

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 & Advice

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 'Commit History' window of the IQMan application. The interface includes a sidebar on the left with sections for 'FILE STATUS', 'BRANCHES', 'TAGS', 'REMITES', 'STASHES', and 'SUBMODULES'. The main area shows a graph of commits and a detailed list of changes.

Graph	Description	Commit	Author	Date
[v1.0.0] Merge branch 'develop'		b42dfc8	Josh Walawender...	Oct 2, 2013, 11:...
[v1.0.0] Merge branch 'master'		438db44	Josh Walawender...	Oct 1, 2013, 2:5...
Merge branch 'Feature/Mark_Brightest_Stars' into develop		d4545c0	Josh Walawender...	Oct 1, 2013, 2:5...
Mark jpeg when number of stars limit has been reached.		7068610	vysosuser <vysos...	Oct 1, 2013, 12:...
Have MakeJPEG first sort the SExtractor results by magnitude then mark the 5000 brightest objects.		b3e1124	Josh Walawender...	Oct 1, 2013, 4:5...
Merge branch 'Feature/Choose_Columns_in_HTML' into develop		b3e1124	Josh Walawender...	Oct 1, 2013, 4:5...
Added code which prevents SExtractor background size from being less than 5 pix. Added code to optionally include target name and exposure time in HTML table.		c31ueb0	Panoplos MLO <p.p...	Sep 27, 2013, 4:...
Removed ImageSubtractor.html file as it is now coded in to IQMan.py.		4d1dfe0	vysosuser <vysos...	Sep 27, 2013, 3:...
Fixed bug in creation of HTML file where header was not written properly.		d2fdd58	vysosuser <vysos...	Sep 27, 2013, 3:...
Fixed bug in web log entry which had a bad path for the third jpeg. Also adjusted extractor background size to be 5x seeing instead of 2x which was too small.		878f6df	vysosuser <vysos...	Sep 27, 2013, 3:...
Additional bug fixes including spelling error on ellipticity.		05b8b72	Josh Walawender...	Sep 27, 2013, 3:...
Bug fix. Did not set up test of whether ellipticity was in the fields specification.		b20fffc	Josh Walawender...	Sep 27, 2013, 3:...
Added option to call of AddWebLogEntry to explicitly choose columns to display. Have not added extra column options yet, just implemented the existing ones.		c5d7055	Josh Walawender...	Sep 27, 2013, 2:...
Merge branch 'Feature/Distortion_Mapping' into develop		a5830dc	Josh Walawender...	Sep 27, 2013, 1:...
Added ability to have a .sd jpeg in the web log entry.		1054e21	Josh Walawender...	Sep 13, 2013, 8:...
Added SExtractorSaturation to telescope properties. It is used to configure SExtractor.		fcbf135	Josh Walawender...	Sep 11, 2013, 1:...
Removed default.sex as it is no longer used. Edits to RunSExtractor to now use a FITS_LDAC output catalog instead of an ascii file. This will be compatible with scans. Edits to the default.param file to make it c...		2a5ab4e	Josh Walawender...	Sep 11, 2013, 1:...
Changes to the RunSExtractor method to dispense with a default extractor config file and simply to generate one on the fly. Changes to the RunSExtractor method to also output a background subtracted fits fil...		01e1295	Josh Walawender...	Sep 10, 2013, 5:...
Merge branch 'master' into develop		b46ec66	Josh Walawender...	Sep 27, 2013, 3:...
Fixed bug in astrometry.net call which did not split the stdout on line feeds, but printed each character in a line.		e82dc77	Josh Walawender...	Sep 27, 2013, 1:...
Added logging of actual subtractor command issued.		a4c3f03	Panoplos MLO <p.p...	Sep 25, 2013, 5:...
Fixed bug in crop where x and y axes were reversed.		666a0a8	Panoplos MLO <p.p...	Sep 25, 2013, 5:...
Added ignore_missing_end=True flag to fits open in GetHeader method. Added code to SolveAstrometry method to make output fits file of astrometry.net solver the new working file.		9bf175b	Panoplos MLO <p.p...	Sep 25, 2013, 4:...
Merge branch 'master' of https://github.com/joshwalawender/IQMan		c04bd4e	Panoplos MLO <p.p...	Sep 25, 2013, 3:...
Updates to readme.md		1b15821	Josh Walawender...	Sep 25, 2013, 3:...
Removed edit of fits header after astrometry.net runs as that info is already added by astrometry.net itself.		c84024a	Panoplos MLO <p.p...	Sep 25, 2013, 3:...
[v1.0.0] Merge branch 'develop'		d2ee093	Josh Walawender...	Sep 25, 2013, 3:...
Added flag to ignore missing end card on header when reading fits file after doing an astrometry.net solve		6d63a0b	Panoplos MLO <p.p...	Sep 25, 2013, 3:...
Tweaks to readme to reflect v1.0.1 and v1.0.2.		d3b1bf0	Josh Walawender...	Aug 27, 2013, 1:...
Fixed bug in MakeJPEG which assumed a binning of 2 for the purposes of marking the header pointing coordinate on the jpeg.		5a0efc4	Josh Walawender...	Sep 20, 2013, 2:...
Edits to RunSExtractor and ReadImage to handle spaces in file names. For simplicity, spaces are replaced with underscores for all temporary files created.		50c385c	vysosuser <vysos...	Sep 16, 2013, 1:...
[v1.0.2] Fixed bug in color coding, had two different red colors.		0142ca5	Josh Walawender...	Aug 22, 2013, 1:...
Added break statement when marking more than 5000 stars to avoid writing logger warning many times.		187c73a	Josh Walawender...	Aug 22, 2013, 5:...
Fixed bug in logger call when more than 5000 stars to be marked in jpeg. Needed self.logger not logger.		d1182e7	Josh Walawender...	Aug 22, 2013, 1:...
Merging edits done on altar after minor edit on local machine.		2429f42	vysosuser <vysos...	Aug 22, 2013, 1:...
Removed unnecessary print command which was used for debugging.		d6de495	Josh Walawender...	Aug 22, 2013, 5:...
Added debug lines to jpeg creation. Fixed bug in jpeg creation.		2439ad1	vysosuser <vysos...	Aug 22, 2013, 5:...
Merge branch 'master' of https://github.com/joshwalawender/IQMan into develop		66cadbe	vysosuser <vysos...	Aug 22, 2013, 5:...
[v1.0.1] Merge branch 'hotfix/Units_Bug_in_FWHM'		81ce473	Josh Walawender...	Aug 20, 2013, 3:...
Added converters, header_start, data_start, and fill_values to addl reader on summary table. This fixes type casting problems when first line of table has masked values.		1473357	vysosuser <vysos...	Aug 22, 2013, 5:...
Used converters for all fields when reading summary test file. This fixes situation when types are recast when first image has missing or masked values. For example, if no FWHM reported for first image, type f...		85e48eb	Josh Walawender...	Aug 22, 2013, 4:...
Finished feature. System will now also handle rotation along with marked stars.		d150509	Josh Walawender...	Aug 20, 2013, 5:...
Merge branch 'hotfix/Units_Bug_in_FWHM' into develop		4cd0047	Josh Walawender...	Aug 20, 2013, 3:...
[hotfix/Units_Bug_in_FWHM] Use astropy.units concept of equivalencies to create conversion between pixels and arcseconds in telescope object. Useful when comparing measured FWHM (which is in pix) to th...		0c726b3	Josh Walawender...	Aug 20, 2013, 3:...
[v1.0] [release/v1.0] Merge branch 'release/v1.0'		9d788d2	Josh Walawender...	Aug 14, 2013, 2:...
Merge branch 'Feature/Green_Color_Coding_of_HTML' into develop		b3bdea1	Josh Walawender...	Aug 20, 2013, 2:...
Change background color to red for FWHM, ellipticity, and pointing error if any are not calculated.		c5b5084	Josh Walawender...	Aug 17, 2013, 2:...
Changed color coding to use background color instead of text color.		1b80316	Josh Walawender...	Aug 17, 2013, 1:...
Fixed bug in which HTML file line returns characters were stripped when				

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 ...

Launch jupyter notebook on your laptop:
`jupyter notebook`

That should open up a page in your browser.
Use that page to navigate to the git repo and open:
`Intro to Python 1.ipynb`

Other Topics

Other Topics

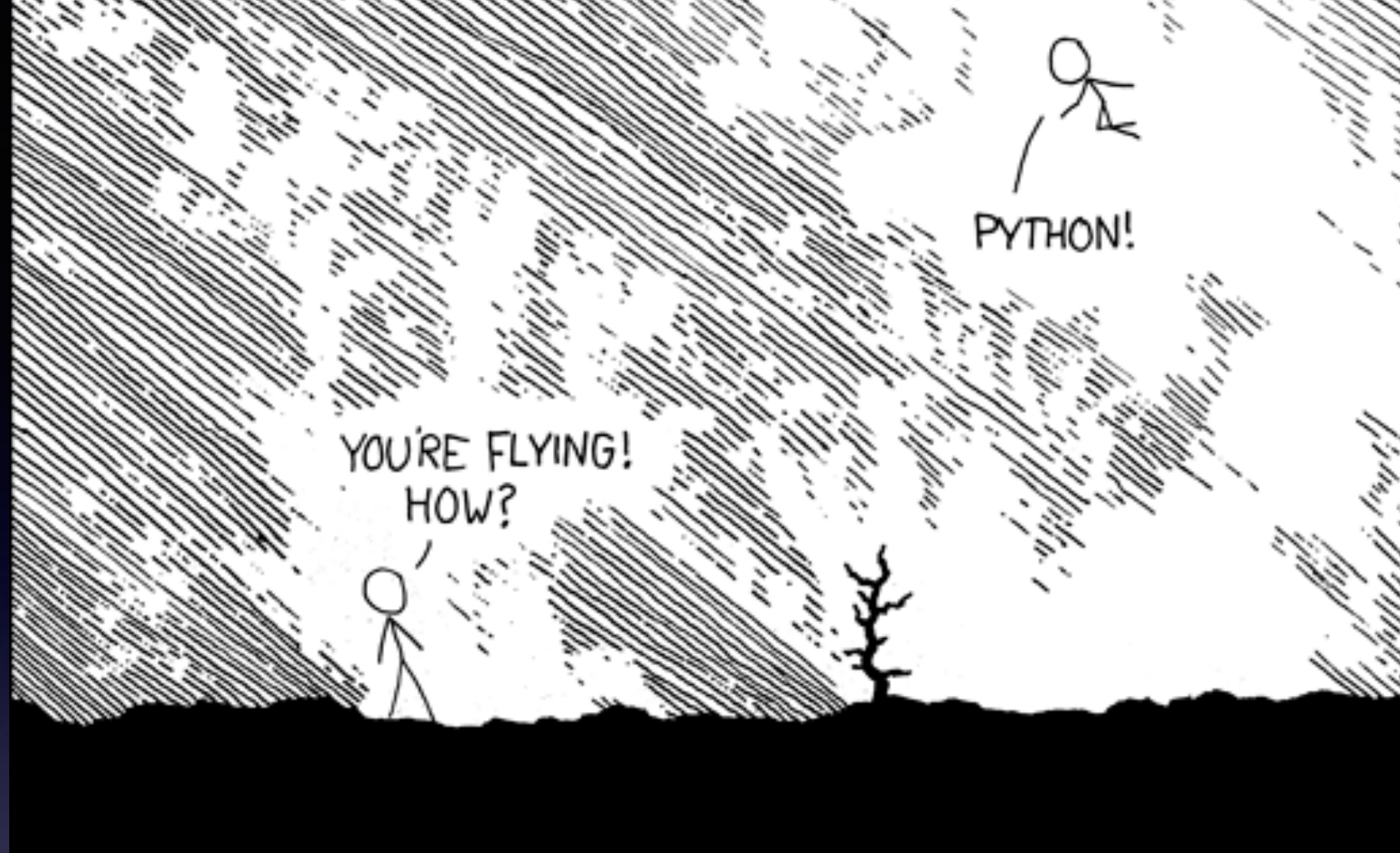
- Things we couldn't cover, but you should look at:
- Other python concepts
 - OrderedDict
 - Named Tuples
 - Building your own Exceptions
 - Testing (e.g. pytest)
 - datetime and pytz

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)




I LEARNED IT LAST NIGHT! EVERYTHING IS SO SIMPLE!
HELLO WORLD IS JUST
print "Hello, world!"

I DUNNO...
DYNAMIC TYPING?
WHITESPACE?



COME JOIN US!
PROGRAMMING
IS FUN AGAIN!
IT'S A WHOLE
NEW WORLD
UP HERE!
BUT HOW ARE
YOU FLYING?



I JUST TYPED
import antigravity
THAT'S IT?
... I ALSO SAMPLED
EVERYTHING IN THE
MEDICINE CABINET
FOR COMPARISON.
BUT I THINK THIS
IS THE PYTHON.

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.

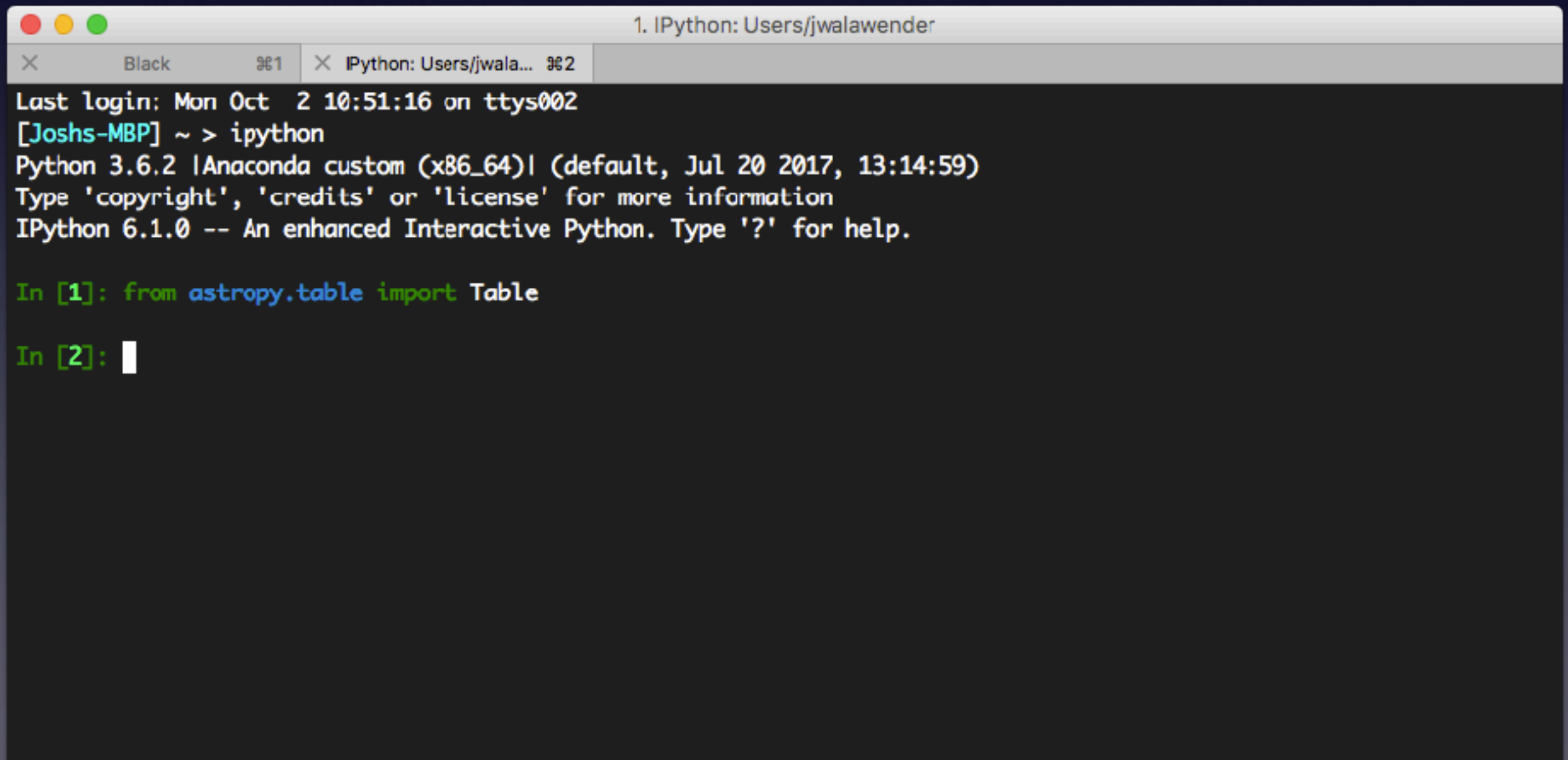
```

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 terminal has two tabs: "Black" (active) and "Python: Users/jwala...". The terminal output is as follows:

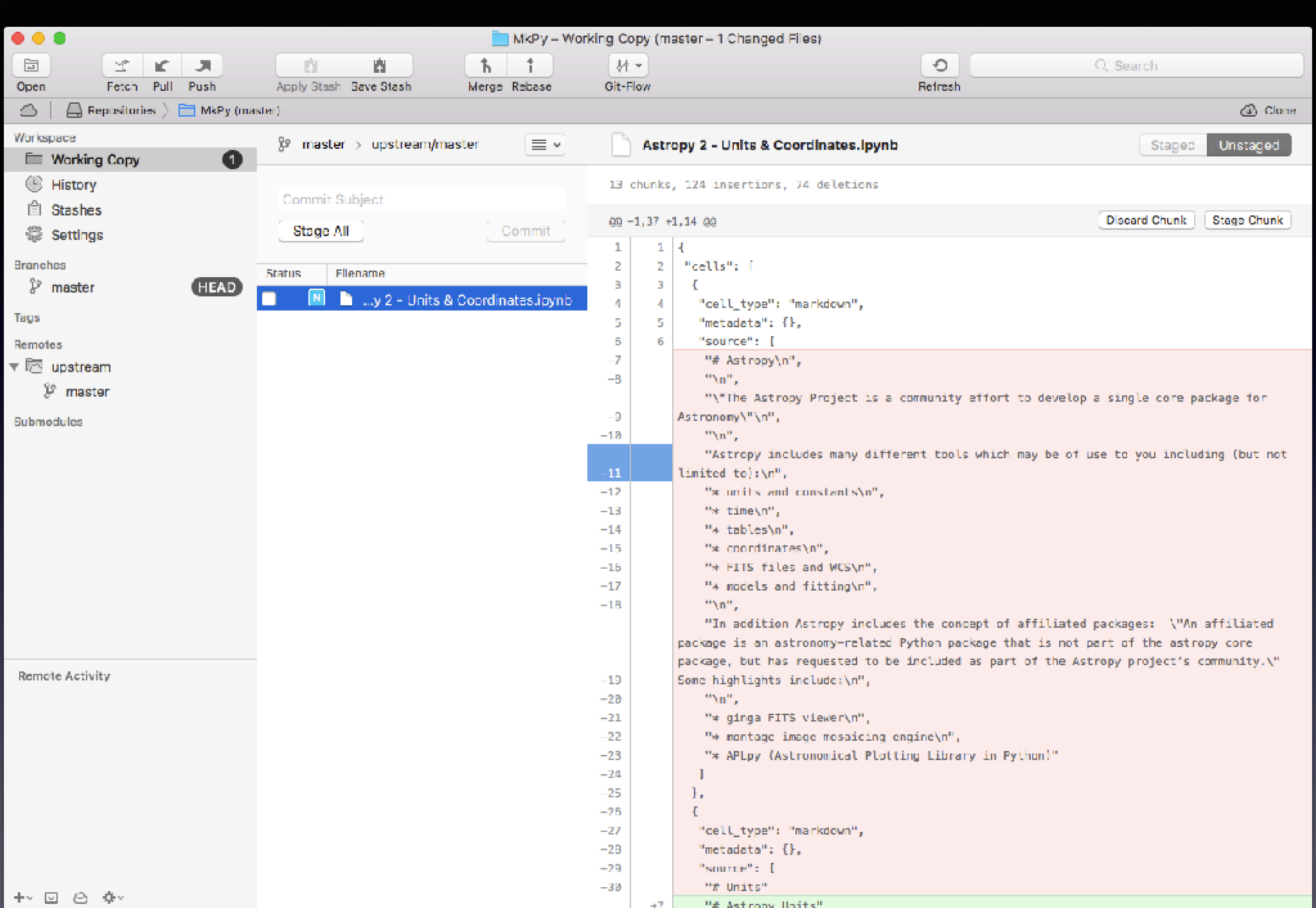
```
Last login: Mon Oct  2 10:51:16 on ttys002
[Josh-MBP] ~ > ipython
Python 3.6.2 |Anaconda custom (x86_64)| (default, Jul 20 2017, 13:14:59)
Type 'copyright', 'credits' or 'license' for more information
IPython 6.1.0 -- An enhanced Interactive Python. Type '?' for help.

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 (\$)



Don't Struggle

- If some common task seems annoying, there's a good chance someone else thinks so too and has 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>