

MkPy Python Tutorial

8:30 - 9:00	Coffee and Tea
9:00 - 10:15	Intro to Python I
10:15 - 10:30	Break
10:30 - 12:00	Intro to Python II
12:00 - 1:00	Lunch (provided)
1:00 - 1:45	Astropy 1
1:45 - 2:45	Plotting
2:45 - 3:00	Break
3:00 - 4:30	Astropy 2 & 3
4:30 - 5:00	Wrap Up

Times are **very** approximate

- The goal today is to give you a brief introduction to python and to show you some of the powerful tools that are available in python.
- We want to help you find useful tools to get your work done, not teach you formal programming skills.

A Brief Introduction to Git and Github

Git

- Git is a “version control system”
- Git is a tool which facilitates collaboration
 - branching and merging
 - remote repository tools

Git: Version Control

```
[trapezium] ~ > mkdir MyProject
[trapezium] ~ > cd MyProject/
[trapezium] ~/MyProject > git init
Initialized empty Git repository in /Users/joshw/MyProject/.git/
[trapezium] ~/MyProject > touch readme.txt
[trapezium] ~/MyProject > edit readme.txt
[trapezium] ~/MyProject > more readme.txt
This is my readme.txt file.
[trapezium] ~/MyProject > git add readme.txt
[trapezium] ~/MyProject > git commit -m "Initial commit. Created a readme file for
this project."
[master (root-commit) 5946c92] Initial commit. Created a readme file for this
project.
1 file changed, 1 insertion(+)
create mode 100644 readme.txt
```

Git: Version Control

```
[trapezium](master) ~/MyProject > git log  
commit 5946c92a938406f4ca155a1d8375dd10043963a7  
Author: Josh Walawender <jmwalawender@gmail.com>  
Date:   Wed Nov 20 14:05:46 2013 -1000
```

Initial commit. Created a readme file for this project.

Git: Version Control

```
[trapezium](master) ~/MyProject > touch FileWhichIsImportant.txt
[trapezium](master) ~/MyProject > edit FileWhichIsImportant.txt
[trapezium](master) ~/MyProject > more FileWhichIsImportant.txt
This file contains an important part of my project.
[trapezium](master) ~/MyProject > git add FileWhichIsImportant.txt
[trapezium](master) ~/MyProject > git commit -a -m "Added FileWhichIsImportant.txt and
added important content to it."
[master a6d94ef] Added FileWhichIsImportant.txt and added important content to it.
1 file changed, 1 insertion(+)
create mode 100644 FileWhichIsImportant.txt
```

Git: Version Control

```
[trapezium](master) ~/MyProject > edit FileWhichIsImportant.txt
```

```
[trapezium](master) ~/MyProject > more FileWhichIsImportant.txt
```

```
This file contains an important part of my project.
```

```
This is some important information.
```

```
[trapezium](master) ~/MyProject > git commit -a -m "Added additional content."
```

```
[master bd6e5b3] Added additional content.
```

```
1 file changed, 2 insertions(+)
```


Git: Version Control

```
[trapezium](master) ~/MyProject > git log  
commit bd6e5b3190d532b0825459928bd2727e91122c05  
Author: Josh Walawender <jmwalawender@gmail.com>  
Date: Thu Nov 21 10:31:05 2013 -1000
```

Added additional content.

```
commit a6d94ef605fcdb3fac466f3c4203c2490d807855  
Author: Josh Walawender <jmwalawender@gmail.com>  
Date: Wed Nov 20 14:14:11 2013 -1000
```

Added FileWhichIsImportant.txt and added important content to it.

```
commit 5946c92a938406f4ca155a1d8375dd10043963a7  
Author: Josh Walawender <jmwalawender@gmail.com>  
Date: Wed Nov 20 14:05:46 2013 -1000
```

Initial commit. Created a readme file for this project.

Git: Branching & Merging

- a git repository can be “branched”
 - allows you to switch between multiple branches of a project
 - can branch a project to experiment with an idea, but always have the “master” branch to return to
- git branch

Git: Branching & Merging

```
[trapezium](master) ~/MyProject > git branch crazy_idea
[trapezium](master) ~/MyProject > git branch -v
  crazy_idea f7ea0e7 Initial commit. Created a readme file
* master      f7ea0e7 Initial commit. Created a readme file
[trapezium](master) ~/MyProject > git checkout crazy_idea
Switched to branch 'crazy_idea'
[trapezium](crazy_idea) ~/MyProject > edit new_file.txt
[trapezium](crazy_idea) ~/MyProject > more new_file.txt
hmmm ... I wonder if this will work.
[trapezium](crazy_idea) ~/MyProject > git add new_file.txt
[trapezium](crazy_idea) ~/MyProject > git commit -m 'Just playing around.'
[crazy_idea 5b64b33] Just playing around.
 1 file changed, 1 insertion(+)
 create mode 100644 new_file.txt
[trapezium](crazy_idea) ~/MyProject > git checkout master
[trapezium](master) ~/MyProject > git branch -v
  crazy_idea 5b64b33 Just playing around.
* master      f7ea0e7 Initial commit. Created a readme file
```

Git: Branching & Merging

- a branch can be merged back in to another branch
- If your crazy idea works out, you can merge back in to master.
 - Very easy if master has not changed in the meantime
 - Still possible (though more complex) if master has changed. This is the utility of git for collaboration.

The screenshot displays the IQMons (Git) web interface. The top navigation bar includes links for 'View', 'Commit', 'Checkout', 'Branch', 'Search', 'Add', 'Remove', 'Add/Remove', 'Watch', 'Pull', 'Push', 'Branch', 'Merge', 'Tag', 'Link-New', and 'Terminal'. The main content area is divided into two panels. The left panel, titled 'FILE STATUS', shows a tree view of the repository with branches (develop, hotfix/Units_Bug_in_FWHM, master, release/v1.0) and tags (v1.0, v1.1, v1.2, v1.3, v1.4, v1.5, v1.6, v1.7, v1.8, v1.9, v1.10, v1.11, v1.12, v1.13, v1.14, v1.15, v1.16, v1.17, v1.18, v1.19, v1.20, v1.21, v1.22, v1.23, v1.24, v1.25, v1.26, v1.27, v1.28, v1.29, v1.30, v1.31, v1.32, v1.33, v1.34, v1.35, v1.36, v1.37, v1.38, v1.39, v1.40, v1.41, v1.42, v1.43, v1.44, v1.45, v1.46, v1.47, v1.48, v1.49, v1.50, v1.51, v1.52, v1.53, v1.54, v1.55, v1.56, v1.57, v1.58, v1.59, v1.60, v1.61, v1.62, v1.63, v1.64, v1.65, v1.66, v1.67, v1.68, v1.69, v1.70, v1.71, v1.72, v1.73, v1.74, v1.75, v1.76, v1.77, v1.78, v1.79, v1.80, v1.81, v1.82, v1.83, v1.84, v1.85, v1.86, v1.87, v1.88, v1.89, v1.90, v1.91, v1.92, v1.93, v1.94, v1.95, v1.96, v1.97, v1.98, v1.99, v1.100, v1.101, v1.102, v1.103, v1.104, v1.105, v1.106, v1.107, v1.108, v1.109, v1.110, v1.111, v1.112, v1.113, v1.114, v1.115, v1.116, v1.117, v1.118, v1.119, v1.120, v1.121, v1.122, v1.123, v1.124, v1.125, v1.126, v1.127, v1.128, v1.129, v1.130, v1.131, v1.132, v1.133, v1.134, v1.135, v1.136, v1.137, v1.138, v1.139, v1.140, v1.141, v1.142, v1.143, v1.144, v1.145, v1.146, v1.147, v1.148, v1.149, v1.150, v1.151, v1.152, v1.153, v1.154, v1.155, v1.156, v1.157, v1.158, v1.159, v1.160, v1.161, v1.162, v1.163, v1.164, v1.165, v1.166, v1.167, v1.168, v1.169, v1.170, v1.171, v1.172, v1.173, v1.174, v1.175, v1.176, v1.177, v1.178, v1.179, v1.180, v1.181, v1.182, v1.183, v1.184, v1.185, v1.186, v1.187, v1.188, v1.189, v1.190, v1.191, v1.192, v1.193, v1.194, v1.195, v1.196, v1.197, v1.198, v1.199, v1.200, v1.201, v1.202, v1.203, v1.204, v1.205, v1.206, v1.207, v1.208, v1.209, v1.210, v1.211, v1.212, v1.213, v1.214, v1.215, v1.216, v1.217, v1.218, v1.219, v1.220, v1.221, v1.222, v1.223, v1.224, v1.225, v1.226, v1.227, v1.228, v1.229, v1.230, v1.231, v1.232, v1.233, v1.234, v1.235, v1.236, v1.237, v1.238, v1.239, v1.240, v1.241, v1.242, v1.243, v1.244, v1.245, v1.246, v1.247, v1.248, v1.249, v1.250, v1.251, v1.252, v1.253, v1.254, v1.255, v1.256, v1.257, v1.258, v1.259, v1.260, v1.261, v1.262, v1.263, v1.264, v1.265, v1.266, v1.267, v1.268, v1.269, v1.270, v1.271, v1.272, v1.273, v1.274, v1.275, v1.276, v1.277, v1.278, v1.279, v1.280, v1.281, v1.282, v1.283, v1.284, v1.285, v1.286, v1.287, v1.288, v1.289, v1.290, v1.291, v1.292, v1.293, v1.294, v1.295, v1.296, v1.297, v1.298, v1.299, v1.300, v1.301, v1.302, v1.303, v1.304, v1.305, v1.306, v1.307, v1.308, v1.309, v1.310, v1.311, v1.312, v1.313, v1.314, v1.315, v1.316, v1.317, v1.318, v1.319, v1.320, v1.321, v1.322, v1.323, v1.324, v1.325, v1.326, v1.327, v1.328, v1.329, v1.330, v1.331, v1.332, v1.333, v1.334, v1.335, v1.336, v1.337, v1.338, v1.339, v1.340, v1.341, v1.342, v1.343, v1.344, v1.345, v1.346, v1.347, v1.348, v1.349, v1.350, v1.351, v1.352, v1.353, v1.354, v1.355, v1.356, v1.357, v1.358, v1.359, v1.360, v1.361, v1.362, v1.363, v1.364, v1.365, v1.366, v1.367, v1.368, v1.369, v1.370, v1.371, v1.372, v1.373, v1.374, v1.375, v1.376, v1.377, v1.378, v1.379, v1.380, v1.381, v1.382, v1.383, v1.384, v1.385, v1.386, v1.387, v1.388, v1.389, v1.390, v1.391, v1.392, v1.393, v1.394, v1.395, v1.396, v1.397, v1.398, v1.399, v1.400, v1.401, v1.402, v1.403, v1.404, v1.405, v1.406, v1.407, v1.408, v1.409, v1.410, v1.411, v1.412, v1.413, v1.414, v1.415, v1.416, v1.417, v1.418, v1.419, v1.420, v1.421, v1.422, v1.423, v1.424, v1.425, v1.426, v1.427, v1.428, v1.429, v1.430, v1.431, v1.432, v1.433, v1.434, v1.435, v1.436, v1.437, v1.438, v1.439, v1.440, v1.441, v1.442, v1.443, v1.444, v1.445, v1.446, v1.447, v1.448, v1.449, v1.450, v1.451, v1.452, v1.453, v1.454, v1.455, v1.456, v1.457, v1.458, v1.459, v1.460, v1.461, v1.462, v1.463, v1.464, v1.465, v1.466, v1.467, v1.468, v1.469, v1.470, v1.471, v1.472, v1.473, v1.474, v1.475, v1.476, v1.477, v1.478, v1.479, v1.480, v1.481, v1.482, v1.483, v1.484, v1.485, v1.486, v1.487, v1.488, v1.489, v1.490, v1.491, v1.492, v1.493, v1.494, v1.495, v1.496, v1.497, v1.498, v1.499, v1.500, v1.501, v1.502, v1.503, v1.504, v1.505, v1.506, v1.507, v1.508, v1.509, v1.510, v1.511, v1.512, v1.513, v1.514, v1.515, v1.516, v1.517, v1.518, v1.519, v1.520, v1.521, v1.522, v1.523, v1.524, v1.525, v1.526, v1.527, v1.528, v1.529, v1.530, v1.531, v1.532, v1.533, v1.534, v1.535, v1.536, v1.537, v1.538, v1.539, v1.540, v1.541, v1.542, v1.543, v1.544, v1.545, v1.546, v1.547, v1.548, v1.549, v1.550, v1.551, v1.552, v1.553, v1.554, v1.555, v1.556, v1.557, v1.558, v1.559, v1.560, v1.561, v1.562, v1.563, v1.564, v1.565, v1.566, v1.567, v1.568, v1.569, v1.570, v1.571, v1.572, v1.573, v1.574, v1.575

Git: Collaboration

- git handles decentralized remote repositories
 - you can **clone** a repository from another source (i.e. another machine on the network)
 - you can then make edits (commits) and **push** your changes (commits) to the remote repository or **pull** someone else's changes (commits) to your machine

Why Is This Important?

- I can start working on a project (code or scientific paper) others can see what I'm doing and **keep up** by using git pull.
- No more emailing versions of files around with increasingly complex names:

A STORY TOLD IN FILE NAMES:

Location: C:\user\research\data

Filename	Date Modified	Size	Type
data_2010.05.28_test.dat	3:37 PM 5/28/2010	420 KB	DAT file
data_2010.05.28_re-test.dat	4:29 PM 5/28/2010	421 KB	DAT file
data_2010.05.28_re-re-test.dat	5:43 PM 5/28/2010	420 KB	DAT file
data_2010.05.28_calibrate.dat	7:17 PM 5/28/2010	1,256 KB	DAT file
data_2010.05.28_huh??.dat	7:20 PM 5/28/2010	30 KB	DAT file
data_2010.05.28_WTF.dat	9:58 PM 5/28/2010	30 KB	DAT file
data_2010.05.29_aaarrgh.dat	12:37 AM 5/29/2010	30 KB	DAT file
data_2010.05.29_#\$_*!&.dat	2:40 AM 5/29/2010	0 KB	DAT file
data_2010.05.29_crap.dat	3:22 AM 5/29/2010	437 KB	DAT file
data_2010.05.29_notbad.dat	4:16 AM 5/29/2010	670 KB	DAT file
data_2010.05.29_woohoo!.dat	4:47 AM 5/29/2010	1,349 KB	DAT file
data_2010.05.29_USETHISONE.dat	5:08 AM 5/29/2010	2,894 KB	DAT file
analysis_graphs.xls	7:13 AM 5/29/2010	455 KB	XLS file
ThesisOutline!.doc	7:26 AM 5/29/2010	38 KB	DOC file
Notes_Meeting_with_ProfSmith.txt	11:38 AM 5/29/2010	1,673 KB	TXT file
JUNK...	2:45 PM 5/29/2010		Folder
data_2010.05.30_startingover.dat	8:37 AM 5/30/2010	420 KB	DAT file

Type: Ph.D Thesis Modified: too many times

Copyright: Jorge Cham

www.phdcomics.com

Why Is This Important?

- Others can make changes and make a “pull request”. You then “merge” their edits in to your code (if you want to).
- Git (especially combined with GitHub) is a powerful sharing and collaboration tool

Github.com

- github.com is a hosting service for git repositories
 - repositories hosted on github are public: anyone can clone, you control who can edit
 - private repositories on github cost money
 - other hosting services (i.e. bitbucket.org) are the opposite (private = free, public = paid)

<https://github.com/astropy/astropy>

Now use git to get today's material

In a terminal on your machine type:

```
git clone https://github.com/MkPy/python-tutorial.git
```

Now you have a directory called python-tutorial.

If you had already cloned that yesterday, you should cd in to that directory and pull the very latest version by typing:

```
git pull
```

Python

How to Run Python Code

- From the command line: `python mycode.py`
- Type lines of code in an interpreter
 - `python`

ipython

- Great for exploration and testing (use this instead of the python interpreter)
- Code highlighting
- Tab completion
- Help: `numpy.mean?`
- Special functions: `%paste`, `%timeit`

Jupyter Notebooks

- Web based (run locally) interactive python sessions with markup and inline graphics.
- Great for exploration and testing
- Great for documentation and teaching
- And since notebooks are good for teaching ...

Other Topics

Other Topics

- Things we couldn't cover, but you should look at:
- Other python concepts
 - OrderedDict
 - Building your own Exceptions
 - Testing (e.g. pytest)

Other Topics

- Things we couldn't cover, but you should look at:
- Other astropy packages
 - astropy.modeling (models and fitting)
 - astropy.stats (statistics)
 - astropy.cosmology (cosmology calculations)
 - astropy.convolution (convolution & filtering)

Other Topics

- Things we couldn't cover, but you should look at:
- Astropy affiliated packages
 - astroquery (query online databases)
 - astroplan (planning observations)
 - ccdproc (CCD reductions)
 - ginga (FITS display)
 - photutils (photometry)
 - specutils (spectroscopy)

Advice

This is my soap box,
your mileage may vary :)

Text Editors

- Don't use ancient editors like vi or emacs (both originally written in 1976) unless you have a particular reason to do so (i.e. you're already a ninja).
 - Yes, they are over 40 years old.
- Try out modern editors such as: TextWrangler (free), BBEdit (\$), Sublime (\$), or Atom (free)
- Some people prefer to use integrated development environments (IDEs)
 - I use Coda on iOS.

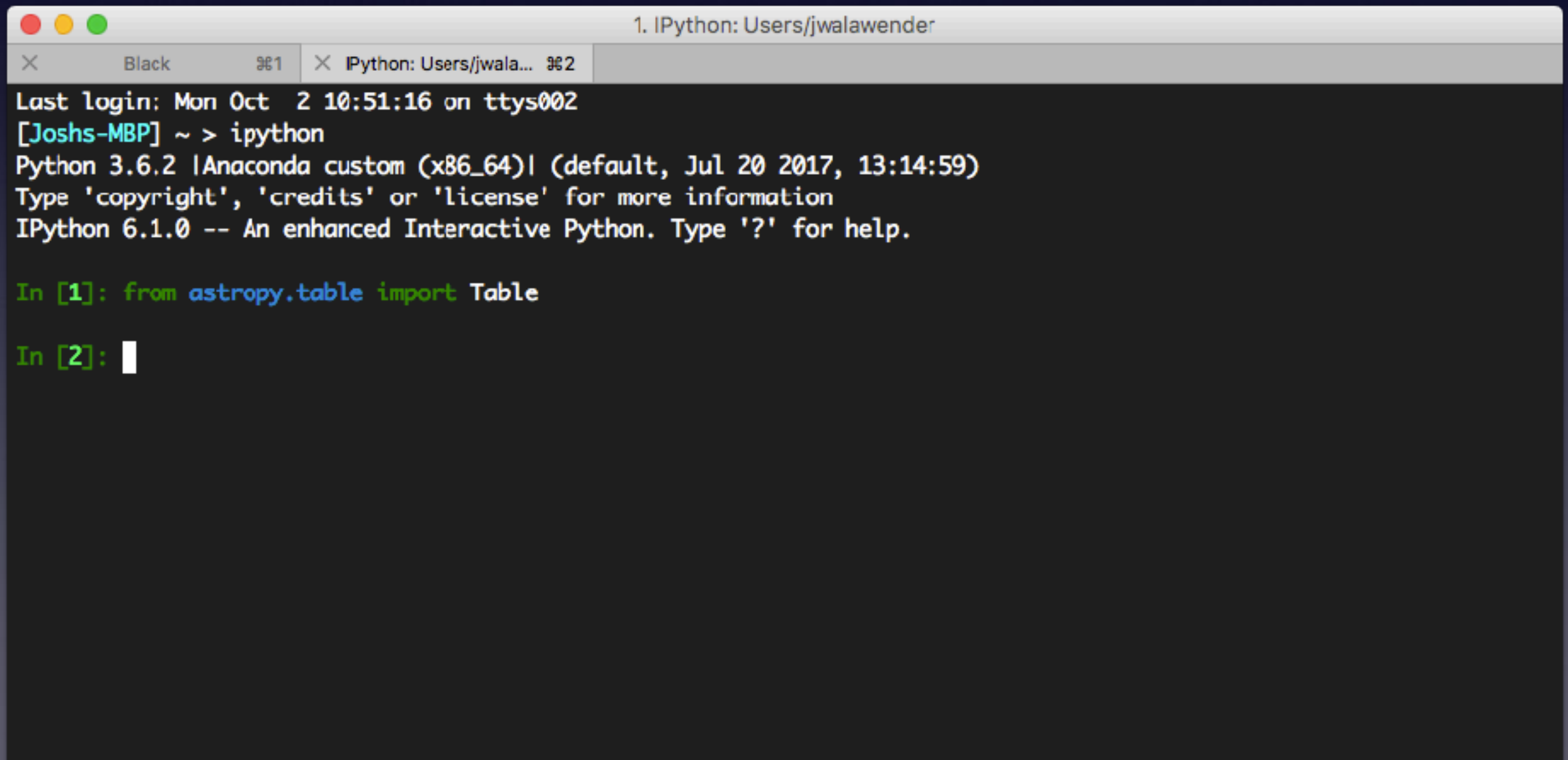
Text Editors

- Most editors have a way to open up a remote file using SFTP, so when you ssh to a remote machine you don't have to use whatever crappy editor is on there.
- My workflow is almost always BBEdit + a terminal (remote or local)
- Also most editors have a feature which will do syntax highlighting to make it easier to read code.

```
10 ~
11 from ginga import GingaPlugin~
12 from ginga.gw import Widgets~
13 ~
14 # import any other modules you want here--it's a python world!~
15 import os~
16 from datetime import datetime as dt~
17 import numpy as np~
18 from ginga import GingaPlugin, RGBImage, colors~
19 from ginga.gw import Widgets~
20 from ginga.misc import ParamSet, Bunch~
21 from ginga.util import dp~
22 from ginga.gw.GWHelp import FileSelection~
23 from astropy.io import fits~
24 from astropy.modeling import models, fitting~
25 from scipy import ndimage~
26 import socket~
27 ~
28 class CSU_initializer(GingaPlugin.LocalPlugin):~
29 ~
30     def __init__(self, fv, fitsimage):~
31         """~
32         This method is called when the plugin is loaded for the first~
33         time. ``fv`` is a reference to the Ginga (reference viewer) shell~
34         and ``fitsimage`` is a reference to the specific ImageViewCanvas~
35         object associated with the channel on which the plugin is being~
36         invoked.~
37         You need to call the superclass initializer and then do any local~
38         initialization.~
39         """~
40         super(CSU_initializer, self).__init__(fv, fitsimage)~
41 ~
42         # Load plugin preferences~
43         prefs = self.fv.get_preferences()~
44         self.settings = prefs.createCategory('plugin_CSU_initializer')~
```


The Terminal

- You don't have to use a standard terminal either. On macOS, I use iTerm2



The screenshot shows an iTerm2 terminal window with a title bar that reads "1. IPython: Users/jwalawender". The window has two tabs: "Black" (active) and "Python: Users/jwala...". The terminal content shows the IPython shell startup sequence, including the last login time, the command to start IPython, and the version information. The user has entered two lines of Python code: `from astropy.table import Table` and a blank line.

```
Last login: Mon Oct  2 10:51:16 on ttys002
[Josh-MBP] ~ > ipython
Python 3.6.2 |Anaconda custom (x86_64)| (default, Jul 20 2017, 13:14:59)
Type 'copyright', 'credits' or 'license' for more information
IPython 6.1.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: from astropy.table import Table

In [2]:
```

Git Can be Confusing

- There are third party solution for that too!
- Check out SourceTree (free) or Git Tower (\$)

Open

Fetch

Pull

Push

Apply Stash

Save Stash

Merge

Rebase

Git-Flow

Refresh

Search for Message

Repositories

POCS (develop)

Clone

Workspace

Working Copy

History

Stashes

Settings

Branches

master

develop

Tags

Remotes

origin

develop

gh-pages

images

master

tracking_model

upstream

develop

gh-pages

hunterman

master

Remote Activity

origin/develop

5a8f64e0

Change set

Tree

Author

Panoptes PAN002 <panoptes@PAN002.subaru.nao.ac.jp>

Author Date

July 31, 2017 at 3:45:56 PM HST

Committer

Panoptes PAN002 <panoptes@PAN002.subaru.nao.ac.jp>

Committer Date

July 31, 2017 at 3:45:56 PM HST

Commit Hash

5a8f64e07cac06a22bed8ca94a9c9ccfe1062956

Parent Hash

4f9639bd10bc85d174c246a058414fcd7879cfc

Tree Hash

5fa532883eab9f275c3290accc58988a912afc15

* Script to collect accelerometer readings

* Small fix for script that sends mount home

* Make timelapse for both cameras

* Add `state` to status output

Expand All

Showing 5 changed files with 150 additions and 5 deletions

modified

M

pocs/state/machine.py

modified

M

pocs/utls/images.py

added

A

scripts/collect-grid-stats.py

modified

M

scripts/send_home.py

modified

M

scripts/upload_image_dir.py

Wilfred Tyler Gee

8/3/17

dfec2fb4

Updating astropy requirement

Wilfred Tyler Gee

8/2/17

bdfaaa3

Misc updates

Wilfred Tyler Gee

8/2/17

a378a9f0

Misc updates to get tests worki...

Panoptes PAN002

7/31/17

b75c9a0f

Merge branch 'develop' of htt...

Panoptes PAN002

7/31/17

5a8f64e0

* Script to collect accelerome...

Panoptes PAN002

7/31/17

4f9639bd

Make pretty images for both...

Wilfred Tyler Gee

7/25/17

f21837f7

Adding a small example noteb...

Wilfred Tyler Gee

7/18/17

0fa5cc56

* Adding a mode to collect st...

Wilfred Tyler Gee

7/16/17

3cc34e72

Return a timestamp along with...

Wilfred Tyler Gee

7/16/17

73db1140

Revert change (different return...

Wilfred Tyler Gee

7/16/17

6154289e

Allow for non-threaded read of...

Wilfred Tyler Gee

7/4/17

217b895a

Add auto-confirm option

Wilfred Tyler Gee

7/4/17

450afb50

* Script to auto-upload

Wilfred Tyler Gee

7/2/17

62dddfa

Remove loop construct

Wilfred Tyler Gee

7/2/17

7c83dbb8

Move the observation dir clean...

Wilfred Tyler Gee

7/2/17

Don't Struggle

- If some common task seems annoying, there's a good chance someone else thinks so too and they may have built a fix.
- **Good tools make you more efficient.** It is worth a bit of time (& money) to find good workflow tools.

Don't Struggle

- Take advantage of online training tools.
- www.CodeFights.com is an online coding “arcade” with practice programming problems.

Don't Struggle

- Take advantage of online training tools.
- For example: some conferences post videos
 - SciPy is a scientific python (SciPy, get it?) conference held every year.
 - It consists of multiple half day tutorial sessions (which are posted to YouTube) and talks (which are also posted to YouTube).

“SCRIPT ALL THE THINGS!”

—James Reed
(at SciPy 2017 Lightning Talks)
<https://youtu.be/Ujc1TmzzORg?t=5m30s>