

Elements Of Data Science - F2022

Introduction to Data Science Tools

9/7/2022

TODOs

- Read Preface of PDSH
- Read Ch 1 of PDSH
- Skim Ch 2 of PDSH: Introduction to NumPy
- Complete Weekly Quiz 01

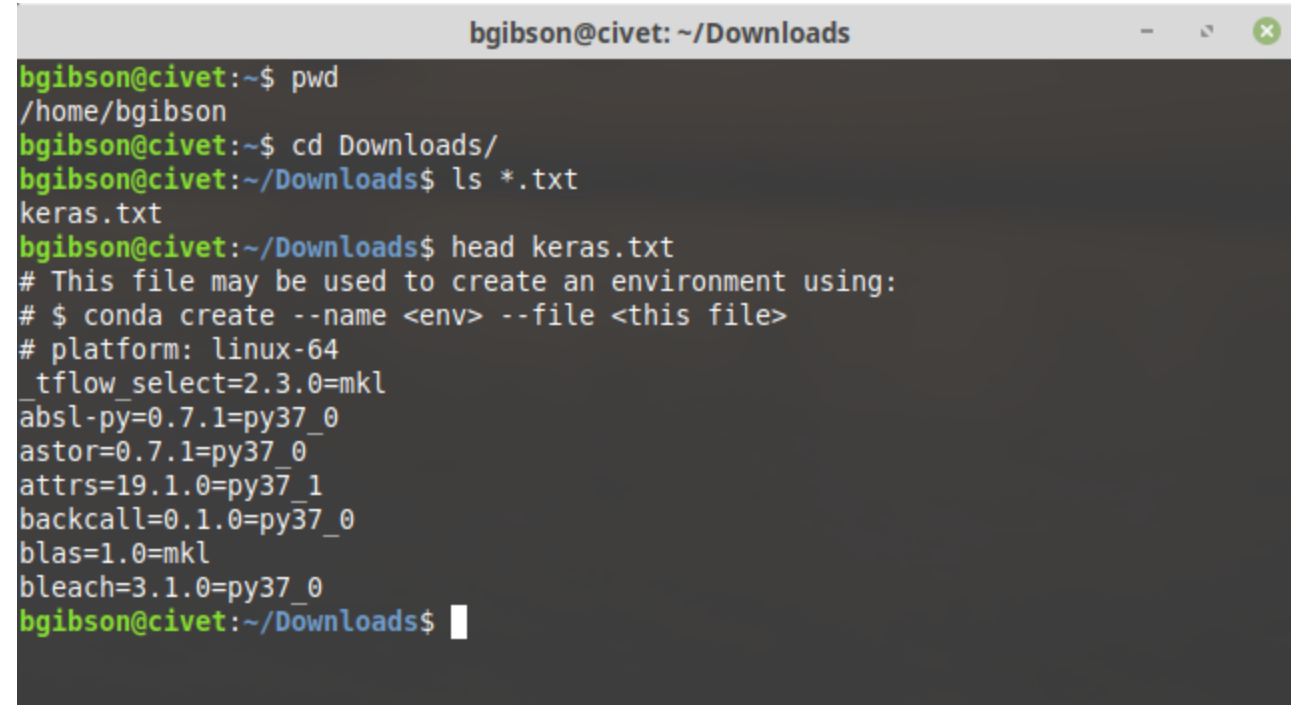
TODAY

- Software tools we'll be using

Our Python Data Science Stack

- Python (3.10): Programming language
- Anaconda : Package maintenance and environments
- Jupyter : IDE
- Git : Source control and versioning

Aside: The Terminal and The Shell



```
bgibson@civet: ~/Downloads
bgibson@civet:~$ pwd
/home/bgibson
bgibson@civet:~$ cd Downloads/
bgibson@civet:~/Downloads$ ls *.txt
keras.txt
bgibson@civet:~/Downloads$ head keras.txt
# This file may be used to create an environment using:
# $ conda create --name <env> --file <this file>
# platform: linux-64
_tflo_select=2.3.0=mkl
absl-py=0.7.1=py37_0
astor=0.7.1=py37_0
attrs=19.1.0=py37_1
backcall=0.1.0=py37_0
blas=1.0=mkl
bleach=3.1.0=py37_0
bgibson@civet:~/Downloads$
```

- If not familiar, get acquainted
- Common set of commands (Ex. cd, ls, cat, mv)
- OSX and Linux: Terminal + bash/zsh (already installed)
- Windows: install Git Bash (or use WSL)

Aside: Common Shell Commands

- **cd** : change directory
- **pwd** : where am i
- **ls** : list directory contents
- **head/tail** : print the beginning/end of a file
- **cat** : print entire file
- **less** : open a file in a pager
- **rm** : remove file
- **which** : path to executable
- ...

- [Links to Tutorials](#)

Data Science Life Skills

- Data munging
- Visualization
- Statistical analysis
- Machine learning
- Reporting
- Prototyping
- Productionizing...

Why Python?

- Robust and active DS stack
 - Cross-platform
 - Relatively low learning curve
 - Fast to answers and prototypes
-
- Many other good languages and frameworks (R, Julia, etc.)

Why Python?

- But isn't python slow?
- **Issues:**
 - GIL (Global Interpreter Lock)
 - dynamic typing
- **Solutions:**
 - numpy + vectorization
 - multiprocessing
 - pypy instead of CPython
 - distributed processing with pyspark?
- Article discussing issues and fixes: ["Are your Python programs running slow?..."](#)

The Python DS Stack

- **Data munging** : pandas, numpy
- **Visualization** : matplotlib, seaborn, plotly
- **Statistical analysis** : scipy, statsmodels, patsy
- **Machine learning** : scikit-learn, tensorflow, pytorch
- **Reporting** : jupyter+ipython, dash
- **Prototyping** : flask
- **Productionizing...**

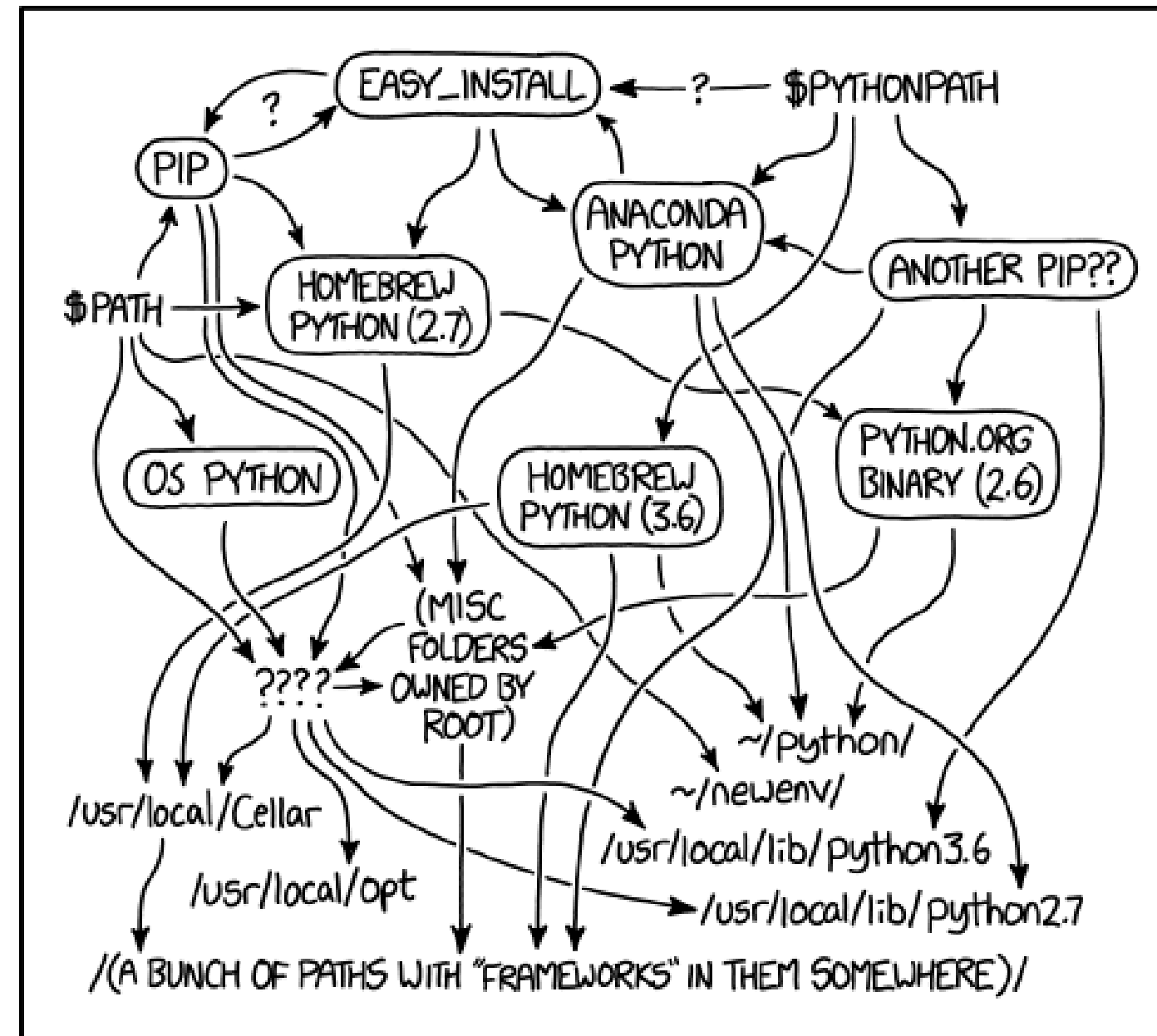
Python 2 vs 3

- We'll be using Python 3.10
- Python 2 end of life was Jan 1, 2020
- Need python 2 for another class? Virtual environments!

How To Get Python

- You might already have it
- But your OS needs it!
- Our solution: Anaconda

Why Anaconda?



MY PYTHON ENVIRONMENT HAS BECOME SO DEGRADED
THAT MY LAPTOP HAS BEEN DECLARED A SUPERFUND SITE.

Why Anaconda?

- includes most of what we need by default
- package curation
- dependency control
- conda virtual environments
- cross-platform

Installing Anaconda

- Download via <https://www.anaconda.com/products/individual>
- Select OS and Grab Python 3.9 version
- Install somewhere easy to navigate to
 - /home/bgibson/anaconda3
 - C:\Users\brygib\anaconda3
- Recommend letting installer run `conda init` to set up your shell
- Note: base environment activated by default
 - To Turn off:

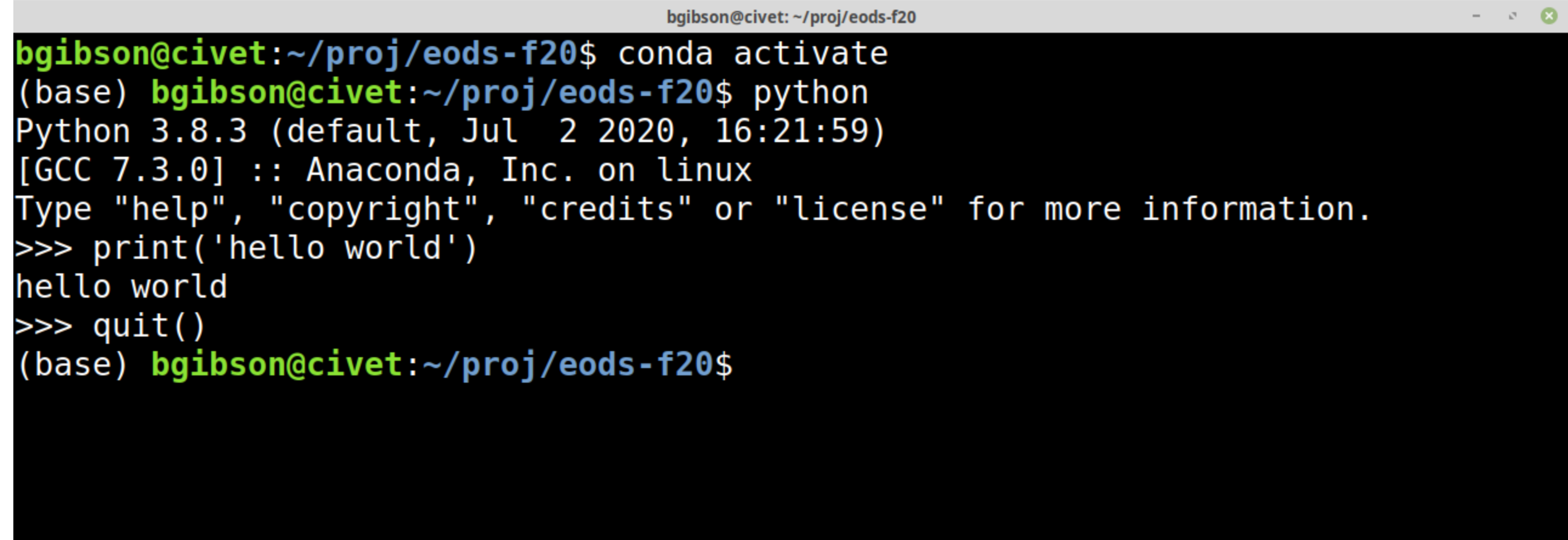
```
conda config --set auto_activate_base false
```

Running Python

- via terminal:
 - python REPL
 - python command line
 - python script
 - ipython REPL
- via jupyter
- via other IDE
- online via Google Colab
- ...

Running Python

- Via REPL (Read-Eval-Print Loop)
 - `$ conda activate`
 - `(base)$ python`



A terminal window titled "bgibson@civet: ~/proj/eods-f20" showing the following commands and output:

```
bgibson@civet:~/proj/eods-f20$ conda activate
(base) bgibson@civet:~/proj/eods-f20$ python
Python 3.8.3 (default, Jul 2 2020, 16:21:59)
[GCC 7.3.0] :: Anaconda, Inc. on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> print('hello world')
hello world
>>> quit()
(base) bgibson@civet:~/proj/eods-f20$
```

- `quit()` or Ctrl-D to exit

Running Python

Via command line

```
(base) bgibson@civet:~$ python -c "print('hello')"  
hello
```

Via script

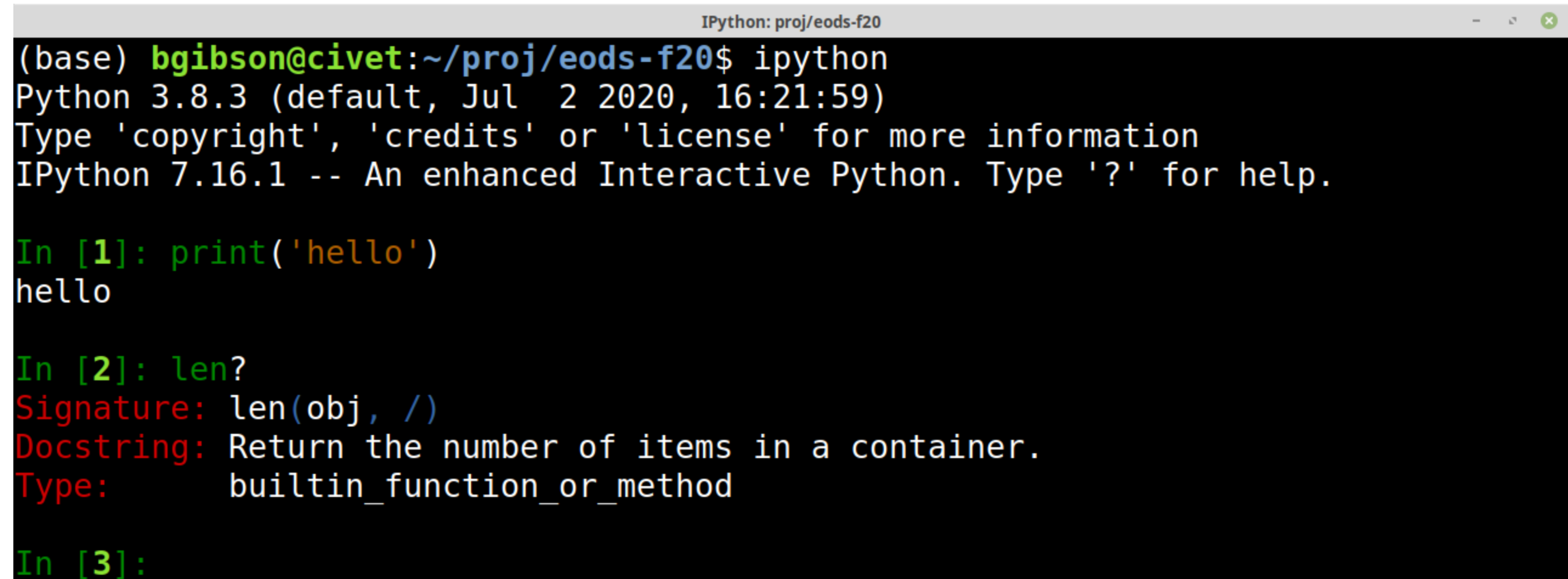
```
(base) bgibson@civet:~$ echo "print('hello')" > /tmp/say_hello.py  
(base) bgibson@civet:~$ python /tmp/say_hello.py  
hello
```

ipython: Interactive Python

- history (`python` does this now as well)
- tab completion (`python` does this now as well)
- "magic" commands
- help via `?` (`python` has `help()` as well)
- (see PDSH Ch 1 for more info)

Ipython : REPL and Help

- `$conda activate` if (base) not activated



```
IPython: proj/eods-f20
(base) bgibson@civet:~/proj/eods-f20$ ipython
Python 3.8.3 (default, Jul 2 2020, 16:21:59)
Type 'copyright', 'credits' or 'license' for more information
IPython 7.16.1 -- An enhanced Interactive Python. Type '?' for help.

In [1]: print('hello')
hello

In [2]: len?
Signature: len(obj, /)
Docstring: Return the number of items in a container.
Type:      builtin_function_or_method

In [3]:
```

IPython Magic Commands

- preceded by % for line, %% for cell

Ipython Magic Commands

- preceded by % for line, %% for cell

```
In [1]: !echo 'print("hello from ipython")' > /tmp/say_hello.py
```

Ipython Magic Commands

- preceded by % for line, %% for cell

```
In [1]: !echo 'print("hello from ipython")' > /tmp/say_hello.py
```

```
In [2]: %run /tmp/say_hello.py
```

```
hello from ipython
```

Ipython Magic Commands

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In [1]: !echo 'print("hello from ipython")' > /tmp/say_hello.py
```

```
In [2]: %run /tmp/say_hello.py
```

```
hello from ipython
```

```
In [3]: %timeit sorted([5,1,2,5])
```

```
141 ns ± 3.9 ns per loop (mean ± std. dev. of 7 runs, 10,000,000 loops each)
```


Ipython Magic Commands

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In [1]: !echo 'print("hello from ipython")' > /tmp/say_hello.py
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hello from ipython

```
In [3]: %timeit sorted([5,1,2,5])
```

141 ns \pm 3.9 ns per loop (mean \pm std. dev. of 7 runs, 10,000,000 loops each)

```
In [4]: %%timeit
x = []
for i in range(20):
    x.append(i**2)
```

3.93 μ s \pm 101 ns per loop (mean \pm std. dev. of 7 runs, 100,000 loops each)

Help with Magic Commands

- get information about the %timeit magic function

`%timeit?`

- get info on all magic functions

`%magic`

- get list of magic functions

`%lsmagic`

Ipython Notebooks with Jupyter

- Jupyter: application that combines code, markup and visualizations
- interact via web browser
- notebooks are easily sharable
- Jupyter can run other kernels as well: R, Julia, C#, etc.
- To launch via command line:

```
(base) bgibson@civet:~$ cd ~/proj  
(base) bgibson@civet:~/proj$ jupyter notebook
```

- launches dashboard in your default browser
- Ctrl-C to kill server

Other IDEs

- jupyterlab
- spyder
- pycharm
- visual studio code ...

Arguments for Notebooks

- fast to iterate
- easy to test new ideas
- wide adoption

Arguments against notebooks

- out of order execution
- messy code
- issues with version control
- [slides by Joel Grus](#)

How to deal with version issues? Virtual Environments

- encapsulate python executable and packages
- allow for easy experimentation
- workaround versioning issues
- two major implementations: virtualenv and conda (we'll be using conda)

Virtual Environments with Conda

Example for creating a new environment called py2 with python=2.7:

```
(base) bgibson@civet:~$ conda create -n py2 python=2.7
...
```

```
(base) bgibson@civet:~$ conda activate py2
```

```
(py2) bgibson@civet:~$ which python
/home/bgibson/anaconda3/envs/py2/bin/python
```

```
(py2) bgibson@civet:~$ python --version
Python 2.7.18 :: Anaconda, Inc.
```

```
(py2) bgibson@civet:~$ conda deactivate
```

```
(base) bgibson@civet:~$ which python
/home/bgibson/anaconda3/bin/python
```

```
(base) bgibson@civet:~$ python --version
Python 3.9.2
```


Managing Conda Enviroments

Installing New Packages

- Again, don't want to mess with system packages!

Installing New Packages

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1. first, try conda (with conda-forge):

```
conda install -n [env_name] -c conda-forge [package]
```

2. next, try another channel : eg. bioconda

```
conda install -n [env_name] -c bioconda [package]
```

3. then, try pip:

```
conda activate [env_name]  
pip install [package]
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- when you can, double check the path to your env

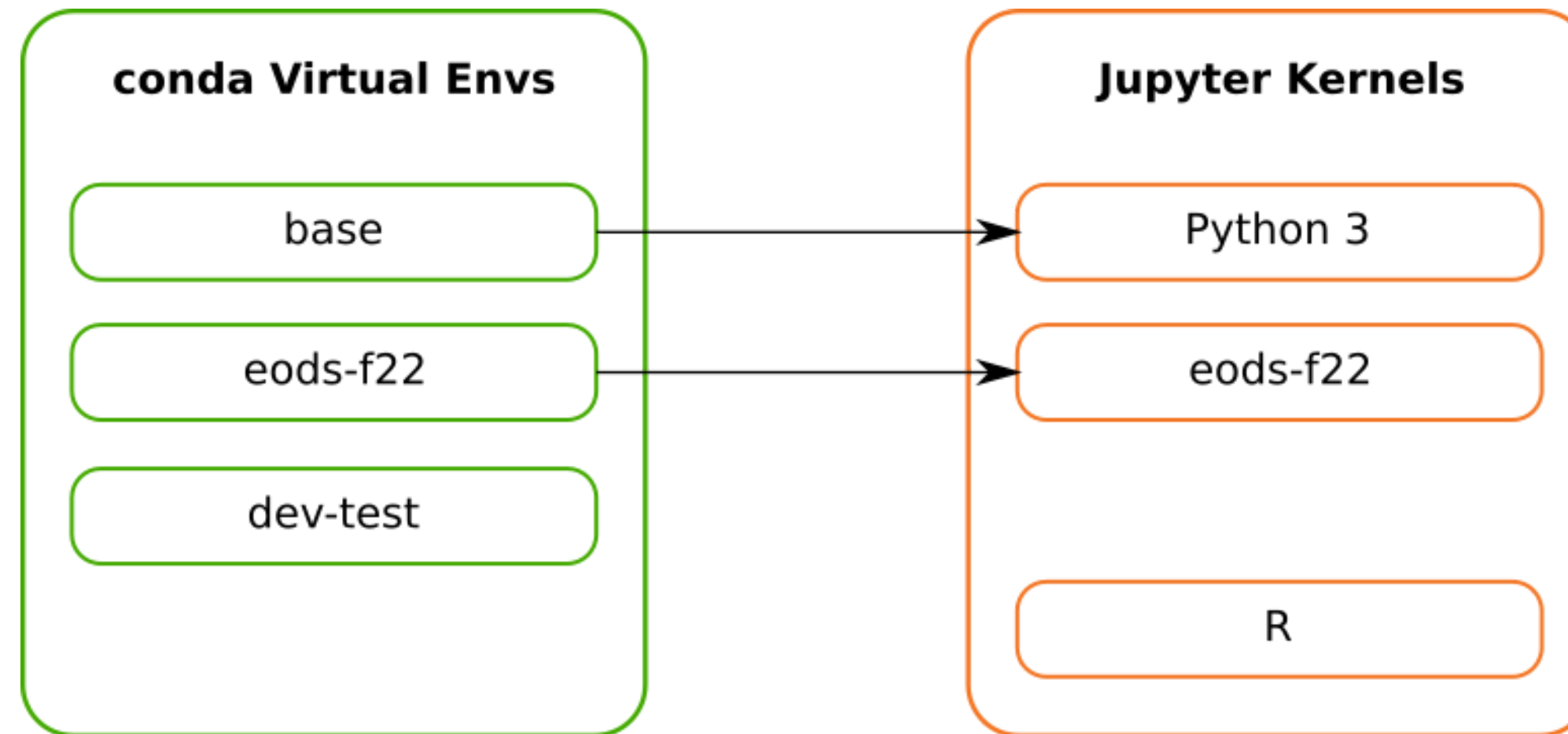
Conda Channels: default vs conda-forge

- channels: locations where packages are stored
 - default: Anaconda terms specify only used in non-commercial application
 - conda-forge: where all of the good stuff is anyway

```
conda install -n [env_name] -c conda-forge [package]
```

Conda Virtual Envs and Jupyter Kernels

- jupyter can run many different kernels
- conda envs not automatically added as available kernels



Controlling Jupyter Kernels

- to install a new kernel in jupyter:

```
(base) $ conda activate py2
```

```
(py2) $ conda install -c conda-forge ipykernel
```

```
(py2) $ python -m ipykernel install --user --name py2
```

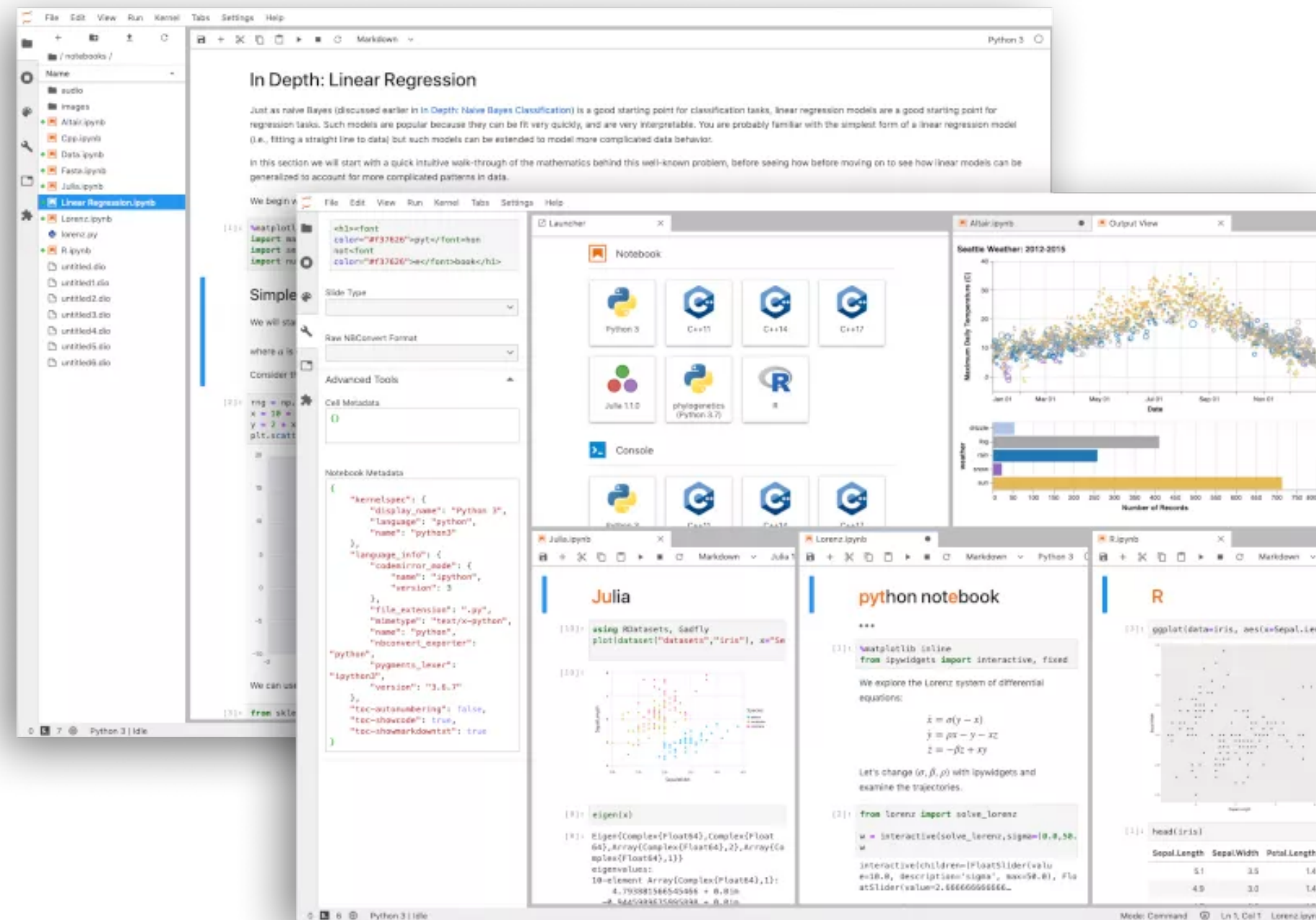
- to list kernels: `jupyter kernelspec list`
- to remove kernel: `jupyter kernelspec uninstall [name]`

Jupyter Demo

- Important: h for help
- Markdown syntax help: <https://daringfireball.net/projects/markdown/syntax>

Jupyter Classic vs JupyterLab

- start as either `jupyter notebook` or `jupyter lab`
- or replace `http://localhost:8888/tree` with `http://localhost:8888/lab`



Example Notebooks

[Gallery of interesting Jupyter Notebooks](#)

Git and Github



<http://imgs.xkcd.com/comics/git.png>

Git

- distributed version control
- for code, documentation, *small* data
- can be used locally or with remote collaborators

Github

- backup
- sharing
- used for both large and small projects
 - Ex: <https://github.com/scikit-learn/scikit-learn>

Getting course material

- Can view online at: <https://github.com/bryanrgibson/eods-f22>
- You'll also want to clone locally:

```
$ cd [your projects folder]
```

```
$ git clone https://github.com/bryanrgibson/eods-f22
```

Demo Week 1 Quiz

https://github.com/bryanrgibson/eods-f22/blob/main/weekly_quiz/Week_01_Quiz.md

Questions?

- Next time: Python review, numpy and pandas