GOOD MORNING

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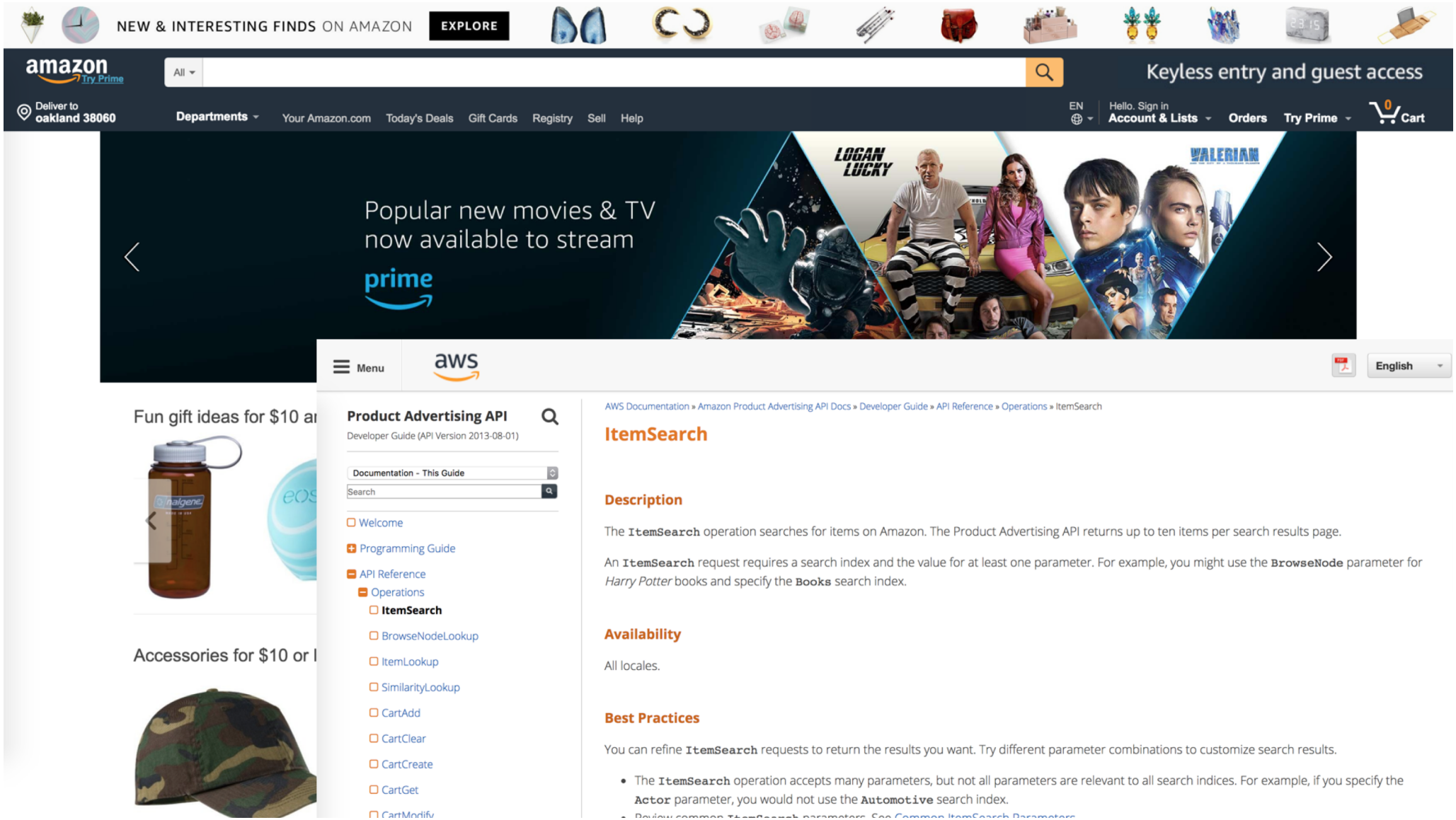
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Best Practices
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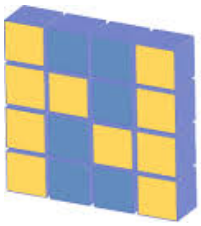

NumPy

matplotlib

pandas

$$y_i t = \beta' x_{it} + \mu_i + \epsilon_{it}$$

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VS

Data Science with Python and Friends

Douglas Starnes

CodeStock 2018

Polyglot ninja

Memphis, TN area

Co-director of MemPy

Data Science/Machine Learning, Mobile Apps, wannabe Game Designer

Pluralsight Author

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Programming

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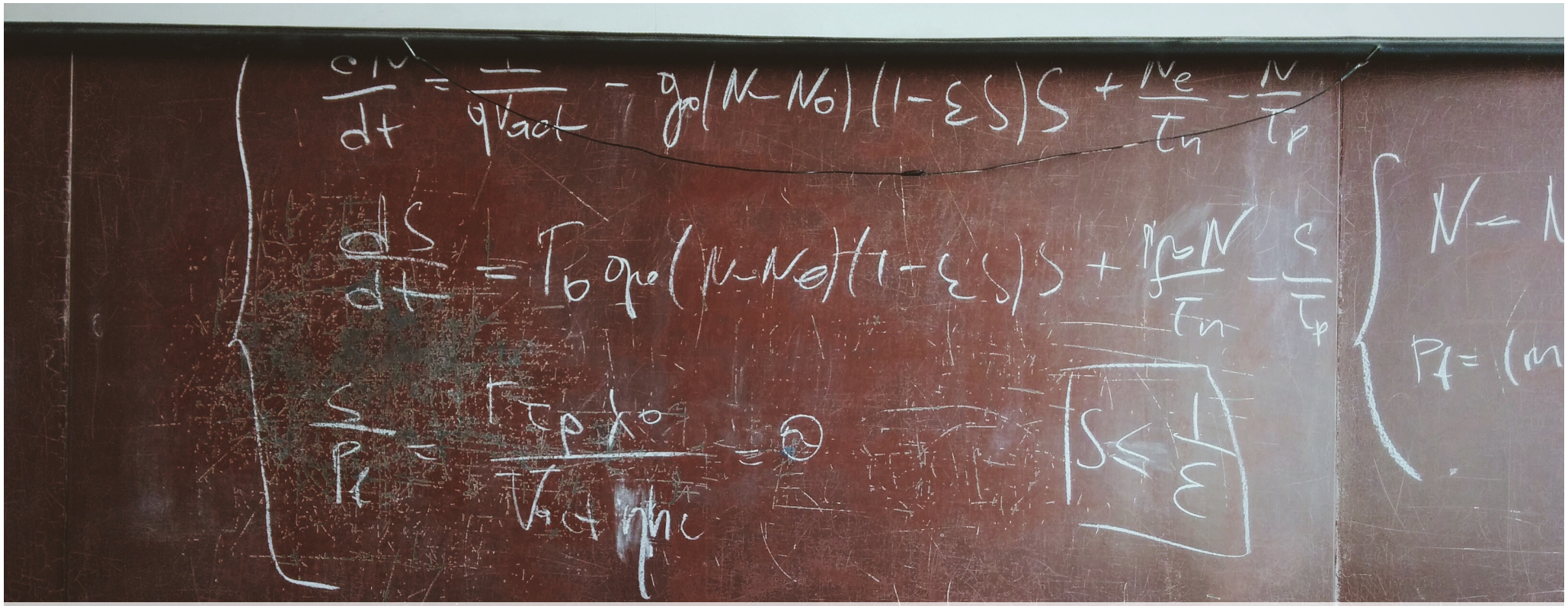

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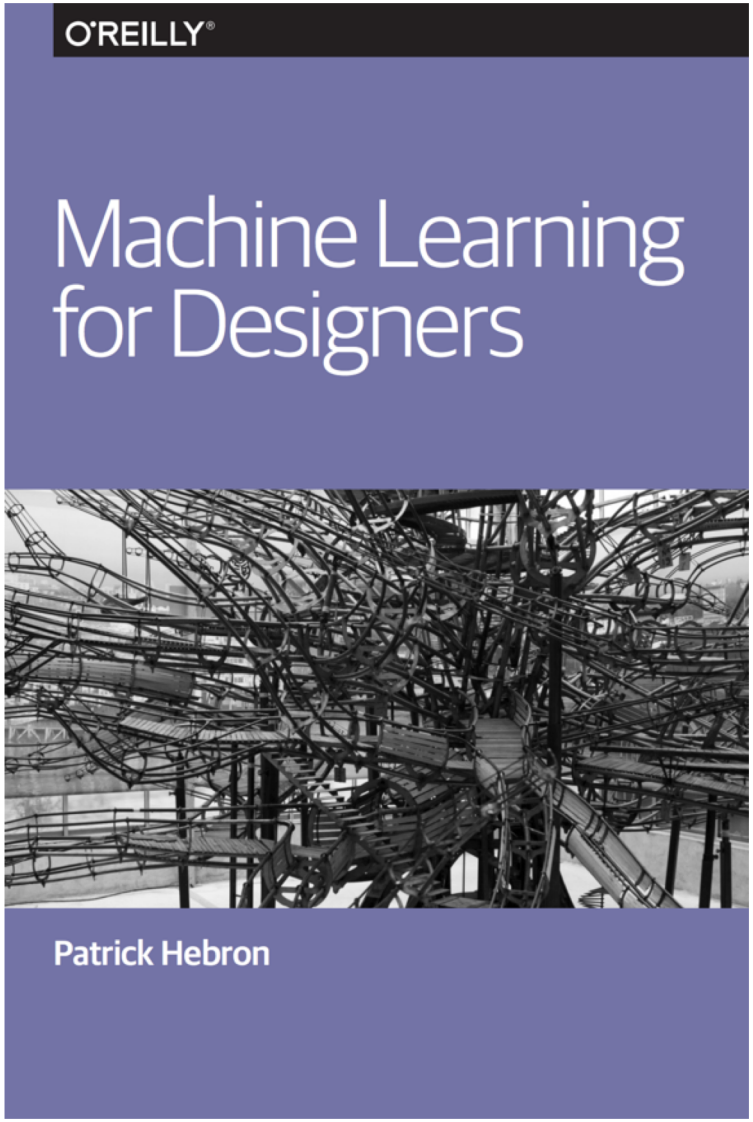
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Patrick Hebron


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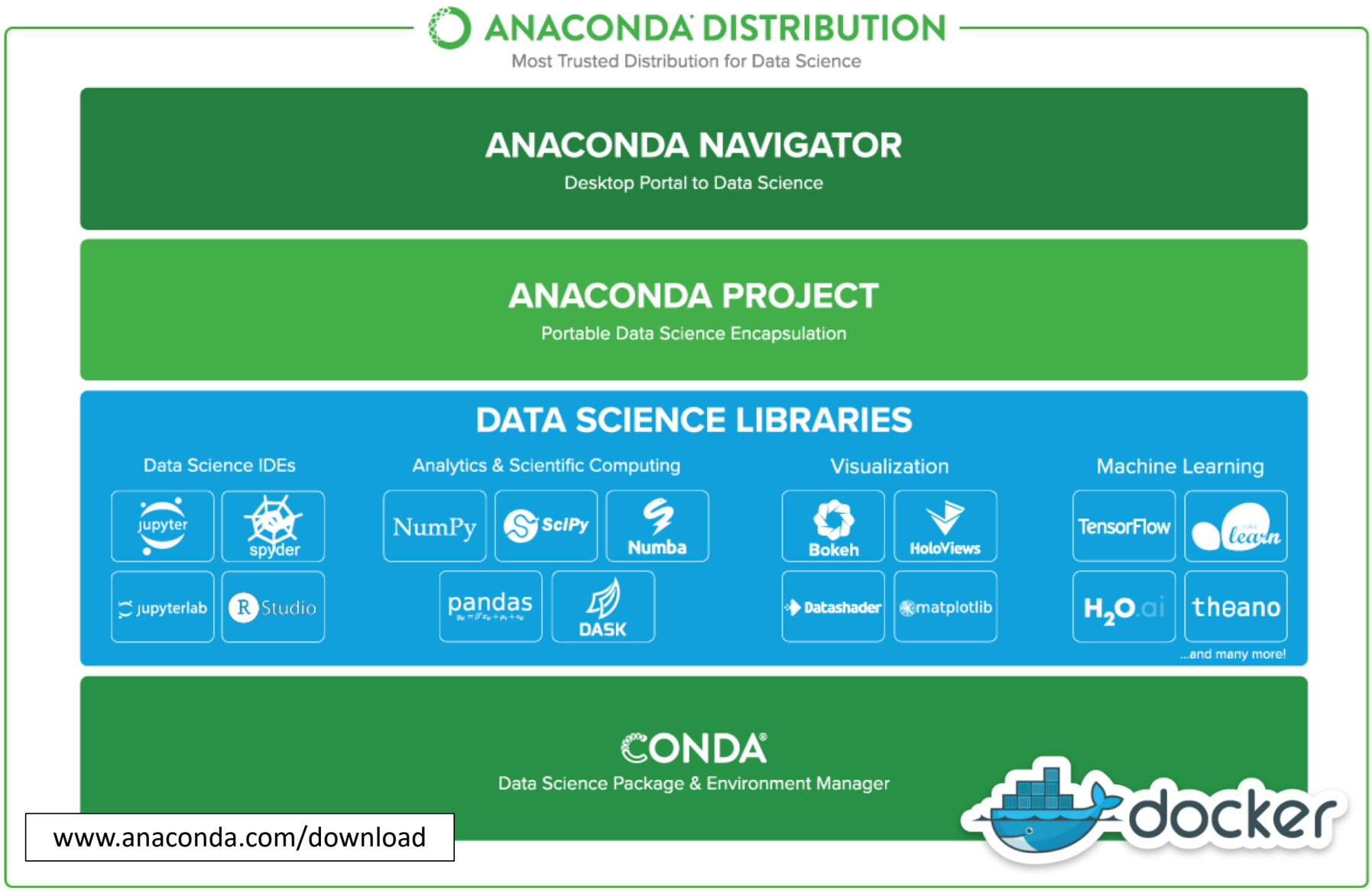

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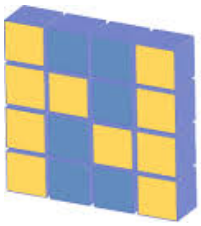

NumPy

matplotlib

pandas

$$y_i t = \beta' x_{it} + \mu_i + \epsilon_{it}$$

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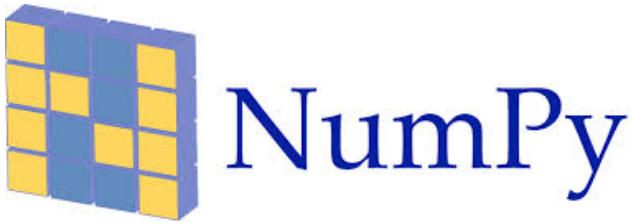


“NumPy is the fundamental package for scientific computing with Python.”

Arrays

Random number generation

```
>>> r = range(10)
>>> r
range(0, 10)
>>> l = list(r)
>>> l
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
>>> type(l)
list
>>> l[4]
4
>>> l[4:8]
[4, 5, 6, 7]
>>> l[-1]
9
>>> m = list(range(10, 20))
>>> m
[10, 11, 12, 13, 14, 15, 16, 17, 18, 19]
```

```
>>> l + m
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,
  11, 12, 13, 14, 15, 16, 17, 18, 19]
>>> l.extend(m)
>>> l
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,
  11, 12, 13, 14, 15, 16, 17, 18, 19]
>>> l - m
TypeError: unsupported operand type(s)
  for -: 'list' and 'list')
>>> l + 1
TypeError: can only concatenate list
  (not "int") to list
>>> [v + 1 for v in l]
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10,
  11, 12, 13, 14, 15, 16, 17, 18, 19, 20]
```

```
>>> import numpy as np
>>> a = np.arange(10)
>>> a
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
>>> type(a)
numpy.ndarray
>>> a[4]
4
>>> a[4:8]
array([4, 5, 6, 7])
>>> a[-1]
9
>>> b = np.arange(10, 20)
>>> c = a + b
>>> c
array([10, 12, 14, 16, 18,
  20, 22, 24, 26, 28])
```

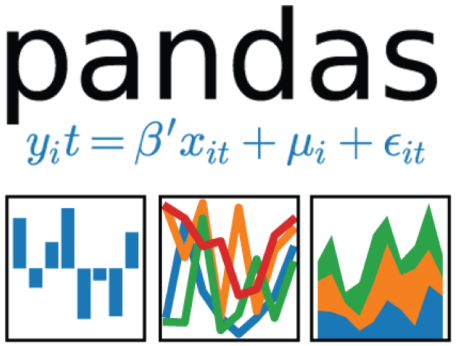
```
>>> c - b
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
>>> a - 1
array([-1,  0,  1,  2,  3,  4,  5,  6,  7,  8])
>>> a < 5
array([ True,  True,  True,  True,  True,
  False, False, False, False, False], dtype=bool)
>>> a[a < 5]
array([0, 1, 2, 3, 4])
```

```
>>> import numpy as np
>>> a = np.arange(20)
>>> a_hat = a.reshape(5, 4)
>>> a_hat
array([[ 0,  1,  2,  3],
       [ 4,  5,  6,  7],
       [ 8,  9, 10, 11],
       [12, 13, 14, 15],
       [16, 17, 18, 19]])
>>> a_hat[1][2]
6
>>> a_hat[1,2]
6
>>> a_hat[:,2]
array([ 2,  6, 10, 14, 18])
```

```
>>> l = list(range(10))
>>> l[:4]
[0, 1, 2, 3]
>>> l[7:]
[7, 8, 9]
>>> l[:]
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

```
>>> import numpy as np
>>> np.random.rand() # randn() uses normal distribution
0.5714800635809371
>>> np.random.rand(5, 4)
array([[ 0.37804532,  0.8301934 ,  0.67764257,  0.23334091],
       [ 0.95522908,  0.40048243,  0.66189479,  0.08995263],
       [ 0.86379148,  0.95826702,  0.38893546,  0.96141803],
       [ 0.49023199,  0.80043109,  0.63809899,  0.52142485],
       [ 0.01152943,  0.48649583,  0.21168751,  0.99074378]])
>>> np.random.rand(5, 4) * 10
array([[ 2.95986735,  0.24069298,  2.6357301 ,  5.4024343 ],
       [ 0.17023176,  2.49200206,  3.92632156,  5.72293003],
       [ 0.44536158,  3.07517235,  6.80317932,  0.20393922],
       [ 9.87761262,  3.24090831,  8.74508052,  4.14903998],
       [ 6.30249775,  9.62854077,  3.70046814,  4.69044164]])
>>> import random
>>> a = [[random.random() * 10 for _ in range(5)] for _ in range(4)]
>>> a.reshape(10, 2)
AttributeError: 'list' object has no attribute 'reshape'
```

```
>>> import numpy as np
>>> np.linspace(0, 10, 25)
array([  0.        ,   0.41666667,   0.83333333,   1.25      ,
         1.66666667,   2.08333333,   2.5       ,   2.91666667,
         3.33333333,   3.75      ,   4.16666667,   4.58333333,
         5.        ,   5.41666667,   5.83333333,   6.25      ,
         6.66666667,   7.08333333,   7.5       ,   7.91666667,
         8.33333333,   8.75      ,   9.16666667,   9.58333333,  10.        ])
>>> x = np.linspace.(0, 2 * np.pi, 361)
>>> y = np.sin(x)
>>> import math
>>> one_degree = 2 * math.pi / 361
>>> x = [i * one_degree for i in range(362)]
>>> y = [math.sin(xi) for xi in x]
>>> y.reshape(36, 10)
AttributeError: 'list' object has no attribute 'reshape'
```



"pandas is an open source, BSD-licensed library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language."

Data frames

```
>>> import numpy as np
>>> import pandas as pd
>>> df = pd.read_csv('dow_jones_index.csv')
>>> df
```

```
quarter,stock,date,open,high,low,close,volume,percent_change_price,percent_change_volume_over_last_wk,previous_weeks_
volume,next_weeks_open,next_weeks_close,percent_change_next_weeks_price,days_to_next_dividend,percent_return_next_div
idend
1,AA,1/7/2011,$15.82,$16.72,$15.78,$16.42,239655616,3.79267,,,$16.71,$15.97,-4.42849,26,0.182704
1,AA,1/14/2011,$16.71,$16.71,$15.64,$15.97,242963398,-4.42849,1.380223028,239655616,$16.19,$15.79,-2.47066,19,0.18785
2
1,AA,1/21/2011,$16.19,$16.38,$15.60,$15.79,138428495,-2.47066,-43.02495926,242963398,$15.87,$16.13,1.63831,12,0.18999
4
1,AA,1/28/2011,$15.87,$16.63,$15.82,$16.13,151379173,1.63831,9.355500109,138428495,$16.18,$17.14,5.93325,5,0.185989
1,AA,2/4/2011,$16.18,$17.39,$16.18,$17.14,154387761,5.93325,1.987451735,151379173,$17.33,$17.37,0.230814,97,0.175029
1,AA,2/11/2011,$17.33,$17.48,$16.97,$17.37,114691279,0.230814,-25.71219489,154387761,$17.39,$17.28,-0.632547,90,0.172
712
1,AA,2/18/2011,$17.39,$17.68,$17.28,$17.28,80023895,-0.632547,-30.22669579,114691279,$16.98,$16.68,-1.76678,83,0.1736
11
1,AA,2/25/2011,$16.98,$17.15,$15.96,$16.68,132981863,-1.76678,66.17769355,80023895,$16.81,$16.58,-1.36823,76,0.179856
1,AA,3/4/2011,$16.81,$16.94,$16.13,$16.58,109493077,-1.36823,-17.66315005,132981863,$16.58,$16.03,-3.31725,69,0.18094
1
```

```
>>> df.columns
Index(['quarter', 'stock', 'date', 'open', 'high', 'low', 'close', 'volume',
       'percent_change_price', 'percent_change_volume_over_last_wk', 'previous_weeks_volume',
       'next_weeks_open', 'next_weeks_close','percent_change_next_weeks_price',
       'days_to_next_dividend','percent_return_next_dividend'], dtype='object')
```

```
>>> df['stock']
>>> df.columns[1:8]
>>> v = df.loc[:, df.columns[1:8]].copy()
>>> v
 stock       date    open    high     low   close     volume
0      AA   1/7/2011  $15.82  $16.72  $15.78  $16.42  239655616
1      AA  1/14/2011  $16.71  $16.71  $15.64  $15.97  242963398
2      AA  1/21/2011  $16.19  $16.38  $15.60  $15.79  138428495
3      AA  1/28/2011  $15.87  $16.63  $15.82  $16.13  151379173
4      AA   2/4/2011  $16.18  $17.39  $16.18  $17.14  154387761
5      AA  2/11/2011  $17.33  $17.48  $16.97  $17.37  114691279
6      AA  2/18/2011  $17.39  $17.68  $17.28  $17.28   80023895
7      AA  2/25/2011  $16.98  $17.15  $15.96  $16.68  132981863
8      AA   3/4/2011  $16.81  $16.94  $16.13  $16.58  109493077
9      AA  3/11/2011  $16.58  $16.75  $15.42  $16.03  114332562
10     AA  3/18/2011  $15.95  $16.33  $15.43  $16.11  130374108
>>> v.volume.max()
1453438639
>>> v.close[0]
'$16.42'
```

```
>>> for column in v.columns[2:6]:
        v.loc[:, column] = v.loc[:, column].apply(lambda x: float(x[1:]), 1)

>>> v
```

	stock	date	open	high	low	close	volume
0	AA	1/7/2011	15.82	16.72	15.78	16.42	239655616
1	AA	1/14/2011	16.71	16.71	15.64	15.97	242963398
2	AA	1/21/2011	16.19	16.38	15.60	15.79	138428495
3	AA	1/28/2011	15.87	16.63	15.82	16.13	151379173
4	AA	2/4/2011	16.18	17.39	16.18	17.14	154387761
5	AA	2/11/2011	17.33	17.48	16.97	17.37	114691279
6	AA	2/18/2011	17.39	17.68	17.28	17.28	80023895
7	AA	2/25/2011	16.98	17.15	15.96	16.68	132981863
8	AA	3/4/2011	16.81	16.94	16.13	16.58	109493077
9	AA	3/11/2011	16.58	16.75	15.42	16.03	114332562

```
>>> v[v.stock == 'DIS']

>>> v[v.stock == 'DIS']['close']

>>> close_index = v[v.stock == 'DIS']['close'].idxmax()

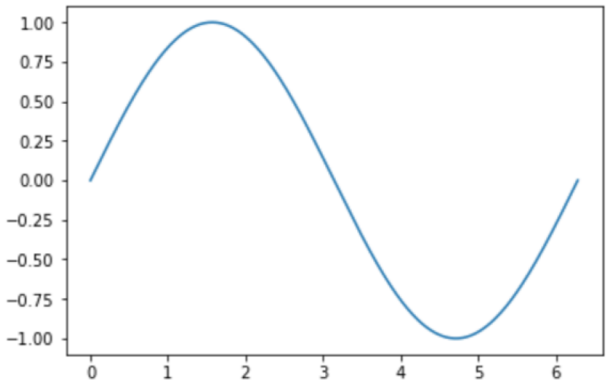
>>> v.loc[close_index, 'volume']

53096584
```

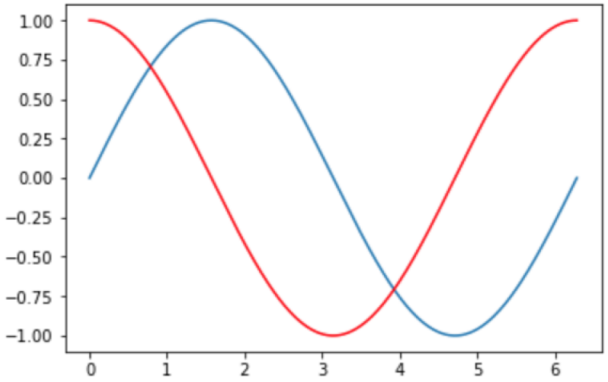
“Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms.”

Visualizations

```
>>> import numpy as np
>>> x = np.linspace(0, 2 * np.pi, 361)
>>> y = np.sin(x)
>>> import matplotlib.pyplot as plt
>>> plt.plot(x, y)
```




```
>>> y2 = np.cos(x)
>>> plt.plot(x, y)
    plt.plot(x, y2, color='r')
```



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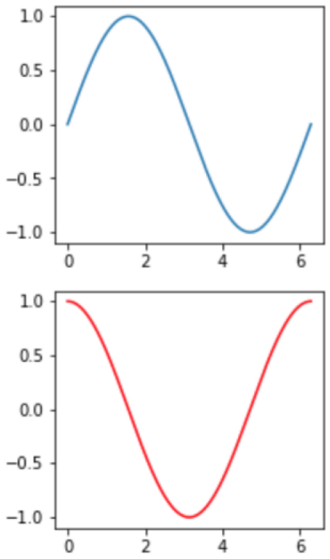
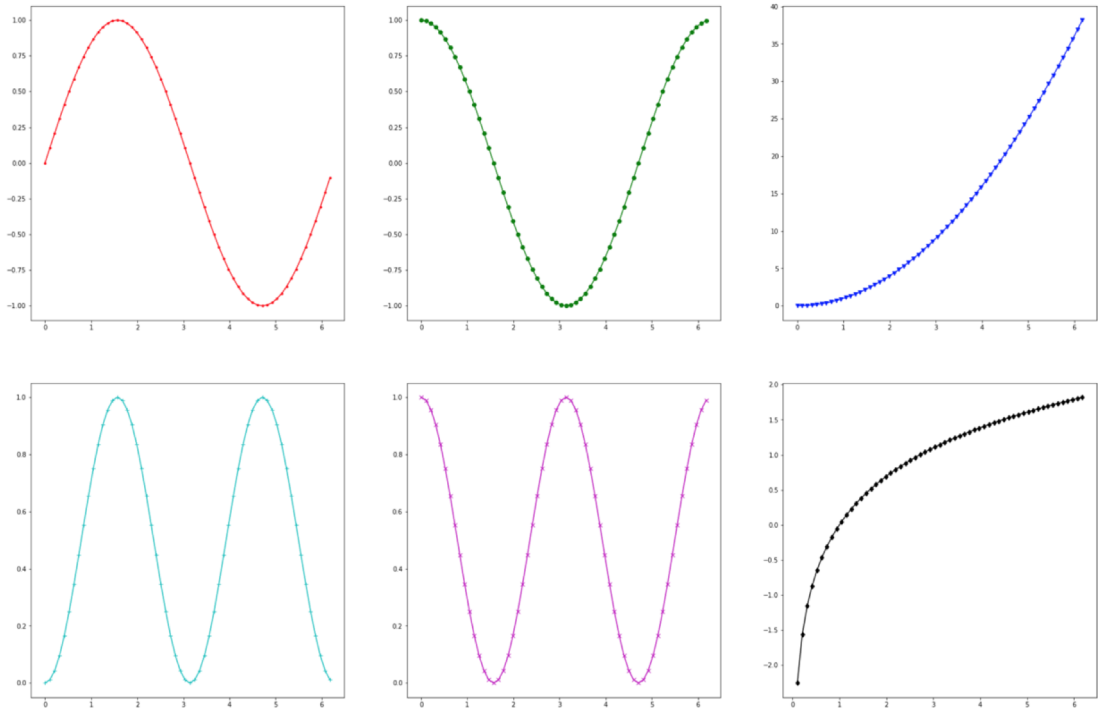
```
>>> plt.figure(figsize=(3, 6)) # height is 2x the width
    plt.subplot(2, 1, 1) # 2 rows, 1 column, position 1
    plt.plot(x, y)
    plt.subplot(2, 1, 2) # position 2
    plt.plot(x, y2, color='r')
```



```
fns = [np.sin, np.cos, lambda x: x ** 2, lambda x: np.sin(x) ** 2, lambda x: np.cos(x) ** 2, np.log]
colors = list('rgbcmk')
markers = list('.ov+xd')
data = zip(fns, colors, markers)

plt.figure(figsize=(30, 20))
for i, (fn, color, marker) in enumerate(data):
    plt.subplot(2, 3, i + 1) # 1-3 on first row, 4-6 on second
    plt.plot(x[np.arange(0, 360, 6)], fn(x[np.arange(0, 360, 6)]), color=color, marker=marker)
```



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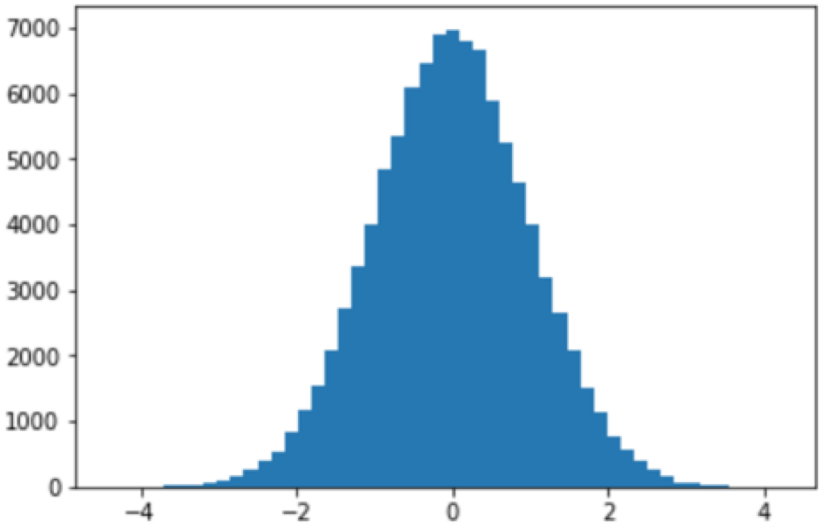
```
x = np.random.randn(100000)
plt.hist(x, bins=50)
```




```
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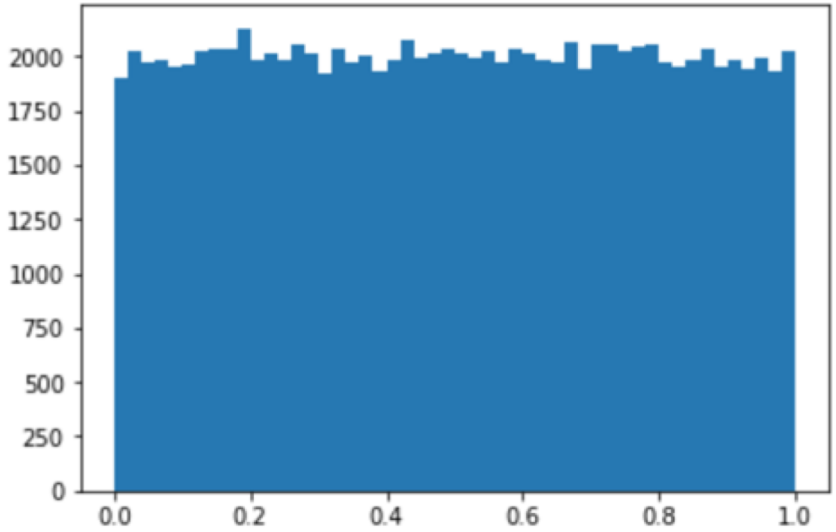
```



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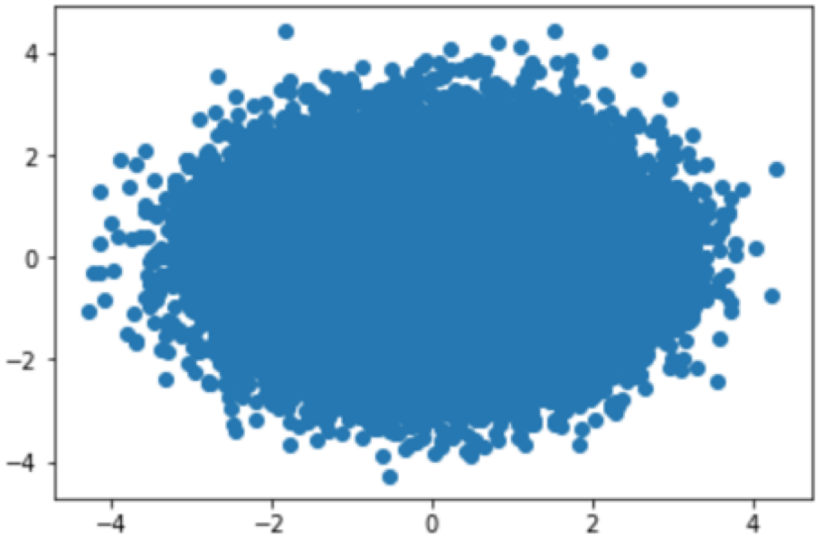
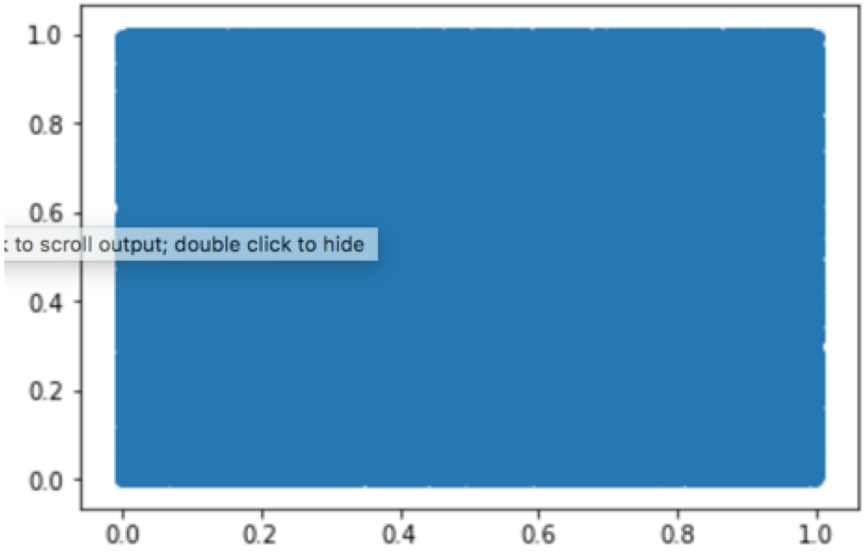
```
x = np.random.randn(100000)
y = np.random.randn(100000)
plt.scatter(x, y)
```




```
x = np.random.rand(100000)
y = np.random.rand(100000)
plt.scatter(x, y)
```



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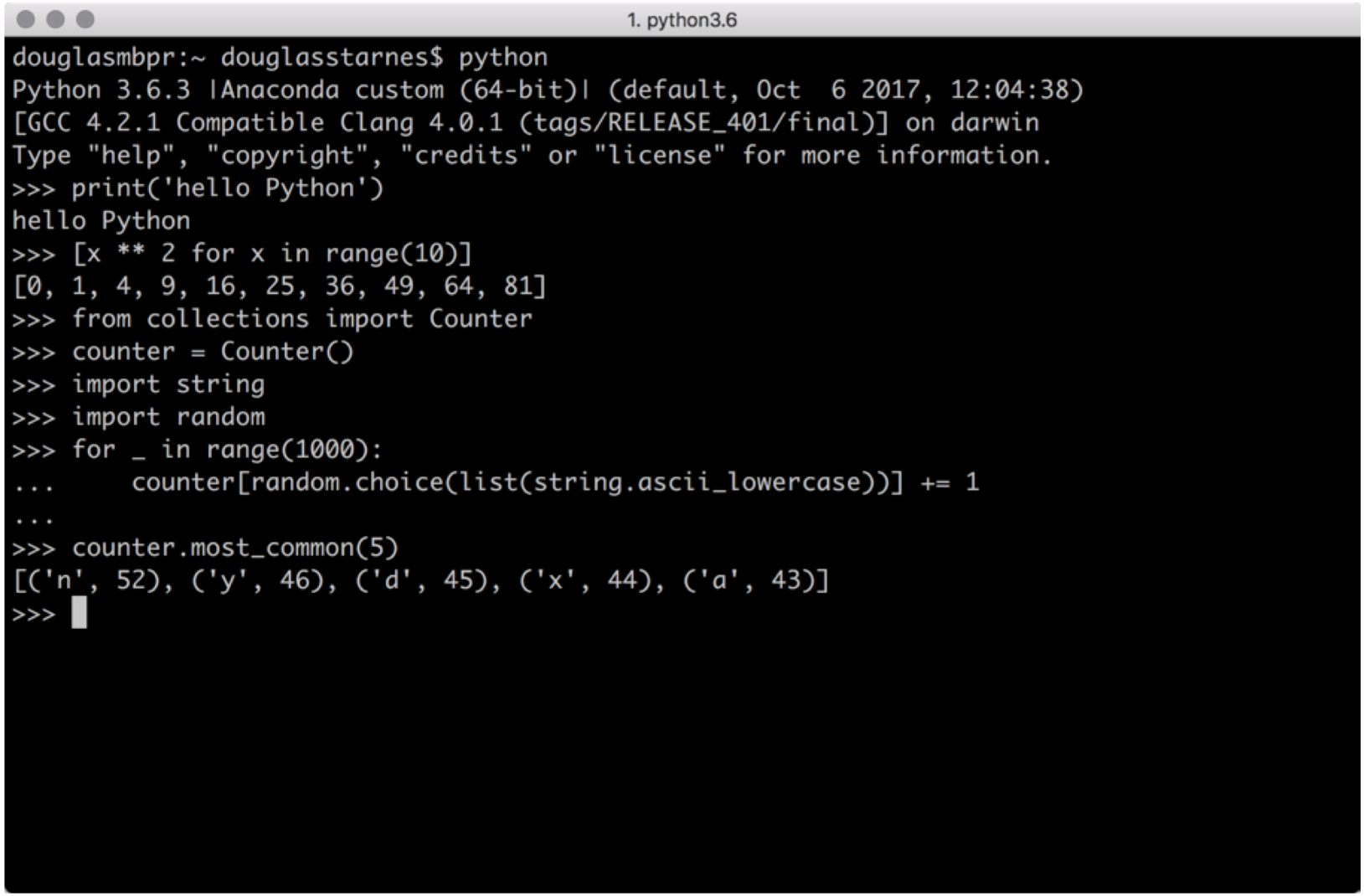
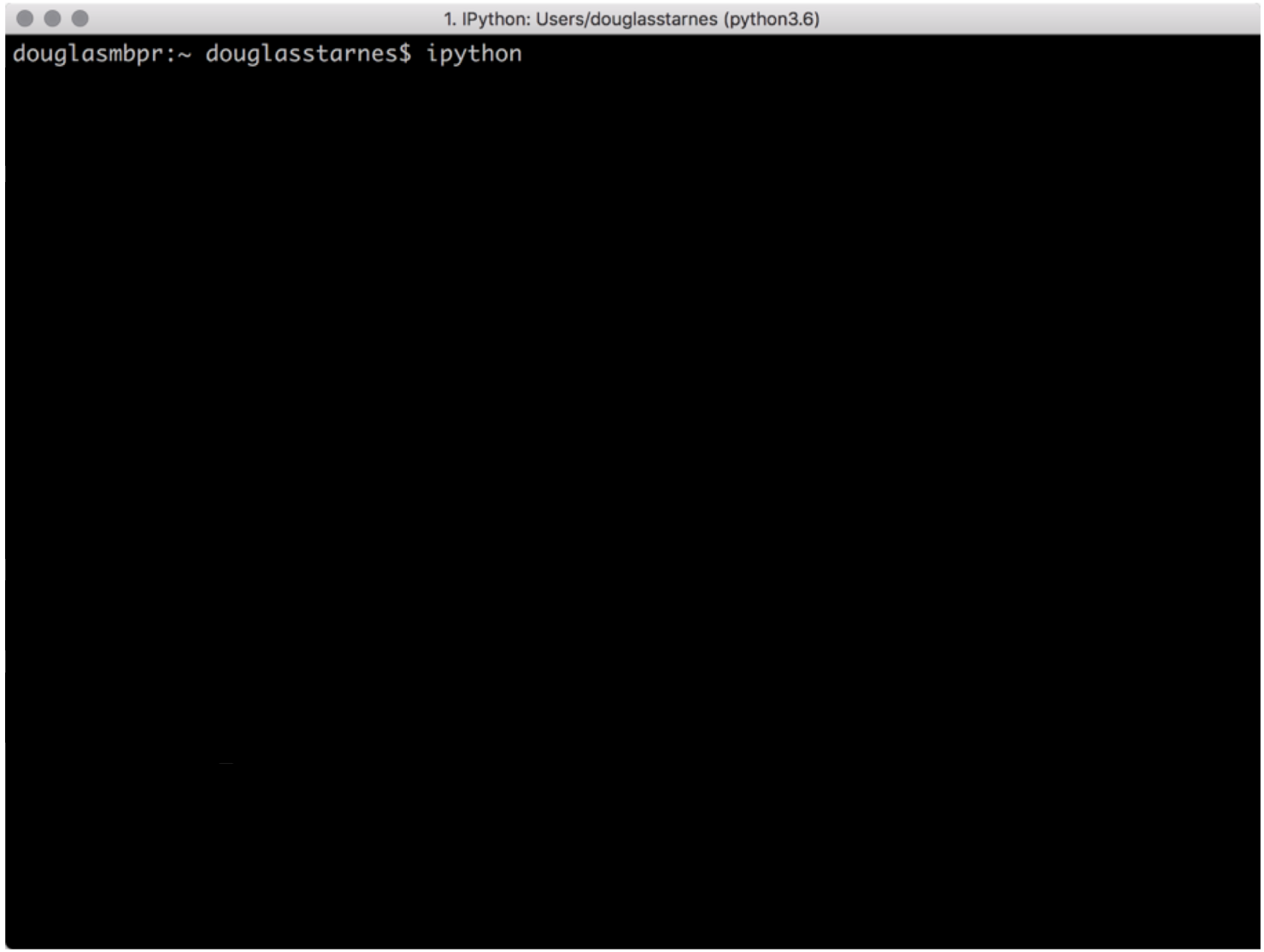
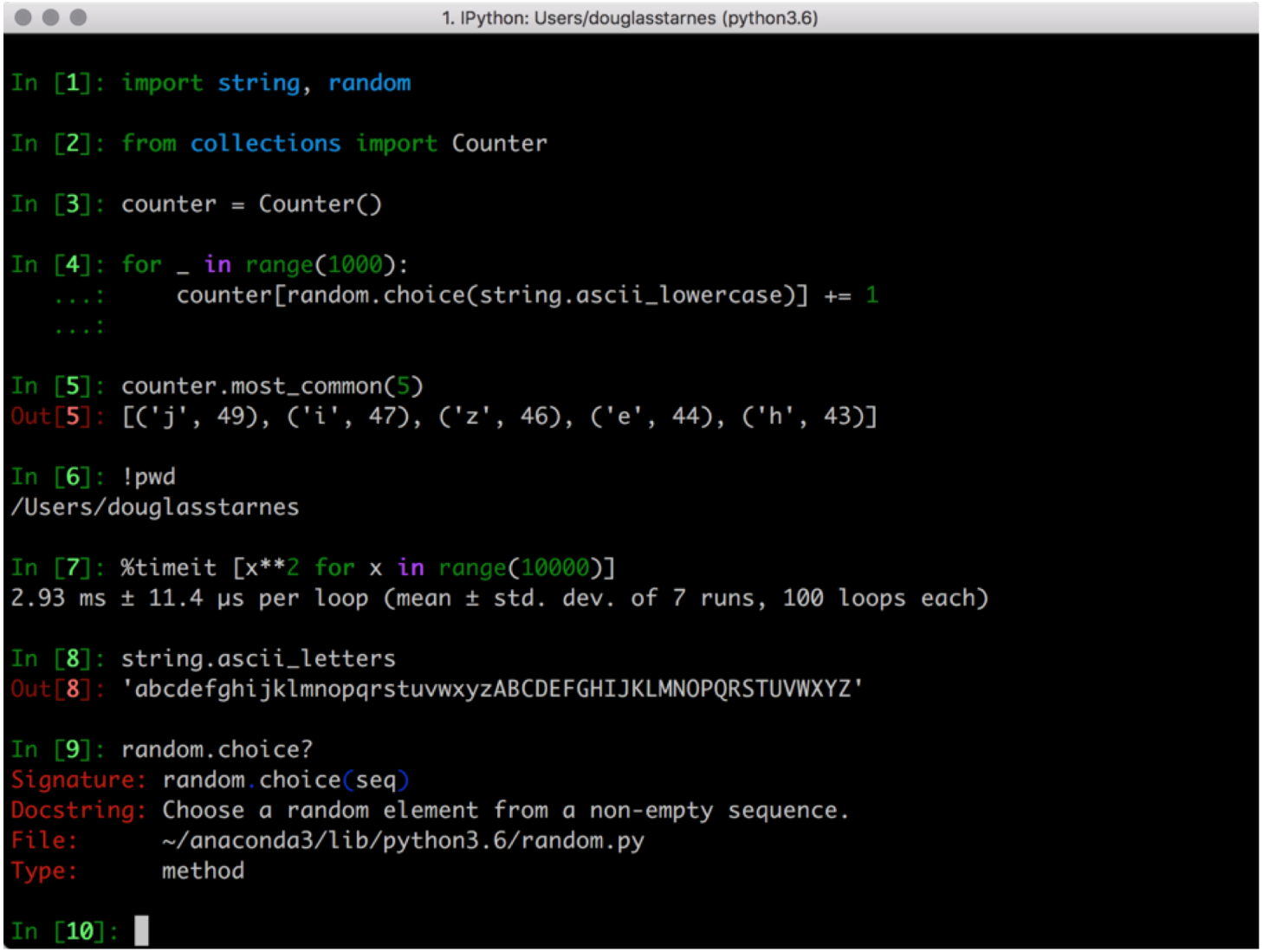
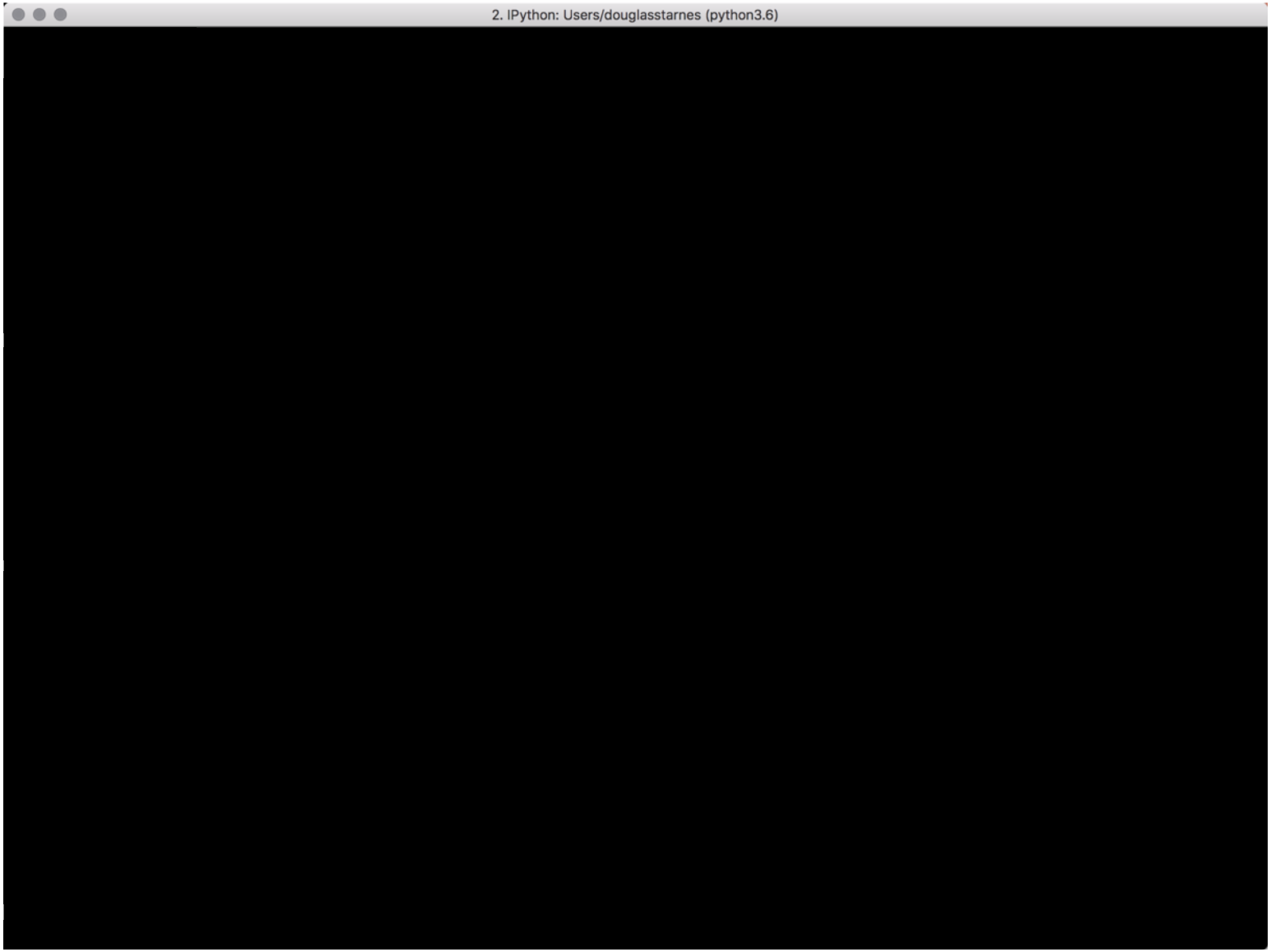
Project Jupyter exists to develop open-source software, open-standards, and services for interactive computing across dozens of programming languages.

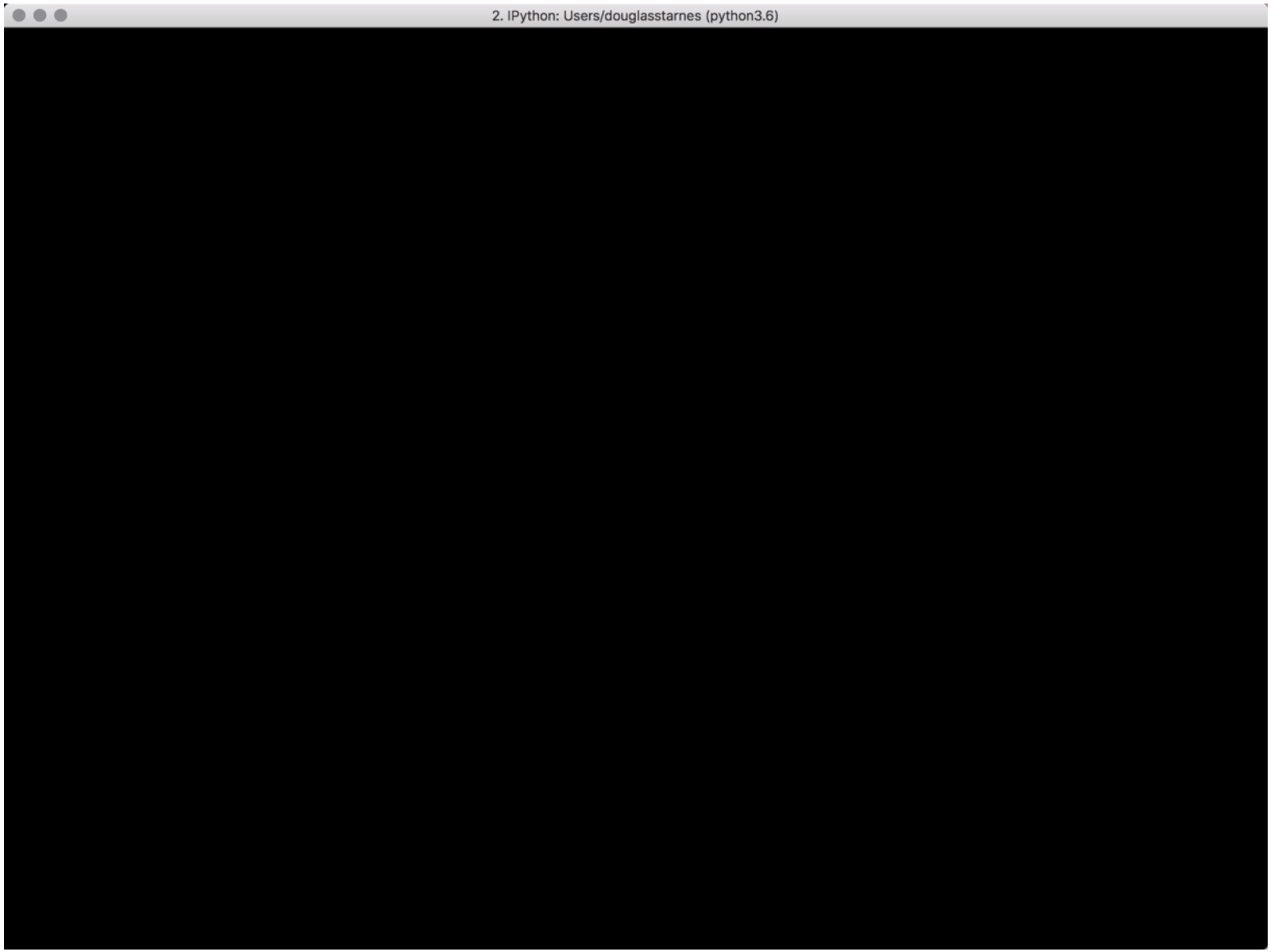
Jupyter notebook


1. python3.6
douglasmbpr:~ douglasstarnes$ python
Python 3.6.3 |Anaconda custom (64-bit)| (default, Oct 6 2017, 12:04:38)
[GCC 4.2.1 Compatible Clang 4.0.1 (tags/RELEASE_401/final)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print('hello Python')
hello Python
>>> [x ** 2 for x in range(10)]
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
>>> from collections import Counter
>>> counter = Counter()
>>> import string
>>> import random
>>> for _ in range(1000):
...   counter[random.choice(list(string.ascii_lowercase))] += 1
...
>>> counter.most_common(5)
[('n', 52), ('y', 46), ('d', 45), ('x', 44), ('a', 43)]
>>>


1. IPython: Users/douglasstarnes (python3.6)
douglasmbpr:~ douglasstarnes$ ipython


1. IPython: Users/douglasstarnes (python3.6)
In [1]: import string, random
In [2]: from collections import Counter
In [3]: counter = Counter()
In [4]: for _ in range(1000):
...: counter[random.choice(string.ascii_lowercase)] += 1
...:
In [5]: counter.most_common(5)
Out[5]: [('j', 49), ('i', 47), ('z', 46), ('e', 44), ('h', 43)]
In [6]: !pwd
/Users/douglasstarnes
In [7]: %timeit [x**2 for x in range(10000)]
2.93 ms ± 11.4 µs per loop (mean ± std. dev. of 7 runs, 100 loops each)
In [8]: string.ascii_letters
Out[8]: 'abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ'
In [9]: random.choice?
Signature: random.choice(seq)
Docstring: Choose a random element from a non-empty sequence.
File: ~/anaconda3/lib/python3.6/random.py
Type: method
In [10]:


2. IPython: Users/douglasstarnes (python3.6)


2. IPython: Users/douglasstarnes (python3.6)

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Run | Code | Enter/Exit RISE Slideshow

The Final Product

This is the complete dashboard.

- Set the endpoints of the slider to the date range
- Check the box to show volume as well as closing price
- Select the stock symbol in the dropdown box

In [33]:

```
date_slider = widgets.SelectionRangeSlider(options=list(stock_dict['AA'].date),
    index=(0, 24),
    description='Dates',
    layout=widgets.Layout(width='500px'))
show_vol2 = widgets.Checkbox(description='Show Volume')
dd_select3 = widgets.Dropdown(options=sorted(list(stock_dict.keys())))
button = widgets.Button(description='Show Graph')

def button_click(b):
    stock_row = stock_dict[dd_select3.value]
    start_index = date_slider.index[0]
    end_index = date_slider.index[1]
    stock_row = stock_row[start_index:(end_index+1)]

    y = stock_row.close
    x = list(range(len(y)))

    plt.xticks(np.arange(len(x)), stock_row.date, rotation='vertical')

    if show_vol2.value == False:
        plt.plot(x, y, color='k')
    else:
        y2 = stock_row.volume
        plt.bar(x, y2, color='#cccccc')
        ax2 = plt.twinx()
        ax2.plot(x, y, color='k')

button.on_click(button_click)

display(date_slider)
display(show_vol2)
display(dd_select3)
display(button)
```

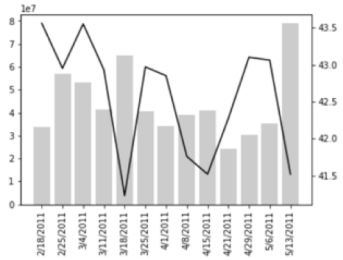
Syntax highlighting
Automatic indentation

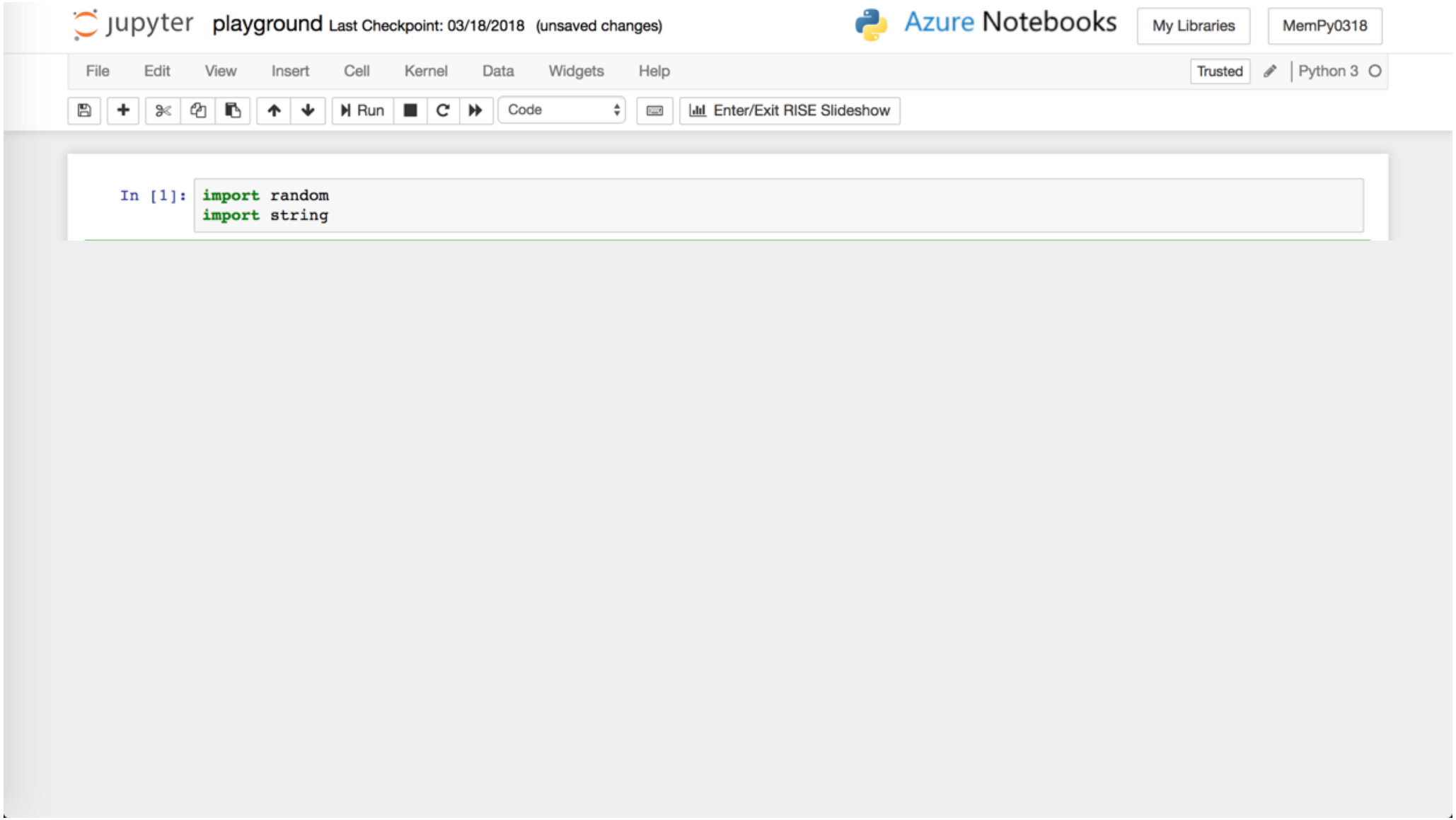
Dates 2/18/2011-5/13/2011

Show Volume

DIS

Show Graph

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My Libraries
MemPy0318
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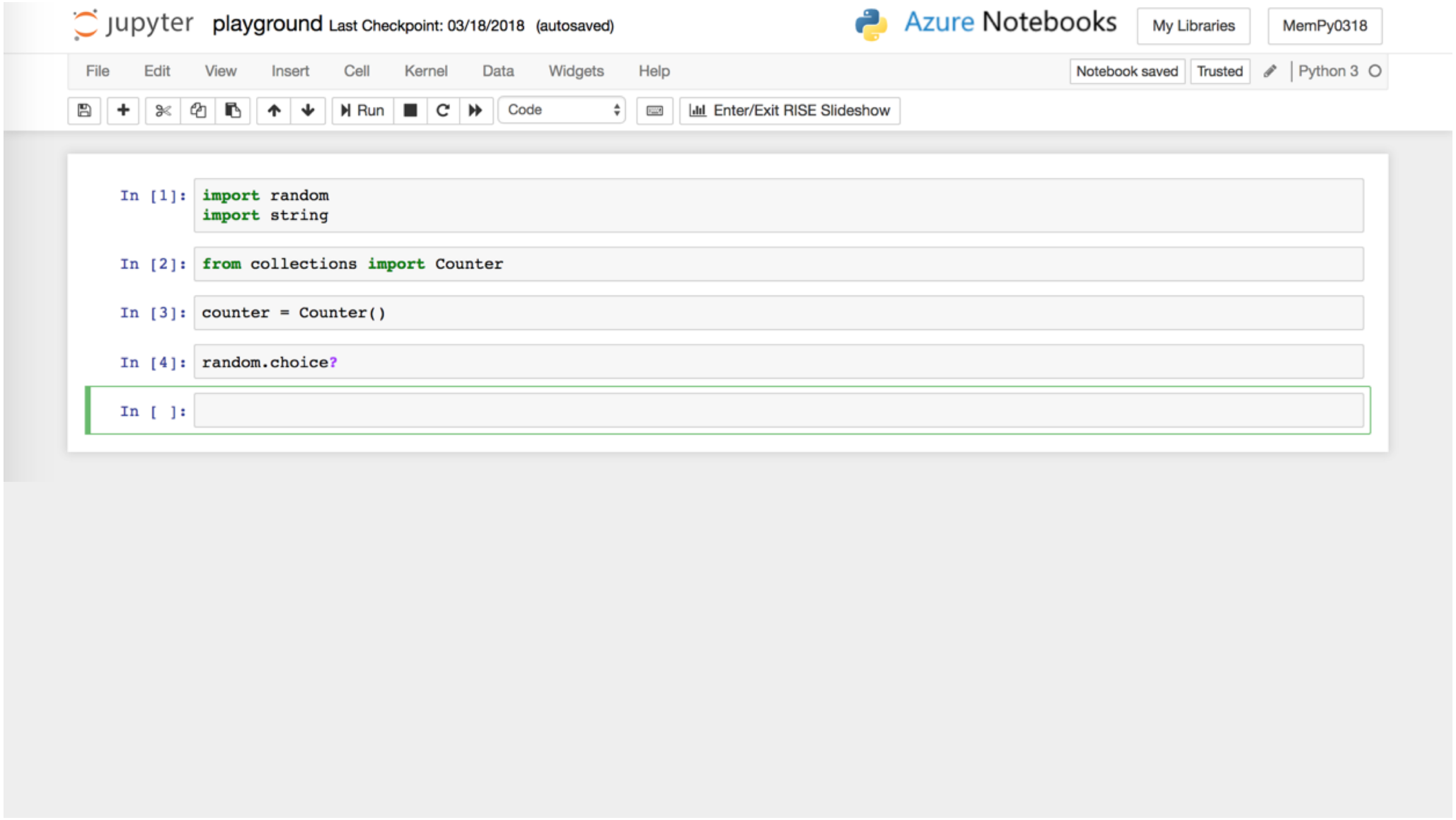
Trusted
Python 3
Run
Code
Enter/Exit RISE Slideshow
In [1]:
import random
import string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File Edit View Insert Cell Kernel Data Widgets Help
Notebook saved
Trusted
Python 3
Run
Code
Enter/Exit RISE Slideshow
In [1]:
import random
import string
In [2]:
from collections import Counter
In [3]:
counter = Counter()
In [4]:
random.choice?
In [ ]:

jupyter playground Last Checkpoint: 03/18/2018 (unsaved changes)

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File Edit View Insert Cell Kernel Data Widgets Help Trusted Python 3

Run Code Enter/Exit RISE Slideshow

In [1]:
```
import random
import string
```

In [2]:
```
from collections import Counter
```

In [3]:
```
counter = Counter()
```

In [4]:
```
random.choice?
```

In [5]:
```
for _ in range(1000):
    counter[random.choice(string.ascii_lowercase)] += 1
```

In [6]:
```
ordered_keys = [i[0] for i in counter.most_common(10)]
ordered_values = [i[1] for i in counter.most_common(10)]
```

In [ ]:

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    stock_row = stock_dict[dd_select3.value]
    start_index = date_slider.index[0]
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    stock_row = stock_row[start_index:(end_index+1)]

    y = stock_row.close
    x = list(range(len(y)))

    plt.xticks(np.arange(len(x)), stock_row.date, rotation='vertical')

    if show_vol2.value == False:
        plt.plot(x, y, color='k')
    else:
        y2 = stock_row.volume
        plt.bar(x, y2, color='#cccccc')
        ax2 = plt.twinx()
        ax2.plot(x, y, color='k')

button.on_click(button_click)

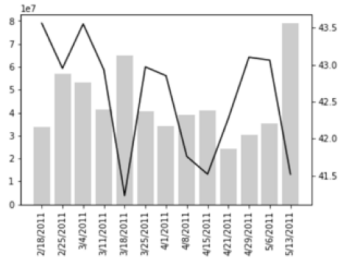
display(date_slider)
display(show_vol2)
display(dd_select3)
display(button)
```

Dates 2/18/2011-5/13/2011

Show Volume

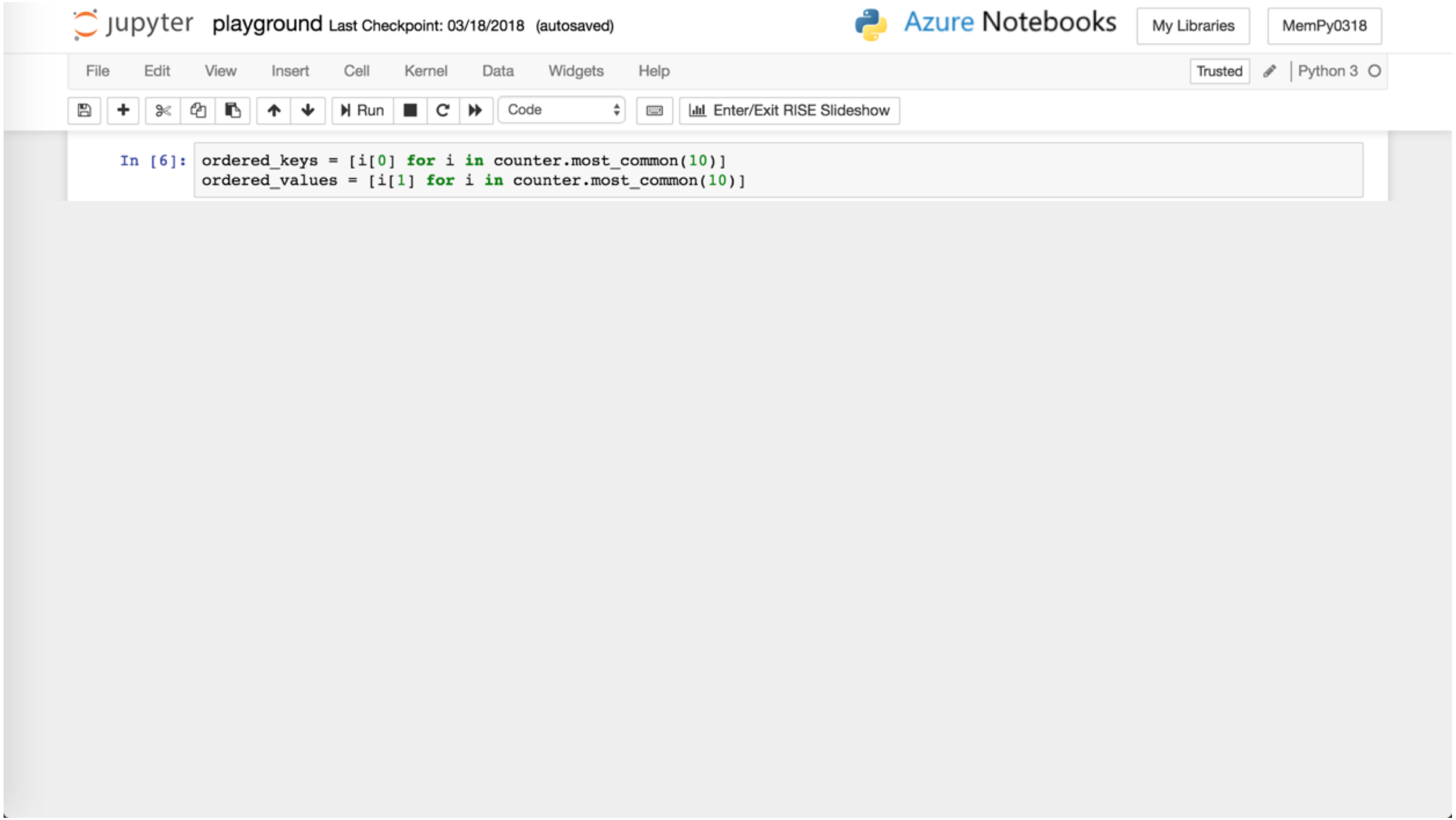
DIS

Show Graph



Syntax highlighting
Automatic indentation

Visualization
(matplotlib)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File Edit View Insert Cell Kernel Data Widgets Help
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In [6]:
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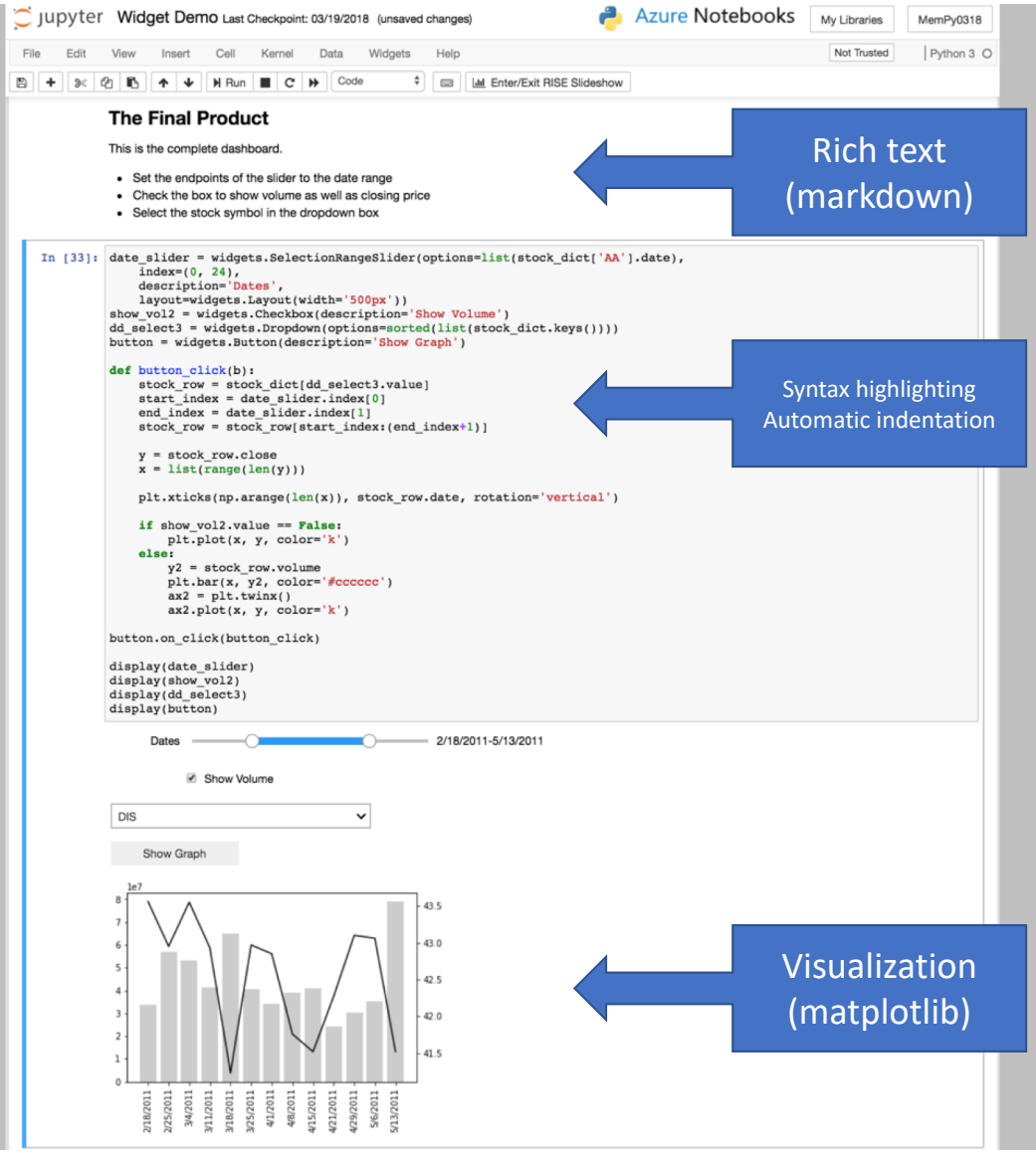
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Dates
2/18/2011-5/13/2011
Show Volume
DIS
Show Graph
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2/18/2011
2/25/2011
3/4/2011
3/11/2011
3/18/2011
3/25/2011
4/1/2011
4/8/2011
4/15/2011
4/21/2011
4/29/2011
5/6/2011
5/13/2011
Rich text (markdown)
Syntax highlighting
Automatic indentation
Visualization (matplotlib)

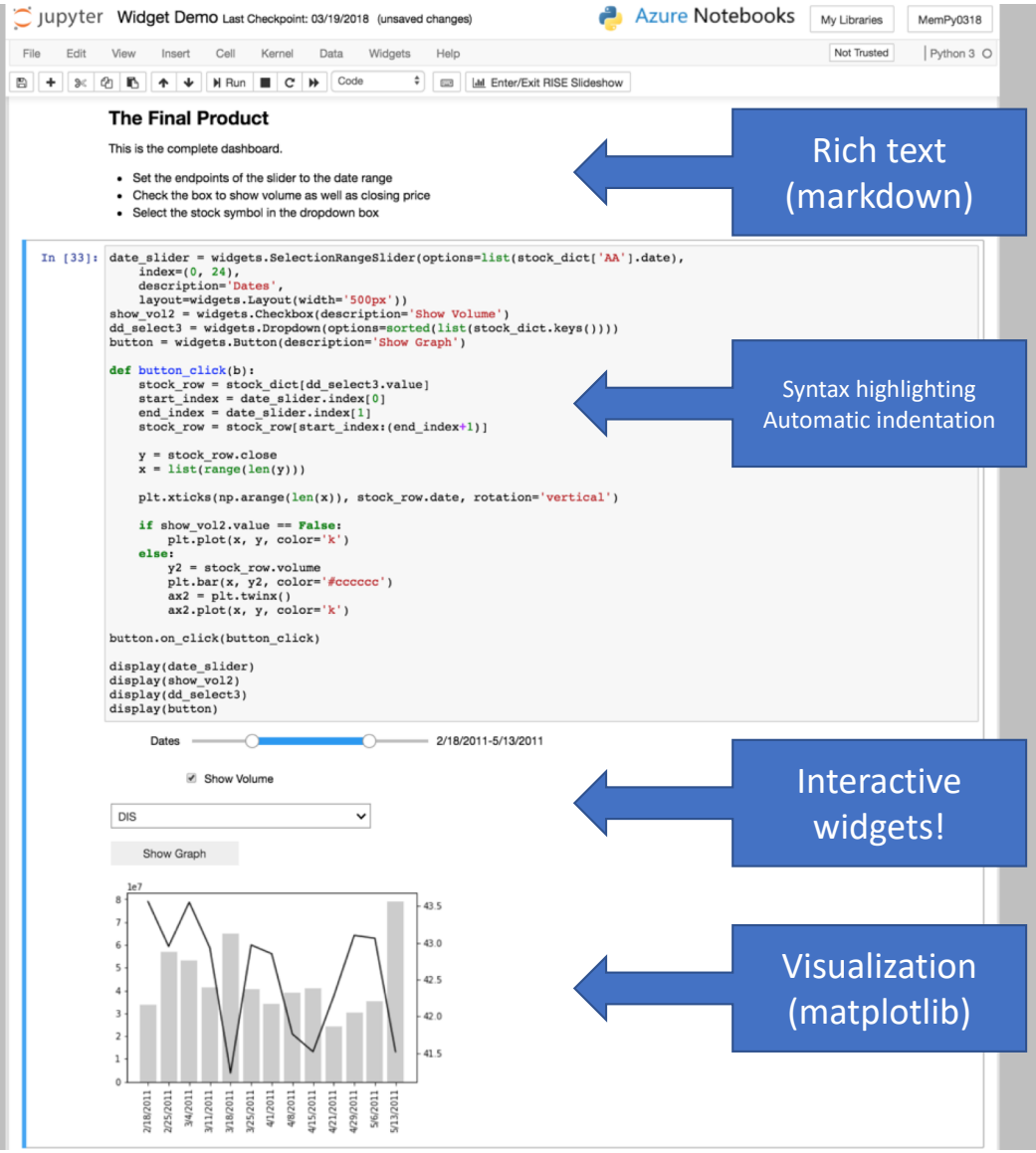
```
## Heading 2
**Bold**
*Italic*

1. Ordered
2. List
3. Items

#### And

* Unordered
* List
* Items

#### And
*  *Formatted*
*  **List**
* Items
```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Dates
2/18/2011-5/13/2011
Show Volume
DIS
Show Graph
1e7
2/18/2011
2/25/2011
3/4/2011
3/11/2011
3/18/2011
3/25/2011
4/1/2011
4/8/2011
4/15/2011
4/21/2011
4/29/2011
5/6/2011
5/13/2011
Rich text (markdown)
Syntax highlighting
Automatic indentation
Interactive widgets!
Visualization (matplotlib)

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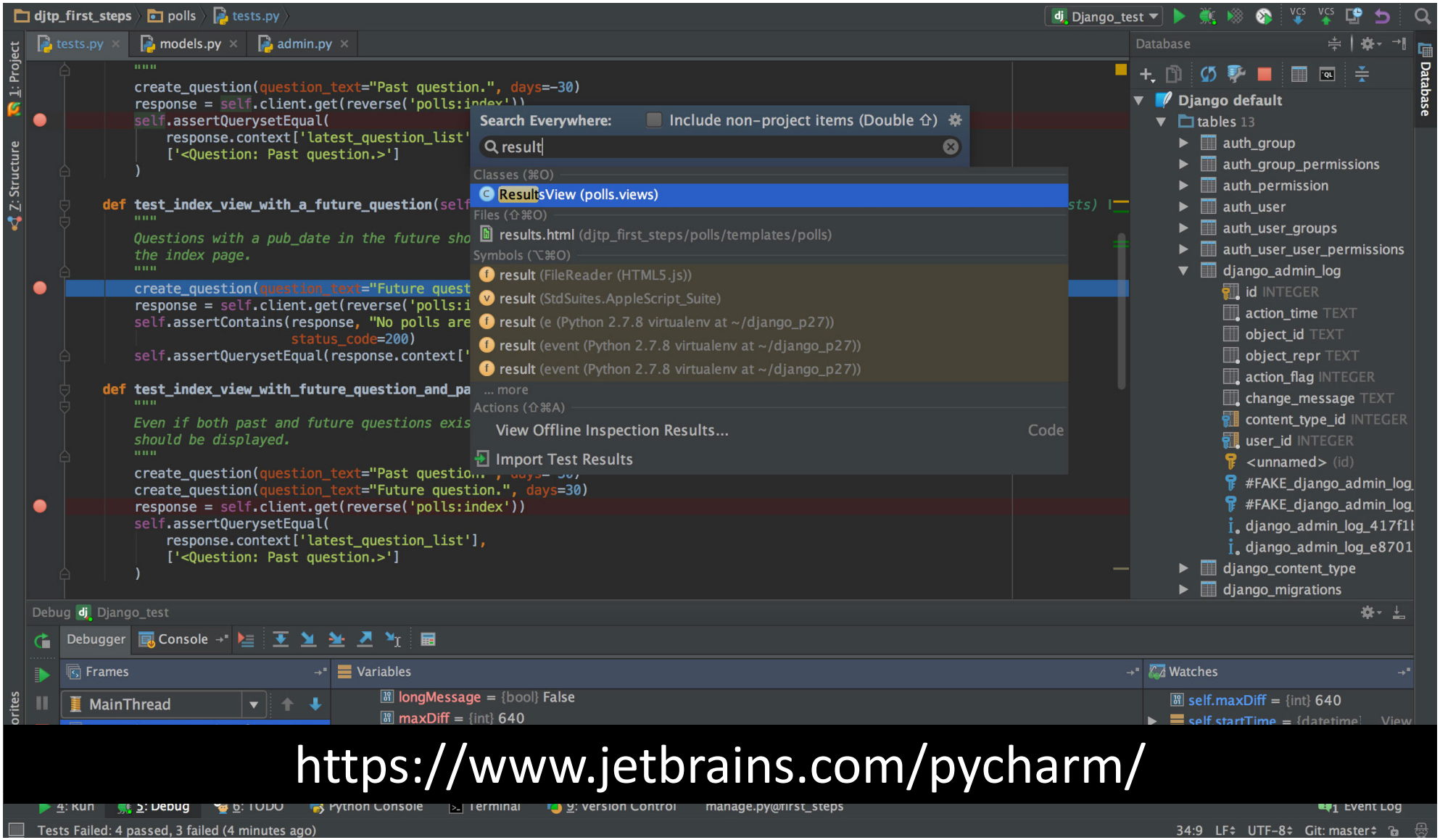
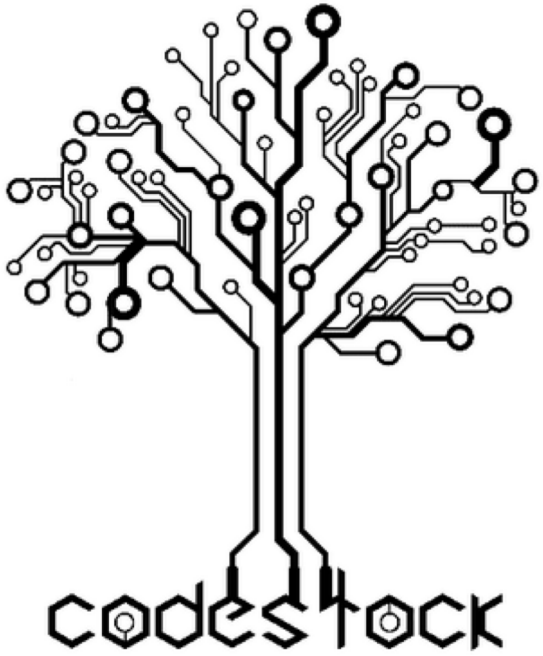


https://www.jetbrains.com/pycharm/

I want to thank the organizers, sponsors, staff and volunteers of CodeStock 2018.



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Thank You!

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douglas@douglasstarnes.com

http://douglasstarnes.com

https://github.com/douglasstarnes/codestock2018