The SciPy Stack

Data Analytics in Python

Data Analytics/Scientific Computing

Gaining insight from data:

- Do instances fall into discernible groups?
  - Which characteristics differentiate groups?
- Do some characteristics of instances predict other characteristics?

Data are evidence. We seek predictive models and explanations.

What is "data?"

First of all, data is the plural form of datum.
Data are measurements or assignments of values of attributes of instances of a class.

- Grades of students in a course. (Calculate grades for course.)
  - Grades of students in other courses. (Do grades from one course predict grades in another course?)
- DNA sequence of humans. (Do parts of DNA predict diseases?)
- Pixel RGB intensities. (Do certain images contain faces? Which faces?)

Fundamental "linquistic" abstraction in data analytics/machine learning:
data are vectors of values.

- Values can be real numbers or categories.
- Multi-dimensional arrays can be "flattened" into 1-D vectors.

The SciPy Stack

SciPy is a Python-based ecosystem of libraries and tools for scientific computing and data analytics

- iPython
- Jupyter notebooks
- Numpy
- Pandas
- Matplotlib

iPython is the primary way of interacting with the SciPy stack – whether through the shell or a Jupyter notebook.

iPython

Two modes:

- Interactive shell
  - Replacement for `python` REPL
- Jupyter notebook
  - Interactive web-based documents mixing text, executable code, graphics

Before we proceed, make sure your computer is ready (OS shell):

```
$ conda update conda
$ conda update python ipython jupyter numpy pandas matplotlib
```

A Taste of Data Analytics in iPython Shell

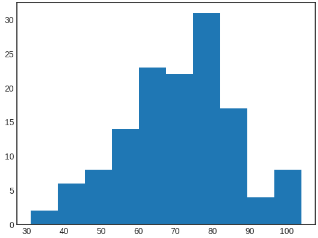
```
In [1]: cd analytics/
/home/chris/vcs/github.com/cs2316/cs2316.github.io/code/analytics

In [3]: exam1grades = np.loadtxt('exam1grades.txt')

In [4]: import matplotlib.pyplot as plt

In [5]: %matplotlib qt5

In [6]: plt.hist(exam1grades)
Out[6]:
(array([ 2.,   6.,   8.,  14.,  23.,  22.,  31.,  17.,   4.,   8.]),
 array([ 31. ,  38.3,  45.6,  52.9,  60.2,  67.5,  74.8,  82.1,
         89.4,  96.7, 104. ]),
 <a list of 10 Patch objects>)
```



Jupyter Notebooks

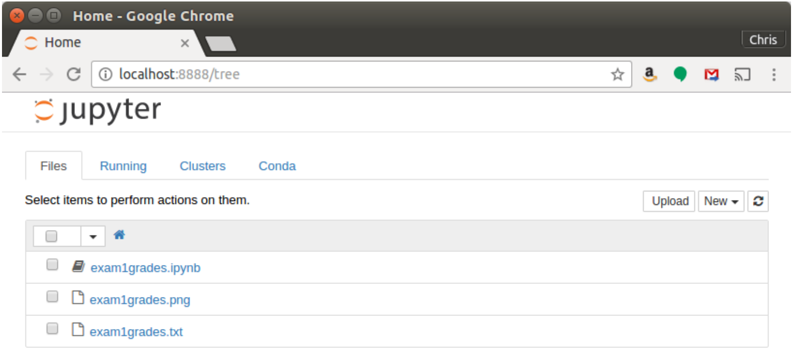
Go to the directory that holds your notebooks, or the class web site repo's `code/analytics` directory for this example and enter `jupter notebook`.

```
[chris@bolshoi ~/vcs/github.com/cs2316/cs2316.github.io/code/analytics]
$ jupyter notebook
[I 15:06:15.705 NotebookApp] Serving notebooks from local directory:
     /home/chris/vcs/github.com/cs2316/cs2316.github.io/code/analytics
[I 15:06:15.705 NotebookApp] 0 active kernels
[I 15:06:15.705 NotebookApp] The Jupyter Notebook is running at:
     http://localhost:8888/
[I 15:06:15.705 NotebookApp] Use Control-C to stop this server and shut down all
     kernels (twice to skip confirmation).
Created new window in existing browser session.
```

Now a Jupter Notebook server is running and you're ready to use iPython from the Jupyter Notebook web interface.

Jupyter Web Interface

After running `jupyter notebook` from your OS command shell, open a browser and navigate to `localhost:8888`. You'll see a screen that looks like this:



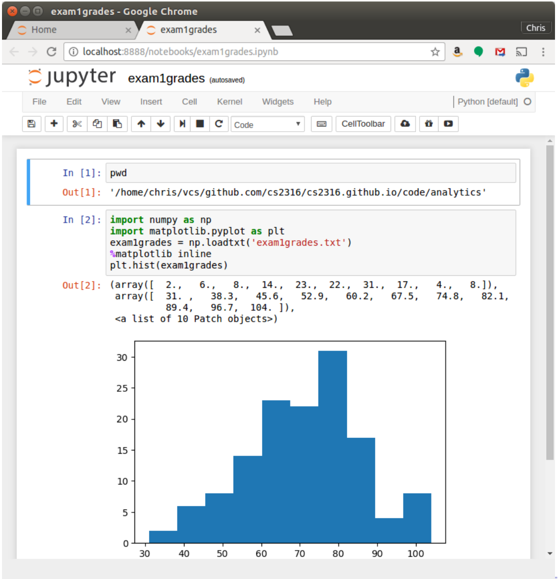
Select items to perform actions on them.

- exam1grades.ipynb
- exam1grades.png
- exam1grades.txt

Notice the listing of files in the directory in which you started the Jupyter notebook server.

A Taste of Data Analytics in Jupyter Notebook

Select the `exam1grades.ipynb` file and you'll get this:



```
In [1]: pwd
Out[1]: '/home/chris/vcs/github.com/cs2316/cs2316.github.io/code/analytics'
```

```
In [2]: import numpy as np
        import matplotlib.pyplot as plt
        exam1grades = np.loadtxt('exam1grades.txt')
        %matplotlib inline
        plt.hist(exam1grades)
```

```
Out[2]: (array([  2.,    6.,    8.,   14.,   23.,   22.,   31.,   17.,    4.,    8.]),
         array([  31. ,   38.3,   45.6,   52.9,   60.2,   67.5,   74.8,   82.1,
                  89.4,   96.7,  104. ]),
         <a list of 10 Patch objects>)
```