y screen coordinates and one of the three data coordinates.

Note

A valid 3D transform must exist in !P.T or be specified by the PTI keyword. The axis scaling variables, !X.S, !Y.S and !Z.S must be valid.

This routine is written in the IDL language. Its source code can be found in the file `coord2to3.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = COORD2TO3(*Mx*, *My*, *Dim*, *D0* [, *PTI*])

Arguments

Mx, My

The normalized X and Y screen coordinates.

Dim

A parameter used to specify which data coordinate is fixed. Use 0 for a fixed X data coordinate, 1 for a fixed Y data coordinate, or 2 for a fixed Z data coordinate.

D0

The value of the fixed data coordinate.

PTI

The inverse of !P.T. If this parameter is not supplied, or set to 0, COORD2TO3 computes the inverse. If this routine is to be used in a loop, the caller should supply PTI for highest efficiency.

Example

To return the data coordinates of the mouse, fixing the data Z value at 10, enter the commands:

```
;Make sure a transformation matrix exists.
```

```
CREATE_VIEW

;Get the normalized mouse coords.
CURSOR, X, Y, /NORM

;Print the 3D coordinates.
PRINT, COORD2TO3(X, Y, 2, 10.0)
```

See Also

CONVERT_COORD, CREATE_VIEW, CV_COORD, SCALE3, T3D

CORRELATE

The CORRELATE function computes the linear Pearson correlation coefficient of two vectors or the correlation matrix of an *m* x *n* array. If vectors of unequal lengths are specified, the longer vector is truncated to the length of the shorter vector and a single correlation coefficient is returned. If an *m* x *n* array is specified, the result will be an *m* x *m* array of linear Pearson correlation coefficients, with the element *i*,*j* corresponding to correlation of the *i*th and *j*th columns of the input array.

Alternatively, this function computes the covariance of two vectors or the covariance matrix of an *m* x *n* array.

This routine is written in the IDL language. Its source code can be found in the file `correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CORRELATE(*X* [, *Y*] [, /COVARIANCE] [, /DOUBLE])

Arguments

X

A vector or an *m* x *n* array. *X* can be integer, single-, or double-precision floating-point.

Y

An integer, single-, or double-precision floating-point vector. If *X* is an *m* x *n* array, *Y* should not be supplied.

Keywords

COVARIANCE

Set this keyword to compute the sample covariance rather than the correlation coefficient.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Examples

Define the data vectors.

```
X = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71]
Y = [68, 66, 68, 65, 69, 66, 68, 65, 71, 67, 68, 70]
```

Compute the linear Pearson correlation coefficient of x and y. The result should be 0.702652:

```
PRINT, CORRELATE(X, Y)
```

IDL prints:

```
0.702652
```

Compute the covariance of x and y. The result should be 3.66667.

```
PRINT, CORRELATE(X, Y, /COVARIANCE)
```

IDL prints:

```
3.66667
```

Define an array with x and y as its columns.

```
A = TRANSPOSE([[X],[Y]])
```

Compute the correlation matrix.

```
PRINT, CORRELATE(A)
```

IDL prints:

```
  1.00000    0.702652
  0.702652   1.00000
```

See Also

A_CORRELATE, C_CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

COS

The periodic function COS returns the trigonometric cosine of X.

Syntax

Result = COS(*X*)

Arguments

X

The angle for which the cosine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers:

COS(*x*) = COMPLEX(cos *I* cosh *R*, -sin *R* sinh (-*I*))

where *R* and *I* are the real and imaginary parts of *x*.

If *X* is an array, the result has the same structure, with each element containing the cosine of the corresponding element of *X*.

Example

Find the cosine of 0.5 radians and print the result by entering:

```
PRINT, COS(.5)
```

IDL prints:

```
0.877583
```

See Also

ACOS, COSH

COSH

The COSH function returns the hyperbolic cosine of *X*.

Syntax

Result = COSH(*X*)

Arguments

X

The value for which the hyperbolic cosine is desired, specified in radians. If *X* is double-precision floating, the result is also double- precision. Complex values are not allowed. All other types are converted to single-precision floating-point and yield floating-point results. COSH is defined as:

$\mathrm{COSH}(u) = (e^{u} + e^{-u}) / 2$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic cosine of the corresponding element of *X*.

Example

Find the hyperbolic cosine of 0.5 radians and print the result by entering:

```
PRINT, COSH(.5)
```

IDL prints:

```
1.12763
```

See Also

ACOS, COS

CRAMER

The CRAMER function solves an *n* by *n* linear system of equations using Cramer's rule.

This routine is written in the IDL language. Its source code can be found in the file `cramer.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CRAMER(*A*, *B* [, /DOUBLE] [, ZERO=*value*])

Arguments

A

An *n* by *n* single- or double-precision floating-point array.

B

An *n*-element single- or double-precision floating-point vector.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ZERO

Use this keyword to set the value of the floating-point zero. A floating-point zero on the main diagonal of a triangular array results in a zero determinant. A zero determinant results in a "Singular matrix" error and stops the execution of CRAMER. For single-precision inputs, the default value is 1.0×10^{-6}. For double-precision inputs, the default value is 1.0×10^{-12}.

Example

Define an array A and right-hand side vector B.

```
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]
B = [3.0, 10.0, -5.0]

;Compute the solution and print.
```

```
PRINT, CRAMER(A,B)
```

IDL prints:

```
1.00000     -1.00000      2.00000
```

See Also

CHOLSOL, GS_ITER, LU_COMPLEX, LUSOL, SVSOL, TRISOL

CREATE_STRUCT

The CREATE_STRUCT function creates a structure given pairs of tag names and values. CREATE_STRUCT can also be used to concatenate structures.

Syntax

Result = CREATE_STRUCT([Tag_1, $Value_1$, ..., Tag_n, $Value_n$])

or

Result = CREATE_STRUCT(NAME=*string*, [Tag_1, ..., Tag_n], $Value_1$, ..., $Value_n$)

Arguments

Tags

The structure tag names. Tag names may be specified either as scalar strings or string arrays. If scalar strings are specified, values alternate with tag names. If a string array is provided, values must still be specified individually. Tag names must be enclosed in quotes.

Note

If a tag name contains spaces, CREATE_STRUCT will replace the spaces with underscores. For example, if you specify a tag name of `'my tag'`, the tag will be created with the name `'my_tag'`.

Values

The value of each field of the structure must be provided.

Keywords

NAME

Use this keyword to create a named structure using the specified string as the structure name.

Examples

To create the anonymous structure { A: 1, B: `'xxx'`} in the variable *P*, enter:

```
p = CREATE_STRUCT('A', 1, 'B', 'xxx')
```

To add the fields “FIRST” and “LAST” to the structure, enter the following:

```
p = CREATE_STRUCT('FIRST', 0, p, 'LAST', 3)
```

The resulting structure contains { FIRST: 0, A: 1, B: 'xxx', LAST: 3}.

Finally, the statement:

```
p = CREATE_STRUCT(name='list', ['A','B','C'], 1, 2, 3)
```

creates the structure { LIST, A: 1, B: 2, C: 3}.

See Also

N_TAGS, TAG_NAMES, Chapter 6, “Structures” in *Building IDL Applications*.

CREATE_VIEW

The CREATE_VIEW procedure sets the various system variables required to define a coordinate system and a 3D view. This procedure builds the system viewing matrix (!P.T) in such a way that the correct aspect ratio of the data is maintained even if the display window is not square. CREATE_VIEW also sets the “Data” to “Normal” coordinate conversion factors (!X.S, !Y.S, and !Z.S) so that center of the unit cube will be located at the center of the display window.

CREATE_VIEW sets the following IDL system variables:

!P.T, !P.T3D, !P.Position, !P.Clip, !P.Region !X.S, !X.Style, !X.Range, !X.Margin !Y.S, !Y.Style, !Y.Range, !Y.Margin, !Z.S, !Z.Style, !Z.Range, !Z.Margin.

This routine is written in the IDL language. Its source code can be found in the file `create_view.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CREATE_VIEW [, AX=*value*] [, AY=*value*] [, AZ=*value*] [, PERSP=*value*] [, /RADIANS] [, WINX=*pixels*] [, WINY=*pixels*] [, XMAX=*scalar*] [, XMIN=*scalar*] [, YMAX=*scalar*] [, YMIN=*scalar*] [, ZFAC=*value*] [, ZMAX=*scalar*] [, ZMIN=*scalar*] [, ZOOM=*scalar or 3-element vector*]

Arguments

This procedure has no required arguments.

Keywords

AX

A floating-point value specifying the orientation (X rotation) of the view. The default is 0.0.

AY

A floating-point value specifying the orientation (Y rotation) of the view. The default is 0.0.

AZ

A floating-point value specifying the orientation (Z rotation) of the view. The default is 0.0.

PERSP

A floating-point value specifying the perspective projection distance. A value of 0.0 indicates an isometric projection (NO perspective). The default is 0.0.

RADIANS

Set this keyword if AX, AY, and AZ are specified in radians. The default is degrees.

WINX

A long integer specifying the X size, in pixels, of the window that the view is being set up for. The default is 640.

WINY

A long integer specifying the Y size, in pixels, of the window that the view is being set up for. The default is 512.

XMAX

A scalar specifying the maximum data value on the X axis. The default is 1.0.

XMIN

A scalar specifying the minimum data value on the X axis. The default is 0.0.

YMAX

A scalar specifying the maximum data value on the Y axis. The default is 1.0.

YMIN

A scalar specifying the minimum data value on the Y axis. The default is 0.0.

ZFAC

Set this keyword to a floating-point value to expand or contract the view in the Z dimension. The default is 1.0.

ZMAX

A scalar specifying the maximum data value on the Z axis. The default is 1.0.

ZMIN

A scalar specifying the minimum data value on the Z axis. The default is 0.0.

ZOOM

A floating-point number or 3-element vector specifying the view zoom factor. If zoom is a single value then the view will be zoomed equally in all 3 dimensions. If zoom is a 3-element vector then the view will be scaled zoom[0] in X, zoom[1] in Y, and zoom[2] in Z. The default is 1.0.

Example

Set up a view to display an iso-surface from volumetric data. First, create some data:

```
vol = FLTARR(40, 50, 30)
vol(3:36, 3:46, 3:26) = RANDOMU(S, 34, 44, 24)
FOR I = 0, 10 DO vol = SMOOTH(vol, 3)
```

Generate the iso-surface.

```
SHADE_VOLUME, vol, 0.2, polygon_list, vertex_list, /LOW
```

Set up the view. Note that the subscripts into the Vol array range from 0 to 39 in X, 0 to 49 in Y, and 0 to 29 in Z. As such, the 3-D coordinates of the iso-surface (vertex_list) may have the same range. Set XMIN, YMIN, and ZMIN to zero (the default), and set XMAX=39, YMAX=49, and ZMAX=29.

```
WINDOW, XSIZE = 600, YSIZE = 400
CREATE_VIEW, XMAX = 39, YMAX = 49, ZMAX = 29, $
  AX = (-60.0), AZ = (30.0), WINX = 600, WINY = 400, $
  ZOOM = (0.7), PERSP = (1.0)
```

Display the iso-surface in the specified view.

```
img = POLYSHADE(polygon_list, vertex_list, /DATA, /T3D)
TVSCL, img
```

See Also

SCALE3, T3D

CROSSP

The CROSSP function returns a floating-point vector that is the vector (or cross) product of two 3-element vectors, *V1* and *V2*.

Syntax

Result = CROSSP(*V1*, *V2*)

Arguments

V1, V2

Three-element vectors.

See Also

"Matrix Multiplication" in Chapter 2 of *Building IDL Applications*.

CRVLENGTH

The CRVLENGTH function computes the length of a curve with a tabular representation, *Y*[*i*] = F(*X*[*i*]).

Warning

Data that is highly oscillatory requires a sufficient number of samples for an accurate curve length computation.

This routine is written in the IDL language. Its source code can be found in the file `crvlength.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CRVLENGTH(*X*, *Y* [, /DOUBLE])

Arguments

X

An *n*-element single- or double-precision floating-point vector. *X* must contain at least three elements, and values must be specified in ascending order. Duplicate *X* values will result in a warning message.

Y

An *n*-element single- or double-precision floating-point vector.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
;Define a 21-element vector of X-values:
x = [-2.00, -1.50, -1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, $
2.50,  3.00,  3.50,  4.00, 4.50, 5.00, 5.50, 6.00, 6.50, $
7.00,  7.50,  8.00]

;Define a 21-element vector of Y-values:
y = [-2.99, -2.37, -1.64, -0.84, 0.00, 0.84, 1.64, 2.37, 2.99, $
3.48,  3.86,  4.14,  4.33, 4.49, 4.65, 4.85, 5.13, 5.51, $
```

```
6.02,  6.64,  7.37]

;Compute the length of the curve:
result = CRVLENGTH(x, y)

Print, result
```

IDL prints:

```
14.8115
```

See Also

INT_TABULATED, PNT_LINE

CT_LUMINANCE

The CT_LUMINANCE function calculates the luminance of colors. The function returns an array containing the luminance values of the specified colors. If the *R*, *G*, and *B* parameters are not specified, or if *R* is of integer, byte or long type, the result is a longword array with the same number of elements as the input arguments. Otherwise, the result is a floating-point array with the same number of elements as the input arguments.

This routine is written in the IDL language. Its source code can be found in the file `ct_luminance.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CT_LUMINANCE([*R*, *G*, *B*] [, BRIGHT=*variable*] [, DARK=*variable*] [, /READ_TABLES])

Arguments

R

An array representing the red color table. If omitted, the color values from either the COLORS common block, or the current color table are used.

G

An array representing the green color table. This parameter is optional.

B

An array representing the blue color table. This parameter is optional.

Keywords

BRIGHT

Set this keyword to a named variable in which the array index of the brightest color is returned.

DARK

Set this keyword to a named variable in which the array index of the darkest color is returned.

READ_TABLES

Set this keyword, and don't specify the *R*, *G*, and *B* arguments, to read colors directly from the current colortable (using TVLCT, /GET) instead of using the COLORS common block.

See Also

GAMMA_CT, STRETCH

CTI_TEST

The CTI_TEST function constructs a “contingency table” from an array of observed frequencies and tests the hypothesis that the rows and columns are independent using an extension of the chi-square goodness-of-fit test. The result is a two-element vector containing the chi-square test statistic X2 and the one-tailed probability of obtaining a value of X2 or greater.

This routine is written in the IDL language. Its source code can be found in the file `cti_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CTI_TEST(*Obfreq* [, COEFF=*variable*] [, /CORRECTED] [, CRAMV=*variable*] [, DF=*variable*] [, EXFREQ=*variable*] [, RESIDUAL=*variable*])

Arguments

Obfreq

An *m* x *n* array containing observed frequencies. *Obfreq* can contain either integer, single-, double-precision floating-point values.

Keywords

COEFF

Set this keyword to a named variable that will contain the Coefficient of Contingency. The Coefficient of Contingency is a non-negative scalar, in the interval [0.0, 1.0], which measures the degree of dependence within a contingency table. The larger the value of COEFF, the greater the degree of dependence.

CORRECTED

Set this keyword to use the “Yate’s Correction for Continuity” when computing the Chi-squared test statistic, X2. The Yate’s correction always decreases the magnitude of X2. In general, this keyword should be set for small sample sizes.

CRAMV

Set this keyword to a named variable that will contain Cramer’s V. Cramer’s V is a non-negative scalar, in the interval [0.0, 1.0], which measures the degree of dependence within a contingency table.

DF

Set this keyword to a named variable that will contain the number of degrees of freedom used to compute the probability of obtaining the value of the Chi-squared test statistic or greater. DF = (*n* - 1) * (*m* - 1) where *m* and *n* are the number of columns and rows of the contingency table, respectively.

EXFREQ

Set this keyword to a named variable that will contain an array of *m*-columns and *n*-rows containing expected frequencies. The elements of this array are often referred to as the "cells" of the expected frequencies. The expected frequency of each cell is computed as the product of row and column marginal frequencies divided by the overall total of observed frequencies.

RESIDUAL

Set this keyword to a named variable that will contain an array of *m*-columns and *n*-rows containing signed differences between corresponding cells of observed frequencies and expected frequencies.

Example

Define a 5-column and 4-row array of observed frequencies.

```
obfreq = [[748, 821, 786, 720, 672], $
          [ 74,  60,  51,  66,  50], $
          [ 31,  25,  22,  16,  15], $
          [  9,  10,   6,   5,   7]]
```

Test the hypothesis that the rows and columns of "obfreq" contain independent data at the 0.05 significance level.

```
result = CTI_TEST(obfreq, COEFF = coeff)
```

The result should be the two-element vector [14.3953, 0.276181].

The computed value of 0.276181 indicates that there is no reason to reject the proposed hypothesis at the 0.05 significance level. The Coefficient of Contingency returned in the parameter "coeff" (coeff = 0.0584860) also indicates the lack of dependence between the rows and columns of the observed frequencies. Setting the CORRECTED keyword returns the two-element vector [12.0032, 0.445420] and (coeff = 0.0534213) resulting in the same conclusion of independence.

See Also

CORRELATE, M_CORRELATE, XSQ_TEST

CURSOR

The CURSOR procedure is used to read the position of the interactive graphics cursor from the current graphics device. Note that not all graphics devices have interactive cursors. CURSOR enables the graphic cursor on the device and optionally waits for the operator to position it. On devices that have a mouse, CURSOR normally waits until a mouse button is pressed (or already down). If no mouse buttons are present, CURSOR waits for a key on the keyboard to be pressed.

The system variable !MOUSE is set to the button status. Each mouse button is assigned a bit in !MOUSE, bit 0 is the left most button, bit 1 the next, etc. See "!MOUSE" on page 2427 for details.

Using CURSOR with Draw Widgets

Note that the CURSOR procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain the cursor position and button state information from a draw widget, examine the X, Y, PRESS, and RELEASE fields in the structures returned by the draw widget in response to cursor events.

Using CURSOR with the TEK Device

Note that for the CURSOR procedure to work properly with Tektronix terminals, you may need to execute the command, `DEVICE, GIN_CHARS=6`.

Syntax

CURSOR, *X*, *Y* [, *Wait* | [, /CHANGE | , /DOWN | , /NOWAIT | , /UP | , /WAIT]] [, /DATA | , /DEVICE, | , /NORMAL]

Arguments

X

A named variable to receive the cursor's current column position.

Y

A named variable to receive the cursor's current row position.

Wait

An integer that specifies the conditions under which CURSOR returns. This parameter can be used interchangeably with the keyword parameters listed below that

specify the type of wait. The default value is 1. The table below describes each type of wait.

Note that not all modes of waiting work with all display devices.

Wait Value	Corresponding Keyword	Action
0	NOWAIT	Return immediately.
1	WAIT	Return if a button is down.
2	CHANGE	Return if a button is pressed, released, or the pointer is moved.
3	DOWN	Return when a button down transition is detected.
4	UP	Return when a button up transition is detected.

Table 9: Values for CURSOR Wait Parameter

Keywords

CHANGE

Set this keyword to wait for pointer movement or button transition within the currently selected window.

DATA

Set this keyword to return *X* and *Y* in data coordinates.

DOWN

Set this keyword to wait for a button down transition within the currently selected window.

DEVICE

Set this keyword to return *X* and *Y* in device coordinates.

NORMAL

Set this keyword to return *X* and *Y* in normalized coordinates.

NOWAIT

Set this keyword to read the pointer position and button status and return immediately. If the pointer is not within the currently selected window, the device coordinates -1, -1 are returned.

UP

Set this keyword to wait for a button up transition within the current window.

WAIT

Set this keyword to wait for a button to be depressed within the currently selected window. If a button is already pressed, return immediately.

Example

Activate the graphics cursor, select a point in the graphics window, and return the position of the cursor in device coordinates. Enter:

```
CURSOR, X, Y, /DEVICE
```

Move the cursor over the graphics window and press the mouse button. The position of the cursor in device coordinates is stored in the variables X and Y. To label the location, enter:

```
XYOUTS, X, Y, 'X marks the spot.', /DEVICE
```

See Also

RDPIX, TVCRS, CURSOR_CROSSHAIR (and other CURSOR_ keywords), WIDGET_DRAW, “!MOUSE” on page 2427

CURVEFIT

The CURVEFIT function uses a gradient-expansion algorithm to compute a non-linear least squares fit to a user-supplied function with an arbitrary number of parameters. The user-supplied function may be any non-linear function where the partial derivatives are known or can be approximated. Iterations are performed until the chi square changes by a specified amount, or until a maximum number of iterations have been performed.

This routine is written in the IDL language. Its source code can be found in the file `curvefit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CURVEFIT(*X*, *Y*, *Weights*, *A* [, *Sigma*] [, CHISQ=*variable*] [, /DOUBLE] [, FUNCTION_NAME=*string*] [, ITER=*variable*] [, ITMAX=*value*] [, /NODERIVATIVE] [, TOL=*value*])

Return Value

CURVEFIT returns a vector of values for the dependent variables, as fitted by the function fit. If *A* is double-precision or if the DOUBLE keyword is set, calculations are performed in double-precision arithmetic, otherwise they are performed in single-precision arithmetic.

Arguments

X

An *n*-element vector of independent variables.

Y

A vector of dependent variables. *Y* must have the same number of elements as *F* returned by the user-defined function.

Weights

For instrumental (Gaussian) weighting, set $Weights_i = 1.0/\text{standard\_deviation}(Y_i)^2$. For statistical (Poisson) weighting, $Weights_i = 1.0/Y_i$. For no weighting, set $Weights_i = 1.0$.

A

A vector with as many elements as the number of terms in the user-supplied function, containing the initial estimate for each parameter. On return, the vector *A* contains the fitted model parameters.

Sigma

A named variable that will contain a vector of standard deviations for the elements of the output vector *A*.

Keywords

CHISQ

Set this keyword equal to a named variable that will contain the value of the reduced chi-squared.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

FUNCTION_NAME

Use this keyword to specify the name of the function to fit. If this keyword is omitted, CURVEFIT assumes that the IDL procedure `FUNCT` is to be used. If `FUNCT` is not already compiled, IDL compiles the function from the file `funct.pro`, located in the `lib` subdirectory of the IDL distribution. `FUNCT` evaluates the sum of a Gaussian and a second-order polynomial.

The function to be fit must be written as an IDL procedure and compiled prior to calling CURVEFIT. The procedure must accept values of *X* (the independent variable), and *A* (the fitted function's initial parameter values). It must return values for *F* (the function's value at *X*), and optionally *PDER* (a 2D array of partial derivatives).

The return value for *F* must have the same number of elements as *Y*. The return value for *PDER* (if supplied) must be a 2D array with dimensions [N_ELEMENTS(*Y*), N_ELEMENTS(*A*)].

See the *Example* section below for an example function.

ITER

Set this keyword equal to a named variable that will contain the actual number of iterations performed.

ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 20.

NODERIVATIVE

If this keyword is set, the routine specified by the FUNCTION_NAME keyword will not be requested to provide partial derivatives. The partial derivatives will be estimated by CURVEFIT using forward differences. If analytical derivatives are available they should always be used.

TOL

Use this keyword to specify the desired convergence tolerance. The routine returns when the relative decrease in chi-squared is less than TOL in one iteration. The default value is 1.0×10^{-3}.

Example

Fit a function of the form `F(x) = a * exp(b*x) + c` to sample pairs contained in arrays *X* and *Y*. The partial derivatives are easily computed symbolically:

```
df/da = exp(b*x)
df/db = a * x * exp(b*x)
df/dc = 1.0
```

First, define a procedure to return `F(x)` and the partial derivatives, given *X*. Note that A is an array containing the values `a`, `b`, and `c`.

```
PRO gfunct, X, A, F, pder
  bx = EXP(A[1] * X)
  F = A[0] * bx + A[2]

;If the procedure is called with four parameters, calculate the
;partial derivatives.
  IF N_PARAMS() GE 4 THEN $
    pder = [[bx], [A[0] * X * bx], [replicate(1.0, N_ELEMENTS(X))]]
END
```

Compute the fit to the function we have just defined. First, define the independent and dependent variables:

```
X = FLOAT(INDGEN(10))
Y = [12.0, 11.0, 10.2, 9.4, 8.7, 8.1, 7.5, 6.9, 6.5, 6.1]

;Define a vector of weights.
weights = 1.0/Y
```

```
;Provide an initial guess of the function's parameters.
A = [10.0,-0.1,2.0]

;Compute the parameters.
yfit = CURVEFIT(X, Y, weights, A, SIGMA, FUNCTION_NAME='gfunct')

;Print the parameters returned in A.
PRINT, 'Function parameters: ', A
```

IDL prints:

```
Function parameters:       9.91120    -0.100883      2.07773
```

Thus, the function that best fits the data is:

$$f(x) = 9.91120(e^{-0.100883x}) + 2.07773$$

See Also

COMFIT, GAUSS2DFIT, GAUSSFIT, LMFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

CV_COORD

The CV_COORD function converts 2D and 3D coordinates between the rectangular, polar, cylindrical, and spherical coordinate systems.

This routine is written in the IDL language. Its source code can be found in the file `cv_coord.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CV_COORD([, /DEGREES] [, /DOUBLE] [, FROM_CYLIN=*cyl_coords* | , FROM_POLAR=*pol_coords* | , FROM_RECT=*rect_coords* | , FROM_SPHERE=*sph_coords*] [, /TO_CYLIN | , /TO_POLAR | , /TO_RECT | , /TO_SPHERE])

Return Value

If the value specified in the “FROM_” keyword is double precision, or if the DOUBLE keyword is set, then all calculations are performed in double precision and the returned value is double precision. Otherwise, single precision is used. If none of the “FROM_” keyword are specified, 0 is returned. If none of the “TO_” keywords are specified, the input coordinates are returned.

Arguments

This function has no required arguments. All data is passed in via keywords.

Keywords

DEGREES

If set, then the input and output coordinates are in degrees (where applicable). Otherwise, the angles are in radians.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

FROM_CYLIN

A vector of the form [*angle*, *radius*, *z*], or a (3, *n*) array of cylindrical coordinates to convert.

FROM_POLAR

A vector of the form [*angle*, *radius*], or a (2, *n*) array of polar coordinates to convert.

FROM_RECT

A vector of the form [*x*, *y*] or [*x*, *y*, *z*], or a (2, *n*) or (3, *n*) array containing rectangular coordinates to convert.

FROM_SPHERE

A vector of the form [*longitude*, *latitude*, *radius*], or a (3, *n*) array of spherical coordinates to convert.

TO_CYLIN

If set, cylindrical coordinates are returned in a vector of the form [*angle*, *radius*, *z*], or a (3, *n*) array.

TO_POLAR

If set, polar coordinates are returned in a vector of the form [*angle*, *radius*], or a (2, n) array.

TO_RECT

If set, rectangular coordinates are returned in a vector of the form [*x*, *y*] or [*x*, *y*, *z*], or a (2, *n*) or (3, *n*) array.

TO_SPHERE

If set, spherical coordinates are returned in a vector of the form [*longitude*, *latitude*, *radius*], or a (3, *n*) array.

Examples

Convert from spherical to cylindrical coordinates:

```
sph_coord = [[45.0, -60.0, 10.0], [0.0, 0.0, 0.0]]
rect_coord = CV_COORD(FROM_SPHERE=sph_coord, /TO_CYLIN, /DEGREES)
```

Convert from rectangular to polar coordinates:

```
rect_coord = [10.0, 10.0]
polar_coord = CV_COORD(FROM_RECT=rect_coord, /TO_POLAR)
```

See Also

CONVERT_COORD, COORD2TO3, CREATE_VIEW, SCALE3, T3D

CVTTOBM

The CVTTOBM function converts a byte array in which each byte represents one pixel into a “bitmap byte array” in which each bit represents one pixel. This is useful when creating bitmap labels for buttons created with the WIDGET_BUTTON function.

Bitmap byte arrays are monochrome; by default, CVTTOBM converts pixels that are darker than the median value to black and pixels that are lighter than the median value to white. You can supply a different threshold value via the THRESHOLD keyword.

Most of IDL’s image file format reading functions (READ_BMP, READ_PICT, etc.) return a byte array which must be converted before use as a button label. Note that there is one exception to this rule; the READ_X11_BITMAP routine returns a bitmap byte array that needs no conversion before use.

This routine is written in the IDL language. Its source code can be found in the file `cvttobm.pro` in the `lib` subdirectory of the IDL distribution.

Note

IDL supports color bitmaps for button labels. The IDL GUIBuilder has a Bitmap Editor that allows you to create color bitmaps for button labels. The BITMAP keyword to WIDGET_BUTTON specifies that the button label is a color bitmap.

Syntax

Result = CVTTOBM(*Array* [, THRESHOLD=*value*{0 to 255}])

Arguments

Array

A 2-dimensional pixel array, one byte per pixel.

Keywords

THRESHOLD

A byte value (or an integer value between 0 and 255) to be used as a threshold value when determining if a particular pixel is black or white. If THRESHOLD is not specified, the threshold is calculated to be the average of the input array.

Example

The following example creates a bitmap button label from a byte array:

```
; Create a byte array:
image = BYTSCL(DIST(100))
; Create a widget base:
base = WIDGET_BASE(/COLUMN)

; Use CVTTOBM to create a bitmap byte array for a button label:
button = WIDGET_BUTTON(base, VALUE = CVTTOBM(image))

; Realize the widget:
WIDGET_CONTROL, base, /REALIZE
```

See Also

WIDGET_BUTTON, "Using the Bitmap Editor" in Chapter 21 of *Building IDL Applications*

CW_ANIMATE

The CW_ANIMATE function creates a compound widget that displays an animated sequence of images using off-screen windows knows as *pixmaps*. The speed and direction of the display can be adjusted using the widget interface.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_ANIMATE(*Parent*, *Sizex*, *Sizey*, *Nframes* [, /NO_KILL] [, OPEN_FUNC=*string*] [, PIXMAPS=*vector*] [, /TRACK] [, UNAME=*string*] [, UVALUE=*value*])

Return Value

This function returns the widget ID of the newly-created animation widget.

Using CW_ANIMATE

Unlike XINTERANIMATE, using the CW_ANIMATE widget requires calls to two separate procedures, CW_ANIMATE_LOAD and CW_ANIMATE_RUN, to load the images to be animated and to run the animation. Alternatively, you can supply a vector of pre-existing pixmap window IDs, eliminating the need to use CW_ANIMATE_LOAD. The vector of pixmaps is commonly obtained from a call to CW_ANIMATE_GETP applied to a previous animation widget. Once the images are loaded, they are displayed by copying the images from the pixmap or buffer to the visible draw widget.

See the documentation for CW_ANIMATE_LOAD, CW_ANIMATE_RUN, and CW_ANIMATE_GETP for more information.

The only event returned by CW_ANIMATE indicates that the user has clicked on the “End Animation” button. The parent application should use this as a signal to kill the animation widget via WIDGET_CONTROL. When the widget is destroyed, the

pixmaps used in the animation are destroyed as well, unless they were saved by a call to CW_ANIMATE_GETP.

See the animation widget's help file (available by clicking the "Help" button on the widget) for more information about the widget's controls.

Arguments

Parent

The widget ID of the parent widget.

Sizex

The width of the displayed image, in pixels.

Sizey

The height of the displayed image, in pixels

Nframes

The number of frames in the animation sequence.

Keywords

NO_KILL

Set this keyword to omit the "End Animation" button from the animation widget.

OPEN_FUNC

Set this keyword equal to a scalar string specifying the name of a user-written function that loads animation data. If a function is specified, an "Open ..." button is added to the animation widget.

PIXMAPS

Use this keyword to provide the animation widget with a vector of pre-existing pixmap (off screen window) IDs. This vector is usually obtained from a call to CW_ANIMATE_GETP applied to a previous animation widget.

TRACK

Set this keyword to cause the frame slider to track the frame number of the currently-displayed frame.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The "user value" to be assigned to the widget.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_ANIMATE Widget

The only event returned by this widget indicates that the user has pressed the DONE button. The parent application should use this as a signal to kill the animation widget via WIDGET_CONTROL.

Example

Assume the following event handler procedure exists:

```
PRO EHANDLER, EV
WIDGET_CONTROL, /DESTROY, EV.TOP
end
```

Tip

If you wish to create this event handler starting from the IDL command prompt, remember to begin with the `.RUN` command.

Enter the following commands to open the file ABNORM.DAT (a series of images of a human heart) and load the images it contains into an array H.

```
OPENR, 1, FILEPATH('abnorm.dat', SUBDIR = ['examples','data'])
H = BYTARR(64, 64, 16)
READU, 1, H
CLOSE, 1
H = REBIN(H, 128, 128, 16)
```

Create an instance of the animation widget and load the frames. Note that because the animation widget is realized before the call to CW_ANIMATE_LOAD, the frames are displayed as they are loaded. This provides the user with an indication of how things are progressing.

```
base = WIDGET_BASE(TITLE = 'Animation Widget')
animate = CW_ANIMATE(base, 128, 128, 16)
WIDGET_CONTROL, /REALIZE, base
FOR I=0,15 DO CW_ANIMATE_LOAD, animate, FRAME=I, IMAGE=H[*,*,I]
```

Save the pixmap window IDs for future use:

```
CW_ANIMATE_GETP, animate, pixmap_vect
```

Start the animation:

```
CW_ANIMATE_RUN, animate
XMANAGER, 'CW_ANIMATE Demo', base, EVENT_HANDLER = 'EHANDLER'
```

Pressing the “End Animation” button kills the application.

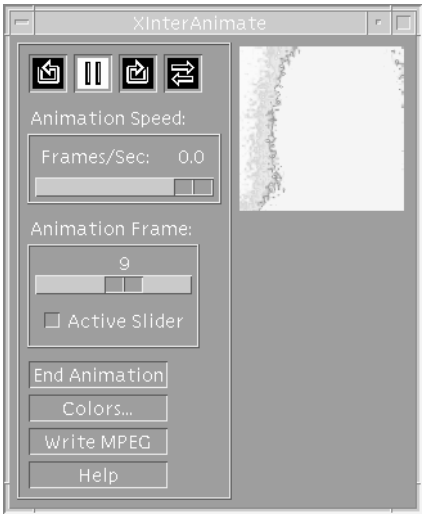


Figure 5: The animation interface created by CW_ANIMATE

See Also

CW_ANIMATE_LOAD, CW_ANIMATE_RUN, CW_ANIMATE_GETP, XINTERANIMATE

CW_ANIMATE_GETP

The CW_ANIMATE_GETP procedure gets a copy of the vector of pixmap window IDs being used by a CW_ANIMATE animation widget. If this routine is called, CW_ANIMATE does not destroy the pixmaps when it is destroyed. You can then provide the pixmaps to a later instance of CW_ANIMATE to re-use them, skipping the pixmap creation and rendering step (CW_ANIMATE_LOAD).

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CW_ANIMATE_GETP, *Widget*, *Pixmaps* [, /KILL_ANYWAY]

Arguments

Widget

The widget ID of the animation widget (created with CW_ANIMATE) that contains the pixmaps.

Pixmaps

A named variable that will contain a vector of the window IDs of the pixmap windows.

Keywords

KILL_ANYWAY

Set this keyword to ensure that the pixmaps are destroyed anyway when CW_ANIMATE exits, despite the fact that CW_ANIMATE_GETP has been called.

Example

See "CW_ANIMATE" on page 276.

See Also

CW_ANIMATE, CW_ANIMATE_LOAD, CW_ANIMATE_RUN, XINTERANIMATE

CW_ANIMATE_LOAD

The CW_ANIMATE_LOAD procedure creates an array of pixmaps which are loaded into a CW_ANIMATE compound widget.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CW_ANIMATE_LOAD, *Widget* [, /CYCLE] [, FRAME=*value*{0 to *NFRAMES*}] [, IMAGE=*value*] [, /ORDER] [, WINDOW=*[window_num* [, *X0*, *Y0*, *Sx*, *Sy*]*]*] [, XOFFSET=*pixels*] [, YOFFSET=*pixels*]

Arguments

Widget

The widget ID of the animation widget (created with CW_ANIMATE) into which the image should be loaded.

Keywords

CYCLE

Set this keyword to cause the animation to cycle. Normally, frames are displayed going either forward or backward. If CYCLE is set, the animation reverses direction after the last frame in either direction is displayed.

FRAME

The frame number to be loaded. This is a value between 0 and NFRAMES. If not supplied, frame 0 is loaded.

IMAGE

The image to be loaded.

ORDER

Set this keyword to display images from the top down instead of the default bottom up. This keyword is only used when loading images with the IMAGE keyword.

WINDOW

When this keyword is specified, an image is copied from an existing window to the animation pixmap. Under some windowing systems, this technique is much faster than reading from the display and then loading with the IMAGE keyword.

The value of this parameter is either an IDL window number (in which case the entire window is copied), or a vector containing the window index and the rectangular bounds of the area to be copied. For example:

```
WINDOW = [Window_Number, X0, Y0, Sx, Sy]
```

XOFFSET

The horizontal offset, in pixels from the left of the frame, of the image in the destination window.

YOFFSET

The vertical offset, in pixels from the bottom of the frame, of the image in the destination window.

Example

See the documentation for CW_ANIMATE for an example using this procedure. Note that if the widget is realized before calls to CW_ANIMATE_LOAD, the frames are displayed as they are loaded. This provides the user with an indication of how things are progressing.

See Also

CW_ANIMATE, CW_ANIMATE_GETP, CW_ANIMATE_RUN, XINTERANIMATE

CW_ANIMATE_RUN

The CW_ANIMATE_RUN procedure displays a series of images that have been loaded into a CW_ANIMATE compound widget by a call to CW_ANIMATE_LOAD.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

CW_ANIMATE_RUN, *Widget* [, *Rate*{0 to 100}] [, NFRAMES=*value*] [, /STOP]

Arguments

Widget

The widget ID of the animation widget (created with CW_ANIMATE) that will display the animation.

Rate

A value between 0 and 100 that represents the speed of the animation as a percentage of the maximum display rate. The fastest animation has a value of 100 and the slowest has a value of 0. The default animation rate is 100.

The animation rate can also be adjusted after the animation has begun by changing the value of the “Animation Speed” slider.

Keywords

NFRAMES

Set this keyword equal to the number of frames to animate. This number must be less than or equal to the *Nframes* argument to CW_ANIMATE.

STOP

If this keyword is set, the animation is stopped.

Example

See “CW_ANIMATE” on page 276.

See Also

CW_ANIMATE, CW_ANIMATE_GETP, CW_ANIMATE_LOAD, XINTERANIMATE

CW_ARCBALL

The CW_ARCBALL function creates a compound widget for intuitively specifying three-dimensional orientations.

The user drags a simulated track-ball with the mouse to interactively obtain arbitrary rotations. Sequences of rotations may be cascaded. The rotations may be unconstrained (about any axis), constrained to the view X, Y, or Z axes, or constrained to the object's X, Y, or Z axis.

This widget is based on "ARCBALL: A User Interface for Specifying Three-Dimensional Orientation Using a Mouse," by Ken Shoemake, Computer Graphics Laboratory, University of Pennsylvania, Philadelphia, PA 19104.

This widget can generate any rotation about any axis. Note, however, that not all rotations are compatible with the IDL SURFACE procedure, which is restricted to rotations that project the object Z axis parallel to the view Y axis.

This routine is written in the IDL language. Its source code can be found in the file `cw_arcball.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_ARCBALL(*Parent* [, COLORS=*array*] [, /FRAME]
[, LABEL=*string*] [, RETAIN={0 | 1 | 2}] [, SIZE=*pixels*] [, /UPDATE]
[, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*array*])

Return Value

This function returns the widget ID of the newly-created ARCBALL widget.

Using CW_ARCBALL

Use the command:

```
WIDGET_CONTROL, id, GET_VALUE = matrix
```

to return the current 3x3 rotation matrix in the variable `matrix`.

You can set the arcball to new rotation matrix using the command:

```
WIDGET_CONTROL, id, SET_VALUE = matrix
```

after the widget is initially realized.

Arguments

Parent

The widget ID of the parent widget.

Keywords

COLORS

A 6-element array containing the color indices to be used.

- Colors[0] = view axis color,
- Colors[1] = object axis color,
- Colors[2] = XZ plane +Y side (body top) color,
- Colors[3] = YZ plane (fin) color,
- Colors[4] = XZ plane -Y side (body bottom),
- Colors[5] = background color.

For devices that are using indexed color (i.e., DECOMPOSED=0), the default value for COLORS is `[1,7,2,3,7,0]`, which yields good colors with the TEK_COLOR table: (white, yellow, red, green, yellow, black). For devices that are using decomposed color (i.e., DECOMPOSED=1), the default value is an array of corresponding decomposed (rather than indexed) colors: (white, yellow, red, green, yellow, black).

For more information on decomposed color, refer to the DECOMPOSED keyword to the DEVICE routine.

FRAME

Set this keyword to draw a frame around the widget.

LABEL

Set this keyword to a string containing the widget's label.

RETAIN

Set this keyword to zero, one, or two to specify how backing store should be handled for the draw widget. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See "Backing Store" on page 2351 for details.

SIZE

The size of the square drawable area containing the arcball, in pixels. The default is 192.

UPDATE

Set this keyword to cause the widget will send an event each time the mouse button is released after a drag operation. By default, events are only sent when the “Update” button is pressed.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

VALUE

Set this keyword to a 3 x 3 array that will be the initial value for the rotation matrix. VALUE must be a valid rotation matrix (no translation or perspective) where TRANSPOSE(VALUE) = INVERSE(VALUE). This can be the upper-left corner of !P.T after executing the command

```
T3D, /RESET, ROTATE = [x,y,z].
```

The default is the identity matrix.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the 3 x 3 rotation matrix in the arcball widget.

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_ARCBALL Widget

Arcball widgets generate event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, VALUE:fltarr(3,3) }
```

The VALUE field contains the 3 x 3 array representing the new rotation matrix.

Example

See the procedure `ARCBALL_TEST`, contained in the `cw_arcball.pro` file. To test CW_ARCBALL, enter the following commands:

```
.RUN cw_arcball
ARCBALL_TEST
```

This results in the following:

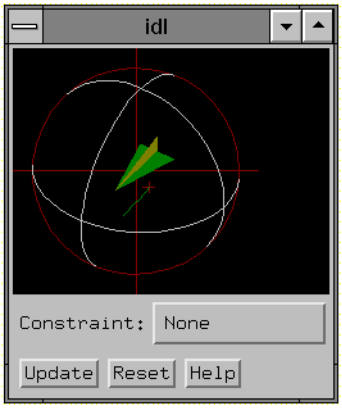


Figure 6: The CW_ARCBALL widget.

See Also

CREATE_VIEW, SCALE3, T3D

CW_BGROUP

The CW_BGROUP function creates a widget base of buttons. It handles the details of creating the proper base (standard, exclusive, or non-exclusive) and filling in the desired buttons. Events for the individual buttons are handled transparently, and a CW_BGROUP event returned. This event can return any one of the following:

- the index of the button within the base,
- the widget ID of the button,
- the name of the button,
- an arbitrary value taken from an array of user values.

Only buttons with textual names are handled by this widget. Bitmaps are not understood.

This routine is written in the IDL language. Its source code can be found in the file `cw_bgroup.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_BGROUP(*Parent*, *Names* [, BUTTON_UVALUE=*array*] [, COLUMN=*value*] [, EVENT_FUNC=*string*] [{, /EXCLUSIVE | , /NONEXCLUSIVE} | [, SPACE=*pixels*] [, XPAD=*pixels*] [, YPAD=*pixels*]] [, FONT=*font*] [, FRAME=*width*] [, IDS=*variable*] [, /LABEL_LEFT | , /LABEL_TOP] [, /MAP] [, /NO_RELEASE] [, /RETURN_ID | , /RETURN_INDEX | , /RETURN_NAME] [, ROW=*value*] [, /SCROLL] [, X_SCROLL_SIZE=*width*] [, Y_SCROLL_SIZE=*height*] [, SET_VALUE=*value*] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*width*] [, YOFFSET=*value*] [, YSIZE=*value*])

Return Value

This function returns the widget ID of the newly-created button group widget.

Arguments

Parent

The widget ID of the parent widget.

Names

A string array, one string per button, giving the name of each button.

Keywords

BUTTON_UVALUE

An array of user values to be associated with each button and returned in the event structure. If this keyword is set, the user values are always returned, even if the any of the RETURN_ID, RETURN_INDEX, or RETURN_NAME keywords are set.

COLUMN

Buttons will be arranged in the number of columns specified by this keyword.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget. This function is called with the return value structure whenever a button is pressed, and follows the conventions for user-written event functions.

EXCLUSIVE

Set this keyword to cause buttons to be placed in an exclusive base, in which only one button can be selected at a time.

FONT

The name of the font to be used for the button titles. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

FRAME

Specifies the width of the frame to be drawn around the base.

IDS

A named variable in which the button IDs will be stored, as a longword vector.

LABEL_LEFT

Creates a text label to the left of the buttons.

LABEL_TOP

Creates a text label above the buttons.

MAP

Set this keyword to cause the base to be mapped when the widget is realized (the default).

NONEXCLUSIVE

Set this keyword to cause buttons to be placed in an non-exclusive base, in which any number of buttons can be selected at once.

NO_RELEASE

If set, button release events will not be returned.

RETURN_ID

Set this keyword to return the widget ID of the button in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set.

RETURN_INDEX

Set this keyword to return the zero-based index of the button within the base in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set. THIS IS THE DEFAULT.

RETURN_NAME

Set this keyword to return the name of the button within the base in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set.

ROW

Buttons will be arranged in the number of rows specified by this keyword.

SCROLL

If set, the base will include scroll bars to allow viewing a large base through a smaller viewport.

SET_VALUE

Allows changing the current state of toggle buttons (i.e., exclusive and nonexclusive groups of buttons). The behavior of SET_VALUE differs between EXCLUSIVE and NONEXCLUSIVE CW_BGROUP widgets. With EXCLUSIVE CW_BGROUP

widgets, the argument to SET_VALUE is the id of the widget to be turned on. With NONEXCLUSIVE CW_BGROUP widgets the argument to SET_VALUE should be an array of on/off flags for the array of buttons.

SPACE

The space, in pixels, to be left around the edges of a row or column major base. This keyword is ignored if EXCLUSIVE or NONEXCLUSIVE are specified.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

XOFFSET

The X offset of the widget relative to its parent.

XPAD

The horizontal space, in pixels, between children of a row or column major base. This keyword is ignored if EXCLUSIVE or NONEXCLUSIVE are specified.

XSIZE

The width of the base.

X_SCROLL_SIZE

The width of the viewport if SCROLL is specified.

YOFFSET

The Y offset of the widget relative to its parent.

YPAD

The vertical space, in pixels, between children of a row or column major base. This keyword is ignored if EXCLUSIVE or NONEXCLUSIVE are specified.

YSIZE

The height of the base.

Y_SCROLL_SIZE

The height of the viewport if SCROLL is specified.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the button group. The values for different types of CW_BGROUP widgets is shown in the table below:

Type	Value
normal	None
exclusive	Index of currently set button
non-exclusive	Vector indicating the position of each button (1-set, 0-unset)

Table 10: Button Group Values

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_BGROUP Widget

Button Group widgets generates event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, SELECT:0, VALUE:0 }
```

The SELECT field is passed through from the button event. VALUE is either the INDEX, ID, NAME, or BUTTON_UVALUE of the button, depending on how the widget was created.

See Also

CW_PDMENU, WIDGET_BUTTON

CW_CLR_INDEX

The CW_CLR_INDEX function creates a compound widget for the selection of a color index. A horizontal color bar is displayed. Clicking on the bar sets the color index.

This routine is written in the IDL language. Its source code can be found in the file `cw_clr_index.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_CLR_INDEX(*Parent* [, COLOR_VALUES=*vector* |
[, NCOLORS=*value*] [, START_COLOR=*value*]]
[, EVENT_FUNC='*function_name*'] [, /FRAME] [, LABEL=*string*]
[, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*value*] [, XSIZE=*pixels*]
[, YSIZE=*pixels*])

Return Value

This function returns the widget ID of the newly-created color index widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

COLOR_VALUES

A vector of color indices containing the colors to be displayed in the color bar. If omitted, NCOLORS and START_COLOR specify the range of color indices.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget. This function is called with the return value structure whenever a button is pressed, and follows the conventions for user-written event functions.

FRAME

If set, a frame will be drawn around the widget.

LABEL

A text label that appears to the left of the color bar.

NCOLORS

The number of colors to place in the color bar. The default is !D.N_COLORS.

START_COLOR

Set this keyword to the starting color index, placed at the left of the bar.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

VALUE

Set this keyword to the index of the color that is to be initially selected. The default is the START_COLOR.

XSIZE

The width of the color bar in pixels. The default is 192.

YSIZE

The height of the color bar in pixels. The default is 12.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the

WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the color selection widget. The value of a CW_CLR_INDEX widget is the index of the color selected.

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_CLR_INDEX Widget

This widget generates event structures with the following definition:

```
Event = {CW_COLOR_INDEX, ID: base, TOP: ev.top, HANDLER: 0L,
VALUE:c}
```

The VALUE field is the color index selected.

See Also

CW_COLORSEL, XLOADCT, XPALETTE

CW_COLORSEL

The CW_COLORSEL function creates a compound widget that displays all the colors in the current colormap in a 16 x 16 (320 x 320 pixels) grid. To select a color index, the user moves the mouse pointer over the desired color square and presses any mouse button. Alternatively, the color index can be selected by moving one of the three sliders provided around the grid.

This routine is written in the IDL language. Its source code can be found in the file `cw_colorsel.pro` in the `lib` subdirectory of the IDL distribution.

Using CW_COLORSEL

The command:

```
WIDGET_CONTROL, widgetID, SET_VALUE = -1
```

informs the widget to initialize itself and redraw. It should be called when any of the following happen:

- the widget is realized,
- the widget needs redrawing,
- the brightest or darkest color has changed.

To set the current color index, use the command:

```
WIDGET_CONTROL, widgetID, SET_VALUE = index
```

To retrieve the current color index and store it in the variable `var`, use the command:

```
WIDGET_CONTROL, widgetID, GET_VALUE = var
```

Syntax

Result = CW_COLORSEL(*Parent* [, /FRAME] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, YOFFSET=*value*])

Return Value

This function returns the widget ID of the newly-created color index widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

FRAME

If set, a frame is drawn around the widget.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

XOFFSET

The X offset position

YOFFSET

The Y offset position

Widget Events Returned by the CW_COLORSEL Widget

This widget generates event structures with the following definition:

```
Event = {COLORSEL_EVENT, ID: base, TOP: ev.top, HANDLER: 0L,
VALUE:c}
```

The VALUE field is the color index selected.

See Also

CW_CLR_INDEX, XLOADCT, XPALETTE

CW_DEFROI

The CW_DEFROI function creates a compound widget that allows the user to define a region of interest within a widget draw window.

Warning

This is a *modal* widget. No other widget applications will be responsive while this widget is in use. Also, since CW_DEFROI has its own event-handling loop, it should not be created as a child of a modal base.

This routine is written in the IDL language. Its source code can be found in the file `cw_defroi.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_DEFROI(*Draw* [, IMAGE_SIZE=*vector*] [, OFFSET=*vector*] [, /ORDER] [, /RESTORE] [, ZOOM=*vector*])

Return Value

The is function returns an array of subscripts defining the region. If no region is defined, the scalar -1 is returned.

Arguments

Draw

The widget ID of draw window in which to draw the region. Note that the draw window must have both BUTTON and MOTION events enabled (see WIDGET_DRAW for more information).

Keywords

IMAGE_SIZE

The size of the underlying array, expressed as a two element vector: [*columns*, *rows*]. Default is the size of the draw window divided by the value of ZOOM.

OFFSET

The offset of lower left corner of image within the draw window. Default = [0,0].

ORDER

Set this keyword to return inverted subscripts, as if the array were output from top to bottom.

RESTORE

Set this keyword to restore the draw window to its previous appearance on exit. Otherwise, the regions remain on the drawable.

ZOOM

If the image array was expanded (using REBIN, for example) specify this two element vector containing the expansion factor in X and Y. Default = [1,1]. Both elements of ZOOM must be integers.

Widget Events Returned by the CW_DEFROI Widget

Region definition widgets do not return an event structure.

Example

The following two procedures create a region-of-interest widget and its event handler. Create a file containing the program code using a text editor and compile using the .RUN command, or type .RUN at the IDL prompt and enter the lines interactively.

First, create the event handler:

```
PRO test_event, ev

; The common block holds variables that are shared between the
; routine and its event handler:
COMMON T, draw, dbutt, done, image

; Define what happens when you click the "Draw ROI" button:
IF ev.id EQ dbutt THEN BEGIN
   ; The ROI definition will be stored in the variable Q:
   Q = CW_DEFROI(draw)
   IF (Q[0] NE -1) then BEGIN
      ; Show the size of the ROI definition array:
      HELP, Q
      ; Duplicate the original image.
      image2 = image

      ; Set the points in the ROI array Q equal to a single
      ; color value:
      image2(Q)=!P.COLOR-1
```

```
      ; Get the window ID of the draw widget:
      WIDGET_CONTROL, draw, GET_VALUE=W

      ; Set the draw widget as the current graphics window:
      WSET, W

      ; Load the image plus the ROI into the draw widget:
      TV, image2
   ENDIF
ENDIF

; Define what happens when you click the "Done" button:
IF ev.id EQ done THEN WIDGET_CONTROL, ev.top, /DESTROY

END
```

Next, create a draw widget that can call CW_DEFROI. Note that you *must* specify both button events and motion events when creating the draw widget, if it is to be used with CW_DEFROI.

```
PRO test
COMMON T, draw, dbutt, done, image

; Create a base to hold the draw widget and buttons:
base = WIDGET_BASE(/COLUMN)

; Create a draw widget that will return both button and
; motion events:
draw = WIDGET_DRAW(base, XSIZE=256, YSIZE=256, /BUTTON, /MOTION)
dbutt = WIDGET_BUTTON(base, VALUE='Draw ROI')
done = WIDGET_BUTTON(base, VALUE='Done')
WIDGET_CONTROL, base, /REALIZE

; Get the widget ID of the draw widget:
WIDGET_CONTROL, draw, GET_VALUE=W

; Set the draw widget as the current graphics window:
WSET, W

; Create an original image:
image = BYTSCL(SIN(DIST(256)))

; Display the image in the draw widget:
TV, image

; Start XMANAGER:
XMANAGER, "test", base

END
```

This results in the following:

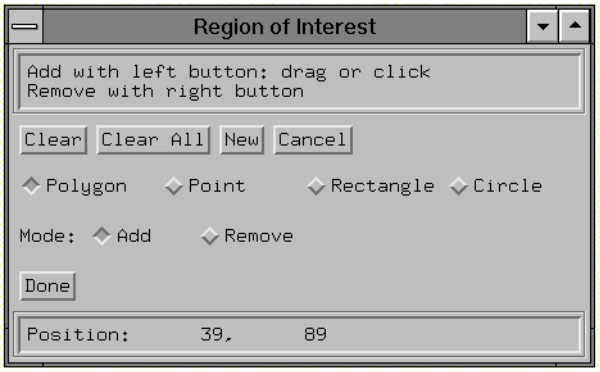


Figure 7: The Region of Interest Definition Widget

See Also

DEFROI

CW_FIELD

The CW_FIELD function creates a widget data entry field. The field consists of a label and a text widget. CW_FIELD can create string, integer, or floating-point fields. The default is an editable string field.

This routine is written in the IDL language. Its source code can be found in the file `cw_field.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_FIELD(*Parent* [, /ALL_EVENTS] [, /COLUMN]
[, FIELDFONT=*font*] [, /FLOATING | , /INTEGER | , /LONG | , /STRING]
[, FONT=*string*] [, FRAME=*pixels*] [, /NOEDIT] [, /RETURN_EVENTS] [, /ROW]
[, /TEXT_FRAME] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*]
[, VALUE=*value*] [, XSIZE=*characters*] [, YSIZE=*lines*])

Return Value

This function returns the widget ID of the newly-created field widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

ALL_EVENTS

Like RETURN_EVENTS but return an event whenever the contents of a text field have changed.

COLUMN

Set this keyword to center the label above the text field. The default is to position the label to the left of the text field.

FIELDFONT

A string containing the name of the font to use for the TEXT part of the field.

FLOATING

Set this keyword to have the field accept only floating-point values. Any number or string entered is converted to its floating-point equivalent.

FONT

A string containing the name of the font to use for the TITLE of the field. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

FRAME

The width, in pixels, of a frame to be drawn around the entire field cluster. The default is no frame.

INTEGER

Set this keyword to have the field accept only integer values. Any number or string entered is converted to its integer equivalent (using FIX). For example, if 12.5 is entered in this type of field, it is converted to 12.

LONG

Set this keyword to have the field accept only long integer values. Any number or string entered is converted to its long integer equivalent (using LONG).

NOEDIT

Normally, the value in the text field can be edited. Set this keyword to make the field non-editable.

RETURN_EVENTS

Set this keyword to make CW_FIELD return an event when a carriage return is pressed in a text field. The default is not to return events. Note that the value of the text field is always returned when the following command is used:

```
WIDGET_CONTROL, field, GET_VALUE = X
```

ROW

Set this keyword to position the label to the left of the text field. This is the default.

STRING

Set this keyword to have the field accept only string values. Numbers entered in the field are converted to their string equivalents. This is the default.

TEXT_FRAME

Set this keyword to draw a frame around the text field. Note that on Windows, a frame is always drawn around the text field.

TITLE

A string containing the text to be used as the label for the field. The default is “Input Field”.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

VALUE

The initial value in the text widget. This value is automatically converted to the type set by the STRING, INTEGER, and FLOATING keywords described below.

XSIZE

An explicit horizontal size (in characters) for the text input area. The default is to let the window manager size the widget. Using the XSIZE keyword is not recommended.

YSIZE

An explicit vertical size (in lines) for the text input area. The default is 1.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the field. If one of the FLOATING, INTEGER, LONG, or STRING keywords to CW_FIELD is set, values set with the SET_VALUE keyword to WIDGET_CONTROL will be forced to the appropriate type. Values returned by the GET_VALUE keyword to WIDGET_CONTROL will be of the type specified when the field widget is created. Note that if the field contains string information, returned values will be contained in a string *array* even if the field contains only a single string.

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_FIELD Widget

This widget generates event structures with the following definition:

```
event = { ID:0L, TOP:0L, HANDLER: 0L, VALUE:'', TYPE:0 , UPDATE:0}
```

The VALUE field is the value of the field. TYPE specifies the type of data contained in the field and can be any of the following: 0=string, 1=floating-point, 2=integer, 3=long integer (the value of TYPE is determined by setting one of the STRING, FLOAT, INTETER, or LONG keywords). UPDATE contains a zero if the field has not been altered or a one if it has.

Example

The code below creates a main base with a field cluster attached to it. The cluster accepts string input, has the title "Name", and has a frame around it:

```
base = WIDGET_BASE()
field = CW_FIELD(base, TITLE = "Name", /FRAME)
WIDGET_CONTROL, base, /REALIZE
```

See Also

WIDGET_LABEL, WIDGET_TEXT

CW_FILESEL

The CW_FILESEL function is a compound widget for file selection.

This routine is written in the IDL language. Its source code can be found in the file `cw_filesel.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_FILESEL (*Parent* [, /FILENAME] [, FILTER=*string array*] [, /FIX_FILTER] [, /FRAME] [, /IMAGE_FILTER] [, /MULTIPLE | , /SAVE] [, PATH=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, /WARN_EXIST])

Return Value

CW_FILESEL returns its widget ID.

Arguments

Parent

The widget ID of the parent.

Keywords

FILENAME

Set this keyword to have the initial filename filled in the filename text area.

FILTER

Set this keyword to an array of strings determining the filter types. If not set, the default is “All Files”. All files containing the chosen filter string will be displayed as possible selections. “All Files” is a special filter which returns all files in the current directory.

Example:

```
FILTER=["All Files", ".txt"]
```

Multiple filter types may be used per filter entry, using a comma as the separator.

Example:

```
FILTER=[".jpg, .jpeg", ".txt, .text"]
```

FIX_FILTER

If set, the user can not change the file filter.

FRAME

If set, a frame is drawn around the widget.

IMAGE_FILTER

If set, the filter “Image Files” will be added to the end of the list of filters. If set, and FILTER is not set, “Image Files” will be the only filter displayed. Valid image files are determined from QUERY_IMAGE.

MULTIPLE

If set, the file selection list will allow multiple filenames to be selected. The filename text area will not be editable in this case. It is illegal to specify both /SAVE and /MULTIPLE.

PATH

Set this keyword to the initial path the widget is to start in. The default is the current directory.

SAVE

Set this keyword to create a widget with a “Save” button instead of an “Open” button. It is illegal to specify both /SAVE and /MULTIPLE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The ‘user value’ to be assigned to the widget.

WARN_EXIST

Set this keyword to produce a question dialog if the user selects a file that already exists. This keyword is useful when creating a “write” dialog. The default is to allow any filename to be quietly accepted, whether it exists or not.

Keywords to WIDGET_CONTROL

You can use the GET_UVALUE and SET_UVALUE keywords to WIDGET_CONTROL to obtain or set the user value of this widget. Use the command to read the currently selected filename including the full path:

```
WIDGET_CONTROL, id, GET_VALUE=filename
```

To set the value of the filename, use the following command:

```
WIDGET_CONTROL, id, SET_VALUE=string
```

where *string* is the filename including the full path.

See “Compound Widgets” in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by CW_FILESEL

This widget generates event structures with the following definition:

```
Event = {FILESEL_EVENT, ID:0L, TOP:0L, HANDLER:0L,VALUE:'',
   DONE:0L, FILTER:''}
```

The ID field is the widget ID of the CW_FILESEL widget. The TOP field contains the widget ID of the top-level widget. The HANDLER field is always set to zero. The VALUE field is a string containing the filename(s) selected, if any. The DONE field can be any of the following:

- 0 = User selected a file but didn’t double-click, or the user changed filters (in this case the VALUE field will be an empty string.)
- 1 = User pressed “Open”/“Save” or double-clicked on a file.
- 2 = User pressed “Cancel”.

The FILTER field is a string containing the current filter.

Example

This example creates a CW_FILESEL widget that is used to select image files for display. Note how the DONE tag of the event structure returned by CW_FILESEL is used to determine which button was pressed, and how the VALUE tag is used to obtain the file that was selected:

```
PRO image_opener_event, event

   WIDGET_CONTROL, event.top, GET_UVALUE=state, /NO_COPY

   CASE event.DONE OF
      0: BEGIN
            state.file = event.VALUE
            WIDGET_CONTROL, event.top, SET_UVALUE=state, /NO_COPY
         END
      1: BEGIN
            IF (state.file NE '') THEN BEGIN
               img = READ_IMAGE(state.file)
               TV, img
            ENDIF
            WIDGET_CONTROL, event.top, SET_UVALUE=state, /NO_COPY
         END
      2: WIDGET_CONTROL, event.top, /DESTROY
   ENDCASE

END

PRO image_opener

   DEVICE, DECOMPOSED=0, RETAIN=2

   base = WIDGET_BASE(TITLE ='Open Image', /COLUMN)
   filesel = CW_FILESEL(base, /IMAGE_FILTER, FILTER='All Files')
   file=''
   state = {file:file}

   WIDGET_CONTROL, base, /REALIZE
   WIDGET_CONTROL, base, SET_UVALUE=state, /NO_COPY

   XMANAGER, 'image_opener', base

END
```

See Also

DIALOG_PICKFILE, FILEPATH

CW_FORM

The CW_FORM function is a compound widget that simplifies creating small forms which contain text, numeric fields, buttons, lists, and droplists. Event handling is also simplified.

This routine is written in the IDL language. Its source code can be found in the file `cw_form.pro` in the `lib` subdirectory of the IDL distribution.

Using CW_FORM

The form has a value that is a structure with a tag/value pair for each field in the form. Use the command

```
WIDGET_CONTROL, id, GET_VALUE=v
```

to read the current value of the form. To set the value of one or more tags, use the command

```
WIDGET_CONTROL, id, SET_VALUE={ Tag:value, ..., Tag:value}
```

Syntax

Result = CW_FORM([*Parent*,] *Desc* [, /COLUMN] [, IDS=*variable*] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*])

Return Value

If the argument *Parent* is present, the returned value of this function is the widget ID of the newly-created form widget. If *Parent* is omitted, the form realizes itself as a modal, top-level widget and CW_FORM returns a structure containing the value of each field in the form when the user finishes.

Arguments

Parent

The widget ID of the parent widget. Omit this argument to created a modal, top-level widget.

Desc

A string array describing the form. Each element of the string array contains two or more comma-delimited fields. Each string has the following format:

'*Depth*, *Item*, *Initial value*, *Settings*'

Use the backslash character ("\") to escape commas that appear within fields. To include the backslash character, escape it with another backslash.

The fields are defined as follows:

- **Depth**

  A digit defining the level at which the element will be placed on the form. Nesting is used primarily for layout, with row or column bases.

  This field must contain the digit 0, 1, or 2, with the following effects:

  - 0 = continue the current nesting level.
  - 1 = begin a new level under the current level.
  - 2 = last element at the current level.

- **Item**

  A label defining the type of element to be placed in the form. *Item* must be one of the following: BASE, BUTTON, DROPLIST, FLOAT, INTEGER, LABEL, LIST, or TEXT.

  BASEs and LABELs do not return a value in the widget value structure. The other items return the following value types:

Item	Description
BUTTON	An integer or integer array. For single buttons, the value is 1 if the button is set, or 0 if it is not set. For exclusive button groups, the value is the index of the currently set button. For non-exclusive button groups, the value is an array containing an element for each button. Array elements are set to 1 if the corresponding button is set, or 0 if it is not set.
DROPLIST	An integer. The value set in the widget value structure is the zero-based index of the item is selected.
FLOAT	A floating-point value. The value set in the widget value structure is the floating-point value of the field.

Table 11: Values for the Item field

Item	Description
INTEGER	An integer. The value set in the widget value structure is the integer value of the field.
LIST	An integer. The value set in the widget value structure is the zero-based index of the item is selected.
TEXT	A string. The value set in the widget value structure is the string value of the field.

Table 11: Values for the Item field

- **Initial value**

  The initial value of the field. The *Initial value* field is left empty for BASEs.

  For BUTTON, DROPLIST, and LIST items, the value field contains one or more item names, separated by the | character. Strings do not need to be enclosed in quotes. For example, the following line defines an exclusive button group with buttons labeled “one,” “two,” and “three.”

  ```
  '0, BUTTON, one|two|three, EXCLUSIVE'
  ```

  For FLOAT, INTEGER, LABEL, and TEXT items, the value field contains the initial value of the field.

- **Settings**

  The *Settings* field contains one of the following keywords or keyword=*value* pairs. Keywords are used to specify optional attributes or options. Any number of keywords may be included in the description string.

  Note that preceding keywords with a “/” character has no effect. Simply including a keyword in the *Settings* field enables that option.

Keyword	Description
CENTER	Specifies alignment of LABEL items.
COLUMN	If present, specifies column layout in BASES or for BUTTON groups.

Table 12: Values for the Settings field

Keyword	Description
EXCLUSIVE	If present, makes an exclusive set of BUTTONs. The default is nonexclusive.
FONT=*font name*	If present, the font for the item is specified. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.
EVENT=*function*	Specifies the name of a user-written event function that is called whenever the element is changed. The event function is called with the widget event structure as a parameter. It may return an event structure or zero to indicate that no further event processing is desired.
FRAME	If present, a frame is drawn around the item. Valid only for BASEs.
LABEL_LEFT=*label*	Place a label to the left of the item. This keyword is valid with BUTTON, DROPLIST, FLOAT, INTEGER and TEXT items.
LABEL_TOP=*label*	Place a label above the item. This keyword is valid with BUTTON, DROPLIST, FLOAT, INTEGER and TEXT items.
LEFT	Specifies alignment of LABEL items.
NO_RELEASE	If present, exclusive and non-exclusive buttons generate only select events. This keyword has no effect on regular buttons.

Table 12: Values for the Settings field

Keyword	Description
QUIT	If the form widget is created as a top-level, modal widget, when the user activates an item defined with this keyword, the form is destroyed and its widget value returned in the widget value structure of CW_FORM. For non-modal form widgets, events generated by changing this item have their QUIT field set to 1.
RIGHT	Specifies alignment of LABEL items.
ROW	If present, specifies row layout in BASES or for BUTTON groups.
SET_VALUE=*value*	Sets the initial value of BUTTON groups or DROPLISTs. For droplists and exclusive button groups, *value* should be the zero-based index of the item selected.
TAG=*name*	The tag name of this element in the widget's value structure. If not specified, the tag name is TAG*nnn*, where *nnn* is the zero-based index of the item in the *Desc* array.
WIDTH=*n*	Specifies the width, in characters, of a TEXT, INTEGER, or FLOAT item.

Table 12: Values for the Settings field

Keywords

COLUMN

Set this keyword to make the orientation of the form vertical. If COLUMN is not set, the form is laid out in a horizontal row.

IDS

Set this keyword equal to a named variable into which the widget id of each widget corresponding to an element in the *Desc* array is stored.

TITLE

Set this keyword equal to a scalar string containing the title of the top level base. TITLE is not used if the form widget has a parent widget.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

Set this keyword equal to the user value associated with the form widget.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the form. The form has a value that is a structure with a tag/value pair for each field in the form. Use the command

```
WIDGET_CONTROL, id, GET_VALUE=v
```

to read the current value of the form. To set the value of one or more tags, use the command

```
WIDGET_CONTROL, id, SET_VALUE={ Tag:value, ..., Tag:value}
```

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_FORM Widget

This widget generates event structures each time the value of the form is changed. The event structure has the following definition:

```
Event = { ID:0L, TOP:0L, HANDLER:0L, TAG:'', VALUE:0, QUIT:0}
```

The ID field is the widget ID of the CW_FORM widget. The TOP field is the widget ID of the top-level widget. The TAG field contains the tag name of the field that

changed. The VALUE field contains the new value of the changed field. The QUIT field contains a zero if the quit flag is not set, or one if it is set.

Example

Define a form with a label, two groups of vertical buttons (one non-exclusive and the other exclusive), a text field, an integer field, and “OK” and “Done” buttons. If either the “OK” or “Done” buttons are pressed, the form exits.

Begin by defining a string array describing the form:

```
desc = [ $
   '0, LABEL, Centered Label, CENTER', $
   '1, BASE,, ROW, FRAME', $
   '0, BUTTON, B1|B2|B3, LABEL_TOP=Nonexclusive:,' $
   + 'COLUMN, TAG=bg1', $
   '2, BUTTON, E1|E2|E2, EXCLUSIVE,LABEL_TOP=Exclusive:,' $
   + 'COLUMN,TAG=bg2', $
   '0, TEXT, , LABEL_LEFT=Enter File name:, WIDTH=12,' $
   + 'TAG=fname', $
   '0, INTEGER, 0, LABEL_LEFT=File size:, WIDTH=6, TAG=fsize', $
   '1, BASE,, ROW', $
   '0, BUTTON, OK, QUIT,' $
   +  'TAG=OK', $
   '2, BUTTON, Cancel, QUIT']
```

To use the form as a modal widget:

```
a = CW_FORM(desc, /COLUMN)
```

When the form is exited, (when the user presses the OK or Cancel buttons), a structure is returned as the function’s value. We can examine the structure by entering:

```
HELP, /STRUCTURE, a
```

IDL Output			Meaning
BG1	INT	Array[3]	Set buttons = 1, unset = 0.
BG2	INT	1	Second button of exclusive button group was set.
FNAME	STRING	'test.dat'	Value of the text field
FSIZE	LONG	120	Value of the integer field

Table 13: Output from HELP, /STRUCTURE

IDL Output			Meaning
OK	LONG	1	This button was pressed
TAG8	LONG	0	This button wasn't pressed

Table 13: Output from HELP, /STRUCTURE

Note that if the "Cancel" button is pressed, the "OK" field is set to 0.

To use CW_FORM inside another widget:

```
a = WIDGET_BASE(TITLE='Testing')
b = CW_FORM(a, desc, /COLUMN)
WIDGET_CONTROL, a, /REALIZE
XMANAGER, 'Test', a
```

The event handling procedure (in this example, called TEST_EVENT), may use the TAG field of the event structure to determine which field changed and perform any data validation or special actions required. It can also get and set the value of the widget by calling WIDGET_CONTROL.

CW_FSLIDER

The CW_FSLIDER function creates a slider that selects floating-point values.

This routine is written in the IDL language. Its source code can be found in the file `cw_fslider.pro` in the `lib` subdirectory of the IDL distribution.

Using CW_FSLIDER

To get or set the value of a CW_FSLIDER widget, use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL.

Note

The CW_FSLIDER widget is based on the WIDGET_SLIDER routine, which accepts only integer values. Because conversion between integers and floating-point numbers necessarily involves round-off errors, the slider value returned by CW_FSLIDER may not exactly match the input value, even when a floating-point number is entered in the slider's text field as an ASCII value. For more information on floating-point issues, see "Accuracy & Floating-Point Operations" in Chapter 16 of *Using IDL*.

Syntax

Result = CW_FSLIDER(*Parent* [, /DRAG] [, /EDIT] [, FORMAT=*string*] [, /FRAME] [, MAXIMUM=*value*] [, MINIMUM=*value*] [, SCROLL=*units*] [, /SUPRESS_VALUE] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*initial_value*] [, XSIZE=*length* | {, /VERTICAL [, YSIZE=*height*]}])

Return Value

This function returns the widget ID of the newly-created slider widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

DRAG

Set this keyword to zero if events should only be generated when the mouse is released. If DRAG is non-zero, events will be generated continuously when the slider is adjusted. Note: On slow systems, /DRAG performance can be inadequate. The default is DRAG = 0.

EDIT

Set this keyword to make the slider label be editable. The default is EDIT = 0.

FORMAT

Provides the format in which the slider value is displayed. This should be a format as accepted by the STRING procedure. The default FORMAT is `'(G13.6)'`

FRAME

Set this keyword to have a frame drawn around the widget. The default is FRAME = 0.

MAXIMUM

The maximum value of the slider. The default is MAXIMUM = 100.

MINIMUM

The minimum value of the slider. The default is MINIMUM = 0.

SCROLL

Under the Motif window manager, the value provided for SCROLL specifies how many units the scroll bar should move when the user clicks the left mouse button inside the slider area, but not on the slider itself. This keyword has no effect under other window systems.

SUPPRESS_VALUE

If this keyword is set, the current slider value is not displayed.

TITLE

Set this keyword to a string defining the title of slider.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

VALUE

The initial value of the slider

VERTICAL

If set, the slider will be oriented vertically. The default is horizontal.

XSIZE

For horizontal sliders, sets the length.

YSIZE

For vertical sliders, sets the height.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the slider. Note that the SET_SLIDER_MAX and SET_SLIDER_MIN keywords to WIDGET_CONTROL and the SLIDER_MIN_MAX keyword to WIDGET_INFO *do not* work with floating point sliders created with CW_FSLIDER.

See “Compound Widgets” in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_FSLIDER Widget

This widget generates event structures with the following definition:

```
Event = { ID:0L, TOP:0L, HANDLER:0L, VALUE:0.0, DRAG:0}
```

The VALUE field is the floating-point value selected by the slider. The DRAG field reports on whether events are generated continuously (when the DRAG keyword is set) or only when the mouse button is released (the default).

See Also

WIDGET_SLIDER

CW_LIGHT_EDITOR

The CW_LIGHT_EDITOR function creates a compound widget to edit properties of existing IDLgrLight objects in a view. Lights cannot be added or removed from a view using this widget. However, lights can be “turned off or on” by hiding or showing them (i.e., HIDE property).

Syntax

Result = CW_LIGHT_EDITOR (*Parent* [, /DIRECTION_DISABLED] [, /DRAG_EVENTS] [, FRAME=*width*] [, /HIDE_DISABLED] [, LIGHT=*objref(s)*] [, /LOCATION_DISABLED] [, /TYPE_DISABLED] [, UVALUE=*value*] [, XSIZE=*pixels*] [, YSIZE=*pixels*] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*])

Return Value

This function returns the widget ID of a newly-created light editor.

Arguments

Parent

The widget ID of the parent widget for the new light editor.

Keywords

DIRECTION_DISABLED

Set this keyword to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

DRAG_EVENTS

Set this keyword to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget. By default, events are only generated when the mouse comes to rest at its final position and the mouse button is released.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

Note

Under Microsoft Windows and Macintosh, sliders do not generate these events, but behave just like regular sliders.

FRAME

The value of this keyword specifies the width of a frame (in pixels) to be drawn around the borders of the widget. Note that this keyword is only a 'hint' to the toolkit, and may be ignored in some instances. The default is no frame.

HIDE_DISABLED

Set this keyword to make the hide widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

LIGHT

Set this keyword to one or more object references to IDLgrLight to edit. This will replace the current set of lights being edited with the list of lights from this keyword.

LOCATION_DISABLED

Set this keyword to make the location widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

TYPE_DISABLED

Set this keyword to make the light type widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

UNAME

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The ‘user value’ to be assigned to the widget. Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created. If UVALUE is not present, the widget's initial user value is undefined.

XRANGE

A two-element vector defining the data range in the x direction. This keyword is used to determine the valid range for the light's location and direction properties

XSIZE

The width of the drawable area in pixels. The default width is 180.

YRANGE

A two-element vector defining the data range in the y direction. This keyword is used to determine the valid range for the light's location and direction properties.

YSIZE

The height of the drawable area in pixels. The default height is 180.

ZRANGE

A two-element vector defining the data range in the z direction. This keyword is used to determine the valid range for the light's location and direction properties

Light Editor Events

There are variations of the light editor event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER). The different light editor event structures are described below.

Light Selected

This is the type of structure returned when the light selected in the light list box is modified by a user.

```
{ CW_LIGHT_EDITOR_LS, ID:0L, TOP:0L, HANDLER:0L, LIGHT:OBJ_NEW()}
```

LIGHT specifies the object ID of the new light selection.

Light Modified

This is the type of structure returned when the user has modified a light property. This event maybe generated continuously if the DRAG_EVENTS keyword was set. See DRAG_EVENTS above.

```
{ CW_LIGHT_EDITOR_LM, ID:0L, TOP:0L, HANDLER:0L}
```

The value of the light editor will need to be retrieved (i.e., CW_LIGHT_EDITOR_GET) in order to determine the extent of the actual user modification.

WIDGET_CONTROL Keywords

The widget ID returned by this compound widget is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with this compound widget (e.g., UNAME, UVALUE).

GET_VALUE

Set this keyword to a named variable to contain the current value of the widget. An IDLgrLight object reference of the currently selected light is returned. The value of a widget can be set with the SET_VALUE keyword to this routine.

SET_VALUE

Sets the value of the specified light editor compound widget. This widget accepts an IDLgrLight object reference of the light in the list of lights to make as the current selection. The property values are retrieved from the light object and the light editor controls are updated to reflect those properties.

See Also

CW_LIGHT_EDITOR_GET, CW_LIGHT_EDITOR_SET, IDLgrLight

CW_LIGHT_EDITOR_GET

The CW_LIGHT_EDITOR_GET procedure gets the CW_LIGHT_EDITOR properties.

Syntax

CW_LIGHT_EDITOR_GET, *WidgetID* [, DIRECTION_DISABLED=*variable*] [, DRAG_EVENTS=*variable*] [, HIDE_DISABLED=*variable*] [, LIGHT=*variable*] [, LOCATION_DISABLED=*variable*] [, TYPE_DISABLED=*variable*] [, XSIZE=*variable*] [, YSIZE=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

WidgetID

The widget ID of the CW_ LIGHT_EDITOR compound widget.

Keywords

DIRECTION_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

DRAG_ EVENTS

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

Note

Under Microsoft Windows and Macintosh, sliders do not generate these events, but behave just like regular sliders.

HIDE_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the hide widget portion of the compound widget unchangeable by the user.

LIGHT

Set this keyword to a named variable that will contain one or more object references to IDLgrLight.

LOCATION_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the location widget portion of the compound widget unchangeable by the user.

TYPE_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the light type widget portion of the compound widget unchangeable by the user.

XRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the x direction.

XSIZE

Set this keyword to a named variable that will contain the width of the drawable area in pixels.

YRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the y direction.

YSIZE

Set this keyword to a named variable that will contain the height of the drawable area in pixels.

ZRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the z direction.

See Also

CW_LIGHT_EDITOR, CW_LIGHT_EDITOR_SET, IDLgrLight

CW_LIGHT_EDITOR_SET

The CW_LIGHT_EDITOR procedure sets the CW_LIGHT_EDITOR properties.

Syntax

CW_LIGHT_EDITOR_SET, *WidgetID* [, /DIRECTION_DISABLED]
[, /DRAG_EVENTS] [, /HIDE_DISABLED] [, LIGHT=*objref(s)*]
[, /LOCATION_DISABLED] [, /TYPE_DISABLED] [, XSIZE=*pixels*]
[, YSIZE=*pixels*] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*]

Arguments

WidgetID

The widget ID of the CW_ LIGHT_EDITOR compound widget.

Keywords

DIRECTION_DISABLED

Set this keyword to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

DRAG_ EVENTS

Set this keyword to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

Note

Under Microsoft Windows and Macintosh, sliders do not generate these events, but behave just like regular sliders.

HIDE_DISABLED

Set this keyword to make the hide widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

LIGHT

Set this keyword to one or more object references to IDLgrLight to edit. This will replace the current set of lights being edited with the list of lights from this keyword.

LOCATION_DISABLED

Set this keyword to make the location widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

TYPE_DISABLED

Set this keyword to make the light type widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

XRANGE

A two-element vector defining the data range in the x direction. This keyword is used to determine the valid range for the light's location and direction properties.

XSIZE

The width of the drawable area in pixels.

YRANGE

A two-element vector defining the data range in the y direction. This keyword is used to determine the valid range for the light's location and direction properties.

YSIZE

The height of the drawable area in pixels.

ZRANGE

A two-element vector defining the data range in the z direction. This keyword is used to determine the valid range for the light's location and direction properties.

See Also

CW_LIGHT_EDITOR, CW_LIGHT_EDITOR_GET, IDLgrLight

CW_ORIENT

The CW_ORIENT function creates a compound widget that provides a means to interactively adjust the three-dimensional drawing transformation and resets the !P.T system variable field to reflect the changed orientation.

This routine is written in the IDL language. Its source code can be found in the file `cw_orient.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_ORIENT(*Parent* [, AX=*degrees*] [, AZ=*degrees*] [, /FRAME] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*] [, YSIZE=*height*])

Return Value

This function returns the widget ID of the newly-created orientation-adjustment widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

AX

The initial rotation in the X direction. The default is 30 degrees.

AZ

The initial rotation in the Z direction. The default is 30 degrees.

FRAME

Set this keyword to draw a frame around the widget.

TITLE

The title of the widget.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

XSIZE

Determines the width of the widget. The default is 100.

YSIZE

Determines the height of the widget. The default is 100.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_ORIENT Widget

CW_ORIENT only returns events when the three dimensional drawing transformation has been altered. The !P.T system variable field is automatically updated to reflect the new orientation.

See Also

CW_ARCBALL, T3D

CW_PALETTE_EDITOR

The CW_PALETTE_EDITOR function creates a compound widget to display and edit color palettes. The palette editor is a base that contains a drawable area to display the color palette, a set of vectors that represent the palette and an optional histogram.

Syntax

Result = CW_PALETTE_EDITOR (*Parent* [, DATA=*array*] [, FRAME=*width*] [, HISTOGRAM=*vector*] [, /HORIZONTAL] [, SELECTION=*[start*, *end]*] [, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*] [, YSIZE=*height*])

Return Value

This function returns the widget ID of the newly created palette editor.

Graphics Area Components

Reference Color bar

A gray scale color bar is displayed at the top of the graphics area for reference purposes.

Palette Colorbar

A color bar containing a display of the current palette is displayed below the reference color bar.

Channel and Histogram Display

The palette channel vectors are displayed below the palette colorbar. The Red channel is displayed in red, the Green channel in green, the Blue channel in blue, and the optional Alpha channel in purple. The optional Histogram vector is displayed in Cyan.

An area with a white background represents the current selection, with gray background representing the area outside of the current selection. Yellow drag handles are an additional indicator of the selection endpoints. These selection endpoints represent the range for some editing operations. In addition, cursor X,Y values and channel pixel values at the cursor location are displayed in a status area below the graphics area.

Interactive Capabilities

Color Space

A droplist allows selection of RGB, HSV or HLS color spaces. RGB is the default color space. Note that regardless of the color space in use, the color vectors retrieved with the GET_VALUE keyword to widget control are always in the RGB color space.

Editing Mode

A droplist allows selection of the editing mode. Freehand is the default editing mode.

Unless noted below, editing operations apply only to the channel vectors currently selected for editing. Unless noted below, editing operations apply only to the portion of the vectors within the selection indicators.

In *Freehand* editing mode the user can click and drag in the graphics area to draw a new curve. Editable channel vectors will be modified to use the new curve for that part of the X range within the selection that was drawn in Freehand mode.

In *Line Segment* editing mode a click, drag and release operation defines the start point and end point of a line segment. Editable channel vectors will be modified to use the new curve for that part of the X range within the selection that was drawn in Line Segment mode.

In *Barrel Shift* editing mode click and drag operations in the horizontal direction cause the editable curves to be shifted right or left, with the portion which is shifted off the end of selection area wrapping around to appear on the other side of the selection area. Only the horizontal component of drag movement is used.

In *Slide* editing mode click and drag operations in the horizontal direction cause the editable curves to be shifted right or left. Unlike the Barrel Shift mode, the portion of the curves shifted off the end of the selection area does not wrap around. Only the horizontal component of drag movement is used.

In *Stretch* editing mode click and drag operations in the horizontal direction cause the editable curves to be compressed or expanded. Only the horizontal component of drag movement is used.

A number of buttons provide editing operations which do not require cursor input:

The *Ramp* operation causes the selected part of the editable curves to be replaced with a linear ramp from 0 to 255.

The *Smooth* operation causes the selected part of the editable curves to be smoothed.

The *Posterize* operation causes the selected part of the editable curves to be replaced with a series of steps.

The *Reverse* operation causes the selected part of the editable curves to be reversed in the horizontal direction.

The *Invert* operation causes the selected part of the editable curves to be flipped in the vertical direction.

The *Duplicate* operation causes the selected part of the editable curves to be compressed by 50% and duplicated to produce two contiguous copies of the channel vectors within the initial selection.

The *Load PreDefined* droplist choice leads to additional choices of pre-defined palettes. Loading a pre-defined palette replaces only the selected portion of the editable color channels, respecting of the settings of the selection endpoints and editable checkboxes. This allows loading only a single channel or only a portion of a pre-defined palette.

Channel Display and Edit

A row of checkboxes allows the user to indicate which channels of Red, Green, Blue and the optional Alpha channel should be displayed. A second row of checkboxes allows the user to indicate which channels should be edited by the current editing operation. The checkboxes for the Alpha channel will be sensitive only if an Alpha channel is loaded.

Zoom

Four buttons allow the user to zoom the display of the palette.

The "| |" button zooms to show the current selection.

The "+" button zooms in 50%.

The "-" button zooms out 100%.

The "1:1" button returns the display to the full palette.

Scrolling of the Palette Window

When the palette is zoomed to a scale greater than 1:1 the scroll bar at the bottom of the graphics area can be used to view a different part of the palette.

Arguments

Parent

The widget ID of the parent widget for the new palette editor.

Keywords

DATA

A 3x256 byte array containing the initial color values for Red, Green and Blue channels. The value supplied can also be a 4x256 byte array containing the initial color values and the optional Alpha channel. The value supplied can also be an IDLgrPalette object reference. If an IDLgrPalette object reference is supplied it is used internally and is not destroyed on exit. If an object reference is supplied the ALPHA keyword to the CW_PALETTE_EDITOR_SET routine can be used to supply the data for the optional Alpha channel.

FRAME

The value of this keyword specifies the width of a frame (in pixels) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances. The default is no frame.

HISTOGRAM

A 256 element byte vector containing the values for the optional histogram curve.

HORIZONTAL

Set this keyword for a horizontal layout for the compound widget. This consists of the controls to the right of the display area. The default is a vertical layout with the controls below the display area.

SELECTION

The selection is a two element vector defining the starting and ending point of the selection region of color indexes. The default is [0,255].

UNAME

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget

hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The ‘user value’ to be assigned to the widget. Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created. If UVALUE is not present, the widget's initial user value is undefined.

XSIZE

The width of the drawable area in pixels. The default width is 256.

YSIZE

The height of the drawable area in pixels. The default height is 256.

Palette Editor Events

There are variations of the palette editor event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER). The different palette editor event structures are described below.

Selection Moved

This is the type of structure returned when one of the vertical bars that define the selection region is moved by a user.

```
{ CW_PALETTE_EDITOR_SM, ID:0L, TOP:0L, HANDLER:0L,
SELECTION:[0,255]}
```

SELECTION indicates a two element vector defining the starting and ending point of the selection region of color indexes.

Palette Edited

This is the type of structure returned when the user has modified the color palette.

```
{ CW_PALETTE_EDITOR_PM, ID:0L, TOP:0L, HANDLER:0L}
```

The value of the palette editor will need to be retrieved (i.e., WIDGET_CONTROL, GET_VALUE) in order to determine the extent of the actual user modification.

WIDGET_CONTROL Keywords for Palette Editor

The widget ID returned by this compound widget is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with this compound widget (e.g., UNAME, UVALUE).

GET_VALUE

Set this keyword to a named variable to contain the current value of the widget. A 3xn (RGB) or 4xn (i.e., RGB and ALPHA) array containing the palette is returned.

The value of a widget can be set with the SET_VALUE keyword to this routine.

SET_VALUE

Sets the value of the specified palette editor compound widget. This widget accepts a 3xn (RGB) or 4xn (i.e., RGB and ALPHA) array representing the value of the palette to be set. Another type of argument accepted is an IDLgrPalette object reference. If an IDLgrPalette object reference is supplied it is used internally and is not destroyed on exit.

See Also

CW_PALETTE_EDITOR_GET, CW_PALETTE_EDITOR_SET, IDLgrPalette

CW_PALETTE_EDITOR_GET

The CW_PALETTE_EDITOR_GET procedure gets the CW_PALETTE_EDITOR properties.

Syntax

CW_PALETTE_EDITOR_GET, *WidgetID* [, ALPHA=*variable*]
[, HISTOGRAM=*variable*]

Arguments

WidgetID

The widget ID of the CW_PALETTE_EDITOR compound widget.

Keywords

ALPHA

Set this keyword to a named variable that will contains the optional alpha curve.

HISTOGRAM

Set this keyword to a named variable that will contains the optional histogram curve.

See Also

CW_PALETTE_EDITOR, CW_PALETTE_EDITOR_SET, IDLgrPalette

CW_PALETTE_EDITOR_SET

The CW_PALETTE_EDITOR_SET procedure sets the CW_PALETTE_EDITOR properties.

Syntax

CW_PALETTE_EDITOR_SET, *WidgetID* [, ALPHA=*byte_vector*] [, HISTOGRAM=*byte_vector*]

Arguments

WidgetID

The widget ID of the CW_PALETTE_EDITOR compound widget.

Keywords

ALPHA

A 256 element byte vector that describes the alpha component of the color palette. The alpha value may also be set to the scalar value zero to remove the alpha curve from the display.

HISTOGRAM

The histogram is an vector to be plotted below the color palette. This keyword can be used to display a distribution of color index values to facilitate editing the color palette. The histogram value may also be set to the scalar value zero to remove the histogram curve from the display.

See Also

CW_PALETTE_EDITOR, CW_PALETTE_EDITOR_GET, IDLgrPalette

CW_PDMENU

The CW_PDMENU function creates widget pulldown menus. It has a simpler interface than the XPDMENU procedure, which it replaces. Events for the individual buttons are handled transparently, and a CW_PDMENU event returned. This event can return any one of the following:

- the Index of the button within the base
- the widget ID of the button
- the name of the button.
- the fully qualified name of the button. This allows different sub-menus to contain buttons with the same name in an unambiguous way.

Only buttons with textual names are handled by this widget. Bitmaps are not understood.

This routine is written in the IDL language. Its source code can be found in the file `cw_pdmenu.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_PDMENU(*Parent*, *Desc* [, /COLUMN] [, DELIMITER=*string*] [, FONT=*value*] [, /MBAR [, /HELP]] [, IDS=*variable*] [, /RETURN_ID | , /RETURN_INDEX | , /RETURN_NAME | , /RETURN_FULL_NAME] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, YOFFSET=*value*])

Return Value

This function returns the widget ID of the newly-created pulldown menu widget.

Arguments

Parent

The widget ID of the parent widget.

Desc

An array of strings or structures. If *Desc* is an array of strings, each element contains the flag field, followed by a backslash character, followed by the name of the menu item, optionally followed by another backslash character and the name of an event-

processing procedure for that element. A string element of the *Desc* array would look like:

```
'n\item_name'
```

or

```
'n\item_name\event_proc'
```

where `n` is the flag field and *item_name* is the name of the menu item. The flag field is a bitmask that controls how the button is interpreted; appropriate values for the flag field are shown in the following table. If the *event_proc* field is present, it is the name of an event-handling procedure for the menu element and all of its children.

If *Desc* is an array of structures, each structure has the following definition:

```
{CW_PDMENU_S, flags:0, name:''}
```

The name tag is a string field with the following components:

```
'item_name'
```

or

```
'item_name\event_proc'
```

where *item_name* is the name of the menu item. If the *event_proc* field is present, it is the name of an event-handling procedure for the menu element and all of its children

The flags field is a bitmask that controls how the button is interpreted; appropriate values for the flag field are shown in the following table. Note that if *Desc* is an array of structures, you cannot specify individual event-handling procedures for each element.

Value	Meaning
0	This button is neither the beginning nor the end of a pulldown level.
1	This button is the root of a sub-pulldown menu. The sub-buttons start with the next button.
2	This button is the last button at the current pulldown level. The next button belongs to the same level as the current parent button. If the name field is not specified (or is an empty string), no button is created, and the next button is created one level up in the hierarchy.
3	This button is the root of a sub-pulldown menu, but it is also the last entry of the current level.

Table 14: Button Flag Bit Meanings

Keywords

COLUMN

Set this keyword to create a vertical column of menu buttons. The default is to create a horizontal row of buttons.

DELIMITER

The character used to separate the parts of a fully qualified name in returned events. The default is to use the "." character.

FONT

The name of the font to be used for the button titles. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See "About Device Fonts" on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

HELP

If the MBAR keyword is set, and one of the buttons on the menubar has the label "help" (case insensitive) then that button is created with the /HELP keyword to give it any special appearance it is supposed to have on a menubar. For example, Motif expects help buttons to be on the right.

IDS

A named variable in which the button IDs will be stored as a longword vector.

MBAR

Set this keyword to create a menubar pulldown. If MBAR is set, *Parent* must be the widget ID of a menubar belonging to a top-level base, and the return value of CW_PDMENU is this widget ID. For an example demonstrating the use of the MBAR keyword, see Example 2 below. Also see the MBAR keyword to WIDGET_BASE.

RETURN_ID

If this keyword is set, the VALUE field of returned events will contain the widget ID of the button.

RETURN_INDEX

If this keyword is set, the VALUE field of returned events will contain the zero-based index of the button within the base. THIS IS THE DEFAULT.

RETURN_NAME

If this keyword is set, the VALUE field of returned events will be the name of the selected button.

RETURN_FULL_NAME

Set this keyword and the VALUE field of returned events will be the fully qualified name of the selected button. This means that the names of all the buttons from the topmost button of the pulldown menu to the selected one are concatenated with the delimiter specified by the DELIMITER keyword. For example, if the top button was named COLORS, the second level button was named BLUE, and the selected button was named LIGHT, the returned value would be

```
COLORS.BLUE.LIGHT
```

This allows different submenus to have buttons with the same name (e.g., COLORS.RED.LIGHT).

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget. If the MBAR keyword is set, the value specified for UVALUE is also assigned as the UVALUE of the parent menu (i.e., the widget specified by the *Parent* argument in the call to CW_PDMENU).

XOFFSET

The X offset of the widget relative to its parent.

YOFFSET

The Y offset of the widget relative to its parent.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the

WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_PDMENU Widget

This widget generates event structures with the following definition:

```
event = { ID:0L, TOP:0L, HANDLER:0L, VALUE:0 }
```

VALUE is either the INDEX, ID, NAME, or FULL_NAME of the button, depending on how the widget was created.

Examples

Example 1

The following is the description of a menu bar with two buttons: "Colors" and "Quit". Colors is a pulldown containing the colors "Red", "Green", Blue", "Cyan", and "Magenta". Blue is a sub-pulldown containing "Light", "Medium", "Dark", "Navy", and "Royal."

The following small program can be used with the above description to create the specified menu:

```
PRO PD_EXAMPLE
   desc = [ '1\Colors' , $
            '0\Red' , $
            '0\Green' , $
            '1\Blue' , $
            '0\Light' , $
            '0\Medium' , $
            '0\Dark' , $
            '0\Navy' , $
            '2\Royal' , $
            '0\Cyan' , $
            '2\Magenta' , $
            '2\Quit' ]

   ; Create the widget:
   base = WIDGET_BASE()
   menu = CW_PDMENU(base, desc, /RETURN_FULL_NAME)
   WIDGET_CONTROL, /REALIZE, base

   ;Provide a simple event handler:
```

```
   REPEAT BEGIN
      ev = WIDGET_EVENT(base)
      PRINT, ev.value
   END UNTIL ev.value EQ 'Quit'
   WIDGET_CONTROL, /DESTROY, base

END
```

The *Desc* array could also have been defined using a structure for each element. The following array of structures creates the same menu as the array of strings shown above. Note, however, that if the *Desc* array is composed of structures, you cannot specify individual event-handling routines.

First, make sure CW_PDMENU_S structure is defined:

```
junk = {CW_PDMENU_S, flags:0, name:'' }
```

Define the menu:

```
desc = [ { CW_PDMENU_S, 1, 'Colors' }, $
         { CW_PDMENU_S, 0, 'Red' }, $
         { CW_PDMENU_S, 0, 'Green' }, $
         { CW_PDMENU_S, 1, 'Blue' }, $
         { CW_PDMENU_S, 0, 'Light' }, $
         { CW_PDMENU_S, 0, 'Medium' }, $
         { CW_PDMENU_S, 0, 'Dark' }, $
         { CW_PDMENU_S, 0, 'Navy' }, $
         { CW_PDMENU_S, 2, 'Royal' }, $
         { CW_PDMENU_S, 0, 'Cyan' }, $
         { CW_PDMENU_S, 2, 'Magenta' }, $
         { CW_PDMENU_S, 2, 'Quit' } ]
```

Example 2

This example demonstrates the use of the MBAR keyword to CW_PDMENU to populate the “Colors” menu item on a menu bar created using WIDGET_BASE.

```
PRO mbar_event, event

   WIDGET_CONTROL, event.id, GET_UVALUE=uval

   CASE uval OF
      'Quit': WIDGET_CONTROL, /DESTROY, event.top
   ELSE: PRINT, event.value
   ENDCASE

END

PRO mbar
```

```
; Create the base widget:
base = WIDGET_BASE(TITLE = 'Example', MBAR=bar, XSIZE=200, $
   UVALUE='base')

file_menu = WIDGET_BUTTON(bar, VALUE='File', /MENU)
file_bttn1=WIDGET_BUTTON(file_menu, VALUE='Quit', $
   UVALUE='Quit')

colors_menu = WIDGET_BUTTON(bar, VALUE='Colors', /MENU)

; Define array for colors menu items:
desc = [ '0\Red' , $
         '0\Green' , $
         '1\Blue' , $
         '0\Light' , $
         '0\Medium' , $
         '0\Dark' , $
         '0\Navy' , $
         '2\Royal' , $
         '0\Cyan' , $
         '2\Magenta' ]

; Create colors menu items. Note that the Parent argument is
; set to the widget ID of the parent menu:
colors = CW_PDMENU(colors_menu, desc, /MBAR, $
   /RETURN_FULL_NAME, UVALUE='menu')

WIDGET_CONTROL, /REALIZE, base

XMANAGER, 'mbar', base, /NO_BLOCK

END
```

See Also

CW_BGROUP, WIDGET_DROPLIST

CW_RGBSLIDER

The CW_RGBSLIDER function creates a compound widget that provides three sliders for adjusting color values. The RGB, CMY, HSV, and HLS color systems can all be used. No matter which color system is in use, the resulting color is always supplied in RGB, which is the base system for IDL.

This routine is written in the IDL language. Its source code can be found in the file `cw_rgbslider.pro` in the `lib` subdirectory of the IDL distribution.

Using CW_RGBSLIDER

The CW_RGBSLIDER widget consists of a pulldown menu which allows the user to change between the supported color systems, and three color adjustment sliders, allowing the user to select a new color value.

Syntax

Result = CW_RGBSLIDER(*Parent* [, /CMY | , /HSV | , /HLS | , /RGB] [, /COLOR_INDEX | , GRAPHICS_LEVEL={1 | 2}] [, /DRAG] [, /FRAME] [, LENGTH=*value*] [, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*[r, g, b]*] [, /VERTICAL])

Return Value

This function returns the widget ID of the newly-created color adjustment widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

CMY

If set, the initial color system used is CMY.

COLOR_INDEX

Set this keyword to display a small rectangle with the selected color. The color is updated as the values are changed. The color initially displayed in this rectangle corresponds to the value specified with the VALUE keyword. If using Object

Graphics, it is recommended that you set the GRAPHICS_LEVEL keyword to 2, in which case the COLOR_INDEX keyword is ignored.

DRAG

Set this keyword and events will be generated continuously when the sliders are adjusted. If not set, events will only be generated when the mouse button is released. Note: On slow systems, /DRAG performance can be inadequate. The default is DRAG = 0.

FRAME

If set, a frame will be drawn around the widget. The default is FRAME = 0.

GRAPHICS_LEVEL

Set this keyword to 2 to use Object Graphics. Set to 1 for Direct Graphics (the default). If set to 2, a small rectangle is displayed with the selected color. The color is updated as the values are changed. The color initially displayed in this rectangle corresponds to the value specified with the VALUE keyword. If this keyword is set, the COLOR_INDEX keyword is ignored.

HSV

If set, the initial color system used is HSV.

HLS

If set, the initial color system used is HLS.

LENGTH

The length of the sliders. The default = 256.

RGB

If set, the initial color system used is RGB. This is the default.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

VALUE

Set this keyword to a 3-element [r, g, b] vector representing the initial RGB value for the CW_RGBSLIDER widget. If the GRAPHICS_LEVEL keyword is set to 2, the color swatch will also initially display this RGB value.

VERTICAL

If set, the sliders will be oriented vertically. The default is VERTICAL = 0.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_RGBSLIDER Widget

This widget generates event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, R:0B, G:0B, B:0B }
```

The ‘R’, ‘G’, and ‘B’ fields contain the Red, Green and Blue components of the selected color. Note that CW_RGBSLIDER reports back the Red, Green, and Blue values no matter which color system is selected.

See Also

CW_CLR_INDEX, XLOADCT, XPALETTE

CW_TMPL

The CW_TMPL procedure is a template for compound widgets that use the XMANAGER. Use this template instead of writing your compound widgets from "scratch". This template can be found in the file `cw_tmpl.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = CW_TMPL(*Parent* [, UNAME=*string*] [, UVALUE=*value*])

Arguments

Parent

The widget ID of the parent widget of the new compound widget.

Keywords

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

A user-specified value for the compound widget.

See Also

XMNG_TMPL

CW_ZOOM

The CW_ZOOM function creates a compound widget that displays two images: an original image in one window and a portion of the original image in another. The user can select the center of the zoom region, the zoom scale, the interpolation style, and the method of indicating the zoom center.

This routine is written in the IDL language. Its source code can be found in the file `cw_zoom.pro` in the `lib` subdirectory of the IDL distribution.

Using CW_ZOOM

The value of the CW_ZOOM widget is the original, un-zoomed image to be displayed (a two-dimensional array). To change the contents of the CW_ZOOM widget, use the command:

```
WIDGET_CONTROL, id, SET_VALUE = array
```

where `id` is the widget ID of the CW_ZOOM widget and `array` is the image array. The value of CW_ZOOM cannot be set until the widget has been realized. Note that the size of the original window, set with the XSIZE and YSIZE keywords to CW_ZOOM, must be the size of the input array.

To return the current zoomed image as displayed by CW_ZOOM in the variable `array`, use the command:

```
WIDGET_CONTROL, id, GET_VALUE = array
```

Syntax

Result = CW_ZOOM(*Parent* [, /FRAME] [, MAX=*scale*] [, MIN=*scale*]
[, RETAIN={0 | 1 | 2}] [, SAMPLE=*value*] [, SCALE=*value*] [, /TRACK]
[, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*]
[, X_SCROLL_SIZE=*width*] [, X_ZSIZE=*zoom_width*] [, YSIZE=*height*]
[, Y_SCROLL_SIZE=*height*] [, Y_ZSIZE=*zoom_height*])

Return Value

This function returns the widget ID of the newly-created zoom widget.

Arguments

Parent

The widget ID of the parent widget.

Keywords

FRAME

If set, a frame will be drawn around the widget. The default is FRAME = 0.

MAX

The maximum zoom scale, which must be greater than or equal to 1. The default is 20.

MIN

The minimum zoom scale, which must be greater than or equal to 1. The default is 1.

RETAIN

Set this keyword to zero, one, or two to specify how backing store should be handled for both windows. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See "Backing Store" on page 2351 for details.

SAMPLE

Set to zero for bilinear interpolation, or to a non-zero value for nearest neighbor interpolation. Bilinear interpolation gives higher quality results, but requires more time. The default is 0.

SCALE

The initial integer scale factor to use for the zoomed image. The default is SCALE = 4. The scale must be greater than or equal to 1.

TRACK

Set this keyword and events will be generated continuously as the cursor is moved across the original image. If not set, events will only be generated when the mouse button is released. Note: On slow systems, /TRACK performance can be inadequate. The default is 0.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UVALUE

The “user value” to be assigned to the widget.

XSIZE

The width of the window (in pixels) for the original image. The default is XSIZE = 500. Note that XSIZE *must* be set to the width of the original image array for the image to display properly.

X_SCROLL_SIZE

The width of the visible part of the original image. This may be smaller than the actual width controlled by the XSIZE keyword. The default is 0, for no scroll bar.

X_ZSIZE

The width of the window for the zoomed image. The default is 250.

YSIZE

The height of the window (in pixels) for the original image. The default is 500. Note that YSIZE *must* be set to the height of the original image array for the image to display properly.

Y_SCROLL_SIZE

The height of the visible part of the original image. This may be smaller than the actual height controlled by the YSIZE keyword. The default is 0, for no scroll bar.

Y_ZSIZE

The height of the window for the zoomed image. The default is 250.

Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the zoom widget. The value of the CW_ZOOM widget is the original, un-zoomed image to be displayed (a two-dimensional array). To change the contents of the CW_ZOOM widget, use the command:

```
WIDGET_CONTROL, id, SET_VALUE = array
```

where `id` is the widget ID of the CW_ZOOM widget and `array` is the image array. The value of CW_ZOOM cannot be set until the widget has been realized. Note that the size of the original window, set with the XSIZE and YSIZE keywords to CW_ZOOM, must be the size of the input array.

To return the current zoomed image as displayed by CW_ZOOM in the variable `array`, use the command:

```
WIDGET_CONTROL, id, GET_VALUE = array
```

See "Compound Widgets" in Chapter 22 of *Building IDL Applications* for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

Widget Events Returned by the CW_ZOOM Widget

When the "Report Zoom to Parent" button is pressed, this widget generates event structures with the following definition:

```
event = {ZOOM_EVENT, ID:0L, TOP:0L, HANDLER:0L, $
         XSIZE:0L, YSIZE:0L, X0:0L, Y0:0L, X1:0L, Y1:0L }
```

The XSIZE and YSIZE fields contain the dimensions of the zoomed image. The X0 and Y0 fields contain the coordinates of the lower left corner of the original image, and the X1 and Y1 fields contain the coordinates of the upper right corner of the original image.

Example

The following code samples illustrate a use of the CW_ZOOM widget.

First, create an event-handler. Note that clicking on the widget's "Zoom" button displays IDL's help output on the console.

```
PRO widzoom_event, event

   WIDGET_CONTROL, event.id, GET_UVALUE=uvalue
   CASE uvalue OF
      'ZOOM': HELP, /STRUCT, event
      'DONE': WIDGET_CONTROL, event.top, /DESTROY
   ENDCASE

END
```

Next, create the widget program:

```
PRO widzoom

   OPENR, lun, FILEPATH('people.dat', $
      SUBDIR = ['examples','data']), /GET_LUN
   image=BYTARR(192,192)
   READU, lun, image
   FREE_LUN, lun
   sz = SIZE(image)

   base=WIDGET_BASE(/COLUMN)
   zoom=CW_ZOOM(base, XSIZE=sz[1], YSIZE=sz[2], UVALUE='ZOOM')
   done=WIDGET_BUTTON(base, VALUE='Done', UVALUE='DONE')
   WIDGET_CONTROL, base, /REALIZE

   WIDGET_CONTROL, zoom, SET_VALUE=image
   XMANAGER, 'widzoom', base

END
```

Once you have entered these programs, type "widzoom" at the IDL command prompt to run the widget application.

See Also

ZOOM, ZOOM_24

DBLARR

The DBLARR function returns a double-precision, floating-point vector or array.

Syntax

Result = DBLARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, DBLARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and DBLARR executes faster.

Example

To create D, an 3-element by 3-element, double-precision, floating-point array with every element set to 0.0, enter:

```
D = DBLARR(3, 3)
```

See Also

COMPLEXARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

DCINDGEN

The DCINDGEN function returns a complex, double-precision, floating-point array with the specified dimensions. Each element of the array has its real part set to the value of its one-dimensional subscript. The imaginary part is set to zero.

Syntax

Result = DCINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create DC, a 4-element vector of complex values with the real parts set to the value of their subscripts, enter:

```
DC = DCINDGEN(4)
```

See Also

BINDGEN, CINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

DCOMPLEX

The DCOMPLEX function returns double-precision complex scalars or arrays given one or two scalars or arrays. If only one parameter is supplied, the imaginary part of the result is zero, otherwise it is set to the value of the *Imaginary* parameter. Parameters are first converted to double-precision floating-point. If either or both of the parameters are arrays, the result is an array, following the same rules as standard IDL operators. If three parameters are supplied, DCOMPLEX extracts fields of data from *Expression*.

Syntax

Result = DCOMPLEX(*Real* [, *Imaginary*])

or

Result = DCOMPLEX(*Expression*, *Offset*, Dim_1 [, ..., Dim_8])

Arguments

Real

Scalar or array to be used as the real part of the complex result.

Imaginary

Scalar or array to be used as the imaginary part of the complex result.

Expression

The expression from which data is to be extracted.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as complex data. See the description in Chapter 3, "Constants and Variables" in *Building IDL Applications* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

Create a complex array from two integer arrays by entering the following commands:

```
; Create the first integer array:
A = [1,2,3]

; Create the second integer array:
B = [4,5,6]

; Make A the real parts and B the imaginary parts of the new
; complex array:
C = DCOMPLEX(A, B)

; See how the two arrays were combined:
PRINT, C
```

IDL prints:

```
( 1.0000000, 4.0000000)( 2.0000000, 5.0000000)
( 3.0000000, 6.0000000)
```

The real and imaginary parts of the complex array can be extracted as follows:

```
; Print the real part of the complex array C:
PRINT, 'Real Part: ', DOUBLE(C)

; Print the imaginary part of the complex array C:
PRINT, 'Imaginary Part: ', IMAGINARY(C)
```

IDL prints:

```
Real Part:          1.0000000   2.0000000   3.0000000
Imaginary Part:     4.0000000   5.0000000   6.0000000
```

See Also

BYTE, COMPLEX, CONJ, DOUBLE, FIX, FLOAT, IMAGINARY, LONG, LONG64, STRING, UINT, ULONG, ULONG64

DCOMPLEXARR

The DCOMPLEXARR function returns a complex, double-precision, floating-point vector or array.

Syntax

Result = DCOMPLEXARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters may be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, DCOMPLEXARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed, and DCOMPLEXARR executes faster.

Example

To create an empty, 5-element by 5-element, complex array DC, enter:

```
DC = DCOMPLEXARR(5, 5)
```

See Also

COMPLEXARR, DBLARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

DEFINE_KEY

The DEFINE_KEY procedure programs the keyboard function *Key* with the string *Value*, or with one of the actions specified by the available keywords.

DEFINE_KEY is primarily intended for use with IDL's command line interface (available under UNIX and VMS). IDL's graphical interface (IDLDE), which is available under all operating systems supported by IDL, uses different system-specific mechanisms.

Syntax

DEFINE_KEY, *Key* [, *Value*] [, /MATCH_PREVIOUS] [, /NOECHO] [, /TERMINATE]

UNIX Keywords: [, /BACK_CHARACTER] [, /BACK_WORD] [, /CONTROL | , /ESCAPE] [, /DELETE_CHARACTER] [, /DELETE_CURRENT] [, /DELETE_EOL] [, /DELETE_LINE] [, /DELETE_WORD] [, /END_OF_LINE] [, /END_OF_FILE] [, /ENTER_LINE] [, /FORWARD_CHARACTER] [, /FORWARD_WORD] [, /INSERT_OVERSTRIKE_TOGGLE] [, /NEXT_LINE] [, /PREVIOUS_LINE] [, /RECALL] [, /REDRAW] [, /START_OF_LINE]

Arguments

Key

A scalar string containing the name of a function key to be programmed. IDL maintains an internal list of function key names and the escape sequences they send.

UNIX — Under UNIX, DEFINE_KEY allows you to set the values of two distinctly different types of keys:

- Control characters: Any of the 26 control characters (CTRL+A through CTRL+Z) can be associated with specific actions by specifying the CONTROL keyword. Control characters are the unprintable ASCII characters at the beginning of the ASCII character set. They are usually entered by holding down the Control key while the corresponding letter key is pressed.
- Function keys: Most terminals (and terminal emulators) send escape sequences when a function key is pressed. An escape sequence is a sequence of characters starting the ASCII Escape character. Escape sequences follow strict rules that allow applications such as IDL to determine when the sequence is complete. For instance, the left arrow key on most machines sends the sequence

<ESC>[D. The available function keys and the escape sequences they send vary from keyboard to keyboard; IDL cannot be built to recognize all of the different keyboards in existence. The ESCAPE keyword allows you to program IDL with the escape sequences for your keyboard. When you press the function key, IDL will recognize the sequence and take the appropriate action.

UNIX — Under UNIX, if *Key* is not already on IDL's internal list, you must use the ESCAPE keyword to specify the escape sequence, otherwise, *Key* alone will suffice. The available function keys and the escape sequences they send vary from keyboard to keyboard. The SETUP_KEYS procedure should be used once at the beginning of the session to enter the keys for the current keyboard. The following table describes the standard key definitions.

Editing Key	Function
Ctrl+A	Move cursor to start of line
Ctrl+B	Move cursor left one word
Ctrl+D	EOF if current line is empty, EOL otherwise
Ctrl+E	Move to end of line
Ctrl+F	Move cursor right one word
Ctrl+K	Erase from the cursor to the end of the line
Ctrl+N	Move back one line in the recall buffer
Ctrl+R	Retype current line
Ctrl+U	Delete from current position to start of line
Ctrl+W	Delete previous word
Ctrl+X	Delete current character
Backspace, Delete	Delete previous character
ESC-I	Overstrike/insert toggle
ESC-Delete	Delete previous word
Up Arrow	Move back one line in the recall buffer
Down Arrow	Move forward one line in the recall buffer

Table 15: Standard Key Definitions for UNIX

Editing Key	Function
Left Arrow	Move left one character
Right Arrow	Move right one character
R13	Move cursor left one word (Sun keyboards)
R15	Move cursor right one word (Sun keyboards)
^*text*	Recall the first line containing *text*. If *text* is blank, recall the previous line
Other Characters	Insert character at the current cursor position

Table 15: Standard Key Definitions for UNIX

VMS — Under VMS, the key names are those defined by the Screen Management utility (SMG). The following table describes some of these keys. For a complete description, refer to the *VMS RTL Screen Management (SMG$) Manual*.

Key Name	Description
DELETE	Delete previous character.
PF1	Recall most recent command that matches supplied string.
PF2—PF4	Top row of keypad.
KP0—KP9	Keypad keys 0 through 9
ENTER	Keypad ENTER key
MINUS	Keypad "-" key
COMMA	Keypad "," key
PERIOD	Keypad "." key
FIND	Editing keypad FIND key
INSERT_HERE	Editing keypad INSERT HERE key
REMOVE	Editing keypad REMOVE key
SELECT	Editing keypad SELECT key

Table 16: VMS Line Editing Keys

Key Name	Description
PREV_SCREEN	Editing keypad PREV_SCREEN key
NEXT_SCREEN	Editing keypad NEXT_SCREEN key

Table 16: VMS Line Editing Keys

Windows — Under Windows, function keys F2, F4, F11, and F12 can be customized.

In IDL for Windows, three special variables can be used to expand the current mouse selection, the current line, or the current filename into the output of defined keys.

Variable	Expansion
%f	filename of the currently-selected IDL Editor window
%l	number of the current line in an IDL Editor window
%s	Currently-selected text from an IDL Output Log or Editor window

Table 17: Variable expansions for defined keys

For example, to define F2 as a key that executes an IDL PRINT command with the current mouse selection as its argument, use the command:

```
DEFINE_KEY, 'F2', 'PRINT, "%S"'
```

Dragging the mouse over any text in an IDL Editor or Output Log window and pressing F1 causes the selected text to be printed. The `%l` and `%f` variables can be used in a similar fashion.

Macintosh — DEFINE_KEY does not currently work with IDL for Macintosh.

Value

The scalar string that will be printed (as if it had been typed manually at the keyboard) when *Key* is pressed. If *Value* is not present, and no function is specified for the key with one of the keywords, the key is cleared so that nothing happens when it is pressed.

Keywords

MATCH_PREVIOUS

Set this keyword to program *Key* to prompt the user for a string, and then search the saved command buffer for the most recently issued command that contains that string. If a match is found, the matching command becomes the current command, otherwise the last command entered is used. Under UNIX, the default match key is the up caret "^" key when pressed in column 1. Under VMS, the default match key is PF1.

NOECHO

Set this keyword to enter the Value assigned to *Key* when pressed, without echoing the string to the screen. This feature is useful for defining keys that perform such actions as erasing the screen. If NOECHO is set, TERMINATE is also assumed to be set.

TERMINATE

If this keyword is set, and *Value* is present, pressing *Key* terminates the current input operation after its assigned value is entered. Essentially, an implicit carriage return is added to the end of *Value*.

UNIX Keywords

BACK_CHARACTER

Set this keyword to program *Key* to move the current cursor position left one character.

BACK_WORD

Set this keyword to program *Key* to move the current cursor position left one word.

CONTROL

Set this keyword to indicate that *Key* is the name of a control key. The default is for *Key* to define a function key escape sequence. To view the names used by IDL for the control keys, type the following at the Command Input Line:

```
HELP, /ALL_KEYS
```

Warning

The CONTROL and ESCAPE keywords are mutually exclusive and cannot be specified together.

DELETE_CHARACTER

Set this keyword to program *Key* to delete the character to the left of the cursor.

DELETE_CURRENT

Set this keyword to program *Key* to delete the character directly underneath the cursor.

DELETE_EOL

Set this keyword to program *Key* to delete from the cursor position to the end of the line.

DELETE_LINE

Set this keyword to program *Key* to delete all characters to the left of the cursor.

DELETE_WORD

Set this keyword to programs *Key* to delete the word to the left of the cursor.

END_OF_LINE

Set this keyword to program *Key* to move the cursor to the end of the line.

END_OF_FILE

Set this keyword to program *Key* to exit IDL if the current line is empty, and to end the current input line if the current line is not empty.

ENTER_LINE

Set this keyword to program *Key* to enter the current line (i.e., the action normally performed by the “Return” key).

ESCAPE

A scalar string that specifies the escape sequence that corresponds to *Key*. See “Defining New Function Keys” on page 372 for further details.

Warning

The CONTROL and ESCAPE keywords are mutually exclusive and cannot be specified together.

FORWARD_CHARACTER

Set this keyword to program *Key* to move the current cursor position right one character.

FORWARD_WORD

Set this keyword to program *Key* to move the current cursor position right one word.

INSERT_OVERSTRIKE_TOGGLE

Set this keyword to program *Key* to toggle between “insert” and “overstrike” mode. When characters are typed into the middle of a line, insert mode causes the trailing characters to be moved to the right to make room for the new ones. Overstrike mode causes the new characters to overwrite the existing ones.

NEXT_LINE

Set this keyword to program *Key* to move forward one command in the saved command buffer and make that command the current one.

PREVIOUS_LINE

Set this keyword to program *Key* to move back one command in the saved command buffer and make that command the current one.

RECALL

Set this keyword to program *Key* to prompt the user for a command number. The saved command corresponding to the entered number becomes the current command. In order to view the currently saved commands and the number currently associated with each, enter the IDL command:

```
HELP, /RECALL COMMANDS
```

Example

The RECALL operation remembers the last command number entered, and if the user simply presses return, it recalls the command currently associated with that saved number. Since the number associated with a given command increases by one each time a new command is saved, this feature can be used to quickly replay a sequence of commands.

```
IDL> PRINT, 1
1
IDL> PRINT, 2
2
IDL> HELP, /RECALL_COMMANDS
Recall buffer length: 20
```

```
1               PRINT, 2
2               PRINT, 1
```

User presses key tied to RECALL.

```
IDL>
```

Line 2 is requested.

```
Recall Line #: 2
```

Saved command 2 is recalled.

```
IDL> PRINT, 1
1
```

User presses return.

```
Recall Line #:
```

Saved command 2 is recalled again.

```
IDL> PRINT, 2
2
```

REDRAW

Set this keyword to program *Key* to retype the current line.

START_OF_LINE

Set this keyword to program *Key* to move the cursor to the start of the line.

Defining New Function Keys

Under VMS, IDL uses the SMG screen management package, which ensures that IDL command editing behaves in the standard VMS way. Hence, it is not possible to use a key SMG does not understand.

Under UNIX, IDL can handle arbitrary function keys. When adding a definition for a function key that is not built into IDL's default list of recognized keys, you must use the ESCAPE keyword to specify the escape sequence it sends. For example, to add a function key named "HELP" which sends the escape sequence <Escape>[28~, use the command:

```
DEFINE_KEY, 'HELP', ESCAPE = '\033[28~'
```

This command adds the HELP key to the list of keys understood by IDL. Since only the key name and escape sequence were specified, pressing the HELP key will do nothing. The Value argument, or one of the keywords provided to specify command

line editing functions, could have been included in the above statement to program it with an action.

Once a key is defined using the ESCAPE keyword, it is contained in the internal list of function keys. It can then be subsequently redefined without specifying the escape sequence.

It is convenient to include commonly used key definitions in a startup file, so that they will always be available. See "Startup File" in Chapter 2 of *Using IDL*.

Usually, the SETUP_KEYS procedure is used to define the function keys found on the keyboard, so it is not necessary to specify the ESCAPE keyword. For example, to program key "F2" on a Sun keyboard to redraw the current line:

```
SETUP_KEYS
DEFINE_KEY, 'F2', /REDRAW
```

The CONTROL keyword alters the action that IDL takes when it sees the specified characters defining the control keys. IDL may not be able to alter the behavior of some control characters. For example, CTRL+S and CTRL+Q are usually reserved by the operating system for flow control. Similarly, CTRL+Z is usually The UNIX suspend character.

Example

CTRL+D is the UNIX end-of-file character. It is a common UNIX convention (followed by IDL) for programs to quit upon encountering CTRL+D.However, CTRL+D is also used by some text editors to delete characters. To disable IDL default handling of CTRL+D, type the following:

```
DEFINE_KEY, /CONTROL, '^D'
```

To print a reminder of how to exit IDL properly, type the following:

```
DEFINE_KEY, /CONTROL, '^D', "print, 'Enter EXIT to quit IDL'", $
/NOECHO, /TERMINATE
```

To use CTRL+D to delete characters, type the following:

```
DEFINE_KEY, /CONTROL, '^D', /DELETE_CURRENT
```

See Also

GET_KBRD

DEFROI

The DEFROI function defines an irregular region of interest of an image using the image display system and the cursor and mouse. The result is a vector of subscripts of the pixels inside the region. The lowest bit in which the write mask is enabled is changed.

DEFROI only works for interactive, pixel oriented devices with a cursor and an exclusive or writing mode. Regions may have at most 1000 vertices.

Warning

DEFROI does not function correctly when used with draw widgets. See CW_DEFROI.

This routine is written in the IDL language. Its source code can be found in the file `defroi.pro` in the `lib` subdirectory of the IDL distribution.

Using DEFROI

After calling DEFROI, click in the image with the left mouse button to mark points on the boundary of the region of interest. The points are connected in sequence. Alternatively, press and hold the left mouse button and drag to draw a curved region. Click the middle mouse button to erase points. The most recently-placed point is erased first. Click the right mouse button to close the region. The function returns after the region has been closed.

Syntax

Result = DEFROI(*Sx, Sy* [, *Xverts*, *Yverts*] [, /NOREGION] [, /NOFILL] [, /RESTORE] [, X0=*device_coord*, Y0=*device_coord*] [, ZOOM=*factor*])

Arguments

Sx, Sy

Integers specifying the horizontal and vertical size of image, in pixels.

Xverts, Yverts

Named vectors that will contain the vertices of the enclosed region.

Keywords

NOREGION

Set this keyword to inhibit the return of the pixel subscripts.

NOFILL

Set this keyword to inhibit filling of the defined region on completion.

RESTORE

Set this keyword to restore the display to its original state upon completion.

X0, Y0

Set these keywords equal to the coordinates of the lower left corner of the displayed image (in device coordinates). If omitted, the default value (0,0) is used.

ZOOM

Set this keyword equal to the zoom factor. If not specified, a value of 1 is assumed.

Example

```
; Create an image:
TVSCL, DIST(200,200)

; Call DEFROI. The cursor becomes active in the graphics window.
; Define a region and click the right mouse button:
X = DEFROI(200, 200)

; Print subscripts of points included in the defined region:
PRINT, X
```

See Also

CW_DEFROI

DEFSYSV

The DEFSYSV procedure creates a new system variable called *Name* initialized to *Value*.

Syntax

DEFSYSV, *Name*, *Value* [, *Read_Only*] [, EXISTS=*variable*]

Arguments

Name

A scalar string containing the name of the system variable to be created. All system variable names must begin with the character ‘!’.

Value

An expression from which the type, structure, and initial value of the new system variable is taken. *Value* can be a scalar, array, or structure.

Read_Only

If the *Read_Only* argument is present and nonzero, the value of the newly-created system variable cannot be changed (i.e., the system variable is read-only, like the !PI system variable). Otherwise, the value of the new system variable can be modified.

Keywords

EXISTS

Set this keyword to a named variable that returns 1 if the system variable specified by *Name* exists. If this keyword is specified, *Value* can be omitted. For example, the following commands could be used to check that the system variable XYZ exists:

```
DEFSYSV, '!XYZ', EXISTS = i
IF i EQ 1 THEN PRINT, '!XYZ exists' ELSE PRINT, $
   '!XYZ does not exist'
```

Example

To create a new, floating-point, scalar system variable called !NEWVAR with an initial value of 2.0, enter:

```
DEFSYSV, '!NEWVAR', 2.0
```

You can both define and use a system variable within a single procedure:

```
PRO foo
   DEFSYSV, '!foo', $
      'Rocky, watch me pull a squirrel out of my hat!'

   ; Print !foo after defining it:
   PRINT, !foo
END
```

See Also

Appendix D, “System Variables”

DELETE_SYMBOL

The DELETE_SYMBOL procedure deletes a DCL (Digital Command Language) interpreter symbol for the current process.

Note

This procedure is available on VMS only.

Syntax

DELETE_SYMBOL, *Name* [, TYPE={1 | 2}]

Arguments

Name

A scalar string containing the name of the symbol to be deleted.

Keywords

TYPE

Indicates the table from which *Name* will be deleted. Set TYPE to 1 to specify the local symbol table. Set TYPE to 2 to specify the global symbol table. The default is to search the local table.

See Also

DELLOG, SET_SYMBOL, SETLOG

DELLOG

The DELLOG procedure deletes a VMS logical name.

Note

This procedure is available on VMS only.

Syntax

DELLOG, *Lognam* [, TABLE=*string*]

Arguments

Lognam

A scalar string containing the name of the logical to be deleted.

Keywords

TABLE

A scalar string giving the name of the logical table from which to delete *Lognam*. If TABLE is not specified, LNM$PROCESS_TABLE is used.

See Also

DELETE_SYMBOL, SET_SYMBOL, SETENV, SETLOG

DELVAR

The DELVAR procedure deletes variables from the main IDL program level. DELVAR frees any memory used by the variable and removes it from the main program's symbol table. The following restrictions apply:

- DELVAR can only be called from the main program level.
- Each time DELVAR is called, the main program is erased. Variables that are not deleted remain unchanged.

Syntax

DELVAR, V_1, ..., V_n

Arguments

V_i

One or more named variables to be deleted.

Example

Suppose that the variable Q is defined at the main program level. Q can be deleted by entering:

```
DELVAR, Q
```

See Also

TEMPORARY

DERIV

The DERIV function performs numerical differentiation using 3-point, Lagrangian interpolation and returns the derivative.

Syntax

Result = DERIV([*X*,] *Y*)

Arguments

X

Differentiate with respect to this variable. If omitted, unit spacing for Y (i.e., X*i* = *i*) is assumed.

Y

The variable to be differentiated.

Example

```
X = [ 0.1, 0.3, 0.4, 0.7, 0.9]
Y = [ 1.2, 2.3, 3.2, 4.4, 6.6]
PRINT, DERIV(Y)
PRINT, DERIV(X,Y)
```

IDL prints:

```
1.20000   1.00000   1.05000   1.70000   2.70000
8.00000   6.66667   5.25000   6.80000   10.800
```

See Also

DERIVSIG

DERIVSIG

The DERIVSIG function computes the standard deviation of a derivative as found by the DERIV function, using the input variables of DERIV and the standard deviations of those input variables.

Syntax

Result = DERIVSIG([*X*, *Y*, Sig_x,] Sig_y)

Arguments

X

Differentiate with respect to this variable. If omitted, unit spacing for Y (i.e., X*i* = *i*) is assumed.

Y

The variable to be differentiated. Omit if *X* is omitted.

Sigx

The standard deviation of *X* (either vector or constant). Use “0.0” if the abscissa is exact; omit if *X* is omitted.

Sigy

The standard deviation of *Y*. *Sigy* must be a vector if the other arguments are omitted, but may be either a vector or a constant if *X*, *Y*, and *Sigx* are supplied.

See Also

DERIV

DETERM

The DETERM function computes the determinant of an *n* by *n* array. LU decomposition is used to represent the input array in triangular form. The determinant is then computed as the product of diagonal elements of the triangular form. Row interchanges are tracked during the LU decomposition to ensure the correct sign.

This routine is written in the IDL language. Its source code can be found in the file `determ.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = DETERM(*A* [, /CHECK] [, /DOUBLE] [, ZERO=*value*])

Arguments

A

An *n* by *n* single- or double-precision floating-point array.

Keywords

CHECK

Set this keyword to check *A* for singularity. The determinant of a singular array is returned as zero if this keyword is set. Run-time errors may result if *A* is singular and this keyword is not set.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ZERO

Use this keyword to set the absolute value of the floating-point zero. A floating-point zero on the main diagonal of a triangular array results in a zero determinant. For single-precision inputs, the default value is 1.0×10^{-6}. For double-precision inputs, the default value is 1.0×10^{-12}. Setting this keyword to a value less than the default may improve the precision of the result.

Example

```
; Define an array A:
A = [[ 2.0,  1.0,  1.0], $
   [ 4.0, -6.0,  0.0], $
```

```
   [-2.0,  7.0,  2.0]]

; Compute the determinant:
PRINT, DETERM(A)
```

IDL prints:

```
-16.0000
```

See Also

COND, INVERT

DEVICE

The DEVICE procedure provides device-dependent control over the current graphics device (as set by the SET_PLOT routine). The IDL graphics procedures and functions are device-independent. That is, IDL presents the user with a consistent interface to all devices. However, most devices have extra abilities that are not directly available through this interface. DEVICE is used to access and control such abilities. It is used by specifying various keywords that differ from device to device.

See Appendix B, "IDL Graphics Devices" for a description of the keywords available for each graphics device.

Syntax

Note

Each keyword to DEVICE is followed by the device(s) to which it applies.

DEVICE

[, /AVANTGARDE | , /BKMAN | , /COURIER | , /HELVETICA | , /ISOLATIN1 | , /PALATINO | , /SCHOOLBOOK | , /SYMBOL | , TIMES | , ZAPFCHANCERY | , ZAPFDINGBATS {PS}]
[, /AVERAGE_LINES{REGIS}]
[, /BINARY | , /NCAR | , /TEXT {CGM}]
[, BITS_PER_PIXEL={1 | 2 | 4 | 8}{PS}]
[, /BOLD{PS}]
[, /BOOK{PS}]
[, /BYPASS_TRANSLATION{MAC, WIN, X}]
[, /CLOSE{Z}]
[, /CLOSE_DOCUMENT{PRINTER}]
[, /CLOSE_FILE{CGM, HP, LJ, METAFILE, PCL, PS, REGIS, TEK}]
[, /COLOR{PCL, PS}]
[, COLORS=*value*{CGM, TEK}]
[, COPY=*[Xsource*, *Ysource*, *cols*, *rows*, *Xdest*, *Ydest* [, *Window_index*]*]*{MAC, WIN, X}]
[, /CURSOR_CROSSHAIR{WIN, X}]
[, CURSOR_IMAGE=*value*{16-element short int vector}{MAC, WIN, X}]
[, CURSOR_MASK=value{MAC, WIN, X}]
[, /CURSOR_ORIGINAL{MAC, WIN, X}]
[, CURSOR_STANDARD=*value*{MAC: crosshair=1}{WIN: arrow=32512,

I-beam=32513, hourglass=32514, black cross=32515, up arrow=32516, size(NT)=32640, icon(NT)=32641, size NW-SE=32642, size NE-SW=32643, size E-W=32644, size N-S=32645}{X: one of the values in file cursorfonts.h}]
[, CURSOR_XY=*[x,y]*{MAC, WIN, X}]
[, /DECOMPOSED{MAC, WIN, X}]
[, DEPTH=*value*{significant bits per pixel}{LJ}]
[, /DIRECT_COLOR{X}]
[, EJECT={0 | 1 | 2}{HP}]
[, ENCAPSULATED={0 | 1}{PS}]
[, ENCODING={1 (binary) | 2 (text) | 3 (NCAR binary)}{CGM}]
[, FILENAME=*filename*{CGM, HP, LJ, METAFILE, PCL, PS, REGIS, TEK}]
[, /FLOYD{LJ, MAC, PCL, X}]
[, FONT_INDEX=*integer*{PS}]
[, FONT_SIZE=*points*{PS}]
[, GET_CURRENT_FONT=*variable*{MAC, METAFILE, PRINTER, WIN, X}]
[, GET_DECOMPOSED=*variable*{MAC, WIN, X}]
[, GET_FONTNAMES=*variable*{MAC, METAFILE, PRINTER, WIN, X}]
[, GET_FONTNUM=*variable*{MAC, METAFILE, PRINTER, WIN, X}]
[, GET_GRAPHICS_FUNCTION=*variable*{MAC, WIN, X, Z}]
[, GET_PAGESIZE=*variable*{PRINTER}]
[, GET_SCREEN_SIZE=*variable*{MAC, WIN, X}]
[, GET_VISUAL_DEPTH=*variable*{MAC, WIN, X}]
[, GET_VISUAL_NAME=*variable*{MAC, WIN, X}]
[, GET_WINDOW_POSITION=*variable*{MAC, WIN, X}]
[, GET_WRITE_MASK=*variable*{X, Z}]
[, GIN_CHARS=*number_of_characters*{TEK}]
[, GLYPH_CACHE=*number_of_glyphs*{MAC, METAFILE, PRINTER, PS, WIN, Z}]
[, /INCHES{HP, LJ, PCL, METAFILE, PRINTER, PS}]
[, /INDEX_COLOR{METAFILE, PRINTER}]
[, /ITALIC{PS}]
[, /LANDSCAPE | , /PORTRAIT{HP, LJ, PCL, PRINTER, PS}]
[, /DEMI | , /LIGHT | , /MEDIUM | , /NARROW | , /OBLIQUE{PS}]
[, OPTIMIZE={0 | 1 | 2}{PCL}] [, /ORDERED{LJ, MAC, PCL, X}]
[, OUTPUT=*scalar string*{HP, PS}]
[, /PIXELS{LJ, PCL}]
[, PLOT_TO=*logical unit num*{REGIS, TEK}]
[, /PLOTTER_ON_OFF{HP}]
[, /POLYFILL{HP}]
[, PRE_DEPTH=*value*{PS}]
[, PRE_XSIZE=*width*{PS}]

[, PRE_YSIZE=*height*{PS}]
[, /PREVIEW{PS}]
[, PRINT_FILE=*filename*{WIN}]
[, /PSEUDO_COLOR{MAC, X}]
[, RESET_STRING=*string*{TEK}]
[, RESOLUTION=*value*{LJ, PCL}]
[, RETAIN={0 | 1 | 2}{MAC, WIN, X}]
[, SCALE_FACTOR=*value*{PRINTER, PS}]
[, SET_CHARACTER_SIZE=*[font size, line spacing]*{CGM, HP, LJ, MAC, METAFILE, PCL, PS, REGIS, TEK, WIN, X, Z}]
[, SET_COLORMAP=*value*{14739-element byte vector}{PCL}]
[, SET_COLORS=*value*{2 to 256}{Z}]
[, SET_FONT=*scalar string*{MAC, METAFILE, PRINTER, PS, WIN, Z}]
[, SET_GRAPHICS_FUNCTION=*code*{0 to 15}{MAC, WIN, X, Z}]
[, SET_RESOLUTION=*[width, height]*{Z}]
[, SET_STRING=*string*{TEK}]
[, SET_TRANSLATION=*variable*{X}]
[, SET_WRITE_MASK=*value*{0 to 2^n-1 for *n*-bit system}{X, Z}]
[, STATIC_COLOR=*value*{bits per pixel}{X}]
[, STATIC_GRAY=*value*{bits per pixel}{X}]
[, /TEK4014{TEK}]
[, TEK4100{TEK}]
[, THRESHOLD=*value*{LJ, MAC, PCL, X}]
[, TRANSLATION=*variable*{MAC, WIN, X}]
[, TRUE_COLOR=*value*{bits per pixel}{MAC, METAFILE, PRINTER, X}]
[, /TT_FONT{MAC, METAFILE, PRINTER, WIN, X, Z}]
[, /TTY{REGIS, TEK}]
[, /VT240 | , /VT241 | , /VT340 | , /VT341 {REGIS}]
[, WINDOW_STATE=*variable*{MAC, WIN, X}]
[, XOFFSET=*value*{HP, LJ, PCL, PRINTER, PS}]
[, XON_XOFF={0 | 1 (default)}{HP}]
[, XSIZE=*width*{HP, LJ, METAFILE, PCL, PRINTER, PS}]
[, YOFFSET=*value*{HP, LJ, PCL, PRINTER, PS}]
[, YSIZE=*height*{HP, LJ, PCL, METAFILE, PRINTER, PS}]
[, Z_BUFFERING={0 | 1 (default)}{Z}]

Keywords

See "Keywords Accepted by the IDL Devices" on page 2311.

Example

The following example retains the name of the current graphics device, sets plotting to the PostScript device, makes a PostScript file, then resets plotting to the original device:

```
; The NAME field of the !D system variable contains the name of the
; current plotting device.
mydevice = !D.NAME

; Set plotting to PostScript:
SET_PLOT, 'PS'

; Use DEVICE to set some PostScript device options:
DEVICE, FILENAME='myfile.ps', /LANDSCAPE

; Make a simple plot to the PostScript file:
PLOT, FINDGEN(10)

; Close the PostScript file:
DEVICE, /CLOSE

; Return plotting to the original device:
SET_PLOT, mydevice
```

DFPMIN

The DFPMIN procedure minimizes a user-written function *Func* of two or more independent variables using the Broyden-Fletcher-Goldfarb-Shanno variant of the Davidon-Fletcher-Powell method, using its gradient as calculated by a user-written function *Dfunc*.

DFPMIN is based on the routine `dfpmin` described in section 10.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

DFPMIN, *X*, *Gtol*, *Fmin*, *Func*, *Dfunc* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLX=*value*]

Arguments

X

On input, *X* is an *n*-element vector specifying the starting point. On output, it is replaced with the location of the minimum.

Gtol

An input value specifying the convergence requirement on zeroing the gradient.

Fmin

On output, *Fmin* contains the value at the minimum-point *X* of the user-supplied function specified by *Func*.

Func

A scalar string specifying the name of a user-supplied IDL function of two or more independent variables to be minimized. This function must accept a vector argument *X* and return a scalar result.

For example, suppose we wish to find the minimum value of the function

$$y = (x_0 - 3)^4 + (x_1 - 2)^2$$

To evaluate this expression, we define an IDL function named MINIMUM:

```
FUNCTION minimum, X
   RETURN, (X[0] - 3.0)^4 + (X[1] - 2.0)^2
```

```
END
```

Dfunc

A scalar string specifying the name of a user-supplied IDL function that calculates the gradient of the function specified by *Func*. This function must accept a vector argument *X* and return a vector result.

For example, the gradient of the above function is defined by the partial derivatives:

$$\frac{\partial y}{\partial x_0} = 4(x_0 - 3)^3, \quad \frac{\partial y}{\partial x_1} = 2(x_1 - 2)$$

We can write a function GRAD to express these relationships in the IDL language:

```
FUNCTION grad, X
   RETURN, [4.0*(X[0] - 3.0)^3, 2.0*(X[1] - 2.0)]
END
```

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

Use this keyword to specify a number close to the machine precision. For single-precision calculations, the default value is 3.0×10^{-8}. For double-precision calculations, the default value is 3.0×10^{-16}.

ITER

Use this keyword to specify a named variable which returns the number of iterations performed.

ITMAX

Use this keyword to specify the maximum number of iterations allowed. The default value is 200.

STEPMAX

Use this keyword to specify the scaled maximum step length allowed in line searches. The default value is 100.0

TOLX

Use this keyword to specify the convergence criterion on *X* values. The default value is 4 x EPS.

Example

To minimize the function MINIMUM:

```
PRO example_dfpmin

   ; Make an initial guess (the algorithm's starting point):
   X = [1.0, 1.0]

   ; Set the convergence requirement on the gradient:
   Gtol = 1.0e-7

   ; Find the minimizing value:
   DFPMIN, X, Gtol, Fmin, 'minimum', 'grad'

   ; Print the minimizing value:
   PRINT, X

END


FUNCTION minimum, X
   RETURN, (X[0] - 3.0)^4 + (X[1] - 2.0)^2
END

FUNCTION grad, X
   RETURN, [4.0*(X[0] - 3.0)^3, 2.0*(X[1] - 2.0)]
END
```

IDL prints:

```
     3.00175  2.00000
```

See Also

POWELL

DIALOG_MESSAGE

The DIALOG_MESSAGE function creates a modal (blocking) dialog box that can be used to display information for the user. The dialog must be dismissed, by clicking on one of its option buttons, before execution of the widget program can continue.

This function differs from widgets in a number of ways. The DIALOG_MESSAGE dialog does not exist as part of a widget tree, has no children, does not exist in an unrealized state, and generates no events. Instead, the dialog is displayed whenever this function is called. While the DIALOG_MESSAGE dialog is displayed, widget activity is limited because the dialog is modal. The function does not return to its caller until the user selects one of the dialog's buttons. Once a button has been selected, the dialog disappears.

DIALOG_MESSAGE returns a string containing the text of the label that the user selected.

There are four basic dialogs that can be displayed. The default type is "Warning". Other types can be selected by setting one of the keywords described below. Each dialog type displays different buttons. Additionally any dialog can be made to show a "Cancel" button by setting the CANCEL keyword. The four types of dialogs are described in the table below:

Dialog Type	Default Buttons
Error	OK
Warning	OK
Question	Yes, No
Information	OK

Table 18: Types of DIALOG_MESSAGE Dialogs

Syntax

Result = DIALOG_MESSAGE(*Message_Text* [, /CANCEL]
[, /DEFAULT_CANCEL | , /DEFAULT_NO] [, DIALOG_PARENT=*widget_id*]
[, DISPLAY_NAME=*string*] [, /ERROR | , /INFORMATION | , /QUESTION]
[, RESOURCE_NAME=*string*] [, TITLE=*string*])

Arguments

Message_Text

A scalar string or string array that contains the text of the message to be displayed. If this argument is set to an array of strings, each array element is displayed as a separate line of text.

Keywords

CANCEL

Set this keyword to add a “Cancel” button to the dialog.

DEFAULT_CANCEL

Set this keyword to make the “Cancel” button the default selection for the dialog. The default selection is the button that is selected when the user presses the default keystroke (usually Space or Return depending on the platform). Setting DEFAULT_CANCEL implies that the CANCEL keyword is also set.

DEFAULT_NO

Set this keyword to make the “No” button the default selection for “Question” dialogs. Normally, the default is “Yes”.

DIALOG_PARENT

Set this keyword to the widget ID of a widget over which the message dialog should be positioned. When displayed, the DIALOG_MESSAGE dialog will be positioned over the specified widget. Dialogs are often related to a non-dialog widget tree. The ID of the widget in that tree to which the dialog is most closely related should be specified.

This keyword is ignored on Macintosh platforms.

DISPLAY_NAME

Set this keyword equal to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified. This keyword is also ignored on Microsoft Windows and Macintosh platforms.

ERROR

Set this keyword to create an “Error” dialog. The default dialog type is “Warning”.

INFORMATION

Set this keyword to create an “Information” dialog. The default dialog type is “Warning”.

QUESTION

Set this keyword to create a “Question” dialog. The default dialog type is “Warning”.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the dialog. See “RESOURCE_NAME” on page 1544 for a complete discussion of this keyword.

TITLE

Set this keyword to a scalar string that contains the text of a title to be displayed in the dialog frame. If this keyword is not specified, the dialog has the dialog type as its title as shown in the table under DIALOG_MESSAGE. This keyword is ignored on Macintosh platforms.

See Also

XDISPLAYFILE

DIALOG_PICKFILE

The DIALOG_PICKFILE function allows the user to interactively pick a file, or multiple files, using the platform's own native graphical file-selection dialog. The user can also enter the name of a file that does not exist (see the description of the WRITE keyword, below).

Syntax

Result = DIALOG_PICKFILE([, /DIRECTORY]
[, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*] [, FILE=*string*]
[, FILTER=*string*/*string array*] [, /FIX_FILTER] [, GET_PATH=*variable*]
[, GROUP=*widget_id*] [, /MULTIPLE_FILES] [, /MUST_EXIST] [, PATH=*string*]
[, /READ | , /WRITE] [, /RESOURCE_NAME] [, TITLE=*string*])

Return Value

DIALOG_PICKFILE returns a string array that contains the full path name of the selected file or files. If no file is selected, DIALOG_PICKFILE returns a null string.

Keywords

DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

DIRECTORY

Set this keyword to display only the existing directories in the current directory. Individual files are not displayed.

DISPLAY_NAME

Set this keyword equal to a string that specifies the name of the X Windows display on which the dialog should be displayed. This keyword is ignored on Microsoft Windows and Macintosh platforms.

FILE

Set this keyword to a scalar string that contains the name of the initial file selection. This keyword is useful for specifying a default filename.

On Windows, this keyword also has the effect of filtering the file list if a wildcard is used, but this keyword should be used to specify a specific filename. To list only files of a certain type, use the FILTER keyword.

FILTER

Set this keyword to a string value or an array of strings specifying the file types to be displayed in the file list. This keyword is used to reduce the number of files displayed in the file list. The user can modify the filter unless the FIX_FILTER keyword is set. If the value contains a vector of strings, multiple filters are used to filter the files. The filter, `*.*`, is automatically added to any filter you specify.

Under Microsoft Windows, the user cannot modify the filter. (The user can, however, enter a filter string in the filename field to filter the files displayed.)

On the Macintosh, the filter is not displayed if the WRITE keyword is set.

On UNIX, the FILTER keyword does not support specifying more than one filter. If you specify more than one filter, all files in the current directory will be displayed.

For example, to display only files of type `.jpg`, `.tif`, or `.png` in the file selection window, you could use the following code:

```
file = DIALOG_PICKFILE(/READ, $
   FILTER = ['*.jpg', '*.tif', '*.png'])
```

FIX_FILTER

When this keyword is set, only files that satisfy the filter can be selected. The user has no ability to modify the filter and the filter is not shown.

Under Microsoft Windows, the user cannot modify the filter even if FIX_FILTER is *not* set. Note that the user can enter a filter string in the filename field of the dialog to change the filter condition even if FIX_FILTER *is* set.

GET_PATH

Set this keyword to a named variable in which the path of the selection is returned.

GROUP

This keyword is obsolete and has been replaced by the DIALOG_PARENT keyword. Code that uses the GROUP keyword will continue to function as before, but we suggest that all new code use DIALOG_PARENT.

MULTIPLE_FILES

Set this keyword to allow for multiple file selection in the file-selection dialog. When you set this keyword, the user can select multiple files using the platform-specific

selection method. The currently selected files appear in the selection text field of the dialog. With this keyword set, DIALOG_PICKFILE can return a string array that contains the full path name of the selected file or files.

MUST_EXIST

Set this keyword to allow only files that already exist to be selected.

PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

READ

Set this keyword to make the title of the dialog “Select File to Read”.

TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Please Select a File”. This keyword is ignored on Macintosh platforms.

WRITE

Set this keyword to make the title of the dialog “Select File to Write”.

Note

On the Macintosh, you *must* set the WRITE keyword in order to be able to enter the name of a file that does not exist. As a result, the FILTER and FIX_FILTER keywords are ignored when the WRITE keyword is specified on a Macintosh.

Example

Create a DIALOG_PICKFILE dialog that lets users select only files with the extension ‘pro’. Use the ‘Select File to Read’ title and store the name of the selected file in the variable `file`. Enter:

```
file = DIALOG_PICKFILE(/READ, FILTER = '*.pro')
```

See Also

FILEPATH

DIALOG_PRINTERSETUP

The DIALOG_PRINTERSETUP function opens a native dialog for setting the applicable properties for a particular printer. DIALOG_PRINTERSETUP returns a nonzero value if the user pressed the “OK” button in the dialog, or zero otherwise. You can use the result of this function to programmatically begin printing.

Syntax

Result = DIALOG_PRINTERSETUP([*PrintDestination*]
[, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, TITLE=*string*])

Arguments

PrintDestination

An instance of the IDLgrPrinter object for which setup properties are to be set. If no *PrintDestination* is specified, the printer used by the IDL Direct Graphics `printer` device is modified.

Keywords

DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

DISPLAY_NAME

Set this keyword equal to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified, and is also ignored on Windows and Macintosh platforms.

RESOURCE_NAME

Set this keyword equal to a string containing an X Window System resource name to be applied to the dialog.

TITLE

Set this keyword equal to a string to be displayed on the dialog frame. This keyword is ignored on Windows and Macintosh platforms.

See Also

DIALOG_PRINTJOB, “The Printer Device” on page 2370

DIALOG_PRINTJOB

The DIALOG_PRINTJOB function opens a native dialog that allows you to set parameters for a printing job (number of copies to print, for example).

Syntax

Result = DIALOG_PRINTJOB([*PrintDestination*]
[, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, TITLE=*string*])

Return Value

DIALOG_PRINTJOB returns a nonzero value if the user pressed the “OK” button in the dialog, or zero otherwise. You can use the result of this function to programmatically begin printing.

Arguments

PrintDestination

An instance of the IDLgrPrinter object for which a printing job is to be initiated. If no *PrintDestination* is specified, the printer used by the IDL Direct Graphics `printer` device is modified.

Keywords

DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

DISPLAY_NAME

Set this keyword to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified, and is also ignored on Windows and Macintosh platforms.

RESOURCE_NAME

Set this keyword to a string containing an X Window System resource name to be applied to the dialog.

TITLE

Set this keyword to a string to be displayed on the dialog frame. This keyword is ignored on Windows and Macintosh platforms.

See Also

DIALOG_PRINTERSETUP, “The Printer Device” on page 2370

DIALOG_READ_IMAGE

The DIALOG_READ_IMAGE function is a graphical interface used for reading image files. The interface is created as a modal dialog with an optional parent widget.

Syntax

Result = DIALOG_READ_IMAGE ([*Filename*] [, BLUE=*variable*]
[, DIALOG_PARENT=*widget_id*] [, FILE=*variable*] [, FILTER_TYPE=*string*]
[, /FIX_FILTER] [, GET_PATH=*variable*] [, GREEN=*variable*]
[, IMAGE=*variable*] [, PATH=*string*] [, QUERY=*variable*] [, RED=*variable*]
[,TITLE=*string*])

Return Value

This function returns 1 if the “Open” button was clicked, and 0 if the “Cancel” button was clicked.

Arguments

Filename

An optional scalar string containing the full pathname of the file to be highlighted.

Keywords

BLUE

Set this keyword to a named variable that will contain the blue channel vector (if any).

DIALOG_PARENT

The widget ID of a widget that calls DIALOG_READ_IMAGE. When this ID is specified, a death of the caller results in the death of the DIALOG_READ_IMAGE dialog. If DIALOG_PARENT is not specified, then the interface is created as a modal, top-level widget.

FILE

Set this keyword to a named variable that will contain the selected filename with full path when the dialog is created.

FILTER_TYPE

Set this keyword to a scalar string containing the format type the dialog filter should begin with. The default is “Image Files”. The user cannot modify the filter if the FIX_FILTER keyword is set. Valid values are obtained from the list of supported image types returned from QUERY_IMAGE. In addition, there is also the “All Files” type. If set to “All Files”, queries will only happen on filename clicks, making the dialog much more efficient.

Example:

```
FILTER='.jpg, .tiff'
```

FIX_FILTER

When this keyword is set, only files that satisfy the filter can be selected. The user has no ability to modify the filter.

GET_PATH

Set this keyword to a named variable in which the path of the selection is returned.

GREEN

Set this keyword to a named variable that will contain the green channel vector (if any).

IMAGE

Set this keyword to a named variable that will contain the image array read. If Cancel was clicked, no action is taken.

PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

QUERY

Set this keyword to a named variable that will return the QUERY_IMAGE structure associated with the returned image. If the “Cancel” button was pressed, the variable set to this keyword is not changed. If an error occurred during the read, the FILENAME field of the structure will be a null string.

RED

Set this keyword to a named variable that will contain the red channel vector (if any).

TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Select Image File”.

See Also

DIALOG_WRITE_IMAGE

DIALOG_WRITE_IMAGE

The DIALOG_WRITE_IMAGE function is a graphical user interface used for writing image files. The interface is created as a modal dialog with an optional parent widget.

Syntax

Result = DIALOG_WRITE_IMAGE (*Image* [, *R*, *G*, *B*]
[, DIALOG_PARENT=*widget_id*] [, FILE=*string*] [, /FIX_TYPE] [, /NOWRITE]
[, OPTIONS=*variable*] [, PATH=*string*] [,TITLE=*string*] [, TYPE=*variable*]
[, /WARN_EXIST])

Return Value

This routine returns 1 if the “Save” button was clicked, and 0 if the “Cancel” button was clicked.

Arguments

Image

The array to be written to the image file.

R, G, B

These are optional arguments defining the Red, Green, and Blue color tables to be associated with the image array.

Keywords

DIALOG_PARENT

The widget ID of a widget that calls DIALOG_WRITE_IMAGE. When this ID is specified, a death of the caller results in the death of the DIALOG_WRITE_IMAGE dialog. If DIALOG_PARENT is not specified, then the interface is created as a modal, top-level widget.

FILE

Set this keyword to a scalar string that contains the name of the initial file selection. This keyword is useful for specifying a default filename.

FIX_TYPE

When this keyword is set, only files that satisfy the type can be selected. The user has no ability to modify the type.

NOWRITE

Set this keyword to prevent the dialog from writing the file when “Save” is clicked. No data conversions will take place when the save type is chosen.

OPTIONS

Set this keyword to a named variable to contain a structure of the chosen options by the user, including the filename and image type chosen.

PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Save Image File”.

TYPE

Set this keyword to a scalar string containing the format type the “Save as type” field should begin with. The default is “TIFF”. The user can modify the type unless the FIX_TYPE keyword is set. Valid values are obtained from the list of supported image types returned from QUERY_IMAGE. The “Save as type” field will reflect the type of the selected file (if one is selected).

WARN_EXIST

Set this keyword to produce a question dialog if the user selects a file that already exists. The default is to quietly overwrite the file.

See Also

DIALOG_READ_IMAGE

DIGITAL_FILTER

The DIGITAL_FILTER function returns the coefficients of a non-recursive, digital filter for evenly spaced data points. Frequencies are expressed in terms of the Nyquist frequency, 1/2T, where T is the time between data samples. Highpass, lowpass, bandpass and bandstop filters may be constructed with this function.

This routine is written in the IDL language. Its source code can be found in the file `digital_filter.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = DIGITAL_FILTER(*Flow*, *Fhigh*, *A*, *Nterms*)

Return Value

This function returns a vector of coefficients with (2 × *Nterms* + 1) elements.

Arguments

Flow

The lower frequency of the filter as a fraction of the Nyquist frequency

Fhigh

The upper frequency of the filter as a fraction of the Nyquist frequency. The following conditions are necessary for various types of filters:

- No Filtering: $Flow = 0, Fhigh = 1$
- Low Pass: $Flow = 0, 0 < Fhigh < 1$
- High Pass: $0 < Flow < 1, Fhigh = 1$
- Band Pass: $0 < Flow < Fhigh < 1$
- Band Stop: $0 < Fhigh < Flow < 1$

A

The filter power relative to the Gibbs phenomenon wiggles in decibels. 50 is a good choice.

Nterms

The number of terms used to construct the filter.

Example

```
; Get coefficients:
Coeff = DIGITAL_FILTER(Flow, Fhigh, A, Nterms)
; Apply the filter:
Yout = CONVOL(Yin, Coeff)
```

See Also

CONVOL, LEEFILT, MEDIAN, SMOOTH

DILATE

The DILATE function implements the morphologic dilation operator on both binary and grayscale images. For details on using DILATE, see "Using DILATE" on page 410.

Syntax

Result = DILATE(*Image*, *Structure* [, X_0 [, Y_0 [, Z_0]]] [, /CONSTRAINED [, BACKGROUND=*value*]] [, /GRAY [, /PRESERVE_TYPE | , /UINT | , /ULONG]] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the dilation is to be performed. If the parameter is not of byte type, a temporary byte copy is obtained. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

Structure

A one-, two-, or three-dimensional array that represents the structuring element. Elements are interpreted as binary: values are either zero or nonzero. This argument must have the same number of dimensions as *Image*.

X_0, Y_0, Z_0

Optional parameters specifying the one-, two-, or three-dimensional coordinate of the structuring element's origin. If omitted, the origin is set to the center, ([N_x/2], [N_y/2], [N_z/2]), where N_x, N_y, and N_z are the dimensions of the structuring element array. The origin need not be within the structuring element.

Keywords

BACKGROUND

Set this keyword to the pixel value that is to be considered the background when dilation is being performed in constrained mode. The default value is 0.

CONSTRAINED

If this keyword is set and grayscale dilation has been selected, the dilation algorithm will operate in constrained mode. In this mode, a pixel is set to the value determined by normal grayscale dilation rules in the output image only if the current value destination pixel value matches the BACKGROUND pixel value. Once a pixel in the output image has been set to a value other than the BACKGROUND value, it cannot change.

GRAY

Set this keyword to perform grayscale, rather than binary, dilation. The nonzero elements of the *Structure* parameter determine the shape of the structuring element (neighborhood). If VALUES is not present, all elements of the structuring element are 0, yielding the neighborhood maximum operator.

PRESERVE_TYPE

Set this keyword to return the same type as the input array. This keyword only applies if the GRAY keyword is set.

UINT

Set this keyword to return an unsigned integer array. This keyword only applies if the GRAY keyword is set.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies if the GRAY keyword is set.

VALUES

An array with the same dimensions as *Structure* providing the values of the structuring element. The presence of this parameter implies grayscale dilation. Each pixel of the result is the maximum of the sum of the corresponding elements of VALUE and the *Image* pixel value. If the resulting sum is greater than 255, the return value is 255.

Using DILATE

Mathematical morphology is a method of processing digital images on the basis of shape. A discussion of this topic is beyond the scope of this manual. A suggested reference is: Haralick, Sternberg, and Zhuang, “Image Analysis Using Mathematical Morphology,” *IEEE Transactions on Pattern Analysis and Machine Intelligence*,

Vol. PAMI-9, No. 4, July, 1987, pp. 532-550. Much of this discussion is taken from that article.

Briefly, the DILATE function returns the dilation of *Image* by the structuring element *Structure*. This operator is commonly known as "fill", "expand", or "grow." It can be used to fill "holes" of a size equal to or smaller than the structuring element.

Used with binary images, where each pixel is either 1 or 0, dilation is similar to convolution. Over each pixel of the image, the origin of the structuring element is overlaid. If the image pixel is nonzero, each pixel of the structuring element is added to the result using the "or" operator.

Letting $A \oplus B$ represent the dilation of an image A by structuring element B, dilation can be defined as:

$$C = A \oplus B = \bigcup_{b \in B} (A)_b$$

where $(A)_b$ represents the translation of A by b. Intuitively, for each nonzero element $b_{i,j}$ of B, A is translated by i,j and summed into C using the "or" operator. For example:

$$\begin{array}{lll} 0100 & & 0110 \\ 0100 & & 0110 \\ 0110 \oplus 11 & = & 0111 \\ 1000 & & 1100 \\ 0000 & & 0000 \end{array}$$

In this example, the origin of the structuring element is at (0,0).

Used with grayscale images, which are always converted to byte type, the DILATE function is accomplished by taking the maximum of a set of sums. It can be used to conveniently implement the neighborhood maximum operator with the shape of the neighborhood given by the structuring element.

Openings and Closings

The *opening* of image B by structuring element K is defined as $(B \otimes K) \oplus K$. The *closing* of image B by K is defined as $(B \oplus K) \otimes K$ where the "o times" symbol represents the erosion operator implemented by the IDL ERODE function.

As stated by Haralick *et al*, the result of iteratively applied dilations and erosions is an elimination of specific image detail smaller than the structuring element without the global geometric distortion of unsuppressed features. For example, opening an

image with a disk structuring element smooths the contour, breaks narrow isthmuses, and eliminates small islands and sharp peaks or capes.

Closing an image with a disk structuring element smooths the contours, fuses narrow breaks and long thin gulfs, eliminates small holes, and fills gaps on the contours.

Note

MORPH_OPEN and MORPH_CLOSE can also be used to perform these tasks.

Examples

Example 1

This example thresholds a gray scale image at the value of 100, producing a binary image. The result is then “opened” with a 3 pixel by 3 pixel square shape operator, using the DILATE and ERODE operators. The effect is to remove holes, islands, and peninsula smaller than the shape operator:

```
; Threshold and make binary image:
B = A GE

; Create the shape operator:
S = REPLICATE(1, 3, 3)

; "Opening" operator:
C = DILATE(ERODE(B, S), S)

; Show the result:
TVSCL, C
```

Example 2

For grayscale images, DILATE takes the neighborhood maximum, where the shape of the neighborhood is given by the structuring element. Elements for which the structuring element extends off the array are indeterminate. For example, assume you have the following image and structuring element:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1]
```

If the origin of the structuring element is not specified in the call to DILATE, the origin defaults to one half the width of the structuring element, which is 1 in this case. Therefore, for the first element in the image array, the structuring element is aligned with the image as depicted below:

```
  [2,1,3,3,3,3,1,2]
   ↑
[1,1]
```

This will cause an indeterminate value for the first element in the DILATE result. If edge values are important, you must pad the image with as many zeros as there are elements in the structuring element that extend off the array, in all dimensions. In this case, you would need to pad the image with a single leading zero. If the structuring element were `s=[1,1,1,1]`, and you specified an origin of 2, the structuring element would align with the image as follows:

```
    [2,1,3,3,3,3,1,2]
     ↑               ↑
[1,1,1,1]     [1,1,1,1]
```

Therefore, you would need to pad the image with at least two leading zeros and at least one trailing zero. You would then perform the dilation operation on the padded image, and remove the padding from the result.

The following code illustrates this method:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1] ; Structuring element
PRINT, 'Image: '
PRINT, image

PRINT, 'Dilation using no padding: '
PRINT, DILATE(image, s, /GRAY)

result = DILATE([0, image], s, /GRAY)
PRINT, 'Dilation using padding: '
PRINT, result[1:N_ELEMENTS(image)]
```

IDL prints:

```
Image:
   2   1   3   3   3   3   1   2
Dilation using no padding:
   1   3   3   3   3   3   2   2
Dilation using padding:
   2   3   3   3   3   3   2   2
```

See Also

ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

DINDGEN

The DINDGEN function returns a double-precision, floating-point array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = DINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters may be any scalar expression. Up to eight dimensions may be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create D, a 100-element, double-precision, floating-point array with each element set to the value of its subscript, enter:

```
D = DINDGEN(100)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

DISSOLVE

The DISSOLVE procedure provides a digital “dissolve” effect for images. The routine copies pixels from the image (arranged into square tiles) to the display in pseudo-random order. This routine is written in the IDL language. Its source code can be found in the file `dissolve.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

DISSOLVE, *Image* [, WAIT=*seconds*] [, /ORDER] [, SIZ=*pixels*] [, X0=*pixels*, Y0=*pixels*]

Arguments

Image

The image to be displayed. It is assumed that the image is already scaled. Byte-valued images display most rapidly.

Keywords

DELAY

The wait between displaying tiles. The default is 0.01 second.

ORDER

The Image display order: 0 = bottom up (the default), 1 = top-down.

SIZ

Size of square tile. The default is 32 x 32 pixels.

X0, Y0

The X and Y offsets of the lower-left corner of the image on screen, in pixels.

Example

Display an image using 16 x 16 pixel tiles:

```
DISSOLVE, DIST(200), SIZ=16
```

See Also

ERASE, TV

DIST

The DIST function creates a rectangular array in which the value of each element is proportional to its frequency. This array may be used for a variety of purposes, including frequency-domain filtering and making pretty pictures.

This routine is written in the IDL language. Its source code can be found in the file `dist.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = DIST(*N* [, *M*])

Arguments

N

The number of columns in the resulting array.

M

The number of rows in the resulting array. If *M* is omitted, the resulting array will be *N* by *N*.

Example

```
; Display the results of DIST as an image:
TVSCL, DIST(100)
```

See Also

FFT

DLM_LOAD

Normally, IDL system routines that reside in dynamically loadable modules (DLMs) are automatically loaded on demand when a routine from a DLM is called. The DLM_LOAD procedure can be used to explicitly cause a DLM to be loaded.

Syntax

DLM_LOAD, *DLMNameStr*$_1$ [, *DLMNameStr*$_2$,..., *DLMNameStr*$_n$]

Arguments

DLMNameStr$_n$

A string giving the name of the DLM to be loaded. DLM_LOAD causes each named DLM to be immediately loaded.

Keywords

None

Example

Force the JPEG DLM to be loaded:

```
DLM_LOAD, 'jpeg'
```

IDL prints:

```
% Loaded DLM: JPEG.
```

DLM_REGISTER

The DLM_REGISTER procedure registers a Dynamically Loadable Module (DLM) in IDL that was not registered when starting IDL. This allows you to create DLMs using the MAKE_DLL procedure and register them in your current session without having to exit and restart IDL.

Note

DLM_REGISTER is not the recommended way to make dynamic link modules known to your IDL session. The primary advantage of DLMs over the use of LINKIMAGE is that IDL knows about the routines from your DLM before it compiles a single line of PRO code. This avoids the LINKIMAGE pitfall in which code that calls the routine gets compiled before the LINKIMAGE call, causing IDL to interpret the call incorrectly. Use of DLM_REGISTER circumvents this benefit.

Syntax

DLM_REGISTER, *DLMDefFilePath*$_1$ [, *DLMDefFilePath*$_2$, ..., *DLMDefFilePath*$_n$]

Arguments

DLMDefFilePath$_n$

The name of the DLM module definition file to read.

Keywords

None.

DO_APPLE_SCRIPT

The DO_APPLE_SCRIPT procedure compiles and executes an AppleScript script, possibly returning a result. DO_APPLE_SCRIPT is only available in IDL for Macintosh.

Syntax

DO_APPLE_SCRIPT, *Script* [, /AG_STRING] [, RESULT=*variable*]

Arguments

Script

A string or array of strings to be compiled and executed by AppleScript.

Keywords

AS_STRING

Set this keyword to cause the result to be returned as a decompiled string. Decompiled strings have the same format as the “The Result” window of Apple’s Script Editor.

RESULT

Set this keyword equal to a named variable that will contain the results of the script.

Example

Suppose you wish to retrieve a range of cell data from a Microsoft Excel spreadsheet. The following AppleScript script and command retrieve the first through fifth rows of the first two columns of a spreadsheet titled “Worksheet 1”, storing the result in the IDL variable A:

```
script = [ 'tell application "Microsoft Excel"', $
   'get Value of Range "R1C1:R5C2" of Worksheet 1', $
   'end tell' ]
DO_APPLE_SCRIPT, script, RESULT = a
```

Similarly, the following lines would copy the contents of the IDL variable A to a range within the spreadsheet:

```
A = [ 1, 2, 3, 4, 5 ]
script = [ 'tell application "IDL" to copy variable "A"', $
```

```
    'into aVariable', $
    'tell application "Excel" to copy aVariable to', $
    'value of range "R1C1:R5C1" of worksheet 1' ]
DO_APPLE_SCRIPT, script
```

See Also

Chapter 5, “AppleScript Support”, in the IDL *External Development Guide*

DOC_LIBRARY

The DOC_LIBRARY procedure extracts documentation headers from one or more IDL programs (procedures or functions). This command provides a standard interface to the operating-system specific DL_DOS, DL_UNIX, and DL_VMS procedures.

The documentation header of the `.pro` file in question must have the following format:

- The first line of the documentation block contains only the characters `;+`, starting in column 1.
- The last line of the documentation block contains only the characters `;-`, starting in column 1.
- All other lines in the documentation block contain a `;` in column 1.

The file `template.pro` in the `general` subdirectory of the `examples` subdirectory of the IDL distribution contains a template for creating your own documentation headers.

This routine is supplied for users to view online documentation from their own IDL programs. Though it could be used to view documentation headers from the `lib` subdirectory of the IDL distribution, we do not recommend doing so. The documentation headers on the files in the `lib` directory are used for historical purposes—most do not contain the most current or accurate documentation for those routines. The most current documentation for IDL's built-in and library routines is found in IDL's online help system (enter `?` at the IDL prompt).

This routine is written in the IDL language. Its source code can be found in the file `doc_library.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

DOC_LIBRARY [, *Name*] [, /PRINT]

UNIX keywords: [, DIRECTORY=*string*] [, /MULTI]

VMS keywords: [, /FILE] [, PATH=*string*] [, /OUTPUTS]

Arguments

Name

A string containing the name of the IDL routine in question. Under Windows or UNIX, *Name* can be "`*`" to get information on all routines.

Keywords (All Platforms)

PRINT

Set this keyword to send the output of DOC_LIBRARY to the default printer. Under UNIX, if PRINT is a string, it is interpreted as a shell command used for output with the documentation from DOC_LIBRARY providing standard input (i.e., `PRINT="cat > junk"`).

UNIX Keywords

DIRECTORY

A string containing the name of the directory to search. If omitted, the current directory and !PATH are used.

MULTI

Set this keyword to allow printing of more than one file if the requested module exists in more than one directory.

VMS Keywords

FILE

If this keyword is set, the output is left in the file `userlib.doc`, in the current directory.

PATH

A string that describes an optional directory/library search path. This keyword uses the same format and semantics as !PATH. If omitted, !PATH is used.

OUTPUTS

If this keyword is set, documentation is sent to the standard output unless the PRINT keyword is set.

Example

To view the documentation header for the library function DIST, enter:

```
DOC_LIBRARY, 'DIST'
```

See Also

MK_HTML_HELP

DOUBLE

The DOUBLE function returns a result equal to *Expression* converted to double-precision floating-point. If *Expression* is a complex number, DOUBLE returns the real part.

Syntax

Result = DOUBLE(*Expression*[, *Offset* [, Dim_1, ..., Dim_n]])

Arguments

Expression

The expression to be converted to double-precision, floating-point.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as double-precision, floating-point data. See the description in Chapter 3, "Constants and Variables" in *Using IDL* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

Suppose that A contains the integer value 45. A double-precision, floating-point version of A can be stored in B by entering:

```
B = DOUBLE(A)
PRINT, B
```

IDL prints:

```
45.000000
```

See Also

BYTE, COMPLEX, DCOMPLEX, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

DRAW_ROI

The DRAW_ROI procedure draws a region or group of regions to the current Direct Graphics device. The primitives used to draw each ROI are based on the TYPE property of the given IDLanROI object. The TYPE property selects between points, polylines, and filled polygons.

Syntax

DRAW_ROI, *oROI* [, /LINE_FILL] [, SPACING=*value*]

Graphics Keywords: [, CLIP=*[X_0, Y_0, X_1, Y_1]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, ORIENTATION=*ccw_degrees_from_horiz*] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*]

Arguments

oROI

A reference to an IDLanROI object to be drawn.

Keywords

LINE_FILL

Set this keyword to indicate that polygonal regions are to be filled with parallel lines, rather than using the default solid fill. When using a line fill, the thickness, linestyle, orientation, and spacing of the lines may be specified by keywords.

SPACING

The spacing, in centimeters, between the parallel lines used to fill polygons.

Graphics Keywords Accepted

CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, ORIENTATION, PSYM, SYMSIZE, T3D, THICK

Example

The following example displays an image and collects data for a region of interest. The resulting ROI is displayed as a filled polygon.

```
PRO roi_ex
; Load and display an image.
img=READ_DICOM(FILEPATH('mr_knee.dcm',SUBDIR=['examples','data']))
TV, img

; Create a polygon region object.
oROI = OBJ_NEW('IDLanROI', TYPE=2)

; Print instructions.
PRINT,'To create a region:'
PRINT,' Left mouse: select points for the region.'
PRINT,' Right mouse: finish the region.'

; Collect first vertex for the region.
CURSOR, xOrig, yOrig, /UP, /DEVICE
oROI->AppendData, xOrig, yOrig
PLOTS, xOrig, yOrig, PSYM=1, /DEVICE

;Continue to collect vertices for region until right mouse button.
x1 = xOrig
y1 = yOrig
while !MOUSE.BUTTON ne 4 do begin
   x0 = x1
   y0 = y1
   CURSOR, x1, y1, /UP, /DEVICE
   PLOTS, [x0,x1], [y0,y1], /DEVICE
   oROI->AppendData, x1, y1
endwhile
PLOTS, [x1,xOrig], [y1,yOrig], /DEVICE

; Draw the the region with a line fill.
DRAW_ROI, oROI, /LINE_FILL, SPACING=0.2, ORIENTATION=45, /DEVICE
END
```

EFONT

The EFONT procedure provides a simple widget-based vector font editor and display. Use this procedure to read and/or modify a local copy of the file `hersh1.chr`, located in the `resource/fonts` subdirectory of the main IDL directory, which contains the vector fonts used by IDL in plotting. This is a very rudimentary editor. Click the "Help" button on the EFONT main menu for more information.

This routine is written in the IDL language. Its source code can be found in the file `efont.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

EFONT [, *Init_Font*] [, /BLOCK] [, GROUP=*widget_id*]

Arguments

Init_Font

The initial font index, from 3 to 29. The default is 3.

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have EFONT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

The widget ID of the widget that calls EFONT. If GROUP is set, the death of the caller results in the death of EFONT.

See Also

SHOWFONT, XFONT

EIGENQL

The EIGENQL function computes the eigenvalues and eigenvectors of an *n*-by-*n* real, symmetric array using Householder reductions and the QL method with implicit shifts.

Syntax

Result = EIGENQL(*A* [, /ABSOLUTE] [, /ASCENDING] [, /DOUBLE] [, EIGENVECTORS=*variable*] [, /OVERWRITE | , RESIDUAL=*variable*])

Return Value

This function returns an *n*-element vector containing the eigenvalues.

Arguments

A

An *n*-by-*n* symmetric single- or double-precision floating-point array.

Keywords

ABSOLUTE

Set this keyword to sort the eigenvalues by their absolute value (their magnitude) rather than by their signed value.

ASCENDING

Set this keyword to return eigenvalues in ascending order (smallest to largest). If not set or set to zero, eigenvalues are returned in descending order (largest to smallest). The eigenvectors are correspondingly reordered.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EIGENVECTORS

Set this keyword equal to a named variable that will contain the computed eigenvectors in an *n*-by-*n* array. The i^{th} row of the returned array contains the i^{th} eigenvalue. If no variable is supplied, the array will not be computed.

OVERWRITE

Set this keyword to use the input array for internal storage and to overwrite its previous contents.

RESIDUAL

Use this keyword to specify a named variable that will contain the residuals for each eigenvalue/eigenvector (λ/x) pair. The residual is based on the definition $Ax - (\lambda)x = 0$ and is an array of the same size as A and the same type as *Result*. The rows of this array correspond to the residuals for each eigenvalue/eigenvector pair.

Note

If the OVERWRITE keyword is set, the RESIDUAL keyword has no effect.

Example

```
 ; Define an n-by-n real, symmetric array:
A = [[ 5.0,  4.0,  0.0, -3.0], $
[ 4.0,  5.0,  0.0, -3.0], $
[ 0.0,  0.0,  5.0, -3.0], $
[-3.0, -3.0, -3.0,  5.0]]

 ; Compute the eigenvalues and eigenvectors:
 eigenvalues = EIGENQL(A, EIGENVECTORS = evecs, $
    RESIDUAL = residual)

 ;Print the eigenvalues and eigenvectors:
 PRINT, 'Eigenvalues: '
 PRINT, eigenvalues
 PRINT, 'Eigenvectors: '
 PRINT, evecs
```

IDL prints:

```
Eigenvalues:
12.0915    6.18662    1.00000    0.721870

Eigenvectors:
-0.554531    -0.554531   -0.241745     0.571446
-0.342981    -0.342981    0.813186    -0.321646
 0.707107    -0.707107   -6.13503e-008-6.46503e-008
 0.273605     0.273605    0.529422     0.754979
```

The accuracy of each eigenvalue/eigenvector (λ/x) pair may be checked by printing the residual array:

```
PRINT, residual
```

The RESIDUAL array has the same dimensions as the input array and the same type as the result. The residuals are contained in the rows of the RESIDUAL array. All residual values should be floating-point zeros.

See Also

EIGENVEC, TRIQL

EIGENVEC

The EIGENVEC function computes the eigenvectors of an *n*-by-*n* real, non-symmetric array using Inverse Subspace Iteration. Use ELMHES and HQR to find the eigenvalues of an *n*-by-*n* real, nonsymmetric array.

This routine is written in the IDL language. Its source code can be found in the file `eigenvec.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = EIGENVEC(*A*, *Eval* [, /DOUBLE] [, ITMAX=*value*] [, RESIDUAL=*variable*])

Return Value

This function returns a complex array with a column dimension equal to *n* and a row dimension equal to the number of eigenvalues.

Arguments

A

An *n*-by-*n* nonsymmetric, single- or double-precision floating-point array.

EVAL

An *n*-element complex vector of eigenvalues.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITMAX

The maximum number of iterations allowed in the computation of each eigenvector. The default value is 4.

RESIDUAL

Use this keyword to specify a named variable that will contain the residuals for each eigenvalue/eigenvector (λ/x) pair. The residual is based on the definition $Ax - \lambda x = 0$

and is an array of the same size and type as that returned by the function. The rows of this array correspond to the residuals for each eigenvalue/eigenvector pair.

Example

```
; Define an n-by-n real, nonsymmetric array:
A = [[1.0, -2.0, -4.0,  1.0], $
     [0.0, -2.0,  3.0,  4.0], $
     [2.0, -6.0, -1.0,  4.0], $
     [3.0, -3.0,  1.0, -2.0]]
; Compute the eigenvalues of A using double-precision complex
; arithmetic and print the result:
eval = HQR(ELMHES(A), /DOUBLE)
PRINT, 'Eigenvalues: '
PRINT, eval
evec = EIGENVEC(A, eval, RESIDUAL = residual)

; Print the eigenvectors:
PRINT, 'Eigenvectors:'
PRINT, evec[*,0], evec[*,1], evec[*,2], evec[*,3]
```

IDL prints:

```
Eigenvalues:
(  0.26366255, -6.1925899)(  0.26366255, 6.1925899)
(  -4.9384492,  0.0000000)(  0.41112406, 0.0000000)
Eigenvectors:
( 0.0076733129,  -0.42912489)(  0.40651652,  0.32973069)
(   0.54537624,  -0.28856257)(  0.33149359, -0.22632585)
(  -0.42145884, -0.081113711)(  0.23867007,  0.46584824)
(  -0.39497143,   0.47402647)( -0.28990600,  0.27760747)
(  -0.54965842,    0.0000000)( -0.18401243,   0.0000000)
(  -0.58124548,    0.0000000)(  0.57111192,   0.0000000)
(   0.79297048,    0.0000000)(  0.50289130,   0.0000000)
( -0.049618509,    0.0000000)(  0.34034720,   0.0000000)
```

You can check the accuracy of each eigenvalue/eigenvector (λ/x) pair by printing the residual array. All residual values should be floating-point zeros.

See Also

ELMHES, HQR, TRIQL, TRIRED

ELMHES

The ELMHES function reduces a real, nonsymmetric *n* by *n* array *A* to upper Hessenberg form. The result is an upper Hessenberg array with eigenvalues that are identical to those of the original array *A*. The Hessenberg array is stored in elements (*j*, *i*) with $i \leq j + 1$. Elements with $i > j + 1$ are to be thought of as zero, but are returned with random values. ELMHES is based on the routine `elmhes` described in section 11.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = ELMHES(*A* [, /COLUMN] [, /DOUBLE] [, /NO_BALANCE])

Arguments

A

An *n* by *n* real, nonsymmetric array.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

NO_BALANCE

Set this keyword to disable balancing. By default, a balancing algorithm is applied to *A*. Balancing a nonsymmetric array is recommended to reduce the sensitivity of eigenvalues to rounding errors.

Example

See the description of HQR for an example using this function.

See Also

EIGENVEC, HQR, TRIQL, TRIRED

EMPTY

The EMPTY procedure causes all buffered output for the current graphics device to be written. IDL uses buffered output on many display devices for reasons of efficiency. This buffering leads to rare occasions where a program needs to be certain that data are not waiting in a buffer, but have actually been output. EMPTY is a low-level graphics routine. IDL graphics routines generally handle flushing of buffered data transparently to the user, so the need for EMPTY is very rare.

Syntax

EMPTY

See Also

FLUSH

ENABLE_SYSRTN

The ENABLE_SYSRTN procedure enables/disables IDL system routines. This procedure is intended for use by runtime and callable IDL applications, and is not generally useful for interactive use.

Syntax

ENABLE_SYSRTN [, *Routines*] [, /DISABLE] [, /EXCLUSIVE] [, /FUNCTIONS]

Arguments

Routines

A string scalar or array giving the names of routines to be enabled or disabled. By default, these are procedures, but this can be changed by setting the FUNCTIONS keyword.

Keywords

DISABLE

By default, the Routines are enabled. Setting this keyword causes them to be disabled instead.

EXCLUSIVE

By default, ENABLE_SYSRTN does not alter routines not listed in Routines. If EXCLUSIVE is set, the specified routines are taken to be the only routines that should be enabled or disabled, and all other routines have the opposite action applied.

Therefore, setting EXCLUSIVE and not DISABLE means that the routines in the Routines argument are enabled and all other system routines of the same type (function or procedure) are disabled. Setting EXCLUSIVE and DISABLE means that all listed routines are disabled and all others are enabled.

FUNCTIONS

Normally, Routines specifies the names of procedures. Set the FUNCTIONS keyword to manipulate functions instead.

Special Cases

The following is a list of cases in which ENABLE_SYSRTN is unable to enable or disable a requested routine. All such attempts are simply ignored without issuing an error, allowing the application to run without error in different IDL environments:

- Attempts to enable/disable non-existent system routines.
- Attempts to enable a system routine disabled due to the mode in which IDL is licensed, as opposed to being disabled via ENABLE_SYSRTN, are quietly ignored (e.g. demo mode).
- The routines CALL_FUNCTION, CALL_METHOD, CALL_PROCEDURE, and EXECUTE cannot be disabled via ENABLE_SYSRTN. However, anything that can be called from them *can* be disabled, so this is not a significant drawback.

Examples

To disable the PRINT procedure:

```
ENABLE_SYSRTN, /DISABLE, 'PRINT'
```

To enable the PRINT procedure and disable all other procedures:

```
ENABLE_SYSRTN, /EXCLUSIVE, 'PRINT'
```

To ensure all possible functions are enabled:

```
ENABLE_SYSRTN, /DISABLE, /EXCLUSIVE, /FUNCTIONS
```

In the last example, all named functions should be disabled and all other functions should be enabled. Since no *Routines* argument is provided, this means that all routines become enabled.

EOF

The EOF function tests the specified file unit for the end-of-file condition. If the file pointer is positioned at the end of the file, EOF returns true (1), otherwise false (0) is returned.

Note

The EOF function cannot be used with files opened with the RAWIO keyword to the OPEN routines. Many of the devices commonly used with RAWIO signal their end-of-file by returning a zero transfer count to the I/O operation that encounters the end-of-file.

Syntax

Result = EOF(*Unit*)

Arguments

Unit

The file unit to test for end-of-file.

Using EOF with VMS Files

Under VMS, the EOF function does not work with files accessed via DECNET, or that do not have sequential organization (i.e., relative or indexed). The EOF procedure cannot be used with such files as it will always return false. Instead, use the ON_IOERROR procedure to detect when the end-of-file occurs.

Examples

If file unit number 1 is open, the end-of-file condition can be checked by examining the value of the expression EOF(1). For example, the following IDL code reads and prints a text file:

```
; Open the file test.lis:
OPENR, 1, 'test.lis'
; Define a string variable:
A = ''
; Loop until EOF is found:
WHILE NOT EOF(1) DO BEGIN
   ; Read a line of text:
```

```
   READF, 1, A
   ; Print the line:
   PRINT,
ENDWHILE
; Close the file:
CLOSE, 1
```

See Also

POINT_LUN

EOS_* Routines

See "Alphabetic Listing of EOS Routines" in the *Scientific Data Formats* manual.

ERASE

The ERASE procedure erases the screen of the currently selected graphics device (or starts a new page if the device is a printer). The device is reset to alphanumeric mode if it has such a mode (e.g., Tektronix terminals).

Syntax

ERASE [, *Background_Color*] [, CHANNEL=*value*] [, COLOR=*value*]

Arguments

Background_Color

The color index for the screen to be erased to. If this argument is omitted, ERASE resets the screen to the default background color (normally 0) stored in the system variable !P.BACKGROUND. Providing a value for *Background_Color* overrides the default.

Warning

Not all devices support this feature.

Keywords

CHANNEL

The channel or channel mask for the erase operation. This parameter has meaning only when used with devices that support TrueColor or multiple-display channels. The default value is !P.CHANNEL.

COLOR

Specifies the background color. Using this keyword is analogous to using the *Background_Color* argument.

Example

```
; Display a simple image in the current window:
TV, DIST(255)

; Erase the image from the window:
ERASE
```

See Also

SET_PLOT, WINDOW, WSET

ERODE

The ERODE function implements the erosion operator on binary and grayscale images and vectors. For details on using ERODE, see "Using ERODE" on page 445.

Syntax

Result = ERODE(*Image*, *Structure* [, X_0 [, Y_0 [, Z_0]]] [, /GRAY [, /PRESERVE_TYPE | , /UINT | , /ULONG]] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the erosion is to be performed. If this parameter is not of byte type, a temporary byte copy is obtained. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values—either zero or nonzero. The structuring element must have the same number of dimensions as *Image*.

X_0, Y_0, Z_0

Optional parameters specifying the one-, two-, or three-dimensional coordinate of the structuring element's origin. If omitted, the origin is set to the center, ([N_x/2], [N_y/2], [N_z/2]), where N_x, N_y, and N_z are the dimensions of the structuring element array. The origin need not be within the structuring element.

Keywords

GRAY

Set this keyword to perform grayscale, rather than binary, erosion. Nonzero elements of the *Structure* parameter determine the shape of the structuring element (neighborhood). If VALUES is not present, all elements of the structuring element are 0, yielding the neighborhood minimum operator.

PRESERVE_TYPE

Set this keyword to return the same type as the input array. This keyword only applies if the GRAY keyword is set.

UINT

Set this keyword to return an unsigned integer array. This keyword only applies if the GRAY keyword is set.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies if the GRAY keyword is set.

VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies grayscale erosion. Each pixel of the result is the minimum of Image less the corresponding elements of VALUE. If the resulting difference is less than zero, the return value will be zero.

Using ERODE

See the description of the DILATE function for background on morphological operators. Erosion is the dual of dilation. It does to the background what dilation does to the foreground.

Briefly, the ERODE function returns the erosion of *Image* by the structuring element *Structure*. This operator is commonly known as “shrink” or “reduce”. It can be used to remove islands smaller than the structuring element.

Over each pixel of the image, the origin of the structuring element is overlaid. If each nonzero element of the structuring element is contained in the image, the output pixel is set to one. Letting $A \otimes B$ represent the erosion of an image A by structuring element B, erosion can be defined as:

$$C = A \otimes B = \bigcap_{b \in B} (A)_{-b}$$

where $(A)_{-b}$ represents the translation of A by b. The structuring element B can be visualized as a probe that slides across image A, testing the spatial nature of A at each point. If B translated by i,j can be contained in A (by placing the origin of B at i,j), then i,j belongs to the erosion of A by B. For example:

In this example, the origin of the structuring element is at (0, 0).

$$\begin{matrix} 0100 & & 0000 \\ 0100 & & 0000 \\ 1110 & \otimes\ 11 & = \ 1100 \\ 1000 & & 0000 \\ 0000 & & 0000 \end{matrix}$$

Used with grayscale images, which are always converted to byte type, the ERODE function is accomplished by taking the minimum of a set of differences. It can be used to conveniently implement the neighborhood minimum operator with the shape of the neighborhood given by the structuring element.

Examples

Example 1

This example thresholds a grayscale image at the value of 100, producing a binary image. The result is then “opened” with a 3 pixel by 3 pixel square shape operator, using the ERODE and DILATE operators. The effect is to remove holes, islands, and peninsula smaller than the shape operator:

```
; Threshold and make binary image:
B = A GE 100

; Create the shape operator:
S = REPLICATE(1, 3, 3)

; "Opening" operator:
C = DILATE(ERODE(B, S), S)

; Show the result:
TVSCL, C
```

Example 2

For grayscale images, ERODE takes the neighborhood minimum, where the shape of the neighborhood is given by the structuring element. Elements for which the structuring element extends off the array are indeterminate. For example, assume you have the following image and structuring element:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1]
```

If the origin of the structuring element is not specified in the call to ERODE, the origin defaults to one half the width of the structuring element, which is 1 in this case.

Therefore, for the first element in the image array, the structuring element is aligned with the image as depicted below:

```
  [2,1,3,3,3,3,1,2]
   ↑
[1,1]
```

This will cause an indeterminate value for the first element in the ERODE result. If edge values are important, you must pad the image with as many elements as there are elements in the structuring element that extend off the array, in all dimensions. The value of the padding elements must be the maximum value in the image, since ERODE calculates a neighborhood minimum. In this case, you would need to pad the image with a single leading 3. If the structuring element were `s=[1,1,1,1]`, and you specified an origin of 2, the structuring element would align with the image as follows:

```
    [2,1,3,3,3,3,1,2]
     ↑             ↑
[1,1,1,1]     [1,1,1,1]
```

Therefore, you would need to pad the image with at least two leading 3s and at least one trailing 3. You would then perform the erosion operation on the padded image, and remove the padding from the result.

The following code illustrates this method:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1] ; Structuring element
PRINT, 'Image: '
PRINT, image

PRINT, 'Erosion using no padding: '
PRINT, ERODE(image, s, /GRAY)

result = ERODE([MAX(image), image], s, /GRAY)
PRINT, 'Erosion using padding: '
PRINT, result[1:N_ELEMENTS(image)]
```

IDL prints:

```
Image:
   2   1   3   3   3   3   1   2
Erosion using no padding:
   0   1   1   3   3   3   1   1
Erosion using padding:
   2   1   1   3   3   3   1   1
```

See Also

DILATE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

ERRORF

The ERRORF function returns the value of the error function:

$$erf(x) = 2/\sqrt{\pi}\int_0^x e^{-t^2}\,dt$$

The result is double-precision if the argument is double-precision. If the argument is floating-point, the result is floating-point. The result always has the same structure as *X*. The ERRORF function does not work with complex arguments.

Syntax

Result = ERRORF(*X*)

Arguments

X

The expression for which the error function is to be evaluated.

Example

To find the error function of 0.4 and print the result, enter:

```
PRINT, ERRORF(0.4)
```

IDL prints:

```
0.428392
```

See Also

GAMMA, IGAMMA, EXPINT

ERRPLOT

The ERRPLOT procedure plots error bars over a previously drawn plot.

This routine is written in the IDL language. Its source code can be found in the file `errplot.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

ERRPLOT, [*X*,] *Low*, *High* [, WIDTH=*value*]

Arguments

X

A vector containing the abscissa values at which the error bars are to be plotted. *X* only needs to be provided if the abscissa values are not the same as the index numbers of the plotted points.

Low

A vector of lower estimates, equal to data - error.

High

A vector of upper estimates, equal to data + error.

Keywords

WIDTH

The width of the error bars. The default is 1% of plot width.

Examples

To plot symmetrical error bars where Y is a vector of data values and ERR is a symmetrical error estimate, enter:

```
; Plot data:
PLOT, Y

; Overplot error bars:
ERRPLOT, Y-ERR, Y+ERR
```

If error estimates are non-symmetrical, provide actual error estimates in the *upper* and *lower* arguments.

```
; Plot data:
PLOT,Y

; Provide custom lower and upper bounds:
ERRPLOT, lower, upper
```

To plot Y versus a vector of abscissas:

```
; Plot data (X versus Y):
PLOT, X, Y

; Overplot error estimates:
ERRPLOT, X, Y-ERR, Y+ERR
```

See Also

OPLOTERR, PLOT, PLOTERR

EXECUTE

The EXECUTE function compiles and executes one or more IDL statements contained in a string at run-time. It also returns *true* (1) if the string was successfully compiled and executed. If an error occurs during either phase, the result is *false* (0).

Like the CALL_PROCEDURE and CALL_FUNCTION routines, calls to EXECUTE can be nested. However, compiling the string at run-time is inefficient. CALL_FUNCTION and CALL_PROCEDURE provide much of the functionality of EXECUTE without imposing this limitation, and should be used instead of EXECUTE whenever possible.

Syntax

Result = EXECUTE(*String* [, *QuietCompile*])

Arguments

String

A string containing the command(s) to be compiled and executed.

QuietCompile

If this argument is set to a non-zero value, EXECUTE will not print the compiler generated error messages (such as syntax errors). If QuietCompile is omitted or set to 0, EXECUTE will output such errors.

Example

Create a string that holds a valid IDL command by entering:

```
com = 'PLOT, [0,1]'
```

Execute the contents of the string by entering:

```
R = EXECUTE(com)
```

A plot should appear. You can confirm that the string was successfully compiled and executed by checking that the value of R is 1.

See Also

CALL_FUNCTION, CALL_METHOD, CALL_PROCEDURE

EXIT

The EXIT procedure quits IDL and exits back to the operating system. All buffers are flushed and open files are closed. The values of all variables that were not saved are lost.

Syntax

EXIT [, /NO_CONFIRM] [, STATUS=*code*]

Keywords

NO_CONFIRM

Set this keyword to suppress any confirmation dialog that would otherwise be displayed in a GUI version of IDL such as the IDL Development Environment.

STATUS

Set this keyword equal to an exit status code that will be returned when IDL exits. For example, on a UNIX system using the Bourne shell:

Start IDL:

```
$ idl
```

Exit IDL specifying exit status 45:

```
IDL> exit, status=45
```

Display last exit status code:

```
$ echo $?
```

The following displays:

```
45
```

See Also

CLOSE, FLUSH, STOP, WAIT

EXP

The EXP function returns the natural exponential function of *Expression*.

Syntax

Result = EXP(*Expression*)

Arguments

Expression

The expression to be evaluated. If *Expression* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. The definition of the exponential function for complex arguments is:

$$\mathrm{EXP}(x) = \mathrm{COMPLEX}(e^R \cos I, e^R \sin I)$$

where:

R = real part of *x*, and *I* = imaginary part of *x*. If *Expression* is an array, the result has the same structure, with each element containing the result for the corresponding element of *Expression*.

Example

Plot a Gaussian with a 1/e width of 10 and a center of 50 by entering:

```
PLOT, EXP(-(FINDGEN(100)/10. - 5.0)^2)
```

See Also

ALOG

EXPAND

The EXPAND procedure shrinks or expands a two-dimensional array, using bilinear interpolation. It is similar to the CONGRID and REBIN routines.

This routine is written in the IDL language. Its source code can be found in the file `expand.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

EXPAND, *A*, *Nx*, *Ny*, *Result* [, FILLVAL=*value*] [, MAXVAL=*value*]

Arguments

A

A two-dimensional array to be magnified.

Nx

Desired size of the X dimension, in pixels.

Ny

Desired size of the Y dimension, in pixels.

Result

A named variable that will contain the magnified array.

Keywords

FILLVAL

Set this keyword equal to the value to use when elements larger than MAXVAL are encountered. The default is -1.

MAXVAL

Set this keyword equal to the largest desired value. Elements greater than this value are set equal to the value of the FILLVAL keyword.

See Also

CONGRID, REBIN

EXPAND_PATH

The EXPAND_PATH function is used to expand a simple path-definition string into a full path name for use with the !PATH system variable.!PATH is a list of locations where IDL searches for currently undefined procedures and functions.

Syntax

Result = EXPAND_PATH(*String* [, /ALL_DIRS] [, /ARRAY] [, COUNT=*variable*] [, /DLM] [, /HELP])

The Path Definition String

EXPAND_PATH accepts a single argument, a scalar string that contains a simple path-definition string, that the function expands into a list of directories that can be assigned to !PATH. This string uses the same format as the IDL_PATH environment variable (UNIX, Windows) or logical name (VMS). This format is also used in the path preferences dialog (Windows, Macintosh).

The path-definition string is a scalar string containing a list of directories (and in the case of VMS, text library files that are prefixed with the "@" character), separated by a special character ("**:**" for UNIX and Macintosh, "**,**" for VMS, and "**;**" for Windows). Prepending a "+" character to a directory name causes all of its subdirectories to be searched.

If a directory specified in the string does *not* have a "+" character prepended to it, it is copied to the output string verbatim. However, if it does have a leading "+" then EXPAND_PATH searches the directory and all of its subdirectories for files of the appropriate type for the path. Any directory containing at least one file of the desired type is added to the search path.

A Note on Order within !PATH

IDL ensures only that all directories containing IDL files are placed in !PATH. The order in which they appear is completely unspecified, and does not necessarily correspond to any specific order (such as top-down alphabetized). This allows IDL to construct the path in the fastest possible way and speeds startup. This is only a problem if two subdirectories in such a hierarchy contain a file with the same name. Such hierarchies usually are a collection of cooperative routines designed to work together, so such duplication is rare.

If the order in which "+" expands directories is a problem for your application, you should add the directories to the path explicitly and not use "+". Only the order of the

files within a given "+" entry are determined by IDL. It never reorders !PATH in any other way. You can therefore obtain any search order you desire by writing the path explicitly.

UNIX — The directory name is expanded to remove wildcards (~ and *). This avoids overhead IDL would otherwise incur as it searches for library routines. It is discarded from the search path if any of the following is true:

- It is not a directory.
- The directory it names does not exist or cannot be accessed.
- The directory does not contain any `.pro` or `.sav` files.

VMS — The directory name is discarded from the search path if any of the following is true:

- It is not a directory.
- The directory it names does not exist or cannot be accessed.
- The directory does not contain any `.PRO` or `.SAV` files).

In addition, any text library (`.TLB`) files are added to the result.

Windows — The directory name is expanded to remove wildcards (*). This avoids overhead IDL would otherwise incur as it searches for library routines. It is discarded from the search path if any of the following is true:

- It is not a directory.
- The directory it names does not exist or cannot be accessed.
- The directory does not contain any `.PRO` or `.SAV` files.

Macintosh — The folder name is expanded to remove wildcards (*). This avoids overhead IDL would otherwise incur as it searches for library routines. It is discarded from the search path if any of the following is true:

- It is not a folder.
- The folder it names does not exist or cannot be accessed.
- The folder does not contain any `.pro` or `.sav` files.

Arguments

String

A scalar string containing the path-definition string to be expanded. See "The Path Definition String" above for details.

Keywords

ALL_DIRS

Set this keyword to return all directories without concern for their contents, otherwise, EXPAND_PATH only returns those directories that contain `.pro` or `.sav` files.

ARRAY

Set this keyword to return the result as a string array with each element containing one path segment. In this case, there is no need for a separator character and none is supplied. Normally, the result is a string array with the various path segments separated with the correct special delimiter character for the current operating system.

COUNT

Set this keyword to a named variable which returns the number of path segments contained in the result.

DLM

Set this keyword to return those directories that contain IDL Dynamically Loadable Module (`.dlm`) description files.

HELP

Set this keyword to return those directories that contain help (`.help` or `.hlp`) files.

Example

Example 1

Assume you have the following directory structure:

```
/home
   myfile.txt
   /programs
      /pro
         myfile.pro
```

Seach the `/home` directroy and all its subdirectories, and return the directories containing `.pro` and `.sav` files:

```
PRINT, EXPAND_PATH('+/home')
```

IDL prints:

```
/home/programs/pro
```

Example 2

Search the same directory, but this time return all directories, not just those containing `.pro` and `.sav` files:

```
PRINT, EXPAND_PATH('+home', /ALL_DIRS)
```

IDL prints:

```
/home/programs/pro:/home/programs
```

See Also

"Executing Program Files" in Chapter 2 of *Using IDL* and "IDL Environment System Variables" on page 2429.

EXPINT

The EXPINT function returns the value of the exponential integral $E_n(x)$.

EXPINT is based on the routine `expint` described in section 6.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = EXPINT(*N*, *X* [, /DOUBLE] [, EPS=*value*] [, ITMAX=*value*])

Arguments

N

An integer specifying the order of $E_n(x)$. *N* can be either a scalar or an array.

X

The value at which $E_n(x)$ is evaluated. *X* can be either a scalar or an array.

Note: If an array is specified for both *N* and *X*, then EXPINT evaluates $E_n(x)$ for each N_i and X_i. If either *N* or *X* is a scalar and the other an array, the scalar is paired with each array element in turn.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

Use this keyword to specify a number close to the desired relative error. For single-precision calculations, the default value is 1.0×10^{-7}. For double-precision calculations, the default value is 1.0×10^{-14}.

ITMAX

An input integer specifying the maximum allowed number of iterations. The default value is 100.

Example

To compute the value of the exponential integral at the following X values:

```
; Define the parametric X values:
X = [1.00, 1.05, 1.27, 1.34, 1.38, 1.50]

; Compute the exponential integral of order 1:
result = EXPINT(1, X)

; Print the result:
PRINT, result
```

IDL prints:

```
  0.219384 0.201873 0.141911 0.127354 0.119803 0.100020
```

This is the exact solution vector to six-decimal accuracy.

See Also

ERRORF

EXTRAC

The EXTRAC function returns as its result any rectangular sub-matrix or portion of the parameter array. Note that it is usually more efficient to use the array subscript ranges (the ":" operator; see "Subscript Ranges" in Chapter 5 of *Building IDL Applications*) to perform such operations. The main advantage to EXTRAC is that, when parts of the specified subsection lie outside the bounds of the array, zeros are entered into these outlying elements.

EXTRAC was originally a built-in system procedure in the PDP-11 version of IDL, and was retained in that form in the original VAX/VMS IDL for compatibility. Most applications of the EXTRAC function are more concisely written using subscript ranges (e.g., X(10:15)). EXTRAC has been rewritten as a library function that provides the same interface as the previous versions.

Note

If you know that the subarray will never lie beyond the edges of the array, it is more efficient to use array subscript ranges (the ":" operator) to extract the data instead of EXTRAC.

This routine is written in the IDL language. Its source code can be found in the file `extrac.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = EXTRAC(*Array*, C_1, C_2, ..., C_n, S_1, S_2, ..., S_n)

Arguments

Array

The array from which the subarray will be copied.

C_i

The starting subscript in *Array* for the subarray. There should be one C_i for each dimension of *Array*. These arguments must be integers.

S_i

The size of each dimension. The result will have dimensions of (S_1, S_2, ..., S_n). There should be one S_i for each dimension of *Array*. These arguments must be non-negative.

Examples

Extracting elements from a vector:

```
; Create a 1000 element floating-point vector with each element set
; to the value of its subscript:
A = FINDGEN(1000)
; Extract 300 points starting at A[200] and extending to A[499]:
B = EXTRAC(A, 200, 300)
```

In the next example, the first 49 points extracted — `B[0]` to `B[49]` — lie outside the bounds of the vector and are set to 0. `B[50]` is gets the value of `A[0]`, `B[51]` gets the value of `A[1]`which is 1. Enter:

```
; Create a 1000 element vector:
A = FINDGEN(1000)
; Extract 50 elements, 49 of which lie outside the bounds of A:
B = EXTRAC(A, -50, 100)
```

The following commands illustrate the use of EXTRAC with multi-dimensional arrays:

```
; Make a 64 by 64 array:
A = INTARR(64,64)
; Extract a 32 by 32 portion starting at A(20,30):
B = EXTRAC(A, 20, 30, 32, 32)
```

As suggested in the discussion above, a better way to perform the same operation as the previous line is:

```
; Use the array subscript operator instead of EXTRAC:
B = A(20:51, 30:61)
```

Extract the 20th column and 32nd row of A:

```
; Extract 20th column of A:
B = EXTRAC(A, 19, 0, 1, 64)
; Extract 32nd row of A:
B = EXTRAC(A, 0, 31, 64, 1)
```

Take a 32 BY 32 matrix from A starting at A(40,50):

```
; Note that those points beyond the boundaries of A are set to 0:
B = EXTRAC(A, 40, 50, 32, 32)
```

See Also

"Subscript Ranges" in Chapter 5 of *Building IDL Applications*.

EXTRACT_SLICE

This EXTRACT_SLICE function returns a two-dimensional planar slice extracted from 3D volumetric data. This function allows for a rotation or vector form of the slice equation. In the vector form, the slice plane is governed by the plane equation (ax+by+cz+d = 0) and a single vector which defines the x direction. This form is more common throughout the IDL polygon interface. In the rotation form, the slicing plane can be oriented at any angle and pass through any desired location in the volume.

This function allows for a vertex grid to be generated without sampling the data. In this form, the return value would be an array of [3,n] vertices which could be used to sample additional dataset or used to form polygonal meshes. It would also be useful to return the planar mesh connectivity in this case.

Support for anisotropic data volumes is included via an ANISOTROPY keyword. This is an important feature in the proper interpolation of common medical imaging data.

This routine is written in the IDL language. Its source code can be found in the file `extract_slice.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = EXTRACT_SLICE(*Vol*, *Xsize*, *Ysize*, *Xcenter*, *Ycenter*, *Zcenter*, *Xrot*, *Yrot*, *Zrot* [, ANISOTROPY=*[xspacing*, *yspacing*, *zspacing]*] [, /CUBIC] [, OUT_VAL=*value*] [, /RADIANS] [, /SAMPLE] [, VERTICES=*variable*])

or

Result = EXTRACT_SLICE(*Vol*, *Xsize*, *Ysize*, *Xcenter*, *Ycenter*, *Zcenter*, *PlaneNormal*, *Xvec* [, ANISOTROPY=*[xspacing*, *yspacing*, *zspacing]*] [, /CUBIC] [, OUT_VAL=*value*] [, /RADIANS] [, /SAMPLE] [, VERTICES=*variable*])

Arguments

PlaneNormal

Set this input argument to a 3 element array. The values are interpreted as the normal of the slice plane.

Xvec

Set this input argument to a 3 element array. The three values are interpreted as the 0 dimension directional vector. This should be a unit vector.

Vol

The volume of data to slice. This argument is a three-dimensional array of any type except string or structure. The planar slice returned by EXTRACT_SLICE has the same data type as *Vol*.

Xsize

The desired X size (dimension 0) of the returned slice. To preserve the correct aspect ratio of the data, Xsize should equal Ysize. For optimal results, set Xsize and Ysize to be greater than or equal to the largest of the three dimensions of *Vol*.

Ysize

The desired Ysize (dimension 1) of the returned slice. To preserve the correct aspect ratio of the data, Ysize should equal Xsize. For optimal results, set Xsize and Ysize to be greater than or equal to the largest of the three dimensions of *Vol*.

Xcenter

The X coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

Ycenter

The Y coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

Zcenter

The Z coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

Xrot

The X-axis rotation of the slicing plane, in degrees. Before transformation, the slicing plane is parallel to the X-Y plane. The slicing plane transformations are performed in the following order:

- Rotate Z_rot degrees about the Z axis.

- Rotate Y_rot degrees about the Y axis.
- Rotate X_rot degrees about the X axis.
- Translate the center of the plane to Xcenter, Ycenter, Zcenter.

Yrot

The Y-axis rotation of the slicing plane, in degrees.

Zrot

The orientation Z-axis rotation of the slicing plane, in degrees.

Keywords

ANISOTROPY

Set this keyword to a three-element array. This array specifies the spacing between the planes of the input volume in grid units of the (isotropic) output image.

CUBIC

Set this keyword to use cubic interpolation. The default is to use tri-linear interpolation. If the SAMPLE keyword is set, then the CUBIC keyword is ignored.

OUT_VAL

Set this keyword to a value that will be assigned to elements of the returned slice that lie outside of the original volume.

RADIANS

Set this keyword to indicate that Xrot, Yrot, and Zrot are in radians. The default is degrees.

SAMPLE

Set this keyword to perform nearest neighbor sampling when computing the returned slice. The default is to use bilinear interpolation. A small reduction in execution time results when SAMPLE is set and the OUT_VAL keyword is *not* used.

VERTICES

Set this output keyword to a named variable in which to return a [3,Xsize,Ysize] floating point array. This is an array of the x, y, z sample locations for each pixel in the normal output.

Example

Display an oblique slice through volumetric data:

```
; Create some data:
vol = RANDOMU(s, 40, 40, 40)

; Smooth the data:
FOR i=0, 10 DO vol = SMOOTH(vol, 3)

; Scale the smoothed part into the range of bytes:
vol = BYTSCL(vol(3:37, 3:37, 3:37))

; Extract a slice:
slice = EXTRACT_SLICE(vol, 40, 40, 17, 17, 17, 30.0, 30.0, 0.0, $
   OUT_VAL=0B)

; Display the 2D slice as a magnified image:
TVSCL, REBIN(slice, 400, 400)
```

See Also

SLICER3

F_CVF

The F_CVF function computes the cutoff value *V* in an F distribution with *Dfn* and *Dfd* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `f_cvf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = F_CVF(*P*, *Dfn*, *Dfd*)

Arguments

P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

Dfn

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the F distribution numerator.

Dfd

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the F distribution denominator.

Example

Use the following command to compute the cutoff value in an F distribution with ten degrees of freedom in the numerator and six degrees of freedom in the denominator such that the probability that a random variable X is greater than the cutoff value is 0.01. The result should be 7.87413:

```
PRINT, F_CVF(0.01, 10, 6)
```

See Also

CHISQR_CVF, F_PDF, GAUSS_CVF, T_CVF

F_PDF

The F_PDF function computes the probability *P* that, in an F distribution with *Dfn* and *Dfd* degrees of freedom, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `f_pdf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = F_PDF(*V*, *Dfn*, *Dfd*)

Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *V*, *Dfn*, and *Dfd*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

Arguments

V

A scalar or array that specifies the cutoff value(s).

Dfn

A positive scalar or array that specifies the number of degrees of freedom of the F distribution numerator.

Dfd

A positive scalar or array that specifies the number of degrees of freedom of the F distribution denominator.

Example

Use the following command to compute the probability that a random variable X, from the F distribution with five degrees of freedom in the numerator and 24 degrees of freedom in the denominator, is less than or equal to 3.90. The result should be 0.990059:

```
PRINT, F_PDF(3.90, 5, 24)
```

See Also

BINOMIAL, CHISQR_PDF, F_CVF, GAUSS_PDF, T_PDF

FACTORIAL

The FACTORIAL function computes the factorial *N*! For integers, the factorial is computed as $(N) \cdot (N-1) \cdot (N-2) \cdot \ldots \cdot 3 \cdot 2 \cdot 1$. For non-integers the factorial is computed using GAMMA(*N*+1).

This routine is written in the IDL language. Its source code can be found in the file `factorial.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = FACTORIAL(*N* [, /STIRLING] [, /UL64])

Arguments

N

A non-negative scalar or array of values.

Note

Large values of *N* will cause floating-point overflow errors. The maximum size of *N* varies with machine architecture. On machines that support the IEEE standard for floating-point arithmetic, the maximum value of *N* is 170. See MACHAR for a discussion of machine-specific parameters affecting floating-point arithmetic.

Keywords

STIRLING

Set this keyword to use Stirling's asymptotic formula to approximate *N*!:

$$N! = \sqrt{2\pi N}\left[\frac{N}{e}\right]^N$$

where *e* is the base of the natural logarithm.

UL64

Set this keyword to return the results as unsigned 64-bit integers. This keyword is ignored if STIRLING is set.

Note

Unsigned 64-bit integers will overflow for values of *N* greater than 20.

Example

Compute 20!:

```
PRINT, FACTORIAL(20)
```

IDL prints:

```
2.4329020e+18
```

See Also

BINOMIAL, TOTAL

FFT

The FFT function returns a result equal to the complex, discrete Fourier transform of *Array*. The result of this function is a single- or double-precision complex array.

The discrete Fourier transform, $F(u)$, of an N-element, one-dimensional function, $f(x)$, is defined as:

$$F(u) = \frac{1}{N} \sum_{x=0}^{N-1} f(x) \exp[-j2\pi ux/N]$$

And the inverse transform, (*Direction* > 0), is defined as:

$$f(x) = \sum_{u=0}^{N-1} F(u) \exp[j2\pi ux/N]$$

If the keyword OVERWRITE is set, the transform is performed in-place, and the result overwrites the original contents of the array.

The result returned by FFT is a complex array that has the same dimensions as the input array. The output array is ordered in the same manner as almost all discrete Fourier transforms. Element 0 contains the zero frequency component, F_0. F_1 contains the smallest nonzero positive frequency, which is equal to $1/(N_i T_i)$, where N_i and T_i are the number of elements and the sampling interval of the i^{th} dimension, respectively. F_2 corresponds to a frequency of $2/(N_i T_i)$. Negative frequencies are stored in the reverse order of positive frequencies, ranging from the highest to lowest negative frequencies (see storage scheme below).

Note

The FFT can be performed on functions of up to eight (8) dimensions in size. If a function has *n* dimensions, IDL performs a transform in each dimension separately, starting with the first dimension and progressing sequentially to dimension *n*. For example, if the function has two dimensions, IDL first does the FFT row by row, and then column by column.

For an even number of points in the i^{th} dimension, the storage scheme of returned complex values is as follows:

F_0	$1/(N_iT_i)$	...	$(N_i-2)/2N_iT_i$	$1/(2T_i)$ (Nyquist)	$-(N_i-2)/2N_iT_i$	...	$-1/(N_iT_i)$
Real, Imag	Real, Imag		Real, Imag	Real, Imag	Real, Imag		Real, Imag

Table 19: Even Number of Points

For an odd number of points in the i^{th} dimension, the storage scheme of returned complex values is as follows:

F_0	$1/(N_iT_i)$	...	$(N_i-1)/2N_iT_i$	$-(N_i-1)/2N_iT_i$	...	$-1/(N_iT_i)$
Real, Imag	Real, Imag		Real, Imag	Real, Imag		Real, Imag

Table 20: Odd Number of Points

Syntax

Result = FFT(*Array* [, *Direction*] [, /DOUBLE] [, /INVERSE] [, /OVERWRITE])

Arguments

Array

The array to which the Fast Fourier Transform should be applied. If *Array* is not of complex type, it is converted to complex type. The dimensions of the result are identical to those of *Array*. The size of each dimension may be any integer value and does not necessarily have to be an integer power of 2, although powers of 2 are certainly the most efficient.

Direction

Direction is a scalar indicating the direction of the transform, which is negative by convention for the forward transform, and positive for the inverse transform. If *Direction* is not specified, the forward transform is performed.

A normalization factor of $1/N$, where N is the number of points, is applied during the forward transform.

Note

When transforming from a real vector to complex and back, it is slightly faster to set *Direction* to 1 in the real to complex FFT.

Note also that the value of *Direction* is ignored if the INVERSE keyword is set.

Keywords

DOUBLE

Set this keyword to a value other than zero to force the computation to be done in double-precision arithmetic, and to give a result of double-precision complex type. If DOUBLE is set equal to zero, computation is done in single-precision arithmetic and the result is single-precision complex. If DOUBLE is not specified, the data type of the result will match the data type of *Array*.

INVERSE

Set this keyword to perform an inverse transform. Setting this keyword is equivalent to setting the *Direction* argument to a positive value. Note, however, that setting INVERSE results in an inverse transform even if *Direction* is specified as negative.

OVERWRITE

If this keyword is set, and the *Array* parameter is a variable of complex type, the transform is done "in-place". The result overwrites the previous contents of the variable. For example, to perform a forward, in-place FFT on the variable a:

```
a = FFT(a, -1, /OVERWRITE)
```

Running Time

For a one-dimensional FFT, running time is roughly proportional to the total number of points in *Array* times the sum of its prime factors. Let *N* be the total number of elements in *Array*, and decompose *N* into its prime factors:

$$N = 2^{K_2} \cdot 3^{K_3} \cdot 5^{K_5} \ldots$$

Running time is proportional to:

$$T_0 + N(T_1 + 2K_2T_2 + T_3(3K_3 + 5K_5 + \ldots))$$

where $T_3 \sim 4T_2$. For example, the running time of a 263 point FFT is approximately 10 times longer than that of a 264 point FFT, even though there are fewer points. The

sum of the prime factors of 263 is 264 (1 + 263), while the sum of the prime factors of 264 is 20 (2 + 2 + 2 + 3 + 11).

Example

Display the log of the power spectrum of a 100-element index array by entering:

```
PLOT, /YLOG, ABS(FFT(FINDGEN(100), -1))
```

As a more complex example, display the power spectrum of a 100-element vector sampled at a rate of 0.1 seconds per point. Show the 0 frequency component at the center of the plot and label the abscissa with frequency:

```
; Define the number of points:
N = 100

; Define the interval:
T = 0.1

; Midpoint+1 is the most negative frequency subscript:
N21 = N/2 + 1

; The array of subscripts:
F = INDGEN(N)
; Insert negative frequencies in elements F(N/2 +1), ..., F(N-1):
F[N21] = N21 -N + FINDGEN(N21-2)

; Compute T0 frequency:
F = F/(N*T)

; Shift so that the most negative frequency is plotted first:
PLOT, /YLOG, SHIFT(F, -N21), SHIFT(ABS(FFT(F, -1)), -N21)
```

See Also

HILBERT

FILE_CHMOD

The FILE_CHMOD procedure allows you to change the current access permissions (sometimes known as modes on UNIX platforms) associated with a file or directory. File modes are specified using the standard Posix convention of three protection classes (user, group, other), each containing three attributes (read, write, execute). These permissions can be specified as an octal bitmask in which desired permissions have their associated bit set and unwanted ones have their bits cleared. This is the same format familiar to users of the UNIX `chmod(1)` command).

Keywords are available to specify permissions without the requirement to specify a bitmask, providing a simpler way to handle many situations. All of the keywords share a similar behavior: Setting them to a non-zero value adds the specified permission to the *Mode* argument. Setting the keyword to 0 removes that permission.

To find the current protection settings for a given file, you can use the GET_MODE keyword to the FILE_TEST function.

Syntax

FILE_CHMOD, *File* [, *Mode*] [, /A_EXECUTE |, /A_READ |, /A_WRITE]
[, /G_EXECTUE | /G_READ | , /G_WRITE]
[, /O_EXECTUE | /O_READ | , /O_WRITE]
[, /U_EXECTUE | /U_READ | , /U_WRITE]

UNIX-Only Keywords: [, /SETGID] [, /SETUID] [, /STICKY_BIT]

Arguments

File

A scalar or array of file or directory names for which protection modes will be changed.

Mode

An optional bit mask specifying the absolute protection settings to be applied to the files. If *Mode* is not supplied, FILE_CHMOD looks up the current modes for the file and uses it instead. Any additional modes specified via keywords are applied relative to the value in *Mode*. Setting a keyword adds the necessary mode bits to *Mode*, and clearing it by explicitly setting a keyword to 0 removes those bits from *Mode*.

The values of the bits in these masks correspond to those used by the UNIX `chmod(2)` system call and `chmod(1)` user command, and are given in the following

table. Since these bits are usually manipulated in groups of three, octal notation is commonly used when referring to them. When constructing a mode, the following platform specific considerations should be kept in mind:

- The setuid, setgid, and sticky bits are specific to the UNIX operating system, and have no meaning elsewhere. FILE_CHMOD ignores them on non-UNIX systems. The UNIX kernel may quietly refuse to set the sticky bit if you are not the root user. Consult the chmod(2) man page for details.
- The VMS operating system has four permission classes, unlike the 3 supported by UNIX. Furthermore, each class has an additional bit (DELETE) not supported by UNIX. IDL uses the C runtime library `chmod()` function supplied by the operating system to translate between the UNIX convention used by IDL and the native VMS permission masks. It maps the VMS SYSTEM and OWNER classes to the user class, GROUP to group, and WORLD to other. The DELETE bit is combined with the WRITE bit.
- The Microsoft Windows and Macintosh operating systems do not have 3 permission classes like UNIX does. Therefore, setting for all three classes are combined into a single request.
- The Microsoft Windows and Macintosh operating systems always allow read access to any files visible to a program. FILE_CHMOD therefore ignores any requests to remove read access.
- The Microsoft Windows and Macintosh operating systems do not maintain an execute bit for their files. Windows uses the file suffix to decide if a file is executable, and Macintosh IDL only considers files of type `APPL` to be executable. Therefore, FILE_CHMOD cannot change the execution status of a file on these platforms. Such requests are quietly ignored.

Bit	Octal Mask	Meaning
12	'4000'o	Setuid: Set user ID on execution.
11	'2000'o	Setgid: Set group ID on execution.
10	'1000'o	Turn on sticky bit. See the UNIX documentation on chmod(2) for details.
9	'0400'o	Allow read by owner.
8	'0200'o	Allow write by owner.

Table 21: UNIX chmod(2) mode bits

Bit	Octal Mask	Meaning
7	'0100'o	Allow execute by owner.
6	'0040'o	Allow read by group.
5	'0020'o	Allow write by group.
4	'0010'o	Allow execute by group.
3	'0004'o	Allow read by others.
2	'0002'o	Allow write by others.
1	'0001'o	Allow execute by others.

Table 21: UNIX chmod(2) mode bits

Keywords

A_EXECUTE

Execute access for all three (user, group, other) categories.

A_READ

Read access for all three (user, group, other) categories.

A_WRITE

Write access for all three (user, group, other) categories.

G_EXECUTE

Execute access for the group category.

G_READ

Read access for the group category.

G_WRITE

Write access for the group category.

O_EXECUTE

Execute access for the other category.

O_READ

Read access for the other category.

O_WRITE

Write access for the other category.

U_EXECUTE

Execute access for the user category.

U_READ

Read access for the user category.

U_WRITE

Write access for the user category.

UNIX-Only Keywords

SETGID

The Set Group ID bit.

SETUID

The Set User ID bit.

STICKY_BIT

Sets the sticky bit.

Example

In the first example, we make the file `moose.dat` read only to everyone except the owner of the file, but not change any other settings:

```
FILE_CHMOD, 'moose.dat', /U_WRITE, G_WRITE=0, O_WRITE=0
```

In the next example, we make the file readable and writable to the owner and group, but read-only to anyone else, and remove any other modes:

```
FILE_CHMOD, 'moose.dat', '664'o
```

FILE_DELETE

The FILE_DELETE procedure deletes a file or empty directory, if the process has the necessary permissions to remove the file as defined by the current operating system. FILE_CHMOD can be used to change file protection settings.

Syntax

FILE_DELETE, *File1* [,... *FileN*] [, /QUIET]

Arguments

FileN

A scalar or array of file or directory names to be deleted, one name per string element. Directories must be specified in the native syntax for the current operating system. See “Operating System Syntax” below for additional details.

Keywords

QUIET

FILE_DELETE will normally issue an error if it is unable to remove a requested file or directory. If QUIET is set, no error is issued and FILE_DELETE simply moves on to the next requested item.

Operating System Syntax

The syntax used to specify directories for removal depends on the operating system in use, and is in general the same as you would use when issuing commands to the operating system command interpreter.

Microsoft Windows users must be careful to not specify a trailing backslash at the end of a specification. For example:

```
FILE_DELETE, 'c:\mydir\myfile'
```

and not:

```
FILE_DELETE, 'c:\mydir\myfile\'
```

For VMS users, the syntax for creating a subdirectory (as with the CREATE/DIRECTORY DCL command) is not symmetric with that used to delete it (using the DELETE,/DIRECTORY). FILE_DELETE follows the same rules. For

instance, to create a subdirectory of the current working directory named `bullwinkle` and then remove it:

```
FILE_MKDIR,'[.bullwinkle]'
FILE_DELETE,'bullwinkle.dir'
```

Example

In this example, we remove an empty directory named `moose`. On the Macintosh, UNIX, or Windows operating systems:

```
FILE_DELETE, 'moose'
```

To do the same thing under VMS:

```
FILE_DELETE, 'moose.dir'
```

FILE_EXPAND_PATH

The FILE_EXPAND_PATH function expands a given file or partial directory name to its fully qualified name regardless of the current working directory.

Note

This routine should be used only to make sure that file paths are fully qualified, but not to expand wildcard characters (e.g. *). The behavior of FILE_EXPAND_PATH when it encounters a wildcard is platform dependent, and should not be depended on. These differences are due to the underlying operating system, and are beyond IDL's control. To expand wildcards and obtain fully qualified paths, combine the FINDFILE function with FILE_EXPAND_PATH:

```
A = FILE_EXPAND_PATH(FINDFILE('*.pro'))
```

Syntax

Result = FILE_EXPAND_PATH (*Path*)

Return Value

FILE_EXPAND_PATH returns a fully qualified file path that completely specifies the location of *Path* without the need to consider the user's current working directory.

Arguments

Path

A scalar or array of file or directory names to be fully qualified.

Keywords

None.

Example

In this example, we change directories to the IDL `lib` directory and expand the file path for the DIST function:

```
cd, FILEPATH('', SUBDIRECTORY=['lib'])
print, FILE_EXPAND_PATH('dist.pro')
```

This results in the following if run on a UNIX system:

```
/usr/local/rsi/idl_5.4/lib/dist.pro
```

See Also

FINDFILE

FILE_MKDIR

The FILE_MKDIR procedure creates a new directory, or directories, with the default access permissions for the current process.

Note

Use the FILE_CHMOD procedure to alter access permissions.

If a specified directory has non-existent parent directories, FILE_MKDIR automatically creates all the intermediate directories as well.

Syntax

FILE_MKDIR, *File1* [,... *FileN*]

Arguments

FileN

A scalar or array of directory names to be created, one name per string element. Directories must be specified in the native syntax for the current operating system.

Keywords

None.

Example

To create a subdirectory named `moose` in the current working directory on the Macintosh, UNIX, or Windows operating systems:

```
FILE_MKDIR, 'moose'
```

To do the same thing under VMS:

```
FILE_MKDIR, '[.moose]'
```

FILE_TEST

The FILE_TEST function checks files for existence and other attributes without having to first open the file.

Syntax

Result = FILE_TEST(*File* [, /DIRECTORY | , /EXECUTABLE | , /READ | , /REGULAR | , /WRITE | , /ZERO_LENGTH] [, GET_MODE=*variable*])

UNIX-Only Keywords: [, /BLOCK_SPECIAL | , /CHARACTER_SPECIAL | , /DANGLING_SYMLINK | , /NAMED_PIPE | , /SETGID | , /SETUID | , /SOCKET | , /STICKY_BIT | , /SYMLINK]

UNIX and VMS-Only Keywords: [, /GROUP | , /USER]

Return Value

FILE_TEST returns 1 (true), if the specified file exists and all of the attributes specified by the keywords are also true. If no keywords are present, a simple test for existence is performed. If the file does not exist or one of the specified attributes is not true, then FILE_TEST returns 0 (false).

Arguments

File

A scalar or array of file names to be tested. The result is of type integer with the same number of elements as *File*.

Keywords

DIRECTORY

Set this keyword to return 1 (true) if *File* exists and is a directory.

EXECUTABLE

Set this keyword to return 1 (true) if *File* exists and is executable. The source of this information differs between operating systems:

- UNIX and VMS: IDL checks the per-file information (the execute bit) maintained by the operating system.

- Microsoft Windows: The determination is made on the basis of the file name extension (e.g. `.exe`).
- Macintosh: Files of type ‘APPL’ (proper applications) are reported as executable. This corresponds to "Double Clickable" applications.

GET_MODE

Set this keyword to a named variable to receive the UNIX style mode (permission) mask for the specified file. The bits in these masks correspond to those used by the UNIX `chmod(2)` system call, and are explained in detail in the description of the *Mode* argument to the FILE_CHMOD procedure. When interpreting the value returned by this keyword, the following platform specific details should be kept in mind:

- The setuid, setgid, and sticky bits are specific to the UNIX operating system, and will never be returned on any other platform. Consult the `chmod(2)` man page and/or other UNIX programming documentation for more details.
- The VMS operating system has four permission classes, unlike the three supported by UNIX. Furthermore, each class has an additional bit (DELETE) not supported by UNIX. IDL uses the C runtime library `stat()` function supplied by the operating system to translate between the UNIX convention used by IDL and the native VMS permission masks. It maps the VMS OWNER to the user class, GROUP to group, and WORLD to other. The DELETE bit is combined with the WRITE bit.
- The Microsoft Windows and Macintosh operating systems do not have 3 permission classes like UNIX does. Therefore, IDL returns the same settings for all three classes.
- The Microsoft Windows and Macintosh operating systems to not maintain an execute bit for their files. Windows uses the file suffix to decide if a file is executable, and Macintosh IDL only considers files of type ‘APPL’ to be executable.

READ

Set this keyword to return 1 (true) if *File* exists and is readable by the user.

REGULAR

Set this keyword to return 1 (true) if *File* exists and is a regular disk file and not a directory, pipe, socket, or other special file type.

WRITE

Set this keyword to return 1 (true) if *File* exists and is writable by the user.

ZERO_LENGTH

Set this keyword to return 1 (true) if *File* exists and has zero length.

Note

The length of a directory is highly system dependent and does not necessarily correspond to the number of files it contains. In particular, it is possible for an empty directory to report a non-zero length. RSI does not recommend using the ZERO_LENGTH keyword on directories, as the information returned cannot be used in a meaningful way.

UNIX-Only Keywords

BLOCK_SPECIAL

Set this keyword to return 1 (true) if *File* exists and is a block special device.

CHARACTER_SPECIAL

Set this keyword to return 1 (true) if *File* exists and is a character special device.

DANGLING_SYMLINK

Set this keyword to return 1 (true) if *File* is a symbolic link that points at a non-existent file.

NAMED_PIPE

Set this keyword to return 1 (true) if *File* exists and is a named pipe (fifo) device.

SETGID

Set this keyword to return 1 (true) if *File* exists and has its Set-Group-ID bit set.

SETUID

Set this keyword to return 1 (true) if *File* exists and has its Set-User-ID bit set.

SOCKET

Set this keyword to return 1 (true) if *File* exists and is a UNIX domain socket.

STICKY_BIT

Set this keyword to return 1 (true) if *File* exists and has its sticky bit set.

SYMLINK

Set this keyword to return 1 (true) if *File* exists and is a symbolic link that points at an existing file.

UNIX and VMS-Only Keywords

GROUP

Set this keyword to return 1 (true) if *File* exists and belongs to the same effective group ID (GID) as the IDL process.

USER

Set this keyword to return 1 (true) if *File* exists and belongs to the same effective user ID (UID) as the IDL process.

Example

Does my IDL distribution support the IRIX operating system?

```
result = FILE_TEST(!DIR + '/bin/bin.sgi', /DIRECTORY)
PRINT, 'IRIX IDL Installed: ', result ? 'yes' : 'no'
```

FILE_WHICH

The FILE_WHICH function separates a specified file path into its component directories, and searches each directory in turn for a specific file. This command is modeled after the UNIX `which(1)` command.

This routine is written in the IDL language. Its source code can be found in the file `file_which.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = FILE_WHICH([*Path*,] *File* [, /INCLUDE_CURRENT_DIR])

Return Value

Returns the path for the first file for the given name found by searching the specified path. If FILE_WHICH does not find the desired file, a NULL string is returned.

Arguments

Path

A search path to be searched. If *Path* is not present, the value of the IDL !PATH system variable is used.

File

The file to look for in the directories given by *Path*.

Keywords

INCLUDE_CURRENT_DIR

If set, FILE_WHICH looks in the current directory before starting to search *Path* for *File*. When IDL searches for a routine to compile, it looks in the current working directory before searching !PATH. The INCLUDE_CURRENT_DIR keyword allows FILE_WHICH to mimic this behavior.

Example

To find the location of this routine:

```
Result = FILE_WHICH('file_which.pro')
```

To find the location of the UNIX `ls` command:

```
Result = FILE_WHICH(getenv('PATH'), 'ls')
```

FILEPATH

The FILEPATH function returns the fully-qualified path to a file found in the IDL distribution. Operating system dependencies are taken into consideration. This routine is used by Research Systems to make the library routines portable. This routine is written in the IDL language. Its source code can be found in the file `filepath.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = FILEPATH(*Filename* [, ROOT_DIR=*string*]
[, SUBDIRECTORY=*string*/*string_array*] [, /TERMINAL] [, /TMP])

Arguments

Filename

A string containing the name of the file to be found. The file should be specified in all lowercase characters. No device or directory information should be included.

Keywords

ROOT_DIR

A string containing the name of the directory from which the resulting path should be based. If not present, the value of !DIR is used. This keyword is ignored if TERMINAL or TMP are specified.

SUBDIRECTORY

The name of the subdirectory in which the file should be found. If this keyword is omitted, the main IDL directory is used. This variable can be either a scalar string or a string array with the name of each level of subdirectory depth represented as an element of the array.

For example, to get a path to the file `filepath.pro` in IDL's `lib` subdirectory, enter:

```
path = FILEPATH('filepath.pro',SUBDIR=['lib'])
```

TERMINAL

Set this keyword to return the filename of the user's terminal.

TMP

Set this keyword to indicate that the specified file is a scratch file. Returns a path to the proper place for temporary files under the current operating system.

On the Macintosh, this keyword accesses a true temporary directory. This creates an invisible `Temp` folder which follows the Macintosh convention for temporary files.

Under Microsoft Windows, FILEPATH checks to see if the following environment variables are set—TMP, TEMP, WINDIR—and uses the value of the first one it finds. If none of these environment variables exists, \TMP is used as the temporary directory.

Example

Open the IDL distribution file `people.dat`:

```
OPENR, 1, FILEPATH('people.dat', SUBDIRECTORY=['examples','data'])
```

See Also

FINDFILE

FINDFILE

The FINDFILE function returns a string array containing the names of all files matching *File_Specification*.

All matched filenames are returned in a string array, one file name per array element. If no files exist with names matching the *File_Specification*, a null scalar string is returned instead of a string array. Except for VMS, described below, FINDFILE returns the full path only if the path itself is specified in *File_Specification*. See the "Examples" section below for details.

Note

Platform specific differences are described below:

- Under Macintosh, FINDFILE function brackets the returned filename in colons if the file is a folder (e.g., :lib:)
- Under UNIX, to include all the files in any subdirectories, use the * wildcard character in the *File_Specification*, such as in `result = FINDFILE('/path/*')`. If *File_Specification* contains only a directory, with no file information, only files in that directory are returned.
- Under VMS, FINDFILE returns the *full path* specification for any file it finds.
- Under Windows, FINDFILE appends a "\" character to the end of the returned file name if the file is a directory. To refer to all the files in a specific directory only, use `result = FINDFILE('\path\*')`.

Syntax

Result = FINDFILE(*File_Specification* [, COUNT=*variable*])

Arguments

File_Specification

A scalar string used to find files. The string can contain any valid command-interpreter wildcard characters. If *File_Specification* contains path information, that path information is included in the returned value. If *File_Specification* is omitted, the names of all files in the current directory are returned.

Keywords

COUNT

A named variable into which the number of files found is placed. If no files are found, a value of 0 is returned.

Examples

To print the file names of all the UNIX files with “dat” extensions in the current directory, use the command:

```
PRINT, FINDFILE('*.dat')
```

To print the full path names of all `.pro` files in the IDL `lib` directory that begin with the letter “x”, use the command:

```
PRINT, FINDFILE('/usr/local/rsi/idl/lib/x*.pro')
```

To print the path names of all `.pro` files in the `profiles` subdirectory of the current directory (a relative path), use the command:

```
PRINT, FINDFILE('profiles/*.pro')
```

Note that the values returned are (like the *File_Specification*) relative path names. Use caution when comparing values against this type of relative path specification.

See Also

FILEPATH

FINDGEN

The FINDGEN function returns a single-precision, floating-point array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = FINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create F, a 6-element vector of single-precision, floating-point values where each element is set to the value of its subscript, enter:

```
F = FINDGEN(6)
```

The value of F[0] is 0.0, F[1] is 1.0, and so on.

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

FINITE

The FINITE function returns 1 (True) if its argument is finite. If the argument is infinite or not a defined number (NaN), 0 (False) is returned. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.) The result is a byte expression of the same structure as the argument *X*.

Syntax

Result = FINITE(*X* [, /INFINITY] [, /NAN])

Arguments

X

A floating-point, double-precision, or complex scalar or array expression. Strings are first converted to floating-point. This function is meaningless for byte, integer, or longword arguments.

Keywords

INFINITY

If INFINITY is set, FINITE returns True if X is positive or negative infinity, and it returns False otherwise.

NAN

If NAN is set, FINITE returns True if X is "Not A Number" (NaN), otherwise it returns False.

Examples

Example 1

To find out if the logarithm of 5.0 is finite, enter:

```
PRINT, FINITE(ALOG(5.0))
```

IDL prints "1" because the argument is finite.

Example 2

To determine which elements of an array are infinity or NaN (Not a Number) values:

```
A = FLTARR(10)

; Set A[5] to NaN:
A[5] = !VALUES.F_NAN

; Find all values in A that are Infinity:
B = FINITE(A, /INFINITY)
PRINT, B
```

IDL prints the following, indicating that none of the elements are equal to infinity:

```
   0   0   0   0   0   0   0   0   0   0
```

```
; Find all values in A that are NaN:
B = FINITE(A, /NAN)
PRINT, B
```

IDL prints the following, indicating that A[5] is NaN:

```
   0   0   0   0   0   1   0   0   0   0
```

```
; Set A[5] to infinity:
A[5] = !VALUES.F_INFINITY

; Find all values in A that are NaN:
B = FINITE(A, /NAN)
PRINT, B
```

IDL prints the following, indicating that none of the elements are equal to NaN:

```
0   0   0   0   0   0   0   0   0   0
```

```
; Find all values in A that are Infinity:
B = FINITE(A, /INFINITY)
PRINT, B
```

IDL prints the following, indicating that A[5] is equal to infinity:

```
   0   0   0   0   0   1   0   0   0   0
```

See Also

CHECK_MATH, MACHAR, !VALUES, “Special Floating-Point Values” on page 434.

FIX

The FIX function returns a result equal to *Expression* converted to integer type. Optionally, the conversion type can be specified at runtime, allowing flexible runtime type-conversion to arbitrary types.

Syntax

Result = FIX(*Expression* [, *Offset* [, Dim_1, ..., Dim_8]] [, /PRINT] [, TYPE=*type code*{0 to 15}])

Arguments

Expression

The expression to be converted.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as integer data. See the description in Chapter 3, "Constants and Variables" in *Building IDL Applications* for details.

The *Offset* and Dim_i arguments are not allowed when converting to or from the string type.

Dim_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

The *Offset* and Dim_i arguments are not allowed when converting to or from the string type.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Keywords

PRINT

Set this keyword to specify that any special-case processing when converting between string and byte data, or the reverse, should be suppressed. The PRINT keyword is ignored unless the TYPE keyword is used to convert to these types.

TYPE

FIX normally converts *Expression* to the integer type. If TYPE is specified, it is the type code to set the type of the conversion. This feature allows dynamic type conversion, where the desired type is not known until runtime, to be carried out without the use of large CASE or IF...THEN logic. When TYPE is specified, FIX behaves as if the appropriate type conversion routine for the desired type had been called. See the "See Also" list below for the complete list of such routines.

When using the TYPE keyword to convert BYTE data to STRING or the reverse, you should be aware of the special-case processing that the BYTE and STRING functions do in this case. To prevent this, and get a simple type conversion in these cases, you must specify the PRINT keyword.

Example

Convert the floating-point array [2.2, 3.0, 4.5] to integer type and store the new array in the variable I by entering:

```
I = FIX([2.2, 3.0, 4.5])
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

FLICK

The FLICK procedure causes the display to flicker between two output images at a given rate.

This routine is written in the IDL language. Its source code can be found in the file `flick.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

FLICK, *A*, *B* [, *Rate*]

Arguments

A

Byte image number 1, scaled from 0 to 255.

B

Byte image number 2, scaled from 0 to 255.

Rate

The flicker rate. The default is 1.0 sec/frame

See Also

CW_ANIMATE, XINTERANIMATE

FLOAT

The FLOAT function returns a result equal to *Expression* converted to single-precision floating-point. If *Expression* is a complex number, FLOAT returns the real part.

Syntax

Result = FLOAT(*Expression* [, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to single-precision floating-point.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as single-precision floating point data.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

If A contains the integer value 6, it can be converted to floating-point and stored in the variable B by entering:

```
B = FLOAT(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, LONG, LONG64, STRING, UINT, ULONG, ULONG64

FLOOR

The FLOOR function returns the closest integer less than or equal to its argument.

Syntax

Result = FLOOR(*X* [, /L64])

Return Value

If the input argument *X* is an integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is a 32-bit longword integer with the same structure as *X*.

Arguments

X

The value for which the FLOOR function is to be evaluated. This value can be any numeric type (integer, floating, or complex).

Keywords

L64

If set, the result type is 64-bit integer regardless of the input type. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

Example

To print the floor function of 5.9, enter:

```
PRINT, FLOOR(5.9)
; IDL prints:
5
```

To print the floor function of 3000000000.1, the result of which is too large to represent in a 32-bit integer:

```
PRINT, FLOOR(3000000000.1D, /L64)
; IDL prints:
3000000000
```

See Also

CEIL, COMPLEXROUND, ROUND

FLOW3

The FLOW3 procedure draws lines representing a 3D flow/velocity field. Note that the 3D scaling system must be in place before calling FLOW3. This procedure works best with Z buffer output device.

This routine is written in the IDL language. Its source code can be found in the file `flow3.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

FLOW3, *Vx*, *Vy*, *Vz* [, ARROWSIZE=*value*] [, /BLOB] [, LEN=*value*] [, NSTEPS=*value*] [, NVECS=*value*] [, SX=*vector*, SY=*vector*, SZ=*vector*]

Arguments

Vx, Vy, Vz

3D arrays containing X, Y, and Z components of the field.

Keywords

ARROWSIZE

Size of arrowheads (default = 0.05).

BLOB

Set this keyword to draw a blob at the beginning of each flow line and suppress the arrows.

LEN

Length of each step used to follow flow lines (default = 2.0). Expressed in units of largest field vector (i.e., the length of the longest step is set to len times the grid spacing.

NSTEPS

Number of steps used to follow the flow lines (default = largest dimension of *Vx* / 5).

NVECS

Number of random flow lines to draw (default = 200). Only used if Sx, Sy, Sz are not present.

SX, SY, SZ

Optional vectors containing the starting coordinates of the flow lines. If omitted random starting points are chosen.

Example

```
; Create a set of random three-dimensional arrays to represent
; the field:
vx = RANDOMU(seed, 5, 5, 5)
vy = RANDOMU(seed, 5, 5, 5)
vz = RANDOMU(seed, 5, 5, 5)

; Set up the 3D scaling system:
SCALE3, xr=[0,4], yr=[0,4], zr = [0,4]

; Plot the vector field:
FLOW3, vx, vy, vz
```

See Also

VEL, VELOVECT

FLTARR

The FLTARR function returns a single-precision, floating-point vector or array.

Syntax

Result = FLTARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, FLTARR sets every element of the result to zero. Set this keyword to inhibit zeroing of the array elements and cause FLTARR to execute faster.

Example

Create F, a 3-element by 3-element floating-point array with each element set to 0.0 by entering:

```
F = FLTARR(3, 3)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

FLUSH

The FLUSH procedure causes all buffered output on the specified file units to be written. IDL uses buffered output for reasons of efficiency. This buffering leads to rare occasions where a program needs to be certain that output data are not waiting in a buffer, but have actually been output.

Syntax

FLUSH, $Unit_1$, ..., $Unit_n$

Arguments

$Unit_i$

The file units (logical unit numbers) to flush.

See Also

CLOSE, EMPTY, EXIT

FOR

The FOR statement executes one or more statements repeatedly, incrementing or decrementing a variable with each repetition, until a condition is met.

Note

For more information on using FOR and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

FOR *variable* = *init*, *limit* [, *Increment*] DO *statement*

or

FOR *variable* = *init*, *limit* [, *Increment*] DO BEGIN

statements

ENDFOR

Example

The following example iterates over the elements of an array, printing the value of each element:

```
array = ['one', 'two', 'three']
n = N_ELEMENTS(array)
FOR i=0,n-1 DO BEGIN
   PRINT, array[i]
ENDFOR
```

FORMAT_AXIS_VALUES

The FORMAT_AXIS_VALUES function accepts a vector of numeric values as an input argument, and returns a vector of formatted string values. This routine uses the same rules for formatting as do the axis routines that label tick marks given a set of tick values.

Syntax

Result = FORMAT_AXIS_VALUES(*Values*)

Arguments

Values

Set this argument to a vector of numeric values to be formatted.

Keywords

None.

Example

Suppose we have a vector of axis values:

```
axis_values = [7.9, 12.1, 15.3, 19.0]
```

Convert these values into an array of strings:

```
new_values = FORMAT_AXIS_VALUES(axis_values)
HELP, new_values
PRINT, new_values
PRINT, axis_values
```

IDL prints:

```
NEW_VALUES      STRING    = Array[4]
7.9 12.1 15.3 19.0
7.90000      12.1000      15.3000      19.0000
```

FORWARD_FUNCTION

The FORWARD_FUNCTION statement causes argument(s) to be interpreted as functions rather than variables (versions of IDL prior to 5.0 used parentheses to declare arrays).

Note

For information on using the FORWARD_FUNCTION statement, see Chapter 12, "Procedures and Functions" in *Building IDL Applications*.

Syntax

FORWARD_FUNCTION $Name_1, Name_2, ..., Name_n$

FREE_LUN

The FREE_LUN procedure deallocates previously-allocated file units. This routine is usually used with file units allocated with GET_LUN, but it will also close any other specified file unit. If the specified file units are open, they are closed prior to the deallocation.

Syntax

FREE_LUN [, *Unit*$_1$, ..., *Unit*$_n$] [, EXIT_STATUS=*variable*] [, /FORCE]

Arguments

Unit$_i$

The IDL file units (logical unit numbers) to deallocate.

Keywords

EXIT_STATUS

Set this keyword to a named variable that will contain the exit status reported by a UNIX child process started via the UNIT keyword to SPAWN. This value is the exit value reported by the process by calling EXIT, and is analogous to the value returned by $? under most UNIX shells.

FORCE

Set this keyword to override the IDL file output buffer and force the file to be closed no matter what errors occur in the process.

IDL buffers file output for performance reasons. If it is not possible to properly flush this data when a file close is requested, an error is normally issued and the file remains open. An example of this might be that your disk does not have room to write the remaining data. This default behavior prevents data from being lost. To override it and force the file to be closed no matter what errors occur in the process, specify FORCE.

Example

See the example for the GET_LUN procedure.

See Also

CLOSE, GET_LUN

FSTAT

The FSTAT function returns status information about a specified file unit.

Syntax

Result = FSTAT(*Unit*)

Return Value

The FSTAT function returns a structure expression of type FSTAT (or FSTAT64 in the case of files that are longer than 2^31-1 bytes in length) containing status information about a specified file unit. The contents of this structure are documented in "The FSTAT Function" in Chapter 8 of *Building IDL Applications*.

Fields of the FSTAT Structure

The following descriptions are of *fields* in the structure returned by the FSTAT function. They are *not* keywords to FSTAT.

- **UNIT** — The IDL logical unit number (LUN).
- **NAME** — The name of the file.
- **OPEN** — Nonzero if the file unit is open. If OPEN is zero, the remaining fields in FSTAT will not contain useful information.
- **ISATTY** — Nonzero if the file is actually a terminal instead of a normal file. For example, if you are using an `xterm` window on a UNIX system and you invoke FSTAT on logical unit 0 (standard input), ISATTY will be set to 1.
- **ISAGUI** — Nonzero if the file is actually a Graphical User Interface (for example, a logical unit associated with the IDL Development Environment). Thus, if you are using the IDLDE and you invoke FSTAT on logical unit 0 (standard input), ISAGUI will be set to 1.
- **INTERACTIVE** — Nonzero if *either* ISATTY or ISAGUI is nonzero.
- **XDR** — Nonzero if the file was opened with the XDR keyword, and is therefore considered to contain data in the XDR format.
- **COMPRESS** — Nonzero if the file was opened with the COMPRESS keyword, and is therefore considered to contain compressed data in the GZIP format.
- **READ** — Nonzero if the file is open for read access.

- **WRITE** — Nonzero if the file is open for write access.
- **ATIME, CTIME, MTIME** — The date of last access, date of creation, and date of last modification given in seconds since 1 January 1970 UTC. Use the SYSTIME function to convert these dates into a textual representation.

Note

Some file systems do not maintain all of these dates (e.g. MS DOS FAT file systems), and may return 0. On some non-UNIX operating systems, access time is not maintained, and ATIME and MTIME will always return the same date.

- **TRANSFER_COUNT** — The number of scalar IDL data items transferred in the last input/output operation on the unit. This is set by the following IDL routines: READU, WRITEU, PRINT, PRINTF, READ, and READF. TRANSFER_COUNT is useful when attempting to recover from input/output errors.
- **CUR_PTR** — The current position of the file pointer, given in bytes from the start of the file. If the device is a terminal (ISATTY is nonzero), the value of CUR_PTR will not contain useful information. When reporting on file units opened with the COMPRESS keyword to OPEN, the position reported by CUR_PTR is the "logical" position—the position it would be at in the uncompressed version of the same file.
- **SIZE** — The current length of the file in bytes. If the device is a terminal (ISATTY is nonzero), the value of SIZE will not contain useful information. When reporting on file units opened with the COMPRESS keyword to OPEN, the size reported by SIZE is the compressed size of the actual file, and not the logical length of the uncompressed data contained within. This is inconsistent with the position reported by CUR_PTR. The reason for reporting the size in this way is that the logical length of the data cannot be known without reading the entire file from beginning to end and counting the uncompressed bytes, and this would be extremely inefficient.

Warning

VMS variable length records have a 2-byte record-length descriptor at the beginning of each record. Because the SIZE field contains the length of the data file *including* the record descriptors, reading a file with VMS variable length records into a byte array of the size returned by FSTAT will result in an RMS EOF error.

- **REC_LEN** — If the file is record-oriented (VMS), this field contains the record length; otherwise, it is zero.

Arguments

Unit

The file unit about which information is required. This parameter can be an integer or an associated variable, in which case information about the variable's associated file is returned.

Keywords

None.

Examples

If file unit number 1 is open, the FSTAT information on that unit can be seen by entering:

```
PRINT, FSTAT(1)
```

Specific information can be obtained by referring to single fields within the structure returned by FSTAT. The following code prints the name and length of the file open on unit 1:

```
; Put FSTAT information in variable A:
A = FSTAT(1)

; Print the name and size fields:
PRINT, 'File: ', A.NAME, ' is ', A.SIZE, ' bytes long.'
```

See Also

ASSOC, OPEN

FULSTR

The FULSTR restores a row-indexed sparse array to full storage mode. If the sparse array was created with the SPRSIN function using the THRESH keyword, any values in the original array that were below the specified threshold are replaced with zeros.

Syntax

Result = FULSTR(*A*)

Arguments

A

A row-indexed sparse array created by the SPRSIN function.

Example

Suppose we have converted an array to sparse storage format with the following commands:

```
A = [[ 5.0, -0.2, 0.1], $
     [ 3.0, -2.0, 0.3], $
     [ 4.0, -1.0, 0.0]]

; Convert to sparse storage mode. All elements of the array A that
; have absolute values less than THRESH are set to zero:
sparse = SPRSIN(A, THRESH=0.5)
```

The variable SPARSE now contains a representation of the array A in structure form. To restore the array from the sparse-format structure:

```
; Restore the array:
result = FULSTR(sparse)

; Print the result:
PRINT, result
```

IDL prints:

```
5.00000      0.00000      0.00000
3.00000     -2.00000      0.00000
4.00000     -1.00000      0.00000
```

Note that the elements with an absolute value less than the specified threshold have been set to zero.

See Also

LINBCG, SPRSAB, SPRSAX, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

FUNCT

The FUNCT procedure evaluates the sum of a Gaussian and a 2nd-order polynomial and optionally returns the value of its partial derivatives. Normally, this function is used by CURVEFIT to fit the sum of a line and a varying background to actual data.

This routine is written in the IDL language. Its source code can be found in the file `funct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

FUNCT, *X*, *A*, *F* [, *Pder*]

Arguments

X

A vector of values for the independent variable.

A

A vector of coefficients for the equations:

$$F = A_0 e^{-Z^2/2} + A_3 + A_4 X + A_5 X^2$$
$$Z = (X - A_1)/A_2$$

F

A named variable that will contain the value of the function at each *Xi*.

Pder

A named variable that will contain an array of the size (N_ELEMENTS(*X*),6) that contains the partial derivatives. *Pder(i,j)* represents the derivative at the i^{th} point with respect to j^{th} parameter.

See Also

CURVEFIT

FUNCTION

The FUNCTION statement defines a function.

Note

For information on using the FUNCTION statement, see Chapter 12, "Procedures and Functions" in *Building IDL Applications*.

Syntax

FUNCTION *Function_Name*, $parameter_1$, ..., $parameter_n$

FV_TEST

The FV_TEST function computes the F-statistic and the probability that two sample populations *X* and *Y* have significantly different variances. *X* and *Y* may be of different lengths. The result is a two-element vector containing the F-statistic and its significance. The significance is a value in the interval [0.0, 1.0]; a small value (0.05 or 0.01) indicates that *X* and *Y* have significantly different variances. This type of test is often referred to as the F-variance test.

The F-statistic formula for sample populations *x* and *y* with means $\bar{x}$ and $\bar{y}$ is defined as:

$$F = \left(\frac{M-1}{N-1}\right)\frac{\left[\sum_{j=0}^{N-1}(x_j-\bar{x})^2-\frac{1}{N}\left[\sum_{j=0}^{N-1}(x_j-\bar{x})\right]^2\right]}{\left[\sum_{j=0}^{M-1}(y_j-\bar{y})^2-\frac{1}{M}\left[\sum_{j=0}^{M-1}(y_j-\bar{y})\right]^2\right]}$$

where $x = (x_0, x_1, x_2, ..., x_{N-1})$ and $y = (y_0, y_1, y_2 ..., y_{M-1})$

This routine is written in the IDL language. Its source code can be found in the file `fv_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = FV_TEST(*X*, *Y*)

Arguments

X

An *n*-element integer, single- or double-precision floating-point vector.

Y

An *m*-element integer, single- or double-precision floating-point vector.

Example

```
; Define two n-element sample populations:
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
   305, 270, 260, 251, 275, 288, 242, 304, 267]
```

```
Y = [201,  56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
       271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute the F-statistic (of X and Y) and its significance:
PRINT, FV_TEST(X, Y)
```

IDL prints:

```
2.48578    0.0540116
```

The result indicates that X and Y have significantly different variances.

See Also

KW_TEST, MOMENT, RS_TEST, S_TEST, TM_TEST

FX_ROOT

The FX_ROOT function computes real and complex roots of a univariate nonlinear function using an optimal Müller's method.

This routine is written in the IDL language. Its source code can be found in the file `fx_root.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = FX_ROOT(*X*, *Func* [, /DOUBLE] [, ITMAX=*value*] [, /STOP] [, TOL=*value*])

Arguments

X

A 3-element real or complex initial guess vector. Real initial guesses may result in real or complex roots. Complex initial guesses will result in complex roots.

Func

A scalar string specifying the name of a user-supplied IDL function that defines the univariate nonlinear function. This function must accept the vector argument X.

For example, suppose we wish to find a root of the following function:

$$y = e^{(\sin x^2 + \cos x^2 - 1)} - 1$$

We write a function FUNC to express the function in the IDL language:

```
FUNCTION func, X
  RETURN, EXP(SIN(X)^2 + COS(X)^2 - 1) - 1
END
```

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITMAX

The maximum allowed number of iterations. The default is 100.

STOP

Use this keyword to specify the stopping criterion used to judge the accuracy of a computed root r(*k*). Setting STOP = 0 (the default) checks whether the absolute value of the difference between two successively-computed roots, | r(*k*) - r(*k*+1) | is less than the stopping tolerance TOL. Setting STOP = 1 checks whether the absolute value of the function FUNC at the current root, | FUNC(r(*k*)) |, is less than TOL.

TOL

Use this keyword to specify the stopping error tolerance. The default is 1.0×10^{-4}.

Example

This example finds the roots of the function FUNC defined above:

```
; First define a real 3-element initial guess vector:
x = [0.0, -!pi/2, !pi]

; Compute a root of the function using double-precision
; arithmetic:
root = FX_ROOT(X, 'FUNC', /DOUBLE)

; Check the accuracy of the computed root:
PRINT, EXP(SIN(ROOT)^2 + COS(ROOT)^2 - 1) - 1
```

IDL prints:

```
0.0000000
```

We can also define a complex 3-element initial guess vector:

```
x = [COMPLEX(-!PI/3, 0), COMPLEX(0, !PI), COMPLEX(0, -!PI/6)]

; Compute the root of the function:
root = FX_ROOT(x, 'FUNC')

; Check the accuracy of the computed complex root:
PRINT, EXP(SIN(ROOT)^2 + COS(ROOT)^2 - 1) - 1
```

IDL prints:

```
(      0.00000,      0.00000)
```

See Also

BROYDEN, NEWTON, FZ_ROOTS

FZ_ROOTS

The FZ_ROOTS function is used to find the roots of an *m*-degree complex polynomial, using Laguerre's method. The result is an *m*-element complex vector.

FZ_ROOTS is based on the routine `zroots` described in section 9.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = FZ_ROOTS(*C* [, /DOUBLE] [, EPS=*value*] [, /NO_POLISH])

Arguments

C

A vector of length *m*+1 containing the coefficients of the polynomial, in ascending order (see example). The type can be real or complex.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

The desired fractional accuracy. The default value is 2.0×10^{-6}.

NO_POLISH

Set this keyword to suppress the usual polishing of the roots by Laguerre's method.

Examples

Example 1: Real coefficients yielding real roots.

Find the roots of the polynomial:

$$P(x) = 6x^3 - 7x^2 - 9x - 2$$

The exact roots are -1/2, -1/3, 2.0.

```
coeffs = [-2.0, -9.0, -7.0, 6.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL prints:

```
( -0.500000, 0.00000)( -0.333333, 0.00000)( 2.00000, 0.00000)
```

Example 2: Real coefficients yielding complex roots.

Find the roots of the polynomial:

$$P\ (x) = x^4 + 3x^2 + 2$$

The exact roots are:

$$0.0 - i\sqrt{2.0},\ \ 0.0 + i\sqrt{2.0}\ ,\ \ \ 0.0 - i\ ,\ \ \ 0.0 + i$$

```
coeffs = [2.0, 0.0, 3.0, 0.0, 1.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL Prints:

```
(0.00000, -1.41421)(0.00000, 1.41421)
(0.00000, -1.00000)(0.00000, 1.00000)
```

Example 3: Real and complex coefficients yielding real and complex roots.

Find the roots of the polynomial:

$$P\ (x) = x^3 + (-4 - i4)x^2 + s\ (-3 + i4)x + (18 + i24)$$

The exact roots are -2.0, 3.0, $(3.0 + i4.0)$

```
coeffs = [COMPLEX(18,24), COMPLEX(-3,4), COMPLEX(-4,-4), 1.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL Prints:

```
( -2.00000, 0.00000) ( 3.00000, 0.00000) ( 3.00000, 4.00000)
```

See Also

FX_ROOT, BROYDEN, NEWTON, POLY

GAMMA

The GAMMA function returns the gamma function of *X*.

The gamma function is defined as:

$$\Gamma(x) \equiv \int_0^{\infty} t^{x-1} e^{-t} dt$$

If *X* is double-precision, the result is double-precision, otherwise the argument is converted to floating-point and the result is floating-point.

Use the LNGAMMA function to obtain the natural logarithm of the gamma function when there is a possibility of overflow.

Syntax

Result = GAMMA(*X*)

Arguments

X

The expression for which the gamma function will be evaluated.

Example

Plot the gamma function over the range 0.01 to 1.0 with a step size of 100 by entering:

```
X = FINDGEN(99)/100. + 0.01
PLOT, X, GAMMA(X)
```

See Also

BETA, IBETA, IGAMMA, LNGAMMA

GAMMA_CT

The GAMMA_CT procedure applies gamma correction to a color table.

This routine is written in the IDL language. Its source code can be found in the file `gamma_ct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

GAMMA_CT, *Gamma* [, /CURRENT] [, /INTENSITY]

Arguments

Gamma

The value of gamma correction. A value of 1.0 indicates a linear ramp (i.e., no gamma correction). Higher values of *Gamma* give more contrast. Values less than 1.0 yield lower contrast.

Keywords

CURRENT

Set this keyword to apply correction from the "current" color table (i.e., the values R_CURR, G_CURR, and B_CURR in the COLORS common block). Otherwise, correction is applied from the "original" color table (i.e., the values R_ORIG, G_ORIG, and B_ORIG in the COLORS common block). The gamma corrected color table is always saved in the "current" table (R_CURR, G_CURR, B_CURR) and the new table is loaded.

INTENSITY

Set this keyword to correct the individual intensities of each color in the colortable. Otherwise, the colors are shifted according to the gamma function.

See Also

PSEUDO, STRETCH, XLOADCT

GAUSS_CVF

The GAUSS_CVF function computes the cutoff value *V* in a standard Gaussian (normal) distribution with a mean of 0.0 and a variance of 1.0 such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `gauss_cvf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = GAUSS_CVF(*P*)

Arguments

P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

Example

Use the following command to compute the cutoff value in a Gaussian distribution such that the probability that a random variable X is greater than the cutoff value is 0.025:

```
PRINT, GAUSS_CVF(0.025)
```

IDL prints:

```
1.95997
```

See Also

CHISQR_CVF, F_CVF, GAUSS_PDF, T_CVF

GAUSS_PDF

The GAUSS_PDF function computes the probability *P* that, in a standard Gaussian (normal) distribution with a mean of 0.0 and a variance of 1.0, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `gauss_pdf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = GAUSS_PDF(*V*)

Return Value

This function returns a scalar or array with the same dimensions as *V*. If *V* is double-precision, the result is double-precision, otherwise the result is single-precision.

Arguments

V

A scalar or array that specifies the cutoff value(s).

Examples

Example 1

Compute the probability that a random variable X, from the standard Gaussian (normal) distribution, is less than or equal to 2.44:

```
PRINT, GAUSS_PDF(2.44)
```

IDL Prints:

```
0.992656
```

Example 2

Compute the probability that a random variable X, from the standard Gaussian (normal) distribution, is less than or equal to 10.0 and greater than or equal to 2.0:

```
PRINT, GAUSS_PDF(10.0) - GAUSS_PDF(2.0)
```

IDL Prints:

```
0.0227501
```

Example 3

Compute the probability that a random variable X, from the Gaussian (normal) distribution with a mean of 0.8 and a variance of 4.0, is less than or equal to 2.44:

```
PRINT, GAUSS_PDF( (2.44 - 0.80)/SQRT(4.0) )
```

IDL Prints:

```
0.793892
```

See Also

BINOMIAL, CHISQR_PDF, F_PDF, GAUSS_CVF, T_PDF

GAUSS2DFIT

The GAUSS2DFIT function fits a two-dimensional, elliptical Gaussian equation to rectilinearly gridded data.

$$Z = F(x, y)$$

where:

$$F(x, y) = A_0 + A_1 e^{-U/2}$$

And the elliptical function is:

$$U = (x'/a)^2 + (y'/b)^2$$

The parameters of the ellipse *U* are:

- Axis lengths are 2*a* and 2*b*, in the unrotated X and Y axes, respectively.
- Center is at (*h, k*).
- Rotation of *T* radians from the X axis, in the *clockwise* direction.

The rotated coordinate system is defined as:

$$x' = (x - h)\cos T - (y - k)\sin T$$

$$y' = (x - h)\sin T + (y - k)\cos T$$

The rotation is optional, and can be forced to 0, making the major and minor axes of the ellipse parallel to the X and Y axes.

Coefficients of the computed fit are returned in argument *A*.

Procedure Used and Other Notes

The peak/valley is found by first smoothing *Z* and then finding the maximum or minimum, respectively. GAUSSFIT is then applied to the row and column running through the peak/valley to estimate the parameters of the Gaussian in X and Y. Finally, CURVEFIT is used to fit the 2D Gaussian to the data.

Be sure that the 2D array to be fit contains the entire peak/valley out to at least 5 to 8 half-widths, or the curve-fitter may not converge.

This is a computationally-intensive routine. The time required is roughly proportional to the number of elements in *Z*.

This routine is written in the IDL language. Its source code can be found in the file `gauss2dfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = GAUSS2DFIT(*Z*, *A* [, *X*, *Y*] [, /NEGATIVE] [, /TILT])

Arguments

Z

The dependent variable. *Z* should be a two-dimensional array with dimensions (N_x, N_y). Gridding in the array must be rectilinear.

A

A named variable in which the coefficients of the fit are returned. *A* is returned as a seven element vector the coefficients of the fitted function. The meanings of the seven elements in relation to the discussion above is:

- $A[0] = A_0$ = constant term
- $A[1] = A_1$ = scale factor
- $A[2] = a$ = width of Gaussian in the X direction
- $A[3] = b$ = width of Gaussian in the Y direction
- $A[4] = h$ = center X location
- $A[5] = k$ = center Y location.
- $A[6] = T$ = *Theta*, the rotation of the ellipse from the X axis in radians, *counter-clockwise*.

X

An optional vector with N_x elements that contains the X values of *Z* (i.e., X_i is the X value for $Z_{i,j}$. If this argument is omitted, a regular grid in X is assumed, and the X location of $Z_{i,j} = i$.

Y

An optional vector with N_y elements that contains the Y values of Z (i.e., Y_j is the Y value for $Z_{i,j}$. If this argument is omitted, a regular grid in Y is assumed, and the Y location of $Z_{i,j} = j$.

Keywords

NEGATIVE

Set this keyword to indicate that the Gaussian to be fitted is a valley (such as an absorption line). By default, a peak is fit.

TILT

Set this keyword to allow the orientation of the major and minor axes of the ellipse to be unrestricted. The default is that the axes of the ellipse must be parallel to the X and Y axes. Therefore, in the default case, *A*[6] is always returned as 0.

Example

This example creates a 2D gaussian, adds random noise and then applies GAUSS2DFIT.

```
; Define array dimensions:
nx = 128 & ny = 100
; Define input function parameters:
A = [ 5., 10., nx/6., ny/10., nx/2., .6*ny]
; Create X and Y arrays:
X = FINDGEN(nx) # REPLICATE(1.0, ny)
Y = REPLICATE(1.0, nx) # FINDGEN(ny)
; Create an ellipse:
U = ((X-A[4])/A[2])^2 + ((Y-A[5])/A[3])^2
; Create gaussian Z:
Z = A[0] + A[1] * EXP(-U/2)
; Add random noise, SD = 1:
Z = Z + RANDOMN(seed, nx, ny)
; Fit the function, no rotation:
yfit = GAUSS2DFIT(Z, B)
; Report results:
PRINT, 'Should be: ', STRING(A, FORMAT='(6f10.4)')
PRINT, 'Is: ', STRING(B(0:5), FORMAT='(6f10.4)')
```

See Also

COMFIT, GAUSSFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

GAUSSFIT

The GAUSSFIT function computes a non-linear least-squares fit to a function $f(x)$ with from three to six unknown parameters. $f(x)$ is a linear combination of a Gaussian and a quadratic; the number of terms is controlled by the keyword parameter NTERMS.

This routine is written in the IDL language. Its source code can be found in the file `gaussfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = GAUSSFIT(*X*, *Y* [, *A*] [, ESTIMATES=*array*] [, NTERMS=*integer*{3 to 6}])

Arguments

X

An *n*-element vector of independent variables.

Y

A vector of dependent variables, the same length as *X*.

A

A named variable that will contain the coefficients *A* of the fit.

Keywords

ESTIMATES

Set this keyword equal to an array of starting estimates for the parameters of the equation. If the NTERMS keyword is specified, the ESTIMATES array should have NTERMS elements. If NTERMS is not specified, the ESTIMATES array should have six elements. If the ESTIMATES array is not specified, estimates are calculated by the GAUSSFIT routine.

NTERMS

Set this keyword to an integer value between three and six to specify the function to be used for the fit. The values correspond to the functions shown below. In all cases:

$$z = \frac{x - A_1}{A_2}$$

NTERMS=6

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3 + A_4 x + A_5 x^2$$

NTERMS=6 is the default setting. Here, A_0 is the height of the Gaussian, A_1 is the center of the Gaussian, A_2 is the width of the Gaussian, A_3 is the constant term, A_4 is the linear term, and A_5 is the quadratic term.

NTERMS=5

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3 + A_4 x$$

NTERMS=4

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3$$

NTERMS=3

$$f(x) = A_0 e^{\frac{-z^2}{2}}$$

Example

```
; Define the independent variables:
X = FINDGEN(13)/5 - 1.2

; Define the dependent variables:
Y = [0.0, 0.1, 0.2, 0.5, 0.8, 0.9, $
    0.99, 0.9, 0.8, 0.5, 0.2, 0.1, 0.0]

; Fit the data to the default function, storing coefficients in A:
```

```
yfit = GAUSSFIT(X, Y, A)

; Print the coefficients:
PRINT, A
```

IDL prints:

```
2.25642 -1.62041e-07     0.703372     -1.25634  3.04487e-07
0.513596
```

We can compare original and fitted data by plotting one on top of the other:

```
; Load an appropriate color table:
LOADCT, 30

; Plot the original data:
PLOT, X, Y

; Overplot the fitted data in a different color:
OPLOT, X, yfit, COLOR = 100
```

See Also

COMFIT, CURVEFIT, GAUSS2DFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

GAUSSINT

The GAUSSINT function evaluates the integral of the Gaussian probability function and returns the result.

The Gaussian integral is defined as:

$$\text{Gaussint}(x) \equiv \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-t^2/2} dt$$

If *X* is double-precision, the result is double-precision, otherwise the argument is converted to floating-point and the result is floating-point. The result has the same structure as the input argument, *X*.

Syntax

Result = GAUSSINT(*X*)

Arguments

X

The expression for which the Gaussian integral is to be evaluated.

Example

Plot the Gaussian probability function over the range -5 to 5 with a step size of 0.1by entering:

```
X = FINDGEN(101)/10. - 5.
PLOT, X, GAUSSINT(X)
```

See Also

GAUSS_CVF, GAUSS_PDF

GET_DRIVE_LIST

The GET_DRIVE_LIST function returns a string array of the names of valid drives / volumes for the file system (Windows / Macintosh only).

Syntax

Result = GET_DRIVE_LIST( )

Return Value

This function returns a string array of the names of valid drives/volumes for the file system.

Arguments

None.

Keywords

None.

GET_KBRD

The GET_KBRD function returns the next character available from the standard input (IDL file unit 0) as a one-character string.

Syntax

Result = GET_KBRD(*Wait*)

Arguments

Wait

If *Wait* is zero, GET_KBRD returns the null string if there are no characters in the terminal type-ahead buffer. If it is nonzero, the function waits for a character to be typed before returning.

Examples

To wait for keyboard input and store one character in the variable R, enter:

```
R = GET_KBRD(1)
```

Press any key to return to the IDL prompt. To see the character that was typed, enter:

```
PRINT, R
```

The following code fragment reads one character at a time and echoes that character's numeric code. It quits when a "q" is entered:

```
REPEAT BEGIN
   A = GET_KBRD(1)
   PRINT, BYTE(A)
ENDREP UNTIL A EQ 'q'
```

Note

The GET_KBRD function can be used to return Windows special characters (in addition to standard keyboard characters), created by holding down the Alt key and entering the character's ANSI equivalent. For example, to return the paragraph marker (¶), ANSI number 0182, enter:

```
C = GET_KBRD(1)
```

While GET_KBRD is waiting, press and hold the Alt key and type 0182 on the numeric keypad. When the IDL prompt returns, enter:

```
PRINT, C
```

IDL prints the paragraph marker,“¶”.

GET_KBRD *cannot* be used to return control characters or other editing keys (e.g., Delete, Backspace, etc.). These characters are used for keyboard shortcuts and command line editing only. GET_KBRD can be used to return the Enter key.

See Also

READ/READF

GET_LUN

The GET_LUN procedure allocates a file unit from a pool of free units. Instead of writing routines to assume the use of certain file units, IDL functions and procedures should use GET_LUN to reserve unit numbers in order to avoid conflicts with other routines. Use FREE_LUN to free the file units when finished.

Syntax

GET_LUN, *Unit*

Arguments

Unit

The named variable into which GET_LUN should place the file unit number. *Unit* is converted into a longword integer in the process. The file unit number obtained is in the range 100 to 128.

Example

Instead of explicitly specifying a file unit number that may already be used, use GET_LUN to obtain a free one and store the result in the variable U by entering:

```
GET_LUN, U
```

Now U can be used in opening a file:

```
OPENR, U, 'file.dat'
```

Once the data from “file.dat” has been read, the file can be closed and the file unit can be freed with the command:

```
FREE_LUN, U
```

Note also that OPENR has a GET_LUN keyword that allows you to simultaneously obtain a free file unit and open a file. The following command performs the same tasks as the first two commands above:

```
OPENR, U, 'file.dat', /GET_LUN
```

See Also

FREE_LUN, OPEN

GET_SCREEN_SIZE

The GET_SCREEN_SIZE function returns a two-element vector of the form [*width*, *height*] that represents the dimensions, measured in device units, of the screen.

Syntax

Result = GET_SCREEN_SIZE([*Display_name*] [, RESOLUTION=*variable*])

X Windows Keywords: [, DISPLAY_NAME=*string*]

Arguments

Display_name (X Only)

A string indicating the name of the X WIndows display that should be used to determine the screen size.

Keywords

DISPLAY_NAME (X Only)

Set this keyword equal to a string indicating the name of the X WIndows display that should be used to determine the screen size. Setting this keyword is equivalent to setting the optional *Display_name* argument.

RESOLUTION

Set this keyword equal to a named variable that will contain a two-element vector, [*xres*, *yres*], specifying the screen resolution in cm/pixel.

Example

You can find the dimensions and screen resolution of your screen by entering the following:

```
dimensions = GET_SCREEN_SIZE(RESOLUTION=resolution)
PRINT, dimensions, resolution
```

For the screen on which this was tested, IDL prints:

```
1280.00      1024.00
0.0282031    0.0281250
```

GET_SYMBOL

The GET_SYMBOL function returns the value of a VMS DCL (Digital Command Language) interpreter symbol as a scalar string. If the symbol is undefined, the null string is returned.

Note

This procedure is available on VMS only.

Syntax

Result = GET_SYMBOL(*Name* [, TYPE={1 | 2}])

Arguments

Name

A scalar string containing the name of the symbol to be translated.

Keywords

TYPE

The table from which *Name* is translated. Set TYPE to 1 to specify the local symbol table. A value of 2 specifies the global symbol table. The default is to search the local table.

See Also

GETENV

GETENV

The GETENV function returns the equivalence string for *Name* from the environment of the IDL process.

Syntax

Result = GETENV(*Name*)

UNIX-Only Keywords: [, /ENVIRONMENT]

Return Value

Returns the equivalence string for *Name* from the environment of the IDL process, or a null string if *Name* does not exist in the environment.

Arguments

Name

The scalar string for which an equivalence string from the environment is desired.

UNIX-Only Keywords

ENVIRONMENT

If set, returns a string array containing all entries in the current process, one variable per entry, in the SETENV format (Variable=*Value*).

If ENVIRONMENT is set, the *Name* argument should not be supplied.

Environment Variables Under VMS

VMS does not directly support the concept of environment variables. Instead, it is emulated (by using the standard C getenv() function) as described below, enabling you to use GETENV portably between UNIX and VMS:

- If *Name* is one of HOME, TERM, PATH, or USER, an appropriate response is generated. This mimics the most common UNIX environment variables.
- An attempt is made to translate *Name* as a logical name. All four logical name tables are searched in the standard order.
- An attempt is made to translate *Name* as a command-language interpreter symbol.

Special Handling of the IDL_TMPDIR Environment Variable

If you specify 'IDL_TMPDIR' as the value of *Name*, and an environment variable with that name exists, GETENV returns its defined value as usual. However, if TMP_DIR is not defined, GETENV returns the path of the location where IDL's internals believe temporary files should be written on your system. Using IDL_TMPDIR in this manner makes it simple for code written in IDL to follow the same conventions as IDL itself, and provides the user with an easy way to override this decision.

The actual location used is system dependent. When possible, IDL tries to follow operating system and vendor conventions.

Example

To print the name of the current UNIX shell, enter the command:

```
PRINT, 'The current shell is: ', GETENV('SHELL')
```

See Also

GET_SYMBOL, SETENV, TRNLOG

The UNIX Environment

Every UNIX process has an environment. The environment consists of environment variables, each of which has a string value associated with it. Some environment variables always exist, such as PATH that tells the shell where to look for programs or TERM that specifies the kind of terminal being used. Others can be added by the user, usually from an interactive shell and often from the `.login` file that is executed when you log in.

When a process is created, it is given a copy of the environment from its parent process. IDL is no exception to this; when started, it inherits a copy of its parent's environment. The parent process to IDL is usually the interactive shell from which it was started. In turn, any child process created by IDL (such as those from the SPAWN procedure) inherits a copy of IDL's current environment.

Note

It is important to realize that environment variables are not an IDL feature; they are part of every UNIX process. Although they can serve as a form of global memory, it is best to avoid using them in that way. Instead, IDL heap variables (pointers or object references), IDL system variables, or common blocks should be used in that

role. This will make your IDL code portable to non-UNIX-based IDL systems. Environment variables should be used for communicating with child processes. One example is setting the value of the SHELL environment variable prior to calling SPAWN to change the shell executed by SPAWN.

IDL provides two routines for manipulating the environment:

GETENV

The GETENV function returns the equivalence string from the environment of the IDL process. It has the form:

```
GETENV(Name)
```

where *Name* is the name of the environment variable for which the translation is desired. If *Name* does not exist in the environment, a null string is returned. For example, to determine the type of terminal being used, you can enter the IDL statement:

```
PRINT, 'The terminal type is:  ', GETENV('TERM')
```

Executing this statement on a Sun workstation give the following result:

```
The terminal type is: sun
```

SETENV

The SETENV function adds a new environment variable or changes the value of an existing environment variable in the IDL process. It has the form:

```
SETENV, Environment_Expression
```

where *Environment_Expression* is a scalar string containing an environment expression to be added to the environment.

For example, you can change the shell used by SPAWN by changing the value of the SHELL environment variable. An IDL statement to change to using the Bourne shell `/bin/sh` would be:

```
SETENV, 'shell=/bin/sh'
```

GOTO

The GOTO statement transfers program control to point specified by a label. The GOTO statement is generally considered to be a poor programming practice that leads to unwieldy programs. Its use should be avoided. However, for those cases in which the use of a GOTO is appropriate, IDL does provide the GOTO statement.

Note that using a GOTO to jump into the middle of a loop results in an error.

Warning

You must be careful in programming with GOTO statements. It is not difficult to get into a loop that will never terminate, especially if there is not an escape (or test) within the statements spanned by the GOTO.

For information on using GOTO and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

GOTO, *label*

Example

In the following example, the statement at label JUMP1 is executed after the GOTO statement, skipping any intermediate statements:

```
GOTO, JUMP1
PRINT, 'Skip this' ; This statement is skipped
PRINT, 'Skip this' ; This statement is also skipped
JUMP1: PRINT, 'Do this'
```

The label can also occur before the GOTO statement that refers to the label, but you must be careful to avoid an endless loop. GOTO statements are frequently the subjects of IF statements, as in the following statement:

```
IF A NE G THEN GOTO, MISTAKE
```

GRID_TPS

The GRID_TPS function uses thin plate splines to interpolate a set of values over a regular two dimensional grid, from irregularly sampled data values. Thin plate splines are ideal for modeling functions with complex local distortions, such as warping functions, which are too complex to be fit with polynomials.

Given n points, (x_i, y_i) in the plane, a thin plate spline can be defined as:

$$f(x, y) = a_0 + a_1 x + a_2 y + \frac{1}{2} \sum_{i=0}^{n-1} b_i r_i^2 \log r_i^2$$

with the constraints:

$$\sum_{i=1}^{n-1} b_i = \sum_{i=1}^{n-1} b_i x_i = \sum_{i=0}^{n-1} b_i y_i = 0$$

where $r_i^2 = (x-x_i)^2 + (y-y_i)^2$. A thin plate spline (TPS) is a smooth function, which implies that it has continuous first partial derivatives. It also grows almost linearly when far away from the points (x_i, y_i). The TPS surface passes through the original points: $f(x_i, y_i) = z_i$.

Note

GRID_TPS requires at least 7 noncolinear points.

Syntax

Interp = GRID_TPS (*Xp*, *Yp*, *Values* [, COEFFICIENTS=*variable*] [, NGRID=*[nx, ny]*] [, START=*[x0, y0]*] [, DELTA=*[dx, dy]*])

Return Value

The function returns an array of dimension (*nx*, *ny*) of interpolated values. If the values argument is a two-dimensional array, the output array has dimensions (*nz*, *nx*, *ny*), where *nz* is the leading dimension of the values array allowing for the interpolation of arbitrarily sized vectors in a single call. Keywords can be used to specify the grid dimensions, size, and location.

Arguments

Xp

A vector of *x* points.

Yp

A vector of *y* points, with the same number of elements as the *Xp* argument.

Values

A vector or two-dimensional array of values to interpolate. If values are a two-dimensional array, the leading dimension is the number of values for which interpolation is performed.

Keywords

COEFFICIENTS

A named variable in which to store the resulting coefficients of the thin plate spline function for the last set of Values. The first *N* elements, where *N* is the number of input points, contain the coefficients b_i, in the previous equation. Coefficients with subscripts n, n+1, and n+2, contain the values of a_0, a_1, and a_2, in the above equation.

DELTA

A two-element array of the distance between grid points (d_x, d_y). If a scalar is passed, the value is used for both *dx* and *dy*. The default is the range of the *xp* and *yp* arrays divided by $(n_x - 1, n_y - 1)$.

NGRID

A two-element array of the size of the grid to interpolate (n_x, n_y). If a scalar is passed, the value is used for both n_x and n_y. The default value is [25, 25].

START

A two-element array of the location of grid point (x_0, y_0). If a scalar is passed, the value is used for both x_0 and y_0. The default is the minimum values in the *xp* and *yp* arrays.

References

I. Barrodale, et al, “Note: Warping digital images using thin plate splines”, Pattern Recognition, Vol 26, No. 2, pp 375-376, 1993.

M. J. D. Powell, “Tabulation of thin plate splines on a very fine two-dimensional grid”, Report No. DAMTP 1992/NA2, University of Cambridge, Cambridge, U.K. (1992).

Example

The following example creates a set of 25 random values defining a surface on a square, 100 units on a side, starting at the origin. Then, we use GRID_TPS to create a regularly gridded surface, with dimensions of 101 by 101 over the square, which is then displayed. The same data set is then interpolated using TRIGRID, and the two results are displayed for comparison.

```
;X values
x = RANDOMU(seed, 25) * 100

;Y values
y = RANDOMU(seed, 25) * 100

;Z values
z = RANDOMU(seed, 25) * 10

z1 = GRID_TPS(x, y, z, NGRID=[101, 101], START=[0,0], DELTA=[1,1])

;Show the result
LIVE_SURFACE, z1, TITLE='TPS'

;Grid using TRIGRID
TRIANGULATE, x, y, tr, bounds

z2 = TRIGRID(x, y, z, tr, [1,1], [0,0,100, 100], $
   EXTRAPOLATE=bounds)

;Show triangulated surface
LIVE_SURFACE, z2, TITLE='TRIGRID - Quintic'
```

See Also

MIN_CURVE_SURF

GRID3

The GRID3 function fits a smooth function to a set of 3D scattered nodes (x_i, y_i, z_i) with associated data values (f_i). The function can be sampled over a set of user-specified points, or over an arbitrary 3D grid which can then be viewed using the SLICER3 procedure.

GRID3 uses the method described in Renka, R. J., "Multivariate Interpolation of Large Sets of Scattered Data," *ACM Transactions on Mathematical Software*, Vol. 14, No. 2, June 1988, Pages 139-148, which has been referred to as the Modified Shepard's Method. The function described by this method has the advantages of being equal to the values of f_i, at each (x_i, y_i, z_i), and being smooth (having continuous first partial derivatives).

If no optional or keyword parameters are supplied, GRID3 produces a regularly-sampled volume with dimensions of (25, 25, 25), made up of single-precision, floating-point values, enclosing the original data points.

Syntax

Result = GRID3(*X*, *Y*, *Z*, *F*, *Gx*, *Gy*, *Gz* [, DELTA=*scalar/vector*] [, DTOL=*value*] [, GRID=*value*] [, NGRID=*value*] [, START=*[x, y, z]*])

Arguments

X, Y, Z and F

Arrays containing the locations of the data points, and the value of the variable to be interpolated at that point. *X*, *Y*, *Z*, and *F* must have the same number of elements (with a minimum of 10 elements per array) and are converted to floating-point if necessary.

Note: For the greatest possible accuracy, the arrays *X*, *Y*, and *Z* should be scaled to fit in the range [0,1].

G_x, G_y, and G_z

Optional arrays containing the locations within the volume to be sampled (if the GRID keyword is not set), or the locations along each axis of the sampling grid (if the GRID keyword is set). If these parameters are supplied, the keywords DELTA, NGRID, and START are ignored.

If the keyword GRID is *not* set, the result has the same number of elements as G_x, G_y, and G_z. The *i*th element of the result contains the value of the interpolate at (G_{xi}, G_{yi}, G_{zi}). The result has the same dimensions as G_x.

If the GRID keyword is set, the result of GRID3 is a three-dimensional, single-precision, floating-point array with dimensions of (N_x, N_y, N_z), where N_x, N_y, and N_z are the number of elements in G_x, G_y, and G_z, respectively.

Keywords

DELTA

Set this keyword to a three-element vector or a scalar that specifies the grid spacing in the X, Y, and Z dimensions. The default spacing produces NGRID samples within the range of each axis.

DTOL

The tolerance for detecting an ill-conditioned system of equations. The default value is 0.01, which is appropriate for small ranges of *X*, *Y*, and *Z*. For large ranges of *X*, *Y*, or *Z*, it may be necessary to decrease the value of DTOL. If you receive the error message "GRID3: Ill-conditioned matrix or all nodes co-planar," try decreasing the value of DTOL.

GRID

This keyword specifies the interpretation of G_x, G_y, and G_z. The default value for GRID is zero if G_x, G_y, and G_z are supplied, otherwise a regularly-gridded volume is produced.

NGRID

The number of samples along each axis. NGRID can be set to a scalar, in which case each axis has the same number of samples, or to a three-element array containing the number of samples for each axis. The default value for NGRID is 25.

START

A three-element array that specifies the starting value for each grid. The default value for START is the minimum value in the respective X, Y, and Z array.

Examples

Produce a set random points within the (0,1) unit cube and simulate a function:

```
; Number of irregular samples:
N = 300
```

```
; Generate random values between 0 and 1:
X = RANDOMU(SEED, N)
Y = RANDOMU(SEED, N)
Z = RANDOMU(SEED, N)

; The function to simulate:
F = (X-.5)^2 + (Y-.5)^2 + Z

; Return a cube with 25 equal-interval samples along each axis:
Result = GRID3(X, Y, Z, F)

; Return a cube with 11 elements along each dimension, which
; samples each axis at (0, 0.1, ..., 1.0):
Result = GRID3(X, Y, Z, F, START=[0., 0., 0], $
   DELTA=0.1, NGRID=10)
```

The same result is produced by the statements:

```
; Create sample values:
S = FINDGEN(11) / 10.
Result = GRID3(X, Y, Z, F, S, S, S, /GRID)
```

See Also

SLICER3

GS_ITER

The GS_ITER function solves an *n* by *n* linear system of equations using Gauss-Seidel iteration with over- and under-relaxation to enhance convergence.

Note that the equations must be entered in *diagonally dominant* form to guarantee convergence. A system is diagonally dominant if the diagonal element in a given row is greater than the sum of the absolute values of the non-diagonal elements in that row.

This routine is written in the IDL language. Its source code can be found in the file `gs_iter.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = GS_ITER(*A*, *B* [, /CHECK] [, /DOUBLE] [, LAMBDA=*value*{0.0 to 2.0}] [, MAX_ITER=*value*] [, TOL=*value*] [, X_0=*vector*])

Arguments

A

An *n* by *n* integer, single-, or double-precision floating-point array. On output, *A* is divided by its diagonal elements. Integer input values are converted to single-precision floating-point values.

B

A vector containing the right-hand side of the linear system **Ax=b**. On output, *B* is divided by the diagonal elements of *A*.

Keywords

CHECK

Set this keyword to check the array *A* for diagonal dominance. If *A* is not in diagonally dominant form, GS_ITER reports the fact but continues processing on the chance that the algorithm may converge.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

LAMBDA

A scalar value in the range: [0.0, 2.0]. This value determines the amount of *relaxation*. Relaxation is a weighting technique used to enhance convergence.

- If LAMBDA = 1.0, no weighting is used. This is the default.
- If 0.0 ≤ LAMBDA < 1.0, convergence improves in oscillatory and non-convergent systems.
- If 1.0 < LAMBDA ≤ 2.0, convergence improves in systems already known to converge.

MAX_ITER

The maximum allowed number of iterations. The default value is 30.

TOL

The relative error tolerance between current and past iterates calculated as: ⎪((current-past)/current)⎪. The default is 1.0×10^{-4}.

X_0

An *n*-element vector that provides the algorithm's starting point. The default is [1.0, 1.0, ... , 1.0].

Example

```
; Define an array A:
A = [[ 1.0,  7.0, -4.0], $
     [ 4.0, -4.0,  9.0], $
     [12.0, -1.0,  3.0]]

; Define the right-hand side vector B:
B = [12.0, 2.0, -9.0]

; Compute the solution to the system:
RESULT = GS_ITER(A, B, /CHECK)
```

IDL prints:

```
Input matrix is not in Diagonally Dominant form.
Algorithm may not converge.
% GS_ITER: Algorithm failed to converge within given parameters.
```

Since the A represents a system of linear equations, we can reorder it into diagonally dominant form by rearranging the rows:

```
A = [[12.0, -1.0,  3.0], $
```

```
     [ 1.0,  7.0, -4.0], $
     [ 4.0, -4.0,  9.0]]

; Make corresponding changes in the ordering of B:
B = [-9.0, 12.0, 2.0]

; Compute the solution to the system:
RESULT = GS_ITER(A, B, /CHECK)
```

IDL prints:

```
-0.999982      2.99988      1.99994
```

See Also

CRAMER, LU_COMPLEX, CHOLSOL, LUSOL, SVSOL, TRISOL

H_EQ_CT

The H_EQ_CT procedure histogram-equalizes the color tables for an image or a region of the display. A pixel-distribution histogram is obtained, the cumulative integral is taken and scaled, and the result is applied to the current color table.

This routine is written in the IDL language. Its source code can be found in the file `h_eq_ct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

H_EQ_CT [, *Image*]

Arguments

Image

A two-dimensional byte array representing the image whose histogram is to be used in determining the new color tables. If this value is omitted, the user is prompted to mark the diagonal corners of a region of the display. If *Image* is specified, it is assumed that the image is loaded into the current IDL window. *Image* must be scaled the same way as the image loaded to the display.

See Also

H_EQ_INT

H_EQ_INT

The H_EQ_INT procedure interactively histogram-equalizes the color tables of an image or a region of the display. By moving the cursor across the screen, the amount of histogram-equalization can be varied.

Either the image parameter or a region of the display marked by the user is used to obtain a pixel-distribution histogram. The cumulative integral is taken and scaled and the result is applied to the current color tables.

This routine is written in the IDL language. Its source code can be found in the file `h_eq_int.pro` in the `lib` subdirectory of the IDL distribution.

Using the H_EQ_INT Interface

A window is created and the histogram equalization function is plotted. A linear ramp is overplotted. Move the cursor from left to right to vary the amount of histogram equalization applied to the color tables from 0 to 100%. Press the right mouse button to exit.

Syntax

H_EQ_INT [, *Image*]

Arguments

Image

A two-dimensional byte array representing the image whose histogram is to be used in determining the new color tables. If this value is omitted, the user is prompted to mark the diagonal corners of a region of the display. If *Image* is specified, it is assumed that the image is loaded into the current IDL window. *Image* must be scaled the same way as the image loaded to the display.

See Also

H_EQ_CT

HANNING

The HANNING function is used to create a “window” for Fourier Transform filtering. It can be used to create both Hanning and Hamming windows.

This routine is written in the IDL language. Its source code can be found in the file `hanning.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = HANNING(N_1 [, N_2] [, ALPHA=*value*{0.5 to 1.0}] [, /DOUBLE])

Return Value

If only *N1* is specified, this function returns an array of dimensions [*N1*]. If both *N1* and *N2* are specified, this function returns an array of dimensions [*N1*, *N2*]. If any of the inputs are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

N_1

The number of columns in the resulting array.

N_2

The number of rows in the resulting array.

Keywords

ALPHA

Set this keyword equal to the width parameter of a generalized Hamming window. ALPHA must be in the range of 0.5 to 1.0. If ALPHA = 0.5 (the default) the function is called a “Hanning” window. If ALPHA = 0.54, the result is called a “Hamming” window.

DOUBLE

Set this keyword to force the computations to be done in double-precision arithmetic.

See Also

FFT

HDF_* Routines

See "Alphabetical Listing of HDF Routines" in the *Scientific Data Formats* manual. The HDF_BROWSER and HDF_READ functions are described on the following pages.

HDF_BROWSER

The HDF_BROWSER function presents a graphical user interface (GUI) that allows the user to view the contents of a Hierarchical Data Format (HDF), HDF-EOS, or NetCDF file, and prepare a template for the extraction of HDF data and metadata into IDL. The output template is an IDL structure that may be used when reading HDF files with the HDF_READ routine. If you have several HDF files of identical form, the returned template from HDF_BROWSER may be reused to extract data from these files with HDF_READ. If you do not need a multi-use template, you may call HDF_READ directly.

Syntax

Template = HDF_BROWSER([*Filename*] [, CANCEL=*variable*] [, GROUP=*widget_id*] [, PREFIX=*string*])

Return Value

Returns a template structure containing heap variable references, or 0 if no file was selected. The user is required to clean up the heap variable references when done with them.

Arguments

Filename

A string containing the name of an HDF file to browse. If *Filename* is not specified, a dialog allows you to choose a file.

Keywords

CANCEL

Set this keyword to a named variable that will contain the byte value 1 (one) if the user clicked the “Cancel” button or the byte value 0 (zero) otherwise.

GROUP

Set this keyword to the widget ID of a widget that calls HDF_BROWSER. When this ID is specified, a death of the caller results in the death of the HDF_BROWSER. The following example demonstrates how to use the GROUP keyword to properly call HDF_BROWSER from within a widget application. To run this example, save the following code as `browser_example.pro`:

```
PRO BROWSER_EXAMPLE_EVENT,ev

   WIDGET_CONTROL,ev.id,GET_VALUE=val
      CASE val of
         'Browser':BEGIN
            a=HDF_BROWSER(GROUP=ev.top)
            HELP,a,/st
         END
         'Exit': WIDGET_CONTROL,ev.top,/DESTROY
      ENDCASE

END

PRO BROWSER_EXAMPLE

   a=WIDGET_BASE(/ROW)
   b=WIDGET_BUTTON(a,VALUE='Browser')
   c=WIDGET_BUTTON(a,VALUE='Exit')
   WIDGET_CONTROL,a,/REALIZE
   XMANAGER,'browser_example',a

END
```

PREFIX

When HDF_BROWSER reviews the contents of an HDF file, it creates default output names for the various data elements. By default these default names begin with a prefix derived from the filename. Set this keyword to a string value to be used in place of the default prefix.

Graphical User Interface Menu Options

The following options are available from the graphical user interface menus.

Pulldown Menu

The following table shows the options available with the pulldown menu.

Menu Selection	Description
HDF/NetCDF Summary	
DF24 (24-bit Images)	24-bit images and their attributes
DFR8 (8-bit Images)	8-bit images and their attributes

Table 22: HDF_BROWSER Pulldown Menu Options

Menu Selection	Description
DFP (Palettes)	Image palettes
SD (Variables/Attributes)	Scientific Datasets and attributes
AN (Annotations)	Annotations
GR (Generic Raster)	Images
GR Global (File) Attributes	Image attributes
VGroups	Generic data groups
VData	Generic data and attributes
HDF-EOS Summary	
Point	EOS point data and attributes
Swath	EOS swath data and attributes
Grid	EOS grid data and attributes

Table 22: HDF_BROWSER Pulldown Menu Options

Preview Button

If you have selected an image, 2D data set, or 3x*n*x*m* data set from the pulldown menu, click on this button to view the image. If you have selected a data item that can be plotted in two dimensions, click on this button to view a 2D plot of the data (the default) or click on the "Surface" radio button to display a surface plot, click on the "Contour" radio button to display a contour plot, or click on the "Show3" radio button for an image, surface, and contour display. You can also select the "Fit to Window" checkbox to fit the image to the window.

Read Checkbox

Select this checkbox to extract the current data or metadata item from the HDF file.

Extract As

Specify a name for the extracted data or metadata item

Note

The Read Checkbox must be selected for the item to be extracted. Default names are generated for all data items, but may be changed at any time by the user.

Example

```
template = HDF_BROWSER('test.hdf')
output_structure = HDF_READ(TEMPLATE=template)
```

or,

```
output_structure = HDF_READ('test.hdf', TEMPLATE=template)
```

See Also

HDF_READ

HDF_READ

The HDF_READ function allows extraction of Hierarchical Data Format (HDF), HDF-EOS, and NetCDF data and metadata into an output structure based upon information provided through a graphical user interface or through a file template generated by HDF_BROWSER. The output structure is a single level structure corresponding to the data elements and names specified by HDF_BROWSER or its output template. Templates generated by HDF_BROWSER may be re-used for HDF files of identical format.

Syntax

Result = HDF_READ([*Filename*] [, DFR8=*variable*] [, DF24=*variable*] [, PREFIX=*string*] [, TEMPLATE =*value*])

Arguments

Filename

A string containing the name of a HDF file to extract data from. If Filename is not specified, a dialog allows you to specify a file. Note that if a template is specified, the template must match the HDF file selected.

Keywords

DFR8

Set this keyword to a named variable that will contain a 2 x *n* string array of extracted DFR8 images and their palettes. The first column will contain the extracted DFR8 image names, while the second column will contain the extracted name of the associated palette. If no palette is associated with a DFR8 image the palette name will be set to the null string. If no DFR8 images were extracted from the HDF file, this returned string will be the null string array ['', ''].

DF24

Set this keyword to a named variable that will contain a string array of the names of all the extracted DF24 24-bit images. This is useful in determining whether a (3,*n*,*m*) extracted data element is a 24-bit image or another type of data. If no DF24 24-bit images were extracted from the HDF file, the returned string will be the null string ('').

PREFIX

When HDF_READ is called without a template, it calls HDF_BROWSER to review the contents of an HDF file and create the default output names for the various data elements. By default, these names begin with a prefix derived from the filename. Set this keyword to a string value to be used in place of the default prefix.

TEMPLATE

Set this keyword to specify the HDF file template (generated by the function HDF_BROWSER), that defines which data elements to extract from the selected HDF file. Templates may be used on any files that have a format identical to the file the template was created from.

Graphical User Interface Menu Options

The following options are available from the graphical user interface menus.

Pulldown Menu

The following table shows the options available with the pulldown menu.

Menu Selection	Description
HDF/NetCDF Summary	
DF24 (24-bit Images)	24-bit images and their attributes
DFR8 (8-bit Images)	8-bit images and their attributes
DFP (Palettes)	Image palettes
SD (Variables/Attributes)	Scientific Datasets and attributes
AN (Annotations)	Annotations
GR (Generic Raster)	Images
GR Global (File) Attributes	Image attributes
VGroups	Generic data groups
VData	Generic data and attributes
HDF-EOS Summary	
Point	EOS point data and attributes

Table 23: HDF_BROWSER Pulldown Menu Options

Menu Selection	Description
Swath	EOS swath data and attributes
Grid	EOS grid data and attributes

Table 23: HDF_BROWSER Pulldown Menu Options

Preview Button

If you have selected an image, 2D data set, or 3x*n*x*m* data set from the pulldown menu, click on this button to view the image. If you have selected a data item that can be plotted in two dimensions, click on this button to view a 2D plot of the data (the default) or click on the "Surface" radio button to display a surface plot, click on the "Contour" radio button to display a contour plot, or click on the "Show3" radio button for an image, surface, and contour display. You can also select the "Fit to Window" checkbox to fit the image to the window.

Read Checkbox

Select this checkbox to extract the current data or metadata item from the HDF file.

Extract As

Specify a name for the extracted data or metadata item

Note

The Read Checkbox must be selected for the item to be extracted. Default names are generated for all data items, but may be changed at any time by the user.

Example

```
template = HDF_BROWSER('my.hdf')
output_structure = HDF_READ(TEMPLATE=template)
```

or,

```
output_structure = HDF_READ('my.hdf')
```

or,

```
;Select'my.hdf' with the file locator
output_structure = HDF_READ()
```

or,

```
output_structure = HDF_READ('just_like_my.hdf', TEMPLATE=template)
```

See Also

HDF_BROWSER

HEAP_GC

The HEAP_GC procedure performs *garbage collection* on heap variables. It searches all current IDL variables (including common blocks, widget user values, etc.) for pointers and object references and determines which heap variables have become inaccessible. Pointer heap variables are freed (via PTR_FREE) and all memory used by the heap variable is released. Object heap variables are destroyed (via OBJ_DESTROY), also freeing all used memory.

The default action is to perform garbage collection on all heap variables regardless of type. Use the POINTER and OBJECT keywords to remove only specific types.

Note

Garbage collection is an expensive operation. When possible, applications should be written to avoid losing pointer and object references and avoid the need for garbage collection.

Warning

HEAP_GC uses a recursive algorithm to search for unreferenced heap variables. If HEAP_GC is used to manage certain data structures, such as large linked lists, a potentially large number of operations may be pushed onto the system stack. If so many operations are pushed that the stack runs out of room, IDL will crash.

Syntax

HEAP_GC [, /OBJ | , /PTR] [, /VERBOSE]

Keywords

OBJ

Set this keyword to perform garbage collection on object heap variables only.

PTR

Set this keyword to perform garbage collection on pointer heap variables only.

Note

Setting *both* the PTR and OBJ keywords is the same a setting neither.

VERBOSE

If this keyword is set, HEAP_GC writes a one line description of each heap variable, in the format used by the HELP procedure, as the variable is destroyed. This is a debugging aid that can be used by program developers to check for heap variable leaks that need to be located and eliminated.

HELP

The HELP procedure gives the user information on many aspects of the current IDL session. The specific area for which help is desired is selected by specifying the appropriate keyword. If no arguments or keywords are specified, the default is to show the current nesting of procedures and functions, all current variables at the current program level, and open files. Only one keyword can be specified at a time.

Syntax

HELP, *Expression*$_1$, ..., *Expression*$_n$ [, /ALL_KEYS] [, /BREAKPOINTS] [, /BRIEF] [, CALLS=*variable*] [, /DEVICE] [, /DLM] [, /FILES] [, /FULL] [, /FUNCTIONS] [, /HEAP_VARIABLES] [, /KEYS] [, /LAST_MESSAGE] [, /MEMORY] [, /MESSAGES] [, NAMES=*string_of_variable_names*] [, /OBJECTS] [, OUTPUT=*variable*] [, /PROCEDURES] [, /RECALL_COMMANDS] [, /ROUTINES] [, /SOURCE_FILES] [, /STRUCTURES] [, /SYSTEM_VARIABLES] [, /TRACEBACK]

Arguments

Expression(s)

The arguments are interpreted differently depending on the keyword selected. If no keyword is selected, HELP displays basic information for its parameters. For example, to see the type and structure of the variable A, enter:

```
HELP, A
```

Keywords

Note that the use of some of the following keywords causes any arguments to HELP to be ignored and HELP provides other types of information instead. If the description of the keyword does not explicitly mention the arguments, the arguments are ignored.

ALL_KEYS

Set this keyword to show current function-key definitions as set by DEFINE_KEY. If no arguments are supplied, information on all function keys is displayed. If arguments are provided, they must be scalar strings containing the names of function keys, and information on the specified keys is given. Under UNIX, this keyword is different from KEYS because every key is displayed, no matter what its current programming. Under VMS and Windows, the two keywords mean the same thing.

On the Macintosh, keys cannot be defined via DEFINE_KEY. ALL_KEYS is equivalent to "/KEYS, /FULL".

BREAKPOINTS

Set this keyword to display the breakpoint table which shows the program module and location for each breakpoint.

BRIEF

If set in conjunction with one of the following keywords, BRIEF produces very terse summary style output instead of the output normally displayed by those keywords:

- DLM
- HEAP_VARIABLES
- MESSAGES
- OBJECTS
- ROUTINES
- SOURCE_FILES
- STRUCTURES
- SYSTEM_VARIABLES

CALLS

Set this keyword to a named variable in which to store the procedure call stack. Each string element contains the name of the program module, source file name, and line number. Array element zero contains the information about the caller of HELP, element one contains information about its caller, etc. This keyword is useful for programs that require traceback information.

DEVICE

Set this keyword to show information about the currently selected graphics device. This information is dependent on the abilities of the current device, but the name of the device is always given. Arguments to HELP are ignored when DEVICE is specified.

DLM

Set this keyword to display all known dynamically loadable modules and their state (loaded or not loaded).

FILES

Set this keyword to display information about file units. If no arguments are supplied in the call to HELP, information on all open file units (except the special units 0, -1, and -2) is displayed. If arguments are provided, they are taken to be integer file unit numbers, and information on the specified file units is given.

For example, the command:

```
HELP, /FILES, -2, -1, 0
```

gives information below about the default file units:

```
Unit Attributes Name
-2   Write, Truncate, Tty, Reserved   <stderr>
-1   Write, Truncate, Tty, Reserved   <stdout>
0   Read, Tty, Reserved              <stdin>
```

The attributes column tells about the characteristics of the file. For instance, the file connected to logical file unit 2 is called “stderr” and is the standard error file. It is opened for write access (Write), is a new file (Truncate), is a terminal (Tty), and cannot be closed by the CLOSE command (Reserved).

FULL

By default, HELP filters its output in an attempt to only display information likely to be of use to the IDL end user. Specify FULL to see all available information on a given topic without any such filtering. The filtering applied by default depends on the type of information being requested:

- **Function keys:** By default, IDL will not display undefined function keys.
- **Structure Definitions And Objects:** Structures and objects that have had their definition hidden using the STRUCT_HIDE procedure are not usually listed.
- **Functions and Procedures:** Functions and procedures compiled with the `COMPILE_OPT HIDDEN` directive are not usually included in HELP output.

FUNCTIONS

Normally, the ROUTINES or SOURCE_FILES keywords produce information on both functions and procedures. If FUNCTIONS is specified, only output on functions is produced. If FUNCTIONS is used without either ROUTINES or SOURCE_FILES, ROUTINES is assumed.

HEAP_VARIABLES

Set this keyword to display help information for all the current heap variables.

KEYS

Set this keyword to show current function key definitions as set by DEFINE_ KEY, for those function keys that are currently programmed to perform a function. Under UNIX, this keyword is different from ALL_KEYS because that keyword displays every key, no matter what its current programming. Under VMS and Windows, the

two keywords mean the same thing. On the Macintosh, keys cannot be defined via DEFINE_KEY. If no arguments are supplied, information on all function keys is displayed. If arguments are provided, they must be scalar strings containing the names of function keys, and information on the specified keys is given.

LAST_MESSAGE

Set this keyword to display the last error message issued by IDL.

MEMORY

Set this keyword to see a report on the amount of dynamic memory (in bytes) currently in use by the IDL session; the maximum amount of dynamic memory allocated since the last call to HELP, /MEMORY; and the number of times dynamic memory has been allocated and deallocated. Arguments to HELP are ignored when MEMORY is specified.

MESSAGES

Set this keyword to display all known message blocks and the error space range into which they are loaded.

NAMES

A string used to determine the names of the variables, whose values are to be printed. A string match (equivalent to the STRMATCH function with the FOLD_CASE keyword set) is used to decide if a given variable will be displayed. The match string can contain any wildcard expression supported by STRMATCH, including “*” and “?”.

For example, to print only the values of variables beginning with “A”, use the command `HELP,/NAME='a*'`. Similarly, `HELP,NAME='?'` prints the values of all variables with a single-character name.

NAMES also works with the output from the following keywords:

- DLM
- HEAP_VARIABLES
- MESSAGES
- OBJECTS
- ROUTINES
- SOURCE_FILES
- STRUCTURES
- SYSTEM_VARIABLES

OBJECTS

Set this keyword to display information on defined object classes. If no arguments are provided, all currently-defined object classes are shown. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output. If arguments are provided, the definition of the object class for the heap variables referred to is displayed.

Information is provided on inherited superclasses and all *known methods*. *A method is known to IDL only if it has been compiled in the current IDL session and called by its own class or a subclass*. *Methods that have not been compiled yet will not be shown*. *Thus, the list of methods displayed by HELP is not necessarily a complete list of all possible method for the object class*.

If called within a class' method, the OBJECTS keyword also displays the instance data of the object on which it was called.

OUTPUT

Set this keyword equal to a named variable that will contain a string array containing the formatted output of the HELP command. Each line of formatted output becomes a single element in the string array.

Warning

The OUTPUT keyword is primarily for use in capturing HELP output in order to display it someplace else, such as in a text widget. This keyword is *not* intended to be used in obtaining programmatic information about the IDL session, and is formatted to be human readable. Research Systems reserves the right to change the format and content of this text *at any time, without warning*. If you find yourself using OUTPUT for a non-display purpose, you should consider submitting an enhancement request for a function that will provide the information you require in a safe form.

PROCEDURES

Normally, the ROUTINES or SOURCE_FILES keywords produce information on both functions and procedures. If PROCEDURES is specified, only output on procedures is produced. If PROCEDURES is used without either ROUTINES or SOURCE_FILES, ROUTINES is assumed.

RECALL_COMMANDS

Set this keyword to display the saved commands in the command input buffer. By default, IDL saves the last 20 lines of input in a buffer from which they can be

recalled for command line editing. Arguments to HELP are ignored when RECALL is specified.

The number of lines saved can be changed by assigning the desired number of lines to the environment variable !EDIT_INPUT in the IDL startup file. See "!EDIT_INPUT" on page 2429 for details.

ROUTINES

Set this keyword to show a list of all compiled procedures and functions with their parameter names. Keyword parameters accepted by each module are shown to the right of the routine name. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output.

SOURCE_FILES

Set this keyword to display information on procedures and functions written in the IDL language that have been compiled during the current IDL session. Full path names (relative to the current directory) of compiled `.pro` files are displayed. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output.

STRUCTURES

Set this keyword to display information on structure-type variables. If no arguments are provided, all currently-defined structures are shown. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output. If arguments are provided, the structure definition for those expressions is displayed. It is often more convenient to use `HELP, /STRUCTURES` instead of `PRINT` to look at the contents of a structure variable because it shows the names of the fields as well as the data.

SYSTEM_VARIABLES

Set this keyword to display information on all system variables. Arguments are ignored.

TRACEBACK

Set this keyword to display the current nesting of procedures and functions.

Example

To see general information on the current IDL session, enter:

```
HELP
```

To see information on the structure definition of the system variable !D, enter:

```
HELP, !D, /STRUCTURES
```

See Also

"Online Help" in the *Getting Started with IDL* manual.

HILBERT

The HILBERT function returns a series that has all periodic terms phase-shifted by 90 degrees. The output is a complex-valued vector with the same size as the input vector. This transform has the interesting property that the correlation between a series and its own Hilbert transform is mathematically zero.

HILBERT generates the fast Fourier transform using the FFT function, and shifts the first half of the transform products by +90 degrees and the second half by -90 degrees. The constant elements in the transform are not changed. Angle shifting is accomplished by multiplying or dividing by the complex number, i = (0.0000, 1.0000). The shifted vector is then submitted to FFT for transformation back to the "time" domain and the output is divided by the number elements in the vector to correct for multiplication effect peculiar to the FFT algorithm.

Note: Because HILBERT uses FFT, it exhibits the same side effects with respect to input arguments as that function.

This routine is written in the IDL language. Its source code can be found in the file `hilbert.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = HILBERT(*X* [, *D*])

Arguments

X

An *n*-element floating-point or complex-valued vector.

D

A flag for rotation direction. Set D = +1 for a positive rotation (the default). Set D = -1 for a negative rotation.

See Also

FFT

HIST_2D

The HIST_2D function returns the two dimensional density function (histogram) of two variables, a longword array of dimensions (MAX(*V1*)+1, MAX(*V2*)+1). Result(*i*,*j*) is equal to the number of simultaneous occurrences of *V1* = *i* and *V2* = *j* at the specified element.

This routine is written in the IDL language. Its source code can be found in the file `hist_2d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = HIST_2D(V_1, V_2 [, BIN1=*width*] [, BIN2=*height*] [, MAX1=*value*] [, MAX2=*value*] [, MIN1=*value*] [, MIN2=*value*])

Arguments

V1, V2

Arrays containing the variables. *V1* and *V2* must be of byte, integer, or longword type, and must contain no negative elements.

Keywords

BIN1

The size of each bin in the *V1* direction (column width). If this keyword is not specified, the size is set to 1.

BIN2

The size of each bin in the *V2* direction (row height). If this keyword is not specified, the size is set to 1.

MAX1

MAX1 is the maximum *V1* value to consider. If this keyword is not specified, then *V1* is searched for its largest value.

MAX2

MAX2 is the maximum *V2* value to consider. If this keyword is not specified, then *V2* is searched for its largest value.

MIN1

MIN1 is the minimum *V1* value to consider. If this keyword is not specified, then it is set to 0.

MIN2

MIN2 is the minimum *V2* value to consider. If this keyword is not specified, then it is set to 0.

Example

To return the 2D histogram of two byte images:

```
R = HIST_2D(image1, image2)
```

To return the 2D histogram made from two floating point images with range of -1 to +1, and with 100 bins:

```
R = HIST_2D(LONG((F1+1) * 50), LONG((F2+1) * 50))
```

See Also

H_EQ_CT, H_EQ_INT, HIST_EQUAL, HISTOGRAM

HIST_EQUAL

The HIST_EQUAL function returns a histogram-equalized byte array.

The HISTOGRAM function is used to obtain the density distribution of the input array. The histogram is integrated to obtain the cumulative density-probability function and finally the lookup function is used to transform to the output image.

Note

The first element of the histogram is always zeroed to remove the background.

This routine is written in the IDL language. Its source code can be found in the file `hist_equal.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = HIST_EQUAL(*A* [, BINSIZE=*value*] [, /HISTOGRAM_ONLY] [, MAXV=*value*] [, MINV=*value*] [, OMAX=*variable*] [, OMIN=*variable*] [, PERCENT=*value*] [, TOP=*value*])

Return Value

This function returns a histogram-equalized array of type byte, with the same dimensions as the input array. If the HISTOGRAM_ONLY keyword is set, then the output will be a vector of type LONG.

Arguments

A

The array to be histogram-equalized.

Keywords

BINSIZE

Set this keyword to the size of the bin to use. The default is BINSIZE=1 if *A* is a byte array, or, for other input types, the default is (MAXV – MINV)/5000.

HISTOGRAM_ONLY

Set this keyword to return a vector of type LONG containing the cumulative distribution histogram, rather than the histogram equalized array.

MAXV

Set this keyword to the maximum value to consider. The default is 255 if *A* is a byte array, otherwise the maximum data value is used. Input elements greater than or equal to MAXV are output as 255.

MINV

Set this keyword to the minimum value to consider. The default is 0 if *A* is a byte array, otherwise the minimum data value is used. Input elements less than or equal to MINV are output as 0.

OMAX

Set this keyword to a named variable that, upon exit, will contain the maximum data value used in constructing the histogram.

OMIN

Set this keyword to a named variable that, upon exit, will contain the minimum data value used in constructing the histogram.

PERCENT

Set this keyword to a value between 0 and 100 to stretch the image histogram. The histogram will be stretched linearly between the limits that exclude the PERCENT fraction of the lowest values, and the PERCENT fraction of the highest values. This is an automatic, semi-robust method of contrast enahncement.

TOP

The maximum value of the scaled result. If TOP is not specified, 255 is used. Note that the minimum value of the scaled result is always 0.

Example

Create a sample image using the DIST function and display it:

```
image = DIST(100)
TV, image
```

Create a histogram-equalized version of the byte array, `image`, and display the new version. Use a minimum input value of 10, a maximum input value of 200, and limit the top value of the output array to 220:

```
new = HIST_EQUAL(image, MINV = 10, MAXV = 200, TOP = 220)
TV, new
```

See Also

H_EQ_CT, H_EQ_INT, HIST_2D, HISTOGRAM

HISTOGRAM

The HISTOGRAM function computes the density function of *Array*. In the simplest case, the density function, at subscript *i*, is the number of *Array* elements in the argument with a value of *i*.

Let F_i= the value of element i, $0 \le i < n$. Let H_v = result of histogram function, an integer vector. The definition of the histogram function becomes:

$$P(F_i, v) = \begin{cases} 1, & v \le (F_i - Min)/Binsize < v + 1 \\ 0, & \text{Otherwise} \end{cases}$$

$$H_v = \sum_{i=0}^{n-1} P(F_i, v), \qquad v = 0, 1, 2, ..., \left\lfloor \frac{Max - Min}{Binsize} \right\rfloor$$

Warning

There may not always be enough virtual memory available to find the density functions of arrays that contain a large number of bins.

For bivariate probability distributions, use the HIST_2D function.

HISTOGRAM can optionally return an array containing a list of the original array subscripts that contributed to each histogram bin. This list, commonly called the reverse (or backwards) index list, efficiently determines which array elements are accumulated in a set of histogram bins. A typical application of the reverse index list is reverse histogram or scatter plot interrogation—a histogram bin or 2D scatter plot location is marked with the cursor and the original data items within that bin are highlighted.

Syntax

Result = HISTOGRAM(*Array* [, BINSIZE=*value*] [, INPUT=*variable*] [, MAX=*value*] [, MIN=*value*] [, /NAN] [, NBINS=*value*] [, OMAX=*variable*] [, OMIN=*variable*] [, /L64 | REVERSE_INDICES=*variable*])

Return Value

Returns a 32-bit or a 64-bit integer vector equal to the density function of the input *Array*.

Arguments

Array

The vector or array for which the density function is to be computed.

Keywords

BINSIZE

Set this keyword to the size of the bin to use. If this keyword is not specified, and NBINS is not set, then a bin size of 1 is used. If NBINS is set, the default is BINSIZE = (MAX – MIN) / (NBINS – 1).

Note

The data type of the value specified for BINSIZE should match the data type of the *Array* argument. Since BINSIZE is converted to the data type of *Array*, specifying mismatched data types may produce undesired results.

INPUT

Set this keyword to a named variable that contains an array to be added to the output of HISTOGRAM. The density function of *Array* is added to the existing contents of INPUT and returned as the result. The array is converted to longword type if necessary and must have at least as many elements as are required to form the histogram. Multiple histograms can be efficiently accumulated by specifying partial sums via this keyword.

L64

By default, the return value of HISTOGRAM is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases. L64 controls the type of *Result* as well as the output from the REVERSE_INDICES keyword.

Note

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

MAX

Set this keyword to the maximum value to consider. If this keyword is not specified, *Array* is searched for its largest value.

Note

The data type of the value specified for MAX should match the data type of the input array. Since MAX is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

Note

If NBINS is specified, the value for MAX will be adjusted to NBINS*BINSIZE + MIN. This ensures that the last bin has the same width as the other bins.

MIN

Set this keyword to the minimum value to consider. If this keyword is not specified, and *Array* is of type byte, 0 is used. If this keyword is not specified and *Array* is not of byte type, *Array* is searched for its smallest value.

Note

The data type of the value specified for MIN should match the data type of the input array. Since MIN is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN (not a number) in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

NBINS

Set this keyword to the number of bins to use. If BINSIZE is specified, the number of bins in *Result* is NBINS, starting at MIN and ending at MIN+(NBINS–1)*BINSIZE. If MAX is specified, the bins will be evenly spaced between MIN and MAX. It is an error to specify NBINS with both BINSIZE and MAX.

OMAX

Set this keyword to a named variable that will contain the maximum data value used in constructing the histogram.

OMIN

A named variable that, upon exit, contains the minimum data value used in constructing the histogram.

REVERSE_INDICES

Set this keyword to a named variable in which the list of reverse indices is returned. When possible, this list is returned as a 32-bit integer vector whose number of elements is the sum of the number of elements in the histogram, *N*, and the number of array elements included in the histogram, plus one. If the number of elements is too large to be contained in a 32-bit integer, or if the L64 keyword is set, REVERSE_INDICES is returned as a 64-bit integer.

The subscripts of the original array elements falling in the *i*th bin, $0 \le i < N$, are given by the expression: R(R[i] : R[i+1]-1), where R is the reverse index list. If R[i] is equal to R[i+1], no elements are present in the *i*th bin.

For example, make the histogram of array A:

```
H = HISTOGRAM(A, REVERSE_INDICES = R)

;Set all elements of A that are in the ith bin of H to 0.
IF R[i] NE R[i+1] THEN A[R[R[I] : R[i+1]-1]] = 0
```

The above is usually more efficient than the following:

```
bini = WHERE(A EQ i, count)
IF count NE 0 THEN A[bini] = 0
```

Examples

```
; Create a simple, 2D dataset:
D = DIST(200)
; Plot the histogram of D with a bin size of 1 and the default
; minimum and maximum:
PLOT, HISTOGRAM(D)
; Plot a histogram considering only those values from 10 to 50
; using a bin size of 4:
PLOT, HISTOGRAM(D, MIN = 10, MAX = 50, BINSIZE = 4)
```

The HISTOGRAM function can also be used to increment the elements of one vector whose subscripts are contained in another vector. To increment those elements of vector A indicated by vector B, use the command:

```
A = HISTOGRAM(B, INPUT=A, MIN=0, MAX=N_ELEMENTS(A)-1)
```

This method works for duplicate subscripts, whereas the following statement never adds more than 1 to any element, even if that element is duplicated in vector B:

```
A[B] = A[B]+1
```

For example, for the following commands:

```
A = LONARR(5)
B = [2,2,3]
PRINT, HISTOGRAM(B, INPUT=A, MIN=0, MAX=4)
```

IDL prints:

```
      0  0  2  1  0
```

The commands:

```
A = LONARR(5)
A[B] = A[B]+1
PRINT, A
```

give the result:

```
      0  0  1  1  0
```

The following example demonstrates how to use HISTOGRAM:

```
PRO t_histogram
data = [[-5,  4,   2,  -8,  1], $
        [ 3,  0,   5,  -5,  1], $
        [ 6, -7,   4,  -4, -8], $
        [-1, -5, -14,   2,  1]]
hist = HISTOGRAM(data)
bins = FINDGEN(N_ELEMENTS(hist)) + MIN(data)
PRINT, MIN(hist)
PRINT, bins
PLOT, bins, hist, YRANGE = [MIN(hist)-1, MAX(hist)+1], PSYM = 10, $
   XTITLE = 'Bin Number', YTITLE = 'Density per Bin'
END
```

IDL prints:

```
0

-14.0000     -13.0000     -12.0000     -11.0000     -10.0000     -
9.00000
-8.00000     -7.00000     -6.00000     -5.00000     -4.00000     -
3.00000
-2.00000     -1.00000      0.00000      1.00000      2.00000
3.00000
 4.00000    5.00000    6.00000
```

See Also

H_EQ_CT, H_EQ_INT, HIST_2D, HIST_EQUAL

HLS

The HLS procedure creates a color table based on the HLS (Hue, Lightness, Saturation) color system.

Using the input parameters, a spiral through the double-ended HLS cone is traced. Points along the cone are converted from HLS to RGB. The current colortable (and the COLORS common block) contains the new colortable on exit.

This routine is written in the IDL language. Its source code can be found in the file `hls.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

HLS, *Litlo*, *Lithi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

Arguments

Litlo

Starting lightness, from 0 to 100%.

Lithi

Ending lightness, from 0 to 100%.

Satlo

Starting saturation, from 0 to 100%.

Sathi

Ending saturation, from 0 to 100%.

Hue

Starting Hue, from 0 to 360 degrees. Red = 0 degs, green = 120, blue = 240.

Loops

The number of loops through the color spiral. This parameter does not have to be an integer. A negative value causes the loops to traverse the spiral in the opposite direction.

Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

See Also

COLOR_CONVERT, HSV, PSEUDO

HOUGH

The HOUGH function implements the Hough transform, used to detect straight lines within a two-dimensional image. This function can be used to return either the Hough transform, which transforms each nonzero point in an image to a sinusoid in the Hough domain, or the Hough backprojection, where each point in the Hough domain is transformed to a straight line in the image.

Syntax

Hough Transform:

Result = HOUGH(*Array* [, /DOUBLE] [, DRHO=*scalar*] [, DX=*scalar*] [, DY=*scalar*] [, /GRAY] [, NRHO=*scalar*] [, NTHETA=*scalar*] [, RHO=*variable*] [, RMIN=*scalar*] [, THETA=*variable*] [, XMIN=*scalar*] [, YMIN=*scalar*])

Hough Backprojection:

Result = HOUGH(*Array*, /BACKPROJECT, RHO=*variable*, THETA=*variable* [, /DOUBLE] [, DX=*scalar*] [, DY=*scalar*] [, NX=*scalar*] [, NY=*scalar*] [, XMIN=*scalar*] [, YMIN=*scalar*])

Return Value

The result of this function is a two-dimensional floating-point array, or a complex array if the input image is complex. If *Array* is double-precision, or if the DOUBLE keyword is set, the result is double-precision, otherwise, the result is single-precision.

Hough Transform Theory

The Hough transform is defined for a function $A(x, y)$ as:

$$H(\theta, \rho) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} A(x,y)\,\delta(\rho - x\cos\theta - y\sin\theta)\,dx\,dy$$

where δ is the Dirac delta-function. With $A(x, y)$, each point (x, y) in the original image, A, is transformed into a sinusoid $\rho = x\cos\theta - y\sin\theta$, where ρ is the perpendicular distance from the origin of a line at an angle θ:

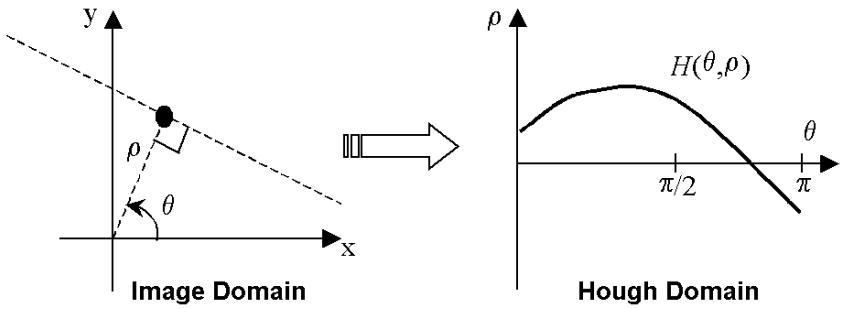


Figure 8: Hough Transform

Points that lie on the same line in the image will produce sinusoids that all cross at a single point in the Hough transform. For the inverse transform, or backprojection, each point in the Hough domain is transformed into a straight line in the image.

Usually, the Hough function is used with binary images, in which case $H(\theta, \rho)$ gives the total number of sinusoids that cross at point (θ, ρ), and hence, the total number of points making up the line in the original image. By choosing a threshold T for $H(\theta, \rho)$, and using the inverse Hough function, you can filter the original image to keep only lines that contain at least T points.

How IDL Implements the Hough Transform

Consider an image A_{mn} of dimensions M by N, with array indices $m = 0,..., M–1$ and $n = 0,..., N–1$.

The discrete formula for the HOUGH function for A_{mn} is:

$$H(\theta,\rho) = \sum_{m} \sum_{n} A_{mn}\ \delta(\rho, [\rho'])$$

where the brackets [ ] indicate rounding to the nearest integer, and

$$\rho' = (m\Delta x + x_{\min})\cos\theta + (n\Delta y + y_{\min})\sin\theta$$

The pixels are assumed to have spacing Δx and Δy in the x and y directions. The delta-function is defined as:

$$\delta(\rho,[\rho']) = \begin{cases} 1 & \rho = [\rho'] \\ 0 & \text{otherwise} \end{cases}$$

How IDL Implements the Hough Backprojection

The backprojection, B_{mn}, contains all of the straight lines given by the (θ, ρ) points given in $H(\theta, \rho)$. The discrete formula is

$$B_{mn} = \begin{cases} \sum_{\theta}\sum_{\rho} H(\theta,\rho)\,\delta(n,[am+b]) & |\sin\theta| > \frac{\sqrt{2}}{2} \\ \sum_{\theta}\sum_{\rho} H(\theta,\rho)\,\delta(m,[a'n+b']) & |\sin\theta| \le \frac{\sqrt{2}}{2} \end{cases}$$

where the slopes and offsets are given by:

$$a = -\frac{\Delta x}{\Delta y}\frac{\cos\theta}{\sin\theta} \qquad b = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta y \sin\theta}$$

$$a' = \frac{1}{a} \qquad b' = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta x \cos\theta}$$

Arguments

Array

The two-dimensional array of size *M* by *N* which will be transformed. If the keyword GRAY is not set, then, for the forward transform, *Array* is treated as a binary image with all nonzero pixels considered as 1.

Keywords

BACKPROJECT

If set, the backprojection is computed, otherwise, the forward transform is computed. When BACKPROJECT is set, *Result* will be an array of dimension *NX* by *NY*.

Note

The Hough transform is not one-to-one: each point (*x*, *y*) is not mapped to a single (θ, ρ). Therefore, instead of the original image, the backprojection, or inverse transform, returns an image containing the set of all lines given by the (θ, ρ) points.

DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

DRHO

Set this keyword equal to a scalar specifying the spacing Δρ between ρ coordinates, expressed in the same units as *Array*. The default is 1/SQRT(2) times the diagonal distance between pixels, $[(DX^2 + DY^2)/2]^{1/2}$. A larger value produces a coarser resolution by mapping multiple pixels onto a single ρ; this is useful for images that do not contain perfectly straight lines. A smaller value may produce undersampling by trying to map fractional pixels onto ρ, and is not recommended. If BACKPROJECT is specified, this keyword is ignored.

DX

Set this keyword equal to a scalar specifying the spacing between the horizontal (X) coordinates. The default is 1.0.

DY

Set this keyword equal to a scalar specifying the spacing between the vertical (Y) coordinates. The default is 1.0.

GRAY

Set this keyword to perform a weighted Hough transform, with the weighting given by the pixel values. If GRAY is not set, the image is treated as a binary image with all nonzero pixels considered as 1. If BACKPROJECT is specified, this keyword is ignored.

NRHO

Set this keyword equal to a scalar specifying the number of ρ coordinates to use. The default is 2 CEIL([MAX($X^2 + Y^2$)]$^{1/2}$ / DRHO) + 1. If BACKPROJECT is specified, this keyword is ignored.

NTHETA

Set this keyword equal to a scalar specifying the number of θ coordinates to use over the interval [0,π]. The default is CEIL(π [MAX(X^2 + Y^2)]$^{1/2}$ / DRHO). A larger value will produce smoother results, and is useful for filtering before backprojection. A smaller value will result in broken lines in the transform, and is not recommended. If BACKPROJECT is specified, this keyword is ignored.

NX

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of horizontal coordinates in the output array. The default is FLOOR(2 MAX(|RHO|)(DX^2 + DY^2)$^{-1/2}$ + 1). For the forward transform this keyword is ignored.

NY

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of vertical coordinates in the output array. The default is FLOOR(2 MAX(|RHO|)(DX^2 + DY^2)$^{-1/2}$ + 1). For the forward transform, this keyword is ignored.

RHO

For the forward transform, set this keyword to a named variable that, on exit, will contain the radial (ρ) coordinates. If BACKPROJECT is specified, this keyword must contain the ρ coordinates of the input *Array*.

RMIN

Set this keyword equal to a scalar specifying the minimum ρ coordinate to use for the forward transform. The default is –0.5(NRHO – 1) DRHO. If BACKPROJECT is specified, this keyword is ignored.

THETA

For the forward transform, set this keyword to a named variable containing a vector of angular (θ) coordinates to use for the transform. If NTHETA is specified instead, and THETA is set to a named variable, then on exit THETA will contain the θ coordinates. If BACKPROJECT is specified, this keyword must contain the θ coordinates of the input *Array*.

XMIN

Set this keyword equal to a scalar specifying the X coordinate of the lower-left corner of the input *Array*. The default is –(*M*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the X

coordinate of the lower-left corner of the *Result*. In this case the default is –DX (NX–1)/2.

YMIN

Set this keyword equal to a scalar specifying the Y coordinate of the lower-left corner of the input *Array*. The default is –(*N*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the Y coordinate of the lower-left corner of the *Result*. In this case the default is –DY (NY–1)/2.

Example

This example computes the Hough transform of a random set of pixels:

```
PRO hough_example

  ;Create an image with a random set of pixels
  seed = 12345   ; remove this line to get different random images
  array = RANDOMU(seed,128,128) GT 0.95

  ;Draw three lines in the image
  x = FINDGEN(32)*4
  array[x,0.5*x+20] = 1b
  array[x,0.5*x+30] = 1b
  array[-0.5*x+100,x] = 1b

  ;Create display window, set graphics properties
  WINDOW, XSIZE=330,YSIZE=630, TITLE='Hough Example'
  !P.BACKGROUND = 255  ; white
  !P.COLOR = 0 ; black
  !P.FONT=2
  ERASE

  XYOUTS, .1, .94, 'Noise and Lines', /NORMAL
  ;Display the image. 255b changes black values to white:
  TVSCL, 255b - array, .1, .72, /NORMAL

  ;Calculate and display the Hough transform
  result = HOUGH(array, RHO=rho, THETA=theta)
  XYOUTS, .1, .66, 'Hough Transform', /NORMAL
  TVSCL, 255b - result, .1, .36, /NORMAL

  ;Keep only lines that contain more than 20 points:
  result = (result - 20) > 0

  ;Find the Hough backprojection and display the output
  backproject = HOUGH(result, /BACKPROJECT, RHO=rho, THETA=theta)
```

```
    XYOUTS, .1, .30, 'Hough Backprojection', /NORMAL
    TVSCL, 255b - backproject, .1, .08, /NORMAL

END
```

The following figure displays the output of this example. The top image shows three lines drawn within a random array of pixels that represent noise. The center image shows the Hough transform, displaying sinusoids for points that lie on the same line in the original image. The bottom image shows the Hough backprojection, after setting the threshold to retain only those lines that contain more than 20 points. The Hough inverse transform, or backprojection, transforms each point in the Hough domain into a straight line in the image.

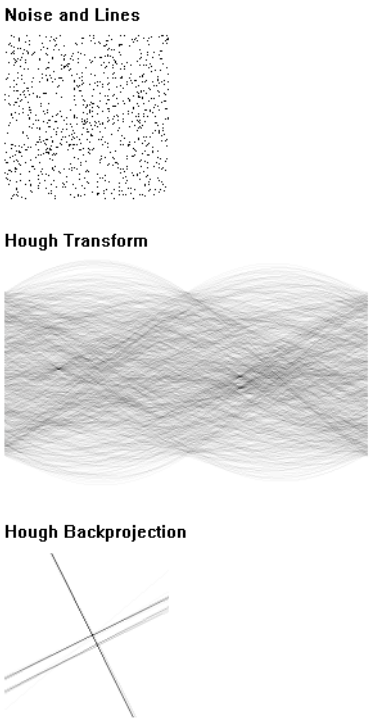


Figure 9: HOUGH example showing random pixels (top), Hough transform (center) and Hough backprojection (bottom)

See Also

RADON

References

1. Gonzalez, R.C., and R.E. Woods. *Digital Image Processing*. Reading, MA: Addison Wesley, 1992.
2. Jain, Anil K. *Fundamentals of Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1989.
3. Toft, Peter. *The Radon Transform: Theory and Implementation*. Denmark: Technical University; 1996. Ph.D. Thesis.
4. Weeks, Arthur. R. *Fundamentals of Electronic Image Processing*. New York: SPIE Optical Engineering Press, 1996.

HQR

The HQR function returns all eigenvalues of an upper Hessenberg array. Using the output produced by the ELMHES function, this function finds all eigenvalues of the original real, nonsymmetric array. The result is an *n*-element complex vector.

HQR is based on the routine `hqr` described in section 11.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = HQR(*A* [, /COLUMN] [, /DOUBLE])

Arguments

A

An *n* by *n* upper Hessenberg array. Typically, *A* would be an array resulting from an application of ELMHES.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To compute the eigenvalues of a real, non-symmetric unbalanced array, first define the array *A*:

```
A = [[ 1.0, 2.0, 0.0, 0.0, 0.0], $
     [-2.0, 3.0, 0.0, 0.0, 0.0], $
     [ 3.0, 4.0, 50.0, 0.0, 0.0], $
     [-4.0, 5.0, -60.0, 7.0, 0.0], $
     [-5.0, 6.0, -70.0, 8.0, -9.0]]

; Compute the upper Hessenberg form of the array:
hes = ELMHES(A)
```

```
; Compute the eigenvalues:
evals = HQR(hes)

; Sort the eigenvalues into ascending order based on their
; real components:
evals = evals(SORT(FLOAT(evals)))

;Print the result.
PRINT, evals
```

IDL prints:

```
( -9.00000, 0.00000)( 2.00000, -1.73205)
(  2.00000, 1.73205)( 7.00000,  0.00000)
( 50.0000,  0.00000)
```

This is the exact solution vector to five-decimal accuracy.

See Also

EIGENVEC, ELMHES, TRIQL, TRIRED

HSV

The HSV procedure creates a color table based on the HSV (Hue and Saturation Value) color system.

Using the input parameters, a spiral through the single-ended HSV cone is traced. Points along the cone are converted from HLS to RGB. The current colortable (and the COLORS common block) contains the new colortable on exit.

This routine is written in the IDL language. Its source code can be found in the file `hsv.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

HSV, *Vlo*, *Vhi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

Arguments

Vlo

Starting value, from 0 to 100%.

Vhi

Ending value, from 0 to 100%.

Satlo

Starting saturation, from 0 to 100%.

Sathi

Ending saturation, from 0 to 100%.

Hue

Starting Hue, from 0 to 360 degrees. Red = 0 degs, green = 120, blue = 240.

Loops

The number of loops through the color spiral. This parameter does not have to be an integer. A negative value causes the loops to traverse the spiral in the opposite direction.

Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

See Also

COLOR_CONVERT, HLS, PSEUDO

IBETA

The IBETA function computes the incomplete beta function.

$$I_x(a, b) \equiv \frac{\int_0^x t^{a-1}(1-t)^{b-1}dt}{\int_0^1 t^{a-1}(1-t)^{b-1}dt}$$

This routine is written in the IDL language. Its source code can be found in the file `ibeta.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = IBETA(*A*, *B*, *X* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*])

Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *A*, *B*, and *X*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

A

A positive scalar or array that specifies the parametric exponent of the integrand.

B

A positive scalar or array that specifies the parametric exponent of the integrand.

X

A scalar or array, in the interval [0, 1], that specifies the upper limit of integration.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double precision.

EPS

Set this keyword to the desired relative accuracy, or tolerance. The default tolerance is 3.0e-7 for single precision, and 3.0d-12 for double precision.

ITER

Set this keyword to a named variable that will contain the actual number of iterations performed.

ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 100.

Example

Compute the incomplete beta function for the corresponding elements of A, B, and X.

```
; Define an array of parametric exponents:
A = [0.5, 0.5, 1.0, 5.0, 10.0, 20.0]
B = [0.5, 0.5, 0.5, 5.0, 5.0, 10.0]

; Define the upper limits of integration:
X = [0.01, 0.1, 0.1, 0.5, 1.0, 0.8]
; Compute the incomplete beta functions:
result = IBETA(A, B, X)
PRINT, result
```

IDL prints:

```
[0.0637686, 0.204833, 0.0513167, 0.500000, 1.00000, 0.950736]
```

See Also

BETA, GAMMA, IGAMMA, LNGAMMA

IDENTITY

The IDENTITY function returns an *n* by *n* identity array (an array with ones along the main diagonal and zeros elsewhere).

This routine is written in the IDL language. Its source code can be found in the file `identity.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = IDENTITY(*N* [, /DOUBLE])

Arguments

N

The desired column and row dimensions.

Keywords

DOUBLE

Set this keyword to return a double-precision identity array.

Example

```
; Define an array, A:
A = [[ 2.0,  1.0,  1.0, 1.5], $
     [ 4.0, -6.0,  0.0, 0.0], $
     [-2.0,  7.0,  2.0, 2.5], $
     [ 1.0,  0.5,  0.0, 5.0]]

; Compute the inverse of A using the INVERT function:
inverse = INVERT(A)

; Verify the accuracy of the computed inverse using the
; mathematical identity, A x A^-1 - I(4) = 0, where A^-1 is the
; inverse of A, I(4) is the 4 by 4 identity array and 0 is a 4 by 4
; array of zeros:
PRINT, A ## inverse - IDENTITY(4)
```

See Also

FINDGEN, FLTARR

IDL_Container Object Class

See Appendix A, “IDL Object Class & Method Reference”.

IDLanROI Object Class

See Appendix A, “IDL Object Class & Method Reference”.

IDLanROIGroup Object Class

See Appendix A, "IDL Object Class & Method Reference"

IDLffDICOM Object Class

See Appendix A, “IDL Object Class & Method Reference”

IDLffDXF Object Class

See Appendix A, "IDL Object Class & Method Reference"

IDLffLanguageCat Object Class

See Appendix A, “IDL Object Class & Method Reference”

IDLffShape Object Class

See Appendix A, "IDL Object Class & Method Reference"

IDLgr* Object Classes

The following IDLgr* object classes are documented in Appendix A, "IDL Object Class & Method Reference":

- IDLgrAxis
- IDLgrBuffer
- IDLgrClipboard
- IDLgrColorbar
- IDLgrContour
- IDLgrFont
- IDLgrImage
- IDLgrLegend
- IDLgrLight
- IDLgrModel
- IDLgrMPEG
- IDLgrPalette
- IDLgrPattern
- IDLgrPlot
- IDLgrPolygon
- IDLgrPolyline
- IDLgrPrinter
- IDLgrROI
- IDLgrROIGroup
- IDLgrScene
- IDLgrSurface
- IDLgrSymbol
- IDLgrTessellator
- IDLgrText
- IDLgrView
- IDLgrViewgroup
- IDLgrVolume
- IDLgrVRML
- IDLgrWindow

IF...THEN...ELSE

The IF...THEN...ELSE statement conditionally executes a statement or block of statements.

Note

For information on using IF...THEN...ELSE and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

IF *expression* THEN *statement* [ELSE *statement*]

or

IF *expression* THEN BEGIN

statements

ENDIF [ELSE BEGIN

statements

ENDELSE]

Example

The following example illustrates the use of the IF statement using the ELSE clause. Notice that the IF statement is ended with ENDIF, and the ELSE statement is ended with ENDELSE. Also notice that the IF statement can be used with or without the BEGIN...END block:

```
A = 2
B = 4

IF (A EQ 2) AND (B EQ 3) THEN BEGIN
   PRINT, 'A = ', A
   PRINT, 'B = ', B
ENDIF ELSE BEGIN
   IF A NE 2 THEN PRINT, 'A <> 2' ELSE PRINT, 'B <> 3'
ENDELSE
```

IDL Prints:

```
B <> 3
```

IGAMMA

The IGAMMA function computes the incomplete gamma function.

$$P_x(a) \equiv \frac{\int_0^x e^{-t} t^{a-1} dt}{\int_0^\infty e^{-t} t^{a-1} dt}$$

IGAMMA uses either a power series representation or a continued fractions method. If *X* is less than or equal to *A*+1, a power series representation is used. If *X* is greater than *A*+1, a continued fractions method is used.

This routine is written in the IDL language. Its source code can be found in the file `igamma.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = IGAMMA(*A*, *X* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*] [, METHOD=*variable*])

Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *A* and *X*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

A

A positive scalar or array that specifies the parametric exponent of the integrand.

X

A scalar or array that specifies the upper limit of integration.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double precision.

EPS

Set this keyword to the desired relative accuracy, or tolerance. The default tolerance is 3.0e-7 for single precision, and 3.0d-12 for double precision.

ITER

Set this keyword to a named variable that will contain the actual number of iterations performed.

ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 100.

METHOD

Set this keyword to a named variable that will contain the method used to compute the incomplete gamma function. A value of 0 indicates that a power series representation was used. A value of 1 indicates that a continued fractions method was used.

Example

Compute the incomplete gamma function for the corresponding elements of A and X.

```
; Define an array of parametric exponents:
A = [0.10, 0.50, 1.00, 1.10, 6.00, 26.00]

; Define the upper limits of integration:
X = [0.0316228, 0.0707107, 5.00000, 1.04881, 2.44949, 25.4951]

; Compute the incomplete gamma functions:
result = IGAMMA(A, X)

PRINT, result
```

IDL prints:

```
[0.742026, 0.293128, 0.993262, 0.607646, 0.0387318, 0.486387]
```

See Also

BETA, GAMMA, IBETA, LNGAMMA

IMAGE_CONT

The IMAGE_CONT procedure overlays an image with a contour plot.

This routine is written in the IDL language. Its source code can be found in the file `image_cont.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

IMAGE_CONT, *A* [, /ASPECT] [, /INTERP] [, /WINDOW_SCALE]

Arguments

A

The two-dimensional array to display and overlay.

Keywords

ASPECT

Set this keyword to retain the image's aspect ratio. Square pixels are assumed. If WINDOW_SCALE is set, the aspect ratio is automatically retained.

INTERP

If this keyword is set, bilinear interpolation is used if the image is resized.

WINDOW_SCALE

Set this keyword to scale the window size to the image size. Otherwise, the image size is scaled to the window size. This keyword is ignored when outputting to devices with scalable pixels (e.g., PostScript).

Example

```
; Create an image to display:
A = BYTSCL(DIST(356))

; Display image and overplot contour lines:
IMAGE_CONT, A, /WINDOW
```

See Also

CONTOUR, TV

IMAGE_STATISTICS

The IMAGE_STATISTICS procedure computes sample statistics for a given array of values. An optional mask may be specified to restrict computations to a spatial subset of the input data.

Syntax

IMAGE_STATISTICS, *Data*
[, /LABELED | [, /WEIGHTED] [, WEIGHT_SUM=*variable*]] [, /VECTOR]
[, LUT=*array*] [, MASK=*array*] [, COUNT=*variable*] [, MEAN=*variable*]
[, STDDEV=*variable*] [, DATA_SUM=*variable*] [, SUM_OF_SQUARES=*variable*]
[, MINIMUM=*variable*] [, MAXIMUM=*variable*] [, VARIANCE=*variable*]

Arguments

Data

An *N*-dimensional input data array.

Keywords

COUNT

Set this keyword to a named variable to contain the number of samples that correspond to nonzero values within the mask.

DATA_SUM

Set this keyword to a named variable to contain the sum of the samples that lie within the mask.

LABELED

When set, this keyword indicates values in the mask representing region labels, where each pixel of the mask is set to the index of the region in which that pixel belongs (see the LABEL_REGION function in the *IDL Reference Guide*). If the LABELED keyword is set, each statistic's value is computed for each region index. Thus, a vector containing the results is provided for each statistic with one element per region. By default, this keyword is set to zero, indicating that all samples with a corresponding nonzero mask value are used to form a scalar result for each statistic.

Note

The LABELED keyword cannot be used with either the WEIGHT_SUM or the WEIGHTED keywords.

LUT

Set this keyword to a one-dimensional array. For non-floating point input *Data*, the pixel values are looked up through this table before being used in any of the statistical computations. This allows an integer image array to be calibrated to any user specified intensity range for the sake of calculations. The length of this array must include the range of the input array. This keyword may not be set with floating point input data. When signed input data types are used, they are first cast to the corresponding IDL unsigned type before being used to access this array. For example, the integer value –1 looks up the value 65535 in the LUT array.

MASK

An array of *N*, or *N*–1 (when the VECTOR keyword is used) dimensions representing the mask array. If the LABELED keyword is set, MASK contains the region indices of each pixel; otherwise statistics are only computed for data values where the MASK array is non-zero.

MAXIMUM

Set this keyword to a named variable to contain the maximum value of the samples that lie within the mask.

MEAN

Set this keyword to a named variable to contain the mean of the samples that lie within the mask.

MINIMUM

Set this keyword to a named variable to contain the minimum value of the samples that lie within the mask.

STDDEV

Set this keyword to a named variable to contain the standard deviation of the samples that lie within the mask.

SUM_OF_SQUARES

Set this keyword to a named variable to contain the sum of the squares of the samples that lie within the mask.

VARIANCE

Set this keyword to a named variable to contain the variance of the samples that lie within the mask.

VECTOR

Set this keyword to specify that the leading dimension of the input array is not to be considered spatial but consists of multiple data values at each pixel location. In this case, the leading dimension is treated as a vector of samples at the spatial location determined by the remainder of the array dimensions.

WEIGHT_SUM

Set the WEIGHT_SUM keyword to a named variable to contain the sum of the weights in the mask.

Note

The WEIGHT_SUM keyword cannot be used if the LABELED keyword is specified.

WEIGHTED

If the WEIGHTED keyword is set, the values in the MASK array are used to weight individual pixels with respect to their count value. If a MASK array is not provided, all pixels are assigned a weight of 1.0.

Note

The WEIGHTED keyword cannot be used if the LABELED keyword is specified.

IMAGINARY

The IMAGINARY function returns the imaginary part of its complex-valued argument. If the complex-valued argument is double-precision, the result will be double-precision, otherwise the result will be single-precision floating-point.

Syntax

Result = IMAGINARY(*Complex_Expression*)

Arguments

Complex_Expression

The complex-valued expression for which the imaginary part is desired.

Example

```
; Create an array of complex values:
C = COMPLEX([1,2,3],[4,5,6])

; Print just the imaginary parts of each element in C:
PRINT, IMAGINARY(C)
```

IDL prints:

```
 4.00000 5.00000 6.00000
```

Tip

The *real* part of a complex number can be returned using one of IDL's type conversion functions. For example, FLOAT can be used to return the real part of a complex number in single precision, and DOUBLE can be used to return the real part of a complex number in double precision. See COMPLEX and DCOMPLEX for examples of extracting the real part of a complex number.

See Also

COMPLEX, DCOMPLEX

INDGEN

The INDGEN function returns an integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = INDGEN(D_1, ..., D_8) [, /BYTE | , /COMPLEX | , /DCOMPLEX | , /DOUBLE | , /FLOAT | , /L64 | , /LONG | , /STRING | , /UINT | , /UL64 | , /ULONG] [, TYPE=*value*]

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Keywords

BYTE

Set this keyword to create a byte array.

COMPLEX

Set this keyword to create a complex, single-precision, floating-point array.

DCOMPLEX

Set this keyword to create a complex, double-precision, floating-point array.

DOUBLE

Set this keyword to create a double-precision, floating-point array.

FLOAT

Set this keyword to create a single-precision, floating-point array.

L64

Set this keyword to create a 64-bit integer array.

LONG

Set this keyword to create a longword integer array.

STRING

Set this keyword to create a string array.

TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of IDL type codes.

UINT

Set this keyword to create an unsigned integer array.

UL64

Set this keyword to create an unsigned 64-bit integer array.

ULONG

Set this keyword to create an unsigned longword integer array.

Example

Create I, a 5-element vector of integer values with each element set to the value of its subscript by entering:

```
I = INDGEN(5)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

INT_2D

The INT_2D function computes the double integral of a bivariate function using iterated Gaussian quadrature. The algorithm's transformation data is provided in tabulated form with 15 decimal accuracy.

This routine is written in the IDL language. Its source code can be found in the file `int_2d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = INT_2D(*Fxy*, *AB_Limits*, *PQ_Limits*, *Pts* [, /DOUBLE] [, /ORDER])

Arguments

Fxy

A scalar string specifying the name of a user-supplied IDL function that defines the bivariate function to be integrated. The function must accept X and Y and return a scalar result.

For example, if we wish to integrate the following function:

$$f(x, y) = e^{-x^2 - y^2}$$

We define a function FXY to express this relationship in the IDL language:

```
FUNCTION fxy, X, Y
   RETURN, EXP(-X^2. -Y^2.)
END
```

AB_Limits

A two-element vector containing the lower (A) and upper (B) limits of integration with respect to the variable *x*.

PQ_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (P(*x*)) and upper (Q(*x*)) limits of integration with respect to the variable *y*. The function must accept *x* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *y*:

```
FUNCTION PQ_limits, X
   RETURN, [-SQRT(16.0 - X^2), SQRT(16.0 - X^2)]
END
```

Pts

The number of transformation points used in the computation. Possible values are: 6, 10, 20, 48, or 96.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ORDER

A scalar value of either 0 or 1. If set to 0, the integral is computed using a dy-dx order of integration. If set to 1, the integral is computed using a dx-dy order of integration.

Example

Example 1

Compute the double integral of the bivariate function.

$$I = \int_{x = 0.0}^{x = 2.0} \int_{y = 0.0}^{y = x^2} y \cdot \cos(x^5) dy dx$$

```
; Define the limits of integration for y as a function of x:
FUNCTION PQ_Limits, x
   RETURN, [0.0, x^2]
END

; Define limits of integration for x:
AB_Limits = [0.0, 2.0]

; Using the function and limits defined above, integrate with 48
; and 96 point formulas using a dy-dx order of integration and
; double-precision arithmetic:
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 48, /DOUBLE)
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 96, /DOUBLE)
```

INT_2D with 48 transformation points yields: 0.055142668

INT_2D with 96 transformation points yields: 0.055142668

Example 2

Compute the double integral of the bivariate function:

```
; Define the limits of integration for y as a function of x:
FUNCTION PQ_Limits, y
```

$$I = \int_{x=0.0}^{x=2.0} \int_{y=0.0}^{y=x^2} y \cdot \cos(x^5) dx dy$$

```
    RETURN, [sqrt(y), 2.0]
END

; Define limits of integration for x:
AB_Limits = [0.0, 4.0]

; Using the function and limits defined above, integrate with 48
; and 96 point formulas using a dy-dx order of integration and
; double-precision arithmetic:
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 48, /DOUBLE, /ORDER)
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 96, /DOUBLE, ORDER)
```

INT_2D with 48 transformation points yields: 0.055142678

INT_2D with 96 transformation points yields: 0.055142668

The exact solution (7 decimal accuracy) is: 0.055142668

See Also

INT_3D, INT_TABULATED, QROMB, QROMO, QSIMP

INT_3D

The INT_3D function computes the triple integral of a trivariate function using iterated Gaussian quadrature. The algorithm's transformation data is provided in tabulated form with 15 decimal accuracy.

This routine is written in the IDL language. Its source code can be found in the file `int_3d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = INT_3D(*Fxyz*, *AB_Limits*, *PQ_Limits*, *UV_Limits*, *Pts* [, /DOUBLE])

Arguments

Fxyz

A scalar string specifying the name of a user-supplied IDL function that defines the trivariate function to be integrated. The function must accept X, Y, and Z, and return a scalar result.

For example, if we wish to integrate the following function:

$$f(x, y, z) = z \cdot (x^2 + y^2 + z^2)^{3/2}$$

We define a function FXY to express this relationship in the IDL language:

```
FUNCTION fxyz, X, Y, Z
   RETURN, z*(x^2+y^2+z^2)^1.5
END
```

AB_Limits

A two-element vector containing the lower (A) and upper (B) limits of integration with respect to the variable *x*.

PQ_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (P(*x*)) and upper (Q(*x*)) limits of integration with respect to the variable *y*. The function must accept *x* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *y*:

```
FUNCTION PQ_limits, X
```

```
   RETURN, [-SQRT(4.0 - X^2), SQRT(4.0 - X^2)]
END
```

UV_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (U(*x*,*y*)) and upper (V(*x*,y)) limits of integration with respect to the variable *z*. The function must accept *x* and *y* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *z*:

```
FUNCTION UV_limits, X, Y
   RETURN, [0, SQRT(4.0 - X^2 - Y^2)]
END
```

Pts

The number of transformation points used in the computation. Possible values are: 6, 10, 20, 48, or 96.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

Compute the triple integral of the trivariate function

$$I = \int_{x=-2}^{x=2} \int_{y=-\sqrt{4-x^2}}^{y=\sqrt{4-x^2}} \int_{z=0}^{z=\sqrt{4-x^2-y^2}} z \cdot (x^2 + y^2 + z^2)^{3/2} dz dy dx$$

Using the functions and limits defined above, integrate with 10, 20, 48, and 96 point formulas (using double-precision arithmetic):

```
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 10,$
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 20,$
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 48,$
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 96,$
   /D)
```

INT_3D with 10 transformation points yields: 57.444248

INT_3D with 20 transformation points yields: 57.446201

INT_3D with 48 transformation points yields: 57.446265

INT_3D with 96 transformation points yields: 57.446266

The exact solution (6 decimal accuracy) is: 57.446267

See Also

INT_2D, INT_TABULATED, QROMB, QROMO, QSIMP

INT_TABULATED

The INT_TABULATED function integrates a tabulated set of data { *xi* , *fi* } on the closed interval [MIN(*x*) , MAX(*x*)], using a five-point Newton-Cotes integration formula.

Warning

Data that is highly oscillatory requires a sufficient number of samples for an accurate integral approximation.

This routine is written in the IDL language. Its source code can be found in the file `int_tabulated.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = INT_TABULATED(*X*, *F* [, /DOUBLE] [, /SORT])

Arguments

X

The tabulated single- or double-precision floating-point *x*-value data. Data may be irregularly gridded and in random order. (If the data is randomly ordered, set the SORT keyword.)

Warning

Each *X* value must be unique; if duplicate *X* values are detected, the routine will exit and display a warning message.

F

The tabulated single- or double-precision floating-point *f*-value data. Upon input to the function, *xi* and *fi* must have corresponding indices for all values of i. If *x* is reordered, *f* is also reordered.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

SORT

Set this keyword to sort the tabulated *x*-value data into ascending order. If SORT is set, both *x* and *f* values are sorted.

Example

Define 11 *x*-values on the closed interval [0.0 , 0.8]:

```
X = [0.0, .12, .22, .32, .36, .40, .44, .54, .64, .70, .80]
```

Define 11 *f*-values corresponding to *xi*:

```
F = [0.200000, 1.30973, 1.30524, 1.74339, 2.07490, 2.45600, $
     2.84299, 3.50730, 3.18194, 2.36302, 0.231964]
result = INT_TABULATED(X, F)
```

In this example, the f-values are generated from a known function

$$f = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$$

which allows the determination of an exact solution. A comparison of methods yields the following results:

- The Multiple Application Trapezoid Method yields: 1.5648
- The Multiple Application Simpson's Method yields: 1.6036
- INT_TABULATED yields: 1.6271

The exact solution (4 decimal accuracy) is: 1.6405

See Also

INT_2D, INT_3D, QROMB, QROMO, QSIMP

INTARR

The INTARR function returns an integer vector or array.

Syntax

Result = INTARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, INTARR sets every element of the result to zero. If NOZERO is nonzero, this zeroing is not performed and INTARR executes faster.

Example

Create I, a 3-element by 3-element integer array with each element set to 0 by entering:

```
I = INTARR(3, 3)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

INTERPOL

The INTERPOL function performs linear, quadratic, or spline, interpolation on vectors with a regular or irregular grid. The result is a single- or double-precision floating-point vector, or a complex vector if the input vector is complex.

This routine is written in the IDL language. Its source code can be found in the file `interpol.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

For regular grids: *Result* = INTERPOL(*V, N* [, /LSQUADRATIC] [, /QUADRATIC] [, /SPLINE])

For irregular grids: *Result* = INTERPOL(*V, X, U* [, /LSQUADRATIC] [, /QUADRATIC] [, /SPLINE])

Arguments

V

An input vector of any type except string.

N

The number of points in the result when both input and output grids are regular. The abscissa values for the output grid will contain the same endpoints as the input.

X

The abscissa values for *V*, in the irregularly-gridded case. *X* must have the same number of elements as *V*, and the values *must* be monotonically ascending or descending.

U

The abscissa values for the result. The result will have the same number of elements as *U*. *U* does not need to be monotonic.

Keywords

LSQUADRATIC

If set, interpolate using a least squares quadratic fit to the equation $y = a + bx + cx^2$, for each 4 point neighborhood (x[i-1], x[i], x[i+1], x[i+2]) surrounding the interval of the interpolate, $x[i] \le u < x[i+1]$.

QUADRATIC

If set, interpolate by fitting a quadratic $y = a + bx + cx^2$, to the three point neighborhood (x[i-1], x[i], x[i+1]) surrounding the interval $x[i] \le u < x[i+1]$.

SPLINE

If set, interpolate by fitting a cubic spline to the 4 point neighborhood (x[i-1], x[i], x[i+1], x[i+2]) surrounding the interval, $x[i] \le u < x[i+1]$.

Note

If LSQUADRATIC or QUADRATIC or SPLINE is not set, the default is to use linear interpolation.

Example

Create a floating-point vector of 61 elements in the range [-3, 3].

```
X = FINDGEN(61)/10 - 3

; Evaluate V[x] at each point:
V = SIN(X)

; Define X-values where interpolates are desired:
U = [-2.50, -2.25, -1.85, -1.55, -1.20, -0.85, -0.50, -0.10, $
   0.30, 0.40, 0.75, 0.85, 1.05, 1.45, 1.85, 2.00, 2.25, 2.75 ]

; Interpolate:
result = INTERPOL(V, X, U)

; Plot the function:
PLOT, X, V

; Plot the interpolated values:
OPLOT, U, result
```

See Also

BILINEAR, INTERPOLATE, KRIG2D

INTERPOLATE

The INTERPOLATE function returns an array of linear, bilinear or trilinear interpolates, depending on the dimensions of the input array *P*. Linear interpolates are returned in the one-dimensional case, bilinear in the two-dimensional case and trilinear interpolates in the three-dimensional case. The returned array has the same type as *P* and its dimensions depend on those of the location parameters *X*, *Y*, and *Z*, as explained below.

Interpolates outside the bounds of *P* can be set to a user-specified value by using the MISSING keyword.

Syntax

Result = INTERPOLATE(*P*, *X* [, *Y* [, *Z*]] [, CUBIC=*value*{-1 to 0}] [, /GRID] [, MISSING=*value*])

Arguments

P

The array of data values. *P* can be an array of any dimensions. Interpolation occurs in the *M* rightmost indices of *P*, where *M* is the number of interpolation arrays.

X, Y, Z

Arrays of numeric type containing the locations for which interpolates are desired. For linear interpolation (*P* is a vector), the result has the same dimensions as *X*. The *i*-th element of the result is *P* interpolated at location X_i. The *Y* and *Z* parameters should be omitted.

For bilinear interpolation *Z* should not be present.

Note

INTERPOLATE considers location points with values between zero and *n*, where *n* is the number of values in the input array *P*, to be valid. Location points outside this range are considered missing data. Location points *x* in the range $n\text{-}1 \le x < n$ return the last data value in the array *P*.

If the keyword GRID is not set, all location arrays must have the same number of elements. See the description of the GRID keyword below for more details on how interpolates are computed from *P* and these arrays.

Keywords

CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than ω_0, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

The number of neighboring points used varies according to the dimension:

- 1-dimensional: 4 points
- 2-dimensional: 16 points
- 3-dimensional: not supported

Note

Cubic convolution interpolation is significantly slower than bilinear interpolation. Also note that cubic interpolation is not supported for three-dimensional data.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

GRID

The GRID keyword controls how the location arrays specify where interpolates are desired. This keyword has no effect in the case of linear interpolation.

If GRID is not set: The location arrays, *X*, *Y*, and, if present, *Z* must have the same number of elements. The result has the same structure and number of elements as *X*.

In the case of bilinear interpolation, the result is obtained as follows: Let $l = \lfloor X_i \rfloor$ and $k = \lfloor Y_i \rfloor$. Element *i* of the result is computed by interpolating between *P*(*l*, *k*), *P*(*l*+1, *k*), *P*(*l*, *k*+1), and *P*(*l*+1, *k*+1). to obtain the estimated value at (*Xi*, *Yi*). Trilinear interpolation is a direct extension of the above.

If GRID is set: Let N_x be the number of elements in *X*, let N_y be the number of elements in *Y*, and N_z be the number of elements in *Z*. The result has dimensions (N_x, N_y) for bilinear interpolation, and (N_x, N_y, N_z) for trilinear interpolation. For bilinear interpolation, element (*i*,*j*) of the result contains the value of *P* interpolated at position (*Xi*, *Yi*). For trilinear interpolation, element (*i*, *j*, *k*) of the result is *P* interpolated at (*Xi*, *Yi*, *Zi*).

MISSING

The value to return for elements outside the bounds of *P*. If this keyword is not specified, interpolated positions that fall outside the bounds of the array *P*—that is, elements of the *X*, *Y*, or *Z* arguments that are either less than zero or greater than the largest subscript in the corresponding dimension of *P*—are set equal to the value of the nearest element of *P*.

Examples

The example below computes bilinear interpolates with the keyword GRID set:

```
p = FINDGEN(4,4)
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5], [.5, 1.5, 2.5], /GRID)
```

and prints the 3 by 3 array:

```
   2.50000   3.50000   4.50000
   6.50000   7.50000   8.50000
   10.5000   11.5000   12.5000
```

corresponding to the locations:

(.5,.5), (1.5, .5), (2.5, .5),
(.5,1.5), (1.5, 1.5), (2.5, 1.5),
(.5,2.5), (1.5, 2.5), (2.5, 2.5)

Another example computes interpolates, with GRID not set and a parameter outside the bounds of *P*:

```
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5, 3.1], [.5, 1.5, 2.5, 2])
```

and prints the result:

```
   2.50000   7.50000   12.5000   11.0000
```

corresponding to the locations (.5,.5), (1.5, 1.5), (2.5, 2.5) and (3.1, 2.0). Note that the last location is outside the bounds of *P* and is set from the value of the last column. The following command uses the MISSING keyword to set such values to -1:

```
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5, 3.1], [.5, 1.5, 2.5, 2], $
   MISSING = -1)
```

and gives the result:

```
      2.50000    7.50000    12.5000    -1.00000
```

See Also

BILINEAR, INTERPOL, KRIG2D

INVERT

The INVERT function uses the Gaussian elimination method to compute the inverse of a square array. Errors from singular or near-singular arrays are accumulated in the optional *Status* argument.

Syntax

Result = INVERT(*Array* [, *Status*] [, /DOUBLE])

Return Value

The result is a single- or double-precision array of floating or complex values.

Arguments

Array

The array to be inverted. *Array* must have two dimensions of equal size (i.e., a square array) and can be of any type except string. Note that the resulting array will be composed of single- or double-precision floating-point or complex values, depending on whether the DOUBLE keyword is set.

Status

A named variable to receive the status of the operation. Possible status values are:

- 0 = Successful completion.
- 1 = Singular array (which indicates that the inversion is invalid).
- 2 = Warning that a small pivot element was used and that significant accuracy was probably lost.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Create an array A:
A = [[ 5.0, -1.0, 3.0], $
     [ 2.0,  0.0, 1.0], $
```

```
     [ 3.0,  2.0, 1.0]]
result = INVERT(A)

; We can check the accuracy of the inversion by multiplying the
; inverted array by the original array. The result should be a 3 x
; 3 identity array.
PRINT, result # A
```

IDL prints:

```
      1.00000      0.00000      0.00000
      0.00000      1.00000      0.00000
      0.00000  9.53674e-07      1.00000
```

See Also

COND, DETERM, INVERT, REVERSE, ROTATE, TRANSPOSE

IOCTL

The IOCTL function provides a thin wrapper over the UNIX `ioctl(2)` system call. IOTCL performs special functions on the specified file. The set of functions actually available depends on your version of UNIX and the type of file (tty, tape, disk file, etc.) referred to.

To use IOCTL, read the C programmer's documentation describing the `ioctl(2)` function for the desired device and convert all constants and data to their IDL equivalents.

The value returned by the system `ioctl` function is returned as the value of the IDL IOCTL function.

Syntax

Result = IOCTL(*File_Unit* [, *Request*, *Arg*] [, /BY_VALUE] [, /MT_OFFLINE] [, /MT_REWIND] [, MT_SKIP_FILE=[-]*number_of_files*] [, MT_SKIP_RECORD=[-]*number_of_records*] [, /MT_WEOF] [, /SUPRESS_ERROR])

Arguments

File_Unit

The IDL logical unit number (LUN) for the open file on which the `ioctl` request is made.

Request

A longword integer that specifies the ioctl request code. These codes are usually contained in C language header files provided by the operating system, and are not generally portable between UNIX versions. If one of the "MT" keywords is used, this argument can be omitted.

Arg

A named variable through which data if passed to and from ioctl. IOCTL requests usually request data from the system or supply the system with information. The user must make *Arg* the correct type and size. Errors in typing or sizing *Arg* can corrupt the IDL address space and/or make IDL crash. If one of the MT keywords is used, this argument can be omitted.

Keywords

Note that the keywords below that start with “MT” can be used to issue commonly used magnetic tape ioctl() calls. When these keywords are used, the *Request* and *Arg* arguments are ignored and an be omitted. Magnetic tape operations not available via these keywords can still be executed by supplying the appropriate *Request* and *Arg* values. When issuing magnetic tape IOCTL calls, be aware that different devices have different rules for which ioctl calls are allowed, and when. The documentation for your computer system explains those rules.

BY_VALUE

If this keyword is set, *Arg* is converted to a scalar longword and this longword is passed by value. Normally, *Arg* is passed to ioctl by reference (i.e., by address).

MT_OFFLINE

Set this keyword to rewind and unload a tape.

MT_REWIND

Set this keyword to rewind a tape.

MT_SKIP_FILE

Use this keyword to skip files on a tape. A positive value skips forward that number of files. A negative value skips backward.

MT_SKIP_RECORD

Use this keyword to skip records on tape. A positive value skips forward that number of files. A negative value skips backward.

MT_WEOF

Set this keyword to write an end of file (“tape mark”) on the tape at the current location.

SUPPRESS_ERROR

Set this keyword to log errors quietly and cause a value of -1 to be returned. The default is for IDL to notice any failures associated with the use of `ioctl` and issue the appropriate IDL error and halt execution.

Example

The following example prints the size of the terminal being used by the current IDL session. It is known to work under SunOS 4.1.2. Changes may be necessary for other operating systems or even other versions of SunOS.

```
; Variable to receive result. This structure is described in
; Section 4 of the SunOS manual pages under termios(4):
winsize = { row:0, col:0, xpixel:0, ypixel:0 }

; The request code for obtaining the tty size, as determined by
; reading the termios(4) documentation, and reading the system
; include files in the /usr/include/sys directory:
TIOCGWINSZ = 1074295912L

; Make the information request. -1 is the IDL logical file unit for
; the standard output:
ret = IOCTL(-1, TIOCGWINSZ, winsize)

; Output the results:
PRINT,winsize.row, winsize.col, $
   format='("TTY has ", I0," rows and ", I0," columns.")'
```

The following points should be noted in this example:

- Even though we only want the number of rows and columns, we must include all the fields required by the TIOCGWINSIZ `ioctl` in the winsize variable (as documented in the `termio(4)` manual page). Not providing a large enough result buffer would cause IDL's memory to be corrupted.
- The value of TIOCGWINSZ was determined by examining the system header files provided in the `/usr/include/sys` directory. Such values are not always portable between major operating system releases.

See Also

OPEN

ISHFT

The ISHFT function performs the bit shift operation on bytes, integers and longwords. If P_2 is positive, P_1 is left shifted P_2 bit positions with 0 bits filling vacated positions. If P_2 is negative, P_1 is right shifted with 0 bits filling vacated positions.

Syntax

Result = ISHFT(P_1, P_2)

Arguments

P_1

The scalar or array to be shifted.

P_2

The scalar or array containing the number of bit positions and direction of the shift.

Example

Bit shift each element of the integer array [1, 2, 3, 4, 5] three bits to the left and store the result in B by entering:

```
B = ISHFT([1,2,3,4,5], 3)
```

The resulting array B is [8, 16, 24, 32, 40].

See Also

SHIFT

ISOCONTOUR

The ISOCONTOUR procedure interprets the contouring algorithm found in the IDLgrContour object. The algorithm allows for contouring on arbitrary meshes and returns line or orientated tessellated polygonal output. The interface will also allow secondary data values to be interpolated and returned at the output vertices as well.

Syntax

ISOCONTOUR, *Values*, *Outverts*, *Outconn*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*] [, C_VALUE=*scalar or vector*][, /DOUBLE][, GEOMX=*vector*] [, GEOMY=*vector*] [, GEOMZ=*vector*] [, /FILL] [, LEVEL_VALUES=*variable*] [, N_LEVELS=*levels*]
[, OUTCONN_INDICES=*variable*] [, POLYGONS=*array of polygon descriptions*]

Arguments

Values

An input vector or a two-dimensional array specifying the values to be contoured.

Outconn

Output variable to contain the connectivity information of the contour geometry in the form: [n0, i(0, 0), i(0, 1)..., i(0, n0–1), n1, i(1, 0), ...].

Outverts

Output variable to contain the contour vertices. The vertices are returned in double-precision floating point if the DOUBLE keyword is specified with a non-zero value. Otherwise, the vertices are returned in single-precision floating point.

Keywords

AUXDATA_IN

The auxiliary values to be interpolated at contour vertices. If *p* is the dimensionality of the auxiliary values, set this argument to a *p*-by-*n* array (if the *Values* argument is a vector of length *n*), or to a *p*-by-*m*-by-*n* array (if the *Values* argument is an *m*-by-*n* two-dimensional array).

AUXDATA_OUT

If the AUXDATA_IN keyword was specified, set this keyword to a named output variable to contain the interpolated auxiliary values at the contour vertices. If *p* is the dimensionality of the auxiliary values, the output is a *p*-by-*n* array of values, where *n* is the number of vertices in *Outverts*.

C_VALUE

Set this keyword to a scalar value or a vector of values for which contour levels are to be generated. If this keyword is set to 0, contour levels will be evenly sampled across the range of the *Values* argument, using the value of the N_LEVELS keyword to determine the number of samples.

DOUBLE

Set this keyword to use double-precision to compute the contours. IDL converts any data supplied by the *Values* argument or GEOMX, GEOMY, and GEOMZ keywords to double precision and returns the *Outverts* argument in double precision. The default behavior is to convert the input to single precision and return the *Outverts* in single precision.

FILL

Set this keyword to generate an output connectivity as a set of polygons (Outconn is in the form used by the IDLgrPolygon POLYGONS keyword). The resulting representation is as a set of filled contours. The default is to generate line contours (Outconn is in the form used by the IDLgrPolyline POLYLINES keyword).

GEOMX

Set this keyword to a vector or two-dimensional array specifying the *X* coordinates of the geometry with which the contour values correspond. If *X* is a vector, it must match the number of elements in the *Values* argument, or it must match the first of the two dimensions of the *Values* argument (in which case the *X* coordinates will be repeated for each column of data values).

GEOMY

Set this keyword to a vector or two-dimensional array specifying the *Y* coordinates of the geometry with which the contour values correspond. If *Y* is a vector, it must match the number of elements in the *Values* argument, or it must match the first of the two dimensions of the *Values* argument (in which case the *Y* coordinates will be repeated for each column of data values).

GEOMZ

Set this keyword to a vector or two-dimensional array specifying the *Z* coordinates of the geometry with which the contour values correspond.

If GEOMZ is a vector or an array, it must match the number of elements in the *Values* argument.

If GEOMZ is not set, the geometry will be derived from the *Values* argument (if it is set to a two-dimensional array). In this case connectivity is implied. The X and Y coordinates match the row and column indices of the array, and the Z coordinates match the data values.

LEVEL_VALUES

Set this keyword to a named output variable to receive a vector of values corresponding to the values used to generate the contours. The length of this vector is equal to the number of contour levels generated. This vector is returned in double precision floating point.

N_LEVELS

Set this keyword to the number of contour levels to generate. This keyword is ignored if the C_VALUE keyword is set to a vector, in which case the number of levels is derived from the number of elements in that vector. Set this keyword to 0 to indicate that IDL should compute a default number of levels based on the range of data values. This is the default.

OUTCONN_INDICES

Set this keyword to a named output variable to receive an array of beginning and ending indices of connectivity for each contour level.

The output array is of the form: [$start_0$, end_0, $start_1$, end_1, ..., $start_{nc-1}$, end_{nc-1}], where *nc* is the number of contour levels. If a level has no contour lines, the start and stop pair is set to 0 and 0 for that level.

POLYGONS

Set this keyword to an array of polygonal descriptions that represents the connectivity information for the data to be contoured (as specified in the *Values* argument). A polygonal description is an integer or long array of the form: [n, i_0, i_1, ..., i_{n-1}], where n is the number of vertices that define the polygon, and i_0...i_{n-1} are indices into the GEOMX, GEOMY, and GEOMZ keywords that represent the polygonal vertices. To ignore an entry in the POLYGONS array, set the vertex count, n to 0. To end the drawing list, even if additional array space is available, set *n* to –1.

ISOSURFACE

The ISOSURFACE procedure algorithm expands on the SHADE_VOLUME algorithm. It returns topologically consistent triangles by using oriented tetrahedral decomposition internally. This also allows the algorithm to isosurface any arbitrary tetrahedral mesh. If the user provides an optional auxiliary array, the data in this array is interpolated onto the output vertices and is returned as well. This auxiliary data array is allowed to have more than one value at each vertex. Any size leading dimension is allowed as long as the number of values in the subsequent dimensions matches the number of elements in the input Data array.

Syntax

ISOSURFACE, *Data*, *Value*, *Outverts*, *Outconn*
[, GEOM_XYZ=*array*, TETRAHEDRA=*array*]
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*]

Arguments

Data

Input three-dimensional array of scalars which are to be contoured.

Value

Input scalar contour value. This value specifies the constant-density surface (also called an iso-surface) to be extracted.

Outverts

A named variable to contain an output [3, *n*] array of floating point vertices making up the triangle surfaces.

Outconn

A named variable to contain an output array of polygonal connectivity values (see IDLgrPolygon, POLYGONS keyword). If no polygons were extracted, this argument returns the array [–1].

Keywords

AUXDATA_IN

Input array of auxiliary data with trailing dimensions being the number of values in Data.

Note

If AUXDATA_IN is specified then AUXDATA_OUT must also be specified.

AUXDATA_OUT

Set this keyword to a named variable that will contain an output array of auxiliary data sampled at the locations in Outverts.

Note

If AUXDATA_OUT is specified then AUXDATA_IN must also be specified.

GEOM_XYZ

A [3,n] input array of vertex coordinates (one for each value in the Data array). This array is used to define the spatial location of each scalar. If this keyword is omitted, Data must be a three-dimensional array and the scalar locations are assumed to be on a uniform grid.

Note

If GEOM_XYZ is specified then TETRAHEDRA must also be specified if either is to be specified.

TETRAHEDRA

An input array of tetrahedral connectivity values. If this array is not specified, the connectivity is assumed to be a rectilinear grid over the input three-dimensional array. If this keyword is specified, the input data array need not be a three-dimensional array. Each tetrahedron is represented by four values in the connectivity array. Every four values in the array correspond to the vertices of a single tetrahedron.

See Also

SHADE_VOLUME, XVOLUME

JOURNAL

The JOURNAL procedure provides a record of an interactive session by saving, in a file, all text entered from the terminal in response to the IDL prompt. The first call to JOURNAL starts the logging process. The read-only system variable !JOURNAL is set to the file unit used. To stop saving commands and close the file, call JOURNAL with no parameters. If logging is in effect and JOURNAL is called with a parameter, the parameter is simply written to the journal file.

Syntax

JOURNAL [, *Arg*]

Arguments

Arg

A string containing the name of the journal file to be opened or text to be written to an open journal file. If *Arg* is not supplied, and a journal file is not already open, the file `idlsave.pro` is used. Once journaling is enabled, a call to JOURNAL with *Arg* supplied causes *Arg* to be written into the journal file. Calling JOURNAL without *Arg* while journaling is in progress closes the journal file and ends the logging process.

Example

To begin journaling to the file `myjournal.pro`, enter:

```
JOURNAL, 'myjournal.pro'
```

Any commands entered at the IDL prompt are recorded in the file until IDL is exited or the JOURNAL command is entered without an argument.

See Also

RESTORE, SAVE

JULDAY

The JULDAY function calculates the Julian Day Number (which begins at noon) for the specified date. This is the inverse of the CALDAT procedure.

Note

The Julian calendar, established by Julius Caesar in the year 45 BCE, was corrected by Pope Gregory XIII in 1582, excising ten days from the calendar. The CALDAT procedure reflects the adjustment for dates after October 4, 1582. See the example below for an illustration.

Note

A small offset is added to the returned Julian date to eliminate roundoff errors when calculating the day fraction from hours, minutes, seconds. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date, and EPS is the EPS field from MACHAR. For typical Julian dates, this offset is approximately $6x10^{-10}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that if the Julian date is converted back to hour, minute, and second, then the hour, minute, and second will have the same integer values as were originally input.

Note

Calendar dates must be in the range 1 Jan 4716 B.C.E. to 31 Dec 5000000, which corresponds to Julian values -1095 and 1827933925, respectively.

This routine is written in the IDL language. Its source code can be found in the file `julday.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = JULDAY(*Month, Day, Year, Hour, Minute, Second*)

Return Value

Result is of type double-precision if Hour, Minute, or Second is specified, otherwise *Result* is of type long integer. If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of the arrays, returning an array with the same dimensions as the smallest array. If the

inputs contain both scalars and arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

Arguments

Month

Number of the desired month (1 = January, ..., 12 = December). *Month* can be either a scalar or an array.

Day

Number of the day of the month (1-31). *Day* can be either a scalar or an array.

Year

Number of the desired year (e.g., 1994). *Year* can be either a scalar or an array.

Hour

Number of the hour of the day (0-23). *Hour* can be either a scalar or an array.

Minute

Number of the minute of the hour (0-59). *Minute* can be either a scalar or an array.

Second

Number of the second of the minute (0-59). *Second* can be either a scalar or an array.

Example

In 1582, Pope Gregory XIII adjusted the Julian calendar to correct for its inaccuracy of slightly more than 11 minutes per year. As a result, the day following October 4, 1582 was October 15, 1582. JULDAY follows this convention, as illustrated by the following commands:

```
PRINT, JULDAY(10,4,1582), JULDAY(10,5,1582), JULDAY(10,15,1582)
```

IDL prints:

```
2299160    2299161    2299161
```

Using arrays, this can also be calculated as follows:

```
PRINT, JULDAY(10, [4, 5, 15], 1582)
```

If you are using JULDAY to calculate an absolute number of days elapsed, be sure to account for the Gregorian adjustment.

See Also

BIN_DATE, CALDAT, SYSTIME

KEYWORD_SET

The KEYWORD_SET function returns a nonzero value if *Expression* is defined and nonzero or an array, otherwise zero is returned. This function is especially useful in user-written procedures and functions that process keywords that are interpreted as being either true (keyword is present and nonzero) or false (keyword was not used, or was set to zero).

Syntax

Result = KEYWORD_SET(*Expression*)

Arguments

Expression

The expression to be tested. *Expression* is usually a named variable.

Example

Suppose that you are writing an IDL procedure that has the following procedure definition line:

```
PRO myproc, KEYW1 = keyw1, KEYW2 = keyw2
```

The following command could be used to execute a set of commands only if the keyword KEYW1 is set (i.e., it is present and nonzero):

```
IF KEYWORD_SET(keyw1) THEN BEGIN
```

The commands to be executed only if KEYW1 is set would follow.

See Also

N_ELEMENTS, N_PARAMS

KRIG2D

The KRIG2D function interpolates a regularly- or irregularly-gridded set of points $z = f(x, y)$ using kriging. It returns a two dimensional floating-point array containing the interpolated surface, sampled at the grid points.

The parameters of the data model – the range, nugget, and sill – are highly dependent upon the degree and type of spatial variation of your data, and should be determined statistically. Experimentation, or preferably rigorous analysis, is required.

For *n* data points, a system of *n*+1 simultaneous equations are solved for the coefficients of the surface. For any interpolation point, the interpolated value is:

$$f(x, y) = \sum w_i \cdot C(x_i, y_i, x, y)$$

The following formulas are used to model the variogram functions:

d(*i*,*j*) = the distance from point i to point j.

V = the variance of the samples.

C(*i*,*j*) = the covariance of sample i with sample j.

C(x_0,y_0,x_1,y_1) = the covariance of point (x_0,y_0) with point (x_1,y_1).

Exponential covariance:

$$C(d) = \begin{cases} C_1 \cdot e^{(-3 \cdot d/A)} & \text{if } d \neq 0 \\ C_1 + C_0 & \text{if } d = 0 \end{cases}$$

Spherical covariance:

$$C(d) = \begin{cases} 1.0 - (1.5 \cdot d/A) + (0.5 \cdot (d/A)^3) & \text{if } d < a \\ C_1 + C_0 & \text{if } d = 0 \\ 0 & \text{if } d > a \end{cases}$$

Note

The accuracy of this function is limited by the single-precision floating-point accuracy of the machine.

This routine is written in the IDL language. Its source code can be found in the file `krig2d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = KRIG2D(*Z* [, *X*, *Y*] [, EXPONENTIAL=*vector*] [, SPHERICAL=*vector*] [, /REGULAR] [, XGRID=*[xstart*, *xspacing]*] [, XVALUES=*array*] [, YGRID=*[ystart*, *yspacing]*] [, YVALUES=*array*] [, GS=*[xspacing*, *yspacing]*] [, BOUNDS=*[xmin*, *ymin*, *xmax*, *ymax]*] [, NX=*value*] [, NY=*value*])

Arguments

Z, X, Y

Arrays containing the *Z*, *X*, and *Y* coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, *X* and *Y* are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and *Z* must be a two dimensional array. For irregular grids, all three parameters must be present and have the same number of elements.

Keywords

Model Parameters:

EXPONENTIAL

Set this keyword to a two- or three-element vector of model parameters [A,C0, C1] to use an exponential semivariogram model. The model parameters are as follows:

- A — The *range*. At distances beyond *A*, the semivariogram or covariance remains essentially constant.
- C0 — The *nugget*, which provides a discontinuity at the origin.
- C1 — If specified, C1 is the covariance value for a zero distance, and the variance of the random sample *z* variable. If only a two element vector is supplied, C1 is set to the sample variance. (C0 + C1) = the *sill*, which is the variogram value for very large distances.

SPHERICAL

Set this keyword to a two- or three-element vector of model parameters [A,C0, C1] to use a spherical semivariogram model. The model parameters are as follows:

- A — The *range*. At distances beyond *A*, the semivariogram or covariance remains essentially constant.
- C0 — The *nugget*, which provides a discontinuity at the origin.

- C1 — If specified, C1 is the covariance value for a zero distance, and the variance of the random sample *z* variable. If only a two element vector is supplied, C1 is set to the sample variance. (C0 + C1) = the *sill*, which is the variogram value for very large distances.

Input Grid Description:

REGULAR

If set, the *Z* parameter is a two dimensional array of dimensions (*n,m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

XGRID

A two-element array, [*xstart*, *xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

YGRID

A two-element array, [*ystart*, *yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

Output Grid Description:

GS

The output grid spacing. If present, GS must be a two-element vector [*xs, ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax* - *xmin*)/(NX-1). *ys* is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin, ymin, xmax, ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

Examples

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))

; Get a 26 by 26 grid over the rectangle bounding x and y:
; Range is 0.25 and nugget is 0. These numbers are dependent on
; your data model:
E = [ 0.25, 0.0]

; Get the surface:
R = KRIG2D(Z, X, Y, EXPON = E)
```

Alternatively, get a surface over the unit square, with spacing of 0.05:

```
R = KRIG2D(Z, X, Y, EXPON=E, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])
```

See Also

BILINEAR, INTERPOLATE

KURTOSIS

The KURTOSIS function computes the statistical kurtosis of an *n*-element vector. If the variance of the vector is zero, the kurtosis is not defined, and KURTOSIS returns !VALUES.F_NAN as the result. KURTOSIS calls the IDL function MOMENT.

Syntax

Result = KURTOSIS(*X* [, /DOUBLE] [, /NAN])

Arguments

X

An *n*-element, floating-point or double-precision vector.

Keywords

DOUBLE

If this keyword is set, computations are performed in double precision arithmetic.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the kurtosis:
result = KURTOSIS(x)
; Print the result:
PRINT, result
```

IDL prints

```
-1.18258
```

See Also

MEAN, MEANABSDEV, MOMENT, STDDEV, SKEWNESS, VARIANCE

KW_TEST

The KW_TEST function tests the hypothesis that three or more sample populations have the same mean of distribution against the hypothesis that they differ. The populations may be of equal or unequal lengths. The result is a two-element vector containing the test statistic H and the one-tailed probability of obtaining a value of H or greater from a Chi-square distribution.

This test is an extension of the Rank Sum Test implemented in the RS_TEST function. When each sample population contains at least five observations, the H test statistic is approximated very well by a Chi-square distribution with DF degrees of freedom. The hypothesis that three of more sample populations have the same mean of distribution is rejected if two or more populations differ with statistical significance. This type of test is often referred to as the Kruskal-Wallis H-Test.

The test statistic H is defined as follows:

$$H = \frac{12}{N_T(N_T+1)} \sum_{i=0}^{M-1} \frac{R_i^2}{N_i} - 3(N_T+1)$$

where N_i is the number of observations in the i^{th} sample population, N_T is the total number of observations in all sample populations, and R_i is the overall rank sum of the i^{th} sample population.

This routine is written in the IDL language. Its source code can be found in the file `kw_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = KW_TEST(*X* [, DF=*variable*] [, MISSING=*nonzero_value*])

Arguments

X

An integer, single-, or double-precision floating-point array of *m*-columns (with $m \geq 3$) and *n*-rows. The columns of this two-dimensional array correspond to the sample populations.

If the sample populations are of unequal length, any columns of *X* that are shorter than the longest column must be “filled in” by appending a user-specified missing

data value. This method requires the use of the MISSING keyword. See the *Example* section below for an example of this case.

Keywords

DF

Use this keyword to specify a named variable that will contain the number of degrees of freedom used to compute the probability of obtaining a value of H or greater from the corresponding Chi-square distribution

MISSING

Set this keyword equal to a non-zero numeric value that has been appended to some columns of *X* to make them all a common length of *n*.

Example

Test the hypothesis that three sample populations have the same mean of distribution against the hypothesis that they differ at the 0.05 significance level. Assume we have the following sample populations:

sp0 = [24.0, 16.7, 22.8, 19.8, 18.9]

sp1 = [23.2, 19.8, 18.1, 17.6, 20.2, 17.8]

sp2 = [18.2, 19.1, 17.3, 17.3, 19.7, 18.9, 18.8, 19.3]

Since the sample populations are of unequal lengths, a missing value must be appended to sp0 and sp1. In this example the missing value is -1.0 and the 3-column, 8-row input array `X` is defined as:

```
X = [[24.0, 23.2, 18.2], $
     [16.7, 19.8, 19.1], $
     [22.8, 18.1, 17.3], $
     [19.8, 17.6, 17.3], $
     [18.9, 20.2, 19.7], $
     [-1.0, 17.8, 18.9], $
     [-1.0, -1.0, 18.8], $
     [-1.0, -1.0, 19.3]]
PRINT, KW_TEST(X, MISSING = -1)
```

IDL prints:

```
[1.65862, 0.436351]
```

The computed probability (0.436351) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that the three sample populations sp0, sp1, and sp2 have the same mean of distribution.

See Also

FV_TEST, RS_TEST, S_TEST, TM_TEST

L64INDGEN

The L64INDGEN function returns a 64-bit integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = L64INDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. These parameters can be any scalar expression, and up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL converts them to integer values before creating the new array.

Example

To create L, a 10-element by 10-element 64-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = L64INDGEN(10, 10)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

LABEL_DATE

The LABEL_DATE function can be used, in conjunction with the [XYZ]TICKFORMAT keyword to IDL plotting routines, to easily label axes with dates and times.

This routine is written in the IDL language. Its source code can be found in the file `label_date.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LABEL_DATE([DATE_FORMAT=*string/string array*]
[, AM_PM=2-element vector of strings]
[, DAYS_OF_WEEK=7-element vector of strings]
[, MONTHS=12-element vector of strings] [, OFFSET=*value*] [, /ROUND_UP])

and then,

PLOT, *x*, *y*, XTICKFORMAT = 'LABEL_DATE'

Arguments

If LABEL_DATE is being called to initialize string formats, it should be called with no arguments and the DATE_FORMAT keyword should be set.

Keywords

Note

The settings for LABEL_DATE remain in effect for all subsequent calls to LABEL_DATE. To restore any default settings, call LABEL_DATE again with the appropriate keyword set to either a null string ('') or to 0, depending uopn the data type of that keyword.

AM_PM

Set this keyword to a two-element string array that contains the names to be used with '%A'. The default is ['am','pm'].

DATE_FORMAT

Set this keyword to a format string or array of format strings. Each string corresponds to an axis level as provided by the [XYZ]TICKUNITS keyword to the plotting

routine. If there are fewer strings than axis levels, then the strings are cyclically repeated. A string can contain any of the following codes:

Code	Description
%M	Month name.
%N	Month number (2 digits).
%D	Day of month (2 digits).
%Y	Year (4 digits, or 5 digits for negative years).
%Z	Last 2 digits of the year.
%W	Day of the week.
%A	AM or PM (%H is then 12-hour instead of 24-hour).
%H	Hours (2 digits).
%I	Minutes (2 digits).
%S	Seconds (2 digits), followed optionally by %n where n is an integer 0-9 representing the number of digits after the decimal point for seconds; the default is no decimal places.
%%	Represents the % character.

Table 10: DATE_FORMAT Codes

Other items you can include can consist of:

- Any other text characters in the format string.
- Any vector font positioning and font change commands. For more information, see "Embedded Formatting Commands" in Appendix H.

If DATE_FORMAT is not specified then the default is the standard 24-character system format, `'%W %M %D %H:%I:%S %Y'`.

The following table contains some examples of DATE_FORMAT strings and the resulting output:

DATE_FORMAT String	Example Result
'%D/%N/%Y'	11/12/1993
'%M!C%Y' **Note -** !C is the code for a newline character.	Dec 1993
'%H:%I:%S'	21:33:58
'%H:%I:%S%3'	21:33:58.125
'%W, %M %D, %H %A'	Sat, Jan 01, 9 pm
'%S seconds'	60 seconds

Table 11: DATE_FORMAT Examples

DAYS_OF_WEEK

Set this keyword to a seven-element string array that contains the names to be used with '%W'. The default is the three-letter English abbreviations, ['Sun, 'Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat'].

MONTHS

Set this keyword to a twelve-element string array that contains the names to be used with '%M'. The default is the three-letter English abbreviations, ['Jan', 'Feb',…, 'Dec'].

OFFSET

Set this keyword to a value representing the offset to be added to each tick value before conversion to a label. This keyword is usually used when your axis values are measured relative to a certain starting time. In this case, OFFSET should be set to the Julian date of the starting time.

ROUND_UP

Set this keyword to force times to be rounded up to the smallest time unit that is present in the DATE_FORMAT string. The default is for times to be truncated to the smallest time unit.

Example

This example creates a sample plot that has a date axis from Jan 1 to June 30, 2000:

```
; Create format strings for a two-level axis:
dummy = LABEL_DATE(DATE_FORMAT=['%D-%M','%Y'])

;Generate the Date/Time data
time = TIMEGEN(START=JULDAY(1,1,2000), FINAL=JULDAY(6,30,2000))

;Generate the Y-axis data
data = RANDOMN(seed, N_ELEMENTS(time))

;Plot the data
PLOT, time, data, XTICKUNITS = ['Time', 'Time'], $
   XTICKFORMAT='LABEL_DATE', XSTYLE=1, XTICKS=6, YMARGIN=[6,2]
```

For more examples, see "[XYZ]TICKFORMAT" on page 2413.

See Also

"[XYZ]TICKFORMAT" on page 2413, CALDAT, JULDAY, SYSTIME, TIMEGEN, "Format Codes" in Chapter 8 of *Building IDL Applications*

LABEL_REGION

The LABEL_REGION function consecutively labels all of the regions, or blobs, of a bi-level image with a unique region index. This process is sometimes called “blob coloring”. A region is a set of non-zero pixels within a neighborhood around the pixel under examination.

The argument for LABEL_REGION is an *n*-dimensional bi-level integer type array—only zero and non-zero values are considered. The result of the function is an integer array of the same dimensions with each pixel containing its region index. A region index of zero indicates that the original pixel was zero and belongs to no region. Output values range from 0 to the number of regions.

Statistics on each of the regions may be easily calculated using the HISTOGRAM function as shown in the examples below.

Syntax

Result = LABEL_REGION(*Data* [, /ALL_NEIGHBORS] [, /ULONG])

Arguments

Data

A *n*-dimensional image to be labeled. *Data* is converted to integer type if necessary. Pixels at the edges of *Data* are considered to be zero.

Keywords

ALL_NEIGHBORS

Set this keyword to indicate that all adjacent neighbors to a given pixel should be searched. (This is sometimes called 8-neighbor searching when the image is 2-dimensional). The default is to search only the neighbors that are exactly one unit in distance from the current pixel (sometimes called 4-neighbor searching when the image is 2-dimensional).

EIGHT

This keyword is now obsolete. It has been replaced by the ALL_NEIGHBORS keyword (because this routine now handles N-dimensional data).

ULONG

Set this keyword to specify that the output array should be an unsigned long integer.

Examples

Example 1

This example counts the number of distinct regions within an image, and their population. Note that region 0 is the set of zero pixels that are not within a region:

```
image = DIST(40)

; Get blob indices:
b = LABEL_REGION(image)

; Get population of each blob:
h = HISTOGRAM(b)
FOR i=0, N_ELEMENTS(h)-1 DO PRINT, 'Region ',i, $
   ', Population = ', h(i)
```

Example 2

This example also prints the average value and standard deviation of each region:

```
image = DIST(40)

; Get blob indices:
b = LABEL_REGION(image)

; Get population and members of each blob:
h = HISTOGRAM(b, REVERSE_INDICES=r)

; Each region
FOR i=0, N_ELEMENTS(h)-1 DO BEGIN
   ;Find subscripts of members of region i.
   p = r(r[i]:r[i+1]-1)

   ; Pixels of region i
   q = image[p]
   PRINT, 'Region ', i, $
      ', Population = ', h[i], $
      ', Standard Deviation = ', STDEV(q, mean), $
      ', Mean = ', mean
ENDFOR
```

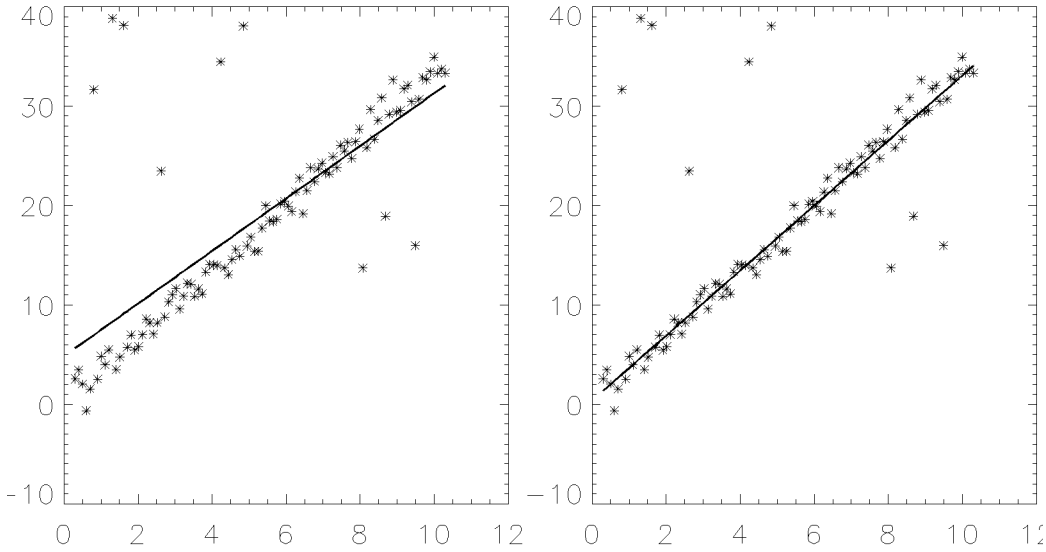
See Also

ANNOTATE, DEFROI, HISTOGRAM, SEARCH2D

LADFIT

The LADFIT function fits the paired data {*xi*, *yi*} to the linear model, y = A + Bx, using a “robust” least absolute deviation method. The result is a two-element vector containing the model parameters, A and B.

The figure below displays a two-dimensional distribution that is fitted to the model y = A + Bx, using a minimized Chi-square error criterion (left) and a “robust” least absolute deviation technique (right). The use of the Chi-square error statistic can result in a poor fit due to an undesired sensitivity to outlying data.



This routine is written in the IDL language. Its source code can be found in the file `ladfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LADFIT(*X*, *Y* [, ABSDEV=*variable*] [, /DOUBLE])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector. Note that the *X* vector must be sorted into ascending order.

Y

An *n*-element integer, single-, or double-precision floating-point vector. Note that the elements of the *Y* vector must be paired with the appropriate elements of *X*.

Keywords

ABSDEV

Set this keyword to a named variable that will contain the mean absolute deviation for each data-point in the y-direction.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define two n-element vectors of paired data:
X = [-3.20, 4.49, -1.66, 0.64, -2.43, -0.89, -0.12, 1.41, $
      2.95, 2.18, 3.72, 5.26]
Y = [-7.14, -1.30, -4.26, -1.90, -6.19, -3.98, -2.87, -1.66, $
     -0.78, -2.61, 0.31, 1.74]

; Sort the X values into ascending order, and sort the Y values to
; match the new order of the elements in X:
XX = X(SORT(X))
YY = Y(SORT(X))

; Compute the model parameters, A and B:
PRINT, LADFIT(XX, YY)
```

IDL prints:

```
-3.15301     0.930440
```

See Also

COMFIT, CURVEFIT, LINFIT, SORT

LAGUERRE

The LAGUERRE function returns the value of the associated Laguerre polynomial $L_n^k(x)$. The associated Laguerre polynomials are solutions to the differential equation:

$$xy'' + (k + 1 - x)y' + ny = 0$$

with orthogonality constraint:

$$\int_0^\infty e^{-x}x^{k+1}L_m^k(x)L_n^k(x)dx = \frac{(n+k)!}{n!}\delta_{mn}$$

Laguerre polynomials are used in quantum mechanics, for example, where the wave function for the hydrogen atom is given by the Laguerre differential equation.

This routine is written in the IDL language. Its source code can be found in the file `laguerre.pro` in the `lib` subdirectory of the IDL distribution.

This routine is written in the IDL language. Its source code can be found in the file `laguerre.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LAGUERRE(*X*, *N* [, *K*] [, COEFFICIENTS=*variable*] [, /DOUBLE])

Return Value

This function returns a scalar or array with the same dimensions as *X*. If *X* is double-precision or if the DOUBLE keyword is set, the result is double-precision complex, otherwise the result is single-precision complex.

Arguments

X

The value(s) at which $L_n^k(x)$ is evaluated. *X* can be either a scalar or an array.

N

A scalar integer, $N \geq 0$, specifying the order n of $L_n^k(x)$. If *N* is of type float, it will be truncated.

K

A scalar, $K \geq 0$, specifying the order k of $L_n^k(x)$. If K is not specified, the default $K = 0$ is used and the Laguerre polynomial, $L_n(x)$, is returned.

Keywords

COEFFICIENTS

Set this keyword to a named variable that will contain the polynomial coefficients in the expansion C[0] + C[1]x + C[2]x^2 + ...

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To compute the value of the Laguerre polynomial at the following *X* values:

```
;Define the parametric X values:
X = [0.0, 0.2, 0.4, 0.6, 0.8, 1.0]

;Compute the Laguerre polynomial of order N=2, K=1:
result = LAGUERRE(X, 2, 1)

;Print the result:
PRINT, result
```

IDL prints:

```
3.00000   2.42000   1.88000   1.38000   0.920000   0.500000
```

This is the exact solution vector to six-decimal accuracy.

See Also

LEGENDRE, SPHER_HARM

LEEFILT

The LEEFILT function performs the Lee filter algorithm on an image array using a box of size 2*N*+1. This function can also be used on vectors. The Lee technique smooths additive image noise by generating statistics in a local neighborhood and comparing them to the expected values.

This routine is written in the IDL language. It is based upon the algorithm published by Lee (*Optical Engineering* 25(5), 636-646, May 1986). Its source code can be found in the file `leefilt.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LEEFILT(*A* [, *N* [, *Sig*]] [, /DOUBLE] [, /EXACT])

Return Value

This function returns an array with the same dimensions as *A*. If any of the inputs are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

A

The input image array or one-dimensional vector.

N

The size of the filter box is 2*N*+1. The default value is 5.

Sig

Estimate of the standard deviation. The default is 5. If *Sig* is negative, IDL interactively prompts for a value of `sigma`, and displays the resulting image using TVSCL (for arrays) or PLOT (for vectors). To end this cycle, enter a value of 0 (zero) for `sigma`.

Keywords

DOUBLE

Set this keyword to force the computations to be done in double-precision arithmetic.

EXACT

Set this keyword to apply a more accurate (but slower) implementation of the Lee filter.

See Also

DIGITAL_FILTER, MEDIAN, SMOOTH, VOIGT

LEGENDRE

The LEGENDRE function returns the value of the associated Legendre polynomial $P_l^m(x)$. The associated Legendre functions are solutions to the differential equation:

$$(1-x^2)y'' - 2xy' + \left[l(l+1) - \frac{m^2}{(1-x^2)} \right] y = 0$$

with orthogonality constraints:

$$\int_{-1}^{+1} P_l^m(x) P_k^n(x) dx = \frac{2}{2l+1} \frac{(l+m)!}{(l-m)!} \delta_{lk} \delta_{mn}$$

The Legendre polynomials are the solutions to the Legendre equation with $m = 0$. For positive m, the associated Legendre functions can be written in terms of the Legendre polynomials as:

$$P_l^m(x) = (-1)^m (1-x^2)^{m/2} \frac{d^m}{dx^m} P_l(x)$$

Associated polynomials for negative m are related to positive m by:

$$P_l^{-m}(x) = (-1)^m \frac{(l-m)!}{(l+m)!} P_l^m(x)$$

LEGENDRE is based on the routine *plgndr* described in section 6.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = LEGENDRE(*X*, *L* [, *M*] [, /DOUBLE])

Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *X*, *L*, and *M*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element

of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

Arguments

X

The expression for which $P_l^m(x)$ is evaluated. Values for *X* must be in the range $-1 \le X \le 1$.

L

An integer scalar or array, $L \ge 0$, specifying the order *l* of $P_l^m(x)$. If *L* is of type float, it will be truncated.

M

An integer scalar or array, $-L \le M \le L$, specifying the order *m* of $P_l^m(x)$. If *M* is not specified, then the default $M = 0$ is used and the Legendre polynomial, $P_l(x)$, is returned. If *M* is of type float, it will be truncated.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Examples

Example 1

Compute the value of the Legendre polynomial at the following X values:

```
; Define the parametric X values:
X = [-0.75, -0.5, -0.25, 0.25, 0.5, 0.75]

; Compute the Legendre polynomial of order L=2:
result = LEGENDRE(X, 2)

; Print the result:
PRINT, result
```

The result of this is:

```
 0.343750 -0.125000 -0.406250 -0.406250 -0.125000  0.343750
```

Example 2

Compute the value of the associated Legendre polynomial at the same X values:

```
; Compute the associated Legendre polynomial of order L=2, M=1:
result = LEGENDRE(X, 2, 1)
; Print the result:
PRINT, result
```

IDL prints:

```
   1.48824   1.29904   0.726184  -0.726184  -1.29904  -1.48824
```

This is the exact solution vector to six-decimal accuracy.

See Also

SPHER_HARM, LAGUERRE

LINBCG

The LINBCG function is used in conjunction with SPRSIN to solve a set of *n* sparse linear equations with *n* unknowns using the iterative biconjugate gradient method. The result is an *n*-element vector.

LINBCG is based on the routine `linbcg` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Note

Numerical Recipes recommends using double-precision arithmetic to perform this computation.

Syntax

Result = LINBCG(*A*, *B*, *X* [, /DOUBLE] [, ITOL={4 | 5 | 6 | 7}] [, TOL=*value*] [, ITER=*variable*] [, ITMAX=*value*])

Arguments

A

A row-indexed sparse array created by the SPRSIN function.

B

An *n*-element vector containing the right-hand side of the linear system **Ax=b**.

X

An *n*-element vector containing the initial solution of the linear system.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITOL

Use this keyword to specify which convergence test should be used. Set ITOL to one of the following:

1. Iteration stops when $|A \cdot x - b| / |b|$ is less than the value specified by TOL.
2. Iteration stops when $|\tilde{A}^{-1} \cdot (A \cdot x - b)| / |\tilde{A}^{-1} \cdot b|$ (where $\tilde{A}$ is a "preconditioning" matrix close to A) is less than the value specified by TOL.
3. The routine uses its own estimate of error in x. Iteration stops when the magnitude of the error divided by the magnitude of x is less than the value specified by TOL. This is the default setting.
4. The same as 3, except that the routine uses the largest (in absolute value) component of the error and the largest component of x rather than the vector magnitudes.

TOL

Use this keyword to specify the desired convergence tolerance. For single-precision calculations, the default value is 1.0×10^{-7}. For double-precision values, the default is 1.0×10^{-14}.

ITER

Use this keyword to specify an output variable that will be set to the number of iterations performed.

ITMAX

The maximum allowed number of iterations. The default is n^2.

Example

```
; Begin with an array A:
A = [[ 5.0,  0.0, 0.0,  1.0, -2.0], $
     [ 3.0, -2.0, 0.0,  1.0,  0.0], $
     [ 4.0, -1.0, 0.0,  2.0,  0.0], $
     [ 0.0,  3.0, 3.0,  1.0,  0.0], $
     [-2.0,  0.0, 0.0, -1.0,  2.0]]

; Define a right-hand side vector B:
B = [7.0, 1.0, 3.0, 3.0, -4.0]

; Start with an initial guess at the solution:
X = REPLICATE(1.0, N_ELEMENTS(B))

; Solve the linear system Ax=b:
result = LINBCG(SPRSIN(A), B, X)

; Print the result:
PRINT, result
```

IDL prints:

```
      1.00000    1.00000    8.94134e-008   -2.37107e-007   -1.00000
```

The exact solution is [1, 1, 0, 0, -1].

See Also

FULSTR, READ_SPR, SPRSAB, SPRSAX, SPRSIN, SPRSTP, WRITE_SPR

LINDGEN

The LINDGEN function returns a longword integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = LINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create L, a 10-element by 10-element longword array where each element is set to the value of its one-dimensional subscript, enter:

```
L = LINDGEN(10, 10)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

LINFIT

The LINFIT function fits the paired data {*xi*, *yi*} to the linear model, y = A + Bx, by minimizing the chi-square error statistic. The result is a two-element vector containing the model parameters [A, B].

This routine is written in the IDL language. Its source code can be found in the file `linfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LINFIT(*X*, *Y* [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, MEASURE_ERRORS=*vector*] [, PROB=*variable*] [, SIGMA=*variable*] [, YFIT=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *n*-element integer, single-, or double-precision floating-point vector.

Keywords

CHISQ

Set this keyword to a named variable that will contain the value of the chi-square goodness-of-fit.

COVAR

Set this keyword to a named variable that will contain the Covariance matrix of the coefficients.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

Note

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(ABS(*Y*)).

PROB

Set this keyword to a named variable that will contain the probability that the computed fit would have a value of CHISQ or greater. If PROB is greater than 0.1, the model parameters are "believable". If PROB is less than 0.1, the accuracy of the model parameters is questionable.

SDEV

The SDEV keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the SDEV keyword will continue to work as before, but new code should use the MEASURE_ERROS keyword. The definition of the MEASURE_ERRORS keyword is identical to that of the SDEV keyword.

SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters

Note

If MEASURE_ERRORS is omitted, then you are assuming that a straight line is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

YFIT

Set this keyword equal to a named variable that will contain the vector of calculated *Y* values.

Example

```
; Define two n-element vectors of paired data:
X = [-3.20, 4.49, -1.66, 0.64, -2.43, -0.89, -0.12, 1.41, $
      2.95, 2.18, 3.72, 5.26]
Y = [-7.14, -1.30, -4.26, -1.90, -6.19, -3.98, -2.87, -1.66, $
     -0.78, -2.61, 0.31, 1.74]

; Define an n-element vector of Poisson measurement errors:
measure_errors = SQRT(ABS(Y))

; Compute the model parameters, A and B, and print the result:
result = LINFIT(X, Y, MEASURE_ERRORS=measure_errors)
PRINT, result
```

IDL prints:

```
-3.16574    0.829856
```

See Also

COMFIT, CURVEFIT, GAUSSFIT, LADFIT, LMFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

LINKIMAGE

The LINKIMAGE procedure merges routines written in other languages with IDL at run-time. Each call to LINKIMAGE defines a new system procedure or function by specifying the routine's name, the name of the file containing the code, and the entry point name. The name of your routine is added to IDL's internal system routine table, making it available in the same manner as any other IDL built-in routine. LINKIMAGE can also be used to add graphics device drivers.

Warning

Using LINKIMAGE requires intimate knowledge of the internals of IDL, and is not for use by the novice user. We recommend use of CALL_EXTERNAL, which has a simpler interface, instead of LINKIMAGE unless your application specifically requires it. To use LINKIMAGE, you should be familiar with the material in the IDL *External Development Guide*.

LINKIMAGE uses the dynamic linking interface supported by the operating system to do its work. Programmers should be familiar with the services supported by their system in order to better understand LINKIMAGE:

- Under VMS, the LIB$FIND_IMAGE_SYMBOL run-time library routine is used to activate your sharable image and merge it into the IDL address space, as described in VMS LINKIMAGE and LIB$FIND_IMAGE_SYMBOL, below.
- Under UNIX, LINKIMAGE uses the `dlopen()` interface to the dynamic linker in all cases except for HP-UX (which uses `shl_load()`) and AIX (which uses `load()`).
- Under Windows, LINKIMAGE uses `LoadLibrary()` to load a 32-bit, Win32 DLL.
- On the PowerPC Macintosh, LINKIMAGE uses the Code Fragment Manager routines `GetDiskFragment()` and `FindSymbol()` to load shared libraries.

Note

Modules must be merged via LINKIMAGE before other procedures and functions that call them are compiled, or the compilation of those routines will fail. Note that because routines merged via LINKIMAGE are considered built-in routines by IDL,

declaring the routine with the FORWARD_FUNCTION statement will not eliminate this restriction.

Syntax

LINKIMAGE, *Name*, *Image* [, *Type* [, *Entry*]] [, /DEVICE] [, /FUNCT] [, /KEYWORDS] [, MAX_ARGS=*value*] [, MIN_ARGS=*value*]

VMS Keywords: [, DEFAULT=*string*]

Arguments

Name

A string containing the IDL name of the function, procedure or device routine which is to be merged. When loading a device driver, *Name* contains the name of the global (also called "universal" under VMS) DEVICE_DEF structure in the driver. Upon successful loading of the routine, a new procedure or function with the given name will exist, or the new device driver will be loaded.

Image

A string that holds the name of the file containing the code to be dynamically linked.

Under VMS, the full interpretation of this argument is discussed in "VMS LINKIMAGE and LIB$FIND_IMAGE_SYMBOL" on page 691. Under other operating systems, this argument contains the full path specification of the dynamically loaded object file. See your system documentation on sharable libraries or DLLs for details.

Type

An optional scalar integer parameter that contains 0 (zero) for a procedure, 1 (one) for a function, and 2 for a device driver. The keyword parameters DEVICE and FUNCT can also be used to indicate the type of routine being merged. The default value is 0, for procedure.

Entry

An optional string that contains the name of the symbol which is the entry point of the procedure or function. With some compilers or operating systems, this name may require the addition of leading or trailing characters. For example, some UNIX C compilers add a leading underscore to the beginning of a function name, and some UNIX FORTRAN compilers add a trailing underscore.

If *Entry* is not supplied, LINKIMAGE will provide a default name by converting the value suppled for *Name* to lower case and adding any special characters (leading or trailing underscores) typical of the system.

Warning

Under Microsoft Windows operating systems, only `cdecl` functions can by used with LINKIMAGE. Attempting to use routines with other calling conventions will yield undefined results, including memory corruption or even IDL crashing.

The Windows operating system has two distinct system defined standards that govern how routines pass arguments: `stdcall`, which is used by much of the operating system as well as languages such as Visual Basic, and `cdecl`, which is used widely for programming in the C language. These standards differ in how and when arguments are pushed onto the system stack. The standard used by a given function is determined when the function is compiled, and can be controlled by the programmer. LINKIMAGE can only be used with `cdecl` functions. Unfortunately, there is no way for IDL to know which convention a given function uses, meaning that LINKIMAGE will quietly accept an entry point of the wrong type. The LINKIMAGE user is responsible for ensuring that Entry is a `cdecl` function.

Keywords

DEFAULT

This keyword is ignored on non-VMS platforms. Under VMS, it is a string containing the default device, directory, file name, and file type information for the file that contains the sharable image. See "VMS LINKIMAGE and LIB$FIND_IMAGE_SYMBOL" on page 691 for additional information.

DEVICE

Set this keyword to indicate that the module being loaded contains a device driver.

FUNCT

Set this keyword to indicate that the module being loaded contains a function.

KEYWORDS

Set this keyword to indicate that the procedure or function being loaded accepts keyword parameters.

MAX_ARGS

Set this keyword equal to the maximum number of non-keyword arguments the procedure or function accepts. If this keyword is not present, the maximum number of parameters is not checked when the routine is called.

Note

It is a very good idea to specify a value for MAX_ARGS. Passing the wrong number of arguments to an external routine may cause unexpected results, including causing IDL to crash. By forcing IDL to check the number of arguments before passing them to the linked routine, you will avoid parameter mismatch problems.

MIN_ARGS

Set this keyword equal to the minimum number of non-keyword arguments accepted by the procedure or function.

VMS LINKIMAGE and LIB$FIND_IMAGE_SYMBOL

Specifying The Library Name

The VMS implementation of LINKIMAGE uses the system runtime library function LIB$FIND_IMAGE_SYMBOL to perform the dynamic linking. This function has a complicated interface in which the name of the library to be linked is given in two separate arguments. We encourage VMS users wishing to use LINKIMAGE to read and fully understand the documentation for LIB$FIND_IMAGE_SYMBOL in order to understand how it is used by IDL. The following discussion assumes that you have a copy of the LIB$FIND_IMAGE_SYMBOL documentation available to consult as you read.

LIB$FIND_IMAGE_SYMBOL uses an argument called *filename* to specify the name of the sharable library or executable to be loaded. Only the actual file name itself is allowed, meaning that none of the file specification punctuation characters (`:`, `[`, `<`, `;`, `.`) are allowed. Filename can also be a logical name, in which case its translated value is the name of the file to be loaded. The translation of such a logical name is allowed to contain additional file specification information. VMS uses this information to find the file to load, using SYS$SHARE as the default location if a location is not specified via a logical name. Alternatively, the user can also supply the optional *image-name* argument, which is used as a “default filespec” to fill in the parts of the file specification not contained in filename. IDL uses the following rules, in the order listed, to determine how to call LIB$FIND_IMAGE_SYMBOL:

1. If LINKIMAGE is called with both the Image argument and DEFAULT keyword, Image is passed to LIB$FIND_IMAGE_SYMBOL as filename, and DEFAULT is passed as image-name. Both are passed directly to the function without any interpretation.
2. If DEFAULT is not present and Image does not contain a file specification character (`:`, `[`, `<`, `;`, `.`) then it is passed to LIB$CALL_IMAGE_SYMBOL as it's filename argument without any further interpretation.
3. If DEFAULT is not present and Image contains a file specification character, then IDL examines it and locates the filename part. The filename part is passed to LIB$FIND_IMAGE_SYMBOL as filename and the entire string from Image is passed as image-name.

This means that although LIB$CALL_IMAGE_SYMBOL has a complicated interface, the LINKIMAGE user can supply a simple file specification for Image and it will be properly loaded by IDL. Full control of LIB$CALL_IMAGE_SYMBOL is still available for those who require it.

Linking To The IDL Executable

LINKIMAGE routines invariably need to call functions supplied by the IDL program. In order to do this, you must link your sharable library with IDL. This requires you to supply the linker with the path (file specification) of the IDL program. The VMS linker in turn includes the path you specify in the resulting library. This can be inconvenient because a library linked this way can only run with the exact IDL executable that it was linked with. This means that you cannot move your IDL installation or keep multiple installations for use with your library. The standard VMS solution to this problem is to use a logical name instead of an actual path. For example, IDL users frequently use the logical name IDL_EXE to point at their IDL executable. To make this process easier and less trouble prone, IDL defines this logical name in the users process logical table when it starts running. Therefore, you can always link with the IDL_EXE logical and know that it will refer to the IDL executable you are actually running when the LINKIMAGE call is made.

Example

To add a procedure called MY_PROC, whose entry symbol is also named MY_PROC, and whose file is pointed to by the logical name MY_PROC_EXE:

```
LINKIMAGE, 'MY_PROC', 'MY_PROC_EXE'
```

Under VMS, to add a device driver contained in the file `DRA0:[SMITH]XXDRIV.EXE`:

```
LINKIMAGE, 'XX_DEV', 'XXDRIV', $
   /DEVICE, DEFAULT='DRA0:[SMITH].EXE'
```

The global symbol `XX_DEV`, which contains the device definition structure, must be defined as universal within the sharable image.

See Also

CALL_EXTERNAL, SPAWN, and the IDL *External Development Guide*.

LIVE_Tools

The LIVE tools allow you to create, modify, and export visualizations directly from the IDL command line. In many cases, you can modify your visualizations using the LIVE tools' graphical user interface directly without ever needing to return the IDL command line. In some cases, however, you may wish to alter your visualizations programmatically rather than using the graphical user interface. Several LIVE routines allow you to do this easily.

The process of using the LIVE tools begins with the creation of a LIVE window via one of the four main LIVE routines: LIVE_CONTOUR, LIVE_IMAGE, LIVE_PLOT, and LIVE_SURFACE. When you use one of these four routines at the IDL command line, you specify some data to be visualized and a LIVE window appears. You can modify many of the properties of the items in your visualization by double-clicking on the item to call up a Properties dialog.

If you find that the graphical user interface does not allow you to perform the operation you wish to perform — saving your visualization as an image file, say — you can use the auxiliary LIVE routines. These routines can be divided into two groups:

- *Overplotting and Annotation Routines* that allow you to add annotations to an existing LIVE window. These routines include LIVE_LINE, LIVE_OPLOT, LIVE_RECT, and LIVE_TEXT. (Lines, rectangles, and text can also be added to LIVE windows using the graphical user interface.)
- *Information and Control Routines* that allow you to get information about an existing LIVE window, alter its properties, or export visualizations. These routines include LIVE_CONTROL, LIVE_DESTROY, LIVE_EXPORT, LIVE_INFO, LIVE_PRINT, and LIVE_STYLE.

To use the auxiliary routines, you will need to know the *Name* of the LIVE window or item you wish to alter. To create an IDL variable containing the names of the elements of a LIVE window, set the REFERENCE_OUT keyword equal to a named variable when you first create your LIVE window. The returned variable will be a structure that contains the names of all of the elements in the visualization you have created. Use the contents of this structure to determine the value of the Name argument for the auxiliary LIVE tools, or to determine the name of the LIVE window you wish to alter.

Note

The LIVE tools do not utilize the !X, !Y, and !Z conventions. Setting these system variables will have no effect on LIVE tool display.

LIVE_CONTOUR

The LIVE_CONTOUR procedure displays contour visualizations in an interactive environment. Because the interactive environment requires extra system resources, this routine is most suitable for relatively small data sets. If you find that performance does not meet your expectations, consider using the Direct Graphics CONTOUR routine or the Object Graphics IDLgrContour class directly.

After LIVE_CONTOUR has been executed, you can double-click on a contour line to display a properties dialog. A set of buttons in the upper left corner of the window allows you to print, undo the last operation, redo the last "undone" operation, copy, draw a line, draw a rectangle, or add text.

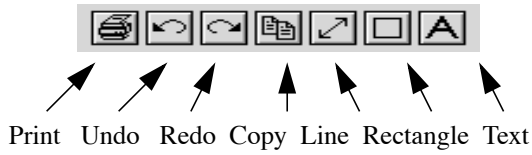


Figure 12: LIVE_CONTOUR Properties Dialog

You can control your LIVE window after it is created using any of several auxiliary routines. See "LIVE_Tools" on page 694 for an explanation.

Syntax

LIVE_CONTOUR [, *Z*$_1$,..., Z$_{25}$] [, /BUFFER] [, DIMENSIONS=*[width, height]*{normal units}] [, /DOUBLE] [, DRAW_DIMENSIONS=*[width, height]*{devive units}] [, ERROR=*variable*] [, /INDEXED_COLOR] [, INSTANCING={-1 | 0 | 1}] [, LOCATION=*[x, y]*{normal units}] [, /MANAGE_STYLE] [, NAME=*structure*] [, /NO_DRAW] [, /NO_SELECTION] [, /NO_STATUS] [, /NO_TOOLBAR] [, PARENT_BASE=*widget_id* | , TLB_LOCATION=*[Xoffset, Yoffset]*{device units}] [, PREFERENCE_FILE=*filename*{full path}] [, REFERENCE_OUT=*variable*] [, RENDERER={0 | 1}] [, REPLACE={*structure* | {0 | 1 | 2 | 3 | 4}}] [, STYLE=*name_or_reference*] [, TEMPLATE_FILE=*filename*] [, TITLE=*string*] [, WINDOW_IN=*string*] [, {X | Y}INDEPENDENT=*value*] [, {/X | /Y}LOG] [, {X | Y}RANGE=*[min, max]*{data units}] [, {X | Y}_TICKNAME=*array*]

Arguments

Zn

A vector of data. Up to 25 of these arguments may be specified. If any of the data is stored in IDL variables of type DOUBLE, LIVE_CONTOUR uses double-precision to store the data and to draw the result.

Keywords

BUFFER

Set this keyword to bypass the creation of a LIVE window and send the visualization to an offscreen buffer. The WINDOW field of the reference structure returned by the REFERENCE_OUT keyword will contain the name of the buffer.

DOUBLE

Set this keyword to force LIVE_CONTOUR to use double-precision to draw the result. This has the same effect as specifying data in the Zn argument using IDL variables of type DOUBLE.

DIMENSIONS

Set this keyword to a two-element, floating-point vector of the form [width, height] specifying the dimensions of the visualization in normalized coordinates. The default is [1.0, 1.0].

DRAW_DIMENSIONS

Set this keyword equal to a vector of the form [width, height] representing the desired size of the LIVE tools draw widget (in pixels). The default is [452, 452].

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

INDEXED_COLOR

If set, the indexed color mode will be used. The default is TrueColor.

INSTANCING

Set this keyword to 1 to instance drawing on, or 0 to turn it off. The default (-1) is to use instancing if and only if the "software renderer" is being used (see RENDERER). For more information, see "Instancing" in the *Objects and Object Graphics* manual.

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.0, 0.0].

Note

LOCATION may be adjusted to take into account window decorations.

MANAGE_STYLE

Set this keyword to have the passed in style item destroyed when the LIVE tool window is destroyed. This keyword has no effect if the STYLE keyword is not set to a style item.

NAME

Set this keyword to a structure containing suggested names for the data items to be created for this visualization. See the REPLACE keyword for details on how they will be used. The fields of the structure are as follows. (Any or all tags may be set.)

Tag	Description
DATA	Dependent Data Name(s)
IX	Independent X Data Name
IY	Independent Y Data Name

Table 24: Fields of the NAME keyword

The default for a field is to use the given variable name. If the variable does not have a name (i.e., is an expression), a default name is automatically generated. The dependent data names will be used in a round-robin fashion if more data than names are input.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing results of LIVE_CONTOUR. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

NO_STATUS

Set this keyword to prevent the creation of the status bar.

NO_TOOLBAR

Set this keyword to prevent the creation of the toolbar.

PARENT_BASE

Set this keyword to the widget ID of an existing base widget to bypass the creation of a LIVE window and create the visualization within the specified base widget.

Note

The location of the draw widget is not settable. It is expected that the user who wishes to insert a tool into their own widget application will determine the setting from the parent base sent to the tool.

Note

LIVE_DESTROY on a window is recommended when using PARENT_BASE so that proper memory cleanup is done. Simply destroying the parent base is not sufficient.

Note

When specifying a PARENT_BASE, that parent base must be running in a non-blocking mode. Putting a LIVE tool into a realized base already controlled by XMANAGER will override the XMANAGER mode to /NO_BLOCK even if blocking had been in effect.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the created items. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name
XAXIS	X-Axis Name
YAXIS	Y-Axis Name
GRAPHIC	Graphic Name(s)
LEGEND	Legend Name
DATA	Dependent Data Name(s)
IX	Independent X Data Name
IY	Independent Y Data Name

Table 25: Fields of the LIVE_CONTOUR Reference Structure

Note

You can also determine the name of an item by opening its properties dialog and checking the “Name” field (or for Windows, by clicking the title bar).

RENDERER

Set this keyword to 1 to use the “software renderer”, or 0 to use the “hardware renderer”. The default (-1) is to use the setting in the IDE (IDL Development Environment) preferences; if the IDE is not running, however, the default is hardware rendering. For more information, see “Hardware vs. Software Rendering” in the *Objects and Object Graphics* manual.

REPLACE

Set this keyword to a structure containing tags as listed for the NAME keyword, with scalar values corresponding to the replacement options listed below. (Any or all of the tags may be set.) The replacement settings are used to determine what action to take when an item (such as data) being input would have the same name as one already existing in the given window or buffer (WINDOW_IN).

Alternatively, this keyword may be set to a single scalar value, which is equivalent to setting each tag of the structure to that choice.

Setting	Action Taken
0	New items will be given unique names.
1	Existing items will be replaced by new items (i.e., the old items will be deleted and new ones created).
2	User will be prompted for the action to take.
3	The values of existing items will be replaced. This will cause dynamic updating to occur for any current uses, e.g., a visualization would redraw to show the new value.
4	Default. Option 0 will be used for items that do not have names (e.g., data input as an expression rather than a named variable, with no name provided via the NAME keyword). Option 3 will be used for all named items.

Table 26: REPLACE keyword Settings and Action Taken

STYLE

Set this keyword to either a string specifying a style name created using LIVE_STYLE.

TITLE

Set this keyword to a string specifying the title to give the main window. It must not already be in use. A default will be chosen if no title is specified.

TLB_LOCATION

Set this keyword to a two-element vector of the form [*Xoffset*, *Yoffset*] specifying the offset (in pixels) of the LIVE window from the upper left corner of the screen. This keyword has no effect if the PARENT_BASE keyword is set. The default is [0, 0].

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer, in which to display the visualization. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. The default is to create a new window.

XINDEPENDENT

Set this keyword to a vector specifying the X values for LIVE_CONTOUR. The default is the data's index values.

Note

Only one independent vector is allowed; all dependent vectors will use the independent vector.

YINDEPENDENT

Set this keyword to a vector specifying the Y values for LIVE_CONTOUR. The default is the data's index values.

Note

Only one independent vector is allowed; all dependent vectors will use the independent vector.

XLOG

Set this keyword to make the X axis a log axis. The default is 0 (linear axis).

YLOG

Set this keyword to make the Y axis a log axis. The default is 0 (linear axis).

XRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the X axis range. The default equals the values computed from the data range.

YRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the Y axis range. The default equals the values computed from the data range.

X_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the X axis. The default equals the values computed from the data range.

Y_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the Yaxis. The default equals the values computed from the data range.

Example

```
; Create a dataset to display:
Z=DIST(10)

; Display the contour. To manipulate contour lines, click on the
; plot to access a graphical user interface.
LIVE_CONTOUR, Z
```

Note

This is a “Live” situation. When data of the same name is used multiple times within the same window, it always represents the same internal data item. For example, if one does the following:

```
Y=indgen(10)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc1
Y=indgen(20)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc2
```

The first plot will update to use the Y of the second plot when the second plot is drawn. If the user wants to display 2 “tweaks” of the same data, a different variable name must be used each time, or at least one should be an expression (thus not a named variable). For example:

```
LIVE_PLOT, Y1,...
LIVE_PLOT, Y2,...
```

or;

```
LIVE_PLOT, Y,...
LIVE_PLOT, myFunc(Y),...
```

In last example, the data of the second visualization will be given a default unique name since an expression rather than a named variable is input.

Note

The above shows the default behavior for naming and replacing data, which can be overridden using the NAME and REPLACE keywords.

See Also

CONTOUR

LIVE_CONTROL

The LIVE_CONTROL procedure allows you to set the properties of (or elements within) a visualization in a LIVE tool from the IDL command line. See "LIVE_Tools" on page 694 for additional discussion of the routines that control the LIVE_ tools.

Note

The LIVE tools do not utilize the !X, !Y, and !Z conventions. Setting these system variables will have no effect on LIVE tool display.

Syntax

LIVE_CONTROL, [*Name*] [, /DIALOG] [, ERROR=*variable*] [, /NO_DRAW] [, PROPERTIES=*structure*] [, /SELECT] [, /UPDATE_DATA] [, WINDOW_IN=*string*]

Arguments

Name

If keywords DIALOG and/or PROPERTIES are used, *Name* is a string (case-insensitive) containing the name of a window visualization or graphic to operate on. WINDOW_IN will default to the window or buffer, if only one is present in the IDL session.

If keyword UPDATE_DATA is used, *Name* must be an IDL variable with the same name as one already used in the given window or buffer (WINDOW_IN). In this case there is no default. If UPDATE_DATA is not set, the parameter must be a name of a window, visualization or visualization element.

Keywords

DIALOG

Set this keyword to have the editable properties dialog of the visualization or graphic appear.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

PROPERTIES

Set this keyword to a properties structure with which to modify the given visualization or graphic. The structure should contain one or more tags as returned from a LIVE_INFO call on the same type of item.

UPDATE_DATA

Set this keyword to force the window to update all of its visualizations that contain the given data passed in the parameter to LIVE_CONTROL.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
; Create a dataset to display:
X=indgen(10)

; Plot the dataset:
LIVE_PLOT, X

; Modify the dataset:
X=X+2
```

```
; Replace old values of X:
LIVE_CONTROL, X, /UPDATE_DATA
```

See Also

LIVE_INFO, LIVE_STYLE

LIVE_DESTROY

The LIVE_DESTROY procedure allows you to destroy a window visualization or an element in a visualization.

Syntax

LIVE_DESTROY, [*Name*$_1$,..., *Name*$_{25}$] [, /ENVIRONMENT] [, ERROR=*variable*] [, /NO_DRAW] [, /PURGE] [, WINDOW_IN=*string*]

Arguments

Name

A string containing the name of a valid LIVE visualization or element. If a visualization is supplied, all components in the visualization will be destroyed. Up to 25 components may be specified in a single call. If not specified, the entire window or buffer (WINDOW_IN) and its contents will be destroyed.

Warning

Using WIDGET_CONTROL to destroy the parent base of a LIVE tool before using LIVE_DESTROY to clean up will leave hanging object references.

Keywords

ENVIRONMENT

Destroys the LIVE_ Tools environment (background processes).

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

PURGE

Destroys LIVE_ Tools (use this keyword for cleaning up the system after fatal errors in LIVE_ Tools). This keyword may cause the loss of data if not used correctly.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_DESTROY, 'Line Plot Visualization'

; Destroy window (if only one window present):
LIVE_DESTROY
```

LIVE_EXPORT

The LIVE_EXPORT procedure allows the user to export a given visualization or window to an image file.

Syntax

LIVE_EXPORT [, /APPEND] [, COMPRESSION={0 | 1 | 2}{TIFF only}] [, /DIALOG] [, DIMENSIONS=*[width, height]*] [, ERROR=*variable*] [, FILENAME=*string*] [, ORDER={0 | 1}{JPEG or TIFF}] [, /PROGRESSIVE{JPEG only}] [, QUALITY={0 | 1 | 2}{for VRML} | {0 to 100}{for JPEG}] [, RESOLUTION=*value*] [, TYPE={'BMP' | 'JPG' | 'PIC' | 'SRF' | 'TIF' | 'XWD' | 'VRML'}] [, UNITS={0 | 1 | 2}] [, VISUALIZATION_IN=*string*] [, WINDOW_IN=*string*]

Arguments

None

Keywords

APPEND

Specifies that the image should be added to the existing file, creating a multi-image TIFF file.

COMPRESSION (TIFF)

Set this keyword to select the type of compression to be used:

- 0 = none (default)
- 2 = PackBits.

DIALOG

Set this keyword to have a dialog appear allowing the user to choose the image type and specifications.

DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the image in units specified by the UNITS keyword. The default is [640, 480] pixels.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

FILENAME

Set this keyword equal to a string specifying the desired name of the image file. The default is `live_export.extension`, where `extension` is one of the following:

```
bmp, jpg, jpeg, pic, pict, srf, tif, tiff, xwd, vrml
```

ORDER (JPEG, TIFF)

Set this keyword to have the image written from top to bottom. Default is bottom to top.

PROGRESSIVE (JPEG)

Set this keyword to write the image as a series of scans of increasing quality. When used with a slow communications link, a decoder can generate a low-quality image very quickly, and then improve its quality as more scans are received.

QUALITY (JPEG, VRML)

This keyword specifies the quality index of VRML images and JPEG images. For VRML, the values are 0=Low, 1=Medium, 2=High. For JPEG the range is 0 ("terrible") to 100 ("excellent"). This keyword has no effect on non-JPEG or non-VRML images.

RESOLUTION

Set this keyword to a floating-point value specifying the device resolution in centimeters per pixel. The default is 72 DPI=2.54 (cm/in)/ 0.0352778 (cm/pixel).

Note

It is important to match the eventual output device's resolution so that text is scaled properly.

TYPE

Set this keyword equal to a string specifying the image type to write. Valid strings are: ‘BMP’, ‘JPG’, ‘JPEG’ (default), ‘PIC’, ‘PICT’, ‘SRF’, ‘TIF’, ‘TIFF’, ‘XWD’, and ‘VRML’.

UNITS

Set this keyword to indicate the units of measure for the DIMENSIONS keyword. Valid values are 0=Device (default), 1=Inches, 2=Centimeters.

VISUALIZATION_IN

Set this keyword equal to the name (string, case-insensitive) of a LIVE tool visualization to export. The VIS field from the REFERENCE_OUT keyword from the creation of the LIVE tool will provide the visualization name. If VISUALIZATION_IN is not specified, the whole window or buffer (WINDOW_IN) will be exported.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer, to export. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_EXPORT, WINDOW_IN='Live Plot 2'
```

LIVE_IMAGE

The LIVE_IMAGE procedure displays visualizations in an interactive environment. Double-click on the image to display a properties dialog. A set of buttons in the upper left corner of the image window allows you to print, undo the last operation, redo the last “undone” operation, copy, draw a line, draw a rectangle, or add text.

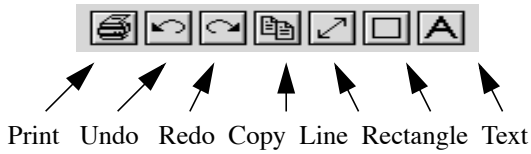


Figure 13: LIVE_IMAGE Properties Dialog

You can control your LIVE window after it is created using any of several auxiliary routines. See “LIVE_Tools” on page 694 for an explanation.

Syntax

LIVE_IMAGE, *Image* [, RED=*byte_vector*] [, GREEN=*byte_vector*] [, BLUE=*byte_vector*] [, /BUFFER] [, DIMENSIONS=*[width, height]*{normal units}] [, DRAW_DIMENSIONS=*[width, height]*{devive units}] [, ERROR=*variable*] [, /INDEXED_COLOR] [, INSTANCING={-1 | 0 | 1}] [, LOCATION=*[x, y]*{normal units}] [, /MANAGE_STYLE] [, NAME=*structure*] [, /NO_DRAW] [, /NO_SELECTION] [, /NO_STATUS] [, /NO_TOOLBAR] [, PARENT_BASE=*widget_id* | , TLB_LOCATION=*[Xoffset, Yoffset]*{device units}] [, PREFERENCE_FILE=*filename*{full path}] [, REFERENCE_OUT=*variable*] [, RENDERER={0 | 1}] [, REPLACE={*structure* | {0 | 1 | 2 | 3 | 4}}] [, STYLE=*name_or_reference*] [, TEMPLATE_FILE=*filename*] [, TITLE=*string*] [, WINDOW_IN=*string*]

Arguments

Image

A two- or three-dimensional array of image data. The three-dimensional array must be for the form [3,X,Y] or [X,3,Y] or [X,Y,3].

Keywords

BLUE

Set this keyword equal to a byte vector of blue values.

Note

The BLUE, GREEN, and RED keywords are only used for 2D image data. They are used to form the color table. The 2D array is a set of values that are just indexes into this table.

BUFFER

Set this keyword to bypass the creation of a LIVE window and send the visualization to an offscreen buffer. The WINDOW field of the reference structure returned by the REFERENCE_OUT keyword will contain the name of the buffer.

DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the image in units specified by the UNITS keyword. The default is [1.0, 1.0].

DRAW_DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the size of the LIVE tools draw widget (in pixels). The default is [452, 452].

Note

This default value may be different depending on previous template projects.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

GREEN

Set this keyword equal to a byte vector of green values.

Note

The BLUE, GREEN, and RED keywords are only used for 2D image data. They are used to form the color table. The 2D array is a set of values that are just indexes into this table.

INDEXED_COLOR

If set, the indexed color mode will be used. The default is TrueColor. (See *Using IDL* for more information on color modes.*)*

INSTANCING

Set this keyword to 1 to instance drawing on, or 0 to turn it off. The default (-1) is to use instancing if and only if the "software renderer" is being used (see RENDERER). For more information, see "Instancing" in the *Objects and Object Graphics* manual.

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.0, 0.0].

Note

LOCATION may be adjusted to take into account window decorations.

MANAGE_STYLE

Set this keyword to have the passed in style item destroyed when the LIVE tool window is destroyed. This keyword will have no effect if the STYLE keyword is not set to a style item.

NAME

Set this keyword to a structure containing suggested names for the items to be created for this visualization. See the REPLACE keyword for details on how they will be used. The fields of the structure are as follows. (Any or all of the tags may be set.)

Tag	Description
DATA	Dependent Data Name(s)
CT	Color Table Name

Table 27: Fields of the NAME keyword

The default for a field is to use the given variable name. If the variable does not have a name (i.e., is an expression), a default name is automatically generated.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing results of LIVE_CONTOUR. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

NO_STATUS

Set this keyword to prevent the creation of the status bar.

NO_TOOLBAR

Set this keyword to prevent the creation of the toolbar.

PARENT_BASE

Set this keyword to the widget ID of an existing base widget to bypass the creation of a LIVE window and create the visualization within the specified base widget.

Note

The location of the draw widget is not settable. It is expected that the user who wishes to insert a tool into their own widget application will determine the setting from the parent base sent to the tool.

Note

LIVE_DESTROY on a window is recommended when using PARENT_BASE so that proper memory cleanup is done. Simply destroying the parent base is not sufficient.

Note

When specifying a PARENT_BASE, that parent base must be running in a non-blocking mode. Putting a LIVE tool into a realized base already controlled by XMANAGER will override the XMANAGER mode to /NO_BLOCK even if blocking had been in effect.

RED

Set this keyword equal to a byte vector of red values.

Note

The BLUE, GREEN, and RED keywords are only used for 2D image data. They are used to form the color table. The 2D array is a set of values that are just indexes into this table.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the created items. The fields of the structure are shown in the following table. Note that the COLORBAR* field does not show up with TrueColor images:

Tag	Description
WIN	Window Name
VIS	Visualization Name
GRAPHIC	Graphic Name
CT	Color Table Name
COLORBAR*	Colorbar Name
DATA	Data Name

Table 28: Fields of the LIVE_IMAGE Reference Structure

RENDERER

Set this keyword to 1 to use the “software renderer”, or 0 to use the “hardware renderer”. The default (-1) is to use the setting in the IDE (IDL Development Environment) preferences; if the IDE is not running, however, the default is hardware rendering. For more information, see “Hardware vs. Software Rendering” in the *Objects and Object Graphics* manual.

REPLACE

Set this keyword to a structure containing tags as listed for the NAME keyword, with scalar values corresponding to the replacement options listed below. (Any or all of the tags may be set.) The replacement settings are used to determine what action to take when an item (such as data) being input would have the same name as one already existing in the given window or buffer (WINDOW_IN).

Setting	Action Taken
0	New items will be given unique names.
1	Existing items will be replaced by new items (i.e., the old items will be deleted and new ones created).
2	User will be prompted for the action to take.
3	The values of existing items will be replaced. This will cause dynamic updating to occur for any current uses, e.g., a visualization would redraw to show the new value.
4	Default. Option 0 will be used for items that do not have names (e.g., data input as an expression rather than a named variable, with no name provided via the NAME keyword). Option 3 will be used for all named items.

Table 29: REPLACE keyword Settings and Action Taken

STYLE

Set this keyword to either a string specifying a style name created using LIVE_STYLE.

TITLE

Set this keyword to a string specifying the title to give the main window. It must not already be in use. A default will be chosen if no title is specified.

TLB_LOCATION

Set this keyword to a two-element vector of the form [*Xoffset*, *Yoffset*] specifying the offset (in pixels) of the LIVE window from the upper left corner of the screen. This keyword has no effect if the PARENT_BASE keyword is set. The default is [0, 0].

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window, or a LIVE tool buffer, in which to display the visualization. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. The default is to create a new window.

Example

```
LIVE_IMAGE, myImage
```

See Also

TV, TVSCL

LIVE_INFO

The LIVE_INFO procedure allows the user to get the properties of a LIVE tool.

Syntax

LIVE_INFO, [*Name*] [, ERROR=*variable*] [, PROPERTIES=*variable*]
[, WINDOW_IN=*string*]

Arguments

Name

A string containing the name of a visualization or element (case-insensitive). The default is to use the window or buffer (WINDOW_IN).

Keywords

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

PROPERTIES

Set this keyword to a named variable to contain the returned properties structure. For a description of the structures, see Properties Structures below.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Structure Tables for LIVE_INFO and LIVE CONTROL

The following tables describe the properties structures used by LIVE_INFO and LIVE_CONTROL (via the PROPERTIES keyword) for:

- Color Names
- Line Annotations
- Rectangle Annotations
- Text Annotations
- Axes
- Colorbars
- Images
- Legends
- Surfaces
- Entire Visualizations
- Windows

Color Names

The following color names are the possible values for color properties:

- Black
- Blue
- Light Gray
- Light Blue
- Red
- Magenta
- Brown
- Light Cyan
- Green
- Cyan
- Light Red
- Light Magenta
- Yellow
- Dark Gray
- Light Green
- White

Line Annotations

The fields in the properties structure of Line Annotations are as follows:

Tag	Description
thick	1 to 10 pixels

Table 30: Line Annotation Properties Structure

Tag	Description
arrow_start	1 = arrow head at line start, 0 = no arrowhead
arrow_end	1 = arrow head at line start, 0 = no arrowhead
arrow_size	0.0 to 0.3 normalized units
arrow_angle	1.0 to 179.0 degrees
linestyle	0=solid, 1=dotted, 2=dashed, 3=dash dot, 4=dash dot dot, 5=long dash
hide	1 = hidden, 0 = visible
name	scalar string (unique within all graphics)
color	see "Color Names" on page 719
location	[x, y] normalized units
dimensions	[width, height] normalized units
uvalue	any value of any type (only returned in structure if defined)

Table 30: Line Annotation Properties Structure

Rectangle Annotations

The fields in the properties structure of Rectangle Annotations are as follows:

Tag	Description
thick	1 to 10 pixels
linestyle	0=solid, 1=dotted, 2=dashed, 3=dash dot, 4=dash dot dot, 5=long dash
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
color	see "Color Names" on page 719
location	[x, y] normalized units
dimensions	[width, height] normalized units

Tag	Description
uvalue	any value of any type (only returned in structure if defined)

Table 31: Rectangle Annotation Properties Structure

Text Annotations

The fields in the properties structure of Text Annotations are as follows:

Tag	Description
fontsize	9 to 72 points
fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
textangle	0.0 to 360.0 degrees
alignment	0.0 to 1.0 where 0.0 = right justified and 1.0 = left justified
location	[x, y] normalized units
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
value	string (scalar or vector) annotation formula (see note below)
enable_formatting	set to allow "!" chars for font commands
color	see "Color Names" on page 719
uvalue	any value of any type (only returned in structure if defined)

Table 32: Text Annotation Properties Structure

Note

Each vector element of the annotation formula (see "value" tag above) is parsed once, left to right, for vertical bars (|).

- Two vertical bars surrounding a data item name will be replaced by the corresponding data value(s), possibly requiring multiple lines.
- Two adjacent bars will be replaced by a single bar.
- Two bars surrounding text that is not a data item name will be left as is.

Axes

The fields in the properties structure of Axes are as follows:

Tag	Description
title_FontSize	9 to 72 points
title_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
title_Color	see "Color Names" on page 719
tick_FontSize	9 to 72 points
tick_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
tick_FontColor	see "Color Names" on page 719
gridStyle	see linestyle
color	see "Color Names" on page 719
thick	1 to 10 pixels
location	[x, y] data units
minor	number of minor ticks (minimum 0)
major	number of major ticks (minimum 0)
default_minor	set to compute default number of minor ticks
default_major	set to compute default number of major ticks
tickLen	normalized units * 100 = percent of visualization dimensions
subticklen	normalized units * 100 = percent of ticklen
tickDir	0 = up (or right), 1 = down (or left)
textPos	0 = below (or left), 1 = above (or right)
tickFormat	standard IDL FORMAT string (See STRING function) excluding parentheses
exact	set to use exact range specified
log	set to display axis as log

Table 33: Axis Properties Structure

Tag	Description
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
compute_range	set to compute axis range from data min/max
tickName	if defined, vector of strings to use at major tick marks
uvalue	any value of any type (only returned in structure if defined)

Table 33: Axis Properties Structure

Colorbars

The fields in the properties structure of Colorbars are as follows:

Tag	Description
title_Fontsize	9 to 72 points
title_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
title_Color	see "Color Names" on page 719
tick_FontSize	see fontsize
tick_Fontname	see fontname
tick_FontColor	see "Color Names" on page 719
color	see "Color Names" on page 719
thick	1 to 10 pixels
location	[x, y]; where [0, 0] = lower left and [1, 1] = position where the entire colorbar fits into the upper right of the visualization
minor	number of minor ticks (minimum 0)
major	number of major ticks (minimum 0)
default_minor	set to compute default number of minor ticks
default_major	set to compute default number of major ticks

Table 34: Colorbar Properties Structure

Tag	Description
tickLen	normalized units * 100 = percent of visualization dimensions
subticklen	normalized units * 100 = percent of ticklen
tickFormat	standard IDL FORMAT string (See STRING function) excluding parentheses
show_axis	set to display the colorbar axis
show_outline	set to display the colorbar outline
axis_thick	see thick
dimensions	[width, height] normalized units
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in structure if defined)

Table 34: Colorbar Properties Structure

Contours

The fields in the properties structure of Contours are as follows:

Tag	Description
min_value	minimum contour value to display
max_value	maximum contour value to display
downhill	set to display downhill tick marks
fill	set to display contour levels as filled
c_thick	vector of thickness values (see thick)
c_linestyle	vector of linestyle values (see linestyle)
c_color	vector of color names (see “Color Names” on page 719)
default_n_levels	set to default the number of levels
n_levels*	specify a positive number for a specific number of levels

Table 35: Contour Properties Structure

Tag	Description
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in structure if defined)
*The MIN and MAX value of the data are returned as contour levels when N_LEVELS is set. Because of this, when setting N_LEVELS, contour plots appear to have N-2 contour levels because the first (MIN) and last (MAX) level is not shown. With LIVE_CONTOUR, this results in a legend that contains unnecessary items in the legend (the MIN and the MAX contour level).	

Table 35: Contour Properties Structure

Images

The fields in the properties structure of Images are as follows:

Tag	Description
order	set to draw from top to bottom
sizing_constraint	[0|1|2] 0=Natural, 1=Aspect, 2=Unrestricted
dont_byte_scale	set to inhibit byte scaling the image
palette	name of managed colortable
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in LIVE_INFO structure if defined)

Table 36: Image Properties Structure

Legends

The fields in the properties structure of Legends are as follows:

Tag	Description
title_FontSize	9 to 72 points

Table 37: Legend Properties Structure

Tag	Description
title_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
title_Color	see “Color Names” on page 719
item_fontSize	see fontsize
item_fontName	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
text_color	color of item text (see “Color Names” on page 719)
border_gap	normalized units * 100 = percent of item text height
columns	number of columns to display the items in (minimum 0)
gap	normalized units * 100 = percent of item text height
glyph_Width	normalized units * 100 = percent of item text height
fill_color	see “Color Names” on page 719
outline_color	see “Color Names” on page 719
outline_thick	see thick
location	[x, y]; where [0, 0] = lower left and [1, 1] = position where the entire legend fits into the upper right of the visualization
show_fill	set to display the fill color
show_outline	set to display the legend outline
title_text	String to display in the legend title
item_format	standard IDL FORMAT string (See STRING function) excluding parentheses (contour legends only)
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in structure if defined)

Table 37: Legend Properties Structure

Surfaces

The fields in the properties structure of Surfaces are as follows:

Tag	Description
min_value	minimum plot line value to display
max_value	maximum plot line value to display
lineStyle	0=solid, 1=dotted, 2=dashed, 3=dash dot, 4=dash dot dot, 5=long dash
color	see "Color Names" on page 719
thick	1 to 10 pixels
bottom	see "Color Names" on page 719
style	0=point, 1=wire, 2=solid, 3=ruledXZ, 4=ruledYZ, 5=lego (wire), 6=lego (solid)
shading	0=flat, 1=Gouraud
hidden_lines	set to not display hidden lines or points
show_skirt	set to display the surface skirt
skirt	z value at which skirt is drawn (data units)
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in structure if defined)

Table 38: Surface Properties Structure

Entire Visualizations

The fields in the properties structure of Entire Visualizations are as follows:

Tag	Description
location	[x, y] normalized units
dimensions	[width, height] normalized units

Table 39: Visualization Properties Structure

Tag	Description
transparent	set to avoid erasing to the background color
color	background color (see “Color Names” on page 719)
hide	1=hidden, 0=visible
name	scalar string (unique within all graphics)
uvalue	any value of any type (only returned in structure if defined)

Table 39: Visualization Properties Structure

Windows

The fields in the properties structure of Windows are as follows:

Tag	Description
dimensions	2-element integer vector (pixels)
hide	boolean (0=show, 1=hide)
location	2-element integer vector (pixels) from upper left corner of screen
title	string

Table 40: Windows Properties Structure

Example

```
LIVE_INFO, 'x axis', PROPERTIES=myProps
```

See Also

LIVE_CONTROL, LIVE_STYLE

LIVE_LINE

The LIVE_LINE procedure is an interface for line annotation.

Syntax

LIVE_LINE [, ARROW_ANGLE=*value*{1.0 to 179.0}] [, /ARROW_END]
[, ARROW_SIZE=*value*{0.0 to 0.3}] [, /ARROW_START] [, COLOR='*color name*'
] [, /DIALOG] [, DIMENSIONS=*[width*, *height]*] [, ERROR=*variable*] [, /HIDE]
[, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, LOCATION=*[x*, *y]*] [, NAME=*string*]
[, /NO_DRAW] [, /NO_SELECTION] [, REFERENCE_OUT=*variable*]
[, THICK=pixels{1 to 10}] [, VISUALIZATION_IN=*string*]
[, WINDOW_IN=*string*]

Arguments

None

Keywords

ARROW_ANGLE

Set this keyword to a floating-point number between 1.0 and 179.0 degrees to indicate the angle of the arrowheads. The default is 30.0.

ARROW_END

Set this keyword to indicate an arrowhead should be drawn at the end of the line. It is not drawn by default.

ARROW_SIZE

Set this keyword to a floating-point number between 0.0 and 0.3 (normalized coordinates) to indicate the size of the arrowheads. The default is 0.02.

ARROW_START

Set this keyword to indicate an arrowhead should be drawn at the start of the line. It is not drawn by default.

COLOR

Set this keyword to a string (case-sensitive) of the color to be used for the line. The default is ‘Black’. The following colors are available:

- Black
- Blue
- Light Gray
- Light Blue
- Red
- Magenta
- Brown
- Light Cyan
- Green
- Cyan
- Light Red
- Light Magenta
- Yellow
- Dark Gray
- Light Green
- White

DIALOG

Set this keyword to display the line properties dialog appear. The dialog will have all known properties supplied by keywords filled in.

DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the X and Y components of the line in normalized coordinates. The default is [0.2, 0.2].

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

HIDE

Set this keyword to a boolean value indicating whether this item should be hidden.

- 0 = Visible (default)
- 1 = Hidden

LINESTYLE

Set this keyword to a pre-defined line style integer:

- 0 = solid line (default)

- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.5, 0.5].

Note

LOCATION may be adjusted to take into account window decorations.

NAME

Set this keyword equal to a string containing the name to be associated with this item. The name must be unique within the given window or buffer (WINDOW_IN). If not specified, a unique name will be assigned automatically.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining names of the modified visualization's properties. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name
GRAPHIC	Graphic Name the line created

Table 41: Fields of the LIVE_LINE Reference Structure

THICK

Set this keyword to an integer value between 1 and 10, specifying the line thickness to be used to draw the line, in pixels. The default is one pixel.

VISUALIZATION_IN

Set this keyword equal to the name (string, case-insensitive) of a LIVE tool visualization. The VIS field from the REFERENCE_OUT keyword from the creation of the LIVE tool will provide the visualization name. If only one visualization is present in the window or buffer (WINDOW_IN), this keyword will default to it.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_LINE, WINDOW_IN='Live Plot 2', $
   VISUALIZATION_IN='line plot visualization'
; Units are in the visualization units ( based on axis ranges).
```

See Also

LIVE_RECT, LIVE_TEXT

LIVE_LOAD

The LIVE_LOAD procedure loads into memory the complete set of routines necessary to run all LIVE tools. By default, portions of the set are loaded when first needed during the IDL session. If you expect to frequently use the tools, you may wish to call LIVE_LOAD from your IDL “startup file”.

Syntax

LIVE_LOAD

Arguments

None

Keywords

None

LIVE_OPLOT

The LIVE_OPLOT procedure allows the insertion of data into pre-existing plots.

Syntax

LIVE_OPLOT, *Yvector1* [,... , *Yvector25*] [, ERROR=*variable*] [, INDEPENDENT=*vector*] [, NAME=*structure*] [, /NEW_AXES] [, /NO_DRAW] [, /NO_SELECTION] [, REFERENCE_OUT=*variable*] [, REPLACE={*structure* | {0 | 1 | 2 | 3 | 4}}] [, SUBTYPE={'LinePlot' | 'ScatterPlot' | 'Histogram' | 'PolarPlot'}] [, VISUALIZATION_IN=*string*] [, WINDOW_IN=*string*] [, {X | Y}_TICKNAME=*array*] [, {X | Y}AXIS_IN=*string*]

Arguments

YVector

A vector argument of data. Up to 25 of these arguments may be specified.

Keywords

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

INDEPENDENT

Set this keyword to an independent vector specifying the X-Values for LIVE_OPLOT.

NAME

Set this keyword to a structure containing suggested names for the data items to be created for this visualization. See the REPLACE keyword for details on how they

will be used. The fields of the structure are as follows. (Any or all of the tags may be set.)

Tag	Description
DATA	Dependent Data Name(s)
I	Independent Data Name

Table 42: Fields of the NAME keyword

The default for a field is to use the given variable name. If the variable does not have a name (i.e., is an expression), a default name is automatically generated. The dependent data names will be used in a round-robin fashion if more data than names are input.

Note

Only one independent vector is allowed; all dependent vectors will use the independent vector.

NEW_AXES

Set this keyword to generate a new set of axes for this plot line. If this keyword is specified, the [XY]AXIS_IN keywords will not be used.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the modified items. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name

Table 43: Fields of the LIVE_OPLOT Reference Structure

Tag	Description
XAXIS	X-Axis Name
YAXIS	Y-Axis Name
GRAPHIC	Graphic Name(s)
LEGEND	Legend Name
DATA	Dependent Data Name(s)
I	Independent Data Name

Table 43: Fields of the LIVE_OPLOT Reference Structure

REPLACE

Set this keyword to a structure containing tags as listed for the NAME keyword, with scalar values corresponding to the replacement options listed below. (Any or all of the tags may be set.) The replacement settings are used to determine what action to take when an item (such as data) being input would have the same name as one already existing in the given window or buffer (WINDOW_IN).

Setting	Action Taken
0	New items will be given unique names.
1	Existing items will be replaced by new items (i.e., the old items will be deleted and new ones created).
2	User will be prompted for the action to take.
3	The values of existing items will be replaced. This will cause dynamic updating to occur for any current uses, e.g., a visualization would redraw to show the new value.
4	Default. Option 0 will be used for items that do not have names (e.g., data input as an expression rather than a named variable, with no name provided via the NAME keyword). Option 3 will be used for all named items.

Table 44: REPLACE keyword Settings and Action Taken

SUBTYPE

Set this keyword to a string (case-insensitive) containing the desired type of plot. SUBTYPE defaults to whatever is being inserted into, if the [XY]AXIS_IN keyword is set. If the keywords are not set, then the default is line plot. Valid strings are:

- ‘LinePlot’ (default)
- ‘ScatterPlot’
- ‘Histogram’
- ‘PolarPlot’

Note

If inserting into a group (defined by the set of axes) that is polar, SUBTYPE cannot be defined as line, scatter, or histogram. The opposite is also true: if inserting into a line, scatter, or histogram group, then SUBTYPE cannot be defined as polar.

VISUALIZATION_IN

Set this keyword equal to the name (string, case-insensitive) of a LIVE tool visualization. The VIS field from the REFERENCE_OUT keyword from the creation of the LIVE tool will provide the visualization name. If only one visualization is present in the window or buffer (WINDOW_IN), this keyword will default to it.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

X_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the X axis. The default equals the values computed from the data range.

Y_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the Yaxis. The default equals the values computed from the data range.

XAXIS_IN

Set this keyword equal to the string name of an existing axis. The name can be obtained from the REFERENCE_OUT keyword, or visually from the GUI. The default is to use the first set of axes in the plot.

Note

If this keyword is set, you must also set the YAXIS_IN keyword, and both keywords must be set to a "pair" of axes. The X and Y axes given must be associated with the same plot line.

YAXIS_IN

Set this keyword equal to the string name of an existing axis. The name can be obtained from the REFERENCE_OUT keyword, or visually from the GUI. The default is to use the first set of axes in the plot.

Note

If this keyword is set, you must also set the XAXIS_IN keyword, and both keywords must be set to a "pair" of axes. The X and Y axes given must be associated with the same plot line.

Example

```
LIVE_OPLOT, tempData, pressureData
```

See Also

LIVE_PLOT, PLOT, OPLOT

LIVE_PLOT

The LIVE_PLOT procedure creates an interactive plotting environment.

Click on a section of the plot to display a properties dialog. A set of buttons in the upper left corner of the image window allows you to print, undo the last operation, redo the last “undone” operation, copy, draw a line, draw a rectangle, or add text.

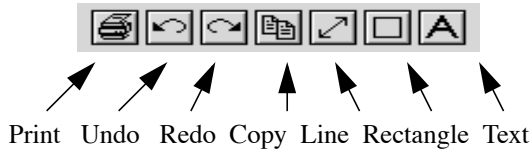


Figure 14: LIVE_PLOT Properties Dialog

You can control your LIVE window after it is created using any of several auxiliary routines. See “LIVE_Tools” on page 694 for an explanation.

Syntax

LIVE_PLOT, *Yvector1* [, *Yvector2*,..., *Yvector25*] [, /BUFFER]
[, DIMENSIONS=*[width*, *height]*{normal units}] [, /DOUBLE]
[, DRAW_DIMENSIONS=*[width*, *height]*{devive units}] [, ERROR=*variable*]
[, /HISTOGRAM | , /LINE | , /POLAR | , /SCATTER] [, /INDEXED_COLOR]
[, INSTANCING={-1 | 0 | 1}] [, LOCATION=*[x*, *y]*{normal units}]
[, INDEPENDENT=*vector*] [, /MANAGE_STYLE] [, NAME=*structure*]
[, /NO_DRAW] [, /NO_SELECTION] [, /NO_STATUS] [, /NO_TOOLBAR]
[, PARENT_BASE=*widget_id* | , TLB_LOCATION=*[Xoffset*, *Yoffset]*{device units}] [, PREFERENCE_FILE=*filename*{full path}]
[, REFERENCE_OUT=*variable*] [, RENDERER={0 | 1}] [, REPLACE={*structure* | {0 | 1 | 2 | 3 | 4}}] [, STYLE=*name_or_reference*] [, TEMPLATE_FILE=*filename*]
[, TITLE=*string*] [, WINDOW_IN=*string*] [, {/X | /Y}LOG] [, {X | Y}RANGE=*[min, max]*{data units}] [, {X | Y}_TICKNAME=*array*]

Arguments

YVector

A vector of data. Up to 25 of these arguments may be specified. If any of the data is stored in IDL variables of type DOUBLE, LIVE_PLOT uses double precision to store the data and to draw the result.

Keywords

BUFFER

Set this keyword to bypass the creation of a LIVE window and send the visualization to an offscreen buffer. The WINDOW field of the reference structure returned by the REFERENCE_OUT keyword will contain the name of the buffer.

DIMENSIONS

Set this keyword to a two-element, floating-point vector specifying the dimensions of the visualization in normalized coordinates. The default is [1.0, 1.0].

DOUBLE

Set this keyword to force LIVE_PLOT to use double-precision to draw the result. This has the same effect as specifying data in the YVector argument using IDL variables of type DOUBLE.

DRAW_DIMENSIONS

Set this keyword equal to a vector of the form [width, height] representing the desired size of the LIVE tools draw widget (in pixels). The default is [452, 452].

Note

This default value may be different depending on previous template projects.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

HISTOGRAM

Set this keyword to represent plot values as a histogram.

INDEPENDENT

Set this keyword to an independent vector specifying X-values for LIVE_PLOT.

INDEXED_COLOR

If set, the indexed color mode will be used. The default is TrueColor. (See *Using IDL* for more information on color modes.*)*

INSTANCING

Set this keyword to 1 to instance drawing on, or 0 to turn it off. The default (-1) is to use instancing if and only if the "software renderer" is being used (see RENDERER). For more information, see "Instancing" in the *Objects and Object Graphics* manual.

LINE

Set this keyword to represent plot values as a line plot. This is the default. Alternate choices are provided by keywords HISTOGRAM, POLAR, and SCATTER.

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.0, 0.0].

Note

LOCATION may be adjusted to take into account window decorations.

MANAGE_STYLE

Set this keyword to have the passed in style item destroyed when the LIVE tool window is destroyed. This keyword will have no effect if the STYLE keyword is not set to a style item.

NAME

Set this keyword to a structure containing suggested names for the data items to be created for this visualization. See the REPLACE keyword for details on how they

will be used. The fields of the structure are as follows. (Any or all of the tags may be set.)

Tag	Description
DATA	Dependent Data Name(s)
I	Independent Data Name

Table 45: Fields of the NAME keyword

The default for a field is to use the given variable name. If the variable does not have a name (i.e., is an expression), a default name is automatically generated. The dependent data names will be used in a round-robin fashion if more data than names are input.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

NO_STATUS

Set this keyword to prevent the creation of the status bar.

NO_TOOLBAR

Set this keyword to prevent the creation of the toolbar.

PARENT_BASE

Set this keyword to the widget ID of an existing base widget to bypass the creation of a LIVE window and create the visualization within the specified base widget.

Note

The location of the draw widget is not settable. To insert a tool into your widget application, you must determine the setting from the parent base sent to the tool. LIVE_DESTROY on a window is recommended when using PARENT_BASE so that proper memory cleanup is done. Destroying the parent base is not sufficient.

Note

When specifying a PARENT_BASE, that parent base must be running in a non-blocking mode. Putting a LIVE tool into a realized base already controlled by

XMANAGER will override the XMANAGER mode to /NO_BLOCK even if blocking had been in effect.

POLAR

Set this keyword to represent plot values as a polar plot. In this case, the arguments to LIVE_PLOT represent values of r (radius), while the INDEPENDENT keyword represents the values of T (angle theta). If POLAR is set, you must specify INDEPENDENT.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the modified items. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name
XAXIS	X-Axis Name
YAXIS	Y-Axis Name
GRAPHIC	Graphic Name(s)
LEGEND	Legend Name
DATA	Dependent Data Name(s)
I	Independent Data Name

Table 46: Fields of the LIVE_PLOT Reference Structure

RENDERER

Set this keyword to 1 to use the “software renderer”, or 0 to use the “hardware renderer”. The default (-1) is to use the setting in the IDE (IDL Development Environment) preferences; if the IDE is not running, however, the default is hardware rendering. For more information, see “Hardware vs. Software Rendering” in the *Objects and Object Graphics* manual.

REPLACE

Set this keyword to a structure containing tags as listed for the NAME keyword, with scalar values corresponding to the replacement options listed below. (Any or all of

the tags may be set.) The replacement settings are used to determine what action to take when an item (such as data) being input would have the same name as one already existing in the given window or buffer (WINDOW_IN).

Setting	Action Taken
0	New items will be given unique names.
1	Existing items will be replaced by new items (i.e., the old items will be deleted and new ones created).
2	User will be prompted for the action to take.
3	The values of existing items will be replaced. This will cause dynamic updating to occur for any current uses, e.g., a visualization would redraw to show the new value.
4	Default. Option 0 will be used for items that do not have names (e.g., data input as an expression rather than a named variable, with no name provided via the NAME keyword). Option 3 will be used for all named items.

Table 47: REPLACE keyword Settings and Action Taken

SCATTER

Set this keyword to represent plot values as a scatter plot.

STYLE

Set this keyword to either a string specifying a style name created with LIVE_STYLE.

Note

If STYLE is not set, the default plot style will be used.

TITLE

Set this keyword to a string specifying the title to give the main window. It must not already be in use. A default will be chosen if no title is specified.

TLB_LOCATION

Set this keyword to a two-element vector of the form [*Xoffset*, *Yoffset*] specifying the offset (in pixels) of the LIVE window from the upper left corner of the screen. This keyword has no effect if the PARENT_BASE keyword is set. The default is [0, 0].

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer, in which to display the visualization. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. The default is to create a new window.

XLOG

Set this keyword to make the X axis a log axis. The default is 0 (linear axis).

YLOG

Set this keyword to make the Y axis a log axis. The default is 0 (linear axis).

XRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the X axis range. The default equals the values computed from the data range.

YRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the Y axis range. The default equals the values computed from the data range.

X_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the X axis. The default equals the values computed from the data range.

Y_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the Yaxis. The default equals the values computed from the data range.

Example

```
; Plot two data sets simultaneously:
LIVE_PLOT, tempdata, pressureData
```

Note

This is a “Live” situation. When data of the same name is used multiple times within the same window, it always represents the same internal data item. For example, if one does the following:

```
Y= indgen(10)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc1
Y = indgen(20)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc2
```

The first plot will update to use the Y of the second plot when the second plot is drawn. If the user wants to display 2 “tweaks” of the same data, a different variable name must be used each time, or at least one should be an expression (thus not a named variable). For example:

```
LIVE_PLOT, Y1,...
LIVE_PLOT, Y2,...
```

or

```
LIVE_PLOT, Y,...
LIVE_PLOT, myFunc(Y),...
```

In last example, the data of the second visualization will be given a default unique name since an expression rather than a named variable is input.

Note

The above shows the default behavior for naming and replacing data, which can be overridden using the NAME and REPLACE keywords.

See Also

LIVE_OPLOT, PLOT, OPLOT

LIVE_PRINT

The LIVE_PRINT procedure allows the user to print a given window to the printer.

Syntax

LIVE_PRINT [, /DIALOG] [, ERROR=*variable*] [, WINDOW_IN=*string*]

Macintosh Keywords: [, /SETUP]

Arguments

None

Keywords

DIALOG

Set this keyword to have a print dialog appear.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

SETUP

(Macintosh users only) Set this keyword to have a printer setup dialog appear. This keyword allows the user to setup the page for printing.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_PRINT, WINDOW_IN='Live Plot 2'
```

See Also

DIALOG_PRINTJOB, DIALOG_PRINTERSETUP

LIVE_RECT

The LIVE_RECT procedure is an interface for insertion of rectangles.

Syntax

LIVE_RECT [, COLOR='*color name*'] [, /DIALOG] [, DIMENSIONS=*[width, height]*] [, ERROR=*variable*] [, /HIDE] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, LOCATION=*[x, y]*] [, NAME=*string*] [, /NO_DRAW] [, /NO_SELECTION] [, REFERENCE_OUT=*variable*] [, THICK=*pixels*{1 to 10}] [, VISUALIZATION_IN=*string*] [, WINDOW_IN=*string*]

Arguments

None

Keywords

COLOR

Set this keyword to a string (case-sensitive) of the color to be used for the rectangle. The default is 'Black'. The following colors are available:

- Black
- Blue
- Light Gray
- Light Blue
- Red
- Magenta
- Brown
- Light Cyan
- Green
- Cyan
- Light Red
- Light Magenta
- Yellow
- Dark Gray
- Light Green
- White

DIALOG

Set this keyword to have the rectangle dialog appear. This dialog will fill in known attributes from set keywords.

DIMENSIONS

Set this keyword to a two-element, floating-point vector of the form [width, height] to specify the dimensions of the rectangle in normalized coordinates. The default is [0.2, 0.2].

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

HIDE

Set this keyword to a boolean value indicating whether this item should be hidden.

- 0 = Visible (default)
- 1 = Hidden

LINESTYLE

Set this keyword to a pre-defined line style integer:

- 0 = Solid line (default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.5, 0.5].

Note

LOCATION may be adjusted to take into account window decorations.

NAME

Set this keyword equal to a string containing the name to be associated with this item. The name must be unique within the given window or buffer (WINDOW_IN). If not specified, a unique name will be assigned automatically.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the modified items. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name
GRAPHIC	Graphic Name the rectangle created

Table 48: Fields of the LIVE_RECT Reference Structure

THICK

Set this keyword to an integer value between 1 and 10, specifying the line thickness to be used to draw the line, in pixels. The default is one pixel.

VISUALIZATION_IN

Set this keyword equal to the name (string, case-insensitive) of a LIVE tool visualization. The VIS field from the REFERENCE_OUT keyword from the creation of the LIVE tool will provide the visualization name. If only one visualization is present in the window or buffer (WINDOW_IN), this keyword will default to it.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_RECT, LOCATION=[0.1,0.1],DIMENSIONS=[0.2,0.2],$
   WINDOW_IN='Live Plot 2',VISUALIZATION_IN='line plot'
```

See Also

LIVE_LINE, LIVE_TEXT

LIVE_STYLE

The LIVE_STYLE function allows the user to create a style.

Syntax

Style = LIVE_STYLE ({ 'contour' | 'image' | 'plot' | 'surface'}
[, BASE_STYLE=*style_name*] [, COLORBAR_PROPERTIES=*structure*]
[, ERROR=*variable*] [, GRAPHIC_PROPERTIES=*structure*] [, GROUP=*widget_id*]
[, LEGEND_PROPERTIES=*structure*] [, NAME=*string*] [, /SAVE]
[, TEMPLATE_FILE=*filename*] [, VISUALIZATION_PROPERTIES=*structure*]
[, {X | Y | Z}AXIS_PROPERTIES=*structure*])

Arguments

Type

A string (case-insensitive) specifying the visualization style type. Available types include: plot, contour, image, and surface.

Keywords

BASE_STYLE

Set this keyword equal to a string (case-insensitive) containing the name of a previously saved style. It will be used for defaulting unspecified properties. If not specified, only those properties you provide will be put into the style. The basic styles that will always exist include:

Visualization Type	Style Name
plot	‘Basic Plot’
contour	‘Basic Contour’
image	‘Basic Image’
surface	‘Basic Surface’

Table 49: Base Style Strings

COLORBAR_PROPERTIES

The table below lists the structure of the COLORBAR_PROPERTIES keyword.

Tag	Description
title_FontSize	9 to 72 points
title_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
title_Color	see color table
tick_FontSize	see fontsize
tick_Fontname	see fontname
tick_FontColor	see color table
color	see color table
thick	1 to 10 pixels
location	[x, y] normalized units
minor	number of minor ticks (minimum 0)
major	number of major ticks (minimum 0)
default_minor	set to compute default number of minor ticks
default_major	set to compute default number of major ticks
tickLen	normalized units * 100 = percent of visualization dimensions
subticklen	normalized units * 100 = percent of ticklen
tickFormat	see format
show_axis	set to display the colorbar axis
show_outline	set to display the colorbar outline
axis_thick	see thick
dimensions	[width, height] normalized units
hide	1=hidden, 0=visible

Table 50: Colorbar Properties Structure

GRAPHIC_PROPERTIES

Set this keyword equal to a scalar or vector of structures defining the graphic properties to use in creating the style. (Use a vector if you want successive graphics to have different properties, e.g., different colored lines in a line plot. The structures are used in a round-robin fashion.) Not all properties need be specified (see BASE_STYLE). The complete structure definitions are listed in the following tables.

Plots

Tag	Data Type/Description
color	string (see color table)
hide	boolean (1=hidden, 0=visible)
linestyle	integer (0=solid, 1=dotted, 2=dashed, 3=dash dot, 4=dash dot dot, 5=long dash)
nSum	integer (1 to number of elements to average over)
symbol_size	[x,y] normalized units relative to the visualization
symbol_type	integer (1-7)
thick	integer (1 to 10 pixels)

Table 51: Plot Graphic Properties Structure

Images

Tag	Data Type/Description
hide	boolean (1=hidden, 0=visible)
order	boolean (set to draw from top to bottom)
sizing_constraint	integer (0=natural, 1=aspect, 2=unrestricted)

Table 52: Image Graphic Properties Structure

Contours

Tag	Data Type/Description
downhill	boolean (set to display downhill tick marks)
fill	boolean (set to display contour levels as filled)
hide	boolean (1=hidden, 0=visible)
n_levels	integer (number of levels)
c_thick	vector of thickness values
c_linestyle	vector of linestyle values
c_color	vector of color names
default_n_levels	integer (set to default number of levels)

Table 53: Contour Graphic Properties Structure

Surfaces

Tag	Data Type/Description
bottom	string (see color table)
color	string (see color table)
hidden_lines	boolean (1=don't show, 0=show)
hide	boolean (1=hidden, 0=visible)
lineStyle	integer (0=solid, 1=dotted, 2=dashed, 3=dash dot, 4=dash dot dot, 5=long dash)
shading	boolean (0=flat, 1=Gouraud)
show_skirt	boolean (1=show, 0=don't show)
skirt	float (z value at which skirt is drawn [data units])
style	integer (0=point, 1=wire, 2=solid, 3=ruledXZ, 4=ruledYZ, 5=lego (wire), 6=lego (solid))
thick	integer (1 to 10 pixels)

Table 54: Surface Graphic Properties Structure

GROUP

Set this keyword to the widget ID of the group leader for error message display. This keyword is used only when the ERROR keyword is not set. If only one LIVE tool window is present in the IDL session, it will default to that.

LEGEND_PROPERTIES

Set this keyword equal to a structure defining the legend properties to use in creating the style. Not all properties need be specified (see BASE_STYLE). The complete structure definitions for different types of styles are listed in the following tables.

Tag	Description
title_FontSize	9 to 72 points
title_Fontname	Helvetica, Courier, Times, Symbol, and Other (where Other is a valid name of a font on the local system)
title_Color	see color table
item_fontSize	see fontsize
item_fontName	see fontname
text_color	see color
border_gap	normalized units * 100 = percent of item text height
columns	number of columns to display the items in (minimum 0)
gap	normalized units * 100 = percent of item text height
glyph_Width	normalized units * 100 = percent of item text height
fill_color	see color table
outline_color	see color table
outline_thick	see thick
location	[x, y] normalized units
show_fill	set to display the fill color
show_outline	set to display the legend outline
hide	1=hidden, 0=visible

Table 55: Legend Properties Structure

NAME

Set this keyword to a string containing a name for the returned style. If the SAVE keyword is set, the name must be unique template file. If not specified, a name will be automatically generated.

SAVE

Set this keyword to save the style in the template file. The supplied Name must not already exist in the template file or an error will be returned.

VISUALIZATION_PROPERTIES

Set this keyword equal to a structure defining the visualization properties to use in creating the style. Not all properties need be specified (see BASE_STYLE). The complete structure definition is in the following table.

Tag	Data Type
color	string (see color table) for background
hide	boolean
transparent	boolean

Table 56: Visualization Properties Structure

XAXIS_PROPERTIES, YAXIS_PROPERTIES, ZAXIS_PROPERTIES

Set these keywords equal to a scalar or vector of structures defining the axis properties to use in creating the style. (Use a vector to specify property structures for successive axes of the same direction have different properties. The structures are used in a round-robin fashion.) Not all properties need be specified (see BASE_STYLE). The user need only define the fields of the structure they wish to be different from the BASE style. The complete structure definition is shown in the following table.

Tag	Data Type
color	string (see color table)
default_major	integer
default_minor	integer

Table 57: Axis Properties Structure

Tag	Data Type
exact	boolean
gridstyle	integer (0-5) (linestyle)
hide	boolean
location	3-element floating vector (normalized units)
major	integer (default=-1, computed by IDL)
minor	integer (default=-1, computed by IDL)
thick	integer (1-10)
tickDir	integer
tickLen	float (normalized units)
tick_fontname	string
tick_fontsize	integer

Table 57: Axis Properties Structure

Example

```
Style=LIVE_STYLE('plot',BASE_STYLE='basic plot', $
   GRAPHIC_PROPERTIES={color:'red'})
```

See Also

LIVE_INFO, LIVE_CONTROL

LIVE_SURFACE

The LIVE_SURFACE procedure creates an interactive plotting environment for multiple surfaces. Because the interactive environment requires extra system resources, this routine is most suitable for relatively small data sets. If you find that performance does not meet your expectations, consider using the Direct Graphics SURFACE routine or the Object Graphics IDLgrSurface class directly.

After LIVE_SURFACE has been executed, you can double-click on a section of the surface to display a properties dialog. A set of buttons in the upper left corner of the image window allows you to print, undo the last operation, redo the last “undone” operation, copy, draw a line, draw a rectangle, or add text.

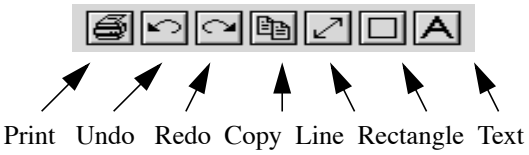


Figure 15: LIVE_SURFACE Properties Dialog

You can control your LIVE window after it is created using any of several auxiliary routines. See “LIVE_Tools” on page 694 for an explanation.

Syntax

LIVE_SURFACE, *Data*, *Data2*,... [, /BUFFER] [, DIMENSIONS=*[width*, *height]*{normal units}] [, /DOUBLE] [, DRAW_DIMENSIONS=*[width*, *height]*{devive units}] [, ERROR=*variable*] [, /INDEXED_COLOR] [, INSTANCING={-1 | 0 | 1}] [, LOCATION=*[x*, *y]*{normal units}] [, /MANAGE_STYLE] [, NAME=*structure*] [, /NO_DRAW] [, /NO_SELECTION] [, /NO_STATUS] [, /NO_TOOLBAR] [, PARENT_BASE=*widget_id* | , TLB_LOCATION=*[Xoffset*, *Yoffset]*{device units}] [, PREFERENCE_FILE=*filename*{full path}] [, REFERENCE_OUT=*variable*] [, RENDERER={0 | 1}] [, REPLACE={*structure* / {0 | 1 | 2 | 3 | 4}}] [, STYLE=*name_or_reference*] [, TEMPLATE_FILE=*filename*] [, TITLE=*string*] [, WINDOW_IN=*string*] [, {X | Y}INDEPENDENT=*vector*] [, {/X | /Y}LOG] [, {X | Y}RANGE=*[min, max]*{data units}] [, {X | Y}_TICKNAME=*array*]

Arguments

Data

A vector of data. Up to 25 of these arguments may be specified. If any of the data is stored in IDL variables of type DOUBLE, LIVE_SURFACE uses double-precision to store the data and to draw the result.

Keywords

BUFFER

Set this keyword to bypass the creation of a LIVE window and send the visualization to an offscreen buffer. The WINDOW field of the reference structure returned by the REFERENCE_OUT keyword will contain the name of the buffer.

DIMENSIONS

Set this keyword to a two-element, floating-point vector of the form [width, height] specifying the dimensions of the visualization in normalized coordinates. The default is [1.0, 1.0].

DOUBLE

Set this keyword to force LIVE_SURFACE to use double-precision to draw the result. This has the same effect as specifying data in the Data argument using IDL variables of type DOUBLE.

DRAW_DIMENSIONS

Set this keyword equal to a vector of the form [width, height] representing the desired size of the LIVE tools draw widget (in pixels). The default is [452, 452].

Note

This default value may be different depending on previous template projects.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

INDEXED_COLOR

If set, the indexed color mode will be used. The default is TrueColor. (See *Using IDL* for more information on color modes.*)*

INSTANCING

Set this keyword to 1 to instance drawing on, or 0 to turn it off. The default (-1) is to use instancing if and only if the "software renderer" is being used (see RENDERER). For more information, see "Instancing" in the *Objects and Object Graphics* manual.

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.0, 0.0].

Note

LOCATION may be adjusted to take into account window decorations.

MANAGE_STYLE

Set this keyword to have the passed in style item destroyed when the LIVE tool window is destroyed. This keyword will have no effect if the STYLE keyword is not set to a style item.

NAME

Set this keyword to a structure containing suggested names for the data items to be created for this visualization. See the REPLACE keyword for details on how they will be used. The fields of the structure are as follows. (Any or all of the tags may be set.)

Tag	Description
DATA	Dependent Data Name(s)

Table 58: Fields of the NAME keyword

Tag	Description
IX	Independent X Data Name
IY	Independent Y Data Name

Table 58: Fields of the NAME keyword

The default for a field is to use the given variable name. If the variable does not have a name (i.e., is an expression), a default name is automatically generated. The dependent data names will be used in a round-robin fashion if more data than names are input.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display

NO_STATUS

Set this keyword to prevent the creation of the status bar.

NO_TOOLBAR

Set this keyword to prevent the creation of the toolbar.

PARENT_BASE

Set this keyword to the widget ID of an existing base widget to bypass the creation of a LIVE window and create the visualization within the specified base widget.

Note

The location of the draw widget is not settable. It is expected that the user who wishes to insert a tool into their own widget application will determine the setting from the parent base sent to the tool.

Note

LIVE_DESTROY on a window is recommended when using PARENT_BASE so that proper memory cleanup is done. Simply destroying the parent base is not sufficient.

Note

When specifying a PARENT_BASE, that parent base must be running in a non-blocking mode. Putting a LIVE tool into a realized base already controlled by XMANAGER will override the XMANAGER mode to /NO_BLOCK even if blocking had been in effect.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the created items. The fields of the structure are shown in the following table.

Tag	Description
WIN	Window Name
VIS	Visualization Name
GRAPHIC	Graphic Name(s)
XAXIS	X-Axis Name
YAXIS	Y-Axis Name
ZAXIS	Z-Axis Name
LEGEND	Legend Name
DATA	Dependent Data Name(s)
IX	Independent X Data Name
IY	Independent Y Data Name

Table 59: Fields of the LIVE_SURFACE Reference Structure

RENDERER

Set this keyword to 1 to use the “software renderer”, or 0 to use the “hardware renderer”. The default (-1) is to use the setting in the IDE (IDL Development Environment) preferences; if the IDE is not running, however, the default is hardware rendering. For more information, see “Hardware vs. Software Rendering” in the *Objects and Object Graphics* manual.

REPLACE

Set this keyword to a structure containing tags as listed for the NAME keyword, with scalar values corresponding to the replacement options listed below. (Any or all of

the tags may be set.) The replacement settings are used to determine what action to take when an item (such as data) being input would have the same name as one already existing in the given window or buffer (WINDOW_IN).

Setting	Action Taken
0	New items will be given unique names.
1	Existing items will be replaced by new items (i.e., the old items will be deleted and new ones created).
2	User will be prompted for the action to take.
3	The values of existing items will be replaced. This will cause dynamic updating to occur for any current uses, e.g., a visualization would redraw to show the new value.
4	Default. Option 0 will be used for items that do not have names (e.g., data input as an expression rather than a named variable, with no name provided via the NAME keyword). Option 3 will be used for all named items.

Table 60: REPLACE keyword Settings and Action Taken

STYLE

Set this keyword to either a string specifying a style name created with LIVE_STYLE.

TITLE

Set this keyword to a string specifying the title to give the main window. It must not already be in use. A default will be chosen if no title is specified.

TLB_LOCATION

Set this keyword to a two-element vector of the form [*Xoffset*, *Yoffset*] specifying the offset (in pixels) of the LIVE window from the upper left corner of the screen. This keyword has no effect if the PARENT_BASE keyword is set. The default is [0, 0].

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer, in which to display the visualization. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the

window or buffer name. Window names are also visible in visualization window titlebars. The default is to create a new window.

XINDEPENDENT

Set this keyword to a vector specifying X values for LIVE_SURFACE. The default is the data's index values.

Note

Only one independent vector is allowed; all dependent vectors will use the independent vector.

YINDEPENDENT

Set this keyword to a vector specifying Y values for LIVE_SURFACE. The default is the data's index values.

Note

Only one independent vector is allowed; all dependent vectors will use the independent vector.

XLOG

Set this keyword to make the X axis a log axis. The default is 0 (linear axis).

YLOG

Set this keyword to make the Y axis a log axis. The default is 0 (linear axis).

XRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the X axis range. The default equals the values computed from the data range.

YRANGE

Set this keyword equal to a two-element array that defines the minimum and maximum values of the Y axis range. The default equals the values computed from the data range.

X_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the X axis. The default equals the values computed from the data range.

Y_TICKNAME

Set this keyword equal to an array of strings to be used to label the tick mark for the Yaxis. The default equals the values computed from the data range.

Example

This example visualizes two surface representations. To manipulate any part of the surface, double click on surface to access a graphical user interface:

```
LIVE_SURFACE, tempData, pressureData
```

Note

This is a “Live” situation. When data of the same name is used multiple times within the same window, it always represents the same internal data item. For example, if one does the following:

```
Y = indgen(10)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc1
Y = indgen(20)
LIVE_PLOT, Y, WINDOW_IN=w, DIMENSIONS=d, LOCATION=loc2
```

The first plot will update to use the Y of the second plot when the second plot is drawn. If the user wants to display 2 “tweaks” of the same data, a different variable name must be used each time, or at least one should be an expression (thus not a named variable). For example:

```
LIVE_PLOT, Y1,...
LIVE_PLOT, Y2,...
```

or;

```
LIVE_PLOT, Y,...
LIVE_PLOT, myFunc(Y),...
```

In last example, the data of the second visualization will be given a default unique name since an expression rather than a named variable is input.

Note

The above shows the default behavior for naming and replacing data, which can be overridden using the NAME and REPLACE keywords.

See Also

SURFACE, SHADE_SURF

LIVE_TEXT

The LIVE_TEXT procedure is an interface for text annotation. You can control your LIVE window after it is created using any of several auxiliary routines. See "LIVE_Tools" on page 694 for an explanation.

Syntax

LIVE_TEXT[, *Text*] [, ALIGNMENT=*value*{0.0 to 1.0}] [, COLOR='*color name*']
[, /DIALOG] [, /ENABLE_FORMATTING] [, ERROR=*variable*]
[, FONTNAME=*string*] [, FONTSIZE=*points*{9 to 72}] [, /HIDE]
[, LOCATION=*[x, y]*] [, NAME=*string*] [, /NO_DRAW] [, /NO_SELECTION]
[, REFERENCE_OUT=*variable*] [, TEXTANGLE=*value*{0.0 to 360.0}]
[, VERTICAL_ALIGNMENT=*value*{0.0 to 1.0}] [, VISUALIZATION_IN=*string*]
[, WINDOW_IN=*string*]

Arguments

Text

The string to be used for the text annotation. The default is "Text". If Text is an array of strings, each element of the string array will appear on a separate line.

Keywords

ALIGNMENT

Set this keyword to a floating-point value between 0.0 and 1.0 to indicate the horizontal alignment of the text. The alignment scheme is as follows:

1.0---- -----0.5----- ---0.0

Left Middle Right

COLOR

Set this keyword to a string (case-sensitive) of the foreground color to be used for the text. The default is 'Black'. The following colors are available:

- Black
- Red
- Green
- Yellow
- Blue
- Magenta
- Cyan
- Dark Gray
- Light Gray
- Brown
- Light Red
- Light Green
- Light Blue
- Light Cyan
- Light Magenta
- White

DIALOG

Set this keyword to have the text annotation dialog appear. This dialog will fill in known attributes from set keywords.

ENABLE_FORMATTING

Set this keyword to have LIVE_TEXT interpret "!" (exclamation mark) as font and positioning commands.

ERROR

Set this keyword to a named variable to contain the returned error message (string). An empty string is returned if no errors occurred during the operation. By default, errors are reported via a GUI.

Note

If a named variable is passed in this keyword and an error occurs, the error GUI will *not* be displayed.

FONTNAME

Set this keyword to a string containing the name of the desired font. The default is Helvetica.

FONTSIZE

Set this keyword to an integer scalar specifying the font point size to be used. The default is 12. Available point sizes are 9 through 72.

HIDE

Set this keyword to a boolean value indicating whether this item should be drawn:

- 0 = Draw (default)
- 1 = Do not draw

LOCATION

Set this keyword to a two-element, floating-point vector of the form [X, Y] specifying the location of the visualization (relative to the lower left hand corner within the visualization window) in normalized coordinates. The default is [0.5, 0.5].

Note

LOCATION may be adjusted to take into account window decorations.

NAME

Set this keyword equal to a string containing the name to be associated with this item. The name must be unique within the given window or buffer (WINDOW_IN). If not specified, a unique name will be assigned automatically.

NO_DRAW

Set this keyword to inhibit the visualization window from drawing. This is useful if multiple visualizations and/or annotations are being created via calls to other LIVE_Tools in order to reduce unwanted draws and help speed the display.

REFERENCE_OUT

Set this keyword to a variable to return a structure defining the names of the created items. The fields of the structure are shown in the following table

Tag	Description
WIN	Window Name
VIS	Visualization Name
GRAPHIC	Graphic Name the text created

Table 61: Fields of the LIVE_TEXT Reference Structure

TEXTANGLE

Set this keyword to a floating-point value defining the angle of rotation of the text. The valid range is from 0.0 to 360.0. The default is 0.0.

VERTICAL_ALIGNMENT

Set this keyword to a floating-point value between 0.0 and 1.0 to indicate the vertical alignment of the text baseline. The alignment scheme is as follows:

0.0 Top

:

0.5 Middle

:

1.0 Bottom

VISUALIZATION_IN

Set this keyword equal to the name (string, case-insensitive) of a LIVE tool visualization. The VIS field from the REFERENCE_OUT keyword from the creation of the LIVE tool will provide the visualization name. If only one visualization is present in the window or buffer (WINDOW_IN), this keyword will default to it.

WINDOW_IN

Set this keyword equal to a name (string, case-sensitive) of a LIVE tool window or a LIVE tool buffer. The WIN tag of the REFERENCE_OUT structure from the creation of the LIVE tool will provide the window or buffer name. Window names are also visible in visualization window titlebars. If only one LIVE tool window (or buffer) is present in the IDL session, this keyword will default to it.

Example

```
LIVE_TEXT, 'My Annotation', WINDOW_IN='Live Plot 2', $
   VISUALIZATION_IN='line plot visualization'
```

See Also

LIVE_LINE, LIVE_RECT

LJLCT

The LJLCT procedure loads standard color tables for LJ-250/252 printer. The color tables are modified only if the device is currently set to “LJ”.

The default color maps used are for the 90 dpi color palette. There are only 8 colors available at 180 dpi.

If the current device is ‘LJ’, the !D.N_COLORS system variable is used to determine how many bit planes are in use (1 to 4). The standard color map for that number of planes is loaded. These maps are described in Chapter 7 of the *LJ250/LJ252 Companion Color Printer Programmer Reference Manual*, Table 7-5. That manual gives the values scaled from 1 to 100, LJLCT scales them from 0 to 255.

This routine is written in the IDL language. Its source code can be found in the file `ljlct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

LJLCT

Example

```
; Set plotting to the LJ device:
SET_PLOT, 'LJ'

; Load the LJ color tables:
LJLCT
```

See Also

SET_PLOT

LL_ARC_DISTANCE

The LL_ARC_DISTANCE function returns a two-element vector containing the longitude and latitude [lon, lat] of a point given arc distance ($-\pi \le Arc\_Dist \le \pi$), and azimuth (*Az*), from a specified location *Lon_lat0*. Values are in radians unless the keyword DEGREES is set.

This routine is written in the IDL language. Its source code can be found in the file `ll_arc_distance.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LL_ARC_DISTANCE(*Lon_lat0*, *Arc_Dist*, *Az* [, /DEGREES])

Arguments

Lon_lat0

A 2-element vector containing the longitude and latitude of the starting point. Values are assumed to be in radians unless the keyword DEGREES is set.

Arc_Dist

The arc distance from *Lon_lat0*. The value must be between $-\pi$ and $+\pi$. To express distances in arc units, divide by the radius of the globe expressed in the original units. For example, if the radius of the earth is 6371 km, divide the distance in km by 6371 to obtain the arc distance.

Az

The azimuth from *Lon_lat0*. The value is assumed to be in radians unless the keyword DEGREES is set.

Keywords

DEGREES

Set this keyword to express all measurements and results in degrees.

Example

```
; Initial point specified in radians:
Lon_lat0 = [1.0, 2.0]

; Arc distance in radians:
```

```
Arc_Dist = 2.0

; Azimuth in radians:
Az = 1.0

Result = LL_ARC_DISTANCE(Lon_lat0, Arc_Dist, Az)
PRINT, Result
```

IDL prints:

```
2.91415   -0.622234
```

See Also

MAP_SET

LMFIT

The LMFIT function does a non-linear least squares fit to a function with an arbitrary number of parameters. LMFIT uses the Levenberg-Marquardt algorithm, which combines the steepest descent and inverse-Hessian function fitting methods. The function may be any non-linear function.

Iterations are performed until three consecutive iterations fail to change the chi square value by more than the specified tolerance amount, or until a maximum number of iterations have been performed. The LMFIT function returns a vector of values for the dependent variables, as fitted by the function fit.

The initial guess of the parameter values should be as close to the actual values as possible or the solution may not converge. Test the value of the variable specified by the CONVERGENCE keyword to determine whether the algorithm converged, failed to converge, or encountered a singular matrix.

This routine is written in the IDL language. Its source code can be found in the file `lmfit.pro` in the `lib` subdirectory of the IDL distribution. LMFIT is based on the routine `mrqmin` described in section 15.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = LMFIT(*X*, *Y*, *A* [, ALPHA=*variable*] [, CHISQ=*variable*] [, CONVERGENCE=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, FITA=*vector*] [, FUNCTION_NAME=*string*] [, ITER=*variable*] [, ITMAX=*value*] [, ITMIN=*value*] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, TOL=*value*])

Arguments

X

A row vector of independent variables. LMFIT does not manipulate or use values in *X*, it simply passes *X* to the user-written function.

Y

A row vector containing the dependent variables.

A

A vector that contains the initial estimate for each coefficient. Upon return, *A* will contain the final estimates for the coefficients.

Keywords

ALPHA

Set this keyword equal to a named variable that will contain the value of the curvature matrix.

CHISQ

Set this keyword equal to a named variable that will contain the final value of the chi-square goodness-of-fit.

CONVERGENCE

Set this keyword equal to a named variable that will indicate whether the LMFIT algorithm converged. The possible returned values are:

- 1 = the algorithm converged.
- 0 = the algorithm did not converge.
- -1 = the algorithm encountered a singular matrix and did not converge.

Tip

If LMFIT fails to converge, try setting the DOUBLE keyword.

COVAR

Set this keyword equal to a named variable that will contain the value of the covariance matrix.

DOUBLE

Set this keyword to force the computations to be performed in double precision.

FITA

Set this keyword equal to a vector, with as many elements as *A*, which contains a zero for each fixed parameter, and a non-zero value for elements of *A* to fit. If FITA is not specified, all parameters are taken to be non-fixed.

FUNCTION_NAME

Use this keyword to specify the name of the function to fit. If this keyword is omitted, LMFIT assumes that the IDL procedure LMFUNCT is to be used. If LMFUNCT is not already compiled, IDL compiles the function from the file `lmfunct.pro`, located in the `lib` subdirectory of the IDL distribution. LMFUNCT is designed to fit a quadratic equation.

The function to be fit must be written as an IDL procedure and compiled prior to calling LMFIT. The function must accept a vector *X* (the independent variables) and a vector *A* containing the fitted function's parameter values. It must return an *A*+1-element vector in which the first (zeroth) element is the evaluated function value and the remaining elements are the partial derivatives with respect to each parameter in *A*.

Note

The returned value must be of the same data type as the input *X* value.

ITER

Set this keyword equal to a named variable that will contain the actual number of iterations which were performed

ITMAX

Set this keyword equal to the maximum number of iterations. The default is 50.

ITMIN

Set this keyword equal to the minimum number of iterations. The default is 5.

MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

Note

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(ABS(*Y*)).

SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters

Note

If MEASURE_ERRORS is omitted, then you are assuming that your user-supplied model (or the default quadratic) is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

TOL

Set this keyword to the convergence tolerance. The routine returns when the relative decrease in chi-squared is less than TOL in an iteration. The default is 1.0×10^{-6} for single-precision, and 1.0×10^{-12} for double-precision.

WEIGHTS

The WEIGHTS keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the WEIGHTS keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword. Note that the definition of the MEASURE_ERRORS keyword is not the same as the WEIGHTS keyword. Using the WEIGHTS keyword, SQRT(1/WEIGHTS[i]) represents the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error for each point is represented as simply MEASURE_ERRORS[i].

Example

In this example, we fit a function of the form:

f(x)=a[0] * exp(a[1]*x) + a[2] + a[3] * sin(x)

```
; First, define a return function for LMFIT:
FUNCTION myfunct, X, A
   bx = A[0]*EXP(A[1]*X)
   RETURN,[ [bx+A[2]+A[3]*SIN(X)], [EXP(A[1]*X)], [bx*X], $
      [1.0] ,[SIN(X)] ]
END

PRO lmfit_example

; Compute the fit to the function we have just defined. First,
; define the independent and dependent variables:
X = FINDGEN(40)/20.0
Y = 8.8 * EXP(-9.9 * X) + 11.11 + 4.9 * SIN(X)
measure_errors = 0.05 * Y
```

```
; Provide an initial guess for the function's parameters:
A = [10.0, -0.1, 2.0, 4.0]
fita = [1,1,1,1]

; Plot the initial data, with error bars:
PLOTERR, X, Y, measure_errors
coefs = LMFIT(X, Y, A, MEASURE_ERRORS=measure_errors, /DOUBLE, $
   FITA = fita, FUNCTION_NAME = 'myfunct')

; Overplot the fitted data:
OPLOT, X, coefs

END
```

See Also

CURVEFIT, GAUSSFIT, LINFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

LMGR

The LMGR function tests whether a particular licensing mode is in effect. The function returns True (1) if the mode specified is in effect, or False (0) otherwise. Different licensing modes are specified by keyword; see the “Keywords” section below for a description of each licensing mode.

The LMGR function can also force IDL into time demo mode or report the LMHostid number for the machine in use.

For more information on IDL’s licensing methods, consult the *IDL License Management Guide*, which is included in Adobe Acrobat Portable Document Format on your IDL CD-ROM.

Syntax

Result = LMGR([, /CLIENTSERVER | , /DEMO | , /EMBEDDED | , /RUNTIME | , /STUDENT | , /TRIAL] [, EXPIRE_DATE=*variable*] [, /FORCE_DEMO] [, INSTALL_NUM=*variable*] [, LMHOSTID=*variable*] [, SITE_NOTICE=*variable*])

Arguments

None

Keywords

CLIENTSERVER

Set this keyword to test whether the current IDL session is using Client/Server licensing (as opposed to Desktop licensing).

DEMO

Set this keyword to test whether the current IDL session is running in timed demo mode. Unlicensed copies of IDL and copies running directly from a CD-ROM run in timed demo mode.

EMBEDDED

Set this keyword to test whether the current IDL session is running in embedded mode. Embedded-mode applications contain a built-in version of the IDL license. Examples of applications running in embedded mode are the IDL demo and the IDL registration program.

EXPIRE_DATE

Set this keyword to a named variable that will receive a string containing the expiration date of the current IDL session if the session is a trial session. This named variable will be undefined if the IDL session has a permanent license.

FORCE_DEMO

Set this keyword to force the current session into timed demo mode. Forcing an IDL session into demo mode can be useful if you are testing an application that will be run with an unlicensed copy of IDL. Note that you must exit IDL and restart to return to normal licensed mode after forcing IDL into demo mode.

INSTALL_NUM

Set this keyword to a named variable that will receive a string containing the installation number of the current IDL session. This named variable will be undefined if the IDL session is unlicensed.

LMHOSTID

Set this keyword equal to a named variable that will contain a string value representing the LMHostid for the machine in use. The LMHostid is used when creating client/server IDL licenses. This keyword returns the string “0” on machines which do not have a unique LMHostid (Macintoshes and some Windows machines that use Desktop licensing.)

RUNTIME

Set this keyword to test whether the current IDL session is running in runtime mode. Runtime-mode applications do not provide access to the IDL command line. See *Building IDL Applications* for additional details on runtime applications.

SITE_NOTICE

Set this keyword to a named variable that will receive a string containing the site notice of the current IDL session. This named variable will be undefined if the IDL session is unlicensed.

STUDENT

Set this keyword to test whether the current IDL session is running in student mode. The IDL Student version, which provides a subset of IDL’s full functionality, is currently the only product that runs in student mode.

TRIAL

Set this keyword to test whether the current IDL session is running in trial mode. Trial mode licenses allow IDL to operate for a limited time period (generally 30 days) but do not otherwise restrict functionality.

Example

Use the following commands to test whether the current IDL session is running in timed demo mode:

```
Result = LMGR(/DEMO)

IF (Result GT 0) THEN PRINT, "IDL is in Demo Mode"
```

Use the following commands to generate the LMHostid number for the machine in use:

```
Result = LMGR(LMHOSTID = myId)
PRINT, "LMHostid for this machine is: ", myId
```

LNGAMMA

The LNGAMMA function returns the logarithm of the gamma function of *X*. This function is undefined for negative integers. If the argument is double-precision, the result is double-precision. Otherwise, this function yields floating-point results.

Syntax

Result = LNGAMMA(*X*)

Arguments

X

The expression for which the logarithm of the gamma function will be evaluated.

Example

To find the logarithm of the gamma function of 0.5 and store the result in variable A, enter:

```
A = LNGAMMA(0.5)
```

See Also

BETA, GAMMA, IBETA, IGAMMA

LNP_TEST

The LNP_TEST function computes the Lomb Normalized Periodogram of two sample populations *X* and *Y* and tests the hypothesis that the populations represent a significant periodic signal against the hypothesis that they represent random noise. The result is a two-element vector containing the maximum peak in the Lomb Normalized Periodogram and its significance. The significance is a value in the interval [0.0, 1.0]; a small value indicates that a significant periodic signal is present.

LNP_TEST is based on the routine `fasper` described in section 13.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = LNP_TEST(*X*, *Y* [, /DOUBLE] [, HIFAC=*scale_factor*] [, JMAX=*variable*] [, OFAC=*value*] [, WK1=*variable*] [, WK2=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector containing equally or unequally spaced time samples.

Y

An *n*-element integer, single-, or double-precision floating-point vector containing amplitudes corresponding to X_i.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

HIFAC

Use this keyword to specify the scale factor of the average Nyquist frequency. The default value is 1.

JMAX

Use this keyword to specify a named variable that will contain the index of the maximum peak in the Lomb Normalized Periodogram.

OFAC

Use this keyword to specify the oversampling factor. The default value is 4.

WK1

Use this keyword to specify a named variable that will contain a vector of increasing linear frequencies.

WK2

Use this keyword to specify a named variable that will contain a vector of values from the Lomb Normalized Periodogram corresponding to the frequencies in WK1.

Example

This example tests the hypothesis that two sample, *n*-element populations X and Y represent a significant periodic signal against the hypothesis that they represent random noise:

```
; Define two n-element sample populations:
X = [ 1.0,  2.0,  5.0,  7.0,  8.0,  9.0, $
     10.0, 11.0, 12.0, 13.0, 14.0, 15.0, $
     16.0, 17.0, 18.0, 19.0, 20.0, 22.0, $
     23.0, 24.0, 25.0, 26.0, 27.0, 28.0]
Y = [ 0.69502, -0.70425,  0.20632,  0.77206, -2.08339,  0.97806, $
      1.77324,  2.34086,  0.91354,  2.04189,  0.53560, -2.05348, $
     -0.76308, -0.84501, -0.06507, -0.12260,  1.83075,  1.41403, $
     -0.26438, -0.48142, -0.50929,  0.01942, -1.29268,  0.29697]

; Test the hypothesis that X and Y represent a significant periodic
; signal against the hypothesis that they represent random noise:
result = LNP_TEST(X, Y, WK1 = wk1, WK2 = wk2, JMAX = jmax)
PRINT, result
```

IDL prints:

```
4.69296    0.198157
```

The small value of the significance represents the possibility of a significant periodic signal. A larger number of samples for *X* and *Y* would produce a more conclusive result. WK1 and WK2 are both 48-element vectors containing linear frequencies and corresponding Lomb values, respectively. JMAX is the indexed location of the maximum Lomb value in WK2.

See Also

CTI_TEST, FV_TEST, KW_TEST, MD_TEST, R_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

LOADCT

The LOADCT procedure loads one of 41 predefined IDL color tables. These color tables are defined in the file `colors1.tbl`, located in the `\resource\colors` subdirectory of the main IDL directory, unless the FILE keyword is specified. The selected colortable is loaded into the COLORS common block as both the “current” and “original” colortable. If the current device has fewer than 256 colors, the color table data is interpolated to cover the number of colors in the device.

This routine is written in the IDL language. Its source code can be found in the file `loadct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

LOADCT [, *Table*] [, BOTTOM=*value*] [, FILE=*string*] [, GET_NAMES=*variable*] [, NCOLORS=*value*] [, /SILENT]

Arguments

Table

The number of the pre-defined color table to load, from 0 to 40. If this value is omitted, a menu of the available tables is printed and the user is prompted to enter a table number.

Keywords

BOTTOM

The first color index to use. LOADCT will use color indices from BOTTOM to BOTTOM+NCOLORS-1. The default is BOTTOM=0.

FILE

Set this keyword to the name of a colortable file to be used instead of the file `colors1.tbl`. See MODIFYCT to create and modify colortable files.

GET_NAMES

Set this keyword to a named variable in which the names of the color tables are returned as a string array. No changes are made to the color table.

NCOLORS

The number of colors to use. The default is all available colors (this number is stored in the system variable !D.TABLE_SIZE).

SILENT

If this keyword is set, the Color Table message is suppressed.

See Also

MODIFYCT, XLOADCT, TVLCT

LOCALE_GET

The LOCALE_GET function returns the current locale (string) of the operating platform.

Syntax

Result = LOCALE_GET( )

Arguments

None

Keywords

None

LON64ARR

The LON64ARR function returns a 64-bit integer vector or array.

Syntax

Result = LON64ARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, LON64ARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and LON64ARR executes faster.

Example

To create L, a 100-element, 64-bit vector with each element set to 0, enter:

```
L = LON64ARR(100)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

LONARR

The LONARR function returns a longword integer vector or array.

Syntax

Result = LONARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, LONARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and LONARR executes faster.

Example

To create L, a 100-element, longword vector with each element set to 0, enter:

```
L = LONARR(100)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

LONG

The LONG function returns a result equal to *Expression* converted to longword integer type.

Syntax

Result = LONG(*Expression*[, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to longword integer.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as longword integer data.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid longword integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

If A contains the floating-point value 32000.0, it can converted to a longword integer and stored in the variable B by entering:

```
B = LONG(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, STRING, UINT, ULONG, ULONG64

LONG64

The LONG64 function returns a result equal to *Expression* converted to 64-bit integer type.

Syntax

Result = LONG64(*Expression*[, *Offset* [, D_1, ..., D_8]])

Arguments

Expression

The expression to be converted to 64-bit integer.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as 64-bit integer data.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be executed in case of such errors.

Example

If A contains the floating-point value 32000.0, it can converted to a 64-bit integer and stored in the variable B by entering:

```
B = LONG64(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, STRING, UINT, ULONG, ULONG64

LSODE

The LSODE function uses adaptive numerical methods to advance a solution to a system of ordinary differential equations one time-step H, given values for the variables *Y* and *X*.

Syntax

Result = LSODE(*Y*, *X*, *H*, *Derivs*[, *Status*] [, ATOL=*value*] [, RTOL=*value*])

Arguments

Y

A vector of values for Y at X

X

A scalar value for the initial condition.

H

A scalar value giving interval length or step size.

Derivs

A scalar string specifying the name of a user-supplied IDL function that calculates the values of the derivatives *Dydx* at X. This function must accept two arguments: A scalar floating value *X*, and one n-element vector *Y*. It must return an *n*-element vector result.

For example, suppose the values of the derivatives are defined by the following relations:

$$dy_0 / dx = -0.5y_{0,} \qquad dy_1 / dx = 4.0 - 0.3y_1 - 0.1y_0$$

We can write a function called `differential` to express these relationships in the IDL language:

```
FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
END
```

Status

An index used for input and output to specify the state of the calculation. This argument contains a positive value if the function was successfully completed. Negative values indicate different errors.

Input Value	Description
1	This is the first call for the problem; initializations will occur. This is the default value.
2	This is not the first call. The calculation is to continue normally.
3	This is not the first call. The calculation is to continue normally, but with a change in input parameters.

Table 62: Input Values for Status

Note

A preliminary call with `tout = t` is not counted as a first call here, as no initialization or checking of input is done. (Such a call is sometimes useful for the purpose of outputting the initial condition *s*.) Thus, the first call for which tout ≠ t requires `STATUS = 1` on input.

Output Value	Description
1	Nothing occurred. (However, an internal counter was set to detect and prevent repeated calls of this type.)
2	The integration was performed successfully, and no roots were found.
3	The integration was successful, and one or more roots were found.
-1	An excessive amount of work was done on this call, but the integration was otherwise successful. To continue, reset STATUS to a value greater than1 and begin again (the excess work step counter will be reset to 0).

Table 63: Output Values for Status

Output Value	Description
-2	The precision of the machine being used is insufficient for the requested amount of accuracy. Integration was successful. To continue, the tolerance parameters must be reset, and STATUS must be set to 3. (If this condition is detected before taking any steps, then an illegal input return (STATUS = -3) occurs instead.)
-3	Illegal input was detected, before processing any integration steps. If the solver detects an infinite loop of calls to the solver with illegal input, it will cause the run to stop.
-4	There were repeated error test failures on one attempted step, before completing the requested task, but the integration was successful. The problem may have a singularity, or the input may be inappropriate.
-5	There were repeated convergence test failures on one attempted step, before completing the requested task, but the integration was successful. This may be caused by an inaccurate jacobian matrix, if one is being used.
-6	ewt(i) became zero for some i during the integration. Pure relative error control was requested on a variable which has now vanished. Integration was successful.

Table 63: Output Values for Status

Note

Since the normal output value of STATUS is 2, it does not need to be reset for normal continuation. Also, since a negative input value of STATUS will be regarded as illegal, a negative output value requires the user to change it, and possibly other inputs, before calling the solver again.

Keywords

ATOL

A scalar or array value that specifies the absolute tolerance. The default value is 1.0e-7. Use ATOL = 0.0 (or ATOL[*i*] = 0.0) for pure relative error control, and use

RTOL = 0.0 for pure absolute error control. For an explanation of how to use ATOL and RTOL together, see RTOL below.

RTOL

A scalar value that specified the relative tolerance. The default value is 1.0e-7. Use RTOL = 0.0 for pure absolute error control, and use ATOL = 0.0 (or ATOL[*i*] = 0.0) for pure relative error control.

The estimated local error in the Y[*i*] argument will be controlled to be less than

```
ewt[i] = RTOL*abs(Y[i]) + ATOL    ; If ATOL is a scalar.
ewt[i] = RTOL*abs(Y[i]) + ATOL[i] ; If ATOL is an array.
```

Thus, the local error test passes if, in each component, either the absolute error is less than ATOL (or ATOL[*i*]), or if the relative error is less than RTOL.

Warning

Actual, or global, errors might exceed these local tolerances, so choose values for ATOL and RTOL conservatively.

Example

To integrate the example system of differential equations for one time step, H:

```
PRO LSODETEST

   ; Define the step size:
   H = 0.5

   ; Define an initial X value:
   X = 0.0

   ; Define initial Y values:
   Y = [4.0, 6.0]

   ; Integrate over the interval (0, 0.5):
   result = LSODE(Y, X, H, 'differential')

   ; Print the result:
   PRINT, result

END

FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
END
```

IDL prints:

```
3.11523      6.85767
```

This is the exact solution vector to 5-decimal precision.

See Also

DERIV, DERIVSIG, RK4

References

1. Alan C. Hindmarsh, ODEPACK, A Systematized Collection of ODE Solvers, in Scientific Computing, R. S. Stepleman et al. (eds.), North-Holland, Amsterdam, 1983, pp. 55-64.
2. Linda R. Petzold, Automatic Selection of Methods for Solving Stiff and Nonstiff Systems of Ordinary Differential Equations, SIAM J. SCI. STAT. COMPUT. 4 (1983), pp. 136-148.
3. Kathie L. Hiebert and Lawrence F. Shampine, Implicitly Defined Output Points for Solutions of ODE's, Sandia Report SAND80-0180, February, 1980.

LU_COMPLEX

The LU_COMPLEX function solves an *n* by *n* complex linear system **Az = b** using LU decomposition. The result is an *n*-element complex vector *z*. Alternatively, LU_COMPLEX computes the generalized inverse of an *n* by *n* complex array. The result is an *n* by *n* complex array.

This routine is written in the IDL language. Its source code can be found in the file `lu_complex.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = LU_COMPLEX(*A*, *B* [, /DOUBLE] [, /INVERSE] [, /SPARSE])

Arguments

A

An *n* by *n* complex array.

B

An *n*-element right-hand side vector (real or complex).

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

INVERSE

Set this keyword to compute the generalized inverse of *A*. If INVERSE is specified, the input argument *B* is ignored.

SPARSE

Set this keyword to convert the input array to row-indexed sparse storage format. Computations are done using the iterative biconjugate gradient method. This keyword is effective only when solving complex linear systems. This keyword has no effect when calculating the generalized inverse.

Example

```
; Define a complex array A and right-side vector B:
```

```
A = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)], $
     [COMPLEX(1, 1), COMPLEX(0, 1), COMPLEX(1, 5)]]
B =  [COMPLEX(1, 1), COMPLEX(3,-2), COMPLEX(1,-2)]

; Solve the complex linear system Az = b:
Z = LU_COMPLEX(A, B)
PRINT, 'Z:'
PRINT, Z

; Compute the inverse of the complex array A by supplying a scalar
; for B (in this example -1):
inv = LU_COMPLEX(A, B, /INVERSE)
PRINT, 'Inverse:'
PRINT, inv
```

IDL prints:

```
Z:
(     0.552267,      1.22818)(    -0.290371,    -0.600974)
(    -0.629824,    -0.340952)

Inverse:
(     0.261521,   -0.0303485)(    0.0138629,     0.329337)
(    -0.102660,    -0.168602)
(     0.102660,     0.168602)(    0.0340952,    -0.162982)
(     0.125890,   -0.0633196)
(   -0.0689397,    0.0108655)(   -0.0666916,   -0.0438366)
(    0.0614462,    -0.161858)
```

See Also

CRAMER, CHOLSOL, GS_ITER, LUSOL, SVSOL, TRISOL, and "Sparse Arrays" in Chapter 16 of *Using IDL*.

LUDC

The LUDC procedure replaces an *n* by *n* array, *A*, with the LU decomposition of a row-wise permutation of itself.

LUDC is based on the routine `ludcmp` described in section 2.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

LUDC, *A*, *Index* [, /COLUMN] [, /DOUBLE] [, INTERCHANGES=*variable*]

Arguments

A

An *n* by *n* array of any type except string. Upon output, *A* is replaced with its LU decomposition.

Index

An output vector that records the row permutations which occurred as a result of partial pivoting.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

INTERCHANGES

An output variable that is set to positive 1 if the number of row interchanges was even, or to negative 1 if the number of interchanges was odd.

Example

See the description of LUSOL for an example using this procedure.

See Also

LUSOL

LUMPROVE

The LUMPROVE function uses LU decomposition to iteratively improve an approximate solution *X* of a set of *n* linear equations in *n* unknowns Ax = b. The result is a vector, whose type and length are identical to *X*, containing the improved solution.

LUMPROVE is based on the routine `mprove` described in section 2.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = LUMPROVE(*A*, *Alud*, *Index*, *B*, *X* [, /COLUMN] [, /DOUBLE])

Arguments

A

The *n* by *n* coefficient array of the linear system Ax = b.

Alud

The *n* by *n* LU decomposition of *A* created by the LUDC procedure.

Index

An input vector, created by the LUDC procedure, containing a record of the row permutations which occurred as a result of partial pivoting.

B

An *n*-element vector containing the right-hand side of the linear system Ax = b.

X

An *n*-element vector containing the approximate solution of the linear system Ax = b.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

This example uses LUMPROVE to improve an approximate solution X to the linear system Ax = B:

```
; Create coefficient array A:
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]

; Create a duplicate of A:
alud = A
; Define the right-hand side vector B:
B = [3.0, -8.0, 10.0]

; Begin with an estimated solution X:
X = [.89, 1.78, -0.88]

; Decompose the duplicate of A:
LUDC, alud, INDEX

; Compute an improved solution:
result = LUMPROVE(A, alud, INDEX, B, X)

; Print the result:
PRINT, result
```

IDL prints:

```
 1.00000 2.00000 -1.00000
```

This is the exact solution vector.

See Also

GS_ITER, LUDC

LUSOL

The LUSOL function is used in conjunction with the LUDC procedure to solve a set of *n* linear equations in *n* unknowns **Ax = b**. The parameter *A* is input not as the original array, but as its LU decomposition, created by the routine LUDC. The result is an *n*-element vector whose type is identical to *A*.

LUSOL is based on the routine `lubksb` described in section 2.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = LUSOL(*A*, *Index*, *B* [, /COLUMN] [, /DOUBLE])

Arguments

A

The *n* by *n* LU decomposition of an array created by the LUDC procedure.

Index

An input vector, created by the LUDC procedure, containing a record of the row permutations which occurred as a result of partial pivoting.

B

An *n*-element vector containing the right-hand side of the linear system Ax = b.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

This example solves the linear system Ax = b using LU decomposition and back substitution:

```
; Define array A:
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]

; Define right-hand side vector B:
B = [3.0, -8.0, 10.0]

; Decompose A:
LUDC, A, INDEX

; Compute the solution using back substitution:
result = LUSOL(A, INDEX, B)

; Print the result:
PRINT, result
```

IDL prints:

```
     1.00000   2.00000   -1.00000
```

This is the exact solution vector.

See Also

CHOLSOL, CRAMER, GS_ITER, LU_COMPLEX, LUDC, SVSOL, TRISOL

M_CORRELATE

The M_CORRELATE function computes the multiple correlation coefficient of a dependent variable and two or more independent variables.

This routine is written in the IDL language. Its source code can be found in the file `m_correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = M_CORRELATE(*X*, *Y* [, /DOUBLE])

Arguments

X

An integer, single-, or double-precision floating-point array of *m*-columns and *n*-rows that specifies the independent variable data. The columns of this two dimensional array correspond to the *n*-element vectors of independent variable data.

Y

An *n*-element integer, single-, or double-precision floating-point vector that specifies the dependent variable data.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
PRO MCORRELATE_TEST

   ; Define the independent (X) and dependent (Y) data:
   X = [[0.477121, 2.0, 13.0], $
        [0.477121, 5.0, 6.0], $
        [0.301030, 5.0, 9.0], $
        [0.000000, 7.0, 5.5], $
        [0.602060, 3.0, 7.0], $
        [0.698970, 2.0, 9.5], $
        [0.301030, 2.0, 17.0], $
        [0.477121, 5.0, 12.5], $
        [0.698970, 2.0, 13.5], $
```

```
          [0.000000, 3.0, 12.5], $
          [0.602060, 4.0, 13.0], $
          [0.301030, 6.0, 7.5], $
          [0.301030, 2.0, 7.5], $
          [0.698970, 3.0, 12.0], $
          [0.000000, 4.0, 14.0], $
          [0.698970, 6.0, 11.5], $
          [0.301030, 2.0, 15.0], $
          [0.602060, 6.0, 8.5], $
          [0.477121, 7.0, 14.5], $
          [0.000000, 5.0, 9.5]]
     Y = [97.682, 98.424, 101.435, 102.266, 97.067, 97.397, $
          99.481, 99.613, 96.901, 100.152, 98.797, 100.796, $
          98.750, 97.991, 100.007, 98.615, 100.225, 98.388, $
          98.937, 100.617]

     ; Compute the multiple correlation of Y on the first column of
     ; X. The result should be 0.798816.
     PRINT, 'Multiple correlation of Y on 1st column of X:'
     PRINT, M_CORRELATE(X[0,*], Y)

     ; Compute the multiple correlation of Y on the first two columns
     ; of X. The result should be 0.875872.
     PRINT, 'Multiple correlation of Y on 1st two columns of X:'
     PRINT, M_CORRELATE(X[0:1,*], Y)

     ; Compute the multiple correlation of Y on all columns of X. The
     ; result should be 0.877197.
     PRINT, 'Multiple correlation of Y on all columns of X:'
     PRINT, M_CORRELATE(X, Y)

END
```

IDL prints:

```
Multiple correlation of Y on 1st column of X:
     0.798816
Multiple correlation of Y on 1st two columns of X:
     0.875872
Multiple correlation of Y on all columns of X:
     0.877196
```

See Also

A_CORRELATE, CORRELATE, C_CORRELATE, P_CORRELATE, R_CORRELATE

MACHAR

The MACHAR function determines and returns machine-specific parameters affecting floating-point arithmetic. Information is returned in the form of a structure with the fields listed below under "MACHAR Fields".

MACHAR is based on the routine `machar` described in section 20.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission. See that section for more details on and sample values of the various parameters returned.

Syntax

Result = MACHAR([, /DOUBLE])

Arguments

None

Keywords

DOUBLE

The information returned is normally for single-precision floating-point arithmetic. Specify DOUBLE to see double-precision information.

MACHAR Fields

The following table lists the fields in the structure returned from the MACHAR function:

Field Name	Description
IBETA	The radix in which numbers are represented. A longword integer.
IT	The number of base-IBETA digits in the floating-point mantissa M. A longword integer.

Table 64: MACHAR Fields

Field Name	Description
IRND	A code in the range 0 – 5 giving information on what type of rounding is done and how underflow is handled. A longword integer.
NGRD	The number of “guard digits” used when truncating the product of two mantissas. A longword integer.
MACHEP	The exponent of the smallest power of IBETA that, added to 1.0, gives something different from 1.0. A longword integer.
NEGEP	The exponent of the smallest power of IBETA that, subtracted from 1.0, gives something different from 1.0. A longword integer.
IEXP	The number of bits in the exponent. A longword integer.
MINEXP	The smallest value of IBETA consistent with there being no leading zeros in the mantissa. A longword integer.
MAXEXP	The smallest positive value of IBETA that causes overflow. A longword integer.
EPS	The floating-point number $IBETA^{MACHEP}$, loosely referred to as the “floating-point precision.”
EPSNEG	The floating-point number $IBETA^{NEGEP}$, which is another way of determining floating-point precision.
XMIN	The floating-point number $IBETA^{MINEXP}$, generally the magnitude of the smallest usable floating-point value.
XMAX	The largest usable floating-point value, defined as the number $(1\text{-EPSNEG})\text{x}IBETA^{MAXEXP}$

Table 64: MACHAR Fields

See Also

CHECK_MATH, “!VALUES” on page 2423, and “Special Floating-Point Values” in Chapter 17 of *Building IDL Applications*.

MAKE_ARRAY

The MAKE_ARRAY function returns an array of the specified type, dimensions, and initialization. This function enables you to dynamically create an array whose characteristics are not known until run time.

Syntax

Result = MAKE_ARRAY ([D_1, ..., D_8] [, /BYTE | , /COMPLEX | , /DCOMPLEX | , /DOUBLE | , /FLOAT | , /INT | , /L64 | , /LONG | , /OBJ, | , /PTR | , /STRING | , /UINT | , /UL64 | , /ULONG] [, DIMENSION=*vector*] [, /INDEX] [, /NOZERO] [, SIZE=*vector*] [, TYPE=*type_code*] [, VALUE=*value*])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

BYTE

Set this keyword to create a byte array.

COMPLEX

Set this keyword to create a complex, single-precision, floating-point array.

DCOMPLEX

Set this keyword to create a complex, double-precision, floating-point array.

DIMENSION

A vector of 1 to 8 elements specifying the dimensions of the result.

DOUBLE

Set this keyword to create a double-precision, floating-point array.

FLOAT

Set this keyword to create a single-precision, floating-point array.

L64

Set this keyword to create a 64-bit integer array.

INDEX

Set this keyword to initialize the array with each element set to the value of its one-dimensional subscript.

INT

Set this keyword to create an integer array.

LONG

Set this keyword to create a longword integer array.

NOZERO

Set this keyword to prevent the initialization of the array. Normally, each element of the resulting array is set to zero.

OBJ

Set this keyword to create an object reference array.

PTR

Set this keyword to create a pointer array.

SIZE

A size vector specifying the type and dimensions of the result. The format of a size vector is given in the description of the SIZE function.

STRING

Set this keyword to create a string array.

TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of IDL type codes.

UINT

Set this keyword to create an unsigned integer array.

UL64

Set this keyword to create an unsigned 64-bit integer array.

ULONG

Set this keyword to create an unsigned longword integer array.

VALUE

The value to initialize each element of the resulting array. VALUE can be a scalar of any type including structure types. The result type is taken from VALUE unless one of the other keywords that specify a type is also set. In that case, VALUE is converted to the type specified by the other keyword prior to initializing the resulting array.

Example

To create a 3-element by 4-element integer array with each element set to the value 5, enter:

```
M = MAKE_ARRAY(3, 4, /INTEGER, VALUE = 5)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, STRARR, UINTARR, ULON64ARR, ULONARR

MAKE_DLL

The MAKE_DLL procedure builds a sharable library from C language code which is suitable for use by IDL's dynamic linking features such as CALL_EXTERNAL, LINKIMAGE, and dynamically loadable modules (DLMs). MAKE_DLL reduces the complexity of building sharable libraries by providing a stable cross-platform method for the user to describe the desired library, and issuing the necessary operating system commands to build the library.

Note

MAKE_DLL is supported under UNIX, VMS, and Microsoft Windows, but is not available for the Macintosh.

Although MAKE_DLL is very convenient, it is not intended for use as a general purpose compiler. Instead, MAKE_DLL is specifically targeted to solving the most common IDL dynamic linking problem: building a sharable library from C language source files that are usable by IDL. Because of this, the following requirements apply:

- You must have a C compiler installed on your system. It is easiest to use the compiler used to build IDL, because MAKE_DLL already knows how to use that compiler without any additional configuring. To determine which compiler was used, query the !MAKE_DLL system variable with a print statement such as the following:

```
PRINT, !MAKE_DLL.COMPILER_NAME
```

- MAKE_DLL only compiles programs written in the C language; it does not understand Fortran, C++, or any other languages.
- MAKE_DLL provides only the functionality necessary to build C code intended to be linked with IDL. Not every possible option supported by the C compiler or system linker is addressed, only those commonly needed by IDL-related C code.

MAKE_DLL solves the most common IDL-centric problem of linking C code with IDL. To do more than this or to use a different language requires a system-specific building process (e.g. make files, projects, etc...).

Syntax

MAKE_DLL, *InputFiles* [, *OutputFile*], *ExportedRoutineNames* [, CC=*string*] [, COMPILE_DIRECTORY=*path*] [, DLL_PATH=*variable*] [, EXPORTED_DATA=*string*] [, EXTRA_CFLAGS=*string*] [, EXTRA_LFLAGS=*string*] [, INPUT_DIRECTORY=*path*] [, LD=*string*] [, /NOCLEANUP] [, OUTPUT_DIRECTORY=*path*] [, /SHOW_ALL_OUTPUT] [, /VERBOSE]

VMS-Only Keywords: [/VAX_FLOAT]

Arguments

InputFiles

A string (scalar or array) giving the names of the input C program files to be compiled by MAKE_DLL. These names should not include any directory path information or the `.c` suffix, they are simply the base file names.

The input directory is specified using the INPUT_DIRECTORY keyword, and the `.c` file suffix is assumed.

OutputFile

The base name of the resulting sharable library. This name should not include any directory path information or the sharable library suffix, which differs between platforms (for example: `.so`, `.a`, `.sl`, `.exe`, `.dll`).

The output directory can be specified using the OUTPUT_DIRECTORY keyword.

If the *OutputFile* argument is omitted, the first name given by *InputFile* is used as the base name of output file.

ExportedRoutineNames

A string (scalar or array) specifying the names of the routines to be exported (i.e., are visible for linking) from the resulting sharable library.

Keywords

CC

If present, a template string to use in generating the C compiler commands to compile *InputFiles*. If CC is not specified, the value given by the !MAKE_DLL.CC system variable is used by default. See the discussion of !MAKE_DLL for a description of how to write the format string for CC.

COMPILE_DIRECTORY

To build a sharable library, MAKE_DLL requires a place to create the necessary intermediate files and possibly the final library itself. If COMPILE_DIRECTORY is specified, the directory specified is used. If COMPILE_DIRECTORY is not specified, the directory given by the !MAKE_DLL.COMPILE_DIRECTORY system variable is used.

DLL_PATH

If present, the name of a variable to receive the complete file path for the newly created sharable library. The location of the resulting sharable library depends on the setting of the OUTPUT_DIRECTORY or COMPILE_DIRECTORY keywords as well as the !MAKE_DLL.COMPILE_DIRECTORY system variable, and different platforms use different file suffixes to indicate sharable libraries. Use of the DLL_PATH keyword makes it possible to determine the resulting file path in a simple and portable manner.

EXPORTED_DATA

A string (scalar or array) containing the names of variables to be exported (i.e., are visible for linking) from the resulting sharable library.

EXTRA_CFLAGS

If present, a string supplying extra options for the command used to execute the C compiler to compile the files given by *InputFiles*. This keyword is frequently used to specify header file include directories. This text is inserted in place of the %X format code in the compile string. See the discussion of the CC keyword and !MAKE_DLL.CC system variable for more information.

EXTRA_LFLAGS

If present, a string supplying extra options for the command used to execute the linker when combining the object files to produce the sharable library. This keyword is frequently used to specify libraries to be included in the link, and is inserted in place of the %X format code in the linker string. See the discussion of the LD keyword and !MAKE_DLL.LD system variable for more information.

INPUT_DIRECTORY

If present, the path to the directory containing the source C files listed in *InputFiles*. If INPUT_DIRECTORY is not specified, the directory given by COMPILE_DIRECTORY is assumed to contain the files.

LD

If present, a template string to use when generating the linker command to generate the resulting sharable library. If LD is not specified, the value given by the !MAKE_DLL.LD system variable is used by default. See the discussion of !MAKE_DLL for a description of how to write the format string for LD.

NOCLEANUP

To produce a sharable library, MAKE_DLL produces several intermediate files:

1. A shell script (UNIX), command file (VMS), or batch file (Windows) that is then executed via SPAWN to build the library.
2. A linker options file. This file is used to control the linker. MAKE_DLL uses it to cause the routines given by the *ExportedRoutineNames* argument (and EXPORTED_DATA keyword) to be exported from the resulting sharable library. The general platform terminology is shown below.

Platform	Linker Options File Terminology
UNIX	export file, or linker map file
VMS	linker options file (`.OPT`)
Windows	a `.DEF` file

Table 65: Platform Terminology for Linker Options File

3. Object files, resulting from compiling the source C files given by the *InputFiles* argument.
4. A log file that captures the output from executing the script, and which can be used for debugging in case of error.

By default, MAKE_DLL deletes all of these intermediate files once the sharable library has been successfully built. Setting the NOCLEANUP keyword prevents MAKE_DLL from removing them.

Note

Set the NOCLEANUP keyword (possibly in conjunction with VERBOSE) for trouble shooting, or to read the files for additional information on how MAKE_DLL works.

OUTPUT_DIRECTORY

By default, MAKE_DLL creates the resulting sharable library in the compile directory specified by the COMPILE_DIRECTORY keyword or the !MAKE_DLL.COMPILE_DIRECTORY system variable. The OUTPUT_DIRECTORY keyword can be used to override this and explicitly specify where the library file should go.

SHOW_ALL_OUTPUT

MAKE_DLL normally produces no output unless an error prevents successful building of the sharable library. Set SHOW_ALL_OUTPUT to see all output produced by the spawned process building the library.

VERBOSE

If set, VERBOSE causes MAKE_DLL to issue informational messages as it carries out the task of building the sharable library. These messages include information on the intermediate files created to build the library and how they are used.

VMS-Only Keywords

This keyword is for VMS platforms only, and is ignored on all other platforms.

VAX_FLOAT

If set, specifies the sharable library to be compiled for VAX F (single) or D (double) floating point formats. The default is to use the IEEE format used by IDL.

Example 1

Testmodule DLM

The IDL distribution contains an example of a simple DLM (dynamically loadable module) in the `external/dlm` subdirectory. This example consists of a single C source file, and the desired sharable library exports a single function called IDL_Load. The following MAKE_DLL statement builds this sharable library, leaving the resulting file in the directory given by !MAKE_DLL.COMPILE_DIRECTORY:

```
; Locate the source file:
INDIR = FILEPATH('', SUBDIRECTORY=['external', 'dlm'])
; Build the sharable library:
MAKE_DLL, 'testmodule', 'IDL_Load', INPUT_DIRECTORY=INDIR
```

Example 2

Using GCC

IDL is built with the standard vendor-supported C compiler in order to get maximum integration with the target system. MAKE_DLL assumes that you have the same compiler installed on your system and its defaults are targeted to use it. To use other compilers, you tell MAKE_DLL how to use them.

For example, many IDL users have the gcc compiler installed on their systems. This example (tested under 32-bit Solaris 7 using gcc 2.95.2) shows how to use gcc to build the testmodule sharable library from the previous example:

```
; We need the include directory for the IDL export.h header
; file. One way to get this is to extract it from the
; !MAKE_DLL system variable using the STREGEX function
INCLUDE=STREGEX(!MAKE_DLL.CC, '-I[^ ]+', /EXTRACT)
; Locate the source file
INDIR = FILEPATH('', SUBDIRECTORY=['external', 'dlm'])
; Build the sharable library, using the CC keyword to specify gcc:
MAKE_DLL, 'testmodule', 'IDL_Load', INPUT_DIRECTORY=INDIR, $
   CC='gcc -c -fPIC '+ INCLUDE + '%C -o %O'
```

See Also

!MAKE_DLL

MAP_2POINTS

The MAP_2POINTS function returns parameters such as distance, azimuth, and path relating to the great circle or rhumb line connecting two points on a sphere.

This routine is written in the IDL language. Its source code can be found in the file `map_2points.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = MAP_2POINTS(*lon0*, *lat0*, *lon1*, *lat1* [, DPATH=*value* | , /METERS | , /MILES | , NPATH=*integer*{2 or greater} | , /PARAMETERS | , RADIUS=*value*] [, /RADIANS] [, /RHUMB])

Return Value

This function returns a two-element vector containing the distance and azimuth of the great circle or rhumb line connecting the two points, P0 to P1, in the specified angular units, unless one or more of the keywords NPATH, DPATH, METERS, MILES, PARAMETERS, or RADIUS is specified. See the keyword descriptions for the return value associated with each of these keywords.

If MILES, METERS, or RADIUS is not set, distances are angular distance, from 0 to 180 degrees (or 0 to !DPI if the RADIANS keyword is set). Azimuth is measured in degrees or radians, east of north.

Arguments

Lon0, Lat0

Longitude and latitude of the first point, P0.

Lon1, Lat1

Longitude and latitude of the second point, P1.

Keywords

DPATH

Set this keyword to a value specifying the maximum angular distance between the points on the path in the prevalent units, degrees or radians.

METERS

Set this keyword to return the distance between the two points in meters, calculated using the Clarke 1866 equatorial radius of the earth.

MILES

Set this keyword to return the distance between the two points in miles, calculated using the Clarke 1866 equatorial radius of the earth.

NPATH

Set this keyword to a value specifying the number of points to return. If this keyword is set, the function returns a (2, NPATH) array containing the longitude/latitude of the points on the great circle or rhumb line connecting P0 and P1. For a great circle, the points will be evenly spaced in distance, while for a rhumb line, the points will be evenly spaced in longitude.

Note

This keyword must be set to an integer of 2 or greater.

PARAMETERS

Set this keyword to return the parameters determining the great circle connecting the two points, [sin(c), cos(c), sin(az), cos(az)], where c is the great circle angular distance, and az is the azimuth of the great circle at P0, in degrees east of north.

RADIANS

Set this keyword if inputs and angular outputs are to be specified in radians. The default is degrees.

RADIUS

Set this keyword to a value specifying the radius of the sphere to be used to calculate the distance between the two points. If this keyword is specified, the function returns the distance between the two points calculated using the given radius.

RHUMB

Set this keyword to return the distance and azimuth of the rhumb line connecting the two points, P0 to P1. The default is to return the distance and azimuth of the great circle connecting the two points. A rhumb line is the line of constant direction connecting two points.

Examples

The following examples use the geocoordinates of two points, Boulder and London:

```
B = [ -105.19, 40.02]   ;Longitude, latitude in degrees.
L = [ -0.07,   51.30]
```

Example 1

Print the angular distance and azimuth, from B, of the great circle connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1])
```

IDL prints `67.854333    40.667833`

Example 2

Print the angular distance and course (azimuth), connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1],/RHUMB)
```

IDL prints `73.966283    81.228057`

Example 3

Print the distance in miles between the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1],/MILES)
```

IDL prints `4693.5845`

Example 4

Print the distance in miles along the rhumb line connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1], /MILES, /RHUMB)
```

IDL prints `5116.3571`

Example 5

Display a map containing the two points, and annotate the map with both the great circle and the rhumb line path between the points, drawn at one degree increments:

```
MAP_SET, /MOLLWEIDE, 40,-50, /GRID, SCALE=75e6,/CONTINENTS
PLOTS, MAP_2POINTS(B[0], B[1], L[0], L[1],/RHUMB, DPATH=1)
PLOTS, MAP_2POINTS(B[0], B[1], L[0], L[1],DPATH=1)
```

This displays the following map:

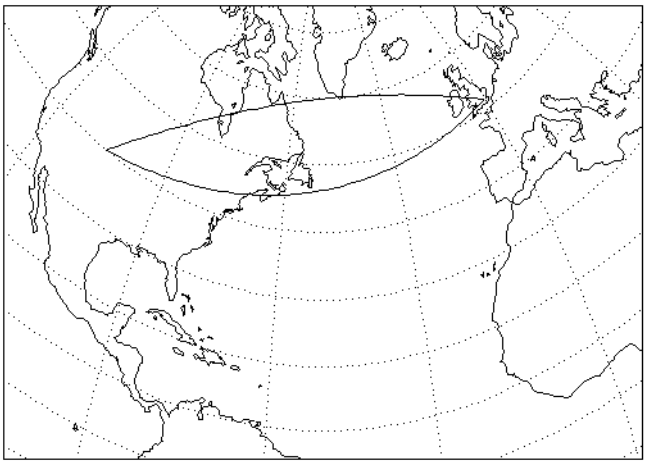


Figure 16: Map annotated with great circle and rhumb line path between Boulder and London, drawn at one degree increments.

See Also

MAP_SET

MAP_CONTINENTS

The MAP_CONTINENTS procedure draws continental boundaries, filled continents, political boundaries, coastlines, and/or rivers, over an existing map projection established by MAP_SET. Outlines can be drawn in low or high-resolution (if the optional high-resolution CIA World Map database is installed). If MAP_CONTINENTS is called without any keywords, it draws low-resolution, unfilled continent outlines.

MAP_SET must be called before MAP_CONTINENTS to establish the projection type, the center of the projection, polar rotation and geographic limits.

Syntax

MAP_CONTINENTS [, /COASTS] [, COLOR=*index*] [, /CONTINENTS]
[, /COUNTRIES] [,FILL_CONTINENTS={1 | 2}[, ORIENTATION=*value*]]
[, /HIRES] [, LIMIT=*vector*] [, MLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}]
[, MLINETHICK=*value*] [, /RIVERS] [, SPACING=*centimeters*] [, /USA]

Graphics Keywords: [, /T3D] [, ZVALUE=*value*{0 to 1}]

Keywords

COASTS

Set this keyword to draw coastlines, islands, and lakes instead of the default continent outlines. Note that if you are using the low-resolution map database (if the HIRES keyword is *not* set), many islands are drawn even when COASTS is not set. If you are using the high-resolution map database (if the HIRES keyword *is* set), no islands are drawn unless COASTS is set.

COLOR

Set this keyword to the color index of the lines being drawn.

CONTINENTS

Set this keyword to plot the continental boundaries. This is the default, unless COASTS, COUNTRIES, RIVERS and/or USA is set.

Note that if you are using the low-resolution map database (if the HIRES keyword is *not* set), outlines for continents, islands, and lakes are drawn when the CONTINENTS keyword is set. If you are using the high-resolution map database (if the HIRES keyword *is* set), only continental outlines are drawn when the

CONTINENTS keyword is set. To draw islands and lakes when using the high-resolution map database, use the COASTS keyword.

COUNTRIES

Set this keyword to draw political boundaries as of 1993.

FILL_CONTINENTS

Set this keyword to 1 to fill continent boundaries with a solid color. The color is set by the COLOR keyword. Set this keyword to 2 to fill continent boundaries with a line fill. For line filling, the COLOR, MLINESTYLE, MLINETHICK, ORIENTATION, and SPACING keywords can be used to control the type of line fill.

Note

When using this keyword in conjunction with the HIRES keyword, lakes on continents will be filled and islands will not be filled.

HIRES

Set this keyword to use high-resolution map data instead of the default low-resolution data. This option is only available if you have installed the optional high-resolution map datasets. If the high-resolution data is not available, a warning is printed and the low-resolution data is used instead.

This keyword can be used in conjunction with the COASTS, COUNTRIES, FILL_CONTINENTS, and RIVERS keywords.

LIMIT

Set this keyword to a four-element vector [Lat_{min}, Lon_{min}, Lat_{max}, Lon_{max}] to only plot continents that pass through the LIMIT rectangle. The points (Lat_{min}, Lon_{min}) and (Lat_{max}, Lon_{max}) are the latitudes and longitudes of two points diagonal from each other on the regionüs boundary. The default is to use the limits from the current map projection.

Note

Line segments for continents which extend outside of the LIMIT rectangle will still be plotted.

MLINESTYLE

The line style of the boundaries being drawn. The default is solid lines. Valid linestyles are shown in the table below:

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot
5	Long Dashes

Table 66: IDL Linestyles

MLINETHICK

The thickness of the boundary or fill lines. The default thickness is 1.

ORIENTATION

Set this keyword to the counterclockwise angle in degrees from horizontal that the line fill should be drawn. The default is 0. This keyword only has effect if the FILL_CONTINENTS keyword is set to 2.

RIVERS

Set this keyword to draw rivers.

SPACING

Set this keyword to the spacing, in centimeters, for a line fill. This keyword only has effect if the FILL_CONTINENTS keyword is set to 2. The default is 0.5 centimeters.

USA

Set this keyword to draw borders for each state in the United States in addition to continental boundaries.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for descriptions of graphics and plotting keywords not listed above. T3D, ZVALUE.

Example

The following example demonstrates the use of map outlines to embellish a map projection:

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

; Load discrete color table:
tek_color

; Match color indices to colors we want to use:
black=0 & white=1 & red=2
green=3 & dk_blue=4 & lt_blue=5

; Set up an orthographic projection centered over the north
; Atlantic.Fill the hemisphere with dark blue. Specify black
; gridlines:
MAP_SET,  /ORTHO, 40, -30, 23, /ISOTROPIC, $
   /HORIZON, E_HORIZON={FILL:1, COLOR:dk_blue}, $
   /GRID, COLOR=black

; Fill the continent boundaries with solid white:
MAP_CONTINENTS, /FILL_CONTINENTS, COLOR=white

; Overplot coastline data:
MAP_CONTINENTS, /COASTS, COLOR=black

; Add rivers, in light blue:
MAP_CONTINENTS, /RIVERS, COLOR=lt_blue

; Show national borders:
MAP_CONTINENTS, /COUNTRIES, COLOR=red, MLINETHICK=2
```

See Also

MAP_GRID, MAP_IMAGE, MAP_PATCH, MAP_SET

MAP_GRID

The MAP_GRID procedure draws the graticule of parallels and meridians, according to the specifications established by MAP_SET. MAP_SET must be called before MAP_GRID to establish the projection type, the center of the projection, polar rotation and geographical limits.

Syntax

MAP_GRID [, /BOX_AXES | [, CLIP_TEXT=0] [, LATALIGN=*value*{0.0 to 1.0}] [, LONALIGN=*value*{0.0 to 1.0}] [, LATLAB=*longitude*] [, LONLAB=*latitude*] [, ORIENTATION=*clockwise_degrees_from_horiz*]] [, CHARSIZE=*value*] [, COLOR=*index*] [, /FILL_HORIZON] [, GLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, GLINETHICK=*value*] [, /HORIZON] [, INCREMENT=*value*] [, LABEL=*n*{label_every_*n*th_gridline}] [, LATDEL=*degrees*] [, LATNAMES=*array*, LATS=*vector*] [, LONDEL=*degrees*] [, LONNAMES=*array*, LONS=*vector*] [, /NO_GRID]

Graphics Keywords: [, /T3D] [, ZVALUE=*value*{0 to 1}]

Keywords

BOX_AXES

Set this keyword to create box-style axes for map plots where the parallels intersect the sides, and the meridians intersect the bottom and top edges of the box.

CHARSIZE

Set this keyword to the size of the characters used for the labels. The default is 1.

CLIP_TEXT

Set this keyword to a zero value to turn off clipping of text labels. By default, text labels are clipped. This keyword is ignored if the BOX_AXES keyword is set.

COLOR

Set this keyword to the color index for the grid lines.

FILL_HORIZON

Set this keyword to fill the current map_horizon.

GLINESTYLE

If set, the line style used to draw the grid of parallels and meridians. See "LINESTYLE" on page 2405 for a list of available linestyles. The default index is 1, drawing a dotted line.

GLINETHICK

Set this keyword to the thickness of the grid lines. Default is 1.

HORIZON

Set this keyword to draw the current map horizon.

INCREMENT

Set this keyword to the spacing between graticle points.

LABEL

Set this keyword to label the parallels and meridians with their corresponding latitudes and longitudes. Setting this keyword to an integer will cause every LABEL gridline to be labeled (that is, if LABEL=3 then every third gridline will be labeled). The starting point for determining which gridlines are labeled is the minimum latitude or longitude (-180 to 180), unless the LATS or LONS keyword is set to a single value. In this case, the starting point is the value of LATS or LONS.

LATALIGN

This keyword controls the alignment of the text baseline for latitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it. This keyword is ignored if the BOX_AXES keyword is set.

LATDEL

Set this keyword equal to the spacing (in degrees) between parallels of latitude in the grid. If this keyword is not set, a suitable value is determined from the current map projection.

LATLAB

The longitude at which to place latitude labels. The default is the center longitude on the map. This keyword is ignored if the BOX_AXES keyword is set.

LATNAMES

Set this keyword equal to an array specifying the names to be used for the latitude labels. By default, this array is automatically generated in units of degrees. The

LATNAMES array can be either type string or any single numeric type, but should not be of mixed type.

When LATNAMES is specified, the LATS keyword must also be specified. The number of elements in the two arrays need not be equal. If there are more elements in the LATNAMES array than in the LATS array, the extra LATNAMES are ignored. If there are more elements in the LATS array than in the LATNAMES array, labels in degrees will be automatically provided for the missing latitude labels.

The LATNAMES keyword can be also used when the LATS keyword is set to a single value. It this case, the first label supplied will be used at the specified latitude; subsequent names will be placed at the next latitude line to the north, wrapping around the globe if appropriate. Caution should be used when using LATNAMES in conjunction with a single LATS value, since the number of visible latitude gridlines is dependent on many factors.

LATS

Set this keyword equal to a one or more element vector of latitudes for which lines will be drawn (and optionally labeled). If LATS is omitted, appropriate latitudes will be generated based on the value of the (optional) LATDEL keyword. If LATS is set to a single value, that latitude and a series of automatically generated latitudes will be drawn (and optionally labeled). Automatically generated latitudes have the values:

```
[...,LATS-LATDEL,LATS,LATS+LATDEL,...]
```

over the extent of the map. If LATS is a single value, that value is taken to be the starting point for labelling (See the LABEL keyword).

LONALIGN

This keyword controls the alignment of the text baseline for longitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it. This keyword is ignored if the BOX_AXES keyword is set.

LONDEL

Set this keyword equal to the spacing (in degrees) between meridians of longitude in the grid. If this keyword is not set, a suitable value is determined from the current map projection.

LONLAB

The latitude at which to place longitude labels. The default is the center latitude on the map. This keyword is ignored if the BOX_AXES keyword is set.

LONNAMES

Set this keyword equal to an array specifying the names to be used for the longitude labels. By default, this array is automatically generated in units of degrees. The LONNAMES array can be either type string or any single numeric type, but should not be of mixed type.

When LONNAMES is specified, the LONS keyword must also be specified. The number of elements in the two arrays need not be equal. If there are more elements in the LONNAMES array than in the LONS array, the extra LONNAMES are ignored. If there are more elements in the LONS array than in the LONNAMES array, labels in degrees will be automatically provided for the missing longitude labels.

The LONNAMES keyword can be also used when the LONS keyword is set to a single value. It this case, the first label supplied will be used at the specified longitude; subsequent names will be placed at the next longitude line to the east, wrapping around the globe if appropriate. Caution should be used when using LONNAMES in conjunction with a single LONS value, since the number of visible longitude gridlines is dependent on many factors.

LONS

Set this keyword equal to a one or more element vector of longitudes for which lines will be drawn (and optionally labeled). If LONS is omitted, appropriate longitudes will be generated based on the value of the (optional) LONDEL keyword. If LONS is set to a single value, that longitudes and a series of automatically generated longitudes will be drawn (and optionally labeled). Automatically generated longitudes have the values:

```
[...,LONS-LONDEL,LONS,LONS+LONDEL,...]
```

over the extent of the map. If LONS is a single value, that value is taken to be the starting point for labelling (See the LABEL keyword).

NO_GRID

Set this keyword if you only want labels but not gridlines.

ORIENTATION

Set this keyword equal to an angle in degrees from horizontal (in the clockwise direction) to rotate the labels. This keyword is ignored if the BOX_AXES keyword is set.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for descriptions of graphics and plotting keywords not listed above. T3D, ZVALUE.

Example

The following example creates an orthographic projection, defines which latitudes to label, and provides text labels. Note that the text labels are rotated to match the orientation of the map projection.

```
; Set up an orthographic projection:
MAP_SET, /ORTHO, 10, 20, 30, /ISOTROPIC, /CONTINENTS, /HORIZON
; Define latitudes of interest:
lats = [ -80, -45, -30, -20, 0, 15, 27, 35, 45, 55, 75]
; Create string equivalents of latitudes:
latnames = strtrim(lats, 2)
; Label the equator:
latnames(where(lats eq 0)) = 'Equator'
; Draw the grid:
MAP_GRID, LABEL=2, LATS=lats, LATNAMES=latnames, LATLAB=7, $
   LONLAB=-2.5, LONDEL=20, LONS=-15, ORIENTATION=-30
```

See Also

MAP_CONTINENTS, MAP_IMAGE, MAP_PATCH, MAP_SET

MAP_IMAGE

The MAP_IMAGE function returns an image (or other dataset) warped to fit the current map projection. This function provides an easy method for displaying geographical data as an image on a map. The MAP_SET procedure should be called prior to calling MAP_IMAGE.

MAP_IMAGE works in image (graphic) space. For each destination pixel (when COMPRESS is set to one) MAP_IMAGE calculates the latitude and longitude by applying the inverse map projection. This latitude and longitude are then used to index and interpolate the *Image* argument, obtaining an interpolated value for the destination pixel. The time required by MAP_IMAGE depends mainly on the number of pixels in the destination and the setting of the COMPRESS parameter.

MAP_IMAGE is more efficient than MAP_PATCH when the input data set is large compared to the destination area. If the converse is true, MAP_PATCH is more efficient.

For more information, see "Image Display" in Chapter 14 of *Using IDL*.

Syntax

Result = MAP_IMAGE(*Image* [, *Startx*, *Starty* [, *Xsize*, *Ysize*]]
[, LATMIN=*degrees*{-90 to 90}] [, LATMAX=*degrees*{-90 to 90}]
[, LONMIN=*degrees*{-180 to 180}] [, LONMAX=*degrees*{-180 to 180}]
[, /BILINEAR] [, COMPRESS=*value*] [, SCALE=*value*] [, MAX_VALUE=*value*]
[, MIN_VALUE=*value*] [, MISSING=*value*])

Arguments

Image

A two-dimensional array containing the image to be overlaid on the map.

Startx

A named variable that, upon return, contains the X coordinate position where the left edge of the image should be placed on the screen.

Starty

A named variable that, upon return, contains the Y coordinate position where the left edge of the image should be placed on the screen.

Xsize

A named variable that, upon return, contains the width of the image expressed in graphic coordinate units. If the current graphics device uses scalable pixels, the values of *Xsize* and *Ysize* should be passed to the TV procedure.

Ysize

A named variable that, upon return, contains the height of the image expressed in graphic coordinate units. If the current graphics device uses scalable pixels, the values of *Xsize* and *Ysize* should be passed to the TV procedure.

Keywords

LATMIN

The latitude corresponding to the first row of *Image*. The default is -90 degrees. Note also that -90° ≤ LATMIN < LATMAX ≤ 90°.

LATMAX

The latitude corresponding to the last row of *Image*. The default value is 90 degrees. Note also that -90° ≤ LATMIN < LATMAX ≤ 90°.

LONMIN

The longitude corresponding to the first (leftmost) column of the *Image* argument. Select LONMIN so that -180° ≤ LONMIN ≤ 180°. The default value is -180.

LONMAX

The longitude corresponding to the last (rightmost) column of the *Image* argument. Select LONMAX so that it is larger than LONMIN. If the longitude of the last column is equal to (LONMIN - (360. /*Nx*)) MODULO 360, it is assumed that the image covers all longitudes (*Nx* being the total number of columns in the *Image* argument).

BILINEAR

Set this flag to use bilinear interpolation to soften edges in the returned image, otherwise, nearest neighbor sampling is used.

COMPRESS

This keyword, the interpolation compression flag, controls the accuracy of the results from MAP_IMAGE. The default is 4 for output devices with fixed pixel sizes. The inverse projection transformation is applied to each *i*th row and column. Setting this

keyword to a higher number saves time while lower numbers produce more accurate results. Setting this keyword to 1 solves the inverse map transformation for every pixel of the output image.

SCALE

Set this keyword to the pixel/graphics scale factor for devices with scalable pixels (e.g., PostScript). The default is 0.02 pixels/graphic coordinate. This setting yields an approximate output image size of 350 x 250. Make this number larger for more resolution (and larger PostScript files and images), or smaller for faster, smaller, and less accurate images.

MAX_VALUE

Data points with values equal to or greater than this value will be treated as missing data, and will be set to the value specified by the MISSING keyword.

MIN_VALUE

Data points with values equal to or less than this value will be treated as missing data, and will be set to the value specified by the MISSING keyword.

MISSING

The pixel value to set areas outside the valid map coordinates. If this keyword is omitted, areas outside the map are set to 255 (white) if the current graphics device is PostScript, otherwise they are set to 0.

Example

The following lines of code set up an orthographic map projection and warp a simple image to it.

```
; Create a simple image to be warped:
image = BYTSCL(SIN(DIST(400)/10))

; Display the image so we can see what it looks like before
; warping:
TV, image
latmin = -65
latmax = 65

; Left edge is 160 East:
lonmin = 160

; Right edge is 70 West = +360:
lonmax = -70 + 360
MAP_SET, 0, -140, /ORTHOGRAPHIC, /ISOTROPIC, $
```

```
   LIMIT=[latmin, lonmin, latmax, lonmax]
result = MAP_IMAGE(image,Startx,Starty, COMPRESS=1, $
   LATMIN=latmin, LONMIN=lonmin, $
   LATMAX=latmax, LONMAX=lonmax)

; Display the warped image on the map at the proper position:
TV, result, Startx, Starty

; Draw continent outlines:
MAP_GRID, latdel=10, londel=10, /LABEL, /HORIZON

; Draw gridlines over the map and image:
MAP_CONTINENTS, /coasts
```

See Also

MAP_CONTINENTS, MAP_GRID, MAP_PATCH, MAP_SET

MAP_PATCH

The MAP_PATCH function returns an image (or other dataset) warped to fit the current map projection. Mapping coordinates should be setup via a call to MAP_SET before using MAP_PATCH.

MAP_PATCH works in object (data) space. It divides the input data set, *Image_Orig*, into triangular patches, either directly from the implicit rectangular grid, or by triangulating the data points on the surface of the sphere using the TRIANGULATE procedure. These triangular patches are then projected to the map plane in the image space of the destination array and then interpolated. The time required by MAP_PATCH depends mainly on the number of elements in the input array.

MAP_PATCH is more efficient than MAP_IMAGE when the destination area is large compared to the input data set. If the converse is true, MAP_IMAGE is more efficient.

This routine is written in the IDL language. Its source code can be found in the file `map_patch.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = MAP_PATCH(*Image_Orig* [, *Lons*, *Lats*] [, LAT0=*value*] [, LAT1=*value*] [, LON0=*value*] [, LON1=*value*] [, MAX_VALUE=*value*] [, MISSING=*value*] [, /TRIANGULATE] [, XSIZE=*variable*] [, XSTART=*variable*] [, YSIZE=*variable*] [, YSTART=*variable*])

Arguments

Image_Orig

A one- or two-dimensional array that contains the data to be overlaid on the map. If the TRIANGULATE keyword is not set, *Image_Orig* must be a two-dimensional array. Rows and columns must be arranged in increasing longitude and latitude order. Also, the corner points of each cell must be contiguous. This means that the seam of a map must lie on a cell boundary, not in its interior, splitting the cell.

Lons

An optional vector that contains the longitude value for each column in *Image_Orig*. If *Lons* is a one-dimensional vector, longitude (*Image_Orig*[i,j]) = *Lons*[i]; if *Lons* is a two-dimensional vector, longitude (*Image_Orig*[i,j]) = *Lons*[i,j].

This argument can be omitted if the longitudes are equally-spaced and the beginning and ending longitudes are specified with the LON0 and LON1 keywords.

Lats

An optional vector that contains the latitude value for each row in *Image_Orig*. If *Lats* is a one-dimensional vector, latitude (*Image_Orig*[i,j]) = *Lats*[i]; if *Lats* is a two-dimensional vector, latitude (*Image_Orig*[i,j]) = *Lats*[i,j].

This argument can be omitted if the latitudes are equally-spaced and the beginning and ending latitudes are specified with the LAT0 and LAT1 keywords.

Keywords

LAT0

The latitude of the first row of data. The default is -90.

LAT1

The latitude of the last row of data. The default is +90.

LON0

The longitude of the first column of data. The default is -180.

LON1

The longitude of the last column of data. The default is 180 - (360/Number-of-Rows)

MAX_VALUE

The largest data value to be warped. Values in *Image_Orig* greater than this value are considered missing. Pixels in the output image that correspond to these missing values are set to the value specified by the MISSING keyword.

MISSING

Set this keyword to a value to be used for areas outside the valid map coordinates (i.e., the “background color”). If the current plotting device is PostScript, the default is 255 (white). Otherwise, the default is 0 (usually black).

TRIANGULATE

Set this keyword to convert the input data to device space and triangulate them. This keyword must be specified if the connectivity of the data points is not rectangular and monotonic in device space.

XSIZE

Set this keyword to a named variable in which the width of the output image is returned, in graphic coordinate units. If the current graphics device has scalable pixels (e.g., PostScript), the values returned by XSIZE and YSIZE should be passed to the TV procedure.

XSTART

Set this keyword to a named variable in which the X coordinate where the left edge of the image should be placed on the screen is returned.

YSIZE

Set this keyword to a named variable in which the height of the output image is returned, in graphic coordinate units. If the current graphics device has scalable pixels (e.g., PostScript), the values returned by XSIZE and YSIZE should be passed to the TV procedure.

YSTART

Set this keyword to a named variable in which the Y coordinate where the bottom edge of the image should be placed on the screen is returned.

Example

```
; Form a 24 x 24 dataset on a sphere:
n = 24

; Specify equally gridded latitudes:
lat = replicate(180./(n-1),n) # findgen(n) - 90

; Specify equally gridded longitudes:
lon = findgen(n) # replicate(360./(n-1), n)

; Convert to Cartesian coordinates:
x = cos(lon * !dtor) * cos(lat * !dtor)
y = sin(lon * !dtor) * cos(lat * !dtor)
z = sin(lat * !dtor)

; Set interpolation function to scaled distance squared
; from (1,1,0):
f = BYTSCL((x-1)^2 + (y-1)^2 + z^2)

; Set up projection:
MAP_SET, 90, 0, /STEREO, /ISOTROPIC, /HORIZ

; Grid and display the data:
```

```
TV, MAP_PATCH(f, XSTART=x0, YSTART=y0), x0, y0

; Draw gridlines over the map and image:
MAP_GRID

; Draw continent outlines:
MAP_CONTINENTS

; Draw a horizon line:
MAP_HORIZON
```

See Also

MAP_CONTINENTS, MAP_GRID, MAP_IMAGE, MAP_SET

MAP_PROJ_INFO

The MAP_PROJ_INFO procedure returns information about the current map and/or the available projections. To establish a current projection, mapping parameters should be setup via a call to MAP_SET.

Syntax

MAP_PROJ_INFO [, *iproj*] [, AZIMUTHAL=*variable*] [, CIRCLE=*variable*] [, CYLINDRICAL=*variable*] [, /CURRENT] [, LL_LIMITS=*variable*] [, NAME=*variable*] [, PROJ_NAMES=*variable*] [, UV_LIMITS=*variable*] [, UV_RANGE=*variable*]

Arguments

Iproj

The projection index. If the CURRENT keyword is set, then the index of the current map projection is returned in Iproj.

Keywords

AZIMUTHAL

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is azimuthal and 0 otherwise.

CIRCLE

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is circular or elliptical and 0 otherwise.

CURRENT

Set this keyword to use the current projection index and return that index in *Iproj*.

CYLINDRICAL

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is cylindrical and 0 otherwise.

LL_LIMITS

Set this keyword to a named variable that will contain the geocoordinate rectangle of the current map in degrees, [Latmin, Lonmin, Latmax, Lonmax]. This range may not

always be available, especially if the LIMIT keyword was not specified in the call to MAP_SET. If either or both the longitude and latitude range are not available, the minimum and maximum values will be set to zero.

NAME

Set this keyword to a named variable that will contain the name of the projection.

PROJ_NAMES

Set this keyword to a named variable that will contain a string array containing the names of the available projections, ordered by their indices. The first projection name is stored in element one.

UV_LIMITS

Set this keyword to a named variable that will contain the UV bounding box of the current map, [Umin, Vmin, Umax, Vmax].

UV_RANGE

Set this keyword to a named variable that will contain the UV coordinate limits of the selected map projection, [Umin, Vmin, Umax, Vmax]. UV coordinates are mapped to normalized coordinates using the system variables !X.S and !Y.S. These limits are dependent upon the selected projection, but independent of the current map.

Example

```
; Establish a projection
MAP_SET, /MERCATOR

;Obtain projection characteristics
MAP_PROJ_INFO, /CURRENT, NAME=name, AZIMUTHAL=az, $
CYLINDRICAL=cyl, CIRCLE=cir
```

On return, the variables will be set as follows:

```
AZIM      INT  =  0
CIRC      INT  =  0
CYL       INT  =  1
NAME      STRING  'Mercator'
```

See Also

MAP_SET

MAP_SET

The MAP_SET procedure establishes the axis type and coordinate conversion mechanism for mapping points on the earth's surface, expressed in latitude and longitude, to points on a plane, according to one of several possible map projections.

The type of map projection, the map center, polar rotation and geographical limits can all be customized. The system variable !MAP retains the information needed to effect coordinate conversions to the plane and, inversely, from the projection plane to points on the earth in latitude and longitude. Users should not change the values of the fields in !MAP directly.

MAP_SET can also be made to plot the grid of latitude and longitude lines and continental boundaries by setting the keywords GRID and CONTINENTS. Many other types of boundaries can be overplotted on maps using the MAP_CONTINENTS procedure.

Note

If the graphics device is changed, MAP_SET (and all other mapping calls) must be re-called for the projection to be set up properly for the new device.

Syntax

MAP_SET [, *P0lat*, *P0lon*, *Rot*]

Keywords—Projection Types: [[, /AITOFF | , /ALBERS | , /AZIMUTHAL | , /CONIC | , /CYLINDRICAL | , /GNOMIC | , /GOODESHOMOLOSINE | , /HAMMER | , /LAMBERT | , /MERCATOR | , /MILLER_CYLINDRICAL | , /MOLLEWIDE | , /ORTHOGRAPHIC | , /ROBINSON | , /SATELLITE | , /SINUSOIDAL | , /STEREOGRAPHIC | , /TRANSVERSE_MERCATOR] | NAME=*string*]]

Keywords—Map Characteristics: [, /ADVANCE] [, CHARSIZE=*value*] [, /CLIP] [, COLOR=*index*] [, /CONTINENTS [, CON_COLOR=*index*] [, /HIRES]] [, E_CONTINENTS=*structure*] [, E_GRID=*structure*] [, E_HORIZON=*structure*] [, GLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, GLINETHICK=*value*] [, /GRID] [, /HORIZON] [, LABEL=*n*{label every *n*th gridline}] [, LATALIGN=*value*{0.0 to 1.0}] [, LATDEL=*degrees*] [, LATLAB=*longitude*] [, LONDEL=*degrees*] [, LONLAB=*latitude*] [, MLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, MLINETHICK=*value*] [, /NOBORDER] [, /NOERASE]

[, REVERSE={0 | 1 | 2 | 3}] [, TITLE=*string*] [, /USA] [, XMARGIN=*value*] [, YMARGIN=*value*]

Keywords—Projection Parameters:
[, CENTRAL_AZIMUTH=*degrees_east_of_north*] [, ELLIPSOID=*array*] [, /ISOTROPIC] [, LIMIT=*vector*] [, SAT_P=*vector*] [, SCALE=*value*] [, STANDARD_PARALLELS=*array*]

Graphics Keywords: [, POSITION=*[X_0, Y_0, X_1, Y_1]*] [, /T3D] [, ZVALUE=*value*{0 to 1}]

Arguments

P0lat

The latitude of the point on the earth's surface to be mapped to the center of the projection plane. Latitude is measured in degrees North of the equator and P_{0lat} must be in the range: $-90° \le P_{0lat} \le 90°$.

If P_{0lat} is not set, the default value is 0.

P0lon

The longitude of the point on the earth's surface to be mapped to the center of the map projection. Longitude is measured in degrees east of the Greenwich meridian and P0lon must be in the range: $-180° \le P_{0lon} \le 180°$.

If P_{0lon} is not set, the default value is zero.

Rot

Rot is the angle through which the North direction should be rotated around the line *L* between the earth's center and the point (P_{0lat}, P_{0lon}). *Rot* is measured in degrees with the positive direction being clockwise rotation around line *L*. *Rot* can have values from -180° to 180°.

If the center of the map is at the North pole, North is in the direction $P_{0lon} + 180°$. If the origin is at the South pole, North is in the direction P_{0lon}.

The default value of *Rot* is 0 degrees.

Keywords: Projection Types

AITOFF

Set this keyword to select the Aitoff projection.

ALBERS

Set this keyword to select the Albers equal-area conic projection. To specify the latitude of the standard parallels, see "STANDARD_PARALLELS" on page 852.

AZIMUTHAL

Set this keyword to select the azimuthal equidistant projection.

CONIC

Set this keyword to select Lambert's conformal conic projection with one or two standard parallels. To specify the latitude of the standard parallels, see "STANDARD_PARALLELS" on page 852. This keyword can be used with the ELLIPSOID keyword.

CYLINDRICAL

Set this keyword to select the cylindrical equidistant projection. Cylindrical is the default map projection.

GOODESHOMOLOSINE

Set this keyword to select the Goode's Homolosine Projection. The central latitude for this projection is fixed on the equator, 0 degrees latitude. This projection is interrupted, as the inventor originally intended, and is best viewed with the central longitude set to 0.

GNOMIC

Set this keyword to select the gnomonic projection. If default clipping is enabled, this projection will display a maximum of ± 60° from the center of the projection area when the center is at either the equator or one of the poles.

HAMMER

Set this keyword to select the Hammer-Aitoff equal area projection.

LAMBERT

Set this keyword to select Lambert's azimuthal equal area projection.

MERCATOR

Set this keyword to select the Mercator projection. Note that this projection will not display regions within ± 10° of the poles of projection.

MILLER_CYLINDRICAL

Set this keyword to select the Miller Cylindrical projection.

MOLLWEIDE

Set this keyword to select the Mollweide projection.

NAME

Set this keyword to a string indicating the projection that you wish to use. A list of available projections can be found using `MAP_PROJ_INFO, PROJ_NAMES=names`. This keyword will override any of the individual projection keywords.

ORTHOGRAPHIC

Set this keyword to select the orthographic projection. Note that this projection will display a maximum of ± 90° from the center of the projection area.

ROBINSON

Set this keyword to select the Robinson pseudo-cylindrical projection.

SATELLITE

Set this keyword to select the satellite projection.

For the satellite projection, P0LAT and P0LON represent the latitude and longitude of the sub-satellite point. Three additional parameters, *P*, *Omega*, and *Gamma* (supplied as a three-element vector argument to the SAT_P keyword), are also required.

Note

Since all meridians and parallels are oblique lines or arcs, the LIMIT keyword must be supplied as an eight-element vector representing four points that delineate the limits of the map. The extent of the map limits, when expressed in latitude/longitude is a complicated polygon, rather than a simple quadrilateral.

SINUSOIDAL

Set this keyword to select the sinusoidal projection.

STEREOGRAPHIC

Set this keyword to select the stereographic projection. Note that if default clipping is enabled, this projection will display a maximum of ± 90° from the center of the projection area.

TRANSVERSE_MERCATOR

Set this keyword to select the Transverse Mercator projection, also called the UTM or Gauss-Krueger projection. This projection works well with the ellipsoid form. The default ellipsoid is the Clarke 1866 ellipsoid. To change the default ellipsoid characteristics, see "ELLIPSOID" on page 851.

Keywords: Map Characteristics

ADVANCE

Set this keyword to advance to the next frame when the screen is set to display multiple plots. Otherwise the entire screen is erased.

CHARSIZE

The size of the characters used for the labels. The default is 1.

CLIP

Set this keyword to clip the map using the map-specific graphics technique. The default is to perform map-specific clipping. Set CLIP=0 to disable clipping.

Note

Clipping controlled by the CLIP keyword to MAP_SET applies only to the map itself. In order to disable general clipping within the plot window, you must set the system variable !P.NOCLIP=1. For more information, see "NOCLIP" on page 2406.

COLOR

The color index of the map border in the plotting window.

CONTINENTS

Set this keyword to plot the continental boundaries. Note that if you are using the low-resolution map database (if the HIRES keyword is *not* set), outlines for continents, islands, and lakes are drawn when the CONTINENTS keyword is set. If you are using the high-resolution map database (if the HIRES keyword *is* set), only continental outlines are drawn when the CONTINENTS keyword is set. To draw islands and lakes when using the high-resolution map database, use the COASTS keyword to the MAP_CONTINENTS procedure.

CON_COLOR

The color index for continent outlines if CONTINENTS is set.

E_CONTINENTS

Set this keyword to a structure containing extra keywords to be passed to MAP_CONTINENTS. For example, to fill continents, the FILL keyword of MAP_CONTINENTS is set to 1. To fill the continents with MAP_SET, specify E_CONTINENTS={FILL:1}.

E_GRID

Set this keyword to a structure containing extra keywords to be passed to MAP_GRID. For example, to label every other gridline on a grid of parallels and meridians, the LABEL keyword of MAP_GRID is set to 2. To do the same with MAP_SET, specify E_GRID={LABEL:2}.

E_HORIZON

Set this keyword to a structure containing extra keywords to be set as modifiers to the HORIZON keyword.

Example

To draw a Stereographic map, with the sphere filled in color index 3, enter:

```
MAP_SET, 0, 0, /STEREO, /HORIZON, /ISOTROPIC, $
   E_HORIZON={FILL:1, COLOR:3}
```

GLINESTYLE

Set this keyword to a line style index used to draw the grid of parallels and meridians. See MLINESTYLE for a list of available linestyles. The default is 1, drawing a grid of dotted lines.

GLINETHICK

Set this keyword to the thickness of the gridlines drawn if the GRID keyword is set. The default is 1.

GRID

Set this keyword to draw the grid of parallels and meridians.

HIRES

Set this keyword to use the high-resolution continent outlines when drawing continents. This keyword only has effect if the CONTINENTS keyword is also set.

HORIZON

Set this keyword to draw a horizon line, when the projection in use permits. The horizon delineates the boundary of the sphere. See E_HORIZON for more options.

LABEL

Set this keyword to label the parallels and meridians with their corresponding latitudes and longitudes. Setting this keyword to an integer will cause every LABEL gridline to be labeled (that is, if LABEL=3 then every third gridline will be labeled). The starting point for determining which gridlines are labeled is the minimum latitude or longitude (-180 to 180).

LATALIGN

The alignment of the text baseline for latitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it.

LATLAB

The longitude at which to place latitude labels. The default is the center longitude of the map.

LATDEL

Set this keyword equal to the spacing (in degrees) between parallels of latitude drawn by the MAP_GRID procedure. If this keyword is not set, a suitable value is determined from the current map projection.

LONALIGN

The alignment of the text baseline for longitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it.

LONDEL

Set this keyword equal to the spacing (in degrees) between meridians of longitude drawn by the MAP_GRID procedure. If this keyword is not set, a suitable value is determined from the current map projection.

LONLAB

The latitude at which to place longitude labels. The default is the center latitude of the map.

MLINESTYLE

The line style index used for continental boundaries. Linestyles are described in the table below. The default is 0 for solid.

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot
5	Long Dashes

Table 67: IDL Linestyles

MLINETHICK

The line thickness used for continental boundaries. The default is 2.

NOBORDER

Set this keyword to not draw a border around the map. The map will fill the extent of the plotting region. If NOBORDER is *not* specified, a margin equalling 1% of the plotting region will be placed between the map and the border.

NOERASE

Set this keyword to have MAP_SET not erase the current plot window. The default is to erase before drawing the map.

REVERSE

Set this keyword to one of the following values to reverse the X and/or Y axes:

- 0 = no reversal (the default)
- 1 = reverse X
- 2 = reverse Y
- 3 = reverse both.

TITLE

A string containing the main title for the map. The title appears centered above the map window.

USA

Set this keyword to draw borders for each state in the United States.

XMARGIN

A scalar or two-element vector that specifies the vertical margin between the map and screen border in character units. If a scalar is specified, the same margin will be used on both sides of the map.

YMARGIN

A scalar or two-element vector that specifies in the horizontal margin between the map and screen border in character units. If a scalar is specified, the same margin will be used on the top and bottom of the map.

Keywords: Projection Parameters

CENTRAL_AZIMUTH

Set this keyword to the angle of the central azimuth, in degrees east of North. This keyword can be used with the following projections: Cylindrical, Mercator, Miller, Mollweide, and Sinusoidal. The default is 0 degrees. The pole is placed at an azimuth of CENTRAL_AZIMUTH degrees CCW of North, as specified by the *Rot* argument.

ELLIPSOID

Set this keyword to a 3-element array, [a, e^2, k_0], defining the ellipsoid for the Transverse Mercator or Lambert Conic projections.

- a: equatorial radius, in meters.
- e^2: eccentricity squared. $e^2 = 2 * f - f^2$, where f = 1 - b/a (a: equatorial radius, b: polar radius; in meters).
- k_0: scale on the central meridian.

The default is the Clarke 1866 ellipsoid, [6378206.4, 0.00676866, 0.9996].

This keyword can be used with the CONIC keyword.

ISOTROPIC

Set this keyword to produce a map that has the same scale in the X and Y directions.

Note

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 2407 for more information.

LIMIT

A four- or eight-element vector that specifies the limits of the map.

As a four-element vector, LIMIT has the form [Lat_{min}, Lon_{min}, Lat_{max}, Lon_{max}] that specifies the boundaries of the region to be mapped. (Lat_{min}, Lon_{min}) and (Lat_{max}, Lon_{max}) are the latitudes and longitudes of two points diagonal from each other on the region's boundary.

As an eight-element vector, LIMIT has the form: [Lat_0, Lon_0, Lat_1, Lon_1, Lat_2, Lon_2, Lat_3, Lon_3]. These four latitude/longitude pairs describe, respectively, four points on the left, top, right, and bottom edges of the map extent.

SAT_P

A three-element vector containing three parameters, *P*, *Omega*, and *Gamma,* that must be supplied when using the SATELLITE projection where:

- *P* is the distance of the point of perspective (camera) from the center of the globe, expressed in units of the radius of the globe.
- *Omega* is the downward tilt of the camera, in degrees from the new horizontal. If both *Gamma* and *Omega* are 0, a Vertical Perspective projection results.
- *Gamma* is the angle, expressed in degrees clockwise from north, of the rotation of the projection plane.

SCALE

Set this keyword to construct an isotropic map with the given scale, set to the ratio of 1:*scale*. If SCALE is not specified, the map is fit to the window. The typical scale for global maps is in the ratio of between 1:100 million and 1:200 million. For continents, the typical scale is in the ratio of approximately 1:50 million. For example, `SCALE=100E6` sets the scale at the center of the map to 1:100 million, which is in the same ratio as 1 inch to 1578 miles (1 cm to 1000 km).

STANDARD_PARALLELS

Set this keyword to a one- or two-element array defining, respectively, one or two standard parallels for conic projections.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for descriptions of graphics and plotting keywords not listed above. POSITION, T3D, ZVALUE.

Examples

To draw a Stereographic map, with the sphere filled in color index 3:

```
MAP_SET, 0, 0, /STEREO, /HORIZON, /ISOTROPIC, E_HORIZON={FILL:1,
COLOR:3}
```

See Also

MAP_CONTINENTS, MAP_GRID, MAP_IMAGE

MATRIX_MULTIPLY

The MATRIX_MULTIPLY function calculates the IDL # operator of two (possibly transposed) arrays. The transpose operation (if desired) is done simultaneously with the multiplication, thus conserving memory and increasing the speed of the operation. If the arrays are not transposed, then MATRIX_MULTIPLY is equivalent to using the # operator.

Syntax

Result = MATRIX_MULTIPLY(*A*, *B* [, /ATRANSPOSE] [, /BTRANSPOSE])

Return Value

The type for the result depends upon the input type. For byte or integer arrays, the result has the type of the next-larger integer type that could contain the result (for example, byte, integer, or long input returns type long integer). For floating-point, the result has the same type as the input.

For the case of no transpose, the resulting array has the same number of columns as the first array and the same number of rows as the second array. The second array must have the same number of columns as the first array has rows.

Note

If A and B arguments are vectors, then C = MATRIX_MULTIPLY(*A*, *B*) is a matrix with $C_{ij} = A_i B_j$. Mathematically, this is equivalent to the outer product, usually denoted by A⊗B.

Arguments

A

The left operand for the matrix multiplication. Dimensions higher than two are ignored.

B

The right operand for the matrix multiplication. Dimensions higher than two are ignored.

Keywords

ATRANSPOSE

Set this keyword to multiply using the transpose of *A*.

BTRANSPOSE

Set this keyword to multiply using the transpose of *B*.

The # Operator vs. MATRIX_MULTIPLY

The following table illustrates how various operations are performed using the # operator versus the MATRIX_MULTIPLY function:

# Operator	Function
A # B	MATRIX_MULTIPLY(*A*, *B*)
transpose(A) # B	MATRIX_MULTIPLY(*A*, *B*, /ATRANSPOSE)
A # transpose(B)	MATRIX_MULTIPLY(*A*, *B*, /BTRANSPOSE)
transpose(A) # transpose(B)	MATRIX_MULTIPLY(*A*, *B*, /ATRANSPOSE, /BTRANSPOSE)

Table 68: The # Operator vs. MATRIX_MULTIPLY

Note

MATRIX_MULTIPLY can also be used in place of the ## operator. For example, A ## B is equivalent to MATRIX_MULTIPLY(*B*, *A*), and A ## TRANSPOSE(B) is equivalent to MATRIX_MULTIPLY(*B*, *A*, /ATRANSPOSE).

See Also

"Multiplying Arrays" in Chapter 16 of *Using IDL*

MAX

The MAX function returns the value of the largest element of *Array*. The type of the result is the same as the type of *Array*.

Syntax

Result = MAX(*Array* [, *Max_Subscript*] [, MIN=*variable*] [, /NAN])

Arguments

Array

The array to be searched.

Max_Subscript

A named variable that, if supplied, is converted to a long integer containing the one-dimensional subscript of the maximum element. Otherwise, the system variable !C is set to the one-dimensional subscript of the maximum element.

Keywords

MIN

A named variable to receive the value of the minimum array element. If you need to find both the minimum and maximum array values, use this keyword to avoid scanning the array twice with separate calls to MAX and MIN.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Note

If the MAX function is run on an array containing NaN values and the NAN keyword is not set, an invalid result will occur.

Example

Example 1

This example prints the maximum value in an array, and the subscript of that value:

```
; Create a simple two-dimensional array:
D = DIST(100)

; Print the maximum value in array D and its linear subscript:
PRINT, 'Maximum value in array D is:', MAX(D, I)
PRINT, 'The subscript of the maximum value is', I
```

IDL Output

```
Maximum value in array D is:      70.7107
The subscript of the maximum value is        5050
```

Example 2

To convert I to a two-dimensional subscript, use the commands:

```
IX = I MOD 100
IY = I/100
PRINT, 'The maximum value of D is at location ('+ STRTRIM(IX, 1) $
   + ', ' + STRTRIM(IY, 1) + ')'
```

IDL Output

```
The maximum value of D is at location (50, 50)
```

See Also

MIN

MD_TEST

The MD_TEST function tests the hypothesis that a sample population is random against the hypothesis that it is not random. The result is a two-element vector containing the nearly-normal test statistic *Z* and its associated probability. This two-tailed function is an extension of the "Runs Test for Randomness" and is often referred to as the Median Delta Test.

This routine is written in the IDL language. Its source code can be found in the file `md_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = MD_TEST(*X* [, ABOVE=*variable*] [, BELOW=*variable*] [, MDC=*variable*])

Arguments

X

An *n*-element integer, single- or double-precision floating-point vector.

Keywords

ABOVE

Use this keyword to specify a named variable that will contain the number of sample population values greater than the median of *X*.

BELOW

Use this keyword to specify a named variable that will contain the number of sample population values less than the median of *X*.

MDC

Use this keyword to specify a named variable that will contain the number of Median Delta Clusters (sequential values of *X* above and below the median).

Example

This example tests the hypothesis that *X* represents a random population against the hypothesis that it does not represent a random population at the 0.05 significance level:

```
; Define a sample population:
X = [ 2.00,  0.90, -1.44, -0.88, -0.24,  0.83, -0.84, -0.74, $
      0.99, -0.82, -0.59, -1.88, -1.96,  0.77, -1.89, -0.56, $
     -0.62, -0.36, -1.01, -1.36]

; Test the hypothesis that X represents a random population against
; the hypothesis that it does not represent a random population at
; the 0.05 significance level:
result = MD_TEST(X, MDC = mdc)
PRINT, result
```

IDL prints:

```
0.459468    0.322949
```

The computed probability (0.322949) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that *X* represents a random population.

See Also

CTI_TEST, FV_TEST, KW_TEST, R_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

MEAN

The MEAN function computes the mean of a numeric vector. MEAN calls the IDL function MOMENT.

Syntax

Result = MEAN(*X* [, /DOUBLE] [, /NAN])

Arguments

X

An *n*-element, integer, double-precision or floating-point vector.

Keywords

DOUBLE

If this keyword is set, computations are done in double precision arithmetic.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]

; Compute the standard deviation:
result = MEAN(x)

; Print the result:
PRINT, result
```

IDL prints:

```
66.7333
```

See Also

KURTOSIS, MEANABSDEV, MOMENT, STDDEV, SKEWNESS, VARIANCE

MEANABSDEV

The MEANABSDEV function computes the mean absolute deviation (average deviation) of an *n*-element vector.

Syntax

Result = MEANABSDEV(*X* [, /DOUBLE] [, /MEDIAN] [, /NAN])

Arguments

X

An *n*-element, floating-point or double-precision vector.

Keywords

DOUBLE

Set this keyword to force computations to be done in double precision arithmetic and to return a double precision result. If this keyword is not set, the computations and result depend upon the type of the input data (integer and float data return float results, while double data returns double results). This has no effect if the MEDIAN keyword is set.

MEDIAN

Set this keyword to return the average deviation from the median. By default, if MEDIAN is not set, MEANABSDEV will return the average deviation from the mean.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define an n-element vector:
x = [1, 1, 1, 2, 5]

; Compute average deviation from the mean:
result = MEANABSDEV(x)
```

```
; Print the result:
PRINT, result
```

IDL prints:

```
1.20000
```

See Also

KURTOSIS, MEAN, MOMENT, STDDEV, SKEWNESS, VARIANCE

MEDIAN

The MEDIAN function returns the median value (element *n*/2) of *Array* if one parameter is present, or applies a one- or two-dimensional median filter of the specified width to *Array* and returns the result. In an ordered set of values, the median is a value with an equal number of values above and below it. Median smoothing replaces each point with the median of the one- or two-dimensional neighborhood of a given width. It is similar to smoothing with a boxcar or average filter but does not blur edges larger than the neighborhood.

In addition, median filtering is effective in removing salt and pepper noise, (isolated high or low values). The scalar median is simply the middle value, which should not be confused with the average value (e.g., the median of the array [1,10,4] is 4, while the average is 5.)

Note

The MEDIAN function treats NaN values as missing data.

Syntax

Result = MEDIAN(*Array* [, *Width*] [, /EVEN])

Arguments

Array

The array to be processed. If *Width* is also supplied, and *Array* is of byte type, the result is of byte type. All other types are converted to single-precision floating-point, and the result is floating-point. *Array* can have only one or two dimensions.

If *Width* is not given, *Array* can have any valid number of dimensions. The array is converted to single-precision floating-point, and the median value is returned as a floating-point value.

Width

The size of the one or two-dimensional neighborhood to be used for the median filter. The neighborhood has the same number of dimensions as *Array*.

Keywords

EVEN

If the EVEN keyword is set when *Array* contains an even number of points (i.e. there is no middle number), MEDIAN returns the average of the two middle numbers. The returned value may not be an element of *Array*. If *Array* contains an odd number of points, MEDIAN returns the median value. The returned value will always be an element of *Array*—even if the EVEN keyword is set—since an odd number of points will always have a single middle value.

Example

```
; Create a simple image and display it:
D = SIN(DIST(200)^0.8) & TVSCL, D

; Display D median-filtered with a width of 9:
TVSCL, MEDIAN(D, 9)

; Print the median of a four-element array, with and without
; the EVEN keyword:
PRINT, MEDIAN([1, 2, 3, 4], /EVEN)
PRINT, MEDIAN([1, 2, 3, 4])
```

IDL prints:

```
2.50000
3.00000
```

See Also

DIGITAL_FILTER, LEEFILT, MOMENT, SMOOTH

MEMORY

The MEMORY function returns information on the amount of dynamic memory currently in use by the IDL session if no keywords are set. If a keyword is set, MEMORY returns the specified quantity.

Syntax

Result = MEMORY([, /CURRENT | , /HIGHWATER | , /NUM_ALLOC | , /NUM_FREE | , /STRUCTURE] [, /L64])

Return Value

The return value is a vector that is always of integer type. The following table describes the information returned if no keywords are set:

Element	Contents
Result[0]	Amount of dynamic memory (in bytes) currently in use by the IDL session.
Result[1]	The number of times IDL has made a memory allocation request from the underlying system.
Result[2]	The number of times IDL has made a request to free memory from the underlying system.
Result[3]	High water mark: The maximum amount of dynamic memory used since the last time the MEMORY function or HELP, /MEMORY procedure was called.

Table 69: MEMORY Function Return Values

Arguments

None.

Keywords

The following keywords determine the return value of the MEMORY function. Except for L64, all of the keywords are mutually exclusive — specify at most one of the following.

CURRENT

Set this keyword to return the amount of dynamic memory (in bytes) currently in use by the IDL session.

HIGHWATER

Set this keyword to return the maximum amount of dynamic memory used since the last time the MEMORY function or HELP,/MEMORY procedure was called. This can be used to determine maximum memory use of a code sequence as shown in the example below.

L64

By default, the result of MEMORY is 32-bit integer when possible, and 64-bit integer if the size of the returned values requires it. Set L64 to force 64-bit integers to be returned in all cases.

Note

Only 64-bit versions of IDL are capable of using enough memory to require 64-bit MEMORY output. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

NUM_ALLOC

Returns the number of times IDL has requested dynamic memory from the underlying system.

NUM_FREE

Returns the number of times IDL has returned dynamic memory to the underlying system.

STRUCTURE

Set this keyword to return all available information about Expression in a structure. The result will be an IDL_MEMORY (32-bit) structure when possible, and an IDL_MEMORY64 structure otherwise. Set L64 to force an IDL_MEMORY64 structure to be returned in all cases.

The following are descriptions of the fields in the returned structure:

Field	Description
CURRENT	Current dynamic memory in use.
NUM_ALLOC	Number of calls to allocate memory.
NUM_FREE	Number of calls to free memory.
HIGHWATER	Maximum dynamic memory used since last call for this information.

Table 70: STRUCTURE Field Descriptions

Example

To determine how much dynamic memory is required to execute a sequence of IDL code:

```
; Get current allocation and reset the high water mark:
start_mem = MEMORY(/CURRENT)

; Arbitrary code goes here.

PRINT, 'Memory required: ', MEMORY(/HIGHWATER) - start_mem
```

The MEMORY function can also be used in conjunction with DIALOG_MESSAGE as follows:

```
; Get current dymanic memory in use:
mem = MEMORY(/CURRENT)
; Prepare dialog message:
message = 'Current amount of dynamic memory used is '
sentence = message + STRTRIM(mem,2)+' bytes.'
; Display the dialog message containing memory usage statement:
status = DIALOG_MESSAGE (sentence, /INFORMATION)
```

See Also

HELP

MESH_CLIP

The MESH_CLIP function clips a polygonal mesh to an arbitrary plane in space and returns a polygonal mesh of the remaining portion. An auxiliary array of data may also be passed and clipped. This array can have multiple values for each vertex.

Syntax

Result = MESH_CLIP (*Plane*, *Vertsin*, *Connin*, *Vertsout*, *Connout*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*] [, CUT_VERTS=*variable*])

Return Value

The return value is the number of triangles in the returned mesh.

Arguments

Plane

Input four element array describing the equation of the plane to be clipped to. The elements are the coefficients (*a*,*b*,*c*,*d*) of the equation *ax+by+cz+d=0*.

Vertsin

Input array of polygonal vertices [3, *n*].

Connin

Input polygonal mesh connectivity array.

Vertsout

Output array of polygonal vertices.

Connout

Output polygonal mesh connectivity array.

Keywords

AUXDATA_IN

Input array of auxiliary data. If present, these values are interpolated and returned through AUXDATA_OUT. The trailing array dimension must match the number of vertices in the Vertsin array.

AUXDATA_OUT

Set this keyword to a named variable that will contain an output array of interpolated auxiliary data.

CUT_VERTS

Set this keyword to a named variable that will contain an output array of vertex indices (into Vertsout) of the vertices which are considered to be “on” the clipped surface.

See Also

MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_DECIMATE

The MESH_DECIMATE function reduces the density of geometry while preserving as much of the original data as possible. The classic case is to thin out a polygonal mesh to use fewer polygons while preserving the mesh form. The decimation algorithm removes triangles from the mesh. This is done in such a way as to preserve the mesh edges and to remove roughly planar polygons.

Decimation is a memory and CPU intensive process. Expect the decimation of large models to require large amounts of memory and dozens of seconds to complete. As a reference, a model with approximately 36,000 vertices and 70,000 faces requires 20-30 seconds to decimate to 10% of its original size on a typical NT PC with 64Mb RAM and 333MHz Pentium processor.

If the input polygons are not all triangles, IDL converts the polygons to triangles before decimating. For best results, the polygons should all be convex. Note that if the input polygons are not all triangles, then IDL may return more polygons (as triangles) than were submitted as input, even after decimating a percentage of the polygons. IDL applies the PERCENT_POLYGONS keyword value to the polygon list after converting the list to triangles to approximate the same visual effect of decimating the requested percentage of polygons.

IDL takes steps to deal with input data with a wide variation in magnitude. For example, a troublesome input polygon list may have X and Y values in the 10^1 to 10^2 range, while the Z values may have magnitudes of about 10^20. If the results of the decimation are unacceptable, consider scaling the input data so that the magnitudes of the data are closer together.

Syntax

Result = MESH_DECIMATE (*Verts*, *Conn*, *Connout* [, VERTICES=*variable*] [, PERCENT_VERTICES=*percent* | , PERCENT_POLYGONS=*percent*])

Return Value

The return value is the number of triangles in the output connectivity array.

Arguments

Verts

Input array of polygonal vertices [3, *n*].

Conn

Input polygonal mesh connectivity array.

Connout

Output polygonal mesh connectivity array.

Note

Some of the vertices in the Verts array may not be referenced by the Connout array.

Keywords

PERCENT_VERTICES

Set this keyword to the percent of the original vertices to be returned in the Connout array. It specifies the amount of decimation to perform.

PERCENT_POLYGONS

Set this keyword to the percent of the original polygons to be returned in the Connout array. It specifies the amount of decimation to perform.

Note

PERCENT_VERTICES and PERCENT_POLYGONS are mutually exclusive keywords.

VERTICES

Set this keyword to a named variable that will contain an output array of the vertices generated by the MESH_DECIMATE function. If this keyword is specified, the function is not restricted to using the original set of vertices specified in the *Verts* parameter when generating the decimated mesh, allowing it to generate a more optimal mesh by determining its own placement of vertices. If this keyword is specified, the *Connout* argument will consist of a polygon connectivity list whose indices refer to the vertex list stored in the named variable specified with this keyword. Otherwise, the *Connout* argument will consist of a polygon connectivity list that refers to the original vertex list *Verts*.

See Also

MESH_CLIP, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_ISSOLID

The MESH_ISSOLID function computes various mesh properties and enables IDL to determine if a mesh encloses space (is a solid). If the mesh can be considered a solid, routines can compute the volume of the mesh.

Syntax

Result = MESH_ISSOLID (*Conn*)

Return Value

Returns 1 if the input mesh fully encloses space (assuming no polygonal interpenetration) or 0 otherwise. A mesh is defined to fully enclose space if each edge in the input mesh appears an even number of times in the mesh.

Note

The input polygonal mesh is assumed to contain only planar, convex polygons.

Arguments

Conn

This is an integer or longword array that represents a series of polygon descriptions. Each polygon description takes the form $[n, i_0, i_1, ..., i_{n-1}]$, where n is the number of vertices that define the polygon, and $i_0...i_{n-1}$ are indices into the vertex array.

Keywords

None.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_MERGE

The MESH_MERGE function merges two polygonal meshes.

Syntax

Result = MESH_MERGE (*Verts*, *Conn*, *Verts1*, *Conn1* [, /COMBINE_VERTICES] [, TOLERANCE=*value*])

Return Value

The function return value is the number of triangles in the modified polygonal mesh connectivity array.

Arguments

Verts

Input/Output array of polygonal vertices [3, *n*]. These are potentially modified and returned to the user.

Conn

Input/Output polygonal mesh connectivity array. This array is modified and returned to the user.

Verts1

Additional input polygonal vertex array [3, *n*].

Conn1

Additional input polygonal mesh connectivity array.

Keywords

COMBINE_VERTICES

If this keyword is set, the routine will attempt to collapse vertices which are at the same location in space into single vertices. If the expression

$$\max(|x_i - x_{i+1}|, |y_i - y_{i+1}|, |z_i - z_{i+1}|) < tolerance$$

is true, the points (*i*) and (*i*+1) can be collapsed into a single vertex. The result is returned as a modification of the *Verts* argument.

TOLERANCE

This keyword is used to specify the tolerance value used with the COMBINE_VERTICES keyword. The default value is 0.0.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_NUMTRIANGLES

The MESH_NUMTRIANGLES function computes the number of triangles in a polygonal mesh.

Syntax

Result = MESH_NUMTRIANGLES (*Conn*)

Return Value

Returns the number of triangles in the mesh (a quad is considered two triangles).

Arguments

Conn

Polygonal mesh connectivity array.

Keywords

None.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_OBJ

The MESH_OBJ procedure generates a polygon mesh (vertex list and polygon list) that represent the desired primitive object. The available primitive objects are: triangulated surface, rectangular surface, polar surface, cylindrical surface, spherical surface, surface of extrusion, surface of revolution, and ruled surface.

This routine is written in the IDL language. Its source code can be found in the file `mesh_obj.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MESH_OBJ, *Type*, *Vertex_List*, *Polygon_List*, *Array1* [, *Array2*] [, /DEGREES] [, P1=*value*] [, P2=*value*] [, P3=*value*] [, P4=*value*] [, P5=*value*]

Arguments

Type

An integer that specifies what type of object to create. The various surface types are described in the table below.

Type	Surface Type
0	Triangulated
1	Rectangular
2	Polar
3	Cylindrical
4	Spherical
5	Extrusion
6	Revolution
7	Ruled
Other values	None

Table 71: Surface Types

Vertex_List

A named variable that will contain the mesh vertices. *Vertex_List* has the same format as the lists returned by the SHADE_VOLUME procedure.

Polygon_List

A named variable that will contain the mesh indexes. *Polygon_List* has the same format as the lists returned by the SHADE_VOLUME procedure.

Array1

An array whose use depends on the type of object being created. The following table describes the differences.

Surface Type	*Array1* Type
Triangulated	A (3, *n*) array containing random [*x, y, z*] points to build a triangulated surface from. The resulting polygon mesh will have *n* vertices. When shading a triangulated mesh, the shading array should have (*n*) elements.
Rectangular	A two dimensional (*n, m*) array containing *z* values. The resulting polygon mesh will have *n* x *m* vertices. When shading a rectangular mesh, the shading array should have (*n, m*) elements.
Polar	A two dimensional (*n, m*) array containing *z* values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the polar angle, and the *m* dimension is mapped to the polar radius. When shading a polar mesh, the shading array should have (*n, m*) elements.
Cylindrical	A two dimensional (*n, m*) array containing radius values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the polar angle, and the m dimension is mapped to the Z axis. When shading a cylindrical mesh, the shading array should have (*n, m*) elements.

Table 72: Array 1 Type

Surface Type	*Array1* Type
Spherical	A two dimensional (*n, m*) array containing radius values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the longitude (0.0 to 360.0 degrees), and the *m* dimension is mapped to the latitude (-90.0 to +90.0 degrees). When shading a spherical mesh, the shading array should have (*n, m*) elements.
Extrusion	A (3, *n*) array of connected 3D points which define the shape to extrude. The resulting polygon mesh will have *n* x (steps+1) vertices (where steps is the number of "segments" in the extrusion). (See the P1 keyword). If the order of the elements in *Array1* is reversed, then the polygon facing is reversed. When shading an extrusion mesh, the shading array should have (*n*, steps+1) elements.
Revolution	A (3, *n*) array of connected 3D points which define the shape to revolve. The resulting polygon mesh will have *n* x ((steps>3)+1) vertices (where steps is the number of "steps" in the revolution). (See the P1 keyword). If the order of the elements in *Array1* is reversed, then the polygon facing is reversed. When shading a revolution mesh, the shading array should have (*n*, (steps>3)+1) elements.
Ruled	A (3, *n*) array of connected 3D points which define the shape of the first ruled vector. The optional (3, *m*) *Array2* parameter defines the shape of the second ruled vector. The resulting polygon mesh will have (*n* > *m*)*(steps+1) vertices (where steps is the number of intermediate "steps"). (See the P1 keyword). When shading a ruled mesh, the shading array should have (*n* > *m*, steps+1) elements.

Table 72: Array 1 Type

Array2

If the object type is 7 (Ruled Surface) then *Array2* is a (3, *m*) array containing the 3D points which define the second ruled vector. If *Array2* has fewer elements than *Array1* then *Array2* is processed with CONGRID to give it the same number of elements as *Array1*. If *Array1* has fewer elements than *Array2* then *Array1* is processed with CONGRID to give it the same number of elements as *Array2*. *Array2* must be supplied if the object type is 7. Otherwise, *Array2* is ignored.

Keywords

DEGREES

If set, then the input parameters are in degrees (where applicable). Otherwise, the angles are in radians.

P1 - P5

The meaning of the keywords P1 through P5 vary depending upon the object type. The table below describes the differences.

Surface Type	Keywords
Triangulated	P1 through P5 are ignored.
Rectangular	If *Array1* is an (*n*, *m*) array, and if P1 has n elements, then the values contained in P1 are the X coordinates for each column of vertices. Otherwise, FINDGEN(*n*) is used for the X coordinates. If P2 has *m* elements, then the values contained in P2 are the Y coordinates for each row of vertices. Otherwise, FINDGEN(*m*) is used for the Y coordinates. The polygon facing is reversed if the order of either P1 or P2 (but not both) is reversed. P3, P4, and P5 are ignored.
Polar	P1 specifies the polar angle of the first column of *Array1* (the default is 0). P2 specifies the polar angle of the last column of *Array1* (the default is 2*PI). If P2 is less than P1 then the polygon facing is reversed. P3 specifies the radius of the first row of *Array1* (the default is 0). P4 specifies the radius of the last row of *Array1* (the default is *m*-1). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored.
Cylindrical	P1 specifies the polar angle of the first column of *Array1* (the default is 0). P2 specifies the polar angle of the last column of *Array1* (the default is 2*PI). If P2 is less than P1 then the polygon facing is reversed. P3 specifies the Z coordinate of the first row of *Array1* (the default is 0). P4 specifies the Z coordinate of the last row of *Array1* (the default is *m*-1). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored.

Table 73: P1-P5 Keywords

Surface Type	Keywords
Spherical	P1 specifies the longitude of the first column of *Array1* (the default is 0). P2 specifies the longitude of the last column of *Array1* (the default is 2*PI). IF P2 is less than P1 then the polygon facing is reversed. P3 specifies the latitude of the first row of *Array1* (the default is -PI/2). P4 specifies the latitude of the last row of *Array1* (the default is +PI/2). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored.
Extrusion	P1 specifies the number of steps in the extrusion (the default is 1). P2 is a three element vector specifying the direction (and length) of the extrusion (the default is [0, 0, 1]). P3, P4, and P5 are ignored.
Revolution	P1 specifies the number of "facets" in the revolution (the default is 3). If P1 is less than 3 then 3 is used. P2 is a three element vector specifying a point that the rotation vector passes through (the default is [0, 0, 0]). P3 is a three element vector specifying the direction of the rotation vector (the default is [0, 0, 1]). P4 specifies the starting angle for the revolution (the default is 0). P5 specifies the ending angle for the revolution (the default is 2*PI). If P5 is less than P4 then the polygon facing is reversed.
Ruled	P1 specifies the number of "steps" in the ruling (the default is 1). P2, P3, P4, and P5 are ignored.

Table 73: P1-P5 Keywords

Examples

```
; Create a 48x64 cylinder with a constant radius of 0.25:
MESH_OBJ, 3, Vertex_List, Polygon_List, $
   Replicate(0.25, 48, 64), P4=0.5

; Transform the vertices:
T3D, /RESET
T3D, ROTATE=[0.0, 30.0, 0.0]
T3D, ROTATE=[0.0, 0.0, 40.0]
T3D, TRANSLATE=[0.25, 0.25, 0.25]
VERTEX_LIST = VERT_T3D(Vertex_List)

; Create the window and view:
WINDOW, 0, XSIZE=512, YSIZE=512
```

```
CREATE_VIEW, WINX=512, WINY=512

; Render the mesh:
SET_SHADING, LIGHT=[-0.5, 0.5, 2.0], REJECT=0
TVSCL, POLYSHADE(Vertex_List, Polygon_List, /NORMAL)

; Create a cone (surface of revolution):
MESH_OBJ, 6, Vertex_List, Polygon_List, $
   [[0.75, 0.0, 0.25], [0.5, 0.0, 0.75]], $
   P1=16, P2=[0.5, 0.0, 0.0]

; Create the window and view:
WINDOW, 0, XSIZE=512, YSIZE=512
CREATE_VIEW, WINX=512, WINY=512, AX=30.0, AY=(140.0), ZOOM=0.5

; Render the mesh:
SET_SHADING, LIGHT=[-0.5, 0.5, 2.0], REJECT=0
TVSCL, POLYSHADE(Vertex_List, Polygon_List, /DATA, /T3D)
```

See Also

CREATE_VIEW, MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME, SET_SHADING, VERT_T3D

MESH_SMOOTH

The MESH_SMOOTH function performs spatial smoothing on a polygon mesh. This function smoothes a mesh by applying Laplacian smoothing to each vertex, as described by the following formula:

$$\vec{x}_{i_{(n+1)}} = \vec{x}_{i_n} + \frac{\lambda}{M} \sum_{j=0}^{M} (\vec{x}_{j_n} - \vec{x}_{i_n})$$

where:

$\vec{x}_{i_n}$	is vertex *i* for iteration *n*
λ	is the smoothing factor
M	is the number of vertices that share a common edge with x_{i_n}.

Syntax

Result = MESH_SMOOTH (*Verts*, *Conn* [, ITERATIONS=*value*] [, FIXED_VERTICES=*array*] [, /FIXED_EDGE_VERTICES] [, LAMBDA=*value*])

Return Value

The output of this function is resulting [3, *n*] array of modified vertices.

Arguments

Verts

Input array of polygonal vertices [3, *n*].

Conn

Input polygonal mesh connectivity array.

Keywords

ITERATIONS

Number of iterations to smooth. The default value is 50.

FIXED_VERTICES

Set this keyword to an array of vertex indices which are not to be modified by the smoothing.

FIXED_EDGE_VERTICES

Set this keyword to specify that mesh outer edge vertices are not to be modified by the smoothing.

LAMBDA

Smoothing factor. The default value is 0.05.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

MESH_SURFACEAREA

The MESH_SURFACEAREA function computes various mesh properties to determine the mesh surface area, including integration of other properties interpolated on the surface of the mesh.

Syntax

Result = MESH_SURFACEAREA (*Verts*, *Conn* [, AUXDATA=*array*] [, MOMENT=*variable*])

Return Value

Returns the cumulative (weighted) surface area of the polygons in the mesh.

Note

The input polygonal mesh is assumed to contain only planar, convex polygons.

Arguments

Verts

Array of polygonal vertices [3, *n*].

Conn

Polygonal mesh connectivity array.

Keywords

AUXDATA

Array of input auxiliary data (one value per vertex). If present, these values are used to weight a vertex for the purpose of the area computation. The surface area integral will linearly interpolate these values over the surface of each triangle. The default weight is 1.0 which results in the basic polygon area.

MOMENT

If this keyword is present, it will return a three element float vector which corresponds to the first order moments computed with respect to the X, Y and Z axis. The computation is:

$$\vec{m} = \sum_{ntris} a_i \vec{c}_i$$

where a is the (weighted) area of the triangle and c is the centroid of the triangle, thus

$$\vec{m} / sarea$$

yields the (weighted) centroid of the polygon mesh.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_VALIDATE, MESH_VOLUME

MESH_VALIDATE

The MESH_VALIDATE function checks for NaN values in vertices, removes unused vertices, and combines close vertices.

Syntax

Result = MESH_VALIDATE (*Verts*, *Conn* [, /REMOVE_NAN] [, /PACK_VERTICES] [, /COMBINE_VERTICES] [, TOLERANCE=*value*])

Return Value

The function return value is the number of triangles in the modified polygonal mesh connectivity array.

Arguments

Verts

Input/Output array of polygonal vertices [3, *n*]. These are potentially modified and returned to the user.

Conn

Input/Output polygonal mesh connectivity array. This array is modified and returned to the user.

Keywords

COMBINE_VERTICES

If this keyword is set, the routine will attempt to collapse vertices which are at the same location in space into single vertices. If the expression

$$\max(|x_i - x_{i+1}|, |y_i - y_{i+1}|, |z_i - z_{i+1}|) < tolerance$$

is true, the points (*i*) and (*i*+1) can be collapsed into a single vertex. The result is returned as a modification of the *Verts* argument.

PACK_VERTICES

If this keyword is set, the Verts input array will be packed to exclude any non-referenced vertices. The result is returned in the Verts argument.

REMOVE_NAN

If this keyword is set, the function will remove any polygons from CONN which reference vertices containing NaN values.

TOLERANCE

This keyword is used to specify the tolerance value used with the COMBINE_VERTS keyword. The default value is 0.0.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VOLUME

MESH_VOLUME

The MESH_VOLUME function computes the volume that the mesh encloses.

Syntax

Result = MESH_VOLUME (*Verts*, *Conn* [, /SIGNED])

Return Value

Returns the volume that the mesh encloses. If the mesh does not enclose space (i.e. MESH_ISSOLID( ) would return 0), this function returns 0.0.

Note

The input polygonal mesh is assumed to contain only planar, convex polygons.

Arguments

Verts

Array of polygonal vertices [3, *n*].

Conn

Polygonal mesh connectivity array.

Keywords

SIGNED

Set this keyword to compute the signed volume. The sign will be negative for a mesh consisting of inward facing polygons.

See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE

MESSAGE

The MESSAGE procedure issues error and informational messages using the same mechanism employed by built-in IDL routines. By default, the message is issued as an error, the message is output, and IDL takes the action specified by the ON_ERROR procedure. As a side-effect of issuing the error, the system variable !ERROR_STATE is set and the text of the error message is placed in !ERROR_STATE.MSG or in !ERROR_STATE.SYS_MSG for the operating system's component of the error message.

If the call to the MESSAGE procedure causes execution to halt, traceback information is displayed automatically.

Syntax

MESSAGE, [*Text*] [, /CONTINUE] [, /INFORMATIONAL] [, /IOERROR] [, /NONAME] [, /NOPREFIX] [, /NOPRINT] [, /RESET]

Arguments

Text

The text of the message to be issued. If *Text* is not supplied, MESSAGE returns quietly.

Keywords

CONTINUE

Set this keyword to return after issuing the error instead of taking the action specified by ON_ERROR. Use this option when it is desirable to report an error and then continue processing.

INFORMATIONAL

Set this keyword to issue informational text instead of an error. In this case, !ERROR_STATE is not set. The !QUIET system variable controls the printing of informational messages.

IOERROR

Set this keyword to indicate that the error occurred while performing I/O. The action specified by the ON_IOERROR procedure is executed instead of ON_ERROR.

NONAME

Set this keyword to suppress printing of the issuing routine's name at the beginning of the error message.

NOPREFIX

Usually, the message includes the message prefix string (as specified by the MSG_PREFIX field of the !ERROR_STATE system variable) at the beginning. Set this keyword to omit the prefix.

NOPRINT

Set this keyword to prevent the message from printing to the screen and cause the other actions to proceed quietly. The error system variables are updated as usual.

RESET

Set this keyword to set the "!ERROR_STATE" on page 2425 system variable back to the "success" state and clear any internal traceback information being saved for use by the LAST_ERROR keyword to the HELP procedure.

TRACEBACK

This keyword is obsolete and is included for compatibility with existing code only. Traceback information is provided by default.

Example

As an example, assume the statement:

```
message, 'Unexpected value encountered.'
```

is executed in a procedure named CALC. If an error occurs, the following message would be printed:

```
% CALC: Unexpected value encountered.
```

and execution would halt.

See Also

CATCH, ON_ERROR, ON_IOERROR, STRMESSAGE

MIN

The MIN function returns the value of the smallest element of *Array*. The type of the result is the same as that of *Array*.

Syntax

Result = MIN(*Array* [, *Min_Subscript*] [, MAX=*variable*] [, /NAN])

Arguments

Array

The array to be searched.

Min_Subscript

A named variable that, if supplied, is converted to a long integer containing the one-dimensional subscript of the minimum element. Otherwise, the system variable !C is set to the one-dimensional subscript of the minimum element.

Keywords

MAX

The name of a variable to receive the value of the maximum array element. If you need to find both the minimum and maximum array values, use this keyword to avoid scanning the array twice with separate calls to MAX and MIN.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Note

If the MIN function is run on an array containing NaN values and the NAN keyword is not set, an invalid result will occur.

Example

```
; Create a simple two-dimensional array:
```

```
D = DIST(100)
; Find the minimum value in array D and print the result:
PRINT, MIN(D)
```

See Also

MAX

MIN_CURVE_SURF

The MIN_CURVE_SURF function interpolates a regularly- or irregularly-gridded set of points, over either a plane or a sphere, with either a minimum curvature surface or a thin-plate-spline surface.

Note

The accuracy of this function is limited by the single-precision floating-point accuracy of the machine.

This routine is written in the IDL language. Its source code can be found in the file `min_curve_surf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = MIN_CURVE_SURF(*Z* [, *X*, *Y*] [, /DOUBLE] [, /TPS] [, /REGULAR] [, /SPHERE [, /CONST]] [, XGRID=*[xstart*, *xspacing]* | , XVALUES=*array*] [, YGRID=*[ystart*, *yspacing]* | , YVALUES=*array*] [, GS=*[xspace*,*yspace]*] [, BOUNDS=*[xmin*, *ymin*, *xmax*, *ymax]*] [, NX=*value*] [, NY=*value*] [, XOUT=*vector*] [, YOUT=*vector*] [, XPOUT=*array*, YPOUT=*array*])

Return Value

This function returns a two-dimensional floating-point array containing the interpolated surface, sampled at the grid points.

Theory

A minimum curvature spline surface is fitted to the data points described by *x*, *y*, and *z*. The basis function is:

$$C(x_0, x_1, y_0, y_1) = d^2 \log(dk)$$

where d is the distance between (x_0, y_0), (x_1, y_1) and $k = 1$ for minimum curvature surface or $k = 2$ for Thin Plate Splines. For n data points, a system of $n+3$ simultaneous equations are solved for the coefficients of the surface. For any interpolation point, the interpolated value is:

$$f(x, y) = b_0 + b_1 \cdot x + b_2 \cdot y + \sum a_i \cdot C(x_i, x, y_i, y)$$

For a sphere the value is:

$$f(l, t) = b_0 + b_1 \cdot x + b_2 \cdot y + b_3 \cdot z + \sum a_i \cdot C(L_i, l, T_i, t)$$

On the sphere, l and t are longitude and latitude. $C(L_i,l, T_i,t)$ is the basis function above, with distance between the two points, (L_i,T_i), and (l , t), measured in radians of arc length. x, y, and z are the 3D cartesian coordinates of the point (l,t) on the unit sphere.

For a sphere with the CONST keyword set, the value is:

$$f(l, t) = b_0 + \sum a_i \cdot CL_i, l, T_i, t$$

The results obtained with the thin plate spline (TPS) and the minimum curvature surface (MCS) methods are very similar. The only difference is in the basis functions: TPS uses d^2*alog(d^2), and MCS uses d^2*alog(d), where d is the distance from point (x_i,y_i).

Arguments

Z, X, Y

Arrays containing the *Z*, *X*, and *Y* coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, *X* and *Y* are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and *Z* must be a two-dimensional array. For irregular grids, all three parameters must be present and have the same number of elements. If Z is specified as a double-precision value, the computation will be performed in double-precision arithmetic. If the SPHERE keyword is set, X and Y are given in degrees of longitude and latitude, respectively.

Keywords

CONST

Set this keyword to fit data on the sphere with a constant baseline, otherwise, data on the sphere is fit with a basline that contains a constant term plus linear X, Y, and Z terms. This keyword has an effect only if SPHERE is set. See Theory above for the formulae.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic. If Z is double precision, the computations will also be done in double precision.

SPHERE

Set this keyword to perform interpolation on the surface of a sphere. The inputs X and Y should be given in degrees of longitude and latitude, respectively.

TPS

Set this keyword to use the thin-plate-spline method. The default is to use the minimum curvature surface method.

Input Grid Description:

REGULAR

If set, the *Z* parameter is a two-dimensional array of dimensions (*n*,*m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

XGRID

A two-element array, [*xstart*, *xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

YGRID

A two-element array, [*ystart*, *yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

Output Grid Description:

GS

The output grid spacing. If present, GS must be a two-element vector [*xs, ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax* - *xmin*)/(NX-1). *ys* is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin, ymin, xmax, ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

XOUT

Use the XOUT keyword to specify a vector containing the output grid *x* values. If this parameter is supplied, GS, BOUNDS, and NX are ignored for the *x* output grid. XOUT allows you to specify irregularly-spaced output grids.

YOUT

Use the YOUT keyword to specify a vector containing the output grid *y* values. If this parameter is supplied, GS, BOUNDS, and NY are ignored for the *y* output grid. YOUT allows you to specify irregularly-spaced output grids.

XPOUT, YPOUT

Use the XPOUT and YPOUT keywords to specify arrays that contain the *x* and *y* values for the output points. If these keywords are used, the output grid need not be regular, and all other output grid parameters are ignored. XPOUT and YPOUT must have the same number of points, which is also the number of points returned in the result.

Examples

Example 1: Irregularly gridded cases

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))
```

Use a 26 by 26 grid over the rectangle bounding x and y:

```
;Get the surface.
R = MIN_CURVE_SURF(Z, X, Y)
```

Alternatively, get a surface over the unit square, with spacing of 0.05:

```
R = MIN_CURVE_SURF(Z, X, Y, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])
```

Alternatively, get a 10 by 10 surface over the rectangle bounding x and y:

```
R = MIN_CURVE_SURF(Z, X, Y, NX=10, NY=10)
```

Example 2: Regularly gridded cases

```
; Make some random data:
z = RANDOMU(seed, 5, 6)

; Interpolate to a 26 x 26 grid:
CONTOUR, MIN_CURVE_SURF(z, /REGULAR)
```

See Also

CONTOUR, GRID_TPS, TRI_SURF

MK_HTML_HELP

The MK_HTML_HELP procedure, given a list of IDL procedure filenames (`.pro` files), VMS text library filenames (`.TLB` files), or the names of directories containing such files, generates a file in HTML (HyperText Markup Language) format that contains documentation for those routines that contain standard IDL documentation headers. The resulting file can then be viewed with a "World Wide Web" browser such as Mosaic or Netscape.

MK_HTML_HELP procedure makes single HTML file that starts with a list of the routines documented in the file. The names of routines in that list are hypertext links to the documentation for those routines. The documentation for each routine is simply the text of the documentation header copied from the corresponding `.pro` file—no reformatting is performed.

The documentation headers of the `.pro` files in question must have the following format:

- The first line of the documentation block contains only the characters `;+`, starting in column 1.
- The last line of the documentation block contains only the characters `;-`, starting in column 1.
- All other lines in the documentation block contain a `;` in column 1.
- If a line containing the string "NAME:" exists in the documentation block, the contents of the following line are used as the name of the routine being described. If the NAME: field is not present, the name of the source file is used as the routine name.

The file `template.pro` in the `examples` subdirectory of the IDL distribution contains a template for creating your own documentation headers.

This routine is supplied for users to make online documentation from their own IDL programs. Although it could be used to create an HTML documentation file from the `lib` subdirectory of the IDL distribution, we do not recommend doing so. The documentation headers on the files in the `lib` directory are used for historical purposes—most do not contain the most current or accurate documentation for those routines. The most current documentation for IDL's built-in and library routines is found in IDL's online help system (enter `?` at the IDL prompt).

This routine is written in the IDL language. Its source code can be found in the file `mk_html_help.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MK_HTML_HELP, *Sources*, *Filename* [, /STRICT] [, TITLE=*string*]
[, /VERBOSE]

Arguments

Sources

A string array containing the names of IDL procedure files (`.pro` files), VMS text libraries (`.TLB` files), or directories containing such files. The *Sources* array may contain both individual file and directory names. Each IDL procedure file must have the file extension `.pro`, and each VMS text library must include the file extension `.TLB`. Elements of the *Sources* array that do not have either of these extensions are assumed to be directories.

All `.pro` files found in *Sources* are searched for documentation headers. The documentation headers are extracted and saved in HTML format in the file specified by *Filename*.

Note

More than one documentation block may exist in a single input file.

Filename

A string containing the name of the output file to be generated. HTML files are usually saved in files named with a `.html` or `.htm` extension.

Keywords

STRICT

Set this keyword to force MK_HTML_HELP to adhere strictly to the HTML format by scanning the documentation blocks for HTML reserved characters and replacing them in the output file with the appropriate HTML syntax. HTML reserved characters include `<` , `>` , `&` , and `"`. By default, this keyword is set to zero to allow for faster processing of the input files.

TITLE

A string that supples the name to be used as the title of the HTML document. The default is “Extended IDL Help”.

VERBOSE

Set this keyword to display informational messages as MK_HTML_HELP generates the HTML file. Normally, MK_HTML_HELP works silently.

Example

To generate an HTML help file named `myhelp.html` from the `.pro` files in the directory `/usr/home/dave/myroutines`, use the command:

```
MK_HTML_HELP, '/usr/home/dave/myroutines', 'myhelp.html'
```

To generate an HTML help file for all routines in a given directory whose file names contain the word “plot”, use the following commands:

```
plotfiles=FINDFILE('/usr/home/dave/myroutines/*plot*.pro')
MK_HTML_HELP, plotfiles, 'myplot.html'
```

See Also

DOC_LIBRARY

MODIFYCT

The MODIFYCT procedure updates the distribution color table file `colors1.tbl`, located in the `\resource\colors` subdirectory of the main IDL directory, or a user-designated file with a new, or modified, colortable.

This routine is written in the IDL language. Its source code can be found in the file `modifyct.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MODIFYCT, *Itab*, *Name*, *R*, *G*, *B* [, FILE=*filename*]

Arguments

Itab

The index of the table to be updated, numbered from 0 to 255. If the specified entry is greater than the next available location in the table, the entry will be added to the table in the available location rather than the index specified by *Itab*. On return, *Itab* contains the index for the location that was modified or extended. The modified table can be then be loaded with the IDL command: LOADCT, *Itab*.

Name

A string, up to 32 characters long, that contains the name for the new color table.

R

A 256-element vector that contains the values for the red colortable.

G

A 256-element vector that contains the values for the green colortable.

B

A 256-element vector that contains the values for the blue colortable.

Keywords

FILE

Set this keyword to the name of a colortable file to be modified instead of the file `colors1.tbl`.

See Also

LOADCT, XLOADCT

MOMENT

The MOMENT function computes the mean, variance, skewness, and kurtosis of a sample population contained in an *n*-element vector *X*. If the vector contains *n* identical elements, MOMENT computes the mean and variance, and returns the IEEE value NaN for the skewness and kurtosis, which are not defined. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications*.)

When $x = (x_0, x_1, x_2, ..., xn_{-1})$, the various moments are defined as follows:

$$\text{Mean} = \bar{x} = \frac{1}{N}\sum_{j=0}^{N-1} x_j$$

$$\text{Variance} = \frac{1}{N-1}\sum_{j=0}^{N-1} (x_j - \bar{x})^2$$

$$\text{Skewness} = \frac{1}{N}\sum_{j=0}^{N-1} \left(\frac{x_j - \bar{x}}{\sqrt{\text{Variance}}}\right)^3$$

$$\text{Kurtosis} = \frac{1}{N}\sum_{j=0}^{N-1} \left(\frac{x_j - \bar{x}}{\sqrt{\text{Variance}}}\right)^4 - 3$$

$$\text{Mean Absolute Deviation} = \frac{1}{N}\sum_{j=0}^{N-1} \left|x_j - \bar{x}\right|$$

$$\text{Standard Deviation} = \sqrt{\text{Variance}}$$

This routine is written in the IDL language. Its source code can be found in the file `moment.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = MOMENT(*X* [, /DOUBLE] [, MDEV=*variable*] [, /NAN] [, SDEV=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

MDEV

Set this keyword to a named variable that will contain the mean absolute deviation of *X*.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

SDEV

Set this keyword to a named variable that will contain the standard deviation of *X*.

Example

```
; Define an n-element sample population:
X = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the mean, variance, skewness and kurtosis:
result = MOMENT(X)
PRINT, 'Mean: ', result[0] & PRINT, 'Variance: ', result[1] & $
   PRINT, 'Skewness: ', result[2] & PRINT, 'Kurtosis: ', result[3]
```

IDL prints:

```
Mean:       66.7333
Variance:    7.06667
Skewness:   -0.0942851
Kurtosis:   -1.18258
```

See Also

KURTOSIS, HISTOGRAM, MAX, MEAN, MEANABSDEV, MEDIAN, MIN, MOMENT, STDDEV, SKEWNESS, VARIANCE

MORPH_CLOSE

The MORPH_CLOSE function applies the closing operator to a binary or grayscale image. MORPH_CLOSE is simply a dilation operation followed by an erosion operation. The result of a closing operation is that small holes and gaps within the image are filled, yet the original sizes of the primary foreground features are maintained. The closing operation is an idempotent operator—applying it more than once produces no further effect.

Both the opening and the closing operators have the effect of smoothing the image, with the opening operation removing pixels, and the closing operation adding pixels.

Syntax

Result = MORPH_CLOSE (*Image*, *Structure* [, /GRAY]
[, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the closing operation is to be performed. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values - either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

Keywords

GRAY

Set this keyword to perform a grayscale, rather than binary, operation. Nonzero elements of the *Structure* parameter determine the shape of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of UINT and ULONG.

UINT

Set this keyword to return an unsigned integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies a grayscale operation.

Example

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then applies a threshold and a morphological closing operator with a 3 by 3 square kernel to the original image. Notice that most of the holes in the pollen grains have been filled by the closing operator.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

;Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 280

;Apply the threshold creating a binary image
thresh = img GE 140B

;Load a simple color table
TEK_COLOR

;Display Edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280
```

```
;Apply closing operator
closing = MORPH_CLOSE(thresh, REPLICATE(1,3,3))

;Show the result
XYOUTS, 180, 265, 'Closing Operator', ALIGNMENT=.5, /DEVICE
TV, closing, 20, 20

;Show added pixels in white
XYOUTS, 520, 265, 'Added Pixels in White', ALIGNMENT=.5, /DEVICE
TV, closing + thresh, 360, 20
```

See Also

DILATE, ERODE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

MORPH_DISTANCE

The MORPH_DISTANCE function estimates *N*-dimensional distance maps, which contain for each foreground pixel the distance to the nearest background pixel, using a given norm. Available norms include: Euclidean, which is exact and is also known as the Euclidean Distance Map (EDM), and two more efficient approximations, chessboard and city block.

The distance map is useful for a variety of morphological operations: thinning, erosion and dilation by discs of radius “r”, and granulometry.

Syntax

Result = MORPH_DISTANCE (*Data* [, /BACKGROUND]
[, NEIGHBOR_SAMPLING={1 | 2 | 3 }] [, /NO_COPY])

Return Value

The returned variable is an array of the same dimension as the input array.

Arguments

Data

An input binary array. Zero-valued pixels are considered to be part of the background.

Keywords

BACKGROUND

By default, the EDM is computed for the foreground (non-zero) features in the *Data* argument. Set this keyword to compute the EDM of the background features instead of the foreground features. If the keyword is set, elements of *Result* that are on an edge are set to 0.

NEIGHBOR_SAMPLING

Set this keyword to indicate how the distance of each neighbor from a given pixel is determined. Valid values include:

- 0 = default. No diagonal neighbors. Each neighbor is assigned a distance of 1.
- 1 = chessboard. Each neighbor is assigned a distance of 1.

- 2 = city block. Each neighbor is assigned a distance corresponding to the number of pixels to be visited when travelling from the current pixel to the neighbor. (The path can only take 90 degree turns; no diagonal paths are allowed.)
- 3 = actual distance. Each neighbor is assigned its actual distance from the current pixel (within the limitations of floating point representations).

Default Two Dimensional Example

```
      1
1     X     1
      1
```

Chessboard Two-Dimensional Example

```
1     1     1
1     X     1
1     1     1
```

City Block Two-Dimensional Example:

```
2     1     2
1     X     1
2     1     2
```

Actual Distance Two-Dimensional Example

```
sqrt(2)  1  sqrt(2)
   1     X     1
sqrt(2)  1  sqrt(2)
```

NO_COPY

Set this keyword to request that the input array be reused, if possible. If this keyword is set, the input argument is undefined upon return.

Example

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then applies a threshold and the morphological distance operator. Thresholding the result distance operator with a value of “n” produces the equivalent of eroding the thresholded image with a disc of radius “n”.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
```

```
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

; Display the original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

; Apply the threshold:
thresh = img GE 140B

; Display the thresholded image
XYOUTS, 520, 525, 'Thresholded Image', ALIGNMENT=.5, /DEVICE
TVSCL, thresh, 360, 280

;Create Euclidean distance function
edist = MORPH_DISTANCE(thresh, NEIGHBOR_SAMPLING = 3)

; Display the distance function
XYOUTS, 180, 265, 'Distance Function', ALIGNMENT=.5, /DEVICE
TVSCL, edist, 20, 20

; Display image after erosion with a disc of radius 5:
XYOUTS, 520, 265, 'After erosion with disc of radius 5',
ALIGNMENT=.5, /DEVICE
TVSCL, edist GT 5, 360, 20
```

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

MORPH_GRADIENT

The MORPH_GRADIENT function applies the morphological gradient operator to a grayscale image. MORPH_GRADIENT is the subtraction of an eroded version of the original image from a dilated version of the original image. The practical result of a morphological gradient operation is that the boundaries of features are highlighted.

Syntax

Result = MORPH_GRADIENT (*Image*, *Structure* [, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the morphological gradient operation is to be performed.

Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values - either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

Keywords

PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

UINT

Set this keyword to return an unsigned integer array. This keyword is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

VALUES

An array of the same dimensions as the *Structure* argument providing the values of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

Example

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then creates disc of radius 2, in a 5 by 5 array, with all elements within a radius of 2 from the center set to 1. This disc is used as the structuring element for the morphological gradient which is then displayed as both a gray scale image, and as a thresholded image.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 280

;Define disc radius
r = 2

;Create a binary disc of given radius.
disc = SHIFT(DIST(2*r+1), r, r) LE r

bdisc = MORPH_GRADIENT(img, disc)

;Show edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TVSCL, bdisc, 360, 280

;Show thresholded edges
XYOUTS, 180, 265, 'Threshold Edges', ALIGNMENT=.5, /DEVICE
TVSCL, bdisc ge 100, 20, 20
```

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

MORPH_HITORMISS

The MORPH_HITORMISS function applies the hit-or-miss operator to a binary image. The hit-or-miss operator is implemented by first applying an erosion operator with a *hit* structuring element to the original image. Then an erosion operator is applied to the complement of the original image with a secondary *miss* structuring element. The result is the intersection of the two results.

The resulting image corresponds to the positions where the hit structuring element lies within the image, and the miss structure lies completely outside the image. The two structures must not overlap.

Syntax

Result = MORPH_HITORMISS (*Image, HitStructure, MissStructure*)

Arguments

Image

A one-, two-, or three-dimensional array upon which the morphological operation is to be performed. The image is treated as a binary image with all nonzero pixels considered as 1.

HitStructure

A one-, two-, or three-dimensional array to be used as the hit structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

MissStructure

A one-, two-, or three-dimensional array to be used as the miss structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

Note

It is assumed that the HitStructure and the MissStructure arguments are disjoint.

Keywords

None.

Example

The following code snippet identifies blobs with a radius of at least 2, but less than 4 in the pollen image. These regions totally enclose a disc of radius 2, contained in the 5 x 5 kernel named “hit”, and in turn, fit within a hole of radius 4, contained in the 9 x 9 array named “miss”. Executing this specific example identifies four blobs in the image with these attributes.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

WINDOW, 0, XSIZE=700, YSIZE=540

; Display the original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

rh = 2 ;Radius of hit disc
rm = 4 ;Radius of miss disc

;Create a binary disc of given radius.
hit = SHIFT(DIST(2*rh+1), rh, rh) LE rh

;Complement of disc for miss
miss = SHIFT(DIST(2*rm+1), rm, rm) GT rm

;Load discrete color table
TEK_COLOR

;Apply the threshold
thresh = img GE 140B

; Display the thresholded image
XYOUTS, 520, 525, 'Thresholded Image', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280

;Compute matches
matches = MORPH_HITORMISS(thresh, hit, miss)

;Expand matches to size of hit disc
matches = DILATE(matches, hit)

;Show matches.
XYOUTS, 180, 265, 'Matches', ALIGNMENT=.5, /DEVICE
```

```
TV, matches, 20, 20

;Superimpose, showing hit regions in blue.
;(Blue = color index 4 for tek_color.)
XYOUTS, 520, 265, 'Superimposed, hit regions in blue',$
   ALIGNMENT=.5, /DEVICE
TV, thresh + 3*matches, 360, 20
```

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

MORPH_OPEN

The MORPH_OPEN function applies the opening operator to a binary or grayscale image. MORPH_OPEN is simply an erosion operation followed by a dilation operation. The result of an opening operation is that small features (e.g., noise) within the image are removed, yet the original sizes of the primary foreground features are maintained. The opening operation is an idempotent operator, applying it more than once produces no further effect.

An alternative definition of the opening, is that it is the union of all sets containing the structuring element in the original image. Both the opening and the closing operators have the effect of smoothing the image, with the opening operation removing pixels, and the closing operation adding pixels.

Syntax

Result = MORPH_OPEN (*Image, Structure* [, /GRAY]
[, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the opening operation is to be performed. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values — either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

Keywords

GRAY

Set this keyword to perform a grayscale, rather than binary, operation. Nonzero elements of the *Structure* parameter determine the shape of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

UINT

Set this keyword to return an unsigned integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies for grayscale operations and is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies a grayscale operation.

Example

The following code reads a data file in the IDL Demo data directory containing an magnified image of grains of pollen. It then applies a threshold and a morphological opening operator with a 3 by 3 square kernel to the original image. Notice that much of the irregular borders of the grains have been smoothed by the opening operator.

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

;Apply the threshold
thresh = img GE 140B

;Load a simple color table
```

```
TEK_COLOR

;Display edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280

;Apply opening operator
open = MORPH_OPEN(thresh, REPLICATE(1,3,3))

;Show the result
XYOUTS, 180, 265, 'Opening Operator', ALIGNMENT=.5, /DEVICE
TV, open, 20, 20

;Show pixels that have been removed in white
XYOUTS, 520, 265, 'Removed Pixels in White', ALIGNMENT=.5, /DEVICE
TV, open + thresh, 360, 20
```

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_THIN, MORPH_TOPHAT

MORPH_THIN

The MORPH_THIN function performs a thinning operation on binary images. The thinning operator is implemented by first applying a hit or miss operator to the original image with a pair of structuring elements, and then subtracting the result from the original image.

In typical applications, this operator is repeatedly applied with the two structuring elements, while rotating them after each application, until the result remains unchanged.

Syntax

Result = MORPH_THIN (*Image, HitStructure, MissStructure*)

Arguments

Image

A one-, two-, or three-dimensional array upon which the thinning operation is to be performed. The image is treated as a binary image with all nonzero pixels considered as 1.

HitStructure

A one-, two-, or three-dimensional array to be used as the hit structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

MissStructure

A one-, two-, or three-dimensional array to be used as the miss structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

Note

It is assumed that the *HitStructure* and the *MissStructure* arguments are disjoint.

Keywords

None.

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_TOPHAT

MORPH_TOPHAT

The MORPH_TOPHAT function applies the top-hat operator to a grayscale image. The top-hat operator is implemented by first applying the opening operator to the original image, then subtracting the result from the original image. Applying the top-hat operator provides a result that shows the bright peaks within the image.

Syntax

Result = MORPH_TOPHAT (*Image, Structure* [, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*])

Arguments

Image

A one-, two-, or three-dimensional array upon which the top-hat operation is to be performed.

Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values — either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

Keywords

PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

UINT

Set this keyword to return an unsigned integer array. This keyword is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

ULONG

Set this keyword to return an unsigned longword integer array. This keyword is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

VALUES

An array of the same dimensions as the *Structure* argument providing the values of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

Example

The following example illustrates an application of the top-hat operator to an image in the `examples/demo/demodata` directory:

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=280

;Show original
XYOUTS, 180, 265, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 20

;Radius of disc
r = 2

;Create a binary disc of given radius.
disc = SHIFT(DIST(2*r+1), r, r) LE r

;Apply top-hat operator
tophat = MORPH_TOPHAT(img, disc)

;Display stretched result.
XYOUTS, 520, 265, 'Stretched Result', ALIGNMENT=.5, /DEVICE
TVSCL, tophat < 50, 360, 20
```

See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN

MPEG_CLOSE

The MPEG_CLOSE procedure closes an MPEG sequence opened with the MPEG_OPEN routine. Note that MPEG_CLOSE does not save the MPEG file associated with the MPEG sequence; use MPEG_SAVE to save the file. The specified MPEG sequence identifier will no longer be valid after calling MPEG_CLOSE.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_close.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MPEG_CLOSE, *mpegID*

Arguments

mpegID

The unique identifier of the MPEG sequence to be freed. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

Example

See MPEG_OPEN for an example using this routine.

See Also

MPEG_OPEN, MPEG_PUT, MPEG_SAVE, XINTERANIMATE

MPEG_OPEN

The MPEG_OPEN function initializes an IDLgrMPEG object for MPEG encoding and returns the object reference. The MPEG routines provide a wrapper around the IDL Object Graphics IDLgrMPEG object, eliminating the need to use the Object Graphics interface to create MPEG files.

Note

The MPEG standard does not allow movies with odd numbers of pixels to be created.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_open.pro` in the `lib` subdirectory of the IDL distribution.

Note

MPEG support in IDL requires a special license. For more information, contact your Research Systems sales representative or technical support.

Syntax

mpegID = MPEG_OPEN(*Dimensions* [, BITRATE=value] [, FILENAME=*string*] [, IFRAME_GAP=*integer value*] [, MOTION_VEC_LENGTH={1 | 2 | 3}] [QUALITY=*value*{0 to 100}])

Arguments

Dimensions

A two-element vector of the form [*xsize*, *ysize*] indicating the dimensions of the images to be used as frames in the MPEG movie file. All images in the MPEG file must have the same dimensions.

Note

When creating MPEG files, you must be aware of the capabilities of the MPEG decoder you will be using to view it. Some decoders only support a limited set of sampling and bitrate parameters to normalize computational complexity, buffer size, and memory bandwidth. For example, the Windows Media Player supports a limited set of sampling and bitrate parameters. In this case, it is best to use 352 x 240 x 30 fps or 352 x 288 x 25 fps when determining the dimensions and frame rate

for your MPEG file. When opening a file in Windows Media Player that does not use these dimensions, you will receive a “Bad Movie File” error message. The file is not “bad”, this decoder just doesn’t support the dimensions of the MPEG.

Keywords

BITRATE

Set this keyword to a double-precision value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

MPEG Version	Range
MPEG 1	0.1 to 104857200.0
MPEG 2	0.1 to 429496729200.0

Table 74: BITRATE Value Range

If you do not set this keyword, IDL computes the BITRATE value based upon the value you have specified for the QUALITY keyword.

Note

Only use the BITRATE keyword if changing the QUALITY keyword value does not produce the desired results. It is highly recommended to set the BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

FILENAME

Set this keyword equal to a string representing the name of the file in which the encoded MPEG sequence is to be saved. The default file name is `idl.mpg`.

IFRAME_GAP

Set this keyword to a positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

If you do not specify this keyword, IDL computes the IFRAME_GAP value based upon the value you have specified for the QUALITY keyword.

Note

Only use the IFRAME_GAP keyword if changing the QUALITY keyword value does not produce the desired results.

MOTION_VEC_LENGTH

Set this keyword to an integer value specifying the length of the motion vectors to be used to generate predictive frames. Valid values include:

- 1 = Small motion vectors.
- 2 = Medium motion vectors.
- 3 = Large motion vectors.

If you do not set this keyword, IDL computes the MOTION_VEC_LENGTH value based upon the value you have specified for the QUALITY keyword.

Note

Only use the MOTION_VEC_LENGTH keyword if changing the QUALITY value does not produce the desired results.

QUALITY

Set this keyword to an integer value between 0 (low quality) and 100 (high quality) inclusive to specify the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

Note

Since MPEG uses JPEG (lossy) compression, the original picture quality can't be reproduced even when setting QUALITY to its highest setting.

Example

The following sequence of IDL commands illustrates the steps needed to create an MPEG movie file from a series of image arrays named image0, image1, .., image*n*, where *n* is the zero-based index of the last image in the movie:

```
; Open an MPEG sequence:
mpegID = MPEG_OPEN()
```

```
; Add the first frame:
MPEG_PUT, mpegID, IMAGE=image0, FRAME=0
MPEG_PUT, mpegID, IMAGE=image1, FRAME=1

; Subsequent frames:
...

; Last frame:
MPEG_PUT, mpegID, IMAGE=imagen, FRAME=n

; Save the MPEG sequence in the file myMovie.mpg:
MPEG_SAVE, mpegID, FILENAME='myMovie.mpg'

; Close the MPEG sequence:
MPEG_CLOSE, mpegID
```

See Also

MPEG_CLOSE, MPEG_PUT, MPEG_SAVE, XINTERANIMATE

MPEG_PUT

The MPEG_PUT procedure stores the specified image array at the specified frame index in an MPEG sequence.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_put.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MPEG_PUT, *mpegID* [, /COLOR] [, FRAME=*frame_number*] [, IMAGE=*array* | , WINDOW=*index*] [, /ORDER]

Arguments

mpegID

The unique identifier of the MPEG sequence into which the image will be inserted. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

Keywords

COLOR

Set this keyword to read off an 8-bit display and pass the information through the current color table to create a 24-bit image.

FRAME

Set this keyword equal to an integer specifying the frame at which the image is to be loaded. If the frame number matches a previously loaded frame, the previous frame is overwritten. The default is 0.

IMAGE

Set this keyword equal to an *m* x *n* image array or a 3 x *m* x *n* True Color image array representing the image to be loaded at the specified frame. This keyword is ignored if the WINDOW keyword is specified.

ORDER

Set this keyword to indicate that the rows of the image should be drawn from top to bottom. By default, the rows are drawn from bottom to top.

WINDOW

Set this keyword to the index of a Direct Graphics Window (or to an object reference to an IDLgrWindow or IDLgrBuffer object) to indicate that the image to be loaded is to be read from the given window or buffer. If this keyword is specified, it overrides the value of the IMAGE keyword.

Example

See MPEG_OPEN for an example using this routine.

See Also

MPEG_CLOSE, MPEG_OPEN, MPEG_SAVE, XINTERANIMATE

MPEG_SAVE

The MPEG_SAVE procedure encodes and saves an open MPEG sequence.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_save.pro` in the `lib` subdirectory of the IDL distribution.

Note

MPEG support in IDL requires a special license. For more information, contact your Research Systems sales representative or technical support.

Syntax

MPEG_SAVE, *mpegID* [, FILENAME=*string*]

Arguments

mpegID

The unique identifier of the MPEG sequence to be saved to a file. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

Keywords

FILENAME

Set this keyword to a string representing the name of the file to which the encoded MPEG sequence is to be saved. The default is `idl.mpg`.

Note

On VMS, if you do not include a file extension when specifying FILENAME, a period will be added to the filename. For example, if you set the FILENAME keyword to “myfile”, the file will be saved as “myfile.”.

Example

See MPEG_OPEN for an example using this routine.

See Also

MPEG_CLOSE, MPEG_OPEN, MPEG_PUT, XINTERANIMATE

MSG_CAT_CLOSE

The MSG_CAT_CLOSE procedure closes a catalog file from the stored cache.

Syntax

MSG_CAT_CLOSE, *object*

Arguments

object

The object reference returned from MSG_CAT_OPEN.

Keywords

None

See Also

MSG_CAT_COMPILE, MSG_CAT_OPEN, IDLffLanguageCat

MSG_CAT_COMPILE

The MSG_CAT_COMPILE procedure creates an IDL language catalog file.

Note

The locale is determined from the system locale in effect when compilation takes place.

Syntax

MSG_CAT_COMPILE, *input*[, *output*] [, LOCALE_ALIAS=*string*] [, /MBCS]

Arguments

input

The input file with which to create the catalog. The file is a text representation of the key/MBCS association. Each line in the file must have a key. The language string must then be surrounded by double quotes, then an optional comment.

For example:

```
VERSION        "Version 1.0"    My revision number of the file
```

There are 2 special tags, one of which must be included when creating the file.

APPLICATION (required)

SUB_QUERY (optional)

output

The optional output file name (including path if necessary) of the IDL language catalog file.

The naming convention for IDL language catalog files is as follows:

```
idl_ + "Application name" + _ + "Locale" + .cat
```

For example:

```
idl_envi_usa_eng.cat
```

If not set, a default filename is used based on the locale:

```
idl_[locale].cat
```

Keywords

LOCALE_ALIAS

Set this keyword to a scalar string containing any locale aliases for the locale on which the catalog is being compiled. A semi-colon is used to separate locales.

For example:

```
MSG_CAT_COMPILE,'input.txt', 'idl_envi_usa_eng.cat',$
LOCALE_ALIAS='C'
```

MBCS

If set, this procedure assumes language strings to be in MBCS format. The default is 8-bit ASCII.

See Also

MSG_CAT_CLOSE, MSG_CAT_OPEN, IDLffLanguageCat

MSG_CAT_OPEN

The MSG_CAT_OPEN function returns a catalog object for the given parameters if found. If a match is not found, an unset catalog object is returned. If unset, the IDLffLanguageCat::Query method will always return the empty string unless a default catalog is provided.

Syntax

Result = MSG_CAT_OPEN(*application* [, DEFAULT_FILENAME=*filename*] [, FILENAME=*string*] [, FOUND=*variable*] [, LOCALE=*string*] [, PATH=*string*] [, SUB_QUERY=*value*])

Arguments

application

A scalar string representing the name of the desired application's catalog file.

Keywords

DEFAULT_FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open if the initial request was not found.

FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open. If this keyword is set, *application*, PATH and LOCALE are ignored.

FOUND

Set this keyword to a named variable that will contain 1 if a catalog file was found, 0 otherwise.

LOCALE

Set this keyword to the desired locale for the catalog file. If not set, the current locale is used.

PATH

Set this keyword to a scalar string containing the path to search for language catalog files. The default is the current directory.

SUB_QUERY

Set this keyword equal to the value of the SUB_QUERY key to search against. If a match is found, it is used to further sub-set the possible return catalog choices.

See Also

MSG_CAT_CLOSE, MSG_CAT_COMPILE, IDLffLanguageCat

MULTI

The MULTI procedure expands the current color table to “wrap around” some number of times.

This routine is written in the IDL language. Its source code can be found in the file `multi.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

MULTI, *N*

Arguments

N

The number of times the color table will wrap. This parameter does not have to be an integer.

Example

Display an image, load color table 1, and make that color table “wrap around” 3 times. Enter:

```
;Display a simple image.
TVSCL, DIST(256)

;Load color table 1.
LOADCT, 1

;See how the new color table affects the image.
MULTI, 3
```

See Also

STRETCH, XLOADCT

N_ELEMENTS

The N_ELEMENTS function returns the number of elements contained in an expression or variable.

Syntax

Result = N_ELEMENTS(*Expression*)

Arguments

Expression

The expression for which the number of elements is to be returned. Scalar expressions always have one element. The number of elements in an array is equal to the product of its dimensions. If *Expression* is an undefined variable, N_ELEMENTS returns zero.

Examples

Example 1

This example finds the number of elements in an array:

```
; Create an integer array:
I = INTARR(4, 5, 3, 6)
; Find the number of elements in I and print the result:
PRINT, N_ELEMENTS(I)
```

Example 2

A typical use of N_ELEMENTS is to check if an optional input is defined, and if not, set it to a default value:

```
IF (N_ELEMENTS(roo) EQ 0) THEN roo=rooDefault
```

The original value of `roo` may be altered by a called routine, passing a different value back to the caller. Unless you intend for the routine to behave in this manner, you should prevent it by differentiating N_ELEMENTS' parameter from your routine's variable:

```
IF (N_ELEMENTS(roo) EQ 0) THEN rooUse=rooDefault $
   ELSE rooUse=roo
```

See Also

N_TAGS

N_PARAMS

The N_PARAMS function returns the number of non-keyword parameters used in calling an IDL procedure or function. This function is only useful within IDL procedures or functions. User-written procedures and functions can use N_PARAMS to determine if they were called with optional parameters.

Note

In the case of object method procedures and functions, the SELF argument is not counted by N_PARAMS.

Syntax

Result = N_PARAMS()

Arguments

None. This function always returns the number of parameters that were used in calling the procedure or function from which N_PARAMS is called.

See Also

KEYWORD_SET

N_TAGS

The N_TAGS function returns the number of structure tags contained in a structure expression. It optionally returns the size, in bytes, of the structure.

Syntax

Result = N_TAGS(*Expression* [, /LENGTH])

Arguments

Expression

The expression for which the number of structure tags is to be returned. Expressions that are not of structure type are considered to have no tags. N_TAGS does not search for tags recursively, so if *Expression* is a structure containing nested structures, only the number of tags in the outermost structure are counted.

Keywords

LENGTH

Set this keyword to return the length of the structure, in bytes.

Note

The length of a structure is machine dependent. The length of a given structure will vary depending upon the host machine. IDL pads and aligns structures in a manner consistent with the host machine's C compiler.

Example

Find the number of tags in the system variable !P and print the result by entering:

```
PRINT, N_TAGS(!P)
```

Find the length of !P, in bytes:

```
PRINT, N_TAGS(!P, /LENGTH)
```

See Also

CREATE_STRUCT, N_ELEMENTS, TAG_NAMES, *Building IDL Applications* Chapter 6, "Structures"

NCDF_* Routines

See Alphabetical Listing of NCDF Routines in the *Scientific Data Formats* manual.

NEWTON

The NEWTON function solves a system of *n* non-linear equations in *n* dimensions using a globally-convergent Newton's method. The result is an *n*-element vector containing the solution.

NEWTON is based on the routine `newt` described in section 9.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = NEWTON(*X*, *Vecfunc* [, CHECK=*variable*] [, /DOUBLE] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLF=*value*] [, TOLMIN=*value*] [, TOLX=*value*])

Arguments

X

An *n*-element vector containing an initial guess at the solution of the system.

Vecfunc

A scalar string specifying the name of a user-supplied IDL function that defines the system of non-linear equations. This function must accept an *n*-element vector argument *X* and return an *n*-element vector result.

For example, suppose the non-linear system is defined by the following equations:

$$y_0 = x_0 + x_1 - 3, \quad y_1 = x_0^2 + x_1^2 - 9$$

We write a function NEWTFUNC to express these relationships in the IDL language:

```
FUNCTION newtfunc, X
   RETURN, [X[0] + X[1] -3.0, X[0]^2 + X[1]^2 - 9.0]
END
```

Keywords

CHECK

NEWTON calls an internal function named `fmin()` to determine whether the routine has converged to a local minimum rather than to a global minimum (see *Numerical Recipes*, section 9.7). Use the CHECK keyword to specify a named variable which

will be set to 1 if the routine has converged to a local minimum or to 0 if it has not. If the routine does converge to a local minimum, try restarting from a different initial guess to obtain the global minimum.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITMAX

The maximum allowed number of iterations. The default value is 200.

STEPMAX

The scaled maximum step length allowed in line search. The default value is 100.0.

TOLF

Set the convergence criterion on the function values. The default value is 1.0×10^{-4}.

TOLMIN

Set the criterion for deciding whether spurious convergence to a minimum of the function `fmin()` has occurred. The default value is 1.0×10^{-6}.

TOLX

Set the convergence criterion on *X*. The default value is 1.0×10^{-7}.

Example

Use NEWTON to solve an *n*-dimensional system of *n* non-linear equations. Systems of non-linear equations may have multiple solutions; starting the algorithms with different initial guesses enables detection of different solutions.

```
PRO TEST_NEWTON

   ; Provide an initial guess as the algorithm's starting point:
   X = [1.0, 5.0]

   ; Compute the solution:
   result = NEWTON(X, 'newtfunc')

   ; Print the result:
   PRINT, 'For X=[1.0, 5.0], result = ', result

   ;Try a different starting point.
   X = [1.0, -1.0]
```

```
   ; Compute the solution:
   result = NEWTON(X,'newtfunc')

   ;Print the result.
   PRINT, 'For X=[1.0, -1.0], result = ', result

END

FUNCTION newtfunc, X
   RETURN, [X[0] + X[1] -3.0, X[0]^2 + X[1]^2 - 9.0]
END
```

IDL prints:

```
For X=[1.0, 5.0], result =  0.000398281    3.00000
For X=[1.0, -1.0], result = 3.00000  -6.45883e-005
```

See Also

BROYDEN, FX_ROOT, FZ_ROOTS

NORM

The NORM function computes the Euclidean norm of a vector. Alternatively, NORM computes the Infinity norm of an array.

This routine is written in the IDL language. Its source code can be found in the file `norm.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = NORM(*A* [, /DOUBLE])

Arguments

A

A can be either of the following:

- An *n*-element real or complex vector, if NORM is being used to compute the Euclidean norm of a vector.
- An *m* by *n* real or complex array, if NORM is being used to compute the Infinity norm of an array.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Examples

```
; Define an n-element complex vector A:
A = [COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)]

; Compute the Euclidean norm of A and print:
PRINT, 'Euclidian Norm of A =', NORM(A)

; Define an m by n complex array B:
B = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)]]

;Compute the Infinity norm of B and print.
PRINT, 'Infinity Norm of B =', NORM(B, /DOUBLE)
```

IDL prints:

```
Euclidian Norm of A =    4.35890
Infinity Norm of B =    6.9907048
```

See Also

COND

OBJ_CLASS

The OBJ_CLASS function returns the name of the class or superclass of its argument, as a string. If the supplied argument is not an object, a null string is returned. If no argument is supplied, OBJ_CLASS returns an array containing the names of all known object classes in the current IDL session.

Syntax

Result = OBJ_CLASS([*Arg*] [, COUNT=*variable*] [, /SUPERCLASS{must specify Arg}])

Arguments

Arg

A scalar object reference or string variable for which the object class name is desired. If *Arg* is an object reference, it's object class definition is used. If *Arg* is a string, it is taken to be the name of the class for which information is desired. Passing a string argument is primarily useful in conjunction with the SUPERCLASS keyword.

Keywords

COUNT

Set this keyword equal to a named variable that will contain the number of names returned by OBJ_CLASS. It can be used to determine how many superclasses a class has when the SUPERCLASS keyword is specified.

SUPERCLASS

Set this keyword to cause OBJ_CLASS to return the names of the object's *direct* superclasses as a string array, one element per superclass. The superclasses are ordered in the order they appear in the class structure declaration. In the case where the class has no superclasses, a scalar null string is returned, and the COUNT keyword (if specified) returns the value 0. If SUPERCLASS is specified, the Arg argument must also be supplied.

OBJ_DESTROY

The OBJ_DESTROY procedure is used to destroy an object. If the class (or one of its superclasses) supplies a procedure method named CLEANUP, the method is called and all arguments and keywords passed by the user are passed to it. This method should perform any required cleanup on the object and return. Whether a CLEANUP method actually exists or not, IDL will destroy the heap variable representing the object and return.

Note that OBJ_DESTROY does not recurse. That is, if `object1` contains a reference to `object2`, destroying `object1` will *not* destroy `object2`. Take care not to lose the only reference to an object by destroying an object that contains that reference. Recursive cleanup of object hierarchies is a good job for a CLEANUP method.

Syntax

OBJ_DESTROY, *ObjRef* [, Arg_1, …, Arg_n]

Arguments

ObjRef

The object reference for the object to be destroyed. *ObjRef* can be an array, in which case all of the specified objects are destroyed in turn. If the NULL object reference is passed, OBJ_DESTROY ignores it quietly.

Arg1…Argn

Any arguments accepted by the CLEANUP method for the object being destroyed can be specified as additional arguments to OBJ_DESTROY.

Keywords

Any keywords accepted by the CLEANUP method for the object being destroyed can be specified as keywords to OBJ_DESTROY.

OBJ_ISA

When one object class is subclassed (inherits) from another class, there is an “Is A” relationship between them. The OBJ_ISA function is used to determine if an object instance is subclassed from the specified class. OBJ_ISA returns True (1) if the specified variable is an object and has the specified class in its inheritance graph, or False (0) otherwise.

Syntax

Result = OBJ_ISA(*ObjectInstance*, *ClassName*)

Arguments

ObjectInstance

A scalar or array variable for which the OBJ_ISA test should be performed. The result is of type byte, and has the same size and organization as *ObjectInstance*.

ClassName

A string giving the name of the class for which *ObjectInstance* is being tested.

OBJ_NEW

Given the name of a structure that defines an object class, the OBJ_NEW function returns an object reference to a new instance of the specified object type by carrying out the following operations in order:

1. If the class structure has not been defined, IDL will attempt to find and call a procedure to define it automatically. (See Chapter 20, "Object Basics" in *Building IDL Applications* for details.) If the structure is still not defined, OBJ_NEW fails and issues an error.
2. If the class structure has been defined, OBJ_NEW creates an object heap variable containing a zeroed instance of the class structure.
3. Once the new object heap variable has been created, OBJ_NEW looks for a *method* function named *Class*::INIT (where *Class* is the actual name of the class). If an INIT method exists, it is called with the new object as its implicit SELF argument, as well as any arguments and keywords specified in the call to OBJ_NEW. If the class has no INIT method, the usual method-searching rules are applied to find one from a superclass. For more information on methods and method-searching rules, see "Method Routines" in Chapter 20 of Building IDL Applications.

   The INIT method is expected to initialize the object instance data as necessary to meet the needs of the class implementation. INIT should return a scalar TRUE value (such as 1) if the initialization is successful, and FALSE (such as 0) if the initialization fails.

Note

OBJ_NEW does not call all the INIT methods in an object's class hierarchy. Instead, it simply calls the first one it finds. Therefore, the INIT method for a class should call the INIT methods of its direct superclasses as necessary.

4. If the INIT method returns true, or if no INIT method exists, OBJ_NEW returns an object reference to the heap variable. If INIT returns false, OBJ_NEW destroys the new object and returns the NULL object reference, indicating that the operation failed. Note that in this case the CLEANUP method is not called. See "Destruction" in Chapter 20 of Building IDL Applications for more on CLEANUP methods.

If called without arguments, OBJ_NEW returns a NULL object reference. The NULL object reference is a special value that never refers to a value object. It is primarily

used as a placeholder in structure definitions, and as the initial value for elements of object arrays created via OBJARR. The null object reference is useful as an indicator that an object reference is currently not usable.

Syntax

Result = OBJ_NEW([*ObjectClassName* [, Arg_1…...Arg_n]])

Arguments

ObjectClassName

String giving the name of the structure type that defines the object class for which a new object should be created.

If *ObjectClassName* is not provided, OBJ_NEW does not create a new heap variable, and returns the *Null Object*, which is a special object reference that is guaranteed to never point at a valid object heap variable. The null object is a convenient value to use when defining structure definitions for fields that are object references, since it avoids the need to have a pre-existing valid object reference.

Arg1…Argn

Any arguments accepted by the INIT method for the class of object being created can be specified when the object is created.

Keywords

Any keywords accepted by the INIT method for the class of object being created can be specified when the object is created.

OBJ_VALID

The OBJ_VALID function verifies the validity of its argument object references, or alternatively returns a vector of references to all the existing valid objects.

If called with an argument, OBJ_VALID returns a byte array of the same size as the argument. Each element of the result is set to True (1) if the corresponding object reference in the argument refers to an existing object, and False (0) otherwise.

If called with an integer or array of integers as its argument and the CAST keyword is set, OBJ_VALID returns an array of object references. Each element of the result is a reference to the heap variable indexed by the integer value. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when the you have lost a reference but see it with HELP and need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

If no argument is specified, OBJ_VALID returns a vector of references to all existing valid objects. If no valid objects exist, a scalar null object reference is returned.

Syntax

Result = OBJ_VALID([*Arg*] [, CAST=*integer*] [, COUNT=*variable*])

Arguments

Arg

Scalar or array argument of object reference type.

Keywords

CAST

Set this keyword equal to an integer that indexes a heap variable to create a new pointer to that heap variable. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when the you have lost a reference but see it with HELP and need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

COUNT

Set this keyword equal to a named variable that will contain the number of currently valid objects. This value is returned as a longword integer.

Examples

To determine if a given object reference refers to a valid heap variable, use:

```
IF (OBJ_VALID(obj)) THEN …
```

To destroy all existing pointer heap variables:

```
OBJ_DESTROY, OBJ_VALID()
```

You can use the CAST keyword to “reclaim” lost object references. For example:

```
; Create a class structure:
junk = {junk, data1:0, data2:0.0}

; Create an object:
A = OBJ_NEW('junk')

; Find the integer index:
PRINT, A

; In this case, the integer index to the heap variable is 3. If we
; reassign the variable A, we will "lose" the object reference, but
; the heap variable will still exist.
; Lose the object reference:
A = 0
PRINT, A, OBJ_VALID()

; We can reclaim the lost heap variable using the CAST keyword:
A = OBJ_VALID(3, /CAST)
PRINT, A
```

IDL prints:

```
<ObjHeapVar3(JUNK)>
0 <ObjHeapVar3(JUNK)>
<ObjHeapVar3(JUNK)>
```

OBJARR

The OBJARR function returns an object reference vector or array. The individual elements of the array are set to the NULL object reference.

Syntax

Result = OBJARR(D_1, …, D_8 [, /NOZERO])

Arguments

Di

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

OBJARR sets every element of the result to the null object reference. If NOZERO is nonzero, this initialization is not performed and OBJARR executes faster.

Warning

If you specify NOZERO, the resulting array will have whatever value happens to exist at the system memory location that the array is allocated from. You should be careful to initialize such an array to valid object reference values.

Example

Create a 3 element by 3 element object reference array with each element containing the null object reference:

```
A = OBJARR(3, 3)
```

ON_ERROR

The ON_ERROR procedure determines the action taken when an error is detected inside an IDL user procedure or function by setting state information applying to the current routine and all nested routines. If an override exists within the nested routine, it takes precedence over the ON_ERROR call.

Syntax

ON_ERROR, *N*

Arguments

N

An integer that specifies the action to take. Valid values for *N* are:

- 0: Stop at the statement in the procedure that caused the error, the default action.
- 1: Return all the way back to the main program level.
- 2: Return to the caller of the program unit that established the ON_ERROR condition.
- 3: Return to the program unit that established the ON_ERROR condition.

See Also

CATCH, MESSAGE, ON_IOERROR, and *Building IDL Applications* Chapter 17, "Controlling Errors".

ON_IOERROR

The ON_IOERROR procedure specifies a statement to be jumped to if an I/O error occurs in the current procedure. Normally, when an I/O error occurs, an error message is printed and program execution is stopped. If ON_IOERROR is called and an I/O related error later occurs in the same procedure activation, control is transferred to the designated statement with the error code stored in the system variable !ERROR_STATE. The text of the error message is contained in !ERROR_STATE.MSG.

The effect of ON_IOERROR can be canceled by using the label “NULL” in the call.

Syntax

ON_IOERROR, *Label*
. . .
Label: *Statement to perform upon I/O error*

Example

The following code segment reads an integer from the keyboard. If an invalid number is entered, the program re-prompts.

```
i = 0 ; Number to read:

valid = 0 ; Valid flag

WHILE valid EQ 0 DO BEGIN
   ON_IOERROR, bad_num
   READ, 'Enter Number: ', i
   ;If we get here, i is good.
   VALID = 1
bad_num: IF NOT valid THEN $
         PRINT, 'You entered an invalid number.'
ENDWHILE
END
```

See Also

CATCH, MESSAGE, ON_ERROR, and *Building IDL Applications* Chapter 17, “Controlling Errors”.

ONLINE_HELP

The ONLINE_HELP procedure invokes the hypertext help viewer. If called with no arguments, it simply starts the help viewer with the default IDL help file displayed. Optionally, a different book, a keyword search string, or a context number can be specified. Note that this procedure is intended for use in user-written routines. To invoke IDL's online help from the command line, it is much simpler to use the `?` command.

Syntax

ONLINE_HELP [, *Value*] [, BOOK='*filename*'] [, /CONTEXT] [, /FULL_PATH] [, /HTML_HELP] [, /QUIT] [, /TOPICS]

Arguments

Value

An optional string that contains text to be searched for using the viewer's Index dialog. If this argument is omitted, the specified or default file is displayed at its beginning.

If the CONTEXT keyword is set, this argument should be an integer value (not a string) that represents the context number of the help topic to be displayed.

Keywords

BOOK

Set this keyword to a string containing the name of the Help file to be displayed. If this keyword is omitted, the default IDL help file is displayed. Any file specified by this keyword must be in the appropriate format for the viewer being invoked:

- On Windows, the file must be a Windows WinHelp (`.hlp`) or HTML Help (`.chm`) file.
- On UNIX and VMS, the file must be a Bristol HyperHelp `.hlp` file.
- On Macintosh, the file must be an Altura QuickHelp file.

By default, this string should be the name of a file found in the default location for IDL's Help files (i.e., wherever the file `idl.hlp` is installed), *without a path or file extension*.

You can set the !HELP_PATH system variable or the IDL_HELP_PATH environment variable to the directory where your Help file exists.

However, if the FULL_PATH keyword is set, this string should be a complete path and filename to the online help file you wish to display.

CONTEXT

Set this keyword to indicate that the *Value* argument is an integer value that represents the context number of the help topic to be displayed. This keyword is intended for use with user-compiled help files that contain topics that have been mapped to specific context numbers when they were compiled using the [MAP] section of the help project file. Specifying a non-existent context number causes the first topic of the requested help file to be displayed. For more information on how to create Help files with context numbers, see the documentation for the Help system compiler that you are using.

FULL_PATH

Set this keyword to indicate that the string specified by the BOOK keyword is the full path to the file, rather than the default file path specification, as described above.

HTML_HELP

If set, the Windows HTML Help system is used. All other keywords to ONLINE_HELP behave as specified, but the HTML help system is utilized. Note that a default file extension of `.chm` is used, not .hlp.

QUIT

Set this keyword to close the Help viewer.

TOPICS

If set, the Topics dialog of the Help system will be shown for the specified help file.

Examples

In the following example, the ONLINE_HELP routine launches the Help viewer and displays the Index dialog at the entry for “handle” if it exists:

```
ONLINE_HELP, 'handle'
```

In the next example, the Help file named `adg.hlp`, located in the default directory, is displayed:

```
ONLINE_HELP, BOOK='adg'
```

In the next example, the Help file named `myhelp.hlp`, located in a directory named `/usr/home/keith`, is displayed:

```
ONLINE_HELP, BOOK='/usr/home/keith/myfile.hlp', /FULL_PATH
```

In the next example, the topic corresponding to context number 100 is displayed:

```
ONLINE_HELP, 100, /CONTEXT, $
   BOOK='/usr/home/keith/myfile.hlp', /FULL_PATH
```

See Also

MK_HTML_HELP, *Building IDL Applications* Chapter 19, "Extending the IDL Online Help System"

OPEN

The three OPEN procedures open a specified file for input and/or output.

- OPENR (OPEN Read) opens an existing file for input only.
- OPENW (OPEN Write) opens a new file for input and output. When creating a new file under VMS, a new file with the same name and a higher version number is created. Under other operating systems, if the file exists, it is truncated and its old contents are destroyed.
- OPENU (OPEN Update) opens an existing file for input and output.

Syntax

There are three forms of the OPEN procedure:

OPENR, *Unit*, *File* [, *Record_Length*]
OPENW, *Unit*, *File* [, *Record_Length*]
OPENU, *Unit*, *File* [, *Record_Length*]

Keywords (all platforms): [, /APPEND | , /COMPRESS] [, BUFSIZE={0 | 1 | *value*>512}] [, /DELETE] [, ERROR=*variable*] [, /F77_UNFORMATTED] [, /GET_LUN] [, /MORE] [, /STDIO] [, /SWAP_ENDIAN] [, SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, /VAX_FLOAT] [, WIDTH=*value*] [, /XDR]

Macintosh-Only Keywords: [, MACCREATOR=*string*] [, MACTYPE= *string*]

UNIX-Only Keywords: [, /RAWIO]

VMS-Only Keywords: [, /BLOCK | , /SHARED | , /UDF_BLOCK] [, DEFAULT='.*extension*'] [, /EXTENDSIZE] [, /FIXED] [, /FORTRAN] [, INITIALSIZE=*blocks*] [, /KEYED] [, /LIST] [, /NONE] [, /PRINT] [, /SEGMENTED] [, /STREAM] [, /SUBMIT] [, /SUPERSEDE] [, /TRUNCATE_ON_CLOSE] [, /VARIABLE]

Arguments

Unit

The unit number to be associated with the opened file.

File

A string containing the name of the file to be opened. Note the following platform-specific behaviors:

- Under UNIX, the filename can contain any wildcard characters recognized by the shell specified by the SHELL environment variable. However, it is faster not to use wildcards because IDL doesn't use the shell to expand file names unless it has to. No wildcard characters are allowed under VMS.
- Under VMS, filenames that do not have a file extension are assumed to have the .DAT extension. No such processing of file names occurs under UNIX.

Record_Length

The *Record_Length* argument has meaning only under VMS. It specifies the file record size in bytes. This argument is required when creating new, fixed-length files, and is optional when opening existing files. If this argument is present when creating variable-length record files, it specifies the maximum allowed record size. If this argument is present and no file organization keyword is specified, fixed-length records are implied.

Due to limitations in RMS (the VMS Record Management System), the length of records must always be an even number of bytes. Odd record lengths are therefore automatically rounded up to the nearest even boundary.

Keywords

Note

Platform-specific keywords are listed at the end of this section.

APPEND

Set this keyword to open the file with the file pointer at the end of the file, ready for data to be appended. Normally, the file is opened with the file pointer at the beginning of the file. Under UNIX, use of APPEND prevents OPENW from truncating existing file contents. The APPEND and COMPRESS keywords are mutually exclusive and cannot be specified together.

BUFSIZE

Set this keyword to a value greater than 512 to specify the size of the I/O buffer (in bytes) used when reading and writing files. Setting BUFSIZE=1 (or any other value

less than 512) sets the buffer to the default size, which is platform-specific. Set BUFSIZE=0 to disable I/O buffering.

Note that the buffer size is only changeable when reading and writing stream files. Under UNIX, the RAWIO keyword must not be set. Also not that the system stdio may choose to ignore the buffer size setting.

COMPRESS

If COMPRESS is set, IDL reads and writes all data to the file in the standard GZIP format. IDL's GZIP support is based on the freely available ZLIB library version 1.1.3 by Mark Adler and Jean-loup Gailly. This means that IDL's compressed files are 100% compatible with the widely available gzip and gunzip programs. COMPRESS cannot be used with the APPEND keyword.

Note

Under VMS, the COMPRESS keyword can only be used with stream files.

DELETE

Set this keyword to delete the file when it is closed.

Warning

Setting the DELETE keyword *causes the file to be deleted* even if it was opened for read-only access. In addition, once a file is opened with this keyword, there is no way to cancel its operation.

ERROR

A named variable to place the error status in. If an error occurs in the attempt to open *File*, IDL normally takes the error handling action defined by the ON_ERROR and/or ON_IOERROR procedures. OPEN always returns to the caller without generating an error message when ERROR is present. A nonzero error status indicates that an error occurred. The error message can then be found in !ERROR_STATE.MSG.

For example, statements similar to the following can be used to detect errors:

```
; Try to open the file demo.dat:
OPENR, 1, 'demo.dat', ERROR = err

; If err is nonzero, something happened. Print the error message to
; the standard error file (logical unit -2):
IF (err NE 0) then PRINTF, -2, !ERROR_STATE.MSG
```

F77_UNFORMATTED

Unformatted variable-length record files produced by UNIX FORTRAN programs contain extra information along with the data in order to allow the data to be properly recovered. This method is necessary because FORTRAN input/output is based on record-oriented files, while UNIX files are simple byte streams that do not impose any record structure. Set the F77_UNFORMATTED keyword to read and write this extra information in the same manner as `f77(1)`, so that data to be processed by both IDL and FORTRAN. See "UNIX-Specific Information" in Chapter 8 of *Building IDL Applications* for further details.

Warning

Do not confused this keyword with the VMS-only keyword FORTRAN.

GET_LUN

Set this keyword to use the GET_LUN procedure to set the value of *Unit* before the file is opened. Instead of using the two statements:

```
GET_LUN, Unit
OPENR, Unit, 'data.dat'
```

you can use the single statement:

```
OPENR, Unit, 'data.dat', /GET_LUN
```

MORE

If MORE is set, and the specified *File* is a terminal, then all output to this unit is formatted in a manner similar to the UNIX `more(1)` command and sent to the standard output stream. Output pauses at the bottom of each screen, at which point the user can press one of the following keys:

- Space: Display the next page of text.
- Return: Display the next line of text.
- 'q' or 'Q': Suppress all remaining output.
- 'h' or 'H': Display this list of options.

For example, the following statements show how to output a file named text.dat to the terminal:

```
; Open the text file:
OPENR, inunit, 'text.dat', /GET_LUN
```

```
; Open the terminal as a file:
OPENW, outunit, '/dev/tty', /GET_LUN, /MORE

; Read the first line:
line = '' & READF, inunit, line

; While there is text left, output it:
WHILE NOT EOF(inunit) DO BEGIN
   PRINTF, outunit, line
   READF, inunit, line
ENDWHILE

; Close the files and deallocate the units:
FREE_LUN, inunit & FREE_LUN, outunit
```

Under VMS, the MORE keyword is only allowed for stream mode files.

STDIO

Forces the file to be opened via the standard C I/O library (stdio) rather than any other more native OS API that might usually be used. This is primarily of interest to those who intend to access the file from external code, and is not necessary for most files.

Note

If you intend to use the opened file with the READ_JPEG or WRITE_JPEG procedures using their UNIT keyword, you must specify the STDIO keyword to OPEN to ensure that the file is compatible.

The only exception to this rule is if the filename ends in `.jpg` or `.jpeg` and the STDIO keyword is not present in the call to OPEN. In this case OPEN, by default uses stdio which covers most uses of jpeg files without requiring the user to take special steps.

SWAP_ENDIAN

Set this keyword to swap byte ordering for multi-byte data when performing binary I/O on the specified file. This is useful when accessing files also used by another system with byte ordering different than that of the current host.

SWAP_IF_BIG_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has big endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

SWAP_IF_LITTLE_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has little endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

VAX_FLOAT

The opened file contains VAX format floating point values. This keyword implies little endian byte ordering for all data contained in the file, and supersedes any setting of the SWAP_ENDIAN, SWAP_IF_BIG_ENDIAN, or SWAP_IF_LITTLE_ENDIAN keywords.

The default setting for this keyword is FALSE. Under VMS, starting the VAX_FLOAT option to the IDL command at startup has the effect of changing this default and making it TRUE. See "Command Line Options" in Chapter 4 of *Using IDL* for details on this qualifier. You can change this setting at runtime using the VAX_FLOAT function.

Warning

Please read "Note On IEEE to VAX Format Conversion" on page 969 before using this feature.

WIDTH

The desired output width. When using the defaults for formatted output, IDL uses the following rules to determine where to break lines:

- If the output file is a terminal, the terminal width is used. Under VMS, if the file has fixed-length records or a maximum record length, the record length is used.
- Otherwise, a default of 80 columns is used.

The WIDTH keyword allows the user to override this default.

XDR

Set this keyword to open the file for unformatted XDR (eXternal Data Representation) I/O via the READU and WRITEU procedures. Use XDR to make binary data portable between different machine architectures by reading and writing all data in a standard format. When a file is open for XDR access, the only I/O data transfer procedures that can be used with it are READU and WRITEU. XDR is described in "Portable Unformatted Input/Output" in Chapter 8 of *Building IDL Applications*.

Under VMS, the XDR keyword can only be used with stream files.

Macintosh-Only Keywords

MACCREATOR

Use this keyword to specify a four-character scalar string identifying the Macintosh file creator code of the file being created. For example, set

```
MACCREATOR = 'MSWD'
```

to create a file with the creator code `MSWD`. The default creator code is `MIDL`.

MACTYPE

Use this keyword to specify a four-character scalar string identifying the Macintosh file type of the file being created. For example, set

```
MACTYPE = 'PICT'
```

to create a file of type `PICT`. The default file type is `TEXT`.

Windows-Only Keywords

The Windows-Only keywords BINARY and NOAUTOMODE are now obsolete. Input/Output on Windows is now handled indentically to Unix, and does not require you to be concerned about the difference between "text" and "binary" modes. These keywords are still accepted for backwards compatibility, but are ignored.

UNIX-Only Keywords

The previous keyword NOSTDIO is now obsolete. It has been renamed RAWIO to reflect the fact that stdio may or may not actually be used. All references to NOSTDIO should be changed to be RAWIO, but NOSTDIO will still be accepted as a synonym for RAWIO.

RAWIO

Set this keyword to disable all use of the standard UNIX I/O for the file, in favor of direct calls to the operating system. This allows direct access to devices, such as tape drives, that are difficult or impossible to use effectively through the standard I/O. Using this keyword has the following implications:

- No formatted or associated (ASSOC) I/O is allowed on the file. Only READU and WRITEU are allowed.

- Normally, attempting to read more data than is available from a file causes the unfilled space to be set to zero and an error to be issued. This does not happen with files opened with RAWIO. When using RAWIO, the programmer must check the transfer count, either via the TRANSFER_COUNT keywords to READU and WRITEU, or the FSTAT function.
- The EOF and POINT_LUN functions cannot be used with a file opened with RAWIO.
- Each call to READU or WRITEU maps directly to UNIX read(2) and write(2) system calls. The programmer must read the UNIX system documentation for these calls and documentation on the target device to determine if there are any special rules for I/O to that device. For example, the size of data that can be transferred to many cartridge tape drives is often forced to be a multiple of 512 bytes.

VMS-Only Keywords

BLOCK

Set this keyword to process the file using RMS block mode. In this mode, most RMS processing is bypassed and IDL reads and writes to the file in disk block units. Such files can only be accessed via unformatted I/O commands. Block mode files are treated as an uninterpreted stream of bytes in a manner similar to UNIX stream files.

For best performance, by default IDL uses RMS block mode for fixed length record files. However, when the SHARED keyword is present, IDL uses standard RMS mode. Do not specify both BLOCK and SHARED.

This keyword is ignored when used with stream files.

Note

With some controller/disk combinations, RMS does not allow transfer of an odd number of bytes.

DEFAULT

A scalar string that provides a default file specification from which missing parts of the File argument are taken. For example, to make .LOG be the default file extension when opening a new file, use the command:

```
OPENW, 'DATA', DEFAULT='.LOG'
```

This statement will open the file DATA.LOG.

EXTENDSIZE

File extension is a relatively slow operation, and it is desirable to minimize the number of times it is done. In order to avoid the unacceptable performance that would result from extending a file a single block at a time, VMS extends its size by a default number of blocks in an attempt to trade a small amount of wasted disk space for better performance. The EXTENDSIZE keyword overrides the default, and specifies the number of disk blocks by which the file should be extended. This keyword is often used in conjunction with the INITIALSIZE and TRUNCATE_ON_CLOSE keywords.

FIXED

Set this keyword to indicate that the file has fixed-length records. The *Record_Length* argument is required when opening new, fixed-length files.

FORTRAN

Set this keyword to use FORTRAN-style carriage control when creating a new file. The first byte of each record controls the formatting.

INITIALSIZE

The initial size of the file allocation in blocks. This keyword is often used in conjunction with the EXTENDSIZE and TRUNCATE_ON_CLOSE keywords.

KEYED

Set this keyword to indicate that the file has indexed organization. Indexed files are discussed in "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

LIST

Set this keyword to specify carriage-return carriage control when creating a new file. If no carriage-control keyword is specified, LIST is the default.

NONE

Set this keyword to specify explicit carriage control when creating a new file. When using explicit carriage control, VMS does not add any carriage control information to the file, and the user must explicitly add any desired carriage control to the data being written to the file.

PRINT

Set this keyword to send the file to SYS$PRINT, the default system printer, when it is closed.

SEGMENTED

Set this keyword to indicate that the file has VMS FORTRAN-style segmented records. Segmented records are a method by which FORTRAN allows logical records to exist with record sizes that exceed the maximum possible physical record sizes supported by VMS. Segmented record files are useful primarily for passing data between FORTRAN and IDL programs.

SHARED

Set this keyword to allow other processes read and write access to the file in parallel with IDL. If SHARED is not set, read-only files are opened for read sharing and read/write files are not shared. The SHARED keyword cannot be used with STREAM files.

Warning

It is not a good idea to allow shared write access to files open in RMS block mode. In block mode, VMS cannot perform the usual record locking that prevents file corruption. It is therefore possible for multiple writers to corrupt a block mode file. This warning also applies to fixed-length record disk files, which are also processed in block mode. When using SHARED, do not specify either BLOCK or UDF_BLOCK.

STREAM

Set this keyword to open the file in stream mode using the Standard C Library (stdio).

SUBMIT

Set this keyword to submit the file to SYS$BATCH, the default system batch queue, when it is closed.

SUPERSEDE

Set this keyword to allow an existing file to be superseded by a new file of the same name, type, and version.

TRUNCATE_ON_CLOSE

Set this keyword to free any unused disk space allocated to the file when the file is closed. This keyword can be used to get rid of excess allocations caused by the EXTENDSIZE and INITIALSIZE keywords. If the SHARED keyword is set, or the file is open for read-only access, TRUNCATE_ON_CLOSE has no effect.

UDF_BLOCK

Set this keyword to create a file similar to those created with the BLOCK keyword except that new files are created with the RMS undefined record type. Files created in this way can only be accessed by IDL in block mode, and cannot be processed by many VMS utilities. Do not specify both UDF_BLOCK and SHARED.

VARIABLE

Set this keyword to indicate that the file has variable-length records. If the *Record_Length* argument is present, it specifies the maximum record size. Otherwise, the only limit is that imposed by RMS (32767 bytes). If no file organization is specified, variable-length records are the default.

Warning

VMS variable length records have a 2-byte record-length descriptor at the beginning of each record. Because the FSTAT function returns the length of the data file *including* the record descriptors, reading a file with VMS variable length records into a byte array of the size returned by FSTAT will result in an RMS EOF error.

Note On IEEE to VAX Format Conversion

Translation of floating-point values from the IDL's native (IEEE) format to the VAX format and back (IEEE to VAX to IEEE) is not a completely reversible operation, and should be avoided when possible. There are many cases where the recovered values will differ from the original, including:

- The VAX floating point format lacks support for the IEEE special values (NaN, Infinity). Hence, their special meaning is lost when they are converted to VAX format and cannot be recovered.
- Differences in precision and range can also cause information to be lost in both directions.

Research Systems recommends using IEEE/VAX conversions only to read existing VAX format data, and strongly recommends that all new files be created using the IEEE format.

For more information, see *Building IDL Applications* Appendix A, "VMS Floating-Point Arithmetic in IDL".

Example

The following example opens the IDL distribution file `people.dat` and reads an image from that file:

```
; Open 'people.dat' on file unit number 1. The FILEPATH
; function is used to return the full path name to this
; distribution file.
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; Define a variable into which the image will be read:
image=BYTARR(192, 192, /NOZERO)

; Read the data:
READU, 1, image

; Display the image:
TV, image
```

See Also

CLOSE, GET_LUN, POINT_LUN, PRINT/PRINTF, READ/READF, READU, VAX_FLOAT, WRITEU

OPLOT

The OPLOT procedure plots vector data over a previously-drawn plot. It differs from PLOT only in that it does not generate a new axis. Instead, it uses the scaling established by the most recent call to PLOT and simply overlays a plot of the data on the existing axis.

Syntax

OPLOT, [*X*,] *Y* [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*value*]

Graphics Keywords: [, CLIP=*[*X_0, Y_0, X_1, Y_1*]*] [, COLOR=*value*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, ZVALUE=*value*{0 to 1}]

Arguments

X

A vector argument. If X is not specified, *Y* is plotted as a function of point number (starting at zero). If both arguments are provided, *Y* is plotted as a function of *X*.

This argument is converted to double-precision floating-point before plotting. Plots created with OPLOT are limited to the range and precision of double precision floating-point values.

Y

The ordinate data to be plotted. This argument is converted to double-precision floating-point before plotting.

Keywords

MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

NSUM

The presence of this keyword indicates the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are *m* data points, then *m*/NSUM points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use NSUM when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

POLAR

Set this keyword to produce polar plots. The *X* and *Y* vector parameters, both of which must be present, are first converted from polar to Cartesian coordinates. The first parameter is the radius, and the second is expressed in radians.

For example, to make a polar plot, use the command:

```
OPLOT, /POLAR, R, THETA
```

THICK

Controls the thickness of the lines connecting the points. A thickness of 1.0 is normal, 2.0 is double wide, etc.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CLIP, COLOR, LINESTYLE, NOCLIP, PSYM, SYMSIZE, T3D, ZVALUE.

Example

```
; Create a simple dataset:
D = SIN(FINDGEN(100)/EXP(FINDGEN(100)/50))

; Create an X-Y plot of vector D:
PLOT, D
```

```
; Overplot the sine of D as a thick, dashed line:
OPLOT, SIN(D), LINESTYLE = 5, THICK = 2
```

See Also

OPLOTERR, PLOT

OPLOTERR

The OPLOTERR procedure plots error bars over a previously drawn plot. A plot of *X* versus *Y* with error bars drawn from *Y* - *Err* to *Y* + *Err* is written to the output device over any plot already there.

This routine is written in the IDL language. Its source code can be found in the file `oploterr.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

OPLOTERR, [*X* ,] *Y* , *Err* [, *Psym*]

Arguments

X

An optional array of X values. The procedure checks whether or not the third parameter passed is a vector to decide if *X* was passed. If *X* is not passed, then INDGEN(*Y*) is assumed for the X values.

Y

The array of Y values. *Y* cannot be of type string.

Err

The array of error bar values.

Psym

The plotting symbol to use (default = +7).

Keywords

None

See Also

ERRPLOT, OPLOT, PLOTERR

P_CORRELATE

The P_CORRELATE function computes the partial correlation coefficient of a dependent variable and one particular independent variable when the effects of all other variables involved are removed.

This routine is written in the IDL language. Its source code can be found in the file `p_correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = P_CORRELATE(*X*, *Y*, *C* [, /DOUBLE])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector that specifies the independent variable data.

Y

An *n*-element integer, single-, or double-precision floating-point vector that specifies the dependent variable data.

C

An integer, single-, or double-precision floating-point array that specifies the independent variable data whose effects are to be removed. The columns of this two-dimensional array correspond to the *n*-element vectors of independent variable data.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define three sample populations:
X0 = [64, 71, 53, 67, 55, 58, 77, 57, 56, 51, 76, 68]
X1 = [57, 59, 49, 62, 51, 50, 55, 48, 52, 42, 61, 57]
X2 = [ 8, 10, 6, 11, 8, 7, 10, 9, 10, 6, 12, 9]

; Compute the partial correlation of X0 and X1 with the effects
```

```
; of X2 removed.
result = P_CORRELATE(X0, X1, REFORM(X2, 1, N_ELEMENTS(X2)))
PRINT, result
```

IDL prints:

```
0.533469
```

See Also

A_CORRELATE, C_CORRELATE, CORRELATE, M_CORRELATE, R_CORRELATE

PARTICLE_TRACE

The PARTICLE_TRACE procedure traces the path of a massless particle through a vector field. The function allows the user to specify a set of starting points and a vector field. The input seed points can come from any vertex-producing process. The points are tracked by treating the vector field as a velocity field and integrating. Each path is tracked until the path leaves the input volume or a maximum number of steps is reached. The vertices generated along the paths are returned packed into a single array along with a polyline connectivity array. The polyline connectivity array organizes the vertices into separate paths (one per seed). Each path has an orientation. The initial orientation may be set using the SEED_NORMAL keyword. As a path is tracked, the change in the normal is also computed and may be returned to the user as an optional argument. Path output can be passed directly to an IDLgrPolyline object or passed to the STREAMLINE procedure for generation of orientated ribbons. Control over aspects of the integration (e.g. method or stepsize) is also provided.

Syntax

PARTICLE_TRACE, *Data*, *Seeds*, *Verts*, *Conn* [, *Normals*]
[, MAX_ITERATIONS=*value*] [, ANISOTROPY=*array*]
[, INTEGRATION={0 | 1}] [, SEED_NORMAL=*vector*] [, TOLERANCE=*value*]
[, MAX_STEPSIZE=*value*] [, /UNIFORM]

Arguments

Data

Input data array. This array can be of dimensions [2, *dx*, *dy*] for two-dimensional vector fields or [3, *dx*, *dy*, *dz*] for three-dimensional vector fields.

Seeds

Input array of seed points ([3, *n*] or [2, *n*]).

Verts

Array of output path vertices ([3, *n*] or [2, *n*] array of floats).

Conn

Output path connectivity array in IDLgrPolyline POLYLINES keyword format. There is one set of line segments in this array for each input seed point.

Normals

Output normal estimate at each output vertex ([3, *n*] array of floats).

Keywords

ANISOTROPY

Set this input keyword to a two- or three- element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0] for three-dimensional data and [1.0, 1.0] for two-dimensional data.

INTEGRATION

Set this keyword to one of the following values to select the integration method:

- 0 = 2nd order Runge-Kutta (the default)
- 1 = 4th order Runge-Kutta

SEED_NORMAL

Set this keyword to a three-element vector which selects the initial normal for the paths. The default value is [0.0, 0.0, 1.0]. This keyword is ignored for 2D data.

TOLERANCE

This keyword is used with adaptive step-size control in the 4th order Runge-Kutta integration scheme. It is ignored if the UNIFORM keyword is set or the 2nd order Runge-Kutta scheme is selected.

MAX_ITERATIONS

This keyword specifies the maximum number of line segments to return for each path. The default value is 200.

MAX_STEPSIZE

This keyword specifies the maximum path step size. The default value is 1.0.

UNIFORM

If this keyword is set, the step size will be set to a fixed value, set via the MAX_STEPSIZE keyword. If this keyword is not specified, and TOLERANCE is either unspecified or inapplicable, then the step size is computed based on the velocity at the current point on the path according to the formula:

stepsize = MIN(MaxStepSize, MaxStepSize/MAX(ABS(U), ABS(V), ABS(W)))

where (U,V,W) is the local velocity vector.

PCOMP

The PCOMP function computes the principal components of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples. The principal components of a multivariate data set may be used to restate the data in terms of derived variables or may be used to reduce the dimensionality of the data by reducing the number of variables (columns). The result is an *nvariables*-column (*nvariables* ≤ *m*), *n*-row array of derived variables.

Syntax

Result = PCOMP(*A* [, COEFFICIENTS=*variable*] [, /COVARIANCE] [, /DOUBLE] [, EIGENVALUES=*variable*] [, NVARIABLES=*value*] [, /STANDARDIZE] [, VARIANCES=*variable*])

Arguments

A

An *m*-column, *n*-row, single- or double-precision floating-point array.

Keywords

COEFFICIENTS

Use this keyword to specify a named variable that will contain the principal components used to compute the derived variables. The principal components are the coefficients of the derived variables and are returned in an *m*-column, *m*-row array. The rows of this array correspond to the coefficients of the derived variables. The coefficients are scaled so that the sums of their squares are equal to the eigenvalue from which they are computed. This keyword must be initialized to a nonzero value before calling PCOMP if the principal components are desired.

COVARIANCE

Set this keyword to compute the principal components using the covariances of the original data. The default is to use the correlations of the original data to compute the principal components.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EIGENVALUES

Use this keyword to specify a named variable that will contain a one-column, *m*-row array of eigenvalues that correspond to the principal components. The eigenvalues are listed in descending order. This keyword must be initialized to a nonzero value before calling PCOMP if the eigenvalues are desired.

NVARIABLES

Use this keyword to specify the number of derived variables. A value of zero, negative values, and values in excess of the input array's column dimension result in a complete set (*m*-columns and *n*-rows) of derived variables.

STANDARDIZE

Set this keyword to convert the variables (the columns) of the input array to standardized variables (variables with a mean of zero and variance of one).

VARIANCES

Use this keyword to specify a named variable that will contain a one-column, *m*-row array of variances. The variances correspond to the percentage of the total variance for each derived variable.

Example

```
; Define an array with 4 variables and 20 observations:
array = [[19.5, 43.1, 29.1, 11.9], $
         [24.7, 49.8, 28.2, 22.8], $
         [30.7, 51.9, 37.0, 18.7], $
         [29.8, 54.3, 31.1, 20.1], $
         [19.1, 42.2, 30.9, 12.9], $
         [25.6, 53.9, 23.7, 21.7], $
         [31.4, 58.5, 27.6, 27.1], $
         [27.9, 52.1, 30.6, 25.4], $
         [22.1, 49.9, 23.2, 21.3], $
         [25.5, 53.5, 24.8, 19.3], $
         [31.1, 56.6, 30.0, 25.4], $
         [30.4, 56.7, 28.3, 27.2], $
         [18.7, 46.5, 23.0, 11.7], $
         [19.7, 44.2, 28.6, 17.8], $
         [14.6, 42.7, 21.3, 12.8], $
         [29.5, 54.4, 30.1, 23.9], $
         [27.7, 55.3, 25.7, 22.6], $
         [30.2, 58.6, 24.6, 25.4], $
         [22.7, 48.2, 27.1, 14.8], $
         [25.2, 51.0, 27.5, 21.1]]
```

```
; Compute the derived variables based upon the principal
; components. The COEFFICENTS, EIGENVALUES, and VARIANCES keywords
; must be initialized as nonzero values prior to calling PCOMP:
coefficients = 1 & eigenvalues = 1 & variances = 1
result = PCOMP(array, COEFFICIENTS = coefficients, $
   EIGENVALUES = eigenvalues, VARIANCES = variances)

PRINT, 'Result: '
PRINT, result, FORMAT = '(4(f5.1, 2x))'
PRINT, 'Coefficients: '
PRINT, coefficients
PRINT, 'Eigenvalues: '
PRINT, eigenvalues
PRINT, 'Variances: '
PRINT, variances
```

IDL prints:

```
Result:
 81.4   15.5   -5.5    0.5
102.7   11.1   -4.1    0.6
109.9   20.3   -6.2    0.5
110.5   13.8   -6.3    0.6
 81.8   17.1   -4.9    0.6
104.8    6.2   -5.4    0.6
121.3    8.1   -5.2    0.6
111.3   12.6   -4.0    0.6
 97.0    6.4   -4.4    0.6
102.5    7.8   -6.1    0.6
118.5   11.2   -5.3    0.6
118.9    9.1   -4.7    0.6
 81.5    8.8   -6.3    0.6
 88.0   13.4   -3.9    0.6
 74.3    7.5   -4.8    0.6
113.4   12.0   -5.1    0.6
109.7    7.7   -5.6    0.6
117.5    5.5   -5.7    0.6
 91.4   12.0   -6.1    0.6
102.5   10.6   -4.9    0.6

Coefficients:
0.983668     0.947119     0.358085     0.925647
0.118704    -0.265644     0.932897    -0.215227
-0.134015    -0.179266    0.0378060     0.311214
-0.0185792    0.0161747   0.00707525  0.000456858

Eigenvalues:
2.84969
1.00128
```

```
0.148380
0.000657078

Variances:
0.712422
0.250319
0.0370950
0.000164269
```

The first two derived variables account for 96.3% of the total variance of the original data.

See Also

CORRELATE, EIGENQL

PLOT

The PLOT procedure draws graphs of vector arguments. If one parameter is used, the vector parameter is plotted on the ordinate versus the point number on the abscissa. To plot one vector as a function of another, use two parameters. PLOT can also be used to create polar plots by setting the POLAR keyword.

Syntax

PLOT, [*X*,] *Y* [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*value*] [, /XLOG] [, /YLOG] [, /YNOZERO]

Graphics Keywords: [, BACKGROUND=*color_index*] [, CHARSIZE=*value*] [, CHARTHICK=*integer*] [, CLIP=*[*X_0, Y_0, X_1, Y_1*]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, /NODATA] [, /NOERASE] [, POSITION=*[*X_0, Y_0, X_1, Y_1*]*] [, PSYM=*integer*{0 to 10}] [, SUBTITLE=*string*] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*] [, TICKLEN=*value*] [, TITLE=*string*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left, right]*]
[, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}RANGE=*[min, max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

Arguments

X

A vector argument. If X is not specified, *Y* is plotted as a function of point number (starting at zero). If both arguments are provided, *Y* is plotted as a function of *X*.

This argument is converted to double precision floating-point before plotting. Plots created with PLOT are limited to the range and precision of double-precision floating-point values.

Y

The ordinate data to be plotted. This argument is converted to double-precision floating-point before plotting.

Keywords

ISOTROPIC

Set this keyword to force the scaling of the X and Y axes to be equal.

Note

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 2407 for more information.

MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

NSUM

The presence of this keyword indicates the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are *m* data points, then *m*/NSUM points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use NSUM when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

POLAR

Set this keyword to produce polar plots. The *X* and *Y* vector parameters, both of which must be present, are first converted from polar to Cartesian coordinates. The first parameter is the radius, and the second is the angle (expressed in radians). For example, to make a polar plot, you would use a command such as:

```
PLOT, /POLAR, R, THETA
```

THICK

Controls the thickness of the lines connecting the points. A thickness of 1.0 is normal, 2 is double wide, etc.

XLOG

Set this keyword to specify a logarithmic X axis, producing a log-linear plot. Set both XLOG and YLOG to produce a log-log plot. Note that logarithmic axes that have ranges of less than a decade are not labeled.

YNOZERO

Set this keyword to inhibit setting the minimum Y axis value to zero when the *Y* data are all positive and nonzero, and no explicit minimum Y value is specified (using YRANGE, or !Y.RANGE). By default, the Y axis spans the range of 0 to the maximum value of *Y*, in the case of positive Y data. Set bit 4 in !Y.STYLE to make this option the default.

YLOG

Set this keyword to specify a logarithmic Y axis, producing a linear-log plot. Set both XLOG and YLOG to produce a log-log plot. Note that logarithmic axes that have ranges of less than a decade are not labeled.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, LINESTYLE, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, PSYM, SUBTITLE, SYMSIZE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

Example

The PLOT procedure has many keywords that allow you to create a vast variety of plots. Here are a few simple examples using the PLOT command.

```
; Create a simple dataset:
D = FINDGEN(100)

; Create a simple plot with the title "Simple Plot":
PLOT, D, TITLE = 'Simple Plot'

; Plot one argument versus another:
PLOT, SIN(D/3), COS(D/6)

; Create a polar plot:
PLOT, D, D, /POLAR, TITLE = 'Polar Plot'

; Use plotting symbols instead of connecting lines by including the
; PSYM keyword. Label the X and Y axes with XTITLE and YTITLE:
PLOT, SIN(D/10), PSYM=4, XTITLE='X Axis', YTITLE='Y Axis'
```

See Also

OPLOT, PLOTS

PLOT_3DBOX

The PLOT_3DBOX procedure plots a function of two variables (e.g., *Z=f(X, Y)*) inside a 3D box. Optionally, the data can be projected onto the "walls" surrounding the plot area.

This routine is written in the IDL language. Its source code can be found in the file `plot_3dbox.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PLOT_3DBOX, *X*, *Y*, *Z* [, GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, PSYM=*integer*{1 to 10}] [, /SOLID_WALLS] [, /XY_PLANE] [, XYSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /XZ_PLANE] [, XZSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /YZ_PLANE] [, YZSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, AX=*degrees*] [, AZ=*degrees*] [, ZAXIS={1 | 2 | 3 | 4}]

Graphics Keywords: Accepts all graphics keywords accepted by PLOT except for: FONT, PSYM, SYMSIZE, {XYZ}TICK_GET, and ZVALUE.

Arguments

X

A vector (i.e., a one-dimensional array) of X coordinates.

Y

A vector of Y coordinates.

Z

A vector of Z coordinates. *Z[i]* is a function of *X[i]* and *Y[i]*.

Keywords

GRIDSTYLE

Set this keyword to the linestyle index for the type of line to be used when drawing the gridlines. Linestyles are described in the following table:

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot
5	Long Dashes

Table 75: IDL Linestyles

PSYM

Set this keyword to a plotting symbol index to be used in plotting the data. For more information, see "PSYM" on page 2408.

SOLID_WALLS

Set this keyword to cause the boundary "walls" of the plot to be filled with the color index specified by the COLOR keyword.

XY_PLANE

Set this keyword to plot the *X* and *Y* values on the Z=0 axis plane.

XYSTYLE

Set this keyword to the linestyle used to draw the XY plane plot. See the table above for a list of linestyles.

XZ_PLANE

Set this keyword to plot the *Y* and *Z* values on the Y=MAX(*Y*) axis plane.

XZSTYLE

Set this keyword to the linestyle used to draw the XZ plane plot. See the table above for a list of linestyles.

YZ_PLANE

Set this keyword to plot the *Y* and *Z* values on the X=MAX(*X*) axis plane.

YZSTYLE

Set this keyword to the linestyle used to draw the YZ plane plot. See the table above for a list of linestyles.

SURFACE Keywords

In addition to the keywords described above, the AX, AZ, and ZAXIS keywords to the SURFACE procedure are accepted by PLOT_3DBOX. See "SURFACE" on page 1366.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKV, [XYZ]TITLE.

Example

```
; Create some data to be plotted:
X = REPLICATE(5., 10.)
X1 = COS(FINDGEN(36)*10.*!DTOR)*2.+5.
X = [X, X1, X]
Y = FINDGEN(56)
Z = REPLICATE(5., 10)
Z1 = SIN(FINDGEN(36)*10.*!DTOR)*2.+5.
Z = [Z, Z1, Z]

; Create the box plot with data projected on all of the walls. The
; PSYM value of -4 plots the data as diamonds connected by lines:
PLOT_3DBOX, X, Y, Z, /XY_PLANE, /YZ_PLANE, /XZ_PLANE, $
   /SOLID_WALLS, GRIDSTYLE=1, XYSTYLE=3, XZSTYLE=4, $
   YZSTYLE=5, AZ=40, TITLE='Example Plot Box', $
   XTITLE='X Coordinate', YTITLE='Y Coodinate', $
```

```
ZTITLE='Z Coordinate', SUBTITLE='Sub Title', $
/YSTYLE, ZRANGE=[0,10], XRANGE=[0,10], $
PSYM=-4, CHARSIZE=1.6
```

See Also

PLOTS, SURFACE

PLOT_FIELD

The PLOT_FIELD procedure plots a 2D field. *N* random points are picked, and from each point a path is traced along the field. The length of the path is proportional to the field vector magnitude.

This routine is written in the IDL language. Its source code can be found in the file `plot_field.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PLOT_FIELD, *U*, *V* [, ASPECT=*ratio*] [, LENGTH=*value*] [, N=*num_arrows*] [, TITLE=*string*]

Arguments

U

A 2D array giving the field vector at each point in the U(X) direction.

V

A 2D array giving the field vector at each point in the V(Y) direction.

Keywords

ASPECT

Set this keyword to the aspect ratio of the plot (i.e., the ratio of the X size to Y size). The default is 1.0.

LENGTH

Set this keyword to the length of the longest field vector expressed as a fraction of the plotting area. The default is 0.1.

N

Set this keyword to the number of arrows to draw. The default is 200.

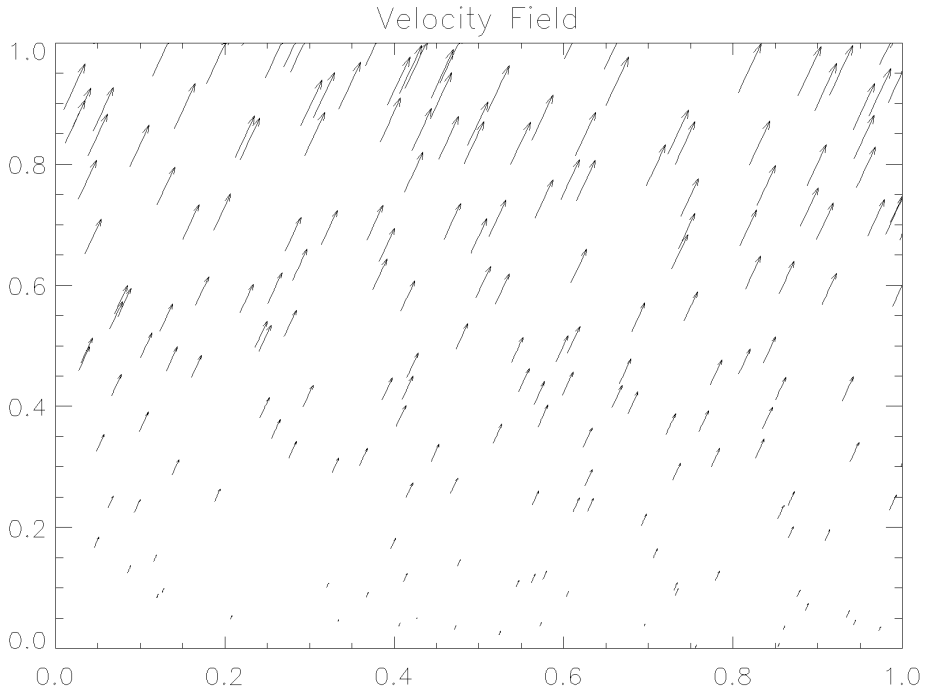
TITLE

Set this keyword to the title of plot. The default is “Velocity Field”.

Example

```
; Create array X:
X = FINDGEN(20, 20)

; Create array Y:
Y = FINDGEN(20, 20)*3

; Plot X vs. Y:
PLOT_FIELD, X, Y
```

The above commands produce the following plot:



See Also

FLOW3, VEL, VELOVECT

PLOTERR

The PLOTERR procedure plots individual data points with error bars.

This routine is written in the IDL language. Its source code can be found in the file `ploterr.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PLOTERR, [*X* ,] *Y* , *Err* [, TYPE={1 | 2 | 3 | 4}] [, PSYM=*integer*{1 to 10}]

Arguments

X

An optional array of X values. The procedure checks the number of arguments passed to decide if X was passed. If X is not passed, INDGEN(Y) is assumed for X values.

Y

The array of Y values. *Y* cannot be of type string.

Err

The array of error-bar values.

Keywords

TYPE

The type of plot to be produced. The possible types are:

- 1 = X Linear - Y Linear (default)
- 2 = X Linear - Y Log
- 3 = X Log - Y Linear
- 4 = X Log - Y Log

PSYM

The plotting symbol to use. The default is +7.

See Also

ERRPLOT, OPLOTERR, PLOT

PLOTS

The PLOTS procedure plots vectors or points on the current graphics device in either two or three dimensions. The coordinates can be given in data, device, or normalized form using the DATA (the default), DEVICE, or NORMAL keywords.

The COLOR keyword can be set to a scalar or vector value. If it is set to a vector value, the line segment connecting (X_i, Y_i) to (X_{i+1}, Y_{i+1}) is drawn with a color index of $COLOR_{i+1}$. In this case, COLOR must have the same number of elements as *X* and *Y*.

Syntax

PLOTS, *X* [, *Y* [, *Z*]] [, /CONTINUE]

Graphics Keywords: [, CLIP=*[X_0, Y_0, X_1, Y_1]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*] [, Z=*value*]

Arguments

X

A vector or scalar argument providing the X components of the points to be connected. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, `X[0,*]` are taken as the X values, `X[1,*]` are taken as the Y values, and `X[2,*]` are taken as the Z values.

Y

An optional argument providing the Y coordinate(s) of the points to be connected.

Z

An optional argument providing the Z coordinates of the points to be connected. If *Z* is not provided, X and Y are used to draw lines in two dimensions.

Z has no effect if the keyword T3D is not specified and the system variable !P.T3D= 0.

Keywords

CONTINUE

Set this keyword to continue drawing a line from the last point of the most recent call to PLOTS.

For example:

```
; Position at (0,0):
PLOTS, 0, 0

; Draws vector from (0,0) to (1,1):
PLOTS, 1, 1, /CONTINUE

; Draws two vectors from (1,1) to (2,2) to (3,3):
PLOTS, [2,3], [2,3], /CONTINUE
```

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, PSYM, SYMSIZE, T3D, THICK, Z.

Examples

```
; Draw a line from (100, 200) to (600, 700), in device coordinates,
; using color index 12:
PLOTS, [100,600], [200,700], COLOR=12, /DEVICE

; Draw a polyline where the line color is proportional to the
; ordinate that ends each line segment.
; First create datasets X and Y:
X = SIN(FINDGEN(100)) & Y = COS(FINDGEN(100))

; Now plot X and Y in normalized coordinates with colors as
; described above:
PLOTS, X, Y, COLOR = BYTSCL(Y, TOP=!D.N COLORS-1), /NORMAL

; Load a good colortable to better show the result:
LOADCT, 13

; Draw 3D vectors over an established SURFACE plot.
; The SAVE keyword tells IDL to save the 3D transformation
; established by SURFACE.
SURFACE, DIST(5), /SAVE

; Draw a line between (0,0,0) and (3,3,3). The T3D keyword makes
```

```
; PLOTS use the previously established 3D transformation:
PLOTS, [0,3], [0,3], [0,3], /T3D

; Draw a line between (3,0,0) and (3,3,3):
PLOTS, [3,3], [0,3], [0,3], /T3D

; Draw a line between (0,3,0) and (3,3,3):
PLOTS, [0,3], [3,3], [0,3], /T3D
```

See Also

ANNOTATE, XYOUTS

PNT_LINE

The PNT_LINE function returns the perpendicular distance between a point *P0* and a line between points *L0* and *L1*. This function is limited by the machine accuracy of single precision floating point.

This routine is written in the IDL language. Its source code can be found in the file `pnt_line.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = PNT_LINE(*P0*, *L0*, *L1* [, *Pl*] [, /INTERVAL])

Arguments

P0

The location of the point. *P0* may have 2 to *n* elements, for *n* dimensions.

L0

One end-point of the line. *L0* must have same number of elements as *P0*.

L1

The other end-point of the line. *L1* must have the same number of elements as *L0*.

Pl

A named variable that will contain the location of the point on the line between *L0* and *L1* that is closest to *P0*. *Pl* is not necessarily in the interval (*L0, L1*).

Keywords

INTERVAL

If set, and if the point on the line between *L0* and *L1* that is closest to *P0* is not within the interval (*L0, L1*), PNT_LINE will return the distance from *P0* to the closer of the two endpoints *L0* and *L1*.

Example

To print the distance between the point (2,3) and the line from (-3,3) to (5,12), and also the location of the point on the line closest to (2,3), enter the following command:

```
PRINT, PNT_LINE([2,3], [-3,3], [5,12], Pl), Pl
```

IDL prints:

```
3.73705    -0.793104      5.48276
```

See Also

CIR_3PNT, SPH_4PNT

POINT_LUN

The POINT_LUN procedure sets or obtains the current position of the file pointer for the specified file.

Note

POINT_LUN cannot be used with files opened with the RAWIO keyword to the OPEN routines. Depending upon the device in question, the IOCTL function might be used instead for files of this type.

Syntax

POINT_LUN, *Unit*, *Position*

Arguments

Unit

The file unit for the file in question. If *Unit* is positive, POINT_LUN sets the file position to the position given by *Position*. If negative, POINT_LUN gets the current file position and assigns it to the variable given by *Position*. Note that POINT_LUN cannot be used with the 3 standard file units (0, -1, and -2).

Position

If *Unit* is positive, *Position* gives the byte offset into the file at which the file pointer should be set. For example, to rewind the file to the beginning, specify 0.

If *Unit* is negative, *Position* must be a named variable into which the current file position will be stored. The returned type will be a longword signed integer if the position is small enough to fit, and an unsigned 64-bit integer otherwise.

Under VMS, be careful to move the file pointer only to record boundaries. It is always safe to move to a file position that was previously obtained via POINT_LUN or the FSTAT function. Files with indexed organization can only be positioned to the beginning of the file.

Use Of POINT_LUN On Compressed Files

In general, it is not possible to arbitrarily move the file pointer within a compressed file (files opened with the COMPRESS keyword to OPEN) because the file compression code needs to maintain a compression state for the file that includes all

the data that has already been passed in the stream. This limitation results in the following constraints on the use of POINT_LUN with compressed files:

- POINT_LUN is not allowed on compressed files open for output, except to positions beyond the current file position. The compression code emulates such motion by outputting enough zero bytes to move the pointer to the new position.
- POINT_LUN is allowed to arbitrary positions on compressed files opened for input. However, this feature is emulated by positioning the file to the beginning of the file and then reading and discarding enough data to move the file pointer to the desired position. This can be extremely slow.

For these reasons, use of POINT_LUN on compressed files, although possible under some circumstances, is best avoided.

Example

To move the file pointer 2048 bytes into the file associated with file unit number 1, enter:

```
POINT_LUN, 1, 2048
```

To return the file pointer for file unit number 2, enter:

```
POINT_LUN, -2, pos
```

See Also

GET_LUN, OPEN

POLAR_CONTOUR

The POLAR_CONTOUR procedure draws a contour plot from data in polar coordinates. Data can be regularly- or irregularly-gridded. All of the keyword options supported by CONTOUR are available to POLAR_CONTOUR.

This routine is written in the IDL language. Its source code can be found in the file `polar_contour.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

POLAR_CONTOUR, *Z*, *Theta*, *R* [, C_ANNOTATION=*vector_of_strings*] [, C_CHARSIZE=*value*] [, C_CHARTHICK=*integer*] [, C_COLORS=*vector*] [, C_LINESTYLE=*vector*] [, /FILL | , CELL_FILL [, C_ORIENTATION=*degrees*] [, C_SPACING=*value*]] [, C_THICK=*vector*] [, /CLOSED] [, /IRREGULAR] [, LEVELS=*vector* / NLEVELS=*integer*{1 to 29}] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /OVERPLOT] [, /PATH_DATA_COORDS | ,TRIANGULATION=*variable*] [, /XLOG] [, /YLOG] [, /ZAXIS] [, SHOW_TRIANGULATION=*color_index*]

Arguments

Z

The data values to be contoured. If the data is regularly gridded, *Z* must have the dimensions (N_ELEMENTS(*Theta*), N_ELEMENTS(*R*). Note that the ordering of the elements in the array *Z* is opposite that used by the POLAR_SURFACE routine.

Theta

A vector of angles in radians. For regularly-gridded data, *Theta* must have the same number of elements as the first dimension of *Z*. For a scattered grid, *Theta* must have the same number of elements as *Z*.

R

A vector of radius values. For regularly-gridded data, *R* must have the same number of elements as the second dimension of *Z*. For a scattered grid, *R* must have the same number of elements as *Z*.

Keywords

POLAR_CONTOUR accepts all of the keywords accepted by the CONTOUR routine except C_LABELS, DOWNHILL, FOLLOW, PATH_FILENAME,

PATH_INFO, and PATH_XY. See “CONTOUR” on page 225. In addition, there is one unique keyword:

SHOW_TRIANGULATION

Set this keyword to a color index to be used in overplotting the triangulation between datapoints.

Example

This example uses POLAR_CONTOUR with regularly-gridded data:

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Load color table
TEK_COLOR

nr = 12 ; number of radii
nt = 18 ; number of Thetas

; Create a vector of radii:
r = FINDGEN(nr)/(nr-1)

; Create a vector of Thetas:
theta = 2*!PI * FINDGEN(nt)/(nt-1)

; Create some data values to be contoured:
z = COS(theta*3) # (r-0.5)^2

; Create the polar contour plot:
POLAR_CONTOUR, z, theta, r, /FILL, c_color=[2, 3, 4, 5]
```

See Also

CONTOUR

POLAR_SURFACE

The POLAR_SURFACE function interpolates a surface from polar coordinates (R, Theta, Z) to rectangular coordinates (X, Y, Z). The function returns a two-dimensional array of the same type as Z.

This routine is written in the IDL language. Its source code can be found in the file `polar_surface.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = POLAR_SURFACE(*Z*, *R*, *Theta* [, /GRID] [, SPACING=*[xspacing*, *yspacing]*] [, BOUNDS=*[*x_0, y_0, x_1, y_1*]*] [, /QUINTIC] [, MISSING=*value*])

Arguments

Z

An array containing the surface value at each point. If the data are regularly gridded in *R* and *Theta*, *Z* is a two dimensional array, where *Zi*,*j* has a radius of *Ri* and an azimuth of *Thetaj*. If the data are irregularly-gridded, *Ri* and *Thetai* contain the radius and azimuth of each *Zi*. Note that the ordering of the elements in the array *Z* is opposite that used by the POLAR_CONTOUR routine.

R

The radius. If the data are regularly gridded in *R* and *Theta*, *Zi*,*j* has a radius of *Ri*. If the data are irregularly-gridded, *R* must have the same number of elements as *Z*, and contains the radius of each point.

Theta

The azimuth, in radians. If the data are regularly gridded in *R* and *Theta*, *Zi*,*j* has an azimuth of *Thetaj*. If the data are irregularly-gridded, *Theta* must have the same number of elements as *Z*, and contains the azimuth of each point.

Keywords

GRID

Set this keyword to indicate that *Z* is regularly gridded in *R* and *Theta*.

SPACING

A two element vector containing the desired grid spacing of the resulting array in *x* and *y*. If omitted, the grid will be approximately 51 by 51.

BOUNDS

A four element vector, $[x_0, y_0, x_1, y_1]$, containing the limits of the *xy* grid of the resulting array. If omitted, the extent of input data sets the limits of the grid.

QUINTIC

Set this keyword to use quintic interpolation, which is slower but smoother than the default linear interpolation.

MISSING

Use this keyword to specify a value to use for areas within the grid but not within the convex hull of the data points. The default is 0.0.

Example

```
; The radius:
R = FINDGEN(50) / 50.0

; Theta:
THETA = FINDGEN(50) * (2 * !PI / 50.0)

; Make a function (tilted circle):
Z = R # SIN(THETA)

; Show it:
SURFACE, POLAR_SURFACE(Z, R, THETA, /GRID)
```

See Also

POLAR keyword to PLOT

POLY

The POLY function evaluates a polynomial function of a variable. The result is equal to:

$$C_0 + C_1x + C_2x^2 + ...$$

This routine is written in the IDL language. Its source code can be found in the file `poly.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = POLY(*X*, *C*)

Arguments

X

The variable. This value can be a scalar, vector or array.

C

The vector of polynomial coefficients. The degree of the polynomial is N_ELEMENTS(*C*) - 1.

See Also

FZ_ROOTS

POLY_2D

The POLY_2D function performs polynomial warping of images. This function performs a geometrical transformation in which the resulting array is defined by:

$$g\,[x, y] = f\,[x', y'] = f\,[a\,[x, y], b\,[x, y]]$$

where $g[x, y]$ represents the pixel in the output image at coordinate (x, y), and $f\,[x', y']$ is the pixel at (x', y') in the input image that is used to derive $g[x, y]$. The functions $a\,(x, y)$ and $b\,(x, y)$ are polynomials in x and y of degree N, whose coefficients are given by P and Q, and specify the spatial transformation:

$$x' = a(x, y) = \sum_{i=0}^{N} \sum_{j=0}^{N} P_{i,j} x^j y^i$$

$$y' = b(x, y) = \sum_{i=0}^{N} \sum_{j=0}^{N} Q_{i,j} x^j y^i$$

Either the nearest neighbor or bilinear interpolation methods can be selected.

Syntax

Result = POLY_2D(*Array*, *P*, *Q* [, *Interp* [, Dim_x, Dim_y]] [, CUBIC={-1 to 0}] [, MISSING=*value*])

Arguments

Array

A two-dimensional array of any basic type except string. The result has the same type as *Array*.

P and Q

P and *Q* are arrays containing the polynomial coefficients. Each array must contain $(N+1)^2$ elements (where *N* is the degree of the polynomial). For example, for a linear transformation, *P* and *Q* contain four elements and can be a 2 x 2 array or a 4-element vector. $P_{i,j}$ contains the coefficient used to determine *x'*, and is the weight of the term $x^j y^i$. The POLYWARP procedure can be used to fit *(x', y')* as a function of *(x, y)* and determines the coefficient arrays *P* and *Q*.

Interp

Set this argument to a 1to perform bilinear interpolation. Set this argument to 2 to perform cubic convolution interpolation (as described under the CUBIC keyword, below). Otherwise, the nearest neighbor method is used. For the linear case, (*N*=1), bilinear interpolation requires approximately twice as much time as does the nearest neighbor method.

Dim$_x$

If present, *Dim*$_x$ specifies the number of columns in the output. If omitted, the output has the same number of columns as *Array*.

Dim$_y$

If present, *Dim*$_y$ specifies the number of rows in the output. If omitted, the output has the same number of rows as *Array*.

Keywords

CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm. Note that cubic convolution interpolation works only with one- and two-dimensional arrays.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than ω_0, and *f* is sampled with spacing less than or equal to $1/2\omega_0$, then *f* can be reconstructed by convolving with a sinc function: sinc (x) = sin (πx) / (πx).

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used. Note that cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

MISSING

Specifies the output value for points whose *x’, y’* is outside the bounds of *Array*. If MISSING is not specified, the resulting output value is extrapolated from the nearest pixel of *Array*.

Example

Some simple linear (degree one) transformations are:

$P_{0,0}$	$P_{1,0}$	$P_{0,1}$	$P_{1,1}$	$Q_{0,0}$	$Q_{1,0}$	$Q_{0,1}$	$Q_{1,1}$	Effect
0	0	1	0	0	1	0	0	Identity
0	0	0.5	0	0	1	0	0	Stretch X by a factor of 2
0	0	1	0	0	2.0	0	0	Shrink Y by a factor of 2
z	0	1	0	0	1	0	0	Shift left by z pixels
0	1	0	0	0	0	1	0	Transpose

Table 76: Simple Transformations for Use with POLY_2D

POLY_2D is often used in conjunction with the POLYWARP procedure to warp images.

```
; Create and display a simple image:
A = BYTSCL(SIN(DIST(250)), TOP=!D.TABLE_SIZE) & TV, A

; Set up the arrays of original points to be warped:
XO = [61, 62, 143, 133]
YO = [89, 34, 38, 105]

; Set up the arrays of points to be fit:
XI = [24, 35, 102, 92]
YI = [81, 24, 25, 92]

; Use POLYWARP to generate the P and Q inputs to POLY_2D:
POLYWARP, XI, YI, XO, YO, 1, P, Q
```

```
; Perform an image warping based on P and Q:
B = POLY_2D(A, P, Q)

; Display the new image:
TV, B, 250, 250
```

Images can also be warped over irregularly gridded control points using the WARP_TRI procedure.

See Also

POLYWARP

POLY_AREA

The POLY_AREA function returns the area of a polygon given the coordinates of its vertices. This value is always positive.

It is assumed that the polygon has *n* vertices with *n* sides and the edges connect the vertices in the order:

[(x1,y1), (x2,y2), ... , (x*n*,y*n*), (x1,y1)]

such that the last vertex is connected to the first vertex.

This routine is written in the IDL language. Its source code can be found in the file `poly_area.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = POLY_AREA(*X*, *Y* [, /SIGNED])

Arguments

X

An *n*-element vector of X coordinate locations for the vertices.

Y

An *n*-element vector of Y coordinate locations for the vertices.

Keywords

SIGNED

If set, returns a signed area. Polygons with edges traversed in counterclockwise order have a positive area; polygons traversed in the clockwise order have a negative area.

See Also

DEFROI, POLYFILLV

POLY_FIT

The POLY_FIT function performs a least-square polynomial fit with optional weighting and returns a vector of coefficients.

The POLY_FIT routine uses matrix inversion to determine the coefficients. A different version of this routine, SVDFIT, uses singular value decomposition (SVD). The SVD technique is more flexible and robust, but may be slower.

This routine is written in the IDL language. Its source code can be found in the file `poly_fit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = POLY_FIT(*X*, *Y*, *Degree* [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, STATUS=*variable*] [, YBAND=*variable*] [, YERROR=*variable*] [, YFIT=*variable*])

Return Value

POLY_FIT returns a vector of coefficients of length *Degree*+1. If the DOUBLE keyword is set, or if *X* or *Y* are double precision, then the result will be double precision, otherwise the result will be single precision.

Arguments

X

An *n*-element vector of independent variables.

Y

A vector of dependent variables, the same length as *X*.

Degree

The degree of the polynomial to fit.

Yfit, Yband, Sigma, Corrm

The Yfit, Yband, Sigma, and Corrm arguments are obsolete, and have been replaced by the YFIT, YBAND, YERROR, and COVAR keywords, respectively. Code using these arguments will continue to work as before, but new code should use the keywords instead.

Keywords

CHISQ

Set this keyword to a named variable that will contain the value of the chi-sqaure goodness-of-fit.

COVAR

Set this keyword to a named variable that will contain the Covariance matrix of the coefficients.

DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

Note

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

Note

If MEASURE_ERRORS is omitted, then you are assuming that a polynomial is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

STATUS

Set this keyword to a named variable to receive the status of the operation. Possible status values are:

- 0 = Successful completion.
- 1 = Singular array (which indicates that the inversion is invalid). *Result* is NaN.
- 2 = Warning that a small pivot element was used and that significant accuracy was probably lost.
- 3 = Undefined (NaN) error estimate was encountered.

Note

If STATUS is not specified, any error messages will be output to the screen.

Tip

Status values of 2 or 3 can often be resolved by setting the DOUBLE keyword.

YBAND

Set this keyword to a named variable that will contain the 1 standard deviation error estimate for each point.

YERROR

Set this keyword to a named variable that will contain the standard error between YFIT and Y.

YFIT

Set this keyword to a named variable that will contain the vector of calculated *Y* values. These values have an error of + or – YBAND.

Example

In this example, we use X and Y data corresponding to the known polynomial $f(x) = 0.25 - x + x^2$. Using POLY_FIT to compute a second degree polynomial fit returns the exact coefficients (to within machine accuracy).

```
; Define an 11-element vector of independent variable data:
X = [0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]

; Define an 11-element vector of dependent variable data:
Y = [0.25, 0.16, 0.09, 0.04, 0.01, 0.00, 0.01, 0.04, 0.09, $
   0.16, 0.25]

; Define a vector of measurement errors:
```

```
measure_errors = REPLICATE(0.01, 11)

; Compute the second degree polynomial fit to the data:
result = POLY_FIT(X, Y, 2, MEASURE_ERRORS=measure_errors, $
   SIGMA=sigma)

; Print the coefficients:
PRINT, 'Coefficients: ', result
PRINT, 'Standard errors: ', sigma
```

IDL prints:

```
Coefficients:    0.250000    -1.00000    1.00000
Standard errors:    0.00761853    0.0354459    0.0341395
```

See Also

COMFIT, CURVEFIT, GAUSSFIT, LINFIT, REGRESS, SFIT, SVDFIT

POLYFILL

The POLYFILL procedure fills the interior of a region of the display enclosed by an arbitrary two or three-dimensional polygon. The available filling methods are: solid fill, hardware-dependent fill pattern, parallel lines, or a pattern contained in an array. Not all methods are available on every hardware output device. See "Fill Methods" below.

The polygon is defined by a list of connected vertices stored in X, Y, and Z. The coordinates can be given in data, device, or normalized form using the DATA, DEVICE, or NORMAL keywords.

Syntax

POLYFILL, *X* [, *Y* [, *Z*]] [, IMAGE_COORD=*array*] [, /IMAGE_INTERP] [, /LINE_FILL] [, PATTERN=*array*] [, SPACING=*centimeters*] [, TRANSPARENT=*value*]

Graphics Keywords: [, CLIP=*[*X_0, Y_0, X_1, Y_1*]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, ORIENTATION=*ccw_degrees_from_horiz*] [, /T3D] [, THICK=*value*] [, Z=*value*]

Fill Methods

Line-fill method: Filling using parallel lines is device-independent and works on all devices that can draw lines. Crosshatching can be simulated by performing multiple fills with different orientations. The spacing, linestyle, orientation, and thickness of the filling lines can be specified using the corresponding keyword parameters. The LINE_FILL keyword selects this filling style, but is not required if either the ORIENTATION or SPACING parameters are present.

Solid fill method: Most, but not all, devices can fill with a solid color. Solid fill is performed using the line-fill method for devices that don't have this hardware capability. Method specifying keyword parameters are not required for solid filling.

Patterned fill: The method of patterned filling and the usage of various fill patterns is hardware dependent. The fill pattern array can be explicitly specified with the PATTERN keyword parameter for some output devices.

Arguments

X

A vector argument providing the X coordinates of the points to be connected. The vector must contain at least three elements. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, the vector `X[0,*]` specifies the X values, `X[1,*]` specifies Y, and `X[2,*]` contain the Z values.

Y

A vector argument providing the Y coordinates of the points to be connected. *Y* must contain at least three elements.

Z

An optional vector argument providing the Z coordinates of the points to be connected. If Z is not provided, X and Y are used to draw lines in two dimensions. Z must contain at least three elements. Z has no effect if the keyword T3D is not specified and the system variable !P.T3D= 0.

Keywords

IMAGE_COORD

(Z-Buffer output only) A 2 x *n* array containing the fill pattern array subscripts of each of the *n* polygon vertices. Use this keyword in conjunction with the PATTERN keyword to warp images over 2D and 3D polygons.

IMAGE_INTERP

(Z-Buffer output only) Specifies the method of sampling the PATTERN array when the IMAGE_COORD keyword is present. The default method is to use nearest-neighbor sampling. Bilinear interpolation sampling is performed if IMAGE_INTERP is set.

LINE_FILL

Set this keyword to indicate that polygons are to be filled with parallel lines, rather than using solid or patterned filling methods.When using the line-drawing method of filling, the thickness, linestyle, orientation, and spacing of the lines may be specified with keywords.

PATTERN

A rectangular array of pixels giving the fill pattern. If this keyword parameter is omitted, POLYFILL fills the area with a solid color. The pattern array may be of any size; if it is smaller than the filled area the pattern array is cyclically repeated.

Note

When the display device selected is PostScript (PS), POLYFILL can only fill with solid colors.

For example, to fill the current plot window with a grid of dots, enter the following commands:

```
; Define pattern array as 10 by 10:
PAT = BYTARR(10,10)

; Set center pixel to bright:
PAT[5,5] = 255

; Fill the rectangle defined by the four corners of the window with
; the pattern:
POLYFILL, !X.WINDOW([0,1,1,0]), $
          !Y.WINDOW([0,0,1,1]), /NORM, PAT = PAT
```

SPACING

The spacing, in centimeters, between the parallel lines used to fill polygons.

TRANSPARENT (Z-Buffer output only)

Specifies the minimum pixel value to draw in conjunction with the PATTERN and IMAGE_COORD keywords. Pixels less than this value are not drawn and the Z-buffer is not updated.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, ORIENTATION, T3D, THICK, Z.

Z-Buffer-Specific Keywords

Certain keyword parameters are only active when the Z-buffer is the currently selected graphics device: IMAGE_COORD, IMAGE_INTERP, TRANSPARENT and COLOR. These parameters allow images to be warped over 2D or 3D polygons,

and the output of shaded polygons. For examples, see “The Z-Buffer Device” on page 62.

For shaded polygons, the COLOR keyword can specify an array that contains the color index at each vertex. Color indices are linearly interpolated between vertices. If COLOR contains a scalar, the entire polygon is drawn with the given color index, just as with the other graphics output devices.

Images can be warped over polygons by passing in the image with the PATTERN parameter, and a (2, *n*) array containing the image space coordinates that correspond to each of the N vertices with the IMAGE_COORD keyword.

The IMAGE_INTERP keyword indicates that bilinear interpolation is to be used, rather than the default nearest-neighbor sampling. Pixels less than the value of TRANSPARENT are not drawn, simulating transparency.

Example

Fill a rectangular polygon that has the vertices (30,30), (100, 30), (100, 100), and (30, 100) in device coordinates:

```
; Create the vectors of X and Y values:
X = [30, 100, 100, 30] & Y = [30, 30, 100, 100]

; Fill the polygon with color index 175:
POLYFILL, X, Y, COLOR = 175, /DEVICE
```

See Also

POLYFILLV

POLYFILLV

The POLYFILLV function returns a vector containing the one-dimensional subscripts of the array elements contained inside a polygon defined by vectors *X* and *Y*.

If no points are contained within the polygon, a -1 is returned and an informational message is printed. The *X* and *Y* parameters are vectors that contain the subscripts of the vertices that define the polygon in the coordinate system of the two-dimensional S_x by S_y array. The S_x and S_y parameters define the number of columns and rows in the array enclosing the polygon. At least three points must be specified, and all points should lie within the limits: $0 \le Xi < Sx$ and $0 \le Y_i < Sy \; \forall i$.

As with the POLYFILL procedure, the polygon is defined by connecting each point with its successor and the last point with the first. This function is useful for defining, analyzing, and displaying regions of interest within a two-dimensional array.

The scan line coordinate system defined by Rogers in *Procedural Elements for Computer Graphics*, McGraw-Hill, 1985, page 71, is used. In this system, the scan lines are considered to pass through the center of each row of pixels. Pixels are activated if the center of the pixel is to the right of the intersection of the scan line and the polygon edge within the interval.

Syntax

Result = POLYFILLV(*X*, *Y*, S_x, S_y [, *Run_Length*])

Arguments

X

A vector containing the X subscripts of the vertices that define the polygon.

Y

A vector containing the Y subscripts of the vertices that define the polygon.

S_x

The number of columns in the array surrounding the polygon.

S_y

The number of rows in the array surrounding the polygon.

Run_Length

Set this optional parameter to a nonzero value to make POLYFILLV return a vector of run lengths, rather than subscripts. For large polygons, a considerable savings in space results. When run-length encoded, each element with an even subscript result contains the length of the run, and the following element contains the starting index of the run.

Example

To determine the mean and standard deviation of the elements within a triangular region defined by the vertices at pixel coordinates (100, 100), (200, 300), and (300, 100), inside a 512 x 512 array called DATA, enter the commands:

```
; Get the subscripts of the elements inside the triangle:
P = DATA[POLYFILLV([100,200,300], [100,300,100], 512, 512)]

; Use the STDEV function to obtain the mean and standard deviation
; of the selected elements:
STD = STDEV(P,MEAN)
```

See Also

POLYFILL

POLYSHADE

The POLYSHADE function returns a shaded-surface representation of one or more solids described by a set of polygons. This function accepts, as arguments, an array of three-dimensional vertices and a list of the indices of the vertices that describe each polygon. Output is a two-dimensional byte array containing the shaded image unless the current graphics output device is the Z-buffer. If the current output device is the Z-buffer, the results are merged with the Z-buffer's contents and the function result contains a dummy value.

Shading values are determined from one of three sources: a light source model, a user-specified array containing vertex shade values, or a user-specified array containing polygon shade values.

The shaded surface is constructed using the scan line algorithm. The default shading model is a combination of diffuse reflection and depth cueing. With this shading model, polygons are shaded using either constant shading, in which each polygon is given a constant intensity, or with Gouraud shading where the intensity is computed at each vertex and then interpolated over the polygon. Use the SET_SHADING procedure to control the direction of the light source and other shading parameters.

User-specified shading arrays allow "4-dimensional" displays that consist of a surface defined by a set of polygons, shaded with values from another variable.

Syntax

Result = POLYSHADE(*Vertices*, *Polygons*)

or

Result = POLYSHADE(*X*, *Y*, *Z*, *Polygons*)

Keywords: [, /DATA | , /NORMAL] [, POLY_SHADES=*array*] [, SHADES=*array*] [, /T3D] [, TOP=*value*] [, XSIZE=*columns*] [, YSIZE=*rows*]

Arguments

Vertices

A (3, *n*) array containing the X, Y, and Z coordinates of each vertex. Coordinates can be in either data or normalized coordinates, depending on which keywords are present.

X, Y, Z

The X, Y, and Z coordinates of each vertex can, alternatively, be specified as three array expressions of the same dimensions.

Polygons

An integer or longword array containing the indices of the vertices for each polygon. The vertices of each polygon should be listed in counterclockwise order when observed from outside the surface. The vertex description of each polygon is a vector of the form: $[n, i_0, i_1, ..., i_{n-1}]$ and the array *Polygons* is the concatenation of the lists of each polygon. For example, to render a pyramid consisting of four triangles, *Polygons* would contain 16 elements, made by concatenating four, four-element vectors of the form $[3, V_0, V_1, V_2]$. V_0, V_1, and V_2 are the indices of the vertices describing each triangle.

Keywords

DATA

Set this keyword to indicate that the vertex coordinates are in data units, the default coordinate system.

NORMAL

Set this keyword to indicate that coordinates are in normalized units, within the three dimensional (0,1) cube.

POLY_SHADES

An array expression, with the same number of elements as there are polygons defined in the *Polygons* array, containing the color index used to render each polygon. No interpolation is performed if all pixels within a given polygon have the same shade value. For most displays, this parameter should be scaled into the range of bytes.

SHADES

An array expression, with the same number of elements as *Vertices*, containing the color index at each vertex. The shading of each pixel is interpolated from the surrounding SHADE values. For most displays, this parameter should be scaled into the range of bytes.

Warning

When using the SHADES keyword on TrueColor devices, we recommend that decomposed color support be turned off by setting DECOMPOSED=0 for DEVICE.

T3D

Set this keyword to use the three-dimensional to two-dimensional transformation contained in the homogeneous 4 by 4 matrix !P.T. Note that if T3D is set, !P.T must contain a valid transformation matrix. The SURFACE, SCALE3, and T3D procedures (and others) can all be used to set up transformations.

TOP

The maximum shading value when light source shading is in effect. The default value is one less than the number of colors available in the currently selected graphics device.

XSIZE

The number of columns in the output image array. If this parameter is omitted, the number of columns is equal to the X size of the currently selected display device.

Warning: The size parameters should be explicitly specified when the current graphics device is PostScript or any other high-resolution device. Making the output image the default full device size is likely to cause an insufficient memory error.

YSIZE

The number of rows in the output image array. If this parameter is omitted, the number of rows is equal to the Y resolution of the currently selected display device.

Example

POLYSHADE is often used in conjunction with SHADE_VOLUME for volume visualization. The following example creates a spherical volume dataset and renders an isosurface from that dataset:

```
; Create an empty, 3D array:
SPHERE = FLTARR(20, 20, 20)

; Create the spherical dataset:
FOR X=0,19 DO FOR Y=0,19 DO FOR Z=0,19 DO $
   SPHERE(X, Y, Z) = SQRT((X-10)^2 + (Y-10)^2 + (Z-10)^2)

; Find the vertices and polygons for a density level of 8:
```

```
SHADE_VOLUME, SPHERE, 8, V, P

; Set up an appropriate 3D transformation so we can see the
; sphere. This step is very important:
SCALE3, XRANGE=[0,20], YRANGE=[0,20], ZRANGE=[0,20]

; Render the image. Note that the T3D keyword has been set so that
; the previously-established 3D transformation is used:
image = POLYSHADE(V, P, /T3D)

; Display the image:
TV, image
```

See Also

PROJECT_VOL, RECON3, SET_SHADING, SHADE_SURF, SHADE_VOLUME, VOXEL_PROJ

POLYWARP

The POLYWARP procedure performs polynomial spatial warping.

Using least squares estimation, POLYWARP determines the coefficients *Kx*(*i*,*j*) and *Ky*(*i*,*j*) of the polynomial functions:

$$X_i = \sum_{i,\,j} Kx_{i,\,j} \cdot Xo^j \cdot Yo^i$$

$$Y_i = \sum_{i,\,j} Ky_{i,\,j} \cdot Xo^j \cdot Yo^i$$

Kx and *Ky* can be used as inputs P and Q to the built-in function POLY_2D. This coordinate transformation may be then used to map from *Xo, Yo* coordinates into *Xi, Yi* coordinates.

This routine is written in the IDL language. Its source code can be found in the file `polywarp.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

POLYWARP, *Xi*, *Yi*, *Xo*, *Yo*, *Degree*, *Kx*, *Ky*

Arguments

Xi, Yi

Vectors of X and Y coordinates to be fit as a function of Xo and Yo.

Xo, Yo

Vectors of X and Y independent coordinates. These vectors must have the same number of elements as *Xi* and *Yi*.

Degree

The degree of the fit. The number of coordinate pairs must be greater than or equal to $(Degree+1)^2$.

Kx

A named variable that will contain the array of coefficients for *Xi* as a function of (*Xo, Yo*). This parameter is returned as a (*Degree*+1) by (*Degree*+1) element array.

Ky

A named variable that will contain the array of coefficients for *Yi*. This parameter is returned as a (*Degree*+1) by (*Degree*+1) element array.

Example

The following example shows how to display an image and warp it using the POLYWARP and POLY_2D routines.

```
; Create and display the original image:
A = BYTSCL(SIN(DIST(250)))
TVSCL, A

; Now set up the Xi's and Yi's:
XI = [24, 35, 102, 92]
YI = [81, 24, 25, 92]

; Enter the Xo's and Yo's:
XO = [61, 62, 143, 133]
YO = [89, 34, 38, 105]

; Run POLYWARP to obtain a Kx and Ky:
POLYWARP, XI, YI, XO, YO, 1, KX, KY

; Create a warped image based on Kx and Ky with POLY_2D:
B = POLY_2D(A, KX, KY)

; Display the new image:
TV, B
```

See Also

POLY_2D, WARP_TRI

POPD

The POPD procedure changes the current working directory to the directory saved on the top of the directory stack maintained by the PUSHD and POPD procedures. This top entry is then removed from the stack.

Attempting to pop a directory when the stack is empty causes a warning message to be printed. The current directory is not changed in this case. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `popd.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

POPD

See Also

CD, PRINTD, PUSHD

POWELL

The POWELL procedure minimizes a user-written function *Func* of two or more independent variables using the Powell method. POWELL does not require a user-supplied analytic gradient.

POWELL is based on the routine `powell` described in section 10.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

POWELL, *P*, *Xi*, *Ftol*, *Fmin*, *Func* [, /DOUBLE] [, ITER=*variable*] [, ITMAX=*value*]

Arguments

P

On input, *P* is an *n*-element vector specifying the starting point. On output, it is replaced with the location of the minimum.

Xi

On input, *Xi* is an initial *n* by *n* element array whose columns contain the initial set of directions (usually the *n* unit vectors). On output, it is replaced with the then-current directions.

Ftol

An input value specifying the fractional tolerance in the function value. Failure to decrease by more than *Ftol* in one iteration signals completeness. For single-precision computations, a value of 1.0×10^{-4} is recommended; for double-precision computations, a value of 1.0×10^{-8} is recommended.

Fmin

On output, *Fmin* contains the value at the minimum-point *P* of the user-supplied function specified by *Func*.

Func

A scalar string specifying the name of a user-supplied IDL function of two or more independent variables to be minimized. This function must accept a vector argument *X* and return a scalar result.

For example, suppose we wish to minimize the function

$$f(x, y) = (x + 2y)e^{-x^2 - y^2}$$

To evaluate this expression, we define an IDL function named POWFUNC:

```
FUNCTION powfunc, X
   RETURN, (X[0] + 2.0*X[1]) * EXP(-X[0]^2 -X[1]^2)
END
```

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITER

Use this keyword to specify an output variable that will be set to the number of iterations performed.

ITMAX

Use this keyword to specify the maximum allowed number of iterations. The default is 200.

Warning

POWELL halts once the value specified with ITMAX has been reached.

Example

We can use POWELL to minimize the function POWFUNC given above.

```
PRO TEST_POWELL

   ; Define the fractional tolerance:
   ftol = 1.0e-4

   ; Define the starting point:
   P = [.5d, -.25d]

   ; Define the starting directional vectors in column format:
   xi = TRANSPOSE([[1.0, 0.0],[0.0, 1.0]])

   ; Minimize the function:
   POWELL, P, xi, ftol, fmin, 'powfunc'
```

```
   ; Print the solution point:
   PRINT, 'Solution point: ', P

   ; Print the value at the solution point:
   PRINT, 'Value at solution point: ', fmin

END

FUNCTION powfunc, X
   RETURN, (X[0] + 2.0*X[1]) * EXP(-X[0]^2 -X[1]^2)
END
```

IDL prints:

```
Solution point:    -0.31622777     -0.63245552
Value at solution point:    -0.95900918
```

The exact solution point is [-0.31622777, -0.63245553].

The exact minimum function value is -0.95900918.

See Also

AMOEBA, DFPMIN

PRIMES

The PRIMES function computes the first *K* prime numbers. The result is a *K*-element long integer vector.

This routine is written in the IDL language. Its source code can be found in the file `primes.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = PRIMES(*K*)

Arguments

K

An integer or long integer scalar that specifies the number of primes to be computed.

Example

To compute the first 25 prime numbers:

```
PRINT, PRIMES(25)
```

IDL prints:

```
  2     3     5     7    11    13
 17    19    23    29    31    37
 41    43    47    53    59    61
 67    71    73    79    83    89
 97
```

PRINT/PRINTF

The two PRINT procedures perform formatted output. PRINT performs output to the standard output stream (IDL file unit -1), while PRINTF requires a file unit to be explicitly specified.

Syntax

PRINT [, $Expr_1$, ..., $Expr_n$]

PRINTF [, *Unit*, $Expr_1$, ..., $Expr_n$]

Keywords: [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, /STDIO_NON_FINITE]

VMS Keywords: [, /REWRITE]

Arguments

Unit

For PRINTF, *Unit* specifies the file unit to which the output is sent.

$Expr_i$

The expressions to be output.

Keywords

AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the output. FORMAT allows the format of the output to be specified in precise detail, using a

FORTRAN-style specification. See "Using Explicitly Formatted Input/Output" in Chapter 8 of *Building IDL Applications*.

MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

STDIO_NON_FINITE

Set this keyword to allow the writing of data files readable by C or FORTRAN programs on a given platform; it is otherwise unnecessary.The various systems supported by IDL differ widely in the representation used for non-finite floating point values (i.e., NaN and Infinity). Consider that the following are all possible representations for NaN on at least one IDL platform:

```
NaN, NanQ, ?.0000, nan0x2, nan0x7, 1.#QNAN, -1.#IND0.
```

And the following are considered to be Infinity:

```
Inf, Infinity, ++.0000, ----.0000, 1.#INF
```

On input, IDL can recognize any of these, but on output, it uses the same standard representation on all platforms. This promotes cross-platform consistency. To cause IDL to use the system C library `sprintf()` function to format such values, yielding the native representation for that platform, set the STDIO_NON_FINITE keyword.

VMS Keywords

REWRITE

When writing data to a file with indexed organization, set the REWRITE keyword to specify that the data should update the contents of the most recently input record instead of creating a new record.

Format Compatibility

If the FORMAT keyword is not present and PRINT is called with more than one argument, and the first argument is a scalar string starting with the characters "$(", this initial argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

Example

To print the string “IDL is fun.” enter the command:

```
PRINT, 'IDL is fun.'
```

To print the same message to the open file associated with file unit number 2, use the command:

```
PRINTF, 2, 'IDL is fun.'
```

See Also

ANNOTATE, MESSAGE, WRITEU, XYOUTS

PRINTD

The PRINTD procedure prints the contents of the directory stack maintained by the PUSHD and POPD procedures. The contents of the directory stack are listed on the default output device. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `printd.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PRINTD

See Also

CD, POPD, PUSHD

PRO

The PRO statement defines an IDL procedure.

Note

For information on using the PRO statement, see Chapter 12, "Procedures and Functions" in *Building IDL Applications*.

Syntax

PRO *Procedure_Name*, $argument_1$, ..., $argument_n$
. . .
END

Arguments

$argument_n$

A parameter that is passed to the procedure.

Example

The following example demonstrates the use of arguments in a PRO statement:

```
PRO MYPROCEDURE
   X = 5
   ; Call the ADD procedure:
   ADD, 3, X
END

PRO ADD, A, B
   PRINT, 'A = ', A
   PRINT, 'B = ', B
   A = A + B
   PRINT, 'A = ', A
END
```

After running `myprocedure.pro`, IDL returns:

```
A =   3
B =   5
A =   8
```

PROFILE

The PROFILE function extracts a profile from an image and returns a floating-point vector containing the values of the image along the profile line marked by the user.

This routine is written in the IDL language. Its source code can be found in the file `profile.pro` in the `lib` subdirectory of the IDL distribution.

Using PROFILE

To mark a profile line after calling PROFILE, click in the image with the left mouse button to mark the beginning and ending points. The pixel coordinates of the selected points are displayed in the IDL command log.

Syntax

Result = PROFILE(*Image* [, *XX*, *YY*] [, /NOMARK] [, XSTART=*value*] [, YSTART=*value*])

Arguments

Image

The data array representing the image. This array can be of any type except complex.

XX

A named variable that will contain the X coordinates of the points along the selected profile.

YY

A named variable that will contain the Y coordinates of the points along the selected profile.

Keywords

NOMARK

Set this keyword to inhibit marking the image with the profile line.

XSTART

The starting X location of the lower-left corner of *Image*. If this keyword is not specified, 0 is assumed.

YSTART

The starting Y location of the lower-left corner of *Image*. If this keyword is not specified, 0 is assumed.

Example

This example displays an image, selects a profile, and plots that profile in a new window:

```
; Create an image:
A = BYTSCL(DIST(256))

; Display the image:
TV, A

; Extract a profile from the image:
R = PROFILE(A)
```

Mark two points on the image with the mouse.

```
; Create a new plotting window:
WINDOW, /FREE

; Plot the profile:
PLOT, R
```

Note

The PROFILES procedure is an interactive version of this routine.

See Also

PROFILES

PROFILER

The PROFILER procedure allows you to access the IDL Code Profiler. The IDL Code Profiler helps you analyze the performance of your applications. You can easily monitor the calling frequency and execution time for procedures and functions.

Syntax

PROFILER [, *Module*] [, /CLEAR] [, DATA=*variable*] [, OUTPUT=*variable*] [, /REPORT] [, /RESET] [, /SYSTEM]

Arguments

Module

The program to which changes in profiling will be applied. If *Module* is not specified, profiling changes will be applied to all currently-compiled programs.

Note

The *Module* is often named with respect to the file in which it is stored. For example, the file `build_it.pro` may contain the module, `build_it`. If you specify the file name, you will incur a syntax error.

Keywords

CLEAR

Set this keyword to disable profiling of *Module* or of all compiled modules if *Module* is not specified.

OUTPUT

Set this keyword to a specified variable in which to store the results of the REPORT keyword.

REPORT

Set this keyword to report the results of profiling. If you enter a program at the command line, the PROFILER procedure will report the status of all the specified modules used either since the beginning of the IDL session, or since the PROFILER was reset.

RESET

Set this keyword to clear the results of profiling.

SYSTEM

Set this keyword to profile IDL system procedures and functions. By default, only user-written or library files, which have been compiled, are profiled.

Example

```
; Include IDL system procedures and functions when profiling:
PROFILER, /SYSTEM

; Create a dataset using the library function DIST. Note that DIST
; is immediately compiled:
A= DIST(500)

; Display the image:
TV, A

; Retrieve the profiling results:
PROFILER, /REPORT
```

IDL prints:

```
Module       Type  Count     Only(s)   Avg.(s)     Time(s)   Avg.(s)
FINDGEN      (S)       1    0.000239  0.000239    0.000239  0.000239
FLTARR       (S)       1    0.010171  0.010171    0.010171  0.010171
N_ELEMENTS   (S)       1    0.000104  0.000104    0.000104  0.000104
ON_ERROR     (S)       1    0.000178  0.000178    0.000178  0.000178
SQRT         (S)     251    0.099001  0.000394    0.099001  0.000394
TV           (S)       1    2.030000  2.030000    2.030000  2.030000
```

See Also

Chapter 18, "Debugging an IDL Program" in the *Building IDL Applications* manual.

PROFILES

The PROFILES procedure interactively draws row or column profiles of an image in a separate window. A new window is created and the mouse location in the original window is used to plot profiles in the new window.

This routine is written in the IDL language. Its source code can be found in the file `profiles.pro` in the `lib` subdirectory of the IDL distribution.

Using PROFILES

Moving the mouse within the original image interactively creates profile plots in the newly-created profile window. Pressing the left mouse button toggles between row and column profiles. The right mouse button exits.

Syntax

PROFILES, *Image* [, /ORDER] [, SX=*value*] [, SY=*value*] [, WSIZE=*value*]

Arguments

Image

The variable that represents the image displayed in the current window. This data need not be scaled into bytes. The profile graphs are made from this array, even if it is not currently displayed.

Keywords

ORDER

Set this keyword to 1 for images written top down or 0 for bottom up. Default is the current value of !ORDER.

SX

Starting X position of the image in the window. If this keyword is omitted, 0 is assumed.

SY

Starting Y position of the image in the window. If this keyword is omitted, 0 is assumed.

WSIZE

The size of the PROFILES window as a fraction or multiple of 640 by 512.

Example

Create and display an image and use the PROFILES routine on it.

```
; Create an image:
A = BYTSCL(DIST(256))

; Display the image:
TV, A

; Run the PROFILES routine:
PROFILES, A, WSIZE = .5
```

A 320 x 256 pixel PROFILES window should appear. Move the cursor over the original image to see the profile at the cursor position. Press the left mouse button to toggle between row and column profiles. Press the right mouse button (with the cursor over the original image) to exit the routine.

See Also

PROFILE

PROJECT_VOL

The PROJECT_VOL function returns a two-dimensional image that is the projection of a 3D volume of data onto a plane (similar to an X-ray). The returned image is a translucent rendering of the volume (the highest data values within the volume show up as the brightest regions in the returned image). Depth queuing and opacity may be used to affect the image. The volume is projected using a 4x4 matrix, so any type of projection may be used including perspective. Typically the system viewing matrix (!P.T) is used as the 4x4 matrix.

Note that the VOXEL_PROJ procedure performs many of the same functions as this routine, and is faster.

This routine is written in the IDL language. Its source code can be found in the file `project_vol.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Return = PROJECT_VOL(*Vol*, *X_Sample*, *Y_Sample*, *Z_Sample*
[, DEPTH_Q=*value*] [, OPAQUE=*3D_array*] [, TRANS=*array*])

Arguments

Vol

A 3D array of any type except string or structure containing the three dimensional volume of data to project.

X_Sample

A long integer specifying the number of rays to project along the X dimension of the image. The returned image will have the dimensions *X_sample* by *Y_sample*.

Y_Sample

A long integer specifying the number of rays to project along the Y dimension of the image. To preserve the correct aspect ratio of the data, *Y_sample* should equal *X_sample*.

Z_Sample

A long integer specifying the number of samples to take along each ray. Higher values for *X_sample*, *Y_sample*, and *Z_sample* increase the image resolution as well as execution time.

Keywords

DEPTH_Q

Set this keyword to indicate that the image should be created using depth queuing. The depth queuing should be a single floating-point value between 0.0 and 1.0. This value specifies the brightness of the farthest regions of the volume relative to the closest regions of the volume. A value of 0.0 will cause the back side of the volume to be completely blacked out, while a value of 1.0 indicates that the back side will show up just as bright as the front side. The default is 1.0 (indicating no depth queuing).

OPAQUE

A 3D array of any type except string or structure, with the same size and dimensions as *Vol*. This array specifies the opacity of each cell in the volume. OPAQUE values of 0 allow all light to pass through. OPAQUE values are cumulative. For example, if a ray emanates from a data value of 50, and then passes through 10 opaque cells (each with a data value of 0 and an opacity value of 5) then that ray would be completely blocked out (the cell with the data value of 50 would be invisible on the returned image). The default is no opacity.

TRANS

A 4x4 floating-point array to use as the transformation matrix when projecting the volume. The default is to use the system viewing matrix (!P.T).

Example

Use the T3D routine to set up a viewing projection and render a volume of data using PROJECT_VOL.

```
; First, create some data:
vol = RANDOMU(S, 40, 40, 40)
FOR I=0, 10 DO vol = SMOOTH(vol, 3)
vol = BYTSCL(vol(3:37, 3:37, 3:37))
opaque = RANDOMU(S, 40, 40, 40)
FOR I=0, 10 DO opaque = SMOOTH(opaque, 3)
opaque = BYTSCL(opaque(3:37, 3:37, 3:37), TOP=25B)

; Set up the view:
xmin = 0 & ymin = 0 & zmin = 0
xmax = 34 & ymax = 34 & zmax = 34
!X.S = [-xmin, 1.0] / (xmax - xmin)
!Y.S = [-ymin, 1.0] / (ymax - ymin)
!Z.S = [-zmin, 1.0] / (zmax - zmin)
```

```
T3D, /RESET
T3D, TRANSLATE=[-0.5, -0.5, -0.5]
T3D, SCALE=[0.7, 0.7, 0.7]
T3D, ROTATE=[30, -30, 60]
T3D, TRANSLATE=[0.5, 0.5, 0.5]
WINDOW, 0, XSIZE=512, YSIZE=512

; Generate and display the image:
img = PROJECT_VOL(vol, 64, 64, 64, DEPTH_Q=0.7, $
  OPAQUE=opaque, TRANS=(!P.T))
TVSCL, img
```

See Also

POLYSHADE, VOXEL_PROJ

PS_SHOW_FONTS

The PS_SHOW_FONTS procedure displays all the PostScript fonts that IDL knows about, with both the StandardAdobe and ISOLatin1 encodings. Each display takes a separate page, and each character in each font is shown with its character index.

A PostScript file is produced, one page per font/mapping combination. The output file contains almost 70 pages of output. A PostScript previewer is recommended rather than sending it to a printer.

This routine is written in the IDL language. Its source code can be found in the file `ps_show_fonts.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PS_SHOW_FONTS [, /NOLATIN]

Keywords

NOLATIN

Set this keyword to prevent output of ISOLatin1 encodings.

See Also

PSAFM

PSAFM

The PSAFM procedure takes an Adobe Font Metrics file as input and generates a new AFM file in the format that IDL likes. This new file differs from the original in the following ways:

- Information not used by IDL is removed.
- AFM files with the AdobeStandardEncoding are supplemented with an ISOLatin1Encoding.

This routine is written in the IDL language. Its source code can be found in the file `psafm.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PSAFM, *Input_Filename*, *Output_Filename*

Arguments

Input_Filename

A string that contains the name of existing AFM file from Adobe.

Output_Filename

A string that specifies the name of new IDL-format AFM file to be created.

See Also

PS_SHOW_FONTS

PSEUDO

The PSEUDO procedure creates a pseudo-color table based on the LHB (Lightness, Hue, and Brightness) system and loads it.

The pseudo-color mapping used is generated by first translating from the LHB coordinate system to the LAB coordinate system, finding *N* colors spread out along a helix that spans this LAB space (supposedly a near maximal entropy mapping for the eye, given a particular *N*) and remapping back into the RGB (Red, Green, and Blue) colorspace. The result is loaded as the current colortable.

This routine is written in the IDL language. Its source code can be found in the file `pseudo.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PSEUDO, *Litlo*, *Lithi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

Arguments

Litlo

Starting lightness, from 0 to 100%.

Lithi

Ending lightness, from 0 to 100%.

Satlo

Starting saturation, from 0 to 100%.

Sathi

Ending saturation, from 0 to 100%.

Hue

Starting hue, in degrees, from 0 to 360.

Loops

The number of loops of hue to make in the color helix. This value can range from 0 to around 3 to 5 and need not be an integer.

Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

See Also

COLOR_CONVERT, COLOR_QUAN

PTR_FREE

The PTR_FREE procedure destroys the heap variables pointed at by its pointer arguments. Any memory used by the heap variable is released, and the variable ceases to exist. No change is made to the arguments themselves and all pointers to the destroyed variables continue to exist. Such pointers are known as *dangling references*. PTR_FREE is the only way that pointer heap variables can be destroyed. If PTR_FREE is not called on a heap variable, it continues to exist until the IDL session ends, even if no pointers remain that can be used to reference it.

Note that PTR_FREE does not recurse. That is, if the heap variable pointed at by `pointer1` contains `pointer2`, destroying `pointer1` will *not* destroy the heap variable pointed at by `pointer2`. Take care not to lose the only pointer to a heap variable by destroying a pointer to a heap variable that contains that pointer.

Syntax

PTR_FREE, P_1, ... …, P_n

Arguments

P_i

Scalar or array arguments of pointer type. If the NULL pointer is passed, PTR_FREE ignores it quietly.

PTR_NEW

The PTR_NEW function provides the primary mechanism for creating heap variables. It returns a pointer to the created variable.

Syntax

Result = PTR_NEW([*InitExpr*] [, /ALLOCATE_HEAP] [, /NO_COPY])

Arguments

InitExpr

If *InitExpr* is provided, PTR_NEW uses it to initialize the newly created heap variable. Note that the new heap variable does not point at the *InitExpr* variable in any sense—the new heap variable simply contains a copy of its value.

If *InitExpr* is not provided, PTR_NEW does not create a new heap variable, and returns the *Null Pointer,* a special pointer with a fixed known value that can never point at a heap variable. The null pointer is useful as a terminator in dynamic data structures, or as a placeholder in structure definitions.

Keywords

ALLOCATE_HEAP

Set this keyword to cause PTR_NEW to allocate an undefined heap variable rather than return a null pointer when *InitExpr* is not specified.

NO_COPY

Usually, when the *InitExpr* argument is provided, PTR_NEW allocates additional memory to make a copy. If the NO_COPY keyword is set, the value data is taken away from the *InitExpr* variable and attached directly to the heap variable. This feature can be used to move data very efficiently. However, it has the side effect of causing the *InitExpr* variable to become undefined. Using the NO_COPY keyword is completely equivalent to the statement:

```
Result = PTR_NEW(TEMPORARY(InitExpr))
```

and is provided as a syntactic convenience.

PTR_VALID

The PTR_VALID function verifies the validity of its pointer arguments, or alternatively returns a vector of pointers to all the existing valid pointer heap variables.

If called with an pointer or array of pointers as its argument, PTR_VALID returns a byte array of the same size as the argument. Each element of the result is set to True (1) if the corresponding pointer in the argument refers to an existing valid heap variable, or to False (0) otherwise.

If called with an integer or array of integers as its argument and the CAST keyword is set, PTR_VALID returns an array of pointers. Each element of the result is a pointer to the heap variable indexed by the integer value. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when you have lost a reference but see it with HELP and need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

If no argument is specified, PTR_VALID returns a vector of pointers to all existing valid pointer heap variables—*even if there are currently no pointers to the heap variable*. This usage allows you to “reclaim” pointer heap variables to which all pointers have been lost. If no valid pointer heap variables exist, a scalar null pointer is returned.

Syntax

Result = PTR_VALID([*Arg*] [, /CAST] [, COUNT=*variable*])

Arguments

Arg

Arg can be one of the following:

1. A scalar or array argument of pointer type.
2. If the CAST keyword is set, an integer index or array of integer indices to heap variables. Integers used to index heap variables are shown in the output of the HELP and PRINT commands.

Keywords

CAST

Set this keyword to create a new pointer to each heap variable index specified in *Arg*.

COUNT

Set this keyword equal to a named variable that will contain the number of currently valid heap variables. This value is returned as a longword integer.

Examples

To determine if a given pointer refers to a valid heap variable:

```
IF (PTR_VALID(p)) THEN …
```

To destroy all existing pointer heap variables:

```
PTR_FREE, PTR_VALID()
```

You can use the CAST keyword to “reclaim” lost heap variables. For example:

```
A = PTR_NEW(10)
PRINT, A
```

IDL prints:

```
<PtrHeapVar2>
```

In this case, the integer index to the heap variable is 2. If we reassign the variable A, we will “lose” the pointer, but the heap variable will still exist:

```
A=0
PRINT, A, PTR_VALID()
```

IDL prints:

```
0 <PtrHeapVar2>
```

We can reclaim the lost heap variable using the CAST keyword:

```
A = PTR_VALID(2, /CAST)
PRINT, A
```

IDL prints:

```
<PtrHeapVar2>
```

PTRARR

The PTRARR function returns a pointer vector or array. The individual elements of the array are set to the Null Pointer.

Syntax

Result = PTRARR(D_1, ... …, D_8 [, /ALLOCATE_HEAP | , /NOZERO])

Arguments

Di

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

ALLOCATE_HEAP

Normally, PTRARR sets every element of the result to the null pointer. It you wish IDL to allocate heap variables for every element of the array instead, set the ALLOCATE_HEAP keyword. In this case, every element of the array will be initialized to point at an undefined heap variable.

NOZERO

If ALLOCATE_HEAP is not specified, PTRARR sets every element of the result to the null pointer. If NOZERO is nonzero, this initialization is not performed and PTRARR executes faster. NOZERO is ignored if ALLOCATE_HEAP is specified.

Warning

If you specify NOZERO, the resulting array will have whatever value happens to exist at the system memory location that the array is allocated from. You should be careful to initialize such an array to valid pointer values.

Example

Create P, a 3 element by 3 element pointer array with each element containing the Null Pointer by entering:

```
P = PTRARR(3, 3)
```

PUSHD

The PUSHD procedure pushes a directory onto the top of the directory stack maintained by the PUSHD and POPD procedures. The name of the current directory is pushed onto the directory stack. This directory becomes the next directory used by POPD. IDL changes directories to the one specified by the *Dir* argument. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `pushd.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

PUSHD, *Dir*

Arguments

Dir

A string containing the name of the directory to change to. The current directory is pushed onto the top of the directory stack.

See Also

CD, POPD, PRINTD

QROMB

The QROMB function evaluates the integral of a function over the closed interval [*A, B*] using Romberg integration. The result will have the same structure as the smaller of *A* and *B*, and the resulting type will be single- or double-precision floating, depending on the input types.

QROMB is based on the routine `qromb` described in section 4.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = QROMB(*Func*, *A*, *B* [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*] [, K=*value*])

Arguments

Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the closed interval [*A, B*].

For example, if we wish to integrate the cubic polynomial

$$y = x^3 + (x - 1)^2 + 3$$

we define a function CUBIC to express this relationship in the IDL language:

```
FUNCTION cubic, X
   RETURN, X^3 + (X - 1.0)^2 + 3.0
END
```

A

The lower limit of the integration. *A* can be either a scalar or an array.

B

The upper limit of the integration. *B* can be either a scalar or an array.

Note

If arrays are specified for *A* and *B*, then QROMB integrates the user-supplied function over the interval $[A_i, B_i]$ for each *i*. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

The desired fractional accuracy. For single-precision calculations, the default value is 1.0×10^{-6}. For double-precision calculations, the default value is 1.0×10^{-12}.

JMAX

$2^{(JMAX - 1)}$ is the maximum allowed number of steps. If this keyword is not specified, a default of 20 is used.

K

Integration is performed by Romberg's method of order 2K. If not specified, the default is K=5. (K=2 is Simpson's rule).

Example

To integrate the CUBIC function (listed above) over the interval [0, 3] and print the result:

```
PRINT, QROMB('cubic', 0.0, 3.0)
```

IDL prints:

```
 32.2500
```

This is the exact solution.

See Also

INT_2D, INT_3D, INT_TABULATED, QROMO, QSIMP

QROMO

The QROMO function evaluates the integral of a function over the open interval (*A*, *B*) using a modified Romberg's method.

QROMO is based on the routine `qromo` described in section 4.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = QROMO(*Func*, *A* [, *B*] [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*] [, K=*value*] [, /MIDEXP | , /MIDINF | , /MIDPNT | , /MIDSQL | , /MIDSQU])

Arguments

Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the open interval (*A*, *B*).

For example, if we wish to integrate the fourth-order polynomial

$$y = 1 / x^4$$

we define a function HYPER to express this relationship in the IDL language:

```
FUNCTION hyper, X
   RETURN, 1.0 / X^4
END
```

A

The lower limit of the integration. *A* can be either a scalar or an array.

B

The upper limit of the integration. *B* can be either a scalar or an array. If the MIDEXP keyword is specified, *B* is assumed to be infinite, and should not be supplied by the user.

Note: If arrays are specified for *A* and *B*, then QROMO integrates the user-supplied function over the interval $[A_i, B_i]$ for each i. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

The fractional accuracy desired, as determined by the extrapolation error estimate. For single-precision calculations, the default value is 1.0×10^{-6}. For double-precision calculations, the default value is 1.0×10^{-12}.

JMAX

Set to specify the maximum allowed number of mid quadrature points to be $3^{(JMAX - 1)}$. The default value is 14.

K

Integration is performed by Romberg's method of order 2K. If not specified, the default is K=5.

MIDEXP

Use the `midexp()` function (see *Numerical Recipes*, section 4.4) as the integrating function. If the MIDEXP keyword is specified, argument B is assumed to be infinite, and should not be supplied by the user.

MIDINF

Use the `midinf()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

MIDPNT

Use the `midpnt()` function (see *Numerical Recipes*, section 4.4) as the integrating function. This is the default if no other integrating function keyword is specified.

MIDSQL

Use the `midsql()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

MIDSQU

Use the `midsqu()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

Example

Consider the following function:

```
FUNCTION hyper, X
   RETURN, 1.0 / X^4
END
```

This example integrates the HYPER function over the open interval (2, ∞) and prints the result:

```
PRINT, QROMO('hyper', 2.0, /MIDEXP)
```

IDL prints:

```
 0.0412050
```

Warning

When using the MIDEXP keyword, the upper integration limit is assumed to be infinity and is not supplied.

See Also

INT_2D, INT_3D, INT_TABULATED, QROMB, QSIMP

QSIMP

The QSIMP function performs numerical integration of a function over the closed interval [*A, B*] using Simpson's rule. The result will have the same structure as the smaller of *A* and *B*, and the resulting type will be single- or double-precision floating, depending on the input types.

QSIMP is based on the routine `qsimp` described in section 4.2 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = QSIMP(*Func*, *A*, *B* [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*])

Arguments

Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the closed interval [*A, B*].

For example, if we wish to integrate the fourth-order polynomial

$$y = (x^4 - 2x^2) \sin(x)$$

we define a function SIMPSON to express this relationship in the IDL language:

```
FUNCTION simpson, X
   RETURN, (X^4 - 2.0 * X^2) * SIN(X)
END
```

A

The lower limit of the integration. *A* can be either a scalar or an array.

B

The upper limit of the integration. *B* can be either a scalar or an array.

Note: If arrays are specified for *A* and *B*, then QSIMP integrates the user-supplied function over the interval $[A_i, B_i]$ for each *i*. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

EPS

The desired fractional accuracy. For single-precision calculations, the default value is 1.0×10^{-6}. For double-precision calculations, the default value is 1.0×10^{-12}.

JMAX

$2^{(JMAX - 1)}$ is the maximum allowed number of steps. If not specified, a default of 20 is used.

Example

To integrate the SIMPSON function (listed above) over the interval [0, π/2] and print the result:

```
; Define lower limit of integration:
A = 0.0

; Define upper limit of integration:
B = !PI/2.0

PRINT, QSIMP('simpson', A, B)
```

IDL prints:

```
 -0.479158
```

The exact solution can be found using the integration-by-parts formula:

```
FB = 4.*B*(B^2-7.)*SIN(B) - (B^4-14.*B^2+28.)*COS(B)
FA = 4.*A*(A^2-7.)*SIN(A) - (A^4-14.*A^2+28.)*COS(A)
exact = FB - FA
PRINT, exact
```

IDL prints:

```
 -0.479156
```

See Also

INT_2D, INT_3D, INT_TABULATED, QROMB, QROMO

QUERY_* Routines

Query routines allow users to obtain information about an image file without having to read the file. The following QUERY_* routines are available in IDL:

- QUERY_BMP
- QUERY_DICOM
- QUERY_IMAGE
- QUERY_JPEG
- QUERY_PICT
- QUERY_PNG
- QUERY_PPM
- QUERY_SRF
- QUERY_TIFF
- QUERY_WAV

All of the QUERY_* routines return a result, which is a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure. If the query was successful, the return argument will be an anonymous structure containing all of the available information for that image format.

The status is intended to be used to determine if it is appropriate to use the corresponding READ_ routine for a given file. The return status of the QUERY_* will indicate success if the corresponding READ_ routine is likely to be able to read the file. The return status will indicate failure for cases that contain formats that are not supported by the READ_ routines, even though the files may be valid outside of the IDL environment. For example, IDL's READ_BMP does not support 1-bit-deep images and so the QUERY_BMP function would return failure in the case of a monochrome BMP file.

The returned anonymous structure will have (minimally) the following fields for all file formats. If the file does not support multiple images in a single file, the NUM_IMAGES field will always be 1 and the IMAGE_INDEX field will always be 0. Individual routines will document additional fields which are returned for a specific format.

Field	IDL data type	Description
CHANNELS	Long	Number of samples per pixel
DIMENSIONS	2-D long array	Size of the image in pixels
HAS_PALETTE	Integer	True if a palette is present

Table 77: Query Routines Info Structure

Field	IDL data type	Description
NUM_IMAGES	Long	Number of images in the file
IMAGE_INDEX	Long	Image number for which this structure is valid
PIXEL_TYPE	Integer	IDL basic type code for a pixel sample
TYPE	String	String identifying the file format

Table 77: Query Routines Info Structure

All the routines accept the IMAGE_INDEX keyword although formats which do not support multiple images in a single file will ignore this keyword.

QUERY_BMP

QUERY_BMP is a method of obtaining information about a BMP image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_BMP (*Filename* [, *Info*])

Arguments

Filename

A scalar string containing the pathname of the BMP file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'BMP'.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

There are no keywords for this routine.

See Also

QUERY_* Routines, READ_BMP, WRITE_BMP

QUERY_DICOM

The QUERY_DICOM function tests a file for compatibility with READ_DICOM and returns an optional structure containing information about images in the DICOM file. This function supports cases in which a blank DICOM tag is supplied. The result is 0 on failure, and 1 on success. A result of 1 means it is likely that the file can be read by READ_DICOM.

This routine is written in the IDL language. Its source code can be found in the file `query_dicom.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = QUERY_DICOM(*Filename* [, *Info*] [, IMAGE_INDEX=*index*])

Arguments

Filename

A scalar string containing the full pathname of the file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'DICOM'.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

IMAGE_INDEX

Set this keyword to the index (zero based) of the image being queried in the file. This keyword has no effect on files containing a single image.

Example

DICOM palette vectors are 16 bit quantities and may not cover the entire dynamic range of the image. To view a paletted DICOM image use the following:

```
IF (QUERY_DICOM('file.dcm',info)) THEN BEGIN
   IF (info.has_palette) THEN BEGIN
```

```
      TV, READ_IMAGE('file.dcm',r, g, b), /ORDER
      TVLCT,r/256, g/256, b/256
   ENDIF
ENDIF
```

See Also

READ_DICOM

QUERY_IMAGE

The QUERY_IMAGE function determines whether a file is recognized as a supported image file. QUERY_IMAGE first checks the filename suffix, and if found, calls the corresponding QUERY_ routine. For example, if the specified file is image.bmp, QUERY_BMP is called to determine if the file is a valid .bmp file. If the file does not contain a filename suffix, or if the query fails on the specified filename suffix, QUERY_IMAGE checks against all supported file types. If the file is a supported image file, an optional structure containing information about the image is returned. If the file is not a supported image file, QUERY_IMAGE returns 0.

Syntax

Result = QUERY_IMAGE (*Filename*[, *Info*] [, CHANNELS=*variable*]
[, DIMENSIONS=*variable*] [, HAS_PALETTE=*variable*]
[, IMAGE_INDEX=*index*] [, NUM_IMAGES=*variable*] [, PIXEL_TYPE=*variable*]
[, SUPPORTED_READ=*variable*] [, SUPPORTED_WRITE=*variable*]
[, TYPE=*variable*])

Return Value

Result is a long with the value of 1 if the query was successful (the file was recognized as an image file) or 0 on failure. The return status will indicate failure for files that contain formats that are not supported by the corresponding READ_* routine, even though the file may be valid outside the IDL environment.

Arguments

Filename

A scalar string containing the name of the file to query.

Info

An optional anonymous structure containing information about the image. This structure is valid only when the return value of the function is 1. The Info structure for all image types has the following fields:

Tag	Type
CHANNELS	Long
DIMENSIONS	Two-dimensional long array
FILENAME	Scalar string
HAS_PALETTE	Integer
IMAGE_INDEX	Long
NUM_IMAGES	Long
PIXEL_TYPE	Integer
TYPE	Scalar string

Table 78: The Info Structure for All Image Types

Keywords

CHANNELS

Set this keyword to a named variable to retrieve the number of channels in the image.

DIMENSIONS

Set this keyword to a named variable to retrieve the image dimensions as a two-dimensional array.

HAS_PALETTE

Set this keyword to a named variable to equal to 1 if a palette is present, else 0.

IMAGE_INDEX

Set this keyword to the index of the image to query from the file. The default is 0, the first image.

NUM_IMAGES

Set this keyword to a named variable to retrieve the number of images in the file.

PIXEL_TYPE

Set this keyword to a named variable to retrieve the IDL Type Code of the image pixel format. See the documentation for the SIZE routine for a complete list of IDL Type Codes.

The valid types for PIXEL_TYPE are:

- 1 = Byte
- 2 = Integer
- 3 = Longword Integer
- 4 = Floating Point
- 5 = Double-precision Floating Point
- 12 = Unsigned Integer
- 13 - Unsigned Longword Integer
- 14 - 64-bit Integer
- 15 - Unsigned 64-bit Integer

SUPPORTED_READ

Set this keyword to a named variable to retrieve a string array of image types recognized by READ_IMAGE. If the SUPPORTED_READ keyword is used the filename and info arguments are optional.

SUPPORTED_WRITE

Set this keyword to a named variable to retrieve a string array of image types recognized by WRITE_IMAGE. If the SUPPORTED_WRITE keyword is used the filename and info arguments are optional.

TYPE

Set this keyword to a named variable to retrieve the image type as a scalar string. Possible return values are BMP, JPEG, PNG, PPM, SRF, TIFF, or DICOM.

QUERY_JPEG

QUERY_JPG is a method of obtaining information about a JPEG image file without having to read the file. See “QUERY_* Routines” on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_JPEG (*Filename* [, *Info*])

Arguments

Filename

A scalar string containing the pathname of the JPEG file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘JPEG’.

Note

See “QUERY_* Routines” on page 1063 for detailed structure info.

Keywords

None

See Also

QUERY_* Routines, READ_JPEG, WRITE_JPEG

QUERY_PICT

QUERY_PICT is a method of obtaining information about a PICT image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_PICT (*Filename* [, *Info*])

Arguments

Filename

A scalar string containing the pathname of the PICT file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'PICT'.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

None

See Also

QUERY_* Routines, READ_PICT, WRITE_PICT

QUERY_PNG

QUERY_PNG is a method of obtaining information about a PNG image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_PNG (*Filename* [, *Info*])

Arguments

Filename

A scalar string containing the pathname of the PNG file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'PNG'.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

None

Example

Query included in creating RGBA (16-bit/channel) and Color Indexed (8-bits/channel) image.

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = indgen(256)
green = indgen(256)
blue = indgen(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue
```

```
; Query and Read the data:
names = ['rgb_image.png','ci_image.png','unknown.png']

FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
   ok = QUERY_PNG(names[i],s)
   IF (ok) THEN BEGIN
   HELP,s,/STRUCTURE
   IF (s.HAS_PALETTE) THEN BEGIN
      img = READ_PNG(names[i],rpal,gpal,bpal)
      HELP,img,rpal,gpal,bpal
   ENDIF ELSE BEGIN
      img = READ_PNG(names[i])
      HELP,img
   ENDELSE
   ENDIF ELSE BEGIN
      PRINT,names[i],' is not a PNG file'
   ENDELSE
ENDFOR
END
```

See Also

QUERY_* Routines, READ_PNG, WRITE_PNG

QUERY_PPM

QUERY_PPM is a method of obtaining information about a PPM image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_PPM (*Filename* [, *Info*] [, MAXVAL=*variable*])

Arguments

Filename

A scalar string containing the pathname of the PPM file to query.

Info

Returns an anonymous structure containing information about the image. The Info.TYPE field will return the value 'PPM'.

Additional field in the Info structure: MAXVAL - maximum pixel value in the image.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

MAXVAL

Set this keyword to a named variable to retrieve the maximum pixel value in the image.

See Also

QUERY_* Routines, READ_PPM, WRITE_PPM

QUERY_SRF

QUERY_SRF is a method of obtaining information about an SRF image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_SRF (*Filename* [, *Info*])

Arguments

Filename

A scalar string containing the pathname of the SRF file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'SRF'.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

None

See Also

QUERY_* Routines, READ_SRF, WRITE_SRF

QUERY_TIFF

QUERY_TIFF is a method of obtaining information about a TIFF image file without having to read the file. See "QUERY_* Routines" on page 1063 for more information.

This routine returns a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_TIFF (*Filename* [, *Info*] [, IMAGE_INDEX=*index*])

Arguments

Filename

A scalar string containing the pathname of the TIFF file to query.

Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'TIFF'.

Additional field in the Info structure: PLANAR_CONFIG.

Note

See "QUERY_* Routines" on page 1063 for detailed structure info.

Keywords

IMAGE_INDEX

Image number index. If this value is larger than the number of images in the file, the function returns 0 (failure).

Example

This is an example of using QUERY_TIFF to write and read a multi-image TIFF file. The first image is a 16-bit, single channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
```

```
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND

; Read the image data back:
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
   FOR i=0,s.NUM_IMAGES-1 DO BEGIN
      imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
      img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
      HELP,t,/STRUCTURE
      HELP,img
   ENDFOR
ENDIF
```

See Also

QUERY_* Routines, READ_TIFF, WRITE_TIFF

QUERY_WAV

The QUERY_WAV function checks that the file is actually a .WAV file and that the READ_WAV function can read the data in the file. Optionally, it can return additional information about the data in the file. This function returns the value of 1 if the query was successful (and the file type was correct) or 0 on failure.

Syntax

Result = QUERY_WAV (*Filename*[, *Info*])

Arguments

Filename

A scalar string containing the full pathname of the .WAV file to read.

Info

An anonymous structure containing information about the data in the file. The fields are defined as:

Tag	Type	Definition
CHANNELS	INT	Number of data channels in the file.
SAMPLES_PER_SEC	LONG	Data sampling rate in samples per second.
BITS_PER_SAMPLE	INT	Number of valid bits in the data.

Table 79: The Info Structure for Info Fields

Keywords

None.

R_CORRELATE

The R_CORRELATE function computes Spearman's (rho) or Kendalls's (tau) rank correlation of two sample populations *X* and *Y*. The result is a two-element vector containing the rank correlation coefficient and the two-sided significance of its deviation from zero. The significance is a value in the interval [0.0, 1.0]; a small value indicates a significant correlation.

$$\text{rho} = \frac{\sum_{i=0}^{N-1} (Rx_i - \overline{Rx})(Ry_i - \overline{Ry})}{\sqrt{\sum_{i=0}^{N-1} (Rx_i - \overline{Rx})^2} \sqrt{\sum_{i=0}^{N-1} (Ry_i - \overline{Ry})^2}}$$

where Rx_i and Ry_i are the magnitude-based ranks among *X* and *Y*, respectively. Elements of identical magnitude are ranked using a rank equal to the mean of the ranks that would otherwise be assigned.

This routine is written in the IDL language. Its source code can be found in the file `r_correlate.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = R_CORRELATE(*X*, *Y* [, D=*variable*] [, /KENDALL] [, PROBD=*variable*] [, ZD=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *n*-element integer, single-, or double-precision floating-point vector.

Keywords

D

Set this keyword to a named variable that will contain the sum-squared difference of ranks. If the KENDALL keyword is set, this parameter is returned as zero.

KENDALL

Set this keyword to compute Kendalls's (tau) rank correlation. By default, Spearman's (rho) rank correlation is computed.

PROBD

Set this keyword to a named variable that will contain the two-sided significance level of ZD. If the KENDALL keyword is set, this parameter is returned as zero.

ZD

Set this keyword to a named variable that will contain the number of standard deviations by which D deviates from its null-hypothesis expected value. If the KENDALL keyword is set, this parameter is returned as zero.

Example

```
; Define two n-element sample populations:
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
     305, 270, 260, 251, 275, 288, 242, 304, 267]
Y = [201, 56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
     271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute Spearman's (rho) rank correlation of X and Y.
result = R_CORRELATE(X, Y)
PRINT, 'Spearman's (rho) rank correlation: ', result

; Compute Kendalls's (tau) rank correlation of X and Y:
result = R_CORRELATE(X, Y, /KENDALL)
PRINT, 'Kendalls's (tau) rank correlation: ', result
```

IDL prints:

```
Spearman's (rho) rank correlation:   0.835967  4.42899e-006
Kendalls's (tau) rank correlation:   0.624347  0.000118729
```

See Also

A_CORRELATE, C_CORRELATE, CORRELATE, M_CORRELATE, P_CORRELATE

R_TEST

The R_TEST function tests the hypothesis that a binary population (a sequence of 1s and 0s) represents a “random sampling”. The result is a two-element vector containing the nearly-normal test statistic Z and its associated probability. This two-tailed test is based on the “theory of runs” and is often referred to as the “Runs Test for Randomness.”

This routine is written in the IDL language. Its source code can be found in the file `r_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = R_TEST(*X* [, N0=*variable*] [, N1=*variable*] [, R=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector. Elements not equal to 0 or 1 are removed and the length of *X* is correspondingly reduced.

Keywords

N0

Set this keyword to a named variable that will contain the number of 0s in *X*.

N1

Set this keyword to a named variable that will contain the number of 1s in *X*.

R

Set this keyword to a named variable that will contain the number of runs (clusters of 0s and 1s) in *X*.

Example

```
; Define a binary population:
X = [0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, $
     1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1]

; Test the hypothesis that X represents a random sampling against
; the hypothesis that it does not represent a random sampling at
```

```
; the 0.05 significance level:
result = R_TEST(X, R = r, N0 = n0, N1 = n1)
PRINT, result
```

IDL prints:

```
[2.26487, 0.0117604]
```

Print the values of the keyword parameters:

```
PRINT, 'Runs: ', r & PRINT, 'Zeros: ', n0 & PRINT, 'Ones: ', n1
Runs:      22
Zeros:     16
Ones:      14
```

The computed probability (0.0117604) is less than the 0.05 significance level and therefore we reject the hypothesis that *X* represents a random sampling. The results show that there are too many runs, indicating a non-random cyclical pattern.

See Also

CTI_TEST, FV_TEST, KW_TEST, LNP_TEST, MD_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

RADON

The RADON function implements the Radon transform, used to detect features within a two-dimensional image. This function can be used to return either the Radon transform, which transforms lines through an image to points in the Radon domain, or the Radon backprojection, where each point in the Radon domain is transformed to a straight line in the image.

Syntax

Radon Transform:

Result = RADON(*Array* [, /DOUBLE] [, DRHO=*scalar*] [, DX=*scalar*] [, DY=*scalar*] [, /GRAY] [, /LINEAR] [, NRHO=*scalar*] [, NTHETA=*scalar*] [, RHO=*variable*] [, RMIN=*scalar*] [, THETA=*variable*] [, XMIN=*scalar*] [, YMIN=*scalar*])

Radon Backprojection:

Result = RADON(*Array,* /BACKPROJECT, RHO=*variable*, THETA=*variable* [, /DOUBLE] [, DX=*scalar*] [, DY=*scalar*] [, /LINEAR] [, NX=*scalar*] [, NY=*scalar*] [, XMIN=*scalar*] [, YMIN=*scalar*])

Return Value

The result of this function is a two-dimensional floating-point array, or a complex array if the input image is complex. If *Array* is double-precision, or if the DOUBLE keyword is set, the result is double-precision, otherwise, the result is single-precision.

Radon Transform Theory

The Radon transform is used to detect features within an image. Given a function $A(x, y)$, the Radon transform is defined as:

$$R(\theta, \rho) = \int_{-\infty}^{\infty} A(\rho \cos\theta - s \sin\theta, \rho \sin\theta + s \cos\theta) ds$$

This equation describes the integral along a line *s* through the image, where ρ is the distance of the line from the origin and θ is the angle from the horizontal.

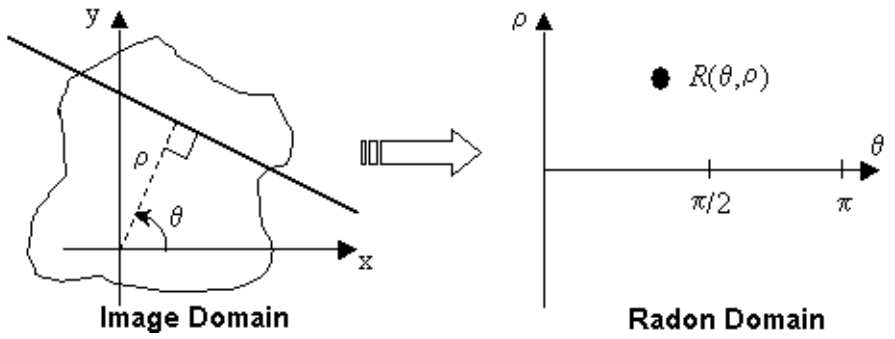


Figure 17: The Radon Transform

In medical imaging, each point $R(\theta, \rho)$ is called a ray-sum, while the resulting image is called a shadowgram. An image can be reconstructed from its ray-sums using the backprojection operator:

$$B(x, y) = \int_0^{\pi} R(\theta, x\cos\theta + y\sin\theta)d\theta$$

where the output, $B(x, y)$, is an image of $A(x, y)$ blurred by the Radon transform.

How IDL Implements the Radon Transform

To avoid the use of a two-dimensional interpolation and decrease the interpolation errors, the Radon transform equation is rotated by θ, and the interpolation is then done along the line *s*. The transform is divided into two regions, one for nearly-horizontal lines ($45° < \theta < 135°$), and the other for steeper lines ($\theta \le 45°$; $135° \le \theta \le 180°$), where θ is assumed to lie on the interval [0°,180°].

For nearest-neighbor interpolation (the default), the discrete transform formula for an image $A(m, n)$ $[m = 0, ..., M–1, n = 0, ..., N–1]$ is:

$$R(\theta,\rho) = \begin{cases} \dfrac{\Delta x}{|\sin\theta|} \sum\limits_{m} A(m,[am+b]) & |\sin\theta| > \dfrac{\sqrt{2}}{2} \\ \dfrac{\Delta y}{|\cos\theta|} \sum\limits_{n} A([a'n+b'],n) & |\sin\theta| \le \dfrac{\sqrt{2}}{2} \end{cases}$$

where brackets $[\cdot]$ indicate rounding to the nearest integer, and the slope and offsets are given by:

$$a = -\frac{\Delta x}{\Delta y}\frac{\cos\theta}{\sin\theta} \qquad b = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta y \sin\theta}$$

$$a' = \frac{1}{a} \qquad b' = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta x \cos\theta}$$

For linear interpolation, the transform is:

$$R(\theta,\rho) = \begin{cases} \dfrac{\Delta x}{|\sin\theta|} \sum\limits_{m} (1-w)A(m,\lfloor am+b \rfloor) + wA(m,\lfloor am+b \rfloor + 1) & |\sin\theta| > \dfrac{\sqrt{2}}{2} \\ \dfrac{\Delta y}{|\cos\theta|} \sum\limits_{n} (1-w)A(\lfloor a'n+b' \rfloor,n) + wA(\lfloor a'n+b' \rfloor + 1,n) & |\sin\theta| \le \dfrac{\sqrt{2}}{2} \end{cases}$$

where the slope and offsets are the same as above, and $\lfloor \cdot \rfloor$ indicates flooring to the nearest lower integer. The weighting w is given by the difference between $am + b$ and its floored value, or between $a'n + b'$ and its floored value.

How IDL Implements the Radon Backprojection

For the backprojection transform, the discrete formula for nearest-neighbor interpolation is:

$$B(m,n) = \Delta\theta \sum_{t} R(\theta_t,[\rho])$$

with the nearest-neighbor for ρ given by:

$$\rho = \{(m\Delta x + x_{\min})\cos\theta_t + (n\Delta y + y_{\min})\sin\theta_t - \rho_{\min}\}\Delta\rho^{-1}$$

For backprojection with linear interpolation:

$$B(m,n) = \Delta\theta\sum_t (1-w)R(\theta_t, \lfloor\rho\rfloor) + wR(\theta_t, \lfloor\rho\rfloor + 1)$$

$$w = \rho - \lfloor\rho\rfloor$$

and ρ is the same as in the nearest-neighbor.

Arguments

Array

The two-dimensional array of size *M* by *N* to be transformed.

Keywords

BACKPROJECT

If set, the backprojection is computed, otherwise, the forward transform is computed.

Note

The Radon backprojection does not return the original image. Instead, it returns an image blurred by the Radon transform. Because the Radon transform is not one-to-one, multiple (*x*, *y*) points are mapped to a single (θ, ρ).

DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

DRHO

Set this keyword equal to a scalar specifying the spacing between ρ coordinates, expressed in the same units as *Array*. The default is one-half of the diagonal distance between pixels, $0.5[(DX^2 + DY^2)]^{1/2}$. Smaller values produce finer resolution, and are useful for zooming in on interesting features. Larger values may result in

undersampling, and are not recommended. If BACKPROJECT is specified, this keyword is ignored.

DX

Set this keyword equal to a scalar specifying the spacing between the horizontal (x) coordinates. The default is 1.0.

DY

Set this keyword equal to a scalar specifying the spacing between the vertical (y) coordinates. The default is 1.0.

GRAY

Set or omit this keyword to perform a weighted Radon transform, with the weighting given by the pixel values. If GRAY is explicitly set to zero, the image is treated as a binary image with all nonzero pixels considered as 1.

LINEAR

Set this keyword to use linear interpolation rather than the default nearest-neighbor sampling. Results are more accurate but slower when linear interpolation is used.

NRHO

Set this keyword equal to a scalar specifying the number of ρ coordinates to use. The default is 2 CEIL([MAX($x^2 + y^2$)]$^{1/2}$ / DRHO) + 1. If BACKPROJECT is specified, this keyword is ignored.

NTHETA

Set this keyword equal to a scalar specifying the number of θ coordinates to use over the interval [0, π]. The default is CEIL(π [($M^2 + N^2$)/2]$^{1/2}$). Larger values produce smoother results, and are useful for filtering before backprojection. Smaller values result in broken lines in the transform, and are not recommended. If BACKPROJECT is specified, this keyword is ignored.

NX

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of horizontal coordinates in the output *Result*. The default is FLOOR(2 MAX(|RHO|)($DX^2 + DY^2$)$^{-1/2}$ + 1). For the forward transform this keyword is ignored.

NY

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of vertical coordinates in the output *Result*. The default is FLOOR(2 MAX(|RHO|)(DX^2 + DY^2)$^{-1/2}$ + 1). For the forward transform, this keyword is ignored.

RHO

For the forward transform, set this keyword to a named variable that will contain the radial (ρ) coordinates. If BACKPROJECT is specified, this keyword must contain the ρ coordinates of the input *Array*. The ρ coordinates should be evenly spaced and in increasing order.

RMIN

Set this keyword equal to a scalar specifying the minimum ρ coordinate to use for the forward transform. The default is –0.5(NRHO – 1) DRHO. If BACKPROJECT is specified, this keyword is ignored.

THETA

For the forward transform, set this keyword to a named variable containing a vector of angular (θ) coordinates to use for the transform. If NTHETA is specified instead, and THETA is set to a named variable, on exit THETA will contain the θ coordinates. If BACKPROJECT is specified, this keyword must contain the θ coordinates of the input *Array*.

XMIN

Set this keyword equal to a scalar specifying the *x*-coordinate of the lower-left corner of the input *Array*. The default is – (*M*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the *x*-coordinate of the lower-left corner of the *Result*. In this case the default is –DX (NX–1)/2.

YMIN

Set this keyword equal to a scalar specifying the *y*-coordinate of the lower-left corner of the input *Array*. The default is – (*N*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the *y*-coordinate of the lower-left corner of the *Result*. In this case, the default is –DY (NY–1)/2.

Example

This example displays the Radon transform and the Radon backprojection:

```
PRO radon_example

   DEVICE, DECOMPOSED=0

   ;Create an image with a ring plus random noise:
   x = (LINDGEN(128,128) MOD 128) - 63.5
   y = (LINDGEN(128,128)/128) - 63.5
   radius = SQRT(x^2 + y^2)
   array = (radius GT 40) AND (radius LT 50)
   array = array + RANDOMU(seed,128,128)

   ;Create display window, set graphics properties:
   WINDOW, XSIZE=440,YSIZE=700, TITLE='Radon Example'
   !P.BACKGROUND = 255  ; white
   !P.COLOR = 0 ; black
   !P.FONT=2
   ERASE

   XYOUTS, .05, .94, 'Ring and Random Pixels', /NORMAL
   ;Display the image. 255b changes black values to white:
   TVSCL, 255b - array, .05, .75, /NORMAL

   ;Calculate and display the Radon transform:
   XYOUTS, .05, .70, 'Radon Transform', /NORMAL
   result = RADON(array, RHO=rho, THETA=theta)
   TVSCL, 255b - result, .08, .32, /NORMAL
   PLOT, theta, rho, /NODATA, /NOERASE, $
      POSITION=[0.08,0.32, 1, 0.68], $
      XSTYLE=9,YSTYLE=9,XTITLE='Theta', YTITLE='R'

   ;For simplicity in this example, remove everything except
   ;the two stripes. A better (and more complicated) method would
   ;be to choose a threshold for the result at each value of theta,
   ;perhaps based on the average of the result over the theta
   ;dimension.
   result[*,0:55] = 0
   result[*,73:181] = 0
   result[*,199:*] = 0

   ;Find the Radon backprojection and display the output:
   XYOUTS, .05, .26, 'Radon Backprojection', /NORMAL
   backproject = RADON(result, /BACKPROJECT, RHO=rho, THETA=theta)
   TVSCL, 255b - backproject, .05, .07, /NORMAL

END
```

The following figure displays the program output. The top image is an image of a ring and random pixels, or noise. The center image is the Radon transform, and displays the line integrals through the image. The bottom image is the Radon backprojection, after filtering all noise except for the two strong horizontal stripes in the middle image.

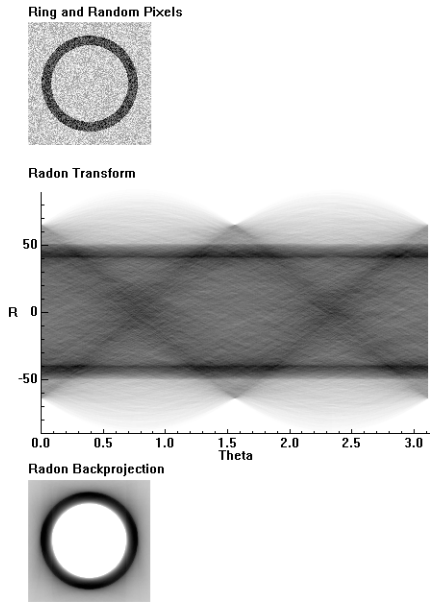


Figure 18: Radon Example - Original image (top), Radon transform (center), and backprojection of the altered Radon transform (bottom).

See Also

HOUGH, VOXEL_PROJ

References

1. Herman, Gabor T. *Image Reconstruction from Projections*. New York: Academic Press, 1980.
2. Hiriyannaiah, H. P. X-ray computed tomography for medical imaging. IEEE Signal Processing Magazine, March 1997: 42-58.

3. Jain, Anil K. *Fundamentals of Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1989.

4. Toft, Peter. *The Radon Transform: Theory and Implementation*. Denmark: Technical University; 1996. Ph.D. Thesis.

RANDOMN

The RANDOMN function returns one or more normally-distributed, floating-point, pseudo-random numbers with a mean of zero and a standard deviation of one. RANDOMN uses the Box-Muller method for generating normally-distributed (Gaussian) random numbers.

Syntax

Result = RANDOMN(*Seed* [, D_1, ..., D_8] [[, BINOMIAL=*[trials, probability]*] [, /DOUBLE] [, GAMMA=*integer*{>0}] [, /NORMAL] [, POISSON=*value*] [, /UNIFORM] | [, /LONG]])

Arguments

Seed

A variable or constant used to initialize the random sequence on input, and in which the state of the random number generator is saved on output.

The state of the random number generator is contained in a long integer vector. This state is saved in the Seed argument when the argument is a named variable. To continue the pseudo-random number sequence, input the variable containing the saved state as the Seed argument in the next call to RANDOMN or RANDOMU. Each independent random number sequence should maintain its own state variable. To maintain a state over repeated calls to a procedure, the seed variable may be stored in a COMMON block.

In addition to states maintained by the user in variables, the RANDOMU and RANDOMN functions contain a single shared generic state that is used if a named variable is not supplied as the Seed argument or the named variable supplied is undefined. The generic state is initialized once using the time-of-day, and may be re-initialized by providing a Seed argument that is a constant or expression.

If the Seed argument is:

- an undefined variable — the generic state is used and the resulting generic state array is stored in the variable.
- a named variable that contains a longword array of the proper length — it is used to continue the pseudo-random sequence, and is updated.
- a named variable containing a scalar — the scalar value is used to start a new sequence and the resulting state array is stored back in the variable.

- a constant or expression — the value is used to re-initialize the generic state.

Note

RANDOMN and RANDOMU use the same sequence. Starting or restarting the sequence for one starts or restarts the sequence for the other. Some IDL routines use the random number generator, so using them will initialize the seed sequence. An example of such a routine is CLUST_WTS.

Note

Do not alter the seed value returned by this function. The only valid use for the seed argument is to pass it back to a subsequent call. Changing the value of the seed will corrupt the random sequence.

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimensions are specified, RANDOMN returns a scalar result

Keywords

The formulas for the binomial, gamma, and Poisson distributions are from section 7.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

BINOMIAL

Set this keyword to a 2-element array, $[n, p]$, to generate random deviates from a binomial distribution. If an event occurs with probability p, with n trials, then the number of times it occurs has a binomial distribution.

Note

For $n > 1.0 \times 10^7$, you should set the DOUBLE keyword.

DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

Note

RANDOMN constructs double-precision uniform random deviates using the formula:

$$Y = \frac{(i1 - 1) \cdot imax + i2}{\text{imax}^2 + 1}$$

where *i1* and *i2* are integer random deviates in the range [1...*imax*], and *imax* = $2^{31} - 2$ is the largest possible integer random deviate. The *Y* values will be in the range $0 < Y < 1$.

GAMMA

Set this keyword to an integer order $i > 0$ to generate random deviates from a gamma distribution. The gamma distribution is the waiting time to the *i*th event in a Poisson random process of unit mean. A gamma distribution of order equal to 1 is the same as the exponential distribution.

Note

For GAMMA > 1.0×10^7, you should set the DOUBLE keyword.

LONG

Set this keyword to return integer uniform random deviates in the range [1...$2^{31} - 2$]. If LONG is set, all other keywords are ignored.

NORMAL

Set this keyword to generate random deviates from a normal distribution.

POISSON

Set this keyword to the mean number of events occurring during a unit of time. The POISSON keyword returns a random deviate drawn from a Poisson distribution with that mean.

Note

For POISSON > 1.0×10^7, you should set the DOUBLE keyword.

UNIFORM

Set this keyword to generate random deviates from a uniform distribution.

Examples

If you start the sequence with an *undefined* variable—if RANDOMN has already been called, *Seed* is no longer undefined—IDL initializes the sequence with the system time:

```
; Generate one random variable and initialize the sequence with an
; undefined variable:
randomValue = RANDOMN(seed)
```

The new state is saved in seed. To generate repeatable experiments, begin the sequence with a particular seed:

```
seed_value = 5L

; Generate one random variable and initialize the sequence with 5:
randomValue = RANDOMN(seed_value)

PRINT, randomValue
```

IDL prints:

```
0.521414
```

To restart the sequence with a particular seed, re-initialize the variable:

```
seed = 5L

;Get a normal random number, and restart the sequence with a seed
;of 5.
randomValue = RANDOMN(seed)

PRINT, randomValue
```

IDL prints:

```
0.521414
```

To continue the same sequence:

```
PRINT, RANDOMN(seed)
```

IDL prints:

```
-0.945489
```

To create a 10 by 10 array of normally-distributed, random numbers, type:

```
R = RANDOMN(seed, 10, 10)
```

Since seed is undefined, the generic state is used to initialize the random number generator. Print the resulting values by entering:

```
PRINT, R
```

A more interesting example plots the probability function of 2000 numbers returned by RANDOMN. Type:

```
PLOT, HISTOGRAM(RANDOMN(SEED, 2000), BINSIZE=0.1)
```

To obtain a sequence of 1000 exponential (gamma distribution, order 1) deviates, type:

```
Result = RANDOMN(seed, 1000, GAMMA=1)
```

Intuitively, the result contains a random series of waiting times for events occurring an average of one per time period.

To obtain a series of 1000 random elapsed times required for the arrival of two events, type:

```
;Returns a series of 1000 random elapsed times required for the
;arrival of two events.
Result = RANDOMN(seed, 1000, GAMMA=2)
```

To obtain a 128 x 128 array filled with Poisson deviates, with a mean of 1.5, type:

```
Result = RANDOMN(seed, 128, 128, POISSON=1.5)
```

To simulate the count of “heads” obtained when flipping a coin 10 times, type:

```
Result = RANDOMN(seed, BINOMIAL=[10,.5])
```

See Also

RANDOMU

RANDOMU

The RANDOMU function returns one or more uniformly-distributed, floating-point, pseudo-random numbers in the range $0 < Y < 1.0$.

The random number generator is taken from: "Random Number Generators: Good Ones are Hard to Find", Park and Miller, *Communications of the ACM*, Oct 1988, Vol 31, No. 10, p. 1192. To remove low-order serial correlations, a Bays-Durham shuffle is added, resulting in a random number generator similar to ran1() in Section 7.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

Syntax

Result = RANDOMU(*Seed* [, D_1, ..., D_8] [[, BINOMIAL=*[trials, probability]*] [, /DOUBLE] [, GAMMA=*integer*{>0}] [, /NORMAL] [, POISSON=*value*] [, /UNIFORM] | [, /LONG]])

Arguments

Seed

A variable or constant used to initialize the random sequence on input, and in which the state of the random number generator is saved on output.

The state of the random number generator is contained in a long integer vector. This state is saved in the Seed argument when the argument is a named variable. To continue the pseudo-random number sequence, input the variable containing the saved state as the Seed argument in the next call to RANDOMN or RANDOMU. Each independent random number sequence should maintain its own state variable. To maintain a state over repeated calls to a procedure, the seed variable may be stored in a COMMON block.

In addition to states maintained by the user in variables, the RANDOMU and RANDOMN functions contain a single shared generic state that is used if a named variable is not supplied as the Seed argument or the named variable supplied is undefined. The generic state is initialized once using the time-of-day, and may be re-initialized by providing a Seed argument that is a constant or expression.

If the Seed argument is:

- an undefined variable — the generic state is used and the resulting generic state array is stored in the variable.

- a named variable that contains a longword array of the proper length — it is used to continue the pseudo-random sequence, and is updated.
- a named variable containing a scalar — the scalar value is used to start a new sequence and the resulting state array is stored back in the variable.
- a constant or expression — the value is used to re-initialize the generic state.

Note

RANDOMN and RANDOMU use the same sequence, so starting or restarting the sequence for one starts or restarts the sequence for the other. Some IDL routines use the random number generator, so using them will initialize the seed sequence. An example of such a routine is CLUST_WTS.

Note

Do not alter the seed value returned by this function. The only valid use for the seed argument is to pass it back to a subsequent call. Changing the value of the seed will corrupt the random sequence.

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimensions are specified, RANDOMU returns a scalar result.

Keywords

The formulas for the binomial, gamma, and Poisson distributions are from Section 7.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

BINOMIAL

Set this keyword to a 2-element array, $[n, p]$, to generate random deviates from a binomial distribution. If an event occurs with probability p, with n trials, then the number of times it occurs has a binomial distribution.

Note

For $n > 1.0 \times 10^7$, you should set the DOUBLE keyword.

DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

Note

RANDOMU constructs double-precision uniform random deviates using the formula:

$$Y = \frac{(i1 - 1) \cdot imax + i2}{\text{imax}^2 + 1}$$

where *i1* and *i2* are integer random deviates in the range [1...*imax*], and *imax* = $2^{31} - 2$ is the largest possible integer random deviate. The *Y* values will be in the range $0 < Y < 1$.

GAMMA

Set this keyword to an integer order $i > 0$ to generate random deviates from a gamma distribution. The gamma distribution is the waiting time to the *i*th event in a Poisson random process of unit mean. A gamma distribution of order equal to 1 is the same as the exponential distribution.

Note

For GAMMA > 1.0×10^7, you should set the DOUBLE keyword.

LONG

Set this keyword to return integer uniform random deviates in the range [1...$2^{31} - 2$]. If LONG is set, all other keywords are ignored.

NORMAL

Set this keyword to generate random deviates from a normal distribution.

POISSON

Set this keyword to the mean number of events occurring during a unit of time. The POISSON keyword returns a random deviate drawn from a Poisson distribution with that mean.

Note

For POISSON > 1.0×10^7, you should set the DOUBLE keyword.

UNIFORM

Set this keyword to generate random deviates from a uniform distribution.

Example

This example simulates rolling two dice 10,000 times and plots the distribution of the total using RANDOMU. Enter:

```
PLOT, HISTOGRAM(FIX(6 * RANDOMU(S, 10000)) + $
   FIX(6 * RANDOMU(S, 10000)) + 2)
```

In the above statement, the expression RANDOMU(S, 10000) is a 10,000-element, floating-point array of random numbers greater than or equal to 0 and less than 1. Multiplying this array by 6 converts the range to $0 \le Y < 6$.

Applying the FIX function yields a 10,000-point integer vector with values from 0 to 5, one less than the numbers on one die. This computation is done twice, once for each die, then 2 is added to obtain a vector from 2 to 12, the total of two dice.

The HISTOGRAM function makes a vector in which each element contains the number of occurrences of dice rolls whose total is equal to the subscript of the element. Finally, this vector is plotted by the PLOT procedure.

An example of reusing a state vector to generate a repeatable sequence:

```
; Init seed for a repeatable sequence:
seed = 1001L

; Print 1st 5 numbers of sequence:
print,randomu(seed,5)
```

IDL prints:

```
      0.705884     0.285924     0.231151     0.715447     0.532836
```

Reuse a state vector:

```
; Re-init seed to same sequence:
seed = 1001L

; Get 5 number of sequence with 5 calls:
for i=0,4 do print, randomu(seed)
```

IDL prints:

```
0.705884
0.285924
0.231151
0.715447
0.532836
```

See Also

RANDOMN

RANKS

The RANKS function computes the magnitude-based ranks of a sample population *X*. Elements of identical magnitude "ties" are ranked according to the mean of the ranks that would otherwise be assigned. The result is a vector of ranks equal in length to *X*.

This routine is written in the IDL language. Its source code can be found in the file `ranks.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = RANKS(*X*)

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector. The elements of this vector must be in ascending order based on their magnitude.

Example

```
; Define an n-element sample population:
X = [-0.8, 0.1, -2.3, -0.6, 0.2, 1.1, -0.3, 0.6, -0.2, 1.1, $
     -0.7, -0.2, 0.6, 0.4, -0.1, 1.1, -0.3, 0.3, -1.3, 1.1]

; Allocate a two-column, n-row array to store the results:
array = FLTARR(2, N_ELEMENTS(X))

; Sort the sample population and store in the 0th column of ARRAY:
array[0, *] = X[SORT(X)]
; Compute the ranks of the sorted sample population and store in
; the 1st column of ARRAY:
array[1, *] = RANKS(X[SORT(X)])

; Display the sorted sample population and corresponding ranks
; with a two-decimal format:
PRINT, array, FORMAT = '(2(5x, f5.2))'
```

IDL prints:

```
-2.30      1.00
-1.30      2.00
-0.80      3.00
-0.70      4.00
-0.60      5.00
```

```
-0.30      6.50
-0.30      6.50
-0.20      8.50
-0.20      8.50
-0.10     10.00
 0.10     11.00
 0.20     12.00
 0.30     13.00
 0.40     14.00
 0.60     15.50
 0.60     15.50
 1.10     18.50
 1.10     18.50
 1.10     18.50
 1.10     18.50
```

See Also

R_CORRELATE

RDPIX

The RDPIX procedure interactively displays the X position, Y position, and pixel value at the cursor.

This routine is written in the IDL language. Its source code can be found in the file `rdpix.pro` in the `lib` subdirectory of the IDL distribution.

Using RDPIX

RDPIX displays a stream of X, Y, and pixel values when the mouse cursor is moved over a graphics window. Press the left or center mouse button to create a new line of output. Press the right mouse button to exit the procedure.

Syntax

RDPIX, *Image* [, *X0*, *Y0*]

Arguments

Image

The array that contains the image being displayed. This array may be of any type. Rather than reading pixel values from the display, values are taken from this parameter, avoiding scaling difficulties.

X0, Y0

The location of the lower-left corner of the image area on screen. If these parameters are not supplied, they are assumed to be zero.

See Also

CURSOR, TVRD

READ/READF

The READ procedures perform formatted input into variables.

READ performs input from the standard input stream (IDL file unit 0), while READF requires a file unit to be explicitly specified.

Syntax

READ, [*Prompt*,] Var_1, ..., Var_n

READF, [*Prompt*,] *Unit*, Var_1, ..., Var_n

Keywords: [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, PROMPT=*string*]

VMS Keywords: [, KEY_ID=*value*] [, KEY_MATCH=*relation*] [, KEY_VALUE=*value*]

Arguments

Prompt

Note that the PROMPT keyword should be used instead of the *Prompt* argument for compatibility with window-based versions of IDL.

A string or explicit expression (i.e, not a named variable) to be used as a prompt. This argument should not be included if the FORMAT keyword is specified. Also, if this argument begins with the characters "$(", it is taken to be a format specification as described below under "Format Compatibility".

Using the *Prompt* argument does not work well with IDL for Windows and IDL for Macintosh. The desired prompt string is written to the log window instead of the command input window. To create custom prompts compatible with these versions of IDL, use the PROMPT keyword, described below.

Unit

For READF, Unit specifies the file unit from which the input is taken.

Var_i

The named variables to receive the input.

Note

If the variable specified for the *Var*$_i$ argument has not been previously defined, the input data is assumed to be of type float, and the variable will be cast as a float.

Keywords

AM_PM

Supplies a string array of two names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the input. FORMAT allows the format of the input to be specified in precise detail, using a FORTRAN-style specification. See "Using Explicitly Formatted Input/Output" in Chapter 8 of *Building IDL Applications*.

MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

PROMPT

Set this keyword to a scalar string to be used as a customized prompt for the READ command. If the PROMPT keyword or *Prompt* argument is not supplied, IDL uses a colon followed by a space (": ") as the input prompt.

VMS Keywords

Note also that the obsolete VMS-only routine READ_KEY has been replaced by the keywords below.

KEY_ID

The index key to be used (primary = 0, first alternate key = 1, etc...) when accessing data from a file with indexed organization. If this keyword is omitted, the primary key is used.

KEY_MATCH

The relation to be used when matching the supplied key with key field values (EQ = 0, GE = 1, GT = 2) when accessing data from a file with indexed organization. If this keyword is omitted, the equality relation (0) is used.

KEY_VALUE

The value of a key to be found when accessing data from a file with indexed organization. This value must match the key definition that is determined when the file was created in terms of type and size—no conversions are performed. If this keyword is omitted, the next sequential record is used.

Format Compatibility

If the FORMAT keyword is not present and READ is called with more than one argument, and the first argument is a scalar string starting with the characters "$(", this initial argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

Example

To read a string value into the variable B from the keyboard, enter:

```
; Define B as a string before reading:
B = ''

; Read input from the terminal:
READ, B, PROMPT='Enter Name: '
```

To read formatted data from the previously-opened file associated with logical unit number 7 into variable C, use the command:

```
READF, 7, C
```

See Also

READS, READU, WRITEU

READ_ASCII

The READ_ASCII function reads data from an ASCII file into an IDL structure variable. READ_ASCII may be used with templates created by the ASCII_TEMPLATE function.

This routine handles ASCII files consisting of an optional header of a fixed number of lines, followed by columnar data. One or more rows of data constitute a *record*. Each data element within a record is considered to be in a different column, or *field*. The data in one field must be of, or promotable to, a single type (e.g., FLOAT). Adjacent fields may be collected into multi-column fields, called *groups*. Files may also contain comments, which exist between a user-specified comment string and the corresponding end-of-line.

READ_ASCII is designed to be used with templates created by the ASCII template function.

This routine is written in the IDL language. Its source code can be found in the file `read_ascii.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = READ_ASCII([*Filename*] [, COMMENT_SYMBOL=*string*] [, COUNT=*variable*] [, DATA_START=*lines_to_skip*] [, DELIMITER=*string*] [, HEADER=*variable*] [, MISSING_VALUE=*value*] [, NUM_RECORDS=*value*] [, RECORD_START=*index*] [, TEMPLATE=*value*] [, /VERBOSE])

Arguments

Filename

A string containing the name of an ASCII file to read into an IDL variable. If *filename* is not specified, a dialog allows the user to choose a file.

Keywords

You can define the attributes of a field in two ways. If you use a template, you can either use a previously generated template, or create a template with ASCII_TEMPLATE. You can use COMMENT_SYMBOL, DATA_START, DELIMITER, or MISSING_VALUE to either override template attributes or to provide one-time attributes for the file to be read, without a template.

COMMENT_SYMBOL

Set this keyword to a string that identifies the character used to delineate comments in the ASCII file to be read. When READ_ASCII encounters the comment character, it discards data from that point until it reaches the end of the current line, identifying the rest of the line as a comment. The default character the null string, ‘’, specifying that no comments will be recognized.

COUNT

Set this keyword equal to a named variable that will contain the number of records read.

DATA_START

Set this keyword equal to the number of header lines you want to skip. The default value is 0 if no template is specified.

DELIMITER

Set this keyword to a string that identifies the end of a field. If no delimiter is specified, READ_ASCII uses information provided by the template in use. The default is a space, ‘ ’, specifying that an empty element constitutes the end of a field.

HEADER

Set this keyword equal to a named variable that will contain the header in a string array of length DATA_START. If no header exists, an empty string is returned.

MISSING_VALUE

Set this keyword equal to a value used to replace any missing or invalid data. The default value, if no template is supplied, is !VALUES.F_NAN. See “!VALUES” on page 2423 for details.

NUM_RECORDS

Set this keyword equal to the number of records to read. The default is to read up to and including the last record.

RECORD_START

Set this keyword equal to the index of the first record to read. The default is the first record of the file (record 0).

TEMPLATE

Use this keyword to specify the ASCII file template (generated by the function ASCII_TEMPLATE), that defines attributes of the file to be read. Specific attributes of the template may be overridden by the following keywords: COMMENT_SYMBOL, DATA_START, DELIMITER, MISSING_VALUE.

VERBOSE

Set this keyword to print runtime messages.

Examples

To read ASCII data using default file attributes, except for setting the number of skipped header lines to 10, type:

```
data = READ_ASCII(file, DATA_START=10)
```

To use a template to define file attributes, overriding the number of skipped header lines defined in the template, type:

```
data = READ_ASCII(file, TEMPLATE=template, DATA_START=10)
```

To use the ASCII_TEMPLATE GUI to generate a template within the function, type:

```
data = READ_ASCII(myfile, TEMPLATE=ASCII_TEMPLATE(myfile))
```

See Also

ASCII_TEMPLATE

READ_BINARY

The READ_BINARY function reads the contents of a binary file using a passed template or basic command line keywords. The result is an array or anonymous structure containing all of the entities read from the file. Data is read from the given filename or from the current file position in the open file pointed to by FileUnit. If no template is provided, keywords can be used to read a single IDL array of data.

Note

The READ_BINARY function does not work on VMS platforms due to limitations in the POINT_LUN procedure. For more information, see POINT_LUN.

Syntax

Result = READ_BINARY ([*Filename*] | *FileUnit* [, TEMPLATE=*template*] | [[, DATA_START=*value*] [, DATA_TYPE=*typecodes*] [, DATA_DIMS=*array*] [, ENDIAN=*string*]])

Arguments

Filename

A scalar string containing the name of the binary file to read. If *filename* and file unit are not specified, a dialog allows the user to choose a file.

FileUnit

A scalar containing an open IDL file unit number to read from.

Keywords

DATA_DIMS

Set this keyword to a scalar or array of up to eight elements specifying the size of the data to be read and returned. For example, DATA_DIMS=[512,512] specifies that a two-dimensional, 512 by 512 array be read and returned. DATA_DIMS=0 specifies that a single, scalar value be read and returned. Default is -1, which, if a TEMPLATE is not supplied that specifies otherwise, indicates that READ_BINARY will read to end-of-file and store the result in a 1D array.

DATA_START

Set this keyword to specify where to begin reading in a file. This value is as an offset, in bytes, that will be applied to the initial position in the file. Default is 0.

DATA_TYPE

Set this keyword to an IDL typecode of the data to be read. See documentation for the SIZE function for a listing of typecodes. Default is 1 (IDL's BYTE typecode).

ENDIAN

Set this keyword to one of three string values: 'big", "little" or "native" which specifies the byte ordering of the file to be read. If the computer running READ_BINARY uses byte ordering that is different than that of the file, READ_BINARY will swap the order of bytes in multi-byte data types read from the file. (Default: "native" = perform no byte swapping.)

TEMPLATE

Set this keyword to a template structure describing the file to be read. A template can be created using BINARY_TEMPLATE. The TEMPLATE keyword cannot be used simultaneously with keywords DATA_START, DATA_TYPE, DATA_DIMS, or ENDIAN.

When a template is used with READ_BINARY, the result of a successful call to READ_BINARY is a structure containing fields specified by the template.

If a template is not used with READ_BINARY, the result of a successful call to READ_BINARY is an array.

READ_BMP

The READ_BMP function reads a Microsoft Windows Version 3 device independent bitmap file (.BMP) and returns a byte array containing the image. Dimensions are taken from the BITMAPINFOHEADER of the file. In the case of 4-bit or 8-bit images, the dimensions of the resulting array are (`biWidth`, `biHeight`).

For 24-bit images, the dimensions are (`3`, `biWidth`, `biHeight`). Color interleaving is blue, green, red; i.e., Result[*0*,*i*,*j*] = blue, Result[*1*,*i*,*j*] = green, etc.

READ_BMP does not handle 1-bit-deep images or compressed images, and is not fast for 4-bit images. The algorithm works best on images where the number of bytes in each scan-line is evenly divisible by 4.

This routine is written in the IDL language. Its source code can be found in the file `read_bmp.pro` in the `lib` subdirectory of the IDL distribution.

Note

To find information about a potential BMP file before trying to read its data, use the QUERY_BMP function.

Syntax

Result = READ_BMP(*Filename*, [, *R*, *G*, *B*] [, *Ihdr*] [, /RGB])

Arguments

Filename

A scalar string specifying the full path name of the bitmap file to read.

R, G, B

Named variables that will contain the color tables from the file. There 16 elements each for 4 bit images, 256 elements each for 8 bit images. Color tables are not defined or used for 24 bit images.

Ihdr

A named variable that will contain a structure holding the BITMAPINFOHEADER from the file. Tag names are as defined in the MS Windows Programmer's Reference Manual, Chapter 7.

Keywords

RGB

If this keyword is set, color interleaving of 16- and 24-bit images will be R, G, B, i.e., Result[*0*,*i*,*j*] = red, Result[*1*,*i*,*j*] = green, Result[2,*i*,*j*] = blue.

Example

To open, read, and display the BMP file named `foo.bmp` in the current directory and store the color vectors in the variables R, G, and B, enter:

```
; Read and display an image:
TV, READ_BMP('foo.bmp', R, G, B)

; Load its colors:
TVLCT, R, G, B
```

Many applications that use 24-bit BMP files outside IDL expect BMP files to be stored as BGR. For example, enter the following commands.

```
; Make a red square image:
a = BYTARR(3, 200, 200)
a[0, *, *] = 255

;View the image:
TV, a, /TRUE
WRITE_BMP, 'foo.bmp', a
```

If you open the `.bmp` file in certain bitmap editors, you may find that the square is blue.

```
image = READ_BMP('foo.bmp')

; IDL reads the image back in and interprets it as red:
TV, image, /TRUE

; Flip the order of the indices by adding the RGB keyword:
image = READ_BMP('foo.bmp', /RGB)

; Displays the image in blue:
TV, image, /TRUE
```

See Also

WRITE_BMP, QUERY_BMP

READ_DICOM

The READ_DICOM function reads an image from a DICOM file along with any associated color table. The return value can be a 2D array for grayscale or a 3D array for TrueColor images. TrueColor images are always returned in pixel interleave format. The return array type depends on the DICOM image pixel type.

This routine is written in the IDL language. Its source code can be found in the file `read_dicom.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = READ_DICOM (*Filename* [, *Red*, *Green*, *Blue*] [, IMAGE_INDEX=*index*])

Arguments

Filename

This argument is a scalar string that contains the full pathname of the file to read.

Red, Green, Blue

Named variables that will contain the red, green, and blue color vectors from the DICOM file if they exist.

Note

DICOM color vectors contain 16- bit color values that may need to be converted for use with IDL graphics routines.

Keywords

IMAGE_INDEX

Set this keyword to the index of the image to read from the file.

Example

```
TVSCL,READ_DICOM(FILEPATH('mr_knee.dcm',$
   SUBDIR=['examples','data']))
```

See Also

QUERY_DICOM

READ_IMAGE

The READ_IMAGE function reads the image contents of a file and returns the image in an IDL variable. If the image contains a palette it can be returned as well in three IDL variables. READ_IMAGE returns the image in the form of a two-dimensional array (for grayscale images) or a (3, n, m) array (for TrueColor images). READ_IMAGE can read most types of image files supported by IDL. See QUERY_IMAGE for a list of supported formats.

Syntax

Result = READ_IMAGE (*Filename* [, *Red*, *Green*, *Blue*]
[, IMAGE_INDEX=*index*])

Return Value

Result is the image array read from the file or scalar value of -1 if the file could not be read.

Arguments

Filename

A scalar string containing the name of the file to read.

Red

An optional named variable to receive the red channel of the color table if a color table exists.

Green

An optional named variable to receive the green channel of the color table if a color table exists.

Blue

An optional named variable to receive the blue channel of the color table if a color table exists.

Keywords

IMAGE_INDEX

Set this keyword to the index of the image to read from the file. The default is 0, the first image.

READ_INTERFILE

The READ_INTERFILE procedure reads image data stored in Interfile (v3.3) format and returns a 3D array.

READ_INTERFILE can only read a series of images if all images have the same height and width. It does not get additional keyword information beyond what is needed to read the image data. If any problems occur when reading the file, READ_INTERFILE prints a message and stops.

If the data is stored on a bigendian machine and read on a littleendian machine (or vice versa) the order of bytes in each pixel element may be reversed, requiring a call to BYTEORDER

This routine is written in the IDL language. Its source code can be found in the file `read_interfile.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

READ_INTERFILE, *File*, *Data*

Arguments

File

A scalar string containing the name of the Interfile to read. Note: if the Interfile has a header file and a data file, this should be the name of the header file (also called the administrative file).

Data

A named variable that will contain a 3D array of data as read from the file. Assumed to be a series of 2D images.

Example

```
READ_INTERFILE, '0_11.hdr', X
```

READ_JPEG

The READ_JPEG procedure reads JPEG (Joint Photographic Experts Group) format compressed images from files or memory. JPEG is a standardized compression method for full-color and gray-scale images. This procedure reads JFIF, the JPEG File Interchange Format, including those produced by WRITE_JPEG. Such files are usually simply called JPEG files

READ_JPEG can optionally quantize TrueColor images contained in files to a pseudo-color palette with a specified number of colors, and with optional color dithering.

This procedure is based in part on the work of the Independent JPEG Group. For a brief explanation of JPEG, see "WRITE_JPEG" on page 1669.

Note

All JPEG files consist of byte data. Input data is converted to bytes before being written to a JPEG file.

Note

To find information about a potential JPEG file before trying to read its data, use the QUERY_JPEG function.

Syntax

READ_JPEG [, *Filename* | , UNIT=*lun*] , *Image* [, *Colortable*] [, BUFFER=*variable*] [, COLORS=*value*{8 to 256}] [, DITHER={0 | 1 | 2}] [, /GRAYSCALE] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /TWO_PASS_QUANTIZE]

Arguments

Filename

A scalar string specifying the full pathname of the JFIF format (JPEG) file to be read. If this parameter is not present, the UNIT and/or the BUFFER keywords must be specified.

Image

A named variable to contain the image data read from the file.

Colortable

A named variable to contain the colormap, when reading a TrueColor image that is to be quantized. On completion, this variable contains a byte array with dimensions (NCOLORS, 3). This argument is filled only if the image is color quantized (refer to the COLORS keyword).

Keywords

BUFFER

Set this keyword to a named variable that is used for a buffer. A buffer variable need only be supplied when reading multiple images per file. Initialize the buffer variable to empty by setting it to 0.

COLORS

If the image file contains a TrueColor image that is to be displayed on an indexed color destination, set COLORS to the desired number of colors to be quantized. COLORS can be set to a value from 8 to 256. The DITHER and TWO_PASS_QUANTIZE keywords affect the method, speed, and quality of the color quantization. These keywords have no effect if the file contains a grayscale image.

DITHER

Set this keyword to use dithering with color quantization (i.e., if the COLORS keyword is in use). Dithering is a method that distributes the color quantization error to surrounding pixels, to achieve higher-quality results. Set the DITHER keyword to one of the following values:

- 0 = No dithering. Images are read quickly, but quality is low.
- 1 = Floyd-Steinberg dithering. This method is relatively slow, but produces the highest quality results. This is the default behavior.
- 2 = Ordered dithering. This method is faster than Floyd-Steinberg dithering, but produces lower quality results.

GRAYSCALE

Set this keyword to return a monochrome (grayscale) image, regardless of whether the file contains an RGB or grayscale image.

ORDER

JPEG/JFIF images are normally written in top-to-bottom order. If the image is to be stored into the *Image* array in the standard IDL order (from bottom-to-top) set ORDER to 0. This is the default. If the image array is to be top-to-bottom order, set ORDER to 1.

TRUE

Use this keyword to specify the index of the dimension for color interleaving when reading a TrueColor image. The default is 1, for pixel interleaving, (3, *m*, *n*). A value of 2 indicates line interleaving (*m*, 3, *n*), and 3 indicates band interleaving, (*m*, *n*, 3).

TWO_PASS_QUANTIZE

Set this keyword to use a two-pass color quantization method when quantization is in effect (i.e., the COLORS keyword is in use). This method requires more memory and time, but produces superior results to the default one-pass quantization method.

UNIT

This keyword can be used to designate the logical unit number of an already open JFIF file, allowing the reading of multiple images per file or the embedding of JFIF images in other data files. When using this keyword, *Filename* should not be specified.

Note

When using VMS, open the file with the /STREAM keyword.

Note

When opening a file intended for use with the UNIT keyword, if the filename does not end in `.jpg`, or `.jpeg`, you must specify the STDIO keyword to OPEN in order for the file to be compatible with READ_JPEG.

Examples

```
; Read a JPEG grayscale image:
READ_JPEG, 'test.jpg', a

; Display the image:
TV, a

; Read and display a JPEG TrueColor image on a TrueColor display:
READ_JPEG, 'test.jpg', a, TRUE=1
```

```
; Display the image returned with pixel interleaving
; (i.e., with dimensions 3, m, n):
TV, a, TRUE=1
```

Read the image, setting the number of colors to be quantized to the maximum number of available colors.

```
; Read a JPEG TrueColor image on an 8-bit pseudo-color display:
READ_JPEG, 'test.jpg', a, ctable, COLORS=!D.N_COLORS-1

; Display the image:
TV, a

; Load the quantized color table:
TVLCT, ctable
```

We could have also included the TWO_PASS_QUANTIZE and DITHER keywords to improve the image's appearance.

Using the BUFFER keyword on VMS.

```
; Initialize buffer:
buff = 0
OPENR, 1, 'images.jpg', /STREAM

; Process each image:
FOR i=1, nimages DO BEGIN
   ; Read next image:
   READ_JPEG, UNIT=1, BUFFER=buff, a

   ; Display the image:
    TV, a
ENDFOR

; Done:
CLOSE, 1
```

See Also

WRITE_JPEG, QUERY_JPEG

READ_PICT

The READ_PICT procedure reads the contents of a PICT (version 2) format image file and returns the image and color table vectors (if present) in the form of IDL variables. The PICT format is used by Apple Macintosh computers.

This routine is written in the IDL language. Its source code can be found in the file `read_pict.pro` in the `lib` subdirectory of the IDL distribution.

Note

To find information about a potential PICT file before trying to read its data, use the QUERY_PICT function.

Syntax

READ_PICT, *Filename*, *Image* [, *R*, *G*, *B*]

Arguments

Filename

A scalar string specifying the full pathname of the PICT file to read.

Image

A named variable that will contain the 2D image read from *Filename*.

R, G, B

Named variables that will contain the Red, Green, and Blue color vectors read from the PICT file.

Example

To open and read the PICT image file named `foo.pict` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables R, G, and B, enter:

```
READ_PICT, 'foo.pict', image1, R, G, B
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

See Also

WRITE_PICT, QUERY_PICT

READ_PNG

The READ_PNG routine reads the image contents of a Portable Network Graphics (PNG) file and returns the image in an IDL variable. If the image contains a palette (see QUERY_PNG), it can be returned as well in three IDL variables. READ_PNG supports 1, 2, 3 and 4 channel images with channel depths of 8 or 16 bits.

Note

IDL supports version 1.0.5 of the PNG Library.

Note

Only single channel 8-bit images may have palettes. If an 8-bit, single-channel image has index values marked as "transparent," these can be retrieved as well.

Note

To find information about a potential PNG file before trying to read its data, use the QUERY_PNG function.

Syntax

Result = READ_PNG (*Filename* [, *R*, *G*, *B*] [,/ORDER] [, /VERBOSE] [, /TRANSPARENT])

or

READ_PNG, *Filename, Image* [, *R*, *G*, *B*] [,/ORDER] [, /VERBOSE] [, /TRANSPARENT]

Note

The procedure form of READ_PNG is available to ease the conversion of IDL code that uses the removed READ_GIF procedure. Instances of READ_GIF can be changed to READ_PNG by simply replacing "READ_GIF" with "READ_PNG". Note, however, that the CLOSE and MULTIPLE keywords to READ_GIF are not accepted by the READ_PNG procedure.

Return Value

For 8-bit images, *Result* will be a two- or three-dimensional array of type byte. For 16-bit images, *Result* will be of type unsigned integer (UINT).

Arguments

Filename

A scalar string containing the full pathname of the PNG file to read.

R, G, B

Named variables that will contain the Red, Green, and Blue color vectors if a color table exists.

Keywords

ORDER

Set this keyword to indicate that the rows of the image should be read from bottom to top. The rows are read from top to bottom by default. ORDER provides compatibility with PNG files written using versions of IDL prior to IDL 5.4, which wrote PNG files from bottom to top.

VERBOSE

Produces additional diagnostic output during the read.

TRANSPARENT

Returns an array of pixel index values that are to be treated as “transparent” for the purposes of image display. If there are no transparent values then TRANSPARENT will be set to a long-integer scalar with the value 0.

Example

Create an RGBA (16-bits/channel) and a Color Indexed (8-bit/channel) image with a palette:

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = indgen(256)
green = indgen(256)
blue = indgen(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue
```

```
;Query and read the data
names = ['rgb_image.png','ci_image.png','unknown.png']
FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
   ok = QUERY_PNG(names[i],s)
   IF (ok) THEN BEGIN
      HELP,s,/STRUCTURE
      IF (s.HAS_PALETTE) THEN BEGIN
         img = READ_PNG(names[i],rpal,gpal,bpal)
         HELP,img,rpal,gpal,bpal
      ENDIF ELSE BEGIN
         img = READ_PNG(names[i])
         HELP,img
      ENDELSE
   ENDIF ELSE BEGIN
      PRINT,names[i],' is not a PNG file'
   ENDELSE
ENDFOR
END
```

See Also

WRITE_PNG, QUERY_PNG

READ_PPM

The READ_PPM procedure reads the contents of a PGM (gray scale) or PPM (portable pixmap for color) format image file and returns the image in the form of a 2D byte array (for grayscale images) or a (3, *n*, *m*) byte array (for TrueColor images).

Files to be read should adhere to the PGM/PPM standard. The following file types are supported: P2 (graymap ASCII), P5 (graymap RAWBITS), P3 (TrueColor ASCII pixmaps), and P6 (TrueColor RAWBITS pixmaps). Maximum pixel values are limited to 255. Images are always stored with the top row first.

PPM/PGM format is supported by the PBMPLUS toolkit for converting various image formats to and from portable formats, and by the Netpbm package.

This routine is written in the IDL language. Its source code can be found in the file `read_ppm.pro` in the `lib` subdirectory of the IDL distribution.

Note

To find information about a potential PPM file before trying to read its data, use the QUERY_PPM function.

Syntax

READ_PPM, *Filename*, *Image* [, MAXVAL=*variable*]

Arguments

Filename

A scalar string specifying the full path name of the PGM or PPM file to read.

Image

A named variable that will contain the image. For grayscale images, *Image* is a 2D byte array. For TrueColor images, *Image* is a (3, *n*, *m*) byte array.

Keywords

MAXVAL

A named variable that will contain the maximum pixel value.

Example

To open and read the PGM image file named “foo.pgm” in the current directory and store the image in the variable IMAGE1:

```
READ_PPM, 'foo.pgm', IMAGE1
```

See Also

WRITE_PPM, QUERY_PPM

READ_SPR

The READ_SPR function reads a row-indexed sparse array from a specified file and returns the array as the result. Row-indexed sparse arrays are created using the SPRSIN function and written to a file using the WRITE_SPR function.

This routine is written in the IDL language. Its source code can be found in the file `read_spr.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = READ_SPR(*Filename*)

Arguments

Filename

A scalar string specifying the name of the file containing a row-indexed sparse array.

Example

Suppose we have already saved a row-indexed sparse array to a file named `sprs.as`, as described in the documentation for the WRITE_SPR routine. To read the sparse array from the file and store it in a variable `sprs`, use the following command:

```
sprs = READ_SPR('sprs.as')
```

See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, WRITE_SPR

READ_SRF

The READ_SRF procedure reads the contents of a Sun rasterfile and returns the image and color table vectors (if present) in the form of IDL variables.

READ_SRF only handles 1-, 8-, 24-, and 32-bit rasterfiles of type `RT_OLD` and `RT_STANDARD`. See the file `/usr/include/rasterfile.h` for the structure of Sun rasterfiles.

This routine is written in the IDL language. Its source code can be found in the file `read_srf.pro` in the `lib` subdirectory of the IDL distribution.

Note

To find information about a potential SRF file before trying to read its data, use the QUERY_SRF function.

Syntax

READ_SRF, *Filename*, *Image* [, *R*, *G*, *B*]

Arguments

Filename

A scalar string containing the name of the rasterfile to read.

Image

A named variable that will contain the 2D byte array (image).

R, G, B

Named variables that will contain the Red, Green, and Blue color vectors, if the rasterfile contains colormaps.

Example

To open and read the Sun rasterfile named `sun.srf` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables `R`, `G`, and `B`, enter:

```
READ_SRF, 'sun.srf', image1, R, G, B
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

See Also

WRITE_SRF, QUERY_SRF

READ_SYLK

The READ_SYLK function reads the contents of a SYLK (Symbolic Link) format spreadsheet data file and returns the contents of the file, or of a cell data range, in an IDL variable. READ_SYLK returns either a vector of structures or a 2D array containing the spreadsheet cell data.

By default, READ_SYLK returns a vector of structures, each of which contains the data from one *row* of the table being read. In this case, the individual fields in the structures have the tag names “Col0”, “Col1”, ..., “Col*n*”. If the COLMAJOR keyword is specified, each of the structures returned contains data from one *column* of the table, and the tag names are “Row0”, “Row1”, ..., “Row*n*”.

Note: This routine reads only numeric and string SYLK data. It ignores all spreadsheet and cell formatting information (cell width, text justification, font type, date, time, and monetary notations, etc). Note also that the data in a given cell range must be of the same data type (all integers, for example) in order for the read operation to succeed. See the example below for further information.

This routine is written in the IDL language. Its source code can be found in the file `read_sylk.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = READ_SYLK(*File* [, /ARRAY] [, /COLMAJOR] [, NCOLS=*columns*] [, NROWS=*rows*] [, STARTCOL=*column*] [, STARTROW=*row*] [, /USEDOUBLES] [, /USELONGS])

Arguments

File

A scalar string specifying the full path name of the SYLK file to read.

Keywords

ARRAY

Set this keyword to return an IDL array rather than a vector of structures. Note that all the data in the cell range specified must be of the same data type to successfully return an array.

COLMAJOR

Set this keyword to create a vector of structures each containing data from a single *column* of the table being read. If you are creating an array rather than a vector of structures (the ARRAY keyword is set), setting COLMAJOR has the same effect as transposing the resulting array.

This keyword should be set when importing spreadsheet data which has column major organization (data stored in columns rather than rows).

NCOLS

Set this keyword to the number of spreadsheet columns to read. If not specified, all of the cell columns found in the file are read.

NROWS

Set this keyword to the number of spreadsheet rows to read. If not specified, all of the cell rows found in the file are read.

STARTCOL

Set this keyword to the first column of spreadsheet cells to read. If not specified, the read operation begins with the first column found in the file (column 0).

STARTROW

Set this keyword to the first row of spreadsheet cells to read. If not specified, the read operation begins with the first row of cells found in the file (row 0).

USEDOUBLES

Set this keyword to read any floating-point cell data as double-precision rather than the default single-precision.

USELONGS

Set this keyword to read any integer cell data as long integer type rather than the default integer type.

Examples

Suppose the following spreadsheet table, with the upper left cell (value = “Index”) at location (0, 0), has been saved as the SYLK file “file.slk”:

```
Index  Name  Gender  Platform
1      Beth  F       UNIX
2      Lubos  M       VMS
3      Louis  M       Windows
```

```
4      Thierry  M       Macintosh
```

Note that the data format of the title row (*string*, *string*, *string*, *string*) is inconsistent with the following four rows (*int*, *string*, *string*, *string*) in the table. Because of this, it is impossible to read all of the table into a single IDL variable. The following two commands, however, will read all of the data:

```
title = READ_SYLK("file.slk", NROWS = 1)
table = READ_SYLK("file.slk", STARTROW = 1)

;Display the top row of the table.
PRINT, title
```

IDL prints:

```
{ Index Name Gender Platform}
```

Print the table:

```
PRINT, table
```

IDL prints:

```
{1 Beth F UNIX}{2 Lubos M VMS}{3 Louis M Windows}{4 Thierry M
Macintosh}
```

To retrieve only the “Name” column:

```
names = READ_SYLK("file.slk", /ARRAY, STARTROW = 1, $
    STARTCOL = 1, NCOLS = 1)
PRINT, names
```

IDL prints:

```
Beth Lubos Louis Thierry
```

To retrieve the “Name” column in column format:

```
namescol = READ_SYLK("file.slk", /ARRAY, /COLMAJOR, $
    STARTROW = 1, STARTCOL = 1, NCOLS = 1)
PRINT, namescol
```

IDL prints:

```
Beth
Lubos
Louis
Thierry
```

See Also

WRITE_SYLK

READ_TIFF

The READ_TIFF function reads single or multi-channel images from TIFF format files and returns the image and color table vectors in the form of IDL variables.

Note

To find information about a potential TIFF file before trying to read its data, use the QUERY_TIFF function. The obsolete routine TIFF_DUMP may also be used to examine the structure and tags of a TIFF file.

Syntax

Result = READ_TIFF(*Filename* [, *R*, *G*, *B*] [, CHANNELS=*scalar or vector*] [, GEOTIFF=*variable*] [, IMAGE_INDEX=*value*] [, INTERLEAVE={0 | 1 |2}] [, ORDER=*variable*] [, PLANARCONFIG=*variable*] [, SUB_RECT=*[x*, *y*, *width*, *height]*] [, /UNSIGNED] [, /VERBOSE])

Return Value

READ_TIFF returns a byte, unsigned integer, long, or float array (based on the data format in the TIFF file) containing the image data. The dimensions of the *Result* are [*Columns*, *Rows*] for single-channel images, or [*Channels*, *Columns*, *Rows*] for multi-channel images, unless a different type of interleaving is specified with the INTERLEAVE keyword.

RGB images are a special case of multi-channel images, and contain three channels. Most TIFF readers and writers can handle only images with one or three channels.

As a special case, for three-channel TIFF image files that are stored in planar interleave format, and if four parameters are provided, READ_TIFF returns the integer value zero, sets the variable defined by the PLANARCONFIG keyword to 2, and returns three separate images in the variables defined by the *R*, *G*, and *B* arguments.

Arguments

Filename

A scalar string specifying the full pathname of the TIFF file to read.

R, G, B

Named variables that will contain the Red, Green, and Blue color vectors of the color table from the file if one exists. If the TIFF file is written as a three-channel image, interleaved by plane, and the R, G, and B parameters are present, the three channels of the image are returned in the R, G, and B variables.

Keywords

CHANNELS

Set this keyword to a scalar or vector giving the channel numbers to be returned for a multi-channel image, starting with zero. The default is to return all of the channels. This keyword is ignored for single-channel images, or for three-channel planar-interleaved images when the *R*, *G*, and *B* arguments are specified.

GEOTIFF

Returns an anonymous structure containing one field for each of the GeoTIFF tags and keys found in the file. If no GeoTIFF information is present in the file, the returned variable is undefined.

The GeoTIFF structure is formed using fields named from the following table.

Anonymous Structure Field Name	IDLDatatype
TAGS:	
"MODELPIXELSCALETAG"	DOUBLE[3]
"MODELTRANSFORMATIONTAG"	DOUBLE[4,4]
"MODELTIEPOINTTAG"	DOUBLE[6,*]
KEYS:	
"GTMODELTYPEGEOKEY"	INT
"GTRASTERTYPEGEOKEY"	INT
"GTCITATIONGEOKEY"	STRING
"GEOGRAPHICTYPEGEOKEY"	INT
"GEOGCITATIONGEOKEY"	STRING
"GEOGGEODETICDATUMGEOKEY"	INT

Table 80: GEOTIFF Structures

Anonymous Structure Field Name	IDLDatatype
"GEOGPRIMEMERIDIANGEOKEY"	INT
"GEOGLINEARUNITSGEOKEY"	INT
"GEOGLINEARUNITSIZEGEOKEY"	DOUBLE
"GEOGANGULARUNITSGEOKEY"	INT
"GEOGANGULARUNITSIZEGEOKEY"	DOUBLE
"GEOGELLIPSOIDGEOKEY"	INT
"GEOGSEMIMAJORAXISGEOKEY"	DOUBLE
"GEOGSEMIMINORAXISGEOKEY"	DOUBLE
"GEOGINVFLATTENINGGEOKEY"	DOUBLE
"GEOGAZIMUTHUNITSGEOKEY"	INT
"GEOGPRIMEMERIDIANLONGGEOKEY"	DOUBLE
"PROJECTEDCSTYPEGEOKEY"	INT
"PCSCITATIONGEOKEY"	STRING
"PROJECTIONGEOKEY"	INT
"PROJCOORDTRANSGEOKEY"	INT
"PROJLINEARUNITSGEOKEY"	INT
"PROJLINEARUNITSIZEGEOKEY"	DOUBLE
"PROJSTDPARALLEL1GEOKEY"	DOUBLE
"PROJSTDPARALLEL2GEOKEY"	DOUBLE
"PROJNATORIGINLONGGEOKEY"	DOUBLE
"PROJNATORIGINLATGEOKEY"	DOUBLE
"PROJFALSEEASTINGGEOKEY"	DOUBLE
"PROJFALSENORTHINGGEOKEY"	DOUBLE
"PROJFALSEORIGINLONGGEOKEY"	DOUBLE
"PROJFALSEORIGINLATGEOKEY"	DOUBLE

Table 80: GEOTIFF Structures

Anonymous Structure Field Name	IDLDatatype
"PROJFALSEORIGINEASTINGGEOKEY"	DOUBLE
"PROJFALSEORIGINNORTHINGGEOKEY"	DOUBLE
"PROJCENTERLONGGEOKEY"	DOUBLE
"PROJCENTERLATGEOKEY"	DOUBLE
"PROJCENTEREASTINGGEOKEY"	DOUBLE
"PROJCENTERNORTHINGGEOKEY"	DOUBLE
"PROJSCALEATNATORIGINGEOKEY"	DOUBLE
"PROJSCALEATCENTERGEOKEY"	DOUBLE
"PROJAZIMUTHANGLEGEOKEY"	DOUBLE
"PROJSTRAIGHTVERTPOLELONGGEOKEY"	DOUBLE
"VERTICALCSTYPEGEOKEY"	INT
"VERTICALCITATIONGEOKEY"	STRING
"VERTICALDATUMGEOKEY"	INT
"VERTICALUNITSGEOKEY"	INT

Table 80: GEOTIFF Structures

Note

If a GeoTIFF key appears multiple times in a file, only the value for the first instance of the key is returned.

IMAGE_INDEX

Selects the image number within the file to be read (see QUERY_TIFF to determine the number of images in the file).

INTERLEAVE

For multi-channel images, set this keyword to one of the following values to force the *Result* to have a specific interleaving, regardless of the type of interleaving in the file being read:

- 0 = Pixel interleaved: *Result* will have dimensions [*Channels*, *Columns*, *Rows*].

- 1 = Scanline (row) interleaved: *Result* will have dimensions [*Columns*, *Channels*, *Rows*].
- 2 = Planar interleaved: *Result* will have dimensions [*Columns*, *Rows*, *Channels*].

If this keyword is not specified, the *Result* will always be pixel interleaved, regardless of the type of interleaving in the file being read. For files stored in planar-interleave format, this keyword is ignored if the *R*, *G*, and *B* arguments are specified.

ORDER

Set this keyword to a named variable that will contain the order value from the TIFF file. This value is returned as 0 for images written bottom to top, and 1 for images written top to bottom. If an order value does not appear in the TIFF file, an order of 1 is returned.

The ORDER keyword can return any of the following additional values (depending on the source of the TIFF file):

Rows	Columns
1	top to bottom, left to right
2	top to bottom, right to left
3	bottom to top, right to left
4	bottom to top, left to right
5	top to bottom, left to right
6	top to bottom, right to left
7	bottom to top, right to left
8	bottom to top, left to right

Table 81: Values for the ORDER keyword

Reference: Aldus TIFF 6.0 spec (TIFF version 42).

PLANARCONFIG

Set this keyword to a named variable that will contain the interleave parameter for the TIFF file. This parameter is returned as 1 for TIFF files that are GrayScale, Palette, or interleaved by pixel. This parameter is returned as 2 for multi-channel TIFF files interleaved by image.

SUB_RECT

Set this keyword to a four-element array, [*x*, *y*, *width*, *height*], that specifies a rectangular region within the file to extract. Only the rectangular portion of the image selected by this keyword is read and returned. The rectangle is measured in pixels from the lower left corner (right hand coordinate system).

UNSIGNED

This keyword is now obsolete because older versions of IDL did not support the unsigned 16-bit integer data type. Set this keyword to return TIFF files containing unsigned 16-bit integers as signed 32-bit longword arrays. If not set, return an unsigned 16-bit integer for these files. This keyword has no effect if the input file does not contain 16-bit integers.

VERBOSE

Produce additional diagnostic output during the read.

Examples

Example 1

Read the file `my.tif` in the current directory into the variable `image`, and save the color tables in the variables, `R`, `G`, and `B` by entering:

```
image = READ_TIFF('my.tif', R, G, B)
```

To view the image, load the new color table and display the image by entering:

```
TVLCT, R, G, B
TV, image
```

Example 2

Write and read a multi-image TIFF file. The first image is a 16-bit single-channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND

; Read the image data back:
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
FOR i=0,s.NUM_IMAGES-1 DO BEGIN
```

```
imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
HELP,t,/STRUCTURE
HELP,img
ENDFOR
ENDIF
```

Example 3

Write and read a multi-channel image:

```
data = LINDGEN(10, 256, 256)   ; 10 channels

; Write the image data:
WRITE_TIFF, 'multichannel.tif', data, /LONG

; Read back only channels [0,2,4,6,8], using planar-interleaving
img = READ_TIFF('multichannel.tif', CHANNELS=[0,2,4,6,8], $
   INTERLEAVE=2)

HELP, img
```

IDL prints:

```
IMG      LONG     = Array[256, 256, 5]
```

See Also

WRITE_TIFF, QUERY_TIFF

READ_WAV

The READ_WAV function reads the audio stream from the named .WAV file. Optionally, it can return the sampling rate of the audio stream.

Syntax

Result = READ_WAV (*Filename* [, *Rate*])

Return Value

In the case of a single channel stream, the returned variable is a BYTE or INT (depending on the number of bits per sample) one-dimensional array. In the case of a file with multiple channels, a similar two-dimensional array is returned, with the leading dimension being the channel number.

Arguments

Filename

A scalar string containing the full pathname of the .WAV file to read.

Rate

Returns an IDL long containing the sampling rate of the stream in samples per second.

Keywords

None.

READ_WAVE

The READ_WAVE procedure reads a `.wave` or `.bwave` file created by the Wavefront Advanced Data Visualizer into an series of IDL variables.

Note

READ_WAVE only preserves the structure of the variables if they are regularly gridded.

This routine is written in the IDL language. Its source code can be found in the file `read_wave.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

READ_WAVE, *File*, *Variables*, *Names*, *Dimensions* [, MESHNAMES=*variable*]

Arguments

File

A scalar string containing the name of the Wavefront file to read.

Variables

A named variable that will contain a block of the variables contained in the wavefront file. Since each variable in a wavefront file can have more than one field (for instance, a vector variable has 3 fields), the fields of each variable make up the major index into the variable block. For instance, if a Wavefront file had one scalar variable and one vector variable, the scalar would be extracted as follows:

```
scalar_variable = variables[0,*,*,*]
```

and the vector variable would be extracted as follows:

```
vector_variable = variables[1:3,*,*,*]
```

To find the dimensions of the returned variable, see the description of the *Dimensions* argument.

Names

A named variable that will contain the string names of each variable contained in the file.

Dimensions

A named variable that will contain a long array describing how many fields in the large returned variable block each variable occupies. In the above example of one scalar variable followed by a vector variable, the dimension variable would be `[1,3]`.

This indicates that the first field of the returned variable block would be the scalar variable and the following 3 fields would comprise the vector variable.

Keywords

MESHNAMES

Set this keyword to a named variable that will contain the name of the mesh used in the Wavefront file for each variable.

See Also

WRITE_WAVE

READ_X11_BITMAP

The READ_X11_BITMAP procedure reads bitmaps stored in the X Windows X11 format. The X Windows `bitmap` program produces a C header file containing the definition of a bitmap produced by that program. This procedure reads such a file and creates an IDL byte array containing the bitmap. It is used primarily to read bitmaps to be used as IDL widget button labels.

This routine is written in the IDL language. Its source code can be found in the file `read_x11_bitmap.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

READ_X11_BITMAP, *File*, *Bitmap* [, *X*, *Y*] [, /EXPAND_TO_BYTES]

Arguments

File

A scalar string containing the name of the file containing the bitmap.

Bitmap

A named variable that will contain the bitmap. This variable is returned as a byte array.

X

A named variable that will contain the width of the bitmap.

Y

A named variable that will contain the height of the bitmap.

Keywords

EXPAND_TO_BYTES

Set this keyword to instruct READ_X11_BITMAP to return a 2D array which has one bit per byte (0 for a 0 bit, 255 for a 1 bit) instead.

Example

To open and read the X11 bitmap file named `my.x11` in the current directory, store the bitmap in the variable `bitmap1`, and the width and height in the variables `X` and `Y`, enter:

```
READ_X11_BITMAP, 'my.x11', bitmap1, X, Y
```

To display the new bitmap, enter:

```
READ_X11_BITMAP, 'my.x11', image, /EXPAND_TO_BYTES
TV, image, /ORDER
```

See Also

READ_XWD

READ_XWD

The READ_XWD function reads the contents of a file created by the `xwd` (X Windows Dump) command and returns the image and color table vectors in the form of IDL variables. READ_XWD returns a 2D byte array containing the image. If the file cannot be open or read, the return value is zero.

Note: this function is intended to be used only on files containing 8-bit pixmaps created with `xwd` version 6 or later.

This routine is written in the IDL language. Its source code can be found in the file `read_xwd.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = READ_XWD(*Filename*[, *R*, *G*, *B*])

Arguments

Filename

A scalar string specifying the full pathname of the XWD file to read.

R, G, B

Named variables that will contain the Red, Green, and Blue color vectors, if the XWD file contains color tables.

Example

To open and read the X Windows Dump file named `my.xwd` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables, `R`, `G`, and `B`, enter:

```
image1 = READ_XWD('my.xwd', R, G, B)
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

See Also

READ_X11_BITMAP

READS

The READS procedure performs formatted input from a string variable and writes the results into one or more output variables. This procedure differs from the READ procedure only in that the input comes from memory instead of a file.

This routine is useful when you need to examine the format of a data file before reading the information it contains. Each line of the file can be read into a string using READF. Then the components of that line can be read into variables using READS.

Syntax

READS, *Input*, Var_1, ..., Var_n [, AM_PM=*[string, string]*]
[, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*]
[, MONTHS=*string_array*{12 names}]

Arguments

Input

The string variable from which the input is taken. If the supplied argument is not a string, it is automatically converted. The argument can be scalar or array. If *Input* is an array, the individual string elements are treated as successive lines of input.

Var_i

The named variables to receive the input.

Note

If the variable specified for the Var_i argument has not been previously defined, the input data is assumed to be of type float, and the variable will be cast as a float.

Keywords

AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the input. FORMAT allows the format of the input to be specified in precise detail, using a FORTRAN-style specification. See "Using Explicitly Formatted Input/Output" in Chapter 8 of *Building IDL Applications*.

MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

See Also

READ/READF, READU

READU

The READU procedure reads unformatted binary data from a file into IDL variables. READU transfers data directly with no processing of any kind performed on the data.

Syntax

READU, *Unit*, Var_1, ..., Var_n [, TRANSFER_COUNT=*variable*]

VMS-Only Keywords: [, KEY_ID=*index*] [, KEY_MATCH=*relation*] [, KEY_VALUE=*value*]

Arguments

Unit

The IDL file unit from which input is taken.

Var_i

Named variables to receive the data. For non-string variables, the number of bytes required for Var are read. When READU is used with a variable of type string, IDL reads exactly the number of bytes contained in the existing string. For example, to read a 5-character string, enter:

```
temp = '12345'
READU, unit, temp
```

Keywords

TRANSFER_COUNT

Set this keyword to a named variable in which to return the number of elements transferred by the input operation. Note that the number of elements is not the same as the number of bytes (except in the case where the data type being transferred is bytes). For example, transferring 256 floating-point numbers yields a transfer count of 256, not 1024 (the number of bytes transferred).

This keyword is useful with files opened with the RAWIO keyword to the OPEN routines. Normally, attempting to read more data than is available from a file causes the unfilled space to be zeroed and an error to be issued. This does not happen with files opened with the RAWIO keyword. Instead, the programmer must keep track of the transfer count.

VMS-Only Keywords

Note

The obsolete VMS routines FORRD, and FORRD_KEY have been replaced by the READU command used with the following keywords.

KEY_ID

The index key to be used (primary = 0, first alternate key = 1, etc...) when accessing data from a file with indexed organization. If this keyword is omitted, the primary key is used.

KEY_MATCH

The relation to be used when matching the supplied key with key field values (EQ = 0, GE = 1, GT = 2) when accessing data from a file with indexed organization. If this keyword is omitted, the equality relation (0) is used.

KEY_VALUE

The value of a key to be found when accessing data from a file with indexed organization. This value must match the key definition that is determined when the file was created in terms of type and size—no conversions are performed. If this keyword is omitted, the previous key value is used.

Example

The following commands can be used to open the IDL distribution file people.dat and read an image from that file:

```
; Open the file for reading as file unit 1:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; The image is a 192 by 192 byte array, so make B that size:
B = BYTARR(192, 192)

; Read the data into B:
READU, 1, B

; Close the file:
CLOSE, 1

; Display the image:
TV, B
```

See Also

READ/READF, READS, WRITEU, *Building IDL Applications* Chapter 8, "Files and Input/Output", "Unformatted Input/Output with Structures" in Chapter 6 of *Building IDL Applications*

REBIN

The REBIN function resizes a vector or array to dimensions given by the parameters D_i. The supplied dimensions must be integral multiples or factors of the original dimension. The expansion or compression of each dimension is independent of the others, so that each dimension can be expanded or compressed by a different value.

If the dimensions of the desired result are not integer multiples of the original dimensions, use the CONGRID function.

Syntax

Result = REBIN(*Array*, D_1 [, ..., D_8] [, /SAMPLE])

Arguments

Array

The array to be resampled. *Array* can be of any basic type except complex or string.

D_i

The dimensions of the resulting resampled array. These dimensions must be integer multiples or factors of the corresponding original dimensions.

Keywords

SAMPLE

Normally, REBIN uses bilinear interpolation when magnifying and neighborhood averaging when minifying. Set the SAMPLE keyword to use nearest neighbor sampling for both magnification and minification. Bilinear interpolation gives higher quality results but requires more time.

Rules Used by REBIN

Assume the original vector X has n elements and the result is to have m elements.

Let $f = n/m$, the ratio of the size of the original vector, X to the size of the result. $1/f$ must be an integer if $n < m$ (expansion). f must be an integer if compressing, ($n > m$). The various resizing options can be described as:

- Expansion, $n < m$, SAMPLE = 0: $Y_i = F(X, f \cdot i)$ $\quad i = 0, 1, \ldots, m\text{-}1$

The linear interpolation function, $F(X, p)$ that interpolates X at location p, is defined as:

$$F(X, p) = \begin{cases} X_{\lfloor p \rfloor} + (\lfloor p \rfloor - p) \cdot (X_{\lfloor p \rfloor + 1} - X_{\lfloor p \rfloor}) & \text{if } p < n - 1 \\ X_{\lfloor p \rfloor} & \text{if } p \geq n - 1 \end{cases}$$

- Expansion, $n < m$, SAMPLE = 1:

$$Y_i = X_{\lfloor fi \rfloor}$$

- Compression, $n > m$, SAMPLE = 0:

$$Y_i = (1/f) \sum_{j=fi}^{f(i+1)-1} X_j$$

- Compression, $n > m$, SAMPLE = 1:

$$Y_i = X_{\lfloor fi \rfloor}$$

- No change, $n = m$: $Y_i = X_i$

Endpoint Effects When Expanding

When expanding an array, REBIN *interpolates*, it never *extrapolates*. Each of the *n*-1 intervals in the *n*-element input array produces *m*/*n* interpolates in the *m*-element output array. The last *m*/*n* points of the result are obtained by duplicating element *n*-1 of the input array because their interpolates would lie outside the input array.

For example

```
; A four point vector:
A = [0, 10, 20, 30]

; Expand by a factor of 3:
B = REBIN(A, 12)

PRINT, B
```

IDL prints:

```
0 3 6 10 13 16 20 23 26 30 30 30
```

Note that the last element is repeated three times. If this effect is undesirable, use the INTERPOLATE function. For example, to produce 12 equally spaced interpolates from the interval 0 to 30:

```
B = INTERPOLATE(A, 3./11. * FINDGEN(12))
PRINT, B
```

IDL prints:

```
0 2 5 8 10 13 16 19 21 24 27 30
```

Here, the sampling ratio is (*n* - 1)/(*m* - 1).

Example

Create and display a simple image by entering:

```
D = SIN(DIST(50)/4) & TVSCL, D
```

Resize the image to be 5 times its original size and display the result by entering:

```
D = REBIN(D, 250, 250) & TVSCL, D
```

See Also

CONGRID

RECALL_COMMANDS

The RECALL_COMMANDS function returns a string array containing the entries in IDL's command recall buffer. The size of the returned array is the size of recall buffer, even if fewer than commands have been entered (any "empty" buffer entries will contain null strings). The default size of the command recall buffer is 20 lines. (See "!EDIT_INPUT" on page 2429 for more information about the command recall buffer.)

Element zero of the returned array contains the most recent command.

Syntax

Result = RECALL_COMMANDS()

RECON3

The RECON3 function can reconstruct a three-dimensional data array from two or more images (or projections) of an object. For example, if you placed a dark object in front of a white background and then photographed it three times (each time rotating the object a known amount) then these three images could be used with RECON3 to approximate a 3D volumetric representation of the object. RECON3 also works with translucent projections of an object. RECON3 returns a 3D byte array.

This routine is written in the IDL language. Its source code can be found in the file `recon3.pro` in the `lib` subdirectory of the IDL distribution.

Using RECON3

Images used in reconstruction should show strong light/dark contrast between the object and the background. If the images contain low (dark) values where the object is and high (bright) values where the object isn't, the MODE keyword should be set to +1 and the returned volume will have low values where the object is, and high values where the object isn't. If the images contain high (bright) values where the object is and low (dark) values where the object isn't, the MODE keyword should be set to -1 and the returned volume will have high values where the object is, and low values where the object isn't.

In general, the object must be CONVEX for a good reconstruction to be possible. Concave regions are not easily reconstructed. An empty coffee cup, for example, would be reconstructed as if it were full.

The more images the better. Images from many different angles will improve the quality of the reconstruction. It is also important to supply images that are parallel and perpendicular to any axes of symmetry. Using the coffee cup as an example, at least one image should be looking through the opening in the handle. Telephoto images are also better for reconstruction purposes than wide angle images.

Syntax

Result = RECON3(*Images*, *Obj_Rot*, *Obj_Pos*, *Focal*, *Dist*,*Vol_Pos*, *Img_Ref*, *Img_Mag*, *Vol_Size* [, /CUBIC] [, MISSING=*value*] [, MODE=*value*])

Arguments

Images

A 3D array containing the images to use to reconstruct the volume. Execution time increases linearly with more images. *Images* must be an 8-bit (byte) array with dimensions (*x*, *y*, *n*) where *x* is the horizontal image dimension, *y* is the vertical image dimension, and *n* is the number of images. Note that *n* must be at least 2.

Obj_Rot

A 3 x *n* floating-point array specifying the amount the object is rotated to make it appear as it does in each image. The object is first rotated about the X axis, then about the Y axis, and finally about the Z axis (with the object's reference point at the origin). *Obj_Rot*[0, *] is the X rotation for each image, *Obj_Rot*[1, *] is the Y rotation, and *Obj_Rot*[2, *] is the Z rotation.

Obj_Pos

A 3 x *n* floating-point array specifying the position of the object's reference point relative to the camera lens. The camera lens is located at the coordinate origin and points in the negative Z direction (the view up vector points in the positive Y direction). *Obj_Pos* should be expressed in this coordinate system. *Obj_Pos*[0, *] is the X position for each image, *Obj_Pos*[1, *] is the Y position, and *Obj_Pos*[2, *] is the Z position. All the values in *Obj_Pos*[2, *] should be less than zero. Note that the values for *Obj_Pos*, *Focal*, *Dist*, and *Vol_Pos* should all be expressed in the same units (mm, cm, m, in, ft, etc.).

Focal

An *n*-element floating-point array specifying the focal length of the lens for each image. Focal may be set to zero to indicate a parallel image projection (infinite focal length).

Dist

An *n*-element floating-point array specifying the distance from the camera lens to the image plane (film) for each image. *Dist* should be greater than *Focal*.

Vol_Pos

A 3 x 2 floating-point array specifying the two opposite corners of a cube that surrounds the object. *Vol_Pos* should be expressed in the object's coordinate system relative to the object's reference point. *Vol_Pos*[*, 0] specifies one corner and *Vol_Pos*[*, 1] specifies the opposite corner.

Img_Ref

A 2 x *n* integer or floating-point array that specifies the pixel location at which the object's reference point appears in each of the images. *Img_Ref*[0, *] is the X coordinate for each image and *Img_Ref*[1, *] is the Y coordinate.

Img_Mag

A 2 x *n* integer or floating-point array that specifies the magnification factor for each image. This number is actually the length (in pixels) that a test object would appear in an image if it were *n* units long and *n* units distant from the camera lens. *Img_Mag*[0, *] is the X dimension (in pixels) of a test object for each image, and *Img_Mag*[1, *] is the Y dimension. All elements in *Img_Mag* should be greater than or equal to 1.

Vol_Size

A 3-element integer or floating-point array that specifies the size of the 3D byte array to return. Execution time (and resolution) increases exponentially with larger values for *Vol_Size*. *Vol_Size*[0] specifies the X dimension of the volume, *Vol_Size*[1] specifies the Y dimension, and *Vol_Size*[2] specifies the Z dimension.

Keywords

CUBIC

Set this keyword to use cubic interpolation. The default is to use tri-linear interpolation, which is slightly faster.

MISSING

Set this keyword equal to a byte value for cells in the 3D volume that do not map to any of the supplied images. The value of MISSING is passed to the INTERPOLATE function. The default value is zero.

MODE

Set this keyword to a value less than zero to define each cell in the 3D volume as the *minimum* of the corresponding pixels in the images. Set MODE to a value greater than zero to define each cell in the 3D volume as the *maximum* of the corresponding pixels in the images. If MODE is set equal to zero then each cell in the 3D volume is defined as the *average* of the corresponding pixels in the images.

MODE should usually be set to -1 when the images contain a bright object in front of a dark background or to +1 when the images contain a dark object in front of a light background. Setting MODE=0 (the default) requires more memory since the volume array must temporarily be kept as an integer array instead of a byte array.

Example

Assumptions for this example:

- The object's major axis is parallel to the Z axis.
- The object's reference point is at its center.
- The camera lens is pointed directly at this reference point.
- The reference point is 5000 mm in front of the camera lens.
- The focal length of the camera lens is 200 mm.

If the camera is focused on the reference point, then the distance from the lens to the camera's image plane must be

dist = (d * f) / (d - f) = (5000 * 200) / (5000 - 200) = (1000000 / 4800) = 208.333 mm

The object is roughly 600 mm wide and 600 mm high. The reference point appears in the exact center of each image.

If the object is 600 mm high and 5000 mm distant from the camera lens, then the object image height must be

hi = (h * f) / (d - f) = (600 * 200) / (5000 - 200) = (120000 / 4800) = 25.0 mm

The object image appears 200 pixels high so the final magnification factor is

img_mag = (200 / 25) = 8.0

From these assumptions, we can set up the following reconstruction:

```
; First, define the variables:
imgx = 256
imgy = 256
frames = 3
images = BYTARR(imgx, imgy, frames)
obj_rot = Fltarr(3, frames)
obj_pos = Fltarr(3, frames)
focal = Fltarr(frames)
dist = Fltarr(frames)
vol_pos = Fltarr(3, 2)
img_ref = Fltarr(2, frames)
img_mag = Fltarr(2, frames)
vol_size = [40, 40, 40]

; The object is 5000 mm directly in front of the camera:
obj_pos[0, *] = 0.0
obj_pos[1, *] = 0.0
```

```
obj_pos[2, *] = -5000.0

; The focal length of the lens is constant for all the images:
focal[*] = 200.0

; The distance from the lens to the image plane is also constant:
dist[*] = 208.333

; The cube surrounding the object is 600 mm x 600 mm:
vol_pos[*, 0] = [-300.0, -300.0, -300.0]
vol_pos[*, 1] = [ 300.0, 300.0, 300.0]

; The image reference point appears at the center of all the
; images:
img_ref[0, *] = imgx / 2
img_ref[1, *] = imgy / 2

; The image magnification factor is constant for all images.
; (The images haven't been cropped or resized):
img_mag[*,*] = 8.0

; Only the object rotation changes from one image to the next.
; Note that the object is rotated about the X axis first, then Y,
; and then Z. Create some fake images for this example:
images[30:160, 20:230, 0] = 255
images[110:180, 160:180, 0] = 180
obj_rot[*, 0] = [-90.0, 0.0, 0.0]
images[70:140, 100:130, 1] = 255
obj_rot[*, 1] = [-70.0, 75.0, 0.0]
images[10:140, 70:170, 2] = 255
images[80:90, 170:240, 2] = 150
obj_rot[*, 2] = [-130.0, 215.0, 0.0]

; Reconstruct the volume:
vol = RECON3(images, obj_rot, obj_pos, focal, dist, $
   vol_pos, img_ref, img_mag, vol_size, Missing=255B, Mode=(-1))

; Display the volume:
shade_volume, vol, 8, v, p
scale3, xrange=[0,40], yrange=[0,40], zrange=[0,40]
image = polyshade(v, p, /t3d, xs=400, ys=400)
tvscl, image
```

See Also

POLYSHADE, SHADE_VOLUME, VOXEL_PROJ

REDUCE_COLORS

The REDUCE_COLORS procedure reduces the number of colors used in an image by eliminating pixel values without members.

The pixel distribution histogram is obtained and the WHERE function is used to find bins with non-zero values. Next, a lookup table is made where table[old_pixel_value] contains new_pixel_value, and is then applied to the image.

This routine is written in the IDL language. Its source code can be found in the file `reduce_colors.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

REDUCE_COLORS, *Image*, *Values*

Arguments

Image

On input, a variable that contains the original image array. On output, this variable contains the color-reduced image array, writing over the original.

Values

A named variable that, on output, contains a vector of non-zero pixel values. If *Image* contains pixel values from 0 to M, *Values* will be an M+1 element vector containing the mapping from the old values to the new. *Values[i]* contains the new color index of old pixel index *i*.

Example

To reduce the number of colors and display an image with the original color tables R, G, B enter the commands:

```
REDUCE_COLORS, image, v
TVLCT, R[V], G[V], B[V]
```

See Also

COLOR_QUAN

REFORM

The REFORM function changes the dimensions of an array without changing the total number of elements. If no dimensions are specified, REFORM returns a copy of *Array* with all dimensions of size 1 removed. If dimensions are specified, the result is given those dimensions. Only the dimensions of *Array* are changed—the actual data remains unmodified.

Syntax

Result = REFORM(*Array*, D_1, ..., D_8 [, /OVERWRITE])

Arguments

Array

The array to have its dimensions modified.

D_i

The dimensions of the result. The D_i arguments can be either a single array containing the new dimensions or a sequence of scalar dimensions. *Array* must have the same number of elements as specified by the product of the new dimensions.

Keywords

OVERWRITE

Set this keyword to cause the specified dimensions to overwrite the present dimensions of the *Array* parameter. No data are copied, only the internal array descriptor is changed. The result of the function, in this case, is the *Array* parameter with its newly-modified dimensions. For example, to change the dimensions of the variable a, without moving data, enter:

```
a = REFORM(a, n1, n2, /OVERWRITE)
```

Example

REFORM can be used to remove “degenerate” leading dimensions of size one. Such dimensions can appear when a subarray is extracted from an array with more dimensions. For example

```
; a is a 3-dimensional array:
a = INTARR(10,10,10)
```

```
; Extract a "slice" from a:
b = a[5,*,*]

; Use HELP to show what REFORM does:
HELP, b, REFORM(b)
```

Executing the above statements produces the output:

```
B            INT = Array[1, 10, 10]
<Expression> INT = Array[10, 10]
```

The statements:

```
b = REFORM(a,200,5)
b = REFORM(a,[200,5])
```

have identical effect. They create a new array, b, with dimensions of (200, 5), from a.

See Also

REVERSE, ROT, ROTATE, TRANSPOSE

REGRESS

The REGRESS function performs a multiple linear regression fit and returns an *Nterm*-element column vector of coefficients.

REGRESS fits the function:

$$y_i = const + a_0 x_{0,\,i} + a_1 x_{1,\,i} + ... + a_{\text{Nterms-1}} x_{\text{Nterms-1},\,i}$$

This routine is written in the IDL language. Its source code can be found in the file `regress.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = REGRESS(*X*, *Y*, [, CHISQ=*variable*] [, CONST=*variable*] [, CORRELATION=*variable*] [, /DOUBLE] [, FTEST=*variable*] [, MCORRELATION=*variable*] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, STATUS=*variable*] [, YFIT=*variable*])

Return Value

REGRESS returns a 1 x *Nterm* array of coefficients. If the DOUBLE keyword is set, or if *X* or *Y* are double-precision, then the result will be double precision, otherwise the result will be single precision.

Arguments

X

An *Nterms* by *Npoints* array of independent variable data, where *Nterms* is the number of coefficients (independent variables) and *Npoints* is the number of samples.

Y

An *Npoints*-element vector of dependent variable points.

Weights

The Weights argument is obsolete, and has been replaced by the MEASURE_ERRORS keyword. Code that uses the Weights argument will continue to work as before, but new code should use the MEASURE_ERRORS keyword instead. Note that the definition of the MEASURE_ERRORS keyword is different from that of the Weights argument. Using the Weights argument, SQRT(1/Weights[i]) represents the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error for each point is represented as simply

MEASURE_ERRORS[i]. Also note that the RELATIVE_WEIGHTS keyword is not necessary when using the MEASURE_ERRORS keyword.

Yfit, Const, Sigma, Ftest, R, Rmul, Chisq, Status

The Yfit, Const, Sigma, Ftest, R, Rmul, Chisq, and Status arguments are obsolete, and have been replaced by the YFIT, CONST, SIGMA, FTEST, CORRELATION, MCORRELATION, CHISQ, and STATUS keywords, respectively. Code that uses these arguments will continue to work as before, but new code should use the keywords instead.

Keywords

CHISQ

Set this keyword equal to a named variable that will contain the value of the chi-sqaure goodness-of-fit.

CONST

Set this keyword to a named variable that will contain the constant term of the fit.

CORRELATION

Set this keyword to a named variable that will contain the vector of linear correlation coefficients.

DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

FTEST

Set this keyword to a named variable that will contain the F-value for the goodness-of-fit test.

MCORRELATION

Set this keyword to a named variable that will contain the multiple linear correlation coefficient.

MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

Note

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

RELATIVE_WEIGHT

This keyword is obsolete. Code using the Weights argument and RELATIVE_WEIGHT keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword, for which case the RELATIVE_WEIGHT keyword is not necessary. Using the Weights argument, it was necessary to specify the RELATIVE_WEIGHT keyword if no weighting was desired. This is not the case with the MEASURE_ERRORS keyword—when MEASURE_ERRORS is omitted, REGRESS assumes you want no weighting.

SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

Note

If MEASURE_ERRORS is omitted, then you are assuming that the regression model is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

STATUS

Set this keyword to a named variable that will contain the status of the operation. Possible status values are:

- 0 = successful completion
- 1 = singular array (which indicates that the inversion is invalid)
- 2 = warning that a small pivot element was used and that significant accuracy was probably lost.

Note

If STATUS is not specified, any error messages will be output to the screen.

YFIT

Set this keyword to a named variable that will contain the vector of calculated *Y* values.

Example

```
; Create two vectors of independent variable data:
X1 = [1.0, 2.0, 4.0, 8.0, 16.0, 32.0]
X2 = [0.0, 1.0, 2.0, 3.0, 4.0, 5.0]
; Combine into a 2x6 array
X = [TRANSPOSE(X1), TRANSPOSE(X2)]

; Create a vector of dependent variable data:
Y = 5 + 3*X1 - 4*X2

; Assume Gaussian measurement errors for each point:
measure_errors = REPLICATE(0.5, N_ELEMENTS(Y))

; Compute the fit, and print the results:
result = REGRESS(X, Y, SIGMA=sigma, CONST=const, $
   MEASURE_ERRORS=measure_errors)
PRINT, 'Constant: ', const
PRINT, 'Coefficients: ', result[*]
PRINT, 'Standard errors: ', sigma
```

IDL prints:

```
Constant:    4.99999
Coefficients:    3.00000    -3.99999
Standard errors:    0.0444831    0.282038
```

See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, SFIT, SVDFIT

REPEAT...UNTIL

The REPEAT...UNTIL statement repeats its subject statement(s) until an expression evaluates to true. The condition is checked after the subject statement is executed. Therefore, the subject statement is always executed at least once, even if the expression evaluates to true the first time.

Note

For information on using REPEAT_UNTIL and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

REPEAT *statement* UNTIL *expression*

or

REPEAT BEGIN

statements

ENDREP UNTIL *expression*

Example

This example shows that because the subject of a REPEAT statement is evaluated before the expression, it is always executed at least once:

```
i = 1

REPEAT BEGIN

   PRINT, i

ENDREP UNTIL (i EQ 1)
```

REPLICATE

The REPLICATE function returns an array with the given dimensions, filled with the scalar value specified as the first parameter.

Syntax

Result = REPLICATE(*Value*, D_1 [, ..., D_8])

Arguments

Value

The scalar value with which to fill the resulting array. The type of the result is the same as that of *Value*. *Value* can be any single element expression such as a scalar or 1 element array. This includes structures.

D_i

The dimensions of the result.

Example

Create D, a 5-element by 5-element array with every element set to the string “IDL” by entering:

```
D = REPLICATE('IDL', 5, 5)
```

REPLICATE can also be used to create arrays of structures. For example, the following command creates a structure named “emp” that contains a string name field and a long integer employee ID field:

```
employee = {emp, NAME:' ', ID:0L}
```

To create a 10-element array of this structure, enter:

```
emps = REPLICATE(employee, 10)
```

See Also

MAKE_ARRAY

REPLICATE_INPLACE

The REPLICATE_INPLACE procedure updates an existing array by replacing all or selected parts of it with a specified value. REPLICATE_INPLACE can be faster and use less memory than the IDL function REPLICATE or the IDL array notation for large arrays that already exist.

Note

REPLICATE_INPLACE is much faster when operating on entire arrays and rows, than when used on columns or higher dimensions.

Syntax

REPLICATE_INPLACE, *X*, *Value* [, *D1*, *Loc1* [, *D2*, *Range*]]

Arguments

X

The array to be updated. *X* can be of any numeric type. REPLICATE_INPLACE does not change the size and type of *X*.

Value

The value which will fill all or part of *X*. *Value* may be any scalar or one-element array that IDL can convert to the type of *X*. REPLICATE_INPLACE does not change *Value*.

D1

An optional parameter indicating which dimension of *X* is to be updated.

Loc1

An array with the same number of elements as the number of dimensions of *X*. The *Loc1* and *D1* arguments together determine which one-dimensional subvector (or subvectors, if *D1* and *Range* are provided) of *X* is to be updated.

D2

An optional parameter, indicating in which dimension of *X* a group of one-dimensional subvectors are to be updated. *D2* should be different from *D1*.

Range

An array of indices of dimension *D2* of *X*, indicating where to put one-dimensional updates of *X*.

Example

```
; Create a multidimensional zero array:
A = FLTARR( 40, 90, 10)

; Populate it with the value 4.5. (i.e., A[*]= 4.5 ):
REPLICATE_INPLACE, A, 4.5
;Update a single subvector.(i.e., A[*,4,0]= 20. ):
REPLICATE_INPLACE, A, 20, 1, [0,4,0]

; Update a group of subvectors.(i.e., A[ 0, [0, 5,89], * ] = -8 ):
REPLICATE_INPLACE, A, -8, 3, [0,0,0], 2, [0,5,89]

; Update a 2-dimensional slice of A (i.e., A[9,*, *] = 0.):
REPLICATE_INPLACE, A, 0., 3, [9,0,0] , 2, LINDGEN(90)
```

See Also

REPLICATE, BLAS_AXPY

RESOLVE_ALL

The RESOLVE_ALL procedure iteratively resolves (by compiling) any uncompiled user-written or library procedures or functions that are called in any already-compiled procedure or function. The process ends when there are no unresolved routines left to compile. If an unresolved procedure or function is not in the IDL search path, this routine exits with an error, and no additional routines are compiled.

RESOLVE_ALL is useful when preparing SAVE/RESTORE files containing all the IDL routines required for an application.

Note

RESOLVE_ALL does not resolve procedures or functions that are called via CALL_PROCEDURE, CALL_FUNCTION, or EXECUTE. Class methods are not resolved either.

Similarly, RESOLVE_ALL does not resolve widget event handler procedures based on a call to the widget routine that uses the event handler. In general, it is best to include the event handling routine in the same program file as the widget creation routine—building widget programs in this way ensures that RESOLVE_ALL will "catch" the event handler for a widget application.

Note

RESOLVE_ALL is of special interest when constructing an IDL SAVE file containing the compiled code for a package of routines. If you are constructing such a `.sav` file, that contains calls to built-in IDL system functions that are not present under all operating systems (e.g., IOCTL, TRNLOG), you must make sure to use FORWARD_FUNCTION to tell IDL that these names are functions. Otherwise, IDL may interpret them as arrays and generate unintended results.

This routine is written in the IDL language. Its source code can be found in the file `resolve_all.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

RESOLVE_ALL [, /CONTINUE_ON_ERROR] [, /QUIET]

Keywords

CONTINUE_ON_ERROR

Set this keyword to allow continuation upon error.

QUIET

Set this keyword to suppress informational messages.

See Also

.COMPILE, RESOLVE_ROUTINE, ROUTINE_INFO

RESOLVE_ROUTINE

The RESOLVE_ROUTINE procedure compiles user-written or library procedures or functions, given their names. Routines are compiled even if they are already defined. RESOLVE_ROUTINE looks for the given filename in IDL's search path. If the file is not found in the path, then the routine exits with an error.

Syntax

RESOLVE_ROUTINE, *Name* [, /COMPILE_FULL_FILE]
[, /EITHER | , /IS_FUNCTION] [, /NO_RECOMPILE]

Arguments

Name

A scalar string or string array containing the name or names of the procedures to compile. If *Name* contains functions rather than procedures, set the IS_FUNCTION keyword. The *Name* argument cannot contain the path to the `.pro` file—it must contain only a `.pro` filename. If you want to specify a path to the `.pro` file, use the .COMPILE executive command.

Keywords

COMPILE_FULL_FILE

When compiling a file to find a specified routine, IDL normally stops compiling when the desired routine (*Name*) is found. If set, COMPILE_FULL_FILE compiles the entire file.

EITHER

If set, indicates that the caller does not know whether the supplied routine names are functions or procedures, and will accept either. This keyword overrides the IS_FUNCTION keyword.

IS_FUNCTION

Set this keyword to compile functions rather than procedures.

NO_RECOMPILE

Normally, RESOLVE_ROUTINE compiles all specified routines even if they have already been compiled. Setting NO_RECOMPILE indicates that such routines are not recompiled.

See Also

.COMPILE, RESOLVE_ALL, ROUTINE_INFO

RESTORE

The RESTORE procedure restores the IDL variables and routines saved in a file by the SAVE procedure.

Warning

While files containing IDL variables can be restored by any version of IDL that supports the data types of the variables (in particular, by any version of IDL later than the version that created the SAVE file), files containing IDL routines can only be restored by versions of IDL that share the same internal code representation. Since the internal code representation changes regularly, you should always archive the IDL language source files (`.pro` files) for routines you are placing in IDL SAVE files so you can recompile the code when a new version of IDL is released.

Note to VMS Users

When reading older VMS format files, IDL knows that all floating-point values are in VAX format. These floating values are automatically converted to IEEE format. Only VMS/IDL is able to restore the native VMS format.

Note

If you are restoring a file created with VAX IDL version 1, you *must* restore on a machine running VMS.

Syntax

RESTORE [, *Filename*] [, FILENAME=*name*]
[, /RELAXED_STRUCTURE_ASSIGNMENT]
[, RESTORED_OBJECTS=*variable*] [, /VERBOSE]

Arguments

Filename

A scalar string that contains the name of the file from which the IDL objects should be restored. If not present, the file `idlsave.dat` is used.

Keywords

FILENAME

The name of the file from which the IDL objects should be restored. If not present, the file `idlsave.dat` is used. This keyword serves exactly the same purpose as the *Filename* argument—only one of them needs to be provided.

RELAXED_STRUCTURE_ASSIGNMENT

Normally, RESTORE is unable to restore a structure variable if the definition of its type has changed since the SAVE file was written. A common case where this occurs is when objects are saved and the class structure of the objects change before they are restored in another IDL session. In such cases, RESTORE issues an error, skips the structure, and continues restoring the remainder of the SAVE file.

Setting the RELAXED_STRUCTURE_ASSIGNMENT keyword causes RESTORE to restore such incompatible values using "relaxed structure assignment," in which all possible data are restored using a field-by-field copy. (See the description of the STRUCT_ASSIGN procedure for additional details.)

RESTORED_OBJECTS

Set this keyword equal to a named variable that will contain an array of object references for any objects restored. The resulting list of objects is useful for programmatically calling the objects' restore methods. If no objects are restored, the variable will contain a null object reference.

VERBOSE

Set this keyword to have IDL print an informative message for each restored object.

Example

Suppose that you have saved all the variables from a previous IDL session with the command:

```
SAVE, /VARIABLES, FILENAME = 'session1.sav'
```

The variables in the file `session1.sav` can be restored by entering:

```
RESTORE, 'session1.sav'
```

See Also

JOURNAL, SAVE, STRUCT_ASSIGN

RETALL

The RETALL command returns control to the main program level. The effect is the same as entering the RETURN command at the interactive command prompt until the main level is reached.

Syntax

RETALL

Arguments

None

See Also

RETURN

RETURN

The RETURN command causes the program context to revert to the next-higher program level. RETURN can be called at the interactive command prompt (see ".RETURN" on page 56), inside a procedure definition, or inside a function definition.

Calling RETURN from the main program level has no effect other than to print an informational message in the command log.

Calling RETURN inside a procedure definition returns control to the calling routine, or to the main level. Since the END statement in a procedure definition also returns control to the calling routine, it is only necessary to use RETURN in a procedure definition if you wish control to revert to the calling routine before the procedure reaches its END statement.

In a function definition, RETURN serves to define the value passed out of the function. Only a single value can be returned from a function.

Note

The value can be an array or structure containing multiple data items.

Syntax

RETURN [, *Return_value*]

Arguments

Return_value

In a function definition, the *Return_value* is the value passed out of the function when it completes its processing.

Return values are not allowed in procedure definitions, or when calling RETURN at the interactive command prompt.

Examples

You can use RETURN within a procedure definition to exit the procedure at some point other than the end. For example, note the following procedure:

```
PRO RET_EXAMPLE, value
   IF value THEN BEGIN
```

```
      PRINT, value, ' is nonzero'
      RETURN
      END
   PRINT, 'Input argument was zero.'
END
```

If the input argument is non-zero, the routine prints the value and exits back to the calling procedure or main level. If the input argument is zero, control proceeds until the END statement is reached.

When defining functions, use RETURN to specify the value returned from the function. For example, the following function:

```
FUNCTION RET_EXAMPLE2, value
   RETURN, value * 2
END
```

multiplies the input value by two and returns the result. If this function is defined at the main level, calling it from the IDL command prompt produces the following:

```
PRINT, RET_EXAMPLE2(4)
```

IDL prints:

```
8
```

See Also

RETALL

REVERSE

The REVERSE function reverses the order of one dimension of an array.

This routine is written in the IDL language. Its source code can be found in the file `reverse.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = REVERSE(*Array* [, *Subscript_Index*] [, /OVERWRITE])

Arguments

Array

The array containing the original data.

Subscript_Index

An integer specifying the dimension index (1, 2, 3, etc.) that will be reversed. This argument must be less than or equal to the number of dimensions of *Array*. If this argument is omitted, the first subscript is reversed.

Keywords

OVERWRITE

Set this keyword to conserve memory by doing the transformation “in-place.” The result overwrites the previous contents of the array. This keyword is ignored for one- or two-dimensional arrays.

Example

Reverse the order of an array where each element is set to the value of its subscript:

```
; Create an array:
A = [[0,1,2],[3,4,5],[6,7,8]]

; Print the array:
PRINT, 'Original Array:'
PRINT, A

; Reverse the columns of A.
PRINT, 'Reversed Columns:'
PRINT, REVERSE(A)
```

```
; Reverse the rows of A:
PRINT, 'Reversed Rows:'
PRINT, REVERSE(A, 2)
```

IDL prints:

```
Original Array:
       0       1       2
       3       4       5
       6       7       8
Reversed Columns:
       2       1       0
       5       4       3
       8       7       6
Reversed Rows:
       6       7       8
       3       4       5
       0       1       2
```

See Also

INVERT, REFORM, ROT, ROTATE, SHIFT, TRANSPOSE

REWIND

The REWIND procedure rewinds the tape on the designated IDL tape unit. REWIND is available only under VMS. See the description of the magnetic tape routines in "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

Syntax

REWIND, *Unit*

Arguments

Unit

The magnetic tape unit to rewind. *Unit* must be a number between 0 and 9, and should not be confused with standard file Logical Unit Numbers (LUNs).

See Also

SKIPF, TAPRD

RK4

The RK4 function uses the fourth-order Runge-Kutta method to advance a solution to a system of ordinary differential equations one time-step *H*, given values for the variables *Y* and their derivatives *Dydx* known at *X*.

RK4 is based on the routine `rk4` described in section 16.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = RK4(*Y*, *Dydx*, *X*, *H*, *Derivs* [, /DOUBLE])

Arguments

Y

A vector of values for *Y* at *X*

Dydx

A vector of derivatives for *Y* at *X*.

X

A scalar value for the initial condition.

H

A scalar value giving interval length or step size.

Derivs

A scalar string specifying the name of a user-supplied IDL function that calculates the values of the derivatives *Dydx* at *X*. This function must accept two arguments: A scalar floating value *X*, and one *n*-element vector *Y*. It must return an *n*-element vector result.

For example, suppose the values of the derivatives are defined by the following relations:

$$dy_0 / dx = -0.5y_0, \qquad dy_1 / dx = 4.0 - 0.3y_1 - 0.1y_0$$

We can write a function DIFFERENTIAL to express these relationships in the IDL language:

```
FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
END
```

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To integrate the example system of differential equations for one time step, H:

```
; Define the step size:
H = 0.5

; Define an initial X value:
X = 0.0

; Define initial Y values:
Y = [4.0, 6.0]

; Calculate the initial derivative values:
dydx = DIFFERENTIAL(X,Y)

; Integrate over the interval (0, 0.5):
result = RK4(Y, dydx, X, H, 'differential')

; Print the result:
PRINT, result
```

IDL prints:

```
 3.11523  6.85767
```

This is the exact solution vector to five-decimal precision.

See Also

BROYDEN, NEWTON

ROBERTS

The ROBERTS function returns an approximation to the Roberts edge enhancement operator for images:

$$G_{jk} = \left|F_{jk} - F_{j+1,k+1}\right| + \left|F_{j,k+1} - F_{j+1,k}\right|$$

where (j, k) are the coordinates of each pixel F_{jk} in the *Image*. This is equivalent to a convolution using the masks,

$$\begin{bmatrix} 0 & -1 \\ \underline{1} & 0 \end{bmatrix} \text{and} \begin{bmatrix} 1 & 0 \\ \underline{0} & -1 \end{bmatrix}$$

where the underline indicates the current pixel F_{jk}. The last column and row are set to zero.

Syntax

Result = ROBERTS(*Image*)

Return Value

ROBERTS returns a two-dimensional array of the same size as *Image*. If *Image* is of type byte or integer, then the result is of integer type, otherwise the result is of the same type as *Image*.

Note

To avoid overflow for integer types, the computation is done using the next larger signed type and the result is transformed back to the correct type. Values larger than the maximum for that integer type are truncated. For example, for integers the function is computed using type long, and on output, values larger than 32767 are set equal to 32767.

Arguments

Image

The two-dimensional array containing the image to which edge enhancement is applied.

Example

If the variable `myimage` contains a two-dimensional image array, a Roberts sharpened version of `myimage` can be displayed with the command:

```
TVSCL, ROBERTS(myimage)
```

See Also

SOBEL

ROT

The ROT function rotates an image by an arbitrary amount. At the same time, it can magnify, demagnify, and/or translate an image. Note that if you want to rotate an array by a multiple of 90 degrees, you should use the ROTATE function for faster results.

This routine is written in the IDL language. Its source code can be found in the file `rot.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = ROT(*A*, *Angle*, [*Mag*, X_0, Y_0] [, /INTERP] [, CUBIC=*value*{-1 to 0}] [, MISSING=*value*] [, /PIVOT])

Arguments

A

The image array to be rotated. This array can be of any type, but must have two dimensions. The output image has the same dimensions and data type of the input image.

ANGLE

Angle of rotation in degrees *clockwise*.

MAG

An optional magnification factor. A value of 1.0 results in no change. A value greater than one performs magnification and a value less than one performs demagnification.

X_0

X subscript for the center of rotation. If omitted, X_0 equals the number of columns in the image divided by 2.

Y_0

Y subscript for the center of rotation. If omitted, Y_0 equals the number of rows in the image divided by 2.

Keywords

INTERP

Set this keyword to use bilinear interpolation. The default is to use nearest neighbor sampling.

CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than ω_0, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used. Note that cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

MISSING

Set this keyword to a value to be substituted for pixels in the output image that map outside the input image.

PIVOT

Set this keyword to cause the image to pivot around the point (X_0, Y_0) so that this point maps into the same point in the output image. By default, the point (X_0, Y_0) in the input image is mapped into the center of the output image.

Example

```
; Create a byte image:
A = BYTSCL(DIST(256))

; Display it:
TV, A

; Rotate the image 33 degrees, magnify it 15 times, and use
; bilinear interpolation to make the output look nice:
B = ROT(A, 33, 1.5, /INTERP)

; Display the rotated image:
TV, B
```

See Also

ROTATE

ROTATE

The ROTATE function returns a rotated and/or transposed copy of *Array*. ROTATE can only rotate arrays in multiples of 90 degrees. To rotate by amounts other than multiples of 90 degrees, use the ROT function. Note, however, that ROTATE is more efficient.

ROTATE can also be used to reverse the order of elements in vectors. For example, to reverse the order of elements in the vector X, use the expression `ROTATE(X,2)`. If X = [0,1,2,3] then `ROTATE(X,2)` yields the resulting array, [3,2,1,0].

Transposition is performed before rotation. Rotations are viewed with the first row at the top.

Syntax

Result = ROTATE(*Array*, *Direction*)

Arguments

Array

The array to be rotated. *Array* can have only one or two dimensions. The result has the same type as *Array*. The dimensions of the result are the same as those of *Array* if *Direction* is equal to 0 or 2. The dimensions are transposed if the direction is 4 or greater.

Direction

Direction specifies the operation to be performed as follows:

Direction	Transpose ?	Rotation Counterclockwise	X_1	Y_1
0	No	None	X_0	Y_0
1	No	90°	$-Y_0$	X_0
2	No	180°	$-X_0$	$-Y_0$
3	No	270°	Y_0	$-X_0$
4	Yes	None	Y_0	X_0

Table 82: Rotation Directions

Direction	Transpose ?	Rotation Counterclockwise	X_1	Y_1
5	Yes	90°	$-X_0$	Y_0
6	Yes	180°	$-Y_0$	$-X_0$
7	Yes	270°	X_0	$-Y_0$

Table 82: Rotation Directions

In the table above, (X_0, Y_0) are the original subscripts, and (X_1, Y_1) are the subscripts of the resulting array. The notation $-Y_0$ indicates a reversal of the Y axis, $Y_1 = N_y - Y_0 - 1$. *Direction* is taken modulo 8, so a rotation of -1 is the same as 7, 9 is the same as 1, etc.

Note

The assertion that *Array* is rotating counterclockwise may cause some confusion. Remember that when arrays are displayed on the screen (using TV or TVSCL, for example), the image is drawn with the origin (0,0) at the bottom left corner of the window. When arrays are printed on the console or command log window (using the PRINT command, for example), the (0,0) element is drawn in the upper left corner of the array. This means that while an image displayed in a window appears to rotate counterclockwise, an array printed in the command log appears to rotate clockwise.

Example

Create and display a wedge image by entering:

```
F = REPLICATE(1, 256) # FINDGEN(256) & TVSCL, F
```

To display the image rotated 90 degrees counterclockwise, enter:

```
TVSCL, ROTATE(F, 1)
```

See Also

ROT, TRANSPOSE

ROUND

The ROUND function rounds the argument to its closest integer.

Syntax

Result = ROUND(*X* [, /L64])

Return Value

Returns the integer closest to its argument. If the input value *X* is integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is returned as a 32-bit longword integer with the same structure as *X*.

Arguments

X

The value for which the ROUND function is to be evaluated. This value can be any numeric type (integer, floating, or complex). Note that only the real part of a complex argument is rounded and returned.

Keywords

L64

If set, the result type is 64-bit integer no matter what type the input has. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

Example

Print the rounded values of a 2-element vector:

```
PRINT, ROUND([5.1, 5.9])
```

IDL prints:

```
      5       6
```

Print the result of rounding 3000000000.1, a value that is too large to represent in a 32-bit integer:

```
PRINT, ROUND(3000000000.1D, /L64)
```

IDL prints:

```
3000000000
```

See Also

CEIL, COMPLEXROUND, FLOOR

ROUTINE_INFO

The ROUTINE_INFO function provides information about currently-compiled procedures and functions. It returns a string array consisting of the names of defined procedures or functions, or of parameters or variables used by a single procedure or function.

Syntax

Result = ROUTINE_INFO([*Routine* [[, /PARAMETERS{must specify *Routine*}] [, /SOURCE] [, /UNRESOLVED] [, /VARIABLES] | , /SYSTEM]] [, /DISABLED] [, /ENABLED] [, /FUNCTIONS])

Arguments

Routine

A scalar string containing the name of routine for which information will be returned. *Routine* can be either a procedure or a function. If *Routine* is not supplied, ROUTINE_INFO returns a list of all currently-compiled procedures.

Keywords

DISABLED

Set this keyword to get the names of currently disabled system procedures or functions (in conjunction with the FUNCTIONS keyword). Use of DISABLED implies use of the SYSTEM keyword, since user routines cannot be disabled.

ENABLED

Set this keyword to get the names of currently enabled system procedures or functions (in conjunction with the FUNCTIONS keyword). Use of ENABLED implies use of the SYSTEM keyword, since user routines cannot be disabled.

FUNCTIONS

Set this keyword to return a string array containing currently-compiled functions. By default, ROUTINE_INFO returns a list of compiled procedures. If the SYSTEM keyword is also set, ROUTINE_INFO returns a list of all IDL built-in internal functions.

PARAMETERS

Set this keyword to return an anonymous structure with the following fields:

- **NUM_ARGS** — An integer containing the number of positional parameters used in *Routine*.
- **NUM_KW_ARGS** — An integer containing the number of keyword parameters used in *Routine*.
- **ARGS** — A string array containing the names of the positional parameters used in *Routine*.
- **KW_ARGS** — A string array containing the names of the keyword parameters used in *Routine*.

You must supply the *Routine* argument when using this keyword. Note that specifying the SYSTEM keyword along with this keyword will generate an error. If *Routine* does not take any arguments, the ARGS field is not included in the anonymous structure. Similarly, if *Routine* does not take any keywords, the KW_ARGS field is not included.

SOURCE

Set this keyword to return an array of anonymous structures with the following fields:

- **NAME** — A string containing the name of the procedure or function.
- **PATH** — A string containing the full path specification of the file that contains the definition of the procedure or function.

If *Routine* is specified, information for that one routine is returned. If *Routine* is not specified, information for all compiled routines is returned. If a routine is unresolved or its path information is unavailable, the PATH field will contain a null string. If a routine has been SAVEd and then RESTOREd, the PATH field will contain the path to the SAVE file.

Note

Specifying the SYSTEM keyword along with this keyword will generate an error.

SYSTEM

Set this keyword to return a string array listing all IDL built-in internal procedures. Built-in internal procedures are part of the IDL executable, and are *not* written in the IDL language. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns a list of all IDL built-in internal functions.

UNRESOLVED

Set this keyword to return a string array listing procedures that are referenced in any currently-compiled procedure or function, but which are themselves not yet compiled. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns a list of functions that are referenced but not yet compiled.

Note that specifying the SYSTEM keyword along with this keyword will generate an error.

VARIABLES

Set this keyword to return a string array listing variables defined in the procedure or function.

You must supply the *Routine* argument when using this keyword. Note that specifying the SYSTEM keyword along with this keyword will generate an error.

See Also

RESOLVE_ALL, RESOLVE_ROUTINE

RS_TEST

The RS_TEST function tests the hypothesis that two sample populations *X* and *Y* have the same mean of distribution against the hypothesis that they differ. *X* and *Y* may be of different lengths. The result is a two-element vector containing the nearly-normal test statistic Z and the one-tailed probability of obtaining a value of Z or greater. This type of test is often referred to as the "Wilcoxon Rank-Sum Test" or the "Mann-Whitney U-Test."

The Mann-Whitney statistics for *X* and *Y* are defined as follows:

$$U_x = N_x N_y + \frac{N_x(N_x + 1)}{2} - W_x$$

$$U_y = N_x N_y + \frac{N_y(N_y + 1)}{2} - W_y$$

where *Nx* and *Ny* are the number of elements in *X* and *Y*, respectively, and *Wx* and *Wy* are the rank sums for *X* and *Y*, respectively. The test statistic Z, which closely follows a normal distribution for sample sizes exceeding 10 elements, is defined as follows:

$$Z = \frac{U_x - (N_x N_y)/2}{\sqrt{(N_x N_y (N_x + N_y + 1))/12}}$$

This routine is written in the IDL language. Its source code can be found in the file `rs_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = RS_TEST(*X*, *Y* [, UX=*variable*] [, UY=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *m*-element integer, single-, or double-precision floating-point vector.

Keywords

UX

Set this keyword to a named variable that will contain the Mann-Whitney statistic for *X*.

UY

Set this keyword to a named variable that will contain the Mann-Whitney statistic for *Y*.

Example

```
; Define two sample populations:
X = [-14, 3, 1, -16, -21, 7, -7, -13, -22, -17, -14, -8, $
       7, -18, -13, -9, -22, -25, -24, -18, -13, -13, -18, -5]
Y = [-18, -9, -16, -14, -3, -9, -16, 10, -11, -3, -13, $
     -21, -2, -11, -16, -12, -13, -6, -9, -7, -11, -9]

; Test the hypothesis that two sample populations, {xi, yi}, have
; the same mean of distribution against the hypothesis in that they
; differ at the 0.05 significance level:
PRINT, RS_TEST(X, Y, UX = ux, UY = uy)

; Print the Mann-Whitney statistics:
PRINT, 'Mann-Whitney Statistics: Ux = ', ux, ', Uy = ', uy
```

IDL prints:

```
[1.45134, 0.0733429]
Mann-Whitney Statistics: Ux = 330.000, Uy = 198.000
```

The computed probability (0.0733429) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that X and Y have the same mean of distribution.

See Also

FV_TEST, KW_TEST, S_TEST, TM_TEST

S_TEST

The S_TEST function tests the hypothesis that two sample populations *X* and *Y* have the same mean of distribution against the hypothesis that they differ. The result is a two-element vector containing the maximum number of signed differences between corresponding pairs of *xi* and *yi* and its one-tailed significance. This type of test is often referred to as the "Sign Test."

This routine is written in the IDL language. Its source code can be found in the file `s_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = S_TEST(*X*, *Y* [, ZDIFF=*variable*])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *n*-element integer, single-, or double-precision floating-point vector.

Keywords

ZDIFF

Set this keyword to a named variable that will contain the number of differences between corresponding pairs of *xi* and *yi* resulting in zero. Paired data resulting in a difference of zero are excluded from the ranking and the sample size is correspondingly reduced.

Example

```
; Define two n-element sample populations:
X = [47, 56, 54, 49, 36, 48, 51, 38, 61, 49, 56, 52]
Y = [71, 63, 45, 64, 50, 55, 42, 46, 53, 57, 75, 60]

; Test the hypothesis that the two sample populations have the same
; mean of distribution against the hypothesis that they differ at
; the 0.05 significance level:
PRINT, S_TEST(X, Y, ZDIFF = zdiff)
```

IDL prints:

```
[9.00000, 0.0729981]
```

The computed probability (0.0729981) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that *X* and *Y* have the same mean of distribution.

See Also

FV_TEST, KW_TEST, MD_TEST, RS_TEST, TM_TEST

SAVE

The SAVE procedure saves variables, system variables, and IDL routines in a file using the XDR (eXternal Data Representation) format for later recovery by RESTORE. Note that variables and routines cannot be saved in the same file. Note also that save files containing routines may not be compatible between different versions of IDL, but that files containing data are always backwards-compatible.

Syntax

SAVE [, *Var*$_1$, ..., *Var*$_n$] [, /ALL] [, /COMM, /VARIABLES] [, /COMPRESS] [, FILENAME=*string*] [, ROUTINES] [, /SYSTEM_VARIABLES] [, /VERBOSE]

Arguments

Var$_n$

Optional named variables that are to be saved.

Keywords

ALL

Set this keyword to save all common blocks, system variables, and local variables from the current IDL session.

Note

Routines and variables cannot be saved in the same file. Setting the ALL keyword does not save routines.

COMM

Set this keyword to save all main level common block definitions. Note that setting this keyword does not cause the contents of the common block to be saved unless the VARIABLES keyword is also set.

COMPRESS

If COMPRESS is set, IDL writes all data to the SAVE file using the ZLIB compression library to reduce its size. IDL's save file compression support is based on the freely available ZLIB library version 1.1.3 by Mark Adler and Jean-loup Gailly.

Compressed save files can be restored by the RESTORE procedure in exactly the same manner as any other save file. The only visible differences are that the files will be smaller, and writing and reading them will be somewhat slower under typical conditions.

FILENAME

A string containing the name of the file into which the IDL objects should be saved. If this keyword is not specified, the file `idlsave.dat` is used.

ROUTINES

Set this keyword to save user defined procedures and functions in a machine independent, binary form. If parameters are present, they must be strings containing the names of the procedures and/or functions to be saved. If no parameters are present, all compiled routines are saved. If you are using VMS, see the XDR keyword below. Routines and variables cannot be saved in the same file.

Warning

Because SAVE stores routines in a binary format, save files containing routines are not guaranteed to be compatible between successive versions of IDL. You will not be able to RESTORE save files containing routines if they are made with incompatible versions of IDL. In this case, you should recompile your original code with the newer version of IDL. Save files containing data will always be restorable.

SYSTEM_VARIABLES

Set this keyword to save the current state of all system variables.

Warning

Saving system variables is not recommended, as the structure may change between versions of IDL.

VARIABLES

Set this keyword to save all variables in the current program unit. This option is the default.

VERBOSE

Set this keyword to print an informative message for each saved object.

Example

Save the status of all currently-defined variables in the file variables1.dat by entering:

```
SAVE, /VARIABLES, FILENAME = 'variables1.dat'
```

The variables can be restored with the RESTORE procedure. Save the user procedures MYPROC and MYFUN:

```
SAVE, /ROUTINES, 'MYPROC', 'MYFUN'
```

See Also

JOURNAL, RESOLVE_ALL, RESTORE

SAVGOL

The SAVGOL function returns the coefficients of a Savitzky-Golay smoothing filter, which can then be applied using the CONVOL function. The Savitzky-Golay smoothing filter, also known as least squares or DISPO (digital smoothing polynomial), can be used to smooth a noisy signal.

The filter is defined as a weighted moving average with weighting given as a polynomial of a certain degree. The returned coefficients, when applied to a signal, perform a polynomial least-squares fit within the filter window. This polynomial is designed to preserve higher moments within the data and reduce the bias introduced by the filter. The filter can use any number of points for this weighted average.

This filter works especially well when the typical peaks of the signal are narrow. The heights and widths of the curves are generally preserved.

Tip

You can use this function in conjunction with the CONVOL function for smoothing and optionally for numeric differentiation.

This routine is written in the IDL language. Its source code can be found in the file `savgol.pro` in the `lib` subdirectory of the IDL distribution.

SAVGOL is based on the Savitzky-Golay Smoothing Filters described in section 14.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SAVGOL(*Nleft*, *Nright*, *Order*, *Degree* [, /DOUBLE])

Return Value

This function returns an array of floating-point numbers that are the coefficients of the smoothing filter.

Arguments

Nleft

An integer specifying the number of data points to the left of each point to include in the filter.

Nright

An integer specifying the number of data points to the right of each point to include in the filter.

Note

Larger values of *Nleft* and *Nright* produce a smoother result at the expense of flattening sharp peaks.

Order

An integer specifying the order of the derivative desired. For smoothing, use order 0. To find the smoothed first derivative of the signal, use order 1, for the second derivative, use order 2, etc.

Note

Order must be less than or equal to the value specified for *Degree*.

Degree

An integer specifying the degree of smoothing polynomial. Typical values are 2 to 4. Lower values for *Degree* will produce smoother results but may introduce bias, higher values for *Degree* will reduce the filter bias, but may "over fit" the data and give a noisier result.

Note

Degree must be less than the filter width (*Nleft* + *Nright* + 1).

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Tip

The DOUBLE keyword is recommended for *Degree* greater than 9.

Example

The following example creates a noisy 400-point vector with 4 Gaussian peaks of decreasing width. It then plots the original vector, the vector smoothed with a 33-point Boxcar smoother (the SMOOTH function), and the vector smoothed with 33-point wide Savitzky-Golay filter of degree 4. The bottom plot shows the first derivative of the noisy signal and the first derivative using the Savitzky-Golay filter of degree 4:

```
n = 401 ; number of points
np = 4  ; number of peaks
; Form the baseline:
y = REPLICATE(0.5, n)
; Index the array:
x = FINDGEN(n)
; Add each Gaussian peak:
FOR i=0, np-1 DO BEGIN
   c = (i + 0.5) * FLOAT(n)/np ; Center of peak
   peak = -(3 * (x-c) / (75. / 1.5 ^ i))^2
   ; Add Gaussian. Cutoff of -50 avoids underflow errors for
   ; tiny exponentials:
   y = y + EXP(peak>(-50))
ENDFOR
; Add noise:
y1 = y + 0.10 * RANDOMN(-121147, n)

!P.MULTI=[0,1,3]

; Boxcar smoothing width 33:
PLOT, x, y1, TITLE='Signal+Noise; Smooth (width33)'
OPLOT, SMOOTH(y1, 33, /EDGE_TRUNCATE), THICK=3

; Savitzky-Golay with 33, 4th degree polynomial:
savgolFilter = SAVGOL(16, 16, 0, 4)
PLOT, x, y1, TITLE='Savitzky-Golay (width 33, 4th degree)'
OPLOT, x, CONVOL(y1, savgolFilter, /EDGE_TRUNCATE), THICK=3

; Savitzky-Golay width 33, 4th degree, 1st derivative:
savgolFilter = SAVGOL(16, 16, 1, 4)
PLOT, x, DERIV(y1), YRANGE=[-0.2, 0.2], TITLE=$
 'First Derivative: Savitzky-Golay(width 33, 4th degree, order 1)'
OPLOT, x, CONVOL(y1, savgolFilter, /EDGE_TRUNCATE), THICK=3
```

The following is the resulting plot. Notice how the Savitzky-Golay filter preserves the high peaks but does not do as much smoothing on the flatter regions. Note also

that the Savitzky-Golay filter is able to construct a good approximation of the first derivative.

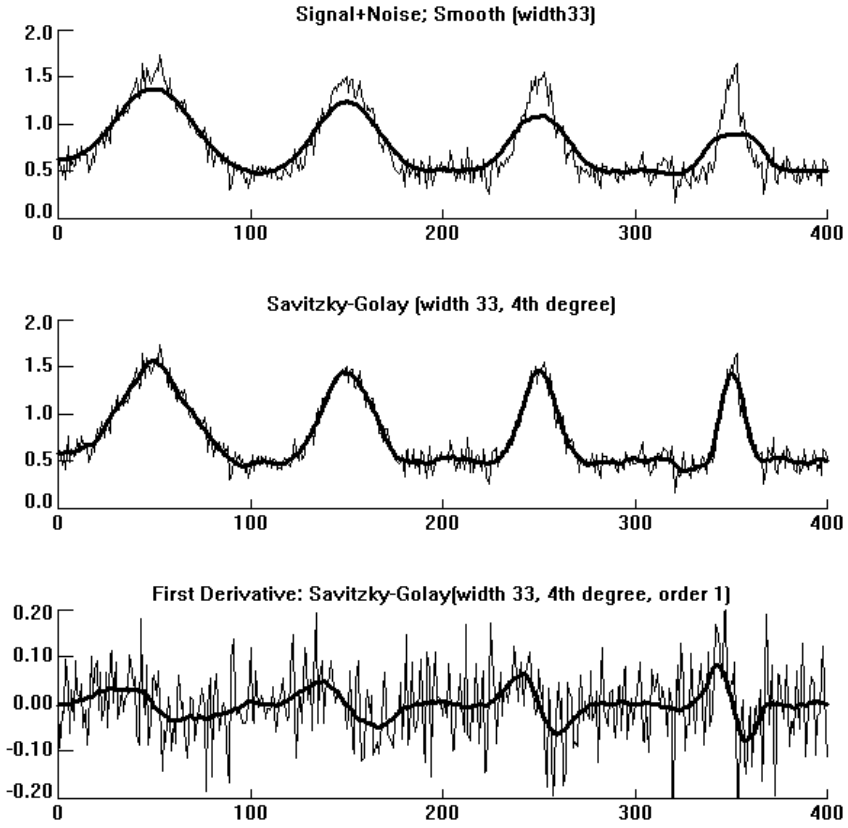


Figure 19: SAVGOL Example

See Also

CONVOL, DIGITAL_FILTER, SMOOTH

SCALE3

The SCALE3 procedure sets up transformation and scaling parameters for basic 3D viewing. This procedure is similar to SURFR and SCALE3D, except that the data ranges must be specified and the scaling does not vary with rotation. Results are stored in the system variables !P.T, !X.S, !Y.S, and !Z.S.

This routine is written in the IDL language. Its source code can be found in the file `scale3.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SCALE3 [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*] [, AX=*degrees*] [, AZ=*degrees*]

Keywords

XRANGE

A two-element vector containing the minimum and maximum X values. If omitted, the X-axis scaling remains unchanged.

YRANGE

A two-element vector containing the minimum and maximum Y values. If omitted, the Y-axis scaling remains unchanged.

ZRANGE

A two-element vector containing the minimum and maximum Z values. If omitted, the Z-axis scaling remains unchanged.

AX

Angle of rotation about the X axis. The default is 30 degrees.

AZ

Angle of rotation about the Z axis. The default is 30 degrees.

Example

Set up a 3D transformation where the data range is 0 to 20 for each of the 3 axes and the viewing area is rotated 20 degrees about the X axis and 55 degrees about the Z axis:

```
SCALE3, XRANGE=[0, 20], YRANGE=[0, 20], ZRANGE=[0, 20], AX=20,
AZ=55
```

See Also

SCALE3D, SURFR, T3D

SCALE3D

The SCALE3D procedure scales the 3D unit cube (a cube with the length of each side equal to 1) into the viewing area. Eight data points are created at the vertices of the 3D unit cube. The vertices are then transformed by the value of the system variable !P.T. The system is translated to bring the minimum (*x*,*y*,*z*) point to the origin, and then scaled to make each coordinate's maximum value equal to 1. The !P.T system variable is modified as a result.

This routine is written in the IDL language. Its source code can be found in the file `scale3D.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SCALE3D

See Also

SCALE3, SURFR, T3D

SEARCH2D

The SEARCH2D function finds “objects” or regions of similar data values within a two-dimensional array. Given a starting location and a range of values to search for, SEARCH2D finds all the cells within the array that are within the specified range and have some path of connectivity through these cells to the starting location. In addition to searching for cells within a global range of data values, SEARCH2D can also search for adjacent cells whose values deviate from their neighbors within specified tolerances.

SEARCH2D returns a longword array that contains a list of the array subscripts that define the located object or region. The original X and Y indices of the array subscripts returned by SEARCH2D can be found with the following IDL code:

```
index_y = Result / (SIZE(Array))(1)
index_x = Result - (index_y * (SIZE(Array))(1))
```

where *Result* is the array returned by SEARCH2D and *Array* is the original input array. The object within *Array* can be subscripted as *Array*`(`*Region*`)` or *Array*`(index_x, index_y)`.

This routine is written in the IDL language. Its source code can be found in the file `search2d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SEARCH2D(*Array*, *Xpos*, *Ypos*, *Min_Val*, *Max_Val* [, /DECREASE, /INCREASE [, LPF_BAND=*integer*{≥3}]] [, /DIAGONAL])

Arguments

Array

A two-dimensional array, of any data type, to be searched.

Xpos

The X coordinate (dimension 0 of *Array*) of the starting location.

Ypos

The Y coordinate (dimension 1 of *Array*) of the starting location.

Min_Val

The minimum data value for which to search. All array subscripts of all cells that are connected to the starting cell, and have a value between *Min_Val* and *Max_Val* (inclusive) are returned.

Max_Val

The maximum data value for which to search.

Keywords

DECREASE

This keyword and the INCREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if INCREASE is specified.

INCREASE

This keyword and the DECREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if DECREASE is specified.

LPF_BAND

Set this keyword to an integer value of 3 or greater to perform low-pass filtering on the edge-enhanced array. The value of LPF_BAND is used as the width of the smoothing window. This keyword is only effective when the DECREASE or INCREASE keywords are also specified. The default is no smoothing.

DIAGONAL

Set this keyword to cause SEARCH2D to find cells meeting the search criteria whose surrounding squares share a common corner. Normally, cells are considered adjacent

only when squares surrounding the cells share a common edge. Setting this option requires more memory and execution time.

Example

Find all the indices corresponding to an object in an image:

```
; Create an image with different valued regions:
img = FLTARR(512, 512)
img[3:503, 9:488] = 0.7
img[37:455, 18:438] = 0.5
img[144:388, 90:400] = 0.7
img[200:301, 1:255] = 1.0
img[155:193, 333:387] = 0.3
TVSCL, img;Display the image.

; Search for an object starting at (175, 300) whose data values are
; between (0.6) and (0.8):
region = SEARCH2D(img, 175, 300, 0.6, 0.8, /DIAGONAL)

; Scale the background cells into the range 0 to 127:
img = BYTSCL(img, TOP=127B)

; Highlight the object region by setting it to 255:
img[region] = 255B

; Display the array with the highlighted object in it:
TVSCL, img
```

See Also

SEARCH3D

SEARCH3D

The SEARCH3D function finds “objects” or regions of similar data values within a 3D array of data. Given a starting location and a range of values to search for, SEARCH3D finds all the cells within the volume that are within the specified range of values and have some path of connectivity through these cells to the starting location. In addition to searching for cells within a global range of data values, SEARCH3D can also search for adjacent cells whose values deviate from their neighbors within specified tolerances.

SEARCH3D returns a longword array that contains a list of the array subscripts that define the selected object or region. The original X and Y indices of the array subscripts returned by SEARCH3D can be found with the following IDL code:

```
S = SIZE(Array)
index_z = Result / (S[1] * S[2])
index_y = (Result - (index_z * S[1] * S[2])) / S[1]
index_x = (Result - (index_z * S[1] * S[2])) - (index_y * S[1])
```

where *Result* is the array returned by SEARCH3D and *Array* is the original input volume. The object within *Array* can be subscripted as `Array[Region]` or `Array[index_x, index_y, index_z]`.

This routine is written in the IDL language. Its source code can be found in the file `search3d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SEARCH3D(*Array*, *Xpos*, *Ypos*, *Zpos*, *Min_Val*, *Max_Val* [, /DECREASE, /INCREASE [, LPF_BAND=*integer*{≥3}]] [, /DIAGONAL])

Arguments

Array

The three-dimensional array, of any data type except string, to be searched.

Xpos

The X coordinate (dimension 0 or *Array*) of the starting location.

Ypos

The Y coordinate (dimension 1 of *Array*) of the starting location.

Zpos

The Z coordinate (dimension 2 of *Array*) of the starting location.

Min_Val

The minimum data value for which to search. All array subscripts of all the cells that are connected to the starting cell, and have a value between *Min_Val* and *Max_Val* (inclusive) are returned.

Max_Val

The maximum data value for which to search.

Keywords

DECREASE

This keyword and the INCREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if INCREASE is specified.

INCREASE

This keyword and the DECREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if DECREASE is specified.

LPF_BAND

Set this keyword to an integer value of 3 or greater to perform low-pass filtering on the edge-enhanced array. The value of LPF_BAND is used as the width of the smoothing window. This keyword is only effective when the DECREASE or INCREASE keywords are also specified. The default is no smoothing.

DIAGONAL

Set this keyword to cause SEARCH3D to find cells meeting the search criteria whose surrounding cubes share a common corner or edge. Normally, cells are considered adjacent only when cubes surrounding the cells share a common edge. Setting this option requires more memory and execution time.

Example

Find all the indices corresponding to an object contained in a 3D array:

```
; Create some data.
vol = RANDOMU(s, 40, 40, 40)
vol[3:13, 1:15, 17:33] = 1.3
vol[15:25, 5:25, 15:25] = 0.2
vol[5:30,17:38,7:28] = 1.3
vol[9:23, 16:27, 7:33] = 1.5

; Search for an object starting at (6, 22, 16) whose data values
; are between (1.2) and (1.4):
region = SEARCH3D(vol, 6, 22, 16, 1.2, 1.4, /DIAGONAL)

; Scale the background cells into the range 0 to 127:
vol = BYTSCL(vol, TOP=127B)

; Highlight the object region by setting it to 255:
vol[Region] = 255B
WINDOW, 0, XSIZE=640, YSIZE=512, RETAIN=2

; Set up a 3-D view:
CREATE_VIEW, XMAX=39, YMAX=39, ZMAX=39, AX=(-30), AZ=30, ZOOM=0.8

; Display the volume with the highlighted object in it:
TVSCL, PROJECT_VOL(vol, 64, 64, 40, DEPTH_Q=0.4)
```

See Also

SEARCH2D

SET_PLOT

The SET_PLOT procedure sets the output device used by the IDL graphics procedures. Keyword parameters control how the color tables are transferred to the newly selected graphics device. SET_PLOT performs the following actions:

- It sets the read-only system variable !D to reflect the configuration of the new device.
- It sets the default color !P.COLOR to the maximum color index minus one or, in the case of devices with white backgrounds, such as PostScript, to 0 (black).
- If the COPY keyword is set, the device color tables are copied directly from IDL's internal color tables. If the new device's color tables contain more indices than those of the old device, the new device's tables are not completely filled.
- If the INTERPOLATE keyword is set, the internal color tables are interpolated to fill the range of the new device.
- It sets the clipping rectangle to the entire device surface.

Warning

After calling SET_PLOT to change graphics devices, the scaling contained in the axis structures !X, !Y, and !Z is invalid. Any routines that rely on data coordinates should not be called until a new data coordinate system has been established. Be careful when switching devices as the number of color indices frequently differs between devices. When in doubt, reload the color table of the new device explicitly.

Syntax

SET_PLOT, *Device* [, /COPY] [, /INTERPOLATE]

Arguments

Device

A scalar string containing the name of the device to use. The case of *Device* is ignored by IDL. See Appendix B, "IDL Graphics Devices" for a list of device names.

Keywords

COPY

Set this keyword to copy the device's color table from the internal color table, preserving the current color mapping. The default is not to load the color table upon selection.

Warning

Unless this keyword is set, IDL's internal color tables will incorrectly reflect the state of the device's color tables until they are reloaded by TVLCT or the LOADCT procedure. Assuming that the previously-selected device's color table contains *M* elements, and the new device's color table contains *N* elements, then the minimum of *M* and *N* elements are loaded.

INTERPOLATE

Set this keyword to indicate that the current contents of the internal color table should be interpolated to cover the range of the newly-selected device. Otherwise, the internal color tables are not changed.

Example

Change the IDL graphics device to PostScript by entering:

```
SET_PLOT, 'PS'
```

After changing the plotting device, all graphics commands are sent to that device until changed again by another use of the SET_PLOT routine.

SET_SHADING

The SET_SHADING procedure modifies the light source shading parameters that affect the output of SHADE_SURF and POLYSHADE. Parameters can be changed to control the light-source direction, shading method, and the rejection of hidden surfaces. SET_SHADING first resets the shading parameters to their default values. The parameter values specified in the call then overwrite the default values. To reset all parameters to their default values, simply call this procedure with no parameters.

Syntax

SET_SHADING [, /GOURAUD] [, LIGHT=*[x, y, z]*] [, /REJECT]
[, VALUES=*[darkest, brightest]*]

Arguments

None.

Keywords

GOURAUD

This keyword controls the method of shading the surface polygons by the POLYSHADE procedure. The SHADE_SURF procedure always uses the Gouraud method. Set this keyword to a nonzero value (the default), to use Gouraud shading. Set this keyword to zero to shade each polygon with a constant intensity.

Gouraud shading interpolates intensities from each vertex along each edge. Then, when scan converting the polygons, the shading is interpolated along each scan line from the edge intensities. Gouraud shading is slower than constant shading but usually results in a more realistic appearance.

LIGHT

A three-element vector that specifies the direction of the light source. The default light source vector is [0,0,1], with the light rays parallel to the Z axis.

REJECT

Set this keyword (the default) to reject polygons as being hidden if their vertices are ordered in a clockwise direction as seen by the viewer. This keyword should always be set when rendering enclosed solids whose original vertex lists are in counterclockwise order. When rendering surfaces that are not closed or are not in

counterclockwise order this keyword can be set to zero although shading anomalies at boundaries between visible and hidden surfaces may occur.

VALUES

A two-element array that specifies the range of pixel values (color indices) to use. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. For example, to render a shaded surface with the darkest shade set to pixel value 100 and the brightest value set to 150, use the commands:

```
SET_SHADING, VALUES=[100, 150]
SHADE_SURF, dataset
```

Example

Change the light source so that the light rays are parallel to the X axis:

```
SET_SHADING, LIGHT = [1, 0, 0]
```

See Also

POLYSHADE, SHADE_SURF

SET_SYMBOL

The SET_SYMBOL procedure defines a DCL (Digital Command Language) interpreter symbol for the current process. SET_SYMBOL is available only under VMS.

Syntax

SET_SYMBOL, *Name*, *Value* [, TYPE={1 | 2}]

Arguments

Name

A scalar string containing the name of the symbol to be defined.

Value

A scalar string containing the value with which *Name* is defined.

Keywords

TYPE

Indicates the table into which *Name* will be defined. Setting TYPE to 1 specifies the local symbol table, while a value of 2 specifies the global symbol table. The default is the local table.

See Also

DELLOG, DELETE_SYMBOL, SETLOG

SETENV

The SETENV procedure adds or changes an environment string in the process environment.

Note

This procedure is only available for UNIX and Windows platforms.

Syntax

SETENV, *Environment_Expression*

Arguments

Environment_Expression

A scalar string containing an environment expression to be added to the environment.

Example

Change the current shell variable by entering:

```
SETENV,'SHELL=/bin/sh'
```

Make sure to eliminate any whitespace around the equal sign:

```
; This is an incorrect usage--there are spaces around the equal
; sign:
SETENV, 'VAR = H:\rsi'

; This is correct--VAR is set to H:\rsi:
SETENV, 'VAR=H:\rsi'
```

See Also

DELLOG, GETENV, SETLOG

SETLOG

The SETLOG procedure defines a logical name.

Note

This procedure is only available for the VMS platform.

Syntax

SETLOG, *Lognam*, *Value* [, /CONCEALED] [, /CONFINE] [, /NO_ALIAS] [, TABLE=*string*] [, /TERMINAL]

Arguments

Lognam

A scalar string containing the name of the logical to be defined.

Value

A string containing the value to which the logical will be set. If *Value* is a string array, *Lognam* is defined as a multi-valued logical where each element of *Value* defines one of the equivalence strings.

Keywords

CONCEALED

If this keyword is set, RMS (VMS Record Management Services) interprets the equivalence name as a device name.

CONFINE

If this keyword is set, the logical name is not copied from the IDL process to its spawned subprocesses.

NO_ALIAS

If this keyword is set, the logical name cannot be duplicated in the same logical table at an outer access mode. If another logical name with the same name already exists at an outer access mode, it is deleted. See the *VMS System Services Manual* for additional information on logical names and access modes.

TABLE

A scalar string containing the name of the logical table into which *Lognam* will be entered. If TABLE is not specified, LNM$PROCESS_TABLE is used.

TERMINAL

If this keyword is set, when attempting to translate the logical, further iterative logical name translation on the equivalence name is not to be performed.

See Also

DELETE_SYMBOL, DELLOG, SETENV, SET_SYMBOL

SETUP_KEYS

The SETUP_KEYS procedure sets function keys for use with UNIX versions of IDL when used with the standard tty command interface.

Under UNIX, the number of function keys, their names, and the escape sequences they send to the host computer vary enough between various keyboards that IDL cannot be written to understand all keyboards. Therefore, IDL provides a very general routine named DEFINE_KEY that allows the user to specify the names and escape sequences of function keys.

SETUP_KEYS provides a convenient interface to DEFINE_KEY, using user input (via the keywords described below), the TERM environment variable and the type of machine the current IDL is running on to determine what kind of keyboard you are using, and then uses DEFINE_KEY to enter the proper definitions for the function keys.

The new mappings for the keys can be viewed using the command

```
HELP, /KEYS.
```

The need for SETUP_KEYS has diminished in recent years because most UNIX terminal emulators have adopted the ANSI standard for function keys, as represented by VT100 terminals and their many derivatives, as well as xterm and the newer CDE based dtterm.

The current version of IDL already knows the function keys of such terminals, so SETUP_KEYS is not required. However, SETUP_KEYS is still needed to define keys on non-ANSI terminals such as the Sun shelltool, SGI Iris-ansi terminal emulator, or IBM's aixterm.

IDL does not support the function keys from the hpterm terminal emulator supplied on HP systems. Hpterm uses non ANSI-standard escape sequences which IDL cannot parse. Research Systems recommends the use of the xterm or dtterm terminal emulators instead.

This routine is written in the IDL language. Its source code can be found in the file `setup_keys.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SETUP_KEYS [, /EIGHTBIT] [, /SUN | , /VT200 | , /HP9000 | , /MIPS | , /PSTERM | , /SGI] [, /APP_KEYPAD] [, /NUM_KEYPAD]

Keywords

Note

If no keyword is specified, SETUP_KEYS uses !VERSION to determine the type of machine running IDL. It assumes that the keyboard involved is of the same type (this assumption is correct).

ANSI

Set this keyword to establish function key definitions for ANSI keyboards.

EIGHTBIT

Set this keyword to use the 8-bit versions of the escape codes (instead of the default 7-bit) when establishing VT200 function key definitions.

SUN

Set this keyword to establish function key definitions for a Sun3 keyboard.

VT200

Set this keyword to establish function key definitions for a DEC VT200 keyboard.

HP9000

Set this keyword to establish function key definitions for an HP 9000 series 300 keyboard. Although the HP 9000 series 300 supports both xterm and hpterm windows, IDL supports only user-definable key definitions in xterm windows—hpterm windows use non-standard escape sequences which IDL does not attempt to handle.

IBM

Set this keyword to establish function key definitions for IBM keyboards.

MIPS

Set this keyword to establish function key definitions for a Mips RS series keyboard.

SGI

Set this keyword to establish function key definitions for SGI keyboards.

APP_KEYPAD

Set this keyword to define escape sequences for the group of keys in the numeric keypad, enabling these keys to be programmed within IDL.

NUM_KEYPAD

Set this keyword to disable programmability of the numeric keypad.

See Also

DEFINE_KEY

SFIT

The SFIT function determines a polynomial fit to a surface and returns a fitted array. The function fitted is:

$$f(x, y) = \sum kx_{j,i} \cdot x^i \cdot y^j$$

This routine is written in the IDL language. Its source code can be found in the file `sfit.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SFIT(*Data*, *Degree* [, KX=*variable*])

Arguments

Data

The two-dimensional array of data to fit. The sizes of the dimensions may be unequal.

Degree

The maximum degree of fit (in one dimension).

Keywords

KX

Set this keyword to a named variable that will contain the array of coefficients for a polynomial function of *x* and *y* to fit data. This parameter is returned as a *Degree*+1 by *Degree*+1 array.

Example

```
; Create a grid from zero to six radians in the X and Y directions:
X = (FINDGEN(61)/10) # REPLICATE(1,61)
Y = TRANSPOSE(X)

; Evaluate a function at each point:
F = -SIN(2*X) + COS(Y/2)

; Compute a sixth-degree polynomial fit to the function data:
result = SFIT(F, 6)
```

```
; Display the original function on the left and the fitted function
; on the right, using identical axis scaling:
WINDOW, XSIZE = 800, YSIZE = 400

; Set up side-by-side plots:
!P.MULTI = [0, 2, 1]

; Set background color to white:
!P.BACKGROUND = 255

; Set plot color to black:
!P.COLOR = 0

SURFACE, F, X, Y, ZRANGE = [-3, 3], ZSTYLE = 1
SURFACE, result, X, Y
```

The following figure shows the result of this example:

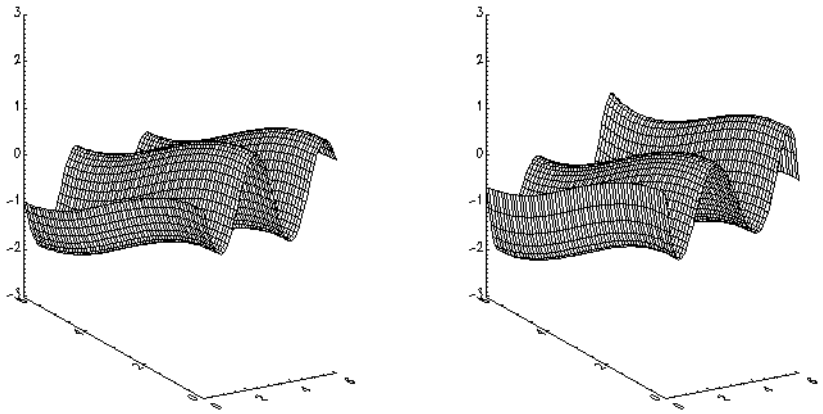


Figure 20: The Original Function (Left) and the Fitted Function (Right)

See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, REGRESS, SVDFIT

SHADE_SURF

The SHADE_SURF procedure creates a shaded-surface representation of a regular or nearly-regular gridded surface with shading from either a light source model or from a user-specified array of intensities. This procedure and its parameters are similar to SURFACE. Given a regular or near-regular grid of elevations it produces a shaded-surface representation of the data with hidden surfaces removed.

The SET_SHADING procedure can be used to control the direction of the light source and other shading parameters.

If the graphics output device has scalable pixels (e.g., PostScript), the output image is scaled so that its largest dimension is less than or equal to 512 (unless the PIXELS keyword is set to some other value). This default resolution may not be high enough for some datasets. If your output looks jagged or "stair-stepped", try specifying a larger value with the PIXELS keyword.

When outputting to a device that prints black on a white background, (e.g., PostScript), pixels that contain the background color index of 0 are set to white.

Restrictions

If the *(X, Y)* grid is not regular or nearly regular, errors in hidden line removal will occur. If the T3D keyword is set, the 3D to 2D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur. The SHADE_SURF_IRR procedure can be used to render many datasets that do not meet these requirements. Irregularly-gridded data can also be made interpolated to a regular grid using the TRIGRID and TRIANGULATE routines.

Syntax

SHADE_SURF, *Z* [, *X*, *Y*] [, AX=*degrees*] [, AZ=*degrees*] [, IMAGE=*variable*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, PIXELS=*pixels*] [, /SAVE] [, SHADES=*array*] [, /XLOG] [, /YLOG]

Graphics Keywords: [, CHARSIZE=*value*] [, CHARTHICK=*integer*] [, COLOR=*value*][, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, /NODATA] [, POSITION=*[*X_0, Y_0, X_1, Y_1*]*] [, SUBTITLE=*string*] [, /T3D] [, THICK=*value*] [, TICKLEN=*value*] [, TITLE=*string*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left, right]*]
[, {X | Y | Z}MINOR=*integer*]

[, {X | Y | Z}RANGE=*[min, max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

Arguments

Z

The two-dimensional array to be displayed. If *X* and *Y* are provided, the surface is plotted as a function of the (*X*, *Y*) locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *Z*.

This argument is converted to double-precision floating-point before plotting. Plots created with SHADE_SURF are limited to the range and precision of double-precision floating-point values.

X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of *X* specifies the X coordinate for a column of *Z* (e.g., `X[0]` specifies the X coordinate for `Z[0,*]`). If *X* is a two-dimensional array, each element of *X* specifies the X coordinate of the corresponding point in *Z* (X_{ij} specifies the X coordinate for Z_{ij}).

This argument is converted to double-precision floating-point before plotting.

Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of *Y* specifies the Y coordinate for a row of *Z* (e.g., `Y[0]` specifies the Y coordinate for `Z[*,0]`). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in *Z* (Y_{ij} specifies the Y coordinate for Z_{ij}).

This argument is converted to double-precision floating-point before plotting.

Keywords

AX

This keyword specifies the angle of rotation, about the X axis, in degrees towards the viewer. This keyword is effective only if !P.T3D and the T3D keyword are not set. If !P.T3D is set, the three-dimensional to two-dimensional transformation used by SURFACE is contained in the 4 by 4 array !P.T.

The surface represented by the two-dimensional array is first rotated, AZ (see below) degrees about the Z axis, then by AX degrees about the X axis, tilting the surface towards the viewer (AX > 0), or away from the viewer.

The AX and AZ keyword parameters default to +30 degrees if omitted.

The three-dimensional to two-dimensional transformation represented by AX and AZ, can be saved in !P.T by including the SAVE keyword.

AZ

This keyword specifies the counterclockwise angle of rotation about the Z axis. This keyword is effective only if !P.T3D is not set. The order of rotation is AZ first, then AX.

IMAGE

A named variable into which an image containing the shaded surface is stored. If this keyword is omitted, the image is displayed but not saved.

MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

PIXELS

Set this keyword to a scalar value that specifies the maximum size of the image dimensions, in pixels. PIXELS only applies when the output device uses scalable pixels (e.g., the PostScript device). Use this keyword to increase the resolution of the output image if the default looks jagged or “stair-stepped”.

SAVE

Set this keyword to save the 3D to 2D transformation matrix established by SHADE_SURF in the system variable field !P.T. Use this keyword when combining the output of SHADE_SURF with the output of other routines in the same plot.

SHADES

An array expression, of the same dimensions as *Z*, that contains the color index at each point. The shading of each pixel is interpolated from the surrounding SHADE values. If this parameter is omitted, light-source shading is used. For most displays, this parameter should be scaled into the range of bytes.

Warning

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting DECOMPOSED=0 for DEVICE.

XLOG

Set this keyword to specify a logarithmic X axis.

YLOG

Set this keyword to specify a logarithmic Y axis.

Graphics Keywords Accepted

See Appendix C, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. CHARSIZE, CHARTHICK, COLOR, DATA, DEVICE, FONT, NODATA, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

Example

```
; Create a simple dataset:
D = DIST(40)
; Display the dataset as a light-source shaded surface:
SHADE_SURF, D, TITLE = 'Shaded Surface'
```

Instead of light-source shading, an array of the same size as the elevation dataset can be used to color the surface. This technique creates four-dimensional displays.

```
; Create an array of shades to use:
S = SIN(D)

; Now create a new shaded surface that uses the array of shading
; values instead of the light source:
SHADE_SURF, D, SHADES = BYTSCL(S)
```

Note that the BYTSCL function is used to scale S into the range of bytes.

See Also

POLYSHADE, SET_SHADING, SHADE_VOLUME, SURFACE

SHADE_SURF_IRR

The SHADE_SURF_IRR procedure creates a shaded surface representation of an irregularly gridded elevation dataset.

The data must be representable as an array of quadrilaterals. This routine should be used when the (*X, Y, Z*) arrays are too irregular to be drawn by SHADE_SURF, but are still semi-regular.

This routine is written in the IDL language. Its source code can be found in the file `shade_surf_irr.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SHADE_SURF_IRR, *Z*, *X*, *Y* [, AX=*degrees*] [, AZ=*degrees*] [, IMAGE=*variable*] [, PLIST=*variable*] [, /T3D]

Arguments

Z

An *n* x *m* array of elevations.

X

An *n* x *m* array containing the *X* location of each *Z* value.

Y

An *n* x *m* array containing the *Y* location of each *Z* value.

Note

The grid described by *X* and *Y* must consist of quadrilaterals, must be semi-regular, and must be in “clockwise” order. Clockwise ordering means that:

```
;for all j
x[i,j] <= x[i+1, j]
```

and

```
;for all i
y[i,j] <= y[i, j+1]
```

Keywords

AX

The angle of rotation about the X axis. The default is 30 degrees.

AZ

The angle of rotation about the Z axis. The default is 30 degrees.

IMAGE

Set this keyword to a named variable that will contain the resulting shaded surface image. The variable is returned as a byte array of the same size as the currently selected graphics device.

PLIST

Set this keyword to a named variable that will contain the polygon list on return. This feature is useful when you want to make a number of images from the same set of vertices and polygons.

T3D

Set this keyword to indicate that the generalized transformation matrix in !P.T is to be used (in which case the keyword values for AX and AZ are ignored)

Example

The following example creates a semi-regular data set in the proper format at displays the resulting irregular surface.

```
; Create some elevation data:
z = DIST(10,10)*100.0
; Create arrays to hold X and Y data:
x = FLTARR(10,10) & y = FLTARR(10,10)
; Ensure that X and Y arrays are in "clockwise" order:
FOR i = 0,9 do x[0:9,i] = FINDGEN(10)
FOR j = 0,9 DO y[j,0:9] = FINDGEN(10)
; Make X and Y arrays irregular:
x = x + RANDOMU(seed,10,10)*0.49
y = y + RANDOMU(seed,10,10)*0.49
; Display the irregular surface:
SHADE_SURF_IRR, z, x, y
```

See Also

SHADE_SURF, TRIGRID

SHADE_VOLUME

Given a 3D volume and a contour value, SHADE_VOLUME produces a list of vertices and polygons describing the contour surface. This surface can then be displayed as a shaded surface by the POLYSHADE procedure. Shading is obtained from either a single light-source model or from user-specified values.

SHADE_VOLUME computes the polygons that describe a three dimensional contour surface. Each volume element (voxel) is visited to find the polygons formed by the intersections of the contour surface and the voxel edges. The method used by SHADE VOLUME is that of Klemp, McIrvin and Boyd, 1990: "PolyPaint—A Three-Dimensional Rendering Package," *American Meteorology Society Proceedings, Sixth International Conference on Interactive Information and Processing Systems*. This method is similar to the marching cubes algorithm described by Lorenson and Cline, 1987: "Marching Cubes: A High Resolution 3D Surface Construction Algorithm," *Computer Graphics 21*, 163-169.

This routine is limited to processing datasets that will fit in memory.

Syntax

SHADE_VOLUME, *Volume*, *Value*, *Vertex*, *Poly* [, /LOW] [, SHADES=*array*] [, /VERBOSE] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*]

Arguments

Volume

A three-dimensional array that contains the dataset to be contoured. If the *Volume* array is dimensioned (D_0, D_1, D_2), the resulting vertex coordinates are as follows:

$$0 < X < D_0 - 1; 0 < Y < D_1 - 1; 0 < Z < D_2 - 1.$$

If floating-point NaN values are present in *Volume*, then SHADE_VOLUME may generate inconsistent surfaces and may return NaN values in the *Vertex* argument. The surfaces generated by SHADE_VOLUME may also vary across platforms if NaN data is present in the *Volume* parameter.

Value

The scalar contour value. This value specifies the constant-density surface (also called an isosurface) to be rendered.

Vertex

The name of a variable to receive the vertex array. On output, this variable is set to a (3, *n*) floating-point array, suitable for input to POLYSHADE.

Poly

A named variable to receive the polygon list, an *m*-element, longword array. This list describes the vertices of each polygon and is suitable for input to POLYSHADE. The vertices of each polygon are listed in counterclockwise order when observed from outside the surface. The vertex description of each polygon is a vector of the form: [*n*, $i_0, i_1, ..., i_{n-1}$] and the *Poly* array is the concatenation of the lists of each polygon. For example, when rendering a pyramid consisting of four triangles, *Poly* would contain 16 elements, made by concatenating four, four-element vectors of the form [3, V_0, V_1, V_2]. V_0, V_1, and V_2 are the indices of the vertices describing each triangle.

Keywords

LOW

Set this keyword to display the low side of the contour surface (i.e., the contour surfaces enclose high data values). If this keyword is omitted or is 0, the high side of the contour surface is displayed and the contour encloses low data values. If this parameter is incorrectly specified, errors in shading will result.

SHADES

An optional array, converted to byte type before use, that contains the user-specified shading color index for each voxel. This array must have the same dimensions as *Volume*. On exit, this array is replaced by another array, that contains the shading value for each vertex, contained in *Vertex*.

Warning

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting DECOMPOSED=0 for DEVICE.

VERBOSE

Set this keyword to print a message indicating the number of polygons and vertices that are produced.

XRANGE

An optional two-element vector that contains the limits, over the first dimension, of the sub-volume to be considered.

YRANGE

An optional two-element vector that contains the limits, over the second dimension, of the sub-volume to be considered.

ZRANGE

An optional two-element vector containing the limits, over the third dimension, of the sub-volume to be considered.

Example

The following procedure shades a volume passed as a parameter. It uses the SCALE3 procedure to establish the viewing transformation. It then calls SHADE_VOLUME to produce the vertex and polygon lists, and POLYSHADE to draw the contour surface.

```
PRO SHOWVOLUME, vol, thresh, LOW = low
   ; Get the dimensions of the volume:
   s = SIZE(vol)
   ; Error, must be a 3D array:
   IF s[0] NE 3 THEN MESSAGE, 'Error: vol must be a 3D array'
   ; Establish the 3D transformation and coordinate ranges:
   SCALE3, XRANGE=[0, S[1]], YRANGE=[0, S[2]], ZRANGE=[0, S[3]]
   ; Default = view high side of contour surface:
   IF N_ELEMENTS(low) EQ 0 THEN low = 0
   ; Produce vertices and polygons:
   SHADE_VOLUME, vol, thresh, v, p, LOW = low
   ; Produce image of surface and display:
   TV, POLYSHADE(v, p, /T3D)
END
```

See Also

POLYSHADE, SHADE_SURF, XVOLUME

SHIFT

The SHIFT function shifts elements of vectors or arrays along any dimension by any number of elements. The result is a vector or array of the same structure and type as *Array*. Positive shifts are to the right while left shifts are expressed as a negative number. All shifts are circular.

Elements shifted off one end wrap around and are shifted onto the other end. In the case of vectors the action of SHIFT can be expressed:

$$\text{Result}_{(i+s)\ modulation} = \text{Array}_i \quad \text{for} \quad (0 \le 1 < n)$$

where s is the amount of the shift, and n is the number of elements in the array.

Syntax

Result = SHIFT(*Array*, S_1, ..., S_n)

Arguments

Array

The array to be shifted.

S_i

The shift parameters. For arrays of more than one dimension, the parameter S_n specifies the shift applied to the *n*th dimension. S_1 specifies the shift along the first dimension and so on. If only one shift parameter is present and the parameter is an array, the array is treated as a vector (i.e., the array is treated as having one-dimensional subscripts).

A shift specification of 0 means that no shift is to be performed along that dimension.

Example

The following example demonstrates using SHIFT with a vector. by entering:

```
A = INDGEN(5)

; Print the original vector, the vector shifted one position to the
; right, and the vector shifted one position to the left:
PRINT, A, SHIFT(A, 1), SHIFT(A, -1)
```

IDL prints:

```
0    1    2    3    4
4    0    1    2    3
1    2    3    4    0
```

Notice how elements of the vector that shift off the end wrap around to the other end. This “wrap around” occurs when shifting arrays of any dimension.

See Also

ISHFT

SHOW3

The SHOW3 procedure combines an image, a surface plot of the image data, and a contour plot of the images data in a single tri-level display.

This routine is written in the IDL language. Its source code can be found in the file `show3.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SHOW3, *Image* [, *X*, *Y*] [, /INTERP] [, E_CONTOUR=*structure*] [, E_SURFACE=*structure*] [, SSCALE=*scale*]

Arguments

Image

The two-dimensional array to display.

X

A vector containing the X values of each column of *Image*. If the *X* argument is omitted, columns have values 0, 1, ..., *n*columns-1.

Y

A vector containing the Y values of each row of *Image*. If the *Y* argument is omitted, rows have values 0, 1, ..., *n*rows-1.

Keywords

INTERP

Set this keyword to use bilinear interpolation on the pixel display. This technique is slightly slower, but for small images, it makes a better display.

E_CONTOUR

Set this keyword equal to an anonymous structure containing additional keyword parameters that are passed to the CONTOUR procedure. Tag names in the structure should be valid keyword arguments to CONTOUR, and the values associated with each tag should be valid keyword values.

E_SURFACE

Set this keyword equal to an anonymous structure containing additional keyword parameters that are passed to the SURFACE procedure. Tag names in the structure should be valid keyword arguments to SURFACE, and the values associated with each tag should be valid keyword values.

SSCALE

Reduction scale for surface. The default is 1. If this keyword is set to a value other than 1, the array size is reduced by this factor for the surface display. That is, the number of points used to draw the wire-mesh surface is reduced. If the array dimensions are not an integral multiple of SSCALE, the image is reduced to the next smaller multiple.

Example

```
; Create a dataset:
A = BESELJ(SHIFT(DIST(30,20), 15, 10)/2.,0)

; Show it with default display:
SHOW3, A

; Specify X axis proportional to square root of values:
SHOW3, A, SQRT(FINDGEN(30))

; Label CONTOUR lines with double size characters, and include
;downhill tick marks:
SHOW3, A, E_CONTOUR={C_CHARSIZE:2, DOWN:1}

; Draw a surface with a skirt and scale Z axis from -2 to 2:
SHOW3, A, E_SURFACE={SKIRT:-1, ZRANGE:[-2,2]}
```

See Also

CONTOUR, SURFACE

SHOWFONT

The SHOWFONT procedure displays a TrueType or vector-drawn font (from the file `hersh1.chr`, located in the `resource/fonts` subdirectory of the IDL distribution) on the current graphics device.

This routine is written in the IDL language. Its source code can be found in the file `showfont.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SHOWFONT, *Font*, *Name* [, /ENCAPSULATED] [, /TT_FONT]

Arguments

Font

The index number of the font (may range from 3 to 29) or, if the TT_FONT keyword is set, a string that contains the name of the TrueType font to display.

Name

A string that contains the text of a title to appear at the top of the font display.

Keywords

ENCAPSULATED

Set this keyword, if the current graphics device is “PS”, to make encapsulated PostScript output.

TT_FONT

If this keyword is set, the specified font will be interpreted as a TrueType font.

Example

To create a display of the Helvetica italic TrueType font on the screen:

```
SHOWFONT, 'Helvetica Italic', 'Helvetica Italic', /TT_FONT
```

To create a display of Font 3 for PostScript:

```
; Set output to PostScript:
SET_PLOT, 'PS'
```

```
; Specify the output filename. If we didn't specify this, the file
; would be saved as idl.ps by default:
DEVICE, FILENAME='font3.ps'

;Display font 3:
SHOWFONT, 3, 'Simplex Roman'

; Close the new PS file:
DEVICE, /CLOSE
```

See Also

EFONT, PS_SHOW_FONTS

SIN

The periodic function SIN returns the trigonometric sine of X.

Syntax

Result = SIN(*X*)

Arguments

X

The angle for which the sine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers:

$$\sin x = \text{COMPLEX}(\sin R \cosh I, \cos R \sinh I)$$

where *R* and *I* are the real and imaginary parts of *x*.

If input argument *X* is an array, the result has the same structure, with each element containing the sine of the corresponding element of *X*.

Examples

To find the sine of 0.5 radians and print the result, enter:

```
PRINT, SIN(0.5)
```

The following example plots the SIN function between 0 and 2π with 100 intervals:

```
X = 2*!PI/100 * FINDGEN(100)
PLOT, X, SIN(X)
```

Note

!PI is a read-only system variable that contains the single-precision value for π.

See Also

ASIN, SINH

SINDGEN

The SINDGEN function returns a string array with the specified dimensions. Each element of the array is set to the string representation of the value of its one-dimensional subscript, using IDL's default formatting rules.

Syntax

Result = SINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create S, a six-element string vector with each element set to the string value of its subscript, enter:

```
S = SINDGEN(6)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

SINH

The SINH function returns the hyperbolic sine of X.

Syntax

Result = SINH(*X*)

Arguments

X

The angle for which the hyperbolic sine is desired, specified in radians. If *X* is double-precision floating-point, the result is also double-precision. Complex values are not allowed. All other types are converted to single-precision floating-point and yield floating-point results. SINH is defined as:

$$\sinh x = (e^{u} - e^{-u}) / 2$$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic sine of the corresponding element of *X*.

Examples

To find the hyperbolic sine of each element in the array [.5, .2, .4] and print the result, enter:

```
PRINT, SINH([.5, .2, .4])
```

To plot the SINH function between 0 and 2π with 100 intervals, enter:

```
X = 2*!PI/100 * FINDGEN(100)
PLOT, X, SINH(X)
```

Note

!PI is a read-only system variable that contains the single-precision value of π.

See Also

ASIN, SIN

SIZE

The SIZE function returns size and type information for its argument if no keywords are set. If a keyword is set, SIZE returns the specified quantity.

Syntax

Result = SIZE(*Expression* [, /L64] [, /DIMENSIONS | , /FILE_LUN | , /N_DIMENSIONS | , /N_ELEMENTS | , /STRUCTURE | , /TNAME | , /TYPE])

Return Value

The returned vector is always of integer type. The first element is equal to the number of dimensions of *Expression*. This value is zero if *Expression* is scalar or undefined. The next elements contain the size of each dimension, one element per dimension (none if *Expression* is scalar or undefined). After the dimension sizes, the last two elements contain the type code (zero if undefined) and the number of elements in *Expression*, respectively. The type codes are listed below.

IDL Type Codes

The following table lists the IDL type codes returned by the SIZE function:

Type Code	Data Type
0	Undefined
1	Byte
2	Integer
3	Longword integer
4	Floating point
5	Double-precision floating
6	Complex floating
7	String
8	Structure
9	Double-precision complex

Table 83: IDL Type Codes

Type Code	Data Type
10	Pointer
11	Object reference
12	Unsigned Integer
13	Unsigned Longword Integer
14	64-bit Integer
15	Unsigned 64-bit Integer

Table 83: IDL Type Codes

Arguments

Expression

The expression for which size information is requested.

Keywords

With the exception of L64, the following keywords determine the return value of the SIZE function and are mutually exclusive — specify at most one of the following.

DIMENSIONS

Set this keyword to return the dimensions of *Expression*. If *Expression* is scalar, the result is a scalar containing a 0. For arrays, the result is an array containing the array dimensions. The result is a 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases.

FILE_LUN

Set this keyword to return the file unit to which *Expression* is associated, if it is an IDL file variable, as created with the ASSOC function. If *Expression* is not a file variable, 0 is returned (0 is not a valid file unit for ASSOC).

L64

By default, the result of SIZE is 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases. In addition to affecting the default result, L64 also affects the output from the DIMENSIONS, N_ELEMENTS, and STRUCTURE keywords.

Note

Only 64-bit versions of IDL are capable of creating variables requiring 64-bit SIZE output. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

N_DIMENSIONS

Set this keyword to return the number of dimension in *Expression*, if it is an array. If *Expression* is scalar, 0 is returned.

N_ELEMENTS

Set this keyword to return the number of data elements in *Expression*. Setting this keyword is equivalent to using the N_ELEMENTS function. The result will be 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases.

STRUCTURE

Set this keyword to return all available information about *Expression* in a structure.

Note

Since the structure is a named structure, the size of its fields is fixed. The result is an IDL_SIZE (32-bit) structure when possible, and an IDL_SIZE64 structure otherwise. Set L64 to force an IDL_SIZE64 structure to be returned in all cases.

The following are descriptions of the fields in the returned structure:

Field	Description
TYPE_NAME	Name of IDL type of *Expression*.
TYPE	Type code of *Expression*.
FILE_LUN	If *Expression* is an IDL file variable, as created with the ASSOC function, the file unit to which it is associated; otherwise, 0.
N_ELEMENTS	Number of data elements in *Expression*.

Table 84: Structure Fields

Field	Description
N_DIMENSIONS	If *Expression* is an array, the number of dimensions; otherwise, *Expression* is 0.
DIMENSIONS	An 8-element array containing the dimensions of *Expression*.

Table 84: Structure Fields

TNAME

Set this keyword to return the IDL type of *Expression* as a string.

TYPE

Set this keyword to return the IDL type code for *Expression*. See "IDL Type Codes" on page 1253 for details. For an example illustrating how to determine the type code of an expression, see "Determining the Size/Type of an Array" in Chapter 15 of *Building IDL Applications*.

Example

Print the size information for a 10 by 20 floating-point array by entering:

```
PRINT, SIZE(FINDGEN(10, 20))
```

IDL prints:

```
      2   10   20    4   200
```

This IDL output indicates the array has 2 dimensions, equal to 10 and 20, a type code of 4, and 200 elements total.

Similarly, to print only the number of dimensions of the same array:

```
PRINT, SIZE(FINDGEN(10, 20), /N_DIMENSIONS)
```

IDL prints:

```
      2
```

SKEWNESS

The SKEWNESS function computes the statistical skewness of an *n*-element vector. If the variance of the vector is zero, the skewness is not defined, and SKEWNESS returns !VALUES.F_NAN as the result. SKEWNESS calls the IDL function MOMENT.

Syntax

Result = SKEWNESS(*X* [, /DOUBLE] [, /NAN])

Arguments

X

A numeric vector.

Keywords

DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the skewness:
result = SKEWNESS(x)
PRINT, 'Skewness = ', result
```

IDL prints:

```
Skewness =    -0.0942851
```

See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, STDDEV, VARIANCE

SKIPF

The SKIPF procedure skips records or files on the designated magnetic tape unit. SKIPF is available only under VMS. If two parameters are supplied, files are skipped. If three parameters are present, individual records are skipped.

The number of files or records actually skipped is stored in the system variable !ERR. Note that when skipping records, the operation terminates immediately when the end of a file is encountered. See the description of the magnetic tape routines in "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

Syntax

SKIPF, *Unit*, *Files*

or

SKIPF, *Unit*, *Records*, *R*

Arguments

Unit

The magnetic tape unit to rewind. *Unit* must be a number between 0 and 9, and should not be confused with the standard file Logical Unit Numbers (LUNs).

Files

The number of files to be skipped. Skipping is in the forward direction if the second parameter is positive, otherwise files are skipped backwards.

Records

The number of records to be skipped. Skipping is in the forward direction if the second parameter is positive, otherwise records are skipped backwards.

R

If this argument is present, records are skipped, otherwise files are skipped. The value of *R* is never examined. Its presence serves only to indicate that records are to be skipped.

SLICER3

The IDL SLICER3 is a widget-based application to visualize three-dimensional datasets. This program supersedes the SLICER program.

This routine is written in the IDL language. Its source code can be found in the file `slicer3.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SLICER3 [, *hData3D*] [, DATA_NAMES=*string*/*string_array*] [, /DETACH] [, GROUP=*widget_id*] [, /MODAL]

Arguments

hData3D

A pointer to a three-dimensional data array, or an array of pointers to multiple three-dimensional arrays. If multiple arrays are specified, they all must have the same X, Y, and Z dimensions. If *hData3D* is not specified, SLICER3 creates a 2 x 2 x 2 array of byte data using the IDL BYTARR function. You can also load data interactively via the File menu of the SLICER3 application (see "Examples" on page 1274 for details).

Note

If data are loaded in this fashion, any data passed to SLICER3 via a pointer (or pointers) is deleted, and the pointers become invalid.

Keywords

DATA_NAMES

Set this keyword equal to a string array of names for the data. The names appear on the droplist widget for the current data. If the number of elements of DATA_NAMES is less than the number of elements in *hData3D* then default names will be generated for the unnamed data.

DETACH

Set this keyword to place the drawing area in a window that is detached from the SLICER3 control panel. The drawing area can only be detached if SLICER3 is not run as a modal application.

GROUP

Set this keyword equal to the Widget ID of an existing widget that serves as the "group leader" for the SLICER3 graphical user interface. When a group leader is destroyed, all widgets in the group are also destroyed. If SLICER3 is started from a widget application, then GROUP should *always* be specified.

MODAL

Set this keyword to block user interaction with all other widgets (and block the command line) until the SLICER3 exits. If SLICER3 is started from some other widget-based application, then it is usually advisable to run SLICER3 with the MODAL keyword set.

Note

SLICER3 modifies the current color table, as well as various elements of the plotting system (i.e., the "!X", "!Y", "!Z", and "!P" system variables). If the MODAL keyword is set (recommended), then SLICER3 will, upon exit, restore these system variables (and the color tables) to the values they had when SLICER3 was started.

The SLICER3 Graphical User Interface

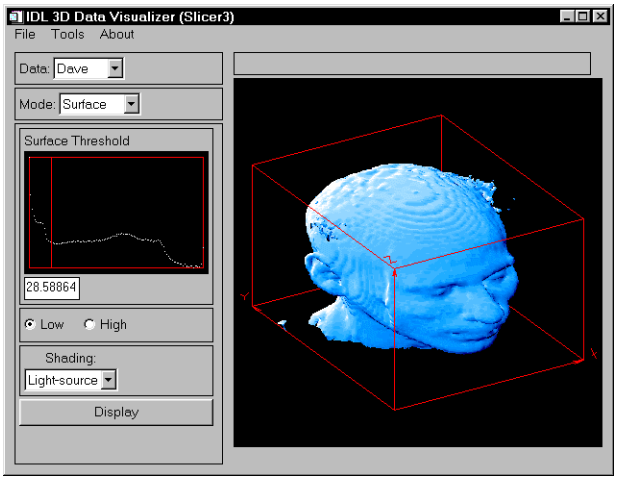


Figure 21: SLICER3 Graphical User Interface

The following options are available via SLICER3's graphical user interface.

File Menu

Load

Select this menu option to choose a file containing a 3D array (or arrays) to load into SLICER3. The file must have been written in the format specified in the following table. For each data array in the file, the following values must be included. Note that the first six values are returned by the IDL SIZE function; see "Examples" on page 1274 for an example of how to create a data file suitable for SLICER3 with just a few IDL commands.

Data item	Data Type	Number of Bytes
Number of dimension in array. (Note: This is always 3 for valid SLICER3 data.)	long	4
Size of first dimension.	long	4
Size of second dimension.	long	4
Size of third dimension.	long	4
Data type (Must be type 1 through 5. See "SIZE" on page 1253 for a list of data types types.)	long	4
Total number of elements (dimX, dimY, dimZ).	long	4
Number of characters in data name. (See "STRLEN" on page 1343 for the easiest way to determine this number.)	long	4
Data name	byte	strlen()
3D data array.	varies	varies

Table 85: SLICER3 Data File Structure

If multiple arrays are present in the file, they must all have the same dimensions.

Note

Files saved by the "Save Subset" operation (see below) are suitable for input via the "Load" operation.

Data files that are moved from one platform to another may not load as expected, due to byte ordering differences. See the BYTEORDER and SWAP_ENDIAN for details.

Save/Save Subset

SLICER3 must be in BLOCK mode to for this option to be available.

Select this menu option to save a subset of the 3D data enclosed in the current block to the specified file. Subsets saved in this fashion are suitable for loading via the "Load" menu option. If multiple 3D arrays are available when this option is selected, multiple subsets are saved to the file.

Save/Save Tiff Image

Select this menu option to save the contents of the current SLICER3 image window as a TIFF image in the specified file. When running in 8-bit mode, a "Class P" palette color TIFF file is created. In 24-bit mode, a "Class R" (interleaved by image) TIFF file is created.

Quit

Select this menu option to exit SLICER3.

Tools Menu

Erase

Select this menu option to erase the display window and delete all the objects in the display list.

Delete/...

As graphical objects are created, they are added to the display list. Select this menu option to delete a specific object from the list. When an object is deleted, the screen is redrawn with the remaining objects.

Colors/Reset Colors

Select this menu option to restore the original color scheme.

Colors/Differential Shading

Use this menu option to change the percentage of differential shading applied to the X, Y, and Z slices.

Colors/Slice/Block

Use this menu option to launch the XLOADCT application to modify the colors used for slices and blocks

Colors/Surface

Use this menu option to launch the XLOADCT application to modify the colors used for isosurfaces.

Colors/Projection

Use this menu option to launch the XLOADCT application to modify the colors used for projections.

Note

On some platforms, the selected colors may not become visible until after you exit the "XLOADCT" application.

Options

Select this menu option to display a panel that allows you to set:

- The axis visibility.
- The wire-frame cube visibility.
- The display window size.

Main Draw Window

Operations available in the Main Draw Window are dependent on the mode selected in the Mode Pulldown menu. In general, when coordinate input is required from the user, it is performed by clicking a mouse button on the "surface" of the wire-frame cube that surrounds the data. This 3D location is then used as the basis for whatever input is needed. In most cases, the "front" side of the cube is used. In a few cases, the coordinate input is on the "back" side of the cube.

Data Pulldown Menu

If multiple datasets are currently available in SLICER3, this menu allows you to select which data will be displayed in the Main Draw Window. Slices, blocks, iso-surfaces, etc. are created from the currently selected data. If only one dataset is loaded, this menu is inactive.

Mode Pulldown Menu

This menu is used to select the current mode of operation.

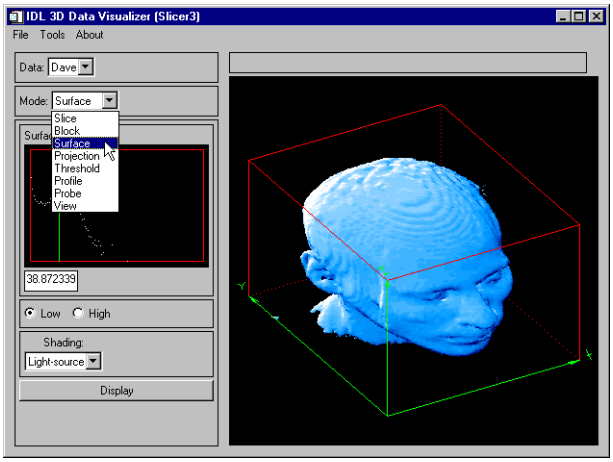


Figure 22: Mode Pulldown Menu

Slice Mode

To display a slice, click and drag the left mouse button on the wire-frame cube. When the button is released, a slice through the data will be drawn at that location.

Draw Radio Button

When in Draw mode, new slices will be merged into the current Z-buffer contents.

Expose Radio Button

When in Expose mode, new slices will be drawn in front of everything else.

Orthogonal Radio Button

When in Orthogonal mode, use the left mouse button in the main draw window to position and draw an orthogonal slicing plane. Clicking the right mouse button in the main draw window (or any mouse button in the small window) will toggle the slicing plane orientation.

X/Y/Z Radio Buttons

- X: This sets the orthogonal slicing plane orientation to be perpendicular to the X axis.

- Y: This sets the orthogonal slicing plane orientation to be perpendicular to the Y axis.
- Z: This sets the orthogonal slicing plane orientation to be perpendicular to the Z axis.

Oblique Radio Button

Clicking any mouse button in the small window will reset the oblique slicing plane to its default orientation.

Normal Radio Button

When in this mode, click and drag the left mouse button in the big window to set the surface normal for the oblique slicing plane.

Center Radio Button

When in this mode, click and drag the left mouse button in the big window to set the center point for the surface normal.

Display Button

Clicking this button will cause an oblique slicing plane to be drawn.

Block Mode

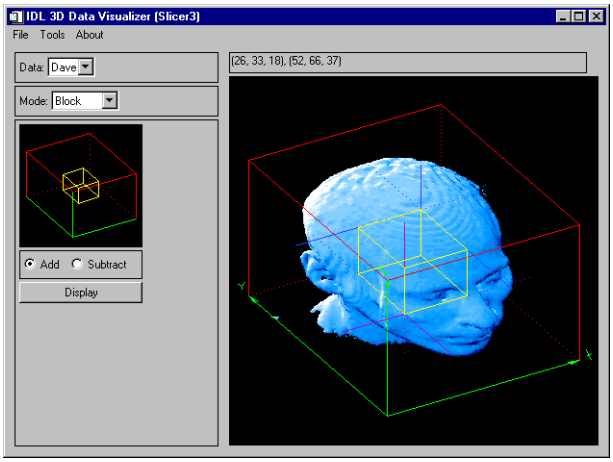


Figure 23: Block Mode

When in Block mode, use the left mouse button in the main draw window to set the location for the “purple” corner of the block. Use the right mouse button to locate the

opposite “blue” corner of the block. When in Block mode, the “Save Subset” operation under the main “File” menu is available.

Add

When in this mode, the block will be “added” to the current Z-buffer contents.

Subtract

When in this mode, the block will be “subtracted” from the current Z-buffer contents. Subtract mode is only effective when the block intersects some other object in the display (such as an iso-surface).

Display Button

Clicking this button will cause the block to be drawn.

Surface Mode

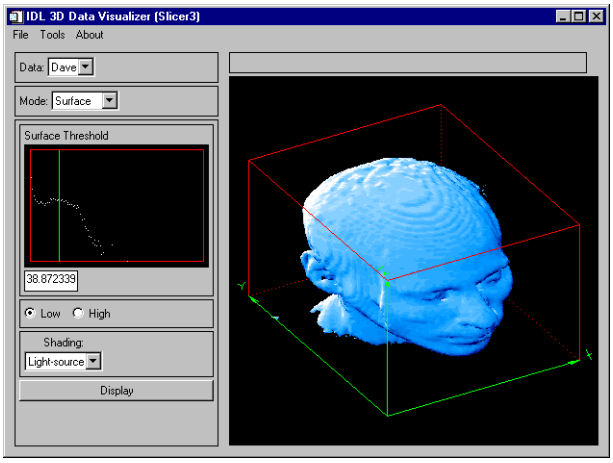


Figure 24: Surface Mode

An iso-surface is like a contour line on a contour map. On one side of the line, the elevation is higher than the contour level, and on the other side of the line, the elevation is lower than the contour level. An iso-surface, however, is a 3D surface that passes through the data such that the data values on one side of the surface are higher than the threshold value, and on the other side of the surface, the data values are lower than the threshold value.

When in Surface mode, a logarithmic histogram plot of the data is displayed in the small draw window. Click and drag a mouse button on this plot to set the iso-surface threshold value. This value is also shown in the text widget below the plot. The threshold value may also be set by typing a new value in this text widget. The histogram plot is affected by the current threshold settings. (See Threshold mode, below).

Low

Selecting this mode will cause the iso-surface polygon facing to face towards the lower data values. Usually, this is the mode to use when the iso-surface is desired to surround high data values.

High

Selecting this mode will cause the iso-surface polygon facing to face towards the higher data values. Usually, this is the mode to use when the iso-surface is desired to surround low data values.

Shading pulldown menu

Iso-surfaces are normally rendered with light-source shading. If multiple datasets are currently loaded, then this menu allows the selection of a different 3D array for the source of the iso-surface shading values. If only one dataset is currently loaded, then this menu is inactive.

Display Button

Clicking this button will cause the iso-surface to be created and drawn. Iso-surfaces often consist of tens of thousands of polygons, and can sometimes take considerable time to create and render.

Projection Mode

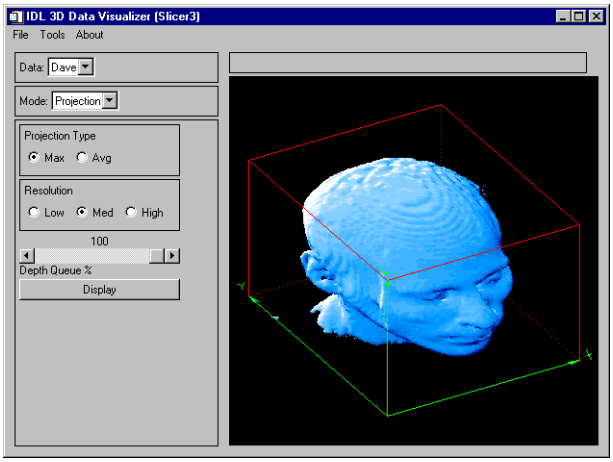


Figure 25: Projection Mode

A “voxel” projection of a 3D array is the projection of the data values within that array onto a viewing plane. This is similar to taking an X-ray image of a 3D object.

Max

Select this mode for a Maximum intensity projection.

Avg

Select this mode for an Average intensity projection.

Low

Select this mode for a Low resolution projection.

Med

Select this mode for a Medium resolution projection.

High

Select this mode for a High resolution projection.

Depth Queue % Slider

Use the slider to set the depth queue percent. A value of 50, for example, indicates that the farthest part of the projection will be 50% as bright as the closest part of the projection.

Display Button

Clicking this button will cause the projection to be calculated and drawn. Projections can sometimes take considerable time to display. Higher resolution projections take more computation time.

Threshold Mode

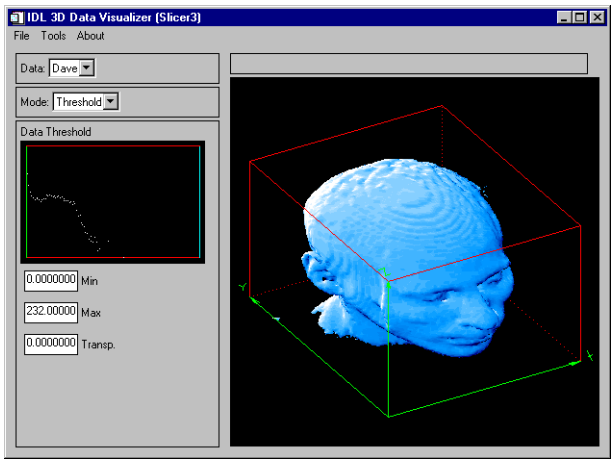


Figure 26: Threshold Mode

When in Threshold mode, a logarithmic histogram plot of the data is displayed in the small draw window. Click and drag the left mouse button on this plot to set the minimum and maximum threshold values. To expand a narrow range of data values into the full range of available colors, set the threshold range before displaying slices, blocks, or projections. The threshold settings also affect the histogram plot in "Surface" mode. The minimum and maximum threshold values are also shown in the text widgets below the histogram plot.

Click and drag the right mouse button on the histogram plot to set the transparency threshold. Portions of any slice, block, or projection that are less than the transparency value are not drawn (clear). Iso-surfaces are not affected by the

transparency threshold. The transparency threshold value is also shown in a text widget below the histogram plot.

Min

In this text widget, a minimum threshold value can be entered.

Max

In this text widget, a maximum threshold value can be entered.

Transp.

In this text widget, a transparency threshold value can be entered.

Profile Mode

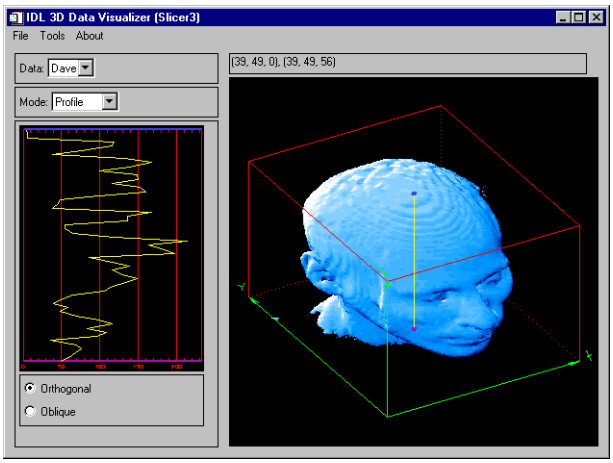


Figure 27: Profile Mode

In Profile mode, a plot is displayed showing the data values along a line. This line is also shown superimposed on the data in the main draw window. The bottom of the plot corresponds to the “purple” end of the line, and the top of the plot corresponds to the “blue” end of the line.

Orthogonal

Click and drag the left mouse button to position the profile line, based upon a point on the “front” faces of the wire-frame cube. Click and drag the right mouse button to

position the profile line, based upon a point on the “back” faces of the wire-frame cube. As the profile line is moved, The profile plot is dynamically updated.

Oblique

Click and drag the left mouse button to position the “purple” end of the profile line on one of the “front” faces of the wire-frame cube. Click and drag the right mouse button to position the “blue” end of the profile line on one of the “back” faces of the wire-frame cube. As the profile line is moved, The profile plot is dynamically updated.

Probe Mode

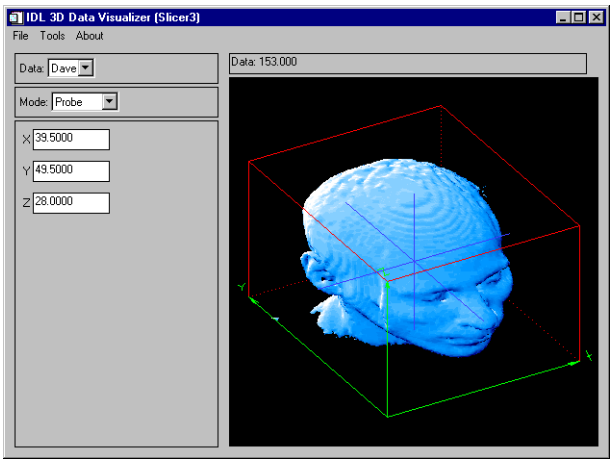


Figure 28: Probe Mode

In Probe mode, click and drag a mouse button over an object in the main draw window. The actual X-Y-Z location within the data volume is displayed in the three text widgets. Also, the data value at that 3D location is displayed in the status window, above the main draw window. If the cursor is inside the wire-frame cube, but not on any object, then the status window displays “No data value”, and the three text widgets are empty. If the cursor is outside the wire-frame cube, then the status window and text widgets are empty.

X

Use this text widget to enter the X coordinate for the probe.

Y

Use this text widget to enter the Y coordinate for the probe.

Z

Use this text widget to enter the Z coordinate for the probe.

View Mode

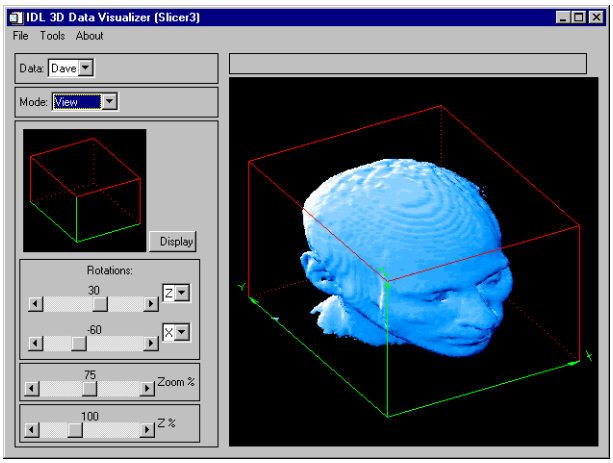


Figure 29: View Mode

In view mode, a small window shows the orientation of the data cube in the current view. As view parameters are changed, this window is dynamically updated. The main draw window is then updated when the user clicks on “Display”, or exits View mode.

Display

Clicking on this button will cause the objects in the main view window to be drawn in the new view. If any view parameters have been changed since the last time the main view was updated, the main view will be automatically redrawn when the user exits View mode.

1st Rotation

Use this slider to set the angle of the first view rotation (in degrees). The droplist widget adjacent to the slider indicates which axis this rotation is about.

2nd Rotation

Use this slider to set the angle of the second view rotation (in degrees). The droplist widget adjacent to the slider indicates which axis this rotation is about.

Zoom % Slider

Use this slider to set the zoom factor percent. Depending upon the view rotations, SLICER3 may override this setting to ensure that all eight corners of the data cube are within the window.

Z % Slider

Use this slider to set a scale factor for the Z axis (to compensate for the data's aspect ratio).

Operational Details

The SLICER3 procedure has the following side effects:

- SLICER3 sets the position for the light source and enables back-facing polygons to be drawn (see the IDL "SET_SHADING" command).
- SLICER3 overwrites the existing contents of the Z-buffer. Upon exiting SLICER3, the Z-buffer contents are the same as what was last displayed by SLICER3.
- On 24-bit displays, SLICER3 sets the device to non-decomposed color mode (DEVICE, DECOMPOSED=0).
- SLICER3 breaks the color table into 6 "bands", based upon the number of available colors (where `max_color=!D.N_COLORS` on 8-bit displays, and `max_color=256` on 24-bit displays and `nColor = (max_color - 9) / 5`):

Band Start index	Band End index	Used For
0	nColor-1	X Slices.
nColor	(2*nColor)-1	Y Slices.
2*nColor	(3*nColor)-1	Z Slices.

Table 86: SLICER3 Band Start/End

Band Start index	Band End index	Used For
3*nColor	(4*nColor)-1	Iso-surfaces
4*nColor	(5*nColor)-1	Projections

Table 86: SLICER3 Band Start/End

Annotation colors are the last “band”, and they are set up as shown in the table:

Color index	Color
max_color - 1	White
max_color - 2	Yellow
max_color - 3	Cyan
max_color - 4	Purple
max_color - 5	Red
max_color - 6	Green
max_color - 7	Blue
max_color - 8	Black

Table 87: SLICER3 Color Bands

On 24-bit displays, you can often improve performance by running SLICER3 in 8-bit mode. This can be accomplished (on some platforms) by entering the following command at the start of the IDL session (before any windows are created):

```
Device, Pseudo_Color=8
```

Examples

The following IDL commands open a data file from the IDL distribution and load it into SLICER3:

```
; Choose a data file:
file=FILEPATH('head.dat', SUBDIR=['examples', 'data'])

; Open the data file:
OPENR, UNIT, file, /GET_LUN
```

```
; Create an array to hold the data:
data = BYTARR(80, 100, 57, /NOZERO)

; Read the data into the array:
READU, UNIT, data

; Close the data file:
CLOSE, UNIT

; Create a pointer to the data array:
hData = PTR_NEW(data, /NO_COPY)

; Load the data into SLICER3:
SLICER3, hdata, DATA_NAMES='Dave'
```

Note

If data are loaded via the File menu after SLICER3 is launched with a pointer argument (as shown above), the pointer becomes invalid. You can use an IDL statement like the following to "clean up" after calling SLICER3 in this fashion:

```
if PTR_VALID(hdata) then PTR_FREE, hdata
```

Because we did not launch SLICER3 with the MODAL keyword, the last contents of the main draw window still reside in IDL's Z-buffer. To retrieve this image after exiting SLICER3, use the following IDL statements:

```
; Save the current graphics device:
current_device = !D.Name

; Change to the Z-buffer device:
SET_PLOT, 'Z'

; Read the image from the Z-buffer:
image_buffer = TVRD()

; Return to the original graphics device:
SET_PLOT, current_device

; Display the image:
TV, image_buffer
```

The following IDL commands manually create a data save file suitable for dynamic loading into SLICER3. Note that if you load data into SLICER3 as shown above, you can also create save files by switching to BLOCK mode and using the Save Subset menu option.

```
; Store some 3D data in a variable called data_1:
```

```
data_1 = INDGEN(20,30,40)

; Store some 3D data in a variable called data_2:
data_2 = FINDGEN(20,30,40)

; Define the names for the datasets. Their names will appear in the
; "Data" pulldown menu in SLICER3:
data_1_name ='Test Data 1'
data_2_name ='Data 2'

; Select a data file name:
dataFile = PICKFILE()

; Write the file:
GET_LUN, lun
OPENW, lun, dataFile
WRITEU, lun, SIZE(data_1)
WRITEU, lun, STRLEN(data_1_name)
WRITEU, lun, BYTE(data_1_name)
WRITEU, lun, data_1
WRITEU, lun, SIZE(data_2)
WRITEU, lun, STRLEN(data_2_name)
WRITEU, lun, BYTE(data_2_name)
WRITEU, lun, data_2
CLOSE, lun
FREE_LUN, lun
```

See Also

GRID3, EXTRACT_SLICE, SHADE_VOLUME, XVOLUME

SLIDE_IMAGE

The SLIDE_IMAGE procedure creates a scrolling graphics window for examining large images. By default, 2 draw widgets are used. The draw widget on the left shows a reduced version of the complete image, while the draw widget on the right displays the actual image with scrollbars that allow sliding the visible window.

This routine is written in the IDL language. Its source code can be found in the file `slide_image.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SLIDE_IMAGE [, *Image*] [, /BLOCK] [, CONGRID=0]
[, FULL_WINDOW=*variable*] [, GROUP=*widget_id*] [, /ORDER] [, /REGISTER]
[, RETAIN={0 | 1 | 2}] [, SLIDE_WINDOW=*variable*] [, SHOW_FULL=0]
[, TITLE=*string*] [, TOP_ID=*variable*] [, XSIZE=*width*] [, XVISIBLE=*width*]
[, YSIZE=*height*] [, YVISIBLE=*height*]

Arguments

Image

A 2D image array to be displayed. If this argument is not specified, no image is displayed. The FULL_WINDOW and SCROLL_WINDOW keywords can be used to obtain the window numbers of the two draw widgets so they can be drawn into at a later time.

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have SLIDE_IMAGE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

CONGRID

Normally, the image is processed with the CONGRID procedure before it is written to the fully visible window on the left. Specifying CONGIRD=0 will force the image to be drawn as is.

FULL_WINDOW

Set this keyword to a named variable that will contain the IDL window number of the fully visible window. This window number can be used with the WSET procedure to draw to the scrolling window at a later point.

GROUP

Set this keyword to the widget ID of the widget that calls SLIDE_IMAGE. If set, the death of the caller results in the death of SLIDE_IMAGE.

ORDER

This keyword is passed directly to the TV procedure to control the order in which the images are drawn. Usually, images are drawn from the bottom up. Set this keyword to a non-zero value to draw images from the top down.

REGISTER

Set this keyword to create a “Done” button for SLIDE_IMAGE and register the widgets with the XMANAGER procedure.

The basic widgets used in this procedure do not generate widget events, so it is not necessary to process events in an event loop. The default is therefore to simply create the widgets and return. Hence, when REGISTER is not set, SLIDE_IMAGE can be displayed and the user can still type commands at the IDL command prompt.

RETAIN

This keyword is passed directly to the WIDGET_DRAW function. Set RETAIN to zero, one, or two to specify how backing store should be handled for the window. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See “Backing Store” on page 2351 for details.

SLIDE_WINDOW

Set this keyword to a named variable that will contain the IDL window number of the sliding window. This window number can be used with the WSET procedure to draw to the scrolling window at a later time.

SHOW_FULL

Set this keyword to zero to show the entire image at full resolution in one scrolling graphics window. By default, SHOW_FULL is set, displaying two draw widgets.

Note

On Windows platforms only, using TVRD to return the array size of the displayed image will cause the returned array to be off by the size of the frame (one pixel per side). To return the dimensions of the original image, you must modify the `slide_image.pro` library routine so that the FRAME keyword is not used with SHOW_FULL.

TITLE

Set this keyword to the title to be used for the SLIDE_IMAGE widget. If this keyword is not specified, “Slide Image” is used.

TOP_ID

Set this keyword to a named variable that will contain the top widget ID of the SLIDE_IMAGE hierarchy. This ID can be used to kill the hierarchy as shown below:

```
SLIDE_IMAGE, TOP_ID=base, ...
WIDGET_CONTROL, /DESTROY, base
```

XSIZE

Set this keyword to the maximum width of the image that can be displayed by the scrolling window. This keyword should not be confused with the visible size of the image, controlled by the XVISIBLE keyword. If XSIZE is not specified, the width of *Image* is used. If *Image* is not specified, 256 is used.

XVISIBLE

Set this keyword to the width of the viewport on the scrolling window. If this keyword is not specified, 256 is used.

YSIZE

Set this keyword to the maximum height of the image that can be displayed by the scrolling window. This keyword should not be confused with the visible size of the image, controlled by the YVISIBLE keyword. If YSIZE is not present the height of *Image* is used. If *Image* is not specified, 256 is used.

YVISIBLE

Set this keyword to the height of the viewport on the scrolling window. If this keyword is not present, 256 is used.

Example

Open an image from the IDL distribution and load it into SLIDE_IMAGE:

```
; Create a variable to hold the image:
image = BYTARR(768,512)

OPENR, unit, FILEPATH('nyny.dat', SUBDIR=['examples','data']),
/GET_LUN
READU, unit, image
CLOSE, unit

; Scale the image into byte range of the display:
image = BYTSCL(image)

; Display the image:
SLIDE_IMAGE, image
```

See Also

TV, TVSCL, WIDGET_DRAW, WINDOW

SMOOTH

The SMOOTH function returns a copy of *Array* smoothed with a boxcar average of the specified width. The result has the same type and dimensions as *Array*. The algorithm used by SMOOTH is:

$$R_i = \begin{cases} \frac{1}{w}\sum_{j=0}^{w-1} A_{i+j-w/2}, & i = w/2, ..., N-w \\ A_i, \text{ otherwise} & \end{cases}$$

where *N* is the number of elements in A.

Syntax

Result = SMOOTH(*Array*, *Width* [, /EDGE_TRUNCATE] [, /NAN])

Arguments

Array

The array to be smoothed. *Array* can have any number of dimensions.

Width

The width of the smoothing window, in each dimension. *Width* should be an odd number, smaller than the smallest dimension of *Array*. If *Width* is an even number, one plus the given value of *Width* is used. For example, if you use a *Width* of 3 to smooth a two-dimensional array, the smoothing window will contain nine elements (including the element being smoothed). The value of *Width* does not affect the running time of SMOOTH to a great extent.

Keywords

EDGE_TRUNCATE

Set this keyword to apply the smoothing function to all points. If the neighborhood around a point includes a point outside the array, the nearest edge point is used to compute the smoothed result. If EDGE_TRUNCATE is not set, the end points are copied from the original array to the result with no smoothing.

For example, when smoothing an *n*-element vector with a three point wide smoothing window, the first point of the result R_0 is equal to A_0 if EDGE_TRUNCATE is not set, but is equal to $(A_0+A_0+A_1)/3$ if the keyword is set. In the same manner, point R_{n-1} is set to A_{n-1} if EDGE_TRUNCATE is not set, or to $(A_{n-2}+A_{n-1}+A_{n-1})/3$ if it is.

Points not within a distance of *Width*/2 from an edge are not affected by this keyword.

Note

Normally, two-dimensional floating-point arrays are smoothed in one pass. If both the EDGE_TRUNCATE and NAN keywords are specified for a two-dimensional array, the result is obtained in two passes, one for each dimension. Therefore, the results may differ slightly when both the EDGE_TRUNCATE and NAN keywords are set.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Note

SMOOTH should never be called without the NAN keyword if the input array may possibly contain NaN values.

Example

Create and display a simple image by entering:

```
D = SIN(DIST(256)/3) & TVSCL, D
```

Now display the same dataset smoothed with a width of 9 by entering:

```
TVSCL, SMOOTH(D, 9), 256, 256
```

See Also

DIGITAL_FILTER, LEEFILT, MEDIAN, TS_DIFF, TS_FCAST, TS_SMOOTH

SOBEL

The SOBEL function returns an approximation to the Sobel edge enhancement operator for images,

$$G_{jk} = |G_x| + |G_y|$$

$$G_X = F_{j+1,k+1} + 2F_{j+1,k} + F_{j+1,k-1} - (F_{j-1,k+1} + 2F_{j-1,k} + F_{j-1,k-1}$$

$$G_Y = F_{j-1,k-1} + 2F_{j,k-1} + F_{j+1,k-1} - (F_{j-1,k+1} + 2F_{j,k+1} + F_{j+1,k+1})$$

where (j, k) are the coordinates of each pixel F_{jk} in the *Image*. This is equivalent to a convolution using the masks,

$$\text{X mask} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad \text{Y mask} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

All of the edge points in the result are set to zero.

Syntax

Result = SOBEL(*Image*)

Return Value

SOBEL returns a two-dimensional array of the same size as *Image*. If *Image* is of type byte or integer then the result is of integer type, otherwise the result is of the same type as *Image*.

Note

To avoid overflow for integer types, the computation is done using the next larger signed type and the result is transformed back to the correct type. Values larger than the maximum for that integer type are truncated. For example, for integers the function is computed using type long, and on output, values larger than 32767 are set equal to 32767.

Arguments

Image

The two-dimensional array containing the image to which edge enhancement is applied.

Example

If the variable `myimage` contains a two-dimensional image array, a Sobel sharpened version of `myimage` can be displayed with the command:

```
TVSCL, SOBEL(myimage)
```

See Also

ROBERTS

SOCKET

The SOCKET procedure, supported on UNIX and Microsoft Windows platforms, opens a client-side TCP/IP Internet socket as an IDL file unit. Such files can be used in the standard manner with any of IDL's Input/Output routines.

Tip

RSI recommends that you don't use the EOF procedure as a way to check to see if a socket is empty. It is recommended that you structure your communication across the socket so that using EOF is not necessary to know when the communication is complete.

Syntax

SOCKET, *Unit*, *Host*, *Port* [, CONNECT_TIMEOUT=*value*] [, ERROR=*variable*] [, /GET_LUN] [, /RAWIO] [, READ_TIMEOUT=*value*] [, /SWAP_ENDIAN] [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, WIDTH=*value*] [, WRITE_TIMEOUT=*value*]

UNIX-Only Keywords: [, /STDIO]

Arguments

Unit

The unit number to associate with the opened socket.

Host

The name of the host to which the socket is connected. This can be either a standard Internet host name (e.g. `ftp.ResearchSystems.com`) or a dot-separated numeric address (e.g. `192.5.156.21`).

Port

The port to which the socket is connected on the remote machine. If this is a well-known port (as contained in the `/etc/services` file on a UNIX host), then you can specify its name (e.g. daytime); otherwise, specify a number.

Keywords

CONNECT_TIMEOUT

Set this keyword to the number of seconds to wait before giving up and issuing an error to shorten the connect timeout from the system-supplied default. Most experts recommend that you not specify an explicit timeout, and instead use your operating system defaults.

Note

Although you can use CONNECT_TIMEOUT to shorten the timeout, you cannot increase it past the system-supplied default.

ERROR

A named variable in which to place the error status. If an error occurs in the attempt to open File, IDL normally takes the error handling action defined by the ON_ERROR and/or ON_IOERROR procedures. SOCKET always returns to the caller without generating an error message when ERROR is present. A nonzero error status indicates that an error occurred. The error message can then be found in the system variable !ERR_STRING.

GET_LUN

Set this keyword to use the GET_LUN procedure to set the value of *Unit* before the file is opened. Instead of using the two statements:

```
GET_LUN, Unit
OPENR, Unit, 'data.dat'
```

you can use the single statement:

```
OPENR, Unit, 'data.dat', /GET LUN
```

RAWIO

Set this keyword to disable all use of the standard operating system I/O for the file, in favor of direct calls to the operating system. This allows direct access to devices, such as tape drives, that are difficult or impossible to use effectively through the standard I/O. Using this keyword has the following implications:

- No formatted or associated (ASSOC) I/O is allowed on the file. Only READU and WRITEU are allowed.
- Normally, attempting to read more data than is available from a file causes the unfilled space to be set to zero and an error to be issued. This does not happen

with files opened with RAWIO. When using RAWIO, the programmer must check the transfer count, either via the TRANSFER_COUNT keywords to READU and WRITEU, or the FSTAT function.

- The EOF and POINT_LUN functions cannot be used with a file opened with RAWIO.
- Each call to READU or WRITEU maps directly to UNIX read(2) and write(2) system calls. The programmer must read the UNIX system documentation for these calls and documentation on the target device to determine if there are any special rules for I/O to that device. For example, the size of data that can be transferred to many cartridge tape drives is often forced to be a multiple of 512 bytes.

READ_TIMEOUT

Set this keyword to the number of seconds to wait for data to arrive before giving up and issuing an error. By default, IDL blocks indefinitely until the data arrives. Typically, this option is unnecessary on a local network, but it is useful with networks that are slow or unreliable.

SWAP_ENDIAN

Set this keyword to swap byte ordering for multi-byte data when performing binary I/O on the specified file. This is useful when accessing files also used by another system with byte ordering different than that of the current host.

SWAP_IF_BIG_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has big endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

SWAP_IF_LITTLE_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has little endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

WIDTH

The desired output width. When using the defaults for formatted output, IDL uses the following rules to determine where to break lines:

- If the output file is a terminal, the terminal width is used. Under VMS, if the file has fixed-length records or a maximum record length, the record length is used.

- Otherwise, a default of 80 columns is used.

The WIDTH keyword allows the user to override this default.

WRITE_TIMEOUT

Set this keyword to the number of seconds to wait to send data before giving up and issuing an error. By default, IDL blocks indefinitely until it is possible to send the data. Typically, this option is unnecessary on a local network, but it is useful with networks that are slow or unreliable.

UNIX-Only Keywords

STDIO

Under UNIX, forces the file to be opened via the standard C I/O library (stdio) rather than any other more native OS API that might usually be used. This is primarily of interest to those who intend to access the file from external code, and is not necessary for most uses.

Note

Under Windows, the STDIO feature is not possible. Requesting it causes IDL to throw an error.

Example

Most UNIX systems maintain a daytime server on the daytime port (port 13). There servers send a 1 line response when connected to, containing the current time of day.

```
; To obtain the current time from the host bullwinkle:
SOCKET, 1, 'bullwinkle','daytime'
date=''
READF, 1, date
CLOSE, 1
PRINT, date
```

IDL prints:

```
Wed Sep 15 17:20:27 1999
```

SORT

The SORT function returns a vector of subscripts that allow access to the elements of *Array* in ascending order.

Syntax

Result = SORT(*Array* [, /L64])

Return Value

The result is always a vector of integer type with the same number of elements as *Array*.

Arguments

Array

The array to be sorted. *Array* can be any basic type of vector or array. String arrays are sorted using the ASCII collating sequence. Complex arrays are sorted by their magnitude. Array values which are Not A Number (NaN) are moved to the end of the resulting array.

Keywords

L64

By default, the result of SORT is 32-bit integer when possible, and 64-bit integer if the number of elements being sorted requires it. Set L64 to force 64-bit integers to be returned in all cases.

Note

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit sort. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

Example 1

```
A = [4, 3, 7, 1, 2]
PRINT, 'SORT(A) = ', SORT(A)

; Display the elements of A in sorted order:
PRINT, 'Elements of A in sorted order: ', A[SORT(A)]
```

```
; Display the elements of A in descending order:
PRINT, 'Elements of A in descending order: ', A[REVERSE(SORT(A))]
```

IDL prints:

```
SORT(A) =    3    4    1    0    2
Elements of A in sorted order:    1    2    3    4    7
Elements of A in descending order:    7    4    3    2    1
```

SORT(A) returns "`3 4 1 0 2`" because:

$$A[3] < A[4] < A[1] < A[0] < A[2]$$

Example 2

Sorting NaN Values

When sorting data including Not A Number (NaN) values, the NaN entries are moved to the end of the resulting array. For example:

```
values = [ 500, !VALUES.F_NAN, -500 ]
PRINT, SORT(values)
```

IDL prints:

```
2           0           1
```

See Also

REVERSE, UNIQ, WHERE

SPAWN

The SPAWN procedure spawns a child process to execute a command or series of commands. The result of calling SPAWN depends on the platform on which it is being used:

- Under UNIX, the shell used (if any) is obtained from the SHELL environment variable. The NOSHELL keyword can be used to execute a command directly as a child process without starting a shell process.
- Under VMS, the DCL command language interpreter is used.
- Under Windows 95/98, a DOS window is opened. Under Windows NT, a Command Shell is opened. The NOSHELL keyword can be used to execute the specified command directly without starting an intermediate command interpreter shell.
- On the Macintosh, SPAWN opens specified files or applications.

On all platforms, IDL execution suspends until the spawned process terminates.

If SPAWN is called without arguments, an interactive command interpreter process is started, in which you can enter one or more operating system commands. While you use the command interpreter process, IDL is suspended.

Note

For more information on using SPAWN, see the *External Development Guide*.

Syntax

SPAWN [, *Command* [, *Result*] [, *ErrResult*]]

Keywords (all platforms): [, COUNT=*variable*] [, EXIT_STATUS=*variable*] [, /FORCE] [, PID=*variable*]

Macintosh-Only Keywords: [, MACCREATOR=*string*] [, /NOWAIT]

UNIX-Only Keywords: [, /NOSHELL] [, /NOTTYRESET] [, /NULL_STDIN] [, /SH] [, /STDERR] [, /UNIT{*Command* required, *Result* not allowed}]

VMS-Only Keywords: [, /NOCLISYM] [, /NOLOGNAM] [[, /NOTIFY] , /NOWAIT]

Windows-Only Keywords: [, /HIDE] [, /LOG_OUTPUT] [, /NOSHELL] [, /NOWAIT] [, /NULL_STDIN] [, /STDERR]

Arguments

Command

A string containing the commands to be executed.

If *Command* is present, it must be specified as follows:

- On UNIX, *Command* is expected to be scalar unless used in conjunction with the NOSHELL keyword, in which case *Command* is expected to be a string array where each element is passed to the child process as a separate argument.
- On Windows, *Command* can be a scalar string or string array. If it is a string array, SPAWN glues together each element of the string array, with each element separated by whitespace.
- On the Macintosh, *Command* must consist of a comma-separated list of strings containing the names of files to be opened. Each filename must be a separate scalar string. If the first filename is an application, it is used to open the remaining files specified. Otherwise, each file is opened by the application that owns it. IDL suspends execution until all spawned applications have terminated. The user can regain control of IDL before a spawned application terminates by issuing the Command Period escape sequence.
- On VMS, *Command* must be a scalar.

If *Command* is not present, SPAWN starts an interactive command interpreter process, which you can use to enter one or more operating system commands. While you use the command interpreter process, IDL is suspended. Under Windows, an interactive MS-DOS window or NT command shell window is created for this purpose. UNIX and VMS spawn do not create a separate window, but simply run on the user's current tty. Under UNIX, the default shell is used (as specified by the SHELL environment variable). The SH keyword can be used to force use of the Bourne shell (`/bin/sh`). When you exit the child process, control returns to IDL, which resumes at the point where it left off. The IDL session remains exactly as you left it. It should be noted that using SPAWN in this manner is equivalent to using the IDL $ command. The difference between these two is that $ can only be used interactively while SPAWN can be used interactively or in IDL programs

Result

Under Macintosh, *Result* has no effect.

A named variable in which to place the output from the child process. Each line of output becomes a single array element. If *Result* is not present, the output from the child shell process goes to the standard output (usually the terminal).

ErrResult

ErrResult is allowed under UNIX and Windows. It is not allowed under VMS, and it has no effect under the Macintosh OS.

A named variable in which to place the error output (stderr) from the child process. Each line of output becomes a single array element. If *ErrResult* is not present, the error output from the child shell process goes to the standard error file.

See the STDERR keyword for another error stream option.

Keywords

COUNT

If *Result* is present and this keyword is also specified, COUNT specifies a named variable into which the number of lines of output is placed. This value gives the number of elements placed into *Result*.

EXIT_STATUS

Set this keyword to a named variable in which the exit status for the child process is returned. The meaning of this value is operating system dependent:

- Under UNIX, it is the value passed by the child to exit(2), and is analogous to the value returned by $? under most UNIX shells. If the UNIT keyword is used, this keyword always returns 0. In this case, use the EXIT_STATUS keyword to FREE_LUN or CLOSE to determine the final exit status of the process.
- Under VMS, it is the process status returned by LIB$SPAWN. If the NOWAIT keyword is set, EXIT_STATUS returns 1 (SS$_NORMAL).
- Under Windows, it is the value returned by the Win32 GetExitCodeProcess() system function. If the NOWAIT keyword is set, EXIT_STATUS returns 0.

FORCE

Set this keyword to override buffered file output in IDL and force the file to be closed no matter what errors occur in the process. If it is not possible to properly flush this data when a file close is requested, an error is normally issued and the file remains open. An example of this might be that your disk does not have room to write the remaining data. This default behavior prevents data from being lost, but the FORCE keyword overrides this behavior.

NOWAIT

If this keyword is set, the IDL process continues executing in parallel with the subprocess. Normally, the IDL process suspends execution until the subprocess completes.

Note

Because the & character is commonly used in Unix to execute a command in the background, the NO_WAIT keyword is not necessary, and is therefore not accepted under Unix. To spawn a separate shell process under Unix, include the & character at the end of the command. For example:

```
SPAWN, 'xterm &'
```

PID

A named variable into which the Process Identification number of the child process is stored.

Macintosh-Only Keywords

MACCREATOR

Use this keyword to specify a four-character scalar string containing the Macintosh file creator code of the application to be used to open the specified files. In no files were specified, the application is launched without any files.

UNIX-Only Keywords

NOSHELL

Set this keyword to specify that *Command* should execute directly as a child process without an intervening shell process. In this case, *Command* should be specified as a string array in which the first element is the name of the command to execute and the following arguments are the arguments to be passed to the command (C programmers will recognize this as the elements of the argv argument that UNIX passes to the child process main function). Since no shell is present, wildcard characters are not expanded, and other tasks normally performed by the shell do not occur. NOSHELL is useful when performing many SPAWNed operations from a program and speed is a primary concern.

NOTTYRESET

Some UNIX systems drop characters when the tty mode is switched between normal and raw modes. IDL switches between these modes when reading command input

and when using the GET_KBRD function. On such systems, IDL avoids losing characters by delaying the switch back to normal mode until it is truly needed. This method has the benefit of avoiding the large number of mode changes that would otherwise be necessary. Routines that cause output to be sent to the standard output (e.g., I/O operations, user interaction and SPAWN) ensure that the tty is in its normal mode before performing their operations.

If the NOTTYRESET keyword is set, SPAWN does not switch the tty back to normal mode before launching the child process assuming instead that the child will not send output to the tty. Use this keyword to avoid characters being dropped in a loop of the form:

```
WHILE (GET_KBRD(0) NE 'q') SPAWN, command
```

This keyword has no effect on systems that don't suffer from dropped characters.

NULL_STDIN

If set, the null device `/dev/null` is connected to the standard input of the child process.

SH

Set this keyword to force the use of the `/bin/sh` shell. Usually, the shell used is determined by the SHELL environment variable.

STDERR

If set, the child's error output (stderr) is combined with the standard output and returned in *Result*. STDERR and the *ErrResult* argument are mutually exclusive. You should use one or the other, but not both.

UNIT

If UNIT is present, SPAWN creates a child process in the usual manner, but instead of waiting for the specified command to finish, it attaches a bidirectional pipe between the child process and IDL. From the IDL session, the pipe appears as a logical file unit. The other end of the pipe is attached to the child process standard input and output. The UNIT keyword specifies a named variable into which the number of the file unit is stored.

Once the child process is started, the IDL session can communicate with it through the usual input/output facilities. After the child process has done its task, the CLOSE procedure can be used to kill the process and close the pipe. Since SPAWN uses GET_LUN to allocate the file unit, FREE_LUN should be used to free the unit.

If UNIT is present, *Command* must be present, and *Result* is not allowed.

Windows-Only Keywords

HIDE

If HIDE is set, the command interpreter shell window is minimized to prevent the user from seeing it.

LOG_OUTPUT

Normally, IDL starts a command interpreter shell, and output from the child process is displayed in the command interpreter's window. If LOG_OUTPUT is set, the command interpreter window is minimized (as with HIDE) and all output is diverted to the IDLDE log window. If the *Result* or *ErrResult* arguments are present, they take precedence over LOG_OUTPUT.

NOSHELL

If set, IDL starts the specified command directly without starting an intermediate command interpreter shell. This is useful for Windows programs that do not require a console, such as Notepad.

Note

Many common DOS commands (e.g. DIR) are not distinct programs, and are instead implemented as part of the command interpreter. Specifying NOSHELL with such commands results in the command not being found. In such cases, the HIDE keyword might be useful.

NULL_STDIN

If set, the null device NUL is connected to the standard input of the child process.

STDERR

If set, the child's error output (stderr) is combined with the standard output and returned in *Result*. STDERR and the *ErrResult* argument are mutually exclusive. You should use one or the other, but not both.

VMS-Only Keywords

NOCLISYM

If this keyword is set, the spawned subprocess does not inherit command language interpreter symbols from its parent process. You can specify this keyword to prevent commands redefined by symbol assignments from affecting the spawned commands, or to speed process startup.

NOLOGNAM

If this keyword is set, the spawned subprocess does not inherit process logical names from its parent process. You can specify this keyword to prevent commands redefined by logical name assignments from affecting the spawned commands, or to speed process startup.

NOTIFY

If this keyword is set, a message is broadcast to SYS$OUTPUT when the child process completes or aborts. NOTIFY has no effect unless NOWAIT is set.

Examples

Example 1

To simply spawn a process from within IDL, enter the command:

```
SPAWN
```

To execute the UNIX `ls` command and return to the IDL prompt, enter:

```
SPAWN, 'ls'
```

To execute the UNIX `ls` command and store the result in the IDL string variable `listing`, enter:

```
SPAWN, 'ls', listing
```

Example 2

The UNIX grep(1) command is documented as providing an exit value of 0 if one or matches are found, 1 if no matches are found, and 2 if some other error prevents it from functioning. We can use this to determine if the word “Bullwinkle” appears in the text files in the current working directory:

```
PRO test_for_moose
   SPAWN, 'grep Bullwinkle *.txt > /dev/null', EXIT_STATUS=e
   CASE e OF
      0: PRINT, 'Bullwinkle exists'
      1: PRINT, 'Bullwinkle does not exist'
      2: PRINT, 'Grep encountered syntax or other errors'
      ELSE : PRINT, 'Unknown error in grep'
   ENDCASE
END
```

See Also

“Dollar Sign ($)” on page 2465, Chapter 2, “Using SPAWN” in the *External Development Guide*

SPH_4PNT

Given four 3-dimensional points, the SPH_4PNT procedure returns the center and radius necessary to define the unique sphere passing through those points.

This routine is written in the IDL language. Its source code can be found in the file `sph_4pnt.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SPH_4PNT, *X*, *Y*, *Z*, *Xc*, *Yc*, *Zc*, *R* [, /DOUBLE]

Arguments

X, Y, Z

4-element floating-point or double-precision vectors containing the X, Y, and Z coordinates of the points.

Xc, Yc, Zc

Named variables that will contain the sphere's center X, Y, and Z coordinates.

R

A named variable that will contain the sphere's radius.

Keywords

DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

Example

Find the center and radius of the unique sphere passing through the points: (1, 1, 0), (2, 1, 2), (1, 0, 3), (1, 0, 1):

```
; Define the floating-point vectors containing the x, y and z
; coordinates of the points:
X = [1, 2, 1, 1] + 0.0
Y = [1, 1, 0, 0] + 0.0
Z = [0, 2, 3, 1] + 0.0

; Compute sphere's center and radius:
SPH_4PNT, X, Y, Z, Xc, Yc, Zc, R
```

```
; Print the results:
PRINT, Xc, Yc, Zc, R
```

IDL prints:

```
-0.500000      2.00000      2.00000      2.69258
```

See Also

CIR_3PNT, PNT_LINE

SPH_SCAT

The SPH_SCAT function performs spherical gridding. Scattered samples on the surface of a sphere are interpolated to a regular grid. This routine is a convenient interface to the spherical gridding and interpolation provided by TRIANGULATE and TRIGRID. The returned value of the function is a regularly-interpolated grid. This routine is written in the IDL language. Its source code can be found in the file `sph_scat.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SPH_SCAT(*Lon*, *Lat*, *F* [, BOUNDS=*[lonmin*, *latmin*, *lonmax*, *latmax]*] [, BOUT=*variable*] [, GOUT=*variable*] [, GS=*[lonspacing*, *latspacing]*] [, NLON=*value*] [, NLAT=*value*])

Arguments

Lon

A vector of sample longitudes, in degrees. Note that *Lon, Lat,* and *F* must all have the same number of points.

Lat

A vector of sample latitudes, in degrees.

F

A vector of data values which are functions of Lon and Lat. F_i represents a value at (Lon_i, Lat_i).

Keywords

BOUNDS

Set this keyword to a four-element vector containing the grid limits in longitude and latitude of the output grid. The four elements are: [Lon_{min}, Lat_{min}, Lon_{max}, Lat_{max}]. If this keyword is not set, the grid limits are set to the extent of *Lon* and *Lat*. Note that, to cover all longitudes, you must explicitly specify the values for the BOUNDS keyword.

BOUT

Set this keyword to a named variable that, on return, contains a four-element vector (similar to BOUNDS) that describes the actual extent of the regular grid.

GOUT

Set this keyword to a named variable that, on return, contains a two-element vector (similar to GS) that describes the actual grid spacing.

GS

Set this keyword to a two-element vector that specifies the spacing between grid points in longitude (the first element) and latitude (the second element).

If this keyword is not set, the default value is based on the extents of *Lon* and *Lat*. The default longitude spacing is (Lon_{max} - Lon_{min})/(NX-1). The default latitude spacing is (Lat_{max} - Lat_{min})/(NY-1). If NX and NY are not set, the default grid size of 26 by 26 is used for NX and NY.

NLON

The output grid size in the longitude direction. The default value is 26. Note that NLON need not be specified if the size can be inferred from GS and BOUNDS.

NLAT

The output grid size in the latitude direction. The default value is 26. Note that NLAT need not be specified if the size can be inferred from GS and BOUNDS.

Example

```
; Create some random longitude points:
lon = RANDOMU(seed, 50) * 360. -180.

; Create some random latitude points:
lat = RANDOMU(seed, 50) * 180. -90.

; Make a function to fit:
z = SIN(lat*!DTOR)
c = COS(lat*!DTOR)
x = COS(lon*!DTOR) * c
y = SIN(lon*!DTOR) * c

; The finished dependent variable:
f = SIN(x+y) * SIN(x*z)
; Interpolate the data and return the result in variable r:
r = SPH_SCAT(lon, lat, f, BOUNDS=[0, -90, 350, 85], GS=[10,5])
```

See Also

TRIANGULATE, TRIGRID

SPHER_HARM

The SPHER_HARM function returns the value of the spherical harmonic $Y_{lm}(\theta,\phi)$, $-l \le m \le l, l \ge 0$, which is a function of two coordinates on a spherical surface.

The spherical harmonics are related to the associated Legendre polynomial by:

$$Y_{lm}(\theta,\phi) = \sqrt{\frac{2l+1}{4\pi}\frac{(l-m)!}{(l+m)!}} P_l^m(\cos\theta) e^{im\phi}$$

For negative *m* the following relation is used:

$$Y_{l,-m}(\theta,\phi) = (-1)^m Y_{lm}^*(\theta,\phi)$$

where * represents the complex conjugate.

This routine is written in the IDL language. Its source code can be found in the file `spher_harm.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SPHER_HARM(*Theta*, *Phi*, *L*, *M*, [, /DOUBLE])

Return Value

SPHER_HARM returns a complex scalar or array containing the value of the spherical harmonic function. The return value has the same dimensions as the input arguments *Theta* and *Phi*. If one argument (*Theta* or *Phi*) is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If either *Theta* or *Phi* are double-precision or if the DOUBLE keyword is set, the result is double-precision complex, otherwise the result is single-precision complex.

Arguments

Theta

The value of the polar (colatitudinal) coordinate θ at which $Y_{lm}(\theta,\phi)$ is evaluated. *Theta* can be either a scalar or an array.

Phi

The value of the azimuthal (longitudinal) coordinate ϕ at which $Y_{lm}(\theta,\phi)$ is evaluated. *Phi* can be either a scalar or an array.

L

A scalar integer, L ≥ 0, specifying the order *l* of $Y_{lm}(\theta,\phi)$. If *L* is of type float, it will be truncated.

M

A scalar integer, $-L \le M \le L$, specifying the azimuthal order *m* of $Y_{lm}(\theta,\phi)$. If *M* is of type float, it will be truncated.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

This example visualizes the electron probability density for the hydrogen atom in state 3d0. (Feynman, Leighton, and Sands, 1965: The Feynman Lectures on Physics, Calif. Inst. Tech, Ch. 19):

```
; Define a data cube (N x N x N)
n = 41L
a = 60*FINDGEN(n)/(n-1) - 29.999  ; [-1,+1]
x = REBIN(a, n, n, n)              ; X-coordinates of cube
y = REBIN(REFORM(a,1,n), n, n, n)  ; Y-coordinates
z = REBIN(REFORM(a,1,1,n), n, n, n); Z-coordinates

; Convert from rectangular (x,y,z) to spherical (phi, theta, r)
spherCoord = CV_COORD(FROM_RECT= $
 TRANSPOSE([[x[*]],[y[*]],[z[*]]]), /TO_SPHERE)
phi = REFORM(spherCoord[0,*], n, n, n)
theta = REFORM(!PI/2 - spherCoord[1,*], n, n, n)
r = REFORM(spherCoord[2,*], n, n, n)

; Find electron probability density for hydrogen atom in state 3d0
; Angular component
L = 2   ; state "d" is electron spin L=2
M = 0   ; Z-component of spin is zero
angularState = SPHER_HARM(theta, phi, L, M)
; Radial component for state n=3, L=2
radialFunction = EXP(-r/2)*(r^2)
```

```
waveFunction = angularState*radialFunction
probabilityDensity = ABS(waveFunction)^2

SHADE_VOLUME, probabilityDensity, $
 0.1*MEAN(probabilityDensity), vertex, poly
oPolygon = OBJ_NEW('IDLgrPolygon', vertex, $
 POLYGON=poly, COLOR=[180,180,180])
XOBJVIEW, oPolygon
```

The results are shown in the following figure (rotated in XOBJVIEW for clarity):

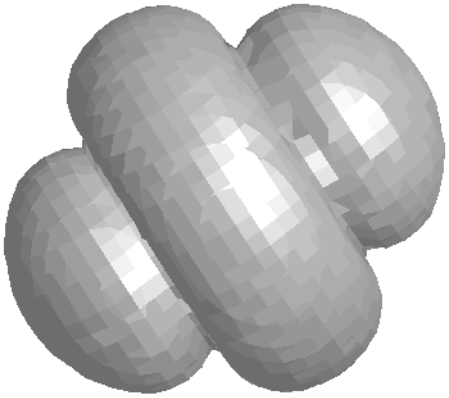


Figure 30: SPHER_HARM Example of Hydrogen Atom
(object rotated in XOBJVIEW for clarity)

See Also

LEGENDRE, LAGUERRE

SPL_INIT

The SPL_INIT function is called to establish the type of interpolating spline for a tabulated set of functional values X_i, $Y_i = F(X_i)$. SPL_INIT returns the values of the 2nd derivative of the interpolating function at the points X_i.

It is important to realize that SPL_INIT should be called only *once* to process an entire tabulated function in arrays *X* and *Y*. Once this has been done, values of the interpolated function for any value of *X* can be obtained by calls (as many as desired) to the separate function SPL_INTERP.

SPL_INIT is based on the routine spline described in section 3.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SPL_INIT(*X*, *Y* [, /DOUBLE] [, YP0=*value*] [, YPN_1=*value*])

Arguments

X

An *n*-element input vector that specifies the tabulate points in ascending order.

Y

An *n*-element input vector that specifies the values of the tabulated function $F(X_i)$ corresponding to X_i.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

YP0

The first derivative of the interpolating function at the point X_0. If YP0 is omitted, the second derivative at the boundary is set to zero, resulting in a “natural spline.”

YPN_1

The first derivative of the interpolating function at the point X_{n-1}. If YPN_1 is omitted, the second derivative at the boundary is set to zero, resulting in a "natural spline."

Example

Example 1

```
X = (FINDGEN(21)/20.) * 2.0*!PI
Y = SIN(X)
PRINT, SPL_INIT(X, Y, YP0 = -1.1, YPN_1 = 0.0)
```

IDL Prints:

```
23.1552    -6.51599    1.06983   -1.26115  -0.839544    -1.04023
-0.950336  -0.817987  -0.592022  -0.311726  2.31192e-05  0.311634
 0.592347   0.816783   0.954825   1.02348   0.902068     1.02781
-0.198994   3.26597  -11.0260
```

Example 2

```
PRINT, SPL_INIT(X, Y, YP0 = -1.1)
```

IDL prints:

```
23.1552    -6.51599    1.06983   -1.26115  -0.839544    -1.04023
-0.950336  -0.817988  -0.592020  -0.311732  4.41521e-05  0.311555
 0.592640   0.815690   0.958905   1.00825   0.958905     0.815692
 0.592635   0.311567   0.00000
```

See Also

SPL_INTERP, SPLINE, SPLINE_P

SPL_INTERP

Given the arrays *X* and *Y*, which tabulate a function (with the X_i in ascending order), and given the array Y_2, which is the output from SPL_INIT, and given an input value of X_2, the SPL_INTERP function returns a cubic-spline interpolated value for the given value of X_I. The result has the same structure as X_2, and is either single- or double-precision floating, based on the input type.

SPL_INTERP is based on the routine `splint` described in section 3.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SPL_INTERP(*X*, *Y*, *Y2*, *X2* [, /DOUBLE])

Arguments

X

An input array that specifies the tabulated points in ascending order.

Y

An input array that specifies the values of the tabulate function corresponding to X_i.

Y2

The output from SPL_INIT for the specified *X* and *Y*.

X2

The input value for which an interpolated value is desired. *X* can be scalar or an array of values. The result of SPL_INIT will have the same structure.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To create a spline interpolation over a tabulated set of data, $[X_i, Y_i]$, first create the tabulated data. In this example, X_i will be in the range $[0.0, 2\pi]$ and Y_i in the range $[\sin(0.0), \sin(2\pi)]$.

```
X = (FINDGEN(21)/20.0) * 2.0 * !PI
Y = SIN(X)

; Calculate interpolating cubic spline:
Y2 = SPL_INIT(X, Y)

; Define the X values P at which we desire interpolated Y values:
X2= FINDGEN(11)/11.0 * !PI

; Calculate the interpolated Y values corresponding to X2[i]:
result = SPL_INTERP(X, Y, Y2, X2)

PRINT, result
```

IDL prints:

```
 0.00000  0.281733  0.540638  0.755739  0.909613  0.989796
 0.989796  0.909613  0.755739  0.540638  0.281733
```

The exact solution vector is $\sin(X_2)$.

To interpolate a line in the XY plane, see SPLINE_P.

See Also

SPL_INIT, SPLINE, SPLINE_P

SPLINE

The SPLINE function performs cubic spline interpolation.

This routine is written in the IDL language. Its source code can be found in the file `spline.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SPLINE(*X*, *Y*, *T* [, *Sigma*])

Arguments

X

The abscissa vector. Values *must* be monotonically increasing.

Y

The vector of ordinate values corresponding to *X*.

T

The vector of abscissa values for which the ordinate is desired. The values of *T must* be monotonically increasing.

Sigma

The amount of "tension" that is applied to the curve. The default value is 1.0. If sigma is close to 0, (e.g., .01), then effectively there is a cubic spline fit. If sigma is large, (e.g., greater than 10), then the fit will be like a polynomial interpolation.

Example

The commands below show a typical use of SPLINE:

```
; X values of original function:
X = [2.,3.,4.]

; Make a quadratic
Y = (X-3)^2
;Values for interpolated points:
T = FINDGEN(20)/10.+2

; Do the interpolation:
Z = SPLINE(X,Y,T)
```

See Also

SPL_INIT, SPLINE_P

SPLINE_P

The SPLINE_P procedure performs parametric cubic spline interpolation with relaxed or clamped end conditions.

This routine is both more general and faster than the SPLINE function. One call to SPLINE_P is equivalent to two calls to SPLINE, as both the X and Y are interpolated with splines. It is suited for interpolating between randomly placed points, and the abscissa values need not be monotonic. In addition, the end conditions may be optionally specified via tangents.

This routine is written in the IDL language. Its source code can be found in the file `spline_p.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SPLINE_P, *X*, *Y*, *Xr*, *Yr* [, INTERVAL=*value*] [, TAN0=*[X_0, Y_0]*] [, TAN1=*[X_{n-1}, Y_{n-1}]*]

Arguments

X

The abscissa vector. *X* should be floating-point or double-precision.

Y

The vector of ordinate values corresponding to X. *Y* should be floating-point or double-precision.

Neither X or Y need be monotonic.

Xr

A named variable that will contain the abscissa values of the interpolated function.

Yr

A named variable that will contain the ordinate values of the interpolated function.

Keywords

INTERVAL

Set this keyword equal to the desired interval in XY space between interpolants. If omitted, approximately 8 interpolants per XY segment will result.

TAN0

The tangent to the spline curve at X[0], Y[0]. If omitted, the tangent is calculated to make the curvature of the result zero at the beginning. TAN0 is a two element vector, containing the X and Y components of the tangent.

TAN1

The tangent to the spline curve at X[*n*-1], Y[*n*-1]. If omitted, the tangent is calculated to make the curvature of the result zero at the end. TAN1 is a two element vector, containing the X and Y components of the tangent.

Example

The commands below show a typical use of SPLINE_P:

```
; Abscissas for square with a vertical diagonal:
X = [0.,1,0,-1,0]

; Ordinates:
Y = [0.,1,2,1,0]

; Interpolate with relaxed end conditions:
SPLINE_P, X, Y, XR, YR

; Show it:
PLOT, XR, YR
```

As above, but with setting both the beginning and end tangents:

```
SPLINE_P, X, Y, XR, YR, TAN0=[1,0], TAN1=[1,0]
```

This yields approximately 32 interpolants.

As above, but with setting the interval to 0.05, making more interpolants, closer together:

```
SPLINE_P, X, Y, XR, YR, TAN0=[1,0], TAN1=[1,0], INTERVAL=0.05
```

This yields 116 interpolants and looks close to a circle.

See Also

SPL_INIT, SPLINE

SPRSAB

The SPRSAB function performs matrix multiplication on two row-indexed sparse arrays created by SPRSIN. The routine computes all components of the matrix products, but only stores those values whose absolute magnitude exceeds the threshold value. The result is a row-indexed sparse array.

SPRSAB is based on the routine `sprstm` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission. The difference between the two routines is that SPRSAB performs the matrix multiplication A·B rather than $A \cdot B^T$.

Syntax

Result = SPRSAB(*A*, *B* [, /DOUBLE] [, THRESHOLD=*value*])

Arguments

A, B

Row-indexed sparse arrays created by the SPRSIN function.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

THRESHOLD

Use this keyword to set the criterion for deciding the absolute magnitude of the elements to be retained in sparse storage mode. For single-precision calculations, the default value is 1.0×10^{-7}. For double-precision calculations, the default is 1.0×10^{-14}.

Example

```
; Begin by creating two arrays:
A = [[ 5.0,  0.0, 0.0,  1.0], $
     [ 3.0, -2.0, 0.0,  1.0], $
     [ 4.0, -1.0, 0.0,  2.0], $
     [ 0.0,  3.0, 3.0,  1.0]]
B = [[ 1.0,  2.0, 3.0,  1.0], $
     [ 3.0, -3.0, 0.0,  1.0], $
```

```
     [-1.0,  3.0, 1.0,  2.0], $
     [ 0.0,  3.0, 3.0,  1.0]]

; Convert the arrays to sparse array format before multiplying. The
; variable SPARSE holds the result in sparse array form:
sparse = SPRSAB(SPRSIN(A), SPRSIN(B))

; Restore the sparse array structure to full storage mode:
result = FULSTR(sparse)

; Print the result:
PRINT, 'result:'
PRINT, result

; Check this result by multiplying the original arrays:
exact = B # A
PRINT, 'exact:'
PRINT, exact
```

IDL prints:

```
result:
 5.00000      13.0000      18.0000       6.00000
-3.00000      15.0000      12.0000       2.00000
 1.00000      17.0000      18.0000       5.00000
 6.00000       3.00000      6.00000      10.0000
exact:
 5.00000      13.0000      18.0000       6.00000
-3.00000      15.0000      12.0000       2.00000
 1.00000      17.0000      18.0000       5.00000
 6.00000       3.00000      6.00000      10.0000
```

See Also

FULSTR, LINBCG, SPRSAX, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

SPRSAX

The SPRSAX function takes a row-indexed sparse array created by the SPRSIN function and multiplies it by an *n*-element vector to its right. The result is a *n*-element vector.

SPRSAX is based on the routine `sprsax` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SPRSAX(*A*, *X* [, /DOUBLE])

Arguments

A

A row-indexed sparse array created by the SPRSIN function.

X

An *n*-element right hand vector.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Begin by creating an array A:
A = [[ 5.0,  0.0, 0.0], $
     [ 3.0, -2.0, 0.0], $
     [ 4.0, -1.0, 0.0]]

; Define the right-hand vector:
X = [1.0, 2.0, -1.0]

; Convert to sparse format, then multiply by X:
result = SPRSAX(SPRSIN(A),X)

; Print the result:
PRINT, result
```

IDL prints:

```
   5.00000      -1.00000       2.00000
```

See Also

FULSTR, LINBCG, SPRSAB, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

SPRSIN

The SPRSIN function converts an array, or list of subscripts and values, into a row-index sparse storage mode, retaining only elements with an absolute magnitude greater than or equal to the specified threshold. The list form is much more efficient than the array form if the density of the matrix is low.

The result is a row-indexed sparse array contained in structure form. The structure consists of two linear sparse storage vectors: SA, a vector of array values, and IJA, a vector of subscripts to the SA vector. The length of these vectors is equal to 1 plus the number of diagonal elements of the array, plus the number of off-diagonal elements with an absolute magnitude greater that or equal to the threshold value. Diagonal elements of the array are always retained even if their absolute magnitude is less than the specified threshold.

SPRSIN is based on the routine `sprsin` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SPRSIN(*A* [, /COLUMN] [, /DOUBLE] [, THRESHOLD=*value*])

or

Result = SPRSIN(*Columns, Rows, Values, N* [, /DOUBLE] [, THRESHOLD=*value*])

Arguments

A

An *n* by *n* array of any type except string or complex.

Columns

A vector containing the column subscripts of the non-zero elements. Values must be in the range of 0 to (N-1).

Rows

A vector, of the same length as Column, containing the row subscripts of the non-zero elements. Values must be in the range of 0 to (N-1).

Values

A vector, of the same length as Column, containing the values of the non-zero elements.

N

The size of the resulting sparse matrix.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors). This keyword is not allowed in the list form of the call.

DOUBLE

Set this keyword to convert the sparse array to double-precision.

THRESHOLD

Use this keyword to set the criterion for deciding the absolute magnitude of the elements to be retained in sparse storage mode. For single-precision calculations, the default value is 1.0×10^{-7}. For double-precision values, the default is 1.0×10^{-14}.

Examples

Example1

Suppose we wish to convert the following array to sparse storage format:

```
A = [[ 5.0, -0.2, 0.1], $
     [ 3.0, -2.0, 0.3], $
     [ 4.0, -1.0, 0.0]]

; Convert to sparse storage mode. All elements of the array A that
; have absolute values less than THRESH are set to zero.
sparse = SPRSIN(A, THRESH = 0.5)
```

The variable SPARSE now contains a representation of A in structure form. See the description of FULSTR for an example that restores such a structure to full storage mode.

Example2

This example demonstrates how to use the list form of the call to SPRSIN. The following line of code creates a sparse matrix, equivalent to a 100 by 100 identity matrix, i.e. all diagonal elements are set to 1, all other elements are zero:

```
I100 = SPRSIN(LINDGEN(100), LINDGEN(100), REPLICATE(1.0,100), 100)
```

See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSTP, READ_SPR, WRITE_SPR

SPRSTP

The SPRSTP function constructs the transpose of a sparse matrix.

Syntax

Result = SPRSTP(*A*)

Arguments

A

A row-indexed sparse array created by the SPRSIN function.

Keywords

None

Example

This example creates a 100 by 100 pseudo-random sparse matrix, with 1000 non-zero elements, and then computes the product of the matrix and its transpose:

```
n = 100                    ;Dimensions of matrix
m = 1000                   ;Number of non-zero elements
a = SPRSIN(RANDOMU(seed, m)*n, RANDOMU(seed, m)*n, $
    RANDOMU(seed, m),n)
b = SPRSAB(a, SPRSTP(a))   ;Transpose and create the product
```

See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, READ_SPR, WRITE_SPR

SQRT

The SQRT function returns the square root of *X*.

Syntax

Result = SQRT(*X*)

Arguments

X

The value for which the square root is desired. If *X* is double-precision floating-point or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers, $z = x+iy$:

$$z^{1/2} = \left[\frac{1}{2}(r + x)\right]^{1/2} \pm i\left[\frac{1}{2}(r - x)\right]^{1/2}$$

$$r = \sqrt{x^2 + y^2}$$

The ambiguous sign is taken to be the same as the sign of *y*. The result has the same structure as *X*.

Example

To find the square root of 145 and store the result in variable S, enter:

```
S = SQRT(145)
```

See Also

"Exponentiation" in Chapter 2 of *Building IDL Applications*.

STANDARDIZE

The STANDARDIZE function computes standardized variables from an array of *m* variables (columns) and *n* observations (rows). The result is an *m*-column, *n*-row array where all columns have a mean of zero and a variance of one.

This routine is written in the IDL language. Its source code can be found in the file `standardize.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = STANDARDIZE(*A* [, /DOUBLE])

Arguments

A

An *m*-column, *n*-row single- or double-precision floating-point array.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define an array with 4 variables and 20 observations:
array = $
           [[19.5, 43.1, 29.1, 11.9], $
            [24.7, 49.8, 28.2, 22.8], $
            [30.7, 51.9, 37.0, 18.7], $
            [29.8, 54.3, 31.1, 20.1], $
            [19.1, 42.2, 30.9, 12.9], $
            [25.6, 53.9, 23.7, 21.7], $
            [31.4, 58.5, 27.6, 27.1], $
            [27.9, 52.1, 30.6, 25.4], $
            [22.1, 49.9, 23.2, 21.3], $
            [25.5, 53.5, 24.8, 19.3], $
            [31.1, 56.6, 30.0, 25.4], $
            [30.4, 56.7, 28.3, 27.2], $
            [18.7, 46.5, 23.0, 11.7], $
            [19.7, 44.2, 28.6, 17.8], $
            [14.6, 42.7, 21.3, 12.8], $
            [29.5, 54.4, 30.1, 23.9], $
            [27.7, 55.3, 25.7, 22.6], $
```

```
            [30.2, 58.6, 24.6, 25.4], $
            [22.7, 48.2, 27.1, 14.8], $
            [25.2, 51.0, 27.5, 21.1]]

; Compute the mean and variance of each variable using the MOMENT
; function. The skewness and kurtosis are also computed:
FOR K = 0, 3 DO PRINT, MOMENT(array[K,*])

; Compute the standardized variables:
result = STANDARDIZE(array)

; Compute the mean and variance of each standardized variable using
; the MOMENT function. The skewness and kurtosis are also computed:
FOR K = 0, 3 DO PRINT, MOMENT(result[K,*])
```

IDL prints:

```
25.3050      25.2331    -0.454763     -1.10028
51.1700      27.4012    -0.356958     -1.19516
27.6200      13.3017     0.420289     0.104912
20.1950      26.0731    -0.363277     -1.24886

-7.67130e-07      1.00000    -0.454761    -1.10028
-3.65451e-07      1.00000    -0.356958    -1.19516
-1.66707e-07      1.00000     0.420290     0.104913
 4.21703e-07      1.00000    -0.363278    -1.24886
```

See Also

MOMENT

STDDEV

The STDDEV function computes the standard deviation of an *n*-element vector.

Syntax

Result = STDDEV(*X* [, /DOUBLE] [, /NAN])

Arguments

X

A numeric vector.

Keywords

DOUBLE

If this keyword is set, computations are performed in double precision arithmetic.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]

; Compute the standard deviation:
result = STDDEV(x)

PRINT, result
```

IDL prints:

```
2.65832
```

See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, SKEWNESS, VARIANCE

STOP

The STOP procedure stops the execution of a running program or batch file. Control reverts to the interactive mode.

Syntax

STOP [, $Expr_1$, ..., $Expr_n$]

Arguments

$Expr_i$

One or more expressions whose value is printed. If no parameters are present, a brief message describing where the STOP was encountered is printed.

Example

Suppose that you want to stop the execution of a procedure and print the values of the variables A, B, C and NUM. At the appropriate location in your procedure include the command:

```
STOP, A, B, C, NUM
```

To continue execution of the procedure (if possible) enter the IDL executive command:

```
.CONT
```

See Also

BREAKPOINT, EXIT, WAIT

STRARR

The STRARR function returns a string array containing zero-length strings.

Syntax

Result = STRARR(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Example

To create S, a 20-element string vector, enter:

```
S = STRARR(20)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, UINTARR, ULON64ARR, ULONARR

STRCMP

The STRCMP function performs string comparisons between its two String arguments, returning True (1) for those that match and False (0) for those that do not. Normally, the IDL equality operator (EQ) is used for such comparisons, but STRCMP can optionally perform case-insensitive comparisons and can be limited to compare only the first N characters of the two strings, both of which require extra steps using the EQ operator.

Syntax

Result = STRCMP(*String1*, *String2* [, *N*] [, /FOLD_CASE])

Return Value

If all of the arguments are scalar, the result is scalar. If one of the arguments is an array, the result is an integer with the same structure. If more than one argument is an array, the result has the structure of the smallest array. Each element of the result contains True (1) if the corresponding elements of String1 and String2 are the same, and False (0) otherwise.

Arguments

String1, String2

The strings to be compared.

N

Normally String1 and String2 are compared in their entirety. If N is specified, the comparison is made on at most the first N characters of each string.

Keywords

FOLD_CASE

String comparison is normally a case sensitive operation. Set FOLD_CASE to perform case insensitive comparisons instead.

Example

Compare two strings in a case-insensitive manner, considering only the first 3 characters:

```
Result = STRCMP('Moose', 'moo', 3, /FOLD_CASE)
PRINT, Result
```

IDL prints:

```
1
```

See Also

STREGEX, STRJOIN, STRMATCH, STRMID, STRPOS, STRSPLIT

STRCOMPRESS

The STRCOMPRESS function returns a copy of *String* with all whitespace (blanks and tabs) compressed to a single space or completely removed.

Syntax

Result = STRCOMPRESS(*String* [, /REMOVE_ALL])

Arguments

String

The string to be compressed. If not of type string, it is converted using IDL's default formatting rules. If *String* is an array, the result is an array with the same structure—each element contains a compressed copy of the corresponding element of *String*.

Keywords

REMOVE_ALL

Set this keyword to remove *all* whitespace. Normally, all whitespace is compressed to a *single* space.

Example

```
; Create a string variable S:
S = 'This is a string with spaces in it.'

; Print S with all of the whitespace removed:
PRINT, STRCOMPRESS(S, /REMOVE_ALL)
```

IDL Output

```
Thisisastringwithspacesinit.
```

See Also

STRTRIM

STREAMLINE

The STREAMLINE procedure generates the visualization graphics from a path. The output is a polygonal ribbon which is tangent to a vector field along its length. The ribbon is generated by placing a line at each vertex in the direction specified by each normal value multiplied by the anisotropy factor. The input normal array is not normalized before use, making it possible to vary the ribbon width as well.

Syntax

STREAMLINE, *Verts*, *Conn*, *Normals*, *Outverts*, *Outconn* [, ANISOTROPY=*array*] [, SIZE=*vector*] [, PROFILE=*array*]

Arguments

Verts

Input array of path vertices ([3, *n*] array).

Conn

Input path connectivity array in IDLgrPolyline POLYLINES keyword format. There is one set of line segments in this array for each streamline.

Normals

Normal estimate at each input vertex ([3, *n*] array).

Outverts

Output vertices ([3xM] float array). Useful if the routine is to be used with Direct Graphics or the user wants to manipulate the data directly.

Outconn

Output polygonal connectivity array to match the output vertices.

Keywords

ANISOTROPY

Set this input keyword to a three-element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0]

SIZE

Set this keyword to a vector of values (one for each path point). These values are used to specify the width of the ribbon or the size of profile at each point along its path. This keyword is generally used to convey additional data parameters along the streamline.

PROFILE

Set this keyword an array of two-dimensional points which are treated as the cross section of the ribbon instead of a line segment. If the first and last points in the array are the same, a closed profile is generated. The profile is placed at each path vertex in the plane perpendicular to the line connecting each path vertex with the vertex normal defining the up direction. This allows for the generation of streamtubes and other geometries.

STREGEX

The STREGEX function performs regular expression matching against the strings contained in StringExpression. STREGEX can perform either a simple boolean True/False evaluation of whether a match occurred, or it can return the position and offset within the strings for each match. The regular expressions accepted by this routine, which correspond to "Posix Extended Regular Expressions", are similar to those used by such UNIX tools as egrep, lex, awk, and Perl.

For more information about regular expressions, see "Learning About Regular Expressions" in Chapter 4 of *Building IDL Applications*.

STREGEX is based on the regex package written by Henry Spencer, modified by RSI only to the extent required to integrate it into IDL. This package is freely available at `ftp://zoo.toronto.edu/pub/regex.shar`.

Syntax

Result = STREGEX(*StringExpression*, *RegularExpression* [, /BOOLEAN | , /EXTRACT | , LENGTH=*variable* [, /SUBEXPR]] [, /FOLD_CASE])

Return Value

By default, STREGEX returns the position and length of the matched string within StringExpression. If no match is found, -1 is returned for both of these. Optionally, it can return a boolean True/False result of the match, or the matched strings.

Arguments

StringExpression

String to be matched.

RegularExpression

A scalar string containing the regular expression to match. See "Learning About Regular Expressions" in Chapter 4 of *Building IDL Applications* for a description of the meta characters that can be used in a regular expression.

Keywords

BOOLEAN

Normally, STREGEX returns the position of the first character in StringExpression that matches RegularExpression. Setting BOOLEAN modifies this behavior to simply return a True/False value indicating if a match occurred or not.

EXTRACT

Normally, STREGEX returns the position of the first character in StringExpression that matches RegularExpression. Setting EXTRACT modifies this behavior to simply return the matched substrings. The EXTRACT keyword cannot be used with either BOOLEAN or LENGTH.

FOLD_CASE

Regular expression matching is normally a case-sensitive operation. Set FOLD_CASE to perform case-insensitive matching instead.

LENGTH

If present, specifies a variable to receive the lengths of the matches. Together with this result of this function, which contains the starting points of the matches in StringExpression, LENGTH can be used with the STRMID function to extract the matched substrings. The LENGTH keyword cannot be used with either BOOLEAN or EXTRACT.

SUBEXPR

By default, STREGEX only reports the overall match. Setting SUBEXPR causes it to report the overall match as well as any subexpression matches. A subexpression is any part of a regular expression written within parentheses. For example, the regular expression ‘(a)(b)(c+)’ has 3 subexpressions, whereas the functionally equivalent 'abc+' has none. The SUBEXPR keyword cannot be used with BOOLEAN.

If a subexpression participated in the match several times, the reported substring is the last one it matched. Note, as an example in particular, that when the regular expression ‘(b*)+’ matches ‘bbb’, the parenthesized subexpression matches the three 'b's and then an infinite number of empty strings following the last ‘b’, so the reported substring is one of the empties. This occurs because the ‘*’ matches *zero or more* instances of the character that precedes it.

In order to return multiple positions and lengths for each input, the result from SUBEXPR has a new first dimension added compared to StringExpression.

Examples

Example 1

To match a string starting with an “a”, followed by a “b”, followed by 1 or more “c”:

```
pos = STREGEX('aaabccc', 'abc+', length=len)
PRINT, STRMID('aaabccc', pos, len)
```

IDL Prints:

```
abccc
```

To perform the same match, and also find the locations of the three parts:

```
pos = STREGEX('aaabccc', '(a)(b)(c+)', length=len, /SUBEXPR)
print, STRMID('aaabccc', pos, len)
```

IDL Prints:

```
abccc a b ccc
```

Or more simply:

```
print,STREGEX('aaabccc','(a)(b)(c+)',/SUBEXPR,/EXTRACT)
```

IDL Prints:

```
abccc a b ccc
```

Example 2

This example searches a string array for words of any length beginning with “f” and ending with “t” without the letter “o” in between:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'affluent']
PRINT, STREGEX(str, '^f[^o]*t$', /EXTRACT, /FOLD_CASE)
```

This statement results in:

```
Feet FAST ferret
```

Note the following about this example:

- Unlike the * wildcard character used by STRMATCH, the * meta character used by STREGEX applies to the item directly on its left, which in this case is [^o], meaning “any character except the letter ‘o’ ”. Therefore, [^o]* means “zero or more characters that are not ‘o’ ”, whereas the following statement would find only words whose second character is not “o”:

  ```
  PRINT, str[WHERE(STRMATCH(str, 'f[!o]*t', /FOLD_CASE) EQ 1)]
  ```

- The anchors (^ and $) tell STREGEX to find only words that begin with “f” and end with “t”. If we left out the ^ anchor in the above example, STREGEX would also return “ffluent” (a substring of “affluent”). Similarly, if we left out the $ anchor, STREGEX would also return “fat” (a substring of “fate”).

See Also

STRCMP, STRJOIN, STRMATCH, STRMID, STRPOS, STRSPLIT

STRETCH

The STRETCH procedure stretches the image display color tables so the full range runs from one color index to another. The modified colortable is loaded, but the COLORS common block is not changed. The original colortable can be restored by calling STRETCH with no arguments. A colortable must be loaded before STRETCH can be called.

This routine is written in the IDL language. Its source code can be found in the file `stretch.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

STRETCH [, *Low*, *High* [, *Gamma*]] [, /CHOP]

Arguments

Low

The lowest pixel value to use. If this parameter is omitted, 0 is assumed. Appropriate values range from 0 to the number of available colors-1. If no parameters are supplied, the original color tables are restored.

High

The highest pixel value to use. If this parameter is omitted, the number of colors-1 is assumed. Appropriate values range from 0 to the number of available colors-1.

Gamma

An optional Gamma correction factor. If this value is omitted, 1.0 is assumed. Gamma correction works by raising the color indices to the *Gamma* power, assuming they are scaled into the range 0 to 1.

Keywords

CHOP

Set this keyword to set color indices above the upper threshold to color index 0. Normally, values above the upper threshold are set to the maximum color index.

Example

Load the STD GAMMA-II color table by entering:

```
LOADCT, 5
```

Create and display and image by entering:

```
TVSCL, DIST(300)
```

Now adjust the color table with STRETCH. Make the entire color table fit in the range 0 to 70 by entering:

```
STRETCH, 0, 70
```

Notice that pixel values above 70 are now colored white. Restore the original color table by entering:

```
STRETCH
```

See Also

GAMMA_CT, H_EQ_CT, MULTI, XLOADCT

STRING

The STRING function returns its arguments converted to string type. It is similar to the PRINT procedure, except that its output is placed in a string rather than being output to the terminal. The case in which a single expression of type byte is specified without the FORMAT keyword is special—see the discussion below for details.

Note

Applying the STRING function to a byte array containing a null (zero) value will result in the resulting string being truncated at that position.

Syntax

Result = STRING($Expression_1$, ..., $Expression_n$ [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, /PRINT])

Arguments

$Expression_n$

The expressions to be converted to string type.

Note

If you supply a comma-separated list of expressions without specifying a FORMAT, and the combined length of the expressions is greater than the current width of your tty or command log window, STRING will create a string array with one element for each expression, rather than concatenating all expressions into a single string. In this case, you can either specify a FORMAT, or use the string concatenation operator, "+".

Keywords

AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

FORMAT

A format string to be used in formatting the expressions. See "Using Explicitly Formatted Input/Output" in Chapter 8 of *Building IDL Applications*.

MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

PRINT

Set this keyword to specify that any special case processing should be ignored and that STRING should behave exactly as the PRINT procedure would.

Differences Between STRING and PRINT

The behavior of STRING differs from the behavior of the PRINT procedure in the following ways (unless the PRINT keyword is set):

- When called with a single non-byte argument and no format specification, STRING returns a result that has the same dimensions as the original argument. For example, the statement:

  ```
  HELP, STRING(INDGEN(5))
  ```

  gives the result:

  ```
  <Expression> STRING = Array[5]
  ```

  while:

  ```
  HELP, STRING(INDGEN(5), /PRINT)
  ```

  results in:

  ```
  <Expression> STRING =' 0 1 2 3 4'
  ```

- If called with a single argument of byte type and the FORMAT keyword is not used, STRING simply stores the unmodified values of each byte element in the result. This result is a string containing the byte values from the original argument. Thus, the result has one less dimension than the original argument.

For example, a 2-dimensional byte array becomes a vector of strings, a byte vector becomes a scalar string. However, a byte scalar also becomes a string scalar. For example, the statement:

```
PRINT, STRING([72B, 101B, 108B, 108B, 111B])
```

produces the output:

```
Hello
```

because the argument to STRING, is a byte vector. Its first element is a 72B which is the ASCII code for “H”, the second is 101B which is an ASCII “e”, and so forth.

- If both the FORMAT and PRINT keywords are not present and STRING is called with more than one argument, and the last argument is a scalar string starting with the characters “$(” or “(”, this final argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

Example

To convert the contents of variable A to string type and store the result in the variable B, enter:

```
B = STRING(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, UINT, ULONG, ULONG64

STRJOIN

The STRJOIN function collapses a string scalar or array into merged strings. This function reduces the rank of its input array by one dimension. The strings in the removed first dimension are concatenated into a single string using the string in *Delimiter* to separate them.

Syntax

Result = STRJOIN(*String* [, *Delimiter*] [, /SINGLE])

Arguments

String

A string scalar or array to be collapsed into merged strings.

Delimiter

The separator string to use between the joined strings. If Delimiter is not specified, an empty string is used.

Keywords

SINGLE

If SINGLE is set, the entire String is joined into a single scalar string result.

Example

Replace all the blanks in a sentence with colons:

```
str = 'Out, damned spot! Out I say!'
print, (STRJOIN(STRSPLIT(str, /EXTRACT), ':'))
```

IDL prints:

```
Out,:damned:spot!:Out:I:say!
```

See Also

STRCMP, STREGEX, STRMATCH, STRMID, STRPOS, STRSPLIT

STRLEN

The STRLEN function returns the length of its string-type argument. If the argument is not a string, it is first converted to string type.

Syntax

Result = STRLEN(*Expression*)

Arguments

Expression

The expression for which the string length is desired. If this parameter is not a string, it is converted using IDL's default formatting rules in order to determine the length. The result is a long integer. If *Expression* is an array, the result is a long integer array with the same structure, where each element contains the length of the corresponding *Expression* element.

Example

To find the length of the string "IDL is fun" and print the result, enter:

```
PRINT, STRLEN('IDL is fun')
```

IDL prints:

```
      10
```

STRLOWCASE

The STRLOWCASE function returns a copy of *String* converted to lowercase characters. Only uppercase characters are modified—lowercase and non-alphabetic characters are copied without change.

Syntax

Result = STRLOWCASE(*String*)

Arguments

String

The string to be converted. If this argument is not a string, it is converted using IDL's default formatting rules. If *String* is an array, the result is an array with the same structure—each element contains a lower case copy of the corresponding element of *String*.

Example

To convert the string "IDL is fun" to all lowercase characters and print the result, enter:

```
PRINT, STRLOWCASE('IDL is fun')
```

IDL prints:

```
idl is fun
```

See Also

STRUPCASE

STRMATCH

The STRMATCH function compares its search string, which can contain wildcard characters, against the input string expression. The result is an array with the same structure as the input string expression. Those elements that match the corresponding input string are set to True (1), and those that do not match are set to False (0).

The wildcards understood by STRMATCH are similar to those used by the standard UNIX shell:

Wildcard Character	Description
*	Matches any string, including the null string.
?	Matches any single character.
[...]	Matches any one of the enclosed characters. A pair of characters separated by "-" matches any character lexically between the pair, inclusive. If the first character following the opening [is a !, any character not enclosed is matched. To prevent one of these characters from acting as a wildcard, it can be quoted by preceding it with a backslash character (e.g. "*" matches the asterisk character). Quoting any other character (including \ itself) is equivalent to the character (e.g. "\a" is the same as "a").

Table 88: Wilcard Characters used by STRMATCH

Syntax

Result = STRMATCH(*String*, *SearchString* [, /FOLD_CASE])

Arguments

String

The String to be matched.

SearchString

The search string, which can contain wildcard characters as discussed above.

Keywords

FOLD_CASE

The comparison is usually case sensitive. Setting the FOLD_CASE keyword causes a case insensitive match to be done instead.

Examples

Example 1

Find all 4-letter words in a string array that begin with “f” or “F” and end with “t” or “T”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f??t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet FAST fort
```

Example 2

Find words of any length that begin with “f” and end with “t”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f*t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet FAST ferret fort
```

Example 3

Find 4-letter words beginning with “f” and ending with “t”, with any combination of “o” and “e” in between:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f[eo][eo]t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet
```

Example 4

Find all words beginning with “f” and ending with “t” whose second character is not the letter “o”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f[!o]*t', /FOLD_CASE) EQ 1)]
```

This results in:

```
Feet FAST ferret
```

See Also

STRCMP, STRJOIN, STREGEX, STRMID, STRPOS, STRSPLIT

STRMESSAGE

The STRMESSAGE function returns the text of the error message specified by *Err*. This function is especially useful in conjunction with the CODE field of the !ERROR_STATE system variable which always contains the error number of the last error. The MSG field of the !ERROR_STATE system variable contains the text of the last error message.

Syntax

Result = STRMESSAGE(*Err* [, /BLOCK | , /CODE | , /NAME])

Arguments

Err

The error number or text. Programs must not make the assumption that certain error numbers are always related to certain error messages—the actual correspondence changes over time as IDL is modified.

Keywords

BLOCK

Set this keyword to return the name of the message block that defines *Err*. If this keyword is specified, *Err* must be an error code.

CODE

Set this keyword to return the error code for the error message specified in *Err*. If this keyword is specified, *Err* must be an error name.

NAME

Set this keyword to return a string containing the error message that goes with *Err*. If this keyword is specified, *Err* must be an error code.

Example

Print the error message associated with error number 4 by entering:

```
PRINT, STRMESSAGE(4)
```

See Also

MESSAGE

STRMID

The STRMID function extracts one or more substring from a string expression. Each extracted string is the result of removing characters. The result of the function is a string of *Length* characters taken from *Expression*, starting at character position *First_Character*.

The form of *First_Character* and *Length* control how they are applied to *Expression*. Either argument can be a scalar or an array:

- If a scalar value is supplied for *First_Character* and *Length*, then those values are applied to all elements of *Expression*. The result has the same structure and number of elements as *Expression*.
- If *First_Character* or *Length* is an array, the size of their first dimension determines how many substrings are extracted from each element of *Expression*. We call this the “stride”. If both are arrays, they must have the same stride. If *First_Character* or *Length* do not contain enough elements to process *Expression*, STRMID automatically loops back to the beginning as necessary. Excess values are ignored. If the stride is 1, the result will have the same structure and number of elements as *Expression*. If it is greater than 1, the result will have an additional dimension, with the new first dimension having the same size as the stride.

Syntax

Result = STRMID(*Expression*, *First_Character* [, *Length*] [, /REVERSE_OFFSET])

Arguments

Expression

The expression from which the substrings are to be extracted. If this argument is not a string, it is converted using IDL's default formatting rules.

First_Character

The starting position within *Expression* at which the substring starts. The first character position is 0.

Length

The length of the substring. If there are not enough characters left in the main string to obtain *Length* characters, the substring is truncated. If *Length* is not supplied,

STRMID extracts all characters from the specified start position to the end of the string.

Keywords

REVERSE_OFFSET

Specifies that *First_Character* should be counted from the end of the string backwards. This allows simple extraction of strings from the end.

Example

If the variable B contains the string “IDL is fun”, the substring “is” can be extracted and stored in the variable C with the command:

```
C = STRMID(B, 4, 2)
```

See Also

STRPOS, STRPUT, STRTRIM

STRPOS

The STRPOS function finds the first occurrence of a substring within an object string. If *Search_String* occurs in *Expression*, STRPOS returns the character position of the match, otherwise it returns -1.

Syntax

Result = STRPOS(*Expression*, *Search String* [, *Pos*] [, /REVERSE_OFFSET] [, /REVERSE_SEARCH])

Arguments

Expression

The expression in which to search for the substring. If this argument is not a string, it is converted using IDL's default formatting rules. If *Expression* is an array, the result is an array with the same structure, where each element contains the position of the substring within the corresponding element *Expression*. If *Expression* is the null string, STRPOS returns the value -1.

Search_String

The substring to be searched for within *Expression*. If this argument is not a string, it is converted using IDL's default formatting rules. If *Search_String* is the null string, STRPOS returns the smaller of *Pos* or one less than the length of *Expression*.

Pos

The character position at which the search is begun. If *Pos* is omitted and the REVERSE_SEARCH keyword is not set, the search begins at the first character (character position 0). If REVERSE_SEARCH is set, the default is to start at the last character in the string. If *Pos* is less than zero, zero is used for the starting position.

Keywords

REVERSE_OFFSET

Normally, the value of *Pos* is used as an offset from the beginning of the expression towards the end. Set REVERSE_OFFSET to use it as an offset from the last character of the string moving towards the beginning. This keyword makes it easy to position the starting point of the search at a fixed offset from the end of the string.

REVERSE_SEARCH

STRPOS usually starts at *Pos* and moves toward the end of the string looking for a match. If REVERSE_SEARCH is set, the search instead moves towards the beginning of the string.

Examples

Example 1

Find the position of the string “fun” within the string “IDL is fun” and print the result by entering:

```
PRINT, STRPOS('IDL is fun', 'fun')
```

IDL prints:

```
      7
```

Example 2

The REVERSE_SEARCH keyword to the STRPOS function makes it easy to find the last occurrence of a substring within a string. In the following example, we search for the last occurrence of the letter “I” (or “i”) in a sentence:

```
sentence = 'IDL is fun.'
sentence = STRUPCASE(sentence)
lasti = STRPOS(sentence, 'I', /REVERSE_SEARCH)
PRINT, lasti
```

This results in:

```
4
```

Note that although REVERSE_SEARCH tells STRPOS to begin searching from the end of the string, the STRPOS function still returns the position of the search string from the beginning of the string (where 0 is the position of the first character).

See Also

STRMID, STRPUT, STRTRIM

STRPUT

The STRPUT procedure inserts the contents of one string into another. The source string, *Source*, is inserted into the destination string, *Destination*, starting at the given position, *Position*. Characters in *Destination* before the starting position and after the starting position plus the length of *Source* remain unchanged. The length of the destination string is not changed. If the insertion extends past the end of the destination, it is clipped at the end.

Syntax

STRPUT, *Destination*, *Source* [, *Position*]

Arguments

Destination

The named string variable into which *Source* is inserted. *Destination* must be a named variable of type string. If it is an array, *Source* is inserted into every element of the array.

Source

A scalar string to be inserted into *Destination*. If this argument is not a string, it is converted using IDL's default formatting rules.

Position

The character position at which the insertion is begun. If *Position* is omitted, the insertion begins at the first character (character position 0). If *Position* is less than zero, zero is used for the initial position.

Examples

If the variable A contains the string "IBM is fun", the substring "IBM" can be overwritten with the string "IDL" by entering:

```
STRPUT, A, 'IDL', 0
```

The following commands demonstrate the clipping of output that extends past the end of the destination string:

```
STRPUT, A, 'FUNNY', 7
PRINT, A
```

IDL prints:

```
IDL is FUN
```

See Also

STRMID, STRPOS, STRTRIM

STRSPLIT

The STRSPLIT function splits its input *String* argument into separate substrings, according to the specified delimiter or regular expression. By default, the position of the substrings is returned. The EXTRACT keyword can be used to cause STRSPLIT to return an array containing the substrings.

Syntax

Result = STRSPLIT(*String* [, *Pattern*] [, ESCAPE=*string* | , /REGEX [, /FOLD_CASE]] [, /EXTRACT | , LENGTH=*variable*] [, /PRESERVE_NULL])

Arguments

String

A scalar string to be split into substrings.

Pattern

Pattern can contain one of two types of information:

- A string containing the character codes that are considered to be separators. In this case, IDL performs a simple string search for those characters. This method is simple and fast.
- A regular expression, as implemented by the STREGEX function, which is used by IDL to match the separators. This method is slower and more complex, but can handle extremely complicated input strings.

Pattern is an optional argument. If it is not specified, STRSPLIT defaults to splitting on spans of whitespace (space or tab characters) in *String*.

Keywords

ESCAPE

When doing simple pattern matching, the ESCAPE keyword can be used to specify any characters that should be considered to be “escape” characters. Preceding any character with an escape character prevents STRSPLIT from treating it as a separator character even if it is found in *Pattern*.

Note that if the EXTRACT keyword is set, STRSPLIT will automatically remove the escape characters from the resulting substrings. If EXTRACT is not specified,

STRSPLIT cannot perform this editing, and the returned position and offsets will include the escape characters.

For example:

```
print, STRSPLIT('a\,b', ',', ESCAPE='\', /EXTRACT)
```

IDL prints:

```
a,b
```

ESCAPE cannot be specified with the FOLD_CASE or REGEX keywords.

EXTRACT

By default, STRSPLIT returns an array of character offsets into *String* that indicate where the substrings are located. These offsets, along with the lengths available from the LENGTH keyword can be used later with STRMID to extract the substrings. Set EXTRACT to bypass this step, and cause STRSPLIT to return the substrings. EXTRACT cannot be specified with the LENGTH keyword.

FOLD_CASE

Indicates that the regular expression matching should be done in a case-insensitive fashion. FOLD_CASE can only be specified if the REGEX keyword is set, and cannot be used with the ESCAPE keyword.

LENGTH

Set this keyword to a named variable to receive the lengths of the substrings. Together with this result of this function, LENGTH can be used with the STRMID function to extract the matched substrings. The LENGTH keyword cannot be used with the EXTRACT keyword.

PRESERVE_NULL

Normally, STRSPLIT will not return null length substrings unless there are no non-null values to report, in which case STRSPLIT will return a single null string. Set PRESERVE_NULL to cause all null substrings to be returned.

REGEX

For complex splitting tasks, the REGEX keyword can be specified. In this case, *Pattern* is taken to be a regular expression to be matched against *String* to locate the separators. If REGEX is specified and *Pattern* is not, the default *Pattern* is the regular expression:

```
'[ ' + STRING(9B) + ']+'
```

which means “any series of one or more space or tab characters” (9B is the byte value of the ASCII TAB character).

Note that the default *Pattern* contains a space after the [character.

The REGEX keyword cannot be used with the ESCAPE keyword.

Examples

Example 1

To split a string on spans of whitespace and replace them with hyphens:

```
Str = 'STRSPLIT chops up strings.'
print, STRJOIN(STRSPLIT(Str, /EXTRACT), '-')
```

IDL prints:

```
STRSPLIT-chops-up-strings.
```

Example 2

As an example of a more complex splitting task that can be handled with the simple character-matching mode of STRSPLIT, consider a sentence describing different colored ampersand characters. For unknown reasons, the author used commas to separate all the words, and used ampersands or backslashes to escape the commas that actually appear in the sentence (which therefore should not be treated as separators). The unprocessed string looks like:

```
Str = 'There,was,a,red,&&&,,a,yellow,&&\,,and,a,blue,\&.'
```

We use STRSPLIT to break this line apart, and STRJOIN to reassemble it as a standard blank-separated sentence:

```
S = STRSPLIT(Str, ',', ESCAPE='&\', /EXTRACT)
PRINT, STRJOIN(S, ' ')
```

IDL prints:

```
There was a red &, a yellow &, and a blue &.
```

Example 3

Finally, suppose you had a complicated string, in which every token was preceded by the count of characters in that token, with the count enclosed in angle brackets:

```
str = '<4>What<1>a<7>tangled<3>web<2>we<6>weave.'
```

This is too complex to handle with simple character matching, but can be easily handled using the regular expression '<[0-9]+>' to match the separators. This regular

expression can be read as “an opening angle bracket, followed by one or more numeric characters between 0 and 9, followed by a closing angle bracket.” The STRJOIN function is used to glue the resulting substrings back together:

```
S = STRSPLIT(str,'<[0-9]+>',/EXTRACT,/REGEX)
PRINT, STRJOIN(S, ' ')
```

IDL prints:

```
What a tangled web we weave.
```

See Also

STRCMP, STRJOIN, STRMATCH, STREGEX, STRMID, STRPOS

STRTRIM

The STRTRIM function returns a copy of *String* with leading and/or trailing blanks removed.

Syntax

Result = STRTRIM(*String* [, *Flag*])

Arguments

String

The string to have leading and/or trailing blanks removed. If this argument is not a string, it is converted using IDL's default formatting rules. If it is an array, the result is an array with the same structure where each element contains a trimmed copy of the corresponding element of *String*.

Flag

A value that controls the action of STRTRIM. If *Flag* is zero or not present, trailing blanks are removed. Leading blanks are removed if it is equal to 1. Both are removed if it is equal to 2.

Example

Converting variables to string type often results in undesirable leading blanks. For example, the following command converts the integer 56 to string type:

```
C = STRING(56)
```

Entering the command:

```
HELP, C
```

IDL prints:

```
C          STRING = '      56'
```

which shows that there are six leading spaces before the characters 5 and 6. To remove these leading blanks, enter the command:

```
C = STRTRIM(C, 1)
```

To confirm that the blanks were removed, enter:

```
HELP, C
```

IDL prints:

```
C          STRING = '56'
```

See Also

STRMID, STRPOS, STRPUT, STRSPLIT

STRUCT_ASSIGN

The IDL "=" operator is unable to assign a structure value to a structure of a different type. The STRUCT_ASSIGN procedure performs "relaxed structure assignment," which is a field-by-field copy of a structure to another structure. Fields are copied according to the following rules:

1. Any fields found in the destination structure that are not found in the source structure are "zeroed" (set to zero, the empty string, or a null pointer or object reference depending on the type of field).
2. Any fields in the source structure that are not found in the destination structure are quietly ignored.
3. Any fields that are found in both the source and destination structures are copied one at a time. If necessary, type conversion is done to make their types agree. If a field in the source structure has fewer data elements than the corresponding field in the destination structure, then the "extra" elements in the field in the destination structure are zeroed. If a field in the source structure has more elements than the corresponding field in the destination structure, the extra elements are quietly ignored.

Relaxed structure assignment is especially useful when restoring structures from disk files into an environment where the structure definition has changed. See the description o f the RELAXED_STRUCTURE_ASSIGNMENT keyword to the RESTORE procedure for additional details. "Relaxed Structure Assignment" in Chapter 6 of *Building IDL Applications* provides a more in-depth discussion of the structure-definition process.

Syntax

STRUCT_ASSIGN, *Source*, *Destination* [, /NOZERO] [, /VERBOSE]

Arguments

Source

A named variable or element of an array containing a structure, the contents of which will be assigned to the structure specified by the *Destination* argument. *Source* can be an object reference if STRUCT_ASSIGN is called inside an object method.

Destination

A named variable containing a structure into which the contents of the structure specified by the *Source* argument will be inserted. *Destination* can be an object reference if STRUCT_ASSIGN is called inside an object method.

Keywords

NOZERO

Normally, any fields found in the destination structure that are not found in the source structure are zeroed. Set NOZERO to prevent this action and leave the original contents of such fields unchanged.

VERBOSE

Set this keyword to cause STRUCT_ASSIGN to issue informational messages about any incompatibilities that prevent data from being copied.

Examples

The following example creates two anonymous structures, then uses STRUCT_ASSIGN to insert the contents of the first into the second:

```
source = { a:FINDGEN(4), b:12 }
dest = { a:INDGEN(2), c:20 }
STRUCT_ASSIGN, /VERBOSE, source, dest
```

IDL prints:

```
% STRUCT_ASSIGN: <Anonymous> tag A is longer than destination.
                 The end will be clipped.
% STRUCT_ASSIGN: Destination lacks <Anonymous> tag B. Not copied.
```

After assignment, `dest` contains a two-element integer array [0, 1] in its field A and the integer 0 in its field C. Since `dest` does not have a field B, field B from `source` is not copied.

STRUCT_HIDE

The IDL HELP procedure displays information on all known structures or object classes when used with the STRUCTURES or OBJECTS keywords. Although this is usually the desired behavior, authors of large vertical applications or library routines may wish to prevent IDL from displaying information on structures or objects that are not part of their public interface, but which exist solely in support of the internal implementation. The STRUCT_HIDE procedure is used to mark such structures or objects as hidden. Items so marked are not displayed by `HELP, /STRUCTURE` unless the user sets the FULL keyword, but are otherwise unaltered.

Note

STRUCT_HIDE is primarily intended for use with named structures or objects. Although it can be safely used with anonymous structures, there is no visible benefit to doing so as anonymous structures are hidden by default.

Tip

Authors of objects will often place a call to STRUCT_HIDE in the _ _DEFINE procedure that defines the structure.

Syntax

STRUCT_HIDE, Arg_1 [, Arg_2, ..., Arg_n]

Arguments

Arg_1, ..., Arg_n

If an argument is a variable of one of the following types, its underlying structure and/or object definition is marked as being hidden from the HELP procedure's default output:

- Structure
- Pointer that refers to a heap variable of structure type
- Object Reference

Any arguments that are not one of these types are quietly ignored. No change is made to the value of any argument.

Keywords

None

Example

This example shows how a structure can be hidden if an application designer doesn't want end-users to be able to see it, but variables are not hidden. To create a named structure called `bullwinkle` and prevent it from appearing in the HELP procedure's default output, do the following.

```
; Define a variable containing the named structure:
tmp = { bullwinkle, moose:1, squirrel:0 }
; IDL returns BULLWINKLE in addition to the other system variables.
HELP, /STRUCTURE, /BRIEF
; Next, specifically hide the structure using
; the STRUCT_HIDE procedure.
STRUCT_HIDE, tmp
; This time IDL returns the system variables but
; not the BULLWINKLE structure.
HELP, /STRUCTURE, /BRIEF
; IDL returns the variable tmp showing that it is
; a named structure called BULLWINKLE.
HELP, tmp
```

See Also

COMPILE_OPT

STRUPCASE

The STRUPCASE function returns a copy of *String* converted to upper case. Only lowercase characters are modified—uppercase and non-alphabetic characters are copied without change.

Syntax

Result = STRUPCASE(*String*)

Arguments

String

The string to be converted. If this argument is not a string, it is converted using IDL's default formatting rules. If it is an array, the result is an array with the same structure where each element contains an uppercase copy of the corresponding element of *String*.

Example

To print an uppercase version of the string "IDL is fun", enter:

```
PRINT, STRUPCASE('IDL is fun')
```

IDL prints:

```
IDL IS FUN
```

See Also

STRLOWCASE

SURFACE

The SURFACE procedure draws a wire-mesh representation of a two-dimensional array projected into two dimensions, with hidden lines removed.

Restrictions

If the *(X, Y)* grid is not regular or nearly regular, errors in hidden line removal occur. The TRIGRID and TRIANGULATE routines can be used to interpolate irregularly-gridded data points to a regular grid before plotting.

If the T3D keyword is set, the 3D to 2D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur.

The surface lines may blend together when drawing large arrays, especially on low or medium resolution displays. Use the REBIN or CONGRID procedure to resample the array to a lower resolution before plotting.

Syntax

SURFACE, *Z* [, *X*, *Y*] [, AX=*degrees*] [, AZ=*degrees*] [, BOTTOM=*index*] [, /HORIZONTAL] [, /LEGO] [, /LOWER_ONLY | , /UPPER_ONLY] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /SAVE] [, SHADES=*array*] [, SKIRT=*value*] [, /XLOG] [, /YLOG] [, ZAXIS={1 | 2 | 3 | 4}] [, /ZLOG]

Graphics Keywords: Accepts all graphics keywords accepted by PLOT except for: PSYM, SYMSIZE. See "Graphics Keywords Accepted" on page 1370.

Arguments

Z

The two-dimensional array to be displayed. If *X* and *Y* are provided, the surface is plotted as a function of the (*X*, *Y*) locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *Z*.

This argument is converted to double-precision floating-point before plotting. Plots created with SURFACE are limited to the range and precision of double-precision floating-point values.

X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of *X* specifies the X coordinate for a column of *Z*

(e.g., `X[0]` specifies the X coordinate for `Z[0,*]`). If *X* is a two-dimensional array, each element of *X* specifies the X coordinate of the corresponding point in *Z* (X_{ij} specifies the X coordinate for Z_{ij}).

This argument is converted to double-precision floating-point before plotting.

Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of *Y* specifies the Y coordinate for a row of *Z* (e.g., `Y[0]` specifies the Y coordinate for `Z[*,0]`). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in *Z* (Y_{ij} specifies the Y coordinate for Z_{ij}).

This argument is converted to double-precision floating-point before plotting.

Keywords

AX

This keyword specifies the angle of rotation, about the X axis, in degrees towards the viewer. This keyword is effective only if !P.T3D is not set. If !P.T3D is set, the three-dimensional to two-dimensional transformation used by SURFACE is taken from the 4 by 4 array !P.T.

The surface represented by the two-dimensional array is first rotated, AZ (see below) degrees about the Z axis, then by AX degrees about the X axis, tilting the surface towards the viewer (AX > 0), or away from the viewer.

The AX and AZ keyword parameters default to +30 degrees if omitted and !P.T3D is 0.

The three-dimensional to two-dimensional transformation represented by AX and AZ, can be saved in !P.T by including the SAVE keyword.

AZ

This keyword specifies the counterclockwise angle of rotation about the Z axis. This keyword is effective only if !P.T3D is not set. The order of rotation is AZ first, then AX.

BOTTOM

The color index used to draw the bottom surface. If not specified, the bottom is drawn with the same color as the top.

HORIZONTAL

A keyword flag which if set causes SURFACE to only draw lines across the plot perpendicular to the line of sight. The default is for SURFACE to draw both across the plot and from front to back.

LEGO

Set this keyword to produce stacked histogram-style plots. Each data value is rendered as a box covering the XY extent of the cell and with a height proportional to the Z value.

If the *X* and *Y* arguments are specified, only N_x-1 columns and N_y-1 rows are drawn. (This means that the last row and column of array data are not displayed.) The rectangular area covered by $Z[i, j]$ is given by $X[i]$, $X[i+1]$, $Y[j]$, and $Y[j+1]$.

LOWER_ONLY

Set this keyword to draw only the lower surface of the object. By default, both surfaces are drawn.

MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

SAVE

Set this keyword to save the 3D to 2D transformation matrix established by SURFACE in the system variable field !P.T. Use this keyword when combining the output of SURFACE with additional output from other routines in the same plot.

When used with AXIS, the SAVE keyword parameter saves the scaling parameters established by the call in the appropriate axis system variable, !X, !Y, or !Z. This causes subsequent overplots to be scaled to the new axis.

For example, to display a two-dimensional array using SURFACE, and to then superimpose contours over the surface (this example assumes that !P.T3D is zero, its default value.), enter the following commands:

```
; Make a surface plot and save the transformation:
SURFACE, Z, /SAVE

; Make contours, don't erase, use the 3D to 2D transform placed
; in !P.T by SURFACE:
CONTOUR, Z, /NOERASE, /T3D
```

To display a surface and to then display a flat contour plot, registered above the surface:

```
; Make the surface, save transform:
SURFACE, Z, /SAVE

; Now display a flat contour plot, at the maximum Z value
; (normalized coordinates):
CONTOUR, Z, /NOERASE, /T3D, ZVALUE=1.0
```

You can display the contour plot below the surface with by using a ZVALUE of 0.0.

SHADES

This keyword allows user-specified coloring of the mesh surfaces. Set this keyword to an array that specifies the color index of the lines emanating from each data point toward the top and right.

Warning

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting `DEVICE, DECOMPOSED=0`. See "DEVICE" on page 385 and "DECOMPOSED" on page 2322.

SKIRT

This keyword represents a Z-value at which to draw a skirt around the array. The Z value is expressed in data units. The default is no skirt.

If the skirt is drawn, each point on the four edges of the surface is connected to a point on the skirt which has the given Z value, and the same X and Y values as the edge point. In addition, each point on the skirt is connected to its neighbor.

UPPER_ONLY

Set this keyword to draw only the upper surface of the object. By default, both surfaces are drawn.

XLOG

Set this keyword to specify a logarithmic X axis.

YLOG

Set this keyword to specify a logarithmic Yaxis.

ZAXIS

This keyword specifies the placement of the Z axis for the SURFACE plot.

By default, SURFACE draws the Z axis at the upper left corner of the axis box. To suppress the Z axis, use `ZAXIS=-1` in the call. The position of the Z axis is determined from the value of ZAXIS as follows: 1 = lower right, 2 = lower left, 3 = upper left, and 4 = upper right.

ZLOG

Set this keyword to specify a logarithmic Zaxis.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, LINESTYLE, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

Example

```
; Create a simple dataset to display:
D = DIST(30)

; Plot a simple wire-mesh surface representation of D:
SURFACE, D

; Create a wire-mesh plot of D with a title and a "skirt" around
; the edges of the dataset at Z=0:
SURFACE, D, SKIRT=0.0, TITLE = 'Surface Plot', CHARSIZE = 2
```

See Also

CONTOUR, SHADE_SURF

SURFR

The SURFR procedure sets up 3D transformations. This procedure duplicates the rotation, translation, and scaling features of the SURFACE routine, but does not display any data. The resulting transformations are stored in the !P.T system variable.

This routine is written in the IDL language. Its source code can be found in the file `surfr.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

SURFR [, AX=*degrees*] [, AZ=*degrees*]

Keywords

AX

Angle of rotation about the X axis. The default is 30 degrees.

AZ

Angle of rotation about the Z axis. The default is 30 degrees.

See Also

SCALE3, SCALE3D, T3D

SVDC

The SVDC procedure computes the Singular Value Decomposition (SVD) of a square (*n* x *n*) or non-square (*n* x *m*) array as the product of orthogonal and diagonal arrays. SVD is a very powerful tool for the solution of linear systems, and is often used when a solution cannot be determined by other numerical algorithms.

The SVD of an (*m* x *n*) non-square array *A* is computed as the product of an (*m* x *n*) column orthogonal array *U*, an (*n* x *n*) diagonal array *SV*, composed of the singular values, and the transpose of an (*n* x *n*) orthogonal array V: $A = U\ SV\ V^T$

SVDC is based on the routine `svdcmp` described in section 2.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

SVDC, *A*, *W*, *U*, *V* [, /COLUMN] [, /DOUBLE] [, ITMAX=*value*]

Arguments

A

The square (*n* x *n*) or non-square (*n* x *m*) single- or double-precision floating-point array to decompose.

W

On output, *W* is an *n*-element output vector containing the “singular values.”

U

On output, *U* is an *n*-column, *m*-row orthogonal array used in the decomposition of *A*.

V

On output, *V* is an *n*-column, *n*-row orthogonal array used in the decomposition of *A*.

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 30.

Example

To find the singular values of an array A:

```
; Define the array A:
A = [[1.0, 2.0, -1.0, 2.5], $
     [1.5, 3.3, -0.5, 2.0], $
     [3.1, 0.7,  2.2, 0.0], $
     [0.0, 0.3, -2.0, 5.3], $
     [2.1, 1.0,  4.3, 2.2], $
     [0.0, 5.5,  3.8, 0.2]]

; Compute the Singular Value Decomposition:
SVDC, A, W, U, V

; Print the singular values:
PRINT, W
```

IDL prints:

```
8.81973      2.65502      4.30598      6.84484
```

To verify the decomposition, use the relationship A = U ## SV ## TRANSPOSE(V), where SV is a diagonal array created from the output vector W:

```
sv = FLTARR(4, 4)
FOR K = 0, 3 DO sv[K,K] = W[K]
result = U ## sv ## TRANSPOSE(V)
PRINT, result
```

IDL prints:

```
      1.00000      2.00000     -1.00000      2.50000
      1.50000      3.30000    -0.500001      2.00000
      3.10000     0.700000      2.20000      0.00000
  2.23517e-08     0.300000     -2.00000      5.30000
      2.10000     0.999999      4.30000      2.20000
 -3.91155e-07      5.50000      3.80000     0.200000
```

This is the input array, to within machine precision.

See Also

CHOLDC, LUDC, SVSOL

"Linear Systems" in Chapter 16 of *Using IDL*.

SVDFIT

The SVDFIT function performs a least squares fit with optional error estimates and returns a vector of coefficients. Either a user-supplied function written in the IDL language or a built-in polynomial can be used to fit the data.

SVDFIT is based on the routine `svdfit` described in section 15.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SVDFIT(*X*, *Y* [, *M*] [, A=*vector*] [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, FUNCTION_NAME=*string*] [, /LEGENDRE] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, SINGULAR=*variable*] [, VARIANCE=*variable*] [, YFIT=*variable*])

Arguments

X

An n-element vector of independent variables.

Y

A vector of dependent variables, the same length as *X*.

M

The number of coefficients in the fitting function. For polynomials, *M* is equal to the degree of the polynomial + 1. If the *M* argument is not specified, you must supply initial coefficient estimates using the A keyword. In this case, *M* is set equal to the number of elements of the array specified by the A keyword.

Keywords

A

This keyword is both an input and output keyword. Set this keyword equal to a variable containing a vector of initial estimates for the fitted function parameters. On exit, SVDFIT returns in this variable a vector of coefficients that are improvements of the initial estimates. If A is supplied, the *M* argument will be set equal to the number of elements in the vector specified by A.

CHISQ

Set this keyword equal to a named variable that will contain the the value of the chi-sqaure goodness-of-fit.

COVAR

Set this keyword equal to a named variable that will contain the covariance matrix of the fitted coefficients.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

FUNCTION_NAME

Set this keyword equal to a string containing the name of a user-supplied IDL basis function with *M* coefficients. If this keyword is omitted, and the LEGENDRE keyword is not set, IDL assumes that the IDL procedure SVDFUNCT, found in the file `svdfunct.pro`, located in the `lib` subdirectory of the IDL distribution, is to be used. SVDFUNCT uses the basis functions for the fitting polynomial

$$y = \sum_{i=0}^{M} A(i)x^{i}$$

The function to be fit must be written as an IDL function and compiled prior to calling SVDFIT. The function must accept values of *X* (a scalar), and *M* (a scalar). It must return an *M*-element vector containing the basis functions.

See the "Example" section below for an example function.

LEGENDRE

Set this keyword to use Legendre polynomials instead of the function specified by the FUNCTION_NAME keyword. If the LEGENDRE keyword is set, the IDL uses the function SVDLEG found in the file `svdleg.pro`, located in the `lib` subdirectory of the IDL distribution.

MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

Note

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

Note

If MEASURE_ERRORS is omitted, then you are assuming that the polynomial (or your user-supplied model) is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

SINGULAR

Set this keyword equal to a named variable that will contain the number of singular values returned. This value should be 0. If not, the basis functions do not accurately characterize the data.

VARIANCE

Set this keyword equal to a named variable that will contain the variance (sigma squared) of each coefficient *M*.

WEIGHTS

The WEIGHTS keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the WEIGHTS keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword. Note that the definition of the MEASURE_ERRORS keyword is not the same as the WEIGHTS keyword. Using the WEIGHTS keyword, 1/WEIGHTS[i] represents the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error is represented as simply MEASURE_ERRORS[i].

YFIT

Set this keyword equal to a named variable that will contain the vector of calculated *Y* values.

Example

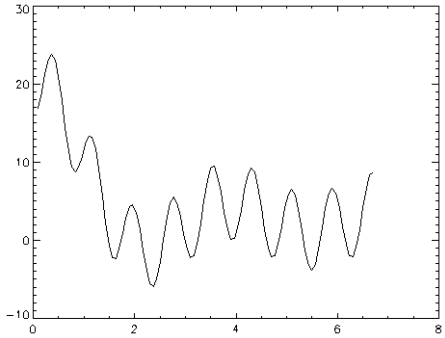
This example fits a function of the following form:

$$F(x) = A(0) + A(1)\sin\frac{(2x)}{x} + A(2)\cos(4x)^2$$

First, create the function in IDL, then create a procedure to perform the fit. Create the following file called `example_svdfit.pro`:

```
PRO example_svdfit

; Provide an array of coefficients:
C = [7.77, 8.88, -9.99]
X = FINDGEN(100)/15.0 + 0.1
Y = C[0] + C[1] * SIN(2*X)/X + C[2] * COS(4.*X)^2.

; Set uncertainties to 5%:
measure_errors = 0.05 * Y

; Provide an initial guess:
A=[1,1,1]
result_a = SVDFIT(X, Y, A=A, MEASURE_ERRORS=measure_errors, $
   FUNCTION_NAME='myfunct', SIGMA=SIGMA, YFIT=YFIT)

; Plot the results:
PLOT, X, YFIT
FOR I = 0, N_ELEMENTS(A)-1 DO $
   PRINT, I, result_a[I], SIGMA[I], C[I],$
   FORMAT = $
   '(" result_a ( ",I1," ) = ",F7.4," +- ",F7.4," VS. ",F7.4)'
END

FUNCTION myfunct, X ,M
   RETURN,[ [1.0], [SIN(2*X)/X], [COS(4.*X)^2.] ]
END
```

Place the file `example_svdfit.pro` in a directory in the IDL search path, and enter `example_svdfit` at the command prompt to create the plot.



In addition to creating the above plot, IDL prints:

```
result_a ( 0 ) =  7.7700 +-  0.0390 VS.  7.7700
result_a ( 1 ) =  8.8800 +-  0.0468 VS.  8.8800
result_a ( 2 ) = -9.9900 +-  0.0506 VS. -9.9900
```

See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, REGRESS, SFIT

SVSOL

The SVSOL function uses “back-substitution” to solve a set of simultaneous linear equations **Ax = b**, given the *U*, *W*, and *V* arrays returned by the SVDC procedure. None of the input arguments are modified, making it possible to call SVSOL multiple times with different right hand vectors, *B*.

SVSOL is based on the routine `svbksb` described in section 2.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = SVSOL(*U*, *W*, *V*, *B* [, /COLUMN] [, /DOUBLE])

Arguments

U

An *n*-column, *m*-row orthogonal array used in the decomposition of *A*. Normally, *U* is returned from the SVDC procedure.

W

An *n*-element vector containing “singular values.” Normally, *W* is returned from the SVDC procedure. Small values (close to machine floating-point precision) should be set to zero prior to calling SVSOL.

V

An *n*-column, *n*-row orthogonal array used in the decomposition of *A*. Normally, *V* is returned from the SVDC procedure.

B

An *m*-element vector containing the right hand side of the linear system **Ax = b**.

Keywords

COLUMN

Set this keyword if the input arrays *U* and *V* are in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To solve the linear system Ax = b using Singular-value decomposition and back substitution, begin with an array A which serves as the coefficient array:

```
; Define the array A:
A = [[1.0, 2.0, -1.0, 2.5], $
     [1.5, 3.3, -0.5, 2.0], $
     [3.1, 0.7,  2.2, 0.0], $
     [0.0, 0.3, -2.0, 5.3], $
     [2.1, 1.0,  4.3, 2.2], $
     [0.0, 5.5,  3.8, 0.2]]

; Define the right-hand side vector B:
B = [0.0, 1.0, 5.3, -2.0, 6.3, 3.8]

; Decompose A:
SVDC, A, W, U, V

; Compute the solution and print the result:
PRINT, SVSOL(U, W, V, B)
```

IDL prints:

```
1.00095   0.00881170     0.984176   -0.0100954
```

This is the correct solution.

See Also

CRAMER, GS_ITER, LU_COMPLEX, CHOLSOL, LUSOL, SVDC, TRISOL

SWAP_ENDIAN

The SWAP_ENDIAN function reverses the byte ordering of arbitrary scalars, arrays or structures. It can make “big endian” number “little endian” and vice-versa. Note that the BYTEORDER procedure can be used to reverse the byte ordering of *scalars and arrays* (SWAP_ENDIAN also allows structures).

SWAP_ENDIAN returns values of the same type and structure as the input value, with the pertinent bytes reversed.

This routine is written in the IDL language. Its source code can be found in the file `swap_endian.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = SWAP_ENDIAN(*Variable*)

Arguments

Variable

The named variable—scalar, array, or structure—to be swapped.

Example

```
; Reverse the byte order of A:
A = SWAP_ENDIAN(A)
```

See Also

BYTEORDER

SWITCH

The SWITCH statement is used to select one statement for execution from multiple choices, depending upon the value of the expression following the word SWITCH.

Each statement that is part of a SWITCH statement is preceded by an expression that is compared to the value of the SWITCH expression. SWITCH executes by comparing the SWITCH expression with each selector expression in the order written. If a match is found, program execution jumps to that statement and execution continues from that point. Whereas CASE executes at most one statement within the CASE block, SWITCH executes the first matching statement and any following statements in the SWITCH block. Once a match is found in the SWITCH block, execution falls through to any remaining statements. For this reason, the BREAK statement is commonly used within SWITCH statements to force an immediate exit from the SWITCH block.

The ELSE clause of the SWITCH statement is optional. If included, it matches any selector expression, causing its code to be executed. For this reason, it is usually written as the last clause in the switch statement. The ELSE statement is executed only if none of the preceding statement expressions match. If an ELSE clause is not included and none of the values match the selector, program execution continues immediately below the SWITCH without executing any of the SWITCH statements.

SWITCH is similar to the CASE statement. For more information on using SWITCH and other IDL program control statements, as well as the differences between SWITCH and CASE, see Chapter 11, “Program Control” in *Building IDL Applications*.

Syntax

SWITCH *expression* OF

expression: *statement*

...

expression: *statement*

ELSE: *statement*

ENDSWITCH

Example

This example illustrates how, unlike CASE, SWITCH executes the first matching statement and any following statements in the SWITCH block:

```
x=2

SWITCH x OF
   1: PRINT, 'one'
   2: PRINT, 'two'
   3: PRINT, 'three'
   4: PRINT, 'four'
ENDSWITCH
```

IDL Prints:

```
two
three
four
```

See Also

CASE

SYSTIME

The SYSTIME function returns the current time as either a date/time string, as the number of seconds elapsed since 1 January 1970, or as a Julian date/time value.

Syntax

String = SYSTIME([0 [, *ElaspedSeconds*]] [, /UTC])

or

Seconds = SYSTIME(1 | /SECONDS)

or

Julian = SYSTIME(/JULIAN [, /UTC])

Arguments

SecondsFlag

If *SecondsFlag* is present and nonzero, the number of seconds elapsed since 1 January 1970 UTC is returned as a double-precision, floating-point value.

Otherwise, if *SecondsFlag* is not present or zero, a scalar string containing the date/time is returned in standard 24-character system format as follows:

```
DOW MON DD HH:MM:SS YEAR
```

where DOW is the day of the week, MON is the month, DD is the day of the month, HH is the hour, MM is the minute, SS is the second, and YEAR is the year. By default, the date/time string is adjusted for the local time zone; use the UTC keyword to override this default.

Note

If the JULIAN or SECONDS keyword is set, the *SecondsFlag* argument is ignored.

ElapsedSeconds

If the *SecondsFlag* argument is zero, the *ElapsedSeconds* argument may be set to the number of seconds past 1 January 1970 UTC. In this case, SYSTIME returns the corresponding date/time string (rather than the string for the current time). The returned date/time string is adjusted for the local time zone, unless the UTC keyword is set. If this argument is present, the JULIAN keyword is not allowed.

Keywords

JULIAN

Set this keyword to specify that the current time is to be returned as a a double precision floating value containing the current Julian date/time. By default, the current time is adjusted for the local time zone; use the UTC keyword to override this default. This keyword is not allowed if the *ElapsedSeconds* argument is present.

Note

If the JULIAN keyword is set, a small offset is added to the returned Julian date to eliminate roundoff errors when calculating the day fraction from hours, minutes, and seconds. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date, and EPS is the EPS field from MACHAR. For typical Julian dates, this offset is approximately $6x10^{-10}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that if the Julian date is converted back to hour, minute, and second, then the hour, minute, and second will have the same integer values as were originally input.

SECONDS

Set this keyword to specify that the current time is to be returned as the number of seconds elapsed since 1 January 1970 UTC. This option is equivalent to setting the *SecondsFlag* argument to a non-zero value.

UTC

Set this keyword to specify that the value returned by SYSTIME is to be returned in Universal Time Coordinated (UTC) rather than being adjusted for the current time zone. UTC time is defined as Greenwich Mean Time updated with leap seconds.

Examples

Print today’s date as a string:

```
PRINT, SYSTIME()
```

Print today’s date as a string in UTC (rather than local time zone):

```
PRINT, SYSTIME(/UTC)
```

Print today’s date as a Julian date/time value in UTC:

```
PRINT, SYSTIME(/JULIAN, /UTC), FORMAT='(f12.2)'
```

Compute the seconds elapsed since 1 January 1970 UTC:

```
seconds = SYSTIME(1) ; or seconds = SYSTIME(/SECONDS)
```

Verify that the seconds from the previous example are correct:

```
PRINT, SYSTIME(0, seconds)
```

Print the day of the week:

```
PRINT, STRMID(SYSTIME(0), 0, 3)
```

Compute the time required to perform a 16,384 point FFT:

```
T = SYSTIME(1)
A = FFT(FINDGEN(16384), -1)
PRINT, SYSTIME(1) - T, 'Seconds'
```

See Also

CALDAT, CALENDAR, JULDAY, TIMEGEN

T_CVF

The T_CVF function computes the cutoff value *V* in a Student's t distribution with *Df* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `t_cvf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = T_CVF(*P*, *Df*)

Arguments

P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

Df

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the Student's t distribution.

Example

Use the following command to compute the cutoff value in a Student's t distribution with five degrees of freedom such that the probability that a random variable X is greater than the cutoff value is 0.025.

```
result = T_CVF(0.025, 5)
PRINT, result
```

IDL prints:

```
2.57058
```

See Also

CHISQR_CVF, F_CVF, GAUSS_CVF, T_PDF

T_PDF

The T_PDF function computes the probability *P* that, in a Student's t distribution with *Df* degrees of freedom, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `t_pdf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = T_PDF(*V*, *Df*)

Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *V* and *Df*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

Arguments

V

A scalar or array that specifies the cutoff value(s).

Df

A scalar or array that specifies the number of degrees of freedom of the Student's t distribution.

Example

Use the following command to compute the probability that a random variable X, from the Student's t distribution with 15 degrees of freedom, is less than or equal to 0.691:

```
PRINT, T_PDF(0.691, 15)
```

IDL prints:

```
0.749940
```

See Also

BINOMIAL, CHISQR_PDF, F_PDF, GAUSS_PDF, T_CVF

T3D

The T3D procedure implements three-dimensional transforms.

This routine accumulates one or more sequences of translation, scaling, rotation, perspective, and oblique transformations and stores the result in !P.T, the 3D transformation system variable. All the IDL graphic routines use this (4,4) matrix for output. Note that !P.T3D is *not* set, so for the transformations to have effect you must set !P.T3D = 1 (or set the T3D keyword in subsequent calls to graphics routines).

This procedure is based on that of Foley & Van Dam, *Fundamentals of Interactive Computer Graphics*, Chapter 8, "Viewing in Three Dimensions". The matrix notation is reversed from the normal IDL sense, i.e., here, the first subscript is the column, the second is the row, in order to conform with this reference.

A right-handed system is used. Positive rotations are counterclockwise when looking from a positive axis position towards the origin.

This routine is written in the IDL language. Its source code can be found in the file `t3d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

T3D [, *Array* | , /RESET] [, MATRIX=*variable*] [, OBLIQUE=*vector*]
[, PERSPECTIVE=*p*{eye at (0,0,*p*)}] [, ROTATE=*[x, y, z]*] [, SCALE=*[x, y, z]*]
[, TRANSLATE=*[x, y, z]*] [, /XYEXCH | , /XZEXCH | , /YZEXCH]

Arguments

Array

An optional 4 x 4 matrix used as the starting transformation. If *Array* is missing, the current !P.T transformation is used. *Array* is ignored if /RESET is set.

Keywords

The transformation specified by each keyword is performed in the order of their descriptions below (e.g., if both TRANSLATE and SCALE are specified, the translation is done first).

MATRIX

Set this keyword to a named variable that will contain the result. If this keyword is specified, !P.T is not modified.

OBLIQUE

A two-element vector of oblique projection parameters. Points are projected onto the XY plane at Z=0 as follows:

```
x' = x + z(d * COS(a))
y' = y + z(d * SIN(a))
```

where OBLIQUE[0] = d and OBLIQUE[1] = a.

PERSPECTIVE

Perspective transformation. This parameter is a scalar (p) that indicates the Z distance of the center of the projection. Objects are projected into the XY plane at Z=0, and the “eye” is at point (0,0,p).

RESET

Set this keyword to reset the transformation to the default identity matrix.

ROTATE

A three-element vector of the rotations, in DEGREES, about the X, Y, and Z axes. Rotations are performed in the order of X, Y, and then Z.

SCALE

A three-element vector of scale factors for the X, Y, and Z axes.

TRANSLATE

A three-element vector of the translations in the X, Y, and Z directions.

XYEXCH

Set this keyword to exchange the X and Y axes.

XZEXCH

Set this keyword to exchange the X and Z axes.

YZEXCH

Set this keyword to exchange the Y and Z axes.

Examples

To reset the transformation, rotate 30 degs about the X axis and do perspective transformation with the center of the projection at Z = -1, X=0, and Y=0, enter:

```
T3D, /RESET, ROT = [ 30,0,0], PERS = 1.
```

Transformations may be cascaded, for example:

```
T3D, /RESET, TRANS = [-.5,-.5,0], ROT = [0,0,45]
T3D, TRANS = [.5,.5,0]
```

The first command resets, translates the point (.5,.5,0) to the center of the viewport, then rotates 45 degrees counterclockwise about the Z axis. The second call to T3D moves the origin back to the center of the viewport.

See Also

SCALE3, SCALE3D, SURFR

TAG_NAMES

The TAG_NAMES function returns a string array containing the names of the tags in a structure expression. It can also be used to determine the expression's structure name (if the structure has a name).

Syntax

Result = TAG_NAMES(*Expression* [, /STRUCTURE_NAME])

Arguments

Expression

The structure expression for which the tag names are returned. This argument must be of structure type. TAG_NAMES does not search for tags recursively, so if *Expression* is a structure containing nested structures, only the names of tags in the outermost structure are returned.

Keywords

STRUCTURE_NAME

Set this keyword to return a scalar string that contains the name of the structure instead of the names of the tags in the structure. If the structure is "anonymous", a null string is returned.

Example

Print the names of the tags in the system variable !P by entering:

```
PRINT, TAG_NAMES(!P)
```

IDL prints:

```
BACKGROUND CHARSIZE CHARTHICK CLIP COLOR FONT LINESTYLE MULTI
NOCLIP NOERASE NSUM POSITION PSYM REGION SUBTITLE SYMSIZE T
T3D THICK TITLE TICKLEN CHANNEL
```

Print the name of the structure in the system variable !P:

```
PRINT, TAG_NAMES(!P, /STRUCTURE_NAME)
```

IDL prints:

```
!PLT
```

See Also

CREATE_STRUCT, N_TAGS

TAN

The TAN function returns the tangent of *X*.

Syntax

Result = TAN(*X*)

Arguments

X

The angle for which the tangent is desired, specified in radians. If *X* is double-precision floating-point, the result is of the same type. Complex values are not allowed. All other types are converted to single-precision floating-point and yield floating-point results. If *X* is an array, the result has the same structure, with each element containing the tangent of the corresponding element of *X*.

Example

```
; Find the tangent of 0.5 radians and store the result in
; the variable T:
T = TAN(0.5)
```

See Also

ATAN, TANH

TANH

The TANH function returns the hyperbolic tangent of X.

Syntax

Result = TANH(*X*)

Arguments

X

The value for which the hyperbolic tangent is desired, specified in radians. If *X* is double-precision floating-point, the result is also double-precision. Complex values are not allowed. All other types are converted to single-precision floating-point and yield floating-point results. TANH is defined as:

$$\tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic tangent of the corresponding element of *X*.

Example

```
; Find the hyperbolic tangent of 1 radian and print the result:
PRINT, TANH(1)

; Plot the hyperbolic tangent from -5 to +5 with an increment
; of 0.1:
PLOT, TANH(FINDGEN(101)/10. - 5)
```

See Also

ATAN, TAN

TAPRD

The TAPRD procedure reads the next record on the selected tape unit into the specified array. TAPRD is available only under VMS. No data or format conversion, with the exception of optional byte reversal, is performed. The array must be defined with the desired type and dimensions. If the read is successful, the system variable !ERR is set to the number of bytes read. See the description of the magnetic tape routines in "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

Syntax

TAPRD, *Array*, *Unit* [, *Byte_Reverse*]

Arguments

Unit

The magnetic tape unit to read. This argument must be a number between 0 and 9, and should not be confused with standard file Logical Unit Numbers (LUN's).

Array

A named variable into which the data is read. If *Array* is larger than the tape record, the extra elements of the array are not changed. If the array is shorter than the tape record, a data overrun error occurs. The length of *Array* and the records on the tape can range from 14 bytes to 65,235 bytes.

Byte_Reverse

If this parameter is present, the even and odd numbered bytes are swapped after reading, regardless of the type of data or variables. This enables reading tapes containing short integers that were written on machines with different byte ordering. You can also use the BYTORDER routine to re-order different data types.

See Also

TAPWRT

TAPWRT

The TAPWRT procedure writes data from the *Array* parameter to the selected tape unit. TAPWRT is available only under VMS. One physical record containing the same number of bytes as the array is written each time TAPWRT is called. The parameters and usage are identical to those in the TAPRD procedure with the exception that here the *Array* parameter can be an expression. Consult the TAPRD procedure for details. See the description of the magnetic tape routines in "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

Syntax

TAPWRT, *Array*, *Unit* [, *Byte_Reverse*]

Arguments

Unit

The magnetic tape unit to write. This argument must be a number between 0 and 9, and should not be confused with standard file Logical Unit Numbers (LUNs).

Array

The expression representing the data to be output. The length of *Array* and the records on the tape can range from 14 bytes to 65,235 bytes.

Byte_Reverse

If this parameter is present, the even and odd numbered bytes are swapped on output, regardless of the type of data or variables. This enables writing tapes that are compatible with other machines.

See Also

TAPRD

TEK_COLOR

The TEK_COLOR procedure loads a 32-color colortable similar to the default Tektronix 4115 colortable. This colortable is useful because of its distinct colors.

By default, this palette consists of 32 colors. The first 9 colors are: Index 0=black, 1=white, 2=red, 3=green, 4=blue, 5=cyan, 6=magenta, 8=orange.

Syntax

TEK_COLOR [, *Start_Index*, *Colors*]

Arguments

Start_Index

An optional starting index for the palette. The default is 0. If this argument is included, the colors are loaded into the current colortable starting at the specified index.

Colors

The number of colors to load. The default is 32, which is also the maximum.

See Also

LOADCT, XLOADCT

TEMPORARY

The TEMPORARY function returns a temporary copy of a variable, and sets the original variable to “undefined”. This function can be used to conserve memory when performing operations on large arrays, as it avoids making a new copy of results that are only temporary. In general, the TEMPORARY routine can be used to advantage whenever a variable containing an array on the left hand side of an assignment statement is also referenced on the right hand side.

Syntax

Result = TEMPORARY(*Variable*)

Arguments

Variable

The variable to be referenced and deleted.

Example

Assume the variable `A` is a large array. The statement:

```
A = A + 1
```

creates a new array for the result of the addition, places the sum into the new array, assigns it to a, and then frees the old allocation of a. Total storage required is twice the size of a. The statement:

```
A = TEMPORARY(A) + 1
```

requires no additional space.

See Also

DELVAR

TETRA_CLIP

The TETRA_CLIP function clips a tetrahedral mesh to an arbitrary plane in space and returns a tetrahedral mesh of the remaining portion. An auxiliary array of data may also be passed and clipped. This array can have multiple values for each vertex (the trailing array dimension must match the number of vertices in the Vertsin array).

A tetrahedral connectivity array consists of groups of four vertex index values. Each set of four index values specifies four vertices which define a single tetrahedron.

Syntax

Result = TETRA_CLIP (*Plane*, *Vertsin*, *Connin*, *Vertsout*, *Connout*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*]
[, CUT_VERTS=*variable*])

Return Value

The return value is the number of tetrahedra returned.

Arguments

Plane

Input four-element array describing the equation of the plane to be clipped to. The elements are the coefficients (*a*,*b*,*c*,*d*) of the equation *ax+by+cz+d=0*.

Vertsin

Input array of tetrahedral vertices [3, *n*].

Connin

Input tetrahedral mesh connectivity array.

Vertsout

Output array of tetrahedral vertices [3, *n*].

Connout

Output tetrahedral mesh connectivity array.

Keywords

AUXDATA_IN

Input array of auxiliary data. If present, these values are interpolated and returned through AUXDATA_OUT. The trailing array dimension must match the number of vertices in the Vertsin array.

AUXDATA_OUT

Set this keyword to a named variable to contain an output array of interpolated auxiliary data.

CUT_VERTS

Set this keyword to a named variable to contain an output array of vertex indices (into Vertsout) of the vertices which are considered to be ‘on’ the clipped surface.

TETRA_SURFACE

The TETRA_SURFACE function extracts a polygonal mesh as the exterior surface of a tetrahedral mesh. The output of this function is a polygonal mesh connectivity array that can be used with the input Verts array to display the outer surface of the tetrahedral mesh.

Syntax

Result = TETRA_SURFACE (*Verts*, *Connin*)

Return Value

Returns a polygonal mesh connectivity array. When used with the input vertex array, this function yields the exposed tetrahedral mesh surface.

Arguments

Verts

Array of vertices [3, *n*].

Connin

Tetrahedral connectivity array.

TETRA_VOLUME

The TETRA_VOLUME function computes properties of a tetrahedral mesh array. The basic property is the volume. An auxiliary data array may be supplied which specifies weights at each vertex which are interpolated through the volume during integration. Higher order moments (with respect to the X, Y, and Z axis) may be computed as well (with or without weights).

Syntax

Result = TETRA_VOLUME (*Verts*, *Conn* [, AUXDATA=*array*] [, MOMENT=*variable*])

Return Value

Returns the cumulative (weighted) volume of the tetrahedrons in the mesh.

Arguments

Verts

Array of vertices [3, *n*].

Conn

Tetrahedral connectivity array.

Keywords

AUXDATA

Array of input auxiliary data (one value per vertex). If present, these values are used to weight a vertex. The volume area integral will linearly interpolate these values. The volume integral will linearly interpolate these values within each tetrahedra. The default weight is 1.0 which results in a basic volume.

MOMENT

Set this keyword to a named variable that will contain a three-element float vector which corresponds to the first order moments computed with respect to the X, Y and Z axis. The computation is:

$$\vec{m} = \sum_{ntetras} v_i \vec{c}_i$$

where v is the (weighted) volume of the tetrahedron and c is the centroid of the tetrahedron, thus

$$\vec{m}/volume$$

yields the (weighted) centroid of the tetrahedral mesh.

THIN

The THIN function returns the “skeleton” of a bi-level image. The skeleton of an object in an image is a set of lines that reflect the shape of the object. The set of skeletal pixels can be considered to be the medial axis of the object. For a much more extensive discussion of skeletons and thinning algorithms, see *Algorithms for Graphics and Image Processing*, Theo Pavlidis, Computer Science Press, 1982. The THIN function is adapted from Algorithm 9.1 (the classical thinning algorithm).

On input, the bi-level image is a rectangular array in which pixels that compose the object have a nonzero value. All other pixels are zero. The result is a byte type image in which skeletal pixels are set to 2 and all other pixels are zero.

Syntax

Result = THIN(*Image* [, /NEIGHBOR_COUNT] [, /PRUNE])

Arguments

Image

The two-dimensional image (array) to be thinned.

Keywords

NEIGHBOR_COUNT

Set this keyword to select an alternate form of output. In this form, output pixel values count the number of neighbors an individual skeletal pixel has (including itself). For example, a pixel that is part of a line will have the value 3 (two neighbors and itself). Terminal pixels will have the value 2, while isolated pixels have the value 1.

PRUNE

If the PRUNE keyword is set, pixels with single neighbors are removed iteratively until only pixels with 2 or more neighbors exist. This effectively removes (or “prunes”) skeleton branches, leaving only closed paths.

Example

The following commands display the “thinned” edges of a Sobel filtered image:

```
; Open a file for reading:
```

```
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; Create a byte array in which to store the image:
A = BYTARR(192, 192)

; Read first 192 by 192 image:
READU, 1, A

; Close the file:
CLOSE, 1

; Display the image:
TV, A, 0

; Apply the Sobel filter, threshold the image at value 75, and
; display the thinned edges:
TVSCL, THIN(SOBEL(A) GT 75), 1
```

See Also

ROBERTS, SOBEL

THREED

The THREED procedure plots a 2D array as a pseudo 3D plot. The orientation of the data is fixed. This routine is written in the IDL language. Its source code can be found in the file `threed.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

THREED, *A* [, *Sp*] [, TITLE=*string*] [, XTITLE=*string*] [, YTITLE=*string*]

Arguments

A

The two-dimensional array to plot.

Sp

The spacing between plot lines. If *Sp* is omitted, the spacing is set to: (MAX(*A*)-MIN(*A*))/ROWS. If *Sp* is negative, hidden lines are not removed.

Keywords

TITLE

Set this keyword to the main plot title.

XTITLE

Set this keyword to the X axis title.

YTITLE

Set this keyword to the Y axis title.

Example

```
; Create a 2D dataset:
A = -SHIFT(DIST(30), 15, 15)
; Make a THREED plot:
THREED, A
; Compare to SURFACE:
SURFACE, A
```

See Also

SURFACE

TIME_TEST2

The TIME_TEST2 procedure is a general-purpose IDL benchmark program that performs approximately 20 common operations and prints the time required.

This routine is written in the IDL language. Its source code can be found in the file `time_test.pro` in the `lib` subdirectory of the IDL distribution. This file also contains the procedure GRAPHICS_TIMES, used to time graphical operations.

Syntax

TIME_TEST2 [, *Filename*]

Arguments

Filename

An optional string that contains the name of output file for the results of the time test.

Example

```
; Run the computational tests:
TIME_TEST2

; Run the graphics tests. Note that TIME_TEST2 must be compiled
; before GRAPHICS_TIMES will run:
GRAPHICS_TIMES
```

See Also

SYSTIME

TIMEGEN

The TIMEGEN function returns an array, with specified dimensions, of double-precision floating-point values that represent times in terms of Julian dates.

The Julian date is the number of days elapsed since Jan. 1, 4713 B.C.E., plus the time expressed as a day fraction. Following the astronomical convention, the day is defined to start at 12 PM (noon). Julian date 0.0d is therefore Jan. 1, 4713 B.C.E. at 12:00:00.

The first value of the returned array corresponds to a Julian date start time, and each subsequent value corresponds to the next Julian date in the sequence. The sequence is determined by specifying the time unit (such as months or seconds) and the step size, or spacing, between the units. You can also construct more complicated arrays by including smaller time units within each major time interval.

A small offset is added to each Julian date to eliminate roundoff errors when calculating the day fraction from the hour, minute, second. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date and EPS is the double-precision floating-point precision parameter from MACHAR. For typical Julian dates the offset is approximately $6x10^{-10}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that when the Julian date is converted back to the hour, minute, and second, the hour, minute, and second will have the same integer values.

Tip

Because of the large magnitude of the Julian date (1 Jan 2000 is Julian day 2451545), the precision of most Julian dates is limited to 1 millisecond (0.001 seconds). If you are not interested in the date itself, you can improve the precision by subtracting a large offset or setting the START keyword to zero.

Note

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

Syntax

Result = TIMEGEN([*D1*,...,*D8* | , FINAL=*value*] [, DAYS=*vector*] [, HOURS=*vector*] [, MINUTES=*vector*] [, MONTHS=*vector*] [, SECONDS=*vector*] [, START=*value*] [, STEP_SIZE=*value*] [, UNITS=*string*] [, YEAR=*value*])

Arguments

D_i

The dimensions of the result. The dimension parameters may be any scalar expression. Up to eight dimensions may be specified. If the dimension arguments are not integer values, IDL will truncate them to integer values before creating the new array. The dimension arguments are required unless keyword FINAL is set, in which case they are ignored.

Keywords

DAYS

Set this keyword to a scalar or a vector giving the day values that should be included within each month. This keyword is ignored if the UNITS keyword is set to “Days”, “Hours”, “Minutes”, or “Seconds”.

Note

Day values that are beyond the end of the month will be set equal to the last day for that month. For example, setting `DAY=[31]` will automatically return the last day in each month.

FINAL

Set this keyword to a double-precision value representing the Julian date/time to use as the last value in the returned array. In this case, the dimension arguments are ignored and *Result* is a one-dimensional array, with the number of elements depending upon the step size. The FINAL time may be less than the START time, in which case STEP_SIZE should be negative.

Note

If the step size is not an integer then the last element may not be equal to the FINAL time. In this case, TIMEGEN will return enough elements such that the last element is less than or equal to FINAL.

HOURS

Set this keyword to a scalar or a vector giving the hour values that should be included within each day. This keyword is ignored if UNITS is set to “Hours”, “Minutes”, or “Seconds”.

MINUTES

Set this keyword to a scalar or a vector giving the minute values that should be included within each hour. This keyword is ignored if UNITS is set to “Minutes” or “Seconds”.

MONTHS

Set this keyword to a scalar or a vector giving the month values that should be included within each year. This keyword is ignored if UNITS is set to “Months”, “Days”, “Hours”, “Minutes”, or “Seconds”.

SECONDS

Set this keyword to a scalar or a vector giving the second values that should be included within each minute. This keyword is ignored if UNITS is set to “Seconds”.

START

Set this keyword to a double-precision value representing the Julian date/time to use as the first value in the returned array. The default is 0.0d [corresponding to January 1, 4713 B.C.E. at 12 pm (noon)].

Note

If subintervals are provided by MONTHS, DAYS, HOURS, MINUTES, or SECONDS, then the first element may not be equal to the START time. In this case the first element in the returned array will be greater than or equal to START.

Tip

Other array generation routines in IDL (such as FINDGEN) do not allow you to specify a starting value because the resulting array can be added to a scalar representing the start value. For TIMEGEN it is correct to add a scalar to the array if the units are days, hours, minutes, seconds, or sub-seconds. For example:

```
MyTimes = TIMEGEN(365, UNITS="Days") + SYSTIME(/JULIAN)
```

However, if the units are months or years, the start value is necessary because the number of days in a month or year can vary depending upon the year in which they fall (for instance, consider leap years). For example:

```
MyTimes = TIMEGEN(12, UNITS="Months", START=JULDAY(1,1,2000))
```

STEP_SIZE

Set this keyword to a scalar value representing the step size between the major intervals of the returned array. The step size may be negative. The default step size is 1. When the UNITS keyword is set to “Years” or “Months”, the STEP_SIZE value is rounded to the nearest integer.

UNITS

Set this keyword to a scalar string indicating the time units to be used for the major intervals for the generated array. Valid values include:

- “Years” or “Y”
- “Months” or “M”
- “Days” or “D”
- “Hours” or “H”
- “Minutes” or “I”
- “Seconds” or “S”

The case (upper or lower) is ignored. If this keyword is not specified, then the default for UNITS is the time unit that is larger than the largest keyword present:

Largest Keyword Present	Default UNITS
SECONDS=*vector*	“Minutes”
MINUTES=*vector*	“Hours”
HOURS=*vector*	“Days”
DAYS=*vector*	“Months”
MONTHS=*vector*	“Years”
YEAR=*value*	“Years”

Table 89: Defaults for the UNITS keyword

If none of the above keywords are present, the default is UNITS=“Days”.

YEAR

Set this keyword to a scalar giving the starting year. If YEAR is specified then the starting year from START is ignored.

Examples

- Generate an array of 366 time values that are one day apart starting with January 1, 2000:

```
MyDates = TIMEGEN(366, START=JULDAY(1,1,2000))
```

- Generate an array of 20 time values that are 12 hours apart starting with the current time:

```
MyTimes = TIMEGEN(20, UNITS='Hours', STEP_SIZE=12, $
   START=SYSTIME(/JULIAN))
```

- Generate an array of time values that are 1 hour apart from 1 January 2000 until the current time:

```
MyTimes = TIMEGEN(START=JULDAY(1,1,2000), $
   FINAL=SYSTIME(/JULIAN), UNITS='Hours')
```

- Generate an array of time values composed of seconds, minutes, and hours that start from the current hour:

```
MyTimes = TIMEGEN(60, 60, 24, $
   START=FLOOR(SYSTIME(/JULIAN)*24)/24d, UNITS='S')
```

- Generate an array of 24 time values with monthly intervals, but with subintervals at 5 PM on the first and fifteenth of each month:

```
MyTimes = TIMEGEN(24, START=FLOOR(SYSTIME(/JULIAN)), $
   DAYS=[1,15], HOURS=17)
```

See Also

"Format Codes" in Chapter 8 of Building IDL Applications, CALDAT, JULDAY, LABEL_DATE, SYSTIME

TM_TEST

The TM_TEST function computes the Student's T-statistic and the probability that two sample populations *X* and *Y* have significantly different means. *X* and *Y* may be of different lengths. The result is a two-element vector containing the T-statistic and its significance. The significance is a value in the interval [0.0, 1.0]; a small value (0.05 or 0.01) indicates that *X* and *Y* have significantly different means. The default assumption is that the data is drawn from populations with the same true variance. This type of test is often referred to as the t-means test.

The T-statistic for sample populations *x* and *y* with means $\bar{x}$ and $\bar{y}$ is defined as:

$$T = \frac{\bar{x} - \bar{y}}{\sqrt{\left(\sum_{j=0}^{N-1} (x_i - \bar{x})^2 + \sum_{j=0}^{M-1} (y_i - \bar{y})^2\right) \left(\frac{1}{N} + \frac{1}{M}\right)}{(N + M - 2)}}}$$

where $x = (x_0, x_1, x_2, ..., x_{N-1})$ and $y = (y_0, y_1, y_2 ..., y_{M-1})$

This routine is written in the IDL language. Its source code can be found in the file `tm_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TM_TEST(*X*, *Y* [, /PAIRED] [, /UNEQUAL])

Arguments

X

An *n*-element integer, single-, or double-precision floating-point vector.

Y

An *m*-element integer, single-, or double-precision floating-point vector. If the PAIRED keyword is set, *X* and *Y* must have the same number of elements.

Keywords

PAIRED

If this keyword is set, *X* and *Y* are assumed to be paired samples and must have the same number of elements.

UNEQUAL

If this keyword is set, *X* and *Y* are assumed to be from populations with unequal variances.

Example

```
; Define two n-element sample populations.
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
     305, 270, 260, 251, 275, 288, 242, 304, 267]
Y = [201, 56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
     271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute the Student's t-statistic and its significance assuming
; that X and Y belong to populations with the same true variance:
PRINT, TM_TEST(X, Y)
```

IDL prints:

```
5.52839  2.52455e-06
```

The result indicates that *X* and *Y* have significantly different means.

See Also

FV_TEST, KW_TEST, RS_TEST, S_TEST

TOTAL

The TOTAL function returns the sum of the elements of *Array*. The sum of the array elements over a given dimension is returned if the *Dimension* argument is present.

Syntax

Result = TOTAL(*Array* [, *Dimension*] [, /CUMULATIVE] [, /DOUBLE] [, /NAN])

Arguments

Array

The array to be summed. This array can be of any basic type except string. If *Array* is double-precision floating-point, complex, or double-precision complex, the result is of the same type. Otherwise, the result is single-precision floating-point.

Dimension

The dimension over which to sum, starting at one. If this argument is not present or zero, the scalar sum of all the array elements is returned. If this argument is present, the result is an array with one less dimension than *Array*. For example, if the dimensions of *Array* are N_1, N_2, N_3, and *Dimension* is 2, the dimensions of the result are (N_1, N_3), and element *(i,j)* of the result contains the sum:

$$\sum_{k=0}^{N_2-1} A_{i,k,j}$$

Keywords

CUMULATIVE

If this keyword is set, the result is an array of the same size as the input, with each element, i, containing the sum of the input array elements 0 to i. This keyword also works with the Dimension parameter, in which case the sum is performed over the given dimension.

DOUBLE

Set this keyword to perform the summation in double-precision floating-point.

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

Example 1

This example sums the elements of a one-dimensional array:

```
; Define a one-dimensional array:
A = [20, 10, 5, 5, 3]

; Sum the elements of the array:
SUMA = TOTAL([20, 10, 5, 5, 3])

; Print the results:
PRINT, 'A = ', A
PRINT, 'Sum of A = ', SUMA
```

IDL prints:

```
A =   20   10   5   5   3
Sum of A =   43.0000
```

Example 2

The results are different when a multi-dimensional array is used:

```
; Define a multi-dimensional array:
A = FINDGEN(5,5)

; Sum each of the rows in A:
SUMROWS = TOTAL(A, 1)

; Sum each of the columns in A:
SUMCOLS = TOTAL(A, 2)

; Print the results:
PRINT, 'A = ', A
PRINT, 'Sum of each row:', SUMROWS
PRINT, 'Sum of each column:', SUMCOLS
```

IDL prints:

```
A = 0.000000   1.00000   2.00000   3.00000   4.00000
    5.00000    6.00000   7.00000   8.00000   9.00000
```

```
    10.0000    11.0000   12.0000   13.0000   14.0000
    15.0000    16.0000   17.0000   18.0000   19.0000
    20.0000    21.0000   22.0000   23.0000   24.0000

Sum of each row:  10.0000  35.0000  60.0000  85.0000  110.000

Sum of each column:  50.0000  55.0000  60.0000  65.0000  70.0000
```

See Also

FACTORIAL

TRACE

The TRACE function computes the trace of an *n* by *n* array.

This routine is written in the IDL language. Its source code can be found in the file `trace.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TRACE(*A* [, /DOUBLE])

Arguments

A

An *n* by *n* real or complex array.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define an array:
A = [[ 2.0,1.0,  1.0, 1.5], $
     [ 4.0, -6.0,  0.0, 0.0], $
     [-2.0,  7.0,  2.0, 2.5], $
     [ 1.0,  0.5,  0.0, 5.0]]

; Compute the trace of A:
result = TRACE(A)

;Print the result:
PRINT, 'TRACE(A) = ', result
```

IDL prints:

```
TRACE(A) =   3.00000
```

See Also

TOTAL

TrackBall Object

See Appendix A, “IDL Object Class & Method Reference”

TRANSPOSE

The TRANSPOSE function returns the transpose of *Array*. If an optional permutation vector is provided, the dimensions of *Array* are rearranged as well.

Syntax

Result = TRANSPOSE(*Array* [, *P*])

Arguments

Array

The array to be transposed.

P

A vector specifying how the dimensions of *Array* will be permuted. The elements of *P* correspond to the dimensions of *Array*; the *i*th dimension of the output array is dimension *P*[*i*] of the input array. Each element of the vector *P* must be unique. Dimensions start at zero and can not be repeated.

If *P* is not present, the order of the indices of *Array* is reversed.

Example

Example 1

Print a simple array and its transpose by entering:

```
; Create an array:
A = INDGEN(3,3)
TRANSA = TRANSPOSE(A)

; Print the array and its transpose:
PRINT, 'A:'
PRINT, A
PRINT, 'Transpose of A:'
PRINT, TRANSA
```

IDL prints:

```
A:
   0   1   2
   3   4   5
   6   7   8
```

```
Transpose of A:
   0   3   6
   1   4   7
   2   5   8
```

Example 2

This example demonstrates multi-dimensional transposition:

```
; Create the array:
A = INDGEN(2, 3, 4)

; Take the transpose, reversing the order of the indices:
B = TRANSPOSE(A)

; Re-order the dimensions of A, so that the second dimension
; becomes the first, the third becomes the second, and the first
; becomes the third:
C = TRANSPOSE(A, [1, 2, 0])

; View the sizes of the three arrays:
HELP, A, B, C
```

IDL prints:

```
A    INT  = Array[2, 3, 4]
B    INT  = Array[4, 3, 2]
C    INT  = Array[3, 4, 2]
```

See Also

REFORM, ROT, ROTATE, REVERSE

TRI_SURF

The TRI_SURF function interpolates a regularly- or irregularly-gridded set of points with a smooth quintic surface. The result is s a two-dimensional floating-point array containing the interpolated surface, sampled at the grid points.

TRI_SURF is similar to MIN_CURVE_SURF but the surface fitted is a smooth surface, not a minimum curvature surface. TRI_SURF has the advantage of being much more efficient for larger numbers of points.

Note

The TRI_SURF function is designed to interpolate low resolution data. Large arrays may cause TRI_SURF to issue the following error message: `Partial Derivative Approximation Failed to Converge`" In such cases, interpolation is most likely unnecessary.

This routine is written in the IDL language. Its source code can be found in the file `tri_surf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TRI_SURF(*Z* [, *X*, *Y*] [, /EXTRAPOLATE] [, MISSING=*value*] [, /REGULAR] [, XGRID=*[xstart*, *xspacing]* | [, XVALUES=*array*]] [, YGRID=*[yxstart*, *yspacing]* | [, YVALUES=*array*]] [, GS=*[xspacing*, *yspacing]*] [, BOUNDS=*[xmin*, *ymin*, *xmax*, *ymax]*] [, NX=*value*] [, NY=*value*])

Arguments

X, Y, Z

arrays containing the X, Y, and Z coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, X and Y are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and Z must be a two dimensional array. For irregular grids, all three parameters must be present and have the same number of elements.

Keywords

EXTRAPOLATE

Set this keyword to cause TRI_SURF to extrapolate the surface to points outside the convex hull of input points. This keyword has no effect if the input points are regularly gridded.

LINEAR

Set this keyword to use linear interpolation, without gradient estimates, instead of quintic interpolation. Linear interpolation does not extrapolate, although it is faster and more numerically stable.

MISSING

Set this keyword equal to the value to which points outside the convex hull of input points should be set. The default is 0. This keyword has no effect if the input points are regularly gridded.

Input Grid Description:

REGULAR

If set, the *Z* parameter is a two-dimensional array of dimensions (*n*,*m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

XGRID

A two-element array, [*xstart, xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

YGRID

A two-element array, [*ystart, yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

Output Grid Description:

Note

The output grid must enclose the convex hull of the input points.

GS

The output grid spacing. If present, GS must be a two-element vector [*xs, ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax - xmin*)/(NX-1). YS is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin, ymin, xmax, ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

Example

Example 1

Regularly gridded case:

```
; Make some random data
Z = randomu(seed, 5, 6)

; Interpolate to a 26 x 26 grid:
CONTOUR, TRI_SURF(Z, /REGULAR)
```

Example 2

Irregularly gridded case:

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))

; Use a 26 by 26 grid over the rectangle bounding x and y.
; Get the surface:
R = TRI_SURF(Z, X, Y)

; Alternatively, get a surface over the unit square, with spacing
; of 0.05:
R = TRI_SURF(z, x, y, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])

; Alternatively, get a 10 by 10 surface over the rectangle bounding
; x and y:
R = TRI_SURF(z, x, y, NX=10, NY=10)
```

See Also

CONTOUR, MIN_CURVE_SURF

TRIANGULATE

The TRIANGULATE procedure constructs a Delaunay triangulation of a planar set of points. Delaunay triangulations are very useful for the interpolation, analysis, and visual display of irregularly-gridded data. In most applications, after the irregularly gridded data points have been triangulated, the function TRIGRID is invoked to interpolate surface values to a regular grid.

Since Delaunay triangulations have the property that the circumcircle of any triangle in the triangulation contains no other vertices in its interior, interpolated values are only computed from nearby points.

TRIANGULATE can, optionally, return the adjacency list that describes, for each node, the adjacent nodes in the Delaunay triangulation. With this list, the Voronoi polygon (the polygon described by the set of points which are closer to that node than to any other node) can be computed for each node. This polygon contains the area influenced by its associated node. Tiling of the region in this manner is also called Dirichlet, Wigner-Seithz, or Thiessen tessellation.

The grid returned by the TRIGRID function can be input to various routines such as SURFACE, TV, and CONTOUR. See the description of TRIGRID for an example.

TRIANGULATE and TRIDGRID can also be used to perform gridding and interpolation over the surface of a sphere. The interpolation is C_1 continuous, meaning that the result is continuous over both the function value and its first derivative. This feature is ideal for interpolating an irregularly-sampled dataset over part or all of the surface of the earth (or other (spherical) celestial bodies). Extrapolation outside the convex hull of sample points is also supported. To perform spherical gridding, you must include the FVALUE and SPHERE keywords described below. The spherical gridding technique used in IDL is based on the paper "Interpolation of Data on the Surface of a Sphere", R. Renka, *Oak Ridge National Laboratory Report ORNL/CSD-108*, 1982.

Syntax

TRIANGULATE, *X*, *Y*, *Triangles* [, *B*] [, CONNECTIVITY=*variable*] [, /DEGREES] [, FVALUE=*variable*] [, REPEATS=*variable*] [, SPHERE=*variable*]

Arguments

X

An array that contains the X coordinates of the points to be triangulated.

Y

An array that contains the Y coordinates of the points to be triangulated. Parameters *X* and *Y* must have the same number of elements.

Triangles

A named variable that, on exit, contains the list of triangles in the Delaunay triangulation of the points specified by the X and Y arguments. Triangles is a longword array dimensioned (3, *number of triangles*), where `Triangles[0, i]`, `Triangles[1, i]`, and `Triangles[2, i]` contain the indices of the vertices of the *i*-th triangle (i.e., `X[Tr[*, i]]` and `Y[Triangles[*, i]]` are the X and Y coordinates of the vertices of the *i*-th triangle).

B

An optional, named variable that, upon return, contains a list of the indices of the boundary points in counterclockwise order.

Keywords

CONNECTIVITY

Set this keyword to a named variable in which the adjacency list for each of the *N* nodes (xy point) is returned. The list has the following form:

Each element *i*, $i \leq 0 < N$, contains the starting index of the connectivity list for node *i* within the list array. To obtain the adjacency list for node i, extract the list elements from LIST[*i*] to LIST[*i*+1]-1.

The adjacency list is ordered in the counter-clockwise direction. The first item on the list of boundary nodes is the subscript of the node itself. For interior nodes, the list contains the subscripts of the adjacent nodes in counter-clockwise order.

For example, the call:

```
TRIANGULATE, X, Y, CONNECTIVITY = LIST
```

returns the adjacency list in the variable LIST. The subscripts of the nodes adjacent to X[i] and Y[i] are contained in the array:

```
LIST[LIST[i] : LIST[i+1]-1]
```

DEGREES

Set this keyword to indicate that the *X* and *Y* arguments contain longitude and latitude coordinates specified in degrees. This keyword is only effective if the SPHERE

keyword is also set. If DEGREES is not set, *X* and *Y* are assumed to be specified in radians when a spherical triangulation is performed.

FVALUE

Set this keyword to a named variable that contains sample values for each longitude/latitude point in a spherical triangulation. On output, the elements of FVALUE are rearranged to correspond to the new ordering of *X* and *Y* (as described in the SPHERE keyword, below). This reordered array can be passed to TRIGRID to complete the interpolation.

REPEATS

Set this keyword to a named variable to return a (2, *n*) list of the indices of duplicated points. That is, for each *i*,

```
X[REPEATS[0,i]] = X[REPEATS[1,i]]
```

and

```
Y[REPEATS[0,i]] = Y[REPEATS[1,i]]
```

SPHERE

Set this keyword to a named variable in which the results from a spherical triangulation are returned. This result is a structure that can be passed to TRIGRID to perform spherical gridding. The structure contains the 3D Cartesian locations sample points and the adjacency list that describes the triangulation.

When spherical triangulation is performed, *X* and *Y* are interpreted as longitude and latitude, in either degrees or radians (see the DEGREE keyword, above). Also, the order of the elements within the *X* and *Y* parameters is rearranged (see the FVALUE keyword, above).

Example

For a examples using the TRIANGULATE routine, see the TRIGRID function.

See Also

SPH_SCAT, TRIGRID

TRIGRID

Given data points defined by the parameters *X, Y,* and *Z* and a triangulation of the planar set of points determined by *X* and *Y*, the TRIGRID function returns a regular grid of interpolated *Z* values. Linear or smooth quintic polynomial interpolation can be selected. Extrapolation for gridpoints outside of the triangulation area is also an option. The resulting grid is a two-dimensional array of the same data type as *Z*, with user-specified bounds and spacing. An input triangulation can be constructed using the procedure TRIANGULATE. Together, the TRIANGULATE procedure and the TRIGRID function constitute IDL's solution to the problem of irregularly-gridded data, including spherical gridding.

Syntax

Result = TRIGRID(*X*, *Y*, *Z*, *Triangles* [, *GS*, *Limits*])

For spherical gridding: *Result* = TRIGRID(*F* , *GS*, *Limits*, SPHERE=*S*)

Keywords: [, /DEGREES] [, EXTRAPOLATE=*array* **|** , /QUINTIC] [, INPUT=*variable*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, MISSING=*value*] [, NX=*value*] [, NY=*value*] [, SPHERE=*variable*] [, XGRID=*variable*] [, YGRID=*variable*] [, XOUT=*vector*, YOUT=*vector*]

Arguments

X, Y, Z

Input arrays of X, Y, and Z coordinates of data points. Integer, long, double-precision and floating-point values are allowed. In addition, *Z* can be a complex array. All three arrays must have the same number of elements.

F

When performing a spherical gridding, this argument should be the named variable that contains the rearranged sample values that were returned by TRIANGULATE's FVALUE keyword.

Triangles

A longword array of the form output by TRIANGULATE. That is, *Triangles* has the dimensions (3, *number of triangles*) and, for each *i*, `Triangles[0,i]`, `Triangles[1,i]`, and `Triangles[2,i]` are the indices of the vertices of the *i*-th triangle.

GS

If present, *GS* should be a two-element vector [*XS, YS*], where *XS* is the horizontal spacing between grid points and *YS* is the vertical spacing. The default is based on the extents of *X* and *Y*. If the grid starts at *X* value x_0 and ends at x_1,then the horizontal spacing is

$(x_1 - x_0)/50$

The default for *YS* is computed in the same way. Since the default grid spacing divides each axis into 50 intervals and produces 51 samples, TRIGRID returns a grid with dimensions (51, 51).

If the NX or NY keywords are set to specify the output grid dimensions, either or both of the values of *GS* may be set to 0. In this case, the grid spacing is computed as the respective range divided by the dimension minus one:

$(x_1 - x_0)/(NX-1)$ and $(y_1 - y_0)/(NY-1)$

For spherical gridding, *GS* is assumed to be specified in radians, unless the DEGREES keyword is set.

Limits

If present, *Limits* should be a four-element vector $[x_0, y_0, x_1, y_1]$ that specifies the data range to be gridded (x_0 and y_0 are the lower X and Y data limits, and x_1 and y_1 are the upper limits). The default for *Limits* is:

```
[MIN(X), MIN(Y), MAX(X), MAX(Y)]
```

If the NX or NY keywords are not specified, the size of the grid produced is specified by the value of *Limits*. If the NX or NY keywords are set to specify the output grid dimensions, a grid of the specified size will be used regardless of the value of *Limits*.

Keywords

DEGREES

For a spherical gridding, set this keyword to indicate that the grid spacing (the *GS* argument) is specified in degrees rather than radians.

EXTRAPOLATE

Set this keyword equal to an array of boundary node indices (as returned by the optional parameter B of the TRIANGULATE procedure) to extrapolate to grid points outside the triangulation. The extrapolation is not smooth, but should give acceptable results in most cases.

Setting this keyword sets the quintic interpolation mode, as if the QUINTIC keyword has been specified.

INPUT

Set this keyword to a named variable (which must be an array of the appropriate size to hold the output from TRIGRID) in which the results of the gridding are returned. This keyword is provided to make it easy and memory-efficient to perform multiple calls to TRIGRID. The interpolates within each triangle overwrite the array and the array is not initialized.

MAX_VALUE

Set this keyword to a value that represents the maximum *Z* value to be gridded. Data larger than this value are treated as missing data and are not gridded.

MIN_VALUE

Set this keyword to a value that represents the minimum *Z* value to be gridded. Data smaller than this value are treated as missing data and are not gridded.

MISSING

The *Z* value to be used for grid points that lie outside the triangles in *Triangles*. The default is 0. This keyword also applies to data points outside the range specified by MIN_VALUE and MAX_VALUE.

Note

Letting MISSING default to 0 does not always produce the same result as explicitly setting it to 0. For example, if you specify INPUT and not EXTRAPOLATE, letting MISSING default to 0 will result in the INPUT values being used for data outside the Triangles; explicitly setting MISSSING to 0 will result in 0 being used for the data outside the Triangles.

NX

The output grid size in the *x* direction. The default value is 51.

NY

The output grid size in the *y* direction. The default value is 51.

QUINTIC

If QUINTIC is set, smooth interpolation is performed using Akima's quintic polynomials from "A Method of Bivariate Interpolation and Smooth Surface Fitting

for Irregularly Distributed Data Points" in *ACM Transactions on Mathematical Software*, 4, 148-159. The default method is linear interpolation.

Derivatives are estimated by Renka's global method in "A Triangle-Based C1 Interpolation Method" in *Rocky Mountain Journal of Mathematics*, vol. 14, no. 1, 1984.

QUINTIC is not available for complex data values. Setting the EXTRAPOLATE keyword implies the use of quintic interpolation; it is not necessary to specify both.

SPHERE

For a spherical gridding, set this keyword to the named variable that contains the results of the spherical triangulation returned by TRIANGULATE's SPHERE keyword.

XGRID

Set this keyword to a named variable that will contain a vector of *X* values for the output grid.

XOUT

Set this keyword to a vector specifying the output grid *X* values. If this keyword is supplied, the *GS* and *Limits* arguments are ignored. Use this keyword to specify irregularly spaced rectangular output grids. If XOUT is specified, YOUT must also be specified. If keyword NX is also supplied then only the first NX points of XOUT will be used.

YGRID

Set this keyword to a named variable that will contain a vector of *Y* values for the output grid.

The following table shows the interrelationships between the keywords EXATRAPOLATE, INPUT, MAX_VALUE, MIN_VALUE, MISSING, and QUINTIC.

INPUT	EXTRAPOLATE	MISSING	Not in Triangles	Beyond MIN_VALUE, MAX_VALUE
no	no	no	uses 0	uses 0
no	no	yes	uses MISSING	uses MISSING
no	yes	no	EXTRAPOLATEs	uses 0
no	yes	yes	EXTRAPOLATEs	uses MISSING
yes	no	no	uses INPUT	uses INPUT
yes	no	yes	uses MISSING	uses MISSING
yes	yes	no	EXTRAPOLATEs	uses INPUT
yes	yes	yes	EXTRAPOLATEs	uses MISSING

Table 90: Keyword Interrelationships for the TRIGRID function

YOUT

Set this keyword to a vector specifying the output grid *Y* values. If this keyword is supplied, the *GS* and *Limits* arguments are ignored. Use this keyword to specify irregularly spaced rectangular output grids. If keyword NY is also supplied then only the first NY points of YOUT will be used.

Examples

Example 1

This example creates and displays a 50 point random normal distribution. The random points are then triangulated, with the triangulation displayed. Next, the interpolated surface is computed and displayed using linear and quintic interpolation. Finally, the smooth extrapolated surface is generated and shown.

```
; Make 50 normal x, y points:
x = RANDOMN(seed, 50)
y = RANDOMN(seed, 50)

; Make the Gaussian:
```

```
z = EXP(-(x^2 + y^2))

; Show points:
PLOT, x, y, psym=1

; Obtain triangulation:
TRIANGULATE, x, y, tr, b

; Show the triangles:
FOR i=0, N_ELEMENTS(tr)/3-1 DO BEGIN & $
   ; Subscripts of vertices [0,1,2,0]:
   t = [tr[*,i], tr[0,i]] & $
   ; Connect triangles:
   PLOTS, x[t], y[t] & $
ENDFOR

; Show linear surface:
SURFACE, TRIGRID(x, y, z, tr)

; Show smooth quintic surface:
SURFACE, TRIGRID(x, y, z, tr, /QUINTIC)

; Show smooth extrapolated surface:
SURFACE, TRIGRID(x, y, z, tr, EXTRA = b)

; Output grid size is 12 x 24:
SURFACE, TRIGRID(X, Y, Z, Tr, NX=12, NY=24)

; Output grid size is 20 x 11. The X grid is
; [0, .1, .2, ..., 19 * .1 = 1.9].  The Y grid goes from 0 to 1:
SURFACE, TRIGRID(X, Y, Z, Tr, [.1, .1], NX=20)

; Output size is 20 x 40.  The range of the grid in X and Y is
; specified by the Limits parameter.  Grid spacing in X is
; [5-0]/(20-1) = 0.263.  Grid spacing in Y is (4-0)/(40-1) = 0.128:
SURFACE, TRIGRID(X, Y, Z, Tr, [0,0], [0,0,5,4],NX=20, NY=40)
```

Example 2

This example shows how to perform spherical gridding:

```
; Create some random longitude points:
lon = RANDOMU(seed, 50) * 360. - 180.

; Create some random latitude points:
lat = RANDOMU(seed, 50) * 180. - 90.

; Make a fake function value to be passed to FVALUE. The system
; variable !DTOR contains the conversion value for degrees to
```

```
; radians.
f = SIN(lon * !DTOR)^2 * COS(lat * !DTOR)

; Perform a spherical triangulation:
TRIANGULATE, lon, lat, tr, $
    SPHERE=s, FVALUE=f, /DEGREES

; Perform a spherical triangulation using the values returned from
; TRIANGULATE. The result, r, is a 180 by 91 element array:
r=TRIGRID(f, SPHERE=s, [2.,2.],$
   [-180.,-90.,178.,90.], /DEGREES)
```

Example 3

This example demonstrates the use of the INPUT keyword:

```
; Make 50 normal x, y points:
x = RANDOMN(seed, 50)
y = RANDOMN(seed, 50)

; Make the Gaussian:
z = EXP(-(x^2 + y^2))

; Show points:
PLOT, x, y, psym=1

; Obtain triangulation:
TRIANGULATE, x, y, tr, b

;Show the triangles.
FOR i=0, N_ELEMENTS(tr)/3-1 DO BEGIN $
   ; Subscripts of vertices [0,1,2,0]:
   t = [tr[*,i], tr[0,i]] & $
   ; Connect triangles:
   PLOTS, x[t], y[t]
ENDFOR

; The default size for the return value of trigrid. xtemp should be
; the same type as Z. xtemp provides temporary space for trigrid:
xtemp=FLTARR(51,51)
xtemp = TRIGRID(x, y, z, INPUT = xtemp, tr)

; Show linear surface:
SURFACE, xtemp
in=' '
READ,"Press enter",in
xtemp = TRIGRID(x, y, z, tr, INPUT = xtemp, /QUINTIC)

; Show smooth quintic surface:
```

```
SURFACE,xtemp
in=' '
READ,"Press enter",in
xtemp = TRIGRID(x, y, z, tr, INPUT = xtemp, EXTRA = b)

; Show smooth extrapolated surface:
SURFACE,xtemp
in=' '
READ,"Press enter",in
END
```

See Also

SPH_SCAT, TRIANGULATE

TRIQL

The TRIQL procedure uses the QL algorithm with implicit shifts to determine the eigenvalues and eigenvectors of a real, symmetric, tridiagonal array. The routine TRIRED can be used to reduce a real, symmetric array to the tridiagonal form suitable for input to this procedure.

TRIQL is based on the routine `tqli` described in section 11.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

TRIQL, *D*, *E*, *A* [, /DOUBLE]

Arguments

D

On input, this argument should be an *n*-element vector containing the diagonal elements of the array being analyzed. On output, *D* contains the eigenvalues.

E

An *n*-element vector containing the off-diagonal elements of the array. E_0 is arbitrary. On output, this parameter is destroyed.

A

A named variable that returns the *n* eigenvectors. If the eigenvectors of a tridiagonal array are desired, *A* should be input as an identity array. If the eigenvectors of an array that has been reduced by TRIRED are desired, *A* is input as the array *Q* output by TRIRED.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To compute eigenvalues and eigenvectors of a real, symmetric, tridiagonal array, begin with an array A representing a symmetric array:

```
; Create the array A:
```

```
A = [[ 3.0,  1.0, -4.0], $
    [ 1.0,  3.0, -4.0], $
    [-4.0, -4.0,  8.0]]

; Compute the tridiagonal form of A:
TRIRED, A, D, E

; Compute the eigenvalues (returned in vector D) and the
; eigenvectors (returned in the rows of the array A):
TRIQL, D, E, A

; Print eigenvalues:
PRINT, 'Eigenvalues:'
PRINT, D

; Print eigenvectors:
PRINT, 'Eigenvectors:'
PRINT, A
```

IDL prints:

```
Eigenvalues:
  2.00000  4.76837e-7  12.0000

Eigenvectors:
  0.707107  -0.707107   0.00000
 -0.577350  -0.577350  -0.577350
 -0.408248  -0.408248   0.816497
```

The exact eigenvalues are:

```
[2.0, 0.0, 12.0]
```

The exact eigenvectors are:

```
[ 1.0/sqrt(2.0), -1.0/sqrt(2.0), 0.0/sqrt(2.0)],
[-1.0/sqrt(3.0), -1.0/sqrt(3.0), -1.0/sqrt(3.0)],
[-1.0/sqrt(6.0), -1.0/sqrt(6.0), 2.0/sqrt(6.0)]
```

See Also

EIGENVEC, ELMHES, HQR, TRIRED

TRIRED

The TRIRED procedure uses Householder's method to reduce a real, symmetric array to tridiagonal form.

TRIRED is based on the routine `tred2` described in section 11.2 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

TRIRED, *A*, *D*, *E* [, /DOUBLE]

Arguments

A

An *n* by *n* real, symmetric array that is replaced, on exit, by the orthogonal array *Q* effecting the transformation. The routine TRIQL can use this result to find the eigenvectors of the array *A*.

D

An *n*-element output vector containing the diagonal elements of the tridiagonal array.

E

An *n*-element output vector containing the off-diagonal elements.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

See the description of TRIQL for an example using this function.

See Also

EIGENVEC, ELMHES, HQR, TRIQL

TRISOL

The TRISOL function solves tridiagonal systems of linear equations that have the form: $A^TU = R$

Note

Because IDL subscripts are in column-row order, the equation above is written $A^TU = R$ rather than $AU = R$. The result *U* is a vector of length *n* whose type is identical to *A*.

TRISOL is based on the routine `tridag` described in section 2.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = TRISOL(*A*, *B*, *C*, *R* [, /DOUBLE])

Arguments

A

A vector of length *n* containing the *n*-1 sub-diagonal elements of A^T. The first element of *A*, A_0, is ignored.

B

An *n*-element vector containing the main diagonal elements of A^T.

C

An *n*-element vector containing the *n*-1 super-diagonal elements of A^T. The last element of *C*, C_{n-1}, is ignored.

R

An *n*-element vector containing the right hand side of the linear system $A^TU = R$.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

To solve a tridiagonal linear system, begin with an array representing a real tridiagonal linear system. (Note that only three vectors need be specified; there is no need to enter the entire array shown.)

$$\begin{bmatrix} -4.0 & 1.0 & 0.0 & 0.0 \\ 2.0 & -4.0 & 1.0 & 0.0 \\ 0.0 & 2.0 & -4.0 & 1.0 \\ 0.0 & 0.0 & 2.0 & -4.0 \end{bmatrix}$$

```
; Define a vector A containing the sub-diagonal elements with a
; leading 0.0 element:
A = [0.0, 2.0, 2.0, 2.0]

; Define B containing the main diagonal elements:
B = [-4.0, -4.0, -4.0, -4.0]

; Define C containing the super-diagonal elements with a trailing
; 0.0 element:
C = [1.0, 1.0, 1.0, 0.0]

; Define the right-hand side vector:
R = [6.0, -8.0, -5.0, 8.0]

; Compute the solution and print:
result = TRISOL(A, B, C, R)
PRINT, result
```

IDL prints:

```
  -1.00000   2.00000   2.00000  -1.00000
```

The exact solution vector is [-1.0, 2.0, 2.0, -1.0].

See Also

CRAMER, GS_ITER, LU_COMPLEX, CHOLSOL, LUSOL, SVSOL, TRISOL

TRNLOG

The TRNLOG function searches the VMS logical name tables for a specified logical name and returns the equivalence string(s) in an IDL variable. TRNLOG is available only under VMS. TRNLOG also returns the VMS status code associated with the translation as a longword value. As with all VMS status codes, success is indicated by an odd value (least significant bit is set) and failure by an even value.

Syntax

Result = TRNLOG(*Lognam*, *Value* [, ACMODE={0 | 1 | 2 | 3}] [, /FULL_TRANSLATION] [, /ISSUE_ERROR] [, RESULT_ACMODE=*variable*] [, RESULT_TABLE=*variable*] [, TABLE=*string*])

Arguments

Lognam

A scalar string containing the name of the logical to be translated.

Value

A named variable into which the equivalence string is placed. If Lognam has more than one equivalence string, the first one is used. The FULL_TRANSLATION keyword can be used to obtain all equivalence strings.

Keywords

ACMODE

Set this keyword to a value specifying the access mode to be used in the translation. Valid values are:

- 0 = Kernal
- 1 = Executive
- 2 = Supervisor
- 3 = User

When you specify the ACMODE keyword, all names at access modes less privileged than the specified mode are ignored. If you do not specify ACMODE, the translation proceeds without regard to access mode. However, the search proceeds from the outermost (User) to the innermost (Kernal) mode. Thus, if two logical names with the

same name but different access modes exist in the same table, the name with the outermost access mode is used.

FULL_TRANSLATION

Set this keyword to obtain the full set of equivalence strings for *Lognam*. By default, when translating a multivalued logical name, *Value* only receives the first equivalence string as a scalar value. When this keyword is set, *Value* instead returns a string array. Each element of this array contains one of the equivalence strings. For example, under recent versions of VMS, the SYS$SYSROOT logical can have multiple values. To see these values from within IDL, enter:

```
; Translate the logical:
ret = TRNLOG('SYS$SYSROOT', trans, /FULL, /ISSUE_ERROR)
; View the equivalence strings:
PRINT, trans
```

ISSUE_ERROR

Set this keyword to issue an error message if the translation fails. Normally, no error is issued and the user must examine the return value to determine if the operation failed.

RESULT_ACMODE

If present, this keyword specifies a named variable in which to place the access mode of the translated logical. The access modes are summarized above.

RESULT_TABLE

If present, this keyword specifies a named variable. The name of the logical table containing the translated logical is placed in this variable as a scalar string.

TABLE

A scalar string giving the name of the logical table in which to search for *Lognam*. If TABLE is not specified, the standard VMS logical tables are searched until a match is found, starting with LNM$PROCESS_TABLE and ending with LNM$SYSTEM_TABLE.

See Also

GETENV

TS_COEF

The TS_COEF function computes the coefficients $\phi_1, \phi_2, \ldots, \phi_P$ used in a P^{th} order autoregressive time-series forecasting model. The result is a *P*-element vector whose type is identical to *X*. This routine is written in the IDL language. Its source code can be found in the file `ts_coef.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TS_COEF(*X*, *P* [, /DOUBLE] [, MSE=*variable*])

Arguments

X

An *n*-element single- or double-precision floating-point vector containing time-series samples.

P

An integer or long integer scalar that specifies the number of coefficients to be computed.

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

MSE

Set this keyword to a named variable that will contain the mean square error of the P^{th} order autoregressive model.

Example

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99, $
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31, $
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]
; Compute the coefficients of a 5th order autoregressive model:
PRINT, TS_COEF(X, 5)
```

IDL prints:

```
1.30168    -0.111783    -0.224527     0.267629    -0.233363
```

See Also

TS_FCAST

TS_DIFF

The TS_DIFF function recursively computes the forward differences of an *n*-element time-series *k* times. The result is an *n*-element differenced time-series with its last *k* elements as zeros. This routine is written in the IDL language. Its source code can be found in the file `ts_diff.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TS_DIFF(*X*, *K* [, /DOUBLE])

Arguments

X

An *n*-element integer, single- or double-precision floating-point vector containing time-series samples.

K

A positive integer or long integer scalar that specifies the number of times *X* is to be differenced. *K* must be in the interval [1, N_ELEMENTS(*X*) - 1].

Keywords

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define an n-element vector of time-series samples:
X = [389, 345, 303, 362, 412, 356, 325, 375, $
     410, 350, 310, 388, 399, 362, 325, 382, $
     399, 382, 318, 385, 437, 357, 310, 391]
; Compute the second forward differences of X:
PRINT, TS_DIFF(X, 2)
```

IDL prints:

```
  2  101   -9 -106   25   81  -15  -95   20
118  -67  -48    0   94  -40  -34  -47  131
-15 -132   33  128    0    0
```

See Also

SMOOTH, TS_FCAST

TS_FCAST

The TS_FCAST function computes future or past values of a stationary time-series using a P^{th} order autoregressive model. The result is an *Nvalues*-element vector whose type is identical to *X*.

A P^{th} order autoregressive model relates a forecasted value x_t of the time series $X = [x_0, x_1, x_2, \ldots, x_{t-1}]$, as a linear combination of *P* past values.

$$x_t = \phi_1 x_{t-1} + \phi_2 x_{t-2} + \ldots + \phi_P x_{t-P} + w_t$$

The coefficients $\phi_1, \phi_2, \ldots, \phi_P$ are calculated such that they minimize the uncorrelated random error terms, *wt*.

This routine is written in the IDL language. Its source code can be found in the file `ts_fcast.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TS_FCAST(*X*, *P*, *Nvalues* [, /BACKCAST] [, /DOUBLE])

Arguments

X

An *n*-element single- or double-precision floating-point vector containing time-series samples.

P

An integer or long integer scalar that specifies the number of actual time-series values to be used in the forecast. In general, a larger number of values results in a more accurate forecast.

Nvalues

An integer or long integer scalar that specifies the number of future or past values to be computed.

Keywords

BACKCAST

Set this keyword to produce past values (backward forecasts or “backcasts”)

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

Example

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99, $
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31, $
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]

; Compute and print five future values of the time-series using ten
; time-series values:
PRINT, TS_FCAST(X, 10, 5)

; Compute five past values of the time-series using ten time-series
;values:
PRINT, TS_FCAST(X, 10, 5, /BACKCAST)
```

IDL prints:

```
4.65870      4.58380      4.50030      4.48828      4.46971
6.94862      6.91103      6.86297      6.77826      6.70282
```

See Also

A_CORRELATE, COMFIT, CURVEFIT, SMOOTH, TS_COEF, TS_DIFF

TS_SMOOTH

The TS_SMOOTH function computes central, backward, or forward moving averages of an *n*-element time-series. Autoregressive forecasting and backcasting are used to extrapolate the time-series and compute a moving average for each point. The result is an *n*-element vector of the same data type as the input vector.

Note that central moving averages require *Nvalues*/2 forecasts and *Nvalues*/2 backcasts. Backward moving averages require *Nvalues*-1 backcasts. Forward moving averages require *Nvalues*-1 forecasts.

This routine is written in the IDL language. Its source code can be found in the file `ts_smooth.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = TS_SMOOTH(*X*, *Nvalues* [, /BACKWARD] [, /DOUBLE] [, /FORWARD] [, ORDER=*value*])

Arguments

X

An *n*-element single- or double-precision floating-point vector containing time-series samples. Note that *n* must be greater than or equal to 11.

Nvalues

A scalar of type integer or long integer that specifies the number of time-series values used to compute each moving-average. If central-moving averages are computed (the default), this parameter must be an odd integer greater than or equal to three.

Keywords

BACKWARD

Set this keyword to compute backward-moving averages. If BACKWARD is set, the *Nvalues* argument must be an integer greater than one.

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

FORWARD

Set this keyword to compute forward-moving averages. If FORWARD is set, the *Nvalues* argument must be an integer greater than one.

ORDER

An integer or long-integer scalar that specifies the order of the autoregressive model used to compute the forecasts and backcasts of the time-series. By default, a time-series with a length between 11 and 219 elements will use an autoregressive model with an order of 10. A time-series with a length greater than 219 will use an autoregressive model with an order equal to 5% of its length. The ORDER keyword is used to override this default.

Example

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99,$
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31,$
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]

; Compute the 11-point central-moving-averages of the time-series:
PRINT, TS_SMOOTH(X, 11)
```

IDL prints:

```
6.65761 6.60592 6.54673 6.47646 6.40480 6.33364
6.27000 6.20091 6.14273 6.09364 6.04455 5.99000
5.92273 5.85455 5.78364 5.72636 5.65818 5.58000
5.50182 5.42727 5.34182 5.24545 5.15273 5.07000
5.00182 4.94261 4.87205 4.81116 4.75828 4.71280
```

See Also

SMOOTH, TS_DIFF, TS_FCAST

TV

The TV procedure displays images on the image display without scaling the intensity. To display an image with scaling, use the TVSCL procedure.

Note

To display a TrueColor image (an image with 16, 24, or 32 bits per pixel) you must specify the TRUE keyword.

While the TV procedure does not *scale* the intensity of an image, it does convert the input image data to byte type. Values outside the range [0,255] are "wrapped" during the conversion. In addition, for displays with less than 256 colors, elements of the input image with values between !D.TABLE_SIZE and 255 will be displayed using the color index !D.TABLE_SIZE-1.

Syntax

TV, *Image* [, *Position*]

or

TV, *Image* [, *X*, *Y* [, *Channel*]]

Keywords: [, /CENTIMETERS | , /INCHES] [, CHANNEL=*value*] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

Arguments

Image

A vector or two-dimensional array to be displayed as an image. If this argument is not already of byte type, it is converted prior to use.

X, Y

If *X* and *Y* are present, they specify the lower-left coordinate of the displayed image, relative to the lower-left corner of the screen.

Position

An integer specifying the position for *Image* within the graphics window. Image positions run from the top left of the screen to the bottom right. If a position number

is used instead of *X* and *Y*, the position of the image is calculated from the dimensions of the image as follows (integer arithmetic is used).

$$\text{Xsize, Ysize} = \text{Size of display or window}$$

$$\text{Xdim, Ydim} = \text{Dimensions of image to be displayed}$$

$$N_x = \frac{\text{Xsize}}{\text{Ydim}} = \text{Images across screen}$$

$$X = \text{XdimPosition}_{\text{modulo}N_x} = \text{Starting X}$$

$$Y = \text{Ysize} - \text{Ydim}\left[1 + \frac{\text{Position}}{N_x}\right] = \text{Starting Y}$$

For example, when displaying 128 by 128 images on a 512 by 512 display, the position numbers run from 0 to 15 as follows:

0	1	2	3
4	5	6	7
8	9	10	11
12	13	14	15

Note

When using a device with scalable pixels (e.g., PostScript), the XSIZE and YSIZE keywords should also be used.

Channel

The memory channel to be written. It is assumed to be zero if not specified. This parameter is ignored on display systems that have only one memory channel. When using a "decomposed" display system, the red channel is 1, the green channel is 2, and the blue channel is 3. Channel 0 indicates all channels.

Keywords

CENTIMETERS

Set this keyword to indicate that the *X*, *Y*, *Xsize*, *Ysize*, and *Z* arguments are given in centimeters from the origin. This system is useful when dealing with devices, such as

PostScript printers, that do not provide a direct relationship between image pixels and the size of the resulting image.

CHANNEL

The memory channel to be written to. The CHANNEL keyword is identical to the optional *Channel* argument.

INCHES

Set this keyword to indicate that all position and size values are given in inches from the origin. This system is useful when dealing with devices, such as PostScript printers, that do not provide a direct relationship between image pixels and the size of the resulting image.

ORDER

If specified, ORDER overrides the current setting of the !ORDER system variable for the current image only. If set, the image is drawn from the top down instead of the normal bottom up.

TRUE

Set this keyword to a nonzero value to indicate that a TrueColor (16-, 24-, or 32-bit) image is to be displayed. The value assigned to TRUE specifies the index of the dimension over which color is interleaved. The image parameter must have three dimensions, one of which must be equal to three. For example, set TRUE to 1 to display an image that is pixel interleaved and has dimensions of (3, *m, n*). Specify 2 for row-interleaved images, of size (*m*, 3, *n*), and 3 for band-interleaved images of the form (*m*, *n*, 3).

See "TrueColor Images" on page 2373 for an example using this keyword to write 24-bit images to the PostScript device.

WORDS

Set this keyword to indicate that words (short integers) instead of 8-bit bytes are to be transferred to the device. This keyword is valid only when using devices that can transfer 16-bit pixels. The normal transfer uses 8-bit pixels. If this keyword is set, the *Image* parameter is converted to short integer type, if necessary, and then written to the display.

XSIZE

The width of the resulting image. On devices with scalable pixel size (such as PostScript), if XSIZE is specified the image will be scaled to fit the specified width. If neither XSIZE nor YSIZE is specified, the image will be scaled to fill the plotting

area, while preserving the image's aspect ratio. This keyword is ignored by pixel-based devices that are unable to change the size of their pixels.

YSIZE

The height of the resulting image. On devices with scalable pixel size (such as PostScript), if YSIZE is specified the image will be scaled to fit the specified height. If neither XSIZE nor YSIZE is specified, the image will be scaled to fill the plotting area, while preserving the image's aspect ratio. This keyword is ignored by pixel-based devices that are unable to change the size of their pixels.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CHANNEL, DATA, DEVICE, NORMAL, T3D, Z.

Example

```
; Create and display a simple image:
D = BYTSCL(DIST(256)) & TV, D

; Erase the screen:
ERASE

; Use the position parameter to display a number of images in the
; same window.
; Display the image in the upper left corner.
TV, D, 0

; Display another copy of the image in the next position:
TV, D, 1
```

See Also

ERASE, SLIDE_IMAGE, TVRD, TVSCL, WIDGET_DRAW, WINDOW

TVCRS

The TVCRS procedure manipulates the display device cursor. The initial state of the cursor is device dependent. Call TVCRS with one argument to enable or disable the cursor. Call TVCRS with two parameters to enable the cursor and place it on pixel location *(X, Y)*.

Note

Under Macintosh, the cursor cannot be positioned from an IDL program using the TVCRS procedure. The Macintosh interface does not allow the cursor to be positioned by any device except the mouse.

Syntax

TVCRS [, *ON_OFF*]

or

TVCRS [, *X*, *Y*]

Keywords: [, /CENTIMETERS | , /INCHES] [, /HIDE_CURSOR] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

Arguments

ON_OFF

This argument specifies whether the cursor should be on or off. If this argument is present and nonzero, the cursor is enabled. If *ON_OFF* is zero or no parameters are specified, the cursor is turned off.

X

The column to which the cursor is set.

Y

The row to which the cursor is set.

Keywords

CENTIMETERS

Set this keyword to cause X and Y to be interpreted as centimeters, based on the current device resolution.

INCHES

Set this keyword to cause X and Y to be interpreted as inches, based on the current device resolution.

HIDE_CURSOR

By default, disabling the cursor works differently for window systems than for other devices. For window systems, the cursor is restored to the standard cursor used for non-IDL windows (and remains visible), while for other devices it is completely blanked out. If the HIDE keyword is set, disabling the cursor causes it to always be blanked out.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. DATA, DEVICE, NORMAL, T3D, Z.

Example

To enable the graphics cursor and position it at device coordinate (100, 100), enter:

```
TVCRS, 100, 100
```

To position the cursor at data coordinate (0.5, 3.2), enter:

```
TVCRS, 0.5, 3.2, /DATA
```

See Also

CURSOR, RDPIX

TVLCT

The TVLCT procedure loads the display color translation tables from the specified variables. Although IDL uses the RGB color system internally, color tables can be specified to TVLCT using any of the following color systems: RGB (Red, Green, Blue), HLS (Hue, Lightness, Saturation), and HSV (Hue, Saturation, Value). Alpha values may also be used when using the second form of the command. The type and meaning of each argument is dependent upon the color system selected, as described below. Color arguments can be either scalar or vector expressions. If no color-system keywords are present, the RGB color system is used. See *Using IDL* Chapter 14, "Image Display Routines" for a more complete explanation of color systems.

Syntax

TVLCT, V_1, V_2, V_3 [, *Start*] [, /GET] [, /HLS | , /HSV]

or

TVLCT, *V* [, *Start*] [, /GET] [, /HLS | , /HSV]

Arguments

TVLCT will accept either three *n*-element vectors (V_1, V_2, and V_3) or a single *n*-by-3 array (*V*) as an argument. The vectors (or columns of the array) have different meanings depending on the color system chosen. If an array *V* is specified, *V*[*,0] is the same as V_1, *V*[*,1] is the same as V_2, *V*[*,2] is the same as V_3. In the description below, we assume that three vectors, V_1, V_2, and V_3 are specified.

The V_1, V_2, and V_3 arguments have different meanings depending upon which color system they represent.

R, G, B Color System

The parameters V_1, V_2, and V_3 contain the Red, Green, and Blue values, respectively. Values are interpreted as integers in the range 0 (lowest intensity) to 255 (highest intensity). The parameters can be scalars or vectors of up to 256 elements. By default, the three arguments are assumed to be R, G, and B values.

H, L, S Color System

Parameters V_1, V_2, and V_3 contain the Hue, Lightness, and Saturation values respectively. All parameters are floating-point. Hue is expressed in degrees and is reduced modulo 360. V_2 (lightness) and V_3 (saturation) and can range from 0 to 1.0. Set the HLS keyword to have the arguments interpreted this way.

H, S, V Color System

Parameters V_1, V_2, and V_3 contain values for Hue, Saturation, and Value (similar to intensity). All parameters are floating-point. Hue is in degrees. The Saturation and Value can range from 0 to 1.0. Set the HSV keyword to have the arguments interpreted this way.

Start

An integer value that specifies the starting point in the color translation table into which the color intensities are loaded. If this argument is not specified, a value of zero is used, causing the tables to be loaded starting at the first element of the translation tables.

Keywords

GET

Set this keyword to return the RGB values from the internal color tables into the V_1, V_2, and V_3 parameters. For example, the statements:

```
TVLCT, H, S, V, /HSV
TVLCT, R, G, B, /GET
```

load a color table based in the HSV system, and then read the equivalent RGB values into the variables R, G, and B.

HLS

Set this keyword to indicate that the parameters specify color using the HLS color system.

HSV

Set this keyword to indicate that the parameters specify color using the HSV color system.

Example

```
; Create a set of R, G, and B colormap vectors:
R = BYTSCL(SIN(FINDGEN(256)))
G = BYTSCL(COS(FINDGEN(256)))
B = BINDGEN(256)

; Load these vectors into the color table:
TVLCT, R, G, B

; Display an image to see the effect of the new color table:
```

```
TVSCL, DIST(400)
```

See Also

LOADCT, XLOADCT, XPALETTE

TVRD

The TVRD function returns the contents of the specified rectangular portion of the current graphics window or device. (X_0, Y_0) is the coordinate of the lower left corner of the area to be read and N_x, N_y is the size of the rectangle in columns and rows. The result is a byte array of dimensions N_x by N_y. All parameters are optional. If no arguments are supplied, the entire display device area is read.

Important Note about TVRD and Backing Store

On some systems, when backing store is provided by the window system (the RETAIN keyword to DEVICE or WINDOW is set to 1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (set the RETAIN keyword to 2) ensures that the window contents will be read properly. More detailed notes about TVRD and the X Window system can be found below in "Unexpected Results Using TVRD with X Windows" on page 1465.

Syntax

Result = TVRD([X_0 [, Y_0 [, N_x [, N_y [, *Channel*]]]]] [, CHANNEL=*value*] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS])

Arguments

X_0

The starting column of data to read. The default is 0.

Y_0

The starting row of data to read. The default is 0.

N_x

The number of columns to read. The default is the width of the display device or window less X_0.

N_y

The number of rows to read. The default is the height of the display device or window less Y_0.

Channel

The memory channel to be read. If not specified, this argument is assumed to be zero. This parameter is ignored on display systems that have only one memory channel.

Keywords

CHANNEL

The memory channel to be read. The CHANNEL keyword is identical to the optional *Channel* argument.

Note: if the display is a 24-bit display, and both the CHANNEL and TRUE parameters are absent, the maximum RGB value in each pixel is returned.

ORDER

Set this keyword to override the current setting of the !ORDER system variable for the current image only. If set, it causes the image to be read from the top down instead of the normal bottom up.

TRUE

If this keyword is present, it indicates that a TrueColor image is to be read, if the display is capable. The value assigned to TRUE specifies the index of the dimension over which color is interleaved. The result is an $(3, n_x, n_y)$ pixel-interleaved array if TRUE is 1; or an $(n_x, 3, n_y)$ line-interleaved array if TRUE is 2; or an $(n_x, n_y, 3)$ image-interleaved array if TRUE is 3.

WORDS

Set this keyword to indicate that words are to be transferred from the device. This keyword is valid only when using devices that can transfer 16-bit pixels. The normal transfer uses 8-bit pixels. If this keyword is set, the function result is an integer array.

Unexpected Results Using TVRD with X Windows

When using TVRD with the X Windows graphics device, there are two unexpected behaviors that can be confusing to users:

- When reading from a window that is obscured by another window (i.e., the target window has another window “on top” or “in front” of it), TVRD may return the contents of the window in front as part of the image contained in the target window.
- When reading from an iconified window, the X server may return a stream of “BadMatch” protocol events.

IDL uses the Xlib function `XGetSubImage()` to implement TVRD. The following quote is from the documentation for XGetSubImage() found in *The X Window System* by Robert W. Scheifler and James Gettys, Second Edition, page 174. It explains the reasons for the behaviors described above:

"If the drawable is a window, the window must be viewable, and it must be the case that if there were no... overlapping windows, the specified rectangle of the window would be fully visible on the screen, ... or a BadMatch error results. If the window has backing-store, then the backing-store contents are returned for regions of the window that are obscured... If the window does not have backing-store, the returned contents of such obscured regions are undefined."

Hence, the first behavior is caused by attempting to use TVRD on an obscured window that does not have backing store provided by the X server. The result in this case is undefined, meaning that the different servers can produce entirely different results. Many servers simply return the image of the obscuring window.

The second behavior is caused by attempting to read from a non-viewable (i.e., unmapped) window. Although IDL could refuse to allow TVRD to work with unmapped windows, some X servers return valid and useful results. Therefore, TVRD is allowed to attempt to read from unmapped windows.

Both of these behavior problems can be solved by using one of the following methods:

- Always make sure that your target window is mapped and is not obscured before using TVRD on it. The following IDL command can be used:

  ```
  WSHOW, Window_Index, ICONIC=0
  ```

- Make IDL provide backing store (rather than the window system) by setting the RETAIN keyword to DEVICE or WINDOW equal to 2.

For a full description of backing store, see "Backing Store" on page 2351. Note that under X Windows, backing store is a request that may or may not be honored by the X server. Many servers will honor backing store for 8-bit visuals but ignore them for 24-bit visuals because they require three times as much memory.

Example

```
; Read the entire contents of the current display device into the
; variable T:
T = TVRD()
```

See Also

RDPIX, TV, WINDOW

TVSCL

The TVSCL procedure scales the intensity values of *Image* into the range of the image display and outputs the data to the image display at the specified location. The array is scaled so the minimum data value becomes 0 and the maximum value becomes the maximum number of available colors (held in the system variable !D.TABLE_SIZE) as follows:

$$\text{Output} = (\text{!D.TABLE\_SIZE} - 1)\frac{\text{Data} - \text{Data}_{\text{min}}}{\text{Data}_{\text{max}} - \text{Data}_{\text{min}}}$$

where the maximum and minimum are found by scanning the array. The parameters and keywords of the TVSCL procedure are identical to those accepted by the TV procedure. For additional information about each parameter, consult the description of TV.

Syntax

TVSCL, *Image* [, *Position*]

or

TVSCL, *Image* [, *X*, *Y* [, *Channel*]]

Keywords: [, /CENTIMETERS | , /INCHES] [, CHANNEL=*value*] [, /NAN] [, /ORDER] [, TOP=*value*] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

Arguments

Image

A two-dimensional array to be displayed as an image. If this argument is not already of byte type, it is converted prior to use.

X, Y

If *X* and *Y* are present, they specify the lower left coordinate of the displayed image.

Position

Image position. See the discussion of the TV procedure for a full description.

Channel

The memory channel to be written. This argument is assumed to be zero if not specified. This parameter is ignored on display systems that have only one memory channel.

Keywords

TVSCL accepts all of the keywords accepted by the TV routine. See "TV" on page 1455. In addition, there are two unique keywords:

NAN

Set this keyword to cause TVSCL to treat elements of *Image* that are not numbers (that is, elements that have the special floating-point values *Infinity* or *NaN*) as missing data, and display them using color index 0 (zero). Note that color index 0 is also used to display elements that have the minimum value in the *Image* array.

TOP

The maximum value of the scaled result. If TOP is not specified, !D.TABLE_SIZE-1 is used. Note that the minimum value of the scaled result is always 0.

Example

Display a floating-point array as an image using the TV command:

```
TV, DIST(200)
```

Note that the image is not easily visible because the values in the array have not been scaled into the full range of display values. Now display the image with the TVSCL command by entering:

```
TVSCL, DIST(200)
```

Notice how much brighter the image appears.

See Also

ERASE, SLIDE_IMAGE, TV, WIDGET_DRAW, WINDOW

UINDGEN

The UINDGEN function returns an unsigned integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = UINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create UI, a 10-element by 10-element 16-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
UI = UINDGEN(10, 10)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UL64INDGEN, ULINDGEN

UINT

The UINT function returns a result equal to *Expression* converted to unsigned integer type.

Syntax

Result = UINT(*Expression*[, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to unsigned integer.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned integer data. See the description in Chapter 3, "Constants and Variables" of *Building IDL Applications* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

If A contains the floating-point value 32000.0, it can converted to an unsigned integer and stored in the variable B by entering:

```
B = UINT(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, ULONG, ULONG64

UINTARR

The UINTARR function returns an unsigned integer vector or array.

Syntax

Result = UINTARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, UINTARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and UINTARR executes faster.

Example

To create L, a 100-element, unsigned integer vector with each element set to 0, enter:

```
L = UINTARR(100)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, ULON64ARR, ULONARR

UL64INDGEN

The UL64INDGEN function returns an unsigned 64-bit integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = UL64INDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create L, a 10-element by 10-element 64-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = UL64INDGEN(10, 10)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UINDGEN, ULINDGEN

ULINDGEN

The ULINDGEN function returns an unsigned longword array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

Syntax

Result = ULINDGEN(D_1, ..., D_8)

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

Example

To create L, a 10-element by 10-element 32-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = ULINDGEN(10, 10)
```

See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN

ULON64ARR

The ULON64ARR function returns an unsigned 64-bit integer vector or array.

Syntax

Result = ULON64ARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, ULON64ARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and ULON64ARR executes faster.

Example

To create L, a 100-element, unsigned 64-bit vector with each element set to 0, enter:

```
L = ULON64ARR(100)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULONARR

ULONARR

The ULONARR function returns an unsigned longword integer vector or array.

Syntax

Result = ULONARR(D_1, ..., D_8 [, /NOZERO])

Arguments

D_i

The dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified.

Keywords

NOZERO

Normally, ULONARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and ULONARR executes more quickly.

Example

To create L, a 100-element, unsigned longword vector with each element set to 0, enter:

```
L = ULONARR(100)
```

See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR,

ULONG

The ULONG function returns a result equal to *Expression* converted to the unsigned longword integer type.

Syntax

Result = ULONG(*Expression*[, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to unsigned longword integer.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned longword integer data. See the description in Chapter 3, "Constants and Variables" of *Building IDL Applications* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

If A contains the floating-point value 32000.0, it can converted to an unsigned longword integer and stored in the variable B by entering:

```
B = ULONG(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG64

ULONG64

The ULONG64 function returns a result equal to *Expression* converted to the unsigned 64-bit integer type.

Syntax

Result = ULONG64(*Expression*[, *Offset* [, Dim_1, ..., Dim_8]])

Arguments

Expression

The expression to be converted to unsigned 64-bit integer.

Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned 64-bit integer data. See the description in Chapter 3, "Constants and Variables" of *Building IDL Applications* for details.

D_i

When extracting fields of data, the D_i arguments specify the dimensions of the result. The dimension parameters can be any scalar expression. Up to eight dimensions can be specified. If no dimension arguments are given, the result is taken to be scalar.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

Example

If A contains the floating-point value 32000.0, it can converted to an unsigned 64-bit integer and stored in the variable B by entering:

```
B = ULONG64(A)
```

See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG

UNIQ

The UNIQ function returns the subscripts of the unique elements in an array. Note that repeated elements must be adjacent in order to be found. This routine is intended to be used with the SORT function: see the examples below. This function was inspired by the UNIX `uniq(1)` command.

UNIQ returns an array of indices into the original array. Note that the index of the last element in each set of non-unique elements is returned. The following expression is a copy of the sorted array with duplicate adjacent elements removed:

Array`(UNIQ(`*Array*`))`

UNIQ returns 0 (zero) if the argument supplied is a scalar rather than an array.

This routine is written in the IDL language. Its source code can be found in the file `uniq.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = UNIQ(*Array* [, *Index*])

Arguments

Array

The array to be scanned. For UNIQ to work properly, the array must be sorted into monotonic order unless the optional parameter *Idx* is supplied.

Index

This optional parameter is an array of indices into *Array* that order the elements into monotonic order. That is, the expression:

Array`(`*Index*`)`

yields an array in which the elements of *Array* are rearranged into monotonic order. If the array is not already in monotonic order, use the command:

```
UNIQ(Array, SORT(Array))
```

Examples

Find the unique elements of an unsorted array:

```
; Create an array:
array = [1, 2, 1, 2, 3, 4, 5, 6, 6, 5]
```

```
; Variable B holds an array containing the sorted, unique values in
; array:
b = array[UNIQ(array, SORT(array))]
PRINT, b
```

IDL prints

```
1     2     3     4     5     6
```

See Also

SORT, WHERE

USERSYM

The USERSYM procedure is used to define the plotting symbol that marks points when the plotting symbol is set to plus or minus 8. Symbols can be drawn with vectors or can be filled. Symbols can be of any size and can have up to 50 vertices. See "Defining Your Own Plotting Symbols" in Chapter 11 of *Using IDL*.

Syntax

USERSYM, *X* [, *Y*] [, COLOR=*value*] [, /FILL] [, THICK=*value*]

Arguments

X, Y

The *X* and/or *Y* parameters define the vertices of the symbol as offsets from the data point in units of approximately the size of a character. In the case of a vector drawn symbol, the symbol is formed by connecting the vertices in order. If only one argument is specified, it must be a (2, *N*) array of vertices, with element [0, *i*] containing the X coordinate of the vertex, and element [1, *i*] containing the Y. If both arguments are provided, *X* contains only the X coordinates.

Keywords

COLOR

The color used to draw the symbols, or used to fill the polygon. The default color is the same as the line color.

FILL

Set this keyword to fill the polygon defined by the vertices. If FILL is not set, lines are drawn connecting the vertices.

THICK

The thickness of the lines used in drawing the symbol. The default thickness is 1.0.

Example

Make a large, diamond-shaped plotting symbol. Define the vectors of X values by entering:

```
X = [-6, 0, 6, 0, -6]
```

Define the vectors of Y values by entering:

```
Y = [0, 6, 0, -6, 0]
```

Now call USERSYM to create the new plotting symbol 8. Enter:

```
USERSYM, X, Y
```

Generate a simple plot to test the plotting symbol by entering:

```
PLOT, FINDGEN(20), PSYM = 8
```

See Also

PLOT

VALUE_LOCATE

The VALUE_LOCATE function finds the intervals within a given monotonic vector that brackets a given set of one or more search values. This function is useful for interpolation and table-lookup, and is an adaptation of the locate() routine in Numerical Recipes. VALUE_LOCATE uses the bisection method to locate the interval.

Syntax

Result = VALUE_LOCATE (*Vector*, *Value* [, /L64])

Return Value

Each return value, *Result* [*i*], is an index, *j*, into *Vector*, corresponding to the interval into which the given *Value* [*i*] falls. The returned values are in the range $-1 \le j \le N-1$, where *N* is the number of elements in the input vector.

If *Vector* is monotonically increasing, the result *j* is:

if $j = -1$	*Value* [*i*] < *Vector* [0]
if $0 \le j < N-1$	*Vector* [*j*] ≤ *Value* [*i*] < *Vector* [*j*+1]
if $j = N-1$	*Vector* [*N*–1] ≤ *Value* [*i*]

If *Vector* is monotonically decreasing

if $j = -1$	*Vector* [*0*] ≤ *Value* [*i*]
if $0 \le j < N-1$	*Vector* [*j*+1] ≤ *Value* [*i*] < *Vector* [*j*]
if $j = N-1$	*Value* [*i*] < *Vector* [*N*–1]

Arguments

Vector

A vector of monotonically increasing or decreasing values. *Vector* may be of type string, or any numeric type except complex, and may not contain the value NaN (not-a-number).

Value

The value for which the location of the intervals is to be computed. *Value* may be either a scalar or an array. The return value will contain the same number of elements as this parameter.

Keywords

L64

By default, the result of VALUE_LOCATE is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases.

Note

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

Example

```
; Define a vector of values.
vec = [2,5,8,10]

; Compute location of other values within that vector.
loc = VALUE_LOCATE(vec, [0,3,5,6,12])
PRINT, loc
```

IDL prints:

```
-1   0   1   1   3
```

VARIANCE

The VARIANCE function computes the statistical variance of an *n*-element vector.

Syntax

Result = VARIANCE(*X* [, /DOUBLE] [, /NAN])

Arguments

X

An *n*-element, floating-point or double-precision vector.

Keywords

DOUBLE

If this keyword is set, VARIANCE performs its computations in double precision arithmetic and returns a double precision result. If this keyword is not set, the computations and result depend upon the type of the input data (integer and float data return float results, while double data returns double results).

NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications* for more information on IEEE floating-point values.)

Example

```
; Define the n-element vector of sample data:
x = [1, 1, 1, 2, 5]
; Compute the variance:
result = VARIANCE(x)
PRINT, result
```

IDL prints:

```
3.00000
```

See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, STDDEV, SKEWNESS

VAX_FLOAT

The VAX_FLOAT function performs one of two possible actions:

1. Determine, and optionally change, the default value for the VAX_FLOAT keyword to the OPEN procedures and the CALL_EXTERNAL function.
2. Determine if an open file unit has the VAX_FLOAT attribute set.

See the discussion of VAX floating-point conversion in Appendix A, "VMS Floating-Point Arithmetic in IDL" in *Building IDL Applications* and the VAX_FLOAT keyword to "OPEN" on page 959 for more on the VAX floating-point conversion issue.

Syntax

Result = VAX_FLOAT([*Default*] [, FILE_UNIT=*lun*])

Arguments

Default

Default is used to change the default value of the VAX_FLOAT keyword to the OPEN procedures and the CALL_EXTERNAL function. A value of 0 (zero) makes the default for those keywords False. A non-zero value makes the default True. Specifying *Default* in conjunction with the FILE_UNIT keyword will cause an error.

Note

If the FILE_UNIT keyword is *not* specified, the value returned from VAX_FLOAT is the default value *before* any change is made. This is the case even if *Default* is specified. This allows you to get the old setting and change it in a single operation.

Keywords

FILE_UNIT

Set this keyword equal to the logical file unit number (LUN) of an open file. VAX_FLOAT returns True (1) if the file was opened with the VAX_FLOAT attribute, or False (0) otherwise. Setting the FILE_UNIT keyword when the *Default* argument is specified will cause an error.

Example

To determine if the default VAX_FLOAT keyword value for OPEN and CALL_EXTERNAL is True or False:

```
default_vax_float = VAX_FLOAT()
```

To determine the current default value of the VAX_FLOAT keyword for OPEN and CALL_EXTERNAL and change it to True (1) in a single operation:

```
old_vax_float = VAX_FLOAT(1)
```

To determine if the file currently open on logical file unit 1 was opened with the VAX_FLOAT keyword set:

```
file_is_vax_float = VAX_FLOAT(FILE_UNIT=1)
```

See Also

CALL_EXTERNAL, OPEN, "Command Line Options" in Chapter 4 of *Using IDL*, and Appendix A, "VMS Floating-Point Arithmetic in IDL" in *Building IDL Applications*.

VECTOR_FIELD

The VECTOR_FIELD procedure is used to place colored, oriented vectors of specified length at each vertex in an input vertex array. The output can be sent directly to an IDLgrPolyline object. The generated display is generally referred to as a hedgehog display and is used to convey various aspects of a vector field.

Syntax

VECTOR_FIELD, *Field*, *Outverts*, *Outconn* [, ANISOTROPY=*array*] [, SCALE=*value*] [, VERTICES=*array*]

Arguments

Field

Input vector field array. This can be a [3, *x*, *y*, *z*] array or a [2, *x*, *y*] array. The leading dimension is the vector quantity to be displayed.

Outverts

Output vertex array ([3, *N*] or [2, *N*] array of floats). Useful if the routine is to be used with Direct Graphics or the user wants to manipulate the data directly.

Outconn

Output polyline connectivity array to be applied to the output vertices.

Keywords

ANISOTROPY

Set this keyword to a two- or three-element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0] for three-dimensional data and [1.0, 1.0] for two-dimensional data.

SCALE

Set this keyword to a scalar scaling factor. All vector lengths are multiplied by this value. The default is 1.0.

VERTICES

Set this keyword to a [3, *n*] or [2, *n*] array of points. If this keyword is set, the vector field is interpolated at these points. The resulting interpolated vectors are displayed as line segments at these locations. If the keyword is not set, each spatial sample point in the input Field grid is used as the base point for a line segment.

VEL

The VEL procedure draws a velocity (flow) field with arrows following the field proportional in length to the field strength. Arrows are composed of a number of small segments that follow the streamlines.

This routine is written in the IDL language. Its source code can be found in the file `vel.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

VEL, *U*, *V* [, NVECS=*value*] [, XMAX= *value*{*xsize*/*ysize*}]
[, LENGTH=*value*{*longest*/*steps*}] [, NSTEPS=*value*] [, TITLE=*string*]

Arguments

U

The X component at each point of the vector field. *U* must be a 2D array.

V

The Y component at each point of the vector field. *V* must have the same dimensions as *U*.

Keywords

LENGTH

The length of each arrow line segment expressed as a fraction of the longest vector divided by the number of steps. The default is 0.1.

NSTEPS

The number of shoots or line segments for each arrow. The default is 10.

NVECS

The number of vectors (arrows) to draw. If this keyword is omitted, 200 vectors are drawn.

TITLE

A string containing the title for the plot.

XMAX

X axis size as a fraction of Y axis size. The default is 1.0. This argument is ignored when !P.MULTI is set.

Example

```
; Create a vector of X values:
X = DIST(20)

; Create a vector of Y values:
Y = SIN(X)*100

; Plot the vector field:
VEL, X, Y
```

See Also

FLOW3, PLOT_FIELD, VELOVECT

VELOVECT

The VELOVECT procedure produces a two-dimensional velocity field plot. A directed arrow is drawn at each point showing the direction and magnitude of the field.

This routine is written in the IDL language. Its source code can be found in the file `velovect.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

VELOVECT, *U*, *V* [, *X*, *Y*] [, COLOR=*index*] [, MISSING=*value* [, /DOTS]] [, LENGTH=*value*] [, /OVERPLOT] [Also accepts all PLOT keywords]

Arguments

U

The X component of the two-dimensional field. *U* must be a two-dimensional array.

V

The Y component of the two dimensional field. *V* must have the same dimensions as *U*.

X

Optional abcissae values. *X* must be a vector with a length equal to the first dimension of *U* and *V*.

Y

Optional ordinate values. *Y* must be a vector with a length equal to the second dimension of *U* and *V*.

Keywords

Note

Keywords not described here are passed directly to the PLOT procedure and may be used to set options such as TITLE, POSITION, NOERASE, etc.

COLOR

Set this keyword equal to the color index used for the plot.

DOTS

Set this keyword to 1 to place a dot at each missing point. Set this keyword to 0 or omit it to draw nothing for missing points. Has effect only if MISSING is specified.

LENGTH

Set this keyword equal to the length factor. The default of 1.0 makes the longest (*U*,*V*) vector the length of a cell.

MISSING

Set this keyword equal to the missing data value. Vectors with a length greater than MISSING are ignored.

OVERPLOT

Set this keyword to make VELOVECT “overplot”. That is, the current graphics screen is not erased, no axes are drawn, and the previously established scaling remains in effect.

PLOT Keywords

In addition to the keywords described above, all other keywords accepted by the PLOT procedure are accepted by VELOVECT. See PLOT.

Example

```
; Create some random data:
U = RANDOMN(S, 20, 20)
V = RANDOMN(S, 20, 20)

; Plot the vector field:
VELOVECT, U, V

; Plot the field, using dots to represent vectors with values
; greater than 18:
VELOVECT, U, V, MISSING=18, /DOTS

; Plot with a title. Note that the XTITLE keyword is passed
; directly to the PLOT procedure:
VELOVECT, U, V, MISSING=18, /DOTS, XTITLE='Random Vectors'
```

See Also

FLOW3, PLOT, PLOT_FIELD, VEL

VERT_T3D

The VERT_T3D function transforms a 3D array by a 4x4 transformation matrix and returns the transformed array. The 3D points are typically an array of polygon vertices that were generated by SHADE_VOLUME or MESH_OBJ.

This routine is written in the IDL language. Its source code can be found in the file `vert_t3d.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = VERT_T3D(*Vertex_List* [, MATRIX=*4x4_array*] [, /NO_COPY] [, /NO_DIVIDE [, SAVE_DIVIDE=*variable*]])

Arguments

Vertex_List

A 3 x *n* array of 3D coordinates to transform.

Keywords

DOUBLE

Set this keyword to a nonzero value to indicate that the returned coordinates should be double-precision. If this kewyord is not set, the default is to return single-precision coordinates (unless double-precision argumetns are input, in which case the DOUBLE keyword is implied to be non-zero).

MATRIX

The 4x4 transformation matrix to use. The default is to use the system viewing matrix (!P.T).

NO_COPY

Normally, a copy of *Vertex_list* is transformed and the original *Vertex_list* is preserved. If NO_COPY is set, however, then the original *Vertex_List* will be undefined after the call to VERT_T3D. Using the NO_COPY requires less memory.

NO_DIVIDE

Normally, when a [*x*, *y*, *z*, 1] vector is transformed by a 4x4 matrix, the final homogeneous coordinates are obtained by dividing the *x*, *y*, and *z* components of the result vector by the fourth element in the result vector. Setting the NO_DIVIDE

keyword will prevent VERT_T3D from performing this division. In some cases (usually when a perspective transformation is involved) the fourth element in the result vector can be very close to (or equal to) zero.

SAVE_DIVIDE

Set this keyword to a named variable that will hold receive the fourth element of the transformed vector(s). If *Vertex_list* is a vector then SAVE_DIVIDE is a scalar. If *Vertex_list* is an array then SAVE_DIVIDE is an array of *n* elements. This keyword only has effect when the NO_DIVIDE keyword is set.

Example

Transform four points representing a square in the x-y plane by first translating +2.0 in the positive X direction, and then rotating 60.0 degrees about the Y axis.

```
points = [[0.0, 0.0, 0.0], [1.0, 0.0, 0.0], $
          [1.0, 1.0, 0.0], [0.0, 1.0, 0.0]]
T3D, /RESET
T3D, TRANSLATE=[2.0, 0.0, 0.0]
T3D, ROTATE=[0.0, 60.0, 0.0]
points = VERT_T3D(points)
```

See Also

T3D

VOIGT

The VOIGT function returns the intensity of an atomic absorption line profile (also known as a VOIGT profile) based on the Voigt damping parameter *a* and the frequency offset *u*, in units of the Doppler width. The result is always floating-point and has the same structure as the arguments. Note that *a* and *u* should not both be vectors.

The returned line profile $\phi(a, u)$ is defined as:

$$\phi(a, u) \equiv \frac{H(a, u)}{\Delta\nu_D\sqrt{\pi}}$$

where *H* is the classical Voigt function:

$$H(a, u) = \frac{a}{\pi}\int_{-\infty}^{\infty}\frac{e^{-y^2}dy}{a^2 + (u - y)^2}$$

The Doppler width $\Delta\nu_D$ (assuming no turbulence), is defined as:

$$\Delta\nu_D = \frac{\nu_0}{c}b = \frac{\nu_0}{c}\sqrt{2kT/m}$$

where ν_0 is the line center frequency. The dimensionless frequency offset *u* and the damping parameter *a* are determined by:

$$u = \frac{\nu - \nu_0}{\Delta\nu_D}$$

$$a = \frac{\Gamma}{4\pi\Delta\nu_D}$$

Here, Γ is the transition rate:

$$\Gamma = \gamma + 2\nu_{col}$$

where γ is the spontaneous decay rate, and ν_{col} is the atomic collision rate. See *Radiative Processes in Astrophysics* by G. B. Rybicki and A. P. Lightman (1979) p 291 for more information. The algorithm is from Armstrong, *JQSRT 7*, 85. (1967).

Syntax

Result = VOIGT(*A*, *U*)

Arguments

A

The Voigt damping parameter.

U

The dimensionless frequency offset in Doppler widths.

See Also

LEEFILT, ROBERTS, SOBEL

VORONOI

The VORONOI procedure computes the Voronoi polygon of a point within an irregular grid of points, given the Delaunay triangulation. The Voronoi polygon of a point contains the region closer to that point than to any other point.

For interior points, the polygon is constructed by connecting the midpoints of the lines connecting the point with its Delaunay neighbors. Polygons are traversed in a counterclockwise direction.

For exterior points, the set is described by the midpoints of the connecting lines, plus the circumcenters of the two triangles that connect the point to the two adjacent exterior points.

This routine is written in the IDL language. Its source code can be found in the file `voronoi.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

VORONOI, *X*, *Y*, *I0*, *C*, *Xp*, *Yp*, *Rect*

Arguments

X

An array containing the X locations of the points.

Y

An array containing the Y locations of the points.

I0

An array containing the indices of the points.

C

A connectivity list from the Delaunay triangulation. This list is produced with the CONNECTIVITY keyword of the TRIANGULATE procedure.

Xp, Yp

Named variables that will contain the X and Y vertices of Voronoi polygon.

Rect

The bounding rectangle: [Xmin, Ymin, Xmax, Ymax]. Because the Voronoi polygon (VP) for points on the convex hull extends to infinity, a clipping rectangle must be supplied to close the polygon. This rectangle has no effect on the VP of interior points. If this rectangle does not enclose all the Voronoi vertices, the results will be incorrect. If this parameter, which must be a named variable, is undefined or set to a scalar value, it will be calculated.

Example

To draw the Voronoi polygons of each point of an irregular grid:

```
N = 20

; Create a random grid of N points:
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; Triangulate it:
TRIANGULATE, X, Y, tr, CONN=C

FOR I=0, N-1 DO BEGIN & $
   ; Get the ith polygon:
   VORONOI, X, Y, I, C, Xp, Yp & $
      ; Draw it:
      POLYFILL, Xp, Yp, COLOR = (I MOD 10) + 2 & $
ENDFOR
```

See Also

TRIANGULATE

VOXEL_PROJ

The VOXEL_PROJ function generates visualizations of volumetric data by computing 2D projections of a colored, semi-transparent volume. Parallel rays from any given direction are cast through the volume, onto the viewing plane. User-selected colors and opacities can be assigned to arbitrary data ranges, simulating the appearance of the materials contained within the volume.

The VOXEL_PROJ function can be combined with the Z-buffer to render volume data over objects. Cutting planes can also be specified to view selected portions of the volume. Other options include: selectable resolution to allow quick "preview" renderings, and average and maximum projections.

VOXEL_PROJ renders volumes using an algorithm similar to the one described by Drebin, Carpenter, and Hanrahan, in "Volume Rendering", *Computer Graphics*, Volume 22, Number 4, August 1988, pp. 125-134, but without the surface extraction and enhancement step.

Voxel rendering can be quite time consuming. The time required to render a volume is proportional to the viewing areas size, in pixels, times the thickness of the volume cube in the viewing direction, divided by the product of the user-specified X, Y, and Z steps.

Syntax

Result = VOXEL_PROJ(*V* [, *RGBO*] [, BACKGROUND=*array*] [, CUTTING_PLANE=*array*] [, /INTERPOLATE] [, /MAXIMUM_INTENSITY] [, STEP=*[Sx*, *Sy*, *Sz]*] [, XSIZE=*pixels*] [, YSIZE=*pixels*] [, ZBUFFER=*int_array*] [, ZPIXELS=*byte_array*])

Arguments

V

A three-dimensional array containing the volume to be rendered. This array is converted to byte type if necessary.

RGBO

This optional parameter is used to specify the look-up tables that indicate the color and opacity of each voxel value. This argument can be one of the following types:

- A (256, 4) byte array for TrueColor rendering. This array represents 256 sets of red, green, blue, and opacity (RGBO) components for each voxel value,

scaled into the range of bytes (0 to 255). The R, G, and B components should already be scaled by the opacity. For example, if a voxel value of 100 contains a material that is red, and 35% opaque, the RGBO values should be, respectively: [89, 0, 0, 89] because 255 * 0.35 = 89. If more than one material is present, the RGBO arrays contain the sum of the individual RGBO arrays. The content and shape of the RGBO curves is highly dependent upon the volume data and experimentation is often required to obtain the best display.

- A (256, 2) byte array for volumes with only one material or monochrome rendering. This array represents 256 sets of pixel values and their corresponding opacities for each voxel value.
- If this argument is omitted, the average projection method, or maximum intensity method (if the MAXIMUM_INTENSITY keyword is set) is used.

Keywords

BACKGROUND

A one- or three-element array containing the background color indices. The default is (0,0,0), yielding a black background with most color tables.

CUTTING_PLANE

A floating-point array specifying the coefficients of additional cutting planes. The array has dimensions of (4, N), where N is the number of additional cutting planes from 1 to 6. Cutting planes are constraints in the form of:

C[0] * X + C[1] * Y + C[2] * Z + D > 0

The X, Y, and Z coordinates are specified in voxel coordinates. For example, to specify a cutting plane that excludes all voxels with an X value greater than 10:

CUTTING_PLANE = [-1.0, 0, 0, 10.], for the constraint: -X + 10 > 0.

INTERPOLATE

Set this keyword to use tri-linear interpolation to determine the data value for each step on a ray. Otherwise, the nearest-neighbor method is used. Setting this keyword improves the quality of images produced, especially when the volume has low resolution in relation to the size of the viewing plane, at the cost of more computing time.

MAXIMUM_INTENSITY

Set this keyword to make the value of each pixel in the viewing plane the maximum data value along the corresponding ray. The *RGBO* argument is ignored if present.

STEP

Set this keyword to a three-element vector, [*Sx*, *Sy*, *Sz*], that controls the resolution of the resulting projection. The first two elements contain the step size in the X and Y view plane, in pixels. The third element is the sampling step size in the Z direction, given in voxels. *Sx* and *Sy* must be integers equal to or greater than one, while *Sz* can contain a fractional part. If *Sx* or *Sy* are greater than one, the values of intermediate pixels in the output image are linearly interpolated. Higher step sizes require less time because fewer rays are cast, at the expense of lower resolution in the output image.

XSIZE

The width, in pixels, of the output image. If this keyword is omitted, the output image is as wide as the currently-selected output device.

YSIZE

The height, in pixels, of the output image. If this keyword is omitted, the output image is as tall as the currently selected output device.

ZBUFFER

An integer array, with the same width and height as the output image, that contains the depth portion of the Z-buffer. Include this parameter to combine the previously-read contents of a Z-buffer with a voxel rendering. See the third example, below, for details.

ZPIXELS

A byte array, with the same width and height as the output image, that contains the image portion of the Z-buffer. Include this parameter to combine the contents of a Z-buffer with a voxel rendering. See the third example, below, for details.

Examples

Example 1

In the following example, assume that variable `v` contains a volume of data, with dimensions `Vx` by `Vy` by `Vz`. The volume contains two materials, muscle tissue represented by a voxel range of 50 to 70, that we want to render with red color, and an opacity of 20; and bone tissue represented by a voxel range of 220-255, that we want to render with white color, and an opacity of 50:

```
; Create the opacity vector:
rgbo = BYTARR(256,4)

; Red and opacity for muscle:
```

```
rgbo[50:70, [0,3]] = 20

; White and opacity for bone:
rgbo[220:255, *] = 50
```

Example 2

Although it is common to use trapezoidal or Gaussian functions when forming the RGBO arrays, this example uses rectangular functions for simplicity.

```
; Set up the axis scaling and default rotation:
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Compute projected image:
C = VOXEL_PROJ(V, rgbo)

; Convert from 24-bit to 8-bit image and display:
TV, COLOR_QUAN(C, 3, R, G, B)

; Load quantized color tables:
TVLCT, R, G, B
```

This example required approximately 27 seconds on a typical workstation to compute the view in a 640- by 512-pixel viewing window. Adding the keyword `STEP=[2,2,1]` in the call to VOXEL_PROJ decreased the computing time to about 8 seconds, at the expense of slightly poorer resolution.

When viewing a volume with only one constituent, the RGBO array should contain only an intensity/opacity value pair. To illustrate, if in the above example, only muscle was of interest we create the RGBO argument as follows:

```
; Create an empty 256 x 2 array:
rgbo = BYTARR(256,2)

; Intensity and opacity for muscle:
rgbo[50:70, *] = 20
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Compute and display the projected image:
TV, VOXEL_PROJ(V, rgbo)

; Create color table array for red:
C = (FINDGEN(256)/255.) # [255., 0., 0]

; Load colors:
TVLCT, C[*,0], C[*,1], C[*,2]
```

Example 3

This example demonstrates combining a volume with the contents of the Z-buffer:

```
; Set plotting to Z-buffer:
SET_PLOT, 'Z'

; Turn on Z buffering:
DEVICE, /Z_BUFFER

; Set scaling:
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Draw a polygon at z equal to half the depth:
POLYFILL, [0, Vx-1, Vx-1, 0], [0, 0, Vy-1, Vy-1], Vz/2., /T3D

; Read pixel values from the Z-buffer:
zpix = TVRD()

; Read depth values from the Z-buffer:
zbuff = TVRD(/WORDS,/CHAN)

; Back to display window:
SET_PLOT, 'X'

; Compute the voxel projection and use the ZPIXELS and ZBUFFER
; keywords to combine the volume with the previously-read contents
; of the Z-buffer:
C = VOXEL_PROJ(V, rgbo, ZPIX=zpix, ZBUFF=zbuff)

;Convert from 24-bit to 8-bit image and display.
TV, COLOR_QUAN(C, 3, R, G, B)

; Load the quantized color tables:
TVLCT, R, G, B
```

See Also

POLYSHADE, PROJECT_VOL, RECON3, SHADE_VOLUME

WAIT

The WAIT procedure suspends execution of an IDL program for a specified period. Note that because of other activity on the system, the duration of program suspension may be longer than requested.

Syntax

WAIT, *Seconds*

Arguments

Seconds

The duration of the wait, specified in seconds. This parameter can be a floating-point value to specify a fractional number of seconds.

Example

To make an IDL program suspend execution for about five and one half seconds, use the command:

```
WAIT, 5.5
```

See Also

EXIT, STOP

WARP_TRI

The WARP_TRI function returns an image array with a specified geometric correction applied. Images are warped using control (tie) points such that locations (*Xi, Yi*) are shifted to (*Xo*, *Yo*).

The irregular grid defined by (*Xo, Yo*) is triangulated using TRIANGULATE. Then the surfaces defined by (*Xo, Yo, Xi*) and (*Xo, Yo, Yi*) are interpolated using TRIGRID to get the locations in the input image of each pixel in the output image. Finally, INTERPOLATE is called to obtain the result. Linear interpolation is used by default. Smooth quintic interpolation is used if the QUINTIC keyword is set.

This routine is written in the IDL language. Its source code can be found in the file `warp_tri.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = WARP_TRI(*Xo*, *Yo*, *Xi*, *Yi*, *Image* [, OUTPUT_SIZE=*vector*] [, /QUINTIC] [, /EXTRAPOLATE])

Arguments

Xo, Yo

Vectors containing the locations of the control (tie) points in the output image.

Xi, Yi

Vectors containing the location of the control (tie) points in the input image. *Xi* and *Yi* must be the same length as *Xo* and *Yo*.

Image

The image to be warped. May be any type of data.

Keywords

OUTPUT_SIZE

Set this keyword equal to a 2-element vector containing the size of the output image. If omitted, the output image is the same size as *Image*.

QUINTIC

Set this keyword to use smooth quintic interpolation. Quintic interpolation is slower but the derivatives are continuous across triangles, giving a more pleasing result than the default linear interpolation.

EXTRAPOLATE

Set this keyword to extrapolate outside the convex hull of the tie points. Setting this keyword implies the use of QUINTIC interpolation.

See Also

INTERPOLATE, TRIANGULATE, TRIGRID

WATERSHED

The WATERSHED function applies the morphological watershed operator to a grayscale image. This operator segments images into watershed regions and their boundaries. Considering the gray scale image as a surface, each local minimum can be thought of as the point to which water falling on the surrounding region drains. The boundaries of the watersheds lie on the tops of the ridges. This operator labels each watershed region with a unique index, and sets the boundaries to zero.

Typically, morphological gradients, or images containing extracted edges are used for input to the watershed operator. Noise and small unimportant fluctuations in the original image can produce spurious minima in the gradients, which leads to oversegmentation. Smoothing, or manually marking the seed points are two approaches to overcoming this problem. For further reading, see Dougherty, “An Introduction to Morphological Image Processing”, SPIE Optical Engineering Press, 1992

Syntax

Result = WATERSHED (*Image* [, CONNECTIVITY={4 | 8}])

Return Value

Returns an image of the same dimensions as the input image. Each pixel of the result will be either zero if the pixel falls along the segmentation between basins, or the identifier of the basin in which that pixel falls.

Arguments

Image

The two-dimensional image to be segmented. *Image* is converted to byte type if necessary.

Keywords

CONNECTIVITY

Set this keyword to either 4 (to select 4-neighbor connectivity) or 8 (to select 8-neighbor connectivity). Connectivity indicates which pixels in the neighborhood of a given pixel are sampled during the segmentation process. 4-neighbor connectivity samples only the pixels that are immediately adjacent horizontally and vertically. 8-

neighbor connectivity samples the diagonally adjacent neighbors in addition to the immediate horizontal and vertical neighbors. The default is 4-neighbor connectivity.

Example

The following code crudely segments the grains in the data file in the IDL Demo data directory containing an magnified image of grains of pollen. Note that the IDL Demos must be installed in order to read the image used in this example.

It inverts the image, because the watershed operator finds holes, and the grains of pollen are bright. Next, the morphological closing operator is applied with a disc of radius 9, contained within a 19 by 19 kernel, to eliminate holes in the image smaller than the disc. The watershed operator is then applied to segment this image. The borders of the watershed images, which have pixel values of zero, are then merged with the original image and displayed as white.

```
;Radius of disc...
r = 9

;Create a disc of radius r
disc = SHIFT(DIST(2*r+1), r, r) LE r

;Read the image
READ_JPEG, FILEPATH('pollens.jpg', $
   SUBDIR=['examples','demo','demodata']), a

;Invert the image
b = MAX(a) - a

TVSCL, b, 0

;Remove holes of radii less than r
c = MORPH_CLOSE(b, disc, /GRAY)

TVSCL, c, 1

;Create watershed image
d = WATERSHED(c)

;Display it, showing the watershed regions
TVSCL, d, 2

;Merge original image with boundaries of watershed regions
e = a > (MAX(a) * (d EQ 0b))

TVSCL, e, 3
```

WDELETE

The WDELETE procedure deletes IDL windows.

Syntax

WDELETE [, *Window_Index* [, ...]]

Arguments

Window_Index

A list of one or more window indices to delete. If this argument is not specified, the current window (as specified by the system variable !D.WINDOW) is deleted. If the window being deleted is not the active window, the value of !D.WINDOW remains unchanged. If the window being deleted is the active window, !D.WINDOW is set to the highest numbered window index or to -1 if no windows remain open.

If this window index is the widget ID of a draw widget, that widget is deleted.

Example

Create IDL graphics window number 5 by entering:

```
WINDOW, 5
```

Delete window 5 by entering:

```
WDELETE, 5
```

See Also

WINDOW, WSET, WSHOW

WEOF

The WEOF procedure writes an end of file mark, sometimes called a tape mark, on the designated tape unit at the current position. WEOF is available only under VMS. The tape must be mounted as a foreign volume. See "VMS-Specific Information" in Chapter 8 of *Building IDL Applications*.

Syntax

WEOF, *Unit*

Arguments

Unit

The magnetic tape unit on which the end of file mark is written. This argument must be a number between 0 and 9, and should not be confused with standard file Logical Unit Numbers (LUNs).

See Also

TAPWRT

WF_DRAW

The WF_DRAW procedure draws weather fronts of various types using parametric spline interpolation to smooth the lines. WF_DRAW uses the POLYFILL routine to make the annotations on the front lines.

This routine is written in the IDL language. Its source code can be found in the file `wf_draw.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WF_DRAW, *X*, *Y* [[, /COLD | , FRONT_TYPE=1] | [, /WARM | , FRONT_TYPE=2] | [, /OCCLUDED | , FRONT_TYPE=3] | [, /STATIONARY | , FRONT_TYPE=4] | [, /CONVERGENCE | , FRONT_TYPE=5]] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, INTERVAL=*value*] [, PSYM=*value*] [, SYM_HT=*value*] [, SYM_LEN=*value*] [, THICK=*value*]

Arguments

X, Y

Vectors of abcissae and ordinates defining the front to be drawn.

Keywords

COLD

Set this keyword to draw a cold front. The default is a plain line with no annotations. A cold front can also be specified by setting the keyword FRONT_TYPE = 1.

COLOR

Use this keyword to specify the color to use. The default = !P.COLOR.

CONVERGENCE

Set this keyword to draw a convergence line. A convergence line can also be specified by setting the keyword FRONT_TYPE = 5.

DATA

Set this keyword if X and Y are specified in data coordinates.

DEVICE

Set this keyword if X and Y are specified in device coordinates.

FRONT_TYPE

Set this keyword equal to the numeric index of type of front to draw. Front type indices are as follows: COLD=1, WARM=2, OCCLUDED=3, STATIONARY=4, CONVERGENCE = 5. Not required if plain line is desired or if an explicit front type keyword is specified.

INTERVAL

Use this keyword to specify the spline interpolation interval, in normalized units. The default = 0.01. Larger values give coarser approximations to curves, smaller values make more interpolated points.

NORMAL

Set this keyword if X and Y are specified in normalized coordinates. This is the default.

OCCLUDED

Set this keyword to draw an occluded front. An occluded front can also be specified by setting the keyword FRONT_TYPE = 3.

PSYM

Set this keyword a standard PSYM value to draw a marker on each actual (*X*, *Y*) data point. See "PSYM" on page 2408 for a list of the symbol types.

STATIONARY

Set this keyword to draw a stationary front. A stationary front can also be specified by setting the keyword FRONT_TYPE = 4.

SYM_HT

Use this keyword to specify the height of front symbols, in normalized units. The default = 0.02.

SYM_LEN

Use this keyword to specify the length and spacing factor for front symbols, in normalized units. The default = 0.15.

THICK

Use this keyword to specify the line thickness. The default = 1.0.

WARM

Set this keyword to draw a warm front. A warm front can also be specified by setting the keyword FRONT_TYPE = 2.

Example

This example draws various fronts on a map of the United States. Note that this example code is in the file `wf_draw.pro`, and can be run by entering `test_wf_draw` at the IDL command line.

```
PRO test_wf_draw

 MAP_SET, LIMIT = [25, -125, 50, -70], /GRID, /USA
 WF_DRAW, [ -120, -110, -100], [30, 50, 45], /COLD, /DATA, THICK=2
 WF_DRAW, [ -80, -80, -75], [ 50, 40, 35], /WARM, /DATA, THICK=2
 WF_DRAW, [ -80, -80, -75]-10., [ 50, 40, 35], /OCCLUDED, /DATA,$
    THICK=2
 WF_DRAW, [ -120, -105], [ 40,35], /STATION, /DATA, THICK=2
 WF_DRAW, [ -100, -90, -90], [ 30,35,40], /CONVERG, /DATA, THICK=2

 names=['None','Cold','Warm','Occluded','Stationary','Convergent']
 x = [.015, .30]
 y = 0.04
 dy = 0.05
 ty = N_ELEMENTS(names) * dy + y
 POLYFILL, x[[0,1,1,0]],[0, 0, ty, ty],/NORM, COLOR=!P.BACKGROUND
 FOR i=0, N_ELEMENTS(names)-1 DO BEGIN
    WF_DRAW, x, y, /NORM, FRONT_TYPE=i, THICK=2
    XYOUTS, x[1]+0.015, y[0], names[i], /NORM, CHARS=1.5
    y = y + dy
 ENDFOR

END
```

See Also

ANNOTATE, XYOUTS

WHERE

The WHERE function returns a longword vector that contains the one-dimensional subscripts of the nonzero elements of *Array_Expression*. The length of the resulting vector is equal to the number of nonzero elements in the parameter. Frequently the result of WHERE is used as a vector subscript to select elements of an array using given criteria. If all elements of *Array_Expression* are zero the result of WHERE is a scalar integer with the value –1.

Syntax

Result = WHERE(*Array_Expression* [, *Count*] [, COMPLEMENT=*variable*] [, /L64] [, NCOMPLEMENT=*variable*])

Result

When WHERE Returns –1

If all the elements of *Array_Expression* are zero, WHERE returns a scalar integer with a value of –1. Attempting to use this result as an index into another array results in a "subscripts out of bounds" error. In situations where this is possible, code similar to the following can be used to avoid errors:

```
; Use Count to get the number of nonzero elements:
index = WHERE(array, count)

; Only subscript the array if it's safe:
IF count NE 0 THEN result = array[index]
```

Arguments

Array_Expression

The array to be searched. Both the real and imaginary parts of a complex number must be zero for the number to be considered zero.

Count

A named variable that will receive the number of nonzero elements found in *Array_Expression*. This value is returned as a longword integer.

Note

The system variable !ERR is set to the number of nonzero elements. This effect is for compatibility with previous versions of IDL and should *not* be used in new code. Use the COUNT argument to return this value instead.

Keywords

COMPLEMENT

Set this keyword to a named variable that receives the subscripts of the zero elements of *Array_Expression*. These are the subscripts that are not returned in *Result*. Together, *Result* and COMPLEMENT specify every subscript in *Array_Expression*. If there are no zero elements in *Array_Expression*, COMPLEMENT returns a scalar integer with the value -1.

L64

By default, the result of WHERE is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases.

Note

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

NCOMPLEMENT

Set this keyword to a named variable that receives the number of zero elements found in *Array_Expression*. This value is the number of subscripts that will be returned via the COMPLEMENT keyword if it is specified.

Examples

Example 1

```
; Create a 10-element integer array where each element is
; set to the value of its subscript:
array = INDGEN(10)
PRINT, 'array = ', array

; Find the subscripts of all the elements in the array that have
; a value greater than 5:
```

```
B = WHERE(array GT 5, count, COMPLEMENT=B_C, NCOMPLEMENT=count_c)

; Print how many and which elements met the search criteria:
PRINT, 'Number of elements > 5: ', count
PRINT, 'Subscripts of elements > 5: ', B
PRINT, 'Number of elements <= 5: ', count_c
PRINT, 'Subscripts of elements <= 5: ', B_C
```

IDL prints:

```
array =  0  1  2  3  4  5  6  7  8  9
Number of elements > 5:  4
Subscripts of elements > 5:  6  7  8  9
Number of elements <= 5:  6
Subscripts of elements <= 5:  0  1  2  3  4  5
```

Example 2

The WHERE function behaves differently with different kinds of array expressions. For instance, if a relational operator is used to compare an array, A, with a scalar, B, then every element of A is searched for B. However, if a relational operator is used to compare two arrays, C and D, then a comparison is made between each corresponding element (i.e. C_i & D_i, C_i+1 & D_i+1, etc) of the two arrays. If the two arrays have different lengths then a comparison is only made up to the number of elements for the shorter array. The following example illustrates this behavior:

```
; Compare array, a, and scalar, b:
a = [1,2,3,4,5,5,4,3,2,1]
b = 5
PRINT, 'a = ', a
PRINT, 'b = ', b

result=WHERE(a EQ b)
PRINT,'Subscripts of a that equal b: ', result

; Now compare two arrays of different lengths:
c = [1,2,3,4,5,5,4,3,2,1]
d = [0,2,4]
PRINT, 'c = ', c
PRINT, 'd = ', d

result=WHERE(c EQ d)
PRINT, 'Subscripts of c that equal d: ', result
```

IDL prints:

```
a =  1  2  3  4  5  5  4  3  2  1
b =  5
Subscripts of a that equal b:  4  5
```

```
c =  1  2  3  4  5  5  4  3  2  1
d =  0  2  4
Subscripts of c that equal d: 1
```

Note that WHERE found only one element in the array d that equals an element in array c. This is because only the first three elements of c were searched, since d has only three elements.

See Also

UNIQ

WHILE...DO

The WHILE...DO statement performs its subject statement(s) as long as the expression evaluates to true. The subject is never executed if the condition is initially false.

Note

For information on using WHILE...DO and other IDL program control statements, see Chapter 11, "Program Control" in *Building IDL Applications*.

Syntax

WHILE *expression* DO *statement*

or

WHILE *expression* DO BEGIN

statements

ENDWHILE

Example

```
i = 0
WHILE (i EQ 1) DO PRINT, i
```

Because the expression (which is false in this case) is evaluated before the subject statement is executed, this code yields no output.

WIDGET_BASE

The WIDGET_BASE function is used to create base widgets. Base widgets serve as containers for other widgets.

Note

In most cases, you will want let IDL determine the placement of widgets within the base widget. Do this by specifying either the COLUMN keyword or the ROW keyword. See "Positioning Child Widgets Within a Base" on page 1536 for details.

The returned value of this function is the widget ID of the newly-created base.

Syntax

Result = WIDGET_BASE([*Parent*] [, /ALIGN_BOTTOM | , /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT | , /ALIGN_TOP]
[, APP_MBAR=*variable*{same as mbar on Windows and Motif} | , /MBAR | , /MODAL] [, /BASE_ALIGN_BOTTOM | , /BASE_ALIGN_CENTER | , /BASE_ALIGN_LEFT | , /BASE_ALIGN_RIGHT | , /BASE_ALIGN_TOP]
[, /COLUMN | , /ROW] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*]
[, /EXCLUSIVE | , /NONEXCLUSIVE] [, /FLOATING] [, FRAME=*width*]
[, FUNC_GET_VALUE=*string*] [, /GRID_LAYOUT]
[, GROUP_LEADER=*widget_id*{must specify for modal dialogs}]
[, /KBRD_FOCUS_EVENTS] [, KILL_NOTIFY=*string*] [, /MAP{not for modal bases}] [, /NO_COPY] [, NOTIFY_REALIZE=*string*]
[, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SCROLL{not for modal bases}] [, /SENSITIVE] [, SPACE=*value*{ignored if exclusive or nonexclusive}] [, TITLE=*string*] [, TLB_FRAME_ATTR=*value*{top-level bases only}] [, /TLB_KILL_REQUEST_EVENTS{top-level bases only}]
[, /TLB_SIZE_EVENTS{top-level bases only}] [, /TRACKING_EVENTS]
[, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, XOFFSET=*value*]
[, XPAD=*value*{ignored if exclusive or nonexclusive}] [, XSIZE=*value*]
[, X_SCROLL_SIZE=*value*] [, YOFFSET=*value*] [, YPAD=*value*{ignored if exclusive or nonexclusive}] [, YSIZE=*value*] [, Y_SCROLL_SIZE=*value*])

X Windows Keywords: [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, RNAME_MBAR=*string*]

Arguments

Parent

The widget ID of the parent widget. To create a *top-level* base, omit the *Parent* argument.

Keywords

ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

APP_MBAR

Set this keyword to a named variable that defines a widget application's menubar. On the Macintosh, the menubar defined by APP_MBAR becomes the system menubar (the menubar at the top of the Macintosh screen). On Motif platforms and under Microsoft Windows, the APP_MBAR is treated in exactly the same fashion as the menubar created with the MBAR keyword. See "MBAR" on page 1524 for details on creating menubars.

Warning

You cannot specify both an APP_MBAR and an MBAR for the same top-level base widget. Doing so will cause an error.

To apply actions triggered by menu items to widgets other than the base that includes the menubar, use the KBRD_FOCUS_EVENTS keyword to keep track of which widget has (or last had) the keyboard focus.

BASE_ALIGN_BOTTOM

Set this keyword to make all children of the new base align themselves with the bottom of the base by default. To take effect, you must also set the ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

BASE_ALIGN_CENTER

Set this keyword to make all children of the new base align themselves with the center of the base by default. To take effect, you must also set the COLUMN or ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created. In ROW bases, child widgets will be vertically centered. In COLUMN bases, child widgets will be horizontally centered.

BASE_ALIGN_LEFT

Set this keyword to make all children of the new base align themselves with the left side of the base by default. To take effect, you must also set the COLUMN keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

BASE_ALIGN_RIGHT

Set this keyword to make all children of the new base align themselves with the right side of the base by default. To take effect, you must also set the COLUMN keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

BASE_ALIGN_TOP

Set this keyword to make all children of the new base align themselves with the top of the base by default. To take effect, you must also set the ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

COLUMN

If this keyword is included, the base lays out its children in columns. The value of this keyword specifies the number of columns to be used. The number of child widgets in each column is calculated by dividing the number of child widgets created by the number of columns specified. When one column is filled, a new one is started.

Specifying both the COLUMN and ROW keywords causes an error.

Column Width

The width of each column is determined by the width of the widest widget in that column. If the GRID_LAYOUT keyword is set, all columns are as wide as the widest widget in the base.

Horizontal Size of Widgets

If any of the BASE_ALIGN_* keywords to WIDGET_BASE is set, each widget has its "natural" width, determined either by the value of the widget or by the XSIZE keyword. Similarly, if any of the child widgets specifies one of the ALIGN_* keywords, that widget will have its "natural" width. If none of the BASE_ALIGN_* or (ALIGN_*) keywords are set, all widgets in the base are as wide as their column.

Vertical Placement

Child widgets are placed vertically one below the other, with no extra space. If the GRID_LAYOUT keyword is set, each row is as high as its tallest member.

DISPLAY_NAME

Set this keyword equal to a string that specifies the name of the X Windows display on which the base should be displayed. This keyword has no effect on Microsoft Windows and Macintosh platforms.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

Note

If the base is a top-level base widget that is managed by the XMANAGER procedure, any value specified via the EVENT_PRO keyword is overridden by the value of the EVENT_HANDLER keyword to XMANAGER. Note also that in this situation, if EVENT_HANDLER is not specified in the call to XMANAGER, an event-handler name will be created by appending the string "`_event`" to the application name specified to XMANAGER. This means that there is no reason to specify this keyword for a top-level base that will be managed by the XMANAGER procedure.

EXCLUSIVE

Set this keyword to specify that the base can have only button-widget children and that only one button can be set at a time. These buttons, unlike normal button widgets, have two states—set and unset.

When one exclusive button is pressed, any other exclusive buttons (in the same base) that are currently set are automatically released. Hence, only one button can ever be set at one time.

This keyword can be used to create exclusive button menus. See the CW_BGROUP and CW_PDMENU functions for high-level menu-creation utilities.

Note

If this keyword is set, the XOFFSET and YOFFSET keywords are ignored for any widgets in this base. Exclusive bases are always laid out in columns or rows. If neither the COLUMN nor ROW keyword is specified for an exclusive base, the base defaults to COLUMN layout.

FLOATING

Set this keyword—along with the GROUP_LEADER keyword—to create a "floating" top-level base widget. If the windowing system provides Z-order control, floating base widgets appear above the base specified as their group leader. If the windowing system does not provide Z-order control, the FLOATING keyword has no effect.

The iconizing, layering, and destruction behavior of floating bases and their group leaders is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GRID_LAYOUT

Set this keyword to force the base to have a grid layout, in which all rows have the same height, and all columns have the same width. The row heights and column widths are taken from the largest child widget.

GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. Widget application hierarchies are defined by group membership relationships between top-level widget bases. When a group leader is killed, for any reason, all widgets in the group are also destroyed. Iconizing and layering behavior is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536. (This is not available on the Mac.)

Note

If you specify a floating base (created with the FLOATING keyword) as a group leader, all member bases must also have either the FLOATING or MODAL keywords set. If you specify a modal base (created with the MODAL keyword) as a group leader, all member bases must have the MODAL keyword set as well.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See the "Events" section below for more information.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MAP

Once a widget hierarchy has been realized, it can be mapped (visible) or unmapped (invisible). This keyword specifies the initial map state for the given base and its descendants. Specifying a non-zero value indicates that the base should be mapped when realized (the default). A zero value indicates that the base should be unmapped initially.

After the base is realized, its map state can be altered using the MAP keyword to the WIDGET_CONTROL procedure.

Note

Modal bases cannot be mapped and unmapped.

Warning

Under Microsoft Windows, when a hidden base is realized, then mapped, a Windows resize message is sent by the windowing system. This "extra" resize event is generated before any manipulation of the base widget by the user.

MBAR

Set this keyword to a named variable to cause a menubar to be placed at the top of the base (the base must be a top-level base). The menubar is itself a special kind of base widget that can only have buttons as children. Upon return, the named variable contains the widget ID of the new menubar base. This widget ID can then be used to

fill the menubar with pulldown menus. For example, the following widget creation commands first create a base with a menubar, then populate the menubar with a simple pulldown menu (CW_PDMENU could also have been used to construct the pulldown menu):

```
base = WIDGET_BASE(TITLE = 'Example', MBAR=bar)
file_menu = WIDGET_BUTTON(bar, VALUE='File', /MENU)
file_bttn1=WIDGET_BUTTON(file_menu, VALUE='Item 1',$
   UVALUE='FILE1')
file_bttn2=WIDGET_BUTTON(file_menu, VALUE='Item 2',$
   UVALUE='FILE2')
```

Note that to set X Window System resources for menubars created with this keyword, you must use the RNAME_MBAR keyword rather than the RESOURCE_NAME keyword.

If you use CW_PDMENU to create a menu for the menubar, be sure to set the MBAR keyword to that function as well.

Note also that the size returned by the GEOMETRY keyword to WIDGET_INFO does not include the size of the menubar.

Note

To control the system menubar on the Macintosh, use the APP_MBAR keyword. On Windows and Motif platforms the MBAR and APP_MBAR keywords are equivalent.

Warning

You cannot specify both the MBAR and MODAL keywords for the same widget. Doing so will cause an error.

To apply actions triggered by menu items to widgets other than the base that includes the menubar, use the KBRD_FOCUS_EVENTS keyword to keep track of which widget has (or last had) the keyboard focus.

MODAL

Set this keyword to create a modal dialog. Modal dialogs can have default and cancel buttons associated with them. Default buttons are highlighted by the window system and respond to a press on the “Return” or “Enter” keys as if they had been clicked on. Cancel buttons respond to a press on the “Escape” key as if they had been clicked on. See the DEFAULT_BUTTON and CANCEL_BUTTON keywords to WIDGET_CONTROL for details.

Note

Modal dialogs must have a group leader. Specify the group leader for a modal top-level base via the GROUP_LEADER keyword.

Modal dialogs cannot be scrollable, nor can they support menubars. Setting the SCROLL, MBAR, or APP_MBAR keywords in conjunction with the MODAL keyword will cause an error. Modal dialogs cannot be mapped or unmapped. Setting the MAP keyword on a modal base will cause an error.

Note

On Windows platforms, the group leader of a modal base must be realized before the modal base itself can be realized. If the group leader has not been realized, it will be realized automatically.

The iconizing, layering, and destruction behavior of modal bases and their group leaders is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_BASE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NONEXCLUSIVE

Set this keyword to specify that the base can only have button widget children. These buttons, unlike normal button widgets, have two states—set and unset. Non-exclusive bases allow any number of the toggle buttons to be set at one time.

Note

If this keyword is set, the XOFFSET and YOFFSET keywords are ignored for any widgets in this base. Non-exclusive bases are always laid out in columns or rows. If neither the COLUMN nor ROW keyword is specified for a non-exclusive base, the base defaults to COLUMN layout.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. Once defined, this name can be used in the user's `.Xdefaults` file to customize widget resources not directly supported via the IDL widget routines. This keyword is accepted by all widget creation routines. This keyword only works with the "X" device and is ignored on platforms that do not use the X Window System (i.e., IDL for Windows, IDL for Macintosh).

RESOURCE_NAME allows unrestricted access to the underlying Motif widgets within the following limitations:

- Users must have the appropriate resources defined in their `.Xdefaults` or application default resource file, or IDL will not see the definitions and they will not take effect.
- Motif resources are documented in the *OSF/Motif Programmer's Reference Manual*. To use them with RESOURCE_NAME, the IDL programmer must determine the type of widget being used by IDL, and then look up the resources that apply to them. Hence, RESOURCE_NAME requires some programmer-level familiarity with Motif.

- Only resources that are not set within IDL can be modified using this mechanism. Although it is not an error to set resources also set by IDL, the IDL settings will silently override user settings. Research Systems does not document the resources used by IDL since the actual resources used may differ from release to release as the IDL widgets evolve. Therefore, you should set only those resources that are obviously not being set by IDL. Among the resources that are not being set by IDL are those that control colors, menu mnemonics, and accelerator keys.

Example

The sample code below produces a pulldown menu named “Menu” with 2 entries named “Item 1” and “Item 2”.

Using the RESOURCE_NAME keyword in conjunction with X resource definitions, we can alter “Item 1” in several ways not possible through the standard IDL widgets interface. We’ll give Item 1 a red background color. We’ll also assign “I” as the keyboard mnemonic. Note that Motif automatically underlines the “I” in the title to indicate this. We’ll also select Meta-F4 as the keyboard accelerator for selecting “Item 1”. If Meta-F4 is pressed while the pointer is anywhere over this application, the effect will be as if the menu was pulled down and “Item 1” was selected with the mouse.

```
; Simple event handler:
PRO test_event, ev
   HELP, /STRUCTURE, ev
END

; Simple widget creation routine:
PRO test

   ; The base gets the resource name "test":
   a = WIDGET_BASE(RESOURCE_NAME = 'test')
   b = WIDGET_BUTTON(a, VALUE='Menu', /MENU)

   ; Assign the Item 1 button the resource name "item1":
   c = WIDGET_BUTTON(b, VALUE='Item 1', $
      RESOURCE_NAME='item1')
   c = WIDGET_BUTTON(b, VALUE='Item 2')
   WIDGET_CONTROL, /REALIZE, a
   XMANAGER, 'test', a
END
```

Note that we gave the overall application the resource name “test”, and the “Item 1” button the resource name “item1”. Now we can use these names in the following `.Xdefaults` file entries:

```
Idl*test*item1*mnemonic: I
Idl*test*item1*accelerator: Meta<Key>F4
Idl*test*item1*acceleratorText: Meta-F4
Idl*test*item1*background: red
```

Note on Specifying Color Resources

If you wish to specify unique colors for your widgets, it is generally a good idea to use a color name (“red” or “lightblue”, for example) rather than specifying an exact color match with a color string (such as “#b1b122222020”). If IDL is not able to allocate an exact color, the entire operation may fail. Specifying a named color implies “closest color match,” an operation that rarely fails.

If you need an exact color match and IDL fails to allocate the color, try modifying the `Idl.colors` resource in the `$IDL_DIR/resource/X11/lib/app-defaults/Idl` file.

RNAME_MBAR

A string containing an X Window System resource name to be applied to the menubar created by the MBAR keyword. This keyword is identical to the RESOURCE_NAME keyword except that the resource it specifies applies only to the menubar.

ROW

If this keyword is included, the base lays out its children in rows. The value of this keyword specifies the number of rows to be used. The number of child widgets in each row is calculated by dividing the number of child widgets created by the number of rows specified. When one row is filled, a new one is started.

Specifying both the COLUMN and ROW keywords causes an error.

Row Height

The height of each row is determined by the height of the tallest widget in that row. If the GRID_LAYOUT keyword is set, all rows are as tall as the tallest widget in the base.

Vertical Size of Widgets

If any of the BASE_ALIGN_* keywords to WIDGET_BASE is set, each widget has its “natural” height, determined either by the value of the widget or by the YSIZE keyword. Similarly, if any of the child widgets specifies one of the ALIGN_* keywords, that widget will have its “natural” height. If none of the BASE_ALIGN_* or (ALIGN_*) keywords are set, all widgets in the base are as tall as their row.

Horizontal Placement

Child widgets are placed horizontally one next to the other, with no extra space. If the GRID_LAYOUT keyword is set, each column is as wide as its widest member.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen.

Note

For the Macintosh, if you set XSIZE or YSIZE to a value less than 48, the base created with the SCROLL keyword will be a minimum of 48x48. If you have not specified values for XSIZE or YSIZE, the base will be set to a minimum of 66x66. If the base is resized, it will jump to the minimum size of 128x64.

Warning

You cannot specify both the SCROLL and MODAL keywords for the same widget. Doing so will cause an error.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

SPACE

The space, in units specified by the UNITS keyword (pixels are the default), between children of a row or column major base. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

TITLE

A string containing the title to be used for the widget. Base widgets use the title only if they are top-level widgets.

Note that if the widget base is not wide enough to contain the specified title, the title may appear truncated. If you must be able to see the full title, you have several alternatives:

- Rearrange the widgets in the base so that the base becomes naturally wide enough. This is the best solution.
- Don't worry about this issue. If the user needs to see the entire label, they can resize the window using the mouse.
- Create the base without using the COLUMN or ROW keywords. Instead, use the XSIZE keyword to explicitly set a usable width. This is an undesirable solution that can lead to strange-looking widget layouts.

TLB_FRAME_ATTR

Set this keyword to one of the values shown in the table below to suppress certain aspects of a top-level base's window frame. This keyword applies only to top-level bases. The settings are merely hints to the window system and may be ignored by some window managers. Valid settings are:

Value	Meaning
1	Base cannot be resized, minimized, or maximized.
2	Suppress display of system menu.

Table 91: Valid Values for TLB_FRAME_ATTR Keyword

Value	Meaning
4	Suppress title bar.
8	Base cannot be closed.
16	Base cannot be moved.

Table 91: Valid Values for TLB_FRAME_ATTR Keyword

This keyword is set bitwise, so multiple effects can be set by adding values together. For example, to make a base that has no title bar (setting 4) and cannot be moved (setting 16), set the TLB_FRAME_ATTR keyword to `4+16`, or 20.

Note

For the Macintosh, you can not suppress the title bar; only modal dialogs use a window without a title bar. Any other use of a suppressed title bar would be contrary to Macintosh Human Interface Guidelines and would create an immovable window.

TLB_KILL_REQUEST_EVENTS

Set this keyword, usable only with top-level bases, to send the top-level base a WIDGET_KILL_REQUEST event if a user tries to destroy the widget using the window manager (by default, widgets are simply destroyed). See the "Events" section below for more information.

Use this keyword to perform complex actions before allowing a widget application to exit. Note that widgets that have this keyword set are responsible for killing themselves after receiving a WIDGET_KILL_REQUEST event—they cannot be destroyed using the usual window system controls.

Use a call to TAG_NAMES with the STRUCTURE_NAME keyword set to differentiate a WIDGET_KILL_REQUEST event from other types of widget events. For example:

```
IF TAG_NAMES(event, /STRUCTURE_NAME) EQ $
   'WIDGET_KILL_REQUEST' THEN ...
```

TLB_SIZE_EVENTS

Set this keyword, when creating a top-level base, to make that base return an event when the base is resized by the user. See the "Events" section below for more information.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer *enters* or *leaves* the region covered by that widget. Widget tracking events are returned as structures with the following definition:

```
{ WIDGET_TRACKING, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID, TOP, and HANDLER are the standard fields found in every widget event. ENTER is 1 if the tracking event is an entry event, and 0 if it is an exit event.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

The user value for a widget can be accessed and modified at any time by using the GET_UVALUE and SET_UVALUE keywords to the WIDGET_CONTROL procedure.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

XPAD

The horizontal space, in units specified by the UNITS keyword (pixels are the default), between child widgets and the edges of a row or column major base. The default value of XPAD is platform dependent. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the scrolling viewport independently of the actual width of the widget.

Use of the X_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when X_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify Y_SCROLL_SIZE when specifying X_SCROLL_SIZE.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

YPAD

The vertical space, in units specified by the UNITS keyword (pixels are the default), between child widgets and the edges of a row or column major base. The default value of YPAD is platform-dependent. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual height of the widget.

Use of the Y_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when Y_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify X_SCROLL_SIZE when specifying Y_SCROLL_SIZE.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of base widgets. In addition to those keywords that affect all widgets, the following are particularly useful: CANCEL_BUTTON, DEFAULT_BUTTON, KBRD_FOCUS_EVENTS.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to base widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: KBRD_FOCUS_EVENTS, MODAL, TLB_KILL_REQUEST_EVENTS.

Exclusive And Non-Exclusive Bases

If the EXCLUSIVE or NONEXCLUSIVE keywords are specified, the base only allows button widget children.

Positioning Child Widgets Within a Base

The standard base widget does not impose any placement constraints on its child widgets. Children of a “bulletin board” base (a base that was created without setting the COLUMN or ROW keywords) have an offset of (0,0) unless an offset is explicitly specified via the XOFFSET or YOFFSET keywords. This means that if you do not specify any of COLUMN, ROW, XOFFSET, or YOFFSET keywords, child widgets will be placed one on top of the other in the upper left corner of the base.

However, laying out widgets using the XSIZE, YSIZE, XOFFSET, and YOFFSET keywords can be both tedious and error-prone. Also, if you want your widget application to display properly on different platforms, you should use the COLUMN and ROW keywords to influence child widget layouts instead of explicitly formatting your interfaces.

When the ROW or COLUMN keywords are specified, the base decides how to lay out its children, and any XOFFSET and YOFFSET keywords specified for such children are ignored.

Positioning Top-Level Bases

When locating a new top level window, some window managers ignore the program’s positioning requests and either choose a position or allow the user to choose. In such cases, the XOFFSET and YOFFSET keywords to WIDGET_BASE will not have an effect. The window manager may provide a way to disable this positioning style. The Motif window manager (mwm) can be told to honor positioning requests by placing the following lines in your `.Xdefaults` file:

```
Mwm*clientAutoPlace: False
Mwm*interactivePlacement: False
```

Iconizing, Layering, and Destroying Groups of Top-Level Bases

Group membership (defined via the GROUP_LEADER keyword) controls the way top-level base widgets are iconized, layered, and destroyed.

Note

A group can contain sub-groups. Group behavior affects all members of a group and its sub-groups. For example, suppose we create three top-level base widgets with the following group hierarchy:

```
base1 = WIDGET_BASE()
base2 = WIDGET_BASE(GROUP_LEADER=base1)
base3 = WIDGET_BASE(GROUP_LEADER=base2)
```

Effectively, two groups are created. One group has `base2` as its leader and `base3` as its member. The other group has `base1` as its leader and both `base2` and `base3` as members. If `base1` is iconized, both `base2` and `base3` are iconized as well. If `base2` is iconized, `base3` is iconized but `base1` is not.

Widgets behave slightly differently when displayed on different platforms, and depending on whether they are floating or modal bases. The following rules apply to groups of widgets within a group leader/member hierarchy. Widgets that do not belong to the same group hierarchy cannot influence each other.

Iconization and Mapping

On Motif and Windows platforms, bases and groups of bases can be *iconized* (or *minimized*) by clicking the system minimize control. Minimization has no meaning on the Macintosh. On all platforms, bases and groups of bases can be *mapped* (made visible) and *unmapped* (made invisible).

Motif

When a group leader is iconized or unmapped, all members of the group are iconized or unmapped as well. Similarly, when a group leader is restored, all members of the group are restored.

Floating and modal bases cannot be iconized or unmapped independently. When the group leader of a floating or modal base is iconized, a single icon is created for both the group leader and the floating or modal base. When the group leader of a floating or modal base is unmapped, both the group leader and floating or modal base are made invisible.

Windows

When a group leader is iconized or unmapped, all members of the group are iconized or unmapped as well. Similarly, when a group leader is restored, all members of the group are restored.

When a floating base is iconized, its group leader is iconized as well and a single icon is created. When a floating base is unmapped, its group leader is unmapped as well.

Modal bases cannot be iconized or unmapped. Other bases cannot be iconized or unmapped until the modal base is dismissed.

Macintosh

On the Macintosh, iconization has no meaning.

When a floating base is unmapped, its group leader is unmapped as well.

Modal bases cannot be unmapped. Other bases cannot be unmapped until the modal base is dismissed.

Layering

Layering is the process by which groups of widgets seem to share the same plane on the display screen. Within a layer on the screen, widgets have a *Z-order*, or front-to-back order, that defines which widgets appear to be on top of other widgets.

Motif

All elements on the screen—widgets, the IDLDE, other Motif applications—share a single layer and have an arbitrary Z-order. There is no special layering of IDL widgets.

Windows and Macintosh

All non-floating and non-modal widgets within a group hierarchy share the same layer—that is, when one group member has the input focus, all members of the group hierarchy are displayed in a layer that appears in front of all other groups or applications. Within the layer, the widgets can have an arbitrary Z-order.

Widgets that are floating or modal always float above their group leaders.

Destruction

When a group leader widget is destroyed, either programmatically or by clicking on the system “close” button, all members of the group and all sub-groups are destroyed as well.

If a modal base is on the display, it must be dismissed before any widget can be destroyed.

Events

Resize Events

Top-level widget bases return the following event structure only when they are resized by the user and the base was created with the TLB_SIZE_EVENTS keyword set:

```
{ WIDGET_BASE, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The X and Y fields return the new width of the base, not including any frame provided by the window manager.

Keyboard Focus Events

Widget bases return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The ENTER field returns 1 (one) if the base is gaining the keyboard focus, or 0 (zero) if the base is losing the keyboard focus.

Kill Request Events

Top-level widget bases return the following event structure only when a user tries to destroy the widget using the window manager and the base was created with the TLB_KILL_REQUEST_EVENTS keyword set:

```
{ WIDGET_KILL_REQUEST, ID:0L, TOP:0L, HANDLER:0L }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine.

See Also

Building IDL Applications Chapter 22, “Widgets”.

WIDGET_BUTTON

The WIDGET_BUTTON function creates button widgets.

The returned value of this function is the widget ID of the newly-created button.

Syntax

Result = WIDGET_BUTTON(*Parent* [, /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT] [, /BITMAP] [, /DYNAMIC_RESIZE] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, /HELP] [, KILL_NOTIFY=*string*] [, /MENU] [, /NO_COPY] [, /NO_RELEASE] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /SEPARATOR] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, X_BITMAP_EXTRA=*bits*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*])

X Windows Keywords: [, RESOURCE_NAME=*string*]

Arguments

Parent

The widget ID of the parent for the new button widget.

Keywords

ALIGN_CENTER

Set this keyword to center justify the button’s text label.

ALIGN_LEFT

Set this keyword to left justify the button’s text label.

ALIGN_RIGHT

Set this keyword to right justify the button’s text label.

BITMAP

Set this keyword to specify that the bitmap specified with the VALUE keyword is a color bitmap. The value of a widget button can be a bitmap as described below under

"Bitmap Button Labels". If you specify a color bitmap with the VALUE keyword, you must also set the /BITMAP keyword.

DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword does not take effect when used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See "About Device Fonts" on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a "hint" to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

HELP

Set this keyword to tell the widget toolkit that this button is a “help” button for a menubar and should be given that appearance. For example, Motif specifies that the help menubar item is displayed on the far right of the menubar. This keyword is ignored in all other contexts and may be ignored by window managers (including that for the Macintosh) that have no such special appearance defined.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MENU

The presence of this keyword indicates that the button will be used to activate a pull-down menu. Such buttons can have button children that are then placed into a pull-down menu.

Under Motif, if the value specified for MENU is greater than 1, the button label is enclosed in a box to indicate that this button is a pull-down menu. See the CW_PDMENU function for a high-level pull-down menu creation utility.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_BUTTON or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NO_RELEASE

Set this keyword to make exclusive and non-exclusive buttons generate only *select* events. This keyword has no effect on regular buttons.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this

technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

SEPARATOR

Set this keyword to tell the widget toolkit that this button is part of a pulldown menu pane and that a separator line should be added directly above this entry. This keyword is ignored in all other contexts.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For

the structure of tracking events, see “TRACKING_EVENTS” on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a widget button is the label for that button. This label can be a string or a bitmap as described below under “Bitmap Button Labels”. If you specify the filename for a color bitmap, you must also set the /BITMAP keyword.

Note

Under Microsoft Windows, including the ampersand character (&) in the value of a button widget causes the window manager to place an underline under the character following the ampersand. (This is a feature of Microsoft Windows, and is generally used to indicate which character is used as a keyboard accelerator for the button.) If you are designing an application that will run on different platforms, you should avoid the use of the ampersand in button value strings.

X_BITMAP_EXTRA

When creating a bitmap button that is not of a “byte-aligned” size (i.e., a dimension is not a multiple of 8), this keyword specifies how many bits of the supplied bitmap must be ignored (within the end byte). For example, to create a 10 by 8 bitmap, you need to supply a 2 by 8 array of bytes and ignore the bottom 6 bits. Therefore, you would specify `X_BITMAP_EXTRA = 6`.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a “hint” to the toolkit and may be ignored in some situations.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a “hint” to the toolkit and may be ignored in some situations.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of button widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, GET_VALUE, INPUT_FOCUS, SET_BUTTON, SET_VALUE, X_BITMAP_EXTRA.

Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to button widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DYNAMIC_RESIZE.

Exclusive And Non-Exclusive Bases

Buttons placed into exclusive or non-exclusive bases (created via the EXCLUSIVE or NONEXCLUSIVE keywords to WIDGET_BASE procedure) are created as two-state “toggle” buttons, which are controlled by such bases.

Events Returned by Button Widgets

Pressing the mouse button while the mouse cursor is over a button widget causes the widget to generate an event. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_BUTTON, ID:0L, TOP:0L, HANDLER:0L, SELECT:0}
```

ID is the widget id of the button generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. SELECT is set to 1 if the button was set, and 0 if released. Normal buttons do not generate events when released, so SELECT will always be 1. However, toggle buttons (created by parenting a button to an exclusive or non-exclusive base) return separate events for the set and release actions.

Bitmap Button Labels

In addition to using a text string as the label of a button (set via the VALUE keyword), a button can have a bitmap label. This allows buttons to contain a graphic symbol. The bitmap is specified via the VALUE keyword. If you specify a color bitmap, you must also specify the /BITMAP keyword, like this:

```
button=WIDGET_BUTTON ( base, VALUE='mybitmap.bmp', /BITMAP )
```

To modify the color bitmap after creation, use the /BITMAP keyword with WIDGET_CONTROL, like this:

```
WIDGET_CONTROL, button. SET_VALUE='mybitmap2.bmp', /BITMAP
```

You can produce appropriate bitmaps in the following ways:

- On Windows, create a color bitmap using the IDL GUIBuilder Bitmap Editor, which creates 16 color bitmaps for buttons. The Bitmap Editor can read and write bitmap files (*.bmp). Using the editor, you can create your own bitmaps, or you can open existing bitmap files and modify them. Open the Bitmap Editor from the Properties dialog for a created button. For more information, see "Using the Bitmap Editor" in Chapter 21 of *Building IDL Applications*.
- Use any color bitmap editor available on your operating system.
- Create a black and white bitmap using an external bitmap editor, and read it into an IDL byte array using the appropriate procedure (READ_BMP, READ_PICT, etc.) and convert the byte array to a bitmap byte array using the CVTTOBM function.
- On an X-Window system, use the X11 bitmap utility to create a black and white bitmap byte array and read it in to IDL using the READ_X11_BITMAP routine.
- Create a black and white bitmap using the XBM_EDIT procedure. This procedure offers several alternatives for the form of the final bitmap.

Although IDL places no restriction on the size of bitmap allowed, the various toolkits may prefer certain sizes.

Transparent Bitmaps

For 16- and 256-color bitmaps, IDL uses the color of the pixel in the lower left corner as the transparent color. All pixels of this color become transparent, allowing the button color to show through. This allows you to use bitmaps that are not rectangular. If you have a rectangular bitmap that you want to use as a button label, you must either draw a border of a different color around the bitmap or save the bitmap as 24-bit (TrueColor). If your bitmap also contains text, make sure the border you draw is a different color than the text, otherwise the text color will become transparent.

See Also

CW_BGROUP, CW_PDMENU

WIDGET_CONTROL

The WIDGET_CONTROL procedure is used to realize, manage, and destroy widget hierarchies. It is often used to change the default behavior or appearance of previously-realized widgets.

Syntax

WIDGET_CONTROL [, *Widget_ID*]

Keywords that apply to all widgets: [, BAD_ID=*variable*] [, /CLEAR_EVENTS]
[, DEFAULT_FONT=*string*{do not specify *Widget_ID*}]
[, /DELAY_DESTROY{do not specify *Widget_ID*}] [, /DESTROY]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FUNC_GET_VALUE=*string*]
[, GET_UVALUE=*variable*] [, GROUP_LEADER=*widget_id*]
[, /HOURGLASS{do not specify *Widget_ID*}] [, KILL_NOTIFY=*string*] [, /MAP]
[, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, /REALIZE] [, /RESET{do not specify *Widget_ID*}]

[, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, SEND_EVENT=*structure*]
[, /SENSITIVE] [, SET_UNAME=*string*] [, SET_UVALUE=*value*] [, /SHOW]
[, TIMER=*value*] [, TLB_GET_OFFSET=*variable*] [, TLB_GET_SIZE=*variable*]
[, /TLB_KILL_REQUEST_EVENTS] [, TLB_SET_TITLE=*string*]
[, TLB_SET_XOFFSET=*value*] [, TLB_SET_YOFFSET=*value*]
[, /TRACKING_EVENTS] [, UNITS={0 | 1 | 2}] [, /UPDATE] [, XOFFSET=*value*]
[, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*]

Keywords that apply to widgets created with widget_base:
[, CANCEL_BUTTON=*widget_id*{for modal bases}]
[, DEFAULT_BUTTON=*widget_id*{for modal bases}] [, /ICONIFY]
[, /KBRD_FOCUS_EVENTS] [, /TLB_KILL_REQUEST_EVENTS]

Keywords that apply to widgets created with widget_button: [, /BITMAP]
[, /DYNAMIC_RESIZE] [, GET_VALUE=*value*] [, /INPUT_FOCUS]
[, /SET_BUTTON] [, SET_VALUE=*value*] [, X_BITMAP_EXTRA=*bits*]

Keywords that apply to widgets created with widget_draw:
[, /DRAW_BUTTON_EVENTS] [, /DRAW_EXPOSE_EVENTS]
[, /DRAW_MOTION_EVENTS] [, /DRAW_VIEWPORT_EVENTS]
[, DRAW_XSIZE=*integer*] [, DRAW_YSIZE=*integer*]
[, GET_DRAW_VIEW=*variable*] [, GET_UVALUE=*variable*]
[, GET_VALUE=*variable*] [, /INPUT_FOCUS] [, SET_DRAW_VIEW=*[x, y]*]

Keywords that apply to widgets created with widget_droplist:
[, /DYNAMIC_RESIZE] [, SET_DROPLIST_SELECT=*integer*]
[, SET_VALUE=*value*]

Keywords that apply to widgets created with widget_label:
[, /DYNAMIC_RESIZE] [, GET_VALUE=*value*] [, SET_VALUE=*value*]

Keywords that apply to widgets created with widget_list:
[, SET_LIST_SELECT=*value*] [, SET_LIST_TOP=*integer*] [, SET_VALUE=*value*]

Keywords that apply to widgets created with widget_slider:
[, GET_VALUE=*value*] [, SET_SLIDER_MAX=*value*]
[, SET_SLIDER_MIN=*value*] [, SET_VALUE=*value*]

Keywords that apply to widgets created with widget_table: [, ALIGNMENT={0 | 1 | 2}] [, /ALL_TABLE_EVENTS] [, AM_PM=*[string, string]*]
[, COLUMN_LABELS=*string_array*] [, COLUMN_WIDTHS=*array*]
[, DAYS_OF_WEEK=*string_array*{7 names}] [, /DELETE_COLUMNS{not for row_major mode}] [, /DELETE_ROWS{not for column_major mode}]
[, /EDITABLE] [, EDIT_CELL=*[integer, integer]*] [, FORMAT=*value*]
[, GET_VALUE=*variable*] [, INSERT_COLUMNS=*value*]
[, INSERT_ROWS=*value*] [, /KBRD_FOCUS_EVENTS]
[, MONTHS=*string_array*{12 names}] [, ROW_LABELS=*string_array*]
[, ROW_HEIGHTS=*array*] [, SET_TABLE_SELECT=*[left, top, right, bottom]*]
[, SET_TABLE_VIEW=*[integer, integer]*] [, SET_TEXT_SELECT=*[integer, integer]*] [, SET_VALUE=*value*] [, TABLE_XSIZE=*columns*]
[, TABLE_YSIZE=*rows*] [, /USE_TABLE_SELECT | , USE_TABLE_SELECT=*[left, top, right, bottom]*] [, /USE_TEXT_SELECT]

Keywords that apply to widgets created with widget_text:
[, /ALL_TEXT_EVENTS] [, /APPEND] [, /EDITABLE] [, GET_VALUE=*variable*]
[, /INPUT_FOCUS] [, /KBRD_FOCUS_EVENTS] [, /NO_NEWLINE]
[, SET_TEXT_SELECT=*[integer, integer]*]
[, SET_TEXT_TOP_LINE=*line_number*] [, SET_VALUE=*value*]
[, /USE_TEXT_SELECT]

Arguments

Widget_ID

The widget ID of the widget to be manipulated. This argument is required by all operations, unless the description of the specific keyword states otherwise. Note that if *Widget_ID* is not provided for a keyword that needs it, that keyword is quietly ignored.

Keywords

Not all keywords to WIDGET_CONTROL apply to all combinations of widgets. In the following list, descriptions of keywords that affect only certain types of widgets include a list of the widgets for which the keyword is useful.

ALIGNMENT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a scalar or 2-D array specifying the alignment of the text within each cell. An alignment of 0 (the default) aligns the left edge of the text with the left edge of the cell. An alignment of 2 right-justifies the text, while 1 results in text centered within the cell. If ALIGNMENT is set equal to a scalar, all table cells are aligned as specified. If ALIGNMENT is set equal to a 2-D array, the alignment of each table cell is governed by the corresponding element of the array. If the USE_TABLE_SELECT keyword is set, then the alignment is changed only for the selected cells.

ALL_TABLE_EVENTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Along with the EDITABLE keyword, ALL_TABLE_EVENTS controls the type of events generated by the table widget. Set the ALL_TABLE_EVENTS keyword to cause the full set of events to be generated. If ALL_TABLE_EVENTS is not set, setting EDITABLE causes only end-of-line events to be generated (which could be used by the programmer as an indication to check the cell value or to set the currently selected cell to the next cell). If EDITABLE is not set, all events are suppressed. See the table below for additional details. Note that the equivalent keyword in the WIDGET_TABLE creation routine is called ALL_EVENTS.

Keywords		Effects	
ALL_TABLE_EVENTS	**EDITABLE**	**Input changes widget contents?**	**Type of events generated**
Not set	Not set	No	None
Not set	Set	Yes	End-of-line insertion
Set	Not set	No	All events
Set	Set	Yes	All events

Table 92: Effects of using the ALL_TABLE_EVENTS and EDITABLE keywords

ALL_TEXT_EVENTS

This keyword applies to widgets created with the WIDGET_TEXT function.

Along with the EDITABLE keyword, ALL_TEXT_EVENTS controls the type of events generated by the text widget. Set the ALL_TEXT_EVENTS keyword to cause the full set of events to be generated. If ALL_TEXT_EVENTS is not set, setting EDITABLE causes only end-of-line events to be generated. If EDITABLE is not set, all events are suppressed. See the table below for additional details. Note that the equivalent keyword in the WIDGET_TEXT creation routine is called ALL_EVENTS.

Keywords		Effects	
ALL_TEXT_EVENTS	**EDITABLE**	**Input changes widget contents?**	**Type of events generated**
Not set	Not set	No	None
Not set	Set	Yes	End-of-line insertion
Set	Not set	No	All events
Set	Set	Yes	All events

Table 93: Effects of using the ALL_TEXT_EVENTS and EDITABLE keywords

AM_PM

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

APPEND

This keyword applies to widgets created with the WIDGET_TEXT function.

When using the SET_VALUE keyword to set the contents of a text widget (as created with the WIDGET_TEXT procedure), setting this keyword indicates that the supplied text should be appended to the existing contents of the text widget rather than replace it.

BAD_ID

This keyword applies to all widgets.

If *Widget_ID* is not a valid widget identifier, this WIDGET_CONTROL normally issues an error and causes program execution to stop. However, if BAD_ID is present and specifies a named variable, the invalid ID is stored into the variable, and this routine quietly returns. If no error occurs, a zero is stored.

CANCEL_BUTTON

This keyword applies to widgets created with the WIDGET_BASE function using the MODAL keyword.

Set this keyword equal to the widget ID of a button widget that will be the cancel button on a modal base widget. Pressing the **Esc** key on the keyboard when a modal widget is on the screen is the same as clicking the button. On Motif and Windows platforms, selecting **Close** from the system menu (generally located at the upper left of the base widget) generates a button event for the **Cancel** button.

CLEAR_EVENTS

This keyword applies to all widgets.

If set, any events generated by the widget hierarchy rooted at *Widget_ID* which have arrived but have not been processed (via the WIDGET_EVENT procedure) are discarded.

COLUMN_LABELS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to an array of strings to be used as labels for the columns of the table. If no label is specified for a column, it receives the default label "*n*" where *n* is the column number. If this keyword is set to the empty string (''), all column labels are set to be empty.

COLUMN_WIDTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to an array of widths for the columns of the table widget. The widths are given in the units specified with the UNITS keyword. If no width is specified for a column, that column is set to the default size, which varies by platform. If COLUMN_WIDTHS is set to a scalar value, all of the column widths are set to that value.

DAYS_OF_WEEK

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

DEFAULT_BUTTON

This keyword applies to widgets created with the WIDGET_BASE function using the MODAL keyword.

Set this keyword equal to the widget ID of a button widget that will be the default button on a modal base widget. The default button is highlighted by the window system. Pressing the **Enter** or **Return** key on the keyboard when a modal widget is on the screen is the same as clicking the button.

DEFAULT_FONT

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

A string containing the name of the default font to be used.

If the font to be used for a given widget is not explicitly specified (via the FONT keyword to the widget creation function), a default supplied by the window system or server is used. Use this keyword to change the default. See "About Device Fonts" on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

DELAY_DESTROY

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

Normally, when the user destroys a widget hierarchy using the window manager, it is immediately removed. This can cause problems for applications that use the background task facility provided by the XMANAGER procedure if the hierarchy is destroyed while a background task is using it.

If DELAY_DESTROY is set, attempts to destroy the hierarchy are delayed until the next attempt to obtain an event for it. Setting DELAY_DESTROY to zero restores the default behavior.

XMANAGER uses this keyword automatically when managing background tasks. It is not expected that applications will need to use it directly.

DELETE_COLUMNS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to delete the currently-selected columns. If the USE_TABLE_SELECT keyword is given as a four element array, the columns specified are deleted.

Warning

You cannot delete columns from a table which displays structure data in /ROW_MAJOR (default) mode because it would change the structure.

DELETE_ROWS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to delete the currently-selected rows. If the USE_TABLE_SELECT keyword is given as a four element array, the rows specified are deleted.

Warning

You cannot delete rows from a table which displays structure data in /COLUMN_MAJOR mode because it would change the structure.

DESTROY

This keyword applies to all widgets.

Set this keyword to destroy the widget and any child widgets in its hierarchy. Any further attempts to use the IDs for these widgets will cause an error.

DRAW_BUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable button press events for draw widgets. Setting a zero value disables such events.

DRAW_EXPOSE_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable viewport expose events for draw widgets. Setting a zero value disables such events.

Note

You must explicitly disable backing store (by setting the RETAIN keyword to WIDGET_DRAW equal to zero) in order to generate expose events.

DRAW_MOTION_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable motion events for draw widgets. Setting a zero value disables such events.

DRAW_VIEWPORT_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable viewport motion events for draw widgets. Setting a zero value disables such events.

DRAW_XSIZE

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to an integer that specifies the new horizontal size for the graphics region (the *virtual size*) of a draw widget in units specified by the UNITS keyword (pixels are the default). For non-scrollable draw widgets, setting this keyword is the same as setting SCR_XSIZE or XSIZE. However, for scrolling draw widgets DRAW_XSIZE is the only way to change the width of the drawable area (XSIZE sets the viewport size).

DRAW_YSIZE

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to an integer that specifies the new vertical size for the graphics region (the *virtual size*) of a draw widget in units specified by the UNITS keyword (pixels are the default). For non-scrollable draw widgets, setting this keyword is the same as setting SCR_YSIZE or YSIZE. However, for scrolling draw widgets DRAW_YSIZE is the only way to change the height of the drawable area (YSIZE sets the viewport size).

DYNAMIC_RESIZE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DROPLIST, and WIDGET_LABEL functions.

Set this keyword to activate (if set to 1) or deactivate (if set to 0) dynamic resizing of the specified WIDGET_BUTTON, WIDGET_LABEL, or WIDGET_DROPLIST widget (see the documentation for the DYNAMIC_RESIZE keyword to those procedures for more information about dynamic widget resizing).

EDITABLE

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Set this keyword to allow direct user editing of the contents of a text or table widget. Normally, the text in text and table widgets is read-only. See the descriptions of the ALL_TABLE_EVENTS and ALL_TEXT_EVENTS keywords for additional details.

EDIT_CELL

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a two-element integer array containing the x (row) and y (column) coordinates of a table cell to put that cell into edit mode. For example, to put the top left cell of a table widget into edit mode, use the following command:

```
WIDGET_CONTROL, table, EDIT_CELL=[0, 0]
```

where *table* is the Widget ID of the table widget.

EVENT_FUNC

This keyword applies to all widgets.

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy given by *Widget_ID*.

This keyword overwrites any event routine supplied by previous uses of the EVENT_FUNC or EVENT_PRO keywords. To specify no event routine, set this keyword to a null string (`''`).

EVENT_PRO

This keyword applies to all widgets.

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy given by *Widget_ID*.

This keyword overwrites any event routine supplied by previous uses of the EVENT_FUNC or EVENT_PRO keywords. To specify no event routine, set this keyword to a null string (`''`).

FORMAT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a single string or an array of strings that specify the format of data displayed within table cells. The string(s) are of the same form as used by the FORMAT keyword to the PRINT procedure, and the default format is the same as that used by the PRINT/PRINTF procedure. If the USE_TABLE_SELECT keyword is set, then the format is changed only for the selected cells.

FUNC_GET_VALUE

This keyword applies to all widgets.

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. The function specified by FUNC_GET_VALUE is called with the widget ID as an argument. The function specified by FUNC_GET_VALUE should return a value for a widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GET_DRAW_VIEW

This keyword applies to widgets created with the WIDGET_DRAW function.

Specifies a named variable which will be assigned the current position of a draw widget viewport. The position is returned as a 2-element integer array giving the X and Y position relative to the lower left corner of the graphics area.

GET_UVALUE

This keyword applies to all widgets.

Set this keyword to a named variable to contain the current user value of the widget.

Each widget can contain a user set value of any data type and organization. This value is not used by the widget in any way, and exists entirely for the convenience of the IDL programmer. This keyword allows you to obtain the current user value.

The user value of a widget can be set with the SET_UVALUE keyword to this routine, or with the UVALUE keyword to the routine that created it.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword (described below) with GET_UVALUE.

GET_VALUE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DRAW, WIDGET_LABEL, WIDGET_SLIDER, WIDGET_TABLE, and WIDGET_TEXT functions.

Note

If you would like information about the values returned for a specific compound widget—beginning with the prefix "CW_"—please refer to the description of the compound widget, which may also include a section titled, "Keywords to WIDGET_CONTROL and WIDGET_INFO". Compound widgets are described in the *Reference Guide*.

Set this keyword to a named variable to contain the current value of the widget. The type of value returned depends on the widget type:

- Button: If the button label is text, it is returned as a string. Attempts to obtain the value of a button with a bitmap label is an error.
- Draw: The value of a draw widget depends on whether the draw widget uses IDL Direct Graphics or IDL Object Graphics. (The type of graphics used is specified by the GRAPHICS_LEVEL keyword to WIDGET_DRAW.) The two possibilities are:

  A. By default, draw widgets use IDL Direct Graphics. In this case, the value of a draw widget is the IDL window ID for the drawing area. This ID is used with procedures such as WSET, WSHOW, etc., to direct graphics to the widget. The window ID is assigned to drawing area widgets at the time they are realized. If the widget has not yet been realized, a value of -1 is returned.

  B. If the draw widget uses IDL Object Graphics (that is, if the GRAPHICS_LEVEL keyword to WIDGET_DRAW is set equal to 2), the value of the draw widget is the object reference of the window object used in the draw widget.

- Label: The label text is returned as a string.
- Slider: The current value of the slider is returned as an integer.

- Table: Normally, the data for the whole table are returned as a two dimensional array or a vector of structures. However, if the USE_TABLE_SELECT keyword is present, the value returned is a subset of the whole data. This may either be a two dimensional array or a vector of (possibly anonymous) structures. If the USE_TEXT_SELECT keyword is set, the value returned is a string corresponding to the currently-selected text in the currently-selected cell.
- Text: The current contents of the text widget are returned as a string array. If the USE_TEXT_SELECT keyword is also specified, only the contents of the current selection are returned.
- Widget types not listed above do not return a value. Attempting to retrieve the value of such a widget causes an error.

The value of a widget can be set with the SET_VALUE keyword to this routine, or with the VALUE keyword to the routine that created it.

GROUP_LEADER

This keyword applies to all widgets.

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

HOURGLASS

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

Set this keyword to turn on an “hourglass-shaped” cursor for all IDL widgets and graphics windows. The hourglass remains in place until the WIDGET_EVENT function attempts to process the next event. Then the previous cursor is reinstated. If an application starts a time-intensive calculation inside an event-handling routine, the hourglass cursor should be used to indicate that the system is not currently responding to events.

ICONIFY

This keyword applies to all widgets.

Set this keyword to a non-zero value to cause the specified widget to become iconified. Set this keyword to zero to open an iconified widget.

INPUT_FOCUS

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DRAW, and WIDGET_TEXT functions.

If *Widget_ID* is a text widget, you can set this keyword to cause the widget to receive the keyboard focus. If *Widget_ID* is a button widget, set this keyword to position the mouse pointer over the button (on Motif), or set the focus to the button so that it can be "pushed" with the spacebar (on Windows). You cannot set the input focus to a button in IDL for Macintosh. If *Widget_ID* is a draw widget, set this keyword to give it the focus in IDL for Macintosh; this allows you to print from the draw widget. This keyword has no effect for other widget types.

Note

You cannot assign the input focus to an unrealized widget.

INSERT_COLUMNS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to the number of columns to be added to the right of the rightmost column of the table. If the USE_TABLE_SELECT keyword is set, the columns are inserted to the left of the current selection.

Warning

You cannot insert columns into a table which displays structure data in /ROW_MAJOR (default) mode because it would change the structure.

INSERT_ROWS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to the number of rows to be added below the bottommost row of the table. If the USE_TABLE_SELECT keyword is set, the rows are inserted above the current selection.

Warning

You cannot insert rows into a table which displays structure data in /COLUMN_MAJOR mode because it would change the structure.

KBRD_FOCUS_EVENTS

This keyword applies to widgets created with the WIDGET_BASE, WIDGET_TABLE, and WIDGET_TEXT functions.

Set this keyword to cause widget keyboard focus events to be issued for the widget whenever the keyboard focus of that widget changes. See the KBRD_FOCUS_EVENTS keywords to WIDGET_BASE, WIDGET_TABLE, and WIDGET_TEXT for details.

KILL_NOTIFY

This keyword applies to all widgets.

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

Use this keyword to change or remove a previously-specified callback procedure for *Widget_ID*. A previously-defined callback can be removed by setting this keyword to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

The CLEANUP keyword to XMANAGER can also be used to specify a procedure to be called when a managed widget dies. The last call to either XMANAGER, CLEANUP or WIDGET_CONTROL, KILL_NOTIFY determines the procedure that is executed when the specified widget dies. Calling XMANAGER with the CLEANUP keyword overrides any previous setting of KILL_NOTIFY. Similarly, calling WIDGET_CONTROL with KILL_NOTIFY overrides any previous setting of CLEANUP.

MANAGED

This keyword applies to all widgets.

This keyword is used by the XMANAGER procedure to mark those widgets that it is currently managing. User applications should not use this keyword directly.

MAP

This keyword applies to all widgets.

Set this keyword to zero to unmap the widget hierarchy rooted at the widget specified by *Widget_ID*. The hierarchy disappears from the screen, but still exists.

The mapping operation applies only to base widgets. If the specified widget is not a base, IDL searches upward in the widget hierarchy until it finds the closest base widget. The map operation is applied to that base.

Set MAP to a nonzero value to re-map the widget hierarchy and make it visible. Normally, the widget is automatically mapped when it is realized, so use of the MAP keyword is not required.

MONTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

NO_COPY

This keyword applies to all widgets.

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

Note

The NO_COPY keyword increases efficiency when sending event structures using the SEND_EVENT keyword to WIDGET_CONTROL.

NO_NEWLINE

This keyword applies to widgets created with the WIDGET_TEXT function.

When setting the value of a multi-line text widget, newline characters are automatically appended to the end of each line of text. The NO_NEWLINE keyword suppresses this action.

NOTIFY_REALIZE

This keyword applies to all widgets.

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. A previously-set callback routine can be removed by setting this keyword to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

This keyword applies to all widgets.

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. The procedure specified by PRO_SET_VALUE is called with 2 arguments— a widget ID and a value. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

REALIZE

This keyword applies to all widgets.

If set, the widget hierarchy is realized. Until the realization step, the widget hierarchy exists only within IDL. Realization is the step of actually creating the widgets on the screen (and mapping them if necessary).

When a previously-realized widget gets a new child widget, the new child is automatically realized.

Tip

Under Microsoft Windows, when a hidden base is realized, then mapped, a Windows resize message is sent by the windowing system. This "extra" resize event is generated before any manipulation of the base widget by the user.

RESET

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword. Set the RESET keyword to destroy every currently active widget. This keyword should be used with caution.

ROW_LABELS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to an array of strings to be used as labels for the rows of the table. If no label is specified for a row, it receives the default label "*n*" where *n* is the row number. If this keyword is set to the empty string (''), all row labels are set to be empty.

ROW_HEIGHTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Note

This keyword is not supported under Microsoft Windows.

Set this keyword equal to an array of heights for the rows of the table widget. The heights are given in any of the units as specified with the UNITS keyword. If no height is specified for a row, that row is set to the default size, which varies by platform. If ROW_HEIGHTS is set to a scalar value, all of the row heights are set to that value.

SCR_XSIZE

This keyword applies to all widgets.

Set this keyword to an integer value that represents the widget's new horizontal size, in units specified by the UNITS keyword (pixels are the default). Attempting to change the size of a widget that is part of a menubar or pulldown menu causes an error. Note that, in many cases, setting this keyword is equivalent to setting the XSIZE keyword. However, this keyword is useful for resizing table, text, list, and scrolling widgets.

SCR_YSIZE

This keyword applies to all widgets.

Set this keyword to an integer value that represents the widget's new vertical size, in units specified by the UNITS keyword (pixels are the default). Attempting to change the size of a widget that is part of a menubar or pulldown menu causes an error. Note

that, in many cases, setting this keyword is equivalent to setting the YSIZE keyword. However, this keyword is useful for resizing table, text, list, and scrolling widgets.

SEND_EVENT

This keyword applies to all widgets.

Set this keyword to a structure containing a valid widget event to be sent to the specified widget. The value of SEND_EVENT *must* be a structure and the first three fields must be ID, TOP, and HANDLER (all of LONG type). Additional fields can be of any type.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword with SEND_EVENT.

SENSITIVE

Set this keyword to control the sensitivity state of a widget after creation. This keyword applies to all widgets. Use the SENSITIVE keyword with the widget creation function to control the initial sensitivity state.

When a widget is sensitive, it has normal appearance and can receive user input. For instance, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, and ignores any input directed at it. If SENSITIVE is zero, the widget hierarchy becomes insensitive. If nonzero, it becomes sensitive.

Sensitivity can be used to control when a user is allowed to manipulate a widget. It should be noted that some widgets do not change their appearance when they are made insensitive, and simply cease generating events.

SET_BUTTON

This keyword applies to widgets created with the WIDGET_BUTTON function.

This keyword allows changing the current state of toggle buttons. If zero, every toggle button in the hierarchy specified by *Widget_ID* is set to the unselected state. If nonzero, the action depends on the type of base holding the buttons. Normally, all buttons are selected. However, exclusive bases may or may not allow more than a single button to be selected in this manner, depending on the toolkit implementation.

SET_DRAW_VIEW

This keyword applies to widgets created with the WIDGET_DRAW function.

A scrollable draw widget provides a large graphics area which is viewed through a smaller viewport. This keyword allows changing the current position of the viewport.

The desired position is specified as a 2-element integer array giving the X and Y position in units specified by the UNITS keyword (pixels are the default) relative to the lower left corner of the graphics area. For example, to position the viewport to the lower left corner of the image:

```
WIDGET_CONTROL, widget, SET_DRAW_VIEW=[0, 0]
```

SET_DROPLIST_SELECT

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to an integer that specifies the droplist element to be current (i.e., the element that is displayed on the droplist button). Positions start at zero. If the specified element is outside the possible range, no new selection is set.

SET_LIST_SELECT

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to an integer scalar or vector that specifies the list element or elements to be highlighted. The previous selection (if there is a selection) is cleared. Positions start at zero. If the specified element is outside the possible range, no new selection in set. Note that the MULTIPLE keyword to WIDGET_LIST must have been set in more than a single list element is specified.

If the selected position is not currently on the screen, the list widget automatically move the current scrolling viewport to make it visible. The resulting topmost visible element is toolkit specific. If you wish to ensure a certain element is at the top of the list, use the SET_LIST_TOP keyword (described below) to explicitly set the viewport.

SET_LIST_TOP

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to an integer that specifies the element of the list widget to the positioned at the top of the scrolling list. If the specified element is outside the range of list elements, nothing happens.

SET_SLIDER_MAX

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to a new maximum value for the specified slider widget.

Note

This keyword does not apply to floating-point sliders created with the CW_FSLIDER function.

SET_SLIDER_MIN

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to a new minimum value for the specified slider widget.

Note

This keyword does not apply to floating-point sliders created with the CW_FSLIDER function.

SET_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to an array of zero-based cell indices, of the form

```
[ left, top, right, bottom ]
```

giving the range of cells to select.

If the selected position is not currently on the screen, the table widget automatically moves the current scrolling viewport to make a portion of it visible. The resulting top-left visible cell is toolkit specific. If you wish to ensure a certain element is at the top of the list, use the SET_TABLE_VIEW keyword to explicitly set the viewport.

SET_TABLE_VIEW

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to a two-element array of zero-based cell indices that specifies the cell of the table widget to the positioned at the top-left of the widget. If the specified cell is outside the range of valid cells, nothing happens.

SET_TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Use this keyword to clear any current selection in the specified table cell or text widget, and either set a new selection, or simply set the text insertion point. To set a selection, specify a two-element integer array containing the starting position and the

length of the selection. For example, to set a selection covering characters 3 though 23:

```
WIDGET_CONTROL, widgetID, SET_TEXT_SELECT=[3, 20]
```

To move the text insertion point without setting a selection, omit the second element, or set it to zero.

SET_TEXT_TOP_LINE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to the zero-based line number of the line to be positioned on the topmost visible line in the text widget's viewport. No horizontal scrolling is performed. Note that this is a line number, not a character offset.

SET_UNAME

This keyword applies to all widgets.

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID. You can set the name at creation time, using the UNAME keyword with the creation function.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

SET_UVALUE

This keyword applies to all widgets.

Each widget can contain a user-set value. This value is not used by IDL in any way, and exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword with SET_UVALUE.

SET_VALUE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DROPLIST, WIDGET_LABEL, WIDGET_LIST, WIDGET_SLIDER, WIDGET_TABLE, and WIDGET_TEXT functions.

Sets the value of the specified widget. The meaning of the value differs between widget types:

- Button: The label to be used for the button. This value can be either a scalar string, or a 2D byte array containing a bitmap.
- Droplist: The contents of the droplist widget (string or string array).
- Label: The text to be displayed by the label widget.
- List: The contents of the list widget (string or string array).
- Slider: The current position of the slider (integer).
- Table: Normally, the data for the whole table is changed to the given data which must be of the form of a two dimensional array or a vector of structures. In this form, the table is resized to fit the given data (unless the TABLE_XSIZE or TABLE_YSIZE keywords are given).

  If the USE_TABLE_SELECT keyword is present, the value given is treated as a subset of the whole data, and only the given range of cells are updated. Used in this form, the type of data stored in the table cannot be changed. The data passed in is converted, as appropriate, to the type of the selected cells. If less data is passed in than fits in the current selection, the cells outside the range of data (but inside the selection) are left unchanged. If more data is passed in than fits in the current selection, the extra data is ignored.

  If the USE_TEXT_SELECT keyword is present, the value must be a string which replaces the currently-selected text in the currently-selected cell.
- Text: The text to be displayed. If the APPEND keyword is also specified, the text is appended to the current contents instead of instead of completely replacing it (string or string array). If the USE_TEXT_SELECT keyword is specified, the new string replaces only the currently-selected text in the text widget.
- Widget types not listed above do not allow the setting of a value. Attempting to set the value of such a widget causes an error.

The value of a widget can also be set with the VALUE keyword to the routine that created it.

SHOW

This keyword applies to all widgets.

Controls the visibility of a widget hierarchy. If set to zero, the hierarchy containing *Widget_ID* is pushed behind any other windows on the screen. If nonzero, the hierarchy is pulled in front.

TABLE_XSIZE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to the number of data columns in the table widget. Note that if the table widget was created with row titles enabled (that is, if the NO_HEADERS keyword to WIDGET_TABLE was *not* set), the table will contain one column more than the number specified by TABLE_XSIZE.

If the table is made smaller as a result of the application of the TABLE_XSIZE keyword, the data outside the new range persists, but the number of columns and/or rows changes as expected. If the table is made larger, the data type of the cells in the new columns is set according to the following rules:

1. If the table was not created with either the ROW_MAJOR or COLUMN_MAJOR keywords set (if the table is an array rather than a vector of structures), the new cells have the same type as all the original cells.
2. If the SET_VALUE keyword is given, the types of all columns are set according to the new structure.
3. If the table was created with the ROW_MAJOR keyword set, and the SET_VALUE keyword is not specified, the cells in the new columns inherit their type from the cells to their left.
4. If the table was created with the COLUMN_MAJOR keyword set, and the SET_VALUE keyword is not specified, any new columns default to type INT.

TABLE_YSIZE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to the number of data rows in the table widget. Note that if the table widget was created with column titles enabled (that is, if the NO_HEADERS keyword to WIDGET_TABLE was *not* set), the table will contain one row more than the number specified by TABLE_YSIZE.

If the table is made smaller as a result of the application of the TABLE_YSIZE keyword, the data outside the new range persists, but the number of columns and/or rows changes as expected. If the table is made larger, the data type of the cells in the new rows is set according to the following rules:

1. If the table was not created with either the ROW_MAJOR or COLUMN_MAJOR keywords set (if the table is an array rather than a vector of structures), the new cells have the same type as all the original cells.
2. If the SET_VALUE keyword is given, the types of all rows are set according to the new structure.
3. If the table was created with the COLUMN_MAJOR keyword set, and the SET_VALUE keyword is not specified, the cells in the new rows inherit their type from the cells above.
4. If the table was created with the ROW_MAJOR keyword set, and the SET_VALUE keyword is not specified, any new rows default to type INT.

TIMER

This keyword applies to all widgets.

If this keyword is present, a WIDGET_TIMER event is generated. Set this keyword to a floating-point value that represents the number of seconds before the timer event arrives. Note that this event is identical to any other widget event except that it contains only the 3 standard event tags. These event structures are defined as:

```
{ WIDGET_TIMER, ID:0L, TOP:0L, HANDLER:0L }
```

It is left to the caller to tell the difference between standard widget events and timer events. The standard way to do this is to use a widget that doesn't normally generate events (e.g., a base or label). Alternately, the TAG_NAMES function can be called with the STRUCTURE_NAME keyword to differentiate a WIDGET_TIMER event from other types of events. For example:

```
IF TAG_NAMES(event, /STRUCTURE_NAME) EQ $
   'WIDGET_TIMER' THEN ...
```

Using the TIMER keyword is more efficient than the background task functionality found in the XMANAGER procedure because it doesn't "poll" like the original background task code. Research Systems will eventually eliminate the background task functionality from XMANAGER. We encourage all users to modify their code to use the TIMER keyword instead.

TLB_GET_OFFSET

This keyword applies to all widgets.

Set this keyword to a named variable in which the offset of the top-level base of the specified widget is returned, in units specified by the UNITS keyword (pixels are the default). The offset is measured in device coordinates relative to the upper-left corner of the screen.

TLB_GET_SIZE

This keyword applies to all widgets.

Set this keyword to a named variable in which the size of the top-level base of the specified widget is returned, in units specified by the UNITS keyword (pixels are the default). The size is returned as a two-element vector that contains the horizontal and vertical size of the base in device coordinates.

TLB_KILL_REQUEST_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Use this keyword to set or clear kill request events for the specified top-level base. For more information on these events see "TLB_KILL_REQUEST_EVENTS" on page 1532.

TLB_SET_TITLE

This keyword applies to all widgets.

Set this keyword to a scalar string to change the title of the specified top-level base after it has been created.

TLB_SET_XOFFSET

This keyword applies to all widgets.

Use this keyword to set the horizontal position of the top level base of the specified widget. The offset is measured from the upper-left corner of the screen to the upper-left corner of the base, in units specified by the UNITS keyword (pixels are the default).

TLB_SET_YOFFSET

This keyword applies to all widgets.

Use this keyword to set the vertical position of the top level base of the specified widget. The offset is measured from the upper-left corner of the screen to the upper-left corner of the base, in units specified by the UNITS keyword (pixels are the default).

TRACKING_EVENTS

This keyword applies to all widgets.

Set this keyword to a non-zero value to enable tracking events for the widget specified by *Widget_ID*. Set the keyword to 0 to disable tracking events for the

specified widget. For a description of tracking events, see “TRACKING_EVENTS” on page 1533.

UNITS

This keyword applies to all widgets.

Use this keyword to specify the unit of measurement used for most widget sizing operations. Set UNITS equal to 0 to specify that all measurements are in pixels (this is the default), to 1 to specify that all measurements are in inches, or to 2 to specify that all measurements are in centimeters.

Note

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_LIST, WIDGET_TABLE, or WIDGET_TEXT.

UPDATE

This keyword applies to all widgets.

Use this keyword to enable (if set to 1) or disable (if set to 0) screen updates for the widget hierarchy to which the specified widget belongs. This keyword is useful for preventing unwanted intermediate screen updates when changing the values of many widgets at once or when adding several widgets to a previously-realized widget hierarchy. When first realized, widget hierarchies are set to update.

Note

Do not attempt to resize a widget on the Windows platform while UPDATE is turned off. Doing so may prevent IDL from updating the screen properly when UPDATE is turned back on.

USE_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to modify the behavior of the ALIGNMENT,COLUMN_WIDTH, FORMAT, GET_VALUE, ROW_HEIGHT, and SET_VALUE keywords. If USE_TABLE_SELECT is set, these other keywords only apply to the currently-selected cells. Normally, these keywords apply to the entire contents of a table widget.

Note

In order to set the format of the currently-selected cells, the value of the FORMAT keyword must be an array of the same dimensions as the selected area.

This keyword can also be specified as a four-element array, of the form

```
[ left, top, right, bottom ]
```

giving the group of cells to act on. In this usage, the value -1 is used to refer to the row or column titles. If row or column titles are selected, this keyword only modifies the behavior of the COLUMN_WIDTH and ROW_HEIGHTS keywords.

Warning

You should set values to -1 only when you can change the labels. For example, on the Macintosh, only COLUMN_WIDTH and ROW_HEIGHT should be set to -1.

USE_TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Set this keyword to modify the behavior of the GET_VALUE and SET_VALUE keywords. If USE_TEXT_SELECT is set, GET_VALUE and SET_VALUE apply only to the current text selection. Normally, these keywords apply to the entire contents of a text widget.

X_BITMAP_EXTRA

This keyword applies to widgets created with the WIDGET_BUTTON function.

When the value of a button widget is a bitmap, the usual width is taken to be 8 times the number of columns in the source byte array. This keyword can be used to indicate the number of bits in the last byte of each row that should be ignored. The value can range between 0 and 7.

XOFFSET

This keyword applies to all widgets.

Set this keyword to an integer value that specifies the widget's new horizontal offset, in units specified by the UNITS keyword (pixels are the default). Attempting to change the offset of a widget that is the child of a ROW or COLUMN base or a widget that is part of a menubar or pulldown menu causes an error.

XSIZE

This keyword applies to all widgets.

Set this keyword to an integer or floating-point value that represents the widget's new horizontal size.

- Text and List widgets: Size is specified in characters. The UNITS keyword is ignored.
- Table widgets: Size is specified in columns. The width of the row labels is automatically added to this value. The UNITS keyword is ignored.
- All other widgets: If the UNITS keyword is present, size is in the units specified. If the UNITS keyword is not present, the size is specified in pixels.

For most non-scrollable widgets, this size is the same as the "screen size" that can be set using the SCR_XSIZE keyword. For scrollable widgets (e.g., scrolling bases and scrolling draw widgets), this keyword adjusts the *viewport* size. Use the DRAW_XSIZE keyword to change the width of the drawing area in scrolling draw widgets. Attempting to resize a widget that is part of a menubar or pulldown menu causes an error.

YOFFSET

This keyword applies to all widgets.

Set this keyword to an integer value that specifies the widget's new vertical offset, in units specified by the UNITS keyword (pixels are the default). Attempting to change the offset of a widget that is the child of a ROW or COLUMN base or a widget that is part of a menubar or pulldown menu causes an error.

YSIZE

This keyword applies to all widgets.

Set this keyword to an integer or floating-point value that represents the widget's new vertical size

- Text and List widgets: Size is specified in lines. The UNITS keyword is ignored.
- Table widgets: Size is specified in rows. The height of the column labels is automatically added to this value. The UNITS keyword is ignored.
- All other widgets: If the UNITS keyword is present, size is in the units specified. If the UNITS keyword is not present, the size is specified in pixels.

For most non-scrollable widgets, this size is the same as the “screen size” that can be set using the SCR_YSIZE keyword. For scrollable widgets (e.g., scrolling bases and scrolling draw and table widgets), this keyword adjusts the *viewport* size. Use the DRAW_YSIZE keyword to change the height of the drawing area in scrolling draw widgets. Attempting to resize a widget that is part of a menubar or pulldown menu causes an error.

See Also

Building IDL Applications Chapter 22, “Widgets”.

WIDGET_DRAW

The WIDGET_DRAW function is used to create draw widgets. Draw widgets are rectangular areas that IDL treats as standard graphics windows. Draw widgets can use either IDL Direct graphics or IDL Object graphics, depending on the value of the GRAPHICS_LEVEL keyword. Any graphical output that can be produced by IDL can be directed to a draw widget. Draw widgets can have optional scroll bars to allow viewing a larger graphics area than could otherwise be displayed in the widget's visible area.

The returned value of this function is the widget ID of the newly-created draw widget.

Note

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD( ) may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly.

Syntax

Result = WIDGET_DRAW(*Parent* [, /APP_SCROLL] [, /BUTTON_EVENTS]
[, /COLOR_MODEL] [, COLORS=*integer*] [, EVENT_FUNC=*string*]
[, EVENT_PRO=*string*] [, /EXPOSE_EVENTS] [, FRAME=*width*]
[, FUNC_GET_VALUE=*string*] [, GRAPHICS_LEVEL=2]
[, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*]
[, /MOTION_EVENTS] [, /NO_COPY] [, NOTIFY_REALIZE=*string*]
[, PRO_SET_VALUE=*string*] [, RENDERER={0 | 1}]
[, RESOURCE_NAME=*string*] [, RETAIN={0 | 1 | 2}] [, SCR_XSIZE=*width*]
[, SCR_YSIZE=*height*] [, /SCROLL] [, /SENSITIVE] [, /TRACKING_EVENTS]
[, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*]
[, /VIEWPORT_EVENTS] [, XOFFSET=*value*] [, XSIZE=*value*]
[, X_SCROLL_SIZE=*width*] [, YOFFSET=*value*] [, YSIZE=*value*]
[, Y_SCROLL_SIZE=*height*])

Arguments

Parent

The widget ID of the parent widget of the new draw widget.

Keywords

APP_SCROLL

Set this keyword to create a scrollable draw widget with horizontal and vertical scrollbars and a draw area canvas with the same size as the viewport. You can specify the size of the viewport using the X_SCROLL_SIZE and Y_SCROLL_SIZE keywords, and the virtual size of the canvas using the XSIZE and YSIZE keywords. If APP_SCROLL is set, the application generates expose and viewport events such as would occur with EXPOSE=1, RETAIN=0, and VIEWPORT_EVENTS=1. This allows you to redraw the appropriate part of the virtual canvas when your application receives expose or viewport events.

Use the APP_SCROLL keyword when displaying images, or anything drawn in device units or pixels. This keyword is good when you are displaying large images because the entire images does not have to be redrawn when change viewport events are generated.

Use the SCROLL keyword when a draw widget is going to display graphics drawn in data units (e.g., PLOT, CONTOUR, SURFACE).

BUTTON_EVENTS

Set this keyword to make the draw widget generate events when the mouse buttons are pressed or released (and the mouse pointer is in the draw widget). Normally, draw widgets do not generate events.

COLOR_MODEL

Set this keyword equal to 1 (one) to cause the draw widget's associated IDLgrWindow object to use indexed color. If the COLOR_MODEL keyword is not set, or is set to a value other than one, the draw widget will use RGB color.

This keyword is only valid when the draw widget uses IDL Object Graphics. (The graphics type used by a draw widget is determined by setting the GRAPHICS_LEVEL keyword to WIDGET_DRAW.) For information on using indexed color in Object Graphics window objects, see Chapter 20, "Working with Color" in *Using IDL*.

COLORS

The maximum number of color table indices to be used. This parameter has effect *only* if it is supplied when the *first* IDL graphics window is created.

If COLORS is not specified when the first window is created, all or most of the available color indices are allocated, depending upon the window system in use.

To use monochrome windows on a color display, set COLORS equal to 2 when creating the first window. One color table is maintained for all IDL windows. A negative value for COLORS specifies that all but the given number of colors from the shared color table should be used.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EXPOSE_EVENTS

Set this keyword to make the draw widget generate event when the visibility of the draw widget changes. This may occur when the widget is hidden behind something else on the screen, brought to the foreground, or when the scroll bars are moved. Normally, draw widgets do not generate events.

If this keyword is set, expose events will be generated only when IDL is unable to restore the contents of the window itself. After the initial draw, expose events are not issued when GRAPHICS_LEVEL=2 and the software renderer is being used (RENDERER=1). In such cases, expose events are not issued because IDL can internally refresh the window itself. On platforms for which OpenGL support is not offered, the software renderer is always being used, and therefore, expose events are not issued after the initial draw.

Note

You must explicitly disable backing store (by setting RETAIN=0) in order to generate expose events. Additional expose events may be generated if both EXPOSE_EVENTS and RETAIN=1 are turned on.

Warning

Large numbers of events may be generated when EXPOSE_EVENTS is specified. You may wish to compress the events (perhaps using a timer) and only act on a subset.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GRAPHICS_LEVEL

Set this keyword equal to 2 (two) to use IDL Object Graphics in the draw widget. If the GRAPHICS_LEVEL keyword is not set, or is set to a value other than two, the draw widget will use IDL Direct Graphics.

GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MOTION_EVENTS

Set this keyword to make the draw widget generate events when the mouse cursor moves across the widget. Normally, draw widgets do not generate events.

Draw widgets that return motion events can generate a large number of events that can result in poor performance on slower machines.

Note that it is possible to generate motion events with coordinates outside the draw widget. If you position the mouse cursor inside the draw widget, press the mouse button, and drag the cursor out of the draw widget, the X and Y fields of the widget event will specify coordinates outside the draw widget.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_DRAW or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RENDERER

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Chapter 28 of *Using IDL* for details. Your choice of renderer may also affect the maximum size of a draw widget. See "IDLgrWindow" on page 2276 for details.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

RETAIN

Set this keyword to 0, 1, or 2 to specify how backing store should be handled for the draw widget. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See "Backing Store" on page 1589 for details on the use of RETAIN with Direct Graphics. For more information on the use of RETAIN with Object Graphics, see "IDLgrWindow::Init" on page 2289.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SCROLL

Set this keyword to give the draw widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen.

Use the SCROLL keyword when a draw widget is going to display graphics drawn in data units (e.g., PLOT, CONTOUR, SURFACE). Use the APP_SCROLL keyword when displaying images, or anything drawn in device units or pixels.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a draw widget is the IDL window number for use with Direct Graphics routines, such as WSET. For Object Graphics routines, it is the draw window object reference. This value cannot be set or modified by the user.

To obtain the window number for a newly-created draw widget, use the GET_VALUE keyword to WIDGET_CONTROL *after* the draw widget has been realized. Draw widgets do not have a window number assigned to them until they are realized. For example, to return the window number of a draw widget in the variable *win_num*, use the command:

```
WIDGET_CONTROL, my_drawwidget, GET_VALUE = win_num
```

where *my_drawwidget* is the widget ID of the desired draw widget.

When using Object Graphics for the widget draw, the following command returns an object reference to the draw window:

```
WIDGET_CONTROL, my_drawwidget, GET_VALUE = oWindow
```

where *oWindow* is a window object.

VIEWPORT_EVENTS

Set this keyword to enable viewport motion events for draw widgets.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations. By default, draw widgets are 100 pixels wide by 100 pixels high.

X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the scrolling viewport independently of the actual width of the widget.

Use of the X_SCROLL_SIZE keyword implies SCROLL.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations. By default, draw widgets are 100 pixels wide by 100 pixels high.

Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible

area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual height of the widget.

Use of the Y_SCROLL_SIZE keyword implies SCROLL.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of draw widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DRAW_BUTTON_EVENTS, DRAW_EXPOSE_EVENTS, DRAW_MOTION_EVENTS, DRAW_VIEWPORT_EVENTS, DRAW_XSIZE, DRAW_YSIZE, GET_DRAW_VIEW, GET_VALUE, INPUT_FOCUS, SET_DRAW_VIEW.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to draw widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DRAW_BUTTON_EVENTS, DRAW_EXPOSE_EVENTS, DRAW_MOTION_EVENTS, DRAW_VIEWPORT_EVENTS.

Widget Events Returned by Draw Widgets

By default, draw widgets do not generate events. If the BUTTON_EVENTS keyword is set when the widget is created, pressing or releasing any mouse button while the mouse cursor is over the draw widget causes events to be generated. Specifying the MOTION_EVENTS keyword causes events to be generated *continuously* as the mouse cursor moves across the draw widget. Specifying the EXPOSE_EVENTS keyword causes events to be generated whenever the visibility of any portion of the draw window (or viewport) changes.

The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_DRAW, ID:0L, TOP:0L, HANDLER:0L, TYPE: 0, X:0L, Y:0L,
   PRESS:0B, RELEASE:0B, CLICKS:0, MODIFIERS:0L}
```

Note

If you defined your own {WIDGET_DRAW} structures prior to the IDL 5.3 release before the structure was defined by an internal call, the MODIFIERS field will break the existing user code.

ID, TOP, and HANDLER are the three standard fields found in every widget event. TYPE returns a value that describes the type of draw widget interaction that generated an event. The values for TYPE are shown in the table below.

Value	Meaning
0	Button Press
1	Button Release
2	Motion
3	Viewport Moved (Scrollbars)
4	Visibility Changed (Exposed)

Table 94: Values for the TYPE field

The X and Y fields give the device coordinates at which the event occurred, measured from the lower left corner of the drawing area. PRESS and RELEASE are bitmasks in which the least significant bit represents the leftmost mouse button. The corresponding bit of PRESS is set when a mouse button is pressed, and in RELEASE when the button is released. If the event is a motion event, both PRESS and RELEASE are zero.

The CLICKS field returns either 1 or 2. If the time interval between two button-press events is less than the time interval for a double-click event for the platform, the CLICKS field returns 2. If the time interval between button-press events is greater than the time interval for a double-click event for the platform, the CLICKS field returns 1. This means that if you are writing a widget application that requires the user to double-click on a draw widget, you will need to handle two events. The CLICKS field will return a 1 on the first click and a 2 on the second click.

The MODIFIERS field is valid for button press, button release and motion events. It is a bitmask which returns the current state of several keyboard modifier keys at the time the event was generated. If a bit is zero, the key is up. If the bit is set, the key is

depressed. The value is generated by OR-ing the following values together if a key is depressed.

Bitmask	Modifier Key
1	Shift
2	Control
4	Caps Lock
8	Alt (See Note following this table.)

Table 31: Bitmask for the MODIFIERS Field

Note

Under UNIX, the Alt key is the currently mapped MOD1 key. There is no Alt key on the Macintosh.

Note that the CURSOR procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain the cursor position and button state information from a draw widget, examine the X, Y, PRESS, and RELEASE fields in the structures returned by the draw widget in response to cursor events.

Backing Store

Draw widgets with scroll bars rely on backing store to repaint the visible area of the window as it is moved. Their performance is best on systems that provide backing store. However, if your system does not automatically provide backing store, you can make IDL supply it with the statement:

```
DEVICE, RETAIN=2
```

or by using the RETAIN keyword to WIDGET_DRAW.

Note

If you are using graphics acceleration, you may wish to turn off backing store entirely and enable expose events (via the EXPOSE_EVENTS keyword) and redraw the draw widget's contents manually. However, because the number of events generated may be quite high, you may wish to enable a timer as well and only redraw the draw widget periodically.

See Also

SLIDE_IMAGE, WINDOW

WIDGET_DROPLIST

The WIDGET_DROPLIST function creates “droplist” widgets. A droplist widget is a button with a label that, when selected, reveals a list of options from which to choose. When the user selects a new option from the list, the list disappears and the button title displays the currently-selected option. This action generates an event containing the index of the selected item, which ranges from 0 to the number of elements in the list minus one, and updates the label on the push-button.

The returned value of this function is the widget ID of the newly-created droplist widget.

Syntax

Result = WIDGET_DROPLIST(*Parent* [, /DYNAMIC_RESIZE]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FRAME=*value*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /NO_COPY]
[, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SENSITIVE] [, TITLE=*string*] [, /TRACKING_EVENTS] [, UNAME=*string*]
[, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*]
[, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*])

Arguments

Parent

The widget ID of the parent widget for the new droplist widget.

Keywords

DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword does not take effect when used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See "About Device Fonts" on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_DROPLIST or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such

"callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TITLE

Set this keyword to a string to be used as the title for the droplist widget.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The "user value" to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a droplist widget is a scalar string or array of strings that contains the text of the list items—one list item per array element. List widgets are sized based on the length (in characters) of the longest item specified in the array of values for the VALUE keyword.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The desired width of the droplist widget area, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the droplist button or of the dropped list. Instead, it controls the size "around" the droplist button and, as such, is not particularly useful.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The desired height of the widget, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the droplist button or of the dropped list. Instead, it controls the size "around" the droplist button and, as such, is not particularly useful.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of droplist widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, SET_DROPLIST_SELECT, SET_VALUE.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to droplist widgets. In addition to those keywords that apply to all

widgets, the following are particularly useful: DROPLIST_NUMBER, DROPLIST_SELECT, DYNAMIC_RESIZE.

Widget Events Returned by Droplist Widgets

Pressing the mouse button while the mouse cursor is over an element of a droplist widget causes the widget to change the label on the droplist button and to generate an event. The appearance of any previously selected element is restored to normal at the same time. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{ WIDGET_DROPLIST, ID:0L, TOP:0L, HANDLER:0L, INDEX:0L }
```

The first three fields are the standard fields found in every widget event. INDEX returns the index of the selected item. This can be used to index the array of names originally used to set the widget's value.

Note

Platform-specific UI toolkits behave differently if a droplist widget has only a single element. On some platforms, selecting that element again does not generate an event. Events are always generated if the list contains multiple items.

See Also

CW_PDMENU, WIDGET_BUTTON, WIDGET_LIST

WIDGET_EVENT

The WIDGET_EVENT function returns events for the widget hierarchy rooted at *Widget_ID*. Widgets communicate information by generating events. Events are generated when a button is pressed, a slider position is changed, and so forth.

Note

Widget applications should use the XMANAGER procedure in preference to calling WIDGET_EVENT directly. See "Widget Events" in Chapter 22 of *Building IDL Applications*.

Syntax

Result = WIDGET_EVENT([*Widget_ID*]) [, BAD_ID=*variable*] [, /NOWAIT] [, /SAVE_HOURGLASS]

UNIX Keywords: [, /YIELD_TO_TTY]

Arguments

Widget_ID

Widget_ID specifies the widget hierarchy for which events are desired. The first available event for the specified widget or any of its children is returned. If this argument is not specified, WIDGET_EVENT processes events for all existing widgets.

Widget_ID can also be an array of widget identifiers, in which case all of the specified widget hierarchies are searched.

Note

Attempting to obtain events for a widget hierarchy which is not producing events will hang IDL, unless the NOWAIT keyword is used.

Keywords

BAD_ID

If one of the values supplied via *Widget_ID* is not a valid widget identifier, this function normally issues an error and causes program execution to stop. However, if

BAD_ID is present and specifies a named variable, the invalid ID is stored into the variable, and this routine quietly returns. If no error occurs, a zero is stored.

This keyword can be used to handle the situation in which IDL is waiting within WIDGET_EVENT when the user kills the widget hierarchy.

This keyword has meaning only if *Widget_ID* is explicitly specified.

NOWAIT

When no events are currently available for the specified widget hierarchy, WIDGET_EVENT normally waits until one is available and then returns it. However, if NOWAIT is set and no events are present, it immediately returns. In this case, the ID field of the returned structure will be zero.

SAVE_HOURGLASS

Set this keyword to prevent the hourglass cursor from being cleared by WIDGET_EVENT. This keyword can be of use if a program has to poll a widget periodically during a long computation.

YIELD_TO_TTY

Unless the NOWAIT keyword is specified, WIDGET_EVENT does not return until the asked for event is available. If the user should enter a line of input from the keyboard, it cannot be processed until WIDGET_EVENT returns. If the YIELD_TO_TTY keyword is specified and the user enters a line of input, WIDGET_EVENT returns immediately. In this case, the ID field of the returned structure will be zero.

Note

This keyword is supported under UNIX only, and there are no plans to extend it to other operating systems. Do not use it if you intend to use non-UNIX systems.

Event Processing

All events for a given widget are processed in the order that they are generated. The event processing performed by WIDGET_EVENT consists of the following steps:

1. Wait for an event from one of the specified widgets to arrive.
2. Starting with the widget that the event belongs to, move up the widget hierarchy looking for a widget that has an event handling procedure or function associated with it. Such routines are associated with a widget via the

EVENT_PRO and EVENT_FUNC keywords to the widget creation functions or the WIDGET_CONTROL procedure.

3. If an event handling *procedure* is found, it is called with the widget ID as its argument. When the procedure returns, WIDGET_EVENT returns to the first step. Hence, event procedures are said to “swallow” events.

4. If an event handling *function* is found, it is called with the widget ID as its argument. When the function returns, its value is examined. If the value is a non-structure, it is discarded and WIDGET_EVENT returns to the first step.

   This behavior allows event functions to selectively act like event procedures and swallow events. If the returned value is a structure, it is checked to ensure that it has the standard first 3 fields: ID, TOP, and HANDLER. If not an error is issued. Otherwise the value replaces the event found in the first step and WIDGET_EVENT returns to the second step.

   Hence, event functions are said to “rewrite” events. This ability to rewrite events is the basis of the “compound widget” in which several widgets are combined to give the appearance of a single, more complicated widget.

5. If an event reaches the top of a widget hierarchy without being swallowed by an event handler, it is returned as the value of WIDGET_EVENT.

Events

A widget event is returned in a structure. The exact contents of this structure vary depending upon the type of widget involved. The first three elements of this structure, however, are always the same. Any other elements vary from widget type to type. The three fixed elements are:

ID

The widget ID of the widget that generated the event.

TOP

The widget ID of the top level base for the widget hierarchy containing `ID`.

HANDLER

When an event is passed as the argument to an event handling procedure or function, as discussed in the previous section, this field contains the identifier of the widget associated with the handler routine. When an event is returned from WIDGET_EVENT, this value is always zero to indicate that no handler routine was found.

See Also

XMANAGER

WIDGET_INFO

The WIDGET_INFO function is used to obtain information about the widget subsystem and individual widgets. The specific area for which information is desired is selected by setting the appropriate keyword.

Syntax

Result = WIDGET_INFO([*Widget_ID*])

Keywords that apply to all widgets: [, /ACTIVE] [, /CHILD] [, /EVENT_FUNC] [, /EVENT_PRO] [, FIND_BY_UNAME=*string*] [, /GEOMETRY] [, /KBRD_FOCUS_EVENTS] [, /MANAGED] [, /NAME] [, /PARENT] [, /REALIZED] [, /SIBLING] [, /TRACKING_EVENTS] [, /TYPE] [, UNITS={0 | 1 | 2}] [, /UNAME] [, /UPDATE] [, /VALID_ID] [, /VERSION]

Keywords that apply to widgets created with widget_base: [, /MODAL] [, /TLB_KILL_REQUEST_EVENTS]

Keywords that apply to widgets created with widget_button: [, /DYNAMIC_RESIZE]

Keywords that apply to widgets created with widget_draw: [, /DRAW_BUTTON_EVENTS] [, /DRAW_EXPOSE_EVENTS] [, /DRAW_MOTION_EVENTS] [, /DRAW_VIEWPORT_EVENTS]

Keywords that apply to widgets created with widget_droplist: [, /DROPLIST_NUMBER] [, /DROPLIST_SELECT] [, /DYNAMIC_RESIZE]

Keywords that apply to widgets created with widget_label: [, /DYNAMIC_RESIZE]

Keywords that apply to widgets created with widget_list: [, /LIST_MULTIPLE] [, /LIST_NUMBER] [, /LIST_NUM_VISIBLE] [, /LIST_SELECT] [, /LIST_TOP]

Keywords that apply to widgets created with widget_slider: [, /SLIDER_MIN_MAX]

Keywords that apply to widgets created with widget_table: [, /COLUMN_WIDTHS] [, /ROW_HEIGHTS{not supported in Windows}] [, /TABLE_ALL_EVENTS] [, /TABLE_EDITABLE] [, /TABLE_EDIT_CELL] [, /TABLE_SELECT] [, /TABLE_VIEW] [, /USE_TABLE_SELECT]

Keywords that apply to widgets created with widget_text: [, /TEXT_ALL_EVENTS] [, /TEXT_EDITABLE] [, /TEXT_NUMBER]

[, TEXT_OFFSET_TO_XY=*integer*] [, /TEXT_SELECT] [, /TEXT_TOP_LINE] [, TEXT_XY_TO_OFFSET=*[column*, *line]*]

Arguments

Widget_ID

Usually this argument should be the widget ID of the widget for which information is desired. If the ACTIVE or VERSION keywords are specified, this argument is not required.

Widget_ID can also be an array of widget identifiers, in which case the result is an array with the same structure in which information on all the specified widgets is returned.

Keywords

Not all keywords to WIDGET_INFO apply to all combinations of widgets. In the following list, descriptions of keywords that affect only certain types of widgets include a list of the widgets for which the keyword is useful.

ACTIVE

This keyword applies to all widgets.

Set this keyword to return 1 if there is at least one realized, managed, top-level widget on the screen. Otherwise, 0 is returned.

CHILD

This keyword applies to all widgets.

Set this keyword to return the widget ID of the first child of the widget specified by *Widget_ID*. If the widget has no children, 0 is returned.

COLUMN_WIDTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return an array of long integers giving the width of each column in the table. If USE_TABLE_SELECT is set, only the column widths for the currently-selected cells are returned.

DRAW_BUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the BUTTON_EVENTS attribute set. Otherwise, 0 is returned.

DRAW_EXPOSE_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the EXPOSE_EVENTS attribute set. Otherwise, 0 is returned.

DRAW_MOTION_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the MOTION_EVENTS attribute set. Otherwise, 0 is returned.

DRAW_VIEWPORT_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the VIEWPORT_EVENTS attribute set. Otherwise, 0 is returned.

DROPLIST_NUMBER

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to return the number of elements currently contained in the specified droplist widget.

DROPLIST_SELECT

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to return the zero-based number of the currently-selected element (i.e., the currently-displayed element) in the specified droplist widget.

DYNAMIC_RESIZE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DROPLIST, and WIDGET_LABEL functions.

Set this keyword to return a True value (1) if the widget specified by *Widget_ID* is a button, droplist, or label widget that has had its DYNAMIC_RESIZE attribute set. Otherwise, False (0) is returned.

EVENT_FUNC

This keyword applies to all widgets.

Set this keyword to return a string containing the name of the event handler function associated with *Widget_ID*. A null string is returned if no event handler function exists.

EVENT_PRO

This keyword applies to all widgets.

Set this keyword to return a string containing the name of the event handler procedure associated with *Widget_ID*. A null string is returned if no event handler procedure exists.

FIND_BY_UNAME

This keyword applies to all widgets.

Set this keyword to a UNAME value that will be searched for in the widget hierarchy, and if a widget with the given UNAME is in the hierarchy, its ID is returned. The search starts in the hierarchy with the given widget ID and travels down, and this keyword returns the widget ID of the first widget that has the specified UNAME value.

If a widget is not found, 0 is returned.

GEOMETRY

This keyword applies to all widgets.

Set this keyword to return a WIDGET_GEOMETRY structure that describes the offset and size information for the widget specified by *Widget_ID*. This structure has the following definition:

```
{ WIDGET_GEOMETRY,
   XOFFSET:0.0,
   YOFFSET:0.0,
   XSIZE:0.0,
   YSIZE:0.0,
   SCR_XSIZE:0.0,
   SCR_YSIZE:0.0,
   DRAW_XSIZE:0.0,
   DRAW_YSIZE:0.0,
   MARGIN:0.0,
   XPAD:0.0,
   YPAD:0.0,
   SPACE:0.0 }
```

With the exception of MARGIN, all of the structure's fields correspond to the keywords of the same name to the various widget routines. MARGIN is the width of

any frame added to the widget, in units specified by the UNITS keyword (pixels are the default). Therefore, the actual width of any widget is:

```
SCR_XSIZE + (2* MARGIN)
```

The actual height of any widget is:

```
SCR_YSIZE + (2 * MARGIN)
```

Note also that if the top-level base includes a menubar, it is not possible to determine the actual height of the base widget. Calling WIDGET_INFO with the GEOMETRY keyword on a top level base that includes a menubar will return a geometry structure that contains zeroes rather than the actual sizes of the widget.

Note

Menubars are not included in the size of a top-level base, so the actual height of a widget that includes a menubar is:

```
SCR_YSIZE + (2 * MARGIN) + menubar height
```

It is not possible to either determine or change the height of a menubar within IDL. Retrieving the WIDGET_GEOMETRY structure of a menubar yields a structure with all the fields set equal to zero.

KBRD_FOCUS_EVENTS

This keyword applies to all widgets.

Set this keyword to return the keyboard focus events status of the widget specified by *Widget ID*. WIDGET_INFO returns 1 (one) if keyboard focus events are currently enabled for the widget, or 0 (zero) if they are not. Only base, table, and text widgets can generate keyboard focus events.

LIST_MULTIPLE

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword equal to a named variable that will contain a non-zero value if the list widget supports multiple item selections. See the MULTIPLE keyword to WIDGET_LIST for more on multiple item selections.

LIST_NUMBER

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the number of elements currently contained in the specified list widget.

LIST_NUM_VISIBLE

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the number of elements that can be visible in the scrolling viewport of the specified list widget. Note that this value can be larger than the total number of elements actually in the list.

LIST_SELECT

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the index or indices of the currently-selected (highlighted) element or elements in the specified list widget. Note that this offset is zero-based. If no element is currently selected, -1 is returned.

LIST_TOP

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the zero-based offset of the topmost element currently visible in the specified list widget.

MANAGED

This keyword applies to all widgets.

Set this keyword to return 1 if the specified widget is managed, or 0 otherwise. If no widget ID is specified in the call to WIDGET_INFO, the return value will be an array containing the widget IDs of all currently-managed widgets.

MODAL

This keyword applies to widgets created with the WIDGET_BASE function and the MODAL keyword.

If this keyword is set, WIDGET_INFO will return True (1) if the base widget specified by *Widget_ID* is a modal base widget, or False (0) otherwise.

NAME

This keyword applies to all widgets.

Set this keyword to return the widget type name of the widget specified by *Widget_ID*. The returned value will be one of the following strings: “BASE”,

"BUTTON", "DRAW", "DROPLIST", "LABEL", "LIST", "SLIDER", "TABLE", or "TEXT". Set the TYPE keyword to return the widget's type code.

PARENT

This keyword applies to all widgets.

Set this keyword to return the widget ID of the parent of the widget specified by *Widget_ID*. If the widget is a top-level base (i.e., it has no parent), 0 is returned.

REALIZED

This keyword applies to all widgets.

Set this keyword to return 1 if the widget specified by *Widget_ID* has been realized. If the widget has not been realized, 0 is returned.

ROW_HEIGHTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Note

This keyword is not supported under Microsoft Windows.

Set this keyword to return an array of long integers giving the height of each row in the table. If USE_TABLE_SELECT is set, only the row heights for the currently-selected cells are returned.

SIBLING

This keyword applies to all widgets.

Set this keyword to return the widget ID of the first sibling of the widget specified by *Widget_ID*. If the widget is the last sibling in the chain, 0 is returned.

SLIDER_MIN_MAX

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to return the current minimum and maximum values of the specified slider as a two-element integer array. Element 0 is the minimum value and element 1 is the maximum value.

TABLE_ALL_EVENTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return 1 (one) if *Widget_ID* is a table widget with the ALL_EVENTS attribute set. Otherwise, 0 (zero) is returned.

TABLE_EDITABLE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return 1 (one) if *Widget_ID* is a table widget that allows user editing of its contents. Otherwise, 0 (zero) is returned.

TABLE_EDIT_CELL

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return a two-element integer array containing the *X* and *Y* coordinates of the currently editable cell. If none of the cells in the table widget is currently editable, the array [-1, -1] is returned.

TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return an array of the form [*left*, *top*, *right*, *bottom*] containing the zero-based indices of the currently-selected (highlighted) cells in the specified table widget.

TABLE_VIEW

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return a two-element array of the form [*left*, *top*] containing the zero-based offsets of the top-left cell currently visible in the specified table widget.

TEXT_ALL_EVENTS

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return 1 if *Widget_ID* is a text widget with the ALL_EVENTS attribute set. Otherwise, 0 is returned.

TEXT_EDITABLE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return 1 if *Widget_ID* is a text widget that allows user editing of its contents. Otherwise, 0 is returned.

TEXT_NUMBER

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the number of characters currently contained in the specified text widget.

TEXT_OFFSET_TO_XY

This keyword applies to widgets created with the WIDGET_TEXT function.

Use this keyword to translate a text widget character offset into column and line form. The value of this keyword should be set to the character offset (an integer) to be translated. WIDGET_INFO returns a two-element integer array giving the column (element 0) and line (element 1) corresponding to the offset. If the offset specified is out of range, the array [-1,-1] is returned.

TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the starting character offset and length (in characters) of the selected (highlighted) text in the specified text widget. WIDGET_INFO returns a two-element integer array containing the starting position of the highlighted text as an offset from character zero of the text in the widget (element 0), and length of the current selection (element 1).

TEXT_TOP_LINE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the zero-based line number of the line currently at the top of a text widget's display viewport. Note that this value is different from the zero-based character offset of the characters in the line. The character offset can be calculated from the line offset via the TEXT_XY_TO_OFFSET keyword.

TEXT_XY_TO_OFFSET

This keyword applies to widgets created with the WIDGET_TEXT function.

Use this keyword to translate a text widget position given in line and column form into a character offset. The value of this keyword should be set to a two-element integer array specifying the column (element 0) and line (element 1) position. WIDGET_INFO returns the character offset (as a longword integer) corresponding to the position. If the position specified is out of range, -1 is returned.

TLB_KILL_REQUEST_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to return 1 if the top-level base of the widget specified by *Widget_ID* is set to return kill request events. Otherwise, 0 is returned.

TRACKING_EVENTS

This keyword applies to all widgets.

Set this keyword to return the tracking events status for the widget specified by *Widget_ID*. WIDGET_INFO returns 1 if tracking events are currently enabled for the widget. Otherwise, 0 is returned.

TYPE

This keyword applies to all widgets.

Set this keyword to return the type code of the specified *Widget_ID*. Possible values are given the following table. Note that you can set the NAME keyword to return string names instead.

Value	Type
0	Base
1	Button
2	Slider
3	Text
4	Draw
5	Label
6	List
8	Droplist
9	Table

Table 95: Widget Type Codes

UNAME

This keyword applies to all widgets.

Set this keyword to have the WIDGET_INFO function return the user name of the widget.

UNITS

This keyword applies to all widgets.

Use this keyword to specify the unit of measurement used when returning dimensions for most widget types. Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

Note

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when retrieving the XSIZE or YSIZE of a WIDGET_LIST, WIDGET_TABLE, or WIDGET_TEXT.

UPDATE

This keyword applies to all widgets.

Set this keyword to return 1 if the widget hierarchy that contains *Widget_ID* is set to display updates. Otherwise, 0 is returned. See "UPDATE" on page 1574.

USE_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to modify the behavior of the COLUMN_WIDTHS and ROW_HEIGHTS keywords. If USE_TABLE_SELECT is set, the COLUMN_WIDTHS and ROW_HEIGHTS keywords only apply to the currently-selected cells. Normally, these keywords apply to the entire contents of a table widget.

The USE_TABLE_SELECT keyword can also be specified as a four-element array, of the form [left, top, right, bottom], giving the group of cells to act on. In this usage, the value -1 is used to refer to the row or column titles.

VALID_ID

This keyword applies to all widgets.

Set this keyword to return 1 if *Widget_ID* represents a currently-valid widget. Otherwise, 0 is returned.

VERSION

This keyword applies to all widgets.

Set this keyword to return a structure that gives information about the widget implementation. This structure has the following definition:

```
{ WIDGET_VERSION, STYLE:'', TOOLKIT:'', RELEASE:'' }
```

`STYLE` is the style of widget toolkit used. `TOOLKIT` is the implementation of the toolkit. `RELEASE` is the version level of the toolkit. This field can be used to distinguish between different releases of a given toolkit, such as Motif 1.0 and Motif 1.1.

See Also

Building IDL Applications Chapter 22, "Widgets".

WIDGET_LABEL

The WIDGET_LABEL function is used to create label widgets.

The returned value of this function is the widget ID of the newly-created label widget.

Syntax

Result = WIDGET_LABEL(*Parent* [, /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT] [, /DYNAMIC_RESIZE] [, FONT=*string*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*])

Arguments

Parent

The widget ID of the parent widget for the new label widget.

Keywords

ALIGN_CENTER

Set this keyword to center justify the label text.

ALIGN_LEFT

Set this keyword to left justify the label text.

ALIGN_RIGHT

Set this keyword to right justify the label text.

DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword cannot be used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the

widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question. This keyword is not supported on the Macintosh.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`).

Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_LABEL or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The "user value" to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a widget label is a string containing the text for the label.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of label widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, GET_VALUE, SET_VALUE.

Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to label widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DYNAMIC_RESIZE.

Widget Events Returned by Label Widgets

Label widgets do not return an event structure.

See Also

CW_FIELD, WIDGET_TEXT

WIDGET_LIST

The WIDGET_LIST function is used to create list widgets. A list widget offers the user a list of text elements from which to choose. The user can select an item by pointing at it with the mouse cursor and pressing a button. This action generates an event containing the index of the selected item, which ranges from 0 to the number of elements in the list minus one.

The returned value of this function is the widget ID of the newly-created list widget.

Syntax

Result = WIDGET_LIST(*Parent* [, EVENT_FUNC=*string*]
[, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*width*]
[, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*]
[, KILL_NOTIFY=*string*] [, /MULTIPLE] [, /NO_COPY]
[, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*]
[, YOFFSET=*value*] [, YSIZE=*value*])

Arguments

Parent

The widget ID of the parent widget for the new list widget.

Keywords

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MULTIPLE

Set this keyword to allow the user to select more than one item from the list in a single operation. Multiple selections are handled using the platform's native mechanism:

Motif

Holding down the Shift key and clicking an item selects the range from the previously selected item to the new item. Holding down the mouse button when selecting items also selects a range. Holding down the Control key and clicking an item toggles that item between the selected and unselected state.

Windows

Holding down the Shift key and clicking an item selects the range from the previously selected item to the new item. Holding down the Control key and clicking an item toggles that item between the selected and unselected state.

Macintosh

Holding down the Shift key and clicking an item selects the range from the previously selected item to the new item. Holding down the Command key and clicking an item toggles that item between the selected and unselected state.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would

otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_LIST or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse

cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

Note

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_LIST.

UVALUE

The "user value" to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the

convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a list widget is a scalar string or array of strings that contains the text of the list items—one list item per array element. List widgets are sized based on the length (in characters) of the longest item specified in the array of values for the VALUE keyword.

Note that the value of a list widget can only be set. It cannot be retrieved using WIDGET_CONTROL.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The desired width of the widget, in characters. Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. Note that the final size of the widget may be adjusted to include space for scrollbars (which are not always visible), so your widget may be slightly larger than specified.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The desired height of the widget, in number of list items visible. Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. Note that the final size of the widget may be adjusted to include space for scrollbars (which are not always visible), so your widget may be slightly larger than specified.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of list widgets. In addition to those keywords that affect all widgets, the following are particularly useful: SET_LIST_SELECT, SET_LIST_TOP, SET_VALUE.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to list widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: LIST_MULTIPLE, LIST_NUMBER, LIST_NUM_VISIBLE, LIST_SELECT, LIST_TOP.

Widget Events Returned by List Widgets

Pressing the mouse button while the mouse cursor is over an element of a list widget causes the widget to highlight the appearance of that element and to generate an event. The appearance of any previously selected element is restored to normal at the same time. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_LIST, ID:0L, TOP:0L, HANDLER:0L, INDEX:0L, CLICKS:0L}
```

The first three fields are the standard fields found in every widget event. INDEX returns the index of the selected item. This index can be used to subscript the array of names originally used to set the widget's value. The CLICKS field returns either 1 or 2, depending upon how the list item was selected. If the list item is double-clicked, CLICKS is set to 2.

Note

If you are writing a widget application that requires the user to double-click on a list widget, you will need to handle two events. The CLICKS field will return a 1 on the first click and a 2 on the second click.

See Also

CW_BGROUP, WIDGET_DROPLIST

WIDGET_SLIDER

The WIDGET_SLIDER function is used to create slider widgets. Slider widgets are used to indicate an integer value from a range of possible values. They consist of a rectangular region which represents the possible range of values. Inside this region is a sliding pointer that displays the current value. This pointer can be manipulated by the user via the mouse, or from within IDL via the WIDGET_CONTROL procedure.

To indicated floating-point values, see CW_FSLIDER.

The returned value of this function is the widget ID of the newly-created slider widget.

Syntax

Result = WIDGET_SLIDER(*Parent* [, /DRAG] [, EVENT_FUNC=*string*]
[, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*width*]
[, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*]
[, KILL_NOTIFY=*string*] [, MAXIMUM=*value*] [, MINIMUM=*value*]
[, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, SCROLL=*units*] [, /SENSITIVE] [, /SUPPRESS_VALUE]
[, /TRACKING_EVENTS] [, TITLE=*string*] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, /VERTICAL] [, XOFFSET=*value*]
[, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*])

Arguments

Parent

The widget ID of the parent for the new slider widget.

Keywords

DRAG

Set this keyword to cause events to be generated continuously while the slider is being dragged by the user. Normally, slider widgets generate position events only when the slider comes to rest at its final position and the mouse button is released.

When a slider widget is set to return drag events, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

Warning

Under Microsoft Windows and Macintosh, sliders do not generate DRAG events. Sliders created with the DRAG keyword behave just like regular sliders.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MAXIMUM

The maximum value of the range encompassed by the slider. If this keyword is not supplied, a default of 100 is used.

MINIMUM

The minimum value of the range encompassed by the slider. If this keyword is not supplied, a default of 0 is used.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it

directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_SLIDER or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SCROLL

Under the Motif window manager, the value provided for SCROLL specifies how many units the scroll bar should move when the user clicks the left mouse button

inside the slider area, but not on the slider itself. This keyword has no effect under other window systems.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

SUPPRESS_VALUE

Set this keyword to inhibit the display of the current slider value.

Sliders work only with integer units. This keyword can be used to suppress the actual value of a slider so that a program can present the user with a slider that seems to work in other units (such as floating-point) or with a non-linear scale.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 1533 in the documentation for WIDGET_BASE.

TITLE

A string containing the title to be used for the slider widget.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget

hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a widget slider is the current position of the slider.

VERTICAL

Set this keyword to create a vertical slider. If this keyword is omitted, the slider is horizontal.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a “hint” to the toolkit and may be ignored in some situations.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of slider widgets. In addition to those keywords that affect all widgets, the following are particularly useful: GET_VALUE, SET_SLIDER_MAX, SET_SLIDER_MIN, SET_VALUE.

Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to slider widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: SLIDER_MIN_MAX.

Slider Widget Events

Slider widgets generate events when the mouse is used to change their value. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_SLIDER, ID:0L, TOP:0L, HANDLER:0L, VALUE:0L, DRAG:0}
```

ID is the widget ID of the button generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. VALUE returns the new value of the slider. DRAG returns integer 1 if the slider event was generated as part of a drag operation, or zero if the event was generated when the user had finished positioning the slider. Note that the slider widget only generates events during the drag operation if the

DRAG keyword is set, and if the application is running under Motif. When the DRAG keyword is set, the DRAG field can be used to avoid computationally expensive operations until the user releases the slider.

Known Implementation Problems

Under Motif 1.0, vertical sliders with a title organized in row bases get horizontally truncated and the slider doesn't show (the title does). Use the XSIZE keyword to work around this.

See Also

CW_FSLIDER

WIDGET_TABLE

The WIDGET_TABLE function creates table widgets. Table widgets display two-dimensional data and allow in-place data editing. They can have one or more rows and columns, and automatically create scroll bars when viewing more data than can otherwise be displayed on the screen.

Note on Table Sizing

Table widgets are sized according to the value of the following pairs of keywords to WIDGET_TABLE, in order of precedence: SCR_XSIZE/SCR_YSIZE, XSIZE/YSIZE, X_SCROLL_SIZE/Y_SCROLL_SIZE, VALUE. If either dimension remains unspecified by one of the above keywords, the default value of six (columns or rows) is used when the table is created. If the width or height specified is less than the size of the table, scroll bars are added automatically.

The returned value of this function is the widget ID of the newly-created table widget.

Syntax

Result = WIDGET_TABLE(*Parent* [, ALIGNMENT={0 | 1 | 2}] [, /ALL_EVENTS]
[, AM_PM=*[string*, *string]*] [, COLUMN_LABELS=*string_array*]
[, /COLUMN_MAJOR | , /ROW_MAJOR] [, COLUMN_WIDTHS=*array*]
[, DAYS_OF_WEEK=*string_array*{7 names}] [, /EDITABLE]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FORMAT=*value*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, /KBRD_FOCUS_EVENTS]
[, KILL_NOTIFY=*string*] [, MONTHS=*string_array*{12 names}] [, /NO_COPY]
[, /NO_HEADERS] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, /RESIZEABLE_COLUMNS] [, /RESIZEABLE_ROWS{not supported in Windows}] [, RESOURCE_NAME=*string*] [, ROW_HEIGHTS=*array*{not supported in Windows}] [, ROW_LABELS=*string_array*] [, SCR_XSIZE=*width*]
[, SCR_YSIZE=*height*] [, /SCROLL] [, /SENSITIVE] [, /TRACKING_EVENTS]
[, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*]
[, XOFFSET=*value*] [, XSIZE=*value*] [, X_SCROLL_SIZE=*width*]
[, YOFFSET=*value*] [, YSIZE=*value*] [, Y_SCROLL_SIZE=*height*])

Arguments

Parent

The widget ID of the parent widget for the new table widget.

Keywords

ALIGNMENT

Set this keyword equal to a scalar or 2-D array specifying the alignment of the text within each cell. An alignment of 0 (the default) aligns the left edge of the text with the left edge of the cell. An alignment of 2 right-justifies the text, while 1 results in text centered within the cell. If ALIGNMENT is set equal to a scalar, all table cells are aligned as specified. If ALIGNMENT is set equal to a 2-D array, the alignment of each table cell is governed by the corresponding element of the array.

ALL_EVENTS

Along with the EDITABLE keyword, ALL_EVENTS controls the type of events generated by the table widget. Set the ALL_EVENTS keyword to cause the full set of events to be generated. If ALL_EVENTS is not set, setting EDITABLE causes only end-of-line events to be generated. If EDITABLE is not set, all events are suppressed. See the table below for additional details.

Keywords		Effects	
ALL_EVENTS	**EDITABLE**	**Input changes widget contents?**	**Type of events generated.**
Not set	Not set	No	None
Not set	Set	Yes	End-of-line insertion
Set	Not set	No	All events
Set	Set	Yes	All events

Table 96: Effects of using the ALL_EVENTS and EDITABLE keywords

AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

COLUMN_LABELS

Set this keyword equal to an array of strings used as labels for the columns of the table widget. The default labels are of the form "Column *n*", where *n* is the column number. If this keyword is set to the empty string (`''`), all column labels are set to be empty.

COLUMN_MAJOR

This keyword is only valid if the table data is organized as a vector of structures rather than a two-dimensional array. See the VALUE keyword for details.

Set this keyword to specify that the data should be read into the table as if each element of the vector is a structure containing one column's data. Note that the structures must all be of the same type, and must have one field for each row in the table. If this keyword is not set, the table widget behaves as if the ROW_MAJOR keyword were set.

COLUMN_WIDTHS

Set this keyword equal to an array of widths for the columns of the table widget. The widths are given in any of the units as specified with the UNITS keyword. If no width is specified for a column, that column is set to the default size, which varies by platform. If COLUMN_WIDTHS is set to a scalar value, all columns are set to that width.

DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

EDITABLE

Set this keyword to allow direct user editing of the text widget contents. Normally, the text in text widgets is read-only. See "ALL_EVENTS" on page 1637 for a description of how EDITABLE interacts with the ALL_EVENTS keyword.

Note

The method by which text widgets are placed into edit mode is dependent upon the windowing system. On Microsoft Windows, for instance, a cell must be double-clicked to be placed into edit mode.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

A single font is shared by the row and column labels and by all of the cells in the widget.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

FORMAT

Set this keyword equal to a single string or array of strings that specify the format of data displayed within table cells. The string(s) are of the same form as used by the FORMAT keyword to the PRINT procedure, and the default format is the same as that used by the PRINT procedure.

Warning

If the format specified is incompatible with the data displayed in a table cell, an error message is generated. Since the error is generated *for each cell displayed*, the number of messages printed is potentially large, and can slow execution significantly. Note also that each time a new cell is displayed (when scroll bars are repositioned, for example), a new error is generated *for each cell displayed*.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a "hint" to the toolkit, and may be ignored in some instances.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See "Widget Events Returned by Table Widgets" on page 1647 for more information.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_TABLE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NO_HEADERS

Set this keyword to disable the display of the table widget’s header area (where row and column labels are normally displayed).

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESIZEABLE_COLUMNS

Set this keyword to allow the user to change the size of columns using the mouse. Note that if the NO_HEADERS keyword was set, the columns cannot be resized interactively.

RESIZEABLE_ROWS

Set this keyword to allow the user to change the size of rows using the mouse. Note that if the NO_HEADERS keyword was set, the rows cannot be resized interactively.

Under Microsoft Windows, the row size cannot be changed.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 1527 for a complete discussion of this keyword.

ROW_HEIGHTS

Set this keyword equal to an array of heights for the rows of the table widget. The heights are given in any of the units as specified with the UNITS keyword. If no height is specified for a row, that row is set to the default size, which varies by platform. If ROW_HEIGHTS is set to a scalar value, all of the row heights are set to that value.

Note

This keyword is not supported under Microsoft Windows.

ROW_LABELS

Set this keyword equal to an array of strings to be used as labels for the rows of the table. If no label is specified for a row, it receives the default label “Row *n*”, where *n* is the row number. If this keyword is set to the empty string (`''`), all row labels are set to be empty.

ROW_MAJOR

This keyword is only valid if the table data is organized as a vector of structures rather than a two-dimensional array. See the VALUE keyword for details.

Set this keyword to specify that the data should be read into the table as if each element of the vector is a structure containing one row's data. Note that the structures must all be of the same type, and must have one field for each column in the table. This is the default behavior if neither the COLUMN_MAJOR or ROW_MAJOR keyword is set.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). Note that the screen width of the widget *includes* the width of scroll bars, if any are present. Setting SCR_XSIZE overrides values set for the XSIZE or X_SCROLL_SIZE keywords. See "Note on Table Sizing" on page 1636.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). Note that the screen height of the widget *includes* the height of scroll bars, if any are present. Setting SCR_YSIZE overrides values set for the YSIZE or Y_SCROLL_SIZE keywords. See "Note on Table Sizing" on page 1636.

SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen. See "Note on Table Sizing" on page 1636

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

Note

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords.

UVALUE

The "user value" to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a table widget is either a two-dimensional array or a vector of structures.

If the value is specified as a two-dimensional array, all data must be of the same data type.

If the value is specified as a vector of structures, it can be displayed either in column-major or row-major format by setting either the COLUMN_MAJOR keyword or the ROW_MAJOR keyword. All of the structures must be of the same type, and must contain one field for each column (if COLUMN_MAJOR is set) or row (if ROW_MAJOR is set) in the table. If neither keyword is set, the data is displayed in row major format.

If none of [XY]SIZE, SCR_[XY]SIZE, or [XY]_SCROLL_SIZE is present, the size of the table is determined by the size of the array or vector of structures specified by VALUE. See "Note on Table Sizing" on page 1636.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The width of the widget in columns. If row labels are present, one column is automatically added to this value. See "Note on Table Sizing" on page 1636.

X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget, in columns. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the scrolling viewport independently of the actual width of the widget. See "Note on Table Sizing" on page 1636.

Use of the X_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when X_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify Y_SCROLL_SIZE when specifying X_SCROLL_SIZE.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The height of the widget in rows. If column labels are present, one row is automatically added to this value. See "Note on Table Sizing" on page 1636.

Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. in rows. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual width of the widget. See "Note on Table Sizing" on page 1636.

Use of the Y_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when Y_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify X_SCROLL_SIZE when specifying Y_SCROLL_SIZE.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of table widgets. In addition to those keywords that affect all widgets, the following are particularly useful: ALIGNMENT, ALL_TABLE_EVENTS, COLUMN_LABELS, COLUMN_WIDTHS, DELETE_COLUMNS, DELETE_ROWS, EDITABLE, EDIT_CELL, FORMAT, GET_VALUE, INSERT_COLUMNS, INSERT_ROWS, KBRD_FOCUS_EVENTS, ROW_LABELS, ROW_HEIGHTS, SET_TABLE_SELECT, SET_TABLE_VIEW, SET_TEXT_SELECT, SET_VALUE, TABLE_XSIZE, TABLE_YSIZE, USE_TABLE_SELECT, USE_TEXT_SELECT.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to table widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: COLUMN_WIDTHS, KBRD_FOCUS_EVENTS, ROW_HEIGHTS, TABLE_ALL_EVENTS, TABLE_EDITABLE, TABLE_EDIT_CELL, TABLE_SELECT, TABLE_VIEW, USE_TABLE_SELECT.

Widget Events Returned by Table Widgets

There are several variations of the table widget event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned. Programs should always check the field type before referencing fields that are not present in all table event structures. The different table widget event structures are described below.

Insert Single Character (TYPE = 0)

This is the type of structure returned when a single character is typed into a cell of a table widget by a user.

```
{WIDGET_TABLE_CH, ID:0L, TOP:0L, HANDLER:0L, TYPE:0, OFFSET:0L,
   CH:0B, X:0L, Y:0L }
```

OFFSET is the (zero-based) insertion position that will result after the character is inserted. CH is the ASCII value of the character. X and Y give the zero-based address of the cell within the table.

Insert Multiple Characters (TYPE = 1)

This is the type of structure returned when multiple characters are pasted into a cell by the window system.

```
{WIDGET_TABLE_STR, ID:0L, TOP:0L, HANDLER:0L, TYPE:1, OFFSET:0L,
   STR:'', X:0L, Y:0L}
```

OFFSET is the (zero-based) insertion position that will result after the text is inserted. STR is the string to be inserted. X and Y give the zero-based address of the cell within the table.

Delete Text (TYPE = 2)

This is the type of structure returned when any amount of text is deleted from a cell of a table widget.

```
{WIDGET_TABLE_DEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:2, OFFSET:0L,
   LENGTH:0L, X:0L, Y:0L}
```

OFFSET is the (zero-based) character position of the first character deleted. It is also the insertion position that will result when the next character is inserted. LENGTH gives the number of characters involved. X and Y give the zero-based address of the cell within the table.

Text Selection (TYPE = 3)

This is the type of structure returned when an area of text is selected (highlighted) by the user.

```
{WIDGET_TABLE_TEXT_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:3,
   OFFSET:0L, LENGTH:0L, X:0L, Y:0L}
```

The event announces a change in the insertion point. OFFSET is the (zero-based) character position of the first character to be selected. LENGTH gives the number of characters involved. A LENGTH of zero indicates that the widget has no selection, and that the insertion position is given by OFFSET. X and Y give the zero-based address of the cell within the table.

Note

Text insertion, text deletion, or any change in the current insertion point causes any current selection to be lost. In such cases, the loss of selection is implied by the text event reporting the insert/delete/movement and a separate zero length selection event is not sent.

Cell Selection (TYPE = 4)

This is the type of structure returned when range of cells is selected (highlighted) or deselected by the user.

```
{WIDGET_TABLE_CELL_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:4,
   SEL_LEFT:0L, SEL_TOP:0L, SEL_RIGHT:0L, SEL_BOTTOM:0L}
```

The event announces a change in the currently selected cells. The range of cells selected is given by the zero-based indices into the table specified by the SEL_LEFT, SEL_TOP, SEL_RIGHT, and SEL_BOTTOM fields. When cells are deselected (either by changing the selection or by clicking in the upper left corner of the table) an event is generated in which the SEL_LEFT, SEL_TOP, SEL_RIGHT, and SEL_BOTTOM fields contain the value -1.

Note

This means that two WIDGET_TABLE_CELL_SEL events are generated when an existing selection is changed to a new selection. If your code pays attention to WIDGET_TABLE_CELL_SEL events, be sure to differentiate between select and deselect events.

Row Height Changed (TYPE = 6)

This is the type of structure returned when a row height is changed by the user.

```
{WIDGET_TABLE_ROW_HEIGHT, ID:0L, TOP:0L, HANDLER:0L, TYPE:6,
    ROW:0L, HEIGHT:0L}
```

The event announces that the height of the given row has been changed by the user. The ROW field contains the zero-based row number, and the HEIGHT field contains the new height.

Column Width Changed (TYPE = 7)

This is the type of structure returned when a column width is changed by the user.

```
{WIDGET_TABLE_COLUMN_WIDTH, ID:0L, TOP:0L, HANDLER:0L, TYPE:7,
   COLUMN:0L, WIDTH:0L}
```

The event announces that the width of the given column has been changed by the user. The COLUMN field contains the zero-based column number, and the WIDTH field contains the new width.

Invalid Data (TYPE = 8)

This is the type of structure returned when the text entered by the user does not pass validation, and the user has finished editing the field (by hitting TAB or ENTER).

```
{WIDGET_TABLE_INVALID_ENTRY, ID:0L, TOP:0L, HANDLER:0L, TYPE:8,
   STR:'', X:0L, Y:0L}
```

When this event is generated, the cell's data is left unchanged. The invalid contents entered by the user is given as a text string in the STR field. The cell location is given by the X and Y fields.

Keyboard Focus Events

Table widgets return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID is the widget ID of the table widget generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The ENTER field returns 1 (one) if the table widget is gaining the keyboard focus, or 0 (zero) if the table widget is losing the keyboard focus.

See Also

WIDGET_CONTROL

WIDGET_TEXT

The WIDGET_TEXT function creates text widgets. Text widgets display text and optionally get textual input from the user. They can have 1 or more lines, and can optionally contain scroll bars to allow viewing more text than can otherwise be displayed on the screen.

The returned value of this function is the widget ID of the newly-created text widget.

Syntax

Result = WIDGET_TEXT(*Parent* [, /ALL_EVENTS] [, /EDITABLE]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FRAME=*width*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, /KBRD_FOCUS_EVENTS]
[, KILL_NOTIFY=*string*] [, /NO_COPY] [, /NO_NEWLINE]
[, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SCROLL] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*]
[, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, /WRAP]
[, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*])

Arguments

Parent

The widget ID of the parent widget for the new text widget.

Keywords

ALL_EVENTS

Along with the EDITABLE keyword, ALL_EVENTS controls the type of events generated by the text widget. Set the ALL_EVENTS keyword to cause the full set of events to be generated. If ALL_EVENTS is not set, setting EDITABLE causes only

end-of-line events to be generated. If EDITABLE is not set, all events are suppressed. See the following table for additional details.

Keywords		Effects	
ALL_EVENTS	**EDITABLE**	**Input changes widget contents?**	**Type of events generated.**
Not set	Not set	No	None
Not set	Set	Yes	End-of-line insertion
Set	Not set	No	All events
Set	Set	Yes	All events

Table 97: Effects of using the ALL_EVENTS and EDITABLE keywords

EDITABLE

Set this keyword to allow direct user editing of the text widget contents. Normally, the text in text widgets is read-only. See "ALL_TEXT_EVENTS" on page 1552 for a description of how EDITABLE interacts with the ALL_TEXT_EVENTS keyword.

EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

FONT

The name of the font to be used by the widget. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See "About Device Fonts" on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

Note

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts.

FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget.

Note

This keyword is only a "hint" to the toolkit, and may be ignored in some instances. Under Microsoft Windows, text widgets *always* have frames.

FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See "Text Widget Events" on page 1658 for more information.

KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_TEXT or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

NO_NEWLINE

Normally, when setting the value of a multi-line text widget, newline characters are automatically appended to the end of each line of text. Set this keyword to suppress this action.

NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 1527 for a complete discussion of this keyword.

SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen.

SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 1533 in the documentation for WIDGET_BASE.

UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

Note

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_TEXT.

UVALUE

The "user value" to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

VALUE

The initial value setting of the widget. The value of a text widget is the current text displayed by the widget.

VALUE can be either a string or an array of strings. Note that variables returned by the GET_VALUE keyword to WIDGET_CONTROL are always string arrays, even if a scalar string is specified in the call to WIDGET_TEXT.

WRAP

Set this keyword to indicate that scrolling or multi-line text widgets should automatically break lines between words to keep the text from extending past the right edge of the text display area. Note that carriage returns are *not* automatically entered when lines wrap; the value of the text widget will remain a single-element array unless you explicitly enter a carriage return.

XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

XSIZE

The width of the widget in characters. Note that the physical width of the text widget depends on both the value of XSIZE and on the size of the font used. The default value of XSIZE varies according to your windowing system. On Windows and Mac, the default size is roughly 20 characters. On Motif, the default size depends on the width of the text widget.

YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

YSIZE

The height of the widget in text lines. Note that the physical height of the text widget depends on both the value of YSIZE and on the size of the font used. The default value of YSIZE is one line.

Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of text widgets. In addition to those keywords that affect all widgets, the following are particularly useful: ALL_TEXT_EVENTS, APPEND, EDITABLE, GET_VALUE, KBRD_FOCUS_EVENTS, INPUT_FOCUS, NO_NEWLINE, SET_TEXT_SELECT, SET_TEXT_TOP_LINE, SET_VALUE, USE_TEXT_SELECT.

Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to text widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: KBRD_FOCUS_EVENTS, TEXT_ALL_EVENTS, TEXT_EDITABLE, TEXT_NUMBER, TEXT_OFFSET_TO_XY, TEXT_SELECT, TEXT_TOP_LINE, TEXT_XY_TO_OFFSET.

Text Widget Events

There are several variations of t1he text widget event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned. Programs should always check the type field before referencing fields that are not present in all text event structures. The different text widget event structures are described below.

Insert Single Character (TYPE = 0)

This is the type of structure returned when a single character is typed or pasted into a text widget by a user.

```
{ WIDGET_TEXT_CH, ID:0L, TOP:0L, HANDLER:0L, TYPE:0, OFFSET:0L,
   CH:0B }
```

OFFSET is the (zero-based) insertion position that will result after the character is inserted. CH is the ASCII value of the character.

Insert Multiple Characters (TYPE = 1)

This is the type of structure returned when multiple characters are pasted into a text widget by the window system.

```
{ WIDGET_TEXT_STR, ID:0L, TOP:0L, HANDLER:0L, TYPE:1, OFFSET:0L,
   STR:'' }
```

OFFSET is the (zero-based) insertion position that will result after the text is inserted. STR is the string to be inserted.

Delete Text (TYPE = 2)

This is the type of structure returned when any amount of text is deleted from a text widget.

```
{ WIDGET_TEXT_DEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:2, OFFSET:0L,
   LENGTH:0L }
```

OFFSET is the (zero-based) character position of the first character to be deleted. It is also the insertion position that will result when the characters have been deleted. LENGTH gives the number of characters involved. A LENGTH of zero indicates that no characters were deleted.

Selection (TYPE = 3)

This is the type of structure returned when an area of text is selected (highlighted) by the user.

```
{ WIDGET_TEXT_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:3, OFFSET:0L,
   LENGTH:0L }
```

The event announces a change in the insertion point. OFFSET is the (zero-based) character position of the first character to be selected. LENGTH gives the number of characters involved. A LENGTH of zero indicates that no characters are selected, and the new insertion position is given by OFFSET.

Note that text insertion, text deletion, or any change in the current insertion point causes any current selection to be lost. In such cases, the loss of selection is implied by the text event reporting the insert/delete/movement and a separate zero length selection event is *not* sent.

Keyboard Focus Events

Text widgets return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID is the widget ID of the text widget generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The ENTER field returns 1 (one) if the text widget is gaining the keyboard focus, or 0 (zero) if the text widget is losing the keyboard focus.

See Also

CW_FIELD, XDISPLAYFILE

WINDOW

The WINDOW procedure creates a window for the display of graphics or text. It is only necessary to use WINDOW if more than one simultaneous window or a special size window is desired because a window is created automatically the first time any display procedure attempts to access the window system. The newly-created window becomes the current window, and the system variable !D.WINDOW is set to that window's window index. (See the description of the WSET procedure for a discussion of the current IDL window.)

The behavior of WINDOW varies slightly depending on the window system in effect. See the discussion of IDL graphics devices in Appendix B, "IDL Graphics Devices" for additional details.

Syntax

WINDOW [, *Window_Index*] [, COLORS=*value*] [, /FREE] [, /PIXMAP] [, RETAIN={0 | 1 | 2}] [, TITLE=*string*] [, XPOS=*value*] [, YPOS=*value*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

Arguments

Window_Index

The window index for the newly-created window. A window index is an integer value between 0 and 31 that is used to refer to the window. If this parameter is omitted, window index 0 is used. If the value of *Window_Index* specifies an existing window, the existing window is deleted and a new one is created. If you need to create more than 32 windows, use the FREE keyword described below.

Keywords

COLORS

Note

This keyword is ignored on Windows and Macintosh.

The maximum number of color table indices to be used when drawing. This keyword has an effect only if supplied when the first window is created. If COLORS is not present when the first window is created, all or most of the available color indices are allocated depending upon the window system in use.

To use monochrome windows on a color display in X Windows, use COLORS = 2 when creating the first window. One color table is maintained for all windows. A negative value for COLORS specifies that all but the given number of colors from the shared color table should be allocated.

Although this keyword is ignored on Windows and Macintosh, we could use the following code to use a monochrome window on all platforms:

```
WINDOW, COLORS=2 ; ignored on Windows and Mac
white=!D.N_COLORS-1
PLOT, FINDGEN(20), COLOR=white
```

FREE

Set this keyword to create a window using the smallest unused window index above 32. If this keyword is present, the *Window_Index* argument can be omitted. The default position of the new window is opposite that of the current window. Using the FREE keyword allows the creation of a large number of windows. The system variable !D.WINDOW is set to the index of the newly-created window.

PIXMAP

Set the PIXMAP keyword to specify that the window being created is actually an invisible portion of the display memory called a pixmap.

RETAIN

Set this keyword to 0, 1, or 2 to specify how backing store should be handled for the window:

- 0 = no backing store
- 1 = requests that the server or window system provide backing store
- 2 = specifies that IDL provide backing store directly

See “Backing Store” on page 2351 for details.

TITLE

A scalar string that contains the window’s label. If not specified, the window is given a label of the form “IDL *n*”, where *n* is the index number of the window. For example, to create a window with the label “IDL Graphics”, enter:

```
WINDOW, TITLE='IDL Graphics'
```

XPOS

The X position of the window, specified in device coordinates. On Motif platforms, XPOS specifies the X position of the *lower* left corner and is measured from the lower left corner of the screen. On Windows and Macintosh platforms, XPOS specifies the X position of the *upper* left corner and is measured from the upper left corner of the screen. That is, specifying

```
WINDOW, XPOS = 0, YPOS = 0
```

will create a window in the lower left corner on Motif machines and in the upper left corner on Windows and Macintosh machines.

If no position is specified, the position of the window is determined from the value of Window Index using the following rules:

- Window 0 is placed in the upper right hand corner.
- Even numbered windows are placed on the top half of the screen and odd numbered windows are placed on the bottom half.
- Windows 0,1,4,5,8, and 9 are placed on the right side of the screen and windows 2,3,6, and 7 are placed on the left.

Note

The order of precedence (highest to lowest) for positioning windows is: XPOS/YPOS keywords to WINDOW, Tile/Cascade IDE graphics (user system) preferences, optional index argument to WINDOW. Also realize that setting LOCATION is only a request to the Window manager and may not always be honored due to system peculiarities.

YPOS

The Y position of the window, specified in device coordinates. See the description of XPOS for details.

XSIZE

The width of the window in pixels.

YSIZE

The height of the window in pixels.

Example

Create graphics window number 0 with a size of 400 by 400 pixels and a title that reads “Square Window” by entering:

```
WINDOW, 0, XSIZE=400, YSIZE=400, TITLE='Square Window'
```

See Also

WDELETE, WSET, WSHOW

WRITE_BMP

The WRITE_BMP procedure writes an image and its color table vectors to a Microsoft Windows Version 3 device independent bitmap file (.BMP).

WRITE_BMP does not handle 1-bit-deep images or compressed images, and is not fast for 4-bit images. The algorithm works best on images where the number of bytes in each scan-line is evenly divisible by 4.

This routine is written in the IDL language. Its source code can be found in the file `write_bmp.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WRITE_BMP, *Filename*, *Image*[, *R*, *G*, *B*] [, /FOUR_BIT] [, IHDR=*structure*] [, HEADER_DEFINE=*h*{define *h* before call}] [, /RGB]

Arguments

Filename

A scalar string containing the full pathname of the bitmap file to write.

Image

The array to write into the new bitmap file. The array should be scaled into a range of bytes for 8- and 24-bit deep images. Scale to 0-15 for 4-bit deep images. If the image has 3 dimensions and the first dimension is 3, a 24-bit deep bitmap file is created.

Note

For 24-bit images, color interleaving is blue, green, red: *Image*[0, *i*, *j*] = blue, *Image*[1, *i*, *j*] = green, *Image*[2, *i*, *j*] = red.

R, G, B

Color tables. If omitted, the colors loaded in the COLORS common block are used.

Keywords

FOUR_BIT

Set this keyword to write as a 4-bit device independent bitmap. If omitted or zero, an 8-bit deep bitmap is written.

IHDR

Set this keyword to a BITMAPINFOHEADER structure containing the file header fields that are not obtained from the image itself. The fields in this structure that can be set are: `bi{XY}PelsPerMeter`, `biClrUsed`, and `biClrImportant`.

HEADER_DEFINE

If this keyword is set, WRITE_BMP returns an empty BITMAPINFOHEADER structure, containing zeros. No other actions are performed. This structure may be then modified with the pertinent fields and passed in via the IHDR keyword parameter. See the Microsoft Windows Programmers Reference Guide for a description of each field in the structure.

Note: this parameter must be defined *before* the call. For example:

```
H = 0
WRITE_BMP, HEADER_DEFINE = H
```

RGB

Set this keyword to reverse the color interleaving for 24-bit images to red, green, blue: *Image*[0, *i*, *j*] = red, *Image*[1, *i*, *j*] = green, *Image*[2, *i*, *j*] = blue. By default, 24-bit images are written with color interleaving of blue, green, red.

Examples

The following command captures the contents of the current IDL graphics window and saves it to a Microsoft Windows Bitmap file with the name `test.bmp`. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_BMP, 'test.bmp', TVRD()
```

The following commands scale an image to 0-15, and then write a 4-bit BMP file, using a grayscale color table:

```
; Create a ramp from 0 to 255:
r = BYTSCL(INDGEN(16))

WRITE_BMP, 'test.bmp', BYTSCL(Image, MAX=15), r, r, r, /FOUR
```

See Also

READ_BMP, QUERY_* Routines

WRITE_IMAGE

The WRITE_IMAGE procedure writes an image and its color table vectors, if any, to a file of a specified type. WRITE_IMAGE can write most types of image files supported by IDL.

Syntax

WRITE_IMAGE, *Filename*, *Format*, *Data* [, *Red*, *Green*, *Blue*] [, /APPEND]

Arguments

Filename

A scalar string containing the name of the file to write.

Format

A scalar string containing the name of the file format to write. The following are the supported formats:

- BMP
- JPEG
- PNG
- PPM
- SRF
- TIFF
- DICOM

Data

An IDL variable containing the image data to write to the file.

Red

An optional vector containing the red channel of the color table if a colortable exists.

Green

An optional vector containing the green channel of the color table if a colortable exists.

Blue

An optional vector containing the blue channel of the color table if a colortable exists.

Keywords

APPEND

Set this keyword to force the image to be appended to the file instead of overwriting the file. APPEND may be used with image formats that supports multiple images per file and is ignored for formats that support only a single image per file.

WRITE_JPEG

The WRITE_JPEG procedure writes compressed images to files. JPEG (Joint Photographic Experts Group) is a standardized compression method for full-color and gray-scale images. This procedure is based in part on the work of the Independent JPEG Group.

As the Independent JPEG Group states, JPEG is intended for real-world scenes (such as digitized photographs). Line art, such as drawings or IDL plots, and other unrealistic images are not its strong suit. Note also that JPEG is a lossy compression scheme. That is, the output image is *not* identical to the input image. Hence you cannot use JPEG if you must have identical output bits. On typical images of real-world scenes, however, very good compression levels can be obtained with no visible change, and amazingly high compression levels are possible if you can tolerate a low-quality image. You can trade off output image quality against compressed file size by adjusting a compression parameter. Files are encoded in JFIF, the JPEG File Interchange Format; however, such files are usually simply called JPEG files.

If you need to store images in a format that uses lossless compression, consider using the WRITE_PNG procedure. This procedure writes a Portable Network Graphics (PNG) file using lossless compression with either 8 or 16 data bits per channel. To store 8-bit or 24-bit images without compression, consider using WRITE_BMP (for Microsoft Bitmap format files) or WRITE_TIFF (to write Tagged Image Format Files).

For a short technical introduction to the JPEG compression algorithm, see: Wallace, Gregory K. “The JPEG Still Picture Compression Standard”, *Communications of the ACM*, April 1991 (vol. 34, no. 4), pp. 30-44.

Note

All JPEG files consist of byte data. Input data is converted to bytes before being written to a JPEG file.

Syntax

WRITE_JPEG [, *Filename* | , UNIT=*lun*] , *Image* [, /ORDER] [, /PROGRESSIVE] [, QUALITY=*value*{0 to 100}] [, TRUE={1 | 2 | 3}]

Arguments

Filename

A string containing the name of file to be written in JFIF (JPEG) format. If this parameter is not present, the UNIT keyword must be specified.

Image

A byte array of either two or three dimensions, containing the image to be written. Grayscale images must have two dimensions. TrueColor images must have three dimensions with the index of the dimension that contains the color specified with the TRUE keyword.

Keywords

ORDER

JPEG/JFIF images are normally written in top-to-bottom order. If the image array is in the standard IDL order (i.e., from bottom-to-top) set ORDER to 0, its default value. If the image array is in top-to-bottom order, ORDER must be set to 1.

PROGRESSIVE

Set this keyword to write the image as a series of scans of increasing quality. When used with a slow communications link, a decoder can generate a low-quality image very quickly, and then improve its quality as more scans are received.

Warning

Not all JPEG applications can handle progressive JPEG files, and it is up the JPEG reader to progressively display the JPEG image. For example, IDL's READ_JPEG routine ignores the progressive readout request and reads the entire image in at the first reading.

QUALITY

This keyword specifies the quality index, in the range of 0 (terrible) to 100 (excellent) for the JPEG file. The default value is 75, which corresponds to very good quality. Lower values of QUALITY produce higher compression ratios and smaller files.

TRUE

This keyword specifies the index, starting at 1, of the dimension over which the color is interleaved. For example, for an image that is pixel interleaved and has dimensions of $(3, m, n)$, set TRUE to 1. Specify 2 for row-interleaved images $(m, 3, n)$; and 3 for

band-interleaved images (*m*, *n*, 3). If TRUE is not set, the image is assumed to have no interleaving (it is not a TrueColor image).

UNIT

This keyword designates the logical unit number of an already open file to receive the output, allowing multiple JFIF images per file or the embedding of JFIF images in other data files. If this keyword is used, *Filename* should not be specified.

Note

When using VMS, open the file with the /STREAM keyword.

Note

When opening a file intended for use with the UNIT keyword, if the filename does not end in `.jpg`, or `.jpeg`, you must specify the STDIO keyword to OPEN in order for the file to be compatible with WRITE_JPEG.

Examples

Write the image contained in the array A, using JPEG compression with a quality index of 25. The image is stored in bottom-to-top order:

```
image = DIST(100)
WRITE_JPEG, 'test1.jpg', image, QUALITY=25
```

Write a TrueColor image to a JPEG file. The image is contained in the band-interleaved array A with dimensions (*m*, *n*, 3). Assume it is stored in top-to-bottom order:

```
WRITE_JPEG, 'test2.jpg', image, TRUE=3, /ORDER
```

See Also

READ_JPEG, QUERY_* Routines

WRITE_NRIF

The WRITE_NRIF procedure writes an image and its color table vectors to an NCAR Raster Interchange Format (NRIF) rasterfile.

WRITE_NRIF only writes 8- or 24-bit deep rasterfiles of types “Indexed Color” (8-bit) and “Direct Color integrated” (24-bit). The color map is included only for 8-bit files.

See the document “NCAR Raster Interchange Format and TAGS Raster Reference Manual,” available from the Scientific Computing Division, National Center for Atmospheric Research, Boulder, CO, 80307-3000, for information on the structure of NRIF files.

This routine is written in the IDL language. Its source code can be found in the file `write_nrif.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WRITE_NRIF, *File*, *Image* [, *R*, *G*, *B*]

Arguments

File

A scalar string containing the full path name of the NRIF file to write.

Image

The byte array to be written to the NRIF file. If *Image* has the dimensions (*n*,*m*), an 8-bit NRIF file with color tables is created. If *Image* has the dimensions (3,*n*,*m*), a 24-bit NRIF file is created, where each byte triple represents the red, green, and blue intensities at (*n*,*m*) on a scale from 0 to 255. The NRIF image will be rendered from bottom to top, in accordance with IDL standards.

R, G, B

The Red, Green, and Blue color vectors to be used as a color table with 8-bit images. If color vectors are supplied, they are included in the output (8-bit images only). If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_NRIF calls LOADCT to load the grayscale entry (table 0).

Note

WRITE_NRIF does not recognize color vectors loaded directly using TVLCT, so if a custom color table is desired and it is not convenient to use XPALETTE, include the R, G, and B vectors that were used to create the color table.

WRITE_PICT

The WRITE_PICT procedure writes an image and its color table vectors to a PICT (version 2) format image file. The PICT format is used by Apple Macintosh computers.

Note: WRITE_PICT only works with 8-bit displays

This routine is written in the IDL language. Its source code can be found in the file `write_pict.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WRITE_PICT, *Filename* [, *Image*, *R*, *G*, *B*]

Arguments

Filename

A scalar string containing the full pathname of the PICT file to write.

Image

The byte array to be written to the PICT file. If *Image* is omitted, the entire current graphics window is read into an array and written to the PICT file.

R, G, B

The Red, Green, and Blue color vectors to be written to the PICT file. If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_PICT calls LOADCT to load the grayscale entry (table 0).

Example

Create a pseudo screen dump from the current window. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_PICT, 'test.pict', TVRD()
```

See Also

READ_PICT, QUERY_* Routines

WRITE_PNG

The WRITE_PNG procedure writes a 2D or 3D IDL variable into a Portable Network Graphics (PNG) file. The data in the file is stored using lossless compression with either 8 or 16 data bits per channel, based on the input IDL variable type. 3D IDL variables must have the number of channels as their leading dimension (pixel interleaved). For BYTE format 2D IDL variables, an optional palette may be stored in the image file along with a list of pixel values which are to be considered transparent by a reading program.

Note

IDL supports version 1.0.5 of the PNG Library.

Syntax

WRITE_PNG, *Filename*, *Image*[, *R*, *G*, *B*] [, /ORDER] [, /VERBOSE] [, TRANSPARENT=*array*]

Arguments

Filename

A scalar string containing the full pathname of the PNG file to write.

Image

The array to write into the new PNG file. If *Image* is one of the integer data types, it is converted to type unsigned integer (UINT) and written out at 16 data bits per channel. All other data types are converted to bytes and written out at 8-bits per channel.

Note

If *Image* is two-dimensional (single-channel) and *R*, *G*, and *B* are provided, all input data types (including integer) are converted to bytes and written out as 8-bit data.

R, G, B

For single-channel images, *R*, *G*, and *B* should contain the red, green, and blue color vectors, respectively. For multi-channel images, these arguments are ignored.

Keywords

ORDER

Set this keyword to indicate that the rows of the image should be written from bottom to top. The rows are written from top to bottom by default. ORDER provides compatibility with PNG files written using versions of IDL prior to IDL 5.4, which wrote PNG files from bottom to top.

VERBOSE

Produces additional diagnostic output during the write.

TRANSPARENT

Set this keyword to an array of pixel index values which are to be treated as "transparent" for the purposes of image display. This keyword is valid only if *Image* is a single-channel (color indexed) image and the R, G, B palette is provided.

Example

Create an RGBA (16-bits/channel) and a Color Indexed (8-bits/channel) image with a palette.

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = INDGEN(256)
green = INDGEN(256)
blue = INDGEN(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue

; Query and Read the data:
names = ['rgb_image.png','ci_image.png','unknown.png']
FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
   ok = QUERY_PNG(names[i],s)
   IF (ok) THEN BEGIN
      HELP,s,/STRUCTURE
      IF (s.HAS_PALETTE) THEN BEGIN
         img = READ_PNG(names[i],rpal,gpal,bpal)
         HELP,img,rpal,gpal,bpal
      ENDIF ELSE BEGIN
         img = READ_PNG(names[i])
         HELP,img
      ENDELSE
   ENDIF ELSE BEGIN
      PRINT,names[i],' is not a PNG file'
   ENDELSE
ENDFOR
```

See Also

READ_PNG, QUERY_* Routines

WRITE_PPM

The WRITE_PPM procedure writes an image to a PPM (TrueColor) or PGM (gray scale) file. This routine is written in the IDL language. Its source code can be found in the file `write_ppm.pro` in the `lib` subdirectory of the IDL distribution.

Note

WRITE_PPM only writes 8-bit deep PGM/PPM files of the standard type. Images should be ordered so that the first row is the top row.

PPM/PGM format is supported by the PBMPLUS toolkit for converting various image formats to and from portable formats, and by the Netpbm package.

Syntax

WRITE_PPM, *Filename*, *Image* [, /ASCII]

Arguments

Filename

A scalar string specifying the full pathname of the PPM or PGM file to write.

Image

The 2D (gray scale) or 3D (TrueColor) array to be written to a file.

Keywords

ASCII

Set this keyword to force WRITE_PPM to use formatted ASCII input/output to write the image data. The default is to use the far more efficient binary input/output (RAWBITS) format.

Example

```
image = DIST(100)
WRITE_PPM, 'file.ppm', image
```

See Also

READ_PPM, QUERY_* Routines

WRITE_SPR

The WRITE_SPR procedure writes a row-indexed sparse array structure to a specified file. Row-indexed sparse arrays are created using the SPRSIN function.

Syntax

WRITE_SPR, *AS*, *Filename*

Arguments

AS

A row-indexed sparse array created by SPRSIN.

Filename

The name of the file that will contain AS.

Example

```
; Create an array:
A = [[3.,0., 1., 0., 0.],$
     [0.,4., 0., 0., 0.],$
     [0.,7., 5., 9., 0.],$
     [0.,0., 0., 0., 2.],$
     [0.,0., 0., 6., 5.]]

; Convert it to sparse storage format:
A = SPRSIN(A)

; Store it in the file sprs.as:
WRITE_SPR, A, 'sprs.as'
```

See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, READ_SPR

WRITE_SRF

The WRITE_SRF procedure writes an image and its color table vectors to a Sun Raster File (SRF).

WRITE_SRF only writes 32-, 24-, and 8-bit-deep rasterfiles of type RT_STANDARD. Use the UNIX command `rasfilter8to1` to convert these files to 1-bit deep files. See the file `/usr/include/rasterfile.h` for the structure of Sun rasterfiles.

This routine is written in the IDL language. Its source code can be found in the file `write_srf.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WRITE_SRF, *Filename* [, *Image*, *R*, *G*, *B*] [, /ORDER] [, /WRITE_32]

Arguments

Filename

A scalar string containing the full pathname of the SRF to write.

Image

The array to be written to the SRF. If *Image* has dimensions (3,*n*,*m*), a 24-bit SRF is written. If *Image* is omitted, the entire current graphics window is read into an array and written to the SRF file. *Image* should be of byte type, and in top to bottom scan line order.

R, G, B

The Red, Green, and Blue color vectors to be written to the file. If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_SRF calls LOADCT to load the grayscale entry (table 0).

Keywords

ORDER

Set this keyword to write the image from the top down instead of from the bottom up. This setting is only necessary when writing a file from the current IDL graphics window; it is ignored when writing a file from a data array passed as a parameter.

WRITE_32

Set this keyword to write a 32-bit file. If the input image is a TrueColor image, dimensioned (3, *n*, *m*), it is normally written as a 24-bit raster file.

Example

Create a pseudo screen dump from the current window:

```
WRITE_SRF, 'test.srf', TVRD()
```

See Also

READ_SRF, QUERY_* Routines

WRITE_SYLK

The WRITE_SYLK function writes the contents of an IDL variable to a SYLK (Symbolic Link) format spreadsheet data file. The function returns TRUE if the write operation was successful.

Note

This routine writes only numeric and string SYLK data. It cannot handle spreadsheet and cell formatting information (cell width, text justification, font type, date, time, monetary notations, etc.). A given SYLK data file cannot be appended with data blocks through subsequent calls.

This routine is written in the IDL language. Its source code can be found in the file `write_sylk.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = WRITE_SYLK(*File*, *Data* [, STARTCOL=*column*] [, STARTROW=*row*])

Arguments

File

A scalar string specifying the full path name of the SYLK file to write.

Data

A scalar, vector, or 2D array to be written to *File*.

Keywords

STARTCOL

Set this keyword to the first column of spreadsheet cells to write. If not specified, the write operation begins with the first column found in the file (column 0).

STARTROW

Set this keyword to the first row of spreadsheet cells to write. If not specified, the write operation begins with the first row of cells found in the file (row 0).

Example

Suppose you wish to write the contents of a 2 by 2 floating-point array, `data`, to a SYLK data file called “bar.slk” such that the matrix would appear with it’s upper left data at the cell in the 10th row and the 20th column. Use the following command:

```
status = WRITE_SYLK('bar.slk', data, STARTROW = 9, STARTCOL = 19)
```

The IDL variable `status` will contain the value 1 if the operation was successful.

See Also

READ_SYLK

WRITE_TIFF

The WRITE_TIFF procedure can write TIFF files with one or more channels, where each channel can contain 8, 16, 32, or floating point pixels.

Syntax

WRITE_TIFF, *Filename* [, *Image*, *Order*] [, /APPEND] [, RED=*value*] [, GREEN=*value*] [, BLUE=*value*] [, COMPRESSION={0 | 1 | 2}] [, GEOTIFF=*structure*] [, /LONG | , /SHORT | ,/FLOAT] [, PLANARCONFIG={1 | 2}] [, /VERBOSE] [, XRESOL=*pixels/inch*] [, YRESOL=*pixels/inch*]

Arguments

Filename

A scalar string containing the full pathname of the TIFF to write.

Image

The array to be written to the TIFF. If *Image* has dimensions (k,n,m), a k-channel TIFF is written. Image should be in top to bottom scan line order. By default, this array is converted to byte format before being written (see the LONG, SHORT and FLOAT keywords below). Note that many TIFF readers can read only one- or three-channel images.

Note

The Image argument is optional if PLANARCONFIG is set to 2 and the RED, GREEN, and BLUE keywords have been set to 2D arrays.

Order

This argument should be 0 if the image is stored from bottom to top (the default). For images stored from top to bottom, this argument should be 1.

Warning

Not all TIFF readers honor the value of the *Order* argument. IDL writes the value into the file, but many known readers ignore this value. In such cases, we recommend that you convert the image to top to bottom order with the REVERSE function and then set *Order* to 1.

Keywords

APPEND

Set this keyword to specify that the image should be added to the existing file, creating a multi-image TIFF file.

COMPRESSION

Set this keyword to select the type of compression to be used:

- 0 = none (default)
- 2 = PackBits.

FLOAT

Set this keyword to write the pixel components as floating-point entities (the default is 8-bit).

GEOTIFF

Set this keyword to an anonymous structure containing one field for each of the GeoTIFF tags and keys to be written into the file. The GeoTIFF structure is formed using fields named from the following table.

Anonymous Structure Field Name	IDLDatatype
TAGS:	
"MODELPIXELSCALETAG"	DOUBLE[3]
"MODELTRANSFORMATIONTAG"	DOUBLE[4,4]
"MODELTIEPOINTTAG"	DOUBLE[6,*]
KEYS:	
"GTMODELTYPEGEOKEY"	INT
"GTRASTERTYPEGEOKEY"	INT
"GTCITATIONGEOKEY"	STRING
"GEOGRAPHICTYPEGEOKEY"	INT
"GEOGCITATIONGEOKEY"	STRING

Table 98: GEOTIFF Structures

Anonymous Structure Field Name	IDLDatatype
"GEOGGEODETICDATUMGEOKEY"	INT
"GEOGPRIMEMERIDIANGEOKEY"	INT
"GEOGLINEARUNITSGEOKEY"	INT
"GEOGLINEARUNITSIZEGEOKEY"	DOUBLE
"GEOGANGULARUNITSGEOKEY"	INT
"GEOGANGULARUNITSIZEGEOKEY"	DOUBLE
"GEOGELLIPSOIDGEOKEY"	INT
"GEOGSEMIMAJORAXISGEOKEY"	DOUBLE
"GEOGSEMIMINORAXISGEOKEY"	DOUBLE
"GEOGINVFLATTENINGGEOKEY"	DOUBLE
"GEOGAZIMUTHUNITSGEOKEY"	INT
"GEOGPRIMEMERIDIANLONGGEOKEY"	DOUBLE
"PROJECTEDCSTYPEGEOKEY"	INT
"PCSCITATIONGEOKEY"	STRING
"PROJECTIONGEOKEY"	INT
"PROJCOORDTRANSGEOKEY"	INT
"PROJLINEARUNITSGEOKEY"	INT
"PROJLINEARUNITSIZEGEOKEY"	DOUBLE
"PROJSTDPARALLEL1GEOKEY"	DOUBLE
"PROJSTDPARALLEL2GEOKEY"	DOUBLE
"PROJNATORIGINLONGGEOKEY"	DOUBLE
"PROJNATORIGINLATGEOKEY"	DOUBLE
"PROJFALSEEASTINGGEOKEY"	DOUBLE
"PROJFALSENORTHINGGEOKEY"	DOUBLE
"PROJFALSEORIGINLONGGEOKEY"	DOUBLE

Table 98: GEOTIFF Structures

Anonymous Structure Field Name	IDLDatatype
"PROJFALSEORIGINLATGEOKEY"	DOUBLE
"PROJFALSEORIGINEASTINGGEOKEY"	DOUBLE
"PROJFALSEORIGINNORTHINGGEOKEY"	DOUBLE
"PROJCENTERLONGGEOKEY"	DOUBLE
"PROJCENTERLATGEOKEY"	DOUBLE
"PROJCENTEREASTINGGEOKEY"	DOUBLE
"PROJCENTERNORTHINGGEOKEY"	DOUBLE
"PROJSCALEATNATORIGINGEOKEY"	DOUBLE
"PROJSCALEATCENTERGEOKEY"	DOUBLE
"PROJAZIMUTHANGLEGEOKEY"	DOUBLE
"PROJSTRAIGHTVERTPOLELONGGEOKEY"	DOUBLE
"VERTICALCSTYPEGEOKEY"	INT
"VERTICALCITATIONGEOKEY"	STRING
"VERTICALDATUMGEOKEY"	INT
"VERTICALUNITSGEOKEY"	INT

Table 98: GEOTIFF Structures

Note

If a GeoTIFF key appears multiple times in a file, only the value for the first instance of the key is returned.

LONG

Set this keyword to write the pixel components as unsigned 32-bit entities (the default is 8-bit).

PLANARCONFIG

This keyword determines the order in which a multi-channel image is stored and written. It has no effect with a single-channel image. Set this keyword to 2 to if the Image parameter is interleaved by “plane”, or band, and its dimensions are (*Columns*, *Rows*, *Channels*). The default value is 1, indicating that multi-channel images are

interleaved by color, also called channel, and its dimensions are (*Channels*, *Columns*, *Rows*).

As a special case, this keyword may be set to 2 to write an RGB image that is contained in three separate arrays (color planes), stored in the variables specified by the RED, GREEN, and BLUE keywords. Otherwise, omit this parameter (or set it to 1).

Note

Many TIFF readers can read only one- or three-channel images.

RED, GREEN, BLUE

If you are writing a Palette color image, set these keywords equal to the color table vectors, scaled from 0 to 255.

If you are writing an RGB interleaved image (i.e., if the PLANARCONFIG keyword is set to 2), set these keywords to the names of the variables containing the three image components.

SHORT

Set this keyword to write the pixel components as unsigned 16-bit entities (the default is 8-bit).

VERBOSE

Set this keyword to produce additional diagnostic output during the write.

XRESOL

Set this keyword to the horizontal resolution, in pixels per inch. The default is 100.

YRESOL

Set this keyword to the vertical resolution, in pixels per inch. The default is 100.

Example

Example 1

Create a pseudo screen dump from the current window. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_TIFF, 'test.tiff', TVRD()
```

Example 2

Write a three-channel image from three one-channel (two-dimensional) arrays, contained in the variables Red, Green, and Blue:

```
WRITE_TIFF, 'test.tif', Red, Green, Blue, PLANARCONFIG=2
```

Example 3

Write and read a multi-image TIFF file. The first image is a 16-bit single channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND
; Read the image data back
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
   FOR i=0,s.NUM_IMAGES-1 DO BEGIN
      imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
      img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
      HELP,t,/STRUCTURE
      HELP,img
   ENDFOR
ENDIF
```

See Also

READ_TIFF, QUERY_* Routines

WRITE_WAV

The WRITE_WAV procedure writes the audio stream to the named .WAV file.

Syntax

WRITE_WAV*, Filename*, *Data*, *Rate*

Arguments

Filename

A scalar string containing the full pathname of the .WAV file to write.

Data

The array to write into the new .WAV file. The array can be a one- or two-dimensional array. A two-dimensional array is written as a multi-channel audio stream where the leading dimension of the IDL array is the number of channels. If the input array is in BYTE format, the data is written as 8-bit samples, otherwise, the data is written as signed 16-bit samples.

Rate

The sampling rate for the data array in samples per second.

Keywords

None.

WRITE_WAVE

The WRITE_WAVE procedure writes a three dimensional IDL array to a `.wave` or `.bwave` file for use with the Wavefront Advanced Data Visualizer. Note that this routine only writes one scalar field for each Wavefront file that it creates.

This routine is written in the IDL language. Its source code can be found in the file `write_wave.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

WRITE_WAVE, *File*, *Array* [, /BIN] [, DATANAME=*string*]
[, MESHNAME=*string*] [, /NOMESHDEF] [, /VECTOR]

Arguments

File

A scalar string containing the full path name of the Wavefront file to write.

Array

A 3D array to be written to the file.

Keywords

BIN

Set this keyword to create a binary file. By default, text files are created.

DATANAME

Set this keyword to the name of the data inside of the Wavefront file. If not specified, the name used is “idldata”.

MESHNAME

Set this keyword to the name of the mesh used in the Wavefront file. If not specified, the name used is “idlmesh”.

NOMESHDEF

Set this keyword to *omit* the mesh definition from the Wavefront file.

VECTOR

Set this keyword to write the variable as a vector. The data is written as an array of 3-space vectors. The array may contain any number of dimensions but must have a leading dimension of 3. If the leading array dimension is not 3, this keyword is ignored.

See Also

READ_WAVE

WRITEU

The WRITEU procedure writes unformatted binary data from an expression into a file. This procedure performs a direct transfer with no processing of any kind being done to the data.

Syntax

WRITEU, *Unit*, $Expr_1$ ..., $Expr_n$ [, TRANSFER_COUNT=*variable*]

VMS-Only Keywords: [, /REWRITE]

Arguments

Unit

The IDL file unit to which the output is sent.

$Expr_i$

The expressions to be output. For non-string variables, the number of bytes implied by the data type is output. When WRITEU is used with a variable of type string, IDL outputs exactly the number of bytes contained in the existing string.

Keywords

TRANSFER_COUNT

Set this keyword to a named variable in which to return the number of elements transferred by the output operation. Note that the number of elements is not the same as the number of bytes (except in the case where the data type being transferred is bytes). For example, transferring 256 floating-point numbers yields a transfer count of 256, not 1024 (the number of bytes transferred).

This keyword is useful with files opened with the RAWIO keyword to the OPEN routines. Normally, writing more data than an output device will accept causes an error. Files opened with the RAWIO keyword will not generate such an error. Instead, the programmer must keep track of the transfer count to judge the success or failure of a WRITEU operation.

VMS-Only Keywords

Note

The obsolete FORWRT routine has been replaced by WRITEU.

REWRITE

When writing data to a file with indexed organization, setting the REWRITE keyword specifies that the data should update the contents of the most recently input record instead of creating a new record.

Example

```
; Create some data to store in a file:
D = BYTSCL(DIST(200))
; Open a new file for writing as IDL file unit number 1:
OPENW, 1, 'newfile'
; Write the data in D to the file:
WRITEU, 1, D
; Close file unit 1:
CLOSE, 1
```

See Also

OPEN, READU, *Building IDL Applications* Chapter 8, "Files and Input/Output", and "Unformatted Input/Output with Structures" in Chapter 6 of *Building IDL Applications*

WSET

The WSET procedure selects the current window. Most IDL graphics routines do not explicitly require the IDL window to be specified. Instead, they use the window known as the current window. The window index number of the current window is contained in the read-only system variable !D.WINDOW. WSET only works with devices that have windowing systems.

Syntax

WSET [, *Window_Index*]

Arguments

Window_Index

This argument specifies the window index of the window to be made current. If this argument is not specified, a default of 0 is used.

If you set *Window_Index* equal to -1, IDL will try to locate an existing window to make current, ignoring any managed draw widgets that may exist. If there is no window to make current, WSET changes the value of the WINDOW field of the !D system variable to -1, indicating that there are no current windows.

If there are no existing IDL windows, and you call WSET without the *Window_Index* argument or with a *Window_Index* of 0, a new window with the index 0 is opened. Calling WSET with a *Window_Index* for a window that does not exist, except for window 0, results in a "Window is closed and unavailable" error message.

Examples

Create IDL windows 1 and 2 by entering:

```
WINDOW, 1 & WINDOW, 2
```

Set the current window to window 1 and display an image by entering:

```
WSET, 1 & TVSCL, DIST(100)
```

Set the current window to window 2 and display an image by entering:

```
WSET, 2 & TVSCL, DIST(100)
```

See Also

WDELETE, WINDOW, WSHOW

WSHOW

The WSHOW procedure exposes or hides the designated window.

Syntax

WSHOW [, *Window_Index* [, *Show*]] [, /ICONIC]

Arguments

Window_Index

The window index of the window to be hidden or exposed. If this argument is not specified, the current window is assumed. If this index is the window ID of a draw widget, the widget base associated with that drawable is brought to the front of the screen.

Show

Set *Show* to 0 to hide the window. Omit this argument or set it to 1 to expose the window.

Keywords

ICONIC

Set this keyword to iconify the window. Set ICONIC to 0 to de-iconify the window.

Under windowing systems, iconification is the task of the window manager, and client applications such as IDL have no direct control over it. The ICONIC keyword serves as a hint to the window manager, which is free to iconify the window or ignore the request as it sees fit.

Example

To bring IDL window number 0 to the front, enter:

```
WSHOW, 0
```

See Also

WDELETE, WINDOW, WSET

WTN

The WTN function returns a multi-dimensional discrete wavelet transform of the input array A. The transform is based on a Daubechies wavelet filter.

WTN is based on the routine `wtn` described in section 13.10 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

Syntax

Result = WTN(*A*, *Coef* [, /COLUMN] [, /DOUBLE] [, /INVERSE] [, /OVERWRITE])

Arguments

A

The input vector or array. The dimensions of *A* must all be powers of 2.

Coef

An integer that specifies the number of wavelet filter coefficients. The allowed values are 4, 12, or 20. When *Coef* is 4, the `daub4()` function (see *Numerical Recipes*, section 13.10) is used. When *Coef* is 12 or 20, `pwt()` is called, preceded by `pwtset()` (see *Numerical Recipes*, section 13.10).

Keywords

COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

INVERSE

If the INVERSE keyword is set, the inverse transform is computed. By default, WTN performs the forward wavelet transform.

OVERWRITE

Set the OVERWRITE keyword to perform the transform “in place.” The result overwrites the original contents of the array.

Example

This example demonstrates the use of IDL’s discrete wavelet transform and sparse array storage format to compress and store an 8-bit gray-scale digital image. First, an image selected from the `people.dat` data file is transformed into its wavelet representation and written to a separate data file using the WRITEU procedure.

Next, the transformed image is converted, using the SPRSIN function, to row-indexed sparse storage format retaining only elements with an absolute magnitude greater than or equal to a specified threshold. The sparse image is written to a data file using the WRITE_SPR procedure.

Finally, the transformed image is reconstructed from the storage file and displayed alongside the original.

```
; Begin by choosing the number of wavelet coefficients to use and a
; threshold value:
coeffs = 12 & thres = 10.0

; Open the people.dat data file, read an image using associated
; variables, and close the file:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])
images = assoc(1, bytarr(192, 192))
image_1 = images[0]
close, 1

; Expand the image to the nearest power of two using cubic
; convolution, and transform the image into its wavelet
; representation using the WTN function:
pwr = 256
image_1 = CONGRID(image_1, pwr, pwr, /CUBIC)
wtn_image = WTN(image_1, coeffs)

; Write the image to a file using the WRITEU procedure and check
; the size of the file (in bytes) using the FSTAT function:
OPENW, 1, 'original.dat'
WRITEU, 1, wtn_image
status = FSTAT(1)
CLOSE, 1
PRINT, 'Size of the file is ', status.size, ' bytes.'

; Now, we convert the wavelet representation of the image to a
; row-indexed sparse storage format using the SPRSIN function,
```

```
; write the data to a file using the WRITE_SPR procedure, and check
; the size of the "compressed" file:
sprs_image = SPRSIN(wtn_image, THRES = thres)
WRITE_SPR, sprs_image, 'sparse.dat'
OPENR, 1, 'sparse.dat'
status = FSTAT(1)
CLOSE, 1
PRINT, 'Size of the compressed file is ', status.size, ' bytes.'

; Determine the number of elements (as a percentage of total
; elements) whose absolute magnitude is less than the specified
; threshold. These elements are not retained in the row-indexed
; sparse storage format:
PRINT, 'Percentage of elements under threshold: ',$
   100.*N_ELEMENTS(WHERE(ABS(wtn_image) LT thres, $
   count)) / N_ELEMENTS(image_1)

; Next, read the row-indexed sparse data back from the file
; sparse.dat using the READ_SPR function and reconstruct the
; image from the non-zero data using the FULSTR function:
sprs_image = READ_SPR('sparse.dat')
wtn_image = FULSTR(sprs_image)

; Apply the inverse wavelet transform to the image:
image_2 = WTN(wtn_image, COEFFS, /INVERSE)

; Calculate and print the amount of data used in reconstruction of
; the image:
PRINT, 'The image on the right is reconstructed from:', $
   100.0 - (100.* count/N_ELEMENTS(image_1)),$
   '% of original image data.'

; Finally, display the original and reconstructed images side by
; side:
WINDOW, 1, XSIZE = pwr*2, YSIZE = pwr, $
   TITLE = 'Wavelet Image Compression and File I/O'
TV, image_1, 0, 0
TV, image_2, pwr - 1, 0
```

IDL Output

```
Size of the file is   262144 bytes.
Size of the compressed file is   69600 bytes.
Percentage of elements under threshold:   87.0331
The image on the right is reconstructed from: 12.9669% of original
image data.
```

The sparse array contains only 13% of the elements contained in the original array. The following figure is created from this example. The image on the left is the

original 256 by 256 image. The image on the right was compressed by the above process and was reconstructed from 13% of the original data. The size of the compressed image's data file is 26.6% of the size of the original image's data file. Note that due to limitations in the printing process, differences between the images may not be as evident as they would be on a high-resolution printer or monitor.

Figure 32: Original image (left) and image reconstructed from 13% of the data (right).

See Also

FFT

XBM_EDIT

The XBM_EDIT procedure is a utility for creating and editing icons for use with IDL widgets as bitmap labels for widget buttons.

The icons created with XBM_EDIT can be saved in two different file formats. IDL "array definition files" are text files that can be inserted into IDL programs. "Bitmap array files" are data files that can be read into IDL programs. Bitmap array files should be used temporarily until the final icon design is determined and then they can be saved as IDL array definitions for inclusion in the final widget code. This routine does not check the file types of the files being read and assumes that they are of the correct size and type for reading. XBM_EDIT maintains its state in a common block so it is restricted to one working copy at a time.

This routine is written in the IDL language. Its source code can be found in the file `xbm_edit.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XBM_EDIT [, /BLOCK] [, FILENAME=*string*] [, GROUP=*widget_id*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XBM_EDIT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

FILENAME

Set this keyword to a scalar string that contains the filename to be used for the new icon. If this argument is not specified, the name “idl.bm” is used. The filename can be changed in XBM_EDIT by editing the “Filename” field before selecting a file option.

GROUP

The widget ID of the widget that calls XBM_EDIT. When this ID is specified, the death of the caller results in the death of XBM_EDIT.

XSIZE

The number of pixels across the bitmap is in the horizontal direction. The default value is 16 pixels.

YSIZE

The number of pixels across the bitmap is in the vertical direction. The default value is 16 pixels.

See Also

WIDGET_BUTTON

XDISPLAYFILE

The XDISPLAYFILE procedure is a utility for displaying ASCII text files using a widget interface.

This routine is written in the IDL language. Its source code can be found in the file `xdisplayfile.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XDISPLAYFILE, *Filename* [, /BLOCK] [, DONE_BUTTON=*string*]
[, /EDITABLE] [, FONT=*string*] [, GROUP=*widget_id*] [, HEIGHT=*lines*]
[, /MODAL] [, TEXT=*string or string array*] [, TITLE=*string*]
[, WIDTH=*characters*] [, WTEXT=*variable*]

Arguments

Filename

A scalar string that contains the filename of the file to display. *Filename* can include a path to that file.

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XDISPLAYFILE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

DONE_BUTTON

Set this keyword to a string containing the text to use for the Done button label. If omitted, the text “Done with <filename>” is used.

EDITABLE

Set this keyword to allow modifications to the text displayed in XDISPLAYFILE. Setting this keyword also adds a “Save” button in addition to the Done button.

FONT

A string containing the name of the font to use. The font specified is a device font (an X Windows font on Motif systems; a TrueType or PostScript font on Windows or Macintosh systems). See “About Device Fonts” on page 2482 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

GROUP

The widget ID of the widget that calls XDISPLAYFILE. If this keyword is specified, the death of the group leader results in the death of XDISPLAYFILE.

HEIGHT

The number of text lines that the widget should display at one time. If this keyword is not specified, 24 lines is the default.

MODAL

Set this keyword to create the XDISPLAYFILE dialog as a modal dialog. Setting the MODAL keyword allows you to call XDISPLAYFILE from another modal dialog.

TEXT

A string or string array to be displayed in the widget instead of the contents of a file. If this keyword is present, the *Filename* input argument is ignored (but is still required). String arrays are displayed one element per line.

TITLE

A string to use as the widget title rather than the file name or “XDisplayFile”.

WIDTH

The width of the widget display in characters. If this keyword is not specified, 80 characters is the default.

WTEXT

Set this keyword to a named variable that will contain the widget ID of the text widget. This allows setting text selections and cursor positions programmatically. For example, the following code opens the XDISPLAYFILE widget and selects the first 10 characters of the file displayed in the text widget:

```
XDISPLAYFILE, 'myfile.txt', /EDITABLE, WTEXT=w
WIDGET_CONTROL, w, SET_TEXT_SELECT=[0, 10]
```

See Also

PRINT/PRINTF, XYOUTS

XDXF

The XDXF procedure is a utility for displaying and interactively manipulating DXF objects.

Syntax

XDXF [, *Filename*] [, /BLOCK] [, GROUP=*widget_id*] [, /MODAL] [, SCALE=*value*] [, /TEST] [*keywords to XOBJVIEW*]

Arguments

Filename

A string specifying the name of the DXF file to display. If this argument is not specified, a file selection dialog is opened.

Keywords

XDXF accepts the keywords to XOBJVIEW. In addition, XDXF supports the following keywords:

BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XDXF block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

The widget ID of the widget that calls XDXF. When this ID is specified, the death of the caller results in the death of XDXF.

MODAL

Set this keyword to block processing of events from other widgets until the user quits XDXF. A group leader must be specified (via the GROUP keyword) for the MODAL keyword to have any effect. By default, XDXF does not block event processing.

SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the object, while ensuring that no portion of the object will be clipped by the XDXF window, regardless of the object's orientation.

TEST

If this keyword is set, the file `heart.dxf` in the IDL distribution is automatically opened in XDXF.

Using XDXF

XDXF displays a resizeable top-level base with a menu and draw widget used to display and manipulate the orientation of a DXF object.

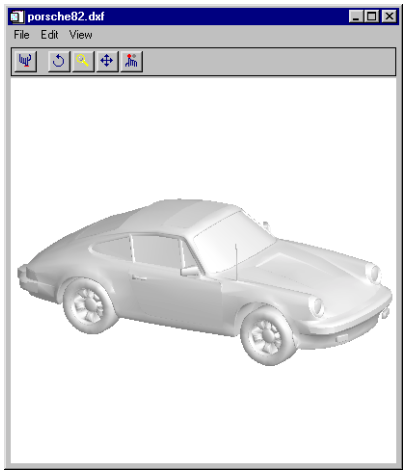


Figure 33: The XDXF Utility

XDXF also displays a dialog that contains block and layer information and allows the user to turn on and off the display of individual layers.

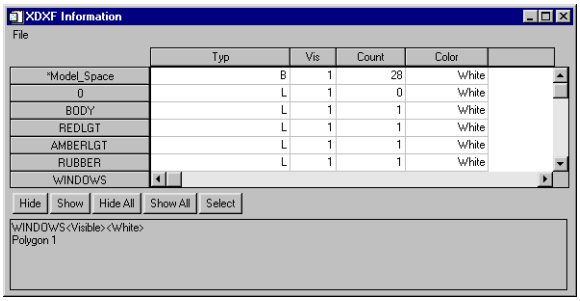


Figure 34: The XDXF Information Dialog

The XDXF Toolbar

The XDXF toolbar contains the following buttons:

Reset: Resets rotation, scaling, and panning.

Rotate: Click the left mouse button on the object and drag to rotate.

Pan: Click the left mouse button on the object and drag to pan.

Zoom: Click the left mouse button on the object and drag to zoom in or out.

Select: Click on the object. The name of the selected object is displayed, if the object has a name, otherwise its class is displayed.

The XDXF Information Dialog

The XDXF Information dialog displays information about the blocks and layers contained in the currently displayed object, and allows you to turn on and off the display of each layer.

To show or hide layers in the DXF object, select the layer from the list of layers on the left of the dialog, and click the **Show** or **Hide** button. Alternatively, you can click in the "Vis" field for the desired layer. To show or hide all layers, click the **Show All** or **Hide All** buttons.

Example

Display the file `heart.dxf`, contained in the IDL distribution:

```
XDXF, FILEPATH('heart.dxf', $
   SUBDIR=['examples', 'data'])
```

See Also

IDLffDXF

XFONT

The XFONT function is a utility that creates a modal widget for selecting and viewing an X Windows font. The function returns a string containing the name of the last selected font. If no font is selected, or the “Cancel” button is clicked, a null string is returned.

Calling XFONT resets the current X Windows font.

This routine is written in the IDL language. Its source code can be found in the file `xfont.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

Result = XFONT([, GROUP=*widget_id*] [, /PRESERVE_FONT_INFO])

Keywords

GROUP

The widget ID of the widget that calls XFONT. When this ID is specified, the death of the caller results in the death of XFONT.

PRESERVE_FONT_INFO

Set this keyword to make XFONT save the server font directory in common blocks so that subsequent calls to XFONT start-up much faster. If this keyword is not set, the common block is cleaned.

See Also

EFONT, SHOWFONT

XINTERANIMATE

The XINTERANIMATE procedure is a utility for displaying an animated sequence of images using off-screen pixmaps or memory buffers. The speed and direction of the display can be adjusted using the widget interface.

MPEG animation files can be created either programmatically using keywords to open and save a file, or interactively using the widget interface. Note that the MPEG standard does not allow movies with odd numbers of pixels to be created.

Note

MPEG support in IDL requires a special license. For more information, contact your Research Systems sales representative or technical support.

Note

Only a single copy of XINTERANIMATE can run at a time. If you need to run multiple instances of the animation widget concurrently, use the CW_ANIMATE compound widget.

This routine is written in the IDL language. Its source code can be found in the file `xinteranimate.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Using XINTERANIMATE

Displaying an animated series of images using XINTERANIMATE requires at least three calls to the routine: one to initialize the animation widget, one to load images, and one to display the images. When initialized using the SET keyword, XINTERANIMATE creates an approximately square pixmap or memory buffer, large enough to contain the requested number of frames of the requested size. Images are loaded using the IMAGE and FRAME keywords. Finally, images are displayed by copying them from the pixmap or memory buffer to the visible draw widget.

See CW_ANIMATE for a description of the widget interface controls used by XINTERANIMATE.

Syntax

XINTERANIMATE [, *Rate*]

Keywords for initialization: [, SET=*[sizex*, *sizey*, *nframes]*] [, /BLOCK] [, /CYCLE] [, GROUP=*widget_id*] [, /MODAL] [, MPEG_BITRATE=*value*]

[, MPEG_IFRAME_GAP=*integer value*] [, MPEG_MOTION_VEC_LENGTH={1 | 2 | 3}] [, /MPEG_OPEN, MPEG_FILENAME=*string*]
[MPEG_QUALITY=*value*{0 to 100}] [, /SHOWLOAD] [, /TRACK]
[, TITLE=*string*]

Keywords for loading images: [, FRAME=*value*{0 to (*nframes*-1)}[, IMAGE=*value*]] [, /ORDER] [, WINDOW=*[window_num* [, *x0*, *y0*, *sx*, *sy*]*]*]

Keywords for running animations: [, /CLOSE] [, /KEEP_PIXMAPS] [, /MPEG_CLOSE] [, XOFFSET=*pixels*] [, YOFFSET=*pixels*]

Arguments

Rate

A value between 0 and 100 that represents the speed of the animation as a percentage of the maximum display rate. The fastest animation is with a value of 100 and the slowest is with a value of 0. The default animation rate is 100. The animation must be initialized using the SET keyword before calling XINTERANIMATE with a rate value.

Keywords: Initialization

The following keywords are used to initialize the animation display. The SET keyword *must* be provided. Other keywords described in this section are optional; note that they work only when SET is specified.

SET

Set this keyword to a three-element vector [*Sizex*, *Sizey*, *Nframes*] to initialize XINTERANIMATE. *Sizex* and *Sizey* represent the width and height of the images to be displayed, in pixels. *Nframes* is the number of frames in the animation sequence. Note that *Nframes* must be at least 2 frames.

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XINTERANIMATE block, any earlier calls to XMANAGER must have been

called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

CYCLE

Normally, frames are displayed going either forward or backwards. If the CYCLE keyword is set, the animation reverses direction after the last frame in either direction is displayed.

GROUP

Set this keyword to the widget ID of the widget that calls XINTERANIMATE. When GROUP is specified, the death of the calling widget results in the death of XINTERANIMATE.

MODAL

Set this keyword to block processing of events from other widgets until the user quits XINTERANIMATE. A group leader must be specified (via the GROUP keyword) for the MODAL keyword to have any effect. By default, XINTERANIMATE does not block event processing.

MPEG_BITRATE

Set this keyword to a double-precision value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

MPEG Version	Range
MPEG 1	0.1 to 104857200.0
MPEG 2	0.1 to 429496729200.0

Table 99: BITRATE Value Range

If you do not set this keyword, IDL computes the MPEG_BITRATE value based upon the value you have specified for the MPEG_QUALITY keyword.

Note

Only use the MPEG_BITRATE keyword if changing the MPEG_QUALITY keyword value does not produce the desired results. It is highly recommended to set

the MPEG_BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

MPEG_FILENAME

Set this keyword equal to a string specifying the name of the MPEG file. If no file name is specified, the default value (`idl.mpg`) is used.

MPEG_IFRAME_GAP

Set this keyword to a positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

If you do not specify this keyword, IDL computes the MPEG_IFRAME_GAP value based upon the value you have specified for the MPEG_QUALITY keyword.

Note

Only use the MPEG_IFRAME_GAP keyword if changing the MPEG_QUALITY keyword value does not produce the desired results.

MPEG_MOTION_VEC_LENGTH

Set this keyword to an integer value specifying the length of the motion vectors to be used to generate predictive frames. Valid values include:

- 1 = Small motion vectors.
- 2 = Medium motion vectors.
- 3 = Large motion vectors.

If you do not set this keyword, IDL computes the MPEG_MOTION_VEC_LENGTH value based upon the value you have specified for the MPEG_QUALITY keyword.

Note

Only use the MPEG_MOTION_VEC_LENGTH keyword if changing the MPEG_QUALITY value does not produce the desired results.

MPEG_OPEN

Set this keyword to open an MPEG file.

MPEG_QUALITY

Set this keyword to an integer value between 0 (low quality) and 100 (high quality) inclusive to specify the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

Note

Since MPEG uses JPEG (lossy) compression, the original picture quality can't be reproduced even when setting QUALITY to its highest setting.

SHOWLOAD

Set this keyword to display each frame and update the frame slider as frames are loaded.

TRACK

Set this keyword to cause the frame slider to track the current frame when the animation is in progress. The default is not to track.

TITLE

Use this keyword to specify a string to be used as the title of the animation widget. If TITLE is not specified, the title is set to "XInterAnimate."

Keywords: Loading Images

The following keywords are used to load images into the animation display. They have no effect when initializing or running animations.

FRAME

Use this keyword to specify the frame number when loading frames. FRAME must be set to a number in the range 0 to *Nframes*-1.

IMAGE

Use this keyword to specify a single image to be loaded at the animation position specified by the FRAME keyword. (FRAME *must* also be specified.)

ORDER

Set this keyword to display images from the top down instead of the default bottom up.

WINDOW

When this keyword is specified, an image is copied from an existing window to the animation pixmap or memory buffer. (When using some windowing systems, using this keyword is much faster than reading from the display and then calling XINTERANIMATE with a 2D array.)

The value of this parameter is either an IDL window number (in which case the entire window is copied), or a vector containing the window index and the rectangular bounds of the area to be copied. For example:

```
WINDOW = [Window_Number, X0, Y0, Sx, Sy]
```

Keywords: Running Animations

The following keywords are used when running the animation. They have no effect when initializing the animation or loading images.

CLOSE

Set this keyword to delete the offscreen pixmaps or buffers and the animation widget itself. This also takes place automatically when the user presses the “Done With Animation” button or closes the window with the window manager.

KEEP_PIXMAPS

If this keyword is set, XINTERANIMATE will not destroy the animation pixmaps or buffers when it is killed. Calling XINTERANIMATE again without going through the SET and LOAD steps will play the same animation without the overhead of creating the pixmaps.

MPEG_CLOSE

Set this keyword to close and save the MPEG file. This keyword has no effect if MPEG_OPEN was not used during initialization.

XOFFSET

Use this keyword to specify the horizontal offset, in pixels from the left of the frame, of the image in the destination window.

YOFFSET

Use this keyword to specify the vertical offset, in pixels from the bottom of the frame, of the image in the destination window.

Example

Enter the following commands to open the file `ABNORM.DAT` (a series of images of a human heart) and animate the images it contains using XINTERANIMATE. For a more detailed example of using XINTERANIMATE, see "Animation with XINTERANIMATE" in Chapter 11 of *Getting Started with IDL*.

```
OPENR, unit, FILEPATH('abnorm.dat', SUBDIR=['examples','data']), $
   /GET_LUN
H = BYTARR(64, 64, 16)
READU, unit, H
CLOSE, unit

; Read the images into variable H:
H = REBIN(H, 128, 128, 16)

; Initialize XINTERANIMATE:
XINTERANIMATE, SET=[128, 128, 16], /SHOWLOAD

; Load the images into XINTERANIMATE:
FOR I=0,15 DO XINTERANIMATE, FRAME = I, IMAGE = H[*,*,I]

; Play the animation:
XINTERANIMATE, /KEEP_PIXMAPS
```

Note

Since the KEEP_PIXMAPS keyword was supplied, the same animation can be replayed (after the animation widget has been destroyed) with the single command `XINTERANIMATE`.

See Also

CW_ANIMATE

XLOADCT

The XLOADCT procedure is a utility that provides a graphical widget interface to the LOADCT procedure. XLOADCT displays the current colortable and shows a list of available predefined color tables. Clicking on the name of a color table causes that color table to be loaded in true color decomposed visual. Many other options, such as Gamma correction, stretching, and transfer functions can also be applied to the colortable.

This routine is written in the IDL language. Its source code can be found in the file `xloadct.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XLOADCT [, /BLOCK] [, BOTTOM=*value*] [, FILE=*string*] [, GROUP=*widget_id*] [, /MODAL] [, NCOLORS=*value*] [, /SILENT]
[, UPDATECALLBACK='*procedure_name*' [, UPDATECBDATA=*value*]]
[, /USE_CURENT]

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XLOADCT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

BOTTOM

The first color index to use. XLOADCT will use color indices from BOTTOM to BOTTOM+NCOLORS-1. The default is BOTTOM=0.

FILE

Set this keyword to a string representing the name of the file to be used instead of the file `colors1.tbl` in the IDL directory.

GROUP

The widget ID of the widget that calls XLOADCT. When this ID is specified, a death of the caller results in a death of XLOADCT.

MODAL

Set this keyword to block processing of events from other widgets until the user quits XLOADCT. A group leader must be specified (via the GROUP keyword) for the MODAL keyword to have any effect. By default, XLOADCT does not block event processing.

NCOLORS

The number of colors to use. Use color indices from 0 to the smaller of !D.TABLE_SIZE-1 and NCOLORS-1. The default is all available colors (!D.TABLE_SIZE).

SILENT

Normally, no informational message is printed when a color map is loaded. If this keyword is set to zero, the message is printed.

UPDATECALLBACK

Set this keyword to a string containing the name of a user-supplied procedure that will be called when the color table is updated by XLOADCT. The procedure may optionally accept a keyword called DATA, which will be automatically set to the value specified by the optional UPDATECBDATA keyword.

UPDATECBDATA

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied procedure specified via the UPDATECALLBACK keyword, if any. If the UPDATECBDATA keyword is not set the value accepted by the DATA keyword to the procedure specified by UPDATECALLBACK will be undefined.

USE_CURRENT

Set this keyword to use the current color tables, regardless of the contents of the COLORS common block.

See Also

LOADCT, XPALETTE, TVLCT

XMANAGER

The XMANAGER procedure provides the main event loop and management for widgets created using IDL. Calling XMANAGER "registers" a widget program with the XMANAGER event handler. XMANAGER takes control of event processing until all widgets have been destroyed.

Beginning with IDL version 5.0, IDL supports an *active command line* that allows the IDL command input line to continue accepting input while properly configured widget applications are running. See "A Note About Blocking in XMANAGER" on page 1725 for a more detailed explanation of the active command line.

This routine is written in the IDL language. Its source code can be found in the file `xmanager.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

XMANAGER [, *Name*, *ID*] [, /CATCH] [, CLEANUP=*string*]
[, EVENT_HANDLER='*procedure_name*'] [, GROUP_LEADER=*widget_id*]
[, /JUST_REG] [, /NO_BLOCK]

Arguments

Name

A string that contains the name of the routine that creates the widget (i.e., the name of the widget creation routine that is calling XMANAGER).

Note

The *Name* argument is stored in a COMMON block for use by the XREGISTERED routine. The stored name is case-sensitive.

ID

The widget ID of the new widget's top-level base.

Keywords

BACKGROUND

This keyword is obsolete and is included in XMANAGER for compatibility with existing code only. Its functionality has been replaced by the TIMER keyword to the WIDGET_CONTROL procedure.

CATCH

Set this keyword to cause XMANAGER to catch any errors, using the CATCH procedure, when dispatching widget events. If the CATCH keyword is set equal to zero, execution halts and IDL provides traceback information when an error is detected. This keyword is set by default (errors are caught and processing continues).

Do not specify either the *Name* or *ID* argument to XMANAGER when specifying the CATCH keyword (they are ignored). CATCH acts as a switch to turn error catching on and off for *all* applications managed by XMANAGER. When CATCH is specified, XMANAGER changes its error-catching behavior and returns immediately, without taking any other action.

Note

Beginning with IDL version 5.0, the default behavior of XMANAGER is to catch errors and continue processing events. In versions of IDL prior to version 5.0, XMANAGER halted when an error was detected. This change in default behavior was necessary in order to allow multiple widget applications (all being managed by XMANAGER) to coexist peacefully. When CATCH is set equal to zero, (the old behavior), any error halts XMANAGER, and thus halts event processing for all running widget applications.

Note also that CATCH is only effective if XMANAGER is blocking to dispatch errors. If event dispatching for an active IDL command line is in use, the CATCH keyword has no effect.

The CATCH=0 setting (errors are not caught and processing halts in XMANAGER when an error is detected) is intended as a debugging aid. Finished programs should not set CATCH=0.

CLEANUP

Set this keyword to a string that contains the name of the routine to be called when the widget dies. If not specified, no routine is called. The cleanup routine must accept one parameter which is the widget ID of the dying widget. The routine specified by CLEANUP becomes the KILL_NOTIFY routine for the application, overriding any cleanup routines that may have been set previously via the KILL_NOTIFY keyword to WIDGET_CONTROL.

EVENT_HANDLER

Set this keyword to a string that contains the name of a routine to be called when a widget event occurs in the widget program being registered. If this keyword is not

supplied, XMANAGER will construct a default name by adding the "_event" suffix to the Name argument. See the example below for a more detailed explanation.

GROUP_LEADER

The widget ID of the group leader for the widget being processed. When the leader dies either by the users actions or some other routine, all widgets that have that leader will also die.

For example, a widget that views a help file for a demo widget would have that demo widget as its leader. When the help widget is registered, it sets the keyword GROUP_LEADER to the widget ID of the demo widget. If the demo widget were destroyed, the help widget led by it would be killed by the XMANAGER.

JUST_REG

Set this keyword to indicate that XMANAGER should just register the widget and return immediately. This keyword is useful if you want to register a group of related top-level widgets before beginning event processing and either:

- your command-processing front-end does not support an active command line, or
- one or more of the registered widgets requests that XMANAGER block event processing. (Note that in this case a later call to XMANAGER without the JUST_REG keyword is necessary to begin blocking.)

(See "A Note About Blocking in XMANAGER" on page 1725 for further discussion of the active command line.)

Warning

JUST_REG is not the same as NO_BLOCK. See "JUST_REG vs. NO_BLOCK" on page 1725 for additional details.

NO_BLOCK

Set this keyword to tell XMANAGER that the registering client does not require XMANAGER to block if active command line event processing is available. If active command line event processing is available *and* every current XMANAGER client specifies NO_BLOCK, then XMANAGER will not block and the user will have access to the command line while widget applications are running.

Note

NO_BLOCK is ignored by IDL Runtime. If a main procedure uses XMANAGER with the NO_BLOCK keyword set, IDL Runtime defers subsequent processing of the commands following the XMANAGER call until the widget associated with the call to XMANAGER is destroyed.

It is important to understand the result of making nested calls to XMANAGER. XMANAGER can only block event processing for one client at a time. In applications involving multiple calls to XMANAGER (either directly or via calls to other routines that call XMANAGER, such as XLOADCT), blocking occurs only for the outermost call to XMANAGER, unless XMANAGER is told not to block in that call. If an application contains two calls to XMANAGER, the second call cannot block unless the first call sets the NO_BLOCK keyword. If an application contains a call to XMANAGER, followed by a call to XLOADCT, XLOADCT will not block unless the NO_BLOCK keyword was set in the call to XMANAGER (and the BLOCK keyword to XLOADCT is set). Consider the following example:

```
PRO blocking_example_event, event
   ; The following call blocks only if the NO_BLOCK keyword to
   ; XMANAGER is set:
   XLOADCT, /BLOCK
END

PRO blocking_example
   base=WIDGET_BASE(/COLUMN)
   button1=WIDGET_BUTTON(base,VALUE='Run XLOADCT')
   WIDGET_CONTROL,base, /REALIZE
   XMANAGER,'blocking_example', base, /NO_BLOCK
END
```

If the NO_BLOCK keyword to XMANAGER was not set in the above example, XLOADCT would not block, even though the BLOCK keyword was set. Setting the NO_BLOCK keyword to XMANAGER prevents XMANAGER from blocking, thereby allowing the subsequent call to XMANAGER (via XLOADCT) to block.

Warning

NO_BLOCK is not the same as JUST_REG. See “JUST_REG vs. NO_BLOCK” on page 1725 for additional details.

Warning

Although this routine is written in the IDL language, it may change in the future in its internal implementation. For future upgradability, it is best not to modify or even worry about what this routine does internally.

A Note About Blocking in XMANAGER

Beginning with IDL version 5.0, most versions of IDL's command-processing front-end are able to support an *active command line* while running properly constructed widget applications. What this means is that—provided the widget application is properly configured—the IDL command input line is available for input while a widget application is running and widget events are being processed.

There are currently 5 separate IDL command-processing front-end implementations:

- Apple Macintosh Integrated Development Environment (IDLDE)
- Microsoft Windows IDLDE
- Motif IDLDE (UNIX and VMS)
- UNIX plain tty
- VMS plain tty

All of these front-ends are able to process widget events except for the VMS plain tty. VMS users can still enjoy an active command line by using the IDLDE interface.

If the command-processing front-end can process widget events (that is, if the front-end is *not* the VMS plain tty), it is still necessary for widget applications to be well-behaved with respect to blocking widget event processing. Since in most cases XMANAGER is used to handle widget event processing, this means that in order for the command line to remain active, all widget applications must be run with the NO_BLOCK keyword to XMANAGER set. (Note that since NO_BLOCK is *not* the default, it is quite likely that some application will block.) If a single application runs in blocking mode, the command line will be inaccessible until the blocking application exits. When a blocking application exits, the IDL command line will once again become active.

JUST_REG vs. NO_BLOCK

Although their names imply a similar function, the JUST_REG and NO_BLOCK keywords perform very different services. It is important to understand what they do and how they differ.

The JUST_REG keyword tells XMANAGER that it should simply register a client and then return immediately. The result is that the client becomes known to XMANAGER, and that future calls to XMANAGER will take this client into account. Therefore, JUST_REG only controls how the registering call to XMANAGER should behave. The client can still be registered as requiring XMANAGER to block by setting NO_BLOCK=0. In this case, *future* calls to XMANAGER will block.

Note

JUST_REG is useful in situations where you suspect blocking might occur—if the active command line is not supported and you wish to keep it active before beginning event processing, or if blocking will be requested at a later time. If no blocking will occur or if the blocking behavior is useful, it is not necessary to use JUST_REG.

The NO_BLOCK keyword tells XMANAGER that the registered client does not require XMANAGER to block if the command-processing front-end is able to support active command line event processing. XMANAGER remembers this attribute of the client until the client exits, even after the call to XMANAGER that registered the client returns. NO_BLOCK is just a "vote" on how XMANAGER should behave—the final decision is made by XMANAGER by considering the NO_BLOCK attributes of *all* of its current clients as well as the ability of the command-processing front-end in use to support the active command line.

Blocking vs. Non-blocking Applications

The issue of blocking in XMANAGER requires some explanation. IDL widget events are not processed until the WIDGET_EVENT function is called to handle them. Otherwise, they are queued by IDL indefinitely. Knowing how and when to call WIDGET_EVENT is the primary service provided by XMANAGER.

There are two ways blocking is typically handled:

1. The first call to XMANAGER processes events by calling WIDGET_EVENT as necessary until no managed widgets remain on the screen. This is referred to as "blocking" because XMANAGER does not return to the caller until it is done, and the IDL command line is not available.
2. XMANAGER does not block, and instead, the part of IDL that reads command input also watches for widget events and calls WIDGET_EVENT as necessary while also reading command input. This is referred to as "non-blocking" or "active command line" mode.

XMANAGER will block unless all of the following conditions are met:

- The command-processing front-end is able to process widget events (that is, the front-end is not the VMS plain tty).
- All registered widget applications have the NO_BLOCK keyword to XMANAGER set.
- No modal dialogs are displayed. (Modal dialogs always block until dismissed.)

In general, we suggest that new widget applications be written with XMANAGER blocking disabled (that is, with the NO_BLOCK keyword set), unless the widget application will be run on IDL Runtime.

Note

NO_BLOCK is ignored by IDL Runtime. If a main procedure uses XMANAGER with the NO_BLOCK keyword set, IDL Runtime defers subsequent processing of the commands following the XMANAGER call until the widget associated with the call to XMANAGER is destroyed.

Since a widget application that does block event processing for itself will block event processing for all other widget applications (and the IDL command line) as well, we suggest that older widget applications be upgraded to take advantage of the new, non-blocking behavior by adding the NO_BLOCK keyword to most calls to XMANAGER.

Example

The following code creates a widget named EXAMPLE that is just a base widget with a “Done” button and registers it with the XMANAGER. Widgets being registered with the XMANAGER must provide at least two routines. The first routine creates the widget and registers it with the manager and the second routine processes the events that occur within that widget. An example widget is supplied below that uses only two routines. A number of other “Simple Widget Examples”, can be viewed by entering WEXMASTER at the IDL prompt. These simple programs demonstrate many aspects of widget programming.

The following lines of code would be saved in a single file, named `example.pro`:

```
; Begin the event handler routine for the EXAMPLE widget:
PRO example_event, ev

; The uservalue is retrieved from a widget when an event occurs:
WIDGET_CONTROL, ev.id, GET_UVALUE = uv
```

```
; If the event occurred in the Done button, kill the widget
; example:
if (uv eq 'DONE') THEN WIDGET_CONTROL, ev.top, /DESTROY

; End of the event handler part:
END

; This is the routine that creates the widget and registers it with
; the XMANAGER:
PRO example

; Create the top-level base for the widget:
base = WIDGET_BASE(TITLE='Example')

; Create the Done button and set its uservalue to "DONE":
done = WIDGET_BUTTON(base, VALUE = 'Done', UVALUE = 'DONE')
; Realize the widget (i.e., display it on screen):
WIDGET_CONTROL, base, /REALIZE

; Register the widget with the XMANAGER, leaving the IDL command
; line active:
XMANAGER, 'example', base, /NO_BLOCK

; End of the widget creation part:
END
```

First the event handler routine is listed. The handler routine has the same name as the main routine with the characters "_event" added. If you would like to use another event handler name, you would need to pass its name to XMANAGER using the EVENT_HANDLER keyword.

Notice that the event routine is listed before the main routine. This is because the compiler will not compile the event routine if it was below the main routine. This is only needed if both routines reside in the same file and the file name is the same as the main routine name with the `.pro` extension added.

Notice also the NO_BLOCK keyword to XMANAGER has been included. This allows IDL to continue processing events and accepting input at the command prompt while the `example` widget application is running.

See Also

XMTOOL, XREGISTERED, *Building IDL Applications* Chapter 22, "Widgets".

XMNG_TMPL

The XMNG_TMPL procedure is a template for widgets that use the XMANAGER. Use this template instead of writing your widget applications from “scratch”. This template can be found in the file `xmng_tmpl.pro` in the `lib` subdirectory of the IDL distribution.

The documentation header should be altered to reflect the actual implementation of the XMNG_TMPL widget. Use a global search and replace to replace the word `XMNG_TMPL` with the name of the routine you would like to use. All the comments with a “`***`” in front of them should be read, decided upon and removed from the final copy of your new widget routine.

Syntax

XMNG_TMPL [, /BLOCK] [, GROUP=*widget_id*]

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XMNG_TMPL block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

The widget ID of the widget that calls XMNG_TMPL. When this ID is specified, the death of the caller results in the death of XMNG_TMPL.

See Also

CW_TMPL

XMTOOL

The XMTOOL procedure displays a tool for viewing widgets currently being managed by the XMANAGER. Only one instance of the XMTOOL can run at one time.

This routine is written in the IDL language. Its source code can be found in the file `xmtool.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XMTOOL [, /BLOCK] [, GROUP=*widget_id*]

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XMTOOL block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

The widget ID of the widget that calls XMTOOL. If the calling widget is destroyed, the XMTOOL is also destroyed.

See Also

XLOADCT

XOBJVIEW

The XOBJVIEW procedure is a utility used to quickly and easily view and manipulate IDL Object Graphics on screen. It displays given objects in an IDL widget with toolbar buttons and menus providing functionality for manipulating, printing, and exporting the resulting graphic. The mouse can be used to rotate, scale, or translate the overall model shown in a view, or to select graphic objects in a view.

This routine is written in the IDL language. Its source code can be found in the file `xobjview.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XOBJVIEW, *Obj* [, BACKGROUND=*[r, g, b]*] [, /BLOCK] [, /DOUBLE_VIEW] [, GROUP=*widget_id*] [, /MODAL] [, REFRESH=*widget_id*] [, SCALE=*value*] [, STATIONARY=*objref(s)*] [, /TEST] [, TITLE=*string*] [, TLB=*variable*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

Arguments

Obj

A reference to an atomic graphics object, an IDLgrModel, or an array of such references. If *Obj* is an array, the array can contain a mixture of such references. Also, if *Obj* is an array, all object references in the array must be unique (i.e. no two references in the array can refer to the same object).

Obj is not destroyed when XOBJVIEW is quit or killed.

Keywords

BACKGROUND

Set this keyword to a three-element [r, g, b] color vector specifying the background color of the XOBJVIEW window.

BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XOBJVIEW block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

DOUBLE_VIEW

Set this keyword to cause XOBJVIEW to set the DOUBLE property on the IDLgrView that it uses to display graphical data.

GROUP

The widget ID of the widget that calls XOBJVIEW. When this ID is specified, the death of the caller results in the death of XOBJVIEW.

MODAL

Set this keyword to block processing of events from other widgets until the user quits XOBJVIEW. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XOBJVIEW fabricates an invisible group leader for you.

Note

To be modal, XOBJVIEW does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536 for more information.)

To provide a simple means of invoking XOBJVIEW as a modal widget in applications that contain no other widgets, XOBJVIEW can be invoked as MODAL without specifying a group leader, in which case XOBJVIEW fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XOBJVIEW, /MODAL. As with other IDL widget procedures with names prefixed with "X", specify the group leader via the GROUP keyword.

REFRESH

Set this keyword to the widget ID of the XOBJVIEW instance to be refreshed. To retrieve the widget ID of an instance of XOBJVIEW, first call XOBJVIEW with the TLB keyword. To refresh that instance of XOBJVIEW, call XOBVIEW again and set REFRESH to the value retrieved by the TLB keyword in the earlier call to XOBJVIEW. For example, in the initial call to XOBJVIEW, use the TLB keyword as follows:

```
XOBJVIEW, myobj, TLB=tlb
```

If the properties of `myobj` are changed in your application or at the IDL command line, refresh the view in XOBJVIEW by calling XOBJVIEW again with the REFRESH keyword:

```
XOBJVIEW, myobj, REFRESH=tlb
```

For an example application demonstrating the use of the REFRESH keyword, see "Example 3" on page 1737.

Note

Currently, the REFRESH keyword can only be used to refresh the object itself. All other keywords to XOBJVIEW are ignored when REFRESH is specified, therefore, properties such as the background color and scale are not affected.

SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the object, while ensuring that no portion of the object will be clipped by the XOBJVIEW window, regardless of the object's orientation.

STATIONARY

Set this keyword to a reference to an atomic graphics object, an IDLgrModel, or an array of such references. If this keyword is an array, the array can contain a mixture of such references. Also, if this keyword is an array, all object references in the array must be unique (i.e., no two references in the array can refer to the same object). Objects passed to XOBJVIEW via this keyword will not scale, rotate, or translate in response to mouse events. Default stationary objects are two lights. These two lights are replaced if one or more lights are supplied via this keyword. Objects specified via this keyword are not destroyed by XOBJVIEW when XOBJVIEW is quit or killed.

For example, to change the default lights used by XOBJVIEW, you could specify your own lights using the STATIONARY keyword as follows:

```
mylight1 = OBJ_NEW('IDLgrLight', TYPE=0, $
   COLOR=[255,0,0]) ; Ambient red
mylight2 = OBJ_NEW('IDLgrLight', TYPE=2, $
   COLOR=[255,0,0], LOCATION=[2,2,5]) ; Directional red

mymodel = OBJ_NEW('IDLgrModel')
mymodel -> Add, mylight1
mymodel -> Add, mylight2

XOBJVIEW, /TEST, STATIONARY=mymodel
```

TLB

Set this keyword to a named variable that upon return will contain the widget ID of the top level base.

TEST

If set, the *Obj* argument is not required (and is ignored if provided). A blue sinusoidal surface is displayed. This allows you to test code that uses XOBJVIEW without having to create an object to display.

TITLE

Set this keyword to the string that appears in the XOBJVIEW title bar.

XSIZE

Set this keyword to the width of the drawable area in pixels. The default is 400.

YSIZE

Set this keyword to the height of the drawable area in pixels. The default is 400.

Using XOBJVIEW

XOBJVIEW displays a resizeable top-level base with a menu, toolbar and draw widget, as shown in the following figure:

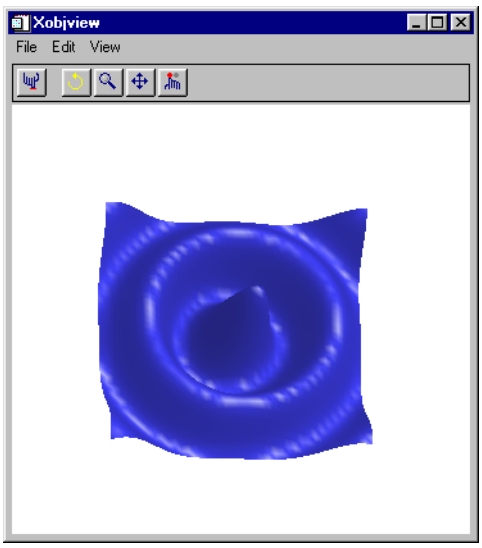


Figure 35: The XOBJVIEW widget

The XOBJVIEW Toolbar

The XOBJVIEW toolbar contains the following buttons:

Reset: Resets rotation, scaling, and panning.

Rotate: Click the left mouse button on the object and drag to rotate.

Pan: Click the left mouse button on the object and drag to pan.

Zoom: Click the left mouse button on the object and drag to zoom in or out.

Select: Click on the object. The name of the selected object is displayed, if the object has a name, otherwise its class is displayed.

Examples

Example 1

This example displays a simple IDLgrSurface object using XOBJVIEW:

```
oSurf = OBJ_NEW('IDLgrSURFACE', DIST(20))
XOBJVIEW, oSurf
```

Example 2

This example displays an IDLgrModel object consisting of two separate objects:

```
; Create contour object:
oCont = OBJ_NEW('IDLgrContour', DIST(20), N_LEVELS=10)

; Create surface object:
oSurf = OBJ_NEW('IDLgrSurface', $
   DIST(20),INDGEN(20)+20, INDGEN(20)+20)

; Create model object:
oModel = OBJ_NEW('IDLgrModel')

; Add contour and surface objects to model:
oModel->Add, oCont
oModel->Add, oSurf

; View model:
XOBJVIEW, oModel
```

This code results in the following view in the XOBJVIEW widget:

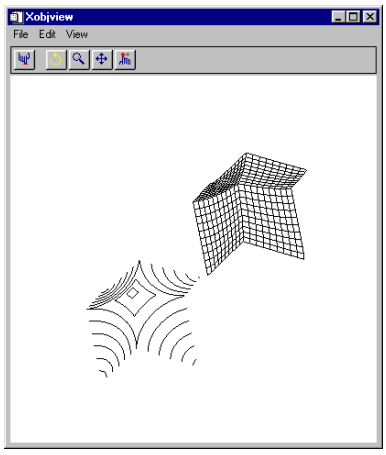


Figure 36: Using XOBJVIEW to view a model consisting of two objects

Note that when you click the Select button, and then click on an object, the class of that object appears next to the Select button. If the selected object has a non-null NAME property associated with it, that string value will be displayed, otherwise the name of the selected object's class will be displayed.

If you want the class of the model to appear when you click over any object in the model, you can set the SELECT_TARGET property of the model as follows:

```
oModel->SetProperty, /SELECT_TARGET
```

Also note that it is not necessary to create a model to view more than one object using XOBJVIEW. We could view the oCont and oSurf objects created in the above example by placing them in an array as follows:

```
XOBJVIEW, [oCont, oSurf]
```

Example 3

This example demonstrates how the REFRESH keyword can be used to refresh the object displayed in an instance of XOBJVIEW.

```
PRO xobjview_refresh_event, event
   WIDGET_CONTROL, event.id, GET_UVALUE=uval
   WIDGET_CONTROL, event.top, GET_UVALUE=state

   CASE uval OF
      'red': BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[val,c[1],c[2]]
          XOBJVIEW, state.myobj, GROUP=event.top, $
             REFRESH=state.tlb
          END
      'green':  BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[c[0],val,c[2]]
          XOBJVIEW, state.myobj, GROUP=event.top, $
             REFRESH=state.tlb
          END
      'blue': BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[c[0],c[1],val]
          XOBJVIEW, state.myobj, GROUP=event.top, $
             REFRESH=state.tlb
          END
   ENDCASE
END
```

```
PRO xobjview_cleanup, wID
   WIDGET_CONTROL, wID, GET_UVALUE=uval
   OBJ_DESTROY, uval.myobj
END

PRO xobjview_refresh
   base = WIDGET_BASE(/COLUMN, TITLE='Adjust Object Color', $
      XOFFSET=420, XSIZE=200)

   myobj = OBJ_NEW('IDLgrSurface', $
      BESELJ(SHIFT(DIST(40), 20, 20) / 2,0) * 20, $
      COLOR=[255, 60, 60], STYLE=2, SHADING=1)
   XOBJVIEW, myobj, TLB=tlb, GROUP=base, BACKGROUND=[0,0,0]

   red = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, TITLE='Red', $
      UVALUE='red', VALUE=255)
   green = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, $
      TITLE='Green', UVALUE='green', VALUE=60)
   blue = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, $
      TITLE='Blue', UVALUE='blue', VALUE=60)

   WIDGET_CONTROL, base, /REALIZE

   state = {myobj:myobj, tlb:tlb}
   WIDGET_CONTROL, base, SET_UVALUE=state

   XMANAGER, 'xobjview_refresh', base, /NO_BLOCK, $
      CLEANUP='xobjview_cleanup'
END
```

XPALETTE

The XPALETTE procedure is a utility that displays a widget interface that allows interactive creation and modification of colortables using the RGB, CMY, HSV, or HLS color systems. Single colors can be defined or multiple color indices between two endpoints can be interpolated.

This routine is written in the IDL language. Its source code can be found in the file `xpalette.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XPALETTE [, /BLOCK] [, GROUP=*widget_id*]
[, UPDATECALLBACK='*procedure_name*' [, UPDATECBDATA=*value*]]

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XPALETTE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

The widget ID of the widget that calls XPALETTE. When this ID is specified, a death of the caller results in a death of XPALETTE.

UPDATECALLBACK

Set this keyword to a string containing the name of a user-supplied procedure that will be called when the color table is updated by XLOADCT. The procedure may optionally accept a keyword called DATA, which will be automatically set to the value specified by the optional UPDATECBDATA keyword.

UPDATECBDATA

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied procedure specified via the UPDATECALLBACK keyword, if any. If the UPDATECBDATA keyword is not set the value accepted by the DATA keyword to the procedure specified by UPDATECALLBACK will be undefined.

Using the XPALETTE Interface

Calling XPALETTE causes a graphical interface to appear. The elements of this interface are described below.

Plots on Left Side of Interface

Three plots show the current red, green, and blue vectors.

Status Region

The center of the XPALETTE widget is a status region containing:

- The total number of colors.
- The current color index. XPALETTE allows changing one color at a time. This color is known as the “current color” and is indicated in the color spectrum display with a special marker.
- The current mark index. The mark is used to remember a color index. Click the “Set Mark Button” to make the current color index the mark index.
- A sample of the current color. The special marker used in the color spectrum display prevents the user from seeing the color of the current index, but it is visible here.

Control Panel

A panel of 8 buttons control common XPALETTE functions:

- **Done:** Click this button to exit XPALETTE. The new color tables are saved in the COLORS common block and loaded to the display.
- **Predefined:** Click this button to start XLOADCT, allowing selection of one of the predefined color tables. Note that when you change the color map via XLOADCT, XPALETTE is not always able to keep its display accurate. This problem can be overcome by pressing the XPALETTE “Redraw” button after changing the colortable via XLOADCT.
- **Help:** Click this button to display help information.

- **Redraw:** Click this button to redraws the display using the current state of the color map.
- **Set Mark:** Click this button to set the value of the mark index to the current color index.
- **Switch Mark:** Click this button to exchange the mark and the current index.
- **Copy Current:** Click this button to make every color lying between the current index and the mark index (inclusive) the same color as the current color.
- **Interpolate:** Click this button to smoothly interpolate colors between the current index and the mark index.

Color System Control

This section of the interface allows you to select the color system used to modify individual colors. The "Select Color System" pulldown menu lets you select from four different systems—RGB, CMY, HSV, and HLS. Depending upon the current system, 3 sliders below the pulldown menu allow you to alter the current color.

Right Side Color Spectrum Display

A display on the right side of the XPALETTE interface shows the current color map as a series of squares. Color index 0 is at the upper left. The color index increases monotonically by rows going left to right and top to bottom. The current color index is indicated by a special marker symbol. There are 4 ways to change the current color:

- Click on any square in the color map display.
- Use the "By Index" slider to move to the desired color index.
- Use the "Row" Slider to move the marker vertically.
- Use the "Column" Slider to move the marker horizontally.

A Note about the Colors Used in the Interface

XPALETTE uses two colors from the current color table as drawing foreground and background colors. These are used for the RGB plots on the left, and the current index marker on the right. This means that if the user set these two colors to the same value, the XPALETTE display could become unreadable (like writing on black paper with black ink). XPALETTE minimizes this possibility by noting changes to the color map and always using the brightest available color for the foreground color and the darkest for the background. Thus, the only way to make XPALETTE's display unreadable is to set the entire color map to a single color, which is highly unlikely.

The only side effect of this policy is that you may notice XPALETTE redrawing the entire display after you've modified the current color. This simply means that the change has made XPALETTE pick new drawing colors.

See Also

LOADCT, MODIFYCT, XLOADCT, TVLCT

XPCOLOR

The XPCOLOR procedure is a utility that allows you to adjust the value of the current plotting color (foreground) using sliders, and store the desired color in the global system variable, !P.COLOR.

When XPCOLOR is called from the IDL input command line, the **Set Plot Color** dialog box appears. The dialog has two buttons (**Done** and **Help**) a single color swatch window, three sliders, and a pulldown menu with the four color systems: red, green, blue (RGB); cyan, magenta, yellow (CMY); hue, saturation, value (HSV); and hue, lightness, and saturation (HLS).

When you have chosen the color system and adjusted the sliders to your liking, click **Done** to store the color selected in the !P.COLOR system variable. Any plots generated in IDL afterwards use the color selected as the plotting (foreground) color until !P.COLOR is changed again.

Note

For a more flexible color editor, use the XPALETTE User Library routine.

This routine is written in the IDL language. Its source code can be found in the file `xpcolor.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XPCOLOR [, GROUP=*widget_id*]

Arguments

None.

Keywords

GROUP

Set this keyword to the group leader widget ID as passed to XMANAGER.

XPLOT3D

The XPLOT3D procedure is a utility for creating and interactively manipulating 3D plots.

This routine is written in the IDL language. Its source code can be found in the file `xplot3d.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XPLOT3D, *X*, *Y*, *Z* [, /BLOCK] [, COLOR=*[r,g,b]*] [, /DOUBLE_VIEW] [, GROUP=*widget_id*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}]] [, /MODAL] [, NAME=*string*] [, /OVERPLOT] [, SYMBOL=*objref(s)*] [, /TEST] [, THICK=*points*{1.0 to 10.0}] [, TITLE=*string*] [, XRANGE=*[min, max]*] [, YRANGE=*[min, max]*] [, ZRANGE=*[min, max]*] [, XTITLE=*string*] [, YTITLE=*string*] [, ZTITLE=*string*]

Arguments

X

A vector of X data values.

Y

A vector of Y data values.

Z

A vector of Z data values.

Keywords

BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XPLOT3D block, any earlier calls to XMANAGER must have been called with the

NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

COLOR

Set this keyword to an [*r*, *g*, *b*] triplet specifying the color of the curve.

DOUBLE_VIEW

Set this keyword to cause XPLOT3D to set the DOUBLE property on the IDLgrView that it uses to display the plot.

GROUP

Set this keyword to the widget ID of the widget that calls XPLOT3D. When this keyword is specified, the death of the caller results in the death of XPLOT3D.

LINESTYLE

Set this keyword to a value indicating the line style that should be used to draw the curve. The value can be either an integer value specifying a pre-defined line style, or a 2-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE keyword to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where repeat indicates the number of times consecutive runs of 1s or 0s in the bitmask should be repeated. (That is, if three consecutive 0s appear in the bitmask and the value of repeat is 2, then the line that is drawn will have six consecutive bits turned off.) The value of repeat must be in the range 1 ≤ repeat ≤ 255.

The bitmask indicates which pixels are drawn and which are not along the length of the line. The bitmask is most conveniently specified as a 16-bit hexadecimal value.

For example, LINESTYLE = [2, 'F0F0'X] describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

MODAL

Set this keyword to block processing of events from other widgets until the user quits XPLOT3D. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XPLOT3D fabricates an invisible group leader for you.

Note

To be modal, XPLOT3D does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536 for more information.)

To provide a simple means of invoking XPLOT3D as a modal widget in applications that contain no other widgets, XPLOT3D can be invoked as MODAL without specifying a group leader, in which case XPLOT3D fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XPLOT3D, /MODAL. As with other IDL widget procedures with names prefixed with "X", specify the group leader via the GROUP keyword.

NAME

Set this keyword to a string specifying the name for the data curve being plotted. The name is displayed on the XPLOT3D toolbar when the curve is selected with the mouse. (To select the curve with the mouse, XPLOT3D must be in select mode. You can put XPLOT3D in select mode by clicking on the rightmost button on the XPLOT3D toolbar.)

OVERPLOT

Set this keyword to draw the curve in the most recently created view. The TITLE, [XYZ]TITLE, [XYZ]RANGE, and MODAL keywords are ignored if this keyword is set.

SYMBOL

Set this keyword to a vector containing one or more instances of the IDLgrSymbol object class to indicate the plotting symbols to be used at each vertex of the polyline.

If there are more vertices than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a polyline, set SYMBOL to a scalar.

TEST

If set, the *X*, *Y*, and *Z* arguments are not required (and are ignored if provided). A sinusoidal curve is displayed instead. This allows you to test code that uses XPLOT3D without having to specify plot data.

THICK

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the polyline, in points. The default is 1.0 points.

TITLE

Set this keyword to a string to appear in the XPLOT3D title bar.

XRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the X-axis range.

YRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the Y-axis range.

ZRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the Z-axis range.

XTITLE

Set this keyword to a string specifying the title for the X axis of the plot.

YTITLE

Set this keyword to a string specifying the title for the Y axis of the plot.

ZTITLE

Set this keyword to a string specifying the title for the Z axis of the plot.

Using XPLOT3D

XPLOT3D displays a resizeable top-level base with a menu, toolbar and draw widget, as shown in the following figure:

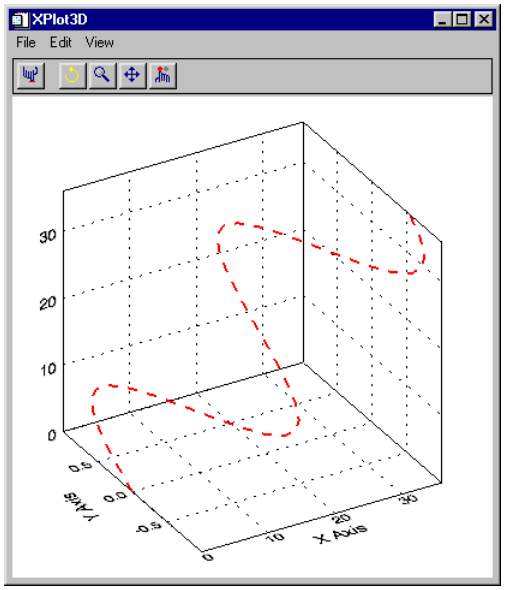


Figure 37: The XPLOT3D Utility

The XPLOT3D Toolbar

The XPLOT3D toolbar contains the following buttons:

Reset: Resets rotation, scaling, and panning.

Rotate: Click the left mouse button on the plot and drag to rotate.

Zoom: Click the left mouse button on the plot and drag to zoom in or out.

Pan: Click the left mouse button on the plot and drag to pan.

Select: Click on a curve to display the curve name (if defined with the NAME keyword) on the XPLOT3D toolbar. If no name was defined for the curve, “IDLGRPOLYLINE” is displayed.

Projecting Data onto Plot “Walls”

To turn on or off the projection of data onto the walls of the box enclosing the 3D plot, select **All On**, **All Off**, **XY**, **YZ**, or **XZ** from the **View → 2D Projection** menu.

Changing the Axis Type

The **View → Axes** menu allows you to select one of the following types of axes:

- Simple Axes — displays the X, Y, and Z axes as lines.
- Box Axes — displays the X, Y, and Z axes as planes.
- No Axes — turns off the display of axes.

Example

The following example displays two curves in XPLOT3D, using a custom plotting symbol for one of the curves:

```
;Define plot data:
X = INDGEN(20)
Y1 = SIN(X/3.)
Y2 = COS(X/3.)
Z = X

;Display curve 1 in XPLOT3D:
XPLOT3D, X, Y1, Z, NAME='Curve1', THICK=2

;Define custom plotting symbols:
oOrb = OBJ_NEW('orb', COLOR=[0, 0, 255])
oOrb->Scale, .75, .1, .5
oSymbol = OBJ_NEW('IDLgrSymbol', oOrb)

;Overplot curve 2 in XPLOT3D:
XPLOT3D, X, Y2, Z, COLOR=[0,255,0], NAME='Curve2', $
   SYMBOL=oSymbol, THICK=2, /OVERPLOT
```

This code results in the following:

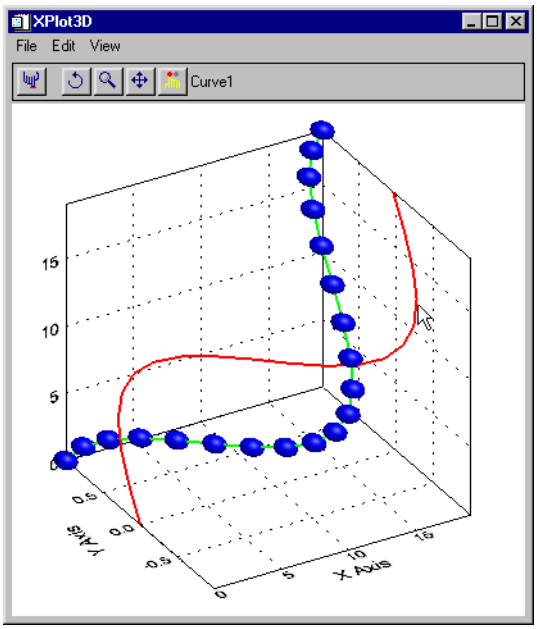


Figure 38: Two curves displayed in XPLOT3D

XREGISTERED

The XREGISTERED function returns True if the widget named as its argument is currently registered with the XMANAGER as an exclusive widget. Otherwise the routine returns false.

If the named widget is registered, XREGISTERED returns the number of instances of that name in the list maintained by XMANAGER. The registered widget is brought to the front of the desktop unless the NOSHOW keyword is set.

This routine is written in the IDL language. Its source code can be found in the file `xregistered.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = XREGISTERED(*Name* [, /NO_SHOW])

Arguments

Name

A string containing the name of the widget in question.

Note

XREGISTERED checks for *Name* in a COMMON block created by XMANAGER. The stored name is case-sensitive.

Keywords

NOSHOW

If the widget in question is registered, it is brought to the front of all the other windows by default. Set this keyword to keep the widget from being brought to the front.

Example

Suppose that you have a widget program that registers itself with the XMANAGER with the command:

```
XMANAGER, 'mywidget', base
```

You could limit this widget to one instantiation by adding the following line as the first line (after the procedure definition statement) of the widget creation routine:

```
IF XREGISTERED('mywidget') THEN RETURN
```

See Also

XMANAGER

XROI

The XROI procedure is a utility for interactively defining regions of interest (ROIs), and obtaining geometry and statistical data about these ROIs.

This routine is written in the IDL language. Its source code can be found in the file `xroi.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XROI [, *ImageData*] [, *R*] [, *G*] [, *B*] [, /BLOCK]
[[, /FLOATING] , GROUP=*widget_ID*] [, /MODAL] [, REGIONS_IN=*value*]
[, REGIONS_OUT=*value*] [, REJECTED=*variable*] [, RENDERER={0 | 1}]
[, ROI_COLOR=*[r, g, b] or variable*] [, ROI_GEOMETRY=*variable*]
[, ROI_SELECT_COLOR=*[r, g, b] or variable*] [, STATISTICS=*variable*]
[, TITLE=*string*] [, TOOLS=*string/string array* {valid values are 'Freehand Draw', 'Polygon Draw', and 'Selection'}]

Arguments

ImageData

ImageData is both an input and output argument. It is an array representing an 8-bit or 24-bit image to be displayed. *ImageData* can be any of the following:

- [*m*, *n*] — 8-bit image
- [3, *m*, *n*] — 24-bit image
- [*m*, 3, *n*] — 24-bit image
- [*m*, *n*, 3] — 24-bit image

If *ImageData* is not supplied, the user will be prompted for a file via DIALOG_PICKFILE. On output, *ImageData* will be set to the current image data. (The current image data can be different than the input image data if the user imported an image via the **File → Import Image** menu item.)

R, G, B

R, *G*, and *B* are arrays of bytes representing red, green, or blue color table values, respectively. *R*, *G*, and *B* are both input and output arguments. On input, these values are applied to the image if the image is 8-bit. To get the red, green, or blue color table values for the image on output from XROI, specify a named variable for the appropriate argument. (If the image is 24-bit, this argument will output a 256-element

byte array containing the values given at input, or BINDGEN(256) if the argument was undefined on input.)

Keywords

BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XROI block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

FLOATING

Set this keyword, along with the GROUP keyword, to create a floating top-level base widget. If the windowing system provides Z-order control, floating base widgets appear above the base specified as their group leader. If the windowing system does not provide Z-order control, the FLOATING keyword has no effect.

Note

Floating widgets must have a group leader. Setting this keyword without also setting the GROUP keyword causes an error.

GROUP

Set this keyword to the widget ID of the widget that calls XROI. When this keyword is specified, the death of the caller results in the death of XROI.

MODAL

Set this keyword to block other IDL widgets from receiving events while XROI is active.

REGIONS_IN

Set this keyword to an array of IDLgrROI references. This allows you to open XROI with ROIs already defined. This is also useful when using a loop to open multiple images in XROI. By using the same named variable for both the REGIONS_IN and REGIONS_OUT keywords, you can reuse the same ROIs in multiple images (see Example 2). This keyword also accepts –1, or OBJ_NEW() (Null object) to indicate that there are no ROIs to read in. This allows you to assign the result of a previous REGIONS_OUT to REGIONS_IN without worrying about the case where the previous REGIONS_OUT is undefined.

REGIONS_OUT

Set this keyword to a named variable that will contain an array of IDLgrROI references. This keyword is assigned the null object reference if there are no ROIs defined. By using the same named variable for both the REGIONS_IN and REGIONS_OUT keywords, you can reuse the same ROIs in multiple images (see Example 2).

REJECTED

Set this keyword to a named variable that will contain those REGIONS_IN that are not in REGIONS_OUT. The objects defined in the variable specified for REJECTED can be destroyed with a call to OBJ_DESTROY, allowing you to perform cleanup on objects that are not required (see Example 2). This keyword is assigned the null object reference if no REGIONS_IN are rejected by the user.

RENDERER

Set this keyword to an integer value to indicate which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation (the default)

ROI_COLOR

This keyword is both an input and an output parameter. Set this keyword to a 3-element byte array, [*r*, *g*, *b*], indicating the color of ROI outlines when they are not selected. This color will be used by XROI unless and until the color is changed by the user via the "Unselected Outline Color" portion of the "ROI Outline Colors" dialog (which is accessed by selecting **Edit → Outline Colors**). If this keyword is assigned a named variable, that variable will be set to the current [*r*, *g*, *b*] value at the time that XROI returns.

ROI_GEOMETRY

Set this keyword to a named variable that will contain an array of anonymous structures, one for each ROI that is valid when this routine returns. The structures will contain the following fields:

Field	Description
area	The area of the region of interest, in square pixels.
centroid	The coordinates (x, y, z) of the centroid of the region of interest, in pixels.
perimeter	The perimeter of the region of interest, in pixels.

Table 100: Fields of the structure returned by ROI_GEOMETRY

If there are no valid regions of interest when this routine returns, ROI_GEOMETRY will be undefined.

Note

If there are no REGIONS_IN, XROI must either be modal or must block control flow in order for ROI_GEOMETRY to be defined upon exit from XROI. Otherwise, XROI will return before an ROI can be defined, and ROI_GEOMETRY will therefore be undefined.

ROI_SELECT_COLOR

This keyword is both an input and an output parameter. Set this keyword to a 3-element byte array, $[r, g, b]$, indicating the color of ROI outlines when they are selected. This color will be used by XROI unless and until the color is changed by the user via the "Selected Outline Color" portion of the "ROI Outline Colors" dialog (which is accessed by selecting **Edit → Outline Colors**). If this keyword is assigned a named variable, that variable will be set to the current $[r, g, b]$ value at the time that XROI returns.

STATISTICS

Set this keyword to a named variable to receive an array of anonymous structures, one for each ROI that is valid when this routine returns. The structures will contain the following fields:

Field	Description
count	Number of pixels in region.
minimum	Minimum pixel value.
maximum	Maximum pixel value.
mean	Mean pixel value.
stddev	Standard deviation of pixel values.

Table 101: Fields of the structure returned by STATISTICS

If *ImageData* is 24-bit, or if there are no valid regions of interest when the routine exits, STATISTICS will be undefined.

Note

If there are no REGIONS_IN, XROI must either be modal or must block control flow in order for STATISTICS to be defined upon exit from XROI. Otherwise, XROI will return before an ROI can be defined, and STATISTICS will therefore be undefined.

TITLE

Set this keyword to a string to appear in the XROI title bar.

TOOLS

Set this keyword a string or vector of strings from the following list to indicate which ROI manipulation tools should be supported when XROI is run:

- 'Freehand Draw' — Freehand ROI drawing. Mouse down begins a region, mouse motion adds vertices to the region (following the path of the mouse), mouse up finishes the region.
- 'Polygon Draw' — Polygon ROI drawing. Mouse down begins a region, subsequent mouse clicks add vertices, double-click finishes the region.

- 'Selection' — ROI selection. Mouse down/up selects the nearest region. The nearest vertex in that region is identified with a crosshair symbol.

If more than one string is specified, a series of bitmap buttons will appear at the top of the XROI widget in the order specified (to the right of the fixed set of bitmap buttons used for saving regions, displaying region information, copying to clipboard, and flipping the image). If only one string is specified, no additional bitmap buttons will appear, and the manipulation mode is implied by the given string. If this keyword is not specified, bitmap buttons for all three manipulation tools are included on the XROI toolbar.

Using XROI

XROI displays a top-level base with a menu, toolbar and draw widget. After defining an ROI, the **ROI Information** window appears, as shown in the following figure:

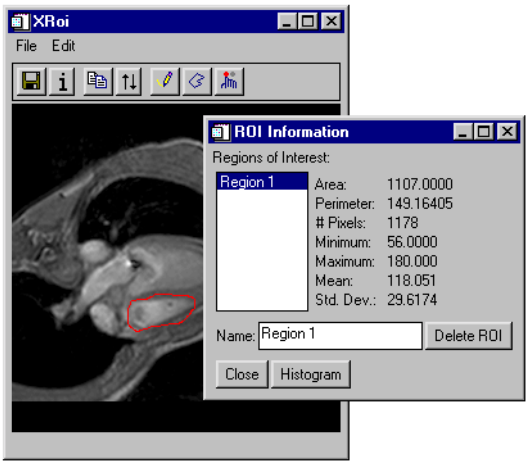


Figure 39: The XROI Utility

As you move the mouse over an image, the x and y pixel locations are shown in the status line on the bottom of the XROI window. For 8-bit images, the data value (z) is also shown. If an ROI is defined, the status line also indicates the mouse position relative to the ROI using the text “Inside”, “Outside”, “On Edge,” or “On Vertex.”

The XROI Toolbar

The XROI toolbar contains the following buttons:

 **Save:**	Opens a file selection dialog for saving the currently defined ROIs to a save file.
 **Info:**	Opens the **ROI Information** window.
 **Copy:**	Copies the contents of the display area to the clipboard.
 **Flip:**	Flips image vertically. Note that only the image is flipped; any ROIs that have been defined do not move.

Depending on the value of the TOOLS keyword, the XROI toolbar may also contain the following buttons:

 **Draw Freehand:**	Click this button to draw freehand ROIs. Mouse down begins a region, mouse motion adds vertices to the region (following the path of the mouse), mouse up finishes the region.
 **Draw Polygon:**	Click this button to draw polygon ROIs. Mouse down begins a region, subsequent mouse clicks add vertices, double-click finishes the region.
 **Select:**	Click this button to select an ROI region. Clicking the image causes a cross hairs symbol to be drawn at the nearest vertex of the selected ROI.

Importing an Image into XROI

To import an image into XROI, select **File → Import Image**. This opens a DIALOG_READ_IMAGE dialog, which can be used to preview and select an image.

Changing the Image Color Table

To change the color table properties for the current image, select **Edit → Image Color Table**. This opens the CW_PALETTE_EDITOR dialog, which is a compound widget used to edit color palettes. See CW_PALETTE_EDITOR for more information. This menu item is grayed out if the image does not have a color palette.

Changing the ROI Outline Colors

To change the outline colors for selected and unselected ROIs, select **Edit → Outline Colors**. This opens the **ROI Outline Colors** dialog, which consists of two CW_RGBSLIDER widgets for interactively adjusting the ROI outline colors. The left widget is used to define the color for the selected ROI, and the right widget is used to define the color of unselected ROIs. You can select the RGB, CMY, HSV, or HLS color system from the **Color System** drop-down list.

Viewing ROI Information

To view geometry and statistical data about the currently selected ROI, click the **Info** button or select **Edit → ROI Information**. This opens the **ROI Information** dialog, which displays area, perimeter, number of pixels, minimum and maximum pixel values, and standard deviation. Values for statistical information (minimum, maximum, mean, and standard deviation) appear as "N/A" for 24-bit images.

To view a histogram for the currently selected ROI, click the **Histogram** button. This opens a LIVE_PLOT dialog, which can be used to interactively control the plot properties.

Note

The **Histogram** button is enabled only for 8-bit images.

Deleting an ROI

To delete an ROI, do the following:

1. Click the **Info** button or select **Edit → ROI Information**. This opens the **ROI Information** dialog.
2. In the **ROI Information** dialog, select the ROI you wish to delete from the list of ROIs. You can also select an ROI by clicking the **Select** button on the XROI toolbar, then clicking on an ROI on the image.
3. Click the **Delete ROI** button.

Examples

Example 1

This example opens a single image in XROI:

```
image = READ_PNG(FILEPATH('mineral.png', $
   SUBDIR=['examples','data']))
XROI,  image
```

Example 2

This example reads 3 images from the file `mr_abdomen.dcm`, and calls XROI for each image. A single list of regions is maintained, saving the user from having to redefine regions on each image:

```
;Read 3 images from mr_abdomen.dcm and open each one in XROI:
FOR i=0,2 DO BEGIN
   image = READ_DICOM(FILEPATH('mr_abdomen.dcm',$
      SUBDIR=['examples','data']), IMAGE_INDEX=i)
   XROI, image, r, g, b, REGIONS_IN=regions,$
      REGIONS_OUT=regions, ROI_SELECT_COLOR=roi_select_color,$
      ROI_COLOR=roi_color, REJECTED=rejected, /BLOCK
   OBJ_DESTROY, rejected
ENDFOR

OBJ_DESTROY, regions
```

Perform the following steps:

1. Draw an ROI on the first image, then close that XROI window. Note that the next image contains the ROI defined in the first image. This is accomplished by setting REGIONS_IN and REGIONS_OUT to the same named variable in the FOR loop of the above code.
2. Draw another ROI on the second image.
3. Click the **Select** button and select the first ROI. Then click the **Info** button to open the **ROI Information** window, and click the **Delete ROI** button.
4. Close the second XROI window. Note that the third image contains the ROI defined in the second image, but not the ROI deleted on the second image. This example sets the REJECTED keyword to a named variable, and calls OBJ_DESTROY on that variable. Use of the REJECTED keyword is not necessary to prevent deleted ROIs from appearing on subsequent images, but allows you perform cleanup on objects that are no longer required.

XSQ_TEST

The XSQ_TEST function computes the Chi-square goodness-of-fit test between observed frequencies and the expected frequencies of a theoretical distribution. The result is a two-element vector containing the Chi-square test statistic X2 and the one-tailed probability of obtaining a value of X2 or greater.

Expected frequencies of magnitude less than 5 are combined with adjacent elements resulting in a reduction of cells used to formulate the chi-squared test statistic. If the observed frequencies differ significantly from the expected frequencies, the Chi-square test statistic will be large and the fit is poor. This situation requires the rejection of the hypothesis that the given observed frequencies are an accurate approximation to the expected frequency distribution.

This routine is written in the IDL language. Its source code can be found in the file `xsq_test.pro` in the `lib` subdirectory of the IDL distribution.

Syntax

Result = XSQ_TEST(*Obfreq*, *Exfreq* [, EXCELL=*variable*] [, OBCELL=*variable*] [, RESIDUAL=*variable*])

Arguments

Obfreq

An *n*-element integer, single-, or double-precision floating-point vector containing observed frequencies.

Exfreq

An *n*-element integer, single-, or double-precision floating-point vector containing expected frequencies.

Keywords

EXCELL

Set this keyword to a named variable that will contain a vector of expected frequencies used to formulate the Chi-square test statistic. If each of the expected frequencies contained in *Exfreq*, has a magnitude of 5 or greater, then this vector is identical to *Exfreq*. If *Exfreq* contains elements of magnitude less than 5, adjacent expected frequencies are combined. The identical combinations are performed on the corresponding elements of *Obfreq*.

OBCELL

Set this keyword to a named variable that will contain a vector of observed frequencies used to formulate the Chi-square test statistic. The elements of this vector are often referred to as the “cells” of the observed frequencies. The length of this vector is determined by the length of EXCELL described below.

RESIDUAL

Set this keyword to a named variable that will contain a vector of signed differences between corresponding cells of observed frequencies and expected frequencies.

```
RESIDUAL[i] = OBCELL[i] - EXCELL[i].
```

The length of this vector is determined by the length of EXCELL described above.

Example

```
; Define the vectors of observed and expected frequencies:
obfreq = [2, 1, 4, 15, 10, 5, 3]
exfreq = [0.5, 2.1, 5.9, 10.3, 10.7, 7.0, 3.5]

; Test the hypothesis that the given observed frequencies are an
; accurate approximation to the expected frequency distribution:
result = XSQ_TEST(obfreq, exfreq)
PRINT, result
```

IDL Output

```
3.05040       0.383920
```

Since the vector of expected frequencies contains elements of magnitude less than 5, adjacent expected frequencies are combined resulting in fewer cells. The identical combinations are performed on the corresponding elements of observed frequencies. The computed value of 0.383920 indicates that there is no reason to reject the proposed hypothesis at the 0.05 significance level.

See Also

CTI_TEST

XSURFACE

The XSURFACE procedure is a utility that provides a graphical interface to the SURFACE and SHADE_SURF commands. Different controls are provided to change the viewing angle and other plot parameters. The command used to generate the resulting surface plot is shown in a text window. Note that this procedure does not accept SURFACE or SHADE_SURF keywords.

This routine is written in the IDL language. Its source code can be found in the file `xsurface.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XSURFACE, *Data* [, /BLOCK] [, GROUP=*widget_id*]

Arguments

Data

The two-dimensional array to display as a wire-mesh or shaded surface.

Keywords

BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XSURFACE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

Set this keyword to the widget ID of the widget that calls XSURFACE. When GROUP is specified, the death of the calling widget results in the death of XSURFACE.

Example

```
; Make a 2D array:
z = DIST(30)

; Call XSURFACE. The XSURFACE widget appears:
XSURFACE, z
```

See Also

SHADE_SURF, SURFACE

XVAREDIT

The XVAREDIT procedure is a utility that provides a widget-based editor for any IDL variable. Use the input fields to change desired values of the variable or array. Click “Accept” to write the new values into the variable. Click “Cancel” to exit XVAREDIT without saving changes.

This routine is written in the IDL language. Its source code can be found in the file `xvaredit.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XVAREDIT, *Var* [, NAME='*variable_name*'{ignored if variable is a structure}] [, GROUP=*widget_id*] [, X_SCROLL_SIZE=*columns*] [, Y_SCROLL_SIZE=*rows*]

Arguments

Var

The variable to be edited. On output, this variable contains the edited value if the user selects the “Accept” button, or the original value if the user selects the “Cancel” button.

Keywords

NAME

The NAME of the variable. This keyword is overwritten with the structure name if the variable is a structure.

GROUP

The widget ID of the widget that calls XVAREDIT. When this ID is specified, a death of the caller results in a death of XVAREDIT.

X_SCROLL_SIZE

Set this keyword to the column width of the scrolling viewport. The default is 4.

Y_SCROLL_SIZE

Set this keyword to the row width of the scrolling viewport. The default is 4.

XVOLUME

The XVOLUME procedure is a utility for viewing and interactively manipulating volumes and isosurfaces.

This routine is written in the IDL language. Its source code can be found in the file `xvolume.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Tip

The XVOLUME_ROTATE and XVOLUME_WRITE_IMAGE procedures, which can be called only after a call to XVOLUME, can be used to easily create animations of volumes and isosurfaces displayed in XVOLUME. See XVOLUME_ROTATE for an example.

Syntax

XVOLUME, *Vol*, [, /BLOCK] [, GROUP=*widget_id*] [, /INTERPOLATE] [, /MODAL] [, RENDERER={0 | 1}] [, /REPLACE] [, SCALE=*value*] [, /TEST] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

Arguments

Vol

A 3-element array of the form [*x*, *y*, *z*] that specifies a data volume.

Keywords

BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

Note

Only the outermost call to XMANAGER can block. Therefore, to have XVOLUME block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

GROUP

Set this keyword to the widget ID of the widget that calls XVOLUME. When this keyword is specified, the death of the caller results in the death of XVOLUME.

INTERPOLATE

Set this keyword to indicate that trilinear interpolation is to be used when rendering the volume and the image planes. Setting this keyword improves the quality of images produced, at the cost of more computing time, especially when the volume has low resolution with respect to the size of the viewing plane. Nearest neighbor sampling is used by default.

MODAL

Set this keyword to block processing of events from other widgets until the user quits XVOLUME. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XVOLUME fabricates an invisible group leader for you.

Note

To be modal, XVOLUME does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 1536 for more information.)

To provide a simple means of invoking XVOLUME as a modal widget in applications that contain no other widgets, XVOLUME can be invoked as MODAL without specifying a group leader, in which case XVOLUME fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XVOLUME, /MODAL. As with other IDL widget procedures with names prefixed with "X", specify the group leader via the GROUP keyword.

RENDERER

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL (the default)
- 1 = IDL's software implementation

REPLACE

If this keyword is set, and there is a current instance of XVOLUME running, the volume displayed in XVOLUME is replaced with the volume specified by *Vol*. For example, display volume1 using the command

```
XVOLUME, volume1
```

To replace volume1 with volume2, you would use the command

```
XVOLUME, volume2, /REPLACE
```

SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the volume, while ensuring that no portion of the volume will be clipped by the XVOLUME window, regardless of the volume's orientation.

TEST

If set, the *Vol* argument is not required (and is ignored if provided). A volume of random numbers is displayed instead. This allows you to test code that uses XVOLUME without having to specify volume data.

XSIZE

The width of the drawable area in pixels.

YSIZE

The height of the drawable area in pixels.

Using XVOLUME

XVOLUME displays a resizeable top-level base with a toolbar, a menu, a graphical interface for controlling volume and isosurface properties, and a draw widget for displaying and manipulating the volume, as shown in the following figure:

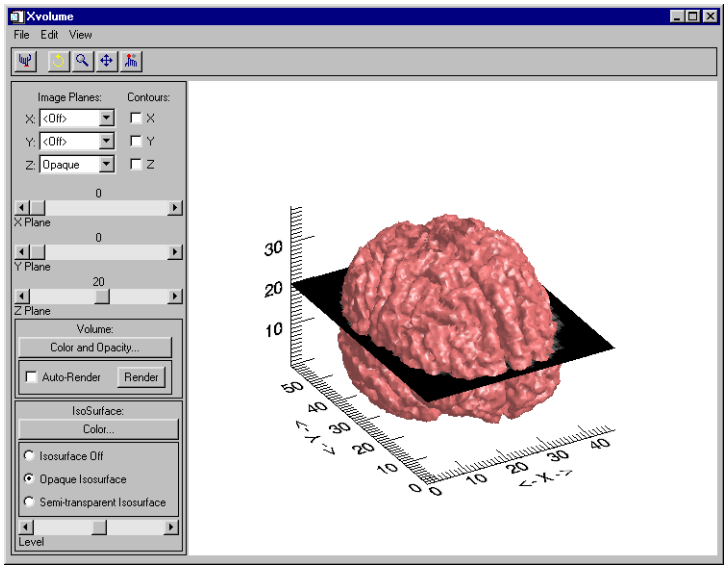


Figure 40: The XVOLUME Utility

The XVOLUME Toolbar

The XVOLUME toolbar contains the following buttons.

Note

If you have the **Auto-Render** option selected, the Rotate, Zoom, and Pan features may be more difficult to use. For the best performance while manipulating the orientation of a volume using these features, uncheck the **Auto-Render** option.

Reset: Resets rotation, scaling, and panning.

Rotate: Click the left mouse button on the volume and drag to rotate.

 **Zoom:** Click the left mouse button on the volume and drag to zoom in or out.

 **Pan:** Click the left mouse button on the volume and drag to pan.

 **Select:** Click in the draw widget to identify the selected item. A name identifying the selected item is displayed next to the Select button.

The XVOLUME Interface

The XVOLUME interface provides the following elements for controlling the display of image planes and contours, volumes, and isosurfaces:

Image Planes and Contours

Image planes and contours allow you to visualize the values associated with the volume or isosurface at a specified X, Y, or Z plane.

- **Image Planes**: Select one of the following options from the dropdown list for each dimension to control the display of image planes:
  - **Off**: Turns off the image plane display.
  - **Opaque**: Displays an opaque image plane at the location specified by the corresponding plane slider.
  - **Transparent**: Displays a transparent image plane at the location specified by the corresponding plane slider. The transparency value of the plane is taken from the volume at the current location of the image plane.
- **Contours**: Check this option to display contours on the specified plane at the location specified by corresponding the plane slider.
- **Plane Sliders**: Move these sliders to change the position of the plane in each dimension.

Volume

- **Color and Opacity**: Click this button to change the color and/or opacity of the current volume. This opens a CW_PALETTE_EDITOR dialog, which is a compound widget used to edit color palettes. See CW_PALETTE_EDITOR for more information.
- **Auto-Render**: Select this option to have rendering executed automatically after each change you make to the volume. If **Auto-Render** is unchecked, you

must manually click the **Render** button to see changes you have made to the volume. If **Auto-Render** is checked, the **Render** button will be grayed out.

- **Render**: Click on this button to execute rendering computations and display the current volume. If **Auto-Render** is checked, this button will be grayed out.

Isosurface

An isosurface is a 3D surface on which the data values are constant along the entire surface. Use the following elements to control the appearance of the isosurface:

- **Color**: Click this button to change the color system and/or values for the current isosurface. This opens a CW_RGBSLIDER dialog, which is a compound widget that provides a drop-down list for selecting the RGB, CMY, HSV, or HLS color system, and three sliders for adjusting the values associated with each color system.
- **Isosurface Off**: Select this option to turn off the isosurface display.
- **Opaque Isosurface**: Select this option to display an opaque isosurface.
- **Semi-transparent Isosurface**: Select this option to display a semi-transparent isosurface.
- **Level**: Use this slider to adjust the threshold value of the isosurface.

Example

Create a volume and display using XVOLUME:

```
; Create a volume:
vol = BYTSCL(RANDOMU((SEED=0),5,5,5))
vol = CONGRID(vol, 30,30,30)

; Display volume:
XVOLUME, vol
```

See Also

XVOLUME_ROTATE, XVOLUME_WRITE_IMAGE, IDLgrVolume, ISOSURFACE, SHADE_VOLUME, SLICER3, "Volume Objects" in Chapter 26 of *Using IDL*.

XVOLUME_ROTATE

The XVOLUME_ROTATE procedure is used to programmatically rotate the volume currently displayed in XVOLUME. XVOLUME must be called prior to calling XVOLUME_ROTATE. This procedure can be used to create animations of volumes and isosurfaces.

This routine is written in the IDL language. Its source code can be found in the file `xvolume_rotate.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XVOLUME_ROTATE, *Axis*, *Angle* [, /PREMULTIPLY]

Arguments

Axis

A 3-element vector of the form [*x*, *y*, *z*] describing the axis about which the model is to be rotated.

Angle

The amount of rotation, measured in degrees.

Keywords

PREMULTIPLY

Set this keyword to cause the rotation matrix specified by *Axis* and *Angle* to be pre-multiplied to the model's transformation matrix. By default, the rotation matrix is post-multiplied.

Example

The following example creates an animation of the volume currently displayed in XVOLUME. It does this by rotating the volume through 360 degrees in increments of 10 degrees using XVOLUME_ROTATE, and writing the volume to a BMP file for each increment using XVOLUME_WRITE_IMAGE. It then loops through the images and uses TV to display each image.

First, display a volume as follows:

```
; Create a volume:
```

```
vol = BYTSCL(RANDOMU((SEED=0),5,5,5))
vol = CONGRID(vol, 30,30,30)

; Display volume:
XVOLUME, vol
```

Now, use the XVOLUME interface to modify the orientation and appearance of the volume or isosurface as desired. Once you have the volume or isosurface displayed the way you want it, run the following program:

```
PRO spin_volume

   inc = 10. ; degrees.
   ; Create images
   FOR i=0,(360./inc)-2 DO BEGIN
      XVOLUME_WRITE_IMAGE, $
         'spin' + STRCOMPRESS(i, /REMOVE_ALL) + '.bmp', 'bmp'
      XVOLUME_ROTATE, [0,0,1], inc, /PREMULTIPLY
   ENDFOR
   XVOLUME_ROTATE, [0,0,1], inc, /PREMULTIPLY

   ; Read images
   img = READ_BMP('spin0.bmp')
   siz = SIZE(img, /DIM)
   arr = BYTARR(3, siz[1], siz[2], 360./inc-1)
   FOR i=0,360./inc-2 DO BEGIN
      img = READ_BMP( $
         'spin' + STRCOMPRESS(i, /REMOVE_ALL) + '.bmp', /RGB)
      arr[0,0,0, i] = img
      PRINT, i
   ENDFOR

   ; Display animation
   FOR i=0,2 DO BEGIN ; num rotations
      FOR j=0,(360./inc)-2 DO BEGIN
         TV, arr[*,*,*,j], /TRUE
      ENDFOR
   ENDFOR

   TV, arr[*,*,*,0], /TRUE

END
```

See Also

XVOLUME, XVOLUME_WRITE_IMAGE

XVOLUME_WRITE_IMAGE

The XVOLUME_WRITE_IMAGE procedure is used to write the volume currently displayed in XVOLUME to an image file with the specified name and file format. XVOLUME must be called prior to calling XVOLUME_WRITE_IMAGE.

This routine is written in the IDL language. Its source code can be found in the file `xvolume_write_image.pro` in the `lib/utilities` subdirectory of the IDL distribution.

Syntax

XVOLUME_WRITE_IMAGE, *Filename*, *Format* [, DIMENSIONS=*[x, y]*]

Arguments

Filename

A scalar string containing the name of the file to write.

Format

A scalar string containing the name of the file format to write. See QUERY_IMAGE for a list of supported formats.

Keywords

DIMENSIONS

Set this keyword to a 2-element vector of the form [*x*, *y*] specifying the size of the output image, in pixels. If this keyword is not specified, the image will be written using the dimensions of the current XVOLUME draw widget.

Example

See XVOLUME_ROTATE.

See Also

XVOLUME, XVOLUME_ROTATE

XYOUTS

The XYOUTS procedure draws text on the currently-selected graphics device starting at the designated coordinate.

Arguments *X*, *Y*, and *String* can be any combination of scalars or arrays. If the arguments are arrays, multiple strings are output.

If the optional *X* and *Y* arguments are omitted, the text is positioned at the end of the most recently output text string.

Important keywords that control the appearance and positioning of the text include: ALIGNMENT, the justification of the text; CHARSIZE, the size of the text; FONT, chooses between vector drawn and hardware fonts; COLOR, the color of the text; and ORIENTATION, the angle between the baseline of the text and the horizontal. With hardware fonts, most of the text attributes, (e.g., size and orientation), are predetermined and not changeable.

Note

Specify the Z coordinate with the Z keyword when positioning text in three dimensions.

Syntax

XYOUTS, [*X*, *Y*,] *String* [, ALIGNMENT=*value*{0.0 to 1.0}] [, CHARSIZE=*value*] [, CHARTHICK=*value*] [, TEXT_AXES={0 | 1 | 2 | 3 | 4 | 5}] [, WIDTH=*variable*]

Graphics Keywords:[, CLIP=*[*X_0, Y_0, X_1, Y_1*]*] [, COLOR=*value*][, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*]
[, ORIENTATION=*ccw_degrees_from_horiz*] [, /NOCLIP] [, /T3D] [, Z=*value*]

Arguments

X, Y

The horizontal and vertical coordinates used to position the string(s). *X* and *Y* are normally interpreted in data coordinates. The DEVICE and NORMAL keywords can be used to specify the coordinate units.

X and *Y* can be arrays of positions if *String* is an array.

String

The string(s) to be output. This argument can be a scalar string or an array of strings. If this argument is not a string, it is converted prior to use using the default formatting rules. If *String* is an array, *X*, *Y*, and the COLOR keyword can also be arrays so that each string can have a separate location and color.

Keywords

ALIGNMENT

Specifies the alignment of the text baseline. An alignment of 0.0 (the default) aligns the left edge of the text baseline with the given (*x*, *y*) coordinate. An alignment of 1.0 right-justifies the text, while 0.5 results in text centered over the point (*x*, *y*).

CHARSIZE

The overall character size for the annotation. A CHARSIZE of 1.0 is normal. Setting CHARSIZE = -1 suppresses output of the text string. This keyword has no effect when used with the hardware drawn fonts; for exceptions, see "Scaled Hardware Fonts" on page 1778.

CHARTHICK

The line thickness of the vector drawn font characters. This keyword has no effect when used with the hardware drawn fonts; for exceptions, see "Scaled Hardware Fonts" on page 1778. The default value is 1.0.

TEXT_AXES

This keyword specifies the plane of vector drawn text when three-dimensional plotting is enabled. By default, text is drawn in the plane of the XY axes. The horizontal text direction is in the X plane, and the vertical text direction is in the Y plane. Values for this keyword can range from 0 to 5, with the following effects: 0 for XY, 1 for XZ, 2 for YZ, 3 for YX, 4 for ZX, and 5 for ZY. The notation ZY means that the horizontal direction of the text lies in the Z plane, and the vertical direction of the text is drawn in the Y plane.

WIDTH

Set this keyword to a named variable in which to return the width of the text string, in normalized coordinate units.

Graphics Keywords Accepted

See Appendix C, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, FONT, NOCLIP, NORMAL, ORIENTATION, T3D, Z.

Examples

Print the string "This is text" at device coordinate position (100,100):

```
XYOUTS, 100, 100, 'This is text', /DEVICE
```

Print an array of strings with each element of the array printed at a different location. Use larger text than in the previous example:

```
XYOUTS, [0, 200, 250], [200, 50, 100], $
   ['This', 'is', 'text'], CHARSIZE = 3, /DEVICE
```

Determine the text size for a window device before opening an on-screen window:

```
WINDOW, /FREE, /PIXMAP, XSIZE=myWinXSize, YSIZE=myWinYSize
XYOUTS, 'Check this out', WIDTH=w
WDELETE
```

myWinXSize and *myWinYSize* are chosen to match your onscreen window. Since we can not know the characteristics of a given device (such as character size) until a window has been opened, the PIXMAP keyword to WINDOW allows you to compute appropriate dimensions for text with an invisible window before displaying a window on your screen.

Scaled Hardware Fonts

One example of hardware fonts which can be scaled are PostScript fonts. If you are using PostScript fonts, the keywords CHARTHICK and CHARSIZE will have an effect on a call to XYOUTS. Of the devices we provide that support hardware fonts, only the PostScript device uses scalable PostScript fonts for its "hardware" font system. All other devices use a bitmapped font technology.

Scaling is related to whether or not a device supports Hershey formatting commands when hardware fonts are used. Formatting requires the ability to scale the text on a per-character basis (i.e. for subscripting). To see if a given device supports Hershey formatting when hardware fonts are used, look at bit 12 of !D.FLAGS. You can also use this indicator to determine whether or not the hardware fonts will be scaled.

See Also

ANNOTATE, PRINT/PRINTF

ZOOM

The ZOOM procedure displays part of an image from the current window enlarged in a new (“zoom”) window. The cursor is used to mark the center of the zoom area, and different zoom factors can be specified interactively.

Note

ZOOM only works with color systems.

This routine is written in the IDL language. Its source code can be found in the file `zoom.pro` in the `lib` subdirectory of the IDL distribution.

Using ZOOM

After calling ZOOM, place the mouse cursor over an image in an IDL graphics window. Click the left mouse button to display a magnified version of the image in a new window. The zoomed image is centered around the pixel selected in the original window. Click the middle mouse button to display a menu of zoom factors. Click the right mouse button to exit the procedure.

Using ZOOM with Draw Widgets

Note that the ZOOM procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain a zooming effect in a draw widget, use the CW_ZOOM function.

Syntax

ZOOM [, /CONTINUOUS] [, FACT=*integer*] [, /INTERP] [, /KEEP]
[, /NEW_WINDOW] [, XSIZE=*value*] [, YSIZE=*value*]
[, ZOOM_WINDOW=*variable*]

Keywords

CONTINUOUS

Set this keyword to make the zoom window track the mouse without requiring the user to press the left mouse button. This feature only works well on fast computers.

FACT

Use this keyword to specify the zoom factor, which must be an integer. The default zoom factor is 4.

INTERP

Set this keyword to use bilinear interpolation. The default is to use pixel replication.

KEEP

Set this keyword to keep the zoom window after exiting the procedure.

NEW_WINDOW

Normally, if ZOOM is called with KEEP and then called again, it will use the same window to display the new zoomed image. Set the NEW_WINDOW keyword to force ZOOM to create a new window for this purpose.

XSIZE

Use this keyword to specify the X size of the zoom window. The default is 512.

YSIZE

Use this keyword to specify the Y size of the zoom window. The default is 512.

ZOOM_WINDOW

Set this keyword to a named variable that will contain the index of the zoom window. KEEP must also be set. If KEEP is not set, ZOOM_WINDOW will contain the integer -1.

See Also

CW_ZOOM, ZOOM_24

ZOOM_24

The ZOOM_24 procedure displays part of a 24-bit color image from the current window expanded in a new (“zoom”) window, and provides information about cursor location and color values in an auxiliary (“data”) window. The cursor is used to mark the center of the zoom area, and different zoom factors can be specified interactively.

Note

ZOOM only works on 24-bit color systems.

This routine is written in the IDL language. Its source code can be found in the file `zoom_24.pro` in the `lib` subdirectory of the IDL distribution.

Using ZOOM_24

After calling ZOOM_24, windows titled “Zoomed Image” (the zoom window) and “Pixel Values” (the data window) appear on the screen. Place the mouse cursor over a 24-bit color image in an IDL graphics window and click the left mouse button to display a magnified version of the image in the zoom window. The zoomed image is centered around the pixel selected in the original window. Move the mouse cursor in the zoom window to determine the coordinates (in the original image) and color values of individual pixels.

With the cursor located in the zoom window, click the right mouse button to return to selection mode, which allows you to either choose a new zoom center, change the zoom factor, or exit the procedure. Move the cursor to the original image and click the middle mouse button to display a menu of zoom factors, or click the right mouse button to exit the procedure.

Using ZOOM_24 with Draw Widgets

Note that the ZOOM_24 procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain a zooming effect in a draw widget, use the CW_ZOOM function.

Syntax

ZOOM_24 [, FACT=*integer*] [, /RIGHT] [, XSIZE=*value*] [, YSIZE=*value*]

Keywords

FACT

Use this keyword to specify the zoom factor, which must be an integer. The default zoom factor is 4.

RIGHT

Set this keyword to position the zoom and data windows to the right of the original window.

XSIZE

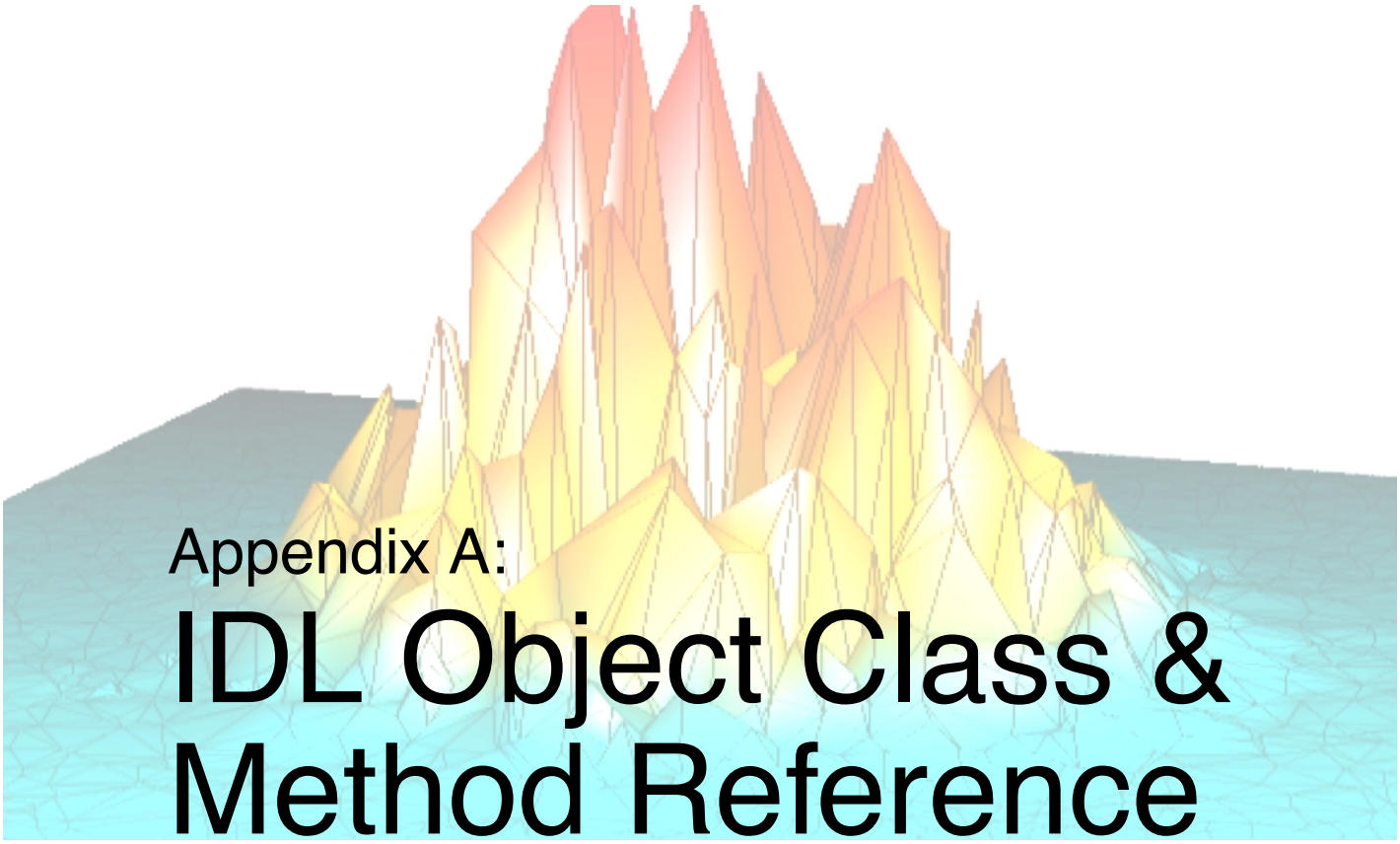
Use this keyword to specify the X size of the zoom window. The default is 512.

YSIZE

Use this keyword to specify the Y size of the zoom window. The default is 512.

See Also

CW_ZOOM, ZOOM



Appendix A: IDL Object Class & Method Reference

This appendix describes IDL's built-in graphics class library. The following objects are covered in this appendix:

- IDL_Container
- IDLanROI
- IDLanROIGroup
- IDLffDICOM
- IDLffDXF
- IDLffLanguageCat
- IDLffShape
- IDLgrAxis
- IDLgrBuffer
- IDLgrClipboard
- IDLgrColorbar
- IDLgrContour
- IDLgrFont
- IDLgrImage
- IDLgrLegend
- IDLgrLight
- IDLgrModel
- IDLgrMPEG
- IDLgrPalette
- IDLgrPattern
- IDLgrPlot
- IDLgrPolygon
- IDLgrPolyline
- IDLgrPrinter
- IDLgrROI
- IDLgrROIGroup
- IDLgrScene
- IDLgrSurface
- IDLgrSymbol
- IDLgrTessellator
- IDLgrText
- IDLgrView
- IDLgrViewgroup
- IDLgrVolume
- IDLgrVRML
- IDLgrWindow
- TrackBall

Using this Appendix

The elements of IDL's graphics class library are documented alphabetically in this appendix. The page or pages describing each class include references to sub- and super-classes, and to the methods associated with the class. Class methods are documented alphabetically following the description of the class itself.

A description of each method follows its name. Beneath the general description of the method are a number of sections that describe the Syntax for the method, its arguments (if any), its keywords (if any). These sections are described below.

Syntax

The Syntax section shows the proper syntax for calling the method.

Procedure Methods

IDL procedure methods have the syntax:

Obj -> Procedure_Name, *Argument* [, *Optional_Arguments*]

where *Obj* is a valid object reference, *Procedure_Name* is the name of the procedure method, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter to the procedure method. Note that the square brackets around optional arguments are not used in the actual call to the procedure, they are simply used to denote the optional nature of the arguments within this document.

Function Methods

IDL function methods have the syntax:

Result = Obj -> Function_Name(*Argument* [, *Optional_Arguments*])

where *Obj* is a valid object reference, *Result* is the returned value of the function method, *Function_Name* is the name of the function method, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter. Note that the square brackets around optional arguments are not used in the actual call to the function, they are simply used to denote the optional nature of the arguments within this document. Note also that all arguments and keyword arguments to functions should be supplied *within* the parentheses that follow the function's name.

Arguments

The “Arguments” section describes each valid argument to the method. Note that these arguments are positional parameters that must be supplied in the order indicated by the method’s syntax.

Named Variables

Often, arguments that contain values upon return from the function or procedure method (“output arguments”) are described as accepting “named variables”. A named variable is simply a valid IDL variable name. This variable *does not* need to be defined before being used as an output argument. Note, however that when an argument calls for a named variable, only a named variable can be used—sending an expression causes an error.

Keywords

The “Keywords” section describes each valid keyword argument to the method. Note that keyword arguments are formal parameters that can be supplied in any order.

Keyword arguments are supplied to IDL methods by including the keyword name followed by an equal sign (“=”) and the value to which the keyword should be set. Note that keywords can be abbreviated to their shortest unique length. For example, the XSTYLE keyword can be abbreviated to XST.

Setting Keywords

When the documentation for a keyword says something similar to, “Set this keyword to enable logarithmic plotting,” the keyword is simply a switch that turns an option on and off. Usually, setting such keywords equal to 1 causes the option to be turned on. Explicitly setting the keyword to zero (or not including the keyword) turns the option off.

There is a “shortcut” that can be used to set a keyword equal to 1 without the usual syntax (i.e., `KEYWORD=1`). To “set” a keyword, simply preface it with a slash character (“/”). For example, to create a surface object with a skirt around it, set the SKIRT keyword to the SURFACE routine as follows:

```
mySurface = OBJ_NEW('IDLgrSurface', DIST(10), /SKIRT)
```

Creating Objects from the Graphics Class Library

To create an object from the IDL Graphics Class Library, use the OBJ_NEW function. See “OBJ_NEW” on page 949. The Init method for each class describes the arguments and keywords available when you are creating a new graphics object.

For example, to create a new graphics object from the IDLgrAxis class, use the following call to OBJ_NEW along with the arguments and keywords accepted by the IDLgrAxis::Init method:

```
myAxis = OBJ_NEW(IDLgrAxis, DIRECTION=1, RANGE=[0.0,40.0])
```

IDL_Container

An IDL_Container object holds other objects. Destroying an IDL_Container object destroys any objects that have been added to the container via the Add method.

Superclasses

This class has no superclasses.

Subclasses

The following classes are subclassed from this class:

- IDLgrModel
- IDLgrScene
- IDLgrView
- IDLgrViewgroup

Creation

See "IDL_Container::Init" on page 1792.

Methods

Intrinsic Methods

This class has the following methods:

- IDL_Container::Add
- IDL_Container::Cleanup
- IDL_Container::Count
- IDL_Container::Get
- IDL_Container::Init
- IDL_Container::IsContained
- IDL_Container::Move
- IDL_Container::Remove

IDL_Container::Add

The IDL_Container::Add procedure method adds a child object to the container.

Syntax

Obj **->** [IDL_Container::]Add, *Object* [POSITION=*index*]

Arguments

Object

An instance of an object to be added to the container object.

Keywords

POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed. The default is to add the new object at the end of the list of contained items.

Example

If the container has three objects, the new object will be placed at the fourth position. Since positions begin at zero, this would be equivalent to setting POSITION=3.

IDL_Container::Cleanup

The IDL_Container::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj–> [IDL_Container::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDL_Container::Count

The IDL_Container::Count function method returns the number of objects contained by the container object.

Syntax

Result = *Obj* -> [IDL_Container::]Count()

Arguments

None

Keywords

None

IDL_Container::Get

The IDL_Container::Get function method returns an array of object references to objects in a container. Unless the ALL or POSITION keywords are specified, the first object in the container is returned. If no objects are found in the container, the Get function returns -1.

Syntax

Result = *Obj* **->** [IDL_Container::]Get ([, /ALL [, ISA=*class_name(s)*] | , POSITION=*index*] [COUNT=*variable*])

Arguments

None

Keywords

ALL

Set this keyword to return an array of object references to all of the objects in the container.

COUNT

Set this keyword equal to a named variable that will contain the number of objects selected by the function. If the ALL keyword is also specified, specifying this keyword is the same as calling the IDL_Container::Count method.

ISA

Set this keyword equal to a class name or vector of class names. This keyword is used in conjunction with the ALL keyword. The ISA keyword filters the array returned by the ALL keyword, returning only the objects that inherit from the class or classes specified by the ISA keyword.

Note

This keyword is ignored if the ALL keyword is not provided.

POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the positions of the objects to return.

IDL_Container::Init

The IDL_Container::Init function method initializes the container object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDL_Container')

or

Result = *Obj* **->** [IDL_Container::]Init( ) (*Only in a subclass' Init method*.)

Arguments

None

Keywords

None

IDL_Container::IsContained

The IDL_Container::IsContained function method returns true (1) if the specified object is in the container, or false (0) otherwise.

Syntax

Result = Obj -> [IDL_Container::]IsContained(*Object* [, POSITION=*variable*])

Arguments

Object

The object reference or vector of object references of the object(s) to search for in the container.

Keywords

POSITION

Set this keyword to a named variable that upon return will contain the position(s) at which (each of) the argument(s) is located within the container, or -1 if it is not contained.

IDL_Container::Move

The IDL_Container::Move procedure method moves an object from one position in a container to a new position. The order of the other objects in the container remains unchanged.

Positioning within a container controls the rendering order of the contained objects. The object whose location has the lowest index value is rendered first. If several objects are located at the same point in three-dimensional space, the object rendered first will occlude objects rendered later. Objects located “behind” other objects in three-dimensional space must be rendered before objects in front of them, even if the “front” objects are translucent.

Syntax

Obj –> [IDL_Container::]Move, *Source*, *Destination*

Arguments

Source

The zero-based index of the current location of the object to be moved.

Destination

The zero-based index of the location in the container where the object will reside after being moved.

Keywords

None

IDL_Container::Remove

The IDL_Container::Remove procedure method removes an object from the container.

Syntax

Obj **->** [IDL_Container::]Remove [, *Child_object* | , POSITION=*index* | , /ALL]

Arguments

Child_object

The object reference of the object to be removed from the container. If *Child_object* is not provided (and neither the ALL nor POSITION keyword are set), the first object in the container will be removed.

Keywords

ALL

Set this keyword to remove all objects from the container. If this keyword is set, the *Child_object* argument is not required.

POSITION

Set this keyword equal to the zero-based index of the object to be removed. If the *Child_object* argument is supplied, this keyword is ignored.

IDLanROI

The IDLanROI object class represents a region of interest.

Note

The IDLan* naming convention is used for objects in the analysis domain.

Regions of interest are described as a set of vertices that may be connected to generate a path or a polygon, or may be treated as separate points. This object may be used as a source for analytical computations on regions. (For additional information about display of ROIs in Object Graphics, refer to the IDLgrROI object class.)

Superclasses

None.

Subclasses

This class is a superclass of IDLgrROI.

Creation

See IDLanROI::Init.

Methods

Intrinsic Methods

The IDLanROI class has the following methods.

- IDLanROI::AppendData
- IDLanROI::Cleanup
- IDLanROI::ComputeGeometry
- IDLanROI::ComputeMask
- IDLanROI::ContainsPoints
- IDLanROI::GetProperty
- IDLanROI::Init
- IDLanROI::RemoveData

- IDLanROI::ReplaceData
- IDLanROI::Rotate
- IDLanROI::Scale
- IDLanROI::SetProperty
- IDLanROI::Translate

IDLanROI::AppendData

The IDLanROI::AppendData procedure method appends vertices to the region.

Syntax

Obj–>[IDLanROI::]AppendData, *X* [, *Y*] [, *Z*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

X

A vector providing the X components of the vertices to be appended. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimensions either 2 or 3 ([2,*] or [3,*]), in which case, X[0,*] represents the X values, X[1,*] represents the Y values, and X[2,*] represents the Z values. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Y

A vector providing the Y components of the vertices to be appended. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Z

A vector providing the Z components of the vertices to be appended. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Keywords

XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin, xmax*], representing the *X* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], representing the *Y* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin, zmax*], representing the *Z* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

IDLanROI::Cleanup

The IDLanROI::Cleanup procedure method performs all cleanup for a region of interest object.

Note

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj–>[IDLanROI::]Cleanup (In a subclass' Cleanup method only)

Arguments

None.

Keywords

None.

IDLanROI::ComputeGeometry

The IDLanROI::ComputeGeometry function method computes the geometrical values for area, perimeter, and/or centroid of the region.

Syntax

Result = *Obj*–>[IDLanROI::]ComputeGeometry([, AREA=*variable*] [, CENTROID=*variable*] [, PERIMETER=*variable*] [, SPATIAL_OFFSET=*vector*] [, SPATIAL_SCALE=*vector*])

Return Value

Result

This function method returns a 1 for success, or a 0 for failure. Each computed value is returned in the *variable* name assigned to each keyword.

Arguments

None.

Keywords

AREA

Set this keyword to a named variable that upon return contains a double-precision floating-point value representing the area of the region. Interior regions (holes) return a negative area.

CENTROID

Set this keyword to a named variable that upon return contains a double-precision floating-point value representing the centroid for the region. If the TYPE of the region is 0 (points), the centroid is computed as the average of each of the vertices in the region. If the TYPE of the region is 1 (path), the centroid is computed as the weighted average of each of the midpoints of the lines in the region. Weights are proportional to the length of the lines. If the TYPE of the region is 2 (polygon), the centroid is computed as a weighted average of the centroids of the polygons making up the ROI (interior centroids use negative weights). Weights are proportional to the polygon area.

PERIMETER

Set this keyword to a named variable that upon return contains a double-precision floating-point value representing the perimeter of the region.

SPATIAL_OFFSET

Set this keyword to a two or three-element vector, [*tx*, *ty*] or [*tx*, *ty*, *tz*], representing the spatial calibration offset factors to be applied for the geometry calculations. The value of SPATIAL_SCALE is applied before the spatial offset values are applied. The default is [0.0, 0.0, 0.0]. IDL converts and maintains this value in double-precision floating-point.

SPATIAL_SCALE

Set this keyword to a two or three-element vector, [*sx*, *sy*] or [*sx*, *sy*, *sz*], representing the spatial calibration scaling factors to be applied for the geometry calculations. The spatial calibration scale is applied first, then the value of SPATIAL_OFFSET is applied. The default is [1.0, 1.0, 1.0]. IDL converts and maintains this value in double-precision floating-point.

IDLanROI::ComputeMask

The IDLanROI::ComputeMask function method prepares a two-dimensional mask for the region.

Syntax

Result = *Obj*–>[IDLanROI::]ComputeMask([, INITIALIZE={ –1 | 0 | 1 }] [, DIMENSIONS=*[xdim*, *ydim]*] | [, MASK_IN=*array*] [, LOCATION=*[x*, *y* [, *z*]*]*] [, MASK_RULE={ 0 | 1 | 2 }] [, PLANE_NORMAL=*[x, y, z]*] [, PLANE_XAXIS=*[x,y,z]*])

Return Value

Result

The return value is a two-dimensional array of bytes whose values range from 0 to 255. The mask is computed by applying the following formula to the current mask for each mask point contained within the ROI:

$$M_{out} = \text{MAX}(\text{MIN}(\ 0, (M_{roi} * Ext) + M_{in}), 255)$$

where M_{roi} is 255 and *Ext* is 1 for points within an exterior region and –1 for points within an interior region.

If the TYPE of the region is 0 (points), a single mask pixel is set for each region vertex that falls within the bounds of the mask.

If the TYPE of the region is 1 (path), one-pixel-wide line segments are set within the mask.

If the TYPE of the region is 2 (closed polygon), a mask pixel is set if that pixel is on the plane of a region, and the pixel falls within the region (according to the MASK_RULE).

Arguments

None.

Keywords

DIMENSIONS

Set this keyword to a two-element vector, [*xdim*, *ydim*], specifying the requested dimensions of the returned mask. If MASK_IN is provided, the value of this keyword

is ignored and the dimensions of that mask are used. Otherwise, the default dimensions are [100, 100].

INITIALIZE

Set this keyword to indicate how the mask should be initialized. Valid values include:

- –1 = The mask is not initialized. This option is useful when updating an already existing mask. This is the default if the MASK_IN keyword is set.
- 0 = The mask is initialized so that each pixel is set to 0. This is the default if the MASK_IN keyword is not set.
- 1 = The mask is initialized so that each pixel is set to 255.

LOCATION

Set this keyword to a vector of the form [*X*, *Y*[, *Z*]] specifying the location of the origin of the mask. The default is [0, 0, 0]. IDL converts and maintains this value in double-precision floating-point.

MASK_IN

Set this keyword to a two-dimensional array representing a mask that is already allocated and to be updated for this region. If this keyword is provided, the data portion of this variable is grabbed and used in the returned value (an implicit NO_COPY). If this keyword is not provided, a mask is allocated by default to match the dimensions specified via the DIMENSIONS keyword.

MASK_RULE

Set this keyword to an integer specifying the rule used to determine whether a given pixel should be set within the mask. Valid values include:

- 0 = Boundary only. All pixels falling on a region's boundary are set.
- 1 = Interior only. All pixels falling within the region's boundary, but not on the boundary, are set.
- 2 = Boundary + Interior. All pixels falling on or within a region's boundary are set.

PLANE_NORMAL

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the normal vector for the plane on which the mask is to be computed. The default is [0, 0, 1].

PLANE_XAXIS

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the direction vector along which each row of mask pixels is to be computed (starting at LOCATION). The default is [1, 0, 0].

IDLanROI::ContainsPoints

The IDLanROI::ContainsPoints function method determines whether the given data coordinates are contained within the closed polygon region.

Syntax

Result = *Obj*–>[IDLanROI::]ContainsPoints(*X* [, *Y* [, *Z*]])

Return Value

The return value is a vector of values, one per provided point, indicating whether that point is contained. Valid values within this return vector include:

- 0 = Exterior. The point lies strictly out of bounds of the ROI.
- 1 = Interior. The point lies strictly inside the bounds of the ROI.
- 2 = On edge. The point lies on an edge of the ROI boundary.
- 3 = On vertex. The point matches a vertex of the ROI.

A point is considered to be exterior if:

- the point falls within the boundary of an interior region (hole).
- the point does not lie in the plane of the region.
- the region TYPE property is set to 0 (points) or 1 (path).

Arguments

X

A vector providing the *X* components of the points to be tested. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values.

Y

A vector providing the *Y* components of the points to be tested.

Z

A scalar or vector providing the *Z* component(s) of the points to be tested. If not provided, the *Z* components default to 0.0.

Keywords

None.

IDLanROI::GetProperty

The IDLanROI::GetProperty procedure method retrieves the value of a property or group of properties for the region.

Syntax

Obj–>[IDLanROI::]GetProperty [, ALL=*variable*] [, N_VERTS=*variable*] [, ROI_XRANGE=*variable*] [, ROI_YRANGE=*variable*] [, ROI_ZRANGE=*variable*]

Arguments

None.

Keywords

Any keyword to IDLanROI::Init followed by the word *(Get)* can be retrieved using IDLanROI::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the state of this object. State information about the object includes things like block size, type, etc., but not vertex data.

Note

The fields in this structure may change in subsequent releases of IDL.

N_VERTS

Set this keyword to a named variable that will contain the number of vertices currently being used by the region.

ROI_XRANGE

Set this keyword to a named variable. Upon return, ROI_XRANGE contains a two-element double-precision floating-point vector of the form [*xmin, xmax*] that specifies the range of X data coordinates covered by the region.

ROI_YRANGE

Set this keyword to a named variable. Upon return, ROI_YRANGE contains a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of Y data coordinates covered by the region.

ROI_ZRANGE

Set this keyword to a named variable. Upon return, ROI_ZRANGE contains a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of Z data coordinates covered by the region.

IDLanROI::Init

The IDLanROI::Init function method initializes a region of interest object.

Note

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLanROI' [, *X* [, *Y* [, *Z*]]] [, BLOCKSIZE{Get, Set}=*vertices*] [, DATA{Get, Set}=*array*] [, /DOUBLE{Get, Set}] [, /INTERIOR{Get, Set}] [, TYPE{Get}={ 0 | 1 | 2 }])

or

Result = *Obj* **->** [IDLanROI::]Init([*X* [, *Y* [, *Z*]]]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector providing the *X* components of the vertices for the region. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

Y

A vector providing the *Y* components of the vertices. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

Z

A scalar or vector providing the *Z* component(s) of the vertices. If not provided, *Z* values default to 0.0. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

Keywords

BLOCK_SIZE *(Get, Set)*

Set this keyword to the number of vertices to allocate per block as needed for the region. When additional vertices are required, an additional block is allocated. The default is 100.

DATA *(Get, Set)*

Set this keyword to a *2 x n* or a *3 x n* array which defines, respectively, the 2D or 3D vertex data. DATA is equivalent to the optional arguments, X, Y, and Z. This property is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is stored as single precision floating point.

DOUBLE *(Get, Set)*

Set this keyword to a non-zero value to indicate that data should be stored in this object in double precision floating point. Set this keyword to zero to indicate that the data should be stored in single precision floating point, which is the default. The DOUBLE property controls the precision used for storing the data in the AppendData, Init, and ReplaceData methods via the X, Y, and Z arguments and in SetProperty method via the DATA keyword. IDL converts any data already stored in the object to the requested precision, if necessary. Note that this keyword does not need to be set if any of the X, Y, or Z arguments or the DATA parameters are of type DOUBLE. However, setting this keyword may be desirable if the data consists of large integers that cannot be accurately represented in single precision floating point. This property is also automatically set to one if any of the X, Y or Z arguments or the DATA parameter is stored using a variable of type DOUBLE.

INTERIOR *(Get, Set)*

Set this keyword to mark this region as an interior region (i.e., a region treated as a hole). By default, the region is treated as an exterior region.

TYPE *(Get)*

Set this keyword to indicate the type of the region. The TYPE keyword determines how computational operations, such as mask generation, are performed. Valid values include:

- 0 = points
- 1 = path
- 2 = closed polygon (the default)

IDLanROI::RemoveData

The IDLanROI::RemoveData procedure method removes vertices from the region.

Syntax

Obj–>[IDLanROI::]RemoveData[, COUNT=*vertices*] [, START=*index*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None.

Keywords

COUNT

Set this keyword to the number of vertices to remove. The default is one vertex.

START

Set this keyword to an index (into the region's current vertex list) where the removal is to begin. By default, the final vertex is removed.

XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin, xmax*], that represents the *X* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], that represents the *Y* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin, zmax*], that represents the *Z* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

IDLanROI::ReplaceData

The IDLanROI::ReplaceData procedure method replaces vertices in the region with alternate values. The number of replacement values need not match the number of values being replaced.

Syntax

Obj–>[IDLanROI::]ReplaceData, *X*[, *Y*[, *Z*]] [, START=*index*] [, FINISH=*index*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

X

A vector providing the X components of the new replacement vertices. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimensions either 2 or 3 ([2, *] or [3, *]), in which case, X[0, *] represents the X values, X[1, *] represents the Y values, and X[2, *] represents the Z values. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Y

A vector providing the Y components of the new replacement vertices. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Z

A vector providing the Z components of the new replacement vertices. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

Keywords

FINISH

Set this keyword to the index of the region's current subregion vertex list where the replacement ends. If the START keyword value is ≥ 0, the default FINISH is given by

FINISH = ((START + N_NEW – 1) MOD N_OLD)

where N_NEW is the number of replacement vertices provided via the [*X*, *Y*, *Z*] arguments and N_OLD is the number of vertices (prior to replacement) in the current subregion.

If the START keyword is not set or is negative, the default FINISH is given by

FINISH = N_OLD – 1

FINISH may be less than START in which case the vertices, including and following START and the vertices preceding and including FINISH, are replaced with the new values.

START

Set this keyword to an index of the region's current subregion vertex list where the replacement begins. If the FINISH keyword value is ≥ 0, the default START is given by

START = ((FINISH – N_NEW + 1) MOD N_OLD)

where N_NEW is the number of replacement vertices provided via the [*X*, *Y*, *Z*] arguments and N_OLD is the number of vertices (prior to replacement) in the current subregion.

If the FINISH keyword is not set (or negative), the default START is clamped to 0 and is given by

N_OLD – N_NEW

XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin, xmax*], representing the *X* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], representing the *Y* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin, zmax*], representing the *Z* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

IDLanROI::Rotate

The IDLanROI::Rotate procedure method modifies the vertices for the region by applying a rotation.

Syntax

Obj–>[IDLanROI::]Rotate, *Axis*, *Angle* [, CENTER=*[x, y*[, *z*]*]*]

Arguments

Axis

A three-element vector of the form [*x*, *y*, *z*] describing the axis about which the region is to be rotated.

Angle

The angle, measured in degrees, by which the rotation is to occur.

Keywords

CENTER

Set this keyword to a two or three-element vector of the form [*x, y*], or [*x, y, z*] specifying the center of rotation. The default is [0, 0, 0]. IDL converts and applies this data in double-precision floating-point.

IDLanROI::Scale

The IDLanROI::Scale procedure method modifies the vertices for the region by applying a scale.

Syntax

Obj–>[IDLanROI::]Scale, *Sx*[, *Sy*[, *Sz*]]

Arguments

Sx

The *X* scale factor. If the *Sy* and *Sz* arguments are not specified, *Sx* must be a two or three-element vector, in which case *Sx*[0] represents the scale in *X*, *Sx*[1] represents the scale in *Y*, *Sx*[2] represents the scale in *Z*. IDL converts and applies this data in double-precision floating-point.

Sy

The *Y* scale factor. IDL converts and applies this data in double-precision floating-point.

Sz

The *Z* scale factor. IDL converts and applies this data in double-precision floating-point.

Keywords

None.

IDLanROI::SetProperty

The IDLanROI::SetProperty procedure method sets the value of a property or group of properties for the region.

Syntax

Obj–>[IDLanROI::]SetProperty

Arguments

None.

Keywords

Any keywords to IDLanROI::Init followed by the word (*Set*) can be set using IDLanROI::SetProperty.

IDLanROI::Translate

The IDLanROI::Translate procedure method modifies the vertices for the region by applying a translation.

Syntax

Obj–>[IDLanROI::]Translate, *Tx*[, *Ty*[, *Tz*]]

Arguments

Tx

The X translation factor. If the *Ty* and *Tz* arguments are not specified, *Tx* must be a two or three-element vector, in which case *Tx*[0] represents translation in *X*, *Tx*[1] represents translation in *Y*, *Tx*[2] represents translation in *Z*. IDL converts and applies this data in double-precision floating-point.

Ty

The *Y* translation factor. IDL converts and applies this data in double-precision floating-point.

Tz

The *Z* translation factor. IDL converts and applies this data in double-precision floating-point.

Keywords

None.

IDLanROIGroup

The IDLanROIGroup object class is an analytical representation of a group of regions of interest.

Superclasses

This class is a subclass of IDL_Container.

Subclasses

This class is a superclass of IDLgrROIGroup.

Creation

See IDLanROIGroup::Init.

Methods

Intrinsic Methods

The IDLanROIGroup class has the following methods:

- IDLanROIGroup::Add
- IDLanROIGroup::Cleanup
- IDLanROIGroup::ComputeMask
- IDLanROIGroup::ComputeMesh
- IDLanROIGroup::ContainsPoints
- IDLanROIGroup::GetProperty
- IDLanROIGroup::Init
- IDLanROIGroup::Rotate
- IDLanROIGroup::Scale
- IDLanROIGroup::Translate

Inherited Methods

This class inherits the following methods:

- IDL_Container::Count

- IDL_Container::Get
- IDL_Container::IsContained
- IDL_Container::Move
- IDL_Container::Remove

IDLanROIGroup::Add

The IDLanROIGroup::Add procedure method adds a region to the region group. Only objects of the IDLanROI class may be added to the group. The regions in the group must all be of the same type: all points, all paths, or all polygons.

Syntax

Obj–>[IDLanROIGroup::]Add, *ROI*

Arguments

ROI

A reference to an instance of the IDLanROI object class representing the region of interest to be added to the group.

Keywords

Accepts all keywords accepted by the IDL_Container::Add method.

IDLanROIGroup::Cleanup

The IDLanROIGroup::Cleanup procedure method performs all cleanup for a region of interest group object.

Note

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj–>[IDLanROIGroup::]Cleanup (In a subclass' Cleanup method only.)

Arguments

None.

Keywords

None.

IDLanROIGroup::ComputeMask

The IDLanROIGroup::ComputeMask function method prepares a two-dimensional mask for this group of regions.

Syntax

Result = *Obj*–>[IDLanROIGroup::]ComputeMask([, INITIALIZE={ –1 | 0 | 1 }] [, DIMENSIONS=*[xdim*, *ydim]*] | [, MASK_IN=*array*] [, LOCATION=*[x*, *y* [, *z*]*]*] [, MASK_RULE={ 0 | 1 | 2 }])

Return Value

Result

The return value is a two-dimensional array of bytes whose values range from 0 to 255. The mask is computed by applying the following formula to the current mask for each mask point contained within the ROI:

$$M_{out} = \text{MAX}(\text{MIN}(0, (M_{roi}*Ext) + M_{in}), 255)$$

where M_{roi} is 255 and *Ext* is 1 for points within an exterior region and –1 for points within an interior region.

If the TYPE of the contained regions is 0 (points), a single mask pixel is set for each region vertex that falls within the bounds of the mask.

If the TYPE of the contained regions is 1 (path), each pixel along the paths of the regions is set if it falls within the mask.

If the TYPE of the region is 2 (closed polygon), a mask pixel is set if that pixel is on the plane of a contained region, and the pixel falls within that region (according to the MASK_RULE).

Arguments

None.

Keywords

DIMENSIONS

Set this keyword to a two-element vector, [*xdim*, *ydim*], specifying the requested dimensions of the returned mask. If MASK_IN is provided, the value of this keyword

is ignored, and the dimensions of that mask are used. Otherwise, the default dimensions are [100, 100].

INITIALIZE

Set this keyword to indicate how the mask should be initialized. Valid values include:

- –1 = The mask is not initialized; the default if the MASK_IN keyword is set. This option is useful when updating an already existing mask.
- 0 = The mask is initialized with each pixel set to 0; the default if the MASK_IN keyword is not set.
- 1 = The mask is initialized with each pixel set to 255.

LOCATION

Set this keyword to a vector of the form [*X*, *Y*[, *Z*]] specifying the location of the origin of the mask. The default is [0, 0, 0].

MASK_IN

Set this keyword to a two-dimensional array representing a mask that is already allocated and to be updated for this region. If this keyword is provided, the data portion of this variable is grabbed and used in the returned value (an implicit NO_COPY). If this keyword is not provided, a mask is allocated by default to match the dimensions specified via the DIMENSIONS keyword.

MASK_RULE

Set this keyword to an integer specifying the rule used to determine whether a given pixel should be set within the mask. Valid values include:

- 0 = Boundary Only. All pixels falling on a region's boundary are set.
- 1 = Interior Only. All pixels falling within the region's boundary, but not on the boundary, are set.
- 2 = Boundary + Interior. All pixels falling on or within a region's boundary are set.

PLANE_NORMAL

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the normal vector for the plane on which the mask is to be computed. The default is [0, 0, 1].

PLANE_XAXIS

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the direction vector along which each row of mask pixels is to be computed (starting at LOCATION). The default is [1, 0, 0].

IDLanROIGroup::ComputeMesh

The IDLanROIGroup::ComputeMesh function method triangulates a surface mesh with optional capping from the stack of regions contained within this group.

Note

The contained regions may be concave. However, this method will fail under the following conditions:

- The region group contains fewer than two regions.
- The TYPE property of the contained regions is 0 (points) or 1 (path).
- Any of the contained regions are not simple (i.e., a region is self-intersecting).
- The region group contains interior regions (holes).
- More than one region lies on the same plane (i.e., the region group contains branches).

Each region pair is normalized by perimeter and the triangulation is computed by walking the contours in parallel, keeping the normalized progress along each contour in sync. The returned triangulation minimizes the mesh surface area. Each vertex may appear only once in the output, and the resulting polygon mesh is solid with outward facing normals computed via the right-hand rule. If capping is requested, it is computed using the IDLgrTessellator on the top and bottom regions, and/or the regions on either side of an inter-slice gap.

Syntax

Result = *Obj*->[IDLanROIGroup::]ComputeMesh(*Vertices*, *Conn* [, CAPPED={ 0 | 1 | 2}] [, SURFACE_AREA=*variable*])

Return Value

Result

The return value of this function method is the number of triangles generated if the surface mesh triangulation is successful, or zero if unsuccessful.

Arguments

Vertices

An output [3, n] array of vertices. If all regions in the group are defined with single precision vertices (DOUBLE property is zero), then IDL returns a single precision

floating point array. Otherwise, if any of the regions in the group are defined with double precision vertices (DOUBLE property is non-zero), then IDL returns a double precision floating point array.

Conn

An output polygon mesh connectivity array.

Keywords

CAPPED

Set this keyword to a value to indicate whether flat caps are to be computed at the top-most or bottom-most regions (as selected by a counter-clockwise rule), or at the regions on either side of an inter-slice gap. The value of this keyword is a bit-wise OR of the values shown below. For example, to cap the top-most and bottom-most regions only, set the CAPPED keyword to 3. The default is 0 (no caps).

- 0 = no caps
- 1 = cap the top-most region
- 2 = cap the bottom-most region

SURFACE_AREA

Set this keyword to a named variable that upon return contains the overall surface area of the computed triangulation. This value was minimized in the computation of the triangulation. IDL returns this value in a double-precision floating-point variable.

IDLanROIGroup::ContainsPoints

The IDLanROIGroup::ContainsPoints function method determines whether the given points (in data coordinates) are contained within this region group.

The regions within this group must have a TYPE of 2 (closed polygon) and must fall on parallel planes for successful containment testing to occur.

For each point to be tested:

- If the point lies directly on one of the region planes, it is tested for containment within each of the regions that fall on that plane.
- If the point lies between two of the region planes, it is projected onto the nearest region plane, and tested for containment within each of the regions on that plane.
- If the point lies above or below the stack of parallel region planes, the point will be considered to be exterior to the region group.

On a given plane, a point will be considered to be exterior if either of the following conditions are true:

- The point does not fall within any of the regions on that plane.
- The point falls within as many or more holes than non-hole regions on that plane.

Syntax

Result = *Obj*–>[IDLanROIGroup::]ContainsPoints(*X*[, *Y*[, *Z*]])

Return Value

The return value is a vector of values, one per provided point, indicating whether that point is contained. Valid values within this return vector include:

- 0 = Exterior. The point lies strictly outside the bounds of the ROI.
- 1 = Interior. The point lies strictly inside the bounds of the ROI.
- 2 = On Edge. The point lies on an edge of the ROI boundary.
- 3 = On Vertex. The point matches a vertex of the ROI.

Arguments

X

A vector providing the *X* components of the points to be tested. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values.

Y

A vector providing the *Y* components of the points to be tested.

Z

A scalar or vector providing the *Z* components of the points to be tested. If not provided, the *Z* components default to 0.0.

Keywords

None.

IDLanROIGroup::GetProperty

The IDLanROIGroup::Get Property procedure method retrieves the value of a property or group of properties for the region group.

Syntax

Obj–>[IDLanROIGroup::]GetProperty[, ALL=*variable*]
[, ROIGROUP_XRANGE=*variable*] [, ROIGROUP_YRANGE=*variable*]
[, ROIGROUP_ZRANGE=*variable*]

Arguments

None.

Keywords

Any keyword to IDLanROIGroup::Init followed by the word (*Get*) can be retrieved using IDLanROIGroup::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable. Upon return, ALL contains an anonymous structure with the values of all of the properties associated with the state of this object.

Note

The fields in this structure may change in subsequent releases of IDL.

ROIGROUP_XRANGE

Set this keyword to a named variable. Upon return, ROIGROUP_XRANGE contains a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of X data coordinates covered by the region.

ROIGROUP_YRANGE

Set this keyword to a named variable. Upon return, ROIGROUP_YRANGE contains a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of Y data coordinates covered by the region.

ROIGROUP_ZRANGE

Set this keyword to a named variable. Upon return, ROIGROUP_ZRANGE contains a two-element double-precision floating-point vector of the form [*zmin, zmax*] that specifies the range of Z data coordinates covered by the region.

IDLanROIGroup::Init

The IDLanROIGroup::Init function method initializes a region of interest group object.

Note

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLanROIGroup')

or

Result = *Obj*–>[IDLanROIGroup::]Init( ) (*Only in a subclass' Init method*.)

Arguments

None.

Keywords

None.

IDLanROIGroup::Rotate

The IDLanROIGroup::Rotate procedure method modifies the vertices for all regions within the group by applying a rotation.

Syntax

Obj–>[IDLanROIGroup::]Rotate, *Axis*, *Angle*[, CENTER=*[x*, *y*[, *z*]*]*]

Arguments

Axis

A three-element vector of the form [*x*, *y*, *z*] describing the axis about which the region group is to be rotated.

Angle

The angle, measured in degrees, by which to rotate the ROI group.

Keywords

CENTER

Set this keyword to a two or three-element vector of the form [*x, y*], or [*x, y, z*] specifying the center of rotation. The default is [0, 0, 0]. IDL converts and applies this data in double-precision floating-point.

IDLanROIGroup::Scale

The IDLanROIGroup::Scale procedure method modifies the vertices for the region by applying a scale.

Syntax

Obj–>[IDLanROIGroup::]Scale, *Sx*[, *Sy*[, *Sz*]]

Arguments

Sx

The *X* scale factor. If the *Sy* and *Sz* arguments are not specified, *Sx* must be a two or three-element vector, in which case *Sx*[0] represents the scale in *X*, *Sx*[1] represents the scale in *Y*, *Sx*[2] represents the scale in *Z*. IDL converts and applies this data in double-precision floating-point.

Sy

The *Y* scale factor. IDL converts and applies this data in double-precision floating-point.

Sz

The *Z* scale factor. IDL converts and applies this data in double-precision floating-point.

Keywords

None.

IDLanROIGroup::Translate

The IDLanROIGroup::Translate procedure method modifies the vertices of all regions within the group by applying a translation.

Syntax

Obj–>[IDLanROIGroup::]Translate, *Tx*[, *Ty*[, *Tz*]]

Arguments

Tx

The *X* translation factor. If the *Ty* and *Tz* arguments are not specified, *Tx* must be a two or three-element vector, in which case *Tx*[0] represents translation in *X*, *Tx*[1] represents translation in *Y*, *Tx*[2] represents translation in *Z*. IDL converts and applies this data in double-precision floating-point.

Ty

The *Y* translation factor. IDL converts and applies this data in double-precision floating-point.

Tz

The *Z* translation factor. IDL converts and applies this data in double-precision floating-point.

Keywords

None.

IDLffDICOM

An IDLffDICOM object contains the data for one or more images embedded in a DICOM Part 10 file. The API to the IDLffDICOM object provides accessor methods to the basic data elements of a DICOM file, namely the group/element tag, value representation, length, and data values. Additional methods deal with the file header preamble, data dictionary description for individual elements, and embedded sequences of elements. Most methods take a DICOM group/element tag as a parameter. An alternative parameter to the DICOM tag in some methods is the reference. A reference value is a LONG integer that is unique to each element in the DICOM object. This value can be used to directly access a specific element and to differentiate between elements in the DICOM file that have the same group/element tag. Valid reference values are always positive.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See IDLffDICOM::Init.

Methods

- IDLffDICOM::Cleanup
- IDLffDICOM::DumpElements
- IDLffDICOM::GetChildren
- IDLffDICOM::GetDescription
- IDLffDICOM::GetElement
- IDLffDICOM::GetGroup
- IDLffDICOM::GetLength
- IDLffDICOM::GetParent
- IDLffDICOM::GetPreamble

- IDLffDICOM::GetReference
- IDLffDICOM::GetValue
- IDLffDICOM::GetVR
- IDLffDICOM::Init
- IDLffDICOM::Read
- IDLffDICOM::Reset

IDL DICOM v3.0 Conformance Summary

Introduction

This section is an abbreviated DICOM conformance statement for IDL, and specifies the compliance of Research Systems IDL DICOM file reading support to the DICOM v3.0 standard. As described in the DICOM Standard PS 3.2 (Conformance), the purpose of this document is to outline the level of conformance to the DICOM standard and to enumerate the supported DICOM Service Classes, Information Objects, and Communications Protocols supported by this implementation.

IDL does not contain or support any of the DICOM services such as Storage, Query/Retrieve, Print, Verification, etc., so there will be no conformance claims relating to these services and no mention of any Application Entities for these services. Communications Protocol profiles will also be absent from this document for the same reasons. The remainder of this document will describe how IDL handles the various Information Objects it is capable of reading.

Reading of DICOM Part 10 files

IDL supports reading files that conform to the DICOM Standard PS 3.10 DICOM File Format. This format provides a means to encapsulate in a file the Data Set representing a SOP (Service Object Pair) Instance related to a DICOM IOD (Information Object Definition). Files written to disk in this DICOM File Format will be referred to as DICOM Part 10 files for the remainder of this document. Note that IDL does NOT support the writing of files in this DICOM File Format, only reading.

Encapsulated Transfer Syntaxes Supported

IDL supports reading DICOM Part 10 files whose contents have been written using the following Transfer Syntaxes. The Transfer Syntax UID is in the file's DICOM Tag field (0002,0010).

UID Value	UID Name
1.2.840.10008.1.2	Implicit VR Little Endian: Default Transfer Syntax for DICOM
1.2.840.10008.1.2.1	Explicit VR Little Endian
1.2.840.10008.1.2.2	Explicit VR Big Endian

Table A-1: Encapsulated Transfer Syntaxes Supported

Encapsulated Transfer Syntaxes NOT Supported

IDL does NOT support reading DICOM Part 10 files whose contents have compressed data that has been written using the following Transfer Syntaxes. IDL will NOT be able to access the data element (DICOM Tag field (7FE0,0010)) of files with these types of compressed data. The Transfer Syntax UID is in the file's DICOM Tag field (0002,0010).

UID Value	UID Name
1.2.840.10008.1.2.4.50	JPEG Baseline (Process 1): Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression
1.2.840.10008.1.2.4.51	JPEG Extended (Process 2 & 4): Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only)
1.2.840.10008.1.2.4.52	JPEG Extended (Process 3 & 5)
1.2.840.10008.1.2.4.53	JPEG Spectral Selection, Non-Hierarchical (Process 6 & 8)
1.2.840.10008.1.2.4.54	JPEG Spectral Selection, Non-Hierarchical (Process 7 & 9)
1.2.840.10008.1.2.4.55	JPEG Full Progression, Non-Hierarchical (Process 10 & 12)
1.2.840.10008.1.2.4.56	JPEG Full Progression, Non-Hierarchical (Process 11 & 13)
1.2.840.10008.1.2.4.57	JPEG Lossless, Non-Hierarchical (Process 14)
1.2.840.10008.1.2.4.58	JPEG Lossless, Non-Hierarchical (Process 15)
1.2.840.10008.1.2.4.59	JPEG Extended, Hierarchical (Process 16 & 18)
1.2.840.10008.1.2.4.60	JPEG Extended, Hierarchical (Process 17 & 19)
1.2.840.10008.1.2.4.61	JPEG Spectral Selection, Hierarchical (Process 20 & 22)
1.2.840.10008.1.2.4.62	JPEG Spectral Selection, Hierarchical (Process 21 & 23)
1.2.840.10008.1.2.4.63	JPEG Full Progression, Hierarchical (Process 24 & 26)
1.2.840.10008.1.2.4.64	JPEG Full Progression, Hierarchical (Process 25 & 27)
1.2.840.10008.1.2.4.65	JPEG Lossless, Hierarchical (Process 28)

Table A-2: Encapsulated Transfer Syntaxes NOT Supported

UID Value	UID Name
1.2.840.10008.1.2.4.66	JPEG Lossless, Hierarchical (Process 29)
1.2.840.10008.1.2.4.70	JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1]): Default Transfer Syntax for Lossless JPEG Image Compression
1.2.840.10008.1.2.5	RLE Lossless

Table A-2: Encapsulated Transfer Syntaxes NOT Supported

Encapsulated SOP Classes Supported

IDL supports reading DICOM Part 10 files whose contents encapsulate the data of the following SOP Classes. The SOP Class UID is in the file's DICOM Tag field (0008,0016).

UID Value	UID Name
1.2.840.10008.5.1.4.1.1.1	CR Image Storage
1.2.840.10008.5.1.4.1.1.2	CT Image Storage
1.2.840.10008.5.1.4.1.1.4	MR Image Storage
1.2.840.10008.5.1.4.1.1.6.1	Ultrasound Image Storage
1.2.840.10008.5.1.4.1.1.7	Secondary Capture Image Storage
1.2.840.10008.5.1.4.1.1.12.1	X-Ray Angiographic Image Storage
1.2.840.10008.5.1.4.1.1.12.2	X-Ray Radiofluoroscopic Image Storage
1.2.840.10008.5.1.4.1.1.20	Nuclear Medicine Image Storage
1.2.840.10008.5.1.4.1.1.128	Positron Emission Tomography Image Storage

Table A-3: Encapsulated SOP Classes Supported

Handling of odd length data elements

The DICOM Standard PS 3.5 (Data Structures and Encoding) specifies that the data element values which make up a DICOM data stream must be padded to an even length. The toolkit upon which IDL's DICOM reading functionality is built strictly enforces this specification. If IDL encounters an incorrectly formed odd length data

field while reading a DICOM Part 10 file it will report an error and stop the reading process.

Handling of undefined VRs

The VR (Value Representation) of a data element describes the data type and format of that data element's values. If IDL encounters an undefined VR while reading a DICOM Part 10 file, it will set that data element's VR to be UN (unknown).

Handling of retired and private data elements

Certain data elements are no longer supported under the v3.0 of the DICOM standard and are denoted as retired. Also, some DICOM implementations may require the communication of information that cannot be contained in standard data elements, and thus create private data elements to contain such information. Retired and private data elements should pose no problem to IDL's DICOM Part 10 file reading capability. When IDL encounters a retired or private data element tag during reading a DICOM Part 10 file, it will treat it just like any standard data element: read the data value and allow it to be accessed via the IDLffDICOM::GetValue method.

IDLffDICOM::Cleanup

This method destroys the IDLffDICOM object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

OBJ -> [IDLffDICOM::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

Examples

```
; create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER="*"))
obj->DumpElements
OBJ_DESTROY, obj

; executing this statement should produce an invalid object
; reference error since obj no longer exists:
obj->DumpElements
```

IDLffDICOM::DumpElements

This method dumps a description of the DICOM data elements of the IDLffDICOM object to the screen or to a file.

Syntax

Obj -> [IDLffDICOM::]DumpElements [, *Filename*]

Arguments

Filename

A scalar string that contains the full path and filename of the file to which to dump the elements. The file is written as ASCII text.

Keywords

None

Examples

The columns output by DumpElements are the element reference, the (group, element) tuple, the value representation, the description, the value length, and some of the data values.

```
; create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))
obj->DumpElements

; dump the contents of the current DICOM object to a file under
; Windows:
obj->DumpElements, 'c:\rsi\elements.dmp'

; dump the contents of the current DICOM object to a file under
; UNIX:
obj->DumpElements, '/rsi/elements.dmp'

OBJ_DESTROY, obj
```

IDLffDICOM::GetChildren

This method is used to find the member element references of a DICOM sequence. It takes as an argument a scalar reference to a DICOM element representing the parent of the sequence, and returns an array of references to the elements of the object that are members of that sequence. The scalar parent reference is possibly obtained by a previous call to GetReference or any method that generates a reference list. Any member of a sequence may also itself be the parent of another sequence. If the scalar reference argument is not the parent of a sequence, the method returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetChildren(*Reference*)

Arguments

Reference

This argument is a scalar reference to a DICOM element that is known to be the parent of a DICOM sequence.

Keywords

None

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get a list of references to all elements that are sequences:
refs = obj->GetReference(VR='SQ')

; Cycle through the returned list and print out the immediate
; children references and descriptions of each sequence:
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   IF (refs[i] NE -1) THEN $
      BEGIN
         children = obj->GetChildren(refs[i])
         FOR j = 0, N_ELEMENTS(children)-1 DO $
            BEGIN
               PRINT,children[j]
                 PRINT,obj->GetDescription(REFERENCE=children[j])
         ENDFOR
   ENDIF
ENDFOR
OBJ_DESTROY,obj
```

IDLffDICOM::GetDescription

This accessor method takes optional DICOM group and element arguments and returns an array of STRING descriptions. The description is a string describing the field's contents as per the data dictionary in the DICOM specification PS 3.6. If no arguments or keywords are specified, the returned array contains the descriptions for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no DICOM elements can be found matching the search criteria, -1 will be returned.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetDescription([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

Arguments

Group

Set this optional argument to the value for the DICOM group to search for, i.e. '0018'x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this argument to the value for the DICOM element for which to search, such as '0010'x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Set this keyword to a list of element reference values from which to return description values.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the description of the patient name element:
arr = obj->GetDescription('0010'x,'0010'x)
PRINT, arr
```

```
; Get array of all of the descriptions from the patient info group:
arr = obj->GetDescription('0010'x)
FOR i = 0, N_ELEMENTS(arr)-1 DO BEGIN
   PRINT, arr[i]
ENDFOR

OBJ_DESTROY, obj
```

IDLffDICOM::GetElement

This accessor method takes optional DICOM group and/or element arguments and returns an array of DICOM Element numbers for those parameters. If no arguments or keywords are specified, the returned array contains Element numbers for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetElement([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

Arguments

Group

Set this optional argument to the value for the DICOM group to search for, i.e. ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this argument to the value for the DICOM element to search for, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Set this keyword to a list of element reference values from which to return element number values.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get references to all elements with "patient" in the description:
refs = obj->GetReference(DESCRIPTION='patient')

; Get the element numbers of the elements containing "patient":
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
```

```
   num = obj->GetElement(REFERENCE=refs[i])
   PRINT,num
ENDFOR

; Get the element numbers from the Patient Info group, 0010:
elements = obj->GetElement('0010'x)
PRINT, elements

OBJ_DESTROY,obj
```

IDLffDICOM::GetGroup

This accessor method takes optional DICOM group and/or element arguments and returns an array of DICOM Group numbers for those parameters. If no arguments or keywords are specified, the returned array contains Group numbers for all groups in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetGroup([*Group*[, *Element*]] [, REFERENCE=*list of element references*])

Arguments

Group

Set this optional argument to the value for the DICOM group for which to search, such as '0018'x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element for which to search, such as '0010'x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Set this keyword to a list of element references from which to return group number values.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get references to all elements with "patient" in the description:
refs = obj->GetReference(DESCRIPTION='patient')

; Get the group numbers of the elements containing "patient":
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
```

```
   num = obj->GetGroup(REFERENCE=refs[i])
   PRINT, num
ENDFOR

; Get the group numbers from the Patient Info group, 0010:
grp = obj->GetGroup('0010'x)
PRINT, grp

OBJ_DESTROY,obj
```

IDLffDICOM::GetLength

This accessor method takes optional DICOM group and/or element arguments and returns an array of LONGs. The length is the field length that explicitly exists in the DICOM file, and represents the length of the element value in bytes. If no arguments or keywords are specified, the returned array contains the lengths for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetLength([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

Arguments

Group

Set this optional argument to the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, all DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Set this keyword to a list of element references from which to return length values.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the length of the patient name element:
arr = obj->GetLength('0010'x,'0010'x)
PRINT, arr

; Get an array of all of the lengths from the patient info group:
arr = obj->GetLength('0010'x)
PRINT, arr
OBJ_DESTROY, obj
```

IDLffDICOM::GetParent

This method is used to find the parent references of a set of elements in a DICOM sequence. It takes as an argument an array of references that represent DICOM elements. If no members of the ReferenceList are members of a sequence, a -1 is returned, and for each member of the ReferenceList which is not a member of a sequence, a -1 is returned.

Syntax

array = *Obj* ->[IDLffDICOM::]GetParent(*ReferenceList*)

Arguments

ReferenceList

An array of references to DICOM elements that are known to be members of a DICOM sequence.

Keywords

None

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the reference to the Referenced Study Sequence
; element, if it exists:
ref = obj->GetReference('0008'x,'1110'x)
PRINT, ref
PRINT, obj->GetDescription(REFERENCE=ref)

; Get and print the parent sequence, if it exists.
; This should result in a -1 since this element is not
; a member of a sequence:
parent = obj->GetParent(ref)
PRINT, parent
PRINT, obj->GetDescription(REFERENCE=parent)

; Get the children of the  Referenced Study Sequence
; element, if it exists:
refs = obj->GetChildren(ref[0])
PRINT, refs
PRINT, obj->GetDescription(REFERENCE=refs)
OBJ_DESTROY,obj
```

IDLffDICOM::GetPreamble

This method returns the preamble of a DICOM v3.0 Part 10 file. The preamble is a fixed 128 byte field available for implementation specified usage. If it is not used by the implementor of the file, it will be set to all zeroes. The return value is a 128-element BYTE array.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetPreamble( )

Arguments

None

Keywords

None

Examples

```
; Create a DICOM object, read a DICOM file:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get an array of the byte contents of the DICOM file preamble:
arr = obj->GetPreamble( )
PRINT, arr

OBJ_DESTROY, obj
```

IDLffDICOM::GetReference

This method takes optional DICOM group and/or element arguments and returns an array of references to matching elements in the object. References are opaque, meaning that they have no specific significance other than a correspondence to the element they refer to. If no arguments or keywords are specified, the returned array contains references to all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetReference([*Group* [, *Element*]] [, DESCRIPTION=*string*] [, VR=*DICOM VR string*])

Arguments

Group

Set this optional argument to the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element to search for, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

DESCRIPTION

Set this keyword to a string containing text to be searched for in each element’s DICOM description. An element will be returned only if the text in this string can be found in the description. The text comparison is case-insensitive.

VR

Set this keyword to a DICOM VR string. An element will be returned only if its value representation matches this string.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the reference to the patient name element:
ref = obj->GetReference('0010'x,'0010'x)
PRINT, ref

; get references to all elements with "patient" in the description:
refs = obj->GetReference(DESCRIPTION='patient')
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   PRINT, refs[i]
   PRINT, obj->GetDescription(REFERENCE=refs[i])
ENDFOR

; Get references to all elements with a VR of DA (date):
refs = obj->GetReference(vr='DA')
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   PRINT, refs[i]
   PRINT, obj->GetDescription(REFERENCE=refs[i])
ENDFOR

OBJ_DESTROY, obj
```

IDLffDICOM::GetValue

This method takes optional DICOM group and/or element arguments and returns an array of POINTERs to the values of the elements matching those parameters. If no arguments or keywords are specified, the returned array contains pointers to all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

ptrArray = *Obj* **->** [IDLffDICOM::]GetValue([*Group* [, *Element*]] [, REFERENCE=*list of element references*] [, /NO_COPY])

Arguments

Group

Set this optional argument to the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Set this keyword to a list of element references from which to return pointer values.

NO_COPY

If this keyword is set, the pointers returned point to the actual data in the object for the specified DICOM fields. If not set (the default), the pointers point to copies of the data instead, and need to be freed by using PTR_FREE.

Examples

Example 1

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the image data
array = obj->GetValue('7fe0'x, '0010'x)
OBJ_DESTROY, obj

TVScl, *array[0]
PTR_FREE, array
```

Example 2

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get all of the image data element(s), 7fe0,0010, from the file:
array = obj->GetValue('7fe0'x,'0010'x,/NO_COPY)

; Get the row & column size of the image(s):
rows = obj->GetValue('0028'x,'0010'x,/NO_COPY)
cols = obj->GetValue('0028'x,'0011'x,/NO_COPY)

; If the image has a samples per pixel value greater than 1
; it is most likely a color image, get the samples per pixel:
isColor = 0
samples = obj->GetValue('0028'x,'0002'x,/NO_COPY)
IF (SIZE(samples,/N_DIMENSIONS) NE 0) THEN BEGIN
   IF (*samples[0] GT 1) THEN isColor = 1
ENDIF

; Next, we need to differentiate between files with color data
; that is either color-by-plane or color-by-pixel, get the planar
; configuration:
IF (isColor EQ 1) THEN BEGIN
   isPlanar = 0
   planar = obj->GetValue('0028'x,'0006'x, /NO_COPY)
   IF (SIZE(planar, /N_DIMENSIONS) NE 0) THEN BEGIN
      IF (*planar[0] EQ 1) THEN isPlanar = 1
   ENDIF
ENDIF

; Display the first NumWin images from the file:
IF N_ELEMENTS(array) GT 10 THEN NumWin = 10 $
ELSE NumWin = N_ELEMENTS(array)
offset = 0
```

```
FOR index = 0, NumWin-1 DO BEGIN
   ; Create window for each image that is the size of the image:
   WINDOW,index,XSize=*cols[0],YSize=*rows[0],XPos=offset,YPos=0
   WSET,index
   ; Display the image data
   IF (isColor EQ 1) THEN $
       IF (isPlanar EQ 1) THEN $
          ; color-by-plane
          TVScl,TRANSPOSE(*array[index],[2,0,1]),/TRUE $
       ELSE $
          ; color-by-pixel
          TVScl,*array[index],/TRUE $
   ELSE $
      ; monochrome
      TVScl,*array[index]
      offset = offset+10
ENDFOR

; Clean up
OBJ_DESTROY,obj
```

IDLffDICOM::GetVR

This accessor method takes optional DICOM group and/or element arguments and returns an array of VR (Value Representation) STRINGs for those parameters. A VR is a string that represents a DICOM value representation as described in the DICOM specification PS 3.5. If no arguments or keywords are specified, the returned array contains VRs for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

Syntax

array = *Obj* **->** [IDLffDICOM::]GetVR([*Group* [, *Element*]] [, REFERENCE=*list of references*])

Arguments

Group

Set this optional argument to the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

Keywords

REFERENCE

Use the specified list of references from which to return VR STRING values.

Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the VR of the patient name element:
arr = obj->GetVR('0010'x,'0010'x)
PRINT, arr
```

```
; Get an array of all of the VRs from the patient info group:
arr = obj->GetVR('0010'x)
PRINT, arr

OBJ_DESTROY,obj
```

IDLffDICOM::Init

This method creates a new IDLffDICOM object and optionally reads the specified file as defined in the IDLffDICOM::Read method.

Syntax

Result = OBJ_NEW('IDLffDICOM' [, *Filename*] [, /VERBOSE])

or

Result = *Obj* **->** [IDLffDICOM::]Init([*Filename*] [, /VERBOSE]) (*Only in a subclass' Init method*.)

Arguments

Filename

This optional argument is a scalar string that contains the full path and filename of a DICOM v3.0 Part 10 file to open, read into memory, then close, when the object is created. It is the same as calling: result->Read(Filename).

Keywords

VERBOSE

Set this keyword to print informational messages to the Output Log during the operational life of the object.

Examples

```
; Create a DICOM object:
obj = OBJ_NEW( 'IDLffDICOM' )

; Create a DICOM object and read in a DICOM file named ct_head.dcm
; under Microsoft Windows:
obj = OBJ_NEW( 'IDLffDICOM', $
   'c:\rsi\idl52\examples\data\mr_brain.dcm' )

; Create a DICOM object and allow the user to choose a DICOM file
; to be read:
obj = OBJ_NEW( 'IDLffDICOM', DIALOG_PICKFILE(FILTER='*'))
```

IDLffDICOM::Read

This method opens and reads from the specified disk file, places the information into the DICOM object, then closes the file. The return value is 1 on success and 0 on failure.

Syntax

result = *Obj* **->** [IDLffDICOM::]Read(*Filename* [, ENDIAN={1 | 2 | 3 | 4}])

Arguments

Filename

This argument is a scalar string that contains the full path and filename of a DICOM Part 10 file to open and read into memory.

Keywords

ENDIAN

Set this keyword to configure the endian format when reading a DICOM file.

- 1 = Implicit VR Little Endian
- 2 = Explicit VR Little Endian
- 3 = Implicit VR Big Endian
- 4 = Explicit VR Big Endian

Examples

```
; Create a DICOM object and read a DICOM file:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))
OBJ_DESTROY, obj
```

IDLffDICOM::Reset

This method removes all of the elements from the IDLffDICOM object, leaving the object otherwise intact.

Syntax

Obj -> [IDLffDICOM::]Reset

Arguments

None

Keywords

None

Examples

```
; Create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))
obj->DumpElements
obj->Reset

; DumpElements should produce no output here:
obj->DumpElements
OBJ_DESTROY, obj
```

IDLffDXF

An IDLffDXF object contains geometry, connectivity and attributes for graphics primitives.

Note

IDL supports version 2.003 of the DXF Library.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLffDXF::Init" on page 1884

Methods

Intrinsic Methods

This class has the following methods:

- IDLffDXF::Cleanup
- IDLffDXF::GetContents
- IDLffDXF::GetEntity
- IDLffDXF::GetPalette
- IDLffDXF::Init
- IDLffDXF::PutEntity
- IDLffDXF::Read
- IDLffDXF::RemoveEntity
- IDLffDXF::Reset
- IDLffDXF::SetPalette

- IDLffDXF::Write

This object treats a DXF file as a list of entities. Note, these are not directly mapped to DXF entity types, rather they are an abstraction of the DXF types. The Read method is used to read the contents of a DXF file into the current entity list. The user may then query this list using the GetContents method to determine the types and number of entities in the file. The user may retrieve arrays of entities from the list using the GetEntity method and add additional entities using the PutEntity method. Entities can also be removed from the list (RemoveEntity) or the entire list destroyed (Reset). The current list of entities can also be written to disk as a DXF file. Note, this object converts DXF entities to IDL entities and back. This conversion is not reversible; thus, if a DXF file is read and then written, the data in the file is not changed, but the internal DXF entity types may be changed by IDL. As an example, DXF face3d entities may be written as DXF polyline entities.

The object has one attribute which can be modified using the Get/SetPalette methods. This palette is used to convert color index values. The palette is not actually written to the DXF file. So, if the user wanted to specify entity colors from a 256 entry table, that table would be set using SetPalette, but the actual colors written to the file are the closest colors matched to the fixed AutoCAD color palette. There are two special color values: (0) = color by block color, (256) = color by layer color.

In this object, blocks and layers are treated as named entities with attributes, but are special in that all other entities have a block and layer entity reference in them. This allows the user to use these entity names as filters for many operations. There is a default block and a default layer. The default block has the name “” (the null string), and the default layer is '0'. The user may change the (non-name) attributes for these implicit blocks using PutEntity.

IDLffDXF::Cleanup

The IDLffDXF::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLffDXF::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLffDXF::GetContents

The IDLffDXF::GetContents method returns the DXF entity types contained in the object. The returned value is a one-dimensional string array of the type names found in the file. The Read or PutEntity methods must have been called previously for the results of this method to be valid.

Valid DXF ENTITY Types	DXF_TYPE (0=default)
ARC	1
CIRCLE	2
ELLIPSE	3
LINE	4
LINE3D	5
TRACE	6
POLYLINE	7
LWPOLYLINE	8
POLYGON	9
FACE3D	10
SOLID	11
RAY	12
XLINE	13
TEXT	14
MTEXT	15
POINT	16
SPLINE	17
BLOCK	18
INSERT	19
LAYER	20

Table A-4: DXF Entity Types

This object uses a small number of IDL named structures to return the data associated which each entity. This means that several of these DXF types are returned in the same structures, using different values of the DXF_TYPE field. The mapping of DXF entities to IDL named structures is as follows (each of these structures is documented in the GetEntity method):

IDL Structure	DXF Entity
IDL_DXF_ELLIPSE	arc, circle, ellipse
IDL_DXF_POLYLINE	line, line3d, trace, polyline, lwpolyline
IDL_DXF_POLYGON	face3d, solid, polyline (3d mesh)
IDL_DXF_POINT	point
IDL_DXF_XLINE	ray, xline
IDL_DXF_SPLINE	spline
IDL_DXF_TEXT	text, multitext
IDL_DXF_BLOCK	block
IDL_DXF_INSERT	insert
IDL_DXF_LAYER	layer

Table A-5: DXF mapping to IDL structures

Syntax

Result = *Obj*-> [IDLffDXF::]GetContents([*Filter*] [BLOCK=*string*] [, COUNT=*variable*] [LAYER=*string*])

Arguments

Filter

An integer array of the DXF entity types to which the return types are restricted. If set, Result can contain only types given in this argument and count will also reflect that restriction.

Keywords

BLOCK

Set this keyword to a string value containing the block name to obtain the entities from. The default is all blocks.

COUNT

A long array containing the number of each entity type contained within the DXF object. If the Filter argument was provided, the numbers reflect the reduced set of entities caused by the Filter argument.

LAYER

Set this keyword to a string value containing the layer name to obtain the entities from. The default is all layers.

IDLffDXF::GetEntity

The IDLffDXF::GetEntity method returns an array of vertex data for the requested entity type.

Syntax

Result = *Obj*–> [IDLffDXF::]GetEntity(*Type* [, BLOCK=*string*] [, INDEX=*value*] [, LAYER=*string*])

Note

Result has one of the named structure formats described in "Structure Formats" on page 1874.

Arguments

Type

The integer DXF entity type from which to obtain the geometry information.

Keywords

BLOCK

Set this keyword to a block name specifying the graphic block from which to obtain the entity geometry information. The default is all blocks. Setting this keyword to the null string " " will cause this method to only return entities from the default DXF entity block.

INDEX

Set this keyword to a scalar long or a long array of indices to return from the entity type. If not set, this method returns all entities for the given type.

LAYER

Set this keyword to a string value containing the layer name to obtain the entities from. The default is all layers.

Fields Common to all Structures

BLOCK

The name of the block this entity is in (these may be in the default block "").

COLOR

A color index value into the current object palette with 0=use block color and 256=use layer color.

EXTRUSION

The DXF extrusion vector (if any).

LAYER

The name of the layer this entity is in (the default layer is '0').

LINESTYLE

Defined the same as the user linestyle for IDLgrPolyline::Init.

Note

IDL will always return a solid line regardless of the linestyle in DXF

THICKNESS

In AutoCAD units.

DXF_TYPE

Set to one of the values listed in IDLffDXF::GetContents.

Note

It is the user's responsibility to free all the pointers returned in these structures when the entity is no longer needed.

Structure Formats

Structure IDL_DXF_ELLIPSE

Field	Data Type
PT0	Double [3]
PT1_OFFSET	Double [3]
MIN_TO_MAJ_RATIO	Double
START_ANGLE	Double
END_ANGLE	Double
EXTRUSION	Double [3]
LINESTYLE	Integer [2]
THICKNESS	Double
COLOR	Integer
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-6: Fields of the IDL_DXF_ELLIPSE structure

This object is centered at PT0 and has a radius defined by the vector PT1_OFFSET. This vector determines the length and orientation of the major axis of an ellipse as well.

The MIN_TO_MAJ_RATIO value specifies the length of the minor axis as a fraction of the major axis length. For a circle, this value is 1.0.

The START_ANGLE and END_ANGLE values select the portion of the curve to be drawn. If they are equal, the entire circle or ellipse is drawn.

Structure IDL_DXF_POLYGON

Field	Data Type
VERTICES	Pointer (to an array of 3D points)
CONNECTIVITY	Pointer (to an array on integers)
VERTEX_COLORS	Pointer (to an array of integers)
MESH_DIMS	Integer [2]
CLOSED	Integer [2]
COLOR	Integer
EXTRUSION	Double [3]
FIT_TYPE	Integer
CURVE_FIT	Integer
SPLINE_FIT	Integer
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-7: Fields of the IDL_DXF_POLYGON structure

VERTICES is a pointer to an array of dimension [3, n] containing the points for this entity.

CONNECTIVITY is the array used to connect these points into polygons (see the POLYGONS keyword for IDLgrPolygon::Init). If this array is not present, the connectivity is implicit in (U, V) space defined by the values in MESH_DIMS; the vertices represent a quad mesh of dimensions (MESH_DIMS[0], MESH_DIMS[1]).

VERTEX_COLORS points to an array of color index values for each of the vertices. If a quad mesh is being returned, it can be closed in either dimension according to the CLOSED array.

FIT_TYPE, CURVE_FIT, and SPLINE_FIT return the type of curve fit (if any) this polygon assumes.

Structure IDL_DXF_POLYLINE

Field	Data Type
VERTICES	Pointer (to an array of 3D points)
CONNECTIVITY	Pointer (to an array on integers)
VERTEX_COLORS	Pointer (to an array of integers)
COLOR	Integer
MESH_DIMS	Integer [2]
CLOSED	Integer [2]
THICKNESS	Double
LINESTYLE	Integer [2]
EXTRUSION	Double [3]
FIT_TYPE	String
CURVE_FIT	Integer
SPLINE_FIT	Integer
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-8: Fields of the IDL_DXF_POLYLINE structure

VERTICES is a pointer to an array of dimension [3, n] containing the points for this entity.

CONNECTIVITY is the array used to connect these points into polylines (see the POLYLINES keyword for IDLgrPolyline::Init). If this array is not present, the connectivity is implicit in (U, V) space defined by the values in MESH_DIMS; the vertices represent a quad mesh of dimensions (MESH_DIMS[0], MESH_DIMS[1]).

VERTEX_COLORS points to an array of color index values for each of the vertices. If a quad mesh is being returned, it can be closed in either dimension according to the CLOSED array.

FIT_TYPE, CURVE_FIT, and SPLINE_FIT return the type of curve fit (if any) this polyline assumes.

Structure IDL_DXF_POINT

Field	Data Type
PT0	Double [3]
UCSX_ANGLE	Double
THICKNESS	Double
COLOR	Integer
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-9: Fields of the IDL_DXF_POINT structure

PT0 is the location of the point in space.

UCSX_ANGLE is an internal DXF orientation parameter used for symbol plotting.

Structure IDL_DXF_SPLINE

Field	Data Type
CTR_PTS	Pointer
FIT_PTS	Pointer
KNOTS	Pointer
WEIGHTS	Pointer
COLOR	Integer
DEGREE	Integer
PERIODIC	Integer
RATIONAL	Integer
PLANAR	Integer
LINEAR	Integer
KNOT_TOLERANCE	Double
CTL_TOLERANCE	Double
FIT_TOLERANCE	Double
START_TANGENT	Double [3]
END_TANGENT	Double [3]
THICKNESS	Double
LINESTYLE	Integer [2]
EXTRUSION	Double [3]
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-10: Fields of the IDL_DXF_SPLINE structure

This structure is returned verbatim from the DXF spline structure without interpretation. It is up to the user to interpret these values.

Structure IDL_DXF_TXT

Field	Data Type
PT0	Double [3]
TEXT_STR	String
COLOR	Integer
HEIGHT	Double
WIDTH_FACTOR	Double
BOX_WIDTH	Double
DIRECTION	Double [3]
ROT_ANGLE	Double
JUSTIFICATION	Integer (0=left, 1=center, 2=right, 3=aligned, 4=middle, 5=fit)
VERTICAL_ALIGN	Integer (0=baseline, 1=bottom, 2=middle, 3=top)
SHAPE_FILE	String
THICKNESS	Double
EXTRUSION	Double [3]
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-11: Fields of the IDL_DXF_TXT structure

PT0 is the location of the text string.

TEXT_STR is the actual string.

HEIGHT specifies the overall scaling of the glyphs while WIDTH_FACTOR is a correction in the baseline direction (anisotropic scaling). For multi-line text, BOX_WIDTH determines where the line breaks should be placed (0.0 for single line text).

The text baseline is specified by DIRECTION and its rotation about the Z axis is specified by ROT_ANGLE. Justification is specified by JUSTIFICATION and

VERTICAL_ALIGN. SHAPE_FILE is the name of the glyph file used to image this string. The shape file is NOT read by IDL.

Structure IDL_DXF_XLINE

Field	Data Type
PT0	Double [3]
UNIT_VEC	Double [3]
COLOR	Integer
THICKNESS	Double
LINESTYLE	Integer [2]
EXTRUSION	Double [3]
DXF_TYPE	Integer
BLOCK	String
LAYER	String

Table A-12: Fields of the IDL_DXF_XLINE structure

PT0 is the start of a ray or a point on a infinite line in space in the case of an XLINE entity.

UNIT_VEC determines the direction of the line in space.

Structure IDL_DXF_INSERT

Field	Data Type
SCALE	Double [3]
PT0	Double [3]
ROTATION	Double
INSTANCE_BLOCK	String
NUM_ROW_COL	Integer [2]
DISTANCE_BETWEEN	Double [2]
DXF_TYPE	Integer
BLOCK	String
COLOR	Integer
LAYER	String

Table A-13: Fields of the IDL_DXF_INSERT structure

The insert entity allows for the “instancing” of a block in a grid fashion.

INSTANCE_BLOCK is the name of a block to repeat.

The block is scaled by SCALE and rotated about the Z axis by ROTATION. The grid begins at PT0 and contains the number of rows and columns specified by NUM_ROW_COL (Note: 0 rows or columns will always give a single instance of the block).

The spacing of the grid is specified by DISTANCE_BETWEEN.

Structure IDL_DXF_BLOCK

Field	Data Type
PT0	Double [3]
COLOR	Integer
NAME	String
DXF_TYPE	Integer

Table A-14: Fields of the IDL_DXF_BLOCK structure

This entity specifies a BLOCK. Blocks have a location in space (PT0) [objects in the block are interpreted relative to this point], a name, and a COLOR. They are not contained in layers or other blocks, so these fields are not present.

Structure IDL_DXF_LAYER

Field	Data Type
COLOR	Integer
NAME	String
DXF_TYPE	Integer

Table A-15: Fields of the IDL_DXF_LAYER structure

This entity specifies a LAYER. Layer is a NAME and a COLOR. They are not contained in layers or other blocks, so these fields are not present.

IDLffDXF::GetPalette

The IDLffDXF::GetPalette method returns the current color table in the object.

Syntax

Obj–> [IDLffDXF::]GetPalette, *Red*, *Green*, *Blue*

Arguments

Red

Returns an array of the red components to the current color table.

Green

Returns an array of the green components to the current color table.

Blue

Returns an array of the blue components to the current color table.

IDLffDXF::Init

The IDL_Container::Init function method initializes the DXF object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Result = OBJ_NEW('IDLffDXF' [, *Filename*])

or

Result = *Obj* **->** [IDLffDXF::]Init([*Filename*]) (*Only in a subclass' Init method*.)

Arguments

Filename

Set this optional argument to a scalar string containing the full path and filename of a DXF file to be read as the object is created.

Keywords

None

IDLffDXF::PutEntity

The IDLffDXF::PutEntity procedure method inserts an entity into the DXF object. The type of the entity is determined from the DXF_TYPE field of the entity structure. If DXF_TYPE is set to 0, the type is implied by the entity structure.

Note

Line3D entity types will be written as Line entities due to the obsolete status of Line3D. Polyline entities will be automatically converted to Lightweight Polylines where applicable.

Syntax

Obj –> [IDLffDXF::]PutEntity, *Data*

Arguments

Data

An array of Entity structures as defined by the GetEntity method.

Note

If the entity references a non-existent block or layer, one will automatically be created. Blocks and layers can also be created by passing IDL_DXF_BLOCK or IDL_DXF_LAYER structures to this routine.

IDLffDXF::Read

The IDLffDXF::Read method reads a file, parsing the DXF object information contained in the file, and inserts it into itself. This method returns an indication of success in reading the file.

Syntax

Result = *Obj*-> [IDLffDXF::]Read(*Filename*)

Arguments

Filename

A scalar string containing the full path and filename of the DXF file to be read.

Example

```
; Read all the lines from the electrical layer:
oDXF = OBJ_NEW('IDLffDXF')
IF (oDXF->Read('myDXF.dxf')) THEN BEGIN
   contents = oDXF->GetContents(4,COUNT=numLines, $
      LAYER='Electrical')
   IF (numLines ne 0) THEN BEGIN
      lines = oDXF->GetEntity(4,LAYER='Electrical')
   ENDIF
ENDIF
```

IDLffDXF::RemoveEntity

The IDLffDXF::RemoveEntity method removes the specified entity or entities from the DXF object.

Syntax

Obj **->** [IDLffDXF::]RemoveEntity[, *Type*] [, INDEX=*value*]

Arguments

Type

An optional scalar string containing the DXF type to be removed from the DXF object.

Note

Specifying a block or layer entity will cause all the entities in that layer or block to be removed.

Keywords

INDEX

Set this keyword to a scalar long or a long array of indices to remove from the DXF object. If not set, or set negative, all entities of the given type are removed.

IDLffDXF::Reset

The IDLffDXF::Reset method removes all the entities from the DXF object.

Syntax

Obj–> [IDLffDXF::]Reset

Arguments

None

Keywords

None

IDLffDXF::SetPalette

The IDLffDXF::SetPalette method sets the current color table in the object.

Syntax

Obj–> [IDLffDXF::]SetPalette, *Red*, *Green*, *Blue*

Arguments

Red

Sets the red components of the current color table to this array.

Green

Sets the green components of the current color table to this array.

Blue

Sets the blue components of the current color table to this array.

Keywords

None

IDLffDXF::Write

The IDLffDXF::Write method writes a file for the DXF entity information this object contains. This method returns an indication of success in writing the file.

Syntax

Result = *Obj*–> [IDLffDXF::]Write(*Filename*)

Arguments

Filename

A scalar string containing the full path and filename of the DXF file to be written.

Example

```
; Write a square to a new DXF file using lines:
oDXF = OBJ_NEW('IDLffDXF')
lines = {IDL_DXF_POLYLINE}
lines.dxf_type = 4
lines.layer='myLayer'
lines.thickness = 1.0

; Create clockwise square:
lines = REPLICATE(lines, 4)
lines[0].vertices = PTR_NEW([[0.0,0.0,0.0], $
     [0.0,1.0,0.0]])
lines[0].connectivity = PTR_NEW([0,1])
lines[1].vertices = PTR_NEW([[0.0,1.0,0.0], $
    [1.0,1.0,0.0]])
lines[1].connectivity = PTR_NEW([0,1])
lines[2].vertices = PTR_NEW([[1.0,1.0,0.0], $
    [1.0,0.0,0.0]])
lines[2].connectivity = PTR_NEW([0,1])
lines[3].vertices = PTR_NEW([[1.0,0.0,0.0], $
    [0.0,0.0,0.0]])
lines[3].connectivity = PTR_NEW([0,1])
oDXF->PutEntity, lines
IF (not oDXF->Write('mySquare.dxf')) THEN $
   PRINT, 'Write Failed.'
   ; Clean up the memory in the structs:
   OBJ_DESTROY, oDXF
   FOR i=0,3 DO BEGIN
      PTR_FREE, lines[i].vertices, lines[i].connectivity
ENDFOR
```

IDLffLanguageCat

The IDLffLanguageCat object provides an interface to IDL language catalog files.

Note

This object is not savable. Restored IDLffLanguageCat objects may contain invalid data.

Note

This object is not intended to be created with OBJ_NEW. The MSG_CAT_OPEN function is used to return the correct object reference.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See MSG_CAT_OPEN.

Methods

- IDLffLanguageCat::IsValid
- IDLffLanguageCat::Query
- IDLffLanguageCat::SetCatalog

See Also

MSG_CAT_CLOSE, MSG_CAT_COMPILE, MSG_CAT_OPEN

IDLffLanguageCat::IsValid

The IDLffLanguageCat::IsValid function method is used to determine whether the object has a valid catalog.

Syntax

Result = *Obj* **->**[IDLffLanguageCat::]IsValid( )

Arguments

None

Keywords

None

IDLffLanguageCat::Query

The IDLffLanguageCat::Query function method is used to return the language string associated with the given key. If the key is not found in the given catalog, the default string is returned.

Syntax

Result = *Obj* **->**[IDLffLanguageCat::]Query(*key* [, DEFAULT_STRING=*string*])

Arguments

key

The scalar, or array of (string) keys associated with the desired language string. If key is an array, *Result* will be a string array of the associated language strings.

Keywords

DEFAULT_STRING

Set this keyword to the desired value of the return string if the key cannot be found in the catalog file. The default value is the empty string.

IDLffLanguageCat::SetCatalog

The IDLffLanguageCat::SetCatalog function method is used to set the appropriate catalog file. This function returns 1 upon success, and 0 on failure.

Syntax

Result = *Obj* **->**[IDLffLanguageCat::]SetCatalog(*application*
[, FILENAME=*string*] [, LOCALE=*string*] [, PATH=*string*])

Arguments

application

A scalar string representing the name of the desired application's catalog file.

Keywords

FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open. If this keyword is set, *application*, PATH, and LOCALE are ignored.

LOCALE

Set this keyword to the desired locale for the catalog file. If not set, the current locale is used.

PATH

Set this keyword to a scalar string containing the path to search for language catalog files. The default is the current directory.

IDLffShape

An IDLffShape object contains geometry, connectivity and attributes for graphics primitives accessed from ESRI Shapefiles.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See IDLffShape::Init

Methods

Intrinsic Methods

This class has the following methods:

- IDLffShape::AddAttribute
- IDLffShape::Cleanup
- IDLffShape::Close
- IDLffShape::DestroyEntity
- IDLffShape::GetAttributes
- IDLffShape::GetEntity
- IDLffShape::GetProperty
- IDLffShape::Init
- IDLffShape::Open
- IDLffShape::PutEntity
- IDLffShape::SetAttributes

Overview

An ESRI Shapefile stores nontopological geometry and attribute information for the spatial features in a data set.

A Shapefile consists of a main file (`.shp`), an index file (`.shx`), and a dBASE table (`.dbf`). For example, the Shapefile "states" would have the following files:

- states.shp
- states.shx
- states.dbf

Naming Conventions for a Shapefile

All the files that comprise an ESRI Shapefile must adhere to the 8.3 filename convention and must be lower case. The main file, index file, and dBASE file must all have the same prefix. The prefix must start with an alphanumeric character and can contain any alphanumeric, underscore (_), or hyphen (-). The main file suffix must use the `.shp` extension, the index file the `.shx` extension, and the dBASE table the `.dbf` extension.

Major Elements of a Shapefile

A Shapefile consists of the following elements that you can access through the IDLffShape class:

- Entities
- Attributes

Entities

The geometry for a feature is stored as a shape comprising a set of vector coordinates (referred to as 'entities'). The entities in a Shapefile must all be of the same type. The following are the possible types for entities in a Shapefile:

Shape Type	Type Code
Point	1
PolyLine	3
Polygon	5

Table A-16: Entity Types

Shape Type	Type Code
MultiPoint	8
PointZ	11
PolyLineZ	13
PolygonZ	15
MultiPointZ	18
PointM	21
PolyLineM	23
PolygonM	25
MultiPointM	28
MultiPatch	31

Table A-16: Entity Types (Continued)

When retrieving entities using the IDLffShape::GetEntity method, an IDL structure is returned. This structure has the following fields:

Field	Data Type
SHAPE_TYPE	IDL_LONG
ISHAPE	IDL_LONG
BOUNDS	Double[8]
N_VERTICES	IDL_LONG
VERTICES	Pointer (to Vertices array)
MEASURE	Pointer (to Measure array)
N_PARTS	IDL_LONG
PARTS	Pointer (to Parts array).
PART_TYPES	Pointer (to part types)
ATTRIBUTES	Pointer to attribute array.

Table A-17: Entity Structure Field Data Types

The following table describes each field in the structure:

Field	Description
SHAPE_TYPE	The entity type.
ISHAPE	The identifier of the specific entity in the shape object.
BOUNDS	A bounding box that specifies the range limits of the entity. This eight element array contains the following information: • Index 0 — X minimum value • Index 1 — Y minimum value • Index 2 — Z minimum value (if Z is supported by type) • Index 3 — Measure minimum value (if measure is supported by entity type). • Index4 — X maximum value. • Index5 — Y maximum value. • Index6 — Z maximum value (if Z is supported by the entity type). • Index7 — Measure maximum value (if measure is supported by entity type). **Note -** If the entity is a point type, the values contained in the bounds array are also the values of the entity.
N_VERTICES	The number of vertices in the entity. If this value is one and the entity is a POINT type (POINT, POINTM, POINTZ), the vertices pointer will be set to NULL and the entity value will be maintained in the BOUNDS field.

Table A-18: Entity Structure Field Descriptions

Field	Description
VERTICES	An IDL pointer that contains the vertices of the entity. This pointer contains a double array that has one of the following formats: • [2, *N*] - If Z data is not present • [3, *N*] - If Z data is present. where *N* is the number of vertices. These array formats can be passed to the polygon and polyline objects of IDL Object Graphics. **Note -** This pointer will be null if the entity is a point type, with the values maintained in the BOUNDS array.
MEASURE	If the entity has a measure value (this is dependent on the entity type), this IDL pointer will contain a vector array of measure values. The length of this vector is N_VERTICES. **Note -** This pointer will be null if the entity is of type POINTM, with the values contained in the BOUNDS array.
N_PARTS	If the values of the entity are separated into parts, the break points are enumerated in the parts array. This field lists the number of parts in this entity. If this value is 0, the entity is one part and the PARTS pointer will be NULL.
PARTS	An IDL pointer that contains an array of indices into the vertex/measure arrays. These values represent the start of each part of the entity. The index range of each entity part is defined by the following: • Start = Parts[I] • End = Parts[I+1]-1 or the end of the array
PART_TYPES	This IDL pointer is only valid for entities of type MultiPatch and defines the type of the particular part. If the entity type is not MultiPatch, part types are assumed to be type RING (SHPP_RING). **Note -** This pointer is NULL if the entity is not type MultiPatch.

Table A-18: Entity Structure Field Descriptions (Continued)

Field	Description
ATTRIBUTES	If the attributes for an entity were requested, this field contains an IDL pointer that contains a structure of attributes for the entity. For more information on this structure, see "Attributes" on page 1900.

Table A-18: Entity Structure Field Descriptions (Continued)

Attributes

A Shapefile provides the ability to associate information describing each entity (a geometric element) contained in the file. This descriptive information, called attributes, consists of a set of named data elements for each geometric entity contained in the file. The set of available attributes is the same for every entity contained in a Shapefile, with each entity having it's own set of attribute values.

An attribute consist of two components:

- A name
- A data value

The name consists of an 11 character string that is used to identify the data value. The data value is not limited to any specific format.

The two components that form an attribute are accessed differently using the shape object. To get the name of attributes for the specific file, the ATTRIBUTE_NAMES keyword to the IDLffShape::GetProperty method is used. This returns a string array that contains the names for the attributes defined for the file.

To get the attribute values for an entity, the IDLffShape::GetAttributes method is called or the ATTRIBUTES keyword of the IDLffShape::GetEntity method is set. In each case, the attribute values for the specified entity is returned as an anonymous IDL structure. The numeric order of the fields in the returned structure map to the numeric order of the attributes defined for the file. The actual format of the returned structure is:

ATTRIBUTE_0 : VALUE,

ATTRIBUTE_1 : VALUE,

ATTRIBUTE_2 : VALUE,

...

ATTRIBUTE_<N-1> : VALUE

To access the values in the returned structure, you can either hardcode the structure field names or use the structure indexing feature of IDL.

Accessing Shapefiles

The following example shows how to access data in a Shapefile. This example sets up a map to display parts of a Shapefile, opens a Shapefile, reads the entities from the Shapefile, and then plots only the state of Colorado:

```
PRO ex_shapefile

DEVICE, RETAIN=2, DECOMPOSED=0
!P.BACKGROUND=255

;Define a color table
r=BYTARR(256) & g=BYTARR(256) & b=BYTARR(256)
r[0]=0 & g[0]=0 & b[0]=0             ;Definition of black
r[1]=100 & g[1]=100 & b[1]=255       ;Definition of blue
r[2]=0 & g[2]=255 & b[2]=0           ;Definition of green
r[3]=255 & g[3]=255 & b[3]=0         ;Definition of yellow
r[255]=255 & g[255]=255 & b[255]=255 ;Definition of white

TVLCT, r, g, b
black=0 & blue=1 & green=2 & yellow=3 & white=255

; Set up map to plot Shapefile on
MAP_SET, /ORTHO,45, -120,  /ISOTROPIC, $
/HORIZON, E_HORIZON={FILL:1, COLOR:blue}, $
/GRID, COLOR=black, /NOBORDER

; Fill the continent boundaries:
MAP_CONTINENTS, /FILL_CONTINENTS, COLOR=green

; Overplot coastline data:
MAP_CONTINENTS, /COASTS, COLOR=black

; Show national borders:
MAP_CONTINENTS, /COUNTRIES, COLOR=black

;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the number of entities so we can parse through them
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

;Parsing through the entities and only plotting the state of
;Colorado
```

```
FOR x=1, (num_ent-1) DO BEGIN
   ;Get the Attributes for entity x
   attr = myshape -> IDLffShape::GetAttributes(x)
   ;See if 'Colorado' is in ATTRIBUTE_1 of the attributes for
   ;entity x
   IF attr.ATTRIBUTE_1 EQ 'Colorado' THEN BEGIN
      ;Get entity
      ent = myshape -> IDLffShape::GetEntity(x)
      ;Plot entity
      POLYFILL, (*ent.vertices)[0,*], (*ent.vertices)[1,*],
COLOR=yellow
      ;Clean-up of pointers
      myshape -> IDLffShape::DestroyEntity, ent
   ENDIF
ENDFOR

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

This results in the following:

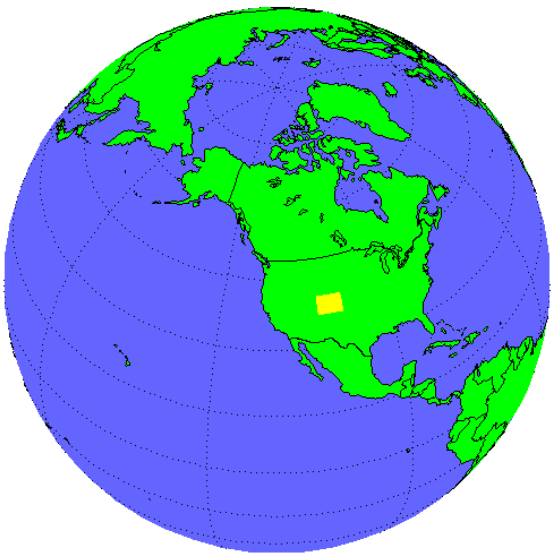


Figure A-1: Example Use of Shapefiles

Creating New Shapefiles

To create a Shapefile, you need to create a new Shapefile object, define the entity and attributes definitions, and then add your data to the file. For example, the following program creates a new Shapefile (`cities.shp`), defines the entity type to be "Point", defines 2 attributes (CITY_NAME and STATE_NAME), and then adds an entity to the new file:

```
PRO ex_shapefile_newfile

;Create the new shapefile and define the entity type to Point
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)

;Set the attribute definitions for the new Shapefile
mynewshape->IDLffShape::AddAttribute, 'CITY_NAME', 7, 25, $
   PRECISION=0
mynewshape->IDLffShape::AddAttribute, 'STAT_NAME', 7, 25, $
   PRECISION=0

;Create structure for new entity
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Create structure for new attributes
attrNew = mynewshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)

;Define the values for the new attributes
attrNew.ATTRIBUTE_0 = 'Denver'
attrNew.ATTRIBUTE_1 = 'Colorado'

;Add the new entity to new shapefile
mynewshape -> IDLffShape::PutEntity, entNew

;Add the Colorado attributes to new shapefile
mynewshape -> IDLffShape::SetAttributes, 0, attrNew
```

```
;Close the shapefile
OBJ_DESTROY, mynewshape

END
```

Updating Existing Shapefiles

You can modify existing Shapefiles with the following:

- Adding new entities
- Adding new attributes (only to Shapefiles without any existing values in any attributes)
- Modifying existing attributes

Note

You cannot modify existing entities.

For example, the following program adds an entity and attributes for the city of Boulder to the `cities.shp` file we created in the previous example:

```
PRO ex_shapefile_modify

;Open the cities Shapefile
myshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)

;Create structure for new entity
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1380
entNew.BOUNDS[0] = -105.25100
entNew.BOUNDS[1] = 40.026878
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -105.25100
entNew.BOUNDS[5] = 40.026878
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Create structure for new attributes
attrNew = myshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)
```

```
;Define the values for the new attributes
attrNew.ATTRIBUTE_0 = 'Boulder'
attrNew.ATTRIBUTE_1 = 'Colorado'

;Add the new entity to new shapefile
myshape -> IDLffShape::PutEntity, entNew

;Add the Colorado attributes to new shapefile
myshape -> IDLffShape::SetAttributes, 0, attrNew

;Close the shapefile
OBJ_DESTROY, myshape

END
```

IDLffShape::AddAttribute

The IDLffShape::AddAttribute method adds an attribute definition to a Shapefile. Adding a the attribute definition is required before adding the actual attribute data to a file. For more information on attributes, see "Attributes" on page 1900.

Note

You can only define new attributes to Shapefiles that do not have any existing values in any attributes.

Syntax

Obj->[IDLffShape::]AddAttribute, *Name*, *Type*, *Width* [, PRECISION=*integer*]

Arguments

Name

Set to a string that contains the attribute name. Name values are limited to 11 characters. Arguments longer than 11 characters will be truncated.

Type

Set to the IDL type code that corresponds to the data type that will be stored in the attribute. The valid types are:

Code	Description
3	Longword Integer
5	Double-precision floating-point
7	String

Table A-19: Type Code Descriptions

Width

Set to the width of the field for the data value of the attribute. The following table describes the possible values depending on the defined Type:

Field Type	Valid Values
Longword Integer	Maximum size of the field.
Double-precision floating-point	Maximum size of the field.
String	Maximum length of the string.

Table A-20: Width Values

Keywords

PRECISION

Set this keyword to the number of positions to be included after the decimal point. The default is 8. This keyword is only valid for fields defined as double-precision floating-point.

Example

In the following example, we add the attribute “ELEVATION” to an existing Shapefile. Note that if the file already contains data in an attribute for any of the entities defined in the file, this operation will fail.

```
PRO ex_addattr_shapefile

;Open a shapefile
myshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)

;Define a new attribute for the Shapefile
myshape->IDLffShape::AddAttribute, 'ELEVATION', 3, 4, $
   PRECISION=0

;Close the shapefile
OBJ_DESTROY, myshape

END
```

IDLffShape::Cleanup

The IDLffShape::Cleanup method performs all cleanup on a Shapefile object. If the Shapefile being accessed by the object is open and the file has been modified, the new information is written to the file if one of the following conditions is met:

- The file was opened with write permissions using the UPDATE keyword to the IDLffShape::Open method
- It is a newly created file that has not been written previously.

Note

Cleanup methods are special lifecycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj -> [IDLffShape::]Cleanup (Only in subclass' Cleanup method.)

Arguments

None

Keywords

None

IDLffShape::Close

The IDLffShape::Close method closes a Shapefile. If the file has been modified, it is also written to the disk if neither of the following conditions is met:

- The file was opened with write permissions using the UPDATE keyword to the IDLffShape::Open method
- It is a newly created file that has not been written previously.

If the file has been modified and one of the previous conditions is not met, the file is closed and the changes are not written to disk.

Syntax

Obj->[IDLffShape::]Close

Arguments

None.

Keywords

None.

IDLffShape::DestroyEntity

The IDLffShape::DestroyEntity method frees memory associated with the entity structure. For more information on the entity structure, see “Entities” on page 1896.

Syntax

Obj->[IDLffShape::]DestroyEntity, *Entity*

Arguments

Entity

This argument specifies a scalar or array of entities to destroy.

Keywords

None.

Example

In the following example, all of the entities from the `states.shp` Shapefile are read and then the DestroyEntity method is called to clean up all pointers:

```
PRO ex_shapefile

;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the number of entities so we can parse through them
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

;Read all the entities
FOR x=1, (num_ent-1) DO BEGIN
   ;Read the entity x
   ent = myshape -> IDLffShape::GetEntity(x)
   ;Clean-up of pointers
   myshape -> IDLffShape::DestroyEntity, ent
ENDFOR

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

IDLffShape::GetAttributes

The IDLffShape::GetAttributes method retrieves the attributes for the entities you specify from a Shapefile.

Syntax

Result = *Obj*->[IDLffShape::]GetAttributes([*Index*] [, /ALL] [, /ATTRIBUTE_STRUCTURE])

Return Value

This method returns an anonymous structure array. For more information on the structure, see "Attributes" on page 1900.

Arguments

Index

A scalar or array of longs specifying the entities for which you want to retrieve the attributes, with 0 being the first entity in the Shapefile.

Note

If you do not specify *Index* and the ALL keyword is not set, the attributes for the first entity (0) are returned.

Keywords

ALL

Set this keyword to retrieve the attributes for all entities in a Shapefile. If you set this keyword, the *Index* argument is not required.

ATTRIBUTE_STUCTURE

Set this keyword to return an empty attribute structure that can then be used with the IDLffShape::SetAttributes method to add attributes to a Shapefile.

Examples

In the first example, we retrieve the attributes associated with entity at location 0 (the first entity in the file):

```
attr = myShape->getAttributes( 0)
```

In the next example, we retrieve the attributes associated with entities 10 through 20:

```
attr = myShape->getAttributes( 10+indgen(11) )
```

In the next example, we retrieve the attributes for entities 1,4, 9 and 70:

```
attr = myShape->getAttributes( [1, 4, 9, 70] )
```

In the next example, we retrieve all the attributes for a Shapefile:

```
attr = myShape->getAttributes( /ALL )
```

IDLffShape::GetEntity

The IDLffShape::GetEntity method returns the entities you specify from a Shapefile.

Syntax

Result = *Obj*->[IDLffShape::]GetEntity([*Index*] [, /ALL] [, /ATTRIBUTES])

Return Value

This method returns a type {IDL_SHAPE_ENTITY} structure array. For more information on the structure, see "Entities" on page 1896.

Note

Since an entity structure contains IDL pointers, you must free all the pointers returned in these structures when the entity is no longer needed using the IDLffShape::DestroyEntity method.

Note

Since entities cannot be modified in a Shapefile, an entity is read directly from the Shapefile each time you use the IDLffShape::GetEntity method even if you have already read that entity. If you modify the structure array returned by this method for a given entity and then use IDLffShape::GetEntity on that same entity, the modified data will NOT be returned, the data that is actually written in the file is returned.

Arguments

Index

A scalar or array of longs specifying the entities for which you want to retrieve with 0 being the first entity in the Shapefile. If the ALL keyword is set, this argument is not required. If you do not specify any entities and the ALL keyword is not set, the first entity (0) is returned.

Keywords

ALL

Set this keyword to retrieve all entities from the Shapefile. If this keyword is set, the Index argument is not required.

ATTRIBUTES

Set this keyword to return the attributes in the entity structure. If not set, the ATTRIBUTES tag in the entity structure will be a null IDL pointer.

Example

In the following example, all of the entities from the `states.shp` Shapefile are read:

```
PRO ex_shapefile

;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the number of entities so we can parse through them
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

;Read all the entities
FOR x=1, (num_ent-1) DO BEGIN
   ;Read the entity x
   ent = myshape -> IDLffShape::GetEntity(x)
   ;Clean-up of pointers
   myshape -> IDLffShape::DestroyEntity, ent
ENDFOR

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

IDLffShape::GetProperty

The IDLffShape::GetProperty method returns the values of properties associated with a Shapefile object. These properties are:

- Number of entities
- The type of the entities
- The number of attributes associated with each entity
- The names of the attributes
- The name, type, width, and precision of the attributes
- The status of a Shapefile
- The filename of the Shapefile object

Syntax

Obj->[IDLffShape::]GetProperty [, N_ENTITIES=*variable*]
[, ENTITY_TYPE=*variable*] [, N_ATTRIBUTES=*variable*]
[, ATTRIBUTE_NAMES=*variable*] [, ATTRIBUTE_INFO=*variable*]
[, IS_OPEN=*variable*] [, FILENAME=*variable*]

Arguments

None.

Keywords

N_ENTITIES

Set this keyword to a named variable to return the number of entities contained in Shapefile object. If the value is unknown, this method returns 0.

ENTITY_TYPE

Set this keyword to a named variable to return the integer type code for the entities contained in the Shapefile object. If the value is unknown, this method returns -1. For more information on entity type codes, see “Entities” on page 1896.

N_ATTRIBUTES

Set this keyword to a named variable to return the number of attributes associated with a Shapefile object. If the value is unknown, this method returns 0.

ATTRIBUTE_NAMES

Set this keyword to a named variable to return the names of each attribute in the Shapefile object. These names are returned as a string array.

ATTRIBUTE_INFO

Set this keyword to a named variable to return the attribute information for each attribute. This consists of an array of attribute information structures that have the following fields:

Field	Description
NAME	A string that contains the name of the attribute.
TYPE	The IDL type code of the attribute.
WIDTH	The width of the attribute.
PRECISION	The precision of the attribute.

Table A-21: ATTRIBUTE_INFO Fields

The file must be open to obtain this information.

IS_OPEN

Set this keyword to a named variable to return information about the status of a Shapefile. The following values can be returned:

Value	Description
0	File is not open
1	File is open in read-only mode.
3	File is open in update mode.

Table A-22: IS_OPEN Values

FILENAME

Set this keyword to a named variable to return the fully qualified path name of the Shapefile in the current Shapefile object.

Examples

In the following example, the number of entities and the entity type is returned:

```
PRO entity_info
;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the number of entities and the entity type
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent, $
   ENTITY_TYPE=ent_type

;Print the number of entities and the type
PRINT, 'Number of Entities: ', num_ent
PRINT, 'Entity Type: ', ent_type

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

This results in the following:

```
Number of Entities:           51
Entity Type:               5
```

In the next example, the definitions for attribute 1 are returned:

```
PRO attribute_info
;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the info for all attribute
myshape -> IDLffShape::GetProperty, ATTRIBUTE_INFO=attr_info

;Print Attribute Info
PRINT, 'Attribute Number: ', '1'
PRINT, 'Attribute Name: ', attr_info[1].name
PRINT, 'Attribute Type: ', attr_info[1].type
PRINT, 'Attribute Width: ', attr_info[1].width
PRINT, 'Attribute Precision: ', attr_info[1].precision

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

This results in the following:

```
Attribute Number: 1
Attribute Name: STATE_NAME
Attribute Type:            7
Attribute Width:           25
Attribute Precision:            0
```

IDLffShape::Init

The IDLffShape::Init function method initializes or constructs a Shapefile object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Result = OBJ_NEW('IDLffShape' [, *Filename*] [, /UPDATE]
[, ENTITY_TYPE='*Value*')

Return Value

This method returns a Shapefile object.

Arguments

Filename

Set this argument to a scalar string containing the full path and filename of a Shapefile (`.shp`) to open. If this file exists, it is opened. If the file does not exist, a new Shapefile object is constructed. You do not need to use IDLffShape::Open to open an existing file when specifying this keyword.

Note

The `.shp`, `.shx`, and `.dbx` files must exist in the same directory for you to be able to open and access the file unless the UPDATE keyword is set.

Keywords

UPDATE

Set this keyword to have the file opened for writing. The default is read-only.

ENTITY_TYPE

Set this keyword to the entity type of a new Shapefile. Use this keyword only when creating a new Shapefile. For more information on entity types, see "Entities" on page 1896.

Example

In the following example, we create a new Shapefile object and open the `examples/data/states.shp` file:

```
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))
```

IDLffShape::Open

The IDLffShape::Open method opens a specified Shapefile.

Syntax

Result = *Obj*->[IDLffShape::]Open(*'Filename'* [, /UPDATE]
[, ENTITY_TYPE=*'value'*])

Return Value

This method returns 1 if the file can be read successfully. If not able to open the file, it returns 0.

Arguments

Filename

Set this argument to a scalar string containing the full path and filename of a Shapefile (`.shp`) to open. Note that the `.shp`, `.shx`, and `.dbx` files must exist in the same directory for you to be able to open and access the file unless the UPDATE keyword is set.

Keywords

UPDATE

Set this keyword to have the file opened for writing. The default is read-only.

ENTITY_TYPE

Set this keyword to the entity type of a new Shapefile. Use this keyword only when creating a new Shapefile. For more information on entity types, see "Entities" on page 1896

Example

In the following example, the file `examples/data/states.shp` is opened for reading and writing:

```
status = myShape->Open(FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)
```

IDLffShape::PutEntity

The IDLffShape::PutEntity method inserts an entity into the Shapefile object. The entity must be in the proper structure. For more information on the structure, see "Entities" on page 1896.

Note

The shape type of the new entity must be the same as the shape type defined for the Shapefile. If the shape type has not been defined for the Shapefile using the ENTITY_TYPE keyword for the IDLffShape::Open or IDLffShape::Init methods, the first entity that is inserted into the Shapefile defines the type.

Note

Only new entities can be inserted into a Shapefile. Existing entities cannot be updated.

Syntax

Obj->[IDLffShape::]PutEntity, *Data*

Arguments

Data

Set this argument to a scalar or an array of entity structures.

Keywords

None.

Example

In the following example, we create a new shapefile, define a new entity, and then use the PutEntity method to insert it into the new file:

```
PRO ex_shapefile_newfile

;Create the new shapefile and define the entity type to Point
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)

;Create structure for new entity
```

```
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Add the new entity to new shapefile
mynewshape -> IDLffShape::PutEntity, entNew

;Close the shapefile
OBJ_DESTROY, mynewshape

END
```

IDLffShape::SetAttributes

The IDLffShape::SetAttributes method sets the attributes for a specified entity in a Shapefile object.

Syntax

Obj->[IDLffShape::]SetAttributes, *Index*, *Attribute_Num*, *Value*

or

Obj->[IDLffShape::]SetAttributes, *Index*, *Attributes*

Arguments

Index

A scalar specifying the entity in which you want to set the attributes. The first entity in the Shapefile object is 0.

Attribute_Num

The field number for the attribute whose value is being set. This value is 0-based.

Value

The value that the attribute is being set to. If the value is not of the correct type, type conversion is attempted.

If *Value* is an array and *Index* is a scalar, the value of record is treated as a starting point. Using this feature, all the attribute values of a specific field can be set for a Shapefile.

Attributes

An Attribute structure whose fields match the fields in the attribute table. If *Attributes* is an array, the entities specified in *Index*, up to the size of the Attributes array, are set. Using this feature, all the attribute values of a set of entities can be set for a Shapefile.

The type of this Attribute structure must match the type that is generated internally for Attribute table. To get a copy of this structure, either get the attribute set for an entity or get the definition using the ATTRIBUTE_STRUCTURE keyword of the IDLffShape::GetProperty method.

Keywords

None.

Example

In the following example, we create a new shapefile, define the attributes for the new file, define a new entity, define some attributes, insert the new entity, and then use the SetAttributes method to insert the attributes into the new file:

```
PRO ex_shapefile_newfile

;Create the new shapefile and define the entity type to Point
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)

;Set the attribute definitions for the new Shapefile
mynewshape->IDLffShape::AddAttribute, 'CITY_NAME', 7, 25, $
   PRECISION=0
mynewshape->IDLffShape::AddAttribute, 'STAT_NAME', 7, 25, $
   PRECISION=0

;Create structure for new entity
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Create structure for new attributes
attrNew = mynewshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)

;Define the values for the new attributes
attrNew.ATTRIBUTE_0 = 'Denver'
attrNew.ATTRIBUTE_1 = 'Colorado'

;Add the new entity to new shapefile
mynewshape -> IDLffShape::PutEntity, entNew
```

```
;Add the Colorado attributes to new shapefile
mynewshape -> IDLffShape::SetAttributes, 0, attrNew

;Close the shapefile
OBJ_DESTROY, mynewshape

END
```

IDLgrAxis

An axis object represents a single vector that may include a set of tick marks, tick labels, and a title.

An IDLgrAxis object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrAxis::Init" on page 1933.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrAxis::Cleanup
- IDLgrAxis::GetCTM
- IDLgrAxis::GetProperty
- IDLgrAxis::Init
- IDLgrAxis::SetProperty

IDLgrAxis::Cleanup

The IDLgrAxis::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrAxis::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrAxis::GetCTM

The IDLgrAxis::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrAxis::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the axis object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrAxis::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrAxis::GetProperty

The IDLgrAxis::GetProperty procedure method retrieves the value of a property or group of properties for the axis.

Syntax

Obj **->** [IDLgrAxis::]GetProperty [, ALL=*variable*] [, CRANGE=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrAxis::Init followed by "Get" can be retrieved using IDLgrAxis::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

CRANGE

Set this keyword to a named variable that will contain the actual full range of the axis as a double-precision floating-point vector of the form [minval, maxval]. This range may not exactly match the requested range provided via the RANGE keyword in the Init and SetProperty methods. Adjustments may have been made to round to the nearest even tick interval or to accommodate the EXTEND keyword.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object.

YRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object.

IDLgrAxis::Init

The IDLgrAxis::Init function method initializes an axis object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrAxis' [, *Direction*] [, AM_PM{Get, Set}=*array*] [, COLOR{Get, Set}=*index or RGB_vector*] [, DAYS_OF_WEEK{Get, Set}=*array*] [, DIRECTION{Get, Set}=*integer*] [, /EXACT{Get, Set}] [, /EXTEND{Get, Set}] [, GRIDSTYLE{Get, Set}=*integer*{0 to 6}or *[repeat*{1 to 255}, *bitmask]*] [, /HIDE{Get, Set}] [, LOCATION{Get, Set}=*[x*, *y]* or *[x*, *y*, *z]*] [, /LOG{Get, Set}] [, MAJOR{Get, Set}=*integer*] [, MINOR{Get, Set}=*integer*] [, MONTHS{Get, Set}=*array*] [, NAME{Get, Set}=*string*] [, /NOTEXT{Get, Set}] [, PALETTE{Get, Set}=*objref*] [, RANGE{Get, Set}=*[min*, *max]*] [, SUBTICKLEN{Get, Set}=*value*] [, TEXTALIGNMENTS{Get, Set}=*[horiz*{0.0 to 1.0}, *vert*{0.0 to 1.0}*]*] [, TEXTBASELINE{Get, Set}=*vector*] [, TEXTPOS{Get, Set}={0 | 1}] [, TEXTUPDIR{Get, Set}=*vector*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, TICKDIR{Get, Set}={0 | 1}] [, TICKFORMAT{Get, Set}=*string or array of strings*] [, TICKFRMTDATA{Get, Set}=*value*] [, TICKINTERVAL{Get, Set}=*value*] [, TICKLAYOUT{Get, Set}=*scalar*] [, TICKLEN{Get, Set}=*value*] [, TICKTEXT{Get, Set}=*objref or vector*] [, TICKUNITS{Get, Set}=*string*] [, TICKVALUES{Get, Set}=*vector*] [, TITLE{Get, Set}=*objref*] [, /USE_TEXT_COLOR{Get, Set}] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrAxis::]Init([*Direction*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Direction

An integer value specifying which axis is being created. Specify 0 (zero) to create an X axis, 1 (one) to create a Y axis, or 2 to create a Z axis.

Keywords

Properties retrievable via IDLgrAxis::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrAxis::SetProperty are indicated by the word "Set" following the keyword.

AM_PM *(Get, Set)*

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the TICKFORMAT keyword.

COLOR *(Get, Set)*

Set this keyword to the color to be used as the foreground color for this axis. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

DAYS_OF_WEEK *(Get, Set)*

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the TICKFORMAT keyword.

DIRECTION *(Get, Set)*

Set this keyword to an integer value specifying which axis is being created. Specify 0 (zero) to create an X axis, 1 (one) to create a Y axis, or 2 to create a Z axis. Specifying this keyword is the same as specifying the optional *Direction* argument.

EXACT *(Get, Set)*

Set this keyword to force the axis range to be exactly as specified. If this keyword is not set, the range may be lengthened or shortened slightly to allow for evenly spaced tick marks.

EXTEND *(Get, Set)*

Set this keyword to a nonzero value to extend the axis slightly beyond the specified range. This can be useful when you specify the axis range based on the minimum and

maximum data values, but do not want the graphic to extend all the way to the end of the axis.

GRIDSTYLE *(Get, Set)*

Set this keyword to indicate the line style that should be used to draw the axis' tick marks. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the GRIDSTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `GRIDSTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

LOCATION *(Get, Set)*

Set this keyword to a two- or three-element vector of the form [*x, y*] or [*x, y, z*] to specify the coordinate through which the axis should pass. The default is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

LOG *(Get, Set)*

Set this keyword to indicate that the axis is logarithmic.

MAJOR *(Get, Set)*

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

MINOR *(Get, Set)*

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

MONTHS *(Get, Set)*

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the TICKFORMAT keyword.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

NOTEXT *(Get, Set)*

Set this keyword to prevent the tick labels and the axis title from being drawn.

PALETTE

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

RANGE *(Get, Set)*

Set this keyword to a two-element vector containing the minimum and maximum data values covered by the axis. The default is [*0.0, 1.0*]. IDL converts, maintains, and returns this data as double-precision floating-point.

SUBTICKLEN *(Get, Set)*

Set this keyword to a scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

TEXTALIGNMENTS *(Get, Set)*

Set this keyword to a two-element floating-point vector, [horizontal, vertical], specifying the horizontal and vertical alignments for the tick text. Each alignment value should be a value between 0.0 and 1.0. For horizontal alignment, 0.0 left-justifies the text; 1.0 right-justifies the text. For vertical alignment, 0.0 bottom-justifies the text, 1.0 top-justifies the text. The defaults are as follows:

- *X*-Axis: [0.5, 1.0] (centered horizontally, top-justified vertically)
- Y-Axis: [1.0, 0.5] (right-justified horizontally, centered vertically)
- Z-Axis: [1.0, 0.5] (right-justified horizontally, centered vertically)

TEXTBASELINE *(Get, Set)*

Set this keyword to a two- or three-element vector describing the direction in which the baseline of the tick text is to be oriented. Use this keyword in conjunction with the TEXTUPDIR keyword to specify the plane on which the tick text lies. The default is [1,0,0].

TEXTPOS *(Get, Set)*

Set this keyword to either a zero or one to indicate on which side of the axis the tick text labels are to be drawn. The table below describes the placement of the tick text with each setting.

Axis	TEXTPOS=0	TEXTPOS=1
X	Tick text will be drawn *below* the X axis, where *below* is defined as being toward the direction of the negative Y axis (this is the default).	Tick text will be drawn *above* the X axis, where *above* is described as being toward the direction of the positive Y axis.
Y	Tick text will be drawn to the *left* of the Y Axis, where *left* is defined as being toward the direction of the negative X axis (this is the default).	Tick text will be drawn to the *right* of the Y axis, where *right* is defined as being toward the direction of the positive X axis.
Z	Tick text will be drawn to the *left* of the Z axis, where *left* is defined as being toward the direction of the negative X axis (this is the default).	Tick text will be drawn to the *right* of the Z axis, where *right* is defined as being toward the direction of the positive X axis.

Table A-23: Values for the TEXTPOS keyword

TEXTUPDIR *(Get,Set)*

Set this keyword to a two- or three-element vector describing the direction in which the up-vector of the tick text is to be oriented. Use this keyword in conjunction with the TEXTBASELINE keyword to specify the plane on which the tick text lies. TEXTUPDIR should be orthogonal to TEXTBASELINE. The default is as follows:

- *X*-Axis: [0, 1, 0]
- *Y*-Axis: [0, 1, 0]
- *Z*-Axis: [0, 0, 1]

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness used to draw the axis, in points. The default is 1.0 points.

TICKDIR *(Get, Set)*

Set this keyword to either zero or one to indicate the tick mark direction. For an X axis, setting TICKDIR=0 means the tick marks will be drawn above the X axis, in the direction of the positive Y axis (this is the default); setting TICKDIR=1 means the tick marks will be drawn below the X axis. For a Y axis, setting TICKDIR=0 means the tick marks will be drawn to the right of the Y axis, in the direction of the positive X axis (this is the default); setting TICKDIR=1 means the tick marks will be drawn to the left of the Y axis. For a Z axis, setting TICKDIR=0 means the tick marks will be drawn to the right the Z axis, in the direction of the positive X axis (this is the default); setting TICKDIR=1 means the tick marks will be drawn to the left of the Z axis.

TICKFORMAT *(Get, Set)*

Set this keyword to a string (or an array of strings), where each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. (The TICKUNITS keyword determines the number of levels for an axis.)

If the string begins with an open parenthesis, it is treated as a standard format string. (Refer to the Format Codes in the IDL Reference Guide.)

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

If TICKUNITS are not specified:

- The callback function is called with three parameters: Axis, Index, and Value, where:
- Axis is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- Index is the tick mark index (indices start at 0)
- Value is the data value at the tick mark (a double-precision floating point value)

If TICKUNITS are specified:

The callback function is called with four parameters: Axis, Index, Value, and Level, where:

- Axis, Index, and Value are the same as described above.
- Level is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this keyword can easily create axes with date/time labels.

TICKFRMTDATA *(Get, Set)*

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied formatting function specified via the TICKFORMAT keyword, if any. By default, this value is 0, indicating that the DATA keyword will not be set (and furthermore, need not be supported by the user-supplied function.)

Note

TICKFRMTDATA will not be included in the structure returned via the ALL keyword to the IDLgrColorbar::GetProperty method.

TICKINTERVAL (Get, Set)

Set this keyword to a scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis RANGE and the number of major tick marks (MAJOR). This keyword takes precedence over MAJOR.

For example, if TICKUNITS=['S','H','D'], and TICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

TICKLAYOUT *(Get, Set)*

Set this keyword to a scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.

1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.

2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

Note

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

TICKLEN *(Get, Set)*

Set this keyword to the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

TICKTEXT *(Get, Set)*

Set this keyword to either a single instance of the IDLgrText object class (with multiple strings) or to a vector of instances of the IDLgrText object class (one per major tick) to specify the annotations to be assigned to the tickmarks. By default, with TICKTEXT set equal to a null object, IDL computes the tick labels based on major tick values. The positions of the provided text objects may be overwritten; position is determined according to tick mark location. The tickmark text will have the same color as the IDLgrAxis object, regardless of the color specified by the COLOR property of the IDLgrText object or objects, unless the USE_TEXT_COLOR keyword is specified.

Note

If IDL computes the tick labels, the text object it creates will be destroyed automatically when the axis object is destroyed, even if you have altered the properties of the text object. If you create your own text object containing tickmark text, however, it will *not* be destroyed automatically.

TICKUNITS *(Get, Set)*

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling.

If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values.

Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS='Day' is equivalent to TICKUNITS='Days').

Note

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

TICKVALUES *(Get, Set)*

Set this keyword to a vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

TITLE *(Get, Set)*

Set this keyword to an instance of the IDLgrText object class to specify the title for the axis. The default is the null object, specifying that no title is drawn. The title will be centered along the axis, even if the text object itself has an associated location. The title will have the same color as the IDLgrAxis object, regardless of the color

specified by the COLOR property of the IDLgrText object, unless the USE_TEXT_COLOR keyword is specified.

USE_TEXT_COLOR *(Get, Set)*

Set this keyword to indicate that, for the tick text and/or title of the axis, the color property values set for the given IDLgrText objects are to be used to draw those text items. By default, this value is zero, indicating that the color properties of the IDLgrText objects will be ignored, and that the COLOR property for the axis object will be used for these text items instead.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrAxis::SetProperty

The IDLgrAxis::SetProperty procedure method sets the value of a property or group of properties for the axis.

Syntax

Obj -> [IDLgrAxis::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrAxis::Init followed by the word “Set” can be set using IDLgrAxis::SetProperty.

IDLgrBuffer

An IDLgrBuffer object is an in-memory, off-screen destination object. Object trees can be drawn to instances of the IDLgrBuffer object and the resulting image can be retrieved from the buffer using the Read() method. The off-screen representation avoids dithering artifacts by providing a full-resolution buffer for objects using either the RGB or Color Index color models.

Note

Objects or subclasses of this type can not be saved or restored.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrBuffer::Init" on page 1957.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrBuffer::Cleanup
- IDLgrBuffer::Draw
- IDLgrBuffer::Erase
- IDLgrBuffer::GetContiguousPixels
- IDLgrBuffer::GetDeviceInfo
- IDLgrBuffer::GetFontnames
- IDLgrBuffer::GetProperty
- IDLgrBuffer::GetTextDimensions

- IDLgrBuffer::Init
- IDLgrBuffer::PickData
- IDLgrBuffer::Read
- IDLgrBuffer::Select
- IDLgrBuffer::SetProperty

IDLgrBuffer::Cleanup

The IDLgrBuffer::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrBuffer::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrBuffer::Draw

The IDLgrBuffer::Draw procedure method draws the given picture to this graphics destination.

Note

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

Syntax

Obj –> [IDLgrBuffer::]Draw [, *Picture*] [, CREATE_INSTANCE={1 | 2}] [, /DRAW_INSTANCE]

Arguments

Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object) or scene (an instance of an IDLgrScene object) to be drawn.

Keywords

CREATE_INSTANCE

Set this keyword equal to one to specify that this scene or view is the unchanging part of a drawing. Some destinations can make an instance from the current window contents without having to perform a complete redraw. If the view or scene to be drawn is identical to the previously drawn view or scene, this keyword can be set equal to 2 to hint the destination to create the instance from the current window contents if it can.

DRAW_INSTANCE

Set this keyword to specify that this scene, viewgroup, or view is the changing part of the drawing. It is overlaid on the result of the most recent CREATE_INSTANCE draw.

IDLgrBuffer::Erase

The IDLgrBuffer::Erase procedure method erases this graphics destination.

Syntax

Obj **->** [IDLgrBuffer::]Erase [, COLOR=*index or RGB vector*]

Arguments

None

Keywords

COLOR

Set this keyword to the color to be used for the erase. The color may be specified as a color lookup table index or as an RGB vector.

IDLgrBuffer::GetContiguousPixels

The IDLgrBuffer::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
```

```
[4,3,2,1,0]
```

Syntax

Return = *Obj* **->** [IDLgrBuffer::]GetContiguousPixels()

Arguments

None

Keywords

None

IDLgrBuffer::GetDeviceInfo

The IDLgrBuffer::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

Syntax

Obj–>[IDLgrBuffer::]GetDeviceInfo [, ALL=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

Arguments

None.

Keywords

ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two-element integer array that specifies the maximum texture size supported by the device.

MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two-element integer array that specifies the maximum size of a graphics display supported by the device.

NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

Note

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI Irix, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

IDLgrBuffer::GetFontnames

The IDLgrBuffer::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned. See Appendix H, "Fonts" for more information.

Syntax

Return = *Obj* **->** [IDLgrBuffer::]GetFontnames(*FamilyName*[, IDL_FONTS={0 | 1 | 2 }] [, STYLES=*string*])

Arguments

FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

Keywords

IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is the string, "*", which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

IDLgrBuffer::GetProperty

The IDLgrBuffer::GetProperty procedure method retrieves the value of a property or group of properties for the buffer.

Syntax

Obj **->** [IDLgrBuffer::]GetProperty [, ALL=*variable*] [, IMAGE_DATA=*variable*] [, SCREEN_DIMENSIONS=*variable*] [, ZBUFFER_DATA=*variable*]

Keywords

Any keyword to IDLgrBuffer::Init followed by the word "Get" can be retrieved using IDLgrBuffer::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object (except IMAGE_DATA and ZBUFFER_DATA).

IMAGE_DATA

Set this keyword to a named variable that will contain a byte array representing the image that is currently rendered within the buffer. If the buffer uses an RGB color model, the returned array will have dimensions (3, *xdim*, *ydim*). If the window object uses an indexed color model, the returned array will have dimensions (*xdim*, *ydim*).

SCREEN_DIMENSIONS

Set this keyword to a named variable that will contain a two-element vector of the form [*width*, *height*] specifying the maximum allowed dimensions (measured in device units) for the buffer object.

ZBUFFER_DATA

Set this keyword to a named variable that will contain a float array representing the zbuffer that is currently within the buffer. The returned array will have dimensions (*xdim*, *ydim*).

IDLgrBuffer::GetTextDimensions

The IDLgrBuffer::GetTextDimensions function method retrieves the dimensions of a text object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text object, measured in data units.

Syntax

Result = *Obj* **->**[IDLgrBuffer::]GetTextDimensions(*TextObj*
[, DESCENT=*variable*] [, PATH=*objref(s)*])

Arguments

TextObj

The object reference to a text or axis object for which text dimensions are requested.

Keywords

DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrBuffer::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add

IDLgrBuffer::Init

The IDLgrBuffer::Init function method initializes the buffer object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrBuffer' [, COLOR_MODEL{Get}={0 | 1}] [, DIMENSIONS{Get, Set}=*[width, height]*] [, GRAPHICS_TREE{Get, Set}=*objref*] [, N_COLORS{Get}=*integer*{2 to 256}] [, PALETTE{Get, Set}=*objref*] [, QUALITY{Get, Set}={0 | 1 | 2}] [, RESOLUTION{Get, Set}=*[xres, yres]*] [, UNITS{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrBuffer::]Init( ) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrBuffer::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrBuffer::SetProperty are indicated by the word "Set" following the keyword.

COLOR_MODEL *(Get)*

Set this keyword to the color model to be used for the buffer:

- 0 = RGB (default)
- 1 = Color Index

DIMENSIONS *(Get, Set)*

Set this keyword to a two-element vector of the form [*width*, *height*] to specify the dimensions of the buffer in units specified by the UNITS property. The default is [640,480].

GRAPHICS_TREE *(Get, Set)*

Set this keyword to an object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

N_COLORS *(Get)*

Set this keyword to the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Color Index.

PALETTE *(Get, Set)*

Set this keyword to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the buffer's color lookup table.

QUALITY *(Get, Set)*

Set this keyword to an integer indicating the rendering quality at which graphics are to be drawn to the buffer. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

RESOLUTION *(Get, Set)*

Set this keyword to a two-element vector of the form [*xres*, *yres*] specifying the device resolution in centimeters per pixel. This value is stored in double precision. The default value is: [0.035277778, 0.035277778] (72 DPI).

UNITS *(Get, Set)*

Set this keyword to indicate the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to 1600 x 1200

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrBuffer::PickData

The IDLgrBuffer::Pickdata function method maps a point in the two-dimensional device space of the buffer to a point in the three-dimensional data space of an object tree. The resulting 3D data space coordinates are returned in a user-specified variable. The Pickdata function returns one if the specified location in the buffer's device space "hits" a graphic object, or zero otherwise.

Syntax

Result = *Obj* **->** [IDLgrBuffer::]PickData(*View*, *Object*, *Location*, *XYZLocation* [, PATH=*objref(s)*])

Arguments

View

The object reference of an IDLgrView object that contains the object being picked.

Object

The object reference of a model or atomic graphic object from which the data space coordinates are being requested.

Location

A two-element vector [*x*, *y*] specifying the location in the buffer's device space of the point to pick data from.

XYZLocation

A named variable that will contain the three-dimensional double-precision floating-point data space coordinates of the picked point. Note that the value returned in this variable is a location, not a data value.

Note

If the atomic graphic object specified as the target has been transformed using either the LOCATION or DIMENSIONS properties (this is only possible with IDLgrAxis, IDLgrImage, and IDLgrText objects), these transformations will *not* be included in the data coordinates returned by the Pickdata function. This means that you may need to re-apply the transformation accomplished by specifying LOCATION or DIMENSIONS once you have retrieved the data coordinates with Pickdata. This situation does not occur if you transform the axis, text, or image object using the [XYZ]COORD_CONV properties.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a data space coordinate. Each path object reference specified with this keyword must contain an alias. The data space coordinate is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrBuffer::Read

The IDLgrWindow::Read function method reads an image from a buffer. The returned value is an instance of the IDLgrImage object class.

Syntax

Result = *Obj* **->** [IDLgrBuffer::]Read()

Arguments

None

Keywords

None

IDLgrBuffer::Select

The IDLgrBuffer::Select function method returns a list of objects selected at a specified location. If no objects are selected, the Select function returns -1.

Note

IDL returns a maximum of 512 objects. This maximum may be smaller if any of the objects are contained in deep model hierarchies. Because of this limit, it is possible that not all objects eligible for selection will appear in the list.

Syntax

Result = *Obj* **->** [IDLgrBuffer::]Select(*Picture, XY* [, DIMENSIONS=*[width, height]*] [, UNITS={0 | 1 | 2 | 3}])

Arguments

Picture

The view, viewgroup, or scene (an instance of the IDLgrView, IDLgrViewgroup, or IDLgrScene class) whose children are among the candidates for selection.

If the first argument is a scene or viewgroup, then the returned object list will contain one or more views. If the first argument is a view, the list will contain atomic graphic objects (or model objects which have their SELECT_TARGET property set). Objects are returned in order, according to their distance from the viewer. The closer an object is to the viewer, the lower its index in the returned object list. If multiple objects are at the same distance from the viewer (views in a scene or 2D geometry), the last object drawn will appear at a lower index in the list.

XY

A two-element array defining the center of the selection box in device space. By default, the selection box is 3 pixels by 3 pixels.

Keywords

DIMENSIONS

Set this keyword to a two-element array [*w*, *h*] to specify that the selection box will have a width *w* and a height *h*, and will be centered about the coordinates [*x*, *y*] specified in the *XY* argument. The box occupies the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/1), y+(h/2))
```

Any object which intersects this box is considered to be selected. By default, the selection box is 3 pixels by 3 pixels.

UNITS

Set this keyword to indicate the units of measure. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the graphics destination.

IDLgrBuffer::SetProperty

The IDLgrBuffer::SetProperty procedure method sets the value of a property or group of properties for the buffer.

Syntax

Obj –> [IDLgrBuffer::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrBuffer::Init followed by the word “Set” can be retrieved using IDLgrBuffer::SetProperty.

IDLgrClipboard

An IDLgrClipboard object will send Object Graphics output to the operating system native clipboard in bitmap format. The format of bitmaps sent to the clipboard is operating system dependent: output is stored as a PICT image on the Macintosh, as a device-independent bitmap under Windows, and as an Encapsulated PostScript (EPS) image under UNIX and VMS.

Note

Objects or subclasses of this type can not be saved or restored.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrClipboard::Init" on page 1976.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrClipboard::Cleanup
- IDLgrClipboard::Draw
- IDLgrClipboard::GetContiguousPixels
- IDLgrClipboard::GetDeviceInfo
- IDLgrClipboard::GetFontnames
- IDLgrClipboard::GetProperty
- IDLgrClipboard::GetTextDimensions
- IDLgrClipboard::Init
- IDLgrClipboard::SetProperty

IDLgrClipboard::Cleanup

The IDLgrClipboard::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj-> [IDLgrClipboard::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrClipboard::Draw

The IDLgrClipboard::Draw procedure method draws the given picture to this graphics destination.

Note

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

Syntax

Obj **->** [IDLgrClipboard::]Draw [, *Picture*] [, FILENAME=*string*] [, POSTSCRIPT=*value*] [, VECTOR={ 0 | 1 }]

Arguments

Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object) or scene (an instance of an IDLgrScene object) to be drawn.

Keywords

FILENAME

Set this keyword to a string representing the name of a file to which the output should be written. By default, this keyword is the null string, indicating that the output is written to the clipboard.

POSTSCRIPT

Set this keyword to a nonzero value to indicate that the generated output should be in PostScript format. By default, the generated output is in Windows Enhanced Metafile Format on Windows platforms, PICT format on Macintosh platforms, and PostScript on Unix/VMS platforms.

VECTOR

Set this keyword to indicate the type of graphics primitives generated. Valid values include:

0 = Bitmap (default)

1 = Vector

If VECTOR = 0 (Bitmap), the Draw method renders the scene to a buffer and then copies the buffer to the printer in bitmap format. The bitmap retains the quality of the original image, but the user cannot scale the bitmap effectively on all devices.

If VECTOR = 1 (Vector), the Draw method renders the scene using simple vector operations that result in a representation of the Scene that is scalable to the printer. The vector representation does not retain all the attributes of the original image, however, a user can effectively scale it on other devices. On Windows, the representation is the Windows Enhanced Metafile (EMF). On UNIX platforms, the representation is PostScript. On Macintosh, it is PICT.

IDLgrClipboard::GetContiguousPixels

The IDLgrClipboard::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
```

```
[4,3,2,1,0]
```

Syntax

Return = *Obj* **->**[IDLgrClipboard::]GetContiguousPixels()

Arguments

None

Keywords

None

IDLgrClipboard::GetDeviceInfo

The IDLgrClipboard::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

Syntax

Obj–>[IDLgrClipboard::]GetDeviceInfo [, ALL=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

Arguments

None.

Keywords

ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two element integer array that specifies the maximum texture size supported by the device.

MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

Note

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI Irix, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

IDLgrClipboard::GetFontnames

The IDLgrClipboard::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

Syntax

Return = *Obj* **->** [IDLgrClipboard::]GetFontnames(*FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*])

Arguments

FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

Keywords

IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is the string, "*", which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

IDLgrClipboard::GetProperty

The IDLgrClipboard::GetProperty procedure method retrieves the value of a property or group of properties for the clipboard buffer.

Syntax

Obj **->** [IDLgrClipboard::]GetProperty [, ALL=*variable*] [, SCREEN_DIMENSIONS=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrClipboard::Init followed by the word "Get" can be retrieved using IDLgrClipboard::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

SCREEN_DIMENSIONS

Set this keyword to a named variable that will contain a two-element vector of the form [*width*, *height*] specifying the maximum allowed dimensions (measured in device units) for the clipboard object.

IDLgrClipboard::GetTextDimensions

The IDLgrClipboard::GetTextDimensions function method retrieves the dimensions of a text object that will be rendered in the clipboard buffer. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text object, measured in data units.

Syntax

Result = *Obj* **->**[IDLgrClipboard::]GetTextDimensions(*TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*])

Arguments

TextObj

The object reference to a text or axis object for which the text dimensions are requested.

Keywords

DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrClipboard::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrClipboard::Init

The IDLgrClipboard::Init function method initializes the clipboard object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrClipboard' [, COLOR_MODEL{Get}={0 | 1}] [, DIMENSIONS{Get, Set}=*[width, height]*] [, GRAPHICS_TREE{Get, Set}=*objref*] [, N_COLORS{Get}=*integer*{2 to 256}] [, PALETTE{Get, Set}=*objref*] [, QUALITY{Get, Set}={0 | 1 | 2}] [, RESOLUTION{Get, Set}=*[xres, yres]*] [, UNITS{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrClipboard::]Init( ) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrClipboard::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrClipboard::SetProperty are indicated by the word "Set" following the keyword.

COLOR_MODEL *(Get)*

Set this keyword to the color model to be used for the clipboard buffer:

- 0 = RGB (default)
- 1 = Color Index

DIMENSIONS *(Get, Set)*

Set this keyword to a two-element vector of the form [*width*, *height*] to specify the dimensions of the clipboard buffer in units specified by the UNITS property. The default is [640,480].

GRAPHICS_TREE *(Get, Set)*

Set this keyword to an object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

N_COLORS *(Get)*

Set this keyword to the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Color Index.

PALETTE *(Get, Set)*

Set this keyword to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the clipboard buffer's color lookup table.

QUALITY *(Get, Set)*

Set this keyword to an integer indicating the rendering quality at which graphics are to be drawn to the clipboard buffer. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

RESOLUTION *(Get, Set)*

Set this keyword to a two-element vector of the form [*xres*, *yres*] specifying the device resolution in centimeters per pixel. This value is stored in double precision. The default value is: [0.035277778, 0.035277778] (72 DPI).

Note

To match screen rendering on an IDLgrClipboard object, the following properties should be matched between the devices: DIMENSIONS, UNITS, RESOLUTION, COLOR_MODEL and N_COLORS.

UNITS *(Get, Set)*

Set this keyword to indicate the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized (relative to 1600 x 1200)

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrClipboard::SetProperty

The IDLgrClipboard::SetProperty procedure method sets the value of a property or group of properties for the clipboard buffer.

Syntax

Obj –> [IDLgrClipboard::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrClipboard::Init followed by the word “Set” can be retrieved using IDLgrClipboard::SetProperty.

IDLgrColorbar

The IDLgrColorbar object consists of a color-ramp with an optional framing box and annotation axis. The object can be horizontal or vertical.

An IDLgrColorbar object is a *composite object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

This object class is implemented in the IDL language. Its source code can be found in the file `idlgrcolorbar__define.pro` in the `lib` subdirectory of the IDL distribution.

Superclasses

This class is a subclass of IDLgrModel.

Subclasses

This class has no subclasses.

Creation

See "IDLgrColorbar::Init" on page 1985.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrColorbar::Cleanup
- IDLgrColorbar::ComputeDimensions
- IDLgrColorbar::GetProperty
- IDLgrColorbar::Init
- IDLgrColorbar::SetProperty

Inherited Methods

This class inherits the following methods:

- IDLgrModel::GetCTM

IDLgrColorbar::Cleanup

The IDLgrColorbar::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY,*Obj*

or

Obj -> [IDLgrColorbar::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrColorbar::ComputeDimensions

The IDLgrColorbar::ComputeDimensions function method retrieves the dimensions of a colorbar object for the given destination object. The result is a three-element double-precision floating-point vector [*xDim, yDim, zDim*] representing the dimensions of the colorbar object measured in data units.

Syntax

Result = Obj **->**[IDLgrColorbar::]ComputeDimensions(*DestinationObj* [, PATH=*objref(s)*])

Arguments

DestinationObject

The object reference to a destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) for which the dimensions of the colorbar are being requested.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrColorbar::ComputeDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrColorbar::GetProperty

The IDLgrColorbar::GetProperty procedure method retrieves the value of a property or group of properties for the colorbar.

Syntax

Obj **->** [IDLgrColorbar::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrColorbar::Init followed by the word "Get" can be retrieved using IDLgrColorbar::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

PARENT

Set this keyword to a named variable that will contain an object reference to the object that contains this colorbar.

XRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] specifying the range of the *x* data coordinates covered by the colorbar.

YRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] specifying the range of the *Y* data coordinates covered by the colorbar.

ZRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] specifying the range of the *Z* data coordinates covered by the colorbar.

Note

Until the colorbar is drawn to the destination object, the [XYZ]RANGE properties will be zero. Use the ComputeDimensions method on the colorbar object to get the data dimensions of the colorbar prior to a draw operation.

IDLgrColorbar::Init

The IDLgrColorbar::Init function method initializes the colorbar object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrColorbar' [, *aRed*, *aGreen*, *aBlue*]
[, BLUE_VALUES{Get, Set}=*vector*] [, COLOR{Get, Set}=*index or RGB vector*]
[, DIMENSIONS{Get, Set}=*[dx*, *dy]*] [, GREEN_VALUES{Get, Set}=*vector*]
[, /HIDE{Get, Set}] [, MAJOR{Get, Set}=*integer*] [, MINOR{Get, Set}=*integer*]
[NAME{Get, Set}=*string*] [, PALETTE{Get, Set}=*objref*] [, RED_VALUES{Get, Set}=*vector*] [, SHOW_AXIS{Get, Set}={0 | 1 | 2}] [, /SHOW_OUTLINE{Get, Set}] [, SUBTICKLEN{Get, Set}=*minor_tick_length/major_tick_length*]
[, THICK{Get, Set}=*points*{1.0 to 10.0}] [, /THREED{Get}]
[, TICKFORMAT{Get, Set}=*string*] [, TICKFRMTDATA{Get, Set}=*value*]
[, TICKLEN{Get, Set}=*value*] [, TICKTEXT{Get, Set}=*objref(s)*]
[, TICKVALUES{Get, Set}=*vector*] [, TITLE{Get, Set}=*objref*] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrColorbar::]Init([*aRed, aGreen, aBlue*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

aRed

A vector containing the red values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aRed* vector must not exceed 256.

aGreen

A vector containing the green values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aGreen* vector must not exceed 256.

aBlue

A vector containing the blue values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aBlue* vector must not exceed 256.

If *aRed*, *aGreen*, and *aBlue* are not provided, the color palette will default to a 256 entry greyscale ramp.

Keywords

Properties retrievable via IDLgrColorbar::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrColorbar::SetProperty are indicated by the word "Set" following the keyword.

BLUE_VALUES *(Get, Set)*

A vector containing the blue values for the color palette. Setting this value is the same as specifying the aBlue argument to the IDLgrColorbar::Init method.

COLOR *(Get, Set)*

Set this keyword to the color to be used as the foreground color for the axis and outline box. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

DIMENSIONS *(Get, Set)*

Set this keyword to a two element vector [*dx*, *dy*] that specifies the size of the ramp display (not the axis) in pixels. If *dx* > *dy*, the colorbar is drawn horizontally with the axis placed below or above the ramp box depending on the value of the SHOW_AXIS property. If *dx* < *dy*, the colorbar is drawn vertically with the axis

placed to the right or left of the ramp box depending on the value of the SHOW_AXIS property. The default value is [16,256].

GREEN_VALUES *(Get, Set)*

A vector containing the green values for the color palette. Setting this value is the same as specifying the *aGreen* argument to the IDLgrColorbar::Init method.

HIDE *(Get, Set)*

Set this keyword to a boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

MAJOR *(Get, Set)*

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

MINOR *(Get, Set)*

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

NAME *(Get, Set)*

Set this keyword to a string representing the name to be associated with this object. The default is the null string, ''.

PALETTE *(Get, Set)*

Set this keyword to an instance of the IDLgrPalette object class. If this keyword is a valid object reference, the colors within the IDLgrPalette are used to specify the colors for the colorbar.

RED_VALUES *(Get, Set)*

A vector containing the red values for the color palette. Setting this value is the same as specifying the *aRed* argument to the IDLgrColorbar::Init method.

SHOW_AXIS *(Get, Set)*

Set this keyword to an integer value indicating whether the axis should be drawn:

- 0 = Do not display axis (the default)

- 1 = Display axis on left side or below the color ramp
- 2 = Display axis on right side or above the color ramp

SHOW_OUTLINE *(Get, Set)*

Set this keyword to a boolean value indicating whether the colorbar bounds should be outlined:

- 0 = Do not display outline (the default)
- 1 = Display outline

SUBTICKLEN *(Get, Set)*

Set this keyword to a scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness used to draw the axis and box outline, in points. The default is 1.0 points.

THREED *(Get)*

Set this keyword on initialization to create the colorbar as a graphic object that can be fully transformed in three dimensions. By default, the colorbar always faces the viewer and is drawn at z=0.

TICKFORMAT *(Get, Set)*

Set this keyword to either a standard IDL format string (see *"Files and Input/Output"* in Chapter 8 of *Building IDL Applications* for details on format codes) or a string containing the name of a user-supplied function that returns a string to be used to format the axis tick mark labels. The function should accept integer arguments for the direction of the axis, the index of the tick mark, and the value of the tick mark, and should return a string to be used as the tick mark's label. The function may optionally accept a keyword called DATA, which will be automatically set to the TICKFRMTDATA value. The default TICKFORMAT is '', the null string, which indicates that IDL will determine the appropriate format for each value.

TICKFRMTDATA *(Get, Set)*

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied formatting function specified via the TICKFORMAT keyword, if any. By default, this value is 0, indicating that the DATA keyword will not be set (and furthermore, need not be supported by the user-supplied function). Note that

TICKFRMTDATA will not be included in the structure returned via the ALL keyword to the IDLgrColorbar::GetProperty method.

TICKLEN *(Get, Set)*

Set this keyword to the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

TICKTEXT *(Get, Set)*

Set this keyword to either a single instance of the IDLgrText object class (with multiple strings) or to a vector of instances of the IDLgrText object class (each with a single string) to specify the annotations to be assigned to the tick marks. By default, TICKTEXT is set to the NULL object, which indicates that IDL will compute tick annotations based upon the major tick values. The positions and orientation of the provided text object(s) may be overwritten by the colorbar.

TICKVALUES *(Get, Set)*

Set this keyword to a vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

TITLE *(Get, Set)*

Set this keyword to an instance of the IDLgrText object class to specify the title for the axis. The default is the null object, specifying that no title is drawn. The title will be centered along the axis, even if the text object itself has an associated location.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You may use this value to contain any information you wish.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrColorbar::SetProperty

The IDLgrColorbar::SetProperty procedure method sets the value of a property or group of properties for the colorbar.

Syntax

Obj –> [IDLgrColorbar::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrColorbar::Init followed by the word “Set” can be retrieved using IDLgrColorbar::SetProperty.

IDLgrContour

The IDLgrContour object draws a contour plot from data stored in a rectangular array or from a set of unstructured points. Both line contours and filled contour plots can be created.

An IDLgrContour object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

The object stores the following argument or property in double-precision if the DOUBLE_DATA keyword parameter is specified, and in single-precision otherwise.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrContour::Init" on page 1998.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrContour::Cleanup
- IDLgrContour::GetCTM
- IDLgrContour::GetProperty
- IDLgrContour::Init
- IDLgrContour::SetProperty

IDLgrContour::Cleanup

The IDLgrContour::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj -> [IDLgrContour::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrContour::GetCTM

The IDLgrContour::GetCTM method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrContour::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the surface object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrContour::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrContour::GetProperty

The IDLgrContour::GetProperty procedure method retrieves the value of a property or group of properties for the contour.

Syntax

Obj **->** [IDLgrContour::]GetProperty [, ALL=*variable*] [, GEOM=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrContour::Init followed by the word "Get" can be retrieved using IDLgrContour::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

GEOM

Set this keyword to a named variable that will contain the geometry associated with the contour. IDL returns this data in single-precision floating-point by default or in double-precision floating-point if the DOUBLE_GEOM keyword is set in the IDLgrContour::Init method.

PARENT

Set this keyword to a named variable that will contain an object reference to the object that contains this contour.

XRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] specifying the range of the *X* data coordinates covered by the contour.

YRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] specifying the range of the *Y* data coordinates covered by the contour.

ZRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] specifying the range of the *Z* data coordinates covered by the contour.

IDLgrContour::Init

The IDLgrContour::Init function method initializes the contour object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrContour' [, *Values*] [, ANISOTROPY{Get, Set}=*[x, y, z]*] [, C_COLOR{Get, Set}=*vector*] [, C_FILL_PATTERN{Get, Set}=*array of IDLgrPattern objects*] [, C_LINESTYLE{Get, Set}=*array of linestyles*] [, C_THICK{Get, Set}=*float array*{each element 1.0 to 10.0}] [, C_VALUE{Get, Set}=*scalar or vector*] [, COLOR{Get, Set}=*index or RGB vector*] [, DATA_VALUES{Get, Set}=*vector or 2D array*] [, /DOUBLE_DATA] [, /DOUBLE_GEOM] [, /DOWNHILL{Get, Set}] [, /FILL{Get, Set}] [, GEOMX{Set}=*vector or 2D array*] [, GEOMY{Set}=*vector or 2D array*] [, GEOMZ{Set}=*scalar, vector, or 2D array*] [, /HIDE{Get, Set}] [, MAX_VALUE{Get, Set}=*value*] [, MIN_VALUE{Get, Set}=*value*] [, NAME{Get, Set}=*string*] [, N_LEVELS{Get, Set}=*value*] [, PALETTE{Get, Set}=*objref*] [, /PLANAR{Get, Set}] [, POLYGONS{Get, Set}=*array of polygon descriptions*] [, SHADE_RANGE{Get, Set}=*[min, max]*] [, SHADING{Get, Set}={0 |1}] [, TICKINTERVAL{Get, Set}=*value*] [, TICKLEN{Get, Set}=*value*] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrContour::]Init([*Values*]) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Values

A vector or two-dimensional array of values to be contoured. If no values are provided, the values will be derived from the GEOMZ keyword value (if set and the PLANAR keyword is not set). In this case, the values to be contoured will match the Z coordinates of the provided geometry. IDL converts and maintains this data as double-precision floating-point if the argument is of type DOUBLE or if the DOUBLE_DATA keyword is set. Otherwise, the data is stored in single-precision. IDL returns the data as double-precision if it was stored in double-precision.

Keywords

Properties retrievable via IDLgrContour::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrContour::SetProperty are indicated by the word "Set" following the keyword.

ANISOTROPY *(Get, Set)*

Set this keyword equal to a three-element vector [*x, y, z*] that represents the multipliers to be applied to the internally computed correction factors along each axis that account for anisotropic geometry. Correcting for anisotropy is particularly important for the appropriate representations of downhill tickmarks.

By default, IDL will automatically compute correction factors for anisotropy based on the [XYZ] range of the contour geometry. If the geometry (as provided via the GEOMX, GEOMY, and GEOMZ keywords) falls within the range [*xmin*, *ymin*, *zmin*] to [*xmax*, *ymax*, *zmax*], then the default correction factors are computed as follows:

```
dx = xmax - xmin
dy = ymax - ymin
dz = zmax - zmin
; Get the maximum of the ranges:
maxRange = (dx > dy) > dz
IF (dx EQ 0) THEN xcorrection = 1.0 ELSE $
   xcorrection = maxRange / dx
IF (dy EQ 0) THEN ycorrection = 1.0 ELSE $
   ycorrection = maxRange / dy
IF (dz EQ 0) THEN zcorrection = 1.0 ELSE $
   zcorrection = maxRange / dz
```

This internally computed correction is then multiplied by the corresponding [*x*, *y*, *z*] values of the ANISOTROPY keyword. The default value for this keyword is [1,1,1]. IDL converts, maintains, and returns this data as double-precision floating-point.

C_COLOR *(Get, Set)*

Set this keyword to a vector of colors representing the colors to be applied at each contour level. If there are more contour levels than elements in this vector, the colors will be cyclically repeated. If C_COLORS is set to 0, all contour levels will be drawn in the color specified by the COLOR keyword (this is the default).

C_FILL_PATTERN *(Get, Set)*

Set this keyword to an array of IDLgrPattern objects representing the patterns to be applied at each contour level if the FILL keyword is non-zero. If there are more contour levels than fill patterns, the patterns will be cyclically repeated. If this keyword is set to 0, all contour levels are filled with a solid color (this is the default).

C_LINESTYLE *(Get, Set)*

Set this keyword to an array of linestyles representing the linestyles to be applied at each contour level. The array may be either a vector of integers representing pre-defined linestyles, or an array of 2-element vectors representing a stippling pattern specification. If there are more contour levels than linestyles, the linestyles will be cyclically repeated. If this keyword is set to 0, all levels are drawn as solid lines (this is the default).

C_THICK *(Get, Set)*

Set this keyword to an array of line thicknesses representing the thickness to be applied at each contour level, where each element is a value between 1.0 and 10.0. If there are more contour levels than line thicknesses, the thicknesses will be cyclically repeated. If this keyword is set to 0, all contour levels are drawn with a line thickness of 1.0 points (this is the default).

C_VALUE *(Get, Set)*

Set this keyword to a scalar value or a vector of values for which contour values are to be drawn. If this keyword is set to 0, contour levels will be evenly sampled across the range of the DATA_VALUES, using the value of the N_LEVELS keyword to determine the number of samples. IDL converts, maintains, and returns this data as double-precision floating-point.

COLOR *(Get, Set)*

Set this keyword to the color to be used to draw the contours. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0]. This value will be ignored if the C_COLORS keyword is set to a vector.

DATA_VALUES *(Get, Set)*

Set this keyword to a vector or two-dimensional array specifying the values to be contoured. The keyword is the same as the *Values* argument described in the Arguments section above. IDL converts and stores this data as double-precision floating-point if the argument is of type DOUBLE or if the DOUBLE_DATA keyword is set. Otherwise, the data is stored in single-precision. IDL returns the data as double-precision if it was stored in double-precision.

DOUBLE_DATA *(Get, Set)*

Set this keyword to indicate that the object is to store data provided by either the *Values* argument or the DATA_VALUES keyword parameter in double-precision floating-point. Otherwise, the data is stored in single-precision floating-point. IDL converts any value data already stored in the object to the requested precision, if necessary.

DOUBLE_GEOM *(Get, Set)*

Set this keyword to indicate that the object is to store data provided by any of the GEOMX, GEOMY, or GEOMZ keyword parameters in double-precision floating-point. Otherwise, the data is stored in single-precision floating-point. IDL converts any geometry data already stored in the object to the requested precision, if necessary.

DOWNHILL *(Get, Set)*

Set this keyword to indicate that downhill tick marks should be rendered as part of each contour level to indicate the downhill direction relative to the contour line.

FILL *(Get, Set)*

Set this keyword to indicate that the contours should be filled. The default is to draw the contour levels as lines without filling. Filling contour may produce less than satisfactory results if your data contains NaNs, or if the contours are not closed.

GEOMX *(Set)*

Set this keyword to a vector or two-dimensional array specifying the X coordinates of the geometry with which the contour values correspond. If X is a vector, it must match the number of elements in the *Values* argument or DATA_VALUES keyword value, or it must match the first of the two dimensions of the *Values* argument or DATA_VALUES keyword value (in which case, the X coordinates will be repeated for each row of data values). IDL converts and maintains this data as double-precision floating-point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single-

precision. IDL returns the data as double-precision if it was stored in double-precision.

GEOMY *(Set)*

Set this keyword to a vector or two-dimensional array specifying the Y coordinates of the geometry with which the contour values correspond. If Y is a vector, it must match the number of elements in the *Values* argument or DATA_VALUES keyword value, or it must match the second of the two dimensions of the *Values* argument or DATA_VALUES keyword value (in which case, the Y coordinates will be repeated for each column of data values). IDL converts and maintains this data as double precision floating point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single precision. IDL returns the data as double precision if it was stored in double precision.

GEOMZ *(Set)*

Set this keyword to a scalar, a vector, or a two-dimensional array specifying the Z coordinates of the geometry with which the contour values correspond.

- If GEOMZ is a scalar, and the PLANAR keyword is set, the resulting contour geometry will be projected onto the plane Z=GEOMZ. If GEOMZ is a scalar, and the PLANAR keyword is not set, any geometry associated with the contour will be freed.
- If GEOMZ is a vector or an array, it must match the number of elements in the *Values* argument or the DATA_VALUES keyword value.
- If GEOMZ is not set, the geometry will be derived from the DATA_VALUES property (if it is set to a two-dimensional array). In this case, the connectivity is implied. The X and Y coordinates match the row and column indices of the array, and the Z coordinates match the data values.

IDL converts and maintains this data as double precision floating point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single precision. IDL returns the data as double precision if it was stored in double precision.

HIDE *(Get, Set)*

Set this keyword to a boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

MAX_VALUE *(Get, Set)*

Set this keyword to the maximum value to be plotted. Data values greater than this value are treated as missing data. The default is the maximum value of the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

MIN_VALUE *(Get, Set)*

Set this keyword to the minimum value to be plotted. Data values less than this value are treated as missing data. The default is the minimum value of the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword to a string representing the name to be associated with this object. The default is the null string, ''.

N_LEVELS *(Get, Set)*

Set this keyword to the number of contour levels to generate. This keyword is ignored if the C_VALUE keyword is set to a vector, in which case, the number of levels is derived from the number of elements in that vector. Set this keyword to zero to indicate that IDL should compute a default number of levels based on the range of data values. This is the default.

PALETTE

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

PLANAR *(Get, Set)*

Set this keyword to indicate that the contoured data is to be projected onto a plane. This keyword is ignored if GEOMZ is not a scalar. The default is non-planar (i.e., to display the contoured data at the Z locations provided by the GEOMZ keyword.

POLYGONS *(Get, Set)*

Set this keyword to an array of polygon descriptions that represents the connectivity information for the data to be contoured (as specified in the *Values* argument or the DATA_VALUES keyword). A polygon description is an integer or longword array of the form: [*n*, i0, i1, ..., i*n*-1], where *n* is the number of vertices that define the

polygon, and i0..i*n*-1 are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGONS array, set the vertex count, *n*, to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this keyword is not specified, a single polygon will be generated.

Note

The connectivity array described by POLYGONS allows an individual object to contain more than one polygon. Vertex, normal, and color information can be shared by the multiple polygons. Consequently, the polygon object can represent an entire mesh and compute reasonable normal estimates in most cases.

SHADE_RANGE *(Get, Set)*

Set this keyword to a two-element array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. This value is ignored when the contour is drawn to a graphics destination that uses the RGB color model.

SHADING *(Get, Set)*

Set this keyword to an integer representing the type of shading to use:

- 0 = Flat (default): The color has a constant intensity for each face of the contour, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

TICKINTERVAL *(Get, Set)*

Set this keyword equal to a number indicating the distance between downhill tickmarks, in data units. If TICKINTERVAL is not set, or if you explicitly set it to zero, IDL will compute the distance based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point.

TICKLEN *(Get, Set)*

Set this keyword equal to a number indicating the length of the downhill tickmarks, in data units. If TICKLEN is not set, or if you explicitly set it to zero, IDL will compute the length based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point

UVALUE *(Get, Set)*

Set this keyword to a value of any type. Use this value to contain any information you wish.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrContour::SetProperty

The IDLgrContour::SetProperty procedure method sets the value of a property or group of properties for the contour.

Syntax

Obj –> [IDLgrContour::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrContour::Init followed by the word “Set” can be retrieved using IDLgrContour::SetProperty.

IDLgrFont

A font object represents a typeface, style, weight, and point size that may be associated with text objects.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLgrFont::Init" on page 2010.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrFont::Cleanup
- IDLgrFont::GetProperty
- IDLgrFont::Init
- IDLgrFont::SetProperty

IDLgrFont::Cleanup

The IDLgrFont::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrFont::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrFont::GetProperty

The IDLgrFont::GetProperty procedure method retrieves the value of a property or group of properties for the font.

Syntax

Obj **->** [IDLgrFont:]GetProperty [, ALL=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrFont::Init followed by the word "Get" can be retrieved using IDLgrFont::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

IDLgrFont::Init

The IDLgrFont::Init function method initializes the font object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrFont' [, *Fontname*] [, NAME{Get, Set}=*string*] [, SIZE{Get, Set}=*points*] [, SUBSTITUTE{Get, Set}={ 'Helvetica' | 'Courier' | 'Times' | 'Symbol' | 'Hershey'}] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrFont::]Init([*Fontname*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Fontname

A string representing the name of the font to be used. This string should take the form 'fontname*modifier1*modifier2*...*modifierN'. All destination objects support the following fontnames: Helvetica, Courier, Times, Symbol, and Monospace Symbol. (These fonts are included with IDL; you may have other fonts installed on your system as well.) Valid modifiers for each of these fonts (except Symbol and Monospace Symbol) are:

- *Font weight:* Bold
- *Font angle:* Italic

For example, 'Helvetica*Bold*Italic'.

To select a Hershey font, use a fontname of the form: 'Hershey*fontnum'. See Appendix H, "Fonts" for further information and a list of fonts supported by IDL.

Note

Beginning with IDL version 5.1, only TrueType and Hershey fonts are supported in the Object Graphics system.

Keywords

Properties retrievable via IDLgrFont::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrFont::SetProperty are indicated by the word "Set" following the keyword.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name of the font to use. Setting the NAME keyword is the same as supplying the *Fontname* argument described above.

SIZE *(Get, Set)*

Set this keyword equal to a floating-point integer representing the point size of the font. The default is 12.0 points.

SUBSTITUTE *(Get, Set)*

Set this keyword to a string that indicates the font to use as a substitute if the specified *Fontname* is not available on the graphics destination. Valid values are only those fonts that are available on all destination objects (the fonts included with IDL). These are: 'Helvetica' (the default), 'Courier', 'Times', 'Symbol', or 'Hershey'.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, indicating the line thickness (measured in points) to use for the Hershey vector fonts. The default is 1.0 points.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrFont::SetProperty

The IDLgrFont::SetProperty procedure method sets the value of a property or group of properties for the font.

Syntax

Obj –> [IDLgrFont:]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrFont::Init followed by the word “Set” can be set using IDLgrFont::SetProperty.

IDLgrImage

An image object represents a mapping from a two-dimensional array of data values to a two dimensional array of pixel colors, resulting in a flat 2D-scaled version of the image, drawn at Z = 0.

The image object is drawn at Z =0 and is positioned and sized with respect to two points:

```
p1 = [LOCATION(0), LOCATION(1), 0]
p2 = [LOCATION(0) + DIMENSION(0), LOCATION(1) + DIMENSION(1), 0].
```

where LOCATION and DIMENSION are properties of the image object. These points are transformed in three dimensions, resulting in screen space points designated as p1' and p2'. The image data is drawn on the display as a 2D image within the 2D rectangle defined by (p1'[0], p1'[1] - p2'[0], p2'[1]). The 2D image data is scaled in 2D (not rotated) to fit into this projected rectangle and then drawn with Z buffering disabled

Note

Image objects do not take into account the Z locations of other objects that may be included in the view object. This means that objects that are drawn to the destination object (window or printer) *after the image is drawn* will appear to be in front of the image, even if they are located at a negative Z value (behind the image object). Objects are drawn to a destination device in the order that they are added (via the Add method) to the model, view, or scene that contains them. To rotate or position image objects in three-dimensional space, use the IDLgrPolygon object with texture mapping enabled.

An IDLgrImage object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrImage::Init" on page 2020.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrImage::Cleanup
- IDLgrImage::GetCTM
- IDLgrImage::GetProperty
- IDLgrImage::Init
- IDLgrImage::SetProperty

IDLgrImage::Cleanup

The IDLgrImage::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrImage::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrImage::GetCTM

The IDLgrImage::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrImage::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the image object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrImage::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrImage::GetProperty

The IDLgrImage::GetProperty procedure method retrieves the value of the property or group of properties for the image.

Syntax

Obj **–>** [IDLgrImage::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrImage::Init followed by the word "Get" can be retrieved using IDLgrImage::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object.

YRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object.

IDLgrImage::Init

The IDLgrImage::Init function method initializes the image object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrImage' [, *ImageData*] [, BLEND_FUNCTION{Get, Set}=*vector*] [, CHANNEL{Get, Set}=*hexadecimal bitmask*] [, DATA{Get, Set}=*nxm*, *2xnxm*, *3xnxm*, or *4xnxm array of image data*] [, DIMENSIONS{Get, Set}=*[width*, *height]*] [, /GREYSCALE{Get, Set}] [, /HIDE{Get, Set}] [, INTERLEAVE{Get, Set}={0 | 1 | 2}] [, /INTERPOLATE{Get, Set}] [LOCATION{Get, Set}=*[x*, *y] or [x*, *y*, *z]*] [, NAME{Get, Set}=*string*] [, /NO_COPY{Get, Set}] [, /ORDER{Get, Set}] [, PALETTE{Get, Set}=*objref*] [, /RESET_DATA{Set}] [, SHARE_DATA{Set}=*objref*] [, SUB_RECT{Get, Set}=*[x*, *y*, *xdim*, *ydim]*] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrImage::]Init([*ImageData*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

ImageData

An array of data values to be displayed as an image. If this argument is not already of byte type, it is converted to byte type when the image object is created. Since IDL maintains the image data using the byte type, the input data values should range from

0 through 255. The input data values can be either color lookup table indices when using a palette or channel intensities for greyscale or RGB images with an optional Alpha channel. When used as channel intensities, the data value of 0 specifies minimum intensity and the data value of 255 specifies maximum intensity. The Alpha channel values are also specified in the image data in the range 0 through 255, with an image data value of 0 corresponding to an Alpha blend factor of 0 and an image data value of 255 corresponding to an Alpha blend factor of 1.0. *ImageData* can be any of the following, where *n* is the width of the image, and *m* is the height:

- An *n* x *m* array of color lookup table indices.
- An *n* x *m* greyscale image, or a 2 x *n* x *m*, *n* x 2 x *m*, or *n* x *m* x 2 greyscale image with an alpha channel. (The alpha channel is ignored if the destination device uses Indexed color mode.)
- A 3 x *n* x *m*, *n* x 3 x *m*, or *n* x *m* x 3 RGB image, or a 4 x *n* x *m*, *n* x 4 x *m*, or *n* x *m* x 4 RGB image with an alpha channel.

If the array has more than one channel, the interleave is specified by the INTERLEAVE property.

Keywords

Properties retrievable via IDLgrImage::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrImage::SetProperty are indicated by the word “Set” following the keyword.

BLEND_FUNCTION *(Get, Set)*

Set this keyword equal to a two-element vector [*src*, *dst*] specifying one of the functions listed below for each of the source and destination objects. These are only valid for RGB model destinations. If no Alpha data are specified in an image, the image’s Alpha blend factor is assumed to be 1.0. The values of the blending function (V_{src} and V_{dst}) are used in the following equation

$$C_d' = (V_{src} \cdot C_i) + (V_{dst} \cdot C_d)$$

where C_d is the initial color of a pixel on the destination device (the background color), C_i is the color of the pixel in the image, and C_d' is the resulting color of the pixel.

Setting *src* and *dst* in the BLEND_FUNCTION vector to the following values determine how each term in the equation is calculated:

src or dst	V_{src} or V_{dst}	What the function does
0	n/a	Alpha blending is disabled. $C_d' = C_i$.
1	0	The value of V_{src} or V_{dst} in the equation is zero, thus the value of the term is zero.
2	1	The value of V_{src} or V_{dst} in the equation is one, thus the value of the term is the same as the color value.
3	$Image_\alpha$	The value of V_{src} or V_{dst} in the equation is the blend factor of the image's Alpha channel.
4	$1\text{-}Image_\alpha$	The value of V_{src} or V_{dst} in the equation is one minus the blend factor of the image's Alpha channel.

Table A-24: Values for src and dst in BLEND_FUNCTION

Since the Alpha blending operation is dependent on the values of pixels already drawn to the destination for some blending functions, the final result may depend more on the order of drawing the images, and not necessarily on their relative location along the Z axis. IDL draws images in the order that they are stored in the IDLgrModel object that contains them.

CHANNEL *(Get, Set)*

Set this keyword to a hexadecimal bitmask that defines which color channel(s) to draw. Each bit that is a 1 is drawn; each bit that is a 0 is not drawn. For example, 'ff0000'X represents a Red channel write. The default is to draw all channels, and is represented by the hexadecimal value 'ffffff'X.

Note

This keyword is ignored for CI destination objects.

DATA *(Get, Set)*

Set this keyword to a *n* x *m*, *2 x n x m*, *3 x n* x *m*, or *4 x n* x *m* array of image data for the object. The *n* and *m* values may be in any position as specified by the

INTERLEAVE keyword. This keyword is equivalent to the optional argument, *ImageData*.

DIMENSIONS *(Get, Set)*

Set this keyword equal to a two-element vector of the form [*width*, *height*] specifying the dimensions of the rectangle in which the image is to be drawn on the device. The image will be resampled as necessary to fit within this rectangle. The default is derived from the dimensions of the given image data and is measured in pixels. IDL converts, maintains, and returns this data as double-precision floating-point.

GREYSCALE *(Get, Set)*

Set this keyword to specify that the image not be drawn through a palette.

If this keyword is not set, for an RGB colormodel destination, if a palette is present in the image object, it is used. If there is no current destination palette, a greyscale palette is used. For a Color Index colormodel destination, the current destination palette is used.

Note

Only single band images (i.e. *1 x n x m*) are affected by this keyword. By default, GREYSCALE is disabled.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

INTERLEAVE *(Get, Set)*

Set this keyword to indicate the dimension over which color is interleaved for images with more than one channel:

- 0 = Pixel interleaved: Images with dimensions (3, *m*, *n*)
- 1 = Scanline interleaved (row interleaved): Images with dimensions (*m*, 3, *n*)
- 2 = Planar interleaved: Images with dimensions (*m*, *n*, 3).

Note

If an alpha channel is present, the 3s should be replaced by 4s. In a greyscale image with an alpha channel, the 3s should be replaced by 2s.

INTERPOLATE *(Get, Set)*

Set this keyword to one to display the IDLgrImage object using bilinear interpolation. The default is to use nearest neighbor interpolation.

LOCATION *(Get, Set)*

A two- or three-element vector [*x*, *y*] or [*x*, *y*, *z*] specifying the position of the lower lefthand corner of the image, measured in data units. If the vector is of the form [*x*, *y*], then the *z* value is set equal to zero. The default is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

NO_COPY *(Get, Set)*

Set this keyword to relocate the image data from the input variable to the image object, leaving the input variable *ImageData* undefined. Only the *ImageData* argument is affected. If this keyword is omitted, the input image data will be duplicated and a copy will be stored in the object.

ORDER *(Get, Set)*

Set this keyword to force the rows of the image data to be drawn from top to bottom. By default, image data is drawn from the bottom row up to the top row.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values of the color lookup table to be associated with the image if it is an indexed color image. This property is ignored if the image is a greyscale or RGB image.

Note

This table is only used when the destination is an RGB model device. The Indexed color model writes the indices directly to the device. In order to ensure that these colors are used when the image is displayed, this palette must be copied to the graphics destination's palette for any graphics destination that uses the Indexed color model.

RESET_DATA *(Set)*

Set this keyword to treat the data provided via the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this keyword if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This keyword has no effect if no new data is provided via the DATA property.

SHARE_DATA *(Set)*

Set this keyword equal to the object reference of an object with which data is to be shared by this image. An image may only share data with another image. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

SUB_RECT *(Get, Set)*

Set this keyword to a four-element vector, [*x*, *y*, *xdim*, *ydim*], specifying the position of the lower left-hand corner and the dimensions of the sub-rectangle to display.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrImage::SetProperty

The IDLgrImage::SetProperty procedure method sets the value of the property or group of properties for the image.

Syntax

Obj –> [IDLgrImage::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrImage::Init followed by the word “Set” can be set using IDLgrImage::SetProperty.

IDLgrLegend

The IDLgrLegend object provides a simple interface for displaying a legend. The legend itself consists of a (filled and/or framed) box around one or more legend items (arranged in a single column) and an optional title string. Each legend item consists of a glyph patch positioned to the left of a text string. The glyph patch is drawn in a square which is a fraction of the legend label font height. The glyph itself can be in one of two types (see the TYPE keyword). In line type, the glyph is a line segment with linestyle, thickness and color attributes and an optional symbol object drawn over it. In fill type, the glyph is a square patch drawn with color and optional pattern object attributes.

An IDLgrLegend object is a *composite object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

This object class is implemented in the IDL language. Its source code can be found in the file `idlgrlegend__define.pro` in the `lib` subdirectory of the IDL distribution.

Superclasses

This class is a subclass of IDLgrModel.

Subclasses

This class has no subclasses.

Creation

See "IDLgrLegend::Init" on page 2034.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrLegend::Cleanup
- IDLgrLegend::ComputeDimensions
- IDLgrLegend::GetProperty
- IDLgrLegend::Init

- IDLgrLegend::SetProperty

Inherited Methods

This class inherits the following methods:

- IDLgrModel::GetCTM

IDLgrLegend::Cleanup

The IDLgrLegend::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrLegend::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrLegend::ComputeDimensions

The IDLgrLegend::ComputeDimensions function method retrieves the dimensions of a legend object for the given destination object. The result is a three-element double-precision floating-point vector [*xDim, yDim, zDim*] representing the dimensions of the legend object measured in data units.

Syntax

Result = Obj **->**[IDLgrLegend::]ComputeDimensions(*DestinationObject* [, PATH=*objref(s)*])

Arguments

DestinationObject

The object reference to a destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) for which the dimensions of the legend are being requested.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrLegend::ComputeDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrLegend::GetProperty

The IDLgrLegend::GetProperty procedure method retrieves the value of a property or group of properties for the legend.

Syntax

Obj **->** [IDLgrLegend::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrLegend::Init followed by the word "Get" can be retrieved using IDLgrLegend::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

PARENT

Set this keyword to a named variable that will contain an object reference to the object that contains this legend.

XRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] specifying the range of the *X* data coordinates covered by the legend.

YRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] specifying the range of the *Y* data coordinates covered by the legend.

ZRANGE

Set this keyword to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] specifying the range of the *Z* data coordinates covered by the legend.

Note

Until the legend is drawn to the destination object, the [XYZ]RANGE properties will be zero. Use the ComputeDimensions method on the legend object to get the data dimensions of the legend prior to a draw operation.

IDLgrLegend::Init

The IDLgrLegend::Init function method initializes the legend object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrLegend' [, *aItemNames*] [, BORDER_GAP{Get, Set}=*value*] [, COLUMNS{Get, Set}=*integer*] [, FILL_COLOR{Get, Set}=*index or RGB vector*] [, FONT{Get, Set}=*objref*] [, GAP{Get, Set}=*value*] [, GLYPH_WIDTH{Get, Set}=*value*] [, /HIDE{Get, Set}] [, ITEM_COLOR{Get, Set}=*array of colors*] [, ITEM_LINESTYLE{Get, Set}=*int array*] [, ITEM_NAME{Get, Set}=*string array*] [, ITEM_OBJECT{Get, Set}=*array of objrefs of type IDLgrSymbol or IDLgrPattern*] [, ITEM_THICK{Get, Set}=*float array*{each element 1.0 to 10.0}] [, ITEM_TYPE{Get, Set}=*int array*{each element 0 or 1}] [, NAME{Get, Set}=*string*] [, OUTLINE_COLOR{Get, Set}=*index or RGB vector*] [, OUTLINE_THICK{Get, Set}=*points*{1.0 to 10.0}] [, /SHOW_FILL{Get, Set}] [, /SHOW_OUTLINE{Get, Set}] [, TEXT_COLOR{Get, Set}=*index or RGB vector*] [, TITLE{Get, Set}=*objref*] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrLegend::]Init([*aItemNames*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

aItemNames

An array of strings to be used as the displayed item label. The length of this array is used to determine the number of items to be displayed. Each item is defined by taking one element from the ITEM_NAME, ITEM_TYPE, ITEM_LINESTYLE, ITEM_THICK, ITEM_COLOR, and ITEM_OBJECT vectors. If the number of items (as defined by the ITEM_NAME array) exceeds any of the attribute vectors, the attribute defaults will be used for any additional items.

Keywords

Properties retrievable via IDLgrLegend::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrLegend::SetProperty are indicated by the word “Set” following the keyword.

BORDER_GAP *(Get, Set)*

Set this keyword to a floating-point value to indicate the amount of blank space to be placed around the outside of the glyphs and text items. The units for this property are fractions of the legend label font height. The default is 0.1 (10% of the label font height).

COLUMNS *(Get, Set)*

Set this keyword to an integer value to indicate the number of columns the legend items should be displayed in. The default is one column.

FILL_COLOR *(Get, Set)*

Set this keyword to the color to be used to fill the legend background box. The color may be specified as a color lookup table index or as an RGB vector. The default is [255,255,255].

FONT *(Get, Set)*

Set this keyword to an instance of an IDLgrFont object class to describe the font to use to draw the legend labels. The default is 12 point Helvetica.

Note

If the default font is in use, retrieving the value of the FONT property (using the GetProperty method) will return a font object that will be destroyed when this legend object is destroyed, leaving a dangling object reference.

GAP *(Get, Set)*

Set this keyword to a floating-point value to indicate the amount of blank space to be placed vertically between each legend item. The units for this keyword are fractions of the legend label font height. The default is 0.1 (10% of the label font height). The same gap is placed horizontally between the legend glyph and the legend text string.

GLYPH_WIDTH *(Get, Set)*

Set this keyword to a floating-point value to indicate the width of the glyphs, measured as a fraction of the font height. The default is 0.8 (80% of the font height).

HIDE *(Get, Set)*

Set this keyword to a boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

ITEM_COLOR *(Get, Set)*

Set this keyword to an array of colors defining the color of each item. The array defines *M* different colors, and should be either of the form [3,*M*] or [*M*]. In the first case, the three values are used as an RGB triplet, in the second case, the single value is used as a color index value. The default color is [0,0,0].

ITEM_LINESTYLE *(Get, Set)*

Set this keyword to an array of integers defining the style of the line to be drawn if the TYPE property is set to zero. The array can be of the form [*M*] or [2,*M*]. The first form selects the linestyle for each legend item from the predefined defaults:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash
- 6 = no line drawn

The second form specifies the stippling pattern explicitly for each legend item (see the LINESTYLE keyword to IDLgrPolyline::Init for details).

ITEM_NAME *(Get, Set)*

Set this keyword to an array of strings. Specifying this keyword is the same as providing the *aName* argument for the IDLgrLegend::Init method.

ITEM_OBJECT *(Get, Set)*

Set this keyword to an array of object references of type IDLgrSymbol or IDLgrPattern. A symbol object is drawn only if the TYPE property is set to zero. A pattern object is used when drawing the color patch if the TYPE property is set to one. The default object is the NULL object.

Note

If one or more IDlgrSymbol object references are provided, the SIZE property of those objects may be modified by this legend to suit its layout needs.

ITEM_THICK *(Get, Set)*

Set this keyword to an array of floats that define the thickness of each item line, in points, where each element is a value between 1.0 and 10.0. This property is only used if the TYPE property is set to zero. The default is 1.0 points.

ITEM_TYPE *(Get, Set)*

Set this keyword to an array of integers which define the type of glyph to be displayed for each item:

- 0 = line type (the default)
- 1 = filled box type

NAME *(Get, Set)*

Set this keyword to a string representing the name to be associated with this object. The default is the null string, ''.

OUTLINE_COLOR *(Get, Set)*

Set this keyword to the color to be used to draw the legend outline box. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0].

OUTLINE_THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0 that defines the thickness of the outline frame, in points. The default is 1.0 points.

SHOW_FILL *(Get, Set)*

Set this keyword to a boolean value indicating whether the background should be filled with a color:

- 0 = Do not fill background (the default)
- 1 = Fill background

SHOW_OUTLINE *(Get, Set)*

Set this keyword to a boolean value indicating whether the outline box should be displayed:

- 0 = Do not display outline (the default)
- 1 = Display outline

TEXT_COLOR *(Get, Set)*

Set this keyword to the color to be used to draw the legend item text. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0].

TITLE *(Get, Set)*

Set this keyword to an instance of the IDLgrText object class to specify the title for the legend. The default is the null object, specifying that no title is drawn. The title will be centered at the top of the legend, even if the text object itself has an associated location.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. Use this value to contain any information you wish.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrLegend::SetProperty

The IDLgrLegend::SetProperty procedure method sets the value of a property or group of properties for the legend.

Syntax

Obj–> [IDLgrLegend::]SetProperty [, RECOMPUTE={0 | 1}{0 prevents recompute, 1 is the default}]

Arguments

None

Keywords

Any keyword to IDLgrLegend::Init followed by the word “Set” can be retrieved using IDLgrLegend::SetProperty. In addition, the following keywords are available:

RECOMPUTE

Set this keyword to 1 to force IDL to recompute the legend dimensions when the legend is redrawn. Set this keyword to 0 to prevent IDL from recomputing legend dimensions.

IDLgrLight

A light object represents a source of illumination for three-dimensional graphic objects. Lights may be either ambient, positional, directional, or spotlights. A maximum of 8 lights per view are allowed. Lights are not required for objects displayed in two dimensions.

An IDLgrLight object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrLight::Init" on page 2046.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrLight::Cleanup
- IDLgrLight::GetCTM
- IDLgrLight::GetProperty
- IDLgrLight::Init
- IDLgrLight::SetProperty

IDLgrLight::Cleanup

The IDLgrLight::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrLight::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrLight::GetCTM

The IDLgrLight::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrLight::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the light object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrLight::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrLight::GetProperty

The IDLgrLight::GetProperty procedure method retrieves the value of a property or group of properties for the light.

Syntax

Obj **->** [IDLgrLight::]GetProperty [, ALL=*variable*] [, PARENT=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrLight::Init followed by the word "Get" can be retrieved using IDLgrLight::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

IDLgrLight::Init

The IDLgrLight::Init function method initializes the light object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrLight' [, ATTENUATION{Get, Set}=*[constant, linear, quadratic]*] [, COLOR{Get, Set}=*[R, G, B]*] [, CONEANGLE{Get, Set}=*degrees*] [, DIRECTION{Get, Set}=*3-element vector*] [, FOCUS{Get, Set}=*value*] [, /HIDE{Get, Set}] [, INTENSITY{Get, Set}=*value*{0.0 to 1.0}] [, LOCATION{Get, Set}=*[x, y, z]*] [, NAME{Get, Set}=*string*] [, TYPE{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrLight::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrLight::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrLight::SetProperty are indicated by the word "Set" following the keyword.

ATTENUATION *(Get, Set)*

Set this keyword to a 3-element floating-point vector of the form [constant, linear, quadratic] that describes the factor by which light intensity is to fall with respect to distance from the light source. ATTENTUATION applies only to Positional and Spot lights, as specified by the TYPE keyword. The overall attenuation factor is computed as follows:

```
attenuation = 1/(constant + linear*distance +
quadratic*distance^2)
```

By default, the values are [1, 0, 0].

COLOR *(Get, Set)*

Set this keyword to a three-element vector specifying the RGB color of the light. The default is [255, 255, 255], which is a white light. The color of a light is ignored when graphics are sent to graphics destinations using the Indexed color model, in which case light intensities are scaled into the range of colors available on the graphics destination.

CONEANGLE *(Get, Set)*

Set this keyword to the angle (measured in degrees) of coverage for a spotlight. The default is 60.

DIRECTION *(Get, Set)*

Set this keyword to the three-element vector representing the direction in which a spotlight is to be pointed. The default is [0,0,-1].

Note

For directional lights, the light's parallel rays follow a vector beginning at the position specified by LOCATION and ending at [0, 0, 0].

FOCUS *(Get, Set)*

Set this keyword to a floating-point value that describes the attenuation of intensity for spotlights as the distance from the center of the cone of coverage increases. This factor is used as an exponent to the cosine of the angle between the direction of the spotlight and the direction from the light to the vertex being lighted. The default is 0.0.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this light should be enabled:

- 0 = Enable light (the default)
- 1 = Disable light

Note

If no lights are present in the view (or if all lights in the view are hidden), an ambient light will be provided by default.

INTENSITY *(Get, Set)*

Set this keyword to a floating-point value between 0.0 (darkest) and 1.0 (brightest) indicating the intensity of the light. The default is 1.0.

LOCATION *(Get, Set)*

Set this keyword to a vector of the form [*x, y, z*] describing the position of the light. By default, the position is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

TYPE *(Get, Set)*

Set this keyword to one of the following values, indicating the type of light. Valid values are:

- 0 = Ambient light. An ambient light is a universal light source, which has no direction or position. An ambient light illuminates every surface in the scene equally, which means that no edges are made visible by contrast. Ambient lights control the overall brightness and color of the entire scene. If no value is specified for the TYPE property, an ambient light is created.
- 1 = Positional light. A positional light supplies divergent light rays, and will make the edges of surfaces visible by contrast if properly positioned. A positional light source can be located anywhere in the scene.
- 2 = Directional light. A directional light supplies parallel light rays. The effect is that of a positional light source located at an infinite distance from scene.
- 3 = Spot light. A spot light illuminates only a specific area defined by the light's position, direction, and the cone angle, or angle which the spotlight covers.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrLight::SetProperty

The IDLgrLight::SetProperty procedure method sets the value of a property or group of properties for the light.

Syntax

Obj –> [IDLgrLight::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrLight::Init followed by the word “Set” can be set using IDLgrLight::SetProperty.

IDLgrModel

A model object represents a graphical item or group of items that can be transformed (rotated, scaled, and/or translated). It serves as a container of other IDLgrModel objects or atomic graphic objects. IDLgrModel applies a transform to the current view tree.

Superclasses

This class is a subclass of IDL_Container.

Subclasses

The following classes are subclassed from this class:

- IDLgrColorbar
- IDLgrLegend

Creation

See "IDLgrModel::Init" on page 2060.

Methods

Intrinsic Methods

This class has this following methods:

- IDLgrModel::Add
- IDLgrModel::Cleanup
- IDLgrModel::Draw
- IDLgrModel::GetByName
- IDLgrModel::GetCTM
- IDLgrModel::GetProperty
- IDLgrModel::Init
- IDLgrModel::Reset
- IDLgrModel::Rotate

- IDLgrModel::Scale
- IDLgrModel::SetProperty
- IDLgrModel::Translate

Inherited Methods

This class inherits the following methods:

- IDL_Container::Count
- IDL_Container::Get
- IDL_Container::IsContained
- IDL_Container::Move

IDLgrModel::Add

The IDLgrModel::Add procedure method adds a child to this Model.

Syntax

Obj **->** [IDLgrModel::]Add, *Object* [, /ALIAS] [, POSITION=*index*]

Arguments

Object

An instance of an atomic graphic object or another model object to be added to the model object.

Keywords

ALIAS

Set this keyword to a nonzero value to indicate that an alias—rather than the object itself—is to be added to the model. With this keyword you can add the same object to multiple models without duplicating that object and its children. If this keyword is set, the PARENT keyword on the object being added will not change. Furthermore, if this keyword is set, the object being added will not be destroyed when the model is destroyed.

POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

IDLgrModel::Cleanup

The IDLgrModel::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrModel::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrModel::Draw

The IDLgrModel::Draw procedure method draws the specified picture to the specified graphics destination. *This method is provided for purposes of sub-classing only, and is intended to be called only from the Draw method of a subclass of IDLgrModel.*

Note

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

Syntax

Obj **->** [IDLgrModel::]Draw, *Destination, Picture*

Arguments

Destination

The destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) to which the specified view object will be drawn.

Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

Keywords

None

IDLgrModel::GetByName

The IDLgrModel::GetByName function method finds contained objects by name and returns the object reference to the named object. If the named object is not found, the GetByName function returns a null object reference.

Note

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

Syntax

Result = *Obj* **->** [IDLgrModel::]GetByName(*Name*)

Arguments

Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX file system. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

Keywords

None

IDLgrModel::GetCTM

The IDLgrModel::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrModel::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the model object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrModel::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrModel::GetProperty

The IDLgrModel::GetProperty procedure method retrieves the value of a property or group of properties for the model.

Syntax

Obj **->** [IDLgrModel::]GetProperty [, ALL=*variable*] [, PARENT=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrModel::Init followed by the word "Get" can be retrieved using IDLgrModel::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with this object.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

IDLgrModel::Init

The IDLgrModel::Init procedure method initializes the model object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrModel' [, /HIDE{Get, Set}] [, LIGHTING{Get, Set}={0 | 1 | 2}] [, NAME{Get, Set}=*string*] [, /SELECT_TARGET{Get, Set}] [, TRANSFORM{Get, Set}=*4x4 transformation matrix*] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrModel::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrModel::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrModel::SetProperty are indicated by the word "Set" following the keyword.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw model and children (the default)
- 1 = Do not draw model or children

Note

HIDE only controls the display attributes of IDLgrModel children since the IDLgrModel object itself lacks geometry.

LIGHTING *(Get, Set)*

Set this keyword to one of the following values to indicate whether lighting is to be enabled or disabled for all atomic graphic objects that have this model as a parent. IDLgrModel objects that have this model as a parent will not be effected, as they have their own value for this property. If this value is set to 0, any lights added as children of this model will be used to illuminate any other models in the view hierarchy that have lighting enabled.

- 0 = Disable lighting
- 1 = Enable single-sided lighting
- 2 = Enable double-sided lighting (the default)

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ''.

SELECT_TARGET *(Get, Set)*

Set this keyword to tag the model object as the target object to be returned when any object contained by the model is selected via the IDLgrWindow::Select method. By default, an IDLgrModel object cannot be returned as the target of a SELECT operation since it contains no geometry.

TRANSFORM *(Get, Set)*

Set this keyword to a 4x4 transformation matrix to be applied to the object. This matrix will be multiplied by its parent's transformation matrix (if the parent has one). The default is the identity matrix. IDL converts, maintains, and returns this data as double-precision floating-point.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrModel::Reset

The IDLgrModel::Reset procedure method sets the current transform matrix for the model object to the identity matrix.

Note

Using this method is functionally identical to the following statement:

```
Obj ->[IDLgrModel::]SetProperty, TRANSFORM=IDENTITY(4)
```

Syntax

Obj -> [IDLgrModel::]Reset

Arguments

None

Keywords

None

IDLgrModel::Rotate

The IDLgrModel::Rotate procedure method rotates the model about the specified axis by the specified angle. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

Syntax

Obj **->** [IDLgrModel::]Rotate, *Axis*, *Angle* [, /PREMULTIPLY]

Arguments

Axis

A three-element vector of the form [*x*, *y*, *z*] describing the axis about which the model is to be rotated.

Angle

The angle (measured in degrees) by which the rotation is to occur.

Keywords

PREMULTIPLY

Set this keyword to cause the rotation matrix specified by *Axis* and *Angle* to be pre-multiplied to the model's transformation matrix. By default, the rotation matrix is post-multiplied.

IDLgrModel::Scale

The IDLgrModel::Scale procedure method scales the model by the specified scaling factors. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

Syntax

Obj –> [IDLgrModel::]Scale, *Sx, Sy, Sz* [, /PREMULTIPLY]

Arguments

Sx, Sy, Sz

The scaling factors in the *x*, *y*, and *z* dimensions by which the model is to be scaled.

Keywords

PREMULTIPLY

Set this keyword to cause the scaling matrix specified by *Sx, Sy, Sz* to be pre-multiplied to the model's transformation matrix. By default, the scaling matrix is post-multiplied.

IDLgrModel::SetProperty

The IDLgrModel::SetProperty procedure method sets the value of a property or group of properties for the model.

Syntax

Obj -> [IDLgrModel::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrModel::Init followed by the word “Set” can be set using IDLgrModel::SetProperty.

IDLgrModel::Translate

The IDLgrModel::Translate procedure method translates the model about the specified axis by the specified translation offsets. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

Syntax

Obj **–>** [IDLgrModel::]Translate, *Tx, Ty, Tz* [, /PREMULTIPLY]

Arguments

Tx, Ty, Tz

The offsets in *X*, *Y*, and *Z*, respectively, by which the model is to be translated.

Keywords

PREMULTIPLY

Set this keyword to cause the translation matrix specified by *Tx, Ty, Tz* to be pre-multiplied to the model's transformation matrix. By default, the translation matrix is post-multiplied.

IDLgrMPEG

An IDLgrMPEG object creates an MPEG movie file from an array of image frames.

Note

The MPEG standard does not allow movies with odd numbers of pixels to be created.

Note

MPEG support in IDL requires a special license. For more information, contact your Research Systems sales representative or technical support.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrMPEG::Init" on page 2070.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrMPEG::Cleanup
- IDLgrMPEG::GetProperty
- IDLgrMPEG::Init
- IDLgrMPEG::Put
- IDLgrMPEG::Save
- IDLgrMPEG::SetProperty

IDLgrMPEG::Cleanup

The IDLgrMPEG::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrMPEG::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrMPEG::GetProperty

The IDLgrMPEG::GetProperty procedure method retrieves the value of a property or group of properties for the MPEG object.

Syntax

Obj **->** [IDLgrMPEG::]GetProperty [, ALL=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrMPEG::Init followed by the word “Get” can be retrieved using IDLgrMPEG::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

IDLgrMPEG::Init

The IDLgrMPEG::Init function method initializes the MPEG object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Note

MPEG support in IDL requires a special license. For more information, contact your Research Systems sales representative or technical support.

Syntax

Obj = OBJ_NEW('IDLgrMPEG' [, BITRATE{Get, Set}=*value*] [, DIMENSIONS{Get, Set}=*2-element array*] [, FILENAME{Get, Set}=*string*] [, FORMAT{Get, Set}={0 | 1}] [, FRAME_RATE{Get, Set} ={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8}] [, IFRAME_GAP{Get, Set}=*integer value*] [, /INTERLACED{Get, Set}] [, MOTION_VEC_LENGTH{Get, Set}={1 | 2 | 3}] [QUALITY{Get, Set}=*value*{0 to 100}] [, SCALE{Get, Set}=*[xscale*, *yscale]*] [, /STATISTICS{Get, Set}] [, TEMP_DIRECTORY=*string*])

or

Result = *Obj* **->** [IDLgrMPEG::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrMPEG::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrMPEG::SetProperty are indicated by the word “Set” following the keyword.

BITRATE *(Get, Set)*

Set this keyword to a double-precision value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

MPEG Version	Range
MPEG 1	0.1 to 104857200.0
MPEG 2	0.1 to 429496729200.0

Table A-25: BITRATE Value Range

Set this keyword to 0.0 (the default setting) to indicate that IDL should compute the BITRATE value based upon the value you have specified for the QUALITY keyword. The value of BITRATE returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero valid value stored in this property.

Note

Only use the BITRATE keyword if changing the QUALITY keyword value does not produce the desired results. It is highly recommended to set the BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

DIMENSIONS *(Get, Set)*

Set this keyword to a 2-element array specifying the dimensions (in pixels) of each of the images to be used as frames for the movie. If this property is not specified, the dimensions of the first image loaded will be used. Once IDLgrMPEG::Put has been called, this keyword can no longer be set.

Note

When creating MPEG files, you must be aware of the capabilities of the MPEG decoder you will be using to view it. Some decoders only support a limited set of

sampling and bitrate parameters to normalize computational complexity, buffer size, and memory bandwidth. For example, the Windows Media Player supports a limited set of sampling and bitrate parameters. In this case, it is best to use 352 x 240 x 30 fps or 352 x 288 x 25 fps when determining the dimensions and frame rate for your MPEG file. When opening a file in Windows Media Player that does not use these dimensions, you will receive a “Bad Movie File” error message. The file is not “bad”, this decoder just doesn’t support the dimensions of the MPEG.

FILENAME *(Get, Set)*

Set this keyword to a string representing the name of the file in which the encoded MPEG sequence is to be stored. The default is `'idl.mpg'`.

FORMAT *(Get, Set)*

Set this keyword to one of the following values to specify the type of MPEG encoding to use:

- 0 = MPEG1 (the default)
- 1 = MPEG2

FRAME_RATE *(Get, Set)*

Set this keyword to one of the following integer values to specify the frame rate used in creating the MPEG file:

Value	Descriptions
1	23.976 frames/sec: NTSC encapsulated film rate
2	24 frames/sec: Standard international film rate
3	25 frames/sec: PAL video frame rate
4	29.97 frames/sec: NTSC video frame rate
5	30 frames/sec: NTSC drop frame video frame rate (the default)
6	50 frames/sec: Double frame rate/progressive PAL
7	59.94 frames/sec: Double frame rate NTSC
8	60 frames/sec: Double frame rate NTSC drop frame video

Table A-26: FRAME_RATE Values

IFRAME_GAP *(Get, Set)*

Set this keyword to a positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

Set this keyword to 0 (the default setting) to indicate that IDL should compute the IFRAME_GAP value based upon the value you have specified for the QUALITY keyword. The value of IFRAME_GAP returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero valid value stored in this property.

Note

Only use the IFRAME_GAP keyword if changing the QUALITY keyword value does not produce the desired results.

INTERLACED *(Get, Set)*

Set this keyword to indicate that frames in the encoded MPEG file should be interlaced. The default is non-interlaced.

MOTION_VEC_LENGTH *(Get, Set)*

Set this keyword to an integer value specifying the length of the motion vectors to be used to generate predictive frames. The following table describes the valid values:

Value	Description
1	Small motion vectors.
2	Medium motion vectors.
3	Large motion vectors.

Table A-27: MOTION_VEC_LENGTH Values

Set this keyword to 0 (the default setting) to indicate that IDL should compute the MOTION_VEC_LENGTH value based upon the value you have specified for the QUALITY keyword. The value of MOTION_VEC_LENGTH returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero value stored in this property.

Note

Only use the MOTION_VEC_LENGTH keyword if changing the QUALITY value does not produce the desired results.

QUALITY *(Get, Set)*

Set this keyword to an integer value between 0 (low quality)and 100 (high quality) inclusive to specify the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

Note

Since MPEG uses JPEG (lossy) compression, the original picture quality can't be reproduced even when setting QUALITY to its' highest setting.

SCALE *(Get, Set)*

Set this keyword to a two-element vector, [*xscale*, *yscale*], indicating the scale factors to be stored with the MPEG file as hints for playback. The default is [1.0, 1.0], indicating that the movie should be played back at the dimensions of the stored image frames.

STATISTICS *(Get, Set)*

Set this keyword to save statistical information about MPEG encoding for the supplied image frames in a file when the IDLgrMPEG::Save method is called. The information will be saved in a file with a name that matches that specified by the FILENAME keyword, with the extension "`.stat`". By default, statistics are not saved.

TEMP_DIRECTORY

Set the keyword to a string value which specifies a directory in which to place temporary files while creating the MPEG movie file. The default value is platform specific.

IDLgrMPEG::Put

The IDLgrMPEG::Put procedure method puts a given image into the MPEG sequence at the specified frame. Note that all images in a given MPEG movie must have matching dimensions. If no dimensions were explicitly specified when the MPEG object was initialized, the dimensions will be set according to the dimensions of the first image.

Syntax

Obj –> [IDLgrMPEG::]Put, *Image*[, *Frame*]

Arguments

Image

An instance of an IDLgrImage object or a *m* x *n* or 3 x *m* x *n* array representing the image to be loaded at the given frame.

Frame

An integer specifying the index of the frame at which the image is to be added. Frame indices start at zero. If *Frame* is not supplied, the frame number used will be one more than the last frame that was put. Frame number need not be consecutive; in case of a gap in frame numbers, the frame before the gap is repeated to fill the space.

Keywords

None

IDLgrMPEG::Save

The IDLgrMPEG::Save procedure method encodes and saves the MPEG sequence to the specified filename.

Note

The MPEG standard does not allow movies with odd numbers of pixels to be created.

Syntax

Obj **->** [IDLgrMPEG::]Save [, FILENAME=*string*]

Macintosh Keywords: [, CREATOR_TYPE=*string*]

Arguments

None

Keywords

CREATOR_TYPE

Set this keyword to a four character string representing the creator string to be used when writing this file on a Macintosh. This property is ignored if the current platform is not a Macintosh. The default is `TVOD` (Apple Movie Player application).

FILENAME

Set this keyword to a string representing the name of the file in which the encoded MPEG sequence is to be stored. The default is `idl.mpg`.

IDLgrMPEG::SetProperty

The IDLgrMPEG::SetProperty procedure method sets the value of a property or group of properties for the MPEG object.

Syntax

Obj -> [IDLgrMPEG::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrMPEG::Init followed by the word “Set” can be retrieved using IDLgrMPEG::SetProperty.

IDLgrPalette

A palette object represents a color lookup table that maps indices to red, green, and blue values.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLgrPalette::Init" on page 2082.

Methods

Intrinsic Methods

This class has this following methods:

- IDLgrPalette::Cleanup
- IDLgrPalette::GetRGB
- IDLgrPalette::GetProperty
- IDLgrPalette::Init
- IDLgrPalette::LoadCT
- IDLgrPalette::NearestColor
- IDLgrPalette::SetRGB
- IDLgrPalette::SetProperty

IDLgrPalette::Cleanup

The IDLgrPalette::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj -> [IDLgrPalette::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrPalette::GetRGB

The IDLgrPalette::GetRGB function method returns the RGB values contained in the palette at the given index. The returned value is a three-element vector of the form [red, green, blue].

Syntax

Result = *Obj* -> [IDLgrPalette::]GetRGB(*Index*)

Arguments

Index

The index whose RGB values are desired. This value should be in the range of $0 \leq Index < N\_COLORS$, where N_COLORS is the number of elements in the color palette, as returned by the N_COLORS keyword to the IDLgrPalette:GetProperty method.

Keywords

None

IDLgrPalette::GetProperty

The IDLgrPalette::GetProperty procedure method retrieves the value of a property or group of properties for the palette.

Syntax

Obj **->** [IDLgrPalette::]GetProperty [, ALL=*variable*] [, N_COLORS=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrPalette::Init followed by the word "Get" can be retrieved using IDLgrPalette::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

N_COLORS

Set this keyword to a named variable that upon return will contain the number of elements in the color palette.

IDLgrPalette::Init

The IDLgrPalette::Init function method initializes a palette object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj=OBJ_NEW('IDLgrPalette', *aRed*, *aGreen*, *aBlue* [, BLUE_VALUES{Get, Set}=*vector*] [, BOTTOM_STRETCH{Get, Set}=*value*{0 to 100}] [, GAMMA{Get, Set}=*value*{0.1 to 10.0}] [, GREEN_VALUES{Get, Set}=*vector*] [, NAME{Get, Set}=*string*] [, RED_VALUES{Get, Set}=*vector*] [, TOP_STRETCH{Get, Set}=*value*{0 to 100}] [, UVALUE{Get, Set}=*value*])

or

Result=*Obj*->[IDLgrPalette::]Init([*aRed*, *aGreen*, *aBlue*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

aRed

A vector containing the red values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aRed* vector must not exceed 256.

aGreen

A vector containing the green values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aGreen* vector must not exceed 256.

aBlue

A vector containing the blue values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aBlue* vector must not exceed 256.

Keywords

Properties retrievable via IDLgrPalette::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrPalette::SetProperty are indicated by the word “Set” following the keyword.

BLUE_VALUES *(Get, Set)*

A vector containing the blue values for the color palette. Setting this value is the same as specifying the *aBlue* argument to the IDLgrPalette::Init method.

BOTTOM_STRETCH *(Get, Set)*

Set this keyword equal to the bottom parameter for stretching the colors in the palette. This value must be in the range of 0 ≤ *Value* ≤ 100. The default value is 0.

GAMMA *(Get, Set)*

Set this keyword to the gamma value to be applied to the color palette. This value should be in the range of 0.1 ≤ *Gamma* ≤ 10.0. The default is 1.0.

GREEN_VALUES *(Get, Set)*

A vector containing the green values for the color palette. Setting this value is the same as specifying the *aGreen* argument to the IDLgrPalette::Init method.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ''.

RED_VALUES *(Get, Set)*

A vector containing the red values for the color palette. Setting this value is the same as specifying the *aRed* argument to the IDLgrPalette::Init method.

TOP_STRETCH *(Get, Set)*

Set this keyword equal to the top parameter for stretching the colors in the palette. This value must be in the range of 0 ≤ Value ≤ 100. The default value is 100.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object to which the user value applies.

IDLgrPalette::LoadCT

The IDLgrPalette::LoadCT procedure method loads one of the IDL predefined color tables into an IDLgrPalette object.

Syntax

Obj **->** [IDLgrPalette::]LoadCT, *TableNum* [, FILENAME=*colortable filename*]

Arguments

TableNum

The number of the pre-defined IDL color table to load, from 0 to 40.

Keywords

FILE

Set this keyword to the name of a colortable file to be used instead of the file `colors1.tbl` in the IDL distribution. The MODIFYCT procedure can be used to create and modify colortable files.

IDLgrPalette::NearestColor

The IDLgrPalette::NearestColor function method returns the index of the color in the palette that best matches the given RGB values.

Syntax

Result = *Obj*–> [IDLgrPalette::]NearestColor(*Red*, *Green*, *Blue*)

Arguments

Red

The red value of the color that should be matched. This value should be within the range of 0 ≤ *Value* ≤ 255.

Green

The green value of the color that should be matched. This value should be within the range of 0 ≤ *Value* ≤ 255.

Blue

The blue value of the color that should be matched. This value should be within the range of 0 ≤ *Value* ≤ 255.

Keywords

None

IDLgrPalette::SetRGB

The IDLgrPalette::SetRGB procedure method sets the color values at a specified index in the palette to the specified Red, Green and Blue values.

Syntax

Obj –> [IDLgrPalette::]SetRGB, *Index*, *Red*, *Green*, *Blue*

Arguments

Index

The index within the Palette object to be set. This value should be in the range of 0 ≤ *Value* < N_COLORS.

Red

The red value to set in the color palette.

Green

The green value to set in the color palette.

Blue

The blue value to set in the color palette.

Keywords

None

IDLgrPalette::SetProperty

The IDLgrPalette::SetProperty procedure method sets the value of a property or group of properties for the palette.

Syntax

Obj –> [IDLgrPalette::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPalette::Init followed by the word “Set” can be set using IDLgrPalette::SetProperty.

IDLgrPattern

A pattern object describes which pixels are filled and which are left blank when an area is filled. Pattern objects are used by setting the FILL_PATTERN property of a polygon object equal to the object reference of the pattern object.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See IDLgrPattern::Init.

Methods

Intrinsic Methods

This class has this following methods:

- IDLgrPattern::Cleanup
- IDLgrPattern::GetProperty
- IDLgrPattern::Init
- IDLgrPattern:SetProperty

IDLgrPattern::Cleanup

The IDLgrPattern::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrPattern::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrPattern::GetProperty

The IDLgrPattern::GetProperty procedure method retrieves the value of a property or group of properties for the pattern.

Syntax

Obj **->** [IDLgrPattern::]GetProperty [, ALL=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrPattern::Init followed by the word "Get" can be retrieved using IDLgrPattern::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

IDLgrPattern::Init

The IDLgrPattern::Init function method initializes the pattern object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrPattern' [, *Style*] [, ORIENTATION{Get, Set}=*ccw degrees from horiz*] [, NAME{Get, Set}=*string*] [, PATTERN{Get, Set}=*32 x 32 bit array*] [, SPACING{Get, Set}=*pixels*] [, STYLE*{Get, Set}*={0 | 1 | 2}] [, THICK=*pixels*{1.0 to 10.0}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrPattern::]Init([*Style*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Style

A integer value representing the type of pattern. Valid values are:

- 0 = Solid color (default)
- 1 = Line Fill
- 2 = Pattern

Keywords

Properties retrievable via IDLgrPattern::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrPattern:SetProperty are indicated by the word "Set" following the keyword.

ORIENTATION *(Get, Set)*

Set this keyword to a scalar representing the angle (measured in degrees counterclockwise from the horizontal) of the lines used in a Line Fill. This keyword is ignored unless the *Style* argument (or STYLE property) is set to one.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

PATTERN *(Get, Set)*

Set this keyword to a 32 x 32 bit array (bitmap) describing the pattern that will be tiled over a polygon when a pattern fill is used. The bitmap must be configured as a 4 x 32 "bitmap byte array" as created by the CVTTOBM function. Each bit that is a 1 is drawn, each bit that is 0 is not drawn. Each bit in this array represents a 1 point by 1 point square area of pixels on the destination device. This keyword is ignored unless the *Style* argument (or STYLE keyword) is set to 2.

SPACING *(Get, Set)*

Set this keyword equal to a floating-point value representing the distance (measured in points) between the lines used for a Line Fill. This keyword is ignored unless the *Style* argument (or STYLE property) is set to 1. The default is 2.0 points.

STYLE *(Get, Set)*

Set this keyword to one of the following values specifying the type of pattern:

- 0 = Solid (default)
- 1 = Line Fill
- 2 = Pattern

This keyword is the same as the *Style* argument described above.

THICK

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the pattern lines for a Line Fill, in points. The default is 1.0 points. This keyword is ignored unless the *Style* argument or STYLE keyword is set to 1.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object to which the user value applies.

IDLgrPattern:SetProperty

The IDLgrPattern::SetProperty procedure method sets the value of a property or group of properties for the pattern.

Syntax

Obj –> [IDLgrPattern::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPattern::Init followed by the word “Set” can be set using IDLgrPattern::SetProperty.

IDLgrPlot

A plot object creates a set of polylines connecting data points in two-dimensional space.

An IDLgrPlot object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrPlot::Init" on page 2101.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrPlot::Cleanup
- IDLgrPlot::GetCTM
- IDLgrPlot::GetProperty
- IDLgrPlot::Init
- IDLgrPlot::SetProperty

IDLgrPlot::Cleanup

The IDLgrPlot::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj* or *Obj* **->** [IDLgrPlot::]Cleanup (*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrPlot::GetCTM

The IDLgrPlot::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrPlot::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the plot object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPlot::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrPlot::GetProperty

The IDLgrPlot::GetProperty procedure method retrieves the value of the property or group of properties for the plot.

Syntax

Obj **->** [IDLgrPlot::]GetProperty [, ALL=*variable*] [, DATA=*variable*] [, PARENT=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrPlot::Init followed by the word "Get" can be retrieved using IDLgrPlot::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

DATA

Set this keyword to a named variable that will contain the plot data in a 3 x *n* array, [*DataX*, *DataY*, *DataZ*].

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

ZRANGE

Set this keyword to a named variable that will contain a two-element vector of the form [*zmin, zmax*] specifying the range of *z* data values covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

Note

The XRANGE and YRANGE properties can also be retrieved via the GetProperty method; ZRANGE, however, can only be retrieved, not initialized (Init method) or set (SetProperty method).

IDLgrPlot::Init

The IDLgrPlot::Init function method initializes the plot object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrPlot' [, [*X*,] *Y*] [, COLOR{Get, Set}=*index or RGB vector* | , VERT_COLORS{Get, Set}=*vector*] [, DATAX {Set}=*vector*] [, DATAY{Set}=*vector*] [, /DOUBLE{Get, Set}] [, /HIDE{Get, Set}] [, /HISTOGRAM{Get, Set}] [, LINESTYLE{Get, Set}=*integer or two-element vector*] [, MAX_VALUE{Get, Set}=*value*] [, MIN_VALUE{Get, Set}=*value*] [, NAME{Get, Set}=*string*] [, NSUM{Get, Set}=*value*] [, PALETTE{Get, Set}=*objref*] [, /POLAR{Get, Set}] [, /RESET_DATA{Set}] [, SHARE_DATA{Set}=*objref*] [, SYMBOL{Get, Set}=*objref(s)*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, /USE_ZVALUE] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, XRANGE{Get, Set}=*[xmin*, *xmax]*] [, YCOORD_CONV{Get, Set}=*vector*] [, YRANGE{Get, Set}=*[ymin*, *ymax]*] [, ZCOORD_CONV{Get, Set}=*vector*] [, ZVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrPlot::]Init([[*X*,] *Y*]) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector representing the abscissa values to be plotted. If *X* is provided, *Y* is plotted as a function of *X*. The value for this argument is double-precision floating-point if

the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise it is converted to single-precision floating-point.

Y

Either a vector of two-element arrays [*x*, y] representing the points to be plotted, or a vector representing the ordinate values to be plotted. If *Y* is a vector of ordinate values and *X* is not specified, *Y* is plotted as a function of the vector index of *Y*. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise it is converted to single-precision floating-point.

Keywords

Properties retrievable via IDLgrPlot::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrPlot::SetProperty are indicated by the word "Set" following the keyword.

COLOR *(Get, Set)*

Set this keyword to the color to be used as the foreground color for this plot. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

DATAX *(Set)*

Set this keyword to a vector specifying the X values to be plotted. This keyword is the same as the X argument.

DATAY *(Set)*

Set this keyword to a vector specifying the Y values to be plotted. This keyword is the same as the Y argument.

DOUBLE *(Get, Set)*

Set this keyword to indicate that data provided by any of the X or Y arguments or DATAX or DATAY keywords will be stored in this object as double-precision floating-point. If you set this keyword equal to 0, the data provided will be stored in this object as single-precision floating-point. If you do not specify this keyword, the data is stored as double-precision floating-point if the original data was of type DOUBLE or as single-precision floating-point if the original data was not of type DOUBLE.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

HISTOGRAM *(Get, Set)*

Set this keyword to force only horizontal and vertical lines to be used to connect the plotted points. By default, the points are connected using a single straight line.

LINESTYLE *(Get, Set)*

Set this keyword to indicate the line style that should be used to draw the plot lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \le repeat \le 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

MAX_VALUE *(Get, Set)*

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

MIN_VALUE *(Get, Set)*

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

NSUM *(Get, Set)*

Set this keyword to the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are M data points, then M/NSUM points are plotted.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

POLAR *(Get, Set)*

Set this keyword to create a polar plot. The *X* and *Y* arguments must both be present. The *X* argument represents the radius, and the *Y* argument represents the angle expressed in radians.

RESET_DATA *(Set)*

Set this keyword to treat the data provided via one of the DATA[XY] properties as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this keyword if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This keyword has no effect if no new data is provided via a DATA property.

SHARE_DATA *(Set)*

Set this keyword to an object with which data is to be shared by this plot. A plot may only share data with another plot. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

SYMBOL *(Get, Set)*

Set this keyword to a vector containing instances of the IDLgrSymbol object class. Each symbol in the vector will be drawn at the corresponding plotted point. If there are more points than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a plot, set the SYMBOL property equal to a null object reference.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the plotted lines, in points. The default is 1.0 points.

USE_ZVALUE

Set this keyword to use the current ZVALUE. The plot is considered three-dimensional if this keyword is set.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

VERT_COLORS *(Get, Set)*

Set this keyword to a vector of colors to be used to draw at each vertex. Color is interpolated between vertices. If there are more plot points than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the plot is all drawn in the single color provided by the COLOR keyword. If the VERT_COLORS is provided, the COLOR keyword is ignored.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

XRANGE *(Get, Set)*

Set this keyword equal to a two-element vector of the form [*xmin*, *xmax*] specifying the range of *x* data coordinates covered by the graphic object. If this property is not specified, the minimum and maximum data values are used. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YRANGE *(Get, Set)*

Set this keyword equal to a two-element vector of the form [*ymin*, *ymax*] specifying the range of *y* data values covered by the graphic object. If this property is not specified, the minimum and maximum data values are used. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZVALUE *(Get, Set)*

Set this keyword equal to a two-element vector of the form [*[xy]min, [xy]max*] specifying the range of [*xy*] data coordinates covered by the graphic object. If this property is not specified, the minimum and maximum data values are used. IDL converts, maintains, and returns this data as double-precision floating-point.

Note

The USE_ZVALUE keyword needs to be set in order for ZVALUEs to take affect.

IDLgrPlot::SetProperty

The IDLgrPlot::SetProperty procedure method sets the value of the property or group of properties for the plot.

Syntax

Obj -> [IDLgrPlot::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPlot::Init followed by the word “Set” can be set using IDLgrPlot::SetProperty.

IDLgrPolygon

A polygon object represents one or more polygons that share a given set of vertices and rendering attributes. All polygons must be convex—that is, a line connecting any pair of vertices on the polygon cannot fall outside the polygon. Concave polygons can be converted to a set of convex polygons using the IDLgrTessellator object.

An IDLgrPolygon object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrPolygon::Init" on page 2114.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrPolygon::Cleanup
- IDLgrPolygon::GetCTM
- IDLgrPolygon::GetProperty
- IDLgrPolygon::Init
- IDLgrPolygon::SetProperty

IDLgrPolygon::Cleanup

The IDLgrPolygon::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrPolygon::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrPolygon::GetCTM

The IDLgrPolygon::GetCTM The IDLgrPolygon::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrPolygon::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the polygon object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPolygonl::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrPolygon::GetProperty

The IDLgrPolygon::GetProperty procedure method retrieves the value of the property or group of properties for the polygons.

Syntax

Obj **–>** [IDLgrPolygon::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

There are no arguments for this methods.

Keywords

Any keyword to IDLgrPolygon::Init followed by the word “Get” can be retrieved using IDLgrPolygon::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

IDLgrPolygon::Init

The IDLgrPolygon::Init function method initializes the polygons object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrPolygon' [, *X* [, *Y*[, *Z*]]] [, BOTTOM{Get, Set}=*index or RGB vector*] [, COLOR{Get, Set}=*index or RGB vector* | , VERT_COLORS{Get, Set}=*vector*] [, DATA{Get, Set}=*array*] [, /DOUBLE{Get, Set}] [, FILL_PATTERN{Get, Set}=*objref to IDLgrPattern object*] [, /HIDDEN_LINES] [, /HIDE{Get, Set}] [, LINESTYLE{Get, Set}=*value*] [, NAME{Get, Set}=*string*] [, NORMALS{Get, Set}=*array*] [, PALETTE=*objref*] [, POLYGONS{Get, Set}=*array of polygon descriptions*] [, REJECT{Get, Set}={0 | 1 | 2}] [, /RESET_DATA{Set}] [, SHADE_RANGE{Get, Set}=*array*] [, SHADING{Get, Set}={0 | 1}] [, SHARE_DATA{Set}=*objref*] [, STYLE{Get, Set}={0 | 1 | 2}] [, TEXTURE_COORD{Get, Set}=*array*] [, /TEXTURE_INTERP{Get, Set}] [, TEXTURE_MAP*{Get, Set}=objref to IDLgrImage object*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*] [, ZERO_OPACITY_SKIP{Get, Set}={0 | 1}])

or

Result = *Obj* **->** [IDLgrPolygon::]Init([*X*, [*Y*, [*Z*]]]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector argument providing the X coordinates of the vertices. The vector must contain at least three elements. If the Y and Z arguments are not provided, X must be an array of either two or three vectors (i.e., [2,*] or [3,*]), in which case, X[0,*] specifies the X values, X[1,*] specifies the Y values, and X[2,*] specifies the Z values.

This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

Y

A vector argument providing the Y coordinates of the vertices. The vector must contain at least three elements. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

Z

A vector argument providing the Z coordinates of the vertices. The vector must contain at least three elements. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

Keywords

Properties retrievable via IDLgrPolygon::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrPolygon::SetProperty are indicated by the word "Set" following the keyword.

BOTTOM *(Get, Set)*

Set this keyword to an RGB or Indexed color for drawing the backs of the polygons. (The *back* of a polygon is the side opposite the normal direction). Setting a bottom color is only supported when the destination device uses RGB color mode.

COLOR *(Get, Set)*

Set this keyword to an RGB or Indexed color for drawing polygons. The default color is [0, 0, 0] (black). If the TEXTURE_MAP property is used, the final color is modulated by the texture map pixel values. This keyword is ignored if the VERT_COLORS keyword is provided.

DATA *(Get, Set)*

Set this keyword to a *2 x n* or a *3 x n* array which defines, respectively, the 2D or 3D vertex data. DATA is equivalent to the optional arguments, X, Y, and Z. This property is stored as double precision floating point values if the property variable is of type DOUBLE or if the DOUBLE keyword parameter is also specified, otherwise it is converted to single precision floating point.

DOUBLE *(Get, Set)*

Set this keyword to a non-zero value to indicate that data provided by any of the X, Y, or Z arguments or DATA keyword should be stored in this object in double precision floating point. Set this keyword to zero to indicate that the data should be stored in single precision floating point. IDL converts any value data already stored in the object to the requested precision, if necessary. Note that this keyword does not need to be set if any of the X, Y, or Z arguments or the DATA parameters are of type DOUBLE. However, setting this keyword may be desirable if the data consists of large integers that cannot be accurately represented in single precision floating point. This property is also automatically set to one if any of the X, Y or Z arguments or the DATA parameter is stored using a variable of type DOUBLE.

FILL_PATTERN *(Get, Set)*

Set this keyword equal to an object reference to an IDLgrPattern object (or an array of IDLgrPattern objects) to specify the fill pattern to use for filling the polygons. By default, FILL_PATTERN is set to a null object reference, specifying a solid fill.

HIDDEN_LINES

Set this keyword to draw point and wireframe surfaces using hidden line (point) removal. By default, hidden line removal is disabled.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

LINESTYLE *(Get, Set)*

Set this keyword to indicate the line style that should be used to draw the polygon. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, `''`.

NORMALS *(Get, Set)*

Set this keyword to a *3 x n* array of unit polygon normals at each vertex. If this keyword is not set, vertex normals are computed by averaging shared polygon normals at each vertex. Normals are computed using the Right Hand Rule; that is, if the polygon is facing the viewer, vertices are taken in counterclockwise order. To remove previously specified normals, set NORMALS to a scalar.

Note

Computing normals is a computationally expensive operation. Rendering speed increases significantly if you supply the surface normals explicitly. You can compute the array of polygon normals used by this keyword automatically. See "COMPUTE_MESH_NORMALS" on page 211 for details.

Once you use the NORMALS keyword in a call to IDLgrPolygon::Init or IDLgrPolygon::SetProperty, you are responsible for that IDLgrPolygon's normals from then on. IDL will not calculate that IDLgrPolygon's normals for you automatically, even if you draw the IDLgrPolygon after vertices or connectivity have been changed.

If you do not use the NORMALS keyword, IDL calculates normals the first time it draws the IDLgrPolygon. IDL reuses those normals for subsequent draws unless it determines that a fresh recalculation of normals is required, such as if the vertices of the IDLgrPolygon are changed, or you supply new normals via the NORMALS keyword.

PALETTE

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

POLYGONS *(Get, Set)*

Set this keyword to an array of polygon descriptions. A polygon description is an integer or longword array of the form: [n, i_0, i_1, ..., i_{n-1}], where n is the number of vertices that define the polygon, and i_0..i_{n-1} are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGONS array, set the vertex count, n, to 0. To end the drawing list, even if additional array space is available, set n to -1. If this keyword is not specified, a single polygon will be generated.

Note

The connectivity array described by POLYGONS allows an individual object to contain more than one polygon. Vertex, normal, and color information can be shared by the multiple polygons. Consequently, the polygon object can represent an entire mesh and compute reasonable normal estimates in most cases.

REJECT *(Get, Set)*

Set this keyword to an integer value to reject polygons as being hidden depending on the orientation of their normals. Select from one of the following values:

- 0 = No polygons are hidden

- 1 = Polygons whose normals point away from the viewer are hidden
- 2 = Polygons whose normals point toward the viewer are hidden

Set this keyword to zero to draw all polygons regardless of the direction of their normals.

RESET_DATA *(Set)*

Set this keyword to treat the data provided via the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this keyword if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This keyword has no effect if no new data is provided via the DATA property.

SHADE_RANGE *(Get, Set)*

Set this keyword to a two-element array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. The default is [0, 255]. This keyword is ignored when the polygons are drawn to a graphics destination that uses the RGB color model.

SHADING *(Get, Set)*

Set this keyword to an integer representing the type of shading to use:

- 0 = Flat (default): The color of the first vertex in each polygon is used to define the color for the entire polygon. The color has a constant intensity based upon the normal vector.
- 1 = Gouraud: The colors along each line are interpolated between vertex colors, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

SHARE_DATA *(Set)*

Set this keyword to an object with which data is to be shared by this polygon(s). Polygons may only share data with another polygons object or a polyline. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

STYLE *(Get, Set)*

Set this keyword to specify how the polygon should be drawn:

- 0 = Points: Only vertices are drawn, using either COLOR or VERT_COLORS.
- 1 = Lines: Each polygon is outlined by connecting vertices.
- 2 = Filled (default): The polygon faces are shaded.

Note

Texturing is in effect only when STYLE = 2 (Filled).

TEXTURE_COORD *(Get, Set)*

A 2 x *n* array containing the texture map coordinates for each of the *n* polygon vertices. Use this keyword in conjunction with the TEXTURE_MAP keyword to wrap images over 2D and 3D polygons. Default coordinates are not provided.

Texture coordinates are normalized. This means that the *m* x *n* image object specified via the TEXTURE_MAP property is mapped into the range [0.0, 0.0] to [1.0, 1.0]. If texture coordinates outside the range [0.0, 0.0] to [1.0, 1.0] are specified, the image object is tiled into the larger range.

For example, suppose the image object specified via TEXTURE_MAP is a 256 x 256 array, and we want to map the image into a square two units on each side. To completely fill the square with a single copy of the image:

```
TEXTURE_COORD = [[0,0], [1,0], [1,1], [0,1]]
```

To fill the square with four tiled copies of the image:

```
TEXTURE_COORD = [[0,0], [2,0], [2,2], [0,2]]
```

TEXTURE_INTERP *(Get, Set)*

Set this keyword to indicate that bilinear sampling is to be used for texture mapping an image onto the polygon(s). The default is nearest neighbor sampling.

TEXTURE_MAP *(Get, Set)*

Set this keyword to the object reference of an IDLgrImage object to be texture mapped onto the polygons. The tiling or mapping of the texture is defined expressly by TEXTURE_COORD. If this keyword is omitted, polygons are filled with the color specified by the COLOR or VERT_COLORS property. If both TEXTURE_MAP and COLORS or VERT_COLORS properties exist, the color of the texture is modulated by the base color of the object. (This means that for the clearest display of the texture image, the COLOR property should be set equal to [255,255,255].) To remove a texture map, set TEXTURE_MAP equal to a null object reference.

Setting TEXTURE_MAP to the object reference of an IDLgrImage that contains an Alpha channel allows you to create a transparent IDLgrPolygon object. For more on the Alpha channel, see "Image Objects" in Chapter 25 of *Using IDL*. If an Alpha channel is present in the IDLgrImage object, IDL blends the texture using the blend function src=Alpha and dst=1 – Alpha, which corresponds to a BLEND_FUNCTION of (3,4) as described for the IDLgrImage object.

If the width and/or height of the provided image is not an exact power of two, then the texture map will consist of the given image pixel values resampled to the nearest larger dimensions that are exact powers of two.

Note

Texture mapping is disabled when rendering to a destination object that uses Indexed color mode.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the size of the points or the thickness of the lines to be drawn when STYLE is set to either 0 (Points) or 1 (Lines), in points. The default is 1.0 points.

VERT_COLORS *(Get, Set)*

Set this keyword to a vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polygons are all drawn in the single color provided by the COLOR keyword. To remove vertex colors, set VERT_COLORS to a scalar.

Note

If the polygon object is being rendered on a destination device that uses the Indexed color model, and the view that contains the polygon also contains one or more light objects, the VERT_COLORS property is ignored and the SHADE_RANGE property is used instead.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZERO_OPACITY_SKIP *(Get, Set)*

Set this keyword to gain finer control over the rendering of textured polygon pixels (texels) with an opacity of 0 in the texture map. Texels with zero opacity do not affect the color of a screen pixel since they have no opacity. If this keyword is set to 1, any texels are “skipped” and not rendered at all. If this keyword is set to zero, the Z-buffer is updated for these pixels and the display image is not affected as noted above. By updating the Z-buffer without updating the display image, the polygon can be used as a *clipping* surface for other graphics primitives drawn after the current graphics object. The default value for this keyword is 1.

Note

This keyword has no effect if no texture map is used or if the texture map in use does not contain an opacity channel.

IDLgrPolygon::SetProperty

The IDLgrPolygon::SetProperty procedure method sets the value of the property or group of properties for the polygons.

Syntax

Obj –> [IDLgrPolygon::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPolygon::Init followed by the word “Set” can be set using IDLgrPolygon::SetProperty.

IDLgrPolyline

A polyline object represents one or more polylines that share a set of vertices and rendering attributes.

An IDLgrPolyline object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrPolyline::Init" on page 2130.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrPolyline::Cleanup
- IDLgrPolyline::GetCTM
- IDLgrPolyline::GetProperty
- IDLgrPolyline::Init
- IDLgrPolyline::SetProperty

IDLgrPolyline::Cleanup

The IDLgrPolyline::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrPolyline::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrPolyline::GetCTM

The IDLgrPolyline::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrPolyline::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the polyline object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPolyline::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrPolyline::GetProperty

The IDLgrPolyline::GetProperty procedure method retrieves the value of a property or group of properties for the polylines.

Syntax

Obj –> [IDLgrPolyline::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrPolyline::Init followed by the word “Get” can be retrieved using IDLgrPolyline::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

IDLgrPolyline::Init

The IDLgrPolyline::Init function method initializes the polylines object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrPolyline' [, *X* [, *Y*[, *Z*]]] [, COLOR{Get, Set}=*index or RGB vector* | , VERT_COLORS{Get, Set}=*vector*] [, DATA{Get, Set}=*array*] [, /DOUBLE{Get, Set}] [, /HIDE{Get, Set}] [, LINESTYLE{Get, Set}=*value*] [, NAME{Get, Set}=*string*] [, PALETTE{Get, Set}=*objref*] [, POLYLINES{Get, Set}=*array of polyline descriptions*] [, /RESET_DATA{Set}] [, SHADING{Get, Set}={0 | 1}] [, SHARE_DATA{Set}=*objref*] [, SYMBOL{Get, Set}=*objref(s)*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, UVALUE{Get, Set}=*value*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrPolyline::]Init([*X*, [*Y*, [*Z*]]]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector providing the X components of the points to be connected. If the Y and Z arguments are not provided, X must be an array of either two or three vectors (i.e., [2,*] or [3,*]), in which case, X[0,*] specifies the X values, X[1,*] specifies the Y values, and X[2,*] specifies the Z values. This argument is stored as double precision

floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Y

A vector providing the Y coordinates of the points to be connected. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Z

A vector providing the Z coordinates of the points to be connected. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Keywords

Properties retrievable via IDLgrPolyline::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrPolyline::SetProperty are indicated by the word "Set" following the keyword.

COLOR *(Get, Set)*

Set this keyword to an RGB or Indexed color for drawing polylines. The default color is [0, 0, 0] (black). This keyword is ignored if the VERT_COLORS keyword is provided.

DATA *(Get, Set)*

Set this keyword to a 2 x *n* or a 3 x *n* array which defines, respectively, the 2D or 3D vertex data. DATA is equivalent to the optional arguments, *X*, *Y*, and *Z*. This property is converted to double-precision floating-point values if the DOUBLE keyword is set. Otherwise, it is converted to single-precision floating-point.

DOUBLE *(Get, Set)*

Set this keyword to indicate that data provided by any of the *X*, *Y*, or *Z* arguments or the DATA keyword will be stored in this object as double-precision floating-point. If you set this keyword equal to 0, the data provided will be stored in this object as single-precision floating-point. If you do not specify this keyword, the data is stored as double-precision floating-point if the original data was of type DOUBLE or as single-precision floating-point if the original data was not of type DOUBLE.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

LINESTYLE *(Get, Set)*

Set this keyword to indicate the line style that should be used to draw the polyline. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, `''`.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

POLYLINES *(Get, Set)*

Set this keyword to an array of polyline descriptions. A polyline description is an integer or longword array of the form: $[n, i_0, i_1, ..., i_{n-1}]$, where n is the number of vertices that define the polyline, and $i_0..i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the vertices of the polyline(s). To ignore an entry in the POLYLINES array, set the vertex count, n, to 0. To end the drawing list, even if additional array space is available, set n to -1. If this keyword is not specified, a single connected polyline will be generated from the *X*, *Y*, and *Z* arguments.

Note

The connectivity array described by POLYLINES allows an individual object to contain more than one polyline. Vertex, normal and color information can be shared by the multiple polylines. Consequently, the polyline object can represent an entire mesh and compute reasonable normal estimates in most cases.

RESET_DATA *(Set)*

Set this keyword to treat the data provided via one of the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this keyword if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This keyword has no effect if no new data is provided via the DATA property.

SHADING *(Get, Set)*

Set this keyword to an integer representing the type of shading to use:

- 0 = Flat (default): The color of the first vertex in a line segment is used to define the color for the entire line segment. The color has a constant intensity based upon the normal vector.
- 1 = Gouraud: The colors along each line are interpolated between vertex colors.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

SHARE_DATA *(Set)*

Set this keyword to an object whose data is to be shared by this polyline. A polyline may only share data with a polygon object or another polyline. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

SYMBOL *(Get, Set)*

Set this keyword to a vector containing one or more instances of the IDLgrSymbol object class to indicate the plotting symbols to be used at each vertex of the polyline. If there are more vertices than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a polyline, set SYMBOL to a scalar.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the polyline, in points. The default is 1.0 points.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

VERT_COLORS *(Get, Set)*

Set this keyword to a vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polyline is drawn in the single color provided by the COLOR keyword. To remove vertex colors, set VERT_COLORS to a scalar.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrPolyline::SetProperty

The IDLgrPolylines::SetProperty procedure method sets the value of a property or group of properties for the polylines.

Syntax

Obj –> [IDLgrPolyline::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPolyline::Init followed by the word “Set” can be set using IDLgrPolyline::SetProperty.

IDLgrPrinter

A printer object represents a hardcopy graphics destination. When a printer object is created, the printer device to which it refers is the default system printer. To change the printer, utilize the printer dialogs (see "DIALOG_PRINTJOB" on page 400 and "DIALOG_PRINTERSETUP" on page 398.)

Note

Objects or subclasses of this type can not be saved or restored.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLgrPrinter::Init" on page 2145.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrPrinter::Cleanup
- IDLgrPrinter::Draw
- IDLgrPrinter::GetContiguousPixels
- IDLgrPrinter::GetFontnames
- IDLgrPrinter::GetProperty
- IDLgrPrinter::GetTextDimensions
- IDLgrPrinter::Init
- IDLgrPrinter::NewDocument
- IDLgrPrinter::NewPage
- IDLgrPrinter::SetProperty

IDLgrPrinter::Cleanup

The IDLgrPrinter::Cleanup procedure method performs all cleanup on the object. If a document is open (that is, if graphics have been draw to the printer), the document is closed and the pending graphics are sent to the current printer.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrPrinter::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrPrinter::Draw

The IDLgrPrinter::Draw procedure method draws the given picture to this graphics destination.

Note

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

Syntax

Obj **->** [IDLgrPrinter::]Draw [, *Picture*] [, VECTOR={ 0 | 1 }]

Arguments

Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

Keywords

VECTOR

Set this keyword to indicate the type of graphics primitives generated. Valid values include:

0 = Bitmap (default)

1 = Vector

If VECTOR = 0 (Bitmap), the Draw method renders the scene to a buffer and then copies the buffer to the printer in bitmap format. The bitmap retains the quality of the original image.

If VECTOR = 1 (Vector), the Draw method renders the scene using simple vector operations that result in a representation of the Scene that is scalable to the printer. The vector representation does not retain all the attributes of the original image. The vector representation is sent to the printer.

IDLgrPrinter::GetContiguousPixels

The IDLgrPrinter::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
```

```
[4,3,2,1,0]
```

Syntax

Return = *Obj* **->** [IDLgrPrinter::]GetContiguousPixels()

Arguments

None

Keywords

None

IDLgrPrinter::GetFontnames

The IDLgrPrinter::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

Syntax

Return = *Obj* **->** [IDLgrPrinter::]GetFontnames(*FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*])

Arguments

FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

Keywords

IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is the string, "*", which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

IDLgrPrinter::GetProperty

The IDLgrPrinter::GetProperty procedure method retrieves the value of a property or group of properties for the printer.

Syntax

Obj **->** [IDLgrPrinter::]GetProperty [, ALL=*variable*] [, DIMENSIONS=*variable*] [, NAME=*string*] [, RESOLUTION=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrPrinter::Init followed by the word "Get" can be retrieved using IDLgrPrinter::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

DIMENSIONS

Set this keyword to a named variable that will contain a two-element vector of the form [*width*, *height*] specifying the overall 'drawable' area that may be printed on a page. By default, the dimensions are measured in device units (refer to the UNITS (Get, Set) keyword).

NAME

A string containing the operating system-specific name of the print stream. e.g. '\\BORG\HpJet'.

RESOLUTION

Set this keyword to a named variable that will contain a vector of the form [*xres*, *yres*] defining the pixel resolution, measured in centimeters per pixel. This value is stored in double precision.

IDLgrPrinter::GetTextDimensions

The IDLgrPrinter::GetTextDimensions function method retrieves the dimensions of a text object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text object, measured in data units.

Syntax

Result = *Obj* **->**[IDLgrPrinter::]GetTextDimensions(*TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*])

Arguments

TextObj

The object reference to a text or axis object for which the text dimensions are requested.

Keywords

DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPrinter::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrPrinter::Init

The IDLgrPrinter::Init function method initializes the printer object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrPrinter' [, COLOR_MODEL{Get}={0 | 1}] [, GRAPHICS_TREE{Get, Set}=*objref of type IDLgrScene, IDLgrViewgroup, or IDLgrView*] [, /LANDSCAPE{Get, Set}] [, N_COLORS{Get}=*integer*{2 to 256}] [, N_COPIES{Get, Set}=*integer*] [, PALETTE{Get, Set}=*objref*] [, PRINT_QUALITY{Get, Set}={0 | 1 | 2}] [, QUALITY{Get, Set}={0 | 1 | 2}] [, UNITS{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrPrinter::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrPrinter::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrPrinter::SetProperty are indicated by the word "Set" following the keyword.

COLOR_MODEL *(Get)*

Set this keyword to the color model to be used for the buffer:

- 0 = RGB (default)
- 1 = Color Index

GRAPHICS_TREE *(Get, Set)*

Set this keyword to an object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

LANDSCAPE *(Get, Set)*

Set this keyword to produce hardcopy output in landscape mode. The default value of zero indicates Portrait mode.

Note

The printer driver may not support the LANDSCAPE option; in general, it is best to use the printer dialogs to set orientation.

N_COLORS *(Get)*

Set this keyword to the number of colors (between 2 and 256) to be used if the COLOR_MODEL is set to Indexed (1). This keyword is ignored if the COLOR_MODEL is set to RGB (0).

N_COPIES *(Get, Set)*

Set this keyword equal to an integer that determines the number of copies of print data to be generated. The default is 1 copy.

Note

Your specific printer driver may not support the N_COPIES option. You can also use the printer dialogs to set the number of copies.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the graphics destination's color lookup table if the Indexed color model is used.

PRINT_QUALITY *(Get, Set)*

Set this keyword to an integer value indicating the print quality at which graphics are to be drawn to the printer. Note that the print quality is independent of the rendering quality (as set by the QUALITY keyword). Valid values are:

- 0 = Low
- 1 = Normal (this is the default)
- 2 = High

Generally, setting the print quality to a lower value will increase the speed of the printing job, but decrease the resolution; setting it to a higher value will cause the printing job to take more time, but will increase the resolution.

Note

Some printer drivers may not be able to support different printing qualities. In these cases, the setting of the PRINT_QUALITY property will be quietly ignored.

QUALITY *(Get, Set)*

Set this keyword to an integer value indicating the rendering quality at which graphics are to be drawn to this destination. Note that the rendering quality is independent of the print quality (as set by the PRINT_QUALITY keyword). Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

UNITS *(Get, Set)*

Set this keyword to indicate the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the drawable area on a page.

Note

If you change the value of the UNITS property (using the SetProperty method), IDL will convert the current value of the DIMENSIONS property to the new units.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrPrinter::NewDocument

The IDLgrPrinter::NewDocument procedure method closes the current document (a page or group of pages), which causes any pending output to be sent to the printer, finishing the printer job.

Syntax

Obj –> [IDLgrPrinter::]NewDocument

Arguments

None

Keywords

None

IDLgrPrinter::NewPage

The IDLgrPrinter::NewPage procedure method issues a new page command to the printer.

Syntax

Obj –> [IDLgrPrinter::]NewPage

Arguments

None

Keywords

None

IDLgrPrinter::SetProperty

The IDLgrPrinter::SetProperty procedure method sets the value of a property or group of properties for the printer.

Syntax

Obj **->** [IDLgrPrinter::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrPrinter::Init followed by the word “Set” can be set using IDLgrPrinter::SetProperty.

IDLgrROI

The IDLgrROI object class is an object graphics representation of a region of interest.

Superclasses

This class is a subclass of IDLanROI.

Subclasses

None.

Creation

See IDLgrROI::Init.

Methods

Intrinsic Methods

The IDLgrROI object class has the following methods:

- IDLgrROI::Cleanup
- IDLgrROI::GetProperty
- IDLgrROI::Init
- IDLgrROI::PickVertex
- IDLgrROI::SetProperty

Inherited Methods

This class inherits the following methods:

- IDLanROI::AppendData
- IDLanROI::ComputeGeometry
- IDLanROI::ComputeMask
- IDLanROI::ContainsPoints
- IDLanROI::RemoveData
- IDLanROI::ReplaceData

- IDLanROI::Rotate
- IDLanROI::Scale
- IDLanROI::Translate

IDLgrROI::Cleanup

The IDLgrROI::Cleanup procedure method performs all cleanup for a region of interest object.

Note

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj–>[IDLgrROI::]Cleanup (In a subclass' Cleanup method only.)

Arguments

None.

Keywords

None.

IDLgrROI::GetProperty

The IDLgrROI::GetProperty procedure method retrieves the value of a property or group of properties for the Object Graphics region.

Syntax

Obj–>[IDLgrROI::]GetProperty [, ALL=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None.

Keywords

Note

All keywords accepted by IDLanROI::GetProperty are also accepted by this method. Furthermore, any keyword to IDLgrROI::Init followed by the word (*Get*) can be retrieved using IDLgrROI::GetProperty.

The following keywords are also accepted:

ALL

Set this keyword to a named variable to contain an anonymous structure with the values of all of the properties associated with the state of this object. State information about the object may include things like color, line style, etc., but not vertex data or user values.

Note

The fields in this structure may change in subsequent releases of IDL.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

IDLgrROI::Init

The IDLgrROI::Init function method initializes an Object Graphics region of interest.

Note

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrROI' [, *X*[, *Y*[, *Z*]]] [, COLOR{Get, Set}=*vector*]
[, /DOUBLE{Get, Set}] [, /HIDE{Get, Set}] [, LINESTYLE{Get, Set}=*value*]
[, NAME{Get, Set}=*string*] [, PALETTE{Get, Set}=*objref*]
[, STYLE{Get, Set}={ 0 | 1 | 2 }] [, SYMBOL{Get, Set}=*objref*]
[, THICK{Get, Set}=*points*{1.0 to 10.0}] [, UVALUE{Get, Set}=*uvalue*]
[, XCOORD_CONV{Get, Set}=*[s_0, s_1]*] [, YCOORD_CONV{Get, Set}=*[s_0, s_1]*]
[, ZCOORD_CONV{Get, Set}=*[s_0, s_1]*])

or

Result = *Obj*->[IDLgrROI::]Init([*X*[, *Y*[, *Z*]]]) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector providing the X components of the vertices for the region. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimension either 2 or 3 ([2, *] or [3, *]), in which case, X[0, *] represents the X values, X[1, *] represents the Y values, and X[2, *] represents the Z values. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

Y

A vector providing the Y components of the vertices. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

Z

A scalar or vector providing the Z components of the vertices. If not provided, Z values default to 0.0. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

Keywords

Note

All keywords accepted by IDLanROI::Init are accepted by this method as well.

In addition, the following keywords are accepted:

COLOR *(Get, Set)*

Set this keyword to an RGB or indexed color for drawing the region. The default color is [0, 0, 0].

DOUBLE *(Get, Set)*

Set this keyword to a non-zero value to indicate that data should be stored in this object in double precision floating point. Set this keyword to zero to indicate that the data should be stored in single precision floating point, which is the default. The DOUBLE property controls the precision used for storing the data in the (inherited)AppendData, Init, and (inherited)ReplaceData methods via the X, Y, and Z arguments and in SetProperty method via the (inherited)DATA keyword. IDL converts any data already stored in the object to the requested precision, if necessary. Note that this keyword does not need to be set if any of the X, Y, or Z arguments or the (inherited)DATA parameters are of type DOUBLE. However, setting this keyword may be desirable if the data consists of large integers that cannot be accurately represented in single precision floating point. This property is also automatically set to one if any of the X, Y or Z arguments or the DATA parameter is stored using a variable of type DOUBLE.

HIDE *(Get, Set)*

Set this keyword to a Boolean value indicating whether this region should be drawn:

- 0 = draw the region (the default)
- 1 = do not draw the region

LINESTYLE *(Get, Set)*

Set this keyword to the line style to be used to draw the region. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

The valid values for the pre-defined line styles are:

- 0 = solid (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

NAME *(Get, Set)*

Set this keyword to a string to use as the name for this region.

PALETTE *(Get, Set)*

Set this keyword to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used for Object Graphics destinations using the RGB color model. In this case, if the color value for the region is specified as a color index value, this palette is used to look up the color for the region. If the PALETTE keyword is not set, the destination object PALETTE property is used, which defaults to a gray scale ramp.

STYLE *(Get, Set)*

Set this keyword to indicate the geometrical primitive to use to represent the region when displayed. Valid values include:

- 0 = points
- 1 = open polyline

- 2 = closed polyline (the default)

SYMBOL *(Get, Set)*

Set this keyword to reference an IDLgrSymbol object for the symbol used for display when STYLE = 0 (points). By default, a dot is used.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the size of the points, or the thickness of the lines, measured in points. The default is 1.0 points.

UVALUE *(Get, Set)*

Set this keyword to a user value of any type to contain any information you wish. Remember if you set this user value equal to a pointer or object reference, you must destroy the pointer or object reference explicitly when destroying this region.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[\ (-X_{min})/(X_{max} - X_{min}),\ 1.0/(X_{max} - X_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[\ (-Y_{min})/(Y_{max} - Y_{min}),\ 1.0/(Y_{max} - Y_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[\ (-Z_{min})/(Z_{max} - Z_{min}),\ 1.0/(Z_{max} - Z_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrROI::PickVertex

The IDLgrROI::PickVertex function method picks a vertex of the region which, when projected onto the given destination device, is nearest to the given 2D device coordinate.

Syntax

Result = *Obj*–>[IDLgrROI::]PickVertex(*Dest*, *View*, *Point* [, PATH=*objref*])

Return Value

Result

The return value is the index of the nearest region vertex. If two or more vertices are equally nearest to the point, the smallest index of those vertices is returned.

Arguments

Dest

An object reference to an IDLgrWindow or IDLgrBuffer for which the pick is to occur.

View

An object reference to the IDLgrView containing this region.

Point

A two-element vector, [*x*, *y*], representing the device location used for picking a nearest vertex.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a location in the data space of the region. Each path object reference specified with this keyword must contain an alias. The selected vertex is computed for the version of the object falling within the specified path. If this keyword is not set, the parent properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

IDLgrROI::SetProperty

The IDLgrROI::SetProperty procedure method sets the value of a property or group of properties for the Object Graphics region.

Syntax

Obj–>[IDLgrROI::]SetProperty

Arguments

None.

Keywords

Note

Any keywords accepted by IDLanROI::SetProperty are also accepted by this method. Furthermore, any keywords to IDLgrROI::Init followed by the word *(Set)* can be set using IDLgrROI::SetProperty as well.

IDLgrROIGroup

The IDLgrROIGroup object class is an Object Graphics representation of a group of regions of interest.

Superclasses

This class is a subclass of IDLanROIGroup.

Subclasses

None.

Creation

See IDLgrROIGroup::Init.

Methods

Intrinsic Methods

The IDLgrROIGroup class has the following methods:

- IDLgrROIGroup::Add
- IDLgrROIGroup::Cleanup
- IDLgrROIGroup::GetProperty
- IDLgrROIGroup::Init
- IDLgrROIGroup::PickRegion
- IDLgrROIGroup::SetProperty

Inherited Methods

This class inherits the following methods:

- IDLanROIGroup::ContainsPoints
- IDLanROIGroup::ComputeMask
- IDLanROIGroup::GetProperty
- IDLanROIGroup::Rotate
- IDLanROIGroup::Scale

- IDLanROIGroup::Translate

IDLgrROIGroup::Add

The IDLgrROIGroup::Add procedure method adds a region to the region group. Only objects of the IDLgrROI class may be added to the group. The regions in the group must all be of the same type: all points, all paths, or all polygons.

Syntax

Obj–>[IDLgrROIGroup::]Add, *ROI*

Arguments

ROI

A reference to an instance of the IDLgrROI object class representing the region of interest to add to the group.

Keywords

Accepts all keywords accepted by the IDLanROIGroup::Add method.

IDLgrROIGroup::Cleanup

The IDLgrROIGroup::Cleanup procedure method performs all cleanup for an Object Graphics region of interest group object.

Note

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj–>[IDLgrROIGroup::]Cleanup (In a subclass' Cleanup method only.)

Arguments

None.

Keywords

None.

IDLgrROIGroup::GetProperty

The IDLgrROIGroup::Get Property procedure method retrieves the value of a property or group of properties for the region group.

Syntax

Obj–>[IDLgrROIGroup::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None.

Keywords

Note

All keywords accepted by IDLanROIGroup::GetProperty are also accepted by this method. Furthermore, any keyword to IDLgrROIGroup::Init followed by the word (*Get*) can be retrieved using IDLgrROIGroup::GetProperty.

ALL

Set this keyword to a named variable. Upon return, ALL contains an anonymous structure with the values of all of the properties associated with the state of this object.

Note

The fields in this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

IDLgrROIGroup::Init

The IDLgrROIGroup::Init function method initializes an Object Graphics region of interest group object.

Note

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrROIGroup' [, COLOR{Get, Set}=*vector*]
[, /HIDE{Get, Set}] [, NAME{Get, Set}=*string*]
[, XCOORD_CONV{Get, Set}=*[s_0, s_1]*] [, YCOORD_CONV{Get, Set}=*[s_0, s_1]*]
[, ZCOORD_CONV{Get, Set}=*[s_0, s_1]*])

or

Result = *Obj*–>[IDLgrROIGroup::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None.

Keywords

COLOR *(Get, Set)*

Set this keyword to an RGB or indexed color for drawing the region group. The default color is [0,0,0].

HIDE *(Get, Set)*

Set this keyword to a Boolean value indicating whether this region group should be drawn:

- 0 = draw the region group (the default)
- 1 = do not draw the region group

NAME *(Get, Set)*

Set this keyword to a string to use as the name for this region group.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[\ (-X_{min})/(X_{max} - X_{min}),\ 1.0/(X_{max} - X_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[\ (-Y_{min})/(Y_{max} - Y_{min}),\ 1.0/(Y_{max} - Y_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[\ (-Z_{min})/(Z_{max} - Z_{min}),\ 1.0/(Z_{max} - Z_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrROIGroup::PickRegion

The IDLgrROIGroup::PickRegion function method picks a region within the group which, when projected onto the given destination device, is nearest to the given 2D device coordinate.

Syntax

Result = *Obj*–>[IDLgrROIGroup::]PickRegion(*Dest*, *View*, *Point* [, PATH=*objref*])

Return Value

Result

The return value is the object reference of the nearest region. If two or more regions are equally nearest to the point, the one that was added to the region group first is returned.

Arguments

Dest

An object reference to an IDLgrWindow or IDLgrBuffer for which the pick is to occur.

View

An object reference to the IDLgrView containing this region.

Point

A two-element vector, [*x*, *y*], representing the device location to use for picking a nearest region.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a location in the data space of the region. Each path object reference specified with this keyword must contain an alias. The selected region is computed for the version of the object falling within the specified path. If this keyword is not set, the parent properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

IDLgrROIGroup::SetProperty

The IDLgrROIGroup::Set Property procedure method sets the value of a property or group of properties for the region group.

Syntax

Obj–>[IDLgrROIGroup::]SetProperty

Arguments

None.

Keywords

Note

Any keywords to IDLgrROIGroup::Init followed by the word *(Set)* can be set using IDLgrROIGroup::SetProperty.

IDLgrScene

A scene object represents the entire scene to be drawn and serves as a container of IDLgrView or IDLgrViewgroup objects.

Superclasses

This class is a subclass of IDL_Container.

Subclasses

This class has no subclasses.

Creation

See "IDLgrScene::Init" on page 2179.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrScene::Add
- IDLgrScene::Cleanup
- IDLgrScene::GetByName
- IDLgrScene::GetProperty
- IDLgrScene::Init
- IDLgrScene::SetProperty

Inherited Methods

This class inherits the following methods:

- IDL_Container::Count
- IDL_Container::Get
- IDL_Container::IsContained
- IDL_Container::Move

IDLgrScene::Add

The IDLgrScene::Add function method verifies that the added item is an instance of an IDLgrView or IDLgrViewgroup object. If it is, IDLgrScene:Add adds the view or viewgroup to the specified scene.

Syntax

Obj **->** [IDLgrScene::]Add, *View* [, POSITION=*index*]

Arguments

View

An instance of the IDLgrView or IDLgrViewgroup object class.

Keywords

POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

IDLgrScene::Cleanup

The IDLgrScene::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrScene::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrScene::GetByName

The IDLgrScene::GetByName function method finds contained objects by name and returns the object reference to the named object. If the named object is not found, the GetByName function returns a null object reference.

Note

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

Syntax

Result = *Obj* **->** [IDLgrScene::]GetByName(*Name*)

Arguments

Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

Keywords

None

IDLgrScene::GetProperty

The IDLgrScene::GetProperty procedure method retrieves the value of a property or group of properties for the contour.

Syntax

Obj **->** [IDLgrScene::]GetProperty [, ALL=*variable*]

Keywords

Any keyword to IDLgrScene::Init followed by the word "Get" can be retrieved using IDLgrScene::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

IDLgrScene::Init

The IDLgrScene::Init function method initializes the scene object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrScene' [, COLOR{Get, Set}=*index or RGB vector*] [, /HIDE{Get, Set}] [, NAME{Get, Set}=*string*] [, /TRANSPARENT{Get, Set}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrScene::]Init( ) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrScene::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrScene::SetProperty are indicated by the word "Set" following the keyword.

HIDE

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

COLOR *(Get, Set)*

Set this keyword to the color to which the scene should be erased before drawing. The color may be specified as a color lookup table index or an RGB vector.

NAME

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ' '.

TRANSPARENT *(Get, Set)*

Set this keyword to disable window clearing. If this keyword is not set, the destination object in use by the scene is automatically erased when the scene is initialized.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrScene::SetProperty

The IDLgrScene::SetProperty procedure method sets the value of a property or group of properties for the buffer.

Syntax

Obj –> [IDLgrScene::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrScene::Init followed by the word “Set” can be set using IDLgrScene::SetProperty.

IDLgrSurface

A surface object represents a shaded or vector representation of a mesh grid.

An IDLgrSurface object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrSurface::Init" on page 2188.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrSurface::Cleanup
- IDLgrSurface::GetCTM
- IDLgrSurface::GetProperty
- IDLgrSurface::Init
- IDLgrSurface::SetProperty

IDLgrSurface::Cleanup

The IDLgrSurface::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrSurface::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrSurface::GetCTM

The IDLgrSurface::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrSurface::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the surface object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrSurface::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrSurface::GetProperty

The IDLgrSurface::GetProperty procedure method retrieves the value of a property or group of properties for the surface.

Syntax

Obj **->** [IDLgrSurface::]GetProperty [, ALL=*variable*] [, DATA=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrSurface::Init followed by the word "Get" can be retrieved using IDLgrSurface::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

DATA

Set this keyword to a named variable that upon return will contain the surface data.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the

graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

IDLgrSurface::Init

The IDLgrSurface::Init function method initializes the surface object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrSurface' [, *Z* [, *X*, *Y*]] [, BOTTOM{Get, Set}=*index or RGB vector*] [, COLOR{Get, Set}=*index or RGB vector*] [, DATAX{Set}=*vector or 2D array*] [, DATAY{Set}=*vector or 2D array*] [, DATAZ{Set}=*2D array*] [, /DOUBLE{Get, Set}] [, /EXTENDED_LEGO{Get, Set}] [, /HIDDEN_LINES{Get, Set}] [, /HIDE{Get, Set}] [, LINESTYLE{Get, Set}=*value*] [, MAX_VALUE{Get, Set}=*value*] [, MIN_VALUE{Get, Set}=*value*] [, NAME{Get, Set}=*string*] [, PALETTE{Get, Set}=*objref*] [, /RESET_DATA{Set}] [, SHADE_RANGE{Get, Set}=*[index of darkest pixel, index of brightest pixel]*] [, SHADING{Get, Set}={0 | 1}] [, SHARE_DATA{Set}=*objref*] [, /SHOW_SKIRT{Get, Set}] [, SKIRT{Get, Set}=*Z value*] [, STYLE{Get, Set}={0 | 1 | 2 | 3 | 4 | 5 | 6}] [, TEXTURE_COORD{Get, Set}=*array*] [, /TEXTURE_INTERP{Get, Set}] [, TEXTURE_MAP{Get, Set}=*objref to IDLgrImage*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, UVALUE{Get, Set}=*value*] [, /USE_TRIANGLES{Get, Set}] [, VERT_COLORS{Get, Set}=*vector*] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*] [, ZERO_OPACITY_SKIP{Get, Set}={0 | 1}])

or

Result = *Obj* **->** [IDLgrSurface::]Init([*Z* [, *X*, *Y*]]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of X specifies the X coordinates for a column of Z (e.g., X[0] specifies the X coordinate for Z[0, *]). If X is a two-dimensional array, each element of X specifies the X coordinate of the corresponding point in Z (Xij specifies the X coordinate of Zij). This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of Y specifies the Y coordinates for a column of Z (e.g., Y[0] specifies the Y coordinate for Z[0, *]). If Y is a two-dimensional array, each element of Y specifies the Y coordinate of the corresponding point in Z (Yij specifies the Y coordinate of Zij). This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Z

The two-dimensional array to be displayed. If X and Y are provided, the surface is defined as a function of the (X, Y) locations specified by their contents. Otherwise, the surface is generated as a function of the array indices of each element of Z. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

Keywords

Properties retrievable via IDLgrSurface::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrSurface::SetProperty are indicated by the word “Set” following the keyword.

BOTTOM *(Get, Set)*

The color value used to draw the bottom surface. If not specified, or set to a negative scalar value, the bottom is drawn with the same color as the top. Setting a bottom color is only supported when the destination device uses RGB color mode.

COLOR *(Get, Set)*

Set this keyword to the color to be used as the foreground color for this model. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

DATAX *(Set)*

Set this keyword to a vector or a two-dimensional array specifying the X coordinates of the surface grid. This keyword is the same as the X argument described above. This property is stored as double precision floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

DATAY *(Set)*

Set this keyword to a vector or a two-dimensional array specifying the Y coordinates of the surface grid. This keyword is the same as the Y argument described above. This property is stored as double precision floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

DATAZ *(Set)*

Set this keyword to the two-dimensional array to display as a surface. This keyword is the same as the Z argument described above. This property is stored as double precision floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

DOUBLE *(Get, Set)*

Set this keyword to a non-zero value to indicate that data provided by any of the X, Y, or Z arguments or DATAX, DATAY, or DATAZ keywords should be stored in this object in double precision floating point. Set this keyword to zero to indicate that the data should be stored in single precision floating point, which is the default. IDL converts any value data already stored in the object to the requested precision, if necessary. Note that this keyword does not need to be set if any of the X, Y, or Z arguments or the DATAX, DATAY, or DATAZ parameters are of type DOUBLE. However, setting this keyword may be desirable if the data consists of large integers that cannot be accurately represented in single precision floating point. This property is also automatically set to one if any of the X, Y or Z arguments or the DATAX, DATAY, or DATAZ parameters is stored using a variable of type DOUBLE.

EXTENDED_LEGO *(Get, Set)*

Set this keyword to force the IDLgrSurface object to display the last row and column of data when lego display styles are selected.

HIDDEN_LINES *(Get, Set)*

Set this keyword to draw point and wireframe surfaces using hidden line (point) removal. By default, hidden line removal is disabled.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

LINESTYLE *(Get, Set)*

Set this keyword to indicate the line style that should be used to draw the surface lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

MAX_VALUE *(Get, Set)*

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

MIN_VALUE *(Get, Set)*

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, `''`.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

RESET_DATA *(Set)*

Set this keyword to treat the data provided via one of the DATA[XYZ] properties as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this keyword if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This keyword has no effect if no new data is provided via a DATA property.

SHADE_RANGE *(Get, Set)*

Set this keyword to a two-element array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color element for the brightest pixel. This value is ignored

when the polygons are drawn to a graphics destination that uses the RGB color model.

SHADING *(Get, Set)*

Set this keyword to an integer representing the type of shading to use if STYLE is set to 2 (Filled) or 6 (LegoFilled).

- 0 = Flat (default): The color has a constant intensity for each face of the surface, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

SHARE_DATA *(Set)*

Set this keyword to an object whose data is to be shared by this surface. A surface may only share data with another surface. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

SHOW_SKIRT *(Get, Set)*

Set this keyword to enable skirt drawing. The default is to disable skirt drawing.

SKIRT *(Get, Set)*

Set this keyword to the *Z* value at which a skirt is to be defined around the array. The *Z* value is expressed in data units; the default is 0.0. If a skirt is defined, each point on the four edges of the surface is connected to a point on the skirt which has the given *Z* value, and the same *X* and *Y* values as the edge point. In addition, each point on the skirt is connected to its neighbor. The skirt value is ignored if skirt drawing is disabled (see SHOW_SKIRT above). IDL converts, maintains, and returns this data as double-precision floating-point.

STYLE *(Get, Set)*

Set this keyword to and integer value that indicates the style to be used to draw the surface. Valid values are:

- 0 = Points
- 1 = Wire mesh (the default)
- 2 = Filled

- 3 = RuledXZ
- 4 = RuledYZ
- 5 = Lego
- 6 = LegoFilled: for outline or shaded and stacked histogram-style plots.

TEXTURE_COORD *(Get, Set)*

A 2 x *n* array of surface coordinate-texturemap coordinate pairs [*s*, *t*] at each vertex., containing the fill pattern array subscripts of each of the *n* polygon vertices. Use this keyword in conjunction with the TEXTURE_MAP keyword to warp images over the surface. To stretch (or shrink) the texture map to cover the surface mesh completely, set TEXTURE_COORD to a scalar. By default, TEXTURE_COORD is set equal to [0.0, 0.0] to [1.0, 1.0] over the surface bounds.

Texture coordinates are normalized. This means that the *m* x *n* image object specified via the TEXTURE_MAP property is mapped into the range [0.0, 0.0] to [1.0, 1.0]. If texture coordinates outside the range [0.0, 0.0] to [1.0, 1.0] are specified, the image object is tiled into the larger range.

For example, suppose the image object specified via TEXTURE_MAP is a 256 x 256 array, and we want to map the image into a square two units on each side. To completely fill the square with a single copy of the image:

```
TEXTURE_COORD = [[0,0], [1,0], [1,1], [0,1]]
```

To fill the square with four tiled copies of the image:

```
TEXTURE_COORD = [[0,0], [2,0], [2,2], [0,2]]
```

TEXTURE_INTERP *(Get, Set)*

Set this keyword to a nonzero value to indicate that bilinear sampling is to be used with texture mapping. The default method is nearest-neighbor sampling.

TEXTURE_MAP *(Get, Set)*

Set this keyword to an instance of the IDLgrImage object class to be texture mapped onto the surface. If this keyword is omitted or set to a null object reference, no texture map is applied and the surface is filled with the color specified by the COLOR or VERT_COLORS property. If both TEXTURE_MAP and COLORS or VERT_COLORS properties exist, the color of the texture is modulated by the base color of the object. (This means that for the clearest display of the texture image, the COLOR property should be set equal to [255,255,255].) By default, the texture map will be stretched (or shrunk) to cover the surface mesh completely.

Setting TEXTURE_MAP to the object reference of an IDLgrImage that contains an Alpha channel allows you to create a transparent IDLgrSurface object. For more on the Alpha channel, see "Image Objects" in Chapter 25 of *Using IDL*.

If the width and/or height of the provided image is not an exact power of two, then the texture map will consist of the given image pixel values resampled to the nearest larger dimensions that are exact powers of two.

Note

Texture mapping is disabled when rendering to a destination object that uses Indexed color mode.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to use to draw surface lines, in points. The default is 1.0 points.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object of which it is a user value.

USE_TRIANGLES *(Get, Set)*

Set this keyword to force the IDLgrSurface object to use triangles instead of quads to draw the surface and skirt.

VERT_COLORS *(Get, Set)*

Set this keyword to a vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polygons are all drawn in the single color provided by the COLOR keyword. If this keyword is omitted or set to a scalar, vertex colors are removed and the surface is drawn in the color specified by the COLOR keyword.

Note

If the surface object is being rendered on a destination device that uses the Indexed color model, and the view that contains the surface also contains one or more light

objects, the VERT_COLORS property is ignored and the SHADE_RANGE property is used instead.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert *X* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert *Y* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert *Z* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZERO_OPACITY_SKIP *(Get, Set)*

Set this keyword to gain finer control over the rendering of textured surface pixels (texels) with an opacity of 0 in the texture map. Texels with zero opacity do not affect

the color of a screen pixel since they have no opacity. If this keyword is set to 1, any texels are “skipped” and not rendered at all. If this keyword is set to zero, the Z-buffer is updated for these pixels and the display image is not affected as noted above. By updating the Z-buffer without updating the display image, the surface can be used as a *clipping* surface for other graphics primitives drawn after the current graphics object. The default value for this keyword is 1.

Note

This keyword has no effect if no texture map is used or if the texture map in use does not contain an opacity channel.

IDLgrSurface::SetProperty

The IDLgrSurface::SetProperty procedure method sets the value of a property or group of properties for the surface.

Syntax

Obj –> [IDLgrSurface::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrSurface::Init followed by the word “Set” can be set using IDLgrSurface::SetProperty.

IDLgrSymbol

A symbol object represents a graphical element that is plotted relative to a particular position.

Note

Seven predefined symbols are provided by IDL.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLgrSymbol::Init" on page 2202.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrSymbol::Cleanup
- IDLgrSymbol::GetProperty
- IDLgrSymbol::Init
- IDLgrSymbol::SetProperty

IDLgrSymbol::Cleanup

The IDLgrSymbol::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrSymbol::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrSymbol::GetProperty

The IDLgrSymbol::GetProperty procedure method retrieves the value of a property or group of properties for the symbol.

Syntax

Obj **->** [IDLgrSymbol::]GetProperty [, ALL=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrSymbol::Init followed by the word "Get" can be retrieved using IDLgrSymbol::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

IDLgrSymbol::Init

The IDLgrSymbol::Init function method initializes the plot symbol.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrSymbol' [, *Data*] [, COLOR{Get, Set}=*index or RGB vector*] [, DATA{Get, Set}=*integer or objref*] [, NAME{Get, Set}=*string*] [, SIZE{Get, Set}=*vector*] [, THICK{Get, Set}=*points*{1.0 to 10.0}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrSymbol::]Init([*Data*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Data

Either an integer value from the list shown below, or an object reference to either an IDLgrModel object or atomic graphic object.

Use one of the following scalar-represented internal default symbols:

- 0 = No symbol
- 1 = Plus sign, '+' (default)
- 2 = Asterisk
- 3 = Period (Dot)
- 4 = Diamond

- 5 = Triangle
- 6 = Square
- 7 = X

If an instance of the IDLgrModel object class or an atomic graphic object is used, the object tree is used as the symbol. For best results, the object should fill the domain from -1 to +1 in all dimensions. The pre-defined symbols listed above are all defined in the domain -1 to +1.

Keywords

Properties retrievable via IDLgrSymbol::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrSymbol::SetProperty are indicated by the word "Set" following the keyword.

COLOR *(Get, Set)*

Set this keyword to the color used to draw the symbol. The color may be specified as a color lookup table index or as an RGB vector. The default color is the color of the object for which this symbol is being used.

DATA *(Get, Set)*

Set this keyword to specify a symbol. This keyword is equivalent to the *Data* argument.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ''.

SIZE *(Get, Set)*

Set this keyword to a one-, two-, or three-element vector describing the X, Y, and Z scaling factors to be applied to the symbol. The default is [1.0, 1.0, 1.0].

- If SIZE is specified as a scalar, then the X, Y, and Z scale factors are all equal to the scalar value.
- If SIZE is specified as a 2-element vector, then the X and Y scale factors are as specified by the vector, and the Z scale factor is 1.0.
- If SIZE is specified as a 3-element vector, then the X, Y, and Z scale factors are as specified by the vector.

IDL converts, maintains, and returns this data as double-precision floating-point.

THICK *(Get, Set)*

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to used to draw any lines that make up the symbol, in points. The default is 1.0 points.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrSymbol::SetProperty

The IDLgrSymbol::SetProperty procedure method sets the value of a property or group of properties for the symbol.

Syntax

Obj –> [IDLgrSymbol::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrSymbol::Init followed by the word “Set” can be set using IDLgrSymbol::SetProperty.

IDLgrTessellator

A tessellator object converts a simple concave polygon (or a simple polygon with "holes") into a number of simple convex polygons (general triangles). A polygon is *simple* if it includes no duplicate vertices, if the edges intersect only at vertices, and exactly two edges meet at any vertex.

Each polygon can be marked as being either an interior or an exterior (default) polygon. Interior polygons are treated as holes in the exterior polygons. Multiple non-overlapping exterior polygons are allowed as well. All polygons should be specified in the same orientation (either clockwise or counter-clockwise). Once all the polygons have been passed into the tessellator object, the final triangulation is accomplished by the IDLgrTessellator::Tessellate method. A list of vertices and a connectivity array are returned. You may process these by hand, or pass them to an IDLgrPolygon object. The tessellator object will not create any vertices in the process, rather the output vertex list will include only those vertices passed into the object originally.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrTessellator::Init" on page 2210.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrTessellator::AddPolygon
- IDLgrTessellator::Cleanup
- IDLgrTessellator::Init
- IDLgrTessellator::Reset
- IDLgrTessellator::Tessellate

IDLgrTessellator::AddPolygon

The IDLgrTessellator::AddPolygon procedure method adds a polygon to the tessellator object.

Syntax

Obj **->** [IDLgrTessellator::]AddPolygon, *X* [, *Y*[, *Z*]] [, POLYGON{Get, Set}=*array of polygon descriptions*] [, /INTERIOR]

Arguments

X

A 1 x *n*, 2 *x n*, or 3 *x n* array of polygon vertices.

Y

A vector of Y values. If *X* and *Y* are both specified, they must be one-dimensional vectors of the same length.

Z

A vector of Z values. If *X*, *Y*, and *Z* are all specified, they must all three be one-dimensional vectors of the same length. If no *Z* values are specified, the *Z* value for the polygon is set to 0.

Keywords

POLYGON *(Get, Set)*

Set this keyword to an array of polygon descriptions. A polygon description is an integer or longword array of the form: [*n*, i_0, i_1, ..., i_{n-1}], where *n* is the number of vertices that define the polygon, and i_0..i_{n-1} are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGON array, set the vertex count, *n*, to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this keyword is not specified, a single polygon will be generated.

Note

The connectivity array described by POLYGONS allows you to add multiple polygons to the tessellator object with a single AddPolygon operation.

INTERIOR

Set this keyword to set a polygon to be an interior polygon, which is treated as a hole in the exterior polygons.

IDLgrTessellator::Cleanup

The IDLgrTessellator::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY,*Obj*

or

Obj **->** [IDLgrTessellator::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrTessellator::Init

The IDLgrTessellator::Init function method initializes the tessellator object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrTesselator')

or

Result = *Obj* -> [IDLgrTessellator::]Init( ) (*Only in a subclass' Init method*.)

Arguments

None

Keywords

None

IDLgrTessellator::Reset

The IDLgrTessellator::Reset procedure method resets the object's internal state. All previously added polygons are removed from memory and the object is prepared for a new tessellation task.

Syntax

Obj –> [IDLgrTessellator::]Reset

Arguments

None

Keywords

None

IDLgrTessellator::Tessellate

The IDLgrTessellator::Tessellate function method performs the actual tessellation.

Syntax

Result = Obj -> [IDLgrTessellator::]Tessellate(*Vertices*, *Poly* [, /QUIET])

Arguments

If the tessellation succeeds, IDLgrTessellator::Tessellate returns 1 and the contents of Vertices and Poly are set to the results of the tessellation. If the tessellation fails, the function returns 0.

Vertices

A 2 *x n* array if all the input polygons were 2D. A 3 *x n* array if all the input polygons were 3D.

Poly

An array of polygon descriptions. A polygon description is an integer or longword array of the form: $[n, i_0, i_1, ..., i_{n-1}]$, where *n* is the number of vertices that define the polygon, and $i_0..i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices.

Note

On output, the *Vertices* array can be used as the value of the DATA property, and the *Poly* array can be used as the value of the POLYGON property, of a polygon object.

Keywords

QUIET

Set this keyword to suppress warning and error message generation due to tessellation errors. !ERROR_STATE is not updated in the case of the return value being ‘0’ when the QUIET keyword is specified.

IDLgrText

A text object represents one or more text strings that share common rendering attributes. An IDLgrText object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrText::Init" on page 2219.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrText::Cleanup
- IDLgrText::GetCTM
- IDLgrText::GetProperty
- IDLgrText::Init
- IDLgrText::SetProperty

Keywords

PALETTE

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

IDLgrText::Cleanup

The IDLgrText::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrText::]Cleanup(*Only in subclass' Cleanup method.*)

Arguments

None

Keywords

None

IDLgrText::GetCTM

The IDLgrText::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrText::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the text object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrText::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrText::GetProperty

The IDLgrText::GetProperty procedure method retrieves the value of a property or group of properties for the text.

Syntax

Obj **->** [IDLgrText::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrText::Init followed by the word "Get" can be retrieved using IDLgrText::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

XRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

YRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

Note

Until the text is drawn to the destination object, the [XYZ]RANGE properties will only report the locations of the text. Use the GetTextDimensions method of the destination object to get the data dimensions of the text prior to a draw operation.

IDLgrText::Init

The IDLgrText::Init function method initializes the text object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrText' [, *String or vector of strings*] [, ALIGNMENT{Get, Set}=*value*{0.0 to 1.0}] [, BASELINE{Get, Set}=*vector*] [, CHAR_DIMENSIONS{Get, Set}=*[width, height]*] [, COLOR{Get, Set}=*index or RGB vector*] [, /ENABLE_FORMATTING{Get, Set}] [, FONT{Get, Set}=*objref*] [, /HIDE{Get, Set}] [, LOCATIONS{Get, Set}=*array*] [, NAME{Get, Set}=*string*] [, /ONGLASS{Get, Set}] [, PALETTE{Get, Set}=*objref*] [, RECOMPUTE_DIMENSIONS{Get, Set}={0 | 1 | 2}] [, STRINGS{Get, Set}=*string or vector of strings*] [, UPDIR{Get, Set}=*vector*] [, UVALUE{Get, Set}=*value*] [, VERTICAL_ALIGNMENT{Get, Set}=*value*{0.0 to 1.0}] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, ZCOORD_CONV{Get, Set}=*vector*])

or

Result = *Obj* **->** [IDLgrText::]Init([*String or vector of strings*]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

String

The string (or vector of strings) to be created. If this argument is not a string, it is converted prior to using the default formatting rules.

Keywords

Properties retrievable via IDLgrText::GetProperty are indicated by the word “Get” following the keyword. Properties settable via IDLgrText::SetProperty are indicated by the word “Set” following the keyword.

ALIGNMENT *(Get, Set)*

Set this keyword to a floating-point value between 0.0 and 1.0 to indicate the requested horizontal alignment of the text baseline. An alignment of 0.0 (the default) aligns the left-justifies the text at the given position; an alignment of 1.0 right-justifies the text, and an alignment of 0.5 centers the text over the given position.

BASELINE *(Get, Set)*

Set this keyword to a two (or three) element vector describing the direction in which the baseline is to be oriented. Use this keyword in conjunction with the UPDIR keyword to specify the plane on which the text lies. The default BASELINE is [1.0,0,0] (i.e., parallel to the x-axis).

CHAR_DIMENSIONS *(Get, Set)*

Set this keyword equal to a two-element vector [*width*, *height*] indicating the dimensions (measured in data units) of a bounding box for each character, to be used when scaling text projected in three dimensions. If either *width* or *height* is zero, the text will be scaled such that if it were positioned halfway between the near and far clipping planes, it will appear at the point size associated with this text object’s font. The default value is [0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

Note

If you set the CHAR_DIMENSIONS property to [0,0] (using the SetProperty method), indicating that IDL should calculate the text size, the value (returned by the GetProperty method) will not be updated to reflect the calculated size until you call either the Draw method or the GetTextDimensions method.

For example, if the VIEWPLANE_RECT of the view the text object is being rendered in is set equal to [0,0,10,10] (that is, it spans ten data units in each of the X and Y directions), setting the CHAR_DIMENSIONS property equal to [2, 3] will scale the text such that each character fills 20% of the X range and 30% of the Y range.

This property has no effect if the ONGLASS property is set equal to one.

COLOR *(Get, Set)*

Set this keyword to the color to be used as the foreground color for the text. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

ENABLE_FORMATTING *(Get, Set)*

Set this keyword to indicate that the text object should honor embedded Hershey-style formatting codes within the strings. (Formatting codes are described in Appendix H, "Fonts".) The default is not to honor the formatting codes.

FONT *(Get, Set)*

Set this keyword to an instance of an IDLgrFont object class to describe the font to use to draw this string. The default is 12 point Helvetica. See IDLgrFont for details.

Note

If the default font is in use, retrieving the value of the FONT property (using the GetProperty method) will return a null object.

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

LOCATIONS *(Get, Set)*

Set this keyword to an array of one or more two- or three-element vectors specifying the coordinates (measured in data units) used to position the string(s). Each vector is of the form [*x*, *y*] or [*x*, *y*, *z*]; if *z* is not provided, it is assumed to be zero. Each location corresponds to the corresponding string in the *String* argument. If only one location is provided, and the *String* argument is a vector of more than one strings, the initial string is positioned at the given location, and each subsequent string is positioned by cyclically reusing the location values. IDL converts, maintains, and returns this data as double-precision floating-point.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ''.

ONGLASS *(Get, Set)*

Set this keyword to indicate that the text should be displayed “on the glass”. The default is projected 3D text.

PALETTE *(Get, Set)*

Set this keyword equal to the object reference of a palette object (an instance of the IDLgrPalette object class). This keyword is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this keyword is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

RECOMPUTE_DIMENSIONS *(Get, Set)*

Set this keyword to one of the following values to indicate when this text object’s character dimensions (refer to the CHAR_DIMENSIONS property) are to be recomputed automatically:

- 0 = Never recompute. Always use the character dimensions provided via the CHAR_DIMENSIONS property. If CHAR_DIMENSIONS is set to [0,0], compute once and re-use the resulting dimensions until the CHARACTER_DIMENSIONS are modified.
- 1 = Recompute, but reuse the current transformation matrix from the previous draw of this text object. If this is the first time the text object is drawn, compute the current transformation matrix. (This option is useful if the parent model of this text object is scaled for zooming, and the text is supposed to increase in size, rather having its data dimensions recomputed to ensure the font size is matched.)
- 2 = Recompute always, including the current transformation matrix.

STRINGS *(Get, Set)*

Set this keyword to the string (or vector of strings) associated with the text object. This keyword is the same as the *String* argument described above.

UPDIR *(Get, Set)*

Set this keyword to a two (or three) element vector describing the vertical direction for the string. The *upward direction* is the direction defined by a vector pointing from the origin to the point specified. Use this keyword in conjunction with the BASELINE keyword to specify the plane on which the text lies; the direction

specified by UPDIR should be orthogonal to the direction specified by BASELINE. The default UPDIR is [0.0, 1.0, 0.0] (i.e., parallel to the *Y* axis).

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

VERTICAL_ALIGNMENT *(Get, Set)*

Set this keyword to a floating-point value between 0.0 and 1.0 to indicate the requested vertical alignment of the text. An alignment of 0.0 (the default) bottom-justifies the text at the given location; an alignment of 1.0 top-justifies the text at the given location.

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrText::SetProperty

The IDLgrText::SetProperty procedure method sets the value of a property or group of properties for the text.

Syntax

Obj –> [IDLgrText::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrText::Init followed by the word “Set” can be set using IDLgrText::SetProperty.

IDLgrView

A view object represents a rectangular area in which graphics objects are drawn. It is a container for objects of the IDLgrModel class.

Superclasses

This class is a subclass of IDL_Container.

Subclasses

This class has no subclasses.

Creation

See "IDLgrView::Init" on page 2231.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrView::Add
- IDLgrView::Cleanup
- IDLgrView::GetByName
- IDLgrView::GetProperty
- IDLgrView::Init
- IDLgrView::SetProperty

Inherited Methods

This class inherits the following methods:

- IDL_Container::Count
- IDL_Container::Get
- IDL_Container::IsContained
- IDL_Container::Move

IDLgrView::Add

The IDLgrView::Add procedure method adds a child to this view.

Syntax

Obj –> [IDLgrView::]Add, *Model* [, POSITION=*index*]

Arguments

Model

An instance of the IDLgrModel object class.

Keywords

POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

IDLgrView::Cleanup

The IDLgrView::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrView::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrView::GetByName

The IDLgrView::GetByName function method finds contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

Note

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

Syntax

Result = *Obj* **->** [IDLgrView::]GetByName(*Name*)

Arguments

Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

Keywords

None

IDLgrView::GetProperty

The IDLgrView::GetProperty procedure method retrieves the value of the property or group of properties for the view.

Syntax

Obj **–>** [IDLgrView::]GetProperty [, ALL=*variable*] [, PARENT=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrView::Init followed by the word "Get" can be retrieved using IDLgrView::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

IDLgrView::Init

The IDLgrView::Init function method initializes the view object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrView' [, COLOR{Get, Set}=*index or RGB vector*] [, DEPTH_CUE{Get, Set}=*[zbright, zdim]*] [, DIMENSIONS{Get, Set}=*[width, height]*] [, /DOUBLE {Get, Set}] [, EYE{Get, Set}=*distance*] [, LOCATION{Get, Set}=*[x, y]*] [, PROJECTION{Get, Set}={1 | 2}] [, /TRANSPARENT{Get, Set}] [, UNITS{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*] [, VIEWPLANE_RECT{Get, Set}=*[x, y, width, height]*] [, ZCLIP{Get, Set}=*[near, far]*])

or

Result = *Obj* **->** [IDLgrView::]Init( ) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrView::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrView::SetProperty are indicated by the word "Set" following the keyword.

COLOR *(Get, Set)*

Set this keyword to the color for the view. This is the color to which the view area will be erased before its contents are drawn. The color may be specified as a color lookup table index or as an RGB vector. The default is [255, 255, 255] (white).

DEPTH_CUE *(Get, Set)*

Set this keyword to a two-element floating-point array [*zbright*, *zdim*] specifying the near and far Z planes between which depth cueing is in effect. Depth cueing is only honored when drawing to a destination object that uses the RGB color model.

Depth cueing causes an object to appear to fade into the background color of the view object with changes in depth. If the depth of an object is further than *zdim* (that is, if the object's location in the Z direction is farther from the origin than the value specified by *zdim*), the object will be painted in the background color. Similarly, if the object is closer than the value of *zbright*, the object will appear in its "normal" color. Anywhere in-between, the object will be a blend of the background color and the object color. For example, if the DEPTH_CUE property is set to [-1,1], an object at the depth of 0.0 will appear as a 50% blend of the object color and the view color.

The relationship between Z_{bright} and Z_{dim} determines the result of the rendering:

- $Z_{bright} < Z_{dim}$: Rendering darkens with depth.
- $Z_{bright} > Z_{dim}$: Rendering brightens with depth.
- $Z_{bright} = Z_{dim}$: Disables depth cueing.

You can disable depth cueing by setting $z_{bright} = z_{dim}$. The default is [0.0, 0.0].

DIMENSIONS *(Get, Set)*

Set this keyword to a two-element vector of the form [*width*, *height*] specifying the dimensions of the viewport (the rectangle in which models are displayed on a graphics destination). By default, the viewport dimensions are set to [0, 0], which indicates that it will match the dimensions of the graphics destination to which it is drawn. The dimensions are measured in the units specified by the UNITS keyword.

DOUBLE *(Get, Set)*

The DOUBLE keyword parameter controls the precision used for rendering the entire contents of the view. If set, IDL calculates the transformations used for the modeling and view transforms using double-precision floating-point arithmetic. This allows the values specified for the VIEWPLANE_RECT, modeling transforms in IDLgrModel objects, and coordinate data in atomic graphic objects to be used as double-precision before mapping to device coordinates.

Note

If this keyword is not specified, IDL uses single-precision floating-point arithmetic for these values which can cause loss of significance and incorrect rendering of data. Using this keyword may impact graphics performance and should only be used when handling data requiring double-precision.

EYE *(Get, Set)*

Set this keyword to specify the distance from the eyepoint to the viewplane (Z=0). The default is 4.0. The eyepoint is always centered within the viewplane rectangle. (That is, if the VIEWPLANE_RECT property is set equal to [0,0,1,1], the eyepoint will be at X=0.5, Y=0.5.) IDL converts, maintains, and returns this data as double-precision floating-point.

LOCATION *(Get, Set)*

Set this keyword to a two-element vector of the form [*x*, *y*] specifying the position of the lower left corner of the view. The default is [0, 0], measured in device units.

PROJECTION *(Get, Set)*

Set this keyword to and integer value indicating the type of projection to use within this view. All models displayed within this view will be projected using this type of projection. Valid values are described below.

- 1 = Orthogonal projection (default).
- 2 = Perspective: Indicates that all models are projected toward the eye (located at the origin), which is the apex of the viewing frustum. With a perspective projection, models that are farther away from the eye will appear smaller in the view than models that are nearer to the eye.

TRANSPARENT *(Get, Set)*

Set this keyword to disable the viewport erase, making the viewport transparent.

UNITS *(Get, Set)*

Set this keyword to specify the units of measure for this view. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the graphics destination's *rect*.

Note

If you set the UNITS property (using the SetProperty method) of a view without also setting the LOCATION and DIMENSIONS properties, IDL will use the existing size and location values in the new units, *without conversion*. This means that if your view's location and dimensions were previously measured in centimeters, and you change the value of UNITS to 1 (measurement in inches), the actual size of the view object will change.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this "user value" to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object to which the user value applies.

VIEWPLANE_RECT *(Get, Set)*

Set this keyword to a four-element vector of the form [*x*, *y*, *width*, *height*] to describe the bounds in x and y of the view volume. Objects within the view volume are projected into the viewport. These values are measured in normalized space. The default is [-1.0, -1.0, 2.0, 2.0] IDL converts, maintains, and returns this data as double-precision floating-point.

Note

The z bounds of the view volume are set via the ZCLIP keyword. The viewplane rectangle is always located at Z=0.

ZCLIP *(Get, Set)*

Set this keyword to a two element vector representing the near and far clipping planes to be applied to the objects in this view. The vector should take the form [*near*, *far*]. By default, these values are [1, -1]. IDL converts, maintains, and returns this data as double-precision floating-point.

IDLgrView::SetProperty

The IDLgrView::SetProperty procedure method sets the value of the property or group of properties for the view.

Syntax

Obj -> [IDLgrView::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrView::Init followed by the word “Set” can be set using IDLgrView::SetProperty.

IDLgrViewgroup

The IDLgrViewgroup object is a simple container object, very similar to the IDLgrScene object. It contains one or more IDLgrView objects and an IDLgrScene can contain one or more of these objects. This object is special in that it can also contain objects which do not have a Draw method (e.g. IDLgrPattern and IDLgrFont). An IDLgrViewgroup object cannot be returned by a call to the IDLgrWindow::Select method.

Superclasses

This class is a subclass of IDL_Container.

Subclasses

This class has no subclasses.

Creation

See IDLgrViewgroup::Init.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrViewgroup::Add
- IDLgrViewgroup::Cleanup
- IDLgrViewgroup::GetByName
- IDLgrViewgroup::GetProperty
- IDLgrViewgroup::Init
- IDLgrViewgroup::SetProperty

Inherited Methods

This class inherits the following methods:

- IDL_Container::Count
- IDL_Container::Get

- IDL_Container::IsContained
- IDL_Container::Move

IDLgrViewgroup::Add

The IDLgrViewgroup::Add function method verifies that the added item is not an instance of the IDLgrScene or IDLgrViewgroup object. If it is not, IDLgrViewgroup:Add adds the object to the specified viewgroup.

Syntax

Obj –> [IDLgrViewgroup::]Add, *Object* [, POSITION=*index*]

Arguments

Object

An instance of an object or a list of objects. Objects which subclass IDLgrScene or IDLgrViewGroup can not be added (avoiding circularity constraints). All other objects are allowed.

Keywords

POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

IDLgrViewgroup::Cleanup

The IDLgrViewgroup::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY,*Obj*

or

Obj **->** [IDLgrViewgroup::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrViewgroup::GetByName

The IDLgrViewgroup::GetByName function method finds contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

Note

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

Syntax

Result = *Obj* **->** [IDLgrViewgroup::]GetByName(*Name*)

Arguments

Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

Keywords

None

IDLgrViewgroup::GetProperty

The IDLgrViewgroup::GetProperty procedure method retrieves the value of a property or group of properties for the viewgroup object.

Syntax

Obj **->** [IDLgrViewgroup::]GetProperty [, ALL=*variable*] [, PARENT=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrViewgroup::Init followed by the word "Get" can be retrieved using IDLgrViewgroup::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

PARENT

Set this keyword to a named variable that will contain an object reference to the object that contains this viewgroup.

IDLgrViewgroup::Init

The IDLgrViewgroup::Init function method initializes the viewgroup object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrViewgroup' [, /HIDE{Get, Set}] [, NAME{Get, Set}=*string*] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrViewgroup::]Init( ) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrViewgroup::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrViewgroup::SetProperty are indicated by the word "Set" following the keyword.

HIDE *(Get, Set)*

Set this keyword to a boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

NAME *(Get, Set)*

Set this keyword to a string representing the name to be associated with this object. The default is the null string, ''.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You may use this value to contain any information you wish.

IDLgrViewgroup::SetProperty

The IDLgrViewgroup::SetProperty procedure method sets the value of a property or group of properties for the viewgroup.

Syntax

Obj –> [IDLgrViewgroup::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrViewgroup::Init followed by the word “Set” can be retrieved using IDLgrViewgroup::SetProperty.

IDLgrVolume

A volume object represents a mapping from a three-dimensional array of data to a three-dimensional array of voxel colors, which, when drawn, are projected to two dimensions.

An IDLgrVolume object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrVolume::Init" on page 2252.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrVolume::Cleanup
- IDLgrVolume::ComputeBounds
- IDLgrVolume::GetCTM
- IDLgrVolume::GetProperty
- IDLgrVolume::Init
- IDLgrVolume::PickVoxel
- IDLgrVolume::SetProperty

IDLgrVolume::Cleanup

The IDLgrVolume::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrVolume::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrVolume::ComputeBounds

The IDLgrVolume::ComputeBounds procedure method computes the smallest bounding box that contains all voxels whose opacity lookup is greater than a given opacity value. The BOUNDS property is updated to the computed bounding box.

Syntax

Obj **->** [IDLgrVolume::]ComputeBounds [, OPACITY=*value*] [, /RESET] [, VOLUMES=*int array*]

Arguments

None

Keywords

OPACITY

Set this keyword to the opacity value to be used to determine which voxels are included within the bounding box. All voxels whose opacity lookup is greater than this value will be included. The default value is zero.

RESET

Set this keyword to cause the BOUNDS keyword of IDLgrVolume::Init to be reset to contain the entire volume.

VOLUMES

Set this keyword to an array of integers which select which volumes to consider when computing the bounding box. A non-zero value selects a volume to be searched. The default is to search all loaded volumes. For example: VOLUMES=[0,1] will cause ComputeBounds to search only the volume loaded in DATA1.

IDLgrVolume::GetCTM

The IDLgrVolume::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

Syntax

Result = *Obj* **->** [IDLgrVolume::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*])

Arguments

None

Keywords

DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the volume object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrVolume::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

IDLgrVolume::GetProperty

The IDLgrVolume::GetProperty procedure method retrieves the value of a property or group of properties for the volume.

Syntax

Obj **->** [IDLgrVolume::]GetProperty [, ALL=*variable*] [, PARENT=*variable*] [, VALID_DATA=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrVolume::Init followed by the word "Get" can be retrieved using IDLgrVolume::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

PARENT

Set this keyword equal to a named variable that will contain an object reference to the object that contains this object.

VALID_DATA

Set his keyword equal to a named variable that will contain an array of integers (one per volume, DATA0, DATA1, etc.) which have the value 1 if volume data has been loaded for that volume and 0 if that volume data is currently undefined.

XRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object.

YRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object.

ZRANGE

Set this keyword equal to a named variable that will contain a two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object.

IDLgrVolume::Init

The IDLgrVolume::Init function method initializes the volume object. At least one volume method must be specified, via arguments or keywords.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrVolume' [, *vol0* [, *vol1* [, *vol2* [, *vol3*]]]] [, AMBIENT{Get, Set}=*RGB vector*] [, BOUNDS{Get, Set}=*[xmin*, *ymin*, *zmin*, *xmax*, *ymax*, *zmax]*] [, COMPOSITE_FUNCTION{Get, Set}={0 | 1 | 2 | 3}] [, CUTTING_PLANES{Get, Set}=*array*] [, DATA0{Get, Set}=*[d_x, d_y, d_z]*] [, DATA1{Get, Set}=*[d_x, d_y, d_z]*] [, DATA2{Get, Set}=*[d_x, d_y, d_z]*] [, DATA3{Get, Set}=*[d_x, d_y, d_z]*] [, DEPTH_CUE{Get, Set}=*[zbright*, *zdim]*] [, /HIDE{Get, Set}] [, HINTS{Get, Set}={0 | 1 | 2 | 3}] [, /INTERPOLATE{Get, Set}] [, /LIGHTING_MODEL{Get, Set}] [, NAME{Get, Set}=*string*] [, /NO_COPY{Get, Set}] [, OPACITY_TABLE0{Get, Set}=*256-element byte array*] [, OPACITY_TABLE1{Get, Set}=*256-element byte array*] [, RENDER_STEP{Get, Set}=*[x*, *y*, *z]*] [, RGB_TABLE0{Get, Set}=*256 x 3-element byte array*] [, RGB_TABLE1{Get, Set}=*256 x 3-element byte array*] [, /TWO_SIDED{Get, Set}] [, UVALUE{Get, Set}=*value*] [, VOLUME_SELECT{Get, Set}={0 | 1 | 2}] [, XCOORD_CONV{Get, Set}=*vector*] [, YCOORD_CONV{Get, Set}=*vector*] [, /ZBUFFER{Get, Set}] [, ZCOORD_CONV{Get, Set}=*vector*] [, ZERO_OPACITY_SKIP{Get, Set}={0 | 1}])

or

Result = *Obj* **->** [IDLgrVolume::]Init([*vol0* [, *vol1* [, *vol2* [, *vol3*]]]]) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

vol_0

A three-element array (d_x, d_y, d_z) which specifies a data volume.

vol_1

A three-element array (d_x, d_y, d_z) which specifies a data volume.

vol_2

A three-element array (d_x, d_y, d_z) which specifies a data volume.

vol_3

A three-element array (d_x, d_y, d_z) which specifies a data volume.

Note

If two or more of the above arguments are specified, they must have matching dimensions.

Keywords

Properties retrievable via IDLgrVolume::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrVolume::SetProperty are indicated by the word "Set" following the keyword.

AMBIENT *(Get, Set)*

Use this keyword to set the color and intensity of the volume's base ambient lighting. Color is specified as an RGB vector. The default is [255, 255, 255]. AMBIENT is applicable only when LIGHTING_MODEL is set.

BOUNDS *(Get, Set)*

Set this keyword to a six-element vector of the form [x_{min}, y_{min}, z_{min}, x_{max}, y_{max}, z_{max}], which represents the sub-volume to be rendered.

COMPOSITE_FUNCTION *(Get, Set)*

The composite function determines the value of a pixel on the viewing plane by analyzing the voxels falling along the corresponding ray, according to one of the following compositing functions:

- 0 = Alpha (default): Alpha-blending. The recursive equation

```
dest' = src * srcalpha + dest * (1 - srcalpha)
```

is used to compute the final pixel color.

- 1 = MIP: Maximum intensity projection. The value of each pixel on the viewing plane is set to the brightest voxel, as determined by its opacity. The most opaque voxel's color appropriation is then reflected by the pixel on the viewing plane.
- 2 = Alpha sum: Alpha-blending. The recursive equation

  ```
  dest' = src + dest * ( 1 - srcalpha)
  ```

  is used to compute the final pixel color. This equation assumes that the color tables have been pre-multiplied by the opacity tables. The accumulated values can be no greater than 255.
- 3 = Average: Average-intensity projection. The resulting image is the average of all voxels along the corresponding ray.

CUTTING_PLANES *(Get, Set)*

Set this keyword to a floating-point array with dimensions (4, *n*) specifying the coefficients of *n* cutting planes. The cutting plane coefficients are in the form {{n_x, n_y, n_z, D}, ...} where $(n_x)X+(n_y)Y+(n_z)Z+ D > 0$, and ($X$, Y, Z) are the voxel coordinates. To clear the cutting planes, set this property to any scalar value (e.g. CUTTING_PLANES = 0). By default, no cutting planes are defined.

DATA0 *(Get, Set)*

Set this keyword to a three-element array of the format (d_x, d_y, d_z), which specifies a data volume. Setting this property is the same as including the vol_0 argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA1, DATA2, or DATA3, all existing data is removed from the object.

DATA1 *(Get, Set)*

Set this keyword to a three-element array of the format (d_x, d_y, d_z), which specifies a data volume. Setting this property is the same as including the vol_1 argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA2, or DATA3, all existing data is removed from the object.

DATA2 *(Get, Set)*

Set this keyword to a three-element array of the format (d_x, d_y, d_z), which specifies a data volume. Setting this property is the same as including the vol_2 argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA1, or DATA3, all existing data is removed from the object.

DATA3 *(Get, Set)*

Set this keyword to a three-element array of the format (d_x, d_y, d_z), which specifies a data volume. Setting this property is the same as including the vol_3 argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA1, or DATA2, all existing data is removed from the object.

Note

DATA0, DATA1, DATA2, and DATA3 sizes are dynamic.

DEPTH_CUE *(Get, Set)*

Set this keyword to a two-element floating-point array [*zbright*, *zdim*] specifying the near and far Z planes between which depth cueing is in effect. Depth cueing is only honored when drawing to a destination object that uses the RGB color model.

Depth cueing causes an object to appear to fade into the background color of the view object with changes in depth. If the depth of an object is further than *zdim* (that is, if the object's location in the Z direction is farther from the origin than the value specified by *zdim*), the object will be painted in the background color. Similarly, if the object is closer than the value of *zbright*, the object will appear in its "normal" color. Anywhere in-between, the object will be a blend of the background color and the object color. For example, if the DEPTH_CUE property is set to [-1,1], an object at the depth of 0.0 will appear as a 50% blend of the object color and the view color.

The relationship between Z_{bright} and Z_{dim} determines the result of the rendering:

- $Z_{bright} < Z_{dim}$: Rendering darkens with depth.
- $Z_{bright} > Z_{dim}$: Rendering brightens with depth.
- $Z_{bright} = Z_{dim}$: Disables depth cueing.

You can disable depth cueing by setting $z_{bright} = z_{dim}$. The default is [0.0, 0.0].

HIDE *(Get, Set)*

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

HINTS *(Get, Set)*

Set this keyword to specify one of the following acceleration hints:

- 0 = Disables all acceleration hints (default).
- 1 = Enables Euclidean distance map (EDM) acceleration. This option generates a volume map containing the distance from any voxel to the nearest non-zero opacity voxel. The map is used to speed ray casting by allowing the ray to jump over open spaces. It is most useful with sparse volumes. After setting the EDM hint, the draw operation generates the volume map; this process can take some time. Subsequent draw operations will reuse the generated map and may be much faster, depending on the volume's sparseness. A new map is not automatically generated to match changes in opacity tables or volume data (for performance reasons). The user may force recomputation of the EDM map by setting the HINTS property to 1 again.
- 2 = Enables the use of multiple CPUs for volume rendering if the platforms used support such use. If HINTS is set to 2, IDL will use all the available (up to 8) CPUs to render portions of the volume in parallel.
- 3 = Selects the two acceleration options described above.

INTERPOLATE *(Get, Set)*

Set this keyword to indicate that Trilinear interpolation is to be used to determine the data value for each step on a ray. Setting this keyword improves the quality of images produced, at the cost of more computing time. especially when the volume has low resolution with respect to the size of the viewing plane. Nearest neighbor sampling is used by default.

LIGHTING_MODEL *(Get, Set)*

Set this keyword to use the current lighting model during rendering in conjunction with a local gradient evaluation.

Note

Only DIRECTIONAL light sources are honored by the volume object. Because normals must be computed for all voxels in a lighted view, enabling light sources increases the rendering time.

NAME *(Get, Set)*

Set this keyword equal to a string containing the name associated with this object. The default is the null string, ''.

NO_COPY *(Get, Set)*

Set this keyword to relocate volume data from the input variables to the volume object, leaving the input variables undefined. Only the DATA0 keyword and the *vol0* argument are affected. If this keyword is omitted, the input volume data will be duplicated and a copy will be stored in the object.

OPACITY_TABLE0 *(Get, Set)*

Set this keyword to a 256-element byte array to specify an opacity table for DATA0. The default table is the linear ramp.

OPACITY_TABLE1 *(Get, Set)*

Set this keyword to a 256-element byte array to specify an opacity table for DATA1. The default table is the linear ramp. This table is used only when VOLUME_SELECT is set equal to 1.

RENDER_STEP *(Get, Set)*

Set this keyword to a three element vector of the form [*x*, *y*, *z*] to specify the stepping factor through the voxel matrix.

RGB_TABLE0 *(Get, Set)*

Set this keyword to a 256 x 3-element byte array to specify an RGB color table for DATA0. The default table is the linear ramp.

RGB_TABLE1 *(Get, Set)*

Set this keyword to a 256 x 3-element byte array to specify an RGB color table for DATA1. The default table is the linear ramp. This table is used only when VOLUME_SELECT is set equal to 1.

TWO_SIDED *(Get, Set)*

Set this keyword to force the lighting model to use a two-sided voxel gradient. The two-sided gradient is different from the one-sided gradient (default) in that the absolute value of the inner product of the light direction and the surface gradient is used instead of clamping to 0.0 for negative values.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

VOLUME_SELECT *(Get, Set)*

Set this keyword to an integer value to select the form of the volume to be rendered. The VOLUME_SELECT keyword is used to modify the `src` and `srcalpha` parameters for the COMPOSITE_FUNCTION keyword.

- 0 = render voxels from the 8bit DATA0 volume (the default)

```
src = RGB_TABLE0[DATA0]
srcalpha = OPACITY_TABLE0[DATA0]
```

- 1 = render voxels formed by modulating the RGBA components from DATA0 and DATA1 (after RGB and OPACITY table lookups).

```
src = (RGB_TABLE0[DATA0]*RGB_TABLE1[DATA1])/256
srcalpha=(OPACITY_TABLE0[DATA0]*OPACITY_TABLE1[DATA1])/256
```

- 2 = render voxels formed using a byte from DATA0 (red), DATA1 (green), DATA2(blue) and DATA3(alpha). The keywords OPACITY_TABLE0 and RGB_TABLE0, described above, are used to indirect the data from each volume before forming the RGBA pixel.

```
src=(RGB_TABLE[DATA0,0],RGB_TABLE[DATA1,1],RGB_TABLE[DATA2,2])/256
srcalpha = (OPACITY_TABLE0[DATA3])/256
```

XCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}), 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

YCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}), 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

ZBUFFER *(Get, Set)*

Set this keyword to clip the rendering to the current Z-buffer and then update the buffer. The default is to not modify the current Z-buffer.

ZCOORD_CONV *(Get, Set)*

Set this keyword to a vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}), 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]IDL converts, maintains, and returns this data as double-precision floating-point.

ZERO_OPACITY_SKIP *(Get, Set)*

Set this keyword to skip voxels with an opacity of 0. This keyword can increase the output contrast of MIP (MAXIMUM_INTENSITY) projections by allowing the background to show through. If this keyword is set, voxels with an opacity of zero will not modify the Z-buffer. The default (not setting the keyword) continues to render voxels with an opacity of zero.

IDLgrVolume::PickVoxel

The IDLgrVolume::PickVoxel function method computes the coordinates of the voxel projected to a location specified by the 2D device coordinates point, $[x_i, y_i]$, and the current Z-buffer. The function returns the volume indices as a a vector of three long integers. If the selected point is not within the volume, this function returns [-1,-1,-1].

Syntax

Result = *Obj* **->** [IDLgrVolume::]PickVoxel (*Win*, *View*, *Point* [, PATH=*objref(s)*])

Arguments

Win

The IDLgrWindow object from which the Z-buffer is to be used.

View

The IDLgrView object that contains the volume.

Point

The $[x, y]$ viewport coordinates of the point chosen.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a voxel coordinate. Each path object reference specified with this keyword must contain an alias. The voxel coordinate is computed for the version of the object falling within the specified path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrVolume::SetProperty

The IDLgrVolume::SetProperty procedure method sets the value of a property or group of properties for the volume.

Syntax

Obj -> [IDLgrVolume::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrVolume::Init followed by the word “Set” can be set using IDLgrVolume::SetProperty.

IDLgrVRML

The IDLgrVRML object allows you to save the contents of an Object Graphics hierarchy into a VRML 2.0 format file. The graphics tree can only contain a single view due to limitations in the VRML specification. The resulting VRML file is interactive and allows you to explore the geometry interactively using a VRML browser.

Note

Objects or subclasses of this type can not be saved or restored.

Aspect ratios are difficult to duplicate as they can be browser dependent. The object is limited to the primitives supported by VRML. Texture maps (and images) will be inlined into the output file. While this will generate large VRML files, the files are fully self-contained.

Several entities cannot be translated perfectly. These include:

IDLgrImage objects

Rotation and Z buffer behavior are not completely supported. Image objects will be converted into texture mapped polygons. BLEND_FUNCTION is not completely supported (only binary srcAlpha,1-srcAlpha) This function is applied automatically if an Alpha channel is present. It is also very browser dependent. Channel masks are not supported.

IDLgrPolygon and IDLgrSurface objects

Hidden line/hidden point display, color and vertex color blending with texture colors, and bottom color are not supported. Shading may be browser dependent. Front face culling is not supported and back face culling is only supported at the browser's discretion.

IDLgrLight objects

Lighting scope and intensity may be browser dependent.

IDLgrText objects

Text using the ONGLASS property is only supported for the initial view.

IDLgrViewgroup, IDLgrScene, IDLgrVolume objects

These objects are not supported.

IDLgrPalette objects

Palette objects are simulated using an RGB color model.

IDLgrPattern objects

Only solid or clear patterns are supported.

IDLgrFont, IDLgrSymbol objects

The THICK property is not supported.

IDLgrPolyline, IDLgrSymbol, IDLgrSurface, IDLgrPolygon and IDLgrPlot objects

Line attributes (thickness, linestyle) are not supported.

IDLgrView objects

Z-clipping control, aspect ratio preservation, the LOCATION property, and orthographic projections are not supported.

Destination objects

The COLOR_MODEL property is not fully supported in Indexed Color mode, when using a SHADER_RANGE (an RGB model will be substituted instead). The QUALITY property is not supported.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "IDLgrVRML::Init" on page 2272.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrVRML::Cleanup

- IDLgrVRML::Draw
- IDLgrVRML::GetDeviceInfo
- IDLgrVRML::GetFontnames
- IDLgrVRML::GetProperty
- IDLgrVRML::GetTextDimensions
- IDLgrVRML::Init
- IDLgrVRML::SetProperty

IDLgrVRML::Cleanup

The IDLgrVRML::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrVRML::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrVRML::Draw

The IDLgrVRML::Draw procedure method draws the given picture to this graphics destination.

Syntax

Obj –> [IDLgrVRML::]Draw [, *Picture*]

Arguments

Picture

The view (an instance of an IDLgrView object) to be drawn. If the view has a LOCATION property, it is ignored.

Keywords

None

IDLgrVRML::GetDeviceInfo

The IDLgrVRML::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

Syntax

Obj–>[IDLgrVRML::]GetDeviceInfo [, ALL=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

Arguments

None.

Keywords

ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, *MAX_TEXTURE_DIMENSIONS* contains a two element integer array that specifies the maximum texture size supported by the device.

MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, *MAX_VIEWPORT_DIMENSIONS* contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

NAME

Set this keyword equal to a named variable. Upon return, *NAME* contains the name of the rendering device as a string.

NUM_CPUS

Set this keyword equal to a named variable. Upon return, *NUM_CPUS* contains an integer that specifies the number of CPUs that are known to, and available to IDL.

Note

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI Irix, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

VENDOR

Set this keyword equal to a named variable. Upon return, *VENDOR* contains the name of the rendering device creator as a string.

VERSION

Set this keyword equal to a named variable. Upon return, *VERSION* contains the version of the rendering device driver as a string.

IDLgrVRML::GetFontnames

The IDLgrVRML::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

Syntax

Return = *Obj* **->**[IDLgrVRML::]GetFontnames(*FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*])

Arguments

FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name, such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

Keywords

IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is the string, "*", which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

IDLgrVRML::GetProperty

The IDLgrVRML::GetProperty procedure method retrieves the value of a property or group of properties for the VRML object.

Syntax

Obj **–>** [IDLgrVRML::]GetProperty [, ALL=*variable*]
[, SCREEN_DIMENSIONS=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrVRML::Init followed by the word “Get” can be retrieved using IDLgrVRML::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the retrievable properties associated with this object.

SCREEN_DIMENSIONS

Set this keyword to a named variable that will contain a two-element vector of the form [*width*, *height*] specifying the dimensions of the overall screen dimensions for the screen with which this object associated. The screen dimensions are measured in device units.

IDLgrVRML::GetTextDimensions

The IDLgrVRML::GetTextDimensions function method retrieves the dimensions of a text object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text object, measured in data units.

Syntax

Result = *Obj* **->**[IDLgrVRML::]GetTextDimensions(*TextObj*
[, DESCENT=*variable*] [, PATH=*objref(s)*])

Arguments

TextObj

The object reference to a text or axis object for which the text dimensions are requested.

Keywords

DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrVRML::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrVRML::Init

The IDLgrVRML::Init function method initializes the VRML object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrVRML' [, COLOR_MODEL{Get}={0 | 1}]
[, DIMENSIONS{Get, Set}=*[width, height]*] [, FILENAME{Get, Set}=*string*]
[, GRAPHICS_TREE{Get, Set}=*objref*] [, N_COLORS{Get}=*integer*{2 to 256}]
[, PALETTE{Get, Set}=*objref*] [, QUALITY{Get, Set}={0 | 1 | 2}]
[, RESOLUTION{Get, Set}=*[xres, yres]*] [, UNITS{Get, Set}={0 | 1 | 2 | 3}]
[, UVALUE{Get, Set}=*value*] [, WORLDINFO=*string array*]
[, WOLRDTITLE=*string*])

or

Result = *Obj* **->** [IDLgrVRML::]Init( ) (*Only in a subclass' Init method.*)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrVRML::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrVRML::SetProperty are indicated by the word "Set" following the keyword.

COLOR_MODEL *(Get)*

Set this keyword to the color model to be used for the buffer:

- 0=RGB (the default)
- 1=Color indexed.

DIMENSIONS *(Get, Set)*

Set this keyword to a two-element vector of the form [*width*, *height*] to specify the dimensions of the window in units specified by the UNITS property. The default is [640,480].

Note

The only use of this property is to support the use of normalized coordinates for the dimensions of the IDLgrView object passed to the IDLgrVRML::Draw method.

FILENAME *(Get, Set)*

Set this keyword to the name of a file into which the vector data will be saved. The default is `idl.wrl`.

GRAPHICS_TREE *(Get, Set)*

Set this keyword to an object reference of type IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

N_COLORS *(Get)*

Set this keyword to the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to indexed.

PALETTE *(Get, Set)*

Set this keyword to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the buffer's color lookup table.

QUALITY *(Get, Set)*

Set this keyword to an integer indicating the rendering quality at which graphics are to be drawn to the buffer. Valid values are:

- 0=Low
- 1=Medium

- 2=High (the default)

RESOLUTION *(Get, Set)*

Set this keyword to a two-element vector of the form [*xres*, *yres*] specifying the device resolution in centimeters per pixel.

Note

This keyword is used for text scaling and partial aspect ratio preservation only. The default value is [0.0352778, 0.0352778] (72 DPI).

UNITS *(Get, Set)*

Set this keyword to indicate the units of measure for the DIMENSIONS property. Valid values are:

- 0=Device (the default)
- 1=Inches
- 2=Centimeters
- 3=Normalized (relative to 1600 x 1200).

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this user value to contain any information you wish.

WORLDINFO

Set this keyword to a list of strings for the info field of the VRML WorldInfo node. The default is the null string, ''.

WOLRDTITLE

Set this keyword to a string containing the title for the VRML WorldInfo node, TITLE field. The default is `'IDL VRML file'`.

IDLgrVRML::SetProperty

The IDLgrVRML::SetProperty procedure method sets the value of a property or group of properties for the VRML world.

Syntax

Obj –> [IDLgrVRML::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrVRML::Init followed by the word “Set” can be retrieved using IDLgrVRML::SetProperty.

IDLgrWindow

A window object is a representation of an on-screen area on a display device that serves as a graphics destination.

Note

Objects or subclasses of this type can not be saved or restored.

Note on Window Size Limits

The OpenGL libraries IDL uses impose limits on the maximum size of a drawable area. The limits are device-dependent — they depend both on your graphics hardware and the setting of the RENDERER property. Currently, the smallest maximum drawable area on any IDL platform is 1280 x 1024 pixels; the limit on your system may be larger.

Superclasses

This class has no superclass.

Subclasses

This class has no subclasses.

Creation

See "IDLgrWindow::Init" on page 2289.

Methods

Intrinsic Methods

This class has the following methods:

- IDLgrWindow::Cleanup
- IDLgrWindow::Draw
- IDLgrWindow::Erase
- IDLgrWindow::GetContiguousPixels
- IDLgrWindow::GetDeviceInfo

- IDLgrWindow::GetFontnames
- IDLgrWindow::GetProperty
- IDLgrWindow::GetTextDimensions
- IDLgrWindow::Iconify
- IDLgrWindow::Init
- IDLgrWindow::Pickdata
- IDLgrWindow::Read
- IDLgrWindow::Select
- IDLgrWindow::SetCurrentCursor
- IDLgrWindow::SetProperty
- IDLgrWindow::Show

IDLgrWindow::Cleanup

The IDLgrWindow::Cleanup procedure method performs all cleanup on the object.

Note

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

Syntax

OBJ_DESTROY, *Obj*

or

Obj **->** [IDLgrWindow::]Cleanup(*Only in subclass' Cleanup method*.)

Arguments

None

Keywords

None

IDLgrWindow::Draw

The IDLgrWindow::Draw procedure method draws the specified scene or view object to this graphics destination.

Note

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

Syntax

Obj **->** [IDLgrWindow::]Draw [, *Picture*] [, CREATE_INSTANCE={1 | 2}] [, /DRAW_INSTANCE]

Arguments

Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

Keywords

CREATE_INSTANCE

Set this keyword equal to one specify that this scene or view is the unchanging part of a drawing. Some destinations can make an instance from the current window contents without having to perform a complete redraw. If the view or scene to be drawn is identical to the previously drawn view or scene, this keyword can be set equal to 2 to hint the destination to create the instance from the current window contents if it can.

DRAW_INSTANCE

Set this keyword to specify that this scene or view is the changing part of a drawing. It is overlaid on the result of the most recent CREATE_INSTANCE draw.

IDLgrWindow::Erase

The IDLgrWindow::Erase procedure method erases the entire contents of the window.

Syntax

Obj **->** [IDLgrWindow::]Erase [, COLOR=*index or RGB vector*]

Arguments

None

Keywords

COLOR

Set this keyword to the color to be used for the erase. The color may be specified as a color lookup table index or as an RGB vector. The default erase color is white.

IDLgrWindow::GetContiguousPixels

The IDLgrWindow::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
```

```
[4,3,2,1,0]
```

Syntax

Return = *Obj* **->** [IDLgrWindow::]GetContiguousPixels()

Arguments

None

Keywords

None

IDLgrWindow::GetDeviceInfo

The IDLgrWindow::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=0 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

Syntax

Obj–>[IDLgrWindow::]GetDeviceInfo [, ALL=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

Arguments

None.

Keywords

ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two element integer array that specifies the maximum texture size supported by the device.

MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

Note

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI Irix, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

IDLgrWindow::GetFontnames

The IDLgrWindow::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

Syntax

Return = *Obj* **->** [IDLgrWindow::]GetFontnames(*FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*])

Arguments

FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

Keywords

IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is the string, "*", which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

IDLgrWindow::GetProperty

The IDLgrWindow::GetProperty procedure method retrieves the value of a property or group of properties for the window.

Syntax

Obj **->** [IDLgrWindow::]GetProperty [, ALL=*variable*]
[, IMAGE_DATA=*variable*] [, RESOLUTION=*variable*]
[, SCREEN_DIMENSIONS=*variable*] [, ZBUFFER_DATA=*variable*]

Arguments

None

Keywords

Any keyword to IDLgrWindow::Init followed by the word "Get" can be retrieved using IDLgrWindow::GetProperty. In addition, the following keywords are available:

ALL

Set this keyword to a named variable that will contain an anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

Note

The fields of this structure may change in subsequent releases of IDL.

IMAGE_DATA

Set this keyword to a named variable that will contain a byte array representing the image that is currently displayed in the window. If the window object uses an RGB color model, the returned array will have dimensions (3, *winXSize*, *winYSize*), or (4, *winXSize*, *winYSize*) if an alpha channel is included. If the window object uses an Indexed color model, the returned array will have dimensions (*winXSize*, *winYSize*). See "IDLgrWindow::Read" on page 2296 for more information.

RESOLUTION

Set this keyword to a named variable that will contain a vector of the form [*xres*, *yres*] reporting the pixel resolution, measured in centimeters per pixel. This value is stored in double precision.

SCREEN_DIMENSIONS

Set this keyword to a named variable that will contain a two-element vector of the form [*width*, *height*] specifying the dimensions of the overall screen dimensions for the screen with which this window is associated. The screen dimensions are measured in device units.

ZBUFFER_DATA

Set this keyword to a named variable that will contain a float array representing the zbuffer that is currently within the buffer. The returned array will have dimensions (*xdim*, *ydim*).

IDLgrWindow::GetTextDimensions

The IDLgrWindow::GetTextDimensions function method retrieves the dimensions of a text object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text object, measured in data units.

Syntax

Result = *Obj* **->**[IDLgrWindow::]GetTextDimensions(*TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*])

Arguments

TextObj

The object reference to a text or axis object for which the text dimensions are requested.

Keywords

DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values are the distance to travel (parallel to the UPDIR direction) from the baseline to reach the bottom of all the descenders for the string; the values will be negative or 0. This keyword is only valid if *TextObj* is of the class IDLgrText.

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrWindow::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrWindow::Iconify

The IDLgrWindow::Iconify procedure method iconifies or de-iconifies the window.

Note

Iconification under window systems is solely handled by the window manager; client applications, such as IDL, do not have the capability to manage icons. The Iconify method provides a hint to the window manager, which applies the information as it sees fit. (On the Macintosh, for example, iconfication is not a standard option; the Iconify method is ignored on the Mac.)

Syntax

Obj –> [IDLgrWindow::]Iconify, *IconFlag*

Arguments

IconFlag

Set *IconFlag* to 1 (one) to iconify the window or to 0 (zero) to restore the window. If the window is already restored, it is brought to the front of the window stack.

Keywords

None

IDLgrWindow::Init

The IDLgrWindow::Init function method initializes the window object.

Note

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

Syntax

Obj = OBJ_NEW('IDLgrWindow' [, COLOR_MODEL{Get}={0 | 1}] [, DIMENSIONS{Get, Set} =*[width, height]*] [, GRAPHICS_TREE{Get, Set}=*objref of type IDLgrScene, IDLgrViewgroup, or IDLgrView*] [, LOCATION{Get, Set}=*[x, y]*] [, N_COLORS{Get}=*integer*{2 to 256}] [, PALETTE{Get, Set}=*objref*] [, QUALITY{Get, Set}={0 | 1 | 2}] [, RENDERER{Get}={0 | 1}] [, RETAIN{Get}={0 | 1 | 2}] [, TITLE{Get, Set}=*string*] [, UNITS{Get, Set}={0 | 1 | 2 | 3}] [, UVALUE{Get, Set}=*value*])

or

Result = *Obj* **->** [IDLgrWindow::]Init( ) (*Only in a subclass' Init method.*)

X Windows Keywords: [, DISPLAY_NAME{Get}=*string*]

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

None

Keywords

Properties retrievable via IDLgrWindow::GetProperty are indicated by the word "Get" following the keyword. Properties settable via IDLgrWindow::SetProperty are indicated by the word "Set" following the keyword.

COLOR_MODEL *(Get)*

Set this keyword to the color model to be used for the window:

- 0 = RGB (default)
- 1 = Color Index

Note

For some X11 display situations, IDL may not be able to support a color index model destination object in object graphics. We do, however, guarantee that an RGB color model destination will be available for all display situations.

DIMENSIONS *(Get, Set)*

Set this keyword to a two-element vector of the form [*width*, *height*] to specify the dimensions of the window in units specified by the UNITS property. By default, if no value is specified for DIMENSIONS, IDL uses the value of the "Default Window Width" and "Default Window Height" preferences set in the IDL Development Environment's (IDLDE) Preferences dialog. If there is no preference file for the IDLDE, the DIMENSIONS property is set equal to one quarter of the screen size. There are limits on the maximum size of an IDLgrWindow object; see "Note on Window Size Limits" on page 2276 for details.

Note

Changing DIMENSIONS properties is merely a request and may be ignored for various reasons.

DISPLAY_NAME *(Get) (X Only)*

Set this keyword to the name of the X Windows display on which the window is to appear.

GRAPHICS_TREE *(Get, Set)*

Set this keyword to an object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

LOCATION *(Get, Set)*

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper lefthand corner of the window relative to the display screen, in units specified by the UNITS property. By default, the window is positioned at one of four quadrants on the display screen, and the location is measured in device units.

Note

Changing LOCATION properties is merely a request and may be ignored for various reasons. LOCATION may be adjusted to take into account window decorations.

N_COLORS *(Get)*

Set this keyword to the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Indexed (1). This keyword is ignored if COLOR_MODEL is set to RGB (0).

Note

If COLOR_MODEL is set to Color Index (1), setting N_COLORS is treated as a request to your operating system. You should always check the actual number of available colors for any Color Indexed destination with the IDLgrWindow::GetProperty method. The actual number of available colors depends on your system and also on how you have used IDL.

PALETTE *(Get, Set)*

Set this keyword to the object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the graphics destination's color lookup table, applicable if the Indexed color model is used.

QUALITY *(Get, Set)*

Set this keyword to an integer indicating the rendering quality at which graphics are to be drawn to this destination. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default).

RENDERER *(Get)*

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Chapter 28 of *Using IDL* for details. Your choice of renderer may also affect the maximum size of an IDLgrWindow object; see "Note on Window Size Limits" on page 2276 for details.

RETAIN *(Get)*

Set this keyword to 0, 1, or 2 to specify how backing store should be handled for the window. By default, if no value is specified for RETAIN, IDL uses the value of the "Backing Store" preference set in the IDL Development Environment's (IDLDE) Preferences dialog. If there is no preference file for the IDLDE (that is, if you always use IDL in plain tty mode), the RETAIN property is set equal to 0 by default.

- 0 = No backing store.
- 1 = The server or window system is requested to provide the backing store. Note that requesting backing store from the server is only a request; backing store may not be provided in all situations.
- 2 = Requests that IDL provide the backing store directly. In some situations, IDL can not provide this backing store in Object Graphics. To see if IDL provided backing store, query the RETAIN keyword of IDLgrWindow::GetProperty. IDL may also alter the RENDERER keyword while attempting to provide backing store.

In IDL Object Graphics, it is almost always best to disable backing store (that is, set the RETAIN property equal to zero). This is because drawing to an off-screen pixmap (which is what happens when backing store is enabled) almost always bypasses any hardware graphics acceleration that may be available, causing all rendering to be done in software. To ensure that windows are redrawn properly, enable the generation of expose events on the WIDGET_DRAW window and redraw the window explicitly when an expose event is received.

TITLE *(Get, Set)*

Set this keyword equal to a string that represents the title of the window.

UNITS *(Get, Set)*

Set this keyword to indicate the units of measure for the LOCATION and DIMENSIONS properties. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the screen.

Note

If you set the value of the UNITS property (using the SetProperty method) without also setting the value of the LOCATION and DIMENSIONS properties, IDL will convert the current size and location values into the new units.

UVALUE *(Get, Set)*

Set this keyword to a value of any type. You can use this “user value” to contain any information you wish. Remember that if you set the user value equal to a pointer or object reference, you should destroy the pointer or object reference explicitly when destroying the object it is a user value of.

IDLgrWindow::Pickdata

The IDLgrWindow::Pickdata function method maps a point in the two-dimensional device space of the window to a point in the three-dimensional data space of an object tree. The resulting 3D data space coordinates are returned in a user-specified variable. The Pickdata function returns one if the specified location in the window's device space "hits" a graphic object, or zero if no object was "hit". Pickdata returns -1 if the point selected falls outside of the specified view or window.

Syntax

Result = *Obj* **->** [IDLgrWindow::]Pickdata(*View*, *Object*, *Location*, *XYZLocation* [, PATH=*objref(s)*])

Arguments

View

The object reference of an IDLgrView object that contains the object being picked.

Object

The object reference of a model or atomic graphic object from which the data space coordinates are being requested.

Location

A two-element vector [*x*, *y*] specifying the location in the window's device space of the point to pick data from.

XYZLocation

A named variable that will contain the three-dimensional double-precision floating-point data space coordinates of the picked point. Note that the value returned in this variable is a location, not a data value.

Note

If the atomic graphic object specified as the target has been transformed using either the LOCATION or DIMENSIONS properties (this is only possible with IDLgrAxis, IDLgrImage, and IDLgrText objects), these transformations will *not* be included in the data coordinates returned by the Pickdata function. This means that you may need to re-apply the transformation accomplished by specifying LOCATION or DIMENSIONS once you have retrieved the data coordinates with

Pickdata. This situation does not occur if you transform the axis, text, or image object using the [XYZ]COORD_CONV properties.

Keywords

PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a data space coordinate. Each path object reference specified with this keyword must contain an alias. The data space coordinate is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

Note

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

IDLgrWindow::Read

The IDLgrWindow::Read function method reads an image from a window. The returned value is an instance of the IDLgrImage object class.

Syntax

Result = *Obj* **->** [IDLgrWindow::]Read()

Arguments

None

Keywords

None

IDLgrWindow::Select

The IDLgrWindow::Select function method returns a list of objects selected at a specified location. If no objects are selected, the Select function returns -1.

Note

IDL returns a maximum of 512 objects. This maximum may be smaller if any of the objects are contained in deep model hierarchies. Because of this limit, it is possible that not all objects eligible for selection will appear in the list.

Syntax

Result = *Obj* **->** [IDLgrWindow::]Select(*Picture, XY* [, DIMENSIONS=*[width, height]*] [, UNITS={0 | 1 | 2 | 3}])

Arguments

Picture

The view or scene (an instance of the IDLgrView, IDLgrViewgroup, or IDLgrScene class) whose children are among the candidates for selection.

If the first argument is a scene, then the returned object list will contain one or more views. If the first argument is a view, the list will contain atomic graphic objects (or model objects which have their SELECT_TARGET property set). Objects are returned in order, according to their distance from the viewer. The closer an object is to the viewer, the lower its index in the returned object list. If multiple objects are at the same distance from the viewer (views in a scene or 2D geometry), the last object drawn will appear at a lower index in the list.

XY

A two-element array defining the center of the selection box in device space. By default, the selection box is 3 pixels by 3 pixels.

Keywords

DIMENSIONS

Set this keyword to a two-element array [*w*, *h*] to specify that the selection box will have a width *w* and a height *h*, and will be centered about the coordinates [*x*, *y*] specified in the *XY* argument. The box occupies the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/1), y+(h/2))
```

Any object that intersects this box is considered to be selected. By default, the selection box is 3 pixels by 3 pixels.

UNITS

Set this keyword to indicate the units of measure. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the graphics destination.

IDLgrWindow::SetCurrentCursor

The IDLgrWindow::SetCurrentCursor procedure method sets the current cursor image to be used while positioned over a drawing area.

Syntax

Obj–> [IDLgrWindow::]SetCurrentCursor [, *CursorName*] [, IMAGE=*16 x 16 bitmap*] [, MASK=*16 x 16 bitmap*] [, HOTSPOT=*[x, y]*]

X Windows Keywords: [, STANDARD=*index*]

Arguments

CursorName

A string that specifies which built-in cursor to use. This argument is ignored if one of the keywords to this routine is set. This string can be one of the following:

- ARROW
- CROSSHAIR
- ICON
- IBEAM
- MOVE
- ORIGINAL
- SIZE_NE
- SIZE_NW
- SIZE_SE
- SIZE_SW
- SIZE_NS
- SIZE_EW
- UP_ARROW

Keywords

IMAGE

Set this keyword to a 16x16 column bitmap, contained in a 16-element short integer vector, specifying the cursor pattern. The offset from the upper-left pixel to the point that is considered the “hot spot” can be provided via the HOTSPOT keyword.

MASK

When the IMAGE keyword is set, the MASK keyword can be used to simultaneously specify the mask that should be used. In the mask, bits that are set indicate bits in the IMAGE that should be seen and bits that are not are “masked out”.

HOTSPOT

Set this keyword to a two-element vector specifying the [*x*, *y*] pixel offset of the cursor "hot spot", the point which is considered to be the mouse position, from the upper left corner of the cursor image. This parameter is only applicable if IMAGE is provided. The cursor image is displayed top-down (the first row is displayed at the top).

STANDARD (X Only)

Set this keyword to an X11 cursor font index to change the appearance of the cursor in the IDL graphics window to a glyph in this font. On non-X platforms, setting this keyword displays the crosshair cursor.

IDLgrWindow::SetProperty

The IDLgrWindow::SetProperty procedure method sets the value of a property or group of properties for the window.

Syntax

Obj –> [IDLgrWindow::]SetProperty

Arguments

None

Keywords

Any keyword to IDLgrWindow::Init followed by the word “Set” can be set using IDLgrWindow::SetProperty.

IDLgrWindow::Show

The IDLgrWindow::Show procedure method exposes or hides a window.

Syntax

Obj –> [IDLgrWindow::]Show, *Position*

Arguments

Position

Set this argument equal to a non-zero value to expose the window, or to 0 to hide the window.

Keywords

None

TrackBall

A TrackBall object translates widget events from a draw widget (created with the WIDGET_DRAW function) into transformations that emulate a virtual trackball (for transforming object graphics in three dimensions).

This object class is implemented in the IDL language. Its source code can be found in the file `trackball__define.pro` in the `lib` subdirectory of the IDL distribution.

Superclasses

This class has no superclasses.

Subclasses

This class has no subclasses.

Creation

See "TrackBall::Init" on page 2304.

Methods

Intrinsic Methods

This class has the following methods:

- TrackBall::Init
- Trackball::Reset
- TrackBall::Update

TrackBall::Init

The TrackBall::Init function method initializes the TrackBall object.

Syntax

Obj = OBJ_NEW('TrackBall', *Center*, *Radius* [, AXIS={0 | 1 | 2}] [, /CONSTRAIN] [, MOUSE=*bitmask*])

or

Result = *Obj* **->** [TrackBall::]Init(*Center*, *Radius*) (*Only in a subclass' Init method*.)

Note

Keywords can be used in either form. They are omitted in the second form for brevity.

Arguments

Center

A two-dimensional vector, [*X*, *Y*], specifying the center coordinates of the trackball. *X* and *Y* should be specified in device units.

Radius

The radius of the trackball, specified in device units.

Keywords

AXIS

Set this keyword to an integer value to indicate the axis about which rotations are to be constrained if the CONSTRAIN keyword is set. Valid values include:

- 0 = Rotate only around the *X* axis.
- 1 = Rotate only around the *Y* axis.
- 2 = Rotate only around the *Z* axis (this is the default).

CONSTRAIN

Set this keyword to indicate that the trackball transformations are to be constrained about the axis specified by the AXIS keyword. The default is not to constrain the transformations.

MOUSE

Set this keyword to a bitmask to indicate which mouse button to honor for trackball events. The least significant bit represents the leftmost button, the next highest bit represents the middle button, and the next highest bit represents the right button. The default is 1b, for the left mouse button.

Trackball::Reset

The TrackBall::Reset procedure method resets the state of the TrackBall object.

Syntax

Obj **->** [TrackBall::]Reset, *Center*, *Radius* [, AXIS={0 | 1 | 2}] [, /CONSTRAIN] [, MOUSE=*bitmask*]

Arguments

Center

A two-dimensional vector, [*X*, *Y*], specifying the center coordinates of the trackball. *X* and *Y* should be specified in device units.

Radius

The radius of the trackball, specified in device units.

Keywords

AXIS

Set this keyword to an integer value to indicate the axis about which rotations are to be constrained if the CONSTRAIN keyword is set. Valid values include:

- 0 = Rotate only around the *X* axis.
- 1 = Rotate only around the *Y* axis.s
- 2 = Rotate only around the *Z* axis (this is the default).

CONSTRAIN

Set this keyword to indicate that the trackball transformations are to be constrained about the axis specified by the AXIS keyword. The default is not to constrain the transformations.

MOUSE

Set this keyword to a bitmask to indicate which mouse button to honor for trackball events. The least significant bit represents the leftmost button, the next highest bit represents the middle button, and the next highest bit represents the right button. The default is 1b, for the left mouse button.

TrackBall::Update

The TrackBall::Update function method updates the state of the TrackBall object based on the information contained in the input widget event structure. The return value is nonzero if a transformation matrix is calculated as a result of the event, or zero otherwise.

Syntax

Result = *Obj* **->** [TrackBall::]Update(*sEvent* [, MOUSE=*bitmask*] [, TRANSFORM=*variable*] [, /TRANSLATE])

Arguments

sEvent

The widget event structure.

Keywords

MOUSE

Set this keyword to a bitmask to indicate which mouse button to honor for trackball events. The least significant bit represents the leftmost button, the next highest bit represents the middle button, and the next highest bit represents the right button. The default is 1b, for the left mouse button.

TRANSFORM

Set this keyword to a named variable that will contain a 4 x 4 element floating-point array if a new transformations matrix is calculated as a result of the widget event.

TRANSLATE

Set this keyword to indicate that the trackball movement should be constrained to translation in the *X*-*Y* plane rather than rotation about an axis.

Example

The example code below provides a skeleton for a widget-based application that uses the TrackBall object to interactively change the orientation of graphics.

Create a trackball centered on a 512x512 pixel drawable area, and a view containing the model to be manipulated:

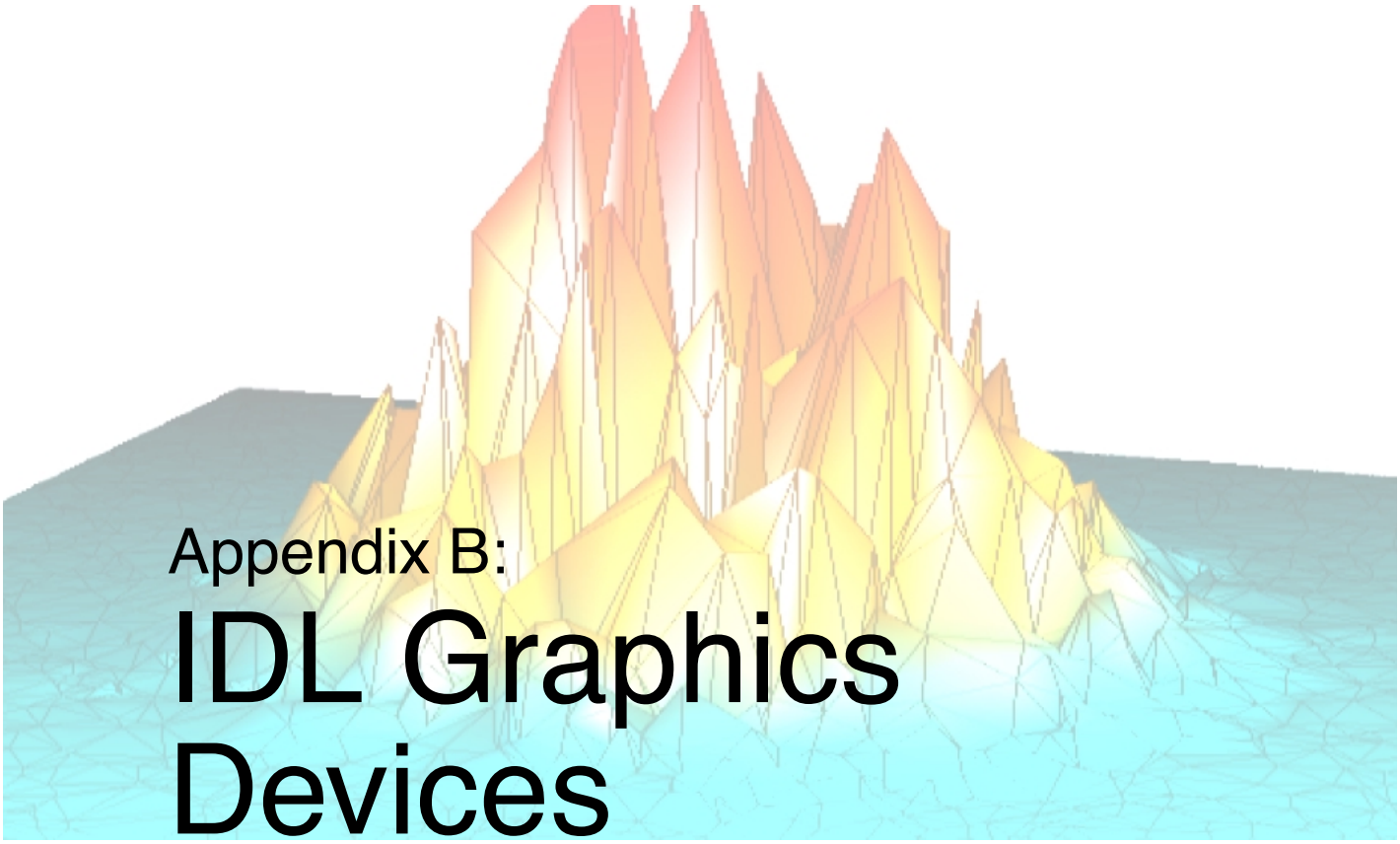
```
xdim = 512
```

```
ydim = 512
wBase = WIDGET_BASE()
wDraw = WIDGET_DRAW(wBase, XSIZE=xdim, YSIZE=ydim, $
    GRAPHICS_LEVEL=2, /BUTTON_EVENTS, $
    /MOTION_EVENTS, /EXPOSE_EVENTS, RETAIN=0 )
WIDGET_CONTROL, wBase, /REALIZE
WIDGET_CONTROL, wDraw, GET_VALUE=oWindow

oTrackball = OBJ_NEW('Trackball', [xdim/2.,ydim/2.], xdim/2.)
oView = OBJ_NEW('IDLgrView')
oModel = OBJ_NEW('IDLgrModel')
oView->Add, oModel
XMANAGER, 'TrackEx', wBase
```

You must handle the trackball updates in the widget event-handling code. As the trackball transformation changes, update the transformation for the model object, and redraw the view:

```
PRO TrackEx_Event, sEvent
...
bHaveXform = oTrackball->Update( sEvent, TRANSFORM=TrackXform )
IF (bHaveXform) THEN BEGIN
oModel->GetProperty, TRANSFORM=ModelXform
oModel->SetProperty, TRANSFORM=ModelXform # TrackXform
oWindow->Draw, oView
ENDIF
...
END
```

For a complete example, see the file `surf_track.pro`, located in the `examples/visual` subdirectory of the IDL distribution. The SURF_TRACK procedure uses IDL widgets to create a graphical user interface to an object tree, creates a surface object from user-specified data (or from default data, if none is specified), and places the surface object in an IDL draw widget. The SURF_TRACK interface allows the user to specify several attributes of the object hierarchy via pulldown menus.



Appendix B: IDL Graphics Devices

The following topics are covered in this appendix:

Supported Devices

IDL Direct Graphics support graphic output to the devices listed below:

Device Name	Description
CGM	Computer Graphics Metafile
HP	Hewlett-Packard Graphics Language (HP-GL)
LJ	Digital Equipment LJ250 (VMS Only)
MAC	Macintosh display
METAFILE	Windows Metafile Format (WMF)
NULL	No graphics output
PCL	Hewlett-Packard Printer Control Language (PCL)
PRINTER	System printer
PS	PostScript
REGIS	Regis graphics protocol (DEC systems only)
TEK	Tektronix compatible terminal
WIN	Microsoft Windows
X	X Window System
Z	Z-buffer pseudo device

Table B-1: IDL Graphics Output Devices

Each of these devices is described in a section of this chapter. The SET_PLOT procedure can be used to select the graphic device to which IDL directs its output. IDL Object Graphics does not rely on the concept of a current graphics device; see *Using IDL* for details about IDL Object Graphics.

The DEVICE procedure controls the graphic device-specific functions. An attempt has been made to isolate all device-specific functions in this procedure. DEVICE controls the graphics device currently selected by SET_PLOT. When using DEVICE, it is important to make sure that the current graphics device is the one you intend to use. This is because most of the devices have different keywords—you will most likely get a "`Keyword ... ... not allowed in call to: Device`" error if you call DEVICE when the wrong device is selected.

Keywords Accepted by the IDL Devices

The following table indicates which keywords are accepted by the DEVICE procedure. The NULL device is not listed as it accepts no keywords. Details of the various keywords can be found on the page indicated in the table.

Note

Most keywords to the DEVICE procedure are sticky — that is, once you set them, they remain in effect until you explicitly change them again, or end your IDL session. The exceptions are keywords used to return a value from the system (GET_FONTNAMES, for example) and those that perform a one-time-only operation (CLOSE_FILE, for example).

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
AVANTGARDE								•					
AVERAGE_LINES									•				
BINARY	•												
BITS_PER_PIXEL								•					
BKMAN								•					
BOLD								•					
BOOK								•					
BYPASS_TRANSLATION				•							•	•	
CLOSE													•
CLOSE_DOCUMENT							•						
CLOSE_FILE	•	•	•		•	•		•	•	•			

Table B-2: Keywords accepted by the IDL devices

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
COLOR						•		•					
COLORS	•									•			
COPY				•							•	•	
COURIER								•					
CURSOR_CROSSHAIR											•	•	
CURSOR_IMAGE				•							•	•	
CURSOR_MASK				•							•	•	
CURSOR_ORIGINAL				•							•	•	
CURSOR_STANDARD				•							•	•	
CURSOR_XY				•							•	•	
DECOMPOSED				•							•	•	
DEMI								•					
DEPTH			•										
DIRECT_COLOR												•	
EJECT		•											
ENCAPSULATED								•					
ENCODING	•												
FILENAME	•	•	•		•	•		•	•	•			
FLOYD			•	•		•						•	
FONT_INDEX								•					
FONT_SIZE								•					
GET_CURRENT_FONT				•	•		•				•	•	

Table B-2: Keywords accepted by the IDL devices

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
GET_DECOMPOSED				•							•	•	
GET_FONTNAMES				•	•		•				•	•	
GET_FONTNUM				•	•		•				•	•	
GET_GRAPHICS_FUNCTION				•							•	•	•
GET_PAGE_SIZE							•						
GET_SCREEN_SIZE				•							•	•	
GET_VISUAL_DEPTH				•							•	•	
GET_VISUAL_NAME				•							•	•	
GET_WINDOW_POSITION				•							•	•	
GET_WRITE_MASK												•	•
GIN_CHARS										•			
GLYPH_CACHE				•	•		•	•			•		•
HELVETICA								•					
INCHES		•	•		•	•	•	•					
INDEX_COLOR					•		•						
ISOLATIN1								•					
ITALIC								•					
LANDSCAPE		•	•			•	•	•					
LIGHT								•					
MEDIUM								•					
NARROW								•					
NCAR	•												

Table B-2: Keywords accepted by the IDL devices

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
OBLIQUE								•					
OPTIMIZE						•							
ORDERED			•	•		•						•	
OUTPUT		•						•					
PALATINO								•					
PIXELS			•			•							
PLOT_TO									•	•			
PLOTTER_ON_OFF		•											
POLYFILL		•											
PORTRAIT		•	•			•	•	•					
PRE_DEPTH								•					
PRE_XSIZE								•					
PRE_YSIZE								•					
PREVIEW								•					
PRINT_FILE											•		
PSEUDO_COLOR				•								•	
RESET_STRING										•			
RESOLUTION			•			•							
RETAIN				•							•	•	
SCALE_FACTOR							•	•					
SCHOOLBOOK								•					
SET_CHARACTER_SIZE	•	•	•	•	•	•	•	•	•	•	•	•	•

Table B-2: Keywords accepted by the IDL devices

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
SET_COLORMAP						•							
SET_COLORS													•
SET_FONT				•	•		•	•			•	•	•
SET_GRAPHICS_FUNCTION				•							•	•	•
SET_RESOLUTION													•
SET_STRING										•			
SET_TRANSLATION												•	
SET_WRITE_MASK												•	•
STATIC_COLOR												•	
STATIC_GRAY												•	
SYMBOL								•					
TEK4014										•			
TEK4100										•			
TEXT	•												
THRESHOLD			•	•		•						•	
TIMES								•					
TRANSLATION				•							•	•	
TRUE_COLOR				•	•		•					•	
TT_FONT				•	•		•				•	•	•
TTY									•	•			
USER_FONT								•					
VT240, VT241									•				

Table B-2: Keywords accepted by the IDL devices

Keywords	Devices												
	CGM	HP	LJ	MAC	METAFILE	PCL	PRINTER	PS	REGIS	TEK	WIN	X	Z
VT340, VT341									•				
WINDOW_STATE				•							•	•	
XOFFSET		•	•			•	•	•					
XON_XOFF		•											
XSIZE		•	•		•	•	•	•					
YOFFSET		•	•			•	•	•					
YSIZE		•	•		•	•	•	•					
ZAPFCHANCERY								•					
ZAPFDINGBATS								•					
Z_BUFFERING													•

Table B-2: Keywords accepted by the IDL devices

Keywords accepted by the DEVICE command are described below. A list of devices that accept the keyword is included in parentheses below the keyword name.

AVANTGARDE

(PS)

Set this keyword to select the ITC Avant Garde PostScript font.

AVERAGE_LINES

(REGIS)

Controls the method of writing images to the VT240. If this keyword is set, (default setting), even and odd pairs of image lines are averaged and written to a single line. If clear, each image line is written to the screen. See the discussion below. This keyword has no effect when using a VT300 series terminal.

BINARY

(CGM)

Set this keyword to set the encoding type for the CGM output file to binary.

BITS_PER_PIXEL

(PS)

IDL is capable of producing PostScript images with 1, 2, 4, or 8 bits per pixel. Using more bits per pixel gives higher resolution at the cost of generating larger files. BITS_PER_PIXEL is used to specify the number of bits to use. If you do not specify a value for BITS_PER_PIXEL, a default value of 4 is used.

It should be noted that many laser printers, including the original Apple Laserwriter are capable of only 32 different shades of gray (which can be represented by 5 bits). Thus, specifying 8 bits per pixel does not give 256 apparent shades of grey as might be expected, only 32, at a cost of sending twice the number of bits to the printer. Often, 4 bits (16 levels of gray) will give acceptable results with a large savings in file size.

BKMAN

(PS)

Set this keyword to select the ITC Bookman PostScript font.

BOLD

(PS)

Set this keyword to specify that the bold version of the current PostScript font should be used.

BOOK

(PS)

Set this keyword to specify that the book version of the current PostScript font should be used.

BYPASS_TRANSLATION

(MAC, WIN, X)

Set this keyword to bypass the translation tables, allowing direct specification of color indices. See “Color Translation” on page 2392 Pixel values read via the TVRD

function are not translated if this keyword is set, and the result contains the byte value of the actual pixel values present in the display.

By default, the translation tables are used with shared and static color tables. When using displays with private color tables, the translation tables are bypassed.

This keyword is accepted by the WIN device (for compatibility with the X device), but has no effect when set.

CLOSE

(Z)

Set this keyword to deallocate the memory used by the Z-buffer. The Z-buffer device is reinitialized if subsequent graphics operations are directed to the device.

CLOSE_DOCUMENT

(PRINTER)

Set this keyword to have IDL send any buffered output to the currently selected printer. This keyword is applicable only when the printer device is selected. See "The Printer Device" on page 2370 for details.

CLOSE_FILE

(CGM, HP, LJ, METAFILE, PCL, PS, REGIS, TEK)

Set this keyword to have IDL output any buffered commands and close the current graphics file.

Caution: Under operating systems other than VMS, if you close the output file and then cause IDL to produce more output (e.g., by executing a new PLOT command), IDL will open the file again, causing the contents of the recently closed file to be lost. To avoid this, use the FILENAME keyword to specify a different file name or use SET_PLOT to disable the graphics driver, or be sure to print the closed output file before creating more output.

See the discussion of printing output files in "Printing Graphics Output Files" on page 2354

COLOR

(PCL, PS)

Set this keyword to enable color PCL or PostScript output. See "The PCL Device" on page 2368 or "The PostScript Device" on page 2371.

COLORS

(CGM, TEK)

This keyword specifies the maximum number of colors and the size of the color table used for output. The value of the system variable fields !D.N_COLORS and !D.TABLE_SIZE are set to this value and !P.COLOR is set to one less than this value.

For Tektronix Terminals Only

This keyword sets the number of colors supported by a 4100 series terminal. For example, if your terminal has 4-bit planes, the number of colors is $2^4 = 16$:

```
DEVICE, COLORS = 16
```

Valid values of this parameter are: 2, 4, 8, 16, or 64; other values will cause problems. Some Tektronix terminals will not operate properly if this parameter does not exactly match the number of colors available in the terminal hardware.

This parameter sets the field !D.N_COLORS, which affects the loading of color tables, the scaling used by the TVSCL procedure, and the number of bits output by the TV procedure to the terminal. It also changes the default color, !P.COLOR to the number of colors minus one.

COPY

(MAC, WIN, X)

Use this keyword to copy a rectangular area of pixels from one region of a window to another. COPY should be set a six or seven element array: $[X_s, Y_s, N_x, N_y, X_d, Y_d, W]$, where: (X_s, Y_s) is the lower left corner of the source rectangle, (N_x, N_y) are the number of columns and rows in the rectangle, and (X_d, Y_d) is the coordinate of the destination rectangle. Optionally, W is the index of the window *from which the pixels should be copied* to the *current* window. If it is not supplied, the current window is used as both the source and destination.

COURIER

(PS)

Set this keyword to select the Courier PostScript font.

CURSOR_CROSSHAIR

(WIN, X)

Set this keyword to selects the crosshair cursor type. This is the IDL default.

CURSOR_IMAGE

(MAC, WIN, X)

Specifies the cursor pattern. The value of this keyword must be a 16-line by 16-column bitmap, contained in a 16-element short integer vector. The offset from the upper left pixel to the point that is considered the hot spot can be provided via the CURSOR_XY keyword.

CURSOR_MASK

(MAC, WIN, X)

When the CURSOR_IMAGE keyword is used to specify a cursor bitmap, the CURSOR_MASK keyword can be used to simultaneously specify the mask that should be used. In the mask, bits that are set indicate bits in the CURSOR_IMAGE that should be seen and bits that are not set are masked out.

By default, the CURSOR_IMAGE bitmap is used for both the image and the mask. This can cause the cursor to be invisible on a black background (because only black pixels are allowed to be displayed).

CURSOR_ORIGINAL

(MAC, WIN, X)

Set this keyword to select the window system's default cursor. Under X Windows, it is the cursor in use by the root window when IDL starts. For the Macintosh and Microsoft Windows devices, it is the arrow pointer.

CURSOR_STANDARD

(MAC, WIN, X)

This keyword can be used to change the cursor appearance in IDL graphics windows.

For X Windows

This keyword selects one of the predefined cursors provided by the X Window system. The available cursors shapes are defined in the file `cursorfont.h` in the directory `/usr/include/X11` (UNIX), or `DECW$INCLUDE:` (VMS). In order to use one of these cursors, you select the number of the cursor and provide it as the value of the CURSOR_STANDARD keyword. For example, the file gives the value of XC_CROSS as being 30. In order to make that the current cursor, use the statement:

```
DEVICE, CURSOR_STANDARD=30
```

For Microsoft Windows

The table below shows the values for CURSOR_STANDARD that result in different cursor shapes. For example, to change the cursor to an "I-beam" when the cursor is in an IDL graphics window, use the command:

```
DEVICE, CURSOR_STANDARD = 32513
```

Cursor Shape	Value
Arrow	32512
I-Beam	32513
Hourglass	32514
Black Crosshair	32515
Up Arrow	32516
Size (Windows NT only)	32640
Icon (Windows NT only)	32641
Size NW-SE	32642
Size NE-SW	32643
Size E-W	32644
Size N-S	32645

Table B-3: Values for the WIN device CURSOR_STANDARD keyword

For Macintosh

Setting the CURSOR_STANDARD keyword changes the cursor to a crosshair in IDL graphics windows.

CURSOR_XY

(MAC, WIN, X)

A two element integer vector giving the (X, Y) pixel offset of the cursor hot spot, the point which is considered to be the mouse position, from the lower left corner of the cursor image. This parameter is only applicable if CURSOR_IMAGE is provided. The cursor image is displayed top-down—the first row is displayed at the top.

DECOMPOSED

(MAC, WIN, X)

This keyword is used to control the way in which graphics color index values are interpreted when using displays with decomposed color (TrueColor or DirectColor visuals). This keyword has no effect with other types of visuals.

Set this keyword to 1 to cause color indices to be interpreted as 3, 8-bit color indices where the least-significant 8 bits contain the red value, the next 8 bits contain the green value, and the most-significant 8 bits contain the blue value. This is the way IDL has always interpreted pixels when using visual classes with decomposed color.

Set this keyword to 0 to cause the least-significant 8 bits of the color index value to be interpreted as a PseudoColor index. This setting allows users with DirectColor and TrueColor displays to use IDL programs written for standard, PseudoColor displays without modification.

In older versions of IDL, color index values higher than !D.N_COLORS-1 were clipped to !D.N_COLORS-1 in the higher level graphics routines. In some cases, this clipping caused the exclusive-OR graphics mode to malfunction with raster displays. This clipping has been removed. Programs that incorrectly specified color indices higher than !D.N_COLORS-1 will now probably exhibit different behavior.

DEMI

(PS)

Set this keyword to specify that the demi version of the current PostScript font should be used.

DEPTH

(LJ)

The DEPTH keyword specifies the number of significant bits in a pixel. The LJ250 can support between 1 and 4 significant bits (known also as planes). The number of available colors is related to the number of significant planes by the equation:

$$\text{Colors} = 2^{\#\text{planes}}$$

Therefore, the LJ250 can support 2, 4, 8, or 16 separate colors on a single page of output. The default is to use a single plane, producing monochrome output.

Since IDL is based around 8-bit pixels, it is necessary to define which bits in a 8-bit pixel are used by the LJ250 driver, and which are ignored. When using a depth of 1 (monochrome), dithering techniques are used to render images. In this case, all 8 bits

are used. If more than a single plane is used, the least significant n bits of a 8-bit pixel are used, where n is the selected depth. For example, using a depth of 4, pixel values of 15, 31, and 47 are all considered to have the value 15 because all three values have the same binary representation in their 4 least significant digits.

When the depth is changed, the standard color map given in Table 7-5 of the *LJ250/LJ252 Companion Color Printer Programmer Reference Manual* is automatically loaded. Therefore, color maps should be loaded with TVLCT after changing the depth.

DIRECT_COLOR

(X)

Set this keyword to select the DirectColor visual. The value of the keyword represents the number of bits per pixel. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 2387.

EJECT

(HP)

In order to perform an erase operation on a plotter, it is necessary to remove the current sheet of paper and load a fresh sheet. The ability of various plotters to do this varies, so the EJECT keyword allows you to specify what should be done. The following table describes the possible values.

Value	Meaning
0	Do nothing. Note that this is likely to cause one page to plot over the previous one, so you should limit yourself to one page of output per file. This is the default.
1	Use the sheet feeder to load the next page.
2	Put the plotter off-line at the beginning of each page after the first.

Table B-4: Values for the HP-GL Eject Keyword

Many HP-GL plotters lack a sheet feeder, and require the user to load the next page manually. Therefore, the default action is for IDL to not issue any page eject instructions. In this case, you must restrict yourself to generating only a single plot at a time. If your plotter has a sheet feeder, you will want to issue the command:

```
DEVICE, /EJECT
```

to tell IDL that it should use the sheet feeder instead of placing the plotter off-line.

If your plotter does not have a sheet feeder, but it does understand the HP-GL NR command, use the command:

```
DEVICE, EJECT=2
```

to place the plotter off-line at the start of every plot except the first one. This causes the plotter to wait between plots for the user to replace the paper. When the user puts the plotter back on-line, the graphics commands for the new page are executed by the plotter. Consult the programming manual for your plotter to determine if this instruction is provided.

ENCAPSULATED

(PS)

Set this keyword to create an encapsulated PostScript file, suitable for importing into another document (e.g., a LaTeX or FrameMaker document).

Note

You must explicitly set this keyword to zero to create "regular" PostScript output after creating encapsulated output. (That is, like most keyword settings to the DEVICE procedure, the setting "sticks" until you change it, or until you quit IDL.)

Normally, IDL assumes that its PostScript-generated output will be sent directly to a printer. It therefore includes PostScript commands to position the plot on the page and to eject the page from the printer. These commands are undesirable if the output is going to be inserted into the middle of another PostScript document. If ENCAPSULATED is present and non-zero, IDL does not generate these commands.

IDL follows the standard PostScript convention for encapsulated files. It assumes the standard PostScript scaling is in effect (72 points per inch), In addition, it declares the size, or *bounding box* of the plotting region at the top of the output file. This size is determined when the output file is opened (when the first graphics command is given), by multiplying the size of the plotting region (as specified with the XSIZE and YSIZE keywords) by the current scale factor (as specified by the SCALE_FACTOR keyword).

Changing the size of the plotting region or scale factor once graphics have been output will not be reflected in the declared bounding box, and will confuse programs that attempt to import the resulting graphics. Therefore, when generating encapsulated PostScript, do not change the plot region size or scaling factor once any graphics commands have been issued. If you need to change these parameters, use the FILENAME keyword to start a new file.

ENCODING

(CGM)

Set this keyword to set the CGM encoding type for the output file. Valid values are: 1 (binary encoding, the default), 2 (text encoding), and 3 (NCAR binary encoding). The encoding type can only be changed when there is no CGM file open.

FILENAME

(CGM, HP, LJ, METAFILE, PCL, PS, REGIS, TEK)

Normally, all generated output is sent to a file named `idl.xxx`, where `xxx` is the lowercase name of the device shown in the table under "Supported Devices" on page 2310. The FILENAME keyword can be used to change these defaults. If FILENAME is specified:

1. If the file is already open (as happens if plotting commands have been directed to the file since the call to SET_PLOT), then the file is completed and closed as if CLOSE_FILE had been specified.
2. The specified file is opened for subsequent graphics output.

HP-GL Only

Under UNIX, if you wish to send HP-GL output directly to a plotter without generating an intermediate file, you should specify the device special file for the plotter as the argument to FILENAME. For example, if your plotter is connected to a serial input/output port known on your system as `/dev/ttya`, you would issue the command:

```
DEVICE, FILENAME='/dev/ttya'
```

All subsequent HP-GL output is sent directly to the plotter connected to serial port `/dev/ttya`.

FLOYD

(LJ, MAC, PCL, X)

Set this keyword to select the Floyd-Steinberg method of dithering. This algorithm distributes the error, due to displaying intermediate shades in either black or white, to surrounding pixels. This method generally gives the most pleasing results but requires the most computer time.

FONT

(MAC, WIN, X)

This keyword is now obsolete and has been replaced by the SET_FONT keyword. Code that uses the FONT keyword will continue to function as before, but we suggest that all new code use SET_FONT.

FONT_INDEX

(PS)

An integer representing the font index to be mapped to the current PostScript font.

Normally the font specification keywords (AVANTGARDE, etc.) take effect immediately to change the current font. The FONT_INDEX keyword alters this behavior. The current font is not changed. Instead, the specified font is mapped to the specified font index. This mapping can then be used within text strings to change the font in the middle of the string. See "Using PostScript Fonts" on page 2372

FONT_SIZE

(PS)

The default height used for displayed text. FONT_SIZE is given in points (a common typesetting unit of measure). The default size is 12 point text.

GET_CURRENT_FONT

(MAC, METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which the name of the current font is returned as a scalar string. A null string is returned if the Windows font is the default font. If the current device is PRINTER or METAFILE, the current font is returned.

GET_DECOMPOSED

(MAC, WIN, X)

Set this keyword to a named variable in which is returned the current state of the decomposed flag in the current direct graphics device.

GET_FONTNAMES

(MAC, METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which a string array containing the names of available fonts is returned. If no fonts are found, a null scalar string is returned. This keyword must be used in conjunction with the SET_FONT keyword. Set the

SET_FONT keyword to a scalar string containing the name of the desired font or to a wildcard. For example, the following command will return in the variable `fnames` the names of all available fonts:

```
DEVICE, GET_FONTNAMES=fnames, SET_FONT='*'
```

GET_FONTNUM

(MAC, METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which the number of fonts available to your installation is returned. This keyword must be used in conjunction with the SET_FONT keyword. Set the SET_FONT keyword to a scalar string containing the name of the desired font or a wildcard. For example, the following command will return in the variable `numfonts` the number of available fonts:

```
DEVICE, GET_FONTNUM=numfonts, SET_FONT='*'
```

GET_GRAPHICS_FUNCTION

(MAC, WIN, X, Z)

Set this keyword to a named variable that returns the value of the current graphics function (which is set with the SET_GRAPHICS_FUNCTION keyword). This can be used to remember the current graphics function, change it temporarily, and then restore it. See "SET_GRAPHICS_FUNCTION" on page 2343 keyword for an example.

GET_PAGE_SIZE

(PRINTER)

Set this keyword to a named variable in which to return a two-element vector that contains the width and height of the page size in pixels.

GET_SCREEN_SIZE

(MAC, WIN, X)

Set this keyword to a named variable in which to return a two-word array that contains the width and height of the server's screen, in pixels.

Note

For the Macintosh, anchoring the Command Input Line reduces the amount of available screen space.

GET_VISUAL_DEPTH

(MAC, WIN, X)

Set this keyword to a named variable into which a long integer is returned containing the depth of the visual associated with this device. Under X, if the X server is not connected when you call the DEVICE procedure with this keyword set, a new connection is made.

GET_VISUAL_NAME

(MAC, WIN, X)

Set this keyword equal to a named variable in which a string containing the name of the current visual class IDL is using is returned. Possible return values are:

- StaticGray (X only)
- GrayScale (X only)
- StaticColor (X only)
- PseudoColor
- TrueColor
- DirectColor (X only)

Under X, if no connection to the X server has been established when the DEVICE procedure is called with this keyword set, a new connection is made.

GET_WINDOW_POSITION

(MAC, WIN, X)

Set this keyword to a named variable that returns a two-element array containing the (X,Y) position of the lower left corner of the current window on the screen. The origin is also in the lower left corner of the screen.

GET_WRITE_MASK

(WIN, X)

Specifies the name of a variable to receive the current value of the write mask.

GIN_CHARS

(TEK)

The number of characters IDL is to read when accepting a GIN (Graphics INput) report. The default is 5. If your terminal is configured to send a carriage return at the

end of each GIN report, set this parameter to 6. If the number of GIN characters is too large, the IDL CURSOR procedure will not respond until two or more keys are struck. If it is too small, the extra characters sent by the terminal will appear as input to the next IDL prompt.

GLYPH_CACHE

(MAC, METAFILE, PRINTER, PS, WIN, Z)

Set this keyword to a scalar specifying the maximum number of glyphs to cache at any given time. The first time a glyph from a TrueType font is used, it is tessellated into triangles. These triangles are cached so that the tessellation step is not repeated for each use of that glyph. If the glyph cache fills, the least used glyph will be released before a new glyph is generated and cached. The default is 256.

HELVETICA

(PS)

Set this keyword to select the Helvetica PostScript font.

INCHES

(HP, LJ, METAFILE, PCL, PRINTER, PS)

Normally, the XOFFSET, XSIZE, YOFFSET, and YSIZE keywords are specified in centimeters. However, if INCHES is present and non-zero, they are taken to be in inches instead.

INDEX_COLOR

(METAFILE, PRINTER)

Set this keyword to place the printer or MetaFile device in index color mode. This is the default. This keyword is applicable only when the printer or MetaFile device is selected.

ISOLATIN1

(PS)

Set this keyword to use Adobe ISO Latin 1 font encoding with any font that supports such coding. Use of this keyword allows access to many commonly-used foreign characters.

ITALIC

(PS)

Set this keyword to specify that the italic version of the current PostScript font should be used.

LANDSCAPE

(HP, LJ, PCL, PRINTER, PS)

IDL normally generates plots with portrait orientation (the abscissa is along the short dimension of the page). If the LANDSCAPE keyword is set, landscape orientation (abscissa along the long dimension of the page) is used instead. Note that explicitly setting LANDSCAPE=0 is the same as setting the PORTRAIT keyword.

If the current device is PRINTER, and a page is open in the printer, it is closed and a new page set to landscape layout is started.

Note

The ability to set a printer to landscape mode is printer-driver dependent. Your printer may not support this functionality; use the system native print setup dialog to set the orientation of the print job.

LIGHT

(PS)

Set this keyword to specify that the light version of the current PostScript font should be used.

MEDIUM

(PS)

Set this keyword to specify that the medium version of the current PostScript font should be used.

NARROW

(PS)

Set this keyword to specify that the narrow version of the current PostScript font should be used.

NCAR

(CGM)

Set this keyword to set the encoding type for the CGM output file to NCAR binary.

The NCAR Binary Encoding

The NCAR binary encoding is used exclusively by the NCAR graphics package. Version 3.01 of NCAR View (`ctrans`, `ictrans`, and `cgm2ncgm`) does not correctly handle the following graphic elements:

- Cell arrays (raster images) with an odd number of pixels in the X dimension. Solution: specify an even number of pixels for the X dimension or make the image one column wider and fill with zeros.
- Raster images drawn in top down order. Solution: invert the image prior to using TV or TVSCL and do not use the /ORDER keyword. For example:

```
TV, image
; Draw image top to bottom:
TV, ROTATE(image, 7)
```

OBLIQUE

(PS)

Set this keyword to specify that the oblique version of the current PostScript font should be used.

OPTIMIZE

(PCL)

It is desirable, though not always possible, to compress the size of the PCL output file. Such optimization reduces the size of the output file, and improves I/O speed to the printer. There are three levels of optimization:

- 0 = No optimization is performed. This is the default because it will work with any PCL device. However, users of devices which can support optimization should use one of the other optimization levels.
- 1 = Optimization is performed using PCL optimization primitives. This gives the best output compression and printing speed. Unfortunately, not all PCL devices support it. On those that can't, the result will be garbage printed on the page.

  Consult the programmers manual for your printer to determine if it supports the required escape sequences. The required sequences are: `<ESC>*b0M`

(select full graphics mode), `<ESC>*b1M` (select compacted graphics mode 1), and `<ESC>*b2M` (select compacted graphics mode 2). The HP LaserJet II does not support this optimization level. The DeskJet PLUS does.

- 2 = IDL attempts to optimize the output by explicitly moving the left margin and then outputting non-blank sections of the page. This is primarily intended for use with the LaserJet II, which does not support optimization level 1. Note: This optimization can be very slow on some devices (such as the DeskJet PLUS). On such devices, it is best to avoid this optimization level.

ORDERED

(LJ, MAC, PCL, X)

Set this keyword to select the ordered dither method. This introduces a pseudo-random error into the display by using a 4 by 4 “dither” matrix, yielding 16 apparent intensities. This is the default method.

Macintosh Only

This keyword is identical to the THRESHOLD keyword.

OUTPUT

(HP, PS)

Specifies a scalar string that is sent directly to the graphics output file without any processing, allowing the user to send arbitrary commands to the file. Since IDL does not examine the string, it is the user’s responsibility to ensure that the string is correct for the target device.

PALATINO

(PS)

Set this keyword to select the Palatino PostScript font.

PIXELS

(LJ, PCL)

Normally, the XOFFSET, XSIZE, YOFFSET, and YSIZE keywords are specified in centimeters. However, if the PIXELS keyword is set, they are taken to be in pixels instead. Note that the selected resolution will determine how large a region is actually written on the page.

PLOT_TO

(REGIS, TEK)

Directs the Tektronix graphic output that would normally go to the user's terminal to the specified I/O unit. The logical unit specified should be open with write access to a device or file. Graphic output may be saved in files for later playback, redirected to other terminals, or to devices that can accept Textronix graphic commands.

Do not use the interactive graphics cursor when graphic output is not directed to your terminal.

To direct the graphic data to both the terminal and the file, set the unit to the negative of the actual unit number. Alternatively, you can use the TTY keyword, described below.

If the specified unit number is zero then Tektronix output to the file is stopped.

PLOTTER_ON_OFF

(HP)

There are some configurations in which a HP-GL plotter is connected between the computer and a terminal. In this mode (known as eavesdrop mode), the plotter ignores everything it is sent and passes it through to the terminal—the plotter is logically off. This state continues until an escape sequence is sent that turns the plotter logically on. At this point the plotter interprets and executes all input as HP-GL commands. Another escape sequence is sent at the end of the HP-GL commands to return the plotter to the logically off state.

Most configurations do not use eavesdrop mode, and the plotter is always logically on. However, if you are using this style of connection, you must use PLOTTER_ON_OFF to instruct IDL to generate the necessary on/off commands. If present and non-zero, PLOTTER_ON_OFF causes each output page to be bracketed by device control commands that turn the plotter logically on and off. Specifying a value of zero stops the issuing of such commands. You should only use this keyword before any output has been generated.

POLYFILL

(HP)

Some plotters (e.g., HP7550A) can perform polygon filling in hardware, while others (e.g., HP7475) cannot. IDL therefore assumes that the plotter cannot, and generates all polygon operations in software using line drawing. Specifying a non-zero value for the POLYFILL keyword causes IDL to use the hardware polygon filling. Setting it to zero reverts to software filling.

Different implementations of HP-GL plotters may have different limits for the number of vertices that can be specified for a polygon region before the plotter runs out of internal memory. Since this limit can vary, the HP-GL driver cannot check for calls to POLYFILL that specify too many points. Therefore, it is possible for the user to produce HP-GL output that causes an error when sent to the plotter. To avoid this situation, minimize the number of points used. On the HP7550A, the limit is about 127 points. If you do generate output that exceeds the limit imposed by your plotter, you will have to break that polygon filling operation into multiple smaller operations.

PORTRAIT

(HP, LJ, PCL, PRINTER, PS)

Set the PORTRAIT keyword to generate plots using portrait orientation. Portrait orientation is the default. Note that explicitly setting PORTRAIT=0 is the same as setting the LANDSCAPE keyword.

If the current device is PRINTER, and a page is open in the printer, it is closed and a new page set to portrait layout is started.

Note

The ability to set a printer to portrait mode is printer-driver dependent. Your printer may not support this functionality; use the system native print setup dialog to set the orientation of the print job.

PRE_DEPTH

(PS)

Set this keyword to a value indicating the bit depth to be used for the preview in the PostScript file. Valid values are 1 (for black and white preview) and 8 (for 8-bit grayscale preview). This keyword applies only if the PREVIEW keyword is nonzero. The default depth is 8.

PRE_XSIZE

(PS)

Set this keyword to the width to be used for the preview in the PostScript file. PRE_XSIZE is specified in centimeters, unless the INCHES keyword is set. This keyword applies only if the PREVIEW keyword value is nonzero. The default is 1.77778 inches (128 pixels at 72dpi).

Also see the note below, “A Note About Preview Dimensions”.

PRE_YSIZE

(PS)

Set this keyword to the height to be used for the preview in the PostScript file. PRE_YSIZE is specified in centimeters, unless the INCHES keyword is set. This keyword applies only if the PREVIEW keyword value is nonzero. The default is 1.77778 inches (128 pixels at 72dpi).

Also see the note below, "A Note About Preview Dimensions".

PREVIEW

(PS)

Set this keyword to 1 to add a platform-independent preview to the PostScript output file in encapsulated PostScript interchange format (EPSI). EPSI is an ASCII format. Set this keyword to 2 to write the EPS file in EPSF format, including an on-screen preview that is supported by many Windows applications, e.g. MSWord. The default (0) is to not include a preview.

Note

EPSF is not an ASCII format and cannot be sent directly to a Postscript printer, unlike the EPSI format. It must be imported into an application for printing.

A Note About Preview Dimensions

Different applications may utilize the information within a PostScript file in different ways when displaying a screen preview. Some applications will ignore the preview contents entirely, and simply use the primary PostScript contents to generate a screen preview. Other applications will use the preview data and its corresponding dimensions for screen display. Still others will use the preview data and stretch it to the dimensions of the primary PostScript contents. It is therefore recommended that the target application (into which the encapsulated PostScript file is to be loaded) be considered when selecting an appropriate XSIZE, YSIZE, PRE_XSIZE, and PRE_YSIZE.

PRINT_FILE

(WIN)

Set this keyword to the name of a file (e.g., PostScript or PCL) to be sent to the currently-selected Windows printer. IDL performs no type checking on this file before sending it to the printer. Therefore, if you have a PostScript printer selected

and you send a file that contains no valid PostScript information, you'll simply get text output.

To send the file `myfile.ps` to the currently-selected Windows printer, enter:

```
DEVICE, PRINT_FILE='myfile.ps'
```

PSEUDO_COLOR

(MAC, X)

If this keyword is present, the PseudoColor visual is used. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 2387.

Macintosh Only

Setting this keyword causes all screen manipulations to be done in 8-bit mode. The value of the keyword is ignored, as is the current bit-depth of the monitor.

RESET_STRING

(TEK)

The string used to place the terminal back into the normal interactive mode after drawing graphics. Use this parameter, in conjunction with the SET_STRING keyword, to control the mode switching of your terminal.

For example, the GraphON 200 series terminals require the string `<ESC>2` to activate the alphanumeric window after drawing graphics. The call to set this is:

```
DEVICE, RESET = string(27b) + '2'
```

If the 4100 series mode switch is set, using the keyword TEK4100, the default mode resetting string is `<ESC>%!1`, which selects the ANSI code mode.

RESOLUTION

(LJ, PCL)

PCL Only

The resolution at which the PCL printer will work. PCL supports resolutions of 75, 100, 150, and 300 dots per inch. The default is 300 dpi. Lower resolution gives smaller output files, while higher resolution gives superior quality.

LJ250 Only

The resolution at which the LJ printer will work. LJ supports resolutions of 90 and 180 dots per inch. The default is 180 dpi. Lower resolution gives smaller output files and a larger selection of colors, while higher resolution gives superior quality.

RETAIN

(MAC, WIN, X)

Use this keyword to specify the default method used for backing store when creating new windows. This is the method used when the RETAIN keyword is not specified with the WINDOW procedure. Backing store is discussed in more detail under "Backing Store" on page 2351, along with the possible values for this keyword. If RETAIN is not used to specify the default method, method 1 (server-supplied backing store) is used.

Microsoft Windows Only

The initial value of this parameter can be set by selecting File-Preferences from the menu bar. See "Backing Store" on page 2351.

A Note on Reading Data from Windows

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly. These types of problems are described in more detail in the documentation for TVRD. See "Unexpected Results Using TVRD with X Windows" on page 1465.

SCALE_FACTOR

(PRINTER, PS)

Specifies a scale factor applied to the entire plot. The default value is 1.0, allowing output to appear at its normal size. SCALE_FACTOR is used to magnify or shrink the resulting output.

The SCALE_FACTOR keyword behaves slightly differently in the context of the PRINTER device than it does in the context of the PS device.

When the current device is PRINTER, the SCALE_FACTOR keyword is designed to emulate a scalable resolution setting on the printer. For example, if you have a 300 x 300 pixel image—stored in the variable *image*—the following IDL commands will print *image* in a 0.5 inch square on a 600 dpi printer:

```
SET_PLOT, 'printer'
TV, image
```

Setting SCALE_FACTOR to 2 will scale the image to a 1 inch square on the same 600 dpi printer:

```
SET_PLOT, 'printer'
DEVICE, SCALE_FACTOR=2
TV, image
```

The output of IDL's Direct Graphics routines (CONTOUR, PLOT, SURFACE, etc.) is automatically scaled to fill the available drawing area. As a result, the following IDL commands will produce two identical copies of the same output on any printer:

```
SET_PLOT, 'printer'
PLOT, data
DEVICE, SCALE_FACTOR=2
PLOT, data
```

SCHOOLBOOK

(PS)

Set this keyword to select the New Century Schoolbook PostScript font.

SET_CHARACTER_SIZE

(CGM, HP, LJ, MAC, METAFILE, PCL, PRINTER, PS, REGIS, TEK, WIN, X, Z)

Set this keyword equal to a two-element vector to specify the font size and line spacing (leading) of vector and TrueType fonts, and the line spacing of device fonts. The way that the value of this vector determines character size is not completely intuitive.

The vector specified to the SET_CHARACTER_SIZE keyword sets the values of the X_CH_SIZE and Y_CH_SIZE fields in the !D System Variable structure. These values describe the size of the rectangle that contains the "average" character in the current font. (It is not important what the "average" character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The first element specifies the width of the rectangle in device units (usually pixels), and the second element specifies the height.

For vector and TrueType fonts, the height of the "average" character is determined by the *width* of the rectangle. The aspect ratio of the "average" character remains fixed; the character is scaled so that its width fits in the specified rectangle. The resulting scale factor is then applied to all of the characters in the font. The amount of spacing between lines (baseline to baseline) is determined explicitly by the height of the rectangle.

For device fonts, the character size is fixed. When the device font system is in use, the first element of the vector specified to SET_CHARACTER_SIZE is silently ignored, and only the line-spacing value is used.

Note

Changing between font systems (and sometimes changing from one font to another within the same font system) can also change the !D structure, so do not assume that the character size you have set is preserved when you change fonts.

SET_COLORMAP

(PCL)

Set this keyword to a 14,739 ($= 3 \cdot 17^3$) element byte vector containing the RGB-to-printer color translation table for a color PCL printer. The default table is for an HP Deskjet 500C printer.

The translation table is divided into red, green, and blue planes of 4913 ($=17^3$) elements each. For a given RGB triple, the offset into each plane is calculated as follows:

```
Offset = (Red/16)*289 + (Green/16)*17 + (Blue/16)
```

Thus, if the RGB triple is [16,32,160], the offset into each plane is 333. The printer will use the value at element 332 of the translation table as the red value, the value at element 5245 (=4913+332) as the green value, and the value at element 10158 (=9826+332) as the blue value.

The following example shows how to scale an existing colortable for use by a PCL printer.

```
; Set the plot window to the X device:
SET_PLOT, 'X'
; Create a window:
WINDOW,0,XS=300,YS=300
; Load a color table:
LOADCT,13
; Read color table values into variables:
TVLCT,r,g,b,/GET
; Re-size color table variables:
r2=CONGRID(r,4913)
g2=CONGRID(g,4913)
b2=CONGRID(b,4913)
; Create 14,739-element color map:
colormap=[r2,g2,b2]
; Change to the PCL device:
```

```
SET_PLOT, 'PCL'
; Set file name, resolution, color, and color map:
DEVICE, FILE = 'pcl.pcl', RESOLUTION = 300, $
    /COLOR, SET_COLORMAP = colormap
; Display an image:
TVSCL,DIST(900)
; Close the device:
DEVICE,/CLOSE
```

Note

The color table used need not be one of IDL's predefined tables.

SET_COLORS

(Z)

Sets the number of pixel values, !D.N_COLORS and !D.TABLE_SIZE. This value is used by a number of IDL routines to determine the scaling of pixel data and the default drawing index. Allowable values range from 2 to 256, and the default value is 256. Use this parameter to make the Z-buffer device compatible with devices with fewer than 256 colors indices.

SET_FONT

(MAC, METAFILE, PRINTER, PS, WIN, X, Z)

Set this keyword to a scalar string specifying the name of the font used when a hardware or TrueType font is selected. Note that hardware fonts cannot be rotated, scaled, or projected, and that the "!" commands for formatting may not work. When generating three-dimensional plots, it is best to use the vector-drawn or TrueType characters. Note that for the PS device, only one hardware font (other than the predefined fonts set via the fontname keywords, such as /AVANTEGARDE) may be loaded at a time.

Note on the FONT Keyword

The SET_FONT keyword was introduced with IDL version 5.1 and replaces the FONT and USER_FONT keywords used in previous versions.

Using TrueType Fonts

For TrueType fonts, the specified font name must exactly match one of the names in the first column of the `ttfont.map` file in the `resource/fonts/tt` directory or (on Macintosh and Windows platforms) the name of an installed font. See "About TrueType Fonts" on page 2477 for details on the `ttfont.map` file and for a listing of TrueType fonts distributed with IDL. Note that you must include the TT_FONT

keyword to indicate that the font specified is a TrueType font. For example, the following sets the font to the font to the TrueType font Helvetica Bold Italic:

```
DEVICE, SET_FONT='Helvetica-BoldItalic', /TT_FONT
```

Note

You can append additional TrueType fonts to the `ttfont.map` file if desired; on Macintosh and Windows platforms, additional fonts can also be added via the normal font installation procedures for your system. Research Systems cannot guarantee that TrueType fonts you add will be satisfactorily tessellated or displayed. See "About TrueType Fonts" on page 2477 for details.

Using Hardware Fonts

Because device fonts are specified differently on different platforms, the syntax of the *fontname* string depends on which platform you are using.

UNIX and VMS

Usually, the window system provides a directory of font files that can be used by all applications. List the contents of that directory to find the fonts available on your system. The size of the font selected also affects the size of vector drawn text. X Windows users can use the `xlsfonts` command to list available X Windows fonts.

On some machines, fonts are kept in subdirectories of `/usr/lib/X11/fonts`.

For example, to select the font 8X13:

```
!P.FONT = 0
DEVICE, SET_FONT = '8X13'
```

Microsoft Windows

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT='font*modifier1*modifier2*...modifiern'
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: THIN, LIGHT, BOLD, HEAVY
- For font quality: DRAFT, PROOF
- For font pitch: FIXED, VARIABLE
- For font angle: ITALIC

- For strikeout text: STRIKEOUT
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font height in pixels.

For example, if you have Garamond installed as one of your Windows fonts, you could select 24-pixel cell height Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
!P.FONT = 0
DEVICE, SET_FONT = 'GARAMOND*ITALIC*24'
PLOT, FINDGEN(10), TITLE = 'IDL Plot'
```

This feature is compatible with TrueType and Adobe Type Manager (and, possibly, other type scaling programs for Windows). If you have TrueType or ATM installed, the TrueType or PostScript outline fonts are used so that text looks good at any size.

Macintosh

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT='font*modifier1*modifier2*...modifiern'
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: BOLD
- For font angle: ITALIC
- For font width: CONDENSED, EXTENDED
- For outlined text: OUTLINE, SHADOW
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font size, in points.

For example, if you have Garamond installed, you could select 24-point Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
IDL> !P.FONT = 0
IDL> DEVICE, SET_FONT = 'GARAMOND*ITALIC*24'
IDL> PLOT, FINDGEN(10), TITLE = 'IDL Plot'
```

SET_GRAPHICS_FUNCTION

(MAC, WIN, X, Z)

Most window systems allow applications to specify the graphics function. This is a logical function which specifies how the source pixel values generated by a graphics operation are combined with the pixel values already present on the screen. The complete list of possible values is given in the following table:

Logical Function	Code	Definition
GXclear	0	0
GXand	1	source AND destination
GXandReverse	2	source AND (NOT destination)
GXcopy	3	source
GXandInverted	4	(NOT source) AND destination
GXnoop	5	destination
GXxor	6	source XOR destination
GXor	7	source OR destination
GXnor	8	(NOT source) AND (NOT destination)
GXequiv	9	(NOT source) XOR destination
GXinvert	10	(NOT destination)
GXorReverse	11	source OR (NOT destination)
GXcopyInverted	12	(NOT source)
GXorInverted	13	(NOT source) OR destination
GXnand	14	(NOT source) OR (NOT destination)
GXset	15	1

Table B-5: Graphic Function Codes

The default graphics function is GXcopy, which causes new pixels to completely overwrite any previous pixels. Not all functions are available on all window systems.

For example, the following code segment inverts the bottom bit in the rectangle defined by its diagonal corners (x_0, y_0) and (x_1, y_1):

```
; Set graphics function to exclusive or (GXor), and save the
; old function:
DEVICE, GET_GRAPHICS_FUNCTION = oldg, SET_GRAPHICS_FUNCTION = 6
; Use POLYFILL to select the area to be inverted. The source
; pixel value is 1:
POLYFILL, [[x0,y0], [x0,y1], [x1,y1], [x1,y0]], $
          /DEVICE, COLOR=1
; Restore the previous graphics function:
DEVICE, SET_GRAPHICS_FUNCTION=oldg
```

SET_RESOLUTION

(Z)

Set this keyword to a two-element vector that specifies the width and height of the Z-buffers. The default size is 640 by 480. If this size is not the same as the existing buffers, the current buffers are destroyed and the device is reinitialized.

SET_STRING

(TEK)

The string used to place the terminal into the graphics mode from the normal interactive terminal mode. If the 4100 series mode switch is set, using the keyword TEK4100, the default graphic mode setting string is `<ESC>%!0`, which selects the Tektronix code mode.

SET_TRANSLATION

(X)

This keyword can be used to allow multiple, simultaneous IDL sessions to use the same colors from a shared colormap. Use this keyword before the X connection is established (i.e., before a window is created), IDL will use the shared color map without allocating any additional colors, and will not load a grayscale ramp as is usually done when the X server starts up. The following example shows two cooperating IDL processes sharing the same colormap:

Execute the following commands in the first IDL session:

```
WINDOW, GET_X_ID = a
DEVICE, TRANSLATION = t
OPENW, 1, 'junk.dat'
WRITEU, 1, a, !D.N_COLORS, t[0:!D.N_COLORS-1]
CLOSE, 1
LOADCT, 3
```

Execute the following commands in the second IDL session:

```
OPENR, 1, 'junk.dat'
a=0L
n=0L
READU,1, a, n
t = BYTARR(n)
READU, 1, t
CLOSE, 1
DEVICE, SET_TRANSLATION = t
WINDOW, COLORS=n, SET_X_ID=a
TV, DIST(256)
```

SET_WRITE_MASK

(X, Z)

Sets the write mask to the specified value. For an *n*-bit system, the write mask can range from 0 to 2^n-1.

STATIC_COLOR

(X)

Use this keyword to select the X Windows StaticColor visual. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 2387.

STATIC_GRAY

(X)

Use this keyword to select the X Windows StaticGray visual. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 2387.

SYMBOL

(PS)

Set this keyword to select the Symbol PostScript font.

TEK4014

(TEK)

Set this keyword to specify that coordinates are to be output with full 12-bit resolution. If this keyword is not present or is zero, 10-bit coordinates are output.

Normally, IDL sends 10-bit coordinates. 12-bit coordinates are compatible with most terminals, even those without the full resolution, but require more characters to send.

Note

The 4014 and the 4100 modes can be used together. The coordinate system IDL uses for the Tektronix is 0 to 4095 in the X direction and 0 to 3120 in the Y direction, even when not in the 4014 mode. In the 10-bit case the internal coordinates are divided by 4 prior to output.

TEK4100

(TEK)

Set this keyword to indicate that the terminal is a 4100 or 4200 series terminal. The use of color, ANSI and Tektronix mode switching, hardware line styles, and pixel output with the TV procedure is supported with these terminals. Also, text is output differently.

TEXT

(CGM)

Set this keyword to set the encoding type for the CGM output file to text.

THRESHOLD

(LJ, MAC, PCL, X)

Set this keyword to select the threshold algorithm—the simplest dithering method. The value of this keyword is the threshold to be used. This algorithm simply compares each pixel against the given threshold, usually 128. If the pixel equals or exceeds the threshold the display pixel is set to white, otherwise it is black.

Macintosh Only

Set this keyword to use the Macintosh's default thresholding. Values greater than one cause the keyword to be set but are otherwise ignored.

TIMES

(PS)

Set this keyword to select the Times-Roman PostScript font.

TRANSLATION

(MAC, WIN, X)

As discussed in "Shared Colormaps" on page 2390, using the shared colormap (normally recommended) causes IDL to translate between IDL color indices (which always start with zero and are contiguous) and the pixel values actually present in the display. The TRANSLATION keyword specifies the name of a variable to receive the translation vector. To read the translation table, use the command:

```
DEVICE, TRANSLATION=TRANSARR
```

where TRANSARR is a named variable into which the translation array is stored. The result is a 256-element byte vector. Element zero of the vector contains the pixel value allocated for the first color in the IDL colormap, and so forth.

Microsoft Windows Only

This keyword is accepted by the WIN device, for compatibility with the X Windows driver, but simply returns a 256-element vector where each element has the value of its subscript (0 to 255).

TRUE_COLOR

(MAC, METAFILE, PRINTER, X)

Use this keyword to select TrueColor visuals. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 2387. If the current device is PRINTER or METAFILE, the printer is placed in RGB or TrueColor mode if the value of the TRUE_COLOR keyword is greater than zero (the number of bits per pixel specified is ignored.)

Macintosh Only

For best results, set TRUE_COLOR equal to 24 after setting the Color Depth to Millions from the Monitors Control Panel in the Apple menu.

TT_FONT

(MAC, METAFILE, PRINTER, WIN, X, Z)

Set this keyword to indicate that the font set via the SET_FONT keyword (either to set the fontname or to retrieve fontnames in conjunction with the GET_FONTNAMES or GET_FONTNUM keywords) should be treated as a TrueType font.

TTY

(REGIS, TEK)

Set this keyword to specify that output should be sent to the terminal at the same time that it is being sent to a file due to the FILENAME or PLOT_TO keywords. A zero value causes output to go only to the file. If no output file is in use, this keyword has no effect.

USER_FONT

(PS)

This keyword is now obsolete and has been replaced by the SET_FONT keyword. Code that uses the USER_FONT keyword will continue to function as before, but we suggest that all new code use SET_FONT.

VT240, VT241

(REGIS)

Set this keyword to configure the REGIS device for VT240 series terminals.

VT340, VT341

(REGIS)

Set this keyword to configure the REGIS device for VT340 series terminals.

WINDOW_STATE

(MAC, WIN, X)

Set this keyword to a named variable that returns an array containing one element for each possible window. Array element `i` contains a 1 if window `i` is open, otherwise it contains a 0.

XOFFSET

(HP, LJ, PCL, PRINTER, PS)

Specifies the X position, on the page, of the lower left corner of output generated by IDL. XOFFSET is specified in centimeters, unless INCHES is specified. See "Positioning Graphics Output" on page 2356.

PostScript Only

SCALE does not affect the value of XOFFSET.

XON_XOFF

(HP)

If present and non-zero, XON_XOFF causes each output page to start with device control commands that instruct the plotter to obey xon/xoff (^S/^Q) style flow control. Specifying a value of zero stops the issuing of such commands. You should only use this keyword before any output has been generated.

Such handshaking is the default. To turn it off, use the command

```
DEVICE, XON_XOFF=0
```

Often, it is not necessary to tell the plotter to obey flow control because the printing facilities on the system handle such details for you, but it is usually harmless.

XSIZE

(HP, LJ, METAFILE, PCL, PRINTER, PS)

Specifies the width of output generated by IDL. XSIZE is specified in centimeters, unless INCHES is specified.

PostScript Only

SCALE modifies the value of XSIZE. Hence, the following statement:

```
DEVICE,/INCHES,XSIZE=7.0,SCALE_FACTOR=0.5
```

results in a real width of 3.5 inches.

Also see "A Note About Preview Dimensions" on page 2335.

YOFFSET

(HP, LJ, PCL, PRINTER, PS)

Specifies the Y position, on the page, of the lower left corner of output generated by IDL. YOFFSET is specified in centimeters, unless INCHES is specified. See "Positioning Graphics Output" on page 2356.

Note

The corner of the page from which the Y offset is measured (lower or upper left) differs on various devices. Read the device specific information in the following sections to determine how this is handled for your device.

PostScript Only

SCALE does not affect the value of YOFFSET.

YSIZE

(HP, LJ, METAFILE, PCL, PRINTER, PS)

Specifies the height of output generated by IDL. YSIZE is specified in centimeters, unless INCHES is specified.

PostScript Only

SCALE modifies the value of YSIZE. Hence, the following statement:

```
DEVICE,/INCHES,YSIZE=5.0,SCALE_FACTOR=0.5
```

results in a real width of 2.5 inches.

Also see "A Note About Preview Dimensions" on page 2335.

LJ250 Only

Changing the size, depth, or orientation of the output causes the current page to be sent to the file. The effect is identical to calling the ERASE procedure.

ZAPFCHANCERY

(PS)

Set this keyword to select the ITC Zapf Chancery PostScript font.

ZAPFDINGBATS

(PS)

Set this keyword to select the ITC Zapf Dingbats PostScript font.

Z_BUFFERING

(Z)

This keyword enables and disables the Z-buffering. If this keyword is specified with a zero value, the driver operates as a standard 2D device, the Z-buffering is disabled, and the Z-buffer (if any) is deallocated. Setting this keyword to one (the default value), enables the Z-buffering.

To disable Z-buffering enter:

```
DEVICE, Z_BUFFERING = 0
```

Window Systems

The different window systems supported by IDL have many features in common. This section describes those features. See the individual descriptions of each system later in this chapter for additional information about each one.

IDL utilizes the window system by creating and using one or more largely independent windows, each of which can be used for the display of graphics and/or images. One color map table is shared among all these windows. Multiple windows can be active simultaneously. Windows are referenced using their index which is a non-negative integer.

"Dithering" or halftoning techniques are used to display images with multiple shades of gray on monochrome displays—displays that can only display white or black. This topic is discussed in "Image Display On Monochrome Devices" on page 2353.

Graphic and image output is always directed to the current window. When a window system is selected as the current IDL graphics device, the index number of the current window is found in the !D.WINDOW system variable. This variable contains -1 if no window is open or selected. The WSET procedure is used to change the current window. WSHOW hides, displays, and iconifies windows. WDELETE deletes a window.

The WINDOW procedure creates a new window with a given index. If a window already exists with the same index, it is first deleted. The size, position, title, and number of colors, may also be specified. If you access the display before creating the first window, IDL automatically creates a window with an index number of 0 and with the default attributes.

Backing Store

One of the features that distinguishes various window systems is how they handle the issue of backing store. When part of a window that was previously not visible is exposed, there are two basic approaches that a window system can take. Some keep track of the current contents of all windows and automatically repair any damage to their visible regions (retained windows). This saved information is known as the backing store. Others simply report the damage to the program that created the

window and leave repairing the visible region to the program (non-retained windows).

Value	Description
0	No backing store.
1	Request the server or window system to perform backing store.
2	Make IDL perform backing store.

Table B-6: Allowed Values for the RETAIN Keyword

There are convincing arguments for and against both approaches. It is generally more convenient for IDL if the window system handles this problem automatically, but this often comes at a performance penalty. The actual cost of retained windows varies between systems and depends partially on the application.

The X Window system does not by default keep track of window contents. Therefore, when a window on the display is obscured by another window, the contents of its obscured portion is lost. Re-exposing the window causes the X server to fill the missing data with the default background color for that window, and request the application to redraw the missing data. Applications can request a backing store for their windows, but servers are not required to provide it. Many X servers do not provide backing store, and even those that do cannot necessarily provide it for all requesting windows. Therefore, requesting backing store from the server might help, but there is no certainty.

The IDL window system drivers allow you to control the issue of backing store using the RETAIN keyword to the DEVICE and WINDOW procedures. Using it with DEVICE allows you to set the default action for all windows, while using it with WINDOW lets you override the default for the new window. The possible values for this keyword are summarized under "Backing Store" on page 2351, and are described below:

- Setting the RETAIN keyword to 0 specifies that no backing store is kept. In this case, exposing a previously obscured window leaves the missing portion of the window blank. Although this behavior can be inconvenient, it usually has the highest performance because there is no need to keep a copy of the window contents.
- Setting the RETAIN keyword to 1 causes IDL to request that a backing store be maintained. If the window system decides to accept the request, it will automatically repair the missing portions when the window is exposed. X

Windows may or may not provide backing store when requested, depending on the capabilities of the server and the resources available to it.

- Setting the RETAIN keyword to 2 specifies that IDL should keep a backing store for the window itself, and repair any window damage when the window system requests it. This option exists for X Windows. In this case, a pixmap (off-screen display memory) the same size as the window is created at the same time the window is created, and all graphics operations sent to the window are also sent to the pixmap. When the server requests IDL to repair freshly exposed windows, this pixmap is used to fill in the missing contents. Pixmaps are a precious resource in the X server, so backing pixmaps should only be requested for windows with contents that must absolutely be preserved.

If the type of backing store to use is not explicitly specified using the RETAIN keyword, IDL assumes option 1 and requests the window system to keep a backing store.

A Note on Reading Data from Windows

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly. These types of problems are described in more detail in the documentation for TVRD. See "Unexpected Results Using TVRD with X Windows" on page 1465.

Image Display On Monochrome Devices

Images are automatically dithered when sent to some monochrome devices. Dithering is a technique which increases the number of apparent brightness levels at the expense of spatial resolution. Images with 256 gray levels are displayed on a display with only two colors, black and white, using halftoning techniques. PostScript handles dithering directly. IDL supports dithering for other devices if their DEVICE procedures accept the FLOYD, ORDERED, or THRESHOLD keywords.

Printing Graphics Output Files

For printer and plotter devices (e.g., PCL, PostScript, and HP-GL), IDL creates a file containing output commands. This file can be sent to the printer via the normal methods provided by the local operating system. When attempting to output the file before exiting IDL, the user must be sure that the graphics output file is complete. For example, the following IDL commands (executed under UNIX) will not produce the desired result:

```
SET_PLOT,'PS'
PLOT,x,y
SPAWN,'lpr idl.ps'
```

These commands fail because the attempt to print the file is premature—the file is still open within IDL and is not yet complete.

The following lines of code are an IDL procedure called OUTPUT_PLOT which closes the current graphics file and sends it to the printer. This routine assumes that the graphics output file is named `idl.xxx`, where `xxx` represents the name of the graphics driver. For example, PostScript output file is assumed to be `idl.ps`. It also assumes that the graphics output to be printed is from the current graphics device, as selected with SET_PLOT.

```
; Close the current graphics file, and print it. If the
; New_file parameter is present, rename the file to the given
; name so it won't be overwritten:
Pro OUTPUT_PLOT, New_file
; Close current graphics file:
DEVICE,/CLOSE
; Build the default output file name by using the idl name for
; the current device (!D.NAME):
file = 'idl.' + STRLOWCASE(!D.NAME)
; Build shell commands to send file to the printer.
; You will probably have to change this command in accordance
; with local usage:
cmd = 'lpr ' + file
; Concatenate rename command if new file specified:
IF N_ELEMENTS(New_file) GT 0 THEN $
  cmd = cmd + '; mv' + file + ' ' + New_file
; Issue shell commands to print/rename file:
SPAWN, cmd
END
```

The call to DEVICE causes IDL to finish the file and close it, which makes it available for printing.

Setting Up The Printer

In order for IDL generated output files to work properly with printers and plotters, it is necessary for the device to be configured properly. This usually involves configuring both the device hardware and the operating system printing software. When setting up your system, keep the following points in mind:

- The device and computer must use some form of flow control to prevent the computer from sending data faster than the printing device can handle it. The most common form of flow control is known as XON/XOFF, and involves the sending of Control-S (off) and Control-Q (on) characters from the device to the printer to manage the flow of data.

  Many printers have a large buffer into which they store incoming data they haven't yet processed. This reduces the need to invoke flow control. When testing your configuration to ensure flow control is actually enabled, you must be sure to print a document long enough to fill any such buffer, or flow control may never occur, giving a false impression that the setup is correct. A common source of problems stem from attempting to print long IDL generated output files without proper flow control.

- Some devices (such as PCL) require an eight-bit data path, while others (such as PostScript) do not. For devices that do, it is important to ensure that the printer port and system printing software provide such a connection.

  If you are having problems printing on a PostScript printer, the `ehandler.ps` file in the `resource/fonts/ps` subdirectory of the IDL distribution can help you to debug your problem. Sending this file to your PostScript Printer causes it to print any subsequent errors it encounters on a sheet of paper and eject it. The effect of this file lasts until the printer is reset.

Setting Up Printers Under UNIX

Printers are configured in the `/etc/printcap` file. This file describes to the system which printers are connected to it, the characteristics of each printer, and how the printer port should be configured. Managing the printcap file is usually discussed in the system management documentation supplied with the system by the manufacturer.

Setting Up Printers Under VMS

Printer queue configuration under VMS is a large topic. However, it is often sufficient to set the printer port up properly using the DCL_SET_TERMINAL command, and set up a printer queue using the standard printer form. Users can send eight-bit data to such a printer using the DCL PRINT/PASSALL command (On very

small systems, it is even possible to dispense with the printer queue entirely and simply use the COPY command to send data to the printer port directly).

However, much more sophisticated arrangements are possible including the definition of specialized printer forms, placing printers on the local area network for use by more than one machine, and so forth. For information on these topics, refer to the relevant VMS documentation.

Positioning Graphics Output

The difference between the XOFFSET and YOFFSET keywords to the DEVICE procedure, and the higher level plot positioning keywords and system variables (discussed in Appendix C, "Graphics Keywords" and *Using IDL*, Chapter 11, "Direct Graphics Plotting") can lead to confusion. A common misunderstanding is to attempt to use the DEVICE procedure "offset" and "size" keywords multiple times in an attempt to produce multiple plots on a single output page.

The DEVICE keywords are intended to specify the size and position of the entire output area on the page, not to move the plotting region for multiple plots. The driver does not monitor their values continuously, but only when initializing a new page or ejecting the current one.

The proper way to produce multiple plots is to use the high level positioning abilities. The !P.MULTI, !P.POSITION, and !P.REGION system variables can be used to position individual plots on the page. The plotting routines also accept the POSITION, MARGIN and REGION keywords.

Image Background Color

Graphical output that is displayed with a black background on a monitor frequently look better if the background is changed to white when printed on white paper. This is easily done with the statement:

```
a(WHERE(a EQ 0B)) = 255B
```

The CGM Device

Device Keywords Accepted by the CGM Device:

BINARY, CLOSE_FILE, COLORS, ENCODING, FILENAME, NCAR, SET_CHARACTER_SIZE, TEXT

The CGM, Computer Graphics Metafile, standard describes a device independent file format used for the exchange of graphic information. The IDL CGM driver produces CGM files encoded in one of three methods: *Text*, *Binary* or *NCAR Binary*. To direct graphics output to a CGM file, issue the command:

```
SET_PLOT,'CGM'
```

This causes IDL to use the CGM driver for producing graphical output. Once the CGM driver is selected, the DEVICE procedure controls its actions, as described below. Typing `HELP, /DEVICE` displays the current state of the CGM driver. The CGM driver defaults to the binary encoding using 256 colors.

Abilities and Limitations

This section describes details specific to IDL's CGM implementation:

- IDL uses the CGM default integer encoding for graphic primitives. Coordinate values range from 0 to 32767. It is advisable to use the values stored in !D.X_SIZE and !D.Y_SIZE instead of assuming a fixed coordinate range.
- Color information is output with a resolution of 8 bits (color indices and intensity values range from 0 to 255).
- The definition of background color in the CGM standard is somewhat ambiguous. According to the standard, color index 0 and the background color are the same. Because background color is specified in the metafile as a color value (RGB triple), not an index, it is possible to have the background color not correspond with the color value of index 0.
- The CGM BACKGROUND_COLOUR attribute is explicitly set by IDL only during an erase operation: changing the value of the color map at index 0 does not cause IDL to generate a BACKGROUND_COLOUR attribute until the next ERASE occurs. An ERASE command sets the background color to the value in the color map at index 0. The command `ERASE, INDEX` (where INDEX is not 0) generates the message "`Value of background color is out of allowed range.`" For consistent results, modify the color table before any graphics are output.

- The CGM standard uses scalable (variable size) pixels for raster images. By default, the TV and TVSCL procedures output images, regardless of size, using the entire graphics output area. To output an image smaller than the graphics output area, specify the XSIZE and YSIZE keywords with the TV and TVSCL procedures. For example:

```
; Select the CGM driver:
SET_PLOT, 'CGM'
; Create a 64 x 64 element array:
X = DIST(64)
; Display the image (fills entire screen):
TVSCL, X
; Now display 4 images on the screen:
ERASE
XS = !D.X_SIZE / 2 ; Size of each image, X dimension
YS = !D.Y_SIZE / 2 ; Size of each image, Y dimension
TVSCL, X, 0, XSIZE=XS, YSIZE=YS ; Upper left
TVSCL, X, 1, XSIZE=XS, YSIZE=YS ; Upper right
TVSCL, X, 2, XSIZE=XS, YSIZE=YS; Lower left
TVSCL, X, 3, XSIZE=XS, YSIZE=YS; Lower right
```

The HP-GL Device

Device Keywords Accepted by the HP-GL Device:

CLOSE_FILE, EJECT, FILENAME, INCHES, LANDSCAPE, OUTPUT, PLOTTER_ON_OFF, POLYFILL, PORTRAIT, SET_CHARACTER_SIZE, XOFFSET, XON_XOFF, XSIZE, YOFFSET, YSIZE

HP-GL (Hewlett-Packard Graphics Language) is a plotter control language used to produce graphics on a wide family of pen plotters. To use HP-GL as the current graphics device, issue the IDL command:

```
SET_PLOT,'HP'
```

This causes IDL to use HP-GL for producing graphical output. Once the HP-GL driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings for the HP-GL driver are shown in the following table. Use the statement:

```
HELP, /DEVICE
```

to view the current state of the HP-GL driver.

Feature	Value
File	idl.hp
Orientation	Portrait
Erase	No action
Polygon filling	Software
Turn plotter logically on/off	No
Specify xon/xoff flow control	Yes
Horizontal offset	3/4 in.
Vertical offset	5 in.
Width	7 in.
Height	5 in.

Table B-7: Default HP-GL Driver Settings

Abilities And Limitations

IDL is able to produce a wide variety of graphical output using HP-GL. The following is a list of what is and is not supported:

- All types of vector graphics can be generated, including line plots, contours, surfaces, etc.
- HP-GL plotters can draw lines in different colors selected from the pen carousel. It should be noted that color tables are not used with HP-GL. Instead, each color index refers directly to one of the pens in the carousel.
- Some HP-GL plotters can do polygon filling in hardware. Others can rely on the software polygon filling provided by IDL.
- It is possible to generate graphics using the hardware generated text characters, although such characters do not give much improvement over the standard vector fonts. To use hardware characters, set the !P.FONT system variable to zero, or set the FONT keyword to the plotting routines to zero.
- Since HP-GL is designed to drive pen plotters, it does not support the output of raster images. Therefore, TV and TVSCL do not work with HP-GL.
- Since pen plotters are not interactive devices, they cannot support such operations as cursors and windows.

HP-GL Linestyles

The LINESTYLE graphics keyword allows specifying any of 6 linestyles. HP-GL does not support all of these linestyles, and styles 3 and 4 differ from the definition in Appendix C, “Graphics Keywords”. The following table summarizes the differences:

Index	Normal Line Style	HP-GL Line Style
0	Solid	same
1	Dotted	same
2	Dashed	same
3	Dash Dot	Relative size of dash and dot are different.
4	Dash Dot Dot Dot	Dash Dot Dot
5	Long Dashes	same

Table B-8: Linestyles for the HP-GL Device

The LJ Device

Device Keywords Accepted by the LJ Device:

CLOSE_FILE, DEPTH, FILENAME, FLOYD, INCHES, LANDSCAPE, ORDERED, PIXELS, PORTRAIT, RESOLUTION, SET_CHARACTER_SIZE, THRESHOLD, XOFFSET, XSIZE, YOFFSET, YSIZE

The LJ250 and LJ252 are color printers sold by Digital Equipment Corporation (DEC). To direct graphics output to a picture description file compatible with these printers, issue the command:

```
SET_PLOT, 'LJ'
```

This causes IDL to use the LJ driver for producing graphical output. To actually print the generated graphics, send the file to the printer using the normal printing facilities supplied by the operating system. Once the LJ driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings for the LJ driver are given in the following table. Use the `HELP, /DEVICE` command to view the current font, file, and other options currently set for LJ output.

Feature	Value
File	idl.lj
Mode	Portrait
Dither method	Floyd-Steinberg
Resolution	180 dpi
Number of planes	1 (monochrome)
Horizontal offset	1/2 in.
Vertical offset	1 in.
Width	7 in.
Height	5 in.

Table B-9: Default LJ Driver Settings

LJ Driver Strengths

The LJ250 produces color graphics at a low cost. It is capable of producing good quality monochrome output, and is also good at color vector graphics and simple color imaging using a small number of predefined solid colors.

LJ Driver Limitations

The LJ250 is intended to be used as a low cost printer for business color graphics. Although it can be used to print color images, it is limited in its ability to produce satisfactory images of the sort commonly encountered in science and engineering. These limitations make it a poor choice for such work.

- Although color is specified via the usual RGB triples using the TVLCT procedure, the LJ250 is only capable of generating a fixed set of colors. The number of possible colors depends on the resolution in use. When producing 180 dpi graphics, only the colors given in the following table are possible. In 90 dpi mode, 256 colors are available.

Color	Red Value	Green Value	Blue Value
Black	10	10	10
Yellow	227	212	33
Magenta	135	13	64
Cyan	5	56	163
Red	135	20	36
Green	8	66	56
Blue	10	10	74
White	229	224	217

Table B-10: LJ250 Colors Available at 180 dpi

If a color is specified that the printer cannot produce, it substitutes the closest color it can. However, the results of such substitutions can give unexpected results. The fixed set of possible colors means that the LOADCT procedure is of limited use with the LJ250. It also means that it is difficult to produce satisfactory grayscale images.

- The number of simultaneous colors possible on an output page is limited. Although images are specified in 8-bit bytes, the number of significant bits used ranges from 1 to 4 (as specified via the DEPTH keyword to the DEVICE procedure), allowing from 2 to 16 colors. Coupled with the above limitation on the colors that are possible, it is difficult to produce high quality image output.

LJ Suggestions

The following suggestions are intended to help you get the most out of the LJ250, taking its limitations into account:

- Use monochrome output when possible. This results in considerably smaller output files, and provides most of the abilities the LJ250 handles well. When producing monochrome output, the LJ250 driver dithers images. This can often produce more satisfying grayscale output than is possible using the printer in color mode.
- The table under "LJ Driver Limitations" above gives the RGB values to use when specifying colors at 180 dpi. To make more colors available, use 90 dpi resolution. The RGB values for the possible colors at 90 dpi are given in Table 7-6 of the *LJ250/LJ252 Companion Color Printer Programmer Reference Manual*. You can cause the printer to display the complete 256 color palette as follows: With the power off, press and hold the READY and DEC/PCL switches while momentarily pressing the power switch. Wait approximately 2 seconds and release the READY and DEC/PCL switches. The printer will take a few minutes to print all 256 colors. The output fits on a single page.

  Use the table in the programmers manual with this display to select the colors to use. Note that the RGB values in the programmers manual are scaled from 1 to 100, while IDL scales such values from 0 to 255. Therefore, multiply the values obtained from the manual by 2.55 to properly scale them for use in IDL.
- Unlike most devices, IDL does not initialize the LJ250 color map to a grayscale ramp because the printer cannot produce a satisfactory grayscale image. Instead, the default palettes given in Table 7-5 of the *LJ250/LJ252 Companion Color Printer Programmer Reference Manual* are used. If you modify the color map, the LJLCT procedure can be used to reset the color table to these defaults. LJLCT examines the !D.N_COLORS system variable to determine the number of output planes in use, then loads the appropriate default color map.
- When producing images, stick to images with small amounts of detail and large sections of uniform color. Complicated images do not reproduce well on this printer.

The Macintosh Display Device

Device Keywords Accepted by the MAC Device:

BYPASS_TRANSLATION, COPY, CURSOR_ORIGINAL, CURSOR_STANDARD, DECOMPOSED, FLOYD, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_GRAPHICS_FUNCTION, GET_SCREEN_SIZE, GET_WINDOW_POSITION, ORDERED, PSEUDO_COLOR, RETAIN, SET_CHARACTER_SIZE, SET_FONT, SET_GRAPHICS_FUNCTION, THRESHOLD, TRANSLATION, TRUE_COLOR

The Macintosh version of IDL uses the “MAC” device by default. This device is similar to The X Windows Device. The “MAC” device is only available in IDL for Macintosh.

To set plotting to the Macintosh device, use the command:

```
SET_PLOT, 'MAC'
```

The Metafile Display Device

Device Keywords Accepted by the Null Device:

CLOSE_FILE, FILENAME, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GLYPH_CACHE, INCHES, INDEX_COLOR, SET_CHARACTER_SIZE, SET_FONT, TRUE_COLOR, TT_FONT, XSIZE, YSIZE

The Windows Metafile Format (WMF) is used by Windows to store vector graphics in order to exchange graphics information between applications. This format is only available on the Windows platforms. To direct graphics to a file in the WMF format, use the SET_PLOT procedure:

```
SET_PLOT, 'METAFILE'
```

This causes IDL to use the Metafile driver for producing graphical output. Once the Metafile driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions. The default settings are given in the following table:

Feature	Value
File	idl.emf
Mode	N/A
Horizontal offset	N/A
Vertical offset	N/A
Width	7 in.
Height	5 in.
Resolution	Screen

Table B-11: Default Metafile Driver Settings

For example, the following will create a WMF file for a simple plot:

```
;Create X and Y Axis data
x=findgen(10)
y=findgen(10)

;Save current device name
mydevice=!D.NAME
```

```
;Set the device to Metafile
SET_PLOT, 'METAFILE'

;Name the file to be created
DEVICE, FILE='test.emf'

;Create the plot
PLOT, x, y

;Close the device which creates the Metafile
DEVICE, /CLOSE

;Set the device back to the original
SET_PLOT, mydevice
```

The Null Display Device

Device Keywords Accepted by the Null Device:

No keywords are accepted by the DEVICE procedure when the NULL device is selected.

To suppress graphics output entirely, use the null device:

```
SET_PLOT, 'NULL'
```

The PCL Device

Device Keywords Accepted by the PCL Device:

CLOSE_FILE, COLOR, FILENAME, FLOYD, INCHES, LANDSCAPE, OPTIMIZE, ORDERED, PIXELS, PORTRAIT, RESOLUTION, SET_CHARACTER_SIZE, SET_COLORMAP, THRESHOLD, XOFFSET, XSIZE, YOFFSET, YSIZE

PCL (Printer Control Language) is used by Hewlett-Packard laser and ink jet printers to produce graphics output. To direct graphics output to a PCL file, issue the command:

```
SET_PLOT,'PCL'
```

This causes IDL to use the PCL driver for producing graphical output. Once the PCL driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings for the PCL driver are listed in the following table:

Feature	Value
File	idl.pcl
Mode	Portrait
Optimization level	0 (None)
Dither method	Floyd-Steinberg
Resolution	300 dpi
Horizontal offset	1/2 in.
Vertical offset	1 in.
Width	7 in.
Height	5 in.

Table B-12: Default PCL Driver Settings

The PCL device draws into a memory buffer of the specified size (or the default size, if the XSIZE and YSIZE keywords to DEVICE are not specified). Anything drawn outside this buffer will be silently discarded.

Note

Unlike monitors where white is the most visible color, PCL writes black on white paper. Setting the output color index to 0, the default when PCL output is selected, writes in black. A color index of 255 writes white which is invisible on white paper.

Color tables are not used with PCL unless the color mode has been enabled using the COLOR keyword to the DEVICE procedure. For images, color dithering produces realistic color image output even though PCL printers only produce eight output colors. In most cases, simply choosing an appropriate color table (using LOADCT or XLOADCT), or creating a color table from an image (via TVLCT) will work fine. If you need finer control over the colors used, see the SET_COLORMAP keyword for additional information. For vector graphics, only eight colors are supported—no line dithering is implemented. Any RGB component that is not zero is treated as 255. The correct RGB definitions for each color are shown in the following table. Use the `HELP, /DEVICE` command to view the current options for PCL output.

Color	Red Value	Green Value	Blue Value
Red	255	0	0
Green	0	255	0
Blue	0	0	255
Cyan	0	255	255
Magenta	255	0	255
Yellow	255	255	0
Black	0	0	0
White	255	255	255

Table B-13: PCL RGB Color Definitions

The Printer Device

Device Keywords Accepted by the PRINTER Device:

CLOSE_DOCUMENT, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_PAGE_SIZE, INDEX_COLOR, PORTRAIT, SCALE_FACTOR, SET_CHARACTER_SIZE, TRUE_COLOR, XOFFSET, XSIZE, YOFFSET, YSIZE

The PRINTER device allows IDL Direct Graphics to be output to a system printer. To direct graphics output to a printer, issue the command:

```
SET_PLOT, 'printer'
```

This causes IDL to use a printer driver to produce graphical output. By default, the default system printer is used for output. Use the DIALOG_PRINTERSETUP function to define the printing parameters for the printer device. Use the DIALOG_PRINTJOB function to control the print job itself.

Note that the printer device is an IDL Direct Graphics device. Like other Direct Graphics devices, you must change to the new device and then issue the IDL commands that send output to that device. With the printer device, you must use the CLOSE_DOCUMENT keyword to the DEVICE routine to actually initiate the print job and make something come out of your printer.

The PostScript Device

Device Keywords Accepted by the PS Device:

AVANTGARDE, BITS_PER_PIXEL, BKMAN, BOLD, BOOK, CLOSE_FILE, COLOR, COURIER, DEMI, ENCAPSULATED, FILENAME, FONT_INDEX, FONT_SIZE, HELVETICA, INCHES, ISOLATIN1, ITALIC, LANDSCAPE, LIGHT, MEDIUM, NARROW, OBLIQUE, OUTPUT, PALATINO, PORTRAIT, PREVIEW, SCALE_FACTOR, SCHOOLBOOK, SET_CHARACTER_SIZE, SET_FONT, SYMBOL, TIMES, TT_FONT, XOFFSET, XSIZE, YOFFSET, YSIZE, ZAPFCHANCERY, ZAPFDINGBATS

PostScript is a programming language designed to convey a description of a page containing text and graphics. Many laser printers and high-resolution, high-quality photo typesetters support PostScript. Color output or direct color separations can be produced with color PostScript. To direct graphics output to a PostScript file, issue the command:

```
SET_PLOT, 'PS'
```

This causes IDL to use the PostScript driver for producing graphical output. Once the PostScript driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings are given in the following table:

Feature	Value
File	idl.ps
Mode	Portrait, non-encapsulated, no color
Horizontal offset	3/4 in.
Vertical offset	5 in.
Width	7 in.
Height	5 in.
Scale factor	1.0
Font size	12 points

Table B-14: Default PostScript Driver Settings

Feature	Value
Font	Helvetica
# Bits / Image Pixel	4

Table B-14: Default PostScript Driver Settings

Note

Unlike monitors where white is the most visible color, PostScript writes black on white paper. Setting the output color index to 0, the default when PostScript output is selected, writes black. A color index of 255 writes white which is invisible on white paper. Color tables are not used with PostScript unless the color mode has been enabled using the DEVICE procedure. See "Color Images" on page 2373

To obtain adequate resolution, the device coordinate system used for PostScript output is expressed in units of 0.001 centimeter (i.e., 1000 pixels/cm).

Use the `HELP, /DEVICE` call to view the current font, file, and other options set for PostScript output.

Using PostScript Fonts

Information necessary for rendering a set of 35 standard PostScript fonts are included with IDL. (The standard 35 fonts are the fonts found on the Apple Laserwriter II PostScript printer; the same fonts are found on almost any PostScript printer made in the time since the LaserWriter II appeared.) Use of PostScript fonts is discussed in detail in "About Device Fonts" on page 2482.

Color PostScript

If you have a color PostScript device you can enable the use of color with the statement:

```
DEVICE, /COLOR
```

Enabling color also enables the color tables. Text and graphic color indices are translated to RGB by dividing the red, green and blue color table values by 255. As with most display devices, color indices range from 0 to 255. Zero is normally black and white is normally represented by an index of 255. For example, to create and load a color table with four elements, black, red, green and blue:

```
TVLCT, [0,255,0,0], [0,0,255,0], [0,0,0,255]
```

Drawing text or graphics with a color index of 0 results in black, 1 in red, 2 in green, and 3 in blue.

Color Images

As with black and white PostScript, images may be output with 1, 2, 4, or 8 bits, yielding 1, 2, 16, or 256 possible colors. In addition, images are either pseudo-color or TrueColor. A pseudo-color image is a two dimensional image, each pixel of which is used to index the color table, thereby obtaining an RGB value for each possible pixel value. Pseudo-color images are similar to those displayed using the workstation monitor.

Note: in the case of pseudo-color images of fewer than 8 bits, the number of columns in the image should be an exact multiple of the number of pixels per byte (i.e., when displaying 4 bit images the number of columns should be even, and 2 bit images should have a column size that is a multiple of 4). If the image column size is not an exact multiple, extra pixels with a value of 255 are output at the end of each row. This causes no problems if the color white is loaded into the last color table entry, otherwise a stripe of the last (index number 255) color is drawn to the right of the image.

TrueColor Images

A TrueColor image consists of an array with three dimensions, one of which has a size of three, containing the three color components. It may be considered as three two dimensional images, one each for the red, green and blue components. For example a TrueColor n by m element image can be ordered in three ways: pixel interleaved (3, n, m), row interleaved (n, 3, m), or image interleaved (n, m, 3). By convention the first color is always red, the second green, and the last is blue.

TrueColor images are also routed through the color tables. The red color table array contains the intensity translation table for the red image, and so forth. Assuming that the color tables have been loaded with the vectors R, G, and B, a pixel with a color value of (r, g, b) is displayed with a color of (R_r, G_g, B_b). As with other devices, a color table value of 255 represents maximum intensity, while 0 indicates an absence of the color. To pass the RGB pixel values without change, load the red, green and blue color tables with a ramp with a slope of 1.0:

```
TVLCT, INDGEN(256), INDGEN(256), INDGEN(256)
```

or with the LOADCT procedure:

```
; Load standard black/white table:
LOADCT, 0
```

Use the TRUE keyword to the TV and TVSCL procedures to indicate that the image is a TrueColor image and to specify the dimension over which color is interleaved. A value of 1 specifies pixel interleaving, 2 is row interleaving, and 3 is image interleaving. The following example writes a 24-bit image, interleaved over the 3rd dimension, to a PostScript file:

```
SET_PLOT, 'PS'
;Set the PostScript device to *8* bits per color, not 24:
DEVICE, FILE='24bit.ps', /COLOR, BITS=8
TV, [[[r]], [[g]], [[b]]], TRUE=3
DEVICE, /CLOSE
; Return plotting to Macintosh windows:
SET_PLOT, 'mac'
```

Note

Currently, the PostScript device does not support TrueColor plots. Only TrueColor images are supported.

Image Background Color

Images that are displayed with a black background on a monitor frequently look better if the background is changed to white when displayed with PostScript. This is easily done with the statement:

```
a(WHERE(a EQ 0B)) = 255B
```

PostScript Positioning

Using the XOFFSET and YOFFSET Keywords

Often, IDL users are confused by the use of the XOFFSET and YOFFSET keywords to the PostScript DEVICE routine. These keywords control the position of IDL plots on the page. XOFFSET specifies the “X” position of the lower left corner of the output generated by IDL. This offset is always taken relative to the lower left-hand corner of the page when viewed in portrait orientation. YOFFSET specifies the “Y” position of the lower left corner of the output generated by IDL. This offset is also taken relative to the lower left-hand corner of the page when viewed in portrait orientation.

The following figure shows how the XOFFSET and YOFFSET keywords are interpreted

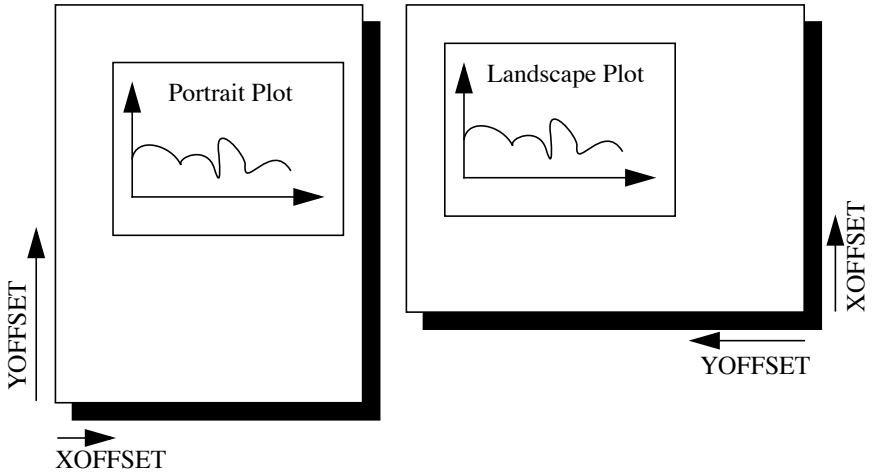


Figure B-1: This diagram shows how the XOFFSET and YOFFSET keywords are interpreted by the PostScript device in the Portrait (left) and Landscape (right) modes. Note that the landscape plot uses the same origin for determining the effect of the XOFFSET and YOFFSET keywords, but that the output is rotated 270 degrees clockwise

The page on the left shows an IDL plot printed in "portrait" orientation. Note that the X and Y offsets work just as we expect them to—increasing the XOFFSET moves the plot to the right and increasing the YOFFSET moves the plot up the page. The page on the right shows an IDL plot printed in "landscape" orientation. Here, the X and Y offsets are still taken relative to the same points even though the orientation of the plot has changed. This happens because IDL moves the origin of the plot `before` rotating the PostScript coordinate system 270 degrees clockwise for the landscape plot.

Note

The XOFFSET and YOFFSET keywords have no effect when you generate ENCAPSULATED PostScript output.

Encapsulated PostScript Output

Another form of PostScript output is Encapsulated PostScript. This is the format used to import PostScript files into page layout and desktop publishing programs. An Encapsulated PostScript (EPS) file is similar to a regular PostScript file except that it contains only one page of PostScript output contained in a “bounding box” that is used to tell other programs about the size and aspect ratio of the encapsulated image.

Most of the time, output from IDL to an EPS file is properly scaled into the EPS bounding box because commands such as PLOT take full advantage of the plotting area made available to them. Sometimes, however, the default bounding box is inappropriate for the image being displayed.

As an example, suppose you have an image that is narrow and tall that, when TV’ed to an IDL window, fills only a small portion of the plotting window. Similarly, when output to an EPS file, this image will only fill a small portion of the bounding box. When the resulting EPS file is brought into a desktop publishing program, it becomes very hard to properly scale the image since the aspect ratio of the bounding box bears no relation to the aspect ratio of the image itself.

To solve this problem, use the XSIZE and YSIZE keywords to the DEVICE procedure to make the bounding box just large enough to contain the image. Since IDL uses a resolution of 1000 dots per centimeter with the PostScript device, the correct XSIZE and YSIZE (in centimeters) can be computed as:

- XSIZE = Width of image in pixels/1000.0 pixels per cm
- YSIZE = Height of image in pixels/1000.0 pixels per cm

The following IDL procedure demonstrates this technique. This procedure reads an X Windows Dump file and writes it back out as a properly-sized, 8-bit-color Encapsulated PostScript file:

```
PRO XWDTOEPS, filename
; Read the XWD file. Pixel intensity information is stored
; in the variable 'array'. Values to reconstruct the color
; table are stored in 'r', 'g', and 'b':
array = READ_XWD(filename, r, g, b)
; Reconstruct the color table:
TVLCT, r,g,b
; Display the image in an IDL window:
TV, array
; Find the size of the picture. The width of the picture
; (in pixels) is stored in s[1]. The height of the picture
; is stored in s[2]:
s = SIZE(array)
; Take the 'xwd' (for X Windows Dump) extension off of
```

```
; the old filename and replace it with 'eps':
fl = STRLEN(filename)
filename = STRMID(filename, 0, fl-4)
filename = filename + '.eps'
PRINT, 'Making file: ', filename
PRINT, s
; Set the plotting device to PostScript:
SET_PLOT, 'ps'
; Use the DEVICE procedure to make the output encapsulated,
; 8 bits, color, and only as wide and high as it needs to
; be to contain the XWD image:
DEVICE, /ENCAPSUL, BITS_PER_PIXEL=8, /COLOR, $
   FILENAME=filename, XSIZE=S[1]/1000., $
   YSIZE=S[2]/1000.
; Write the image to the file:
TV, array
; Close the file:
DEVICE, /CLOSE
; Return plotting to X Windows:
SET_PLOT, 'x'
END
```

Multiple Plots on the Same Page

To put multiple plots on the same PostScript page, use the !P.MULTI system variable (described in more detail in "!P System Variable" on page 2440). !P.MULTI is a 5-element integer array that controls the number of rows and columns of plots to make on a page or in a graphics window.

The first element of !P.MULTI is a counter that reports how many plots remain on the page. The second element of !P.MULTI is the number of columns per page. The third element is the number of rows per page.

For example, the following lines of code create a PostScript file, `multi.ps`, with 6 different plots arranged as 2 columns and 3 rows:

```
; Set plotting to PostScript:
SET_PLOT, 'PS'
; Set the filename:
DEVICE, FILENAME='multi.ps'
; Make IDL's plotting area hold 2 columns and 3 rows of plots:
!P.MULTI = [0, 2, 3]
; Create a simple dataset:
A = FINDGEN(10)
; Make 6 different plots:
PLOT, A
PLOT, SIN(A)
PLOT, COS(A)
PLOT, TAN(A)
```

```
PLOT, TANH(A)
PLOT, SINH(A)
; Close the file:
DEVICE, /CLOSE
; Return plotting to Windows:
SET_PLOT, 'win'
; Reset plotting to 1 plot per page:
!P.MULTI = 0
```

The resulting file produces a set of plots as shown in the following figure:

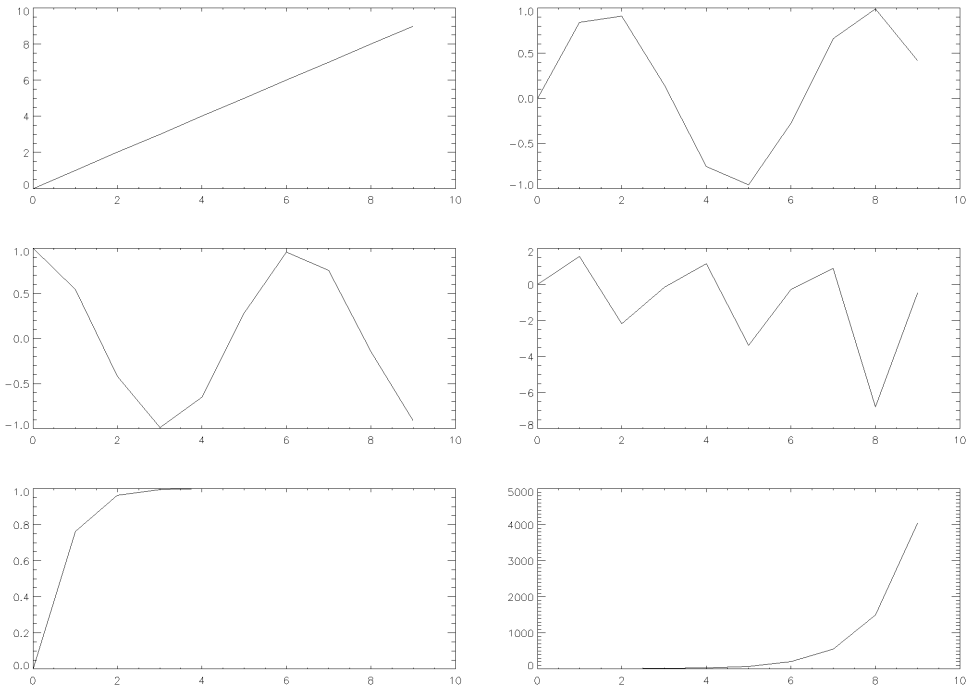


Figure B-2: Multiple plots on a single page produced by setting the !P.MULTI system variable.

Importing IDL Plots into Other Documents

This section shows how to generate IDL PostScript graphics so that they can be inserted into other documents. It also provides several examples of how the PostScript graphics device is used. Simply omit the ENCAPSULATED keyword from the calls to DEVICE if you wish to produce plots that can be printed directly.

The following figure is an encapsulated PostScript file suitable for inclusion in other documents. The figure was produced with the following IDL statements. Note the use of the ENCAPSULATED keyword in the call to DEVICE:

```
; Select the PostScript driver:
SET_PLOT, 'PS'
; Note use of ENCAPSULATED keyword:
DEVICE, /ENCAPSULATED, FILENAME = 'pic1.ps'
x = FINDGEN(200)
; Plot the sine wave:
PLOT, 10000 * SIN(x/5) / EXP(x/100), $
    LINESTYLE = 2, TITLE = 'IDL PostScript Plot', $
    XTITLE = 'Point Number', YTITLE='Y Axis Title', $
    FONT = 0
; Add the cosine:
OPLOT, 10000 * COS(x/5) / EXP(x/100), LINESTYLE = 4
; Annotate the plot:
XYOUTS, 100, -6000, 'Sine', FONT = 0
OPLOT, [120, 180], [-6000, -6000], LINESTYLE = 2
XYOUTS, 100, -8000, 'Cosine', FONT = 0
OPLOT, [120, 180], [-8000, -8000], LINESTYLE = 4
```

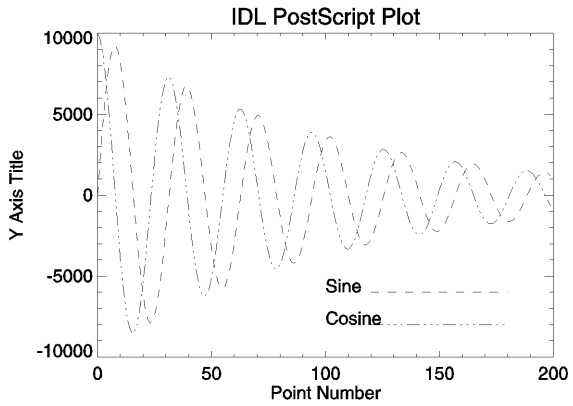


Figure B-3: Sample PostScript plot using Helvetica font.

The following figure is a more complicated plot. It demonstrates some of the three-dimensional plotting capabilities of IDL. It was produced with the following IDL statements:

```
; Select the PostScript driver:
SET_PLOT, 'PS'
; Note use of ENCAPSULATED keyword:
DEVICE, /ENCAPSULATED, FILENAME = 'pic2.ps'
; Access the data:
OPENR, 1, !DIR+'/images/abnorm.dat'
aa = ASSOC(1, BYTARR(64, 64))
; Get a smoothed version:
a = SMOOTH(aa[0], 3)
; Generate the surface:
SURFACE, a, /SAVE, ZAXIS = 1, XSTYLE = 1, YSTYLE = 1
; Add the contour:
CONTOUR, a, /T3D, /NOERASE, ZVALUE = 1, $
   XSTYLE = 1, YSTYLE = 1, C_LINESTYLE = [0,1,2], $
   TITLE = 'IDL PostScript Plot'
CLOSE, 1
```

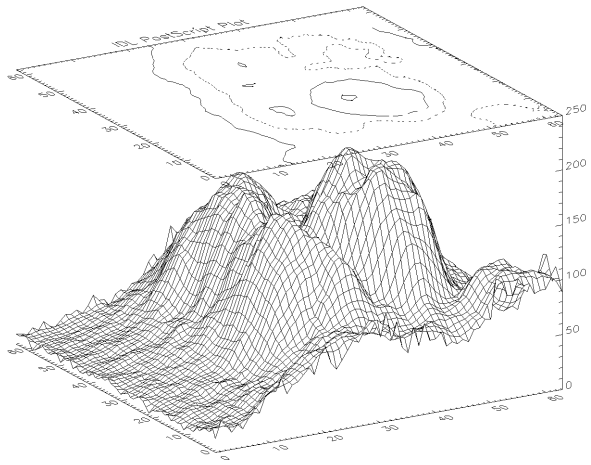


Figure B-4: Three-Dimensional Plot with Vector-Drawn Characters

The following figure illustrates polygon filling. It was produced with the following IDL statements:

```
SET_PLOT, 'PS'
DEVICE, /ENCAPSULATED, FILENAME = 'pic3.ps'
x = FINDGEN(200)
; Upper sine wave:
a = 10000 * sin(x / 5) / exp(x / 100)
PLOT, a, /NODATA, TITLE = 'IDL PostScript Plot', $
```

```
   XTITLE='Point Number', YTITLE='Y Axis Title', $
   FONT = 0
; Vector of X vertices for polygon filling. Note that the
; ROTATE(V,2) function call returns the vector V in reverse order:
C = [X, ROTATE(X, 2)]
; Vector of Y vertices for polygon filling:
D = [A, ROTATE(A-2000, 2)]
; Fill the region using an intensity of about 75% white:
POLYFILL, C, D, COLOR=192
```

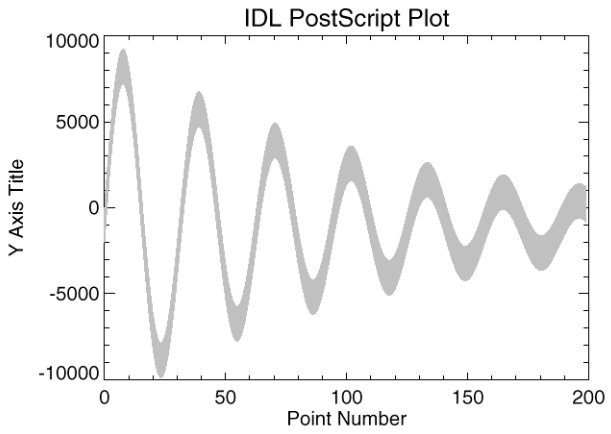


Figure B-5: Polygon Filling Example

The following figure illustrates IDL PostScript images. In this case, the same image is reproduced four times. In each case, a different number of bits are used per image pixel. It was produced with the following IDL statements:

```
SET_PLOT, 'PS'
DEVICE, /ENCAPSULATED, FILENAME = 'pic4.ps'
; Open image file:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])
; Variable to hold image:
a = BYTARR(192, 192, /NOZERO)
; Input the image:
READU, 1, a
; Done with the file:
CLOSE, 1
; Add a color table ramp to the bottom of the image:
A[0,0] = BYTSCL(INDGEN(192))#REPLICATE(1,16)
; Output the image four times:
FOR i = 0,3 DO BEGIN
```

```
   ;Use 1, 2, 4, and 8 bits per pixel:
   DEVICE, BITS_PER_PIXEL=2^i
   ; Output using TV with position numbers 0, 1, 2, and 3:
   TV, a, i, XSIZE=2.5, YSIZE=2.5, /INCHES
ENDFOR
```

Figure B-6: 1, 2, 4, and 8-bit PostScript Images

The Regis Terminal Device

Device Keywords Accepted by the REGIS Device:

AVERAGE_LINES, CLOSE_FILE, FILENAME, PLOTTER_ON_OFF, SET_CHARACTER_SIZE, TTY, VT240, VT241, VT340, VT341

IDL provides Regis graphics output for the DEC VT240, VT330, and VT340 series of terminals. To output graphics to such terminals, issue the IDL command:

```
SET_PLOT, 'REGIS'
```

This causes IDL to use the Regis driver for producing graphical output.

Defaults for Regis Devices

The default setting for Regis output is: VT340, 16 colors, 4 bits per pixel.

Regis Limitations

- Four colors are available with VT240 and VT241 terminals, sixteen colors are available with the VT330 and VT340.
- Thick lines are emulated by filling polygons. There may be a difference in linestyle appearance between thick and normal lines.
- Image output is slow and is of poor quality, especially on the VT240 series. The VT240 is only able to write pixels on even numbered screen lines. IDL offers two methods of writing images to the 240:
- Even and odd pairs of rows are averaged and written to the screen. An *n*, *m* image will occupy *n* columns and *m* screen rows. If this method is selected, graphics and image coordinates coincide. This method is the default (`AVERAGE_LINES = 1`). Routines that rely on a uniform graphics and image coordinate system, such as SHADE_SURF, work only in this mode.
- Each line of the image is written to the screen, displaying every image pixel. An *n*, *m* image occupies 2*m* lines on the screen. (`AVERAGE_LINES = 0`). Graphics and image coordinates coincide only at the lower left corner of the image.
- Pixel values cannot be read back from the terminal, rendering the TVRD function inoperable.

The Tektronix Device

Device Keywords Accepted by the REGIS Device:

CLOSE_FILE, COLORS, FILENAME, GIN_CHARS, PLOT_TO, RESET_STRING, SET_CHARACTER_SIZE, SET_STRING, TEK4014, TEK4100, TTY

The Tektronix 4000 (4010, 4014, etc.), 4100 and 4200 series of graphics terminals (and the multitude of terminals and microcomputers that emulate them) are among the most common graphics devices available. To use IDL graphics with such terminals, issue the command:

```
SET_PLOT,'TEK'
```

This causes IDL to use the Tektronix driver for producing graphical output. Once the Tektronix driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, and to configure IDL for the specific features of your terminal. If you never call the DEVICE procedure, IDL assumes a plain vanilla Tektronix 4000 series compatible terminal. The 4200 series is upwardly compatible with the 4100 series; all references to the 4100 series also include the 4200 series. To set up IDL for use with a 4100 series compatible terminal with *n* colors, enter the following commands:

```
SET_PLOT, 'TEK'
DEVICE, /TEK4100, COLORS = n
```

The number of colors should be set to 2B where B is the number of bit planes in your terminal. If you use a Tektronix compatible terminal that requires calling the DEVICE procedure for configuration, you should probably create and use a start-up procedure the calls the DEVICE procedure, as described in Chapter 2. Because of the tremendous variation among the requirements and abilities of these terminals, it is crucial that you configure IDL properly for your terminal. In particular, the mode switching character sequences, set by the keyword parameters SET_STRING and RESET_STRING must be set correctly.

The DEVICE Procedure For Tektronix Terminals

The default setting for Tektronix output is: 10-bit coordinates, 4000 series terminals, and no use of color. The DEVICE keywords can be used to modify these defaults.

Tektronix Limitations

- The line drawing procedures work with all models. Line style and color capabilities vary greatly among terminal models and/or emulation programs.

- Color and the display of images (albeit very slowly and frequently of a poor quality because of the small number of colors) is usable only with 4100 series terminals. Hardware polygon fill and thick lines do not work with the 4000 series.
- The image coordinate system does not match the graphics coordinate system. The graphics coordinates range from 0 to 3071 in Y, and from 0 to 4095 in X. Image coordinates vary according to terminal model. A typical range is from 0 to 479 in Y, and 0 to 639 in X. Because of this, the SHADE_SURF procedure does not work with Tektronix terminals.

Warning

Not all 4100 series terminals are capable of displaying images—the Tektronix pixel operations option is required. Many terminal emulators do not emulate this option. The Tektronix commands used to output images are: RU, begin pixel operations, RS, set pixel viewport, and RP, raster write. If your terminal or emulator does not accept these commands, you will not be able to display images.

- The Tektronix graphics protocol does not allow the specification of line thickness. Lines with a thickness more than 1.0 are drawn using polygon filling in the case of 4100 series terminals. With 4000 series terminals, thick lines are emulated by drawing multiple thin lines. This scheme will produce artifacts on some Tektronix emulating devices because of differing resolutions, normal line thicknesses and inexact coordinate conversions.

Tektronix Device Limitations

Usage of Tektronix and Tektronix-compatible terminals with IDL has the following limitations:

- Image coordinates do not match the coordinates used by the rest of the graphic procedures. This is because no two models of Tektronix terminals are compatible. The graphics procedures utilize the default coordinate system of 1024 by 780, or 4096 by 3120 in the 12-bit mode. The size of the pixel memory and coordinate system vary widely between models. The *Position* parameter of the TV and TVSCL procedures does not work.
- The cursor can not be positioned from the computer meaning that the TVCRS procedure cannot be used with the Tektronix driver.
- Pixel values may not be read back from the terminal, rendering the TVRD function inoperable.

The Microsoft Windows Device

Device Keywords Accepted by the WIN Device:

BYPASS_TRANSLATION, COPY, CURSOR_CROSSHAIR, CURSOR_ORIGINAL, CURSOR_STANDARD, DECOMPOSED, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_GRAPHICS_FUNCTION, GET_SCREEN_SIZE, GET_WINDOW_POSITION, PRINT_FILE, RETAIN, SET_CHARACTER_SIZE, SET_FONT, SET_GRAPHICS_FUNCTION, TRANSLATION, WINDOW_STATE

The Microsoft Windows version of IDL uses the “WIN” device by default. This device is similar to the X Windows device described below. The “WIN” device is only available in IDL for Windows.

To set plotting to the Microsoft Windows device, use the command:

```
SET_PLOT, 'WIN'
```

The X Windows Device

Device Keywords Accepted by the X Device:

BYPASS_TRANSLATION, COPY, CURSOR_CROSSHAIR, CURSOR_IMAGE, CURSOR_MASK, CURSOR_ORIGINAL, CURSOR_STANDARD, CURSOR_XY, DECOMPOSED, DIRECT_COLOR, FLOYD, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_GRAPHICS_FUNCTION, GET_SCREEN_SIZE, GET_VISUAL_NAME, GET_WINDOW_POSITION, GET_WRITE_MASK, ORDERED, PSEUDO_COLOR, RETAIN, SET_CHARACTER_SIZE, SET_FONT, SET_GRAPHICS_FUNCTION, SET_TRANSLATION, SET_WRITE_MASK, STATIC_COLOR, STATIC_GRAY, THRESHOLD, TRUE_COLOR, TTY, WINDOW_STATE

X Windows is a network-based windowing system developed by MIT's project Athena. IDL uses the X System (often referred to simply as "X"), to provide an environment in which the user can create one or more independent windows, each of which can be used for the display of graphics and/or images.

In the X system, there are two basic cooperating processes: *clients* and *servers*. A server consists of a display, keyboard, and pointer (such as a mouse) as well as the software that controls them. Client processes (such as IDL) display graphics and text on the screen of a server by sending X protocol requests across the network to the server. Although in the most common case, the server and client reside on the same machine, this network based design allows much more elaborate configurations.

To use X Windows as the current graphics device, issue the IDL command:

```
SET_PLOT, 'X'
```

This causes IDL to use the X Window System for producing graphical output. Once the X driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below.

Use the statement:

```
HELP, /DEVICE
```

to view the current state of the X Windows driver.

X Windows Visuals

Visuals specify how the hardware deals with color. The X Window server (your display) may provide colors or only gray scale (black and white), or both. The color

tables may be changeable from within IDL (read-write), or may be fixed (read-only). The value of each pixel value may be mapped to any color (Un-decomposed Colormap), or certain bits of each pixel are dedicated to the red, green, and blue primary colors (Decomposed Colormap).

There are six X Windows visual classes—read-write and read-only visuals for three types of displays: Gray Scale, Pseudo Color, and Decomposed Color. The names of the visuals are shown in the following table:

Visual Name	Writable	Description
StaticGray	no	Gray scale
GrayScale	yes	Gray scale
StaticColor	no	Undecomposed color
PseudoColor	yes	Undecomposed color
TrueColor	no	Decomposed color
DirectColor	yes	Decomposed color

Table B-15: X Windows Visual Classes

IDL supports all six types of visuals, although not at all possible depths. UNIX X Window System users can use the command `xdpyinfo` to determine which visuals are supported by their systems.

Each X Window server has a default visual class. Many servers may provide multiple visual classes. For example, a server with display hardware that supports an 8-bit-deep, un-decomposed, writable color map (PseudoColor), may also easily provide StaticColor, StaticGray, and GrayScale visuals.

You can select the visual used by IDL using the DEVICE procedure before a window is created, or by including the resource `idl.gr_visual` in your X defaults file, as explained in "Setting the X Window Defaults" on page 2394.

How IDL Selects a Visual Class

When opening the display, IDL asks the display for the following visuals, in order, until a supported visual class is found:

1. DirectColor, 24-bit
2. TrueColor, 24-bit

3. PseudoColor, 8-bit, then 4-bit
4. StaticColor, 8-bit, then 4-bit
5. GrayScale, any depth
6. StaticGray, any depth

You can override this behavior by using the DEVICE routine to specify the desired visual class and depth before you create a window. For example, if you are using a display that supports both the DirectColor, 24-bit-deep visual, and an 8-bit-deep PseudoColor visual, IDL will select the 24-bit-deep DirectColor visual. To instead use PseudoColor, issue the following command before creating a window:

```
DEVICE, PSEUDO_COLOR = 8
```

The colormap/visual class combination is chosen when IDL first connects with the X Window server. Note that if you connect with the X server by creating a window or using the DEVICE keyword to the HELP procedure, the visual class will be set; it then cannot be changed until IDL is restarted. If you wish to use a visual class other than the default, be sure to set it with a call to the DEVICE procedure *before* creating windows or otherwise connecting with the X Window server.

Windows are created in two ways:

1. Using the WINDOW procedure. WINDOW allows you to explicitly control many aspects of how the window is created.
2. If no windows exist and a graphics operation requiring a window is executed, IDL implicitly creates window 0 with the default characteristics.

Once the visual class is selected, all subsequently-created windows share the same class and colormap. The number of simultaneous colors available is stored in the system variable !D.N_COLORS. The visual class and number of colors, once initialized, cannot be changed without first exiting IDL.

How IDL Obtains a Colormap

IDL chooses the type of colormap in the following manner:

- By default, the shared colormap is used whenever possible (i.e., whenever IDL is using the default visual for the system). All available colors from the shared colormap are allocated for use by IDL. This is what happens when no window currently exists and a graphics operation causes IDL to implicitly create one.
- If the number of colors to use is explicitly specified using the COLORS keyword with the WINDOW procedure, IDL attempts to allocate the number of colors specified from the shared colormap using the default visual of the

screen. If there aren't enough colors available, a private colormap with that number of colors is used instead.

- Specifying a negative value for the COLORS keyword to the WINDOW procedure causes IDL to attempt to use the shared colormap, allocating all but the specified number of colors. For example:

```
WINDOW, COLORS = -8
```

allocates all but 8 of the currently available colors. This allows other applications that might need their own colors to run in tandem with IDL.

- If a visual type and depth is specified, via the DEVICE procedure, which does not match the default visual of the screen, a new, private, colormap is created.

Using Color Under X

Colormaps define the mapping from color index to screen color. Two attributes of colormaps are important to the IDL user: they may be *private* or *shared*; and they may be *static* or *writable*. These different types of colormaps are described below.

Shared Colormaps

The window manager creates a colormap when it is started. This is known as the default colormap, and can be shared by most applications using the display. When each application requires a colormap entry (i.e., a mapping from a color index to a color), it allocates one from this shared table. Advantages and disadvantages of shared colormaps include:

- Using the shared colormap ensures that all applications share the available colors without conflict. A given application will not change a color that is allocated to a different application. In the case of IDL it means that IDL can change the colors it has allocated without changing the colors in use by the window manager or other applications.
- The window system interface routines must translate between the actual and allocated pixel values, significantly slowing the transfer of images.
- The shared colormap might not have enough colors available to perform the desired operations with IDL.
- The number of available colors in the shared colormap depends on the window manager in use and the demands of other applications. Thus, the number of available colors can vary.

- The allocated colors in a shared colormap do not generally start at zero and they are not necessarily contiguous. This makes it difficult to use the write mask for certain operations.

Private Colormaps

An application can create its own private color map. Most hardware can only display a single colormap at a time, so these private colormaps are called virtual color maps, and only one at a time is actually in use and visible. When the window manager gives the color focus to a window with a private colormap, the X window system loads its virtual colormap into the hardware colormap.

- Every color index supported by the hardware is available to IDL, improving the quality of images.
- Allocated colors always start at zero and are contiguous. This simplifies using the write mask.
- No translation between internal pixel values and the values required by the server is required, making the transfer of images more efficient.
- When the IDL colormap is loaded, other applications are displayed using the wrong colors. Furthermore, colors from the shared colormap are usually allocated from the lower end of the map first. These are the colors allocated by the window manager for such things as window borders, the color of text, and so forth. Since most IDL colormaps have very dark colors in the lower entries, the end effect with the IDL colormap loaded is that the non-IDL portions of the screen go blank.

Static Colormaps

As mentioned above, the contents of static colormaps are determined outside of IDL and cannot be changed. When using a static colormap, the TVLCT procedure simulates writable colormaps by finding the closest RGB color entry in the colormap to the requested color. The colormap translation table is then set to map IDL color indices to those of the closest colors in the colormap.

The colors present in the colormap may, and probably will, *not* match the requested colors exactly. For example, with a typical static color map, loading the IDL standard color table number 0, which consists of 256 intensities of gray, results in only 8 or 16 distinct intensities.

With static colormaps, loading a new color table does not affect the appearance of previously written objects. The internal translation tables are modified, which only affects objects that are subsequently written.

Color Translation

As mentioned above, colors from the shared colormap do not necessarily start from index zero, and are not necessarily contiguous. IDL preserves the illusion of a zero based contiguous colormap by maintaining a translation table between user color indices, which range from 0 to !D.TABLE_SIZE, and the actual pixel values allocated from the X server. Normally, the user need not be concerned with this translation table, but it is available using the statement:

```
DEVICE, TRANSLATION=T
```

This statement stores the current translation table, a 256 element byte vector, in the variable T. Element zero of the vector contains the value pixel allocated for the zeroth color in the IDL colormap, and so forth. In the case of a private colormap, each element of the translation vector contains it's own index value, because private colormaps start at zero and are contiguous.

The translation table may be bypassed, allowing direct access to the display's color indices, by setting the BYPASS_TRANSLATION keyword in the DEVICE procedure.

```
DEVICE, /BYPASS_TRANSLATION
```

Translation can be reestablished by setting the keyword to zero:

```
DEVICE, BYPASS_TRANSLATION=0
```

When a private or static (read-only) color table is initialized, the bypass flag is cleared. It is set when initializing a shared color table.

Using Pixmaps

X Windows can direct graphics to *windows* or *pixmaps*. Windows are the usual windows that appear on the screen and contain graphics. Pixmaps are invisible graphics memory contained in the server. Drawing to a window produces a viewable result, while drawing to a pixmap simply updates the pixmap memory.

Pixmaps are useful because it is possible to write graphics to a pixmap and then copy the contents of the pixmap to a window where it can be viewed. Furthermore, this copy operation is very fast because it happens entirely within the server. Provided enough pixmap memory is available, this technique works very well for animating a series of images by placing the images into pixmap memory and then sequentially copying them to a visible window.

To create a pixmap, use the PIXMAP keyword with the WINDOW procedure. For example, to create a square pixmap with 128 pixels per side as IDL window 1, use the command:

```
WINDOW, 1, /PIXMAP, XSIZE=128, YSIZE=128
```

Once they are created, pixmaps are treated just like normal windows, although some operations (WSHOW for instance) don't do anything useful when applied to a pixmap.

The following procedure shows how animation can be done using pixmap memory. It uses a series of 15 heart images taken from the file `abnorm.dat`. This file is supplied with all IDL distributions in the `examples/data` subdirectory of the main IDL directory. It creates a pixmap and writes the heart images to it. It then uses the COPY keyword of the DEVICE procedure to copy the images to a visible window. Pressing any key causes the display process to halt:

```
; Animate heart series:
PRO animate_heart
; Open the file containing the images:
OPENR, u, FILEPATH('abnorm.dat', SUBDIR = ['examples','data']), $
   /GET_LUN
; Associate a file variable with the file. Each heart image
; is 64x64 pixels:
frame = ASSOC(u, BYTARR(64,64))
; Window pixwin is a pixmap which is 4 images tall and 4
; images wide. The images will be placed in this pixmap:
WINDOW, pixwin, /PIXMAP, XSIZE = 512, YSIZE = 512, /FREE
; Write each image to the pixmap. SMOOTH is used to improve
; the appearance of each image and REBIN is used to
; enlarge/shrink each image to the final display size:
FOR i=0, 15-1 DO TV, REBIN(SMOOTH(frame[i],3), 128, 128),i
; Close the image file and free the file unit:
FREE_LUN, u
; Window win is a visible window. It will be used to display
; the animated heart cycle:
WINDOW, win, XSIZE = 128, YSIZE=128, TITLE='Heart', /FREE
; Current frame number:
i = 0L
; Display frames until any key is pressed:
WHILE GET_KBRD(0) EQ '' DO BEGIN
; Compute x and y locations of pixmap image's lower left corner:
   x = (i mod 4) * 128 & y = 384 - (i/4) * 128
; Copy the next image from the pixmap to the visible window:
DEVICE, COPY = [x, y, 128, 128, 0, 0, pixwin]
; Keep track of total frame count:
i = (i + 1) MOD 15
ENDWHILE
END
```

Animation sequences with more and/or larger images can be made. See the documentation for the XANIMATE procedure, which is a more generalized embodiment of the above procedure.

Note: Some X Windows servers will refuse to create a pixmap that is larger than the physical screen in either dimension.

Setting the X Window Defaults

You can set the initial default value of the following parameters by setting resources in the file `.Xdefaults` (UNIX), or `DECW$SM_GENERAL.DAT` (VMS) in your home directory as follows:

Resource Name	Description
idl.colors	The number of colors used by IDL.
idl.gr_depth	The depth, in bits, of the visual used by IDL.
idl.retain	The default setting for the *retain* parameter: 0=none, 1= by server, 2=by IDL.
idl.gr_visual	The type of visual: StaticGray, GrayScale, StaticColor, PseudoColor, TrueColor, or DirectColor.
idl.olh_text_width	The width for the online help window.
idl.olh_text_height	The height for the online help window.

Table B-16: IDL/ X Window Defaults

For example, to set the default visual to PseudoColor, and to allocate 100 colors, insert the following lines in your defaults file:

```
idl.gr_visual: PseudoColor
idl.colors: 100
```

The Z-Buffer Device

Device Keywords Accepted by the Z Device:

CLOSE, GET_GRAPHICS_FUNCTION, GET_WRITE_MASK, SET_CHARACTER_SIZE, SET_COLORS, SET_FONT, SET_GRAPHICS_FUNCTION, SET_RESOLUTION, Z_BUFFERING

The IDL Z-buffer device is a pseudo device that draws 2D or 3D graphics in a buffer contained in memory. This driver implements the classic Z buffer algorithm for hidden surface removal. Although primarily used for 3D graphics, the Z-buffer driver can be used to create 2D objects in a frame buffer in memory. The resolution of this device can be set by the user.

All of the IDL plotting and graphics routines work with the Z-buffer device driver. In addition, the POLYFILL procedure has a few keyword parameters, allowing Gouraud shading and warping images over 3D polygons, that are only effective when used with the Z-buffer.

When used for 3D graphics, two buffers are present: an 8-bit-deep frame buffer that contains the picture; and a 16-bit-deep Z-buffer of the same resolution, containing the z-value of the visible surface of each pixel. The Z-buffer is initialized to the depth at the back of the viewing volume. When objects are drawn, the z-value of each pixel is compared with the value at the same location in the Z-buffer, and if the z-value is greater (closer to the viewer), the new pixel is written in the frame buffer and the Z-buffer is updated with the new z-value.

The Z-buffer device is a “pseudo device” in that drawing commands update buffers in memory rather than sending commands to a physical device or file. The TVRD function reads the contents of either buffer to an IDL array. This array may then be further processed, written to a file, or output to a raster-based graphics output device.

The Z-buffer driver can be used for 2D graphics by disabling the depth computations.

To use the Z-buffer as the current graphics device, issue the IDL command:

```
SET_PLOT, 'Z'
```

Once the Z-buffer driver is enabled the DEVICE procedure is used to control its actions, as described below.

Use the statement:

```
HELP, /DEVICE
```

to view the current state of the Z-buffer driver and the amount of memory used for the buffers.

Reading and Writing Buffers

The contents of both buffers are directly accessed by the TV and TVRD routines. The frame buffer that contains the picture is 8 bits deep and is accessed as channel 0. The Z depth buffer contains 16 bit integers and is accessed as channel 1. Always use `CHANNEL=1` and set the keyword WORDS when reading or writing the depth buffer.

The normal procedure is to set the graphics device to "Z", draw the objects, read the frame buffer, and then select another graphics device and write the image. For example, to create an image with the Z-buffer driver and then display it on an X-Window display:

```
; Select Z-buffer device:
SET_PLOT,'Z'
; Write objects to the frame buffer using normal graphics
; routines, e.g. PLOT, SURFACE, POLYFILL
... ... ...
; Read back the entire frame buffer:
a=TVRD()
; Select X Windows:
SET_PLOT,'X'
; Display the contents of the frame buffer:
TV, a
```

To read the depth values in the Z-buffer, use the command:

```
a = TVRD(CHANNEL=1, /WORDS)
```

To write the depth values, use the command:

```
TV, a, /WORDS, CHANNEL=1
```

The TV, TVSCL, and TVRD routines write or read pixels directly to a rectangular area of the designated buffer without affecting the other buffer.

Z-Axis Scaling

The values in the depth buffer are short integers, scaled from -32765 to +32765, corresponding to normalized Z-coordinate values of 0.0 to 1.0.

Polyfill Procedure

The following POLYFILL keywords are active only with the Z-buffer device: IMAGE_COORDINATES, IMAGE_INTERPOLATE, and TRANSPARENT. These

parameters allow images, specified via the PATTERN keyword, to be warped over 2D and 3D polygons.

The IMAGE_COORDINATES keyword contains a 2 by *N* array containing the image space coordinates that correspond to each of the *N* vertices of the polygon. The IMAGE_INTERPOLATE keyword indicates that bilinear interpolation is to be used, rather than the default nearest neighbor sampling. Pixels less than the value of TRANSPARENT are not drawn, simulating transparency. For Gouraud shading of polygons, the COLOR keyword can contain an array specifying the color index for each polygon vertex.

Examples Using the Z-Buffer

This example forms a Bessel function, draws its shaded surface and overlays its contour, using the Z-buffer as shown in the following figure.The final output is directed to PostScript.

```
; Select the Z-buffer:
SET_PLOT, 'Z'
n = 50 ; Size of array for Bessel
; Make the Bessel function:
a = BESELJ(SHIFT(DIST(n), n/2, n/2)/2, 0)
; Draw the surface, label axes in black, background in white:
SHADE_SURF, a, /SAVE, COLOR=1, BACKGROUND=255
nlev = 8 ; Number of contour levels
; Make the Contour at normalized Z=.6:
CONTOUR, a, /OVERPLOT, ZVALUE=.6, /T3D, $
   LEVELS=FINDGEN(nlev)*1.5/nlev-.5, COLOR=1
; Read image:
b=TVRD()
; Select PostScript output:
SET_PLOT, 'PS'
; Output the image:
TV, b
; Close the new PostScript file:
DEVICE, /CLOSE
```

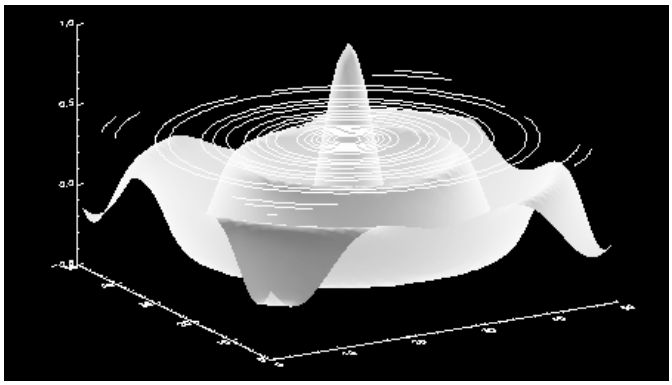


Figure B-7: Combined Shaded Surface and Contour Plot

The following example warps an image to a cube as shown in the figure below. The lower two quadrants of the image are warped to the front two faces of the cube. The upper-right quadrant is warped to the top face of the cube. The image is held in the array `a`, with dimensions `nx` by `ny`. The image is then output to PostScript as in the previous example.

```
; Select the Z-buffer:
SET_PLOT, 'Z'
; Make a white background for final output to PostScript:
ERASE, 255
; Establish 3D scaling as (0,1) cube:
SCALE3, XRANGE=[0,1], YRANGE=[0,1], ZRANGE=[0,1]
; Define vertices of cube. Vertices 0-3 are bottom, 4-7 are top:
verts = [[0,0,0], [1,0,0], [1,1,0], [0,1,0], $
   [0,0,1], [1,0,1], [1,1,1], [0,1,1]]
; Fill lower left face:
POLYFILL, verts[*, [3,0,4,7]], /T3D, PATTERN=a, $
   IMAGE_COORD=[[0,0], [nx/2,0], [nx/2,ny/2], [0,ny/2]]
; Fill lower right face:
POLYFILL, verts[*, [0,1,5,4]], /T3D, PATTERN=a, $
   IMAGE_COORD=[[nx/2,0], [nx-1,0], $
   [nx-1,ny/2], [nx/2,ny/2]]
; Fill top face:
POLYFILL, verts[*, [4,5,6,7]], /T3D, PATTERN=a, $
   IMAGE_COORD = [[nx/2,ny/2], [nx-1,ny/2], $
   [nx-1,ny-1], [nx/2,ny-1]]
; Draw edges of cube in black:
PLOTS, verts[*, [0,4]], /T3D, COLOR=0
; Edges of top face:
```

```
PLOTS, verts[*, [4,5,6,7,4]], /T3D, COLOR=0
```

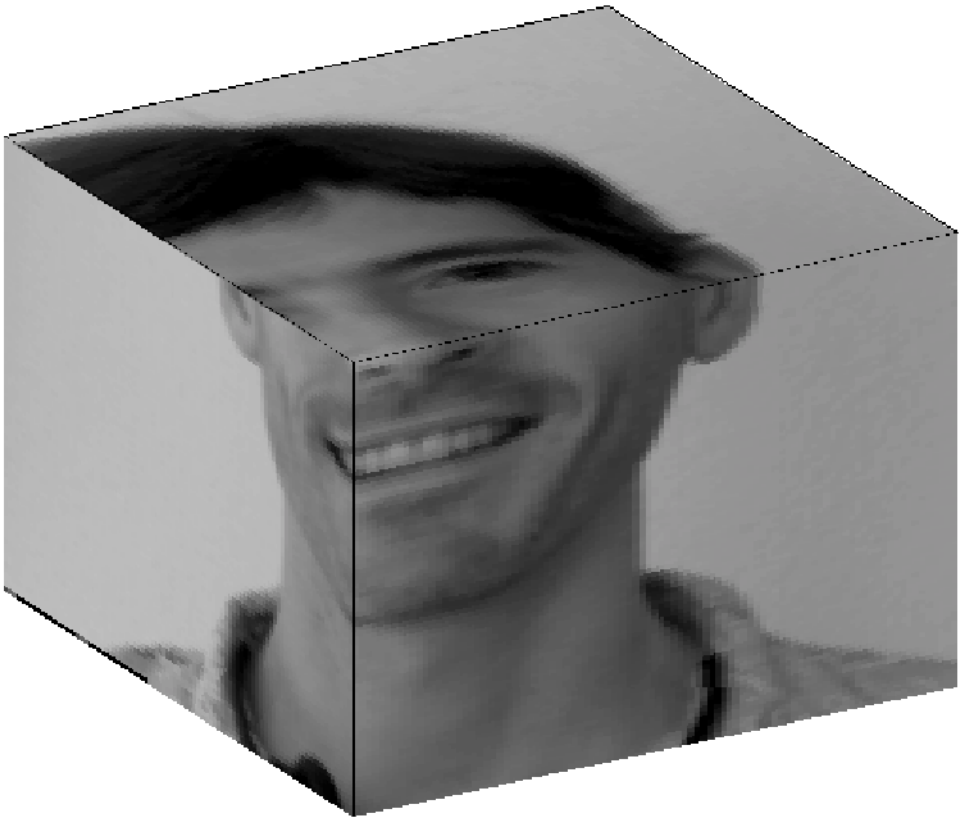
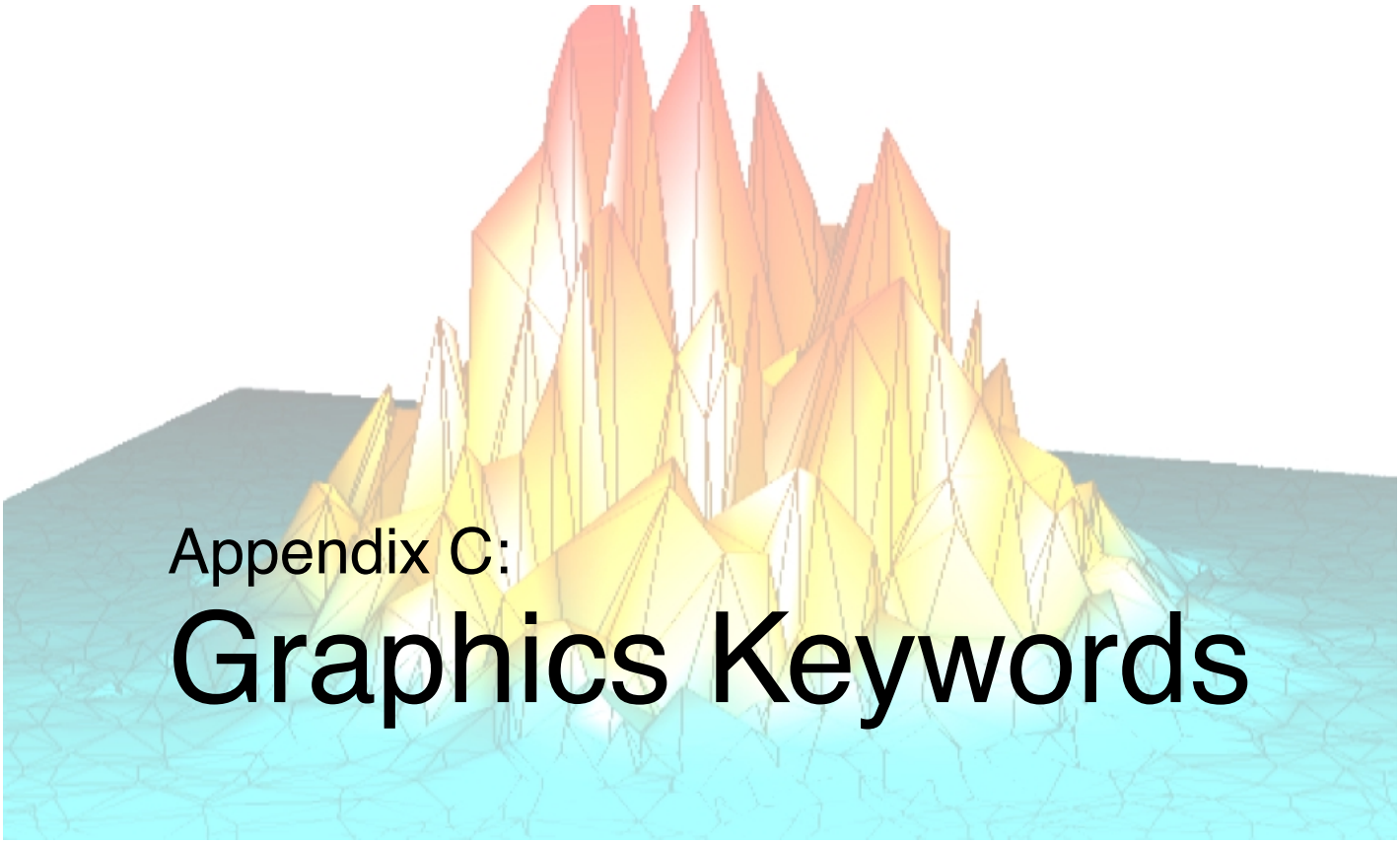


Figure B-8: Image Warped to a Cube Using the Z-Buffer



Appendix C: Graphics Keywords

The IDL Direct Graphics routines, CURSOR, ERASE, PLOTS, POLYFILL, TV (and TVSCL), TVCRS, TVRD, and XYOUTS, and the plotting procedures, AXIS, CONTOUR, PLOT, OPLOT, SHADE_SURF, and SURFACE, accept a number of common keywords. Therefore, instead of describing each keyword along with the description of each routine, this section contains a brief summary of each graphics keyword. Routine-specific keywords are documented in the description of the routine.

The graphics keywords are described below. The name of each keyword is followed by a list of routines that accept that keyword. Keywords that have a direct correspondence to fields in a system variable (usually !P) are also indicated.

The keywords that control the plot axes are prefixed with the character ‘X’, ‘Y’, or ‘Z’ depending on the axis in question. These keywords correspond to fields in the axis system variables: !X, !Y, and !Z, and are described in more detail in “Graphics System Variables” on page 2437 The axis keywords are shown in the form [XYZ]NAME. For example, [XYZ]CHARSIZE refers to the three keywords XCHARSIZE, YCHARSIZE, and ZCHARSIZE, which control the size of the characters annotating the three axes.

The system variable fields that control this are !X.CHARSIZE, !Y.CHARSIZE, and !Z.CHARSIZE.

The following graphics keywords are discussed in this appendix:

BACKGROUND	ORIENTATION	[XYZ]STYLE
CHANNEL	POSITION	[XYZ]THICK
CHARSIZE	PSYM	[XYZ]TICK_GET
CHARTHICK	SUBTITLE	[XYZ]TICKFORMAT
CLIP	SYMSIZE	[XYZ]TICKINTERVAL
COLOR	T3D	[XYZ]TICKLAYOUT
DATA	THICK	[XYZ]TICKLEN
DEVICE	TICKLEN	[XYZ]TICKNAME
FONT	TITLE	[XYZ]TICKS
LINESTYLE	[XYZ]CHARSIZE	[XYZ]TICKUNITS
NOCLIP	[XYZ]GRIDSTYLE	[XYZ]TICKV
NODATA	[XYZ]MARGIN	[XYZ]TITLE
NOERASE	[XYZ]MINOR	Z
NORMAL	[XYZ]RANGE	ZVALUE

BACKGROUND

Accepted by: CONTOUR, PLOT, SURFACE.

System variable equivalent: !P.BACKGROUND.

The background color index to which all pixels are set when erasing the screen or page. The default is 0 (black). Not all devices support erasing the background to a specified color index.

For example, to produce a black plot with a white background on a color display:

```
PLOT, Y, BACKGROUND = 255, COLOR = 0
```

CHANNEL

Accepted by: ERASE, TV, TVRD. System variable equivalent: !P.CHANNEL.

This keyword specifies the memory channel for the operation. This parameter is ignored on display systems that have only one memory channel. When using a "decomposed" display system, the red channel is 1, the green channel is 2, and the blue channel is 3. Channel 0 indicates all channels. If omitted, !P.CHANNEL contains the default channel value.

Note

CONTOUR, PLOT, SHADE_SURF, and SURFACE also accept the CHANNEL keyword, but simply pass it to ERASE.

CHARSIZE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.CHARSIZE.

The overall character size for the annotation when Hershey fonts are selected. This keyword does not apply when hardware (i.e. PostScript) fonts are selected. A CHARSIZE of 1.0 is normal. The size of the annotation on the axes may be set, relative to CHARSIZE, with *x*CHARSIZE, where *x* is X, Y, or Z. The main title is written with a character size of 1.25 times this parameter.

CHARTHICK

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.CHARTHICK.

An integer value specifying the line thickness of the vector drawn font characters.This keyword has no effect when used with the hardware drawn fonts. The default value is 1.

CLIP

Accepted by: CONTOUR, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SURFACE, XYOUTS. System variable equivalent: !P.CLIP.

The coordinates of a rectangle used to clip the graphics output. The rectangle is specified as a vector of the form $[X_0, Y_0, X_1, Y_1]$, giving coordinates of the lower left and upper right corners, respectively. The default clipping rectangle is the plot window, the area enclosed within the axes of the most recent plot. Coordinates are specified in data units unless an overriding coordinate unit specification keyword is present (i.e., NORMAL or DEVICE). If the clipping is provided in data or

normalized units, the actual clipping rectangle is computed by converting those values to device units. The clipping itself always occurs in device space.

Note

The default is not to clip the output of PLOTS and XYOUTS. To enable clipping include the keyword parameter NOCLIP = 0. With PLOTS, POLYFILL, and XYOUTS, this keyword controls the clipping of vectors and vector-drawn text.

For example, to draw a vector using normalized coordinates with its contents clipped within a rectangle covering the upper left quadrant of the display:

```
PLOTS, X, Y, CLIP=[0.,.5,.5,1.0], /NORM, NOCLIP=0
```

COLOR

Accepted by: AXIS, CONTOUR, DRAW_ROI, ERASE, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.COLOR.

The color index of the data, text, line, or solid polygon fill to be drawn. If this keyword is omitted, !P.COLOR specifies the color index.

When used with the PLOTS, POLYFILL, or XYOUTS procedure, this keyword parameter can be set to a vector to specify multiple color indices.

Gouraud shading of polygons is performed with the Z-buffer graphics output device and POLYFILL procedure when COLOR contains an array of color indices, one for each vertex.

DATA

Accepted by: AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the data coordinate system. The default coordinate system is DATA if no other coordinate-system specifications are present.

DEVICE

AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the device coordinate system. The default coordinate system is DATA if no other coordinate-system specifications are present.

For example, the following code displays an image contained in the variable A and then draws a contour plot of pixels [100:499, 100:399] over the correct section of the image:

```
;Display the image.
TV,A

;Draw the contour plot, specify the coordinates of the plot, in
;device coordinates, do not erase, set the X and Y axis styles to
;EXACT.
CONTOUR, A[100:499, 100:399], $
    POS = [100,100, 499,399], /DEVICE, $
   /NOERASE, XSTYLE=1, YSTYLE=1
```

Note that in the above example, the keyword specification `/DEVICE` is equivalent to `DEVICE = 1`.

FONT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.FONT.

An integer that specifies the graphics text font system to use. Set FONT equal to -1 to selects the Hershey character fonts, which are drawn using vectors. Set FONT equal to 0 (zero) to select the device font of the output device. Set FONT equal to 1 (one) to select the TrueType font system. See Appendix H, “Fonts” for a complete description of IDL’s font systems.

LINESTYLE

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS, SURFACE. System variable equivalent: !P.LINESTYLE.

This keyword indicates the line style used to draw lines; it indicates the line style of the lines used to connect the data points. This keyword should be set to the appropriate index for the desired linestyle as described in the following table.

Index	Linestyle
0	Solid
1	Dotted
2	Dashed
3	Dash Dot
4	Dash Dot Dot
5	Long Dashes

Table C-1: IDL Linestyles

NOCLIP

Accepted by: CONTOUR, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SURFACE, XYOUTS. System variable equivalent: !P.NOCLIP.

Set this keyword to suppress clipping of the plot. The clipping rectangle is contained in !P.CLIP. By default, the plot is clipped within the plotting window.

Note

The default value is clipping-disabled for PLOTS, POLYFILL, and XYOUTS. For all other routines, the default is to enable clipping.

With PLOTS, POLYFILL, and XYOUTS, this keyword controls the clipping of vectors and vector-drawn text. The default is to disable clipping, so to enable clipping include the parameter NOCLIP = 0. To explicitly disable clipping set this parameter to one.

NODATA

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE.

If this keyword is set, only the axes, titles, and annotation are drawn. No data points are plotted.

For example, to draw an empty set of axes between some given values:

```
PLOT, [XMIN, XMAX],[YMIN, YMAX], /NODATA
```

NOERASE

Accepted by: AXIS, CONTOUR, PLOT, SURFACE. System variable equivalent: !P.NOERASE.

Specifies that the screen or page is not to be erased. By default, the screen is erased, or a new page is begun, before a plot is produced.

NORMAL

Accepted by: AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the normalized coordinate system, and range from 0.0 to 1.0. The default coordinate system is DATA if no other coordinate-system specifications are present.

ORIENTATION

Accepted by: DRAW_ROI, POLYFILL, XYOUTS.

Specifies the counterclockwise angle in degrees from horizontal of the text baseline and the lines used to fill polygons.When used with the POLYFILL procedure, this keyword forces the “linestyle” type of fill, rather than solid or patterned fill.

POSITION

Accepted by: CONTOUR, MAP_SET, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.POSITION.

Allows direct specification of the plot window. POSITION is a 4-element vector giving, in order, the coordinates $[(X_0, Y_0), (X_1, Y_1)]$, of the lower left and upper right corners of the data window. Coordinates are expressed in normalized units ranging from 0.0 to 1.0, unless the DEVICE keyword is present, in which case they are in actual device units. The value of POSITION is never specified in data units, even if the DATA keyword is present.

When setting the position of the window, be sure to allow space for the annotation, which resides outside the window. IDL outputs the message “% Warning: Plot truncated.” if the plot region is larger than the screen or page size. The plot region is the rectangle enclosing the plot window and the annotation.

When plotting in three dimensions, the POSITION keyword is a 6-element vector with the first four elements describing, as above, the XY position, and with the last two elements giving the minimum and maximum Z coordinates. The Z specification is always in normalized coordinate units.

When making more than one plot per page it is more convenient to set !P.MULTI than to manipulate the position of the plot directly with the POSITION keyword.

For example, the following statement produces a contour plot with data plotted in only the upper left quarter of the screen:

```
CONTOUR, Z, POS=[0., 0.5, 0.5, 1.0]
```

Because no space on the left or top edges was allowed for the axes or their annotation, the above described warning message results.

PSYM

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS. System variable equivalent: !P.PSYM.

The symbol used to mark each data point. Normally, PSYM is 0, data points are connected by lines, and no symbols are drawn to mark the points. Set this keyword, or the system variable !P.PSYM, to the symbol index as shown in the table below to mark data points with symbols. The keyword SYMSIZE is used to set the size of the symbols.

PSYM Value	Plotting Symbol
1	Plus sign (+)
2	Asterisk (*)
3	Period (.)
4	Diamond
5	Triangle
6	Square
7	X
8	User-defined. See USERSYM procedure.

Table C-2: Values for the PSYM Keyword

PSYM Value	Plotting Symbol
9	Undefined
10	Histogram mode. Horizontal and vertical lines connect the plotted points, as opposed to the normal method of connecting points with straight lines.

Table C-2: Values for the PSYM Keyword

Negative values of PSYM cause the symbol designated by PSYM to be plotted at each point with solid lines connecting the symbols. For example, a value of -5 plots triangles at each data point and connects the points with lines.

The following IDL code plots an array using points, and then overplots the smoothed array, connecting the points with lines:

```
;Plot using points.
PLOT, A, PSYM=3

;Overplot smoothed data.
OPLOT, SMOOTH(A,7)
```

SUBTITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.SUBTITLE.

A text string to be used as a subtitle for the plot. Subtitles appear below the X axis.

SYMSIZE

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS.

Specifies the size of the symbols drawn when PSYM is set. The default size of 1.0 produces symbols approximately the same size as a character.

T3D

Accepted by: AXIS, CONTOUR, DRAW_ROI, MAP_SET, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS. System variable equivalent: !P.T3D.

Set this keyword to indicate that the generalized transformation matrix in !P.T is to be used. If not present, the user-supplied coordinates are simply scaled to screen coordinates. See the examples in the description of the SAVE keyword.

Note

Since T3D uses the transformation matrix in !P.T, it is important that !P.T contain a valid transformation matrix. This can be achieved in several ways:

- Use the SAVE keyword to save the transformation matrix from an earlier graphics operation.
- Establish a transformation matrix using the T3D, SURFR, or, SCALE3 procedures.
- Set the value of !P.T directly.

THICK

Accepted by: AXIS, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE. System variable equivalent: !P.THICK.

Indicates the line thickness. THICK overrides the setting of !P.THICK.

TICKLEN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.TICKLEN.

Controls the length of the axis tick marks, expressed as a fraction of the window size. The default value is 0.02. TICKLEN of 1.0 produces a grid, while a negative TICKLEN makes tick marks that extend outside the window, rather than inwards.

For example, to produce outward-going tick marks of the normal length:

```
PLOT, X, Y, TICKLEN = -0.02
```

To provide a new default tick length, set !P.TICKLEN.

TITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.TITLE.

Produces a main title centered above the plot window. The text size of this main title is larger than the other text by a factor of 1.25. For example:

```
PLOT, X, Y, TITLE = 'Final Results'
```

[XYZ]CHARSIZE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalents: ![XYZ].CHARSIZE.

The size of the characters used to annotate the axis and its title when Hershey fonts are selected. This keyword does not apply when hardware (i.e. PostScript) fonts are selected. This field is a scale factor applied to the global scale factor set by !P.CHARSIZE or the keyword CHARSIZE.

[XYZ]GRIDSTYLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE

The index of the linestyle to be used for plot tickmarks and grids (i.e., when [XYZ]TICKLEN is set to 1.0). See LINESTYLE for a list of linestyles.

[XYZ]MARGIN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].MARGIN.

A 2-element array specifying the margin on the left (bottom) and right (top) sides of the plot window, in units of character size. Default margins are 10 and 3 for the X axis, and 4 and 2 for the Y axis. The ZMARGIN keyword is present for consistency and is currently ignored.

[XYZ]MINOR

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].MINOR.

The number of minor tick marks.

[XYZ]RANGE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].RANGE.

The desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum. IDL will frequently round this range. This override can be defeated using the [XYZ]STYLE keywords.

[XYZ]STYLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].STYLE.

This keyword allows specification of axis options such as rounding of tick values and selection of a box axis. Each option is described in the following table:

Value	Description
1	Force exact axis range.
2	Extend axis range.
4	Suppress entire axis
8	Suppress box style axis (i.e., draw axis on only one side of plot)
16	Inhibit setting the Y axis minimum value to 0 (Y axis only)

Table C-3: Values for the [XYZ]STYLE Keyword

Note that this keyword is set bitwise, so multiple effects can be set by adding values together. For example, to make an X axis that is both exact (value 1) and suppresses the box style (setting 8), set the XAXIS keyword to `1+8`, or 9.

[XYZ]THICK

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].THICK.

This keyword controls the thickness of the lines forming the axis and tick marks. A value of 1.0 is the default.

[XYZ]TICK_GET

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE.

A named variable in which to return the values of the tick marks for the designated axis. The result is a double precision floating-point array with the same number of elements as ticks.

For example, to retrieve in the variable V the values of the tick marks selected by IDL for the Y axis:

```
PLOT, X, Y, YTICK_GET = V
```

[XYZ]TICKFORMAT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKFORMAT.

Set this keyword to a string or a vector of strings. If a vector is provided, each string corresponds to a level of the axis. The [XYZ]TICKUNITS keyword determines the number of levels for an axis.

Each string is one of the following:

A format code:

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 8 of *Building IDL Applications* for more information on format codes.

Example 1: Display the X axis tick values using a format of F6.2 (six characters, with 2 places after the decimal point):

```
PLOT, X, Y, XTICKFORMAT='(F6.2)'
```

Example 2: Display the Y tick values using the "dollars and cents" format $*dddd.dd*:

```
PLOT, X, Y, YTICKFORMAT='("$", F7.2)'
```

The string 'LABEL_DATE' :

Set [XYZ]TICKFORMAT to the string 'LABEL_DATE' to create axes with date labels. The formatting of the labels is specified by first calling LABEL_DATE with the DATE_FORMAT keyword. See LABEL_DATE for more information.

Example: Use the LABEL_DATE function as the callback function to display the X tick values in a date/time format:

```
dummy = LABEL_DATE(DATE_FORMAT='%M %Z')
mytimes = TIMEGEN(12, UNITS='MONTHS', START=JULDAY(1,1,2000))
y = FINDGEN(12)
PLOT, mytimes, y, XTICKUNITS='Time', XTICKFORMAT='LABEL_DATE'
```

The name of a user-defined function:

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels. This function is defined with either three or four parameters, depending on whether [XYZ]TICKUNITS is specified:

If [XYZ]TICKUNITS is *not* specified, the callback function is called with three parameters, *Axis*, *Index*, and *Value*, where:

- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis.
- *Index* is the tick mark index (indices start at 0).
- *Value* is the data value at the tick mark (a double-precision floating point value).

Note

Value is a double-precision floating-point value that represents the Julian date. The Julian date follows the astronomical convention, where Julian date 0.0d corresponds to 1 Jan 4713 B.C.E. at 12 pm.

If [XYZ]TICKUNITS is specified, the callback function is called with four parameters, *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled (level indices start at 0).

Example 1: Use a callback function to display the Y tick values as a percentage of a fixed value. Note that because we don't specify [XYZ]TICKUNITS, we do not include the *Level* parameter in our function definition:

```
FUNCTION YTICKS, axis, index, value
   fixvalue = 389.0d
   pvalue = (value/fixvalue) * 100.0d
   RETURN, STRING(pvalue, FORMAT='(D5.2,"%")')
END

PRO use_callback

   Y = FINDGEN(10)
   PLOT, Y, YTICKFORMAT='YTICKS'

END
```

Example 2: Create a two-level X axis. Display the X tick values in a customized date/time format that shows the number of days open for business for each month on one level, and marks leap years with an asterisk on another level:

```
FUNCTION XTICKS, axis, index, value, level

   CASE level OF
```

```
      0: BEGIN ; months
           ; Number of days open for business in given month:
           CALDAT, value, month
           open = [18,19,23,20,22,22,19,10,20,21,22,14]
           nbdays = open[month]
           ; Return a string containing the month name plus
           ; the number of business days in parentheses:
           RETURN, STRING(value, nbdays, $
              FORMAT='(C(CMoA), "(", I2, ")")')
         END
      1: BEGIN ; years
           ; Generate a string for the year.
           yrStr = STRING(value, FORMAT='(C(CYI))')
           ; Determine if a leap year.  If so,
           ; append an asterisk to the string.
           CALDAT, value, mo, da, yr
           IF (yr MOD 4 EQ 0) THEN BEGIN
              IF (yr MOD 100 EQ 0) THEN $
                 isLeap = (yr MOD 400) EQ 0 $
              ELSE $
                 IsLeap = 1b
           ENDIF ELSE $
           isLeap = 0b
           IF (isLeap NE 0b) THEN $
              yrStr = yrStr + '*'
              RETURN, yrStr
           END
      ENDCASE

END

PRO plot_sales

   myDates = TIMEGEN(12, UNITS='Months', START=JULDAY(1,1,2000))
   sales = [180,190,230,200,220,220,190,100,200,210,220,140]
   PLOT, myDates, sales, XTICKUNITS=['Months', 'Years'], $
      XTICKFORMAT='XTICKS', XTITLE = 'Date (* = Leap Year)', $
      YTITLE='Sales (units)', POSITION = [0.2, 0.2, 0.9, 0.9]

END
```

[XYZ]TICKINTERVAL

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE

variable equivalent: ![XYZ].TICKINTERVAL

Set this keyword to a scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis range

([XYZ]RANGE) and the number of major tick intervals ([XYZ]TICKS). This keyword takes precedence over [XYZ]TICKS.

For example, if TICKUNITS=["Seconds", "Hours", "Days"], and XTICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

[XYZ]TICKLAYOUT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKLAYOUT.

Set this keyword to a scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

Note

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

[XYZ]TICKLEN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKLEN.

This keyword controls the lengths of tick marks (expressed in normal coordinates) for the individual axes. This keyword, if nonzero, overrides the global tick length specified in !P.TICKLEN, and/or the TICKLEN keyword parameter, which is expressed in terms of the window size.

[XYZ]TICKNAME

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKNAME.

A string array of up to 30 elements that controls the annotation of each tick mark.

[XYZ]TICKS

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKS.

The number of major tick *intervals* to draw for the axis. If this keyword is omitted, IDL selects from three to six tick intervals. Setting this field to *n*, where $n > 1$, produces exactly *n* tick intervals, and *n*+1 tick marks. Setting this field equal to 1 suppresses tick marks.

[XYZ]TICKUNITS

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKUNITS.

Set this keyword to a string or a vector of strings indicating the units to be used for axis tick labeling. If a vector of strings is provided, the axis will be drawn in multiple levels, where each string represents one level in the specified units.

Note

When creating multiple-level axes, you may need to adjust the plot positioning using the POSITION or [XYZ]MARGIN keywords in order to ensure that axis labels and titles are visible in the plot window.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- 'Numeric'
- 'Years'
- 'Months'
- 'Days'

- 'Hours'
- 'Minutes'
- 'Seconds'
- 'Time' - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- '' - Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the 'Numeric' unit. This is the default setting.

If any of the time units are utilized, the tick values are interpreted as Julian date/time values.

Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS='Day' is equivalent to TICKUNITS='Days').

Note

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

[XYZ]TICKV

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKV.

The data values for each tick mark, an array of up to 60 elements.

Note

To specify the number of ticks and their values exactly, set [XYZ]TICKS=*N(where N > 1)* and [XYZ]TICKV=*Values*, where *Values* has *N*+1 elements.

[XYZ]TITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TITLE.

A string that contains a title for the specified axis.

Z

Accepted by: PLOTS, POLYFILL, TV, TVCRS, XYOUTS.

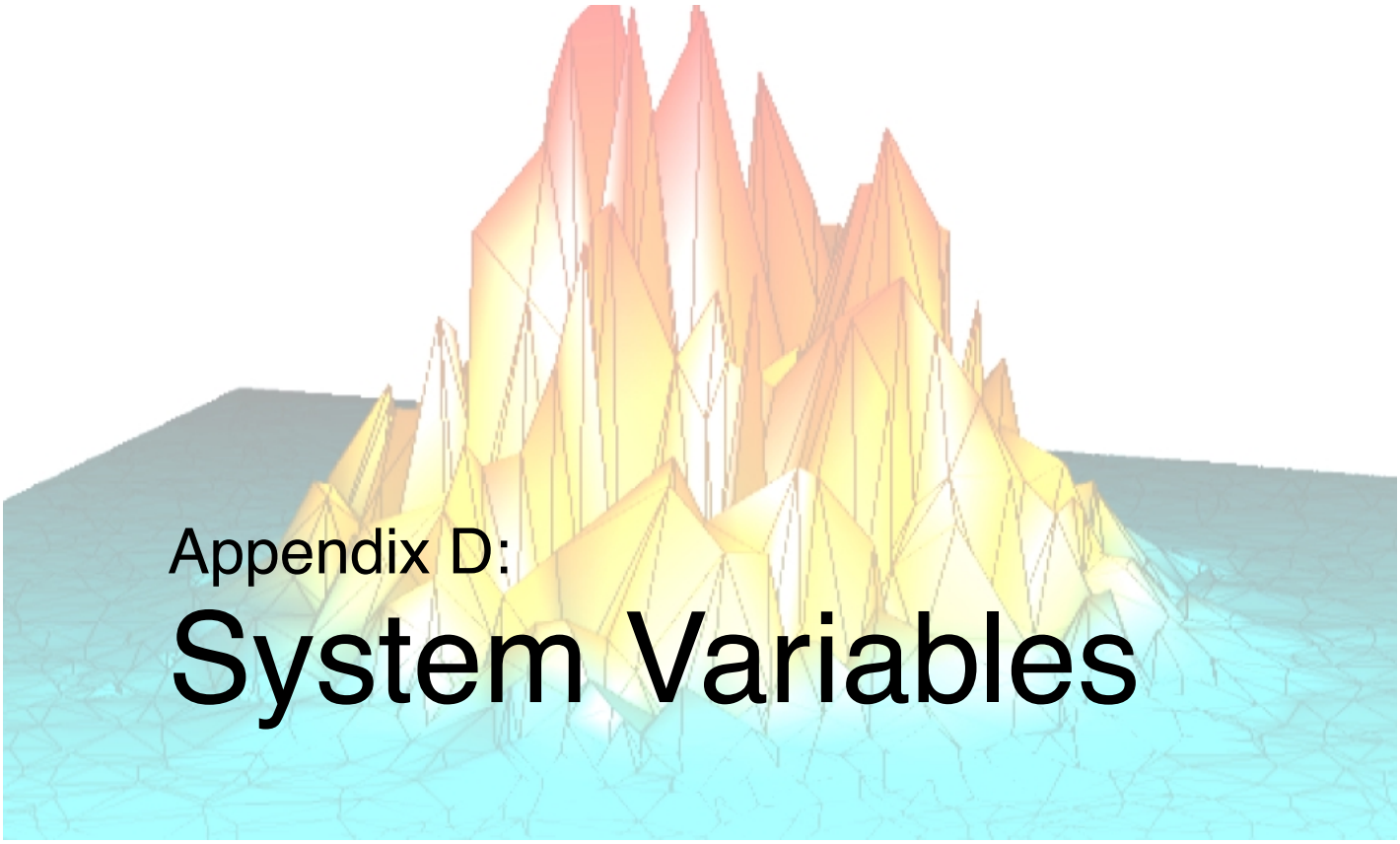
Provides the Z coordinate if a Z parameter is not present in the call. This is of use only if the three-dimensional transformation is in effect (i.e., the T3D keyword is set).

ZVALUE

Accepted by: AXIS, CONTOUR, MAP_SET, OPLOT, PLOT, SHADE_SURF, SURFACE.

Sets the Z coordinate, in normalized coordinates in the range of 0 to 1, of the axis and data output from PLOT, OPLOT, and CONTOUR.

This keyword has effect only if !P.T3D is set and the three-dimensional to two-dimensional transformation is stored in !P.T. If ZVALUE is not specified, CONTOUR will output each contour at its Z coordinate, and the axes and title at a Z coordinate of 0.0.



Appendix D: System Variables

The following topics are included in this appendix:

What Are System Variables?

System variables are a special class of predefined variables available to all program units. Their names always begin with the exclamation mark character (**!**). System variables are used to set the options for plotting, to set various internal modes, to return error status, etc.

System variables have a predefined type and structure that cannot be changed. When an expression is stored into a system variable, it is converted to the variable type, if necessary and possible. Certain system variables are *read only*, and their values cannot be changed. The user can define new system variables with the DEFSYSV procedure.

Constant System Variables

The following system variables contain pre-defined constants or values for use by IDL routines. System variables can be used just like other variables. For example, the command:

```
PRINT, ACOS(A) * !RADEG
```

converts a result expressed in radians to one expressed in degrees.

!DPI

A read-only variable containing the double-precision value of pi (π).

!DTOR

A read-only variable containing the floating-point value used to convert degrees to radians (π/180 ≅ 0.01745).

!MAP

An array variable containing the information needed to effect coordinate conversions between points of latitude and longitude and map coordinates. The values in this array are established by the MAP_SET procedure; the user should not change them directly.

!PI

A read-only variable containing the single-precision value of pi (π).

!RADEG

A read-only variable containing the floating-point value used to convert radians to degrees (180/π ≅ 57.2958).

!VALUES

A read-only variable containing the IEEE single- and double-precision floating-point values *Infinity* and *NaN* (Not A Number). !VALUES is a structure variable with the following fields:

```
** Structure !VALUES, 4 tags, length=24:
   F_INFINITY      FLOAT           Infinity
   F_NAN           FLOAT                NaN
```

```
D_INFINITY      DOUBLE          Infinity
D_NAN           DOUBLE               NaN
```

where *Infinity* is the value Infinity and *NaN* is the value Not A Number. (For more information on these special floating-point values, see "Special Floating-Point Values" in Chapter 17 of *Building IDL Applications*.)

Error Handling System Variables

The following system variables are either set by IDL when an error condition occurs or used by IDL when displaying information about errors.

!ERR

This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERR system variable will continue to function as before, but all new code should use !ERROR_STATE.CODE.

!ERROR_STATE

A structure variable which contains the status of the last error message. !ERROR_STATE includes the following fields:

```
** Structure !ERROR_STATE, 7tags, length=52:
   NAME            STRING       'M_SUCCESS'
   BLOCK           STRING   'IDL_MBLK_CORE'
   CODE            LONG                   0
   SYS_CODE        LONG           Array[2]
   MSG             STRING                 ''
   SYS_MSG         STRING                 ''
   MSG_PREFIX      STRING                '%'
```

- NAME: A read-only string variable containing the error name of the IDL-generated component of the last error message.
- BLOCK: A read-only string variable containing the name of the message block for the last error message's IDL-generated component.
- See the *External Development Guide* for more information about blocks.
- CODE: A long-integer variable containing the error code of the last error's IDL-generated component.
- SYS_CODE: A long-integer variable containing the error code of the last error's operating system-generated component, if it exists.
- MSG: A read-only string variable containing the text of the last IDL-generated error message.
- SYS_MSG: A read-only string variable containing the text of the last error's operating system-generated component, if it exists.

- MSG_PREFIX: A string variable containing the prefix string used for error messages.

This system variable replaces !ERROR, !ERR_STRING, !MSG_PREFIX, !SYSERR_STRING, and !SYSERROR, and includes two new fields: error name and block name. For a more detailed explanation of !ERROR_STATE, see "Error Handling" in Chapter 17 of *Building IDL Applications*.

!ERROR

This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERROR system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.CODE.

!ERR_STRING

This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERR_STRING system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.MSG.

!EXCEPT

An integer variable that controls when IDL checks for invalid mathematical computations (exceptions), such as division by zero. The three allowed values are:

Value	Description
0	Never report exceptions.
1	Report exceptions when the interpreter is returning to an interactive prompt (the default).
2	Report exceptions at the end of each IDL statement. Note that this slows IDL by roughly 5% compared to setting !EXCEPT=1.

Table D-1: EXCEPT Values

For more information on invalid mathematical computations and error reporting, see "Math Errors" in Chapter 17 of *Building IDL Applications*.

The value of !EXCEPT is used by the CHECK_MATH function to determine when to return errors. See "CHECK_MATH" on page 172 for details.

Note

In versions of IDL up to and including IDL 4.0.1, the default exception handling was functionally identical to setting !EXCEPT=2.

!MOUSE

A structure variable that contains the status from the last cursor read operation. !MOUSE has the following fields:

```
** Structure !MOUSE, 4 tags, length=16:
   X               LONG                511
   Y               LONG                252
   BUTTON          LONG                  4
   TIME            LONG         1428829775
```

- X and Y: Contain the location (in device coordinates) of the cursor when the mouse button was pressed.
- BUTTON: Contains
  - - 1 (one) if the left mouse button was pressed,
  - - 2 (two) if the middle mouse button was pressed
  - - 4 (four) if the right mouse button was pressed.
- TIME: Contains the number of milliseconds since a base time.

See "CURSOR" on page 265 for details on reading the cursor position.

!MSG_PREFIX

This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !MSG_PREFIX system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.MSG_PREFIX.

!SYSERROR

This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !SYSERROR system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.SYS_CODE.

!SYSERR_STRING

*This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !*SYSERR_STRING *system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.SYS_MSG.*

!WARN

A structure variable that causes IDL to print warnings to the console or command log when obsolete IDL features are found at compile time. !WARN has the following fields:

```
** Structure !WARN, 3 tags, length=3:
   OBS_ROUTINES         BYTE         0
   OBS_SYSVARS          BYTE         0
   PARENS               BYTE         0
   TRUNCATED_FILENAME   BYTE         0
```

Setting each of the four fields to 1 (one) generates a warning for a different type of obsolete code. If the OBS_ROUTINES field is set equal to one, IDL generates warnings when it encounters references to obsolete internal or library routines. If the OBS_SYSVARS field is set equal to one, IDL generates warnings when it encounters references to obsolete system variables. If the PARENS field is set equal to one, IDL generates warnings when it encounters a use of parentheses to specify an index into an array. If the TRUNCATED_FILENAME field is set equal to one, IDL generates warnings whenever a file can only be found by truncating its full name.

Warning

IDL version 5.1 is the last version of IDL that will support DOS 8.3 filename limitations. All future IDL releases will not truncate filenames. You can use !WARN.TRUNCATE_FILENAME to locate and rename truncated filenames. Please rename the file upon being warned that a filename has been truncated to avoid future problems.

No warnings are generated when the fields of the !WARN structure are set equal to zero (the default).

IDL Environment System Variables

The following system variables contain information about IDL's configuration.

!DIR

A string variable containing the path to the main IDL directory.

!DLM_PATH

Significant portions of IDL's built in functionality are packaged in the form of Dynamically Loadable Modules (DLMs). DLMs correspond to Macintosh code fragments, UNIX sharable libraries, VMS sharable executables, or Windows DLLs, depending on the operating system in use. At startup, IDL searches for DLM definition files (which end in the `.dlm` suffix) and makes note of the routines supplied by each DLM. If such are routine is called, IDL loads the DLM that supplies it into memory. To see a list of the DLMs that IDL knows about, use `HELP, /DLM_PATH` (see "HELP" on page 571 for more information).

!DLM_PATH is initialized from the environment variable IDL_DLM_PATH at startup. If the IDL_DLM_PATH environment variable is not defined, IDL supplies a default that contains the directory in the IDL distribution where the RSI supplied DLMs reside. This initialization is similar to that performed for IDL_PATH, (see "!PATH" on page 2433), including recursive path expansion denoted with a leading "+". Once !DLM_PATH is expanded, IDL uses it as the list of places to look for DLM definition files.

Since all DLM searching happens once at startup time, it would be meaningless to change the value of !DLM_PATH afterwards. For this reason, it is a read-only system variable and cannot be assigned to. The value of !DLM_PATH is useful because it shows you where IDL looked for DLMs when it started.

!EDIT_INPUT

An integer variable indicating whether keyboard line editing is enabled (when set to a non-zero value) or disabled (when set to zero). By default, !EDIT_INPUT is set equal to one, and line editing is enabled.

By default, IDL saves the last 20 command lines. You can change the number of command lines saved in the recall buffer by setting !EDIT_INPUT equal to the number of lines you would like to save. In order for the change to take effect, IDL must be able to process the assignment statement before providing a command

prompt. This means that you must put the assignment statement in the IDL startup file. (See "Startup File" in Chapter 2 of *Using IDL* for more information on startup files.)

!HELP_PATH

A string variable listing the directories IDL will search for online help files. The default is the `help` subdirectory of the main IDL directory. The default can be changed by setting the IDL_HELP_PATH environment variable or logical name under UNIX or VMS, or by specifying the desired help path using the DEFSYSV command under Microsoft Windows or the Macintosh OS.

!JOURNAL

A read-only long-integer variable containing the logical unit number of the file used for journal output.

!MAKE_DLL

The MAKE_DLL procedure and CALL_EXTERNAL function's AUTO_GLUE keyword use the standard system C compiler and linker to generate sharable libraries that can be used by IDL in various contexts (CALL_EXTERNAL, DLMs, LINKIMAGE). There is a great deal of variation possible in the use of these tools between different platforms, operating system versions, and compiler releases. The !MAKE_DLL system variable is used to configure how IDL uses them for the current platform.

The !MAKE_DLL structure is defined as follows:

```
{ !MAKE_DLL, COMPILE_DIRECTORY:'', COMPILER_NAME:'', CC:'', LD:''}
```

The meaning of the fields of !MAKE_DLL are given in Table D-2. When expanding !MAKE_DLL.CC and !MAKE_DLL.LD, IDL substitutes text in place of the PRINTF style codes described in the following table. These codes are case-insensitive, and can be either upper or lower case.

Note

It is possible to use C compilers other than the one assumed by RSI in !MAKE_DLL to build sharable libraries. To do so, you can alter the contents of !MAKE_DLL or use the CC and/or LD keyword to MAKE_DLL and CALL_EXTERNAL. Please understand that RSI cannot and does not maintain a list of all possible compilers and the necessary compiler options. This information

is available in your compiler and system documentation. It is the programmers responsibility to understand the rules for their chosen compiler.

Field	Meaning
COMPILE_DIRECTORY	IDL requires a place to create the intermediate files necessary to build a sharable library, and possibly the final library itself. Unless told to use an explicit directory, it uses the directory given by the COMPILE_DIRECTORY field of !MAKE_DLL. If the IDL_MAKE_DLL_COMPILE_DIRECTORY environment variable is set, IDL uses its value to initialize the COMPILE_DIRECTORY field. Otherwise, IDL supplies a standard location. **Note -** Note that if the directory given by !MAKE_DLL.COMPILE_DIRECTORY does not exist when IDL needs it, IDL automatically creates it for you.
COMPILER_NAME	A string containing the name of the C compiler used by RSI to build the currently running IDL. This field is not used by IDL, and exists solely for informational purposes and to help the end user decide which C compiler to install on their system.
CC	A string used by IDL as a template to construct the command for using the C compiler. This template uses PRINTF style substitution codes, as described in the following table.
LD	A string used by IDL as a template to construct the command for using the linker. This template uses PRINTF style substitution codes, as described in the following table.

Table D-2: Meaning of !MAKE_DLL fields

The following table describes the substitution codes for the CC and LD fields:

Code	Meaning
%B %b	The base name of a C file to compile. For example, if the C file is `moose.c`, then %B substitutes `moose`.
%C %c	The name of the C file.
%E %e	The name of the linker options file. This file, which is automatically generated by IDL as needed, is used to control the linker. Under UNIX, the system documentation refers to this as an export file, or a linker map file. VMS calls it a linker options file (`.OPT`). Microsoft Windows calls it a `.DEF` file.
%F %f	A floating point switch to C compiler. This is only meaningful under VMS, and corresponds to the VAX_FLOAT keyword to MAKE_DLL and CALL_EXTERNAL.
%L %l	The name of the resulting sharable library. IDL constructs this name by using the base name (%B) and adding the appropriate suffix for the current platform (`.dll`, `.so`, `.sl`, `.exe`, ...).
%O %o	An object file name. IDL constructs this name by using the base name (%B) and adding the appropriate suffix for the current platform (`.o`, `.obj`).
%X %x	When expanding !MAKE_DLL.CC, any text supplied via the EXTRA_CFLAGS keyword to MAKE_DLL or CALL_EXTERNAL is inserted in place of %X. IDL does not interpret this text. It is the users responsibility to ensure that it is meaningful in the command. When expanding !MAKE_DLL.LD, the text from the EXTRA_LFLAGS keyword is substituted. The primary use for this code is to include necessary header include directories and link libraries.
%%	Replaced with a single % character.

Table D-3: Description of CC and LD Field Codes

!MORE

An integer variable indicating whether IDL should paginate help output sent to a tty device. Setting !MORE to zero (0) prevents IDL from paginating the output text. A non-zero value (the default) causes IDL to display output text one screen at a time.

!PATH

A string variable listing the directories IDL will search for libraries, include files, and executive commands.

UNIX

!PATH is a colon-separated list of directories, similar in concept to the PATH environment variable which UNIX uses to locate commands.

!PATH is initialized from the environment variable IDL_PATH when IDL starts. Note that directories that do not contain at least one `.pro` or `.sav` file will not be included in !PATH, even if they are specified by the IDL_PATH environment variable. This initial value can be changed, as desired, once in IDL. For example, the following statement adds the directory `/usr2/project/idl_files` to the beginning of the search path:

```
!path = '/usr2/project/idl_files:' + !path
```

To specify a directory tree that includes all of that directory's subdirectories, use the EXPAND_PATH function.

Each user can assign IDL_PATH to a series of directories that are searched for IDL programs, procedures, functions, and "include" files. It is convenient to set up this variable in your `~/.cshrc`:

```
setenv IDL_PATH ~/idl_lib:/usr/local/rsi/idl/lib
```

or `~/.profile`:

```
IDL_PATH=~/idl_lib:/usr/local/rsi/idl/lib ; export IDL_PATH
```

This causes IDL to search for programs first in the current directory, then in your `idl/lib` directory, and then in the system-wide directory `/usr/local/rsi/idl/lib`.

If IDL_PATH is not defined, IDL initializes !PATH to the default value `+/usr/local/rsi/idl`. Note that the current directory is always searched before consulting !PATH.

VMS

!PATH is a comma-separated list of directories and text libraries. Text libraries are distinguished by prepending a "@" character to their name.

!PATH is initialized from the logical name IDL_PATH when IDL starts. Note that directories that do not contain at least one `.pro` or `.sav` file will not be included in !PATH, even if they are specified by the IDL_PATH logical. This initial value can be

changed once in IDL as desired. For example, the following statement adds the directory `DISKA:[PROJECTLIB]` to the beginning of the search path:

```
path = 'diska:[projectlib],' + !path
```

To specify a directory tree that includes all of that directory's subdirectories, use the EXPAND_PATH function.

Each user can assign IDL_PATH to a series of directories and text libraries that are searched in order for IDL programs, procedures, functions, and "include" files. It is convenient to set up this variable in your `LOGIN.COM` file. For example,

```
DEFINE IDL_PATH "DISKA:[USER.IDLLIB],@IDL_DIR:[LIB]USERLIB.TLB"
```

causes IDL to search for programs first in the current directory, then in the directory `DISKA:[USER.IDLLIB]`, and finally in the library of routines written in IDL and included in the standard IDL distribution, which is supplied as a VMS text library. Note that the current directory is always searched before consulting !PATH.

The logical IDL_PATH also can be defined as a multi-valued logical name (e.g., a search list logical). Therefore, the above example also can be written as follows:

```
DEFINE IDL_PATH DISKA:[USER.IDLLIB],"@IDL_DIR:[LIB]USERLIB.TLB"
```

IDL simply takes the various translations and concatenates them together into a comma-separated list. Note that the quotes around the second translation in this example are necessary to keep DCL from seeing the "@" character as an invitation to execute a command file.

Windows

!PATH is a semicolon-separated list of directories, similar in concept to the PATH environment variable DOS uses to locate commands. !PATH is initialized from the saved IDL for Windows preferences data, or from a DOS environment variable IDL_PATH, when IDL starts. Note that directories that do not contain at least one `.pro` or `.sav` file will not be included in !PATH, even if they are specified by the preferences data or the IDL_PATH environment variable. Change the path settings by adding to or altering the list of directories in the "Path" dialog, found under the "Preferences" selection of the IDL for Windows File menu, or by changing the value of !PATH from the IDL command prompt.

To specify a directory tree that includes all of that directory's subdirectories, use the EXPAND_PATH function.

Macintosh

!PATH is a comma-separated list of folders. !PATH is initialized from the saved IDL for Macintosh preferences data when IDL starts. Note that folders that do not contain

at least one `.pro` or `.sav` file will not be included in !PATH, even if they are specified by the preferences data. Change the path settings by adding to or altering the list of directories in the "Search Path" dialog, found in the IDL for Macintosh File menu, or by changing the value of !PATH from the IDL command prompt.

Use the following syntax is used to specify Macintosh path locations:

- Filenames are specified as a colon-separated list of drive names and folders.
- Folder and file names can contain spaces and/or commas.

Thus, the file `myprogram.pro`, located in the folder named `Programs` which resides on the drive named `Macintosh HD` would be specified:

```
'Macintosh HD:Programs:myprogram.pro'
```

To specify a directory tree that includes all of that directory's subdirectories, use the EXPAND_PATH function.

A Note on Order within !PATH

IDL ensures only that all directories containing IDL files are placed in !PATH. The order in which they appear is completely unspecified, and does not necessarily correspond to any specific order (such as top-down alphabetized). This allows IDL to construct the path in the fastest possible way and speeds startup. This is only a problem if two subdirectories in such a hierarchy contain a file with the same name. Such hierarchies usually are a collection of cooperative routines designed to work together, so such duplication is rare.

If the order in which "+" expands directories is a problem for your application, you should add the directories to the path explicitly and not use "+". Only the order of the files within a given "+" entry are determined by IDL. It never reorders !PATH in any other way. You can therefore obtain any search order you desire by writing the path explicitly.

!PROMPT

A string variable containing the text string used by IDL to prompt the user for input. The default is `IDL>.`

!QUIET

A long-integer variable indicating whether informational messages should be printed (0) or suppressed (nonzero). By default, !QUIET is set to zero.

!VERSION

A structure variable containing information about the version of IDL in use. The structure is defined as follows:

```
{!VERSION, ARCH:'', OS:'', OS_FAMILY:'', RELEASE:'', $
   BUILD_DATE:'', MEMORY_BITS:0, FILE_OFFSET_BITS:0 }}
```

The meaning of the fields of !VERSION are given in the following table.

Field	Meaning
ARCH	CPU hardware architecture of the system.
OS	The vendor name of the operating system (for example: AIX, HP-UX, IRIX, linux, MacOS, OSF, sunos, VMS, Win32). RSI recommends that you first consider using the OS_FAMILY field before using the OS field, as most programs are mainly concerned with high level platform differences.
OS_FAMILY	The generic name of the operating system (MacOS, UNIX, VMS, Windows).
RELEASE	IDL version number.
BUILD_DATE	The date the IDL executable was compiled, in the format dictated by ANSI C for the `__DATE__` macro.
MEMORY_BITS	The number of bits used to address memory. Possible values are 32 or 64. The number of bits used to address memory places a theoretical upper limit on the amount of memory available to IDL.
FILE_OFFSET_BITS	The number of bits used to position file offsets. Possible values are 32 or 64. The number of bits used to position files places a theoretical upper limit on the largest file IDL can access.

Table D-4: Meaning of the !VERSION Fields

If you need to differentiate between different IDL versions in your code, use !VERSION.OS_FAMILY. At present, four operating system families are supported: MacOS, UNIX, VMS, Windows. For even more detail, you can use !VERSION.OS.

Graphics System Variables

The following system variables control various IDL Direct Graphics functions. These system variables are structures that contain many tags. For example, the command

```
!P.TITLE = 'Cross Section'
```

sets the default plot title.

Many of the functions of the graphics keywords described in Appendix C, "Graphics Keywords", are also controlled by the system variables !P, !X, !Y, and !Z.

You can change the default style of plots, fonts, etc., by setting the corresponding field in the appropriate system variable. Also, some effects that persist longer than one call are controlled only by system variables. The field !P.MULTI is one example.

!C System Variable

The cursor system variable. Currently, the only function of this system variable is to contain the subscript of the largest or smallest element found by the MAX and MIN functions. That information is better obtained through the optional output arguments to those routines. !C is included only for compatibility with old versions of IDL.

!D System Variable

This system variable is a structure that contains information about the current graphics output device (or window, on a windowing system). Fields, in alphabetical order, are:

FILL_DIST

The line interval, in device coordinates, required to obtain a solid fill.

FLAGS

A longword of flags that provide information about the current device. Each bit is a flag encoded as shown in the following table.

Bit	Value	Function
0	1	Device has scalable pixel size (e.g., PostScript).
1	2	Device can output text at an arbitrary angle using hardware.
2	4	Device can control line thickness with hardware.
3	8	Device can display images.
4	16	Device supports color.
5	32	Device supports polygon filling with hardware.
6	64	Device hardware characters are monospace.
7	128	Device can read pixels (i.e., it supports TVRD).
8	256	Device supports windows.
9	512	Device prints black on a white background (e.g., printers are plotters).
10	1024	Device has *no* hardware characters.
11	2048	Device does line-fill style polygon filling in hardware.
12	4096	Device will apply Hershey-style embedded formatting commands to device fonts.
13	8192	Device is a pen plotter.
14	16384	Device can transfer 16-bit pixels.
15	32768	Device supports Kanji characters.
16	65536	Device supports widgets.
17	131072	Device has Z-buffer.
18	262144	Device supports TrueType fonts.

Table D-5: !D.FLAGS Bit Definitions

To test whether a particular bit is set on your system, use an IDL command like the following:

```
IF (!D.FLAGS AND value) NE 0 THEN PRINT, 'Bit is set.'
```

where value is the value associated with the bit you wish to examine. For example, to check whether the device supports color, use:

```
IF (!D.FLAGS AND 16) NE 0 THEN PRINT, 'Bit is set.'
```

N_COLORS

The number of allowed color values. In the case of devices with windows, this field is set after the window system is initialized. For a monochrome system, !D.N_COLORS is 2. For TrueColor displays, !D.N_COLORS is 2^24-1 (roughly 16.7 million colors).

NAME

A string containing the name of the device.

ORIGIN

A two-element integer array containing the current pan/scroll offset. An offset of (0, 0) is normal. Positive offsets shift the display memory to the right and upwards. This field has relevance only with devices with hardware pan and scroll abilities.

TABLE_SIZE

The number of color table indices.

UNIT

The logical number of the file open for output by the current graphics device. This field only has meaning for devices that write to a file if the file is accessible to the user from IDL, and is 0 if no file is open.

For example, the PostScript driver fills this field with the unit number of the file open for PostScript output. In the case of Tektronix output to a file, !D.UNIT may be set to either + or – the logical unit number.

WINDOW

The index of the currently open window. This field is set to -1 if no window is currently open. This field is used only with devices that support windows.

X_CH_SIZE, Y_CH_SIZE

The width and height of the rectangle that encloses the “average” character in the current font, in device units (usually pixels).

These values describe the size of the rectangle that contains the “average” character in the current font. (It is not important what the “average” character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The first element specifies the width of the rectangle in device units (usually pixels), and the second element specifies the height.

For vector and TrueType fonts, the height of the “average” character is determined by the *width* of the rectangle. The aspect ratio of the “average” character remains fixed; the character is scaled so that its width is the value of X_CH_SIZE. The resulting scale factor is then applied to all of the characters in the font. The amount of spacing between lines is determined explicitly by the value of Y_CH_SIZE.

For device fonts, the character size is fixed. When the device font system is in use, the value of X_CH_SIZE is silently ignored, and only the Y_CH_SIZE value is used.

X_PX_CM, Y_PX_CM

The approximate number of pixels per centimeter in the X and Y directions.

X_SIZE, Y_SIZE

The total size of the display or window in the X and Y directions, in device units.

X_VSIZE, Y_VSIZE

The size of the visible area of the display or window. This area can be smaller than the total size fields.

ZOOM

This field contains the current X and Y zoom factors for the display or window. This field has relevance only with devices equipped with hardware zoom. A zoom factor of [1, 1] is normal.

!ORDER System Variable

Controls the direction of image transfers when using the TV, TVSCL, and TVRD procedures. If !ORDER is 0, images are transferred from bottom to top, i.e. the row with a 0 subscript is written on the bottom. Setting !ORDER to 1, transfers images from top to bottom.

!P System Variable

The main plotting system variable structure. All fields, except !P.MULTI, have a directly corresponding keyword parameter in the plot procedures: PLOT, OPLOT, CONTOUR, and SURFACE. Fields, in alphabetical order, are:

BACKGROUND

The background color index. When erasing the screen or page, all pixels are set to this color. The default value is 0. Not all devices support this feature.

CHANNEL

The default source or destination channel. This field has meaning only on graphics devices that contain multiple display channels, and is device dependent. It may contain either a channel mask or index.

CHARSIZE

The overall character size of all annotation when Hershey fonts are selected. This field has no effect on the character size when hardware (device) fonts are selected, except for devices that support scalable pixel sizes (i.e., Postscript). Note, however, that !P.CHARSIZE always affects the layout and scaling of a plot, regardless of the font system being used. The default size is 1.0.

CHARTHICK

An integer specifying the thickness of the lines used to draw the characters when using the vector drawn fonts. This field has no effect on the appearance of characters drawn with the hardware fonts. Normal thickness is 1.

CLIP

The device coordinates of the clipping window, a 6-element vector of the form $[x_0, y_0, x_1, y_1, z_0, z_1]$, specifying two opposite corners of the volume to be displayed. In the case of two-dimensional displays, the Z coordinates can be omitted. Normally, the clipping window coordinates are implicitly set by PLOT, CONTOUR, SHADE_SURF, and SURFACE to correspond to the plot window. You may also manually set !P.CLIP if you want to specify a different rectangular clipping window or if the clipping coordinates have not yet been set in the current IDL session.

COLOR

The default color index.

FONT

An integer that specifies the graphics text font system to use. Set FONT equal to -1 to selects the Hershey character fonts, which are drawn using vectors. Set FONT equal to 0 (zero) to select the device font of the output device. Set FONT equal to 1 (one) to select the TrueType font system. See Appendix H, “Fonts”, for a complete description of IDL’s font systems.

LINESTYLE

The default style of the lines used to connect points. A line style index of 0 yields a solid line. See "LINESTYLE" on page 2405 for a description of the linestyles.

MULTI

!P.MULTI allows making multiple plots on a page or screen. It is a 5-element integer array defined as follows:

!P.MULTI[0] contains the number of plots remaining on the page. If !P.MULTI[0] is less than or equal to 0, the page is cleared, the next plot is placed in the upper left hand corner, and !P.MULTI[0] is reset to the number of plots per page.

Setting !P.MULTI[0] to a value greater than zero can be used to manually set the plotting area to a specific row and column. For example, to plot in the lower left corner of a window of two rows and two columns, set !P.MULTI as follows:

```
!P.MULTI=[2,2,2]
PLOT, X, Y
```

!P.MULTI[1] is the number of plot columns per page. If this value is less than or equal to 0, one is assumed. If more than two plots are ganged in either the X or Y direction, the character size is halved.

!P.MULTI[2] is the number of rows of plots per page. If this value is less than or equal to 0, one is assumed.

!P.MULTI[3] contains the number of plots stacked in the Z dimension.

!P.MULTI[4] is 0 to make plots from left to right (column major), and top to bottom, and is 1 to make plots from top to bottom, left to right (row major).

Note

If !P.MULTI[0] is zero, an erase will occur before the current plot is displayed (unless the /NOERASE keyword is set). This is true no matter whether !P.POSITION and/or !P.REGION are set.

For example, to gang two plots across the page:

```
!P.MULTI = [0, 2, 0, 0, 0]
PLOT, X0, Y0        ;Make left plot.
PLOT, X1, Y1        ;Right plot.
```

To gang two plots vertically:

```
!P.MULTI = [0, 0, 2, 0, 0]
PLOT, X0, Y0        ;Make top plot.
```

```
PLOT, X1, Y1        ;Bottom plot.
```

To make four plots per page, two across and two up and down:

```
!P.MULTI = [0, 2, 2, 0, 0]
```

and then call plot four times.

To reset !P.MULTI back to the normal one plot per page:

```
!P.MULTI = 0
```

NOCLIP

A field which, if set, inhibits the clipping of the graphic vectors and vector-drawn text. By default, most routines clip to the plotting window, with the exception of PLOTS and XYOUTS. !P.CLIP contains the clipping rectangle.

NOERASE

Set this field to a non-zero value to inhibit erasing the screen before plotting.

NSUM

The number of adjacent points to average to obtain a plotted point.

POSITION

Specifies the normalized coordinates of the rectangular plot window. This is a four element floating point vector (x_0, y_0, x_1, y_1), where (x_0, y_0) is the origin, and (x_1, y_1) is the upper right corner.

!P.POSITION determines the plotting window if x_0 does not equal x_1, and the POSITION keyword is not present. If set, it overrides the effect of the MARGIN and !P.MULTI variables and keywords.

Note

If !P.POSITION (or the POSITION keyword) or !P.REGION is set, all but the first element of !P.MULTI are ignored.

PSYM

The default plotting symbol index. Each point drawn by PLOT, PLOTS, and OPLOT is marked with a symbol if this field is non-zero. The possible symbols are given in "PSYM" on page 2408.

REGION

A four element vector that specifies the normalized coordinates of the rectangle enclosing the plot region, which includes the plot data window and its surrounding annotation area. It is in the same form as !P.POSITION, (x_0, y_0, x_1, y_1), where (x_0, y_0) is the origin, and (x_1, y_1) is the upper right corner. It is ignored if !P.REGION[0] is equal to !P.REGION[2].

Note

!P.POSITION (or the POSITION keyword) takes precedence over !P.REGION.

SUBTITLE

The plot subtitle, placed under the X axis label.

T

Contains the homogeneous 4 x 4 transformation matrix. This field is a two-dimensional array of double-precision floating-point values. For more information about transformations, refer to: "Three-Dimensional Graphics" on page 323, of *Using IDL*.

T3D

Enables the three-dimensional to two-dimensional transformation contained in the homogeneous 4 by 4 matrix !P.T. Note that if T3D is set, !P.T must contain a valid transformation matrix.

THICK

The thickness of the lines connecting points. 1.0 is normal.

TITLE

The main plot title.

TICKLEN

The length of the tick marks, expressed as a fraction of the plot size (from 0.0 to 1.0). The default is 0.02. A value of 0.5 makes a grid. Negative values make the tick marks point outward.

!X, !Y, !Z System Variables

The system variables !X, !Y, and !Z, are structures of type AXIS, that affect the appearance and scaling of the three axes. The fields for !X, !Y, and !Z have identical

fields with identical meanings and usage. In addition, almost all fields have corresponding keyword parameters, with identical function, but with temporary effect. For example, to suppress the minor tick marks on the X axis using the !X system variable, you could use the command:

```
!X.MINOR = -1
```

To suppress the tick marks for just one call to plot, you could use the command:

```
PLOT, X, Y, XMINOR = -1
```

The name of the keyword parameter is simply the name of the system variable field, prefixed with the letter X, Y, or Z.

The fields for these system variables, in alphabetical order are:

CHARSIZE

The size of the characters used to annotate the axis and its title when Hershey fonts are selected. This field has no meaning when hardware (i.e. PostScript) fonts are selected. This field is a scale factor applied to the global scale factor. For example, setting !P.CHARSIZE to 2.0, and !X.CHARSIZE to 0.5 results in a character size of 1.0 for the X axis.

CRANGE

The output axis range. Setting this variable has no effect; set ![XYZ].RANGE to change the range. ![XYZ].CRANGE[0]) always contains the minimum axis value, and ![XYZ].CRANGE[1] contains the maximum axis value of the last plot before extending the axes.

Note

If the axis is logarithmic, the CRANGE field reports the log (base 10) of the minimum and maximum axis values.

Example 1:

```
;Create a 10-element array.
a = INDGEN(10)

;Plot the straight line.
PLOT, a

;Print the minimum and maximum axis values.
PRINT, !X.CRANGE
```

IDL prints:

```
0.00000      10.0000
```

Example 2:

```
;Plot a with logarithmic scaling on the X axis.
PLOT, a, /XLOG

;Print the minimum and maximum axis values.
PRINT, !X.CRANGE
```

The axis is scaled from 10^{-12} to 10^{2}.IDL prints:

```
-12.0000      2.00000
```

GRIDSTYLE

The index of the linestyle to be used for tick marks and grids. See "LINESTYLE" on page 2405 for a description of the linestyles

MARGIN

A 2-element array specifying the margin on the left (bottom) and right (top) sides of the plot window, in units of character size. The plot window is the rectangular area that contains the plot data, i.e. the area enclosed by the axes.

The default values for !X.MARGIN are [10, 3] yielding a 10-character wide left margin and a 3-character wide right margin. The values for !Y.MARGIN are [4, 2], for a 4-character high bottom margin and a 2-character high top margin. While specifying !Z.MARGIN will not cause an error, Z margins are currently ignored.

When calculating the size and position of the plot window, IDL first determines the plot region, the area enclosing the window plus the axis annotation and titles. It then subtracts the appropriate margin from each side, obtaining the window.

Setting !P.POSITION, or specification of the POSITION parameter overrides the effect of this field.

MINOR

The number of minor tick marks. If !X.MINOR is 0, the default, the number of minor ticks is automatically determined from the tick mark increment. You can force a given number of minor ticks by setting this field to the desired number. To suppress minor tick marks, set !X.MINOR to -1.

OMARGIN

A 2-element array specifying the "outer" margin on the left (bottom) and right (top) sides of a multi-plot window, in units of character size. A multi-plot window is created by setting the !P.MULTI system variable field. OMARGIN controls the amount of space around the entire plot area, including individual plot margins set

with !X.MARGIN and !Y.MARGIN. The default values for !X.OMARGIN and !Y.OMARGIN are [0, 0].

When calculating the size and position of the individual plots, IDL first determines the plot region, the area enclosing the window plus the axis annotation and titles. It then subtracts the appropriate margin from each side, obtaining the window.

Setting !P.POSITION, or specification of the POSITION parameter overrides the effect of this field.

RANGE

The input axis range, a 2-element vector. The first element is the axis minimum, and the second is the maximum. Set this field, or use the corresponding keyword parameter, to specify the data range to plot. If axis end point rounding is selected (see STYLE above), the final axis range may not be equal to this input range. The field !X.CRANGE contains the axis range used for the plot before extending the axes. Set both elements equal to 0 for automatic axis ranges:

```
!X.RANGE = 0
```

For example, to force the X axis to run from 5.5 to 8.3:

```
!X.RANGE = [5.5, 8.3]
PLOT, X, Y
```

Alternatively, by using keywords:

```
PLOT, X, Y, XRANGE=[5.5, 8.3]
```

Note that even though the range was set to (5.5, 8.3), the resulting plot has a range of (5.5, 8.5), because axis rounding is the default.

REGION

Contains the normalized coordinates of the region. This field is similar to WINDOW, in that it is set by the graphics procedures and is a 2-element floating point array. To change the default plotting region, set !P.REGION.

S

The scaling factors for converting between data coordinates and normalized coordinates (a 2-element array). The formula for conversion from data (X_d) to normalized (X_n) coordinates is $X_n = S_1 X_d + S_0$

If logarithmic scaling is in effect, substitute $\log_{10}(X_d)$ for X_d.

The CONVERT_COORD function can be used to convert between coordinate systems. The user should save and restore these fields when switching between windows or devices with different sizes and/or scaling.

STYLE

The style of the axis encoded as bits in a longword. The axis style can be set to exact, extended, none, or no box using this field. The following table lists the axis style bit values:

Bit	Value	Function
0	1	Exact. By default, the end points of the axis are rounded in order to obtain even tick increments. Setting this bit inhibits rounding, making the axis fit the data range exactly.
1	2	Extend. If this bit is set, the axes are extended by 5% in each direction, leaving a border around the data.
2	4	None. If this bit is set, the axis and its annotation are not drawn.
3	8	No box. Normally, PLOT and CONTOUR draw a box-style axis with the data window surrounded by axes.
4	16	Inhibits setting the Y axis minimum value to zero when the data are all greater than 0. The keyword YNOZERO sets this bit temporarily.

Table D-6: Axis Style Bit Values

Note that this system variable field is set bitwise, so multiple effects can be set by adding values together. For example, to make an X axis that is both exact (value 1) and suppresses the box style (setting 8), set the !X.STYLE system variable to `1+8`, or 9.

For example, to set the Y axis style to exact using the !Y system variable:

```
!Y.STYLE = 1
```

or by using a keyword parameter:

```
PLOT, X, Y, YSTYLE = 1
```

THICK

The thickness of the axis line. 1.0 is normal.

TICKFORMAT

Set this field to a format string or a string containing the name of a function that returns a string to be used to format the axis tick mark *labels*.

See "[XYZ]TICKFORMAT" on page 2413 for more information.

TICKINTERVAL

A scalar indicating the interval between major tick marks for the first axis level. This setting takes precedence over ![XYZ].TICKS.

For example, if !X.TICKUNITS=["Seconds", "Hours", "Days"], and !X.TICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

See "[XYZ]TICKINTERVAL" on page 2415 for more information.

TICKLAYOUT

Set this keyword to a scalar that indicates the tick layout style to be used to draw each level of the axis.

See "[XYZ]TICKLAYOUT" on page 2416 for more information.

TICKLEN

The lengths of tick marks (expressed in normal coordinates) for the individual axes.

TICKNAME

The annotation for each tick. A string array of up to 60 elements. Setting elements of this array allows direct specification of the tick label. If this element contains a null string, the default value, IDL annotates the thick with its numeric value. Setting the element to a 1-blank string suppresses the tick annotation.

For example, to produce a plot with an abscissa labeled with the days of the week:

```
;Set up X axis tick labels.
!X.TICKNAME = ['SUN', 'MON', 'TUE', 'WED', $
    'THU', 'FRI', 'SAT']

;Use six tick intervals, requiring seven tick labels.
!X.TICKS = 6

;Plot the data, this assumes that Y contains 7 elements.
PLOT, Y
```

The same plot can be produced, using keyword parameters, with:

```
;Set fields, as above, only temporarily.
PLOT, Y, XTICKN = ['SUN', 'MON', 'TUE', 'WED',$
    'THU', 'FRI', 'SAT'], XTICKS = 6
```

TICKS

The number of major tick intervals to draw for the axis. If !X.TICKS is set to 0, the default, IDL will select from three to six tick intervals. Setting this field to *n*, where *n* > 1, produces exactly *n* tick intervals, and *n*+1 tick marks. Setting this field equal to 1 suppresses tick marks.

TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling.

Note

The singular form of each of the time value strings is also acceptable (e.g, !X.TICKUNITS='Day' is equivalent to !X.TICKUNITS='Days').

Note

To set the ![XYZ].TICKUNITS field to a single string, the following approach is recommended:

```
!X.TICKUNITS = ''     ; Clear all previous tick unit strings.
!X.TICKUNITS = ['Days']  ;Single unit string in array.
```

The following:

```
!X.TICKUNITS = 'Days'
```

will copy the 'Days' string to all levels, resulting in a multi-level axis.

See “[XYZ]TICKUNITS” on page 2417 for more information.

TICKV

An array of up to 60 elements containing the data values for each tick mark. You can directly specify the location of each tick by setting !X.TICKS to the number of tick marks (the number of intervals plus 1) and storing the data values of the tick marks in !X.TICKV. If, as is true by default, !X.TICKV[0] is equal to !X.TICKV[1], IDL automatically determines the value of the tick marks.

TITLE

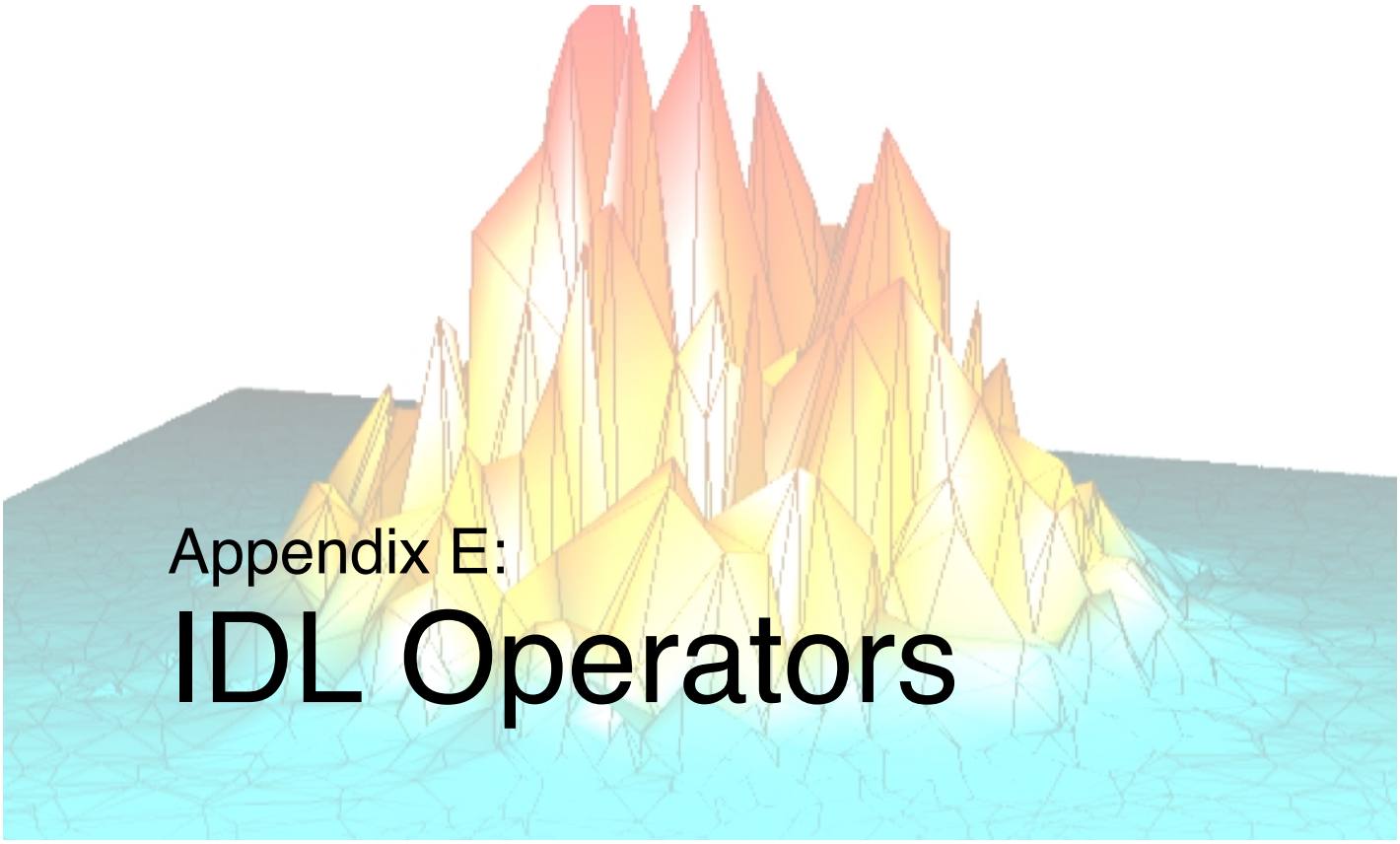
A string containing the axis title.

TYPE

The type of axis, 0 for linear, 1 for logarithmic.

WINDOW

Contains the normalized coordinates of the axis end points, the plot data window. This field is set by PLOT, CONTOUR, SHADE_SURF, and SURFACE. Changing its value has no effect. A 2-element floating point array. To change the default plotting window, set !P.POSITION. The keyword parameter POSITION sets the plot data window on a per call basis.



Appendix E: IDL Operators

This appendix lists all IDL operators and provides brief examples of their usage. For more information on the usage of IDL operators, see Chapter 2, "Expressions and Operators" in *Building IDL Applications*. The following topics are covered in this appendix:

Mathematical Operators

Operator	Description	Example
+	Addition	`;Store the sum of 3 and 6 in B:` `B = 3 + 6`
	String Concatenation	`;Store the string value of "John Doe" in B:` `B = 'John' + ' ' + 'Doe'`
–	Subtraction	`;Store the value of 5 subtracted from 9 in C:` `C = 9 - 5`
	Negation	`;Change the sign of C:` `C = -C`
*	Multiplication	`;Store the product of 2 and 5 in variable C:` `C = 2 * 5`
	Pointer dereference	If `ptr` is a valid pointer (created via the PTR_NEW function), then `*ptr` is the value held by the heap variable that `ptr` points to. For more information on IDL pointers, see Chapter 7, "Pointers" in *Building IDL Applications*.

/	Division	`;Store result of 10.0 divided by 3.2 in`
		`;variable D:`
		`D = 10.0/3.2`

^	Exponentiation	`;Store result of 2 raised to the 3rd power in`
		`;variable B:`
		`B = 2^3`

MOD	Modulo	`;Print the value of 9 modulo 5:`
		`PRINT, 9 MOD 5`
		
		IDL Prints:
		`4`

Table E-1: Mathematical Operators

Minimum and Maximum Operators

Operator	Description	Example
<	Minimum operator. The value of "A < B" is equal to the smaller of A or B.	;Set A equal to 3. A = 5 < 3 ;Set all points in array ARR that are larger ;than 100 to 100: ARR = ARR < 100 ;Set X to the smallest of the three operands: X = X0 < X1 < X2
>	Maximum operator. "A > B" is equal to the larger of A or B.	;'>' is used to avoid taking the log of zero ;or negative numbers: C = ALOG(D > 1E - 6) ;Plot positive points only. Negative points ;are plotted as zero: PLOT, ARR > 0

Table E-2: Minimum and Maximum Operators

Matrix Operators

Operator	Description	Example
#	Computes array elements by multiplying the columns of the first array by the rows of the second array.	;A 3-column by 2-row array: array1 = [[1, 2, 1], [2, -1, 2]] ;A 2-column by 3-row array: array2 = [[1, 3], [0, 1], [1, 1]] PRINT, array1#array2 IDL prints: 7 -1 7 2 -1 2 3 1 3
##	Computes array elements by multiplying the rows of the first array by the columns of the second array.	;A 3-column by 2-row array: array1 = [[1, 2, 1], [2, -1, 2]] ;A 2-column by 3-row array: array2 = [[1, 3], [0, 1], [1, 1]] PRINT, array1##array2 IDL prints: 2 6 4 7

Table E-3: Matrix Operators

Boolean Operators

Operator	Description	Example

AND	Boolean AND. Returns "true" whenever both of its operands are true; otherwise, the result is "false." Any odd integer is considered true, and any even integer is considered false. For integer, longword, and byte operands, a bitwise AND operation is performed. For operations on other types, the result is equal to the second operand if the first operand is not equal to zero or the null string; otherwise, the result is zero or the null string.	`PRINT, (5 GT 2) AND (4 GT 2)`
		IDL Prints: `1`
		
		`PRINT, (5 GT 2) AND (4 GT 5)`
		IDL Prints: `0`
		
		`PRINT, 5 AND 3`
		IDL Prints: `1`
		
		`PRINT, 5 AND 2`
		IDL Prints: `0`
		
		`PRINT, 4 AND 2`
		IDL Prints: `0`

NOT	Boolean complement. "NOT true" is equal to "false" and "NOT false" is equal to "true." For floating-point operands, the result is 1.0 if the operand is zero; otherwise, the result is zero. Not valid for string or complex operands.	`IF (NOT (5 GT 6)) THEN PRINT, 'True'`
		
		IDL Prints:
		`True`

Table E-4: Boolean Operators

Operator	Description	Example
OR	Boolean OR. For integer or byte operands, a bitwise inclusive OR is performed. For example, `3 OR 5` equals 7. For floating-point operands, the OR operator returns the first operand if it is non-zero, or the 2nd operand otherwise.	`IF ((5 GT 3) OR (4 GT 5)) THEN PRINT, 'True'`

XOR	Boolean exclusive OR. XOR is only valid for byte, integer, and longword operands. A bit in the result is set to 1 if the corresponding bits in the operands are different; if they are equal, it is set to zero.	`IF ((5 GT 3) XOR (4  GT 5)) THEN $`
		`  PRINT, 'Different' ELSE PRINT, 'Same'`
		
		IDL Prints:
		
		`Different`

Table E-4: Boolean Operators

Relational Operators

Operator	Description	Example
EQ	Equal to	`;Determine if A equals B:` `IF (A EQ B) THEN PRINT, 'True'`

GE	Greater than or equal to	`;Determine if A is greater than or equal`
		`;to B:`
		`IF (A GE B) THEN PRINT, 'True'`

GT	Greater than	`;Determine if A is greater than B:` `IF (A GT B) THEN PRINT, 'True'`

LE	Less than or equal to	`;Determine if A is less than or equal`
		`;to B:`
		`IF (A LE B) THEN PRINT, 'True'`

LT	Less than	`; Determine if A is less than B:` `IF (A LT B) THEN PRINT, 'True'`
NE	Not equal to	`; Determine if A does not equal B:` `IF (A NE B) THEN PRINT, 'True'`

Table E-5: Relational Operators

Other Operators

Operator	Description	Example

[ ]	Array concatenation. The expression `[A,B]` is an array formed by concatenating A and B.	`;Define C as three-point vector:`
		`C = [0, 1, 3]`
		
		`;Add 5 to the end of C:`
		`PRINT, [C, 5]`
		
		IDL Prints: `0 1 3 5`
		
		`;Insert -1 at the beginning of C:`
		`PRINT, [-1, C]`
		
		IDL Prints: `-1 0 1 3`

	Enclose array subscripts	`A = [2, 1, 5]`
		`;Print the 3rd element in A:`
		`PRINT, A[2]`
		
		IDL Prints: `5`

( )	Group expressions to control order of evaluation	`PRINT, 3 + 4 * 2 ^ 2 /2`
		
		IDL Prints: `11`
		
		`PRINT, (3 + (4 * 2) ^ 2 / 2)`
		
		IDL Prints: `35`

=	Assignment	`;Assign 5 to variable A:`
		`A = 5`
		
		`Assign "Hello World" to variable B:`
		`B='Hello World'`

?:	Conditional expression. For *value=expr1* ? *expr2* : *expr3* *expr1* is evaluated first. If *expr1* is true, then *value=expr2*. If *expr1* is false, *value=expr3*.	`A=6 & B=4`
		`;Set Z to the greater of A and B:`
		`Z = (A GT B) ? A : B`
		`PRINT, Z`
		
		IDL Prints: `6`

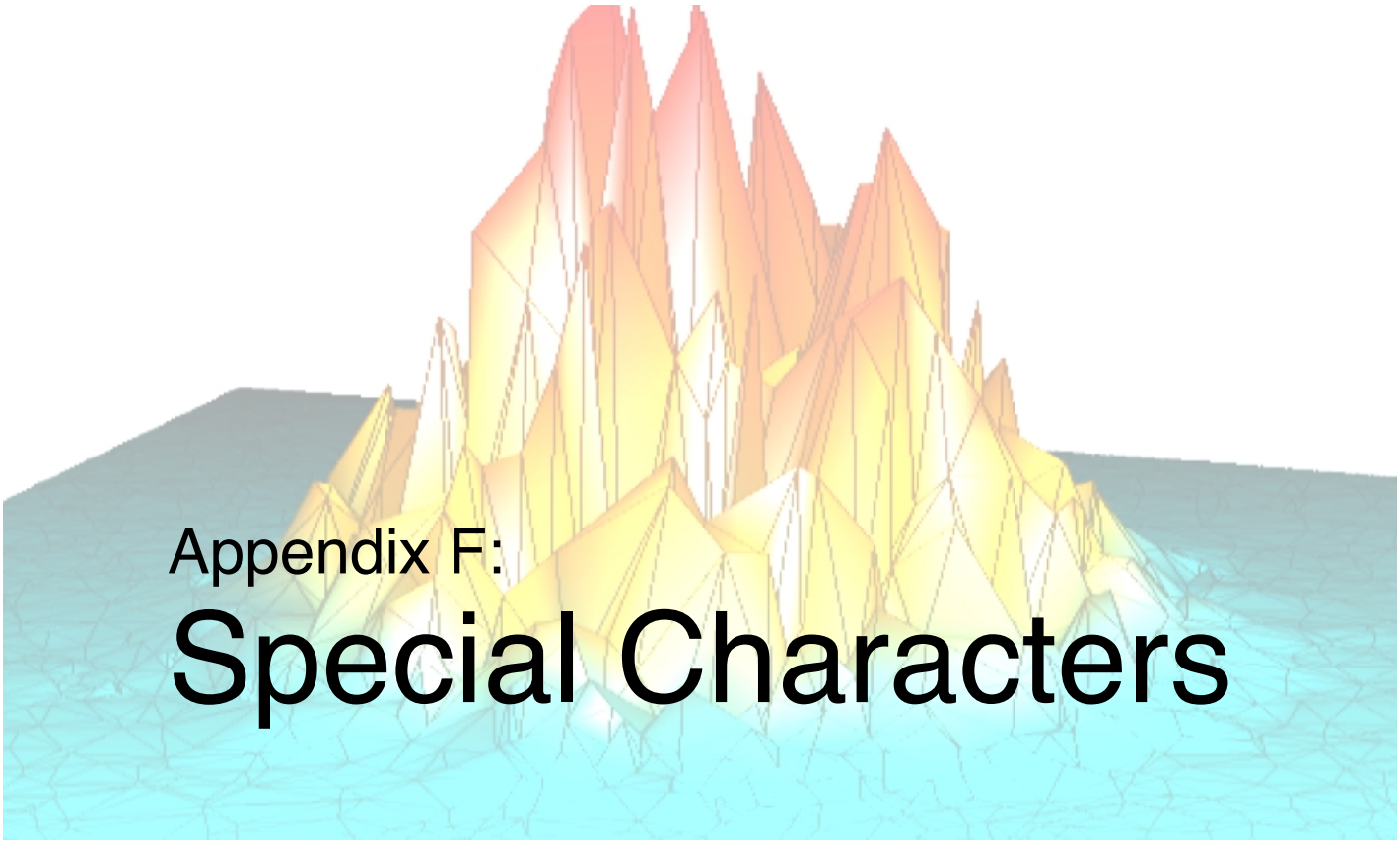
Table E-6: Other Operators

Operator Precedence

The following table lists IDL's operator precedence. Operators with the highest precedence are evaluated first. Operators with equal precedence are evaluated from left to right.

Priority	Operator
First (highest)	( ) (parentheses, to group expressions)
Second	* (pointer dereference)
	^ (exponentiation)
Third	* (multiplication)
	# and ## (matrix multiplication)
	/ (division)
	MOD (modulus)
Fourth	+ (addition)
	- (subtraction and negation)
	< (minimum)
	> (maximum)
	NOT (Boolean negation)
Fifth	EQ (equality)
	NE (not equal)
	LE (less than or equal)
	LT (less than)
	GE (greater than or equal)
	GT (greater than)
Sixth	AND (Boolean AND)
	OR (Boolean OR)
	XOR (Boolean exclusive OR)
Seventh	?: (conditional expression)

Table 0-1: Operator Precedence



Appendix F: Special Characters

Within the IDL environment, a number of characters have special meanings. The following table lists characters with special interpretations and states their functions in IDL. These characters are discussed further in the descriptions following the table.

Character	Function
!	First character of system variable names
'	• Delimit string constants • Indicate part of octal or hex constant
;	Begin comment field

Table F-1: Special Characters

Character	Function
$	• Continue current command on the next line • Issue operating system command if entered on a line by itself.
"	Delimit string constants or precede octal constants
.	• Indicate constant is floating point • Start executive command
&	Separate multiple statements on one line
:	End label identifiers
*	• Multiplication operator • Array subscript range • Pointer dereference (if in front of a valid pointer)
@	• Include file • Execute IDL batch file
?	• Invokes online help when entered at the IDL command line. • Part of the ?: ternary operator used in conditional expressions.

Table F-1: Special Characters

Exclamation Point (!)

The exclamation point is the first character of names of IDL system-defined variables. System variables are predefined scalar variables of a fixed type. Their purpose is to override defaults for system procedures, to return status information, and to control the action of IDL.

Apostrophe (')

The apostrophe delimits string literals and indicates part of an octal or hex constant.

Semicolon (;)

The semicolon is the first character of the optional comment field of an IDL statement. All text on a line following a semicolon is ignored by IDL. A line can consist of a comment only or both a valid statement and a comment.

Dollar Sign ($)

The dollar sign at the end of a line indicates that the current statement is continued on the following line. The dollar sign character can appear anywhere a space is legal except within a string constant or between a function name and the first open parenthesis. Any number of continuation lines are allowed.

When the $ character is entered as the first character after the IDL prompt, the rest of the line is sent to the operating system as a command. If $ is the only character present, an interactive subprocess is started. Under UNIX and VMS, IDL execution suspends until the new shell process terminates. Note that in IDL for Macintosh, there must be no space between the $ character and the full path name of the application being started.

Quotation Mark (")

The quotation mark precedes octal numbers, which are always integers, and delimits string constants. Example: "`100B` is a byte constant equal to 64 base 10 and "`Don't drink the water`" is a string constant.

Period (.)

The period or decimal point indicates in a numeric constant that the number is of floating-point or double-precision type. Example: 1.0 is a floating-point number. Also, in response to the IDL prompt, the period begins an executive command. For example,

```
.run myfile
```

causes IDL to compile the file *myfile.pro*. If *myfile.pro* contains a main program, the program also will be executed. In addition, the period precedes the name of a tag when referring to a field within a structure. For example, a reference to a tag called NAME in a structure stored in the variable A is A.NAME.

Ampersand (&)

The ampersand separates multiple statements on one line. Statements can be combined until the maximum line length is reached. For example, the following line contains two statements:

```
I = 1 & PRINT, 'value:', I
```

Colon (:)

The colon ends label identifiers. Labels can only be referenced by GOTO and ON_ERROR statements. The following line contains a statement with the label LOOP1.

```
LOOP1: X = 2.5
```

The colon also separates the starting and ending subscripts in subscript range specifiers. For example, A(3:6) designates elements three to six of the variable A.

Asterisk (*)

The asterisk represents one of the following, depending on context:

1. Multiplication (3 * 3).
2. An ending subscript range equal to the size of the dimension. For example, `A[3:*]` represents all elements of the vector A from A[3] to the last element, while `B[*,3]` represents all elements of row four of matrix B.
3. A pointer dereference operation. For example, if `ptr` is a valid pointer (created via the PTR_NEW function), then `*ptr` is the value held by the heap variable that `ptr` points to. For more information on IDL pointers, see Chapter 7, "Pointers" in *Building IDL Applications*.

At Sign (@)

The "at" sign is used both as an include character and to signal batch execution.

@ as an Include Character

The "at" sign at the beginning of a line causes the IDL compiler to substitute the contents of the file whose name appears after the @ for the line. If the full path name is not specified after the @ symbol, IDL searches the current directory and a list of known locations where procedures are kept.

- **UNIX:** IDL searches for the file in the list of directories (as established by the environment variable IDL_PATH) stored in the system variable !PATH.

- **VMS:** IDL searches the list of directories (but not text libraries) established by the logical name IDL_PATH and stored in the system variable !PATH for the file.
- **Windows:** IDL searches for the file in the list of directories stored in the system variable !PATH (specified in the "Preferences" dialog of the File menu).
- **Macintosh:** IDL searches for the file in the list of directories stored in the system variable !PATH (specified in the "Search Path" dialog of the Edit menu).

For example, the line

```
@doit
```

when included in a file, causes the file *doit.pro* to be compiled in its place. (The suffix *.pro* is the default for IDL program files.) When the end of the file is reached, compilation resumes at the line after the @.

@ to Signal Batch Processing

When IDL is running in interactive mode, a line beginning with the character @ is entered in response to the IDL prompt and the file is opened for batch input. See "Batch Execution" in Chapter 2 of *Using IDL* for details.

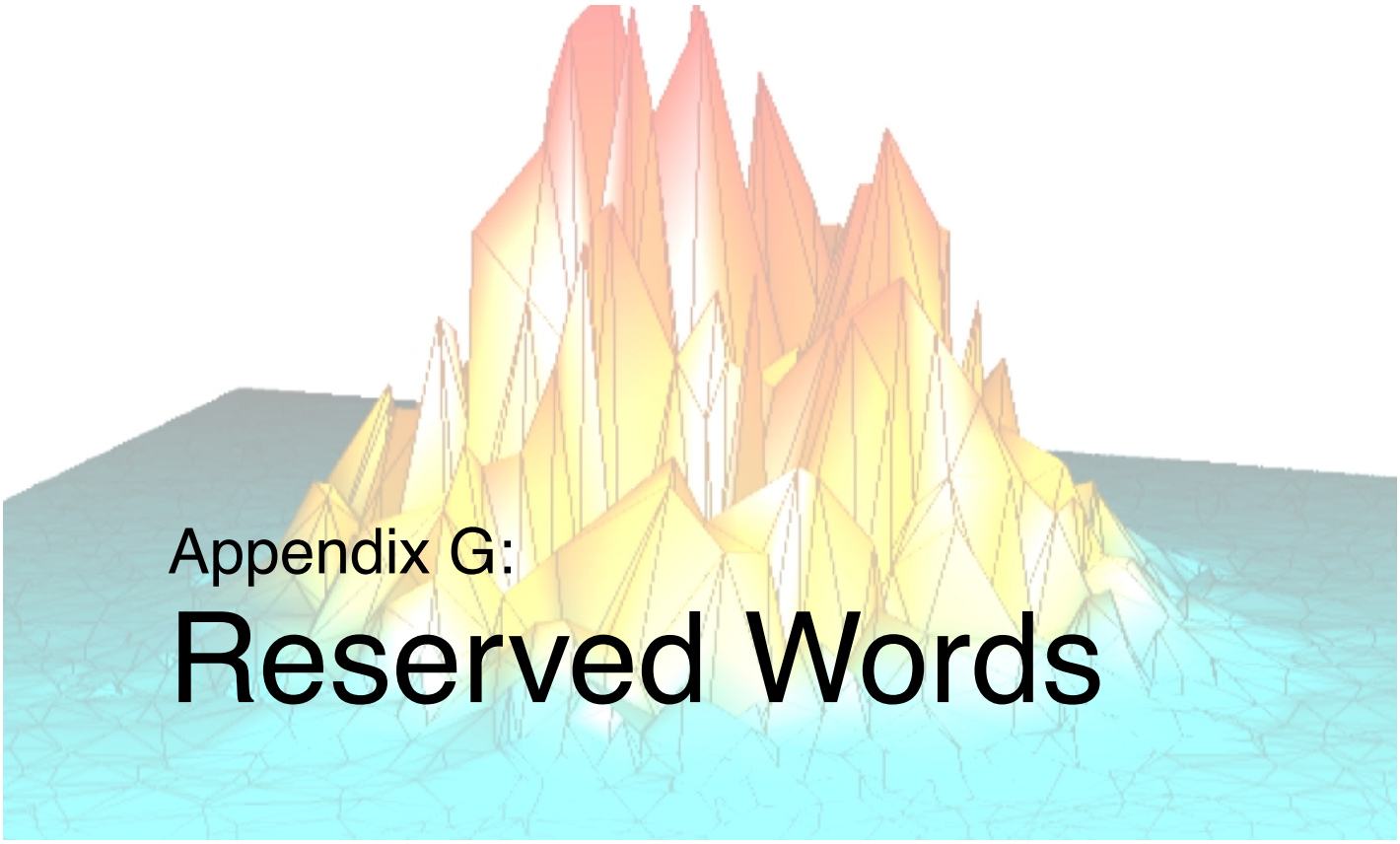
Question Mark (?)

The question mark is used as follows:

- When entered at the IDL command line, the IDL online help facility is invoked.
- Used in conditional expressions as part of the ?: ternary operator. For example:

```
; A shorter way of saying IF (a GT b) THEN z=a ELSE z=b:
z = (a GT b) ? a : b
```

  For more on conditional expressions, see "Conditional Expression" in Chapter 2 of *Building IDL Applications*.

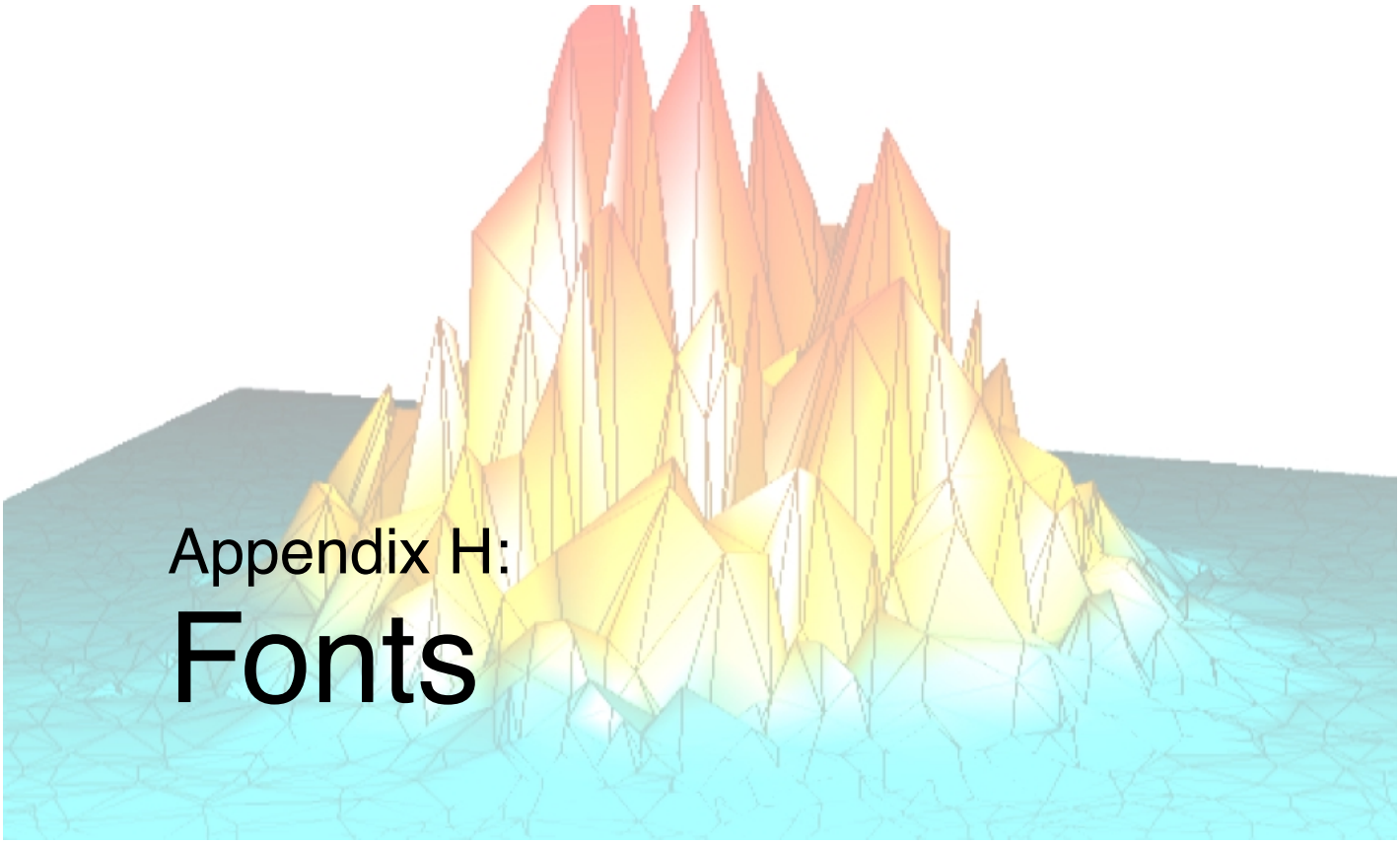


Appendix G: Reserved Words

Variables, user-written procedures, and user-written functions should not have the same names as IDL functions or procedures. Re-using names of IDL routines can lead to syntax errors or to “hiding” variables. In addition, certain words representing IDL language constructs are strictly forbidden—using any of these *reserved words* as a variable, procedure, or function name will cause an immediate syntax error. The following table lists all of the reserved words in IDL.

AND	BEGIN	BREAK
CASE	COMMON	COMPILE_OPT
CONTINUE	DO	ELSE
END	ENDCASE	ENDELSE
ENDFOR	ENDIF	ENDREP
ENDSWITCH	ENDWHILE	EQ
FOR	FORWARD_FUNCTION	FUNCTION

GE	GOTO	GT
IF	INHERITS	LE
LT	MOD	NE
NOT	OF	ON_IOERROR
OR	PRO	REPEAT
SWITCH	THEN	UNTIL
WHILE	XOR	



Appendix H: Fonts

The following topics are covered in this appendix:

Overview

IDL uses three font systems for writing characters on the graphics device: Hershey (vector) fonts, TrueType (outline) fonts, and device (hardware) fonts. This chapter describes each of the three types of fonts, discusses when to use each type, and explains how to use fonts when creating graphical output in IDL.

Vector-drawn fonts, also referred to as *Hershey fonts*, are drawn as lines. They are device-independent (within the limits of device resolution). All vector fonts included with IDL are guaranteed to be available in any IDL installation. See "About Vector Fonts" on page 2474 for additional details.

TrueType fonts, also referred to here as *outline fonts*, are drawn as character outlines, which are filled when displayed. They are largely device-independent, but do have some device-dependent characteristics. Four TrueType font families are included with IDL; these fonts should display in a similar way on any IDL platform. TrueType font support for IDL Object Graphics was introduced in IDL version 5.0 and support in IDL Direct Graphics was introduced in IDL version 5.1. See "About TrueType Fonts" on page 2477 for additional details.

Device fonts, also referred to as *hardware fonts*, rely on character-display hardware or software built in to a specific display device. Device fonts, necessarily, are device-dependent and differ from platform to platform and display device to display device. See "About Device Fonts" on page 2482 for additional details.

Fonts in IDL Direct vs. Object Graphics

This volume deals almost exclusively with IDL Direct Graphics. However, the vector and TrueType font systems described here are also available in the IDL Object Graphics system, described in *Using IDL*.

IDL Direct Graphics

When generating characters for Direct Graphics plots, IDL uses the font system specified by the value of the system variable !P.FONT. The normal default for this variable is -1, which specifies that the built-in, vector-drawn (Hershey) fonts should be used. Setting !P.FONT equal to 1 specifies that TrueType fonts should be used. Setting !P.FONT equal to zero specifies that fonts supplied by the graphics device should be used.

The setting of the IDL system variable !P.FONT can be overridden for a single IDL Direct Graphics routine (AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, or XYOUTS) by setting the FONT keyword equal to -1, 0, or 1.

Once a font system has been selected, an individual font can be chosen either via a formatting command embedded in a text string as described in "Embedded Formatting Commands" on page 2491, or by setting the value of the FONT keyword to the DEVICE routine (see "FONT" on page 2326).

IDL Object Graphics

IDL Object Graphics can use the vector and TrueType font systems. See *Using IDL* for more information on using fonts with Object Graphics. Any TrueType fonts you add to your IDL installation as described in "About TrueType Fonts" on page 2477 will also be available to the Object Graphics system.

About Vector Fonts

The vector fonts used by IDL were digitized by Dr. A.V. Hershey of the Naval Weapons Laboratory. Characters in the vector fonts are stored as equations, and can be scaled and rotated in three dimensions. They are drawn as lines on the current graphics device, and are displayed quickly and efficiently by IDL. The vector fonts are built into IDL itself, and are always available.

All the available fonts are illustrated in "Vector Font Samples" on page 2501. The default vector font (Font 3, Simplex Roman) is in effect if no font changes have been made.

Using Vector Fonts

To use the vector font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to -1 (negative one), or set the FONT keyword of one of the Direct Graphics routines equal to -1. The vector font system is the default font system for IDL.

Once the vector font system is selected, use an embedded formatting command to select a vector font (or fonts) for each string. (See "Embedded Formatting Commands" on page 2491 for details on embedded formatting commands.) The font selected "sticks" from string to string; that is, if you change fonts in one string, future strings will use the new font until you change it again or exit IDL.

For example, to use the Duplex Roman vector font for the title of a plot, you would use a command that looks like this:

```
PLOT, mydata, TITLE="!5Title of my plot"
```

Consult *Using IDL* for details on using the vector font system with IDL Object Graphics.

Specifying Font Size

To specify the size of a vector font, use the SET_CHARACTER_SIZE keyword to the DEVICE procedure. The SET_CHARACTER_SIZE keyword takes a two-element vector as its argument. The first element specifies the width of the "average"

character in the font (in pixels) and calculates a scaling factor that determines the height of the characters. (It is not important what the "average" character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The second element of the vector specifies the number of pixels between baselines of lines of text.

The ratio of the "average" character's height to its width differs from font to font, so specifying the same value [*x, y*] to the SET_CHARACTER_SIZE keyword may produce characters of different sizes in different fonts.

Note

While the first element of the vector specified to SET_CHARACTER_SIZE is technically a width, it is important to note that the width value has no effect on the widths of individual characters in the font. The width value is used only to calculate the appropriate scaling factor for the font.

For example, the following IDL commands display the word "Hello There" on the screen, in letters based on an "average" character that is 70 pixels wide, with 90 pixels between lines:

```
DEVICE, SET_CHARACTER_SIZE=[70,90]
XYOUTS, 0.1, 0.5, 'Hello!CThere'
```

You can also use the CHARSIZE keyword to the graphics routines or the CHARSIZE field of the !P System Variable to change the size of characters to a multiple of the size of the currently-selected character size. For example, to create characters one half the size of the current character size, you could use the following command:

```
XYOUTS, 0.1, 0.5, 'Hello!CThere', CHARSIZE=0.5
```

Note

Changing CHARSIZE adjusts both the character size and the space between lines.

ISO Latin 1 Encoding

The default font (Font 3, Simplex Roman) follows the ISO Latin 1 Encoding scheme and contains many international characters. The illustration of this font under "Vector Font Samples" on page 2501 can be used to find the octal codes for the special characters.

For example, suppose you want to display some text with an Angstrom symbol in it. Looking at the chart of font 3, we see that the Angstrom symbol has octal code 305.

Non-printable characters can be represented in IDL using octal or hexadecimal notation and the STRING function (see "Representing Non-Printable Characters" in Chapter 3 of *Building IDL Applications* for details). So the Angstrom can be printed by inserting a `STRING("305B)` character in our text string as follows:

```
XYOUTS,.1, .5, 'Here is an Angstrom symbol: ' + STRING("305B), $
    /NORM, CHARSIZE=3
```

Customizing the Vector Fonts

The EFONT procedure is a widget application that allows you to edit the Hershey fonts and save the results. Use this routine to add special characters or completely new, custom fonts to the Hershey fonts.

About TrueType Fonts

A TrueType Font

Beginning with version 5.2, five TrueType font families are included with IDL. The fonts included are:

Font Family	Italic	Bold	BoldItalic
Courier	Courier Italic	Courier Bold	Courier Bold Italic
Helvetica	Helvetica Italic	Helvetica Bold	Helvetica Bold Italic
Monospace Symbol			
Times	Times Italic	Times Bold	Times Bold Italic
Symbol			

Table H-1: TrueType font names

When TrueType fonts are rendered on an IDL graphics device or destination object, the font outlines are first scaled to the proper size. After scaling, IDL converts the character outline information to a set of polygons using a triangulation algorithm. When text in a TrueType font is displayed, IDL is actually drawing a set of polygons calculated from the font information. This process has two side effects:

1. Computation time is used to triangulate and create the polygons. This means that you may notice a slight delay the first time you use text in a particular font and size. Once the polygons have been created, the information is cached by IDL and there is no need to re-triangulate each time text is displayed. Subsequent uses of the same font and size happen quickly.
2. Because the TrueType font outlines are converted into polygons, you may notice some chunkiness in the displayed characters, especially at small point sizes. The smoothness of the characters will vary with the quality of the TrueType font you are using, the point size, and the general smoothness of the font outlines.

Using TrueType Fonts

To use the TrueType font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to 1 (one), or set the FONT keyword to on one of the Direct Graphics routines equal to 1.

Once the TrueType font system is selected, use the SET_FONT keyword to the DEVICE routine to select the font to use. The value of the SET_FONT keyword is a *font name string*. The font name is the name by which IDL knows the font; the names of the TrueType fonts included with IDL are listed under "About TrueType Fonts" on page 2477. Finally, specify the TT_FONT keyword in the call to the DEVICE procedure. For example, to use Helvetica Bold Italic, use the following statement:

```
DEVICE, SET_FONT='Helvetica Bold Italic', /TT_FONT
```

To use Times Roman Regular:

```
DEVICE, SET_FONT='Times', /TT_FONT
```

IDL's default TrueType font is 12 point Helvetica regular.

Specifying Font Size

To specify the size of a TrueType font, use the SET_CHARACTER_SIZE keyword to the DEVICE procedure. The SET_CHARACTER_SIZE keyword takes a two-element vector as its argument. The first element specifies the width of the "average" character in the font (in pixels) and calculates a scaling factor that determines the height of the characters. (It is not important what the "average" character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The second element of the vector specifies the number of pixels between baselines of lines of text.

The ratio of the "average" character's height to its width differs from font to font, so specifying the same value [*x, y*] to the SET_CHARACTER_SIZE keyword may produce characters of different sizes in different fonts.

Note

While the first element of the vector specified to SET_CHARACTER_SIZE is technically a width, it is important to note that the width value has no effect on the widths of individual characters in the font. The width value is used only to calculate the appropriate scaling factor for the font.

For example, the following IDL commands display the word “Hello There” on the screen in Helvetica Bold, in letters based on an “average” character that is 70 pixels wide, with 90 pixels between lines:

```
DEVICE, FONT='Helvetica Bold', /TT_FONT,
SET_CHARACTER_SIZE=[70,90]
XYOUTS, 0.1, 0.5, 'Hello!CThere'
```

You can also use the CHARSIZE keyword to the graphics routines or the CHARSIZE field of the !P System Variable to change the size of characters to a multiple of the size of the currently-selected character size. For example, to create characters one half the size of the current character size, you could use the following command:

```
XYOUTS, 0.1, 0.5, 'Hello!CThere', CHARSIZE=0.5
```

Note that changing the CHARSIZE adjusts both the character size and the space between lines.

Using Embedded Formatting Commands

Embedded formatting commands allow you to position text and change fonts within a single line of text. A subset of the embedded formatting commands available for use with the vector fonts are also available when using the TrueType font system. See “Embedded Formatting Commands” on page 2491 for a list of in-line formatting commands.

IDL TrueType Font Resource Files

The TrueType font system relies on a resource file named `ttfont.map`, located in the `resource/fonts/tt` subdirectory of the IDL directory. The format of the ttfont.map file is:

```
FontName    FileName    DirectGraphicsScale    ObjectGraphicsScale
```

where the fields in each row must be separated by white space (spaces and/or tabs). The fields contain the following information

The *Fontname* field contains the name that would be used for the SET_FONT keywords to the DEVICE routine.

The *Filename* field contains the name of the TrueType font file. On UNIX and VMS platforms, IDL will search for the file specified in the *FileName* field in the current directory (that is, in the `resource/fonts/tt` subdirectory of the IDL directory) if a bare filename is provided, or it will look for the file in the location specified by the fully-qualified file name if a complete path is provided. Because different platforms

use different path-specification syntax, we recommend that you place any TrueType font files you wish to add to the `ttfont.map` file in the `resource/fonts/tt` subdirectory of the IDL directory. On Macintosh and Windows platforms, this entry may be '*', in which case the font will be loaded from the operating system font list, but that the following two scale entries will be honored.

The *DirectGraphicsScale* field contains a correction factor that will be applied when choosing a scale factor for the glyphs prior to being rendered on a Direct Graphics device. If you want the tallest character in the font to fit exactly within the vertical dimension of the device's current character size (as set via the SET_CHARACTER_SIZE keyword to the DEVICE procedure), set the scale factor equal to 1.0. Change the scale factor to a smaller number to scale a smaller portion of the tallest character into the character size.

For example, suppose the tallest character in your font is "Å". Setting the scale factor to 1.0 will scale this character to fit the current character size, and then apply the same scaling to all characters in the font. As a result, the letter "M" will fill only approximately 85% of the full height of the character size. To scale the font such that the height of the "M" fills the vertical dimension of the character size, you would include the value 0.85 in the scale field of the `ttfont.map` file.

The *ObjectGraphicsScale* field contains a correction factor that will be applied when choosing a scale factor for the glyphs prior to being rendered on a Direct Graphics device. (This field works just like the *DirectGraphicsScale* field.) This scale factor should be set to 1.0 if the maximum ascent among all glyphs within a given font is to fit exactly within the font size (as set via the SIZE property to the IDLgrFont object).

Adding Your Own Fonts

To add a your own font to the list of fonts known to IDL, use a text editor to edit the `ttfont.map` file, adding the *FontName*, *FileName*, *DirectGraphicsScale*, and *ObjectGraphicsScale* fields for your font. You will need to restart IDL for the changes to the `ttfont.map` file to take effect. On Windows and Macintosh systems, you can use fonts that are not mentioned in the `ttfont.map` file, as long as they are installed in the Fonts control panel or Font folder, as described below.

Warning

If you choose to modify the `ttfont.map` file, be sure to keep a backup copy of the original file so you can restore the defaults if necessary. Note also that applications that use text may appear different on different platforms if the scale entries in the `ttfont.map` file have been altered.

Where IDL Searches for Fonts

The TrueType font files included with IDL are located in the `resource/fonts/tt` subdirectory of the IDL directory. When attempting to resolve a font name (specified via the FONT keyword to the DEVICE procedure), IDL will look in the `ttfont.map` file first. If it fails to find the specified font file in the `ttfont.map` file, it will search for the font file in the following locations:

UNIX and VMS

No further search will be performed. If the specified font is not included in the `ttfont.map` file, IDL will substitute Helvetica.

Microsoft Windows

If the specified font is not included in the `ttfont.map` file, IDL will search the list of fonts installed in the system (the fonts installed in the Font control panel). If the specified font is not found, IDL will substitute Helvetica.

Macintosh

If the specified font is not included in the `ttfont.map` file, IDL will search the list of fonts installed in the system (the fonts installed 1in the Fonts subfolder of the System folder). If the specified font is not found, IDL will substitute Helvetica.

About Device Fonts

Device, or hardware, fonts are fonts that are provided directly by your system's hardware or by software other than IDL. In past releases of IDL, we have used the term "*hardware fonts*" extensively to discuss these types of fonts. This is because in the early days of IDL, computer displays were either text-only terminals or dedicated graphics display devices such as plotters or Tektronix graphics terminals. These graphics displays generally came with a set of fonts built-in; when IDL asked the device to display characters in a built-in font, it was making a request to the hardware to display those characters.

As computer displays have become more sophisticated, the concept of fonts provided "by the hardware" has expanded to include fonts provided by the computer's operating system, or by font-management software. For example, many computers now use font management software like Adobe Type Manager to manage the fonts made available by the operating system to all applications. We use the term "device font" to refer to a font that is available to one of IDL's graphics devices from a source *other than IDL itself*. (In this case, a "graphics device" can be either a Direct Graphics device as specified by the DEVICE routine or an Object Graphics "destination" such as a window or a printer.) While device fonts may include fonts only available because a particular piece of hardware knows how to draw characters in that font (a pen plotter is an example of a device that may still have its own special fonts), in most cases device fonts are fonts supplied by the operating system to any application that may want to use them.

Which Device Fonts Are Available?

To determine which device fonts are available on your system and the exact font strings to specify for each, use the GET_FONTNAMES keyword to the DEVICE procedure. You can also use an operating system specific method to determine which fonts are available:

UNIX and VMS

On most systems, the `xlsfonts` utility displays a list of fonts available to the operating system.

Microsoft Windows

Fonts available to the system are displayed in the Fonts control panel. You may also have other fonts available if you use font-management software such as Adobe Type Manager.

Macintosh

Fonts available to the system are displayed in the Fonts folder in the System folder. You may also have other fonts available if you use font-management software such as Adobe Type Manager.

Using Device Fonts

To use the Device font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to 0 (zero), or set the FONT keyword to on one of the Direct Graphics routines equal to 0.

Once the Device font system is selected, use the SET_FONT keyword to the DEVICE routine to select the font to use. Because device fonts are specified differently on different platforms, the syntax of the *fontname* string depends on which platform you are using.

UNIX and VMS

Usually, the window system provides a directory of font files that can be used by all applications. List the contents of that directory to find the fonts available on your system. The size of the font selected also affects the size of vector drawn text. On some machines, fonts are kept in subdirectories of `/usr/lib/X11/fonts`. You can use the `xlsfonts` command to list available X Windows fonts.

For example, to select the font 8X13:

```
!P.FONT = 0
DEVICE, SET_FONT = '8X13'
```

Microsoft Windows

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT="font*modifier1*modifier2*...modifiern"
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: THIN, LIGHT, BOLD, HEAVY

- For font quality: DRAFT, PROOF
- For font pitch: FIXED, VARIABLE
- For font angle: ITALIC
- For strikeout text: STRIKEOUT
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font height in pixels.

For example, if you have Garamond installed as one of your Windows fonts, you could select 24-pixel cell height Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
!P.FONT = 0
DEVICE, SET_FONT = "GARAMOND*ITALIC*24"
PLOT, FINDGEN(10), TITLE = "IDL Plot"
```

This feature is compatible with TrueType and Adobe Type Manager (and, possibly, other type scaling programs for Windows). If you have TrueType or ATM installed, the TrueType or PostScript outline fonts are used so that text looks good at any size.

Macintosh

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT="font*modifier1*modifier2*...modifiern"
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: BOLD
- For font angle: ITALIC
- For font width: CONDENSED, EXTENDED
- For outlined text: OUTLINE, SHADOW
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font size, in points.

For example, if you have Garamond installed, you could select 24-point Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
IDL> !P.FONT = 0
IDL> DEVICE, SET_FONT = "GARAMOND*ITALIC*24"
IDL> PLOT, FINDGEN(10), TITLE = "IDL Plot"
```

Fonts and the PostScript Device

A special set of device fonts are available when the current Direct Graphics device is `PS` (PostScript). IDL includes font metric information for 35 standard PostScript fonts, and can create PostScript language files that include text in these fonts. (The 35 fonts known to IDL are listed in the following table; they the standard fonts included in memory in the vast majority of modern PostScript printers.) The PostScript font metric files (`*.afm` files) are located in the `resource/fonts/ps` subdirectory of the IDL directory.

AvantGarde-Book	Helvetica-Narrow-Oblique
AvantGarde-BookOblique	Helvetica-Oblique
AvantGarde-Demi	NewCenturySchlbk-Bold
AvantGarde-DemiOblique	NewCenturySchlbk-BoldItalic
Bookman-Demi	NewCenturySchlbk-Italic
Bookman-DemiItalic	NewCenturySchlbk-Roman
Bookman-Light	Palatino-Bold
Bookman-LightItalic	Palatino-BoldItalic
Courier	Palatino-Italic
Courier-Bold	Palatino-Roman
Courier-BoldOblique	Symbol
Courier-Oblique	Times-Bold
Helvetica	Times-BoldItalic
Helvetica-Bold	Times-Italic
Helvetica-BoldOblique	Times-Roman
Helvetica-Narrow	ZapfChancery-MediumItalic
Helvetica-Narrow-Bold	ZapfDingats
Helvetica-Narrow-BoldOblique	

Table H-2: Names of Supported PostScript Fonts

Using PostScript Fonts

To use a PostScript font in your Direct Graphics output, you must first specify that IDL use the device font system, they switch to the PS device, then choose a font using the SET_FONT keyword to the DEVICE procedure.

The following IDL commands choose the correct font system, set the graphics device, select the font Palatino Roman, open a PostScript file to print to, plot a simple data set, and close the PostScript file:

```
!P.FONT = 0
SET_PLOT, 'PS'
DEVICE, SET_FONT = 'Palatino-Roman', FILE = 'testfile.ps'
PLOT, INDGEN(10), TITLE = 'My Palatino Title'
DEVICE, /CLOSE
```

Note

Subsequent PostScript output will continue to use the font Palatino Roman until you explicitly change the font again, or exit IDL.

You can also specify PostScript fonts using a set of keywords to the DEVICE procedure. The keyword combinations for the fonts included with IDL are listed in the following table.

PostScript Font	DEVICE Keywords
Courier	/COURIER
Courier Bold	/COURIER, /BOLD
Courier Oblique	/COURIER, /OBLIQUE
Courier Bold Oblique	/COURIER, /BOLD, /OBLIQUE
Helvetica	/HELVETICA
Helvetica Bold	/HELVETICA, /BOLD
Helvetica Oblique	/HELVETICA, /OBLIQUE
Helvetica Bold Oblique	/HELVETICA, /BOLD, /OBLIQUE
Helvetica Narrow	/HELVETICA, /NARROW
Helvetica Narrow Bold	/HELVETICA, /NARROW, /BOLD

Table H-3: The Standard 35 PostScript Fonts

PostScript Font	DEVICE Keywords
Helvetica Narrow Oblique	/HELVETICA, /NARROW, /OBLIQUE
Helvetica Narrow Bold Oblique	/HELVETICA, /NARROW, /BOLD, /OBLIQUE
ITC Avant Garde Gothic Book	/AVANTGARDE, /BOOK
ITC Avant Garde Gothic Book Oblique	/AVANTGARDE, /BOOK, /OBLIQUE
ITC Avant Garde Gothic Demi	/AVANTGARDE, /DEMI
ITC Avant Garde Gothic Demi Oblique	/AVANTGARDE, /DEMI, /OBLIQUE
ITC Bookman Demi	/BKMAN, /DEMI
ITC Bookman Demi Italic	/BKMAN, /DEMI, /ITALIC
ITC Bookman Light	/BKMAN, /LIGHT
ITC Bookman Light Italic	/BKMAN, /LIGHT, /ITALIC
ITC Zapf Chancery Medium Italic	/ZAPFCHANCERY, /MEDIUM, /ITALIC
ITC Zapf Dingbats	/ZAPFDINGBATS
New Century Schoolbook	/SCHOOLBOOK
New Century Schoolbook Bold	/SCHOOLBOOK, /BOLD
New Century Schoolbook Italic	/SCHOOLBOOK, /ITALIC
New Century Schoolbook Bold Italic	/SCHOOLBOOK, /BOLD, /ITALIC
Palatino	/PALATINO
Palatino Bold	/PALATINO, /BOLD
Palatino Italic	/PALATINO, /ITALIC
Palatino Bold Italic	/PALATINO, /BOLD, /ITALIC
Symbol	/SYMBOL
Times	/TIMES
Times Bold	/TIMES, /BOLD

Table H-3: The Standard 35 PostScript Fonts

PostScript Font	DEVICE Keywords
Times Italic	/TIMES, /ITALIC
Times Bold Italic	/TIMES, /ITALIC, /BOLD

Table H-3: The Standard 35 PostScript Fonts

For example to use the PostScript font Palatino Bold Italic, you could use either of the following DEVICE commands:

```
DEVICE, SET_FONT = 'Palatino*Bold*Italic'
DEVICE, /PALATINO, /BOLD, /ITALIC
```

Changing the PostScript Font Assigned to an Index

You can change the PostScript font assigned to a given font index using the FONT_INDEX keyword to the DEVICE procedure. Font indices and their use are discussed in "Embedded Formatting Commands" on page 2491.

Changing the font index assigned to a font can be useful when changing PostScript fonts in the middle of a text string. For example, the following statements map Palatino Bold Italic to font index 4, and then output text using that font and the Symbol font:

```
; Map the font selected by !4 to be PalatinoBoldItalic:
DEVICE, /PALATINO, /BOLD, /ITALIC, FONT_INDEX=4
; Output "Alpha :" in PalatinoBoldItalic followed by an
; Alpha character:
XYOUTS, .3, .5, /NORMAL, "!4Alpha: !9a", FONT=0, SIZE=5.0
```

Adding Your Own PostScript Fonts

Because the 35 PostScript fonts included with IDL are built in to a PostScript printer's memory, the IDL distribution includes only the font metric files, which provide positioning information. In addition, the `.afm` files used by IDL are specially processed to provide the information in a format IDL expects.

You can add your own PostScript fonts to the list of fonts known to IDL if you have access to the PostScript font file (usually named *font*`.pfb`) to load into your printer and to the *font*`.afm` file supplied by Adobe. You can convert the standard `.afm` file into a file IDL understands using the IDL routine PSAFM. Consult the file `README.TXT` in the `resource/fonts/ps` subdirectory of the IDL directory for details on adding PostScript fonts to your system.

Choosing a Font Type

Some of the issues involved in choosing between vector, TrueType, and device fonts are explained below.

Appearance

Vector-drawn characters are of medium quality, suitable for most uses. TrueType characters are of relatively high quality, although at some point sizes the triangulation process (described in "About TrueType Fonts" on page 2477) may cause characters to appear slightly jagged. The appearance of device characters varies from mediocre (characters found in many graphics terminals) to publication quality (PostScript).

Three-Dimensional Transformations

Vector or TrueType fonts should always be used with three-dimensional transformations. Both vector and TrueType characters pass through the same transformations as the rest of the plot, yielding a better looking plot. See "Three-Dimensional Graphics" in Chapter 12 of *Using IDL* for an example of vector-drawn characters with three-dimensional graphics. Device characters are not subject to the three-dimensional transforms.

Portability

The vector-drawn fonts work using any graphics device and look the same on every device (within the limitations of device resolution) on any system supported by IDL.

TrueType fonts are available only on the `X`, `WIN`, `MAC`, `PRINTER`, `PS`, and `Z` Direct Graphics devices, and in IDL's Object Graphics system. If you use only the fonts supplied with IDL, TrueType fonts also look the same on every supported device (again within the limits of the device resolution). If you use TrueType fonts other than those supplied with IDL, your font may not be installed on the system which runs your program. In this case, IDL will substitute a known font for the missing font.

The appearance, size, and availability of device fonts varies greatly from device to device. Many, if not most, of the positioning and font changing commands recognized by the vector-drawing routines are ignored when using device fonts. The exception to this rule is the Direct Graphics `PS` device; if you use one of the PostScript fonts supported by IDL, the PostScript output from the `PS` device will be identical between platforms.

Computational Time

Device fonts are generally rendered the most quickly, since the hardware device or operating system handles all computations and caching.

It takes more computer time to draw characters with line vectors and generally results in more input/output. However, this is not an important issue unless the plot contains a large number of characters or the transmission link to the device is very slow.

The initial triangulation step used when displaying TrueType fonts for the first time can be computationally expensive. However, since the font shapes are cached, subsequent uses of the same font are relatively speedy.

Flexibility

Vector-drawn fonts provide a great deal of flexibility. There are many different typefaces available, as shown in the tables at the end of this chapter. In addition, such fonts can be arbitrarily scaled, rotated, and transformed.

TrueType fonts support fewer embedded formatting commands than do the vector fonts, and cannot be scaled, rotated, or transformed.

The abilities of hardware-generated characters differ greatly between devices so it is not possible to make a blanket statement on when they should be used—the best font to use depends on the available hardware. In general, however, the vector or TrueType fonts are easier to use and often provide superior results to what is available from the hardware. See the discussion of the device you are using in Appendix B, "IDL Graphics Devices" for details on the hardware-generated characters provided by that device.

Print Quality

For producing publication-quality output, we recommend using either the TrueType font system or the Direct Graphics PS device and one of the PostScript fonts supported by IDL.

Embedded Formatting Commands

When you use vector, TrueType, and some device fonts, text strings can include embedded formatting commands that facilitate subscripting, superscripting, and equation formatting. The method used is similar to that developed by Grandle and Nystrom (1980). Embedded formatting commands are always introduced by the exclamation mark, (`!`). (The string "`!!`" is used to produce a literal exclamation mark.)

Note

Embedded formatting commands prefaced by the exclamation mark have no special significance for hardware-generated characters unless the ability is provided by the particular device in use. The IDL PostScript device driver accepts many of the standard embedded formatting commands, and is described here. If you wish to use hardware fonts with IDL Direct Graphics devices other than the PostScript device, consult the description of the device in Appendix B, "IDL Graphics Devices" before trying to use these commands with hardware characters.

You can determine whether embedded formatting commands are available for use with device fonts on your current graphics device by inspecting bit 12 of the *Flags* field of the !D System Variable. Use the IDL statement:

```
IF (!D.FLAGS AND 4096) NE 0 THEN PRINT, 'Bit is set.'
```

to determine whether bit 12 of the *Flags* field is set for the current graphics device.

Changing Fonts within a String

You can change fonts one or more times within a text string using the embedded font commands shown in the table below. The character following the exclamation mark can be either upper or lower case.

Examples of commands used to change fonts in mid-string are included in "Formatting Command Examples" on page 2494.

Command	Vector Font	TrueType Font	PostScript Font
!3	Simplex Roman (default)	Helvetica	Helvetica
!4	Simplex Greek	Helvetica Bold	Helvetica Bold
!5	Duplex Roman	Helvetica Italic	Helvetica Narrow
!6	Complex Roman	Helvetica Bold Italic	Helvetica Narrow Bold Oblique
!7	Complex Greek	Times	Times Roman
!8	Complex Italic	Times Italic	Times Bold Italic
!9	Math/special characters	Symbol	Symbol
!M	Math/special characters (change effective for one character only)	Symbol	Symbol
!10	Special characters	Symbol *	Zapf Dingbats
!11(!G)	Gothic English	Courier	Courier
!12(!W)	Simplex Script	Courier Italic	Courier Oblique
!13	Complex Script	Courier Bold	Palatino
!14	Gothic Italian	Courier Bold Italic	Palatino Italic
!15	Gothic German	Times Bold	Palatino Bold
!16	Cyrillic	Times Bold Italic	Palatino Bold Italic
!17	Triplex Roman	Helvetica *	Avant Garde Book
!18	Triplex Italic	Helvetica *	New Century Schoolbook
!19		Helvetica *	New Century Schoolbook Bold
!20	Miscellaneous	Helvetica *	Undefined User Font
!X	Revert to the entry font	Revert to the entry font	Revert to the entry font
* The font assigned to this index may be replaced in a future release of IDL.			

Table H-4: Embedded Font Selection Commands

Positioning Commands

The positioning and other font-manipulation commands are described in the following table. Examples of commands used to position text are included in "Formatting Command Examples" on page 2494.

Command	Action
!A	Shift above the division line .
!B	Shift below the division line .
!C	"Carriage return," begins a new line of text. Shift back to the starting position and down one line.
!D	Shift down to the first level subscript and decrease the character size by a factor of 0.62.
!E	Shift up to the exponent level and decrease the character size by a factor of 0.44.
!I	Shift down to the index level and decrease the character size by a factor of 0.44.
!L	Shift down to the second level subscript. Decrease the character size by a factor of 0.62.
!N	Shift back to the normal level and original character size.
!R	Restore position. The current position is set from the top of the saved positions stack.
!S	Save position. The current position is saved on the top of the saved positions stack.
!U	Shift to upper subscript level. Decrease the character size by a factor of 0.62.
!X	Return to the entry font.
!Z(u_0,u_1,...,u_n)	Display one or more character glyphs according to their unicode value. Each u_i within the parentheses will be interpreted as a 16-bit hexadecimal unicode value. If more than one unicode value is to be included, the values should be separated by commas.
!!	Display the ! symbol.

Table H-5: Vector-Drawn Positioning and Miscellaneous Commands

Formatting Command Examples

The figure below illustrates the relative positions and effects on character size of the level commands. In this figure, the letters "**!N**" are normal level and size characters.

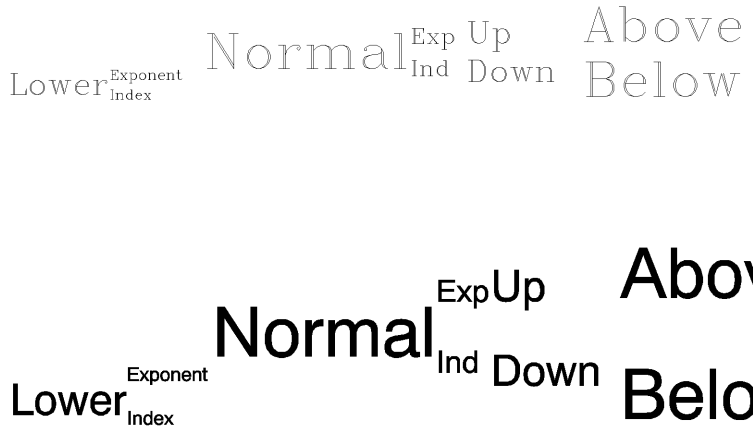


Figure H-1: Positioning commands with vector fonts (top) and TrueType fonts (bottom).

The positioning shown was created with the following command:

```
XYOUTS, 0.1, 0.3, $
'!LLower!S!EExponent!R!IIndex!N  Normal!S!EExp!R!IInd!N!S!U Up
!R!D Down!N!S!A Above!R!B Below'
```

Note that the string argument to the XYOUTS procedure must be entered on a single line rather than the two lines shown above.

A Complex Equation

Embedded positioning commands and the vector font system can be used to create the integral shown below:

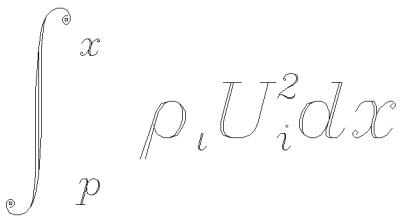


Figure H-2: An integral created with the vector fonts.

The command string used to produce the integral is:

```
XYOUTS, 0, .2, $
    '!MI!S!A!E!8x!R!B!Ip!N !7q!Ii!N!8U!S!E2!R!Ii!Ndx', $
        SIZE = 3, /NORMAL
```

Remember that the case of the letter in an embedded command is not important. The string may be broken down into the following components:

!MI

Changes to the math set and draws the integral sign, uppercase I.

!S

Saves the current position on the position stack.

!A!E!8x

Shifts above the division line and to the exponent level, switches to the Complex Italic font (Font 8), and draws the "*x*."

!R!B!Ip

Restores the position to the position immediately after the integral sign, shifts below the division line to the index level, and draws the "*p*."

!N !7q

Returns to the normal level, advances one space, shifts to the Complex Greek font (Font 7), and draws the Greek letter rho, which is designated by "*q*" in this set.

!Ii!N

Shifts to the index level and draws the "*i*" at the index level. Returns to the normal level.

!8U

Shifts to the Complex Italic font (Font 8) and outputs the upper case "*U*."

!S!E2

Saves the position and draws the exponent "2."

!R!Ii

Restores the position and draws the index "*i*."

!N dx

Returns to the normal level and outputs "*dx*."

Note

The equation shown in the figure above could not be created so simply using the TrueType font system, because the large integral symbol is broken into two or more characters in the TrueType fonts.

Vector-Drawn Font Example

IDL uses vector-drawn font when the value of the system variable !P.FONT is -1. This is the default condition. Initially, all characters are drawn using the Simplex Roman font (Font 3). When plotting, font changing commands may be embedded in the title strings keyword arguments (XTITLE, YTITLE, and TITLE) to select other fonts. For example, the following statement uses the Complex Roman font (Font 6) for the *x*-axis title:

```
PLOT, X, XTITLE = '!6X Axis Title'
```

This font remains in effect until explicitly changed. The order in which the annotations are drawn is main title, *x*-axis numbers, *x*-axis title, *y*-axis numbers, and *y*-axis title. Strings to be output also may contain embedded information

selecting subscripting, superscripting, plus other features that facilitate equation formatting.

The following statements were used to produce the figure below. They serve as an example of a plot using vector-drawn characters and of equation formatting.

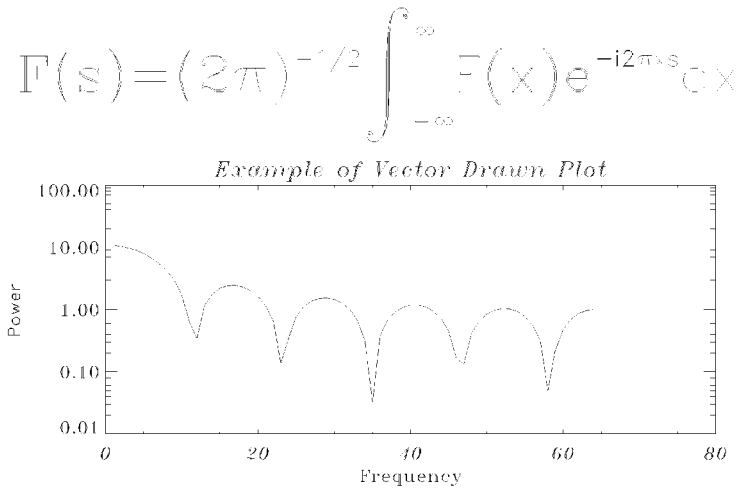


Figure H-3: Example of a Vector-drawn Plot.

```
; Define an array:
X = FLTARR(128)
; Make a step function:
X[30:40] = 1.0
;Take FFT and magnitude:
X = ABS(FFT(X, 1))
; Produce a log-linear plot. Use the Triplex Roman font for the
; x title (!17), Duplex Roman for the y title (!5), and Triplex
; Italic for the main title (!18). The position keyword is used to
; shrink the plotting window:
PLOT, X[0:64], /YLOG, XTITLE = '!17Frequency', $
   YTITLE = '!5Power', $
   TITLE = '!18Example of Vector Drawn Plot', $
   POSITION = [.2, .2, .9, .6]
SS = '!6F(s) = (2!4p)!e-1/2!n !mi!s!a!e!m $
     !r!b!i ' + '-!m $
; String to produce equation:
     !nF(x)e !e-i2!4p!3xs!ndx'
XYOUTS, 0.1, .75, SS, SIZE = 3, $
; Output string over plot. The NOCLIP keyword is needed because
; the previous plot caused the clipping region to shrink:
     /NORMAL, /NOCLIP
```

TrueType Font Samples

The following figures show roman versions of the four TrueType font families included with IDL. The character sets for the bold, italic, and bold italic versions of these fonts are the same as the roman versions.

The SHOWFONT command was used to create these figures. For example, to display the following figure on the screen, you would the command:

```
SHOWFONT, 'Helvetica', 'Helvetica', /TT_FONT
```

For more information, see "SHOWFONT" on page 1248.

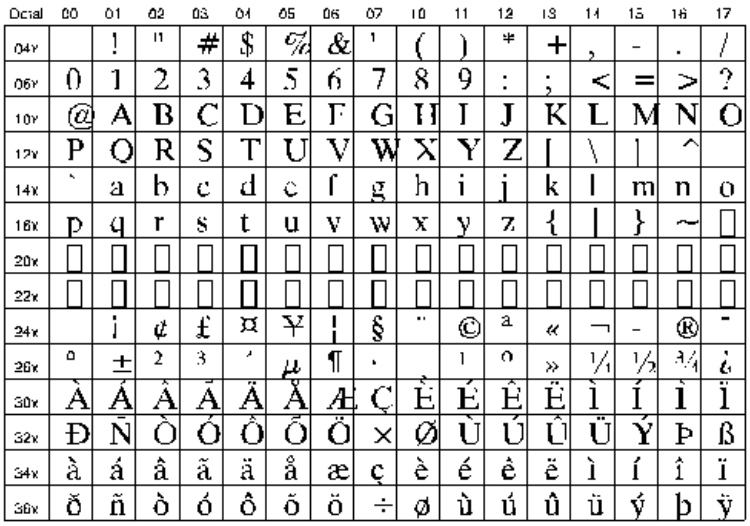
Note

The following font charts are numbered in octal notation. To read the octal number of a character, add the column index (along the top) to ten times the row index. For example, the capital letter "A" is octal 101, and the copyright symbol is octal 251.

Font Helvetica

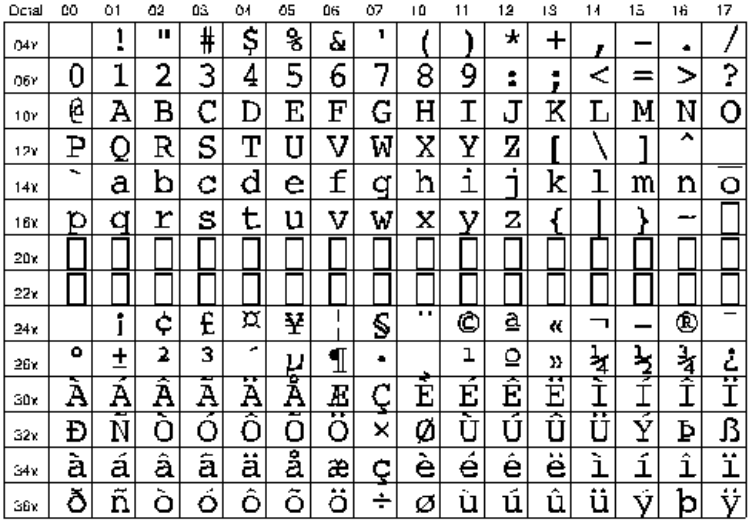
Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12x	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
14x	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16x	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	□
20x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
22x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
24x		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	-	®	¯
26x	°	±	2	3	´	µ	¶	·	¸	1	º	»	¼	½	¾	¿
30x	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
32x	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
34x	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
36x	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

Font Times



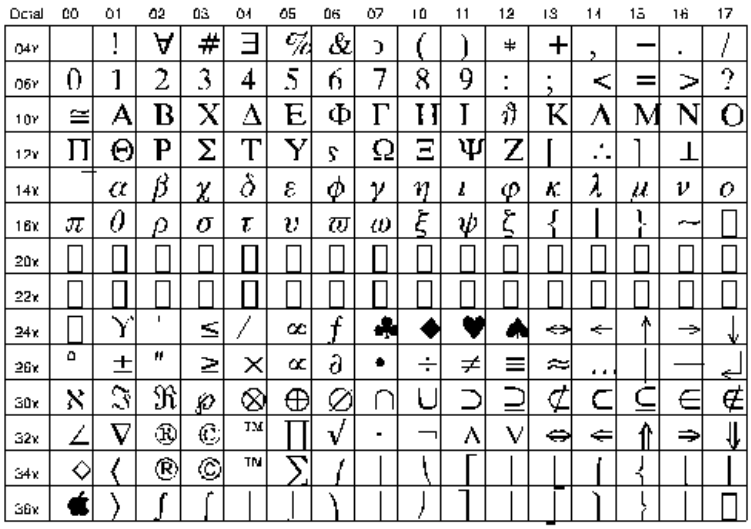
Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12x	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	
14x	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16x	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	□
20x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
22x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
24x		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	-	®	¯
26x	°	±	2	3	´	µ	¶	·	¸	1	º	»	¼	½	¾	¿
30x	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
32x	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
34x	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
36x	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

Font Courier



Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12x	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	
14x	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16x	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	□
20x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
22x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
24x		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬	–	®	¯
26x	°	±	2	3	´	µ	¶	·	¸	1	º	»	¼	½	¾	¿
30x	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
32x	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
34x	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
36x	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

Font Symbol



Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	∀	#	∃	%	&	∋	(	)	*	+	,	−	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	≅	Α	Β	Χ	Δ	Ε	Φ	Γ	Η	Ι	ϑ	Κ	Λ	Μ	Ν	Ο
12x	Π	Θ	Ρ	Σ	Τ	Υ	ς	Ω	Ξ	Ψ	Ζ	[	∴	]	⊥	
14x	‾	α	β	χ	δ	ε	φ	γ	η	ι	φ	κ	λ	μ	ν	ο
16x	π	θ	ρ	σ	τ	υ	ϖ	ω	ξ	ψ	ζ	{	|	}	~	□
20x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
22x	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
24x	□	ϒ	′	≤	/	∞	ƒ	♣	♦	♥	♠	↔	←	↑	→	↓
26x	°	±	″	≥	×	∝	∂	•	÷	≠	≡	≈	…	|	—	↵
30x	ℵ	ℑ	ℜ	℘	⊗	⊕	∅	∩	∪	⊃	⊇	⊄	⊂	⊆	∈	∉
32x	∠	∇	®	©	™	∏	√	·	¬	∧	∨	⇔	⇐	⇑	⇒	⇓
34x	◊	〈	®	©	™	∑	⎛	⎜	⎝	⎡	⎢	⎣	⎧	⎨	⎩	⎪
36x		〉	⌠	⌡	⎮	⎟	⎞	⎢	⎠	⎤	⎥	⎦	⎫	⎬	⎭	□

Vector Font Samples

The following figures show samples of various vector-drawn fonts. The SHOWFONT command was used to create these figures. For example, to display the following figure on the screen, you would the command:

```
SHOWFONT, 3, 'Simplex Roman'
```

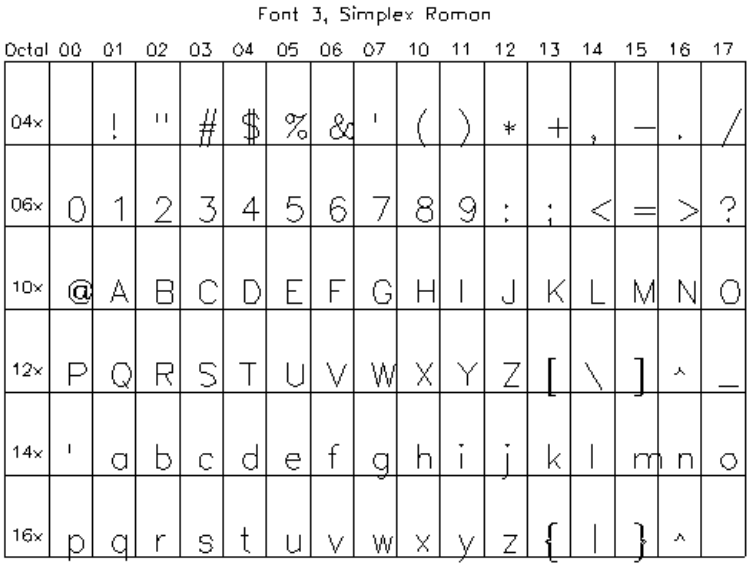
To output this figure to a postscript file, you would use the following commands:

```
SET_PLOT, 'PS'
SHOWFONT, 3, 'Simplex Roman'
DEVICE, /CLOSE
```

For more information, see “SHOWFONT” on page 1248.

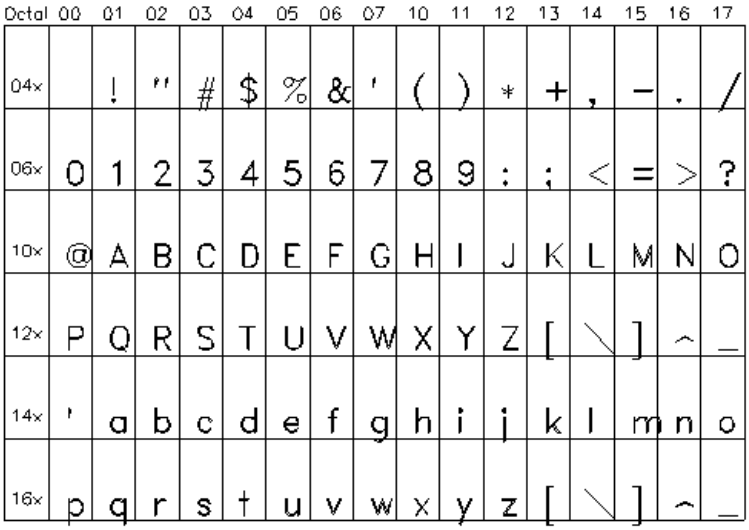
Note

The following font charts are numbered in octal notation. To read the octal number of a character, add the column index (along the top) to ten times the row index. For example, the capital letter “A” is octal 101, and the “$” symbol is octal 44.

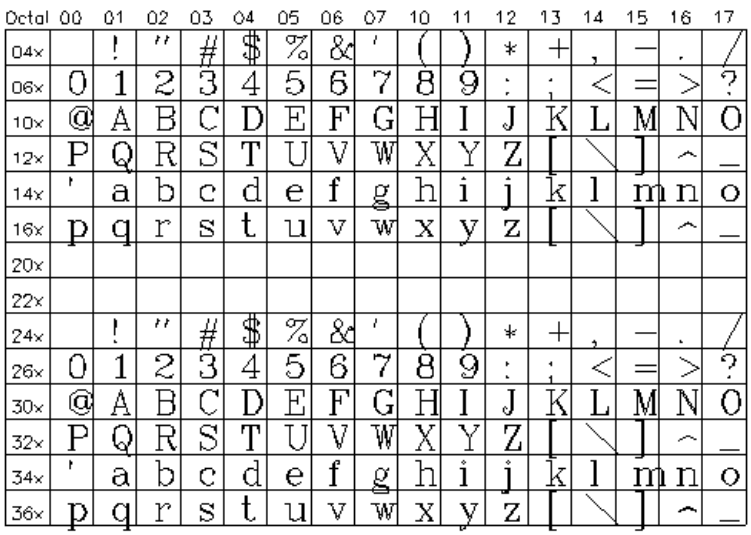


Font 4, Simplex Greek

Font 5, Duplex Roman



Font 6, Complex Roman

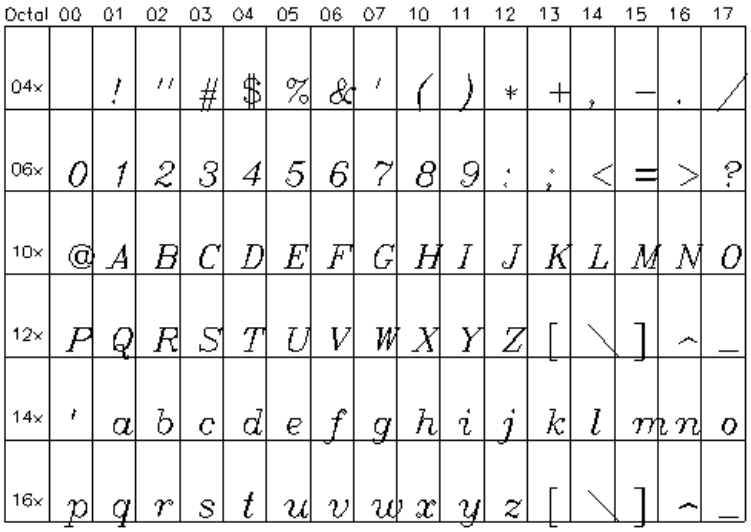


Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12x	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
14x	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16x	p	q	r	s	t	u	v	w	x	y	z	[	\	]	^	_
20x																
22x																
24x		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
26x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
30x	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
32x	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
34x	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
36x	p	q	r	s	t	u	v	w	x	y	z	[	\	]	^	_

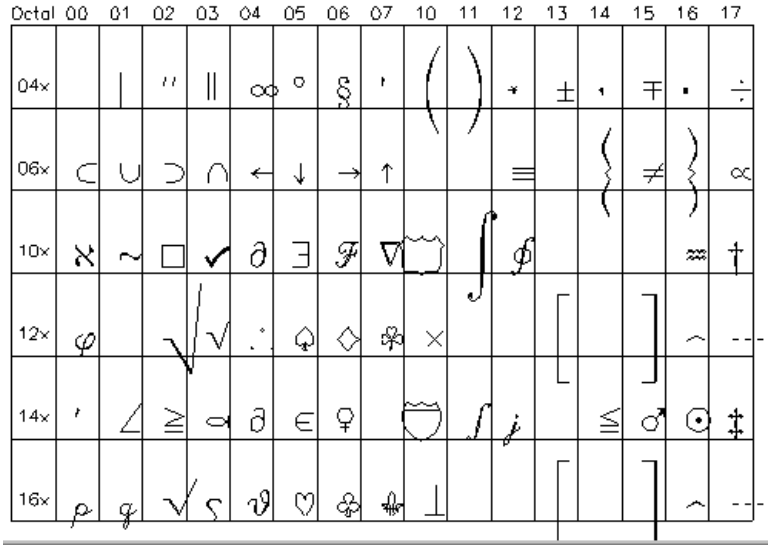
Font 7, Complex Greek

Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	@	A	B	Γ	Δ	E	Z	H	Θ	I	K	Λ	M	N	Ξ	O
12x	Π	P	Σ	T	ϒ	Φ	X	Ψ	Ω	∞	ℓ	[	\	]	^	_
14x	'	α	β	γ	δ	ϵ	ζ	η	θ	ι	κ	λ	μ	ν	ξ	ο
16x	π	ρ	σ	τ	υ	ϕ	χ	ψ	ω	∞	ℓ	[	\	]	^	_

Font 8, Complex Italic

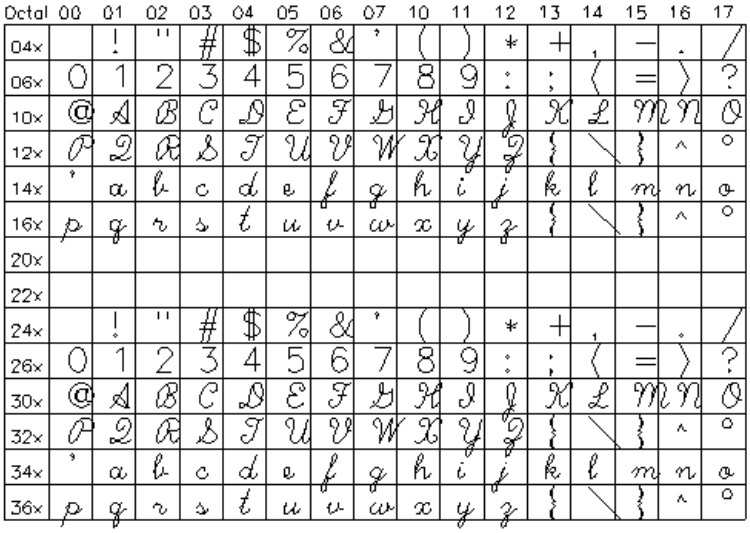


Font 9, Math and Special

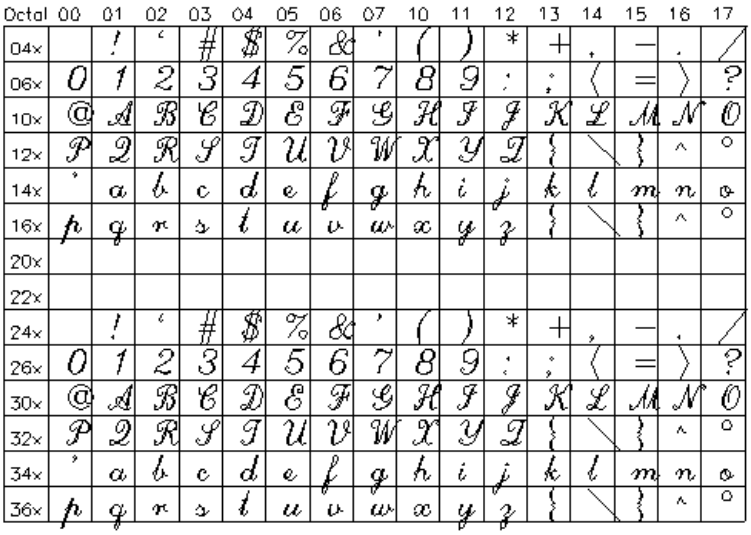


Font 11, Gothic English

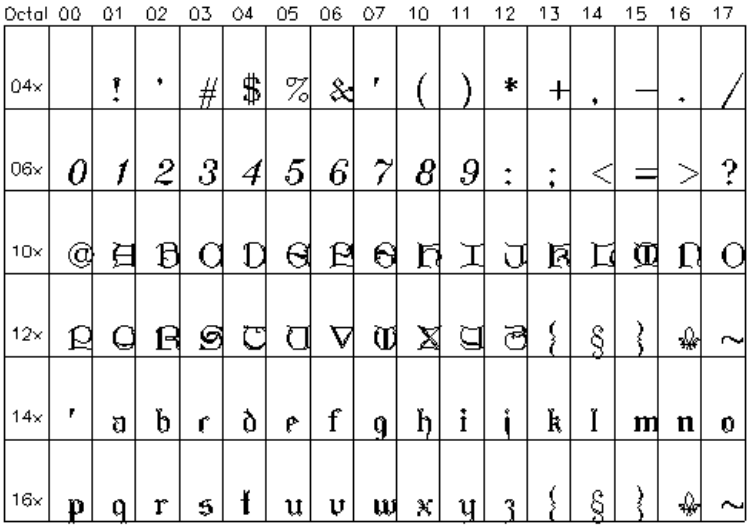
Font 12, Simplex Script



Font 13, Complex Script



Font 14, Gothic Italian



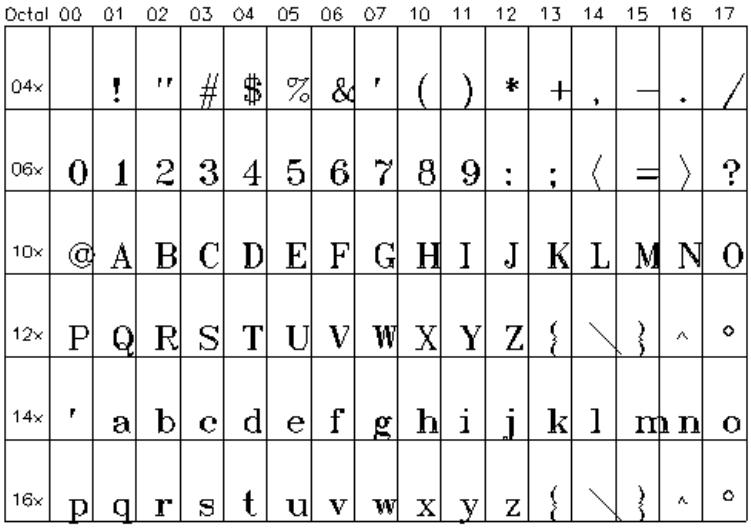
Font 15, Gothic German

Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	'	#	$	%	&	'	(	)	*	+	,	–	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10x	s	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12x	P	Q	R	S	T	U	V	W	X	Y	Z	{	ß	}	ß	~
14x	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16x	p	q	r	s	t	u	v	w	x	y	z	{	ß	}	ß	~

Font 16, Cyrillic

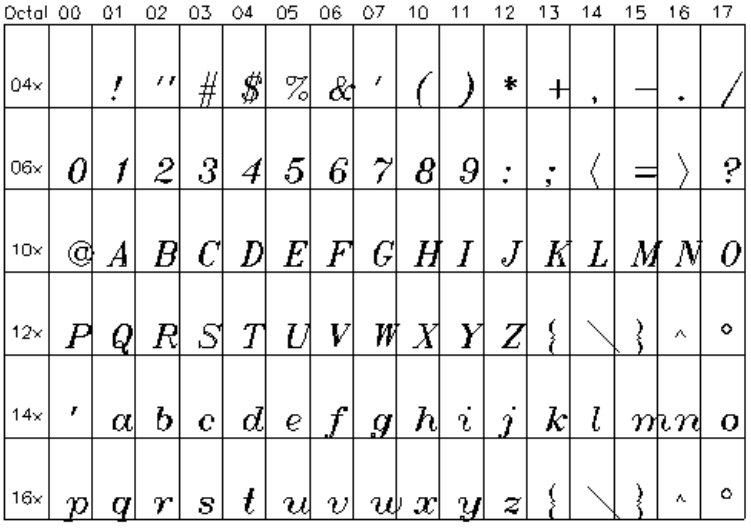
Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04x		!	Ю	Ъ	$	Э	&	'	(	)	*	+	,	–	.	/
06x	0	1	2	3	4	5	6	7	8	9	:	я	ъ	=	ы	?
10x	ь	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
12x	П	Р	С	Т	У	Ф	Х	Ц	Ч	Ш	Щ	Ы	э	Ь	ю	Я
14x	'	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
16x	п	р	с	т	у	ф	х	ц	ч	ш	щ	Ы	э	Ь	ю	Я
20x																
22x																
24x		!	Ю	Ъ	$	Э	&	'	(	)	*	+	,	–	.	/
26x	0	1	2	3	4	5	6	7	8	9	:	я	ъ	=	ы	?
30x	ь	А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О
32x	П	Р	С	Т	У	Ф	Х	Ц	Ч	Ш	Щ	Ы	э	Ь	ю	Я
34x	'	а	б	в	г	д	е	ж	з	и	й	к	л	м	н	о
36x	п	р	с	т	у	ф	х	ц	ч	ш	щ	Ы	э	Ь	ю	Я

Font 17, Triplex Roman



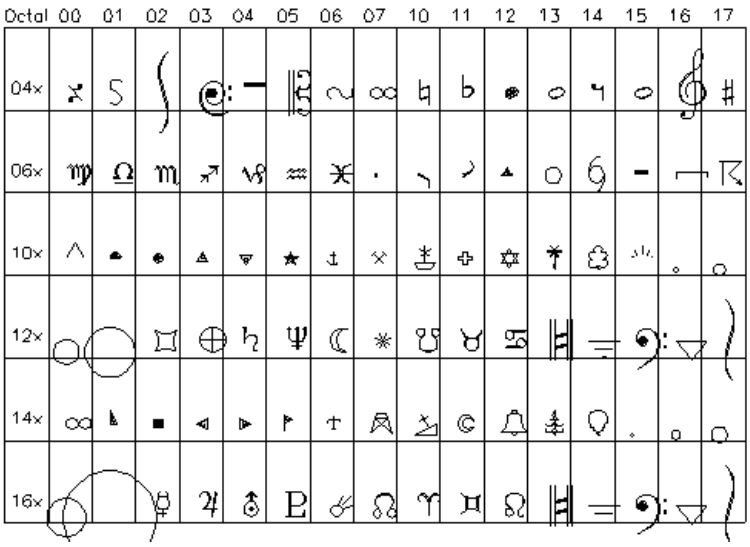
Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04×		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
06×	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10×	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12×	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	°
14×	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16×	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	°

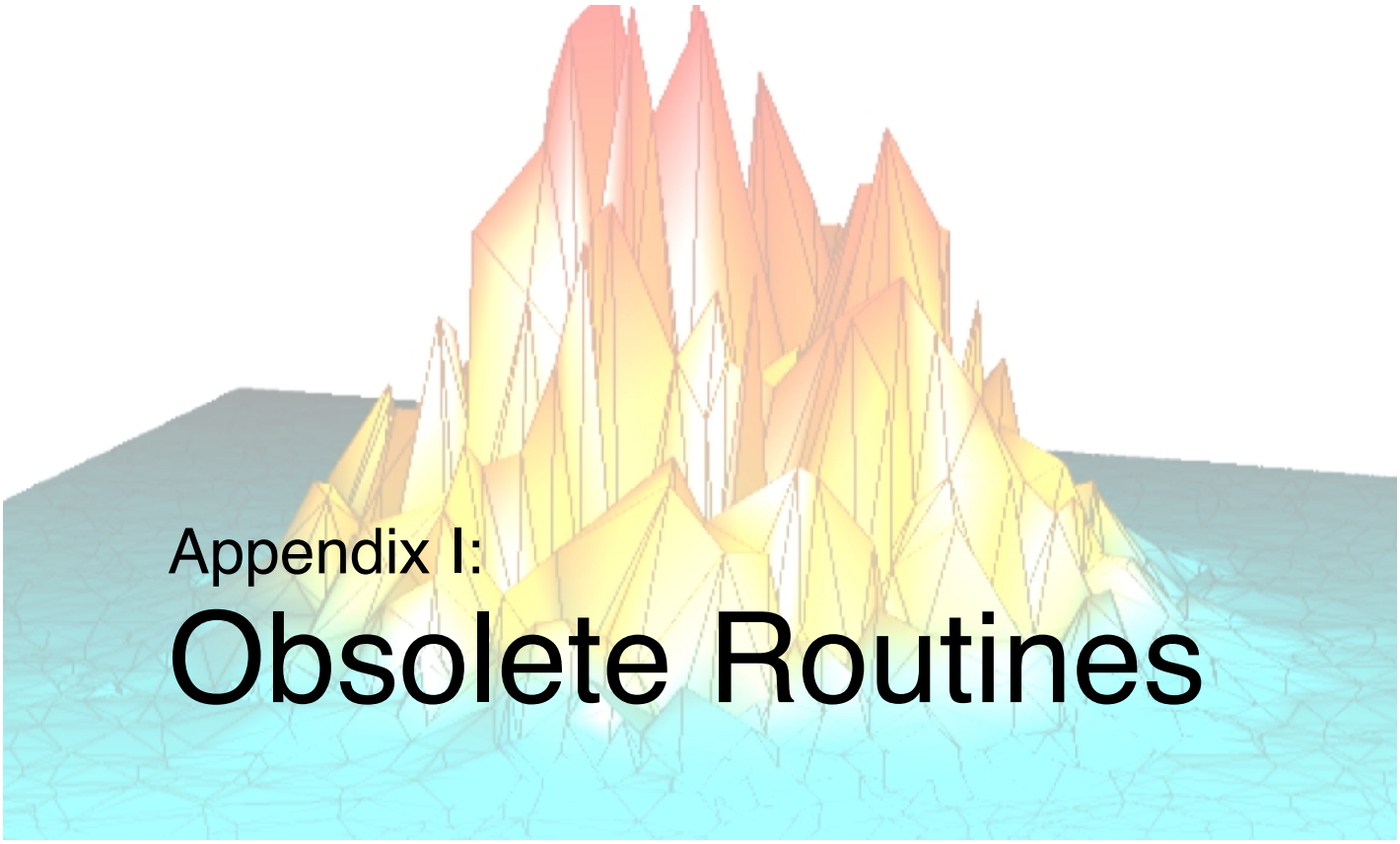
Font 18, Triplex Italic



Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17
04×		!	"	#	$	%	&	'	(	)	*	+	,	–	.	/
06×	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
10×	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
12×	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	°
14×	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
16×	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	°

Font 20, Miscellaneous





Appendix I: Obsolete Routines

The following topics are covered in this appendix:

What Are Obsolete Routines?

To improve the overall quality and functionality of IDL, Research Systems, Inc. occasionally replaces existing routines with new, improved routines. In many cases, existing routines are improved without changing their existing behavior—through improvements of the underlying algorithms, for example, or by adding keyword functionality. In some cases, however, the improved methods are incompatible with the old. In these situations, we consider the routines that we have replaced to be *obsolete*.

This chapter lists the routines that have become obsolete in each version of IDL. These routines are not documented in the online help. To view reference information for routines obsoleted in IDL version 5.0 and later, see the `obsolete.pdf` file in the `docs` subdirectory of the IDL distribution. Routines obsoleted in IDL 4.0 and earlier are not documented in the `obsolete.pdf` file. If a `.pro` file for the routine exists, it is located in the `lib/obsolete` subdirectory of the IDL distribution. You can read the documentation header of a routine in the `obsolete` directory either by opening the `.pro` file or using the DOC_LIBRARY routine.

Routines Obsoleted in IDL 5.4

The following routines were present in IDL Version 5.3 but became obsolete in IDL Version 5.4.

Routine	Replaced by	.pro File?
POLYFITW	POLY_FIT, MEASURE_ERRORS keyword	`polyfitw.pro`
RIEMANN	RADON	

Table I-1: Routines Obsoleted in IDL 5.4

Routines Obsoleted in IDL 5.3

The following routines were present in IDL Version 5.2 but became obsolete in IDL Version 5.3.

Routine	Replaced by	.pro File?
HDF_DFSD_* Routines	HDF_SD_* Routines	
RSTRPOS	STRPOS, /REVERSE_SEARCH	`rstrpos.pro`
STR_SEP	STRSPLIT for single character delimiters STRSPLIT, /REGEX for longer delimiters	`str_sep.pro`

Table I-2: Routines Obsoleted in IDL 5.3

Routines Obsoleted in IDL 5.2

The following routines were present in IDL Version 5.1 but became obsolete in IDL Version 5.2.

Routine	Replaced by	.pro File?
DEMO_MODE	LMGR	`demo_mode.pro`

Table I-3: Routines Obsoleted in IDL 5.2

Routines Obsoleted in IDL 5.1

The following routines were present in IDL Version 5.0 but became obsolete in IDL Version 5.1.

Routine	Replaced by	.pro File?
SLICER	SLICER3	`slicer3.pro`

Table I-4: Routines Obsoleted in IDL 5.1

Routines Obsoleted in IDL 5.0

The following routines were present in IDL Version 4.0 but became obsolete in IDL Version 5.0.

Routine	Replaced by	.pro File?
DDE Routines	n/a	
GETHELP	OUTPUT keyword to HELP	
HANDLE_CREATE	PTR_NEW	
HANDLE_FREE	PTR_FREE	
HANDLE_INFO	PTR_VALID	
HANDLE_MOVE	n/a	
HANDLE_VALUE	dereference operator	
INP, INPW, OUTP, OUTPW	n/a	
PICKFILE	DIALOG_PICKFILE	
Old RPC API	New RPC API	
.SIZE Executive Command	No longer needed	
TIFF_DUMP	n/a	
TIFF_READ	READ_TIFF	
TIFF_WRITE	WRITE_TIFF	
WIDED	n/a	
WIDGET_MESSAGE	DIALOG_MESSAGE	

Table I-5: Routines Obsoleted in IDL 5.0

Routines Obsoleted in IDL 4.0 or Earlier

The following routines became obsolete in IDL version 4.0 or earlier. These routines are not documented in the `obsolete.pdf` file. If a `.pro` file for the routine exists, it is located in the `obsolete` subdirectory of the `lib` directory of the IDL distribution. You can read the documentation header of a routine in the `obsolete` directory either by opening the `.pro` file or using the DOC_LIBRARY routine.

Routine	Replaced by	.pro File?
ADDSYSVAR	DEFSYSV	`addsysvar.pro`
ADJCT	XPALETTE	`adjct.pro`
ANOVA	KW_TEST	`anova.pro`
ANOVA_UNEQUAL	KW_TEST	`anova_uneqal.pro`
BETAI	IBETA	`betai.pro`
C_EDIT	XPALETTE	`c_edit.pro`
CALL_VMS	CALL_EXTERNAL	
CHI_SQR	CHISQR_CVF	`chi_sqr.pro`
CHI_SQR1	CHISQR_PDF	`chi_sqr1.pro`
COLOR_EDIT	XPALETTE	`color_edit.pro`
CONTINGENT	CTI_TEST	`contingent.pro`
CORREL_MATRIX	CORRELATE	`correl_matrix.pro`
COSINES	n/a	`cosines.pro`
CW_BSELECTOR	WIDGET_DROPLIST	`cw_bselector.pro`
CW_LOADSTATE	NO_COPY keyword to WIDGET_CONTROL	`cw_loadstate.pro`
CW_SAVESTATE	NO_COPY keyword to WIDGET_CONTROL	`cw_savestate.pro`
DIFFEQ_23	RK4	`diffeq_23.pro`
DIFFEQ_45	RK4	`diffeq_23.pro`

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Routine	Replaced by	.pro File?
DISP_TEXT	XYOUTS	disp_text.pro
EIGEN_II	EIGENVEC	eigen_ii.pro
EQUAL_VARIANCE	FV_TEST	equal_variance.pro
F_TEST	F_CVF	f_test.pro
F_TEST1	F_PDF	f_test1.pro
FILLCONTOUR	FILL keyword to CONTOUR	fillcontour.pro
FORRD	READU	
FORRD_KEY	READU	
FORWRT	WRITEU	
FRIEDMAN	KW_TEST	friedman.pro
GAUSS	GAUSS_CVF	gauss.pro
GOODFIT	XSQ_TEST	goodfit.pro
HELP_VM	MEMORY keyword to HELP	help_vm.pro
HSV_TO_RGB	COLOR_CONVERT	hsv_to_rgb.pro
JOIN	CLUSTER	join.pro
KMEANS	CLUSTER	kmeans.pro
KRUSKAL_WALLIS	KW_TEST	kruskal_wallis.pro
LATLON	n/a	latlon.pro
LEGO	LEGO keyword to SURFACE	lego.pro
LISTREP	n/a	listrep.pro
LISTWISE	n/a	listwise.pro
LN03	n/a	ln03.pro
LUBKSB	LUSOL	

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Routine	Replaced by	.pro File?
LUDCMP	LUDC	
MAKETREE	CLUSTER	maketree.pro
MANN_WHITNEY	RS_TEST	mann_whitney.pro
MENUS	WIDGET_DROPLIST, etc.	menus.pro
MIPSEB_DBLFIXUP	n/a	mipseb_dblfixup.pro
MOVIE	XINTERANIMATE	movie.pro
MPROVE	LUMPROVE	
MULTICOMPARE	Hypothesis Testing Routines	multicompare.pro
NR_BETA	BETA	
NR_BROYDN	BROYDEN	
NR_CHOLDC	CHOLDC	
NR_CHOLSL	CHOLSOL	
NR_DFPMIN	DFPMIN	
NR_ELMHES	ELMHES	nr_elmhes.pro
NR_EXPINT	EXPINT	
NR_FULSTR	FULSTR	
NR_HQR	HQR	nr_hqr.pro
NR_INVERT	INVERT	
NR_LINBCG	LINBCG	
NR_LUBKSB	LUSOL	nr_lubksb.pro
NR_LUDCMP	LUDC	nr_ludcmp.pro
NR_MACHAR	MACHAR	
NR_MPROVE	LUMPROVE	
NR_NEWT	NEWTON	
NR_POWELL	POWELL	

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Routine	Replaced by	.pro File?
NR_QROMB	QROMB	
NR_QROMO	QROMO	
NR_QSIMP	QSIMP	
NR_RK4	RK4	
NR_SPLINE	SPL_INIT	
NR_SPLINT	SPL_INTERP	
NR_SPRSAB	SPRSAB	
NR_SPRSAX	SPRSAX	
NR_SPRSIN	SPRSIN	nr_sprsin.pro
NR_SVBKSB	SVSOL	nr_svbksb.pro
NR_SVD	SVDC	nr_svd.pro
NR_TQLI	TRIQL	
NR_TRED2	TRIRED	
NR_TRIDAG	TRISOL	
NR_WTN	WTN	nr_wtn.pro
NR_ZROOTS	FZ_ROOTS	
ONLY_8BIT	n/a	only_8bit.pro
PALETTE	XPALETTE	palette.pro
PARTIAL2_COR	P_CORRELATE	partial2_cor.pro
PARTIAL_COR	P_CORRELATE	partical_cor.pro
PHASER	n/a	phaser.pro
PM	n/a	pm.pro
PMF	n/a	pmf.pro
POLYCONTOUR	FILL keyword to CONTOUR	polycontour.pro
PROMPT	n/a	prompt.pro

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Routine	Replaced by	.pro File?
PWIDGET	n/a	pwidget.pro
REGRESS1	REGRESS	regress1.pro
REGRESSION	REGRESS	regression.pro
RGB_TO_HSV	COLOR_CONVERT	rgb_to_hsv.pro
RM	n/a	rm.pro
RMF	n/a	rmf.pro
ROT_INT	ROT	rot_int.pro
RSI_GAMMAI	IGAMMA	rsi_gamma.pro
RUNS_TEST	R_TEST	runs_test.pro
SET_NATIVE_PLOT	n/a	set_native_plot.pro
SET_SCREEN	n/a	set_screen.pro
SET_VIEWPORT	n/a	set_viewport.pro
SET_XY	n/a	set_xy.pro
SIGMA	MOMENT	sigma.pro
SIGN_TEST	S_TEST	sign_test.pro
SIMPSON	QSIMP or QROMB	simpson.pro
SPEARMAN	R_CORRELATE	sprearman.pro
STDEV	MOMENT	stdev.pro
STEPWISE	REGRESS	stepwise.pro
STUDENT1_T	T_PDF	student1_t.pro
STUDENT_T	T_CVF	student_t.pro
STUDRANGE	T_PDF	studrange.pro
SURFACE_FIT	SFIT	surface_fit.pro
SVBKSB	SVSOL	
SVD	SVDC	

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Routine	Replaced by	.pro File?
TESTCONTRAST	n/a	testcontrast.pro
TQLI	TRIQL	
TRED2	TRIRED	
TRIDAG	TRISOL	
TVDELETE	WDELETE	
TVRDC	CURSOR	
TVSET	WSET	
TVSHOW	WSHOW	
TVWINDOW	WINDOW	
VMSCODE	n/a	vmscode.pro
WILCOXON	RS_TEST	wilcoxon.pro
WMENU	WIDGET_DROPLIST, etc.	wmenu.pro
XANIMATE	XINTERANIMATE	xanimate.pro
XBACKREGISTER	TIMER keyword to WIDGET_CONTROL	xbackregister.pro
XDL	n/a	xdl.pro
XMANAGERTOOL	XMTOOL	xmanagertool.pro
XMENU	WIDGET_DROPLIST, etc.	xmenu.pro
XPDMENU	WIDGET_DROPLIST, etc.	xpdmenu.pro
ZROOTS	FZ_ROOTS	

Table I-6: Routines Obsoleted in IDL 4.0 or Earlier

Obsolete System Variables

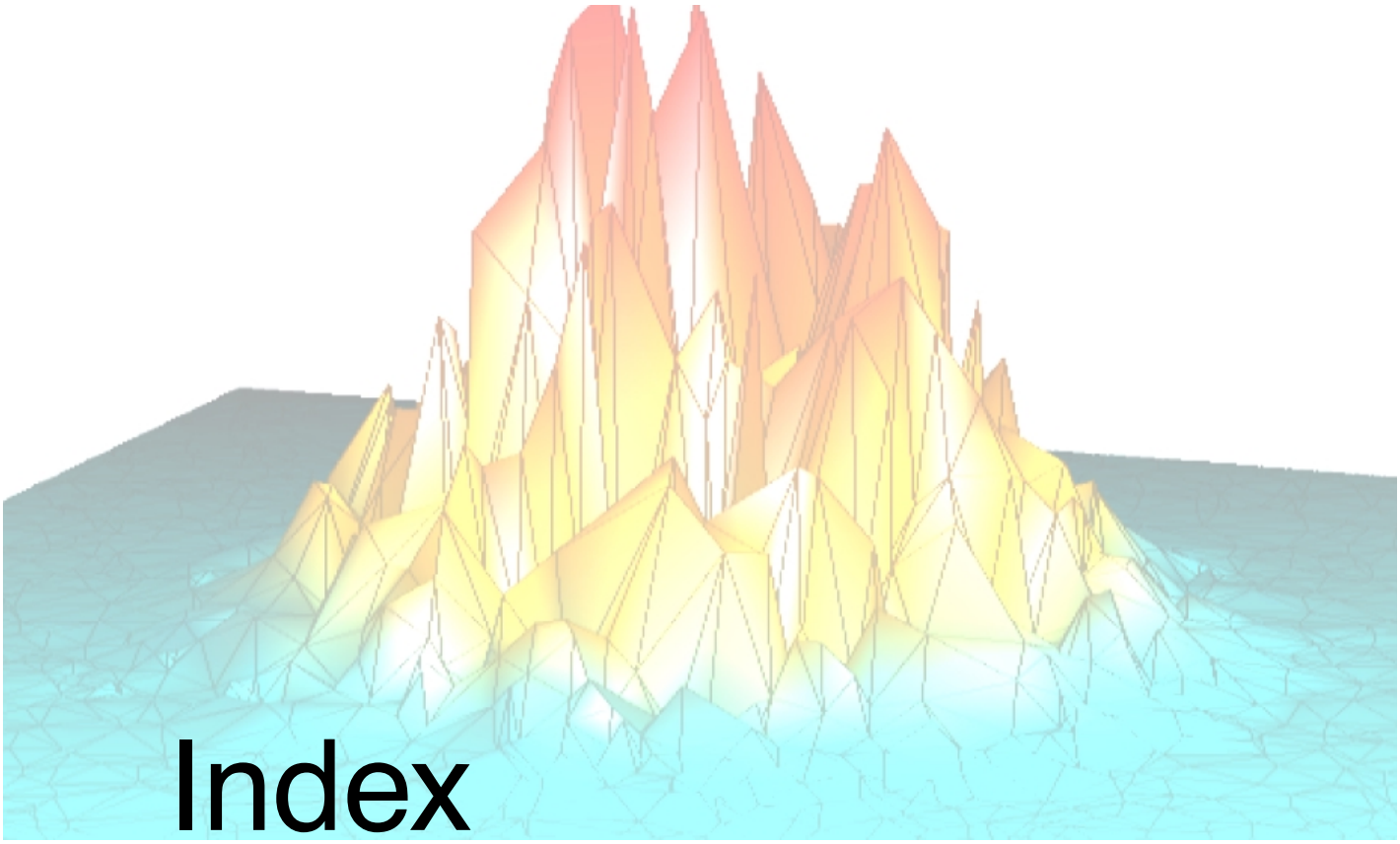
The following IDL system variables became obsolete in the change from VAX IDL (IDL version 1) to IDL version 2. While it is highly unlikely that you will find references to these system variables in existing code, we include them here because they are flagged when the OBS_SYSVARS field of the !WARN structure is set equal to one. See Appendix D, "System Variables" in the *IDL Reference Guide* for information on IDL system variables.

System Variable	Replaced by
!BCOLOR	BOTTOM keyword to SURFACE
!COLOR	!P.COLOR
!CXMAX	!X.CRANGE[1]
!CXMIN	!X.CRANGE[0]
!CYMAX	!Y.CRANGE[1]
!CYMIN	!Y.CRANGE[0]
!FANCY	No direct equivalent. Use !P.FONT and !P.CHARSIZE
!FLIP	No equivalent.
!GRID	!P.TICKLEN
!HI	No equivalent.
!IGNORE	!P.NOCLIP
!LINETYPE	!P.LINESTYLE
!LO	No equivalent.
!MTITLE	!P.TITLE
!NOERAS	!P.NOERASE
!NORMALCONT	FOLLOW keyword to CONTOUR
!NSUM	!P.NSUM
!PSYM	!P.PSYM

Table I-7: Obsolete System Variables

System Variable	Replaced by
!SC1	!P.POSITION[0] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !X.WINDOW[0] * !D.X_VSIZE otherwise.
!SC2	!P.POSITION[2] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !X.WINDOW[1] * !D.X_VSIZE otherwise.
!SC3	!P.POSITION[1] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !Y.WINDOW[0] * !D.X_VSIZE otherwise.
!SC4	!P.POSITION[3] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !Y.WINDOW[1] * !D.X_VSIZE otherwise.
!TERM	DEVICE procedure.
!TYPE	!X.TYPE, !X.STYLE, !Y.TYPE, !Y.STYLE, !P.TICKLEN
!XMAX	!X.RANGE[1]
!XMIN	!X.RANGE[0]
!XTICKS	!X.TICKS
!XTITLE	!X.TITLE
!YMAX	!Y.RANGE[1]
!YMIN	!Y.RANGE[0]
!YTICKS	!Y.TICKS
!YTITLE	!Y.TITLE

Table I-7: Obsolete System Variables



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