Python Tutorial: Python for Data Science

By Fahad Kamran

Overview

- Introduction
- Variables and Types
- Operators
- Containers
- Functions
- Control Flow
- Packages
  - Numpy
  - Pandas
  - Matplotlib

Overview

- **Introduction**
- Variables and Types
- Operators
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- Control Flow
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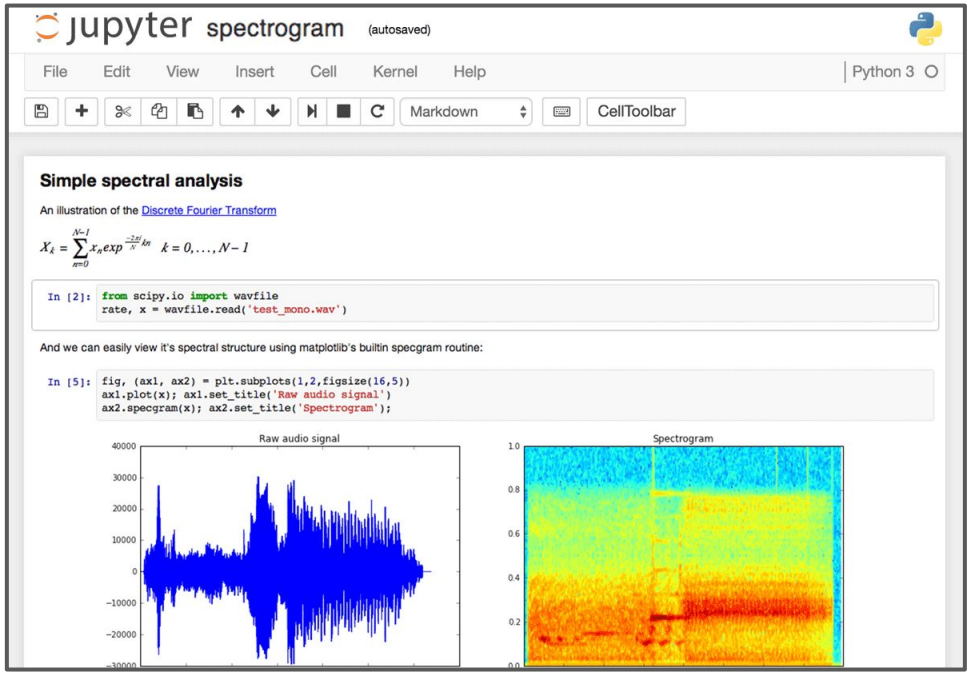
  - Pandas
  - Matplotlib

- Easy to learn.
- Elegant syntax.
- Lots of scientific computing resources.
- Very user friendly.

Jupyter Notebook




```
print("Hello World")
```

Hello World

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Variables

- Put data in memory, and give it a name.
- Created using the assignment operator =

```
x = 3
print(x)
```
3

```
x = 3 + 3
print(x)
```
6

Variables

`x = 3` **Int:** Integers

`pi = 3.14` **Float:** Real numbers

`day = "Monday"` **String:** Characters, *different* than a variable.

`is_monday = True` **Boolean:** `True/False`.

`# Objects.` **Comment:** Notes for programmers, doesn't get executed.

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Operators

- Symbols that carry out computation.
- PEMDAS

```
x = 15
y = 4
print(x + y)   # Addition.
19

print(y - x)   # Subtraction.
-11

print(y * x)   # Multiplication.
60
```

Operators

```
x = 15
y = 4

print(x / y)  # Division.
3.75

print(x // y)  # Floor Division.
3

print(x % y)  # Modulus (remainder).
3

print(y ** y)  # Exponent.
256
```

Operators

```
x = 15
y = 4

print(x == y)  # Equality.
```
False

```
print(x > y)  # Greater than.
```
True

```
print(x <= y)  # Less than or Equal.
```
False

```
print(x != y)  # Not Equal.
```
True

Operators

```
print(True and True)
True

print(True and False)
False

print(True or False)
True

print(False or False)
False
```

Operators

```
w = “Hello “
x = “World!”
y = 1
z = 1.1

print(w + x)
Hello World!

print(y + z)
2.1

print(w + y)
Error!
```

Operators

Arithmetic Operators

```
+
-
*
/
//
%
**
```

Logical Operators

```
==
>
>=
!=
<
<=
and
or
not
```

Logical operators are evaluated after arithmetic.

Demo

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Class/Object

- Combine data and *behaviors* related to the class' data.
- Making our own is out of the scope of this course.
- We will use them!

List

- Series of values.

```
a = [] # Empty list.

b = [1, 2, 3, 4, 5]  # List containing 5 elements.
```

List

- Series of values.

```
a = [] # Empty list.

b = [1, 2, 3, 4, 5]  # List containing 5 elements.

b[0]  # Zero-indexed!
1
```

List

- Series of values.

```
a = [] # Empty list.

b = [1, 2, 3, 4, 5]  # List containing 5 elements.

b[0]  # Zero-indexed!
1

b[3]
4
```

List

```
        0    1    2    3    4     # Index.
b = [1, 2, 3, 4, 5]
```

- We can get parts of the list with the **slice** operator **:**
- Optionally, define a range of indices, *excludes last element*.

```
b[:1]
```
[1]

```
b[1:3]
```
[2, 3]

List

- Access class **methods** using the **dot** operator .

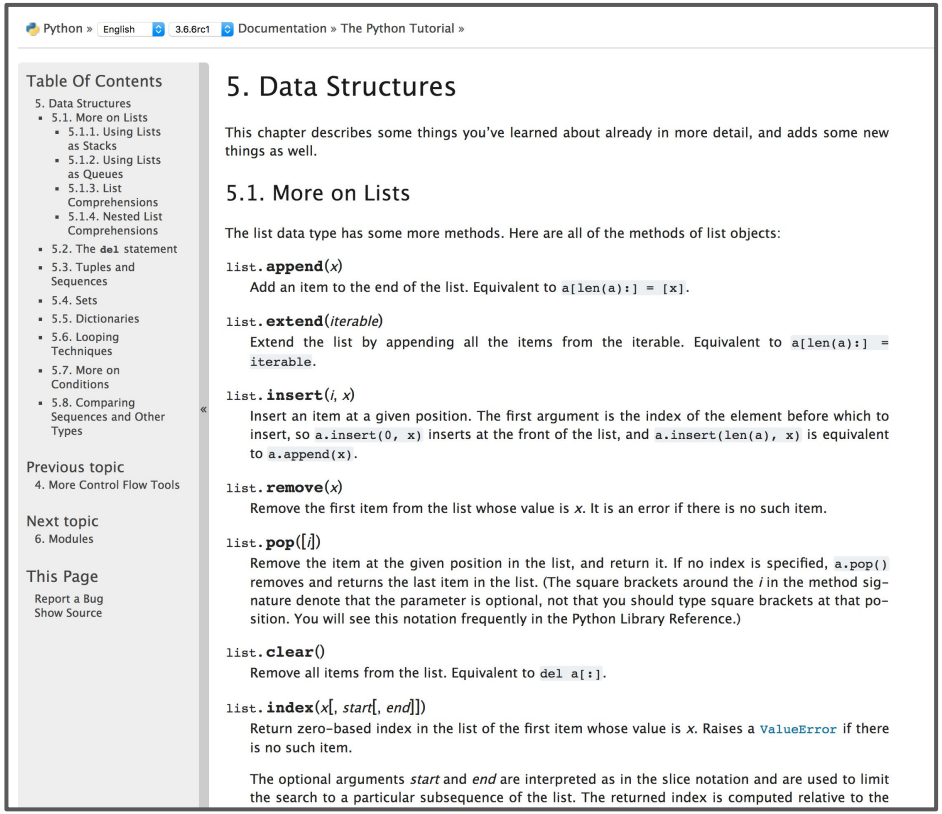
```
x = [1]
print(x)
[1]

x.append(2)  # Add element to end of list.
[1, 2]

x.pop()  # Get last element in list and remove from list.
2
print(x)
[1]
```

List

- Reassign parts of a list

```
x = [1]
print(x)
[1]
x[0] = 'new element!'
print(x)
['new element!']
```

docs.python.org/3/tutorial/datastructures.html



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5. Data Structures

This chapter describes some things you've learned about already in more detail, and adds some new things as well.

5.1. More on Lists

The list data type has some more methods. Here are all of the methods of list objects:

`list.`**`append`**(*x*)
Add an item to the end of the list. Equivalent to `a[len(a):] = [x]`.

`list.`**`extend`**(*iterable*)
Extend the list by appending all the items from the iterable. Equivalent to `a[len(a):] = iterable`.

`list.`**`insert`**(*i*, *x*)
Insert an item at a given position. The first argument is the index of the element before which to insert, so `a.insert(0, x)` inserts at the front of the list, and `a.insert(len(a), x)` is equivalent to `a.append(x)`.

`list.`**`remove`**(*x*)
Remove the first item from the list whose value is *x*. It is an error if there is no such item.

`list.`**`pop`**([*i*])
Remove the item at the given position in the list, and return it. If no index is specified, `a.pop()` removes and returns the last item in the list. (The square brackets around the *i* in the method signature denote that the parameter is optional, not that you should type square brackets at that position. You will see this notation frequently in the Python Library Reference.)

`list.`**`clear`**()
Remove all items from the list. Equivalent to `del a[:]`.

`list.`**`index`**(*x*[, *start*[, *end*]])
Return zero-based index in the list of the first item whose value is *x*. Raises a `ValueError` if there is no such item.

The optional arguments *start* and *end* are interpreted as in the slice notation and are used to limit the search to a particular subsequence of the list. The returned index is computed relative to the

Dictionary / Map

- List of key-value pairs.
- Lists but access elements with anything!

```
a = {}  # Empty dict.


a[“key”] = “value”

print(a)
{“key”: “value”}
```

Dictionary / Map

```
person = {
    “name”: “Jim”,
    “family_name”: “Harbaugh”
}

person[“name”]
Jim

person[“age”] = 55

print(person)
{“name”: “Jim”, “family_name”: “Harbaugh”, “age”: 55}
```

Other Containers

Containers not covered include:

- Sets
- Tuples
- Generators

Creating Copies

- What does an assignment statement do?

```
x = [1,2,3]
y = x  # Make a copy of x.
y[2] = 100  # Reassign part of y.
print(x)
```

Creating Copies

- What does an assignment statement do?

```
x = [1,2,3]
y = x  # Make a copy of x.
y[2] = 100  # Reassign part of y.
print(x)
[1, 2, 100]
```

Creating Copies

- What does an assignment statement do?

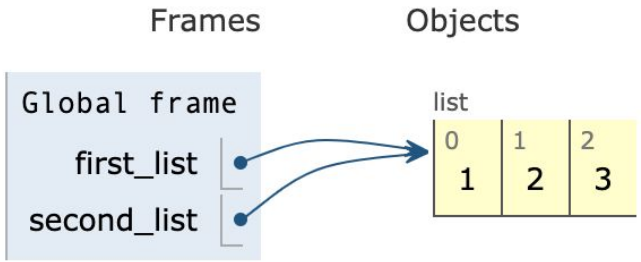
```
x = [1,2,3]
y = x  # Make a copy of x.
y[2] = 100  # Reassign part of y.
print(x)
[1, 2, 100]
```

Changing `y` still changes `x`

Creating Copies

- What does an assignment statement do?

```
x = [1,2,3]
y = x  # Make a copy of x.
y[2] = 100  # Reassign part of y.
print(x)
[1, 2, 100]
```



Changing `y` still changes `x`

Creating Copies

- Fixing the assignment issue

```
x = [1,2,3]
y = x[:]  # Make a new copy of x.
y[2] = 100  # Reassign part of y.
print(x)
```

Creating Copies

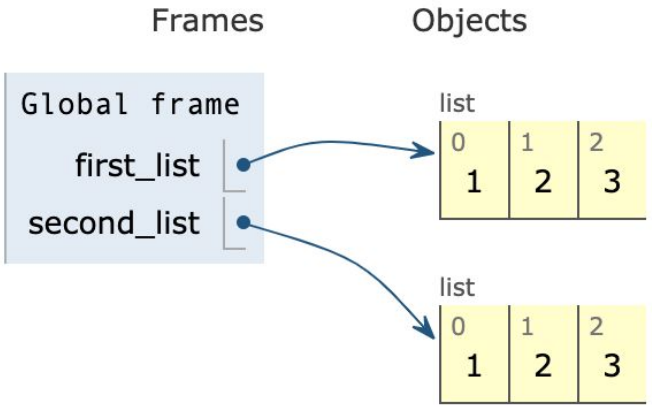
- Fixing the assignment issue

```
x = [1,2,3]
y = x[:]  # Make a new copy of x.
y[2] = 100  # Reassign part of y.
print(x)
[1, 2, 3]
```

Creating Copies

- Fixing the assignment issue

```
x = [1,2,3]
y = x[:]  # Make a new copy of x.
y[2] = 100  # Reassign part of y.
print(x)
[1, 2, 3]
```



Exercise #1

- What are the outputs of each line of code?

```
fib = [“hello”, “hi”, “hey”, “hola”, “heyo”, “sup”, “howdy”]

fib[1:5]
# Q1.

fib[3:]
# Q2.

fib[:3]
# Q3.
```

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Functions

- Group related code that performs a task.
- Reusable blocks of code.
- Take in *arguments*.

Functions

```
n_hours = 181 // 60
n_minutes = 181 % 60
print(n_hours)
print(n_minutes)

n_hours = 72 // 60
n_minutes = 72 % 60

n_hours = 451 // 60
n_minutes = 451 % 60
print(n_hours)
print(n_minutes)
```

```
print(n_hours)
print(n_minutes)
```

Functions

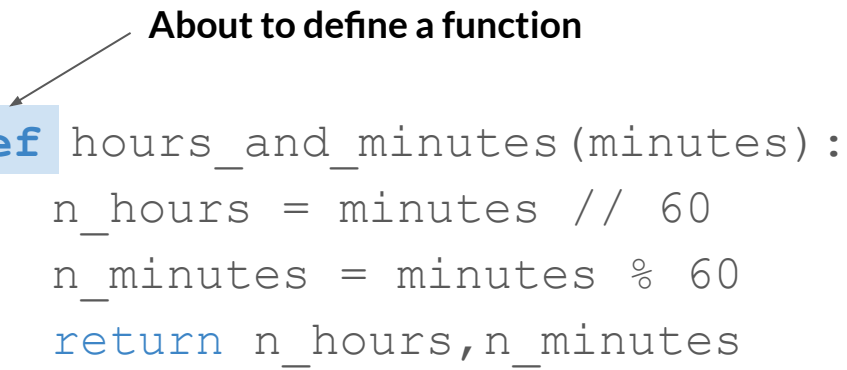
```
n_hours = 181 // 60
n_minutes = 181 % 60
print(n_hours)
print(n_minutes)

n_hours = 72 // 60
n_minutes = 72 % 60
print(n_hours)
print(n_minutes)

n_hours = 451 // 60
n_minutes = 451 % 60
print(n_hours)
print(n_minutes)
```

Functions

```
n_hours = 181 // 60
n_minutes = 181 % 60
print(n_hours)
print(n_minutes)

n_hours = 72 // 60
n_minutes = 72 % 60
print(n_hours)
print(n_minutes)

n_hours = 451 // 60
n_minutes = 451 % 60
print(n_hours)
print(n_minutes)
```

```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes

print(hours_and_minutes(181))
print(hours_and_minutes(72))
print(hours_and_minutes(451))
```

Functions


About to define a function
def hours_and_minutes(minutes):
n_hours = minutes // 60
n_minutes = minutes % 60
return n_hours,n_minutes

Functions


```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes
```

Functions


```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes
```

Functions

```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes
```

Code the function performs.

Whitespace/tabs matter!

Define scope

Functions

```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes

n_hours = 10
ret_hours,ret_minutes = hours_and_minutes(81)
print(n_hours)
```

Functions

```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    return n_hours,n_minutes

n_hours = 10
ret_hours,ret_minutes = hours_and_minutes(81)
print(n_hours)
```

10

Functions

```
def hours_and_minutes(minutes):
    n_hours = minutes // 60
    n_minutes = minutes % 60
    print(n_hours,n_minutes)

ret_hours,ret_minutes = hours_and_minutes(81)
1,21
print(ret_hours)
None
ret_hours + 1
Error
```

Exercise #2

```
def fahrenheit_to_celsius(f):
  # Converts from °F to °C.
  # Where: °C = (°F - 32) * 5/9


  # Your code here.


  return c


farhenheit_to_celsius(98.6)
37.0
```

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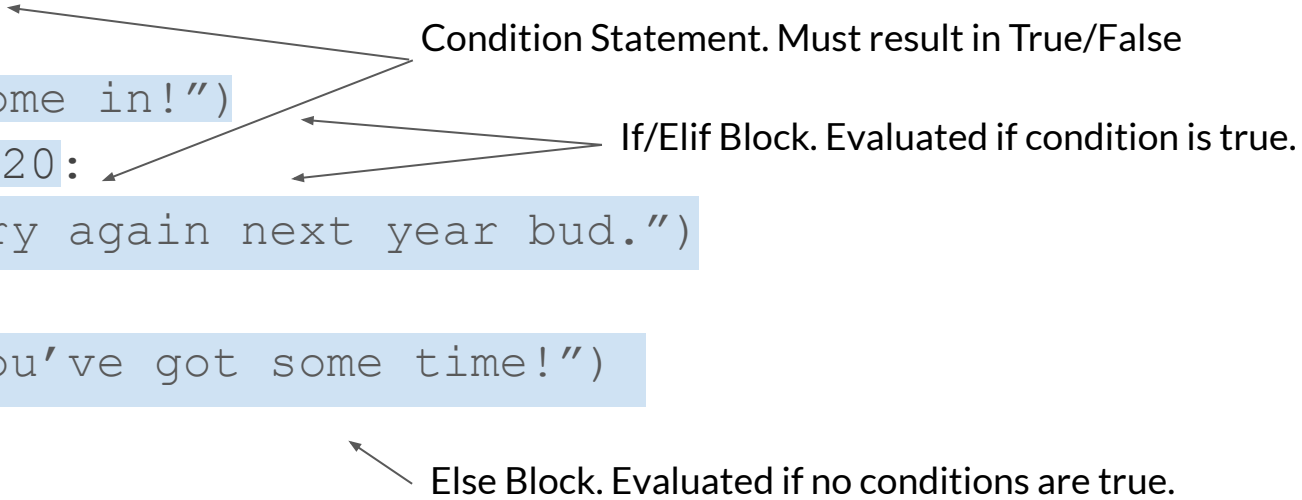
If

- Only execute a block of code if a **condition** is True.

```
if age > 21:
    print("Come in!")
elif age == 20:
    print("Try again next year bud.")
else:
    print("You've got some time!")
```



COLONS

For-Loop

- Perform operations using item(s) in a container.
- *Cannot modify items.*

```
container = [1, 2, 3]
```

For-Loop

- Perform operations using item(s) in a container.
- *Cannot modify items.*

```
container = [1, 2, 3]

for x in container:
    print(x)
```

```
1
2
3
```

For-Loop

`range(n)` function creates container of size *n*

useful for repeating an action *n* times

```
for x in range(5):
    print('Hello world!')
```

```
Hello world!
Hello world!
Hello world!
Hello world!
Hello world!
```

List Comprehensions

```
lst = [1,2,3,4,5]
squared_lst = []
for num in lst:
    squared_lst.append(num**2)
squared_list
[1,4,9,16,25]
```

List Comprehensions

```
lst = [1,2,3,4,5]
squared_lst = []
for num in lst:
    squared_lst.append(num**2)
squared_list
[1,4,9,16,25]
```

s

```
quared_lst2 = [num**2 for num in lst]
squared_list
[1,4,9,16,25]
```

List Comprehensions

```
lst = [1,2,3,4,5]
squared_even_lst = []
for num in lst:
    if num % 2 == 0:
        squared_even_lst.append(num**2)
squared_even_lst
[4,16]
```

```
squared_even_lst2 = [num**2 for num in lst if num % 2 == 0]
squared_even_lst2
[4,16]
```

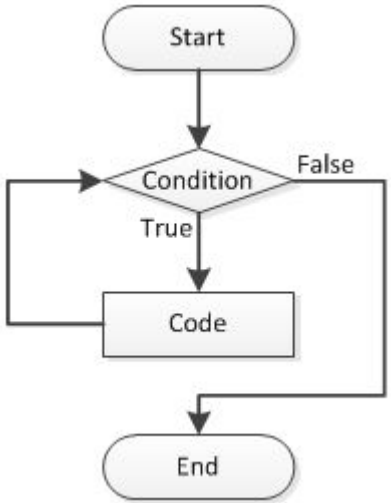
While-Loop

- Perform operations until condition is met.

```
i = 0

while i < 3:
    print(i)
    i += 1
```

0
1
2



Exercise #3

Please sort the following data, into **two new lists:** one for words and the other numbers.

```
data = [“michigan”, 1, “stats”, 3.33, “hello”]

# Your code here.
```

At the end we’ll have two lists one containing “michigan”, “stats”, and “hello”; the other list containing 1, 3.33.

Exercise #4

Define a function `only_odd`, which takes in a dictionary, and returns a new dictionary with the key:value pairs where the value is an odd number

```
dct = {“Janice”: 3, “Fred”: 2, “Gregg”: 8, “Gloria”: 1}

# Your code here.

only_odd(dct)
{“Janice”: 3, “Gloria”: 1}
```

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Module

- Collect variables, functions, classes into a **module**.
  - Sometimes called: library or package.

Module

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```
import math
```

Module

- Collect variables, functions, classes into a **module**.
  - Sometimes called: library or package.

```
import math
math.sqrt(16)
```

```
4
```

Module

- Collect variables, functions, classes into a **module**.
  - Sometimes called: library or package.

```
import math
math.sqrt(16)
```

```
4
```

```
from math import sqrt
sqrt(16)
```

```
4
```

NumPy

- Tensor/matrix operation library.
- Lists, but more dimensions, and faster.
- **NOTE:** Normally you would need to install this library.

```
import numpy as np
x = np.array([1, 2, 3])
```

NumPy

- Tensor/matrix operation library.
- Lists, but more dimensions, and faster.
- **NOTE:** Normally you would need to install this library.

```
import numpy as np
x = np.array([1, 2, 3])

np.dot([1, 2], [1, 2])  # Dot Product.
4
```

NumPy Array with Operators

```
x = np.array([1, 2, 3])

x + 1
[2, 3, 4]

x + x
[2, 4, 6]

x ** 2
[2, 4, 9]
```

NumPy Array with Operators

```
x = np.array([1, 2, 3])

x > 1
[False, True, True]

x == 1
[True, False, False]
```

NumPy Statistics

```
np.sum([[0, 1], [2, 3]])
```

```
6
```

```
np.sum([[0, 1], [2, 3]], axis=1)
```

```
[1, 5]
```

```
np.max([[0, 1], [2, 3]])
```

```
3
```

```
np.max([[0, 1], [2, 3]], axis=0)
```

```
[2, 3]
```

NumPy Statistics

```
np.sum([[0, 1], [2, 3]])
6

np.sum([[0, 1], [2, 3]], axis=1)
[1, 5]

np.max([[0, 1], [2, 3]])
3

np.max([[0, 1], [2, 3]], axis=0)
[2, 3]
```

https://docs.scipy.org/doc/numpy-1.13.0/reference/routines.statistics.html

Creating Sequences in NumPy

```
np.arange(3)
```

```
[0, 1, 2]
```

```
np.arange(0, 4, 2)  # (start, stop, step).
```

```
[0, 2]
```

Creating Arrays in NumPy

```
np.zeros(5)
arr([0, 0, 0, 0, 0])

np.ones(5)*3
arr([3, 3, 3, 3, 3])

np.random.random((2,2))
arr([[.810, .081],[.687, .541]])
```

Array Indexing

```
a = np.array([[1,2,3,4],[5,6,7,8],[9,10,11,12]])
a[0,0]
1

a[1,:]
arr([5, 6, 7, 8])

a[1:,2:]
arr([[7, 8], [11, 12]])
```

Array Indexing

```
a = np.array([[1,2,3,4],[5,6,7,8],[9,10,11,12]])
a[0,0] = 4
a[1] = [4,8,9,1]
print(a)
```

arr([[4,2,3,4],[4,8,9,1],[9,10,11,12]])

Array Indexing

```
a = np.array([[1,2,3,4],[5,6,7,8],[9,10,11,12]])
b = a[:2,1:3]
print(b)
```

arr([[2, 3], [6, 7]])

```
b[0,0] = 1
print(a)
```

arr([[1,1,3,4],[5,6,7,8],[9,10,11,12]])

Array Indexing

```
a = np.array([[1,2,3,4],[5,6,7,8],[9,10,11,12]])
b = np.array(a[:2,1:3])
print(b)
arr([[2, 3], [6, 7]])

b[0,0] = 1
print(a)
arr([[1,2,3,4],[5,6,7,8],[9,10,11,12]])
```

Demo

Pandas

- Database package.
- Import data from:
  - Excel (csv, tsv, etc.)
  - Stata, sas, matlab
  - SQL,
  - Etc.

```
import pandas as pd
```

Pandas

- This will be a high-level summary of the package.
- We'll look at stuff that you can follow along with our data.

Pandas

```
[24] s = pd.Series([1, 3, 4, np.nan, 6, 8])
     print(s)
```

```
0    1.0
1    3.0
2    4.0
3    NaN
4    6.0
5    8.0
dtype: float64
```

Pandas

```
In [8]: df = pd.DataFrame(np.random.randn(6,4), index=dates, columns=list('ABCD'))

In [9]: df
Out[9]:
                   A         B         C         D
2013-01-01  0.469112 -0.282863 -1.509059 -1.135632
2013-01-02  1.212112 -0.173215  0.119209 -1.044236
2013-01-03 -0.861849 -2.104569 -0.494929  1.071804
2013-01-04  0.721555 -0.706771 -1.039575  0.271860
2013-01-05 -0.424972  0.567020  0.276232 -1.087401
2013-01-06 -0.673690  0.113648 -1.478427  0.524988
```

Pandas

```
In [10]: df2 = pd.DataFrame({ 'A' : 1.,
    ....:                     'B' : pd.Timestamp('20130102'),
    ....:                     'C' : pd.Series(1,index=list(range(4)),dtype='float32'),
    ....:                     'D' : np.array([3] * 4,dtype='int32'),
    ....:                     'E' : pd.Categorical(["test","train","test","train"]),
    ....:                     'F' : 'foo' })
    ....:

In [11]: df2
Out[11]:
     A          B    C  D      E    F
0  1.0 2013-01-02  1.0  3   test  foo
1  1.0 2013-01-02  1.0  3  train  foo
2  1.0 2013-01-02  1.0  3   test  foo
3  1.0 2013-01-02  1.0  3  train  foo
```

Pandas

```
[27] df2.columns
```

```
Index(['A', 'B', 'C', 'D', 'E', 'F'], dtype='object')
```

Pandas

```
In [14]: df.head()
Out[14]:
                   A         B         C         D
2013-01-01  0.469112 -0.282863 -1.509059 -1.135632
2013-01-02  1.212112 -0.173215  0.119209 -1.044236
2013-01-03 -0.861849 -2.104569 -0.494929  1.071804
2013-01-04  0.721555 -0.706771 -1.039575  0.271860
2013-01-05 -0.424972  0.567020  0.276232 -1.087401

In [15]: df.tail(3)
Out[15]:
                   A         B         C         D
2013-01-04  0.721555 -0.706771 -1.039575  0.271860
2013-01-05 -0.424972  0.567020  0.276232 -1.087401
2013-01-06 -0.673690  0.113648 -1.478427  0.524988
```

Pandas

```
In [19]: df.describe()
Out[19]:
                A         B         C         D
count   6.000000  6.000000  6.000000  6.000000
mean    0.073711 -0.431125 -0.687758 -0.233103
std     0.843157  0.922818  0.779887  0.973118
min    -0.861849 -2.104569 -1.509059 -1.135632
25%    -0.611510 -0.600794 -1.368714 -1.076610
50%     0.022070 -0.228039 -0.767252 -0.386188
75%     0.658444  0.041933 -0.034326  0.461706
max     1.212112  0.567020  0.276232  1.071804
```

Pandas

```
In [22]: df.sort_values(by='B')
Out[22]:
                   A         B         C         D
2013-01-03 -0.861849 -2.104569 -0.494929  1.071804
2013-01-04  0.721555 -0.706771 -1.039575  0.271860
2013-01-01  0.469112 -0.282863 -1.509059 -1.135632
2013-01-02  1.212112 -0.173215  0.119209 -1.044236
2013-01-06 -0.673690  0.113648 -1.478427  0.524988
2013-01-05 -0.424972  0.567020  0.276232 -1.087401
```

Pandas

```
In [23]: df['A']
Out[23]:
2013-01-01    0.469112
2013-01-02    1.212112
2013-01-03   -0.861849
2013-01-04    0.721555
2013-01-05   -0.424972
2013-01-06   -0.673690
Freq: D, Name: A, dtype: float64
```

Pandas

```
In [24]: df[0:3]
Out[24]:
                   A         B         C         D
2013-01-01  0.469112 -0.282863 -1.509059 -1.135632
2013-01-02  1.212112 -0.173215  0.119209 -1.044236
2013-01-03 -0.861849 -2.104569 -0.494929  1.071804
```

Pandas

```
In [39]: df[df.A > 0]
Out[39]:
                   A         B         C         D
2013-01-01  0.469112 -0.282863 -1.509059 -1.135632
2013-01-02  1.212112 -0.173215  0.119209 -1.044236
2013-01-04  0.721555 -0.706771 -1.039575  0.271860
```

```
In [51]: df
Out[51]:
                   A         B         C  D    F
2013-01-01  0.000000  0.000000 -1.509059  5  NaN
2013-01-02  1.212112 -0.173215  0.119209  5  1.0
2013-01-03 -0.861849 -2.104569 -0.494929  5  2.0
2013-01-04  0.721555 -0.706771 -1.039575  5  3.0
2013-01-05 -0.424972  0.567020  0.276232  5  4.0
2013-01-06 -0.673690  0.113648 -1.478427  5  5.0
```

```
In [51]: df
Out[51]:
                   A         B         C  D    F
2013-01-01  0.000000  0.000000 -1.509059  5  NaN
2013-01-02  1.212112 -0.173215  0.119209  5  1.0
2013-01-03 -0.861849 -2.104569 -0.494929  5  2.0
2013-01-04  0.721555 -0.706771 -1.039575  5  3.0
2013-01-05 -0.424972  0.567020  0.276232  5  4.0
2013-01-06 -0.673690  0.113648 -1.478427  5  5.0
```

```
In [52]: df2 = df.copy()

In [53]: df2[df2 > 0] = -df2

In [54]: df2
Out[54]:
                   A         B         C  D    F
2013-01-01  0.000000  0.000000 -1.509059 -5  NaN
2013-01-02 -1.212112 -0.173215 -0.119209 -5 -1.0
2013-01-03 -0.861849 -2.104569 -0.494929 -5 -2.0
2013-01-04 -0.721555 -0.706771 -1.039575 -5 -3.0
2013-01-05 -0.424972 -0.567020 -0.276232 -5 -4.0
2013-01-06 -0.673690 -0.113648 -1.478427 -5 -5.0
```

Useful Functions

```
df.values #converts a pandas table to a 2D numpy array

df.iloc[[0,2], [1,3]] #returns rows 1-2, columns 1-3 of df

df.loc[df['A'] > 4] #returns rows where A is greater than 4
```

Pandas

https://pandas.pydata.org/pandas-docs/stable/getting_started/10min.html

```
import pandas as pd
dataset = pd.read_csv("nbaallelo.csv")
dataset.describe()
```

	gameorder	game_id	lg_id	_iscopy	year_id	date_game	seasongame	is_playoffs	team_id	fran_id	...	win_equiv	opp_id	opp_fran	opp_pts	opp_elo_i	opp_elo_n	game_loc
1	1	194611010TRH	NBA	1	1947	11/1/1946	1	0	NYK	Knicks	...	41.705170	TRH	Huskies	66	1300.0000	1293.2767	
3	2	194611020CHS	NBA	1	1947	11/2/1946	2	0	NYK	Knicks	...	40.692783	CHS	Stags	63	1300.0000	1309.6521	
5	3	194611020DTF	NBA	1	1947	11/2/1946	1	0	WSC	Capitols	...	43.135952	DTF	Falcons	33	1300.0000	1279.6189	
6	4	194611020PRO	NBA	1	1947	11/2/1946	1	0	BOS	Celtics	...	40.459381	PRO	Steamrollers	59	1300.0000	1305.1542	
8	5	194611020STB	NBA	1	1947	11/2/1946	1	0	PIT	Ironmen	...	40.507980	STB	Bombers	56	1300.0000	1304.6908	
10	6	194611030CLR	NBA	1	1947	11/3/1946	2	0	TRH	Huskies	...	39.548164	CLR	Rebels	71	1300.0000	1307.1233	
13	7	194611040PIT	NBA	1	1947	11/4/1946	2	0	WSC	Capitols	...	44.946995	PIT	Ironmen	56	1295.3092	1277.9456	
15	8	194611050BOS	NBA	1	1947	11/5/1946	2	0	CHS	Stags	...	42.686188	BOS	Celtics	55	1294.8458	1288.4139	
16	9	194611050DTF	NBA	1	1947	11/5/1946	2	0	STB	Bombers	...	42.347137	DTF	Falcons	49	1279.6189	1271.4624	
18	10	194611070GSW	NBA	1	1947	11/7/1946	3	0	PIT	Ironmen	...	38.201401	PHW	Warriors	81	1300.0000	1304.6670	
21	11	194611070PRO	NBA	1	1947	11/7/1946	3	0	CHS	Stags	...	42.020947	PRO	Steamrollers	73	1305.1542	1311.5032	
23	12	194611070STB	NBA	1	1947	11/7/1946	3	0	NYK	Knicks	...	41.767715	STB	Bombers	63	1312.8473	1302.5988	
25	13	194611080TRH	NBA	1	1947	11/8/1946	3	0	DTF	Falcons	...	37.697380	TRH	Huskies	73	1286.1534	1289.1691	
26	14	194611090CHS	NBA	1	1947	11/9/1946	4	0	TRH	Huskies	...	39.286152	CHS	Stags	62	1309.7350	1315.2522	
28	15	194611090DTF	NBA	1	1947	11/9/1946	3	0	BOS	Celtics	...	38.410091	DTF	Falcons	69	1268.4468	1281.5840	
31	16	194611090PRO	NBA	1	1947	11/9/1946	4	0	PIT	Ironmen	...	37.595333	PRO	Steamrollers	76	1311.5032	1317.3143	
33	17	194611090STB	NBA	1	1947	11/9/1946	3	0	WSC	Capitols	...	44.621101	STB	Bombers	70	1302.5988	1305.7323	
35	18	194611100CLR	NBA	1	1947	11/10/1946	4	0	WSC	Capitols	...	43.162102	CLR	Rebels	92	1307.1233	1321.1034	
36	19	194611110NYK	NBA	1	1947	11/11/1946	5	0	CHS	Stags	...	44.073521	NYK	Knicks	68	1307.3197	1293.2161	
39	20	194611110PIT	NBA	1	1947	11/11/1946	4	0	PRO	Steamrollers	...	41.757576	PIT	Ironmen	84	1267.4674	1277.5587	
40	21	194611130CHS	NBA	1	1947	11/13/1946	4	0	BOS	Celtics	...	37.847424	CHS	Stags	71	1329.3558	1334.7465	

Matplotlib

- Package for plotting data.

```
import matplotlib.pyplot as plt
```

Matplotlib

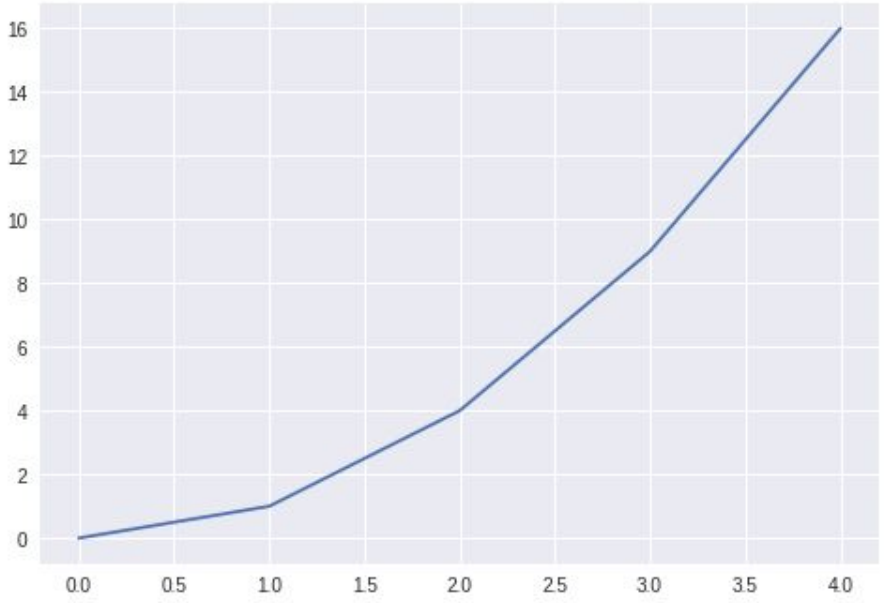
- Package for plotting data.

- Collection of functions that make changes to a figure.
- The package keeps track of the current figure,
- Therefore changes are all to the same figure.

Matplotlib

- Package for plotting data.

```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y)
```



Matplotlib

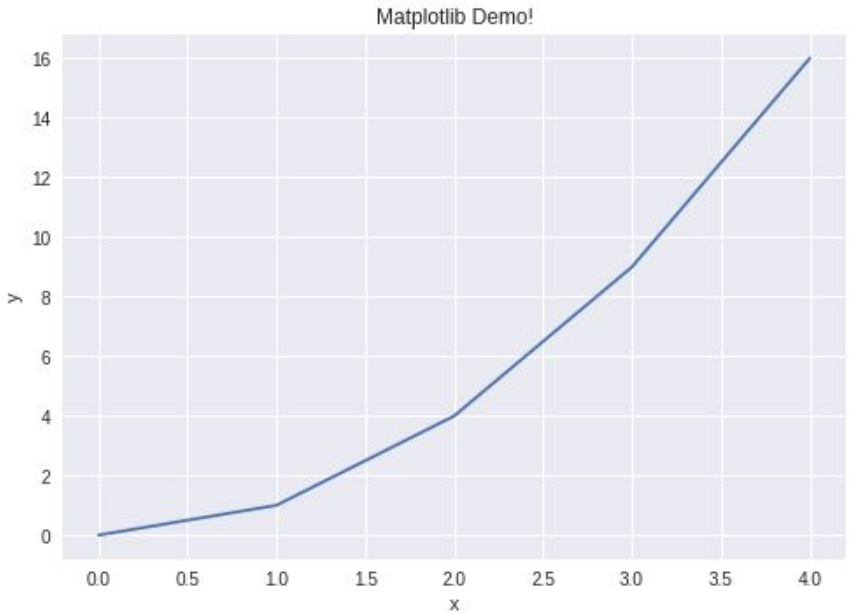
- Package for plotting data.

```
import matplotlib.pylab as plt

plt.figure()  # Let's start plotting on a new figure.
```

Matplotlib

- Package for plotting data.

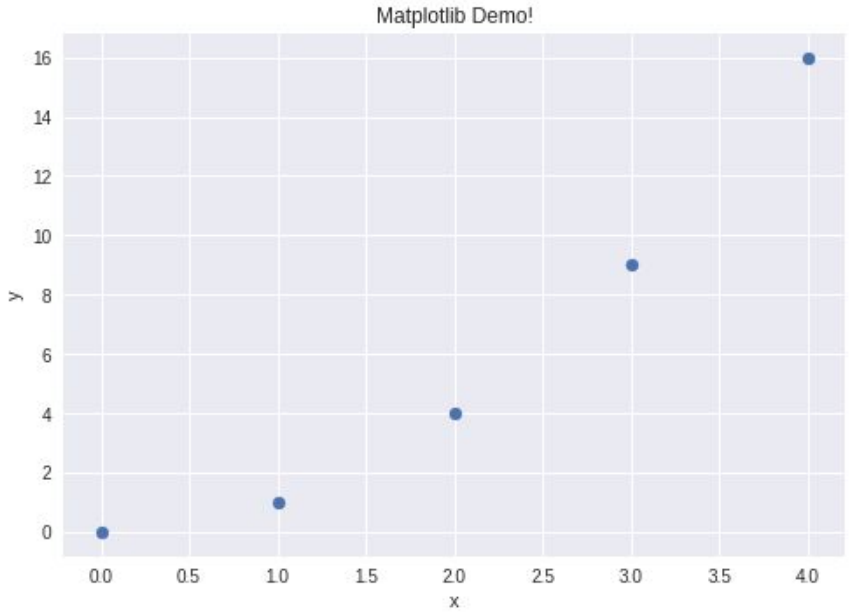
```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y)

plt.xlabel("x")
plt.ylabel("y")
plt.title("Matplotlib Demo!")
```



Matplotlib

- Package for plotting data.

```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.scatter(x, y)

plt.xlabel("x")
plt.ylabel("y")
plt.title("Matplotlib Demo!")
```



Matplotlib

- For most functions that plot data,
- They accept a **format string** after the data.

```
plt.plot(x, y, “b-”)
```

Matplotlib

- For most functions that plot data,
- They accept a **format string** after the data.

```
plt.plot(x, y, “b-”)
```

- “b-” is the default.
- The pattern of the string is:
  - Color (b: blue),
  - Pattern (-: straight line).

Matplotlib

```
plt.plot(x, y, “b-”)
```

character	color
`'b'`	blue
`'g'`	green
`'r'`	red
`'c'`	cyan
`'m'`	magenta
`'y'`	yellow
`'k'`	black
`'w'`	white

Matplotlib

```
plt.plot(x, y, "b-")
```

character	color
'b'	blue
'g'	green
'r'	red
'c'	cyan
'm'	magenta
'y'	yellow
'k'	black
'w'	white

character	description
'-'	solid line style
'--'	dashed line style
'-.'	dash-dot line style
':'	dotted line style

Markers

character	description
'.'	point marker
','	pixel marker
'o'	circle marker
'v'	triangle_down marker
'^'	triangle_up marker
'<'	triangle_left marker
'>'	triangle_right marker
'1'	tri_down marker
'2'	tri_up marker

Colors

- The world is more diverse than a Crayola 8-pack.

Colors

- **HTML Color Codes:** method for describing colors used in websites.
- Specify how much of each primary color to use in mixed color (R, G, B).

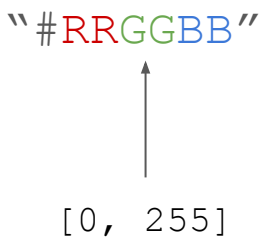
Colors

- **HTML Color Codes:** method for describing colors used in websites.
- Specify how much of each primary color to use in mixed color (R, G, B).
- *Slang*: hex, hex-code.

"#RRGGBB"

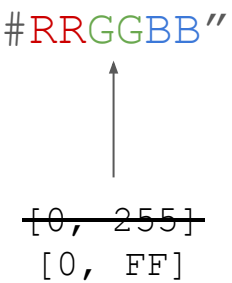
Colors

- **HTML Color Codes:** method for describing colors used in websites.
- Specify how much of each primary color to use in mixed color (R, G, B).
- *Slang*: hex, hex-code.



Colors

- **HTML Color Codes:** method for describing colors used in websites.
- Specify how much of each primary color to use in mixed color (R, G, B).
- *Slang*: hex, hex-code.



Decimal number	Hexadecimal number
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F

HTML Color Codes
HTMLCOLORCODES.COM

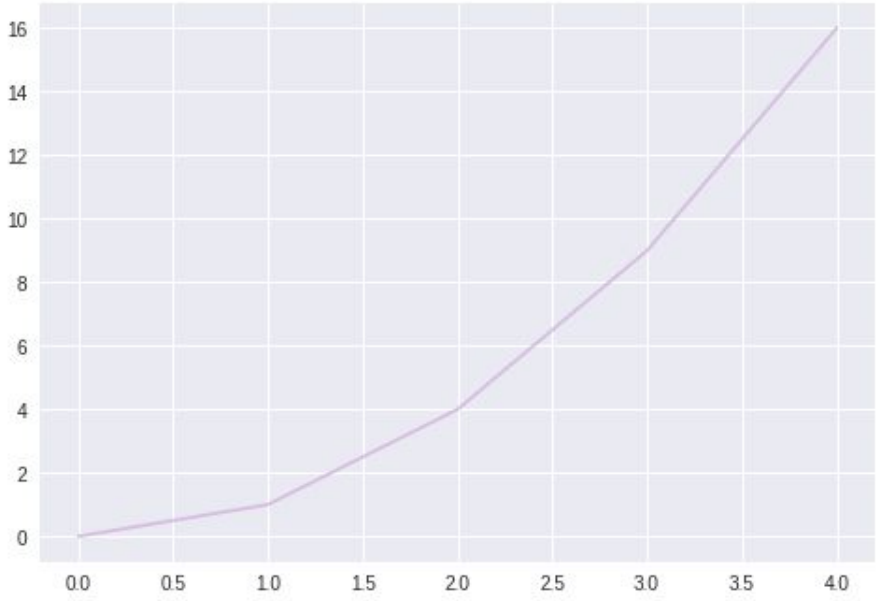
Flat Design Color Chart

16.7m colors

Matplotlib

- Package for plotting data.

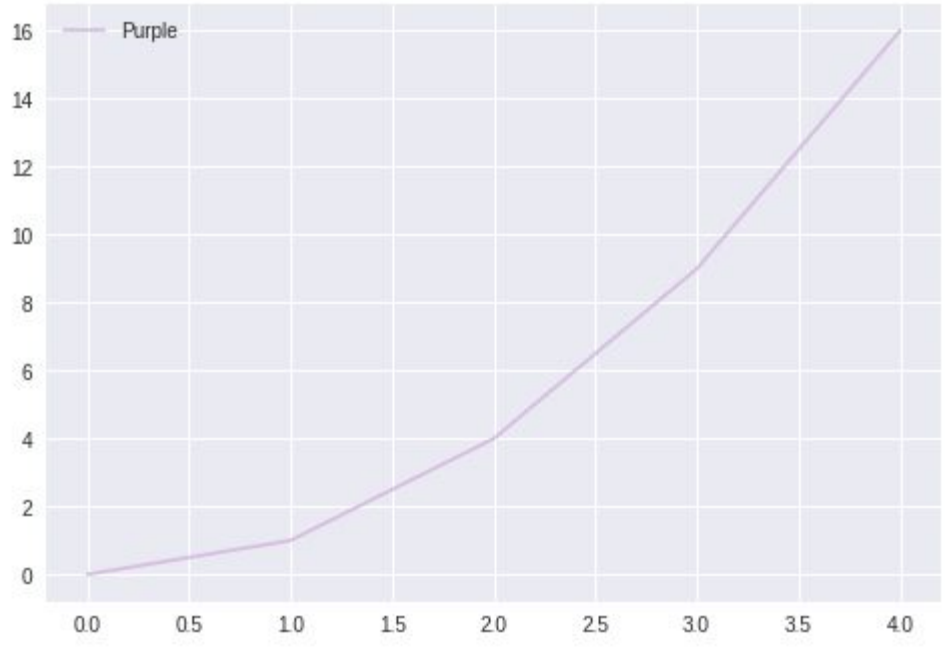
```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y,
         color="#D7BDE2")
```



Matplotlib

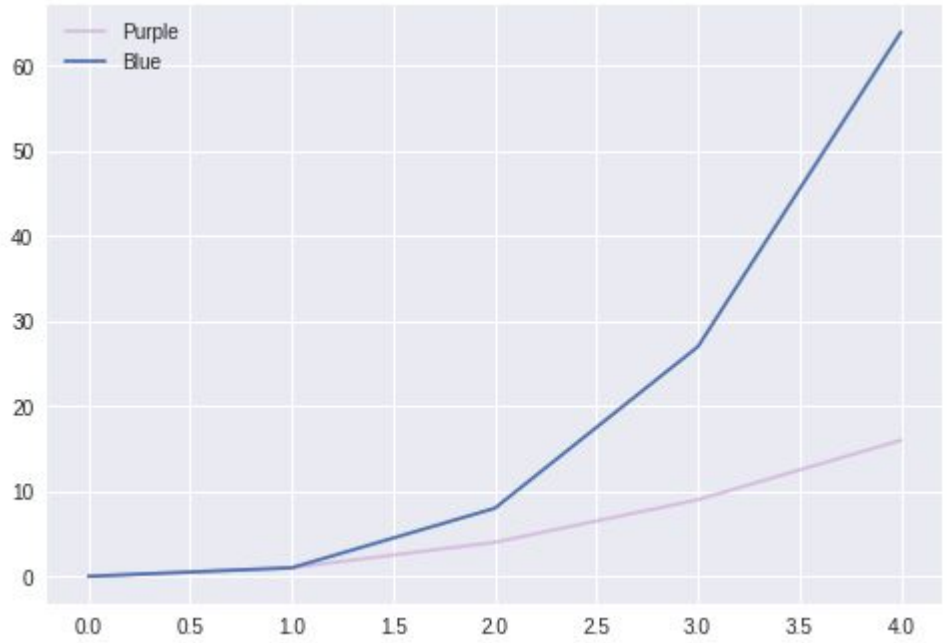
- Package for plotting data.

```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y,
         color="#D7BDE2",
         label="Purple")
plt.legend()
```



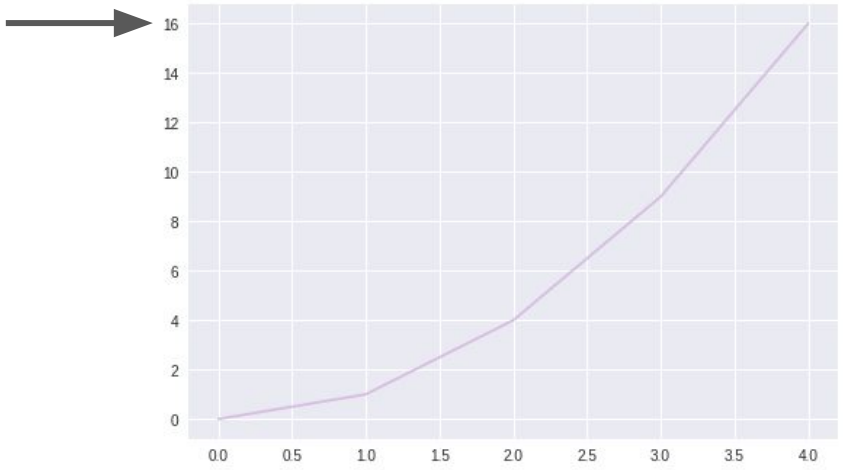
Matplotlib

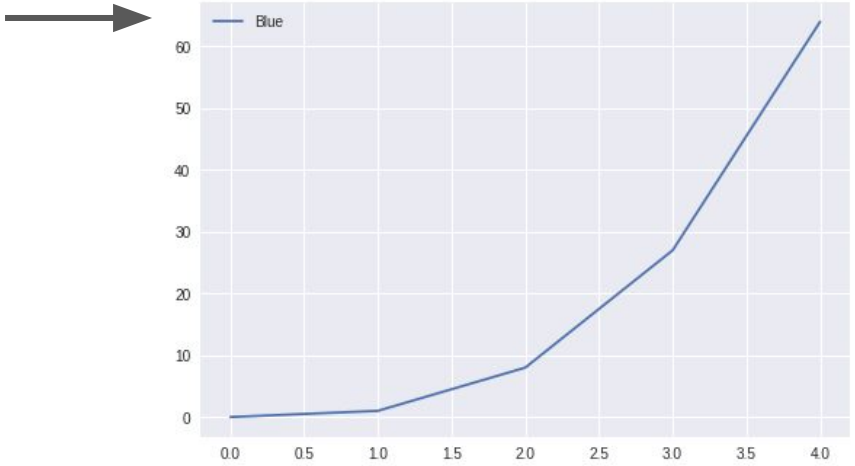
```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y,
         color="#D7BDE2",
         label="Purple")
plt.plot(x, x**3,
         label="Blue")
plt.legend()
```



Matplotlib

```
import matplotlib.pylab as plt

x = np.arange(5)
y = x ** 2
plt.plot(x, y,
         color="#D7BDE2",
         label="Purple")

plt.figure()

plt.plot(x, x**3,
         label="Blue")
plt.legend()
```





Demo

Other Useful Packages

- SciPy
  - Scientific computing package often used in conjunction with the others
- Scikit-Learn
  - Machine learning packages for classification, regression, model selection, etc.
  - Algorithms include linear regression, k-nearest neighbors, support vector machines, etc.
- PyTorch
  - User-friendly deep learning python package

We’re done! Now what?

- Learning Python for 3 hours through slides and demos is not enough
- Go home and **practice!**
- Continue learning what different packages have to offer
- Try Python out to analyze some datasets you might have
    - Get comfortable with pandas, numpy, and matplotlib