

## IRAF Tutorial

Commands that you will type into a terminal screen are shown below in `courier` font. Whenever the directions tell you to type in a command, you should always hit the enter/return button after typing the command to make sure that it is issued and the computer knows to execute it. I will not tell you to hit “enter” every time.

1. Log on to your computer. Right-click on an empty part of the desktop and open a new terminal
2. In the terminal, type `pwd`  
 This will tell you in which directory you are located (likely to be your home directory or the Desktop)  
 Type `cd` to move your location to the home directory if needed.

### Starting IRAF and opening an image display window

**3. If you are working on a Mac laptop:** In the terminal, type `source activate iraf` and once that command has completed, type `xgterm &` to open an xgterminal (different from a regular terminal)

(yes, the “&” is important, don’t forget it)

**If you are working on a Dell laptop:** In the terminal, type `xgterm &` to open an xgterminal (different from a regular terminal)

(yes, the “&” is important, don’t forget it)

4. IN THE XGTERM THAT YOU JUST OPENED, type `cd iraf` to move to the “iraf” directory. The “iraf” directory is located in your home directory. You should be in your home directory if you followed step 2 above. If you are not sure what directory you are in, type `pwd`

You will see in response: `/home/astrouser/`  
 or a similar address based on your login name and system structure

5. Now start IRAF by typing (still in the xgterm): `c1`

You should see something that looks similar to the following:

*NOAO/IRAF PC-IRAF Revision 2.15.1a EXPORT Mon Feb 21 18:54:16 MST 2011  
 This is the EXPORT version of IRAF V2.15.1a supporting PC systems.*

*Welcome to IRAF. To list the available commands, type ? or ??. To get detailed information about a command, type 'help <command>'. To run a command or load a package, type its name. Type 'bye' to exit a package, or 'logout' to get out of the CL. Type 'news' to find out what is new in the version of the system you are using.*

Visit <http://iraf.net> if you have questions or to report problems.

The following commands or packages are currently defined:

*apropos images. noao. proto. system.  
 dataio. language. obsolete. softools. tables.*

*dbms. lists. plot. stsdas. utilities.*

*ec/>*

**NOTE:** If you see a message about there being no login.cl file, then you are not in the iraf directory. Type `logout` , move into the correct directory using `cd` , and then restart IRAF

6. Now you will want to open a display window so that you can look at the calibration files and images from your observing run. At the IRAF “ec/>” prompt, type `!ds9 &`

(Yes, you need to make sure that you have both the “!” at the beginning and “&” at the end, don’t forget either one). You should see an SAOImage ds9 window open.

### IRAF fiddly details and hints

--- IRAF will remember the commands you have recently issued. You can go through these commands (without retyping them) by using the command history. To scroll through your recently issued commands, use the up arrow. If you pass the one you want, use the down arrow to get back to it.

--- You can use the “tab” key to auto-complete a file name or directory address. Just type part of the name or directory and hit “tab” -- autocomplete will fill in as much as it can based on the uniqueness of the names and what you already typed.

--- IRAF expects all files to end with “.fits” (as ours do), so you can either type the full image name (e.g., feb08-0037r.fits) when you are running tasks, or you can just type the name without the file extension (e.g., feb08-0037r). They will be treated the same.

--- All tasks in IRAF have associated parameter files. These parameters control the details for how a task will be carried out. In the steps directly below, you will use the task “display”. To list the parameters controlling the task “display” and their current values, type `lpar display`. To edit the parameters, type `epar display`

--- All tasks have help files that you can read by typing `phelp taskname`. For the task “display”, you would type `phelp display`. This is especially useful if you forget what a task does or you want to know what parameters are available and what each one controls within a task.

--- **Note that the first line printed on the help page for any task gives the packages within which the task lives.** Some packages are loaded by default when IRAF starts, others have to be loaded by the user before the tasks inside them can be used. If you need to run a task that lives inside packages that haven’t been loaded yet, you will load the packages in order (as displayed in phelp) by typing their names (one at a time) at the IRAF prompt and hitting “enter” after each one. When they are loaded, then you can edit and/or run the task. *Packages only need to be loaded once per session, they stay loaded until you close IRAF.*

--- When editing the parameters for a task, use the arrows to move up and down to the parameter you want. While on the line for the parameter you want to edit, just type the new value. Hit “enter” or one of the arrow keys to move to a new line and you will see the new value replace the old value for that parameter. Some lists of parameters are very long and you

need to keep going down beyond the bottom of the first page to see them all. If you want to save your edits and exit the editor, type `“:wq”`. If you want to exit without saving, type `“:q!”`. If you want to save and exit and immediately run the task, type `“:go”` (the colon is important for each of these commands -- don't forget it).

### Displaying images - two different ways

7. Before you can work with any files in IRAF, you have to move to the directory where you have stored your files. In your xgterm window, with IRAF running, use `cd` to change to the correct directory. The commands `ls` and `pwd` also work in IRAF to help you get there.

8. Method number 1: use IRAF to display the image.

(Best for working with images directly in IRAF because many tasks will require you to interact with the displayed image.)

Use your logsheet to choose an image of a science target or a flatfield image from your observing run (don't pick a bias, biases are boring to look at and have little info)

At the IRAF `“ecl>”` prompt, type `display imagename.fits` and hit enter to accept the default image frame that IRAF suggests

(Shortcut: `display imagename.fits 1` --- IRAF will display into frame 1 and won't prompt you for a frame number)

If you want to change the contrast or the stretch of the image, you will need to change those parameters within the IRAF task “display” and then re-display the image. The examples below work best when you have a science image.

**a.) Display the full intensity range of the image:**

Type `epar display` to edit the parameters for the task “display”, then use the arrows to move up and down among the parameters. When you get to the line for “zscale”, type “no” to turn off the the compression of the intensity range, and make sure the line for “zrange” says “yes”. To save the new parameters and quit the editor, type `:wq` and when you are back at the IRAF prompt, you can redisplay the image by typing `display imagename` (Shortcut: type `:go` to write and save your parameters and execute the task all at once from within the parameter editor)

**b.) Display the full intensity range with a logarithmic stretch:**

Type `epar display`. Make sure “zscale” is still “no”, “zrange” is “yes”, and go all the way to the bottom to change “ztrans” from “linear” to “log”. Save your parameters and re-display the image.

**c.) Display a selected portion of the intensity range (e.g., 0 to 2000 counts):**

Type `epar display` and move among the parameters. Make sure “zscale” is “no”, “zrange” is “no”, and at the bottom, set “z1” to your lowest intensity value (0, in this case) and “z2” to your highest intensity value (2000). Make sure that “ztrans” is what you prefer (“linear” or “log”), save the parameters and re-display the image. Try some different combinations of low and high intensity values and different scaling laws (linear vs log). Pick numbers that make sense for the image you are looking at, don't just assume that 0 to 2000 will work in your case (e.g., if you are displaying a flat-field and all the counts are around 20,000, then displaying 0 to 2000 would be a poor choice).

**9. Method number 2: use ds9 to display the image without IRAF.**

(Best for quick looks at images or working with images when you won't be using IRAF.)  
In the ds9 window, go to "file" and choose "open" to search for and find your image file.

You can change the contrast and stretch by using the "scale" menu in ds9

- a.) Display the full intensity range of the image: choose "minmax" from the "scale" menu
- b.) Display the full intensity range with a logarithmic stretch: choose "log" and "minmax" from the "scale" menu
- c.) Display a selected portion of the intensity range (e.g., 0 to 1000 counts): choose "log" or "linear" as appropriate, then choose "scale parameters" and type in your low and high values in the boxes. Hit "apply", then "close". Again, pick numbers that make sense for the image you are displaying.

**Investigating images**

**10. Determine the size of an image**

```
imhead imagename
```

*imagename [2048,2048][ushort]:*            the image has 2048x2048 pixels

**11. Determine the minimum, maximum, mean, and standard deviation of the pixel values**

```
imstat imagename
```

#	IMAGE	NPIX	MEAN	STDDEV	MIN	MAX
	<i>imagename.fits</i>	4194304	1188.	28.98	1156.	23197.

(Note: the numbers may not always line up properly with the column heads on your terminal, especially if your files have long names. However, they will always be in the correct order. The mean value will always be the third item listed, and the max value will always be the 6th item listed, for example.)

**12. Determine the minimum, maximum, mean, and standard deviation of the pixel values for a lot of images:**

```
imstat feb07*
```

*(the \* is a wild card that means here "any combination of characters after feb07";  
examples: feb07.test.fits, feb07-001.fits, feb07-050.fits, but not vflat.fits)*

```
imstat feb07-00?.fits
```

*(the ? is a wild card that means here "any single character between feb07-00 and .fits";  
examples: feb07-001.fits, feb07-008.fits, but not feb07-020.fits)*

```
imstat @filelist
```

*(the "@filelist" tells IRAF to look for a list of filenames inside the text file "filelist")*

**13. Read all the associated header info for your image**

```
imhead imagename l o+ | page
```

*(hitting the "return" button will take you down one line, the space bar will page down)*  
Look for parameters that you should recognize, like RA and Dec, airmass, etc

**14. Make various plots from the image for quick analysis.**

```
display imagename 1
```

```
imexam imagename
```

(\*\* click somewhere on the ds9 image frame to activate the display window \*\*)

You will see a blinking circle. Use the mouse to move the circle so that it is hovering over an area of interest in the image (such as a star). Then type the various letters below (you do not need to click the mouse) to give shortcut calls to commands:

```
c      -- plot the intensity values in the current column
l      -- plot the intensity values in the current line
r      -- plot the intensity values radially from the current position
s      -- plot the intensity values as a surface map
e      -- plot the intensity values as a contour plot
h      -- plot the intensity values as a histogram
a      -- print measurements (position, flux, etc)
```

To quit at any time, press the “q” button while the mouse is hovering over the ds9 window (if you opened up a radial plot or other plot, you may have to click on the border of the ds9 window to bring it back to focus). This will return you to the IRAF command prompt. **DO NOT close one of the popup windows from this task (like a radial plot or column plot) before quitting imexam. If you do, you will crash IRAF.**

Each of the shortcut commands above has default parameters that control the command’s behavior. To edit the parameters for the histogram plot above, for example, once you are at the command prompt, type `epar himexam` then use the arrows to move around and edit parameters, save and quit as usual. For example, by default the histogram function will only plot a histogram for the box of 21x21 pixels around the location of the cursor in the image. Maybe you want to see a histogram of all the pixels in the image (useful for investigating a flat-field or a bias, for example). You would need to edit the range for the histogram function. Or maybe you don’t like the default binning that was chosen for the histogram bars, you can change that too.

Note: this is one case where the `:go` command will not work. You will have to use `:wg` to save and quit, and then reissue the `imexam` command to use the new parameters you set.

There is also a way to edit parameters while a task is already running, but that is slightly more advanced and so I will not include it here.

If you are not sure what you can do while a task is running (maybe that blinking cursor is taunting you and you don’t know what it wants from you), type `?` to see what options you have. They will appear in the xgterm window. Try it with `imexam` to see what else you can investigate beyond the list I gave you above.

## 15. Image arithmetic

Example 1: add two images together to create a new image called “addedimg”.

```
imarith imagename1 + imagename2 addedimg
```

Example 2: multiply two images together to create a new image called “multimg”

```
imarith imagename1 * imagename2 multimg
```

## **Exiting IRAF**

To exit IRAF at any time, simply type `logout`

**\*\*\*\* Now that you have gotten to this point, it's time to do the in-class worksheet!!**

**Basic Linux cheat sheet:**

<b><i>Moving around in the file system</i></b>	
<i>Command</i>	<i>Action</i>
pwd	"Print working directory" - show what dir you're in.
ls	List the contents of a dir.
ls -l	List the contents of a dir and show additional info of the files.
ls -a	List all files, including hidden files.
cd	Change directory.
cd ..	Go to the parent directory.
<b><i>Examining files</i></b>	
<i>Command</i>	<i>Action</i>
file	Determine the type of a file.
cat	Concatenate a file.
less	View text files and paginate them if needed.
<b><i>Manipulating files and directories</i></b>	
<i>Command</i>	<i>Action</i>
cp	Copy a file.
cp -i	Copy a file and ask before overwriting.
cp -r	Copy a directory with its contents.
mv	Move or rename a file.
mv -i	Move or rename a file and ask before overwriting.
rm	Remove a file.
rm -r	Remove a directory with its contents.
rm -i	Ask before removing a file. Good to use with the -r option.
mkdir	Make a directory.
rmdir	Remove an empty directory.