

Elements Of Data Science - S2022

Introduction to Data Science Tools

1/18/2022

# TODOs

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

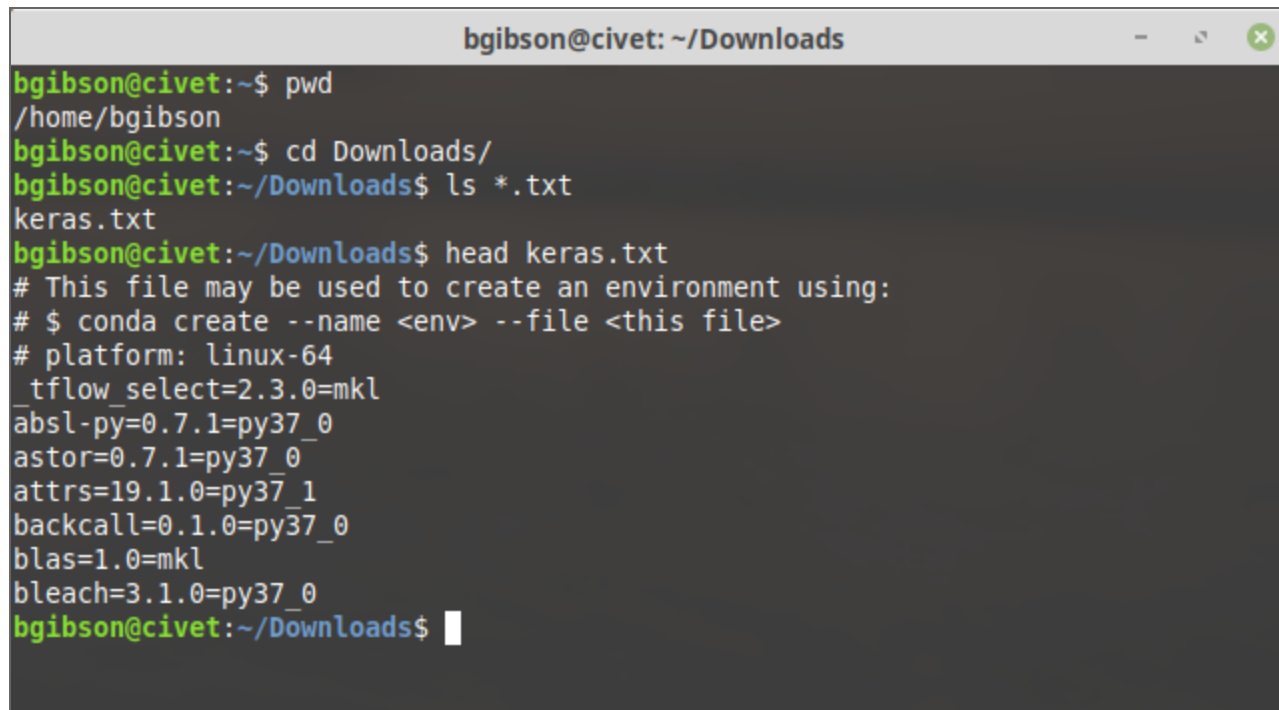
# TODAY

- Software tools we'll be using

# Our Python Data Science Stack

- Python (3.9): Programming language
- Anaconda : Package maintenance and environments
- Jupyter : IDE
- Git : Source control and versioning

## Aside: The Terminal and The Shell

A terminal window titled 'bgibson@civet: ~/Downloads' with standard window controls. The terminal shows a sequence of commands and their outputs: 'pwd' returns '/home/bgibson'; 'cd Downloads/' changes the directory; 'ls \*.txt' lists 'keras.txt'; 'head keras.txt' displays the first lines of a file, including instructions on how to use it with conda and a list of package specifications like '\_tflow\_select=2.3.0=mkl', 'absl-py=0.7.1=py37\_0', etc. The prompt is currently at 'bgibson@civet:~/Downloads\$' with a cursor.

```
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
_tflow_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
- ...
- **Basic Shell Commands**
- **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, Scala, 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...**

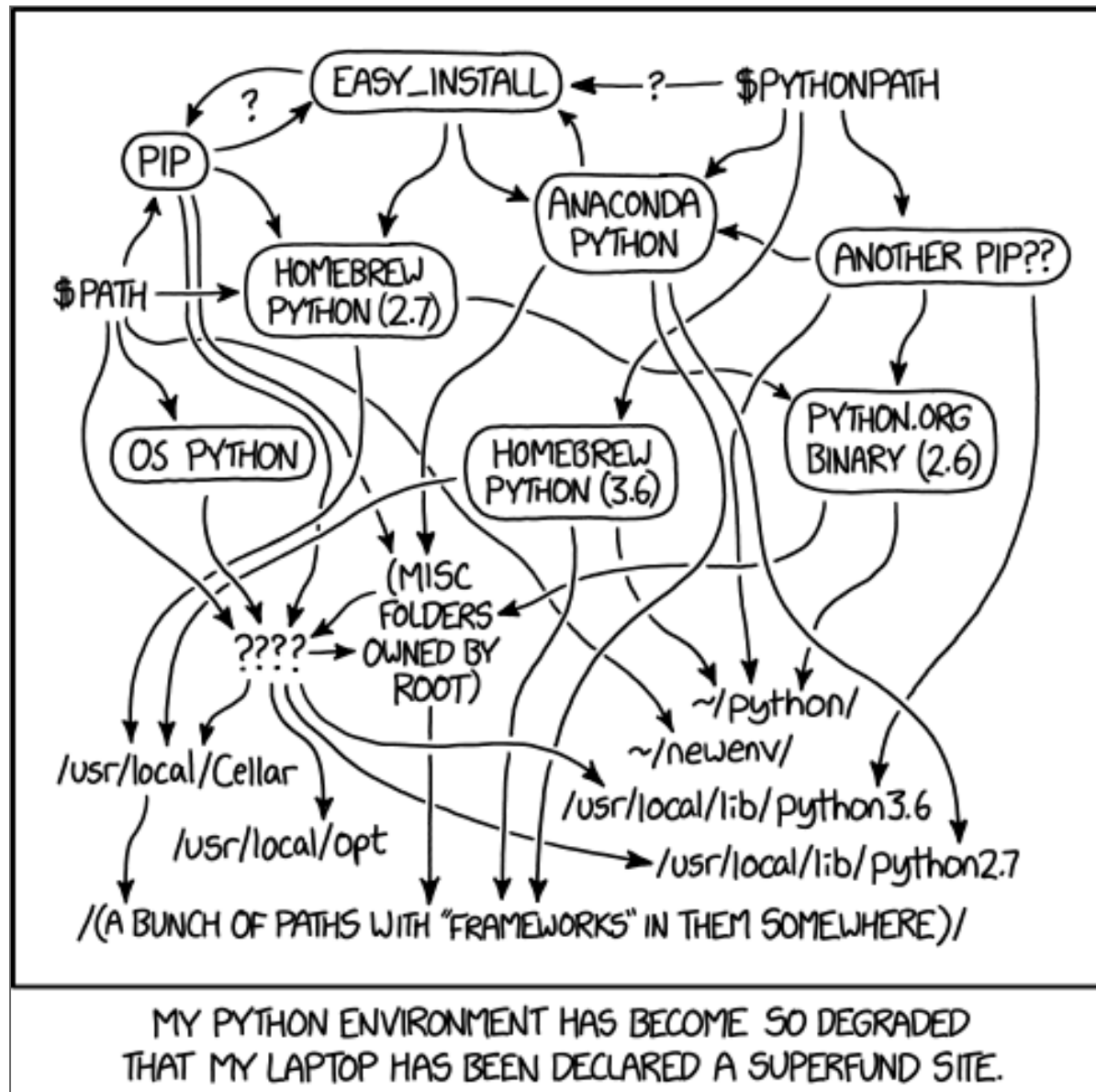
# Python 2 vs 3

- We'll be using Python 3.9
- 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?



**[https://imgs.xkcd.com/comics/python\\_environment.png](https://imgs.xkcd.com/comics/python_environment.png)**

# Why Anaconda?

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



# Installing Anaconda

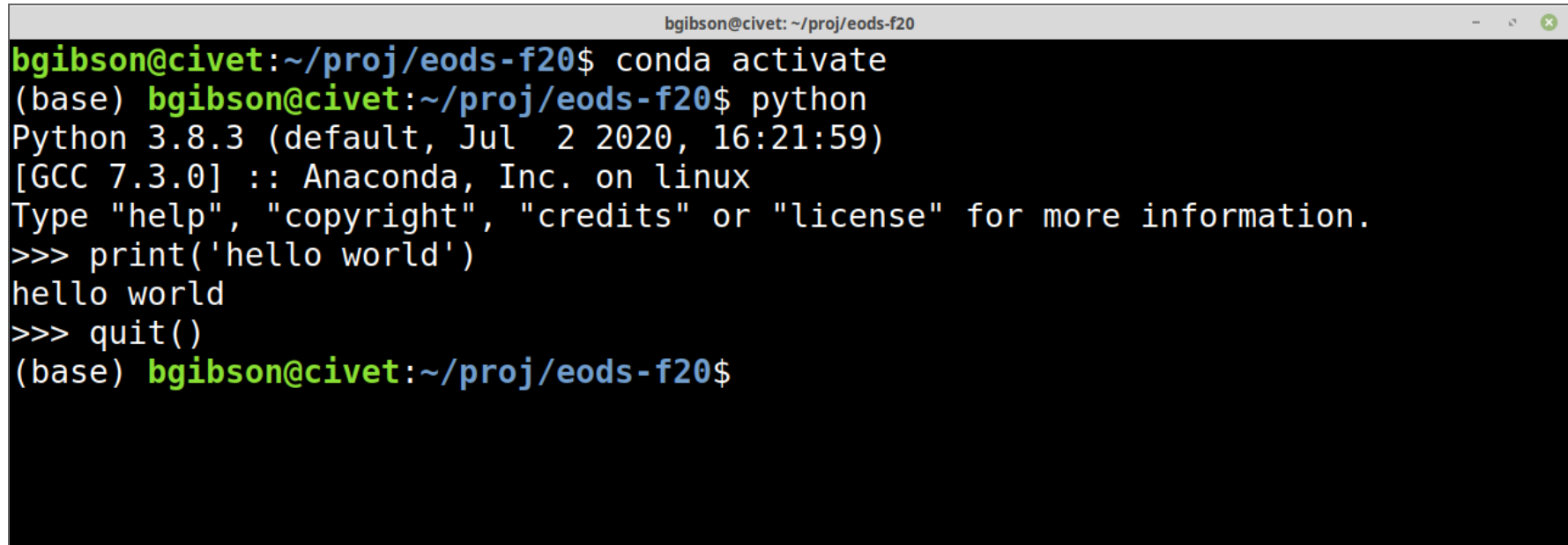
- Download via **<https://www.anaconda.com/products/individual>**
- Select OS and Grab Python 3.9 version
- Install somewhere easy to navigate to
  - /home/bgibson/anaconda3
  - C:\Users\brygib\anaconda3
- Recommend letting installer run `conda init` to set up your shell
- Note: base environment activated 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 with a dark background and light-colored text. The window title is 'bgibson@civet: ~/proj/eods-f20'. The text inside shows the user running 'conda activate' to enter a base environment, then 'python' to start the Python interpreter. The interpreter displays version 3.8.3 and the Anaconda logo. The user enters 'print('hello world')' and the output 'hello world' is shown. Finally, the user enters 'quit()' and the prompt returns to the shell.

```
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

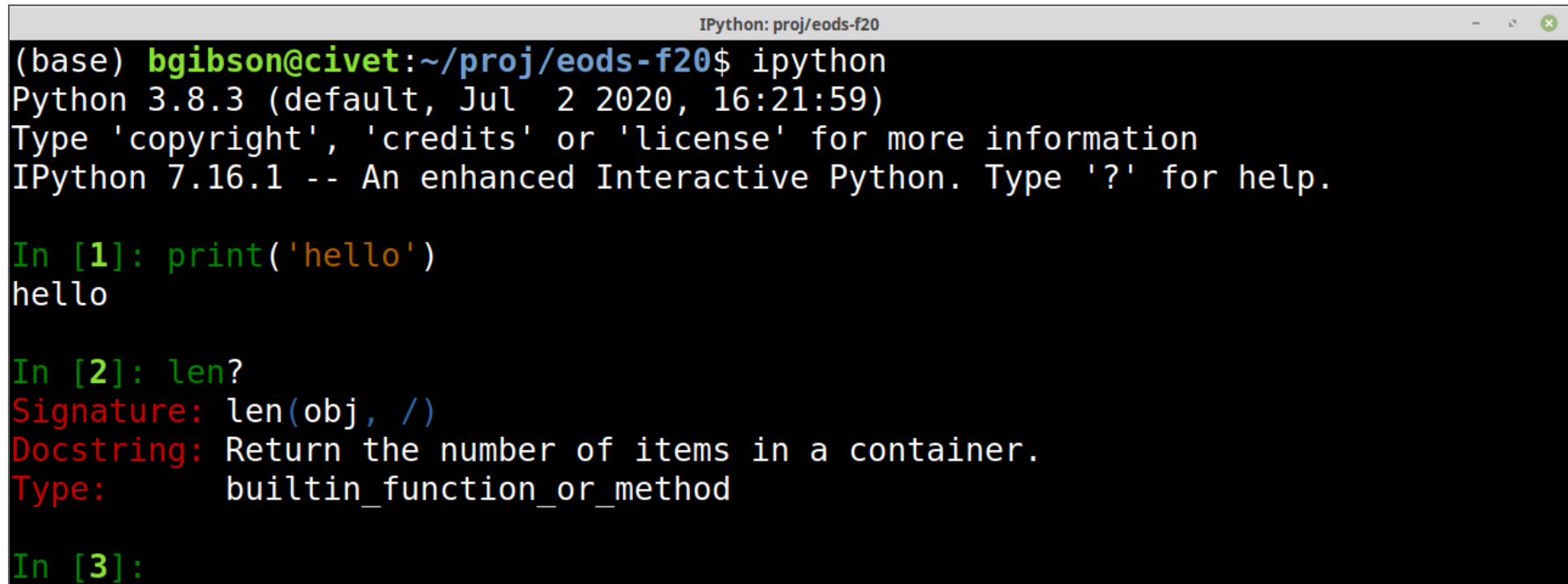
```
(base) bgibson@civet:~$ echo "print('hello')" > /tmp/say_hello.py  
(base) bgibson@civet:~$ python /tmp/say_hello.py  
hello
```

# 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

In [1]:

```
!mkdir tmp
```

In [2]:

```
!echo print("Welcome to STAT5293: Hello from ipython!") > .\tmp\say_hello.py
```

In [3]:

```
%run .\tmp\say_hello.py
```

Welcome to STAT5293: Hello from ipython!

In [4]:

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

265 ns  $\pm$  12.5 ns per loop (mean  $\pm$  std. dev. of 7 runs, 1000000 loops each)

In [5]:

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

5.86  $\mu$ s  $\pm$  318 ns per loop (mean  $\pm$  std. dev. of  
7 runs, 100000 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
```

# Python 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 3.9.7
```





# Managing Conda Enviroments

- `conda create -n [env_name]`
- `conda create -n [env_name] [package] [package]=[version]`
- `conda env create --file [requirementsfile].yaml`
- `conda activate [name]`
- `conda deactivate`
- `conda env list`
- For more information see:

**<https://docs.conda.io/projects/conda/en/latest/user-guide/tasks/manage-environments.html>**

# Installing New Packages

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

1. first, try conda:

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

2. next, try another channel : eg. conda-forge

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

3. lastly, try pip:

```
conda activate [env_name]  
pip install [package]
```

- when you can, double check the path to your env

# Conda Envs and Jupyter

- jupyter can run many different kernels
- conda envs not automatically added as available kernels
- to install a new kernel in jupyter:

```
(base) $ conda activate py2
(py2) $ conda install 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>**

## Example Notebooks

**<https://github.com/jupyter/jupyter/wiki/A-gallery-of-interesting-Jupyter-Notebooks>**

# Git and Github





# Git

- distributed version control
- for code, documentation, *small* data
- can but 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/cueods/eods-s22>**
- You'll also want to clone locally:

```
$ cd [your projects folder]  
$ git clone https://github.com/cueods/eods-s22
```

# Demo Week 1 Quiz

# Questions?

- Next time: Python review, numpy and pandas