IR image data reduction.
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Steps:

1. Bias/dark subtract
2. Flatfield divide
3. Create bad pixel mask if needed
4. Mosiac data
5. Perform astrometry if required
6. Aperture photometry if required

IRAF is the easiest programme to use for this, but it takes a little getting used to. There are good guides to using IRAF for various tasks here:

http://www.twilightlandscapes.com/IRAFtutorial/
http://iraf.noao.edu/tutorials/tutorials.html

IRAF only functions correctly from an xgterm or xterm

In your home area start up an xgterm
>xgterm –sb &

in the xterm type mkiraf (only do this if you have never started iraf before)
to run type cl

This opens up the IRAF startup

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:

color. gemini. lists. obsolete. stsdas.
ctio. gmisc. mscred. plot. system.
dataio. guiapps. nlocal. proto. tables.
dbms. images. nmisc. rvsao. utilities.
fitsutil. language. noao. softools. vol.

ecl>

The list at the top is the list of packages – type one to load it.

We will use noao, imred, ccdred and xdimsum load them in your terminal

To open a routine, type epar name
To exit the routine menu type :q to run from inside the routine :g.
To run from the commandline, type the routine name.
Flpr will perform a terminal reset

Backspace and delete do not always do what you think they will in IRAF, and the mouse does not work, you need to use the up and down keys.

To start:

Identify which files are which and separate them as appropriate.
Using more/gaia/fv identify what you need to know from the header:
Exposure time, filter, image type, seeing are good places to start.

hselect *.fits[0], $I,x,y,z yes>info.txt

Open info.txt and the separate the files accordingly. I like to use different directories for the bias, flats and data.

First step: Create master Dark for the flats and one for the images. **Why might these be different? How could you create darks for the flats if there aren't any?**

>epar darkcombine

Create a list of the darks you want to use:

Your list needs to include the extension for the image at the end. Extension 0 is the header: r12345.fit[1]

Enter you input list, as images. Use the @ to tell iraf it's a list
Enter an output. Alter the readnoise and gain to header values by entering the header keyword or look it up for your instrument (we're using LIRIS on the WHT) and enter the number.

Run the routine.

If you need to alter the dark, imarith perform arithmetic on the images.

Then, open ccdproc and subtract the dark from each flat.
Turn off fixpix, overscam, trim and zerocorr and flatcorr. Turn on darkcorr and enter your master dark in the relevant box.

Put your list of flat images in the input and a similar list in the output (I like to append a _ds to my filenames so I know what has been done). Add gain and readnoise as before
Run the routine.

Then combine the flats using flatcombine.
What is the routine doing - How is it combining the imaging? Why? What method is it using to reject pixels – how and why is this different from the darkcombine routine?

Dark subtract and flat subtract your imaging data using ccdproc – make sure your turn on these flags and enter the filename.

Create a bad pixel mask if the telescope doesn't provide one.
Have a look at the flats – what value are the hot/bad pixels?
Use ccdproc in mscred (different ccdproc to the one we have used so far) to enter a top level above which things are "bad" using the flat field.

If you have flats with short exposure times and long exposure times, you can also flat combine the short ones and the long ones, and then divide the lowflats by the highflats to get the ratio, and then enter this into ccdmask in imred. Up the lsigma and hsigma to ~20.

We can't combine these normally so we must take into account the dither pattern.

Why do we dither?

Open xmosaic
Enter your list of dark subtractd, flatfielded data
Put your first object as the reference image. Make a note of this object name.
Pick a "root name" for your outputs – the object name is normally a good choice.
Turn on everything marked "fp" – first pass, but turn off the cosmic ray correction. The routine occasionally overcompensates for cosmic rays and can remove data on the first pass through. We'll turn it on later.
Also turn on mp_mkma to create a combined object mask.

This masks out the objects to create a nice background called a "skyframe".
Everything else in the mp (mask pass) step should be off.
If you have a bad pixel mask, add it in. If not, leave blank and turn off "force bad pixel fitting"
Change repeats for bad pixel setting to 11.
Change number of sky images to 10
Change minimum number for sky to 5
Turn off enable caching
Turn off check and confirm new shifts
Turn off magnification factor for mask pass – this one is really important
Enter a name for the shiftlist. This is created throughout the first pass.
Turn off mp_kpch

You are now ready to run.
Before you do this, open up ds9 in iraf

>!ds9 &

This should open up an image window
>display filename & will put an image in the window.

Run xmosaic

The shiftlist is created manually. This is tricky and requires concentration.

A message will appear telling you to examine images – this just lets you look at the images. Have a look at a few (ideally round the dither pattern once) and pick a star that is in all images also keep your eye on other stars in all images that can be used as references.

Type q

It will then ask you to determine shifts using reference star
This time following the instructions, put your cursor over the star you want and type a then type n to move to the next image.
IRAF does not keep count! It does not tell you when you reach the end of the list – you must keep an eye on the files.
Do not press anything twice on the image either.

This step can take a few times to get it right!

When you have done the whole list and the image displayed is the first image in your list type q (without typing a first)

It will then ask you to pick some reference stars on that image.
Type a over your star from the previous images, then type a over about 5 other good stars.

What is a good star? What should be avoided?

Type q. IRAF will then take a while to create a "first pass" image.

When this has exited correctly, you will see a set of files marked _fp.fits
What is each file for?

Now we must run the mask pass.
Open up xmosaic again, now, turn off all the fp options and mp_mkma as we've done that already.
Turn on all the mp options apart from the one mentioned above.
Run the routine.

We turned off “determine shifts interactively” as we did that already, so it will run through the mask pass step without our help. If you have a lot of files, now is a good time to have a cup of tea.

When it’s done, you’ll have a list of files marked as _mp.fits.
These are the final images and _mp.fits is the final stack that you’ll do photometry on.

Astrometry can be done in Gaia as can photometry.