AO1 Practice Course

May 4, 2023
Astronomical Observation and Practice 1

Bumhoo LIM

Who am I

Name	Bumhoo Lim (임범후) (통합 2022 Spring)
Team	Solar System Research Team (Prof. Ishiguro)
Office	19-309
E-mail	bumhoo7@snu.ac.kr
Phone	010-3374-3963

Please feel free to contact me anytime if you have any questions!

What We Do in TA Session

5 / 4 (Thu)

1. **Setup (Most important & time consuming…)**
2. **Pre-processing (*0-preprocessing.ipynb*)**
3. **FITS file handling (*1-fits-basic.ipynb*)**
4. **Query (*5-query.ipynb*)**

5 / 9 (Tue)

1. **Aperture Photometry (*2-center, 3-aperture, 4-annulus.ipynb*)**
2. **Differential Photometry (*6-diffphot.ipynb*)**

What we don’t do: PSF photometry, Surface photometry

Reference

This TA session largely based on the SNU AO Class Python Notes produced by previous TA of this class (Yoonsoo P. Bach; github)

You can download full materials (SNU_AOpython) from here OR

```
$ (move to your directory)
$ git clone https://github.com/ysBach/SNU_AOpython.git
```

Also you can find previous repository (SNU_AOclass) from here OR

```
$ (move to your directory)
$ git clone https://github.com/ysBach/SNU_AOclass.git
```

We are not gonna learn about git & github (due to the time limit)

File Setup

1. Make your own directory

```
$ mkdir AO1_BumhooLIM        # make directory
$ cd AO1_BumhooLIM           # change current directory
```

- You are gonna use this directory for the whole practice.
- This directory will be deleted after the semester. So please make sure to back up your files if you need.

```
# example of basic commands
$ rmdir # remove empty directory
$ . current directory
$ .. parent directory
$ ~ home directory
```

- If you need other basic UNIX commands, refer here.

File Setup

2. Download your own data from the SAO NAS homepage

- https://sao.snu.ac.kr/
  - You may need ID & PW (TA will notify to you)
  - File Station > IMSNG > date(e.g. 2023-04-27) > choose files > *download in .zip*

  - You need to download at least

    1) bias (*calibration-*bias.fit*)
    2) dark (*calibration-*dk*.fit*)
    3) flat (with your filter) (*Flat-*(UBVRI).fit*)
    4) target raw data ([*target*]-*(*UBVRI*).*fit*)

  - You can unzip the .zip file with

    $ unzip [*filename*].*zip*

(tip) Most of the files will be downloaded to *home/Downloads* folder. You can move the files with

$ mv ~/Downloads/[*filename*] . (current directory)

File Setup

3. **Download tutorial data here. (*Tutorial_Data.zip*)**
4. **Download Python scripts from eTL module.**
    - These scripts are basically same with *SNU AO1 Python Notes* made by *Yoonsoo P. Bach*.
    - We are going to utilize this lecture note in our practice.
    - Due to the time limit, we are not gonna treat all the sections in this note. **But I highly recommend you to read and execute all the sections in this lecture note**.

Software Setup

1. Anaconda

Anaconda is open-source Python distribution platform to perform Python/R data science.

1) Download the latest version of Anaconda installer from here.

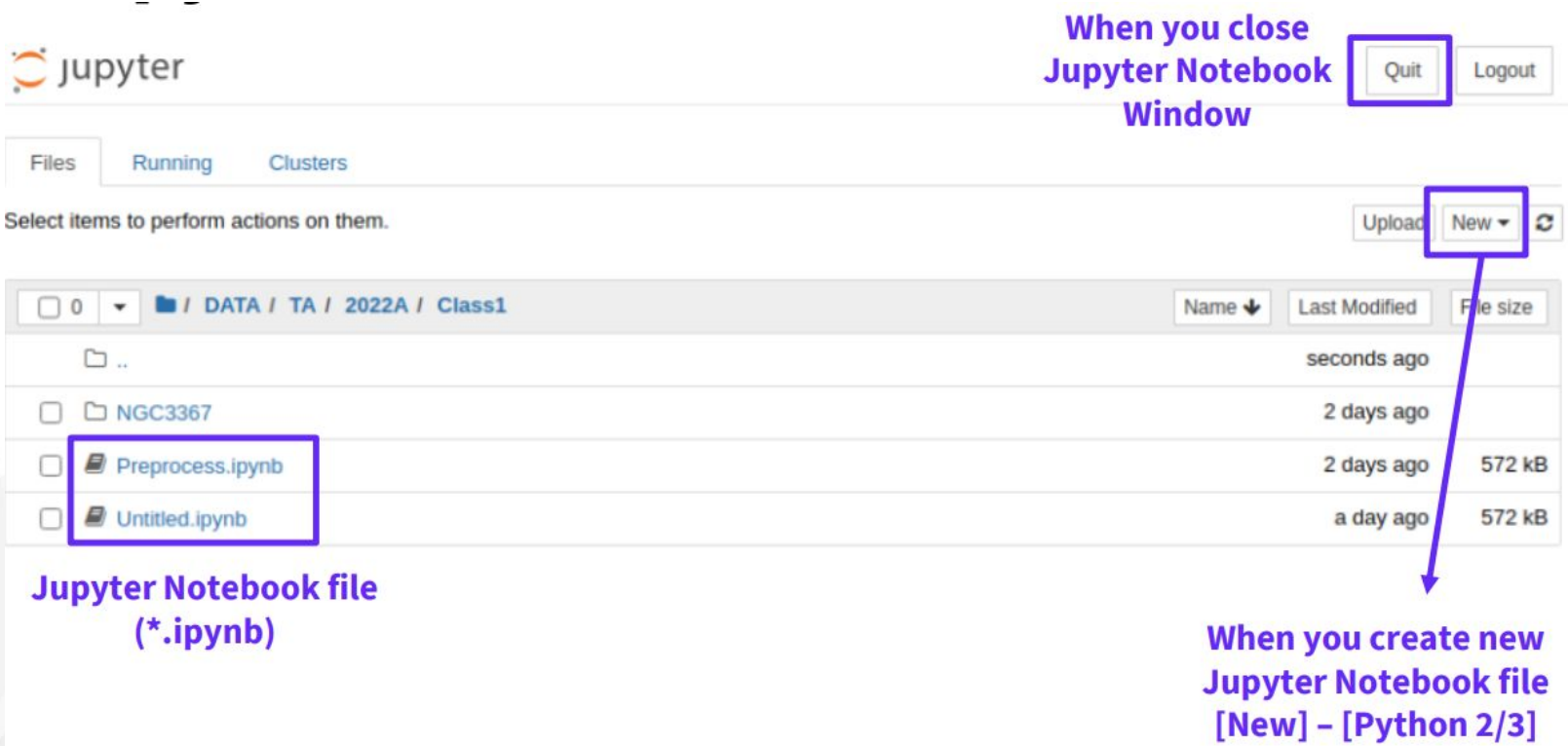
2) Install Anaconda3
   $ bash Anaconda3-[*latest version*].sh # if Anaconda3 already exists, add option -u (update)

3) Execute conda
   $ conda activate # In case of Windows, you can open 'Anaconda Prompt' by searching.
   # If this command not working, try **$** *source ~/anaconda3/etc/profile.d/conda.sh* and retry.

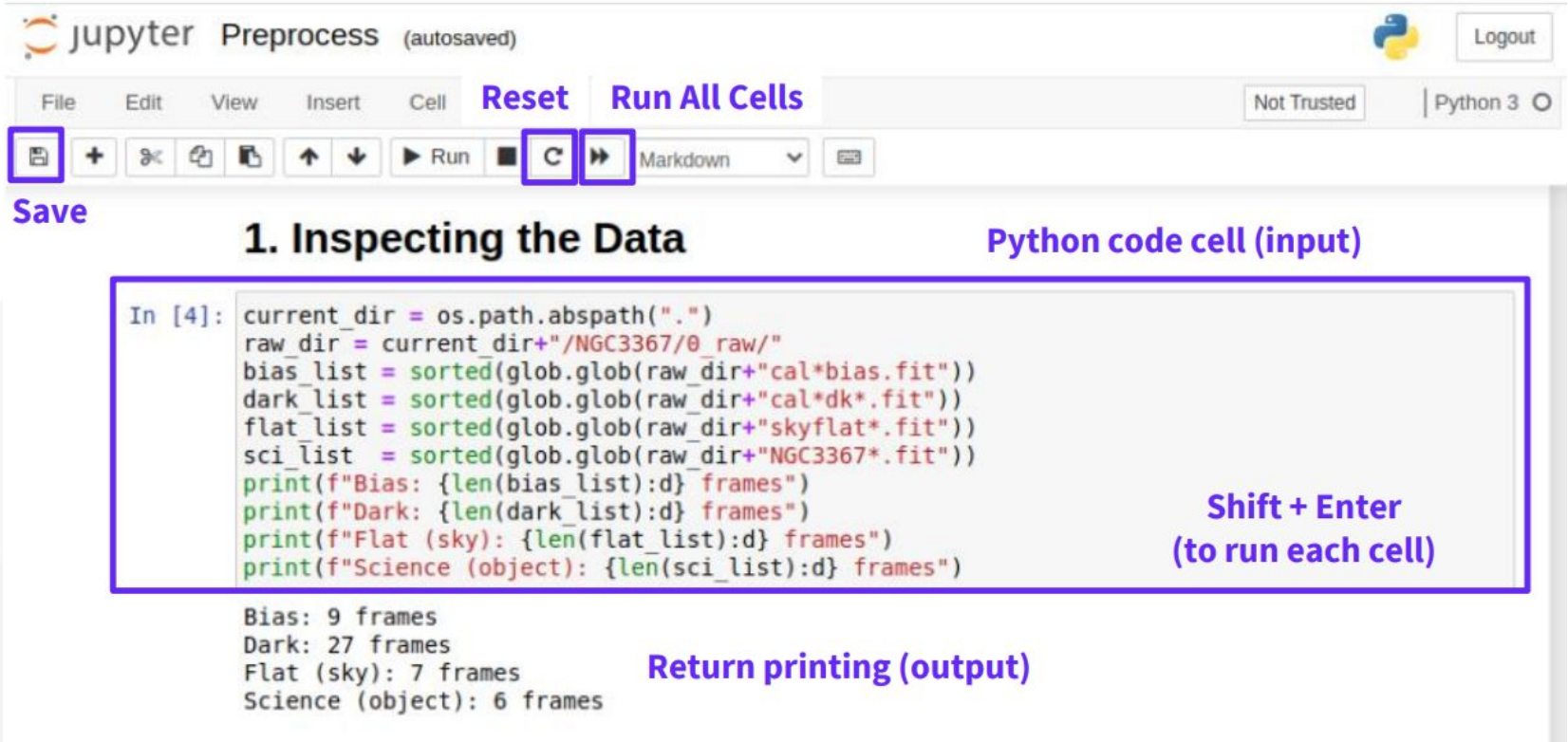
4) (**Important**) Setup your virtual environment referring to the instruction here.

5) Activate your environment and open *Jupyter Notebook* (One of the Python interpreters)
   $ conda activate *snuao* # when you open the conda next time
   $ jupyter notebook &

Jupyter Notebook



Jupyter Notebook



Software Setup

2. SAO DS9

DS9 is very useful fits file display and visualization tool.

1) You can install ds9 with
   $ sudo apt-get update
   $ sudo apt-get -y install saods9

2) After installation, test with
   $ ds9 &

3) You can open your fits file using
   $ ds9 [*filename*].fits &

Software Setup

3. Slack

- Basically “chatting app” like kakaotalk

- I will invite you to the 2023-AO1 (excluded) channel via your email.
  You can ask about your projects, group works, and Python code.

- *I will expire the channel after the end of the semester.*

If you are not familiar with Python…

- There are numerous materials related to the Python programming language, including Yoonsoo's lecture note. (here)

- I'm not gonna explain the very basic grammar of Python due to the time limit. However, **I'll explain in detail as possible each line's purpose, function, and related grammar.**

We will utilize Tutorial_Data in this practice course. If you want to adopt your data in this practice similar with tutorial data, you should prepare <u>two things</u>.

1. pre-processing (bias, dark, flat)

2. Insert WCS to fits file (to do query)

Pre-processing (*0_Preprocessing.ipynb*)

1. Bias

- Measuring **zero noise level** of instrument
- No exposure to light (exposure time = 0 sec)
- Exist in all kinds of data (dark, flat, raw)

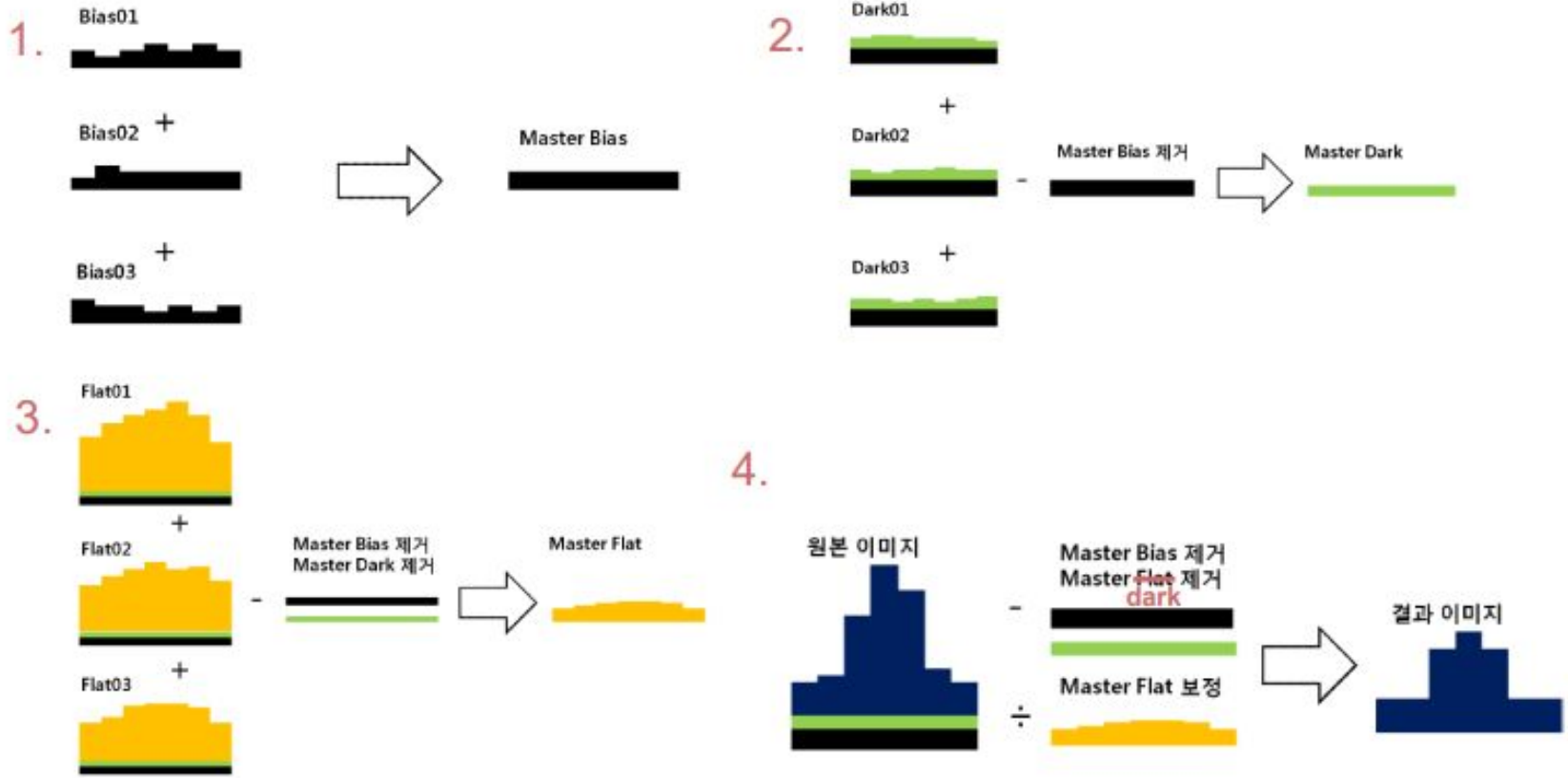
2. Dark

- Measuring **thermal noise (dark current)** in the instrument
- Pixel values proportional to exposure time
- Exist in flat & raw data

3. Flat

- To correct for pixel-to-pixel variations of instrument response
- Varying with wavelength (U, B, V, R, I…)
- Dome flat, twilight flat, etc.

Pre-processing (*0_Preprocessing.ipynb*)



WCS setup

To do query from the sky catalog (*5_Querying_from_the_Catalog.ipynb*), we should insert WCS (World Coordinate System) to the fits file.

- Upload your fits file to astronomy.net
  - Advanced Settings
    - Scale → custom, Units → “arcseconds per pixel”, Lower bound: 0.3, Upper bound: 0.4
    - CRPIX center: check
- Click upload
- After a success, go to result page and download the new FITS file (*new-image.fits*)
- Check it with DS9 (Analysis → Catalogs → Optical → *URAT1*(*or other catalog*))

- If you have too many FITS files to upload, you may try the offline version of the astronomy.net in here. It is only available for Linux or Mac (or virtual Linux in Window).