



# **Numdisplay Documentation**

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**Warren Hack**

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# NUMDISPLAY CLASS INTERFACE

This class provides the primary functionality for displaying numpy arrays in DS9 using the IIS protocol.

**numdisplay: Package for displaying numpy arrays in IRAF-compatible**  
image display tool such as DS9 or XIMTOOL.

This package provides several methods for controlling the display of the numpy array; namely,

**open(imtdev=None)::**

Open the default display device or the device specified in 'imtdev', such as 'inet:5137' or 'fifo:/dev/imt10'.

**close()::**

Close the display device defined by 'imtdev'. This must be done before resetting the display buffer to a new size.

**display(pix, name=None, bufname=None, z1=None, z2=None, quiet=False, transform=None, scale=None, offset=None, fra**

Display the scaled array in display tool (ds9/ximtool/...).

**readcursor(sample=0)::**

Return a single cursor position from the image display. By default, this operation will wait for a keystroke before returning the cursor position. If 'sample' is set to 1, then it will NOT wait to read the cursor. This will return a string containing: x,y,frame and key.

**help()::**

print Version ID and this message.

## 1.1 Notes

**Displaying a numpy array object involves:**

1. Opening the connection to a usable display tool (such as DS9).
2. Setting the display parameters for the array, such as min and max array value to be used for min and max grey scale level, along with any offset, scale factor and/or transformation function to be applied to the array.
3. Applying any transformation to the input array. This transformation could be a simple numpy ufunc or a user-defined function that returns a modified array.
4. Building the byte-scaled version of the transformed array and sending it to the display tool. The image sent to the display device will be trimmed to fit the image buffer defined by the 'imtdev' device from the

'imtoolrc' or the 'stdimage' variable under IRAF. If the image is smaller than the buffer, it will be centered in the display device.

All pixel positions reported back will be relative to the full image size.

## 1.2 Examples

The user starts with a 1024x1024 array in the variable 'fdata'. This array has min pixel value of -157.04 and a max pixel value of 111292.02. The display tool DS9 has already been started from the host level and awaits the array for display. Displaying the array requires:

```
>>> import numdisplay
>>> numdisplay.display(fdata)
```

If there is a problem connecting to the DS9 application, the connection can be manually started using:

```
>>> numdisplay.open()
```

To bring out the fainter features, an offset value of 158 can be added to the array to allow a 'log' scaling can be applied to the array values using:

```
>>> numdisplay.display(fdata, transform=np.log, offset=158.0)
```

To redisplay the image with default full-range scaling:

```
>>> numdisplay.display(fdata)
```

To redisplay using the IRAF display zscale algorithm, and with a contrast value steeper than the default value of 0.25:

```
>>> numdisplay.display(fdata, zscale=True, contrast=0.5)
```

### class stsci.numdisplay.NumDisplay

Class to manage the attributes and methods necessary for displaying the array in the image display tool.

#### This class contains the methods:

open(imtdev=None):

close():

set(z1=None, z2=None, scale=None, factor=None, frame=None): reset(names=None)

display(pix, name=None, bufname=None):

readcursor():

checkDisplay ()

close ()

Close the display device entry.

display (pix, name=None, bufname=None, z1=None, z2=None, transform=None, zscale=False, contrast=0.25, scale=None, offset=None, frame=None, quiet=False)

Displays byte-scaled (UInt8) n to XIMTOOL device. This method uses the IIS protocol for displaying the data to the image display device, which requires the data to be byte-scaled.

If input is not byte-scaled, it will perform scaling using set values/defaults.

#### Parameters

**name** : str

optional name to pass along for identifying array



**bufname** : str

name of buffer to use for displaying array (such as 'imt512'). Other valid values include:

'iraf': look for 'stdimage' and use that buffer or default to 'imt1024' [1024x1024]  
 None : ignore 'stdimage' and automatically select a buffer matched to the size of

**z1,z2** : float

minimum/maximum pixel value to display. Not specifying values will default to the full range values of the input array.

**transform** : function

Python function to apply to array (function)

**zscale** : bool

Specify whether or not to use an algorithm like that in the IRAF display task. If zscale=True, any z1 and z2 set in the call to display are ignored. Using zscale=True invalidates any transform specified in the call.

**contrast** : float (Default=0.25)

Same as the *contrast* parameter in the IRAF *display* task. Only applies if zscale=True. Higher contrast values make z1 and z2 closer together, while lower values give a gentler (wider) range.

**scale** : float/int

multiplicative scale factor to apply to array. The value of this parameter remains persistent, so to reset it you must specify scale=1 in the display call.

**offset** : float/int

additive factor to apply to array before scaling. This value is persistent, so to reset it you have to set it to 0.

**frame** : int

image buffer frame number in which to display array

**quiet** : bool (Default: False)

if True, this parameter will turn off all status messages

## Notes

The display parameters set here will ONLY apply to the display of the current array.

**getHandle** ()

**open** (*imtdev=None*)

Open a display device.

**readcursor** (*sample=0*)

Return the cursor position from the image display.

**reset** (*names=None*)

Reset specific attributes, or all by default.

### Parameters

**names** : string or list of strings

names of attributes to be reset, separated by commas or spaces; the default is to reset all attributes to None

**set** (*frame=None, z1=None, z2=None, contrast=None, transform=None, scale=None, offset=None*)  
Allows user to set multiple parameters at one time.

# DISPLAYDEV MODULE

displaydev.py: Interact with IRAF-compatible image display

Modeled after the NOAO Client Display Library (CDL)

Public functions:

**readCursor(sample=0)**

Read image cursor position

**open(imtdev=None)**

Open a connection to the display server. This is called automatically by readCursor if the display has not already been opened, so it is not generally necessary for users to call it.

See the open doc string for info on the imtdev argument, which allows various forms of socket and network connections.

**close()**

Close the active display server. Called automatically on exit.

Various classes are defined for the different connections (ImageDisplay, ImageDisplayProxy, UnixImageDisplay, InetImageDisplay, FifoImageDisplay). They should generally be created using the `_open` factory function. This could be used to maintain references to multiple display servers.

Ultimately more functionality may be added to make this a complete replacement for CDL.

\$Id: displaydev.py 19347 2012-09-12 20:36:42Z hack \$

**class** `stsci.numdisplay.displaydev.FifoImageDisplay` (*infile, outfile*)  
FIFO version of image display

**`_write`** (*s*)

Write string *s* to image display

Raises IOError on failure

**class** `stsci.numdisplay.displaydev.ImageDisplay`  
Interface to IRAF-compatible image display

**`_read`** (*n*)

Read *n* bytes from image display and return as string

Raises IOError on failure. If a Tkinter widget exists, runs a Tk mainloop while waiting for data so that the Tk widgets remain responsive.

**`_write`** (*s*)

Write string *s* to image display

Raises IOError on failure

**\_writeHeader** (*tid, subunit, thingct, x, y, z, t*)  
Write request to image display

**close** (*os\_close=<built-in function close>*)  
Close image display connection

**eraseFrame** ()  
Sends commands to erase active frame.

**getConfigno** (*stdname*)  
Determine which config number matches specified frame buffer name.

**readCursor** (*sample=0*)  
Read image cursor value for this image display  
Return immediately if sample is true, or wait for keystroke if sample is false (default). Returns a string with x, y, frame, and key.

**readData** (*x, y, pix*)  
Reads data from x,y position in active frame.

**readInfo** ()  
Read tx and ty from active frame of display device.

**readWCS** (*wcsinfo*)  
Reads WCS information from active frame of display device.

**selectFB** (*nx, ny, reset=None, useiraf=True*)  
Select the frame buffer that best matches the input image size.

**setCursor** (*x, y, wcs*)  
Moves cursor to specified position in frame.

**setFBconfig** (*fbnum, bufname=None*)  
Set the frame buffer values for the given frame buffer name.

**setFrame** (*frame\_num=1*)  
Sets the active frame in frame buffer to specified value.

**syncWCS** (*wcsinfo*)  
Update WCS to match frame buffer being used.

**writeData** (*x, y, pix*)  
Writes out image data to x,y position in active frame.

**writeImage** (*pix, wcsinfo*)  
Write out image to display device in 32Kb sections.

**writeWCS** (*wcsinfo*)  
Writes out WCS information for frame to display device.

**class** `stsci.numdisplay.displaydev.ImageDisplayProxy` (*imtdev=None*)  
Interface to IRAF-compatible image display  
This is a proxy to the actual display that allows retries on failures and can switch between display connections.

**checkDisplay** ()  
Returns True if a valid connection to a display device is found, False if no connection could be found.

**close** ()  
Close active image display connection

**open** (*imtdev=None*)  
Open image display connection, closing any active connection

**readCursor** (*sample=0*)

Read image cursor value for the active image display

Return immediately if *sample* is true, or wait for keystroke if *sample* is false (default). Returns a string with *x*, *y*, *frame*, and *key*. Opens image display if necessary.

**class** `stsci.numdisplay.displaydev.InetImageDisplay` (*port, hostname=None*)

INET socket version of image display

**class** `stsci.numdisplay.displaydev.UnixImageDisplay` (*filename, family=1, type=1*)

Unix socket version of image display

**close** ()

Close image display connection

`stsci.numdisplay.displaydev._open` (*imtdev=None*)

Open connection to the image display server

This is a factory function that returns an instance of the `ImageDisplay` class for the specified *imtdev*. The default connection if no *imtdev* is specified is given in the environment variable `IMTDEV` (if defined) or is “`unix:/tmp/.IMT%d`”. Failing that, a connection is attempted on the `/dev/imt1[io]` named fifo pipes.

The syntax for the *imtdev* argument is `<domain>:<address>` where `<domain>` is one of “`inet`” (internet tcp/ip socket), “`unix`” (unix domain socket) or “`fifo`” (named pipe). The form of the address depends upon the domain, as illustrated in the examples below.

<code>inet:5137</code>	Server connection to port 5137 on the local host. For a client, a connection to the given port on the local host.
<code>inet:5137:foo.bar.edu</code>	Client connection to port 5137 on internet host <code>foo.bar.edu</code> . The dotted form of address may also be used.
<code>unix:/tmp/.IMT212</code>	Unix domain socket with the given pathname IPC method, local host only.
<code>fifo:/dev/imt1i:/dev/imt1o</code>	FIFO or named pipe with the given pathname. IPC method, local host only. Two pathnames are required, one for input and one for output, since FIFOs are not bidirectional. For a client the first fifo listed will be the client's input fifo; for a server the first fifo will be the server's output fifo. This allows the same address to be used for both the client and the server, as for the other domains.

The address field may contain one or more “`%d`” fields. If present, the user's UID will be substituted (e.g. “`unix:/tmp/.IMT%d`”).



# ZSCALE MODULE

```
stsci.numdisplay.zscale.zscale(image, nsamples=1000, contrast=0.25, bpmask=None,  
                                zmask=None)
```

Implement IRAF zscale algorithm

## Parameters

**image** : arr

2-d numpy array

**nsamples** : int (Default: 1000)

Number of points in array to sample for determining scaling factors

**contrast** : float (Default: 0.25)

Scaling factor for determining min and max. Larger values increase the difference between min and max values used for display.

**bpmask** : None

Not used at this time

**zmask** : None

Not used at this time

## Returns

(z1, z2) :





# OVERLAY MODULE

`stsci.numdisplay.overlay.circle(**kwargs)`

Draw a circle.

## Parameters

**x** : int

image X coordinate of center

**y** : int

image Y coordinate of center

**center** : tuple

(x,y) coordinates of center

**radius** : int

radius of circle

**color** : int

color code to use; if not specified, use default

**undo** : bool

if specified [default=True], keep track of overlays for undo()

## Examples

Samples illustrating the syntax include:

```
overlay.circle (x=x0, y=y0, radius=r)
overlay.circle (center=(x0,y0), radius=r)
overlay.circle (x=x0, y=y0, radius=r, color=overlay.C_<color>)
```

`stsci.numdisplay.overlay.close_display(frame=1)`

Close the device.

`stsci.numdisplay.overlay.marker(**kwargs)`

Draw a character.

## Parameters

**x** : int

image X coordinate of point

**y** : int

image Y coordinate of point

**mark** : str  
character to be drawn

**size** : int  
magnification to be used in drawing the character

**color** : int  
color code to use; if not specified, use default

**undo** : bool  
if specified [default=True], keep track of overlays for undo()

### Examples

Samples illustrating the syntax include:

```
overlay.marker (x=x0, y=y0, mark='+')
overlay.marker (x=x0, y=y0, mark='+', size=2)
overlay.marker (x=x0, y=y0, mark='+', color=overlay.C_<color>)
```

`stsci.numdisplay.overlay.point` (\*\*kwargs)

Draw a point.

#### Parameters

**x** : int  
image X coordinate of point

**y** : int  
image Y coordinate of point

**center** : tuple  
(x,y) coordinates of point

**color** : int  
color code to use; if not specified, use default

**undo** : bool  
if specified [default=True], keep track of overlays for undo()

### Examples

Samples illustrating the syntax include:

```
overlay.point (x=x0, y=y0)
overlay.point (center=(x0,y0))
overlay.point (x=x0, y=y0, color=overlay.C_<color>)
```

`stsci.numdisplay.overlay.polyline` (\*\*kwargs)

Draw a series of connected line segments.

#### Parameters

**points** : list of tuples  
(x,y) points to connect with line segments

**vertices** : list of tuples  
(x,y) points to connect with line segments

**color** : int

color code to use; if not specified, use default

**undo** : bool

if specified [default=True], keep track of overlays for undo()

## Examples

Samples illustrating the syntax include:

```
overlay.polyline (points=[(x1,y1), (x2,y2), (x3,y3)])
overlay.polyline (vertices=[(x1,y1), (x2,y2), (x3,y3)])
overlay.polyline (points=[(x1,y1), (x2,y2), (x3,y3)],
                 color=overlay.C_<color>)
```

```
stsci.numdisplay.overlay.rectangle (**kwargs)
```

Draw a rectangle.

### Parameters

**left** : int

image X coordinate of left edge

**right** : int

image X coordinate of right edge

**lower** : int

image Y coordinate of lower edge

**upper** : int

image Y coordinate of upper edge

**center** : tuple

(x,y) coordinates of middle of rectangle

**width** : int

width of rectangle (X direction)

**height** : int

height of rectangle (Y direction)

**color** : int

color code to use; if not specified, use default

**undo** : bool

if specified [default=True], keep track of overlays for undo()

## Examples

Samples illustrating the syntax include:

```
overlay.rectangle (left=x1, right=x2, lower=y1, upper=y2)
overlay.rectangle (center=(x0,y0), width=w, height=h)
overlay.rectangle (left=x1, lower=y1, center=(x0,y0))
overlay.rectangle (left=x1, lower=y1, width=w, height=h)
overlay.rectangle (right=x2, upper=y2, width=w, height=h)
```

```
overlay.rectangle (right=x2, upper=y2, center=(x0,y0))
overlay.rectangle (left=x1, right=x2, lower=y1, upper=y2, color=overlay.C_<color>)
```

```
stsci.numdisplay.overlay.set (color=None, radius=None)
```

Specify the color or the radius.

**Parameters**

**color** : int

color code to use for graphic overlays; the allowed values (202..217) are:

```
C_BLACK, C_WHITE, C_RED, C_GREEN, C_BLUE, C_YELLOW, C_CYAN, C_MAGENTA,
C_CORAL, C_MAROON, C_ORANGE, C_KHAKI, C_ORCHID, C_TURQUOISE, C_VIOLET,
C_WHEAT
```

**radius**: int :

radius to use when drawing circles

```
stsci.numdisplay.overlay.undo ()
```

Restore the values before the last overlay was written.

## ICHAR MODULE

`stsci.numdisplay.ichar.expandchar` (*indices, size*)

block replicate a character. This implementation is inefficient but probably won't matter unless many large characters are used

`stsci.numdisplay.ichar.initichar` ()

read the data file (old form) and generate the dict for numdisplay to use

`stsci.numdisplay.ichar.initichar_old` ()

read the data file (old form) and generate the dict for numdisplay to use

`stsci.numdisplay.ichar.nextchar` (*lines*)

read next character data in file, and return numeric array 5x7 pixels

`stsci.numdisplay.ichar.read_inc` ()

Read the iraf include file that defines the bit patterns for characters used for image display



# IMCONFIG MODULE

Version 1.0alpha - 9-Oct-2003 (WJH)

**loadImtoolrc (imtoolrc=None):**

Locates, then reads in IMTOOLRC configuration file from system or user-specified location, and returns the dictionary for reference.

**The table gets loaded into a dictionary of the form:**

{ configno: { 'nframes': n, 'width': nx, 'height': ny }, ... }

**It can then be accessed using the syntax:**

fbtab[configno][attribute]

**For example:**

```
fbtab = loadImtoolrc() print fbtab[34]['width'] 1056 1024
```

`stsci.numdisplay.imconfig.loadImtoolrc(imtoolrc=None)`

Locates, then reads in IMTOOLRC configuration file from system or user-specified location, and returns the dictionary for reference.





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