University of Pittsburgh

STEPUP Image Analysis User Guide

Allegheny Observatory

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Chapter 1

Preliminary Steps

1.1 Transferring Data

Note: If you have already created a directory for your night of observation, skip to step 2. You may check this by opening a terminal window at the top of the screen and typing **cd /home/depot/STEPUP/raw/*target-name*/*date-of-observation***. If this command is successful, then the directory already exists.

1. Log onto Ptolemy in Allen 302. Open up a terminal window by clicking the terminal icon at the top of the screen. If a directory for your target does not exist, use the **mkdir** command to first make a directory for your target in **/home/depot/STEPUP/raw** and then make a directory for your night of observing within the target directory. The end result should be this path: **/home/depot/STEPUP/raw/*target-name*/*date-of-observation***. **Note:** it is important that your naming of the directory is consistent with how you named the files when you observed.

2. Once there is a directory for your night of observation, use the **cd** command to enter into it. Now, in order to remotely access the data on the observatory computer, type **ftp aoserver1.univ.pitt.edu**. When it prompts you for a name, type *anonymous* and hit enter. You may type anything for the password and hit enter.

3. Now you must go to the directory from which you wish to transfer data. Do this by typing **cd /STEPUPDataFiles/*date-of-observation***.

4. Before you begin copying files, make sure that prompting is turned off so that you do not have to confirm the transfer of each file individually. Do this by typing **prompt**. The setting toggles between on and off, so you may need to type it twice to make sure it says that prompting is turned off.

5. Next, type **binary**. This changes the mode to transfer.

6. Finally, to copy the files use the **mget** command. Type **mget *name-of-target**.fit**. This will transfer all files that have the target name in the title and the ".fit" extension. If you do not have a copy of the observing report on the Astro Lab computers, be sure to type **mget obsreport.txt** to transfer it as well.

7. Type **bye** to log off of the observatory computer.

8. Now, back in a Ptolemy terminal window, check to make sure that the files are in the directory that you created.

1.2 Creating Input File

1. Copy the input file template to the target directory by typing **cp /home/depot/STEPUP/input-file.txt /home/depot/STEPUP/raw/*target-name*/*date-of-observation***.

2. Make sure you are **cd**'ed into the night's directory and type the command **gedit input-file.txt**. Now you will begin editing the file.

3. Go through the file and input all of the parameters that you're immediately aware of. These should include **DATE, TARGET, RA** and **DEC**. If you are unsure of any of them, check the observing report.

4. Now that you have completed all of the immediately known entries, you must determine **VSPCODE, COMPMAGS, COMPCOORDS, CNAME, CCOORDS, KNAME** and **KCOORDS**. All of this information will be found on *aavso.org*. Go to that site and sign in.

5. Once you are on the site and logged in, mouse over the *Observing* tab at the top. Under the *Variable Star Charts* option, click on *Variable Star Plotter (VSP).*

6. Once on the Variable Star Plotter page, you will need to specify the right ascension, declination, predefined chart scale (which should be option F, 18.5 arcminutes), and the filters which the photometry table should display (at the bottom). If you have previously used VSP for this target, you may skip these steps and simply use the Chart ID from last time, which can be found in the input-file.txt for that night of observing. Once you have filled out this information, click *Plot Chart* at the bottom.

7. You should have been redirected to a page that has a star chart for your target on it. At the top under where it says "Variable Star Plotter" click *Photometry Table for This Chart.*

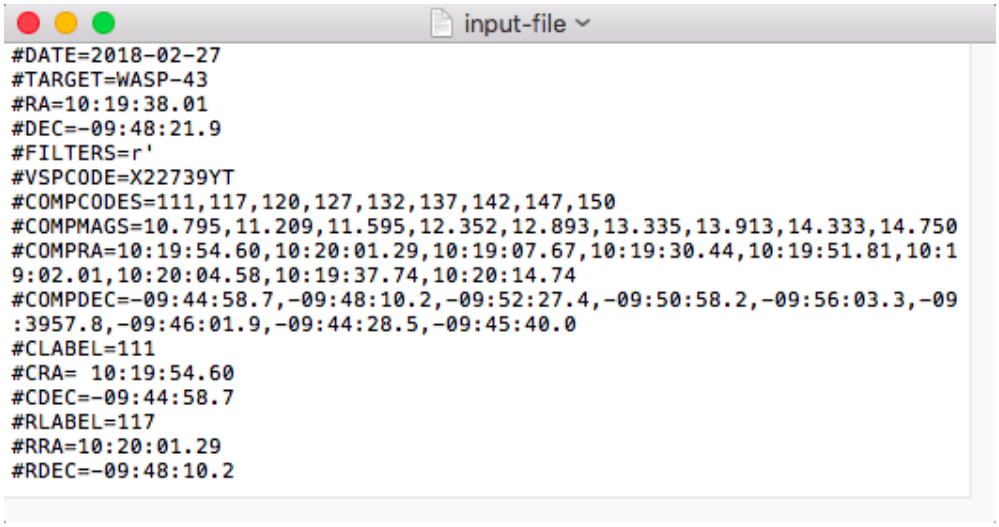
8. Back in input-file.txt, enter the bolded code at the top where it says "Report this sequence as..." in the **VSPCODE** entry point.

9. Now, in the **COMPMAGS** category, enter in the magnitudes in the order that they appear, top to bottom, each separated by a comma. **Important**: be sure to include the magnitude values for only the filter that you observed in.

10. Also in order from top to bottom, enter the right ascension and declination for each comparison star under the **COMPRA** and **COMPDEC** keywords. They should be in the form **HH:MM:SS** for RA and **DD:MM:SS** for Dec.

11. Now you will need to choose one "comparison" star and one "check" star that the program will output data on. Choose the two of the closest stars in the image to the target star by looking at the numerical values of the RA and Dec and comparing them to that of the target star. These will be your comparison star and check star (it doesn't matter which is which). Enter in their AAVSO Unique Identifier (AUID), RA, and Dec into the **CLABEL, CRA, CDEC, KLABEL, KRA**, and **KDEC** categories.

12. Now that you have completed all of the entries, verify that the file is in your target directory by **cd**ing into your target directory and then using the **ls** command, which will show you everything in the current directory you are in. It should be saved in the directory exactly as *input-file.txt*. If it is named anything other than that, be sure to change it.



Example of input-file.txt

Chapter 2

Running STEPUP Image Analysis

1. Before you run the code, be sure to check that you have all of the calibration and target images in your directory as well as that your input file. Additionally, make sure that the naming of each image is consistent with the target name that you put in your input file and how your directory is named.

2. Open up a new terminal window and type **export PATH=$PATH:/usr/local/wcstools-3.3.3/bin**.

3. Next, type **cd /home/depot/STEPUP/STEPUP_image_analysis/**. Now that you have entered into the directory containing the code, type the command **python3 main.py**. This will begin running the code.

4. You will first be asked which computer the code is being ran from. If it is being ran from a computer in Allen 302, type **W**. If it is being ran from Helena's personal device, then type **H**.

5. Next you will be prompted for the name of the target. Be consistent as you enter it and be sure not to include any additional capital/lowercase letters and spaces.

6. Next, you will be prompted to enter the date of observation. Enter is as **YYYY-MM-DD** with no additional spaces.

7. Now you will be asked whether or not you would like to run the entire image analysis routine. If you wish to, type **Y**. Then, the instrument signature removal part of the routine will begin running. If you wish to perform only certain parts of the code, then type **N**. You will be asked if you would still like to perform a function, which you should specify **Y** to until you are finished using the code. Next, you will be asked what part of the code you would like to run. Enter **ISR**, **ASTROM**, or **PHOT** to perform instrument signature removal, astrometry, or photometry respectively.
   Note: while you are able to give the command to repeat a function here, keep in mind that you can only run the same function more than once in a row without getting an error is PHOT. However, you should not need to run ISR or ASTROM more than once in a row in most cases. If, for some reason, you do need to repeat these functions be sure to remove the directories that the code creates in each function.

8. If you chose to run the whole routine, once instrument signature removal is competed the program will pause to make sure you have save a new-image.fits calibration file to the appropriate directory. If you have, enter **Y**. If not, you must create an image of the field of view of

the target star with WCS information in its header before the program starts running again. ***Note:*** you may reuse new-image.fits file for the same target that are saved in **/home/depot/STEPUP/analysis_history**, but you should only do this if you are sure that the new-image.fits file and your images that you are processing are centered at the same position.

9. To generate this image, go to *astrometry.net*

10. Once on their homepage, select the *use* option.

11. Now on the *Use the Code* page, select *web*.

12. At the top of the page you're redirected to, select *Upload*. You will go into the directory that was just created containing all of your instrument signature removed images. It should be called **/home/depot/STEPUP/raw/*name-of-target*/*date-of-observation*/ISR_Images/**. Choose any one of the images in there.

13. Once you have chosen your image, select *Upload*. It will take a minute or so for the image to upload, so don't press anything of leave the page until it does.

14. You will be redirected to a new page. It will take another minute or so for the image to be processed. Once it says *Success*. Click on *Go to results page*.

15. Under the *Calibration* column along the right side, click on *new-image.fits*. This will save the image to the computer's **Downloads** directory.

16. Move this image into the directory with your instrument signature removed images by typing **mv /home/Downloads/new-image.fits /home/depot/STEPUP/raw/*name-of-target*/*date-of-observation*/ISR_Images/**. Now that this image is the correct directory, enter **Y** to continue.

17. If you continued with the program, the astrometry part of the program will begin to run. This takes may take up to an hour to complete, so keep checking in on the program every 15 minutes or so as it runs. Once this part is completed, if you are running the entire image analysis routine photometry will automatically begin running. If you are running only one part of the code, once it is finished it will ask you if you would like to perform another function. Answer accordingly, and follow similar steps as when you ran the first function.

18. After the photometry process has completed the program will be finished running. Check your target directory to make sure that a *lightcurve.pdf* and a *output.txt* file are both in there. You can use the command **xdg-open lightcurve.pdf** to view the light curve and make sure everything looks okay. If, for instance, you see any points that are certainly outliers (they lie more than 3σ from the mean), you may remove that file from **/home/depot/STEPUP/raw/AGDra/*name-of-target*/*date-of-observation*/ISR_Images/*filter-name*/WCS/accurate_WCS**, as it is most likely a bad image. Then, you can rerun photometry and you should see a light curve without that outlier point.

Chapter 3

Uploading Data

1. Once you have ran the program on your dataset and have your *output.txt* file, go to *www.aavso.org*.
2. On the AAVSO homepage, under the *Observing* tab, select *WebObs (Search AID or Submit Your Data)*.
3. On the *WebObs* page, select *Upload a file of observations*.
4. Now, on the *Upload a File of Observations* page, click *Choose File* and find your *output.txt* file in your target directory and select it.
5. Now that you have selected the file, click *Upload File*.

Chapter 4

Troubleshooting

Note: STEPUP Image Analysis was written in 2017 in Python 3.6.2. The Troubleshooting tips below are written in accordance with the Python 3.6.2 documentation and syntax.

4.1 Instrument Signature Removal

1. **NotADirectoryError**: If you get an error telling you that a certain directory does not exist, it is most likely because you typed something wrong (i.e. capitalizing/not capitalizing letters that should be capital or adding additional spaces). Simply type **python3 main.py** to try again and by *very careful* to make sure you are typing the target name and date of observation exactly as it appears in the directory containing the data you are trying to process.

2. **FileNotFoundError**: This error may occur if there are no Bias Frame or Flat Field images in the target directory. If you did not take any calibration images the night you observed, you will need to copy them in from another directory from a night when you observed in the same filter. Technically, you can use Bias images from any night, since they are taken without a filter, but your Flat images *must* be in the same filter. Once you have copied them in with the **cp** command, you must remove the directory which has been created to store the calibration images by typing **rmdir /home/depot/STEPUP/raw/*name-of-target*/*date-of-observation*/mcalib**. Once you have done this and the calibration images are in the target directory type **cd** into **STEPUP_image_analysis** and type **python3 main.py** to begin running the code again.

4.2 Perform Astrometry

4.3 Perform Photometry