Lab 5
Final Project: Outline of Steps

The final project is a lab-like exercise that will use the techniques you have learned during the course. The objective is to use image data that was acquired using the Sedgwick telescope to estimate the age and distance of a particular open cluster of stars. Your methods and results should be prepared in the form of a scientific journal article, as described in the "Final Project Expectations" document. Here I describe the sequence of steps that you will probably want to follow in order to go from raw data to results. I will also indicate various possible extensions of the minimum acceptable procedure, if you want to enhance your grade. Recall that this paper and the oral presentation that goes with it are important -- together, they make up 30% of your grade.

Basic Steps

Here is the minimum necessary.

1. Select the data you wish to use. Each cluster has at least 3 images in each of the filters Blue, Green, and Red. Not all of these may be of equal quality, and you will need at least one image taken with each of the Blue and Green filters. Use ds9 to examine your candidate images, and decide which are the best in each filter that you intend to use. Bad images are those that have objectionable artifacts (eg satellite or airplane trails going through them), or that have flat-fielded poorly, or that have fuzzy or distorted star images, or that are not actually images of the cluster that you want.

2. Use SExtractor to make catalog files of your chosen images, making at least one each with Blue and Green filters.

3. Use match_stars to match the catalog entries between your Blue and Green catalogs, developing a merged catalog that contains information on all stars that appear on both images.

4. Read the magnitudes in Blue and Green filters into xmgrace as a data set.

5. Use xmgrace's arithmetic functions combined with the color transformation information from Lab4 to convert Blue and Green magnitudes into B and V magnitudes on the photometric system of Montgomery.

6. Use xmgrace to plot the stars from your images on a color-magnitude (H-R) diagram. Save this as an xmgrace plot (not a .ps file), since you will be playing with it a lot.

7. By some means of your choice (but be able to explain your choice), decide which stars probably belong to the cluster and which stars are foreground or background objects.

8. Onto the color-magnitude diagram comprising your "cluster" stars, overplot one or more of the theoretical isochrones from the Yonsei-Yale models. You may shift the models vertically (along the V Magnitude axis) to allow for the distance to your cluster. Also you may choose the age of the isochrone to best match the morphology of any star sequence that you see. Thus, two numbers (cluster distance and age) describe your model-fitting.

9. Make the best estimate you can of the uncertainty in the cluster age and distance. Be as quantitative as you can. Be able to justify your estimates.

10. Search the scientific literature for other results on your cluster. Be able to explain how your conclusions do or do not agree with those of other scientists. A useful resource will be the "ADS" link that is now linked from the course web page. Also be able to describe the image acquisition and data reduction steps that went into creating the images that you used.

11. Write all of this up in a logical and coherent way. If you worked in a team, explain your part in the team's work, as well as the conclusions of the whole team. Show plots and equations where needed. Stick to the length limitations. Cite the work and results from other sources that you used in your own paper.

Extras

The above is the minimum expected content of a paper. There are a lot of ways that you can add to this, to achieve a higher grade. A few of these are:

1. Use several Blue and Green images, and combine results from them to reduce errors compared to using single images.

2. Make color-magnitude diagrams showing both V magnitude vs B-V color, and V magnitude vs G-R color. Combine results from the two diagrams to reduce noise or otherwise increase confidence.

3. Experiment with the various SExtractor parameters to determine how to obtain optimal photometry from your images. Use these parameter choices in your subsequent analysis.

4. Do some serious literature research (eg, relating to proper motions) to determine which stars are actually members of your cluster.

5. Perform an unusually comprehensive or quantitative error analysis, particularly of the step in which you decide which isochrone and what cluster distance best match the observations. Doing this will likely require some programming skills.

6. Provide a discussion of the possible role of interstellar light absorption and reddening, and how these effects might modify your estimates of the cluster age and distance. Describe methods for measuring the absorption and reddening quantitatively.