UNIX command line

Also called terminal, shell, etc...

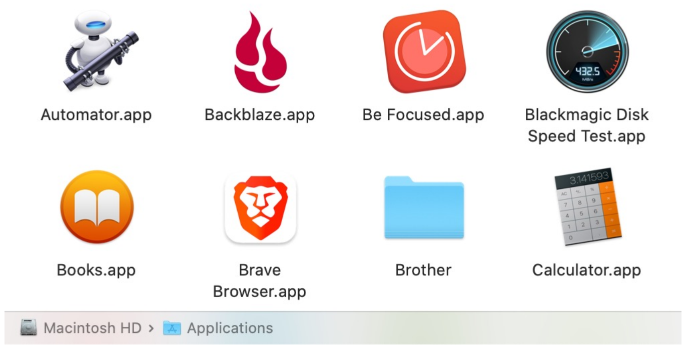
Terence Parr
MSDS program
University of San Francisco

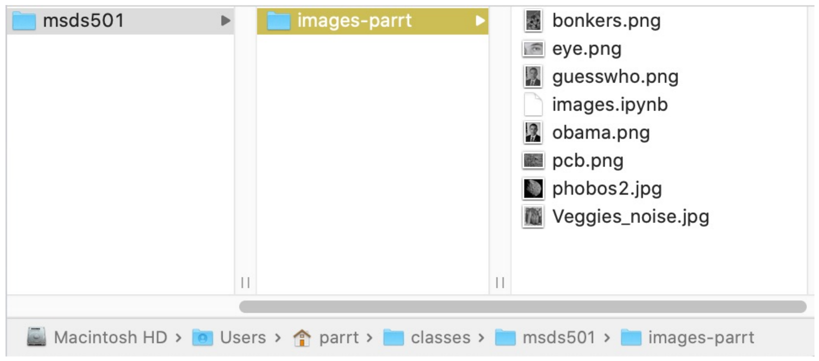
See also [Videos from Philip Guo (pythontutor guy) on terminal]()

UNIVERSITY OF SAN FRANCISCO

Controlling your machine w/o a GUI

- The Mac "Finder" is a graphical way to launch and control programs as well as manipulate files and folders on the disk





- But, the "terminal" is an old-school text-based interface that has a number of advantages

UNIVERSITY OF SAN FRANCISCO

The terminal is running a *shell*

Terminal.app

- The UNIX shell is an interactive domain-specific language used to control and monitor the UNIX operating system (Mac OS)
- It is also a programming language, though we'll use it mostly to move files around, execute commands, ...
- You need to get comfortable on the UNIX command line because, at minimum, you will control cloud computing facilities using the command line
- We type commands at the **$** *prompt* and hit return to execute

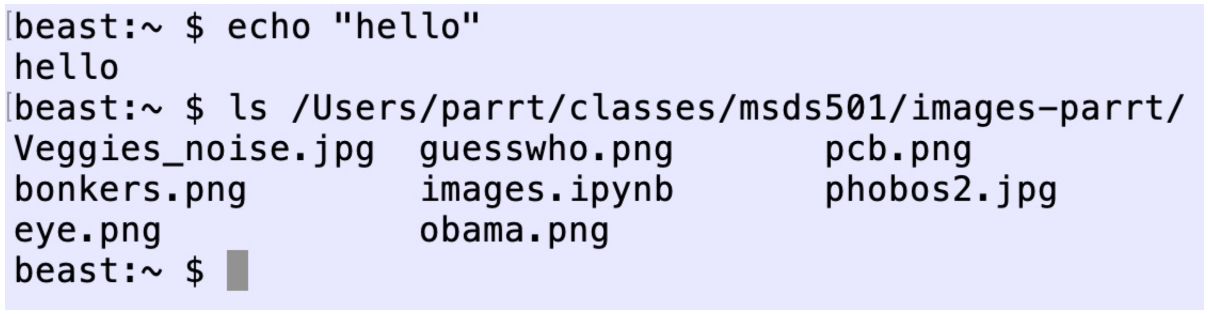
```
beast:~ $ 
```

(*Note: OS X changed the default shell to be zsh not bash.*)

UNIVERSITY OF SAN FRANCISCO

Commands are analogous to Python function calls, including arguments

- In Python we say **print("hello")**, but in the shell we don't use parentheses around arguments and use spaces not commas



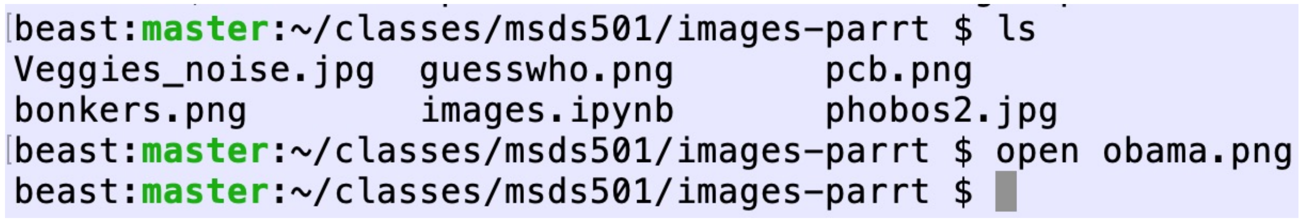
```
beast:~ $ echo "hello"
hello
beast:~ $ ls /Users/parrt/classes/msds501/images-parrt/
Veggies_noise.jpg  guesswho.png       pcb.png
bonkers.png        images.ipynb       phobos2.jpg
eye.png            obama.png
beast:~ $ 
```

- Notation: *command arg1 arg2 arg3*
  vs python: *command(arg1, arg2, arg3)*

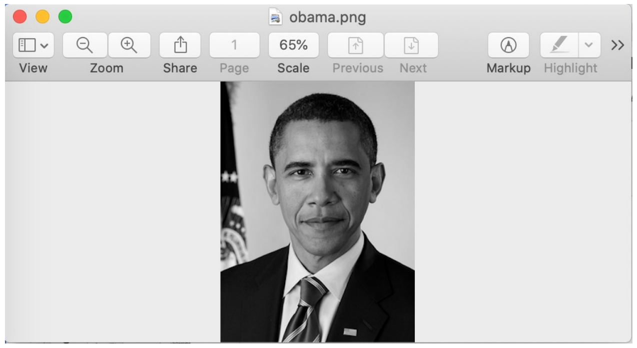
UNIVERSITY OF SAN FRANCISCO

Executing programs by opening files

- Instead of double-clicking on an image file, for example, we can tell the terminal to open it



```
beast:master:~/classes/msds501/images-parrt $ ls
Veggies_noise.jpg  guesswho.png        pcb.png
bonkers.png        images.ipynb        phobos2.jpg
beast:master:~/classes/msds501/images-parrt $ open obama.png
beast:master:~/classes/msds501/images-parrt $ 
```

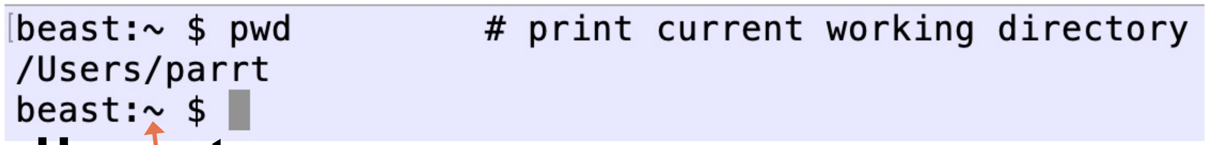


UNIVERSITY OF SAN FRANCISCO

Looking at file contents

- **cat** *filename*: show entire file
- **head** *filename*: show first n lines of file
- **tail** *filename*: show last n lines of file

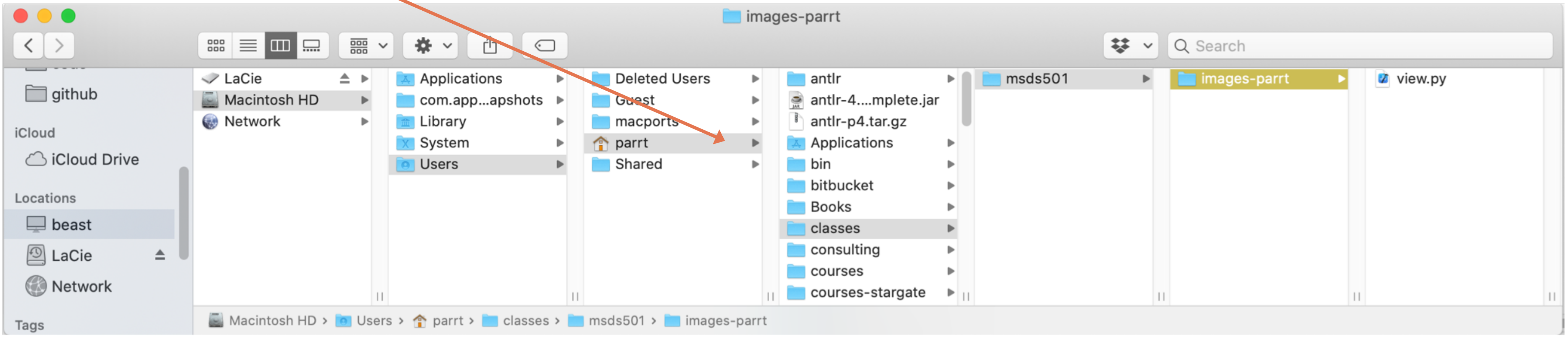
```
$ head -5 hours-worked.csv
"LOCATION","INDICATOR","SUBJECT","MEASURE","FREQUENCY","TIME","Value","Flag Codes"
"AUS","HRWKD","TOT","HR_WKD","A","1979",1834,
"AUS","HRWKD","TOT","HR_WKD","A","1980",1836,
"AUS","HRWKD","TOT","HR_WKD","A","1981",1820,
"AUS","HRWKD","TOT","HR_WKD","A","1982",1802,
```



```
beast:~ $ pwd          # print current working directory
/Users/parrt
beast:~ $
```

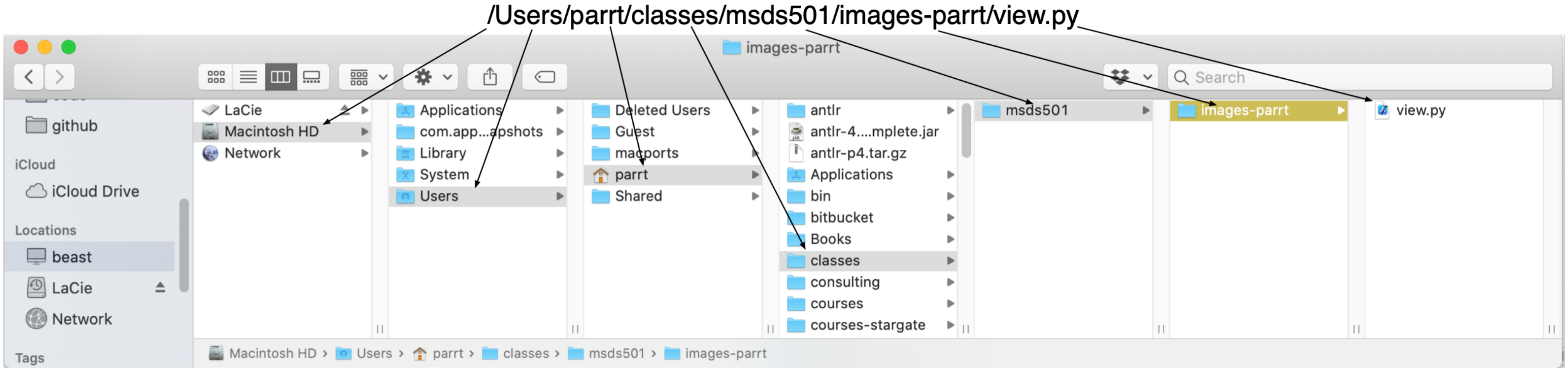
Current working directory

- The shell has a number of state variables, one of which is the *current working directory*, and it is by far the most important
- Most commands execute relative to this working directory
- When terminal opens, working directory is set to your user home directory abbreviated as "~"



Path specifications

- As we saw previously, the folders or directories on your disk represent a tree; files in a folder represent leaves of the tree
- A *fully-qualified* path to a file starts with "/" and consists of the directories used to reach the file from the root of the disk; root is "/" and we separate path elements with "/"
- *Relative pathnames* do not start with "/" and are relative to WD

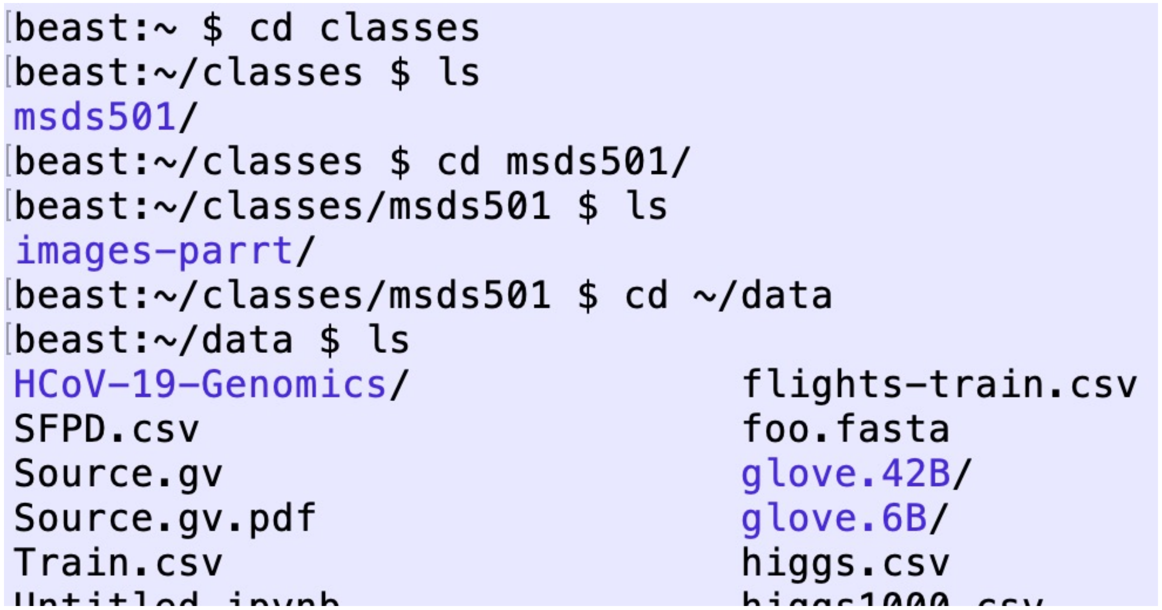


Useful directories to know about

- Other then your home directory, **/Users/***youruser*, you should know about:
  - /Applications
  - /tmp
  - /usr/local (such as brew's install area /usr/local/Cellar)
  - /bin, /usr/local/bin
- Also to configure zsh (your shell), see file **~/.zshrc**

cd: change working directory

- To "move" around the disk hierarchy/tree, use **cd** command to change the current working directory (i.e., where am I?)

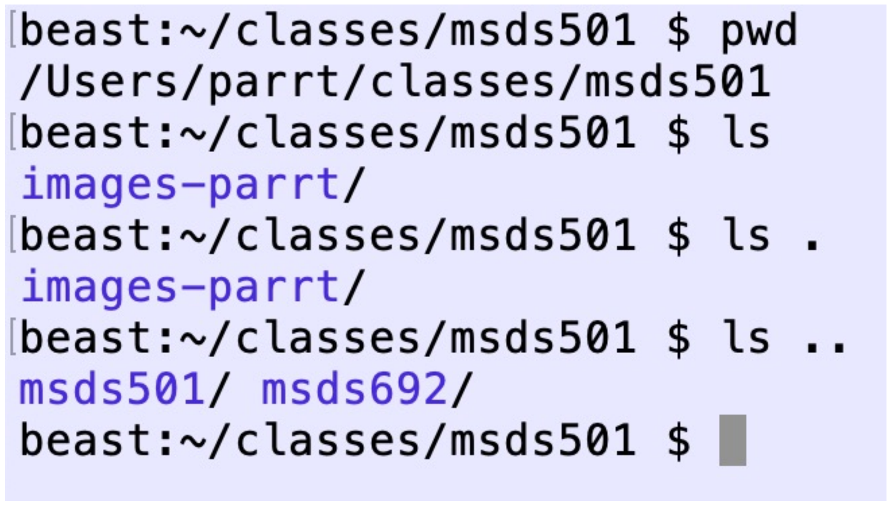


```
beast:~ $ cd classes
beast:~/classes $ ls
msds501/
beast:~/classes $ cd msds501/
beast:~/classes/msds501 $ ls
images-parrt/
beast:~/classes/msds501 $ cd ~/data
beast:~/data $ ls
HCoV-19-Genomics/              flights-train.csv
SFPD.csv                       foo.fasta
Source.gv                      glove.42B/
Source.gv.pdf                  glove.6B/
Train.csv                      higgs.csv
Untitled.ipynb                 higgs1000.csv
```

UNIVERSITY OF SAN FRANCISCO

Dot, Dot-Dot

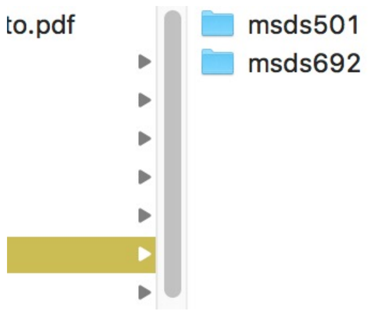
- Dot "." means current working directory
- Dot-Dot ".." means directory above current working directory



```
beast:~/classes/msds501 $ pwd
/Users/parrt/classes/msds501
beast:~/classes/msds501 $ ls
images-parrt/
beast:~/classes/msds501 $ ls .
images-parrt/
beast:~/classes/msds501 $ ls ..
msds501/ msds692/
beast:~/classes/msds501 $
```

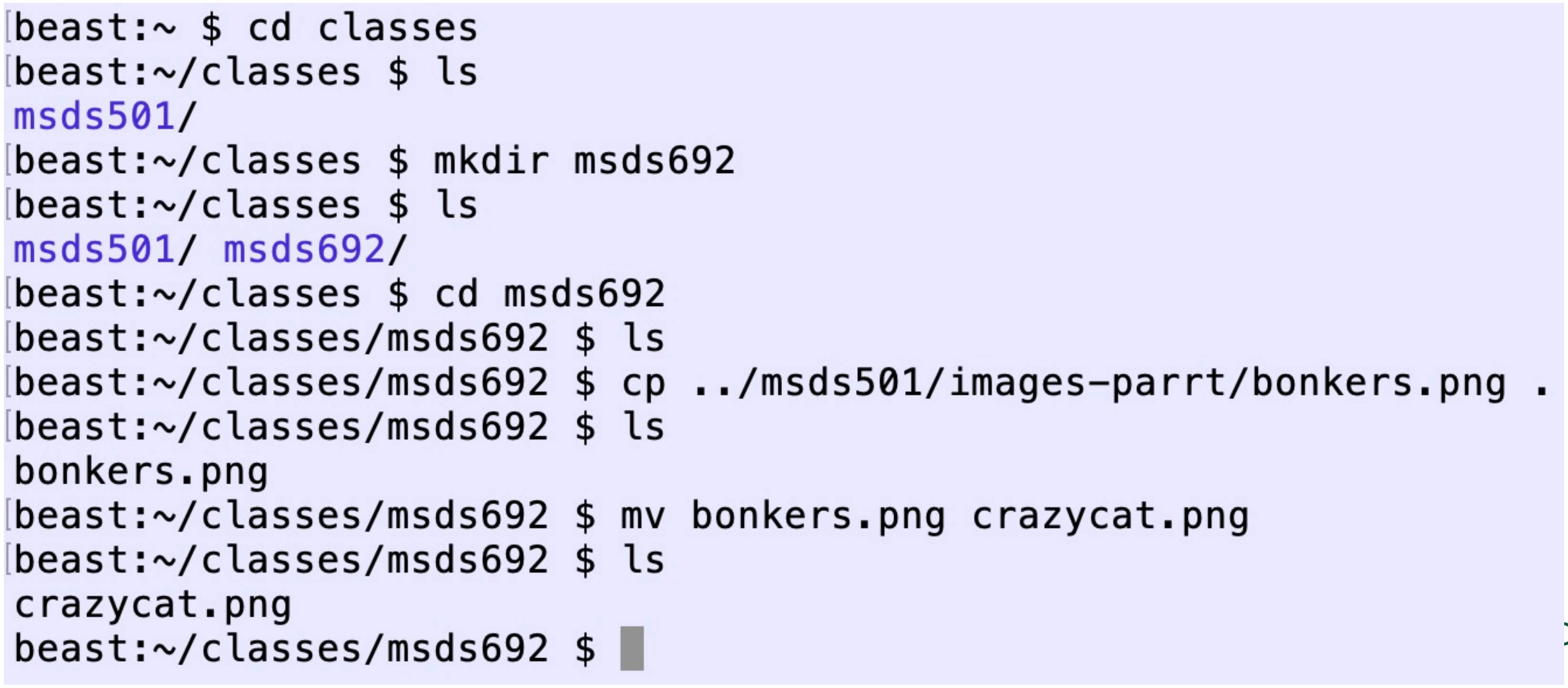
UNIVERSITY OF SAN FRANCISCO

watch dir appear



Manipulating files and directories

- **mkdir** *newdirname*: make directory
- **cp** *source target*: copy file or directory
- **mv** *oldname newname*: rename or move files/dirs

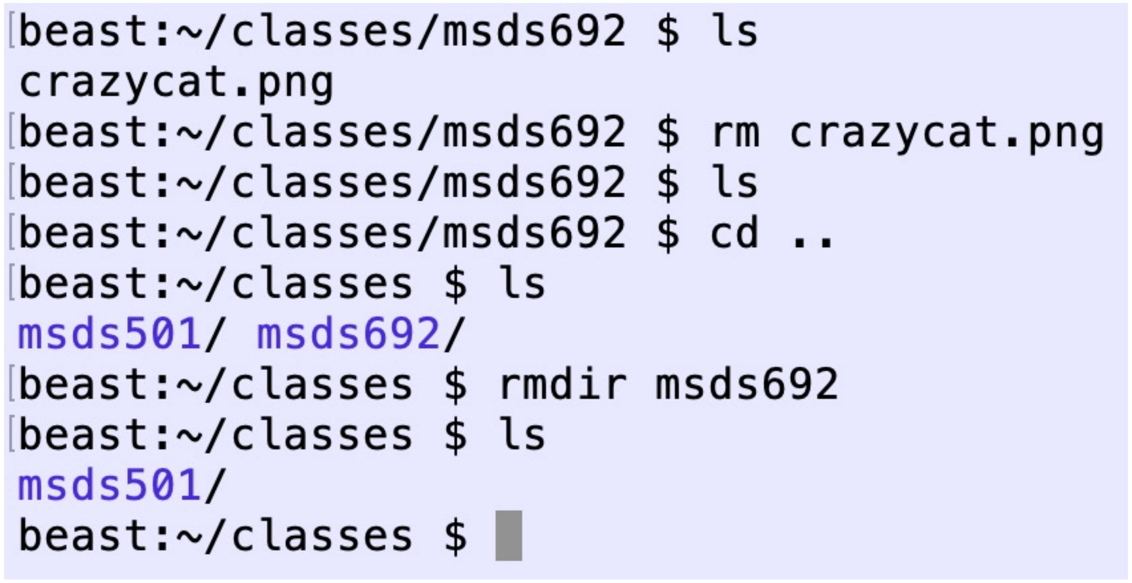


```
beast:~ $ cd classes
beast:~/classes $ ls
msds501/
beast:~/classes $ mkdir msds692
beast:~/classes $ ls
msds501/ msds692/
beast:~/classes $ cd msds692
beast:~/classes/msds692 $ ls
beast:~/classes/msds692 $ cp ../msds501/images-parrt/bonkers.png .
beast:~/classes/msds692 $ ls
bonkers.png
beast:~/classes/msds692 $ mv bonkers.png crazycat.png
beast:~/classes/msds692 $ ls
crazycat.png
beast:~/classes/msds692 $ 
```

CISCO

Removing files and directories

- **rm** *filename*: remove file
- **rmdir** *dirname*: remove empty directory
- **rm –rf** *dirname*: remove directory and everything underneath it

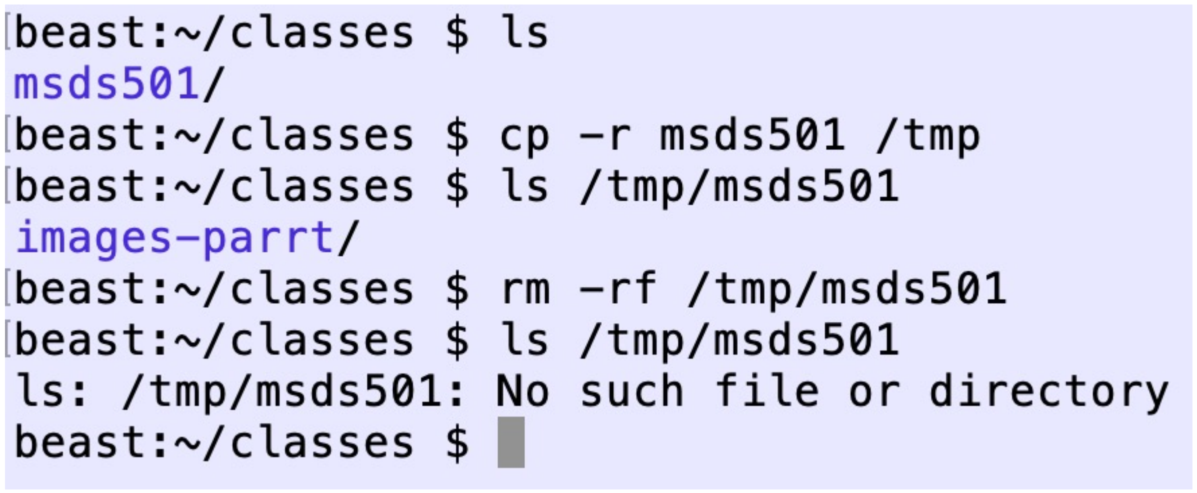


```
[beast:~/classes/msds692 $ ls
crazycat.png
[beast:~/classes/msds692 $ rm crazycat.png
[beast:~/classes/msds692 $ ls
[beast:~/classes/msds692 $ cd ..
[beast:~/classes $ ls
msds501/ msds692/
[beast:~/classes $ rmdir msds692
[beast:~/classes $ ls
msds501/
beast:~/classes $ 
```

UNIVERSITY OF SAN FRANCISCO

Removing files and directories Cont'd

- **rm** *filename*: remove file
- **rmdir** *dirname*: remove empty directory
- **rm** –rf *dirname*: remove directory and everything underneath it

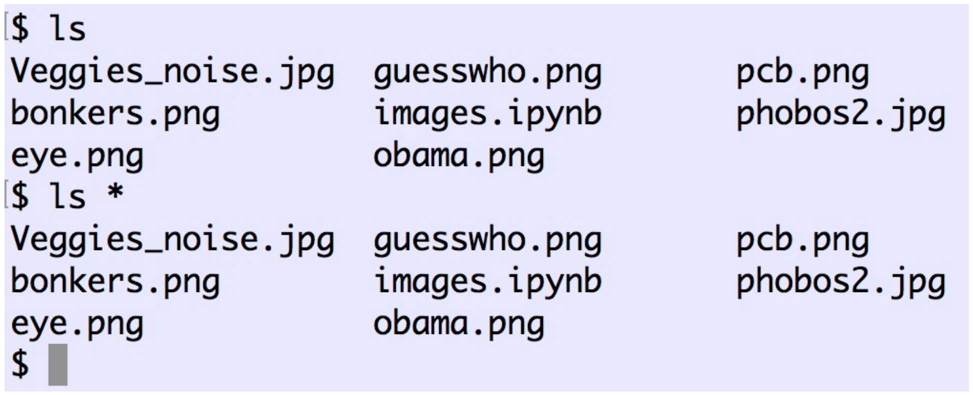


```
beast:~/classes $ ls
msds501/
beast:~/classes $ cp -r msds501 /tmp
beast:~/classes $ ls /tmp/msds501
images-parrt/
beast:~/classes $ rm -rf /tmp/msds501
beast:~/classes $ ls /tmp/msds501
ls: /tmp/msds501: No such file or directory
beast:~/classes $ 
```

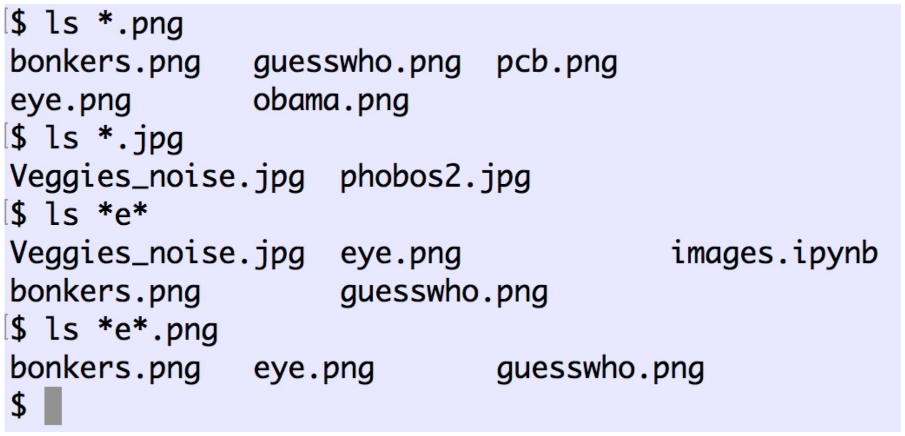
UNIVERSITY OF SAN FRANCISCO

Wildcards

- Star "*" means roughly "any word that matches", such as all files
- Good example of something that's impossible with a GUI; imagine that you have 1000 datafiles and you need to delete all files whose names have the word “old”
- Here are some examples listing various image files



```
$ ls
Veggies_noise.jpg  guesswho.png       pcb.png
bonkers.png        images.ipynb       phobos2.jpg
eye.png            obama.png
$ ls *
Veggies_noise.jpg  guesswho.png       pcb.png
bonkers.png        images.ipynb       phobos2.jpg
eye.png            obama.png
$
```

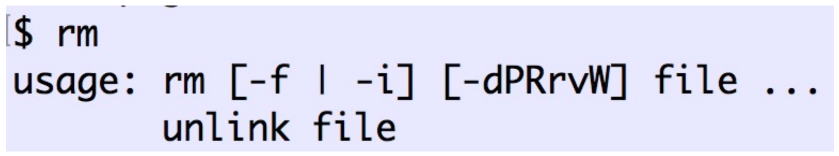


```
$ ls *.png
bonkers.png   guesswho.png   pcb.png
eye.png       obama.png
$ ls *.jpg
Veggies_noise.jpg  phobos2.jpg
$ ls *e*
Veggies_noise.jpg  eye.png           images.ipynb
bonkers.png        guesswho.png
$ ls *e*.png
bonkers.png   eye.png        guesswho.png
$
```

UNIVERSITY OF SAN FRANCISCO

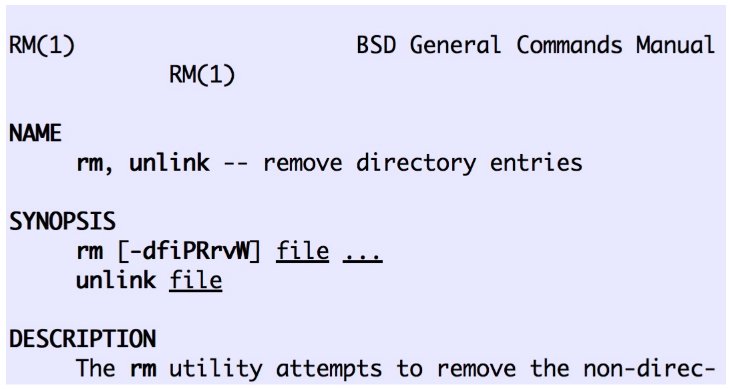
Manual pages; Getting help

- Google search (your shell is called **zsh**)
- Stackoverflow
- Often you can type the command without arguments and it will give a help line:



```
$ rm
usage: rm [-f | -i] [-dPRrvW] file ...
       unlink file
```

- Or, type "**man rm**" to get the manual page:



```
RM(1)                    BSD General Commands Manual
          RM(1)

NAME
     rm, unlink -- remove directory entries

SYNOPSIS
     rm [-dfiPRrvW] file ...
     unlink file

DESCRIPTION
     The rm utility attempts to remove the non-direc-
```

Installing more terminal commands

- There are lots of useful UNIX programs available that are not currently installed on your machine
- The **homebrew** program installs new code for you
- For example, we'll likely install a Python library that requires an open source graphing tool called graphviz:

```
$ brew install graphviz
```

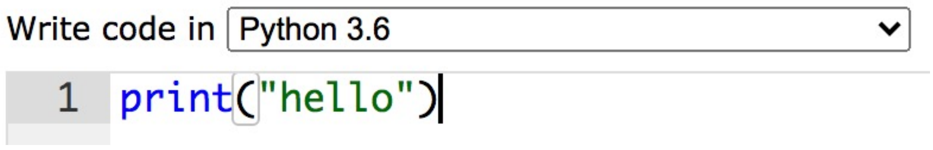
Python-related commands

UNIVERSITY OF SAN FRANCISCO

(Hit Ctrl-D to exit python, go back to shell)

Interactive Python console from terminal

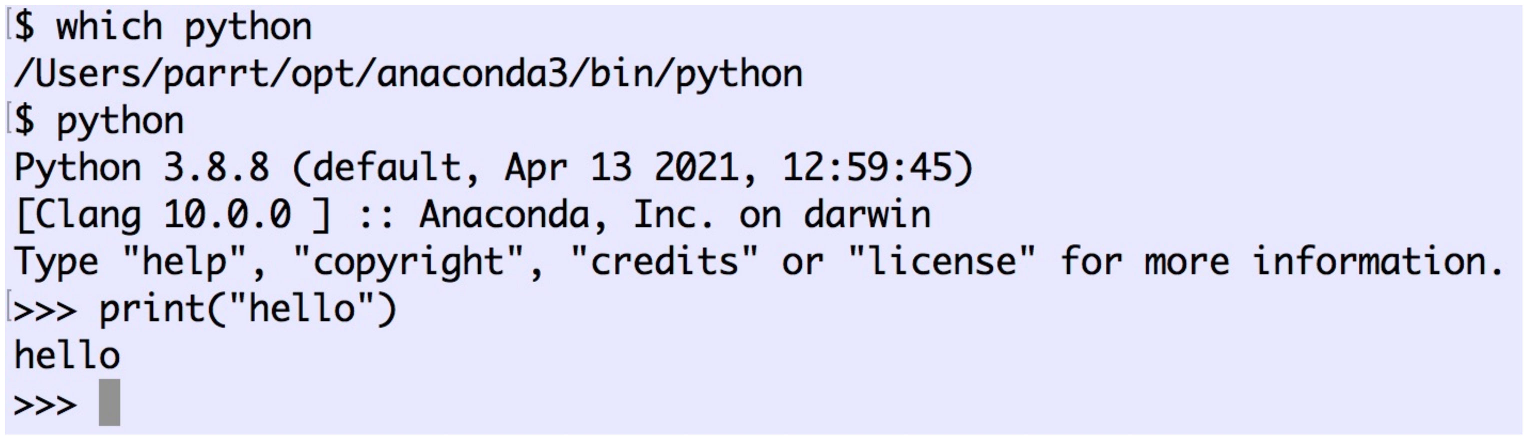
- Pythontutor gives us a text box to edit code and a run button to visualize the execution



Write code in Python 3.6

```
print("hello")
```

- Can also execute Python interactively line by line from the shell



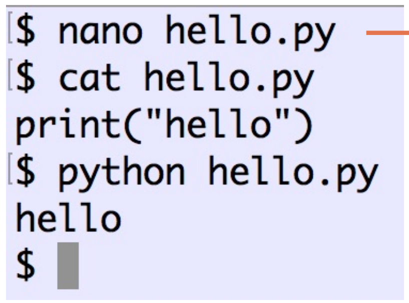
```
$ which python
/Users/parrt/opt/anaconda3/bin/python
$ python
Python 3.8.8 (default, Apr 13 2021, 12:59:45)
[Clang 10.0.0 ] :: Anaconda, Inc. on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("hello")
hello
>>> 
```

Warning: there are multiple copies of Python on your Mac possibly

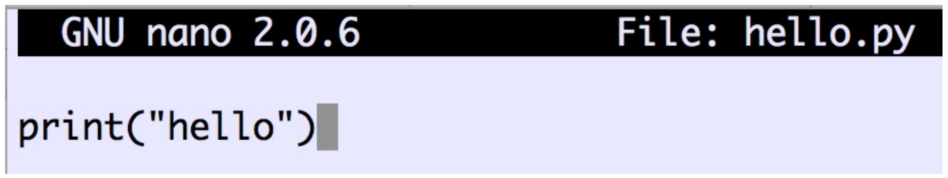
UNIVERSITY OF SAN FRANCISCO

Executing python scripts

- All of the code we type into the Python console disappears when we exit and return to the command line
- Save python into a .py file, using your favorite editor, such as **nano**



```
$ nano hello.py
$ cat hello.py
print("hello")
$ python hello.py
hello
$
```



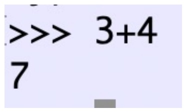
```
 GNU nano 2.0.6                    File: hello.py

print("hello")
```

(To Save, hit Ctrl-X then "Y" to save changes then hit return at "File Name to Write: …")

- We call this a Python script, program, or simply a Python file
- Use "**python** *file.py*" from terminal to execute the script in "batch mode"
- NOTE: *file.py* must be a TEXT file, w/o formatting like in M$ Word files

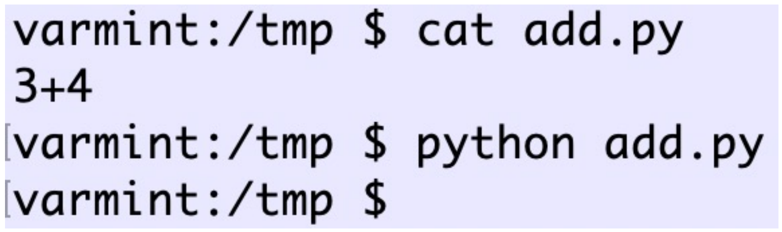
Warning: interactive console vs scripts

- In the console or Jupyter lab, typing an expression evaluates it and displays the result
- In a script file, no output is generated unless you use **print()**
- Compare console:



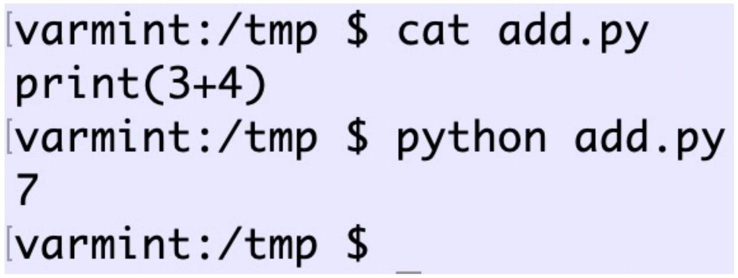
```
>>> 3+4
7
```

to script:



```
varmint:/tmp $ cat add.py
3+4
varmint:/tmp $ python add.py
varmint:/tmp $
```

- Must use **print()** to get output:

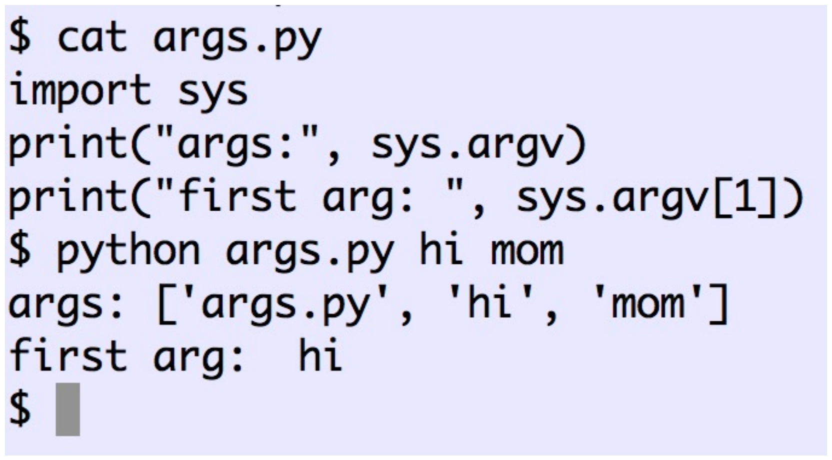


```
varmint:/tmp $ cat add.py
print(3+4)
varmint:/tmp $ python add.py
7
varmint:/tmp $
```

UNIVERSITY OF SAN FRANCISCO

Passing arguments to python scripts

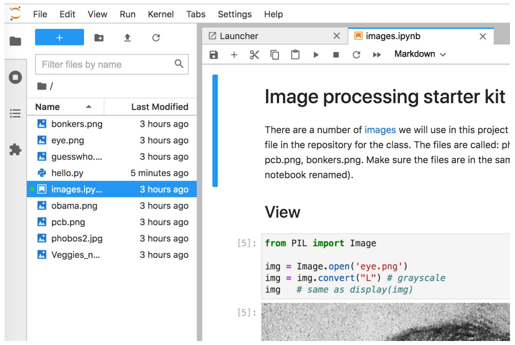
- Sometimes python scripts need information about their environment, such as where to find data files
- The executing script can access arguments from the command line used to launch it using the **sys** package:



```
$ cat args.py
import sys
print("args:", sys.argv)
print("first arg: ", sys.argv[1])
$ python args.py hi mom
args: ['args.py', 'hi', 'mom']
first arg:  hi
$ 
```

This is a very good reason why you should never use spaces in your directory or file names

Launch Jupyter Lab (notebooks)



Name	Last Modified
bonkers.png	3 hours ago
eye.png	3 hours ago
guesswho....	3 hours ago
hello.py	5 minutes ago
images.ipy...	3 hours ago
obama.png	3 hours ago
pcb.png	3 hours ago
phobos2.jpg	3 hours ago
Veggies_n...	3 hours ago

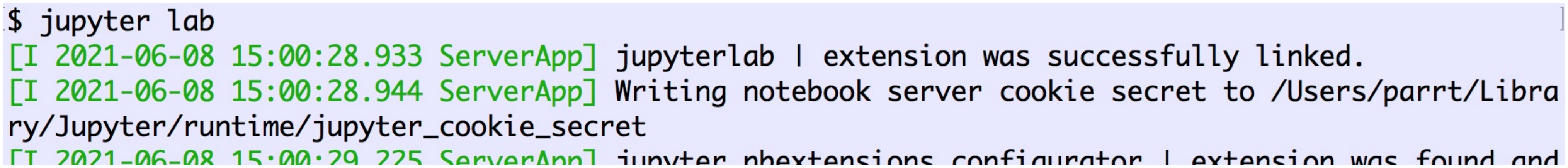
Image processing starter kit

There are a number of images we will use in this project
file in the repository for the class. The files are called: ph
pcb.png, bonkers.png. Make sure the files are in the sam
notebook renamed).

View

```
[5]: from PIL import Image

     img = Image.open('eye.png')
     img = img.convert("L") # grayscale
     img   # same as display(img)
[5]:
```

- A “notebook” is a sequence of “cells” that can contain code, output, notes, etc.
- A notebook is stored like a script but into a *file*.**ipynb** file not **.py**
- A server that we launch from the command line starts up a Python interpreter and connects to a browser window where we can make notes and execute code snippets interactively



```
$ jupyter lab
[I 2021-06-08 15:00:28.933 ServerApp] jupyterlab | extension was successfully linked.
[I 2021-06-08 15:00:28.944 ServerApp] Writing notebook server cookie secret to /Users/parrt/Libra
ry/Jupyter/runtime/jupyter_cookie_secret
[I 2021-06-08 15:00:29.225 ServerApp] jupyter_nbextensions_configurator | extension was found and
```

Tutorials:
  https://www.youtube.com/watch?v=RFabWieskak
  https://www.dataquest.io/blog/jupyter-notebook-tutorial/

UNIVERSITY OF SAN FRANCISCO