Python Programming Essentials

Today's Agenda:

Get started with Python! **Learn how to apply dictionaries and sets, files, and methods with analytical use cases. We'll also explore some common use cases that are often used in Data Analysis and Data Science.**

Topics We'll Explore Today:

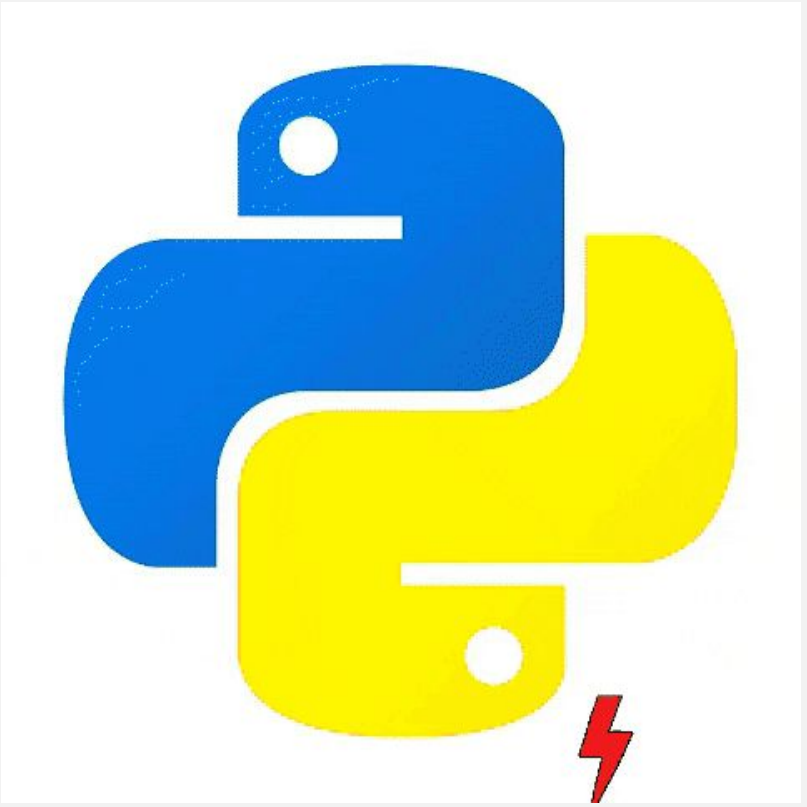
Dictionaries and Sets
Files
Methods
Pandas Introduction

Files and Methods

Overview

In this lesson, you will learn

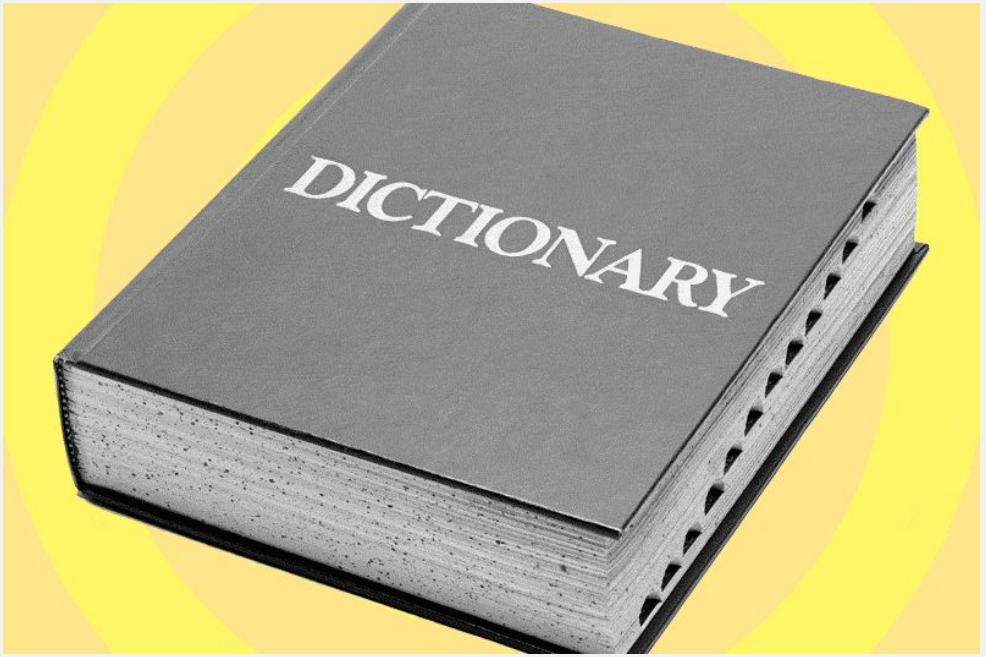
- Dictionaries / Sets
- Files
- Calling Methods
- Defining Methods
- Variable Scope
- Using a main Method
- Method Parameters
- Modules



Dictionary

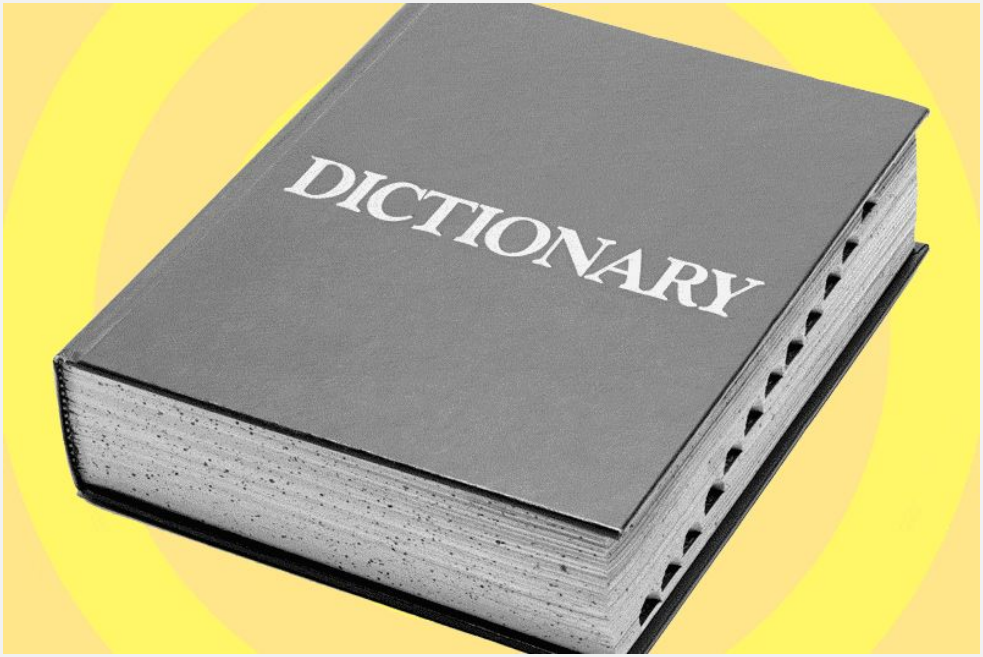
A Python dictionary is an extremely efficient data structure for storing pairs of values in the form key:value.

```
>>> color = {'red' : 1, 'blue' : 2, 'green' : 3}
>>> color
{'blue': 2, 'green': 3, 'red': 1}
>>> color['green’]
3
>>> color['red’]
1
```



Dictionary

```
>>> color = {'red' : 1, 'blue' : 2, 'green' : 3}
>>> color
{'blue': 2, 'green': 3, 'red': 1}
>>> color['red'] = 0
>>> color
{'blue': 2, 'green': 3, 'red': 0}
```



Dictionary Restrictions

keys are unique within the dictionary:

```
>>> color = {'red' : 1, 'blue' : 2, 'green' : 3, 're
4}
>>> color
{'blue': 2, 'green': 3, 'red': 4}
```

Name	Return Value
`d.items()`	Returns a view of the (key, value) pairs in `d`
`d.keys()`	Returns a view of the keys of `d`
`d.values()`	Returns a view of the values in `d`
`d.get(key)`	Returns the value associated with `key`
`d.pop(key)`	Removes `key` and returns its corresponding value
`d.popitem()`	Returns some (key, value) pair from `d`
`d.clear()`	Removes all items from `d`
`d.copy()`	A copy of `d`
`d.fromkeys(s, t)`	Creates a new dictionary with keys taken from `s` and values taken from `t`
`d.setdefault(key, v)`	If `key` is in `d`, returns its value; if `key` is not in `d`, returns `v` and adds (`key`, `v`) to `d`
`d.update(e)`	Adds the (key, value) pairs in `e` to `d`; `e` may be another dictionary or a sequence of pairs

Dictionaries are immutable

Sets

```
>>> lst = [1, 1, 6, 8, 1, 5, 5, 6, 8, 1, 5]
>>> s = set(lst)
>>> s
{8, 1, 5, 6}
```

Files

- A file is a named collection of bits stored on a secondary storage device, such as a hard disk, USB drive, flash memory stick, and so on.

Folders

- In addition to files, folders (or directories) are used to store files and other folders.
- The folder structure of most file systems is quite large and complex, forming a hierarchical folder structure.

Current Working Directory

- Many programs use the idea of a *current working directory*, or *cwd*.
- This is simply one directory that has been designated as the *default directory.*

Name	Action
`os.getcwd()`	Returns the name of the current working directory
`os.listdir(p)`	Returns a list of strings of the names of all the files and folders in the folder specified by path `p`
`os.chdir(p)`	Sets the current working directory to be path `p`
`os.path.isfile(p)`	Returns `True` just when path `p` specifies the name of a file, and `False` otherwise
`os.path.isdir(p)`	Returns `True` just when path `p` specifies the name of a folder, and `False` otherwise
`os.stat(fname)`	Returns information about `fname`, such as its size in bytes and the last modification time

Current Working Directory

```
# list.py
def list_cwd():
    return os.listdir(os.getcwd())
```

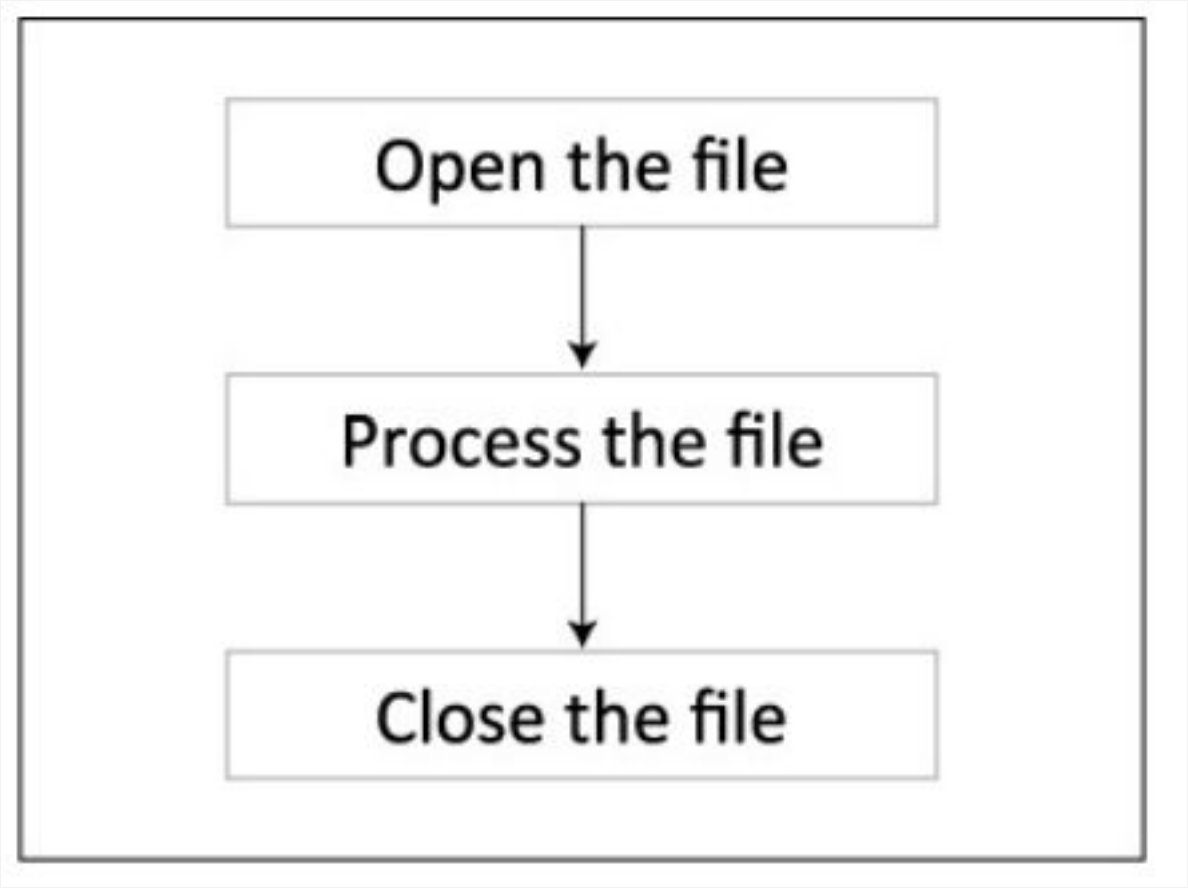
```
# list2.py
def files_cwd():
    return [p for p in list_cwd()
        if os.path.isfile(p)]

def folders_cwd():
    return [p for p in list_cwd()
        if os.path.isdir(p)]
```

Current Working Directory

```
# list.py
def list_py(path = None):
    if path == None:
        path = os.getcwd()
        return [fname for fname in os.listdir(path)
                    if os.path.isfile(fname)
                    if fname.endswith('.py')]
```

Dealing with Text Files



Dealing with Text Files

```
# printfile.py
def print_file1(fname):
    f = open(fname, 'r’)
    for line in f:
        print(line, end = ‘’)
    f.close() # optional
```

Character	Meaning
'r'	Open for reading (default)
'w'	Open for writing
'a'	Open for appending to the end of the file
'b'	Binary mode
't'	Text mode (default)
'+'	Open a file for reading and writing

Dealing with Text Files

```
# printfile.py
def print_file2(fname):
    f = open(fname, 'r’)
    print(f.read())
    f.close()
```

Writing to Text Files

```
# write.py
def make_story1():
        f = open('story.txt', 'w’)
        f.write('Mary had a little lamb,\n’)
        f.write('and then she had some
    more.\n')
```

```
# write2.py
import os
def make_story2():
    if os.path.isfile('story.txt’):
        print('story.txt already exists)
    else:
        f = open('story.txt', 'w’)
        f.write('Mary had a little lamb,\n’)
        f.write('and then she had some more.\n')
```

Appending to Text Files

```
def add_to_story(line, fname = 'story.txt’):
    f = open(fname, 'a’)
    f.write(line)
```

Appending to Text Files

```
def add_to_story(line, fname = 'story.txt’):
    f = open(fname, 'a’)
    f.write(line)
```

Appending to the START of Text Files

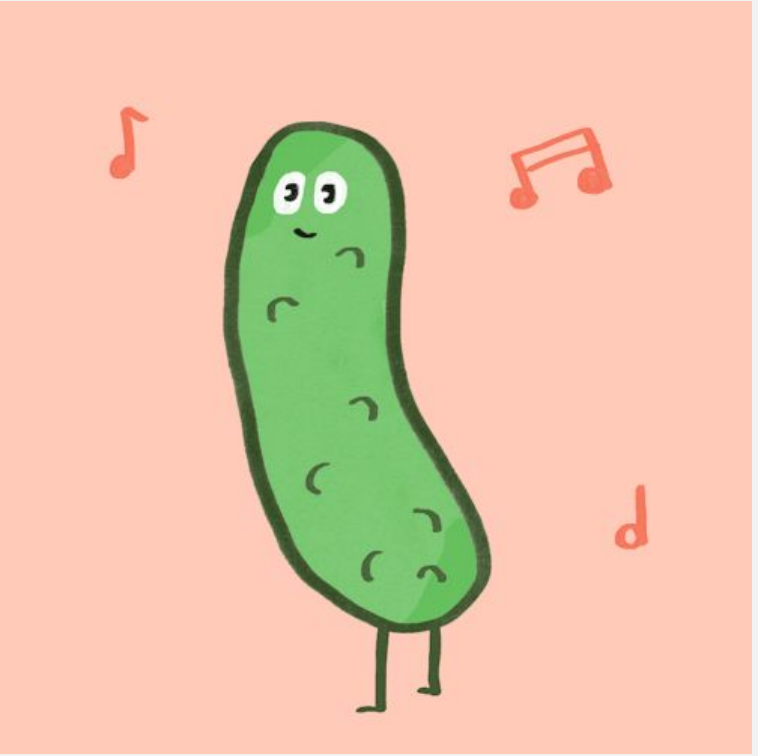
```
def add_to_story(line, fname = 'story.txt’):
    f = open(fname, 'a’)
    f.write(line)
    f.seek(0) # reset file pointer
        # to beginning
```

Binary Files

```
def is_gif(fname):
    f = open(fname, 'br’)
    first4 = tuple(f.read(4))
    return first4 == (0x47, 0x49, 0x46, 0x38)
```

What is Pickling?

- Pickle is used for serializing and de-serializing Python object structures.
- Serialization refers to the process of converting an object in memory to a byte stream that can be stored on disk or sent over a network.
- Later on, this character stream can then be retrieved and de-serialized back to a Python object.
- Pickling is not to be confused with compression!
  - ***Pickling*** is the ***conversion of an object from one representation (data in Random Access Memory (RAM)) to another (text on disk)***
  - While the latter is the process of encoding data with fewer bits, in order to save disk space.



What can be done with a Pickle?

Use Cases

1) saving a program's state data to disk so that it can carry on where it left off when restarted (persistence)
2) sending **python** data over a TCP connection in a multi-core o distributed system (marshalling)
3) storing **python** objects in a database
4) converting an arbitrary **python** object to a string so that it can be used as a dictionary key (e.g. for caching & memorization).

What can be pickled?

- **Booleans**
- **Integers**
- **Floats**
- **Complex numbers**
- **(normal and Unicode) Strings**
- **Tuples**
- **Lists**
- **Sets**
- **Dictionaries**

What can be pickled?

Pickle a File

```
import pickle
dogs_dict = { 'Ozzy': 3, 'Filou': 8, 'Luna': 5, 'Skippy': 10, 'Barco': 12, 'Balou': 9, 'Laika': 16 }
filename = 'dogs'
outfile = open(filename,'wb')
pickle.dump(dogs_dict,outfile)
outfile.close()
```

UnPickle a File

```
infile = open(filename,'rb')
new_dict = pickle.load(infile)
infile.close()
print(new_dict)
print(new_dict==dogs_dict)
print(type(new_dict))
```

Pickling

```
# picklefile.py
import pickle
def make_pickled_file():
    grades = {'alan' : [4, 8, 10, 10],
        'tom' : [7, 7, 7, 8],
        'dan' : [5, None, 7, 7],
        'may' : [10, 8, 10, 10]}
    outfile = open('grades.dat', 'wb')
    pickle.dump(grades, outfile)

def get_pickled_data():
    infile = open('grades.dat', 'rb')
    grades = pickle.load(infile)
    return grades
```

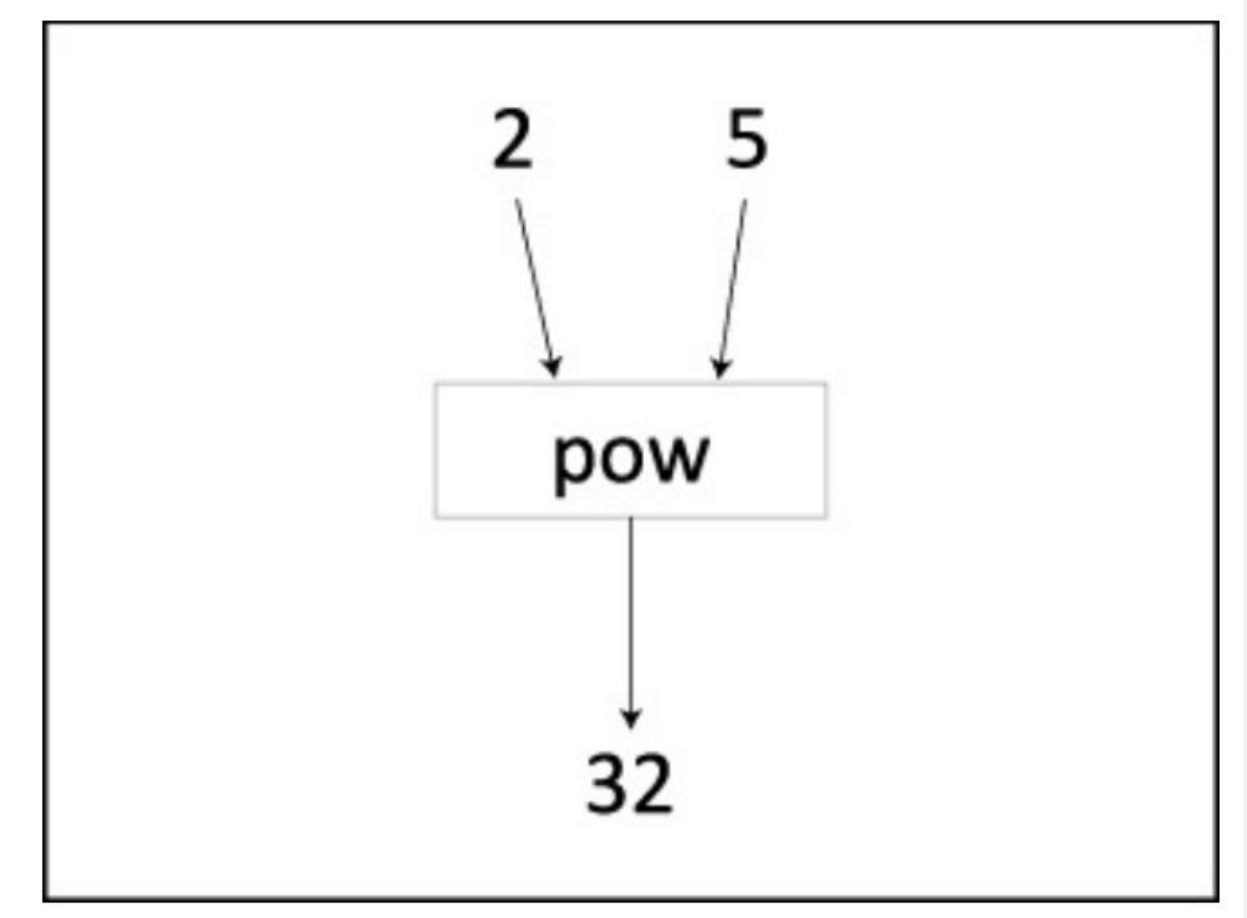
Calling Methods

- We've been calling methods quite a bit so far, so let's take a moment to look a little more carefully at a method call.
- Consider the built-in method pow(x, y), which calculates x **y—that is to say, x raised to the power y:

```
>>> pow(2, 5)
32
```

Calling Methods

- Figure gives a high-level overview of a method call



Calling Methods

- When a method takes no input (that is to say, it has zero arguments), you must still include the round brackets () afterthe method name:

```
>>> dir()
['__builtins__', '__doc__', '__name__', '__package__']
```

Calling Methods

- The () tells Python to execute the method.
- If you leave off the (), then you get this:

```
>>> dir
<built-in method dir>
```

Methods that don’t return a value

- Some methods, such as print, are not meant to return values. Consider:

```
>>> print('hello')
hello
>>> x = print('hello')
hello
>>> x
>>> print(x)
None
```

Reassigning method names

```
>>> dir = 3
>>> dir
3
>>> dir()
Traceback (most recent call last):
    File "<pyshell#28>", line 1, in <module>
    dir()
TypeError: 'int' object is not callable
```

Defining Methods

```
# area.py
import math
def area(radius):
    """ Returns the area of a circle
    with the given radius.
    For example:
    >>> area(5.5)
    95.033177771091246
    """
    return math.pi * radius ** 2
```

Defining Methods

- If everything is typed correctly, a prompt should appear and nothing else; a method is not executed until you call it.
- To call it, just type the name of the method, with the radius in brackets:

```
>>> area(1)
3.141592653589793
>>> area(5.5)
95.03317771091246
>>> 2 * (area(3) + area(4))
157.07963267948966
```

Parts of a method

Let’s look at each part of the area method.

- The first line, the one that begins with def, is called the method header; all the code indented beneath the header is called the method body.
- Method headers always begin with the keyword def (short for definition), followed by a space, and then the name of the method (in this case, area).
- Method names follow essentially the same rules as names for variables.

Parts of a method

- In the case of the area method, the return statement is the last line of the method, and it simply returns the value of the area of a circle using the standard formula.

- Note that it uses the radius parameter in its calculation; the value for radius is set when the area method is called.

Parts of a method

- A method is not required to have an explicit return statement.
- For example:

```
# hello.py
def say_hello_to(name):
    """ Prints a hello message.
    """
    cap_name = name.capitalize()
    print('Hello ' + cap_name + ', how are you?')
```

Parts of a method

- If you don’t put a return anywhere in a method, Python treats the method as if it ended with this line:

```
return None
```

Variable Scope

- An important detail that methods bring up is the issue of scope.
- The scope of a variable (or method) is where in a program it is accessible, or visible.
- Consider these two methods:

```
# local.py
import math
def dist(x, y, a, b):
    s = (x - a) ** 2 + (y - b) ** 2
    return math.sqrt(s)
def rect_area(x, y, a, b):
    width = abs(x - a)
    height = abs(y - b)
    return width * height
```

Global variables

- Variables declared outside of any method are called global variables, and they are readable anywhere by any method or code within the program

Global variables

- Consider the following:

```
# global_error.py
name = 'Jack'
def say_hello():
    print('Hello ' + name + '!')
def change_name(new_name):
    name = new_name
```

Global variables

- The say_hello() method reads the value of name and prints it to the screen as you would expect:

```
>>> say_hello()
Hello Jack!
```

Global variables

- However, things don’t work as expected when you call change_name:

```
>>> change_name('Piper')
>>> say_hello()
Hello Jack!
```

Global variables

- To access the global variable, you must use the global statement:

```
# global_correct.py
name = 'Jack'
def say_hello():
    print('Hello ' + name + '!')
def change_name(new_name):
    global name
    name = new_name
```

Global variables

- Makes all the difference. Both methods now work as expected:

```
>>> say_hello()
Hello Jack!
>>> change_name('Piper')
>>> say_hello()Hello Piper!
```

Using a Main Method

- It is usually a good idea to use at least one method in any Python program you write: main().
- A main() method is, by convention, assumed to be the starting point of your program
- Important: The main() method is NOT required in Python but it is a good practice.

Using a Main Method

```
# password2.py
def main():
    pwd = input('What is the password? ')
    if pwd == 'apple':
        print('Logging on ...')
    else:
        print('Incorrect password.')
    print('All done!')
```

Method Parameters

Pass by reference

- Python passes parameters to a method using a technique known as pass by reference.
- This means that when you pass parameters, the method refers to the original passed values
- using new names.
- For example, consider this simple program:

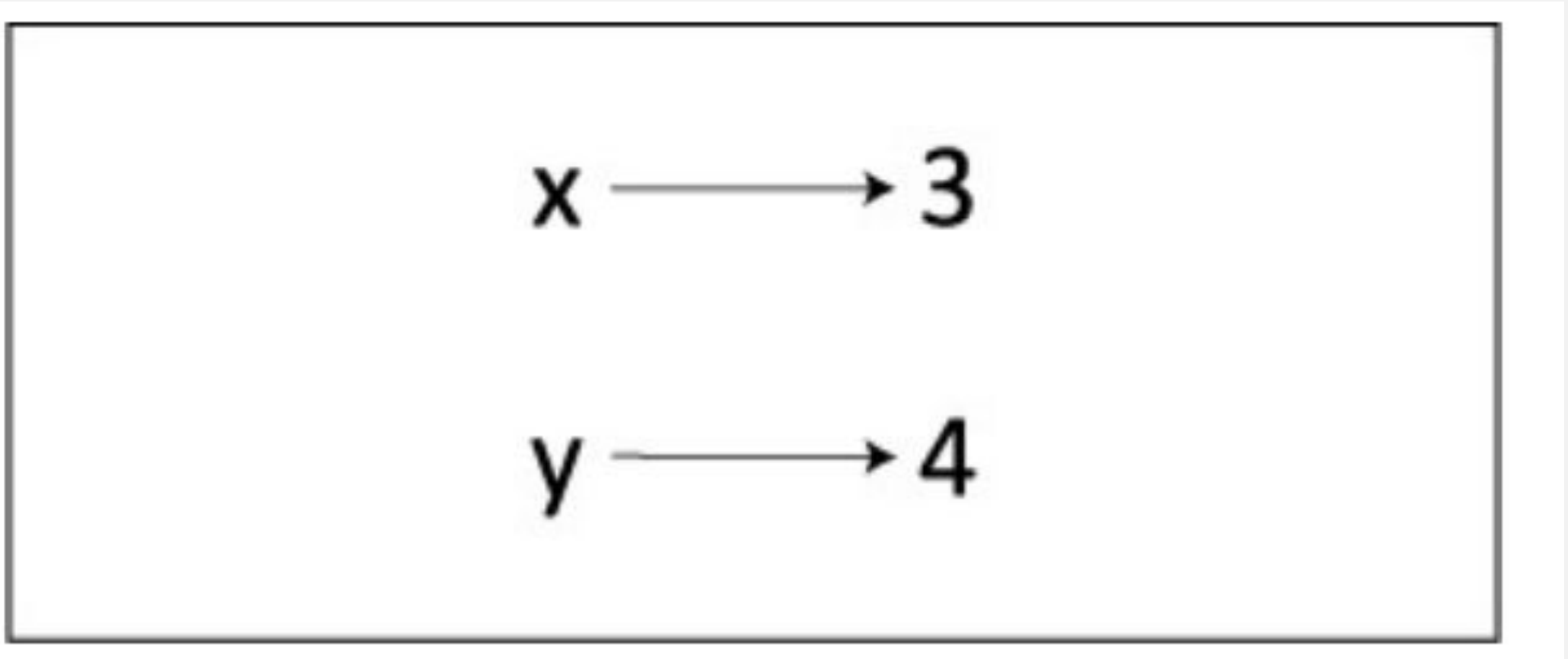
```
# reference.py
def add(a, b):
return a + b
```

Method Parameters

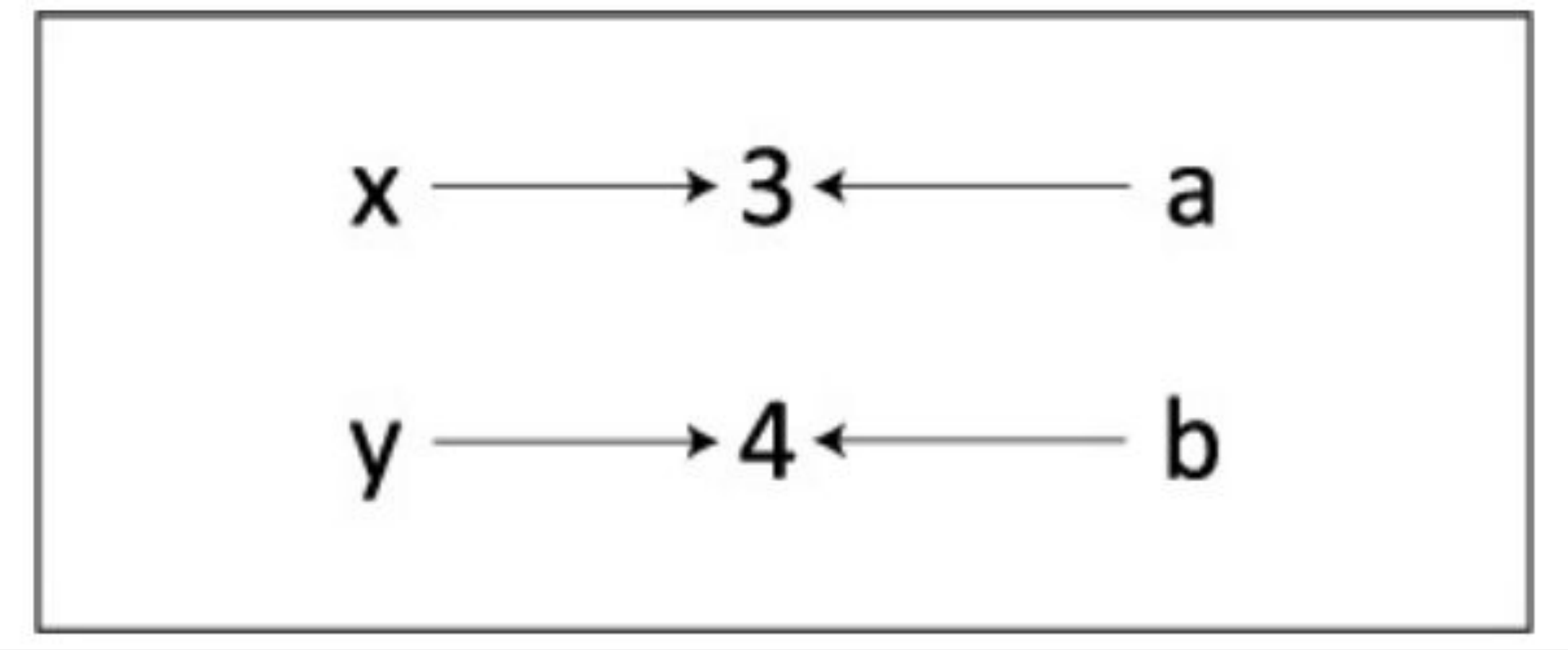
- Run the interactive command line and type this:

```
>>> x, y = 3, 4
>>> add(x, y)
7
```

Method Parameters



Method Parameters



An important example

- Passing by reference is simple and efficient, but there are some things it cannot do.

- For example, consider this plausibly named method:

```
# reference.pydef set1(x):
x = 1
```

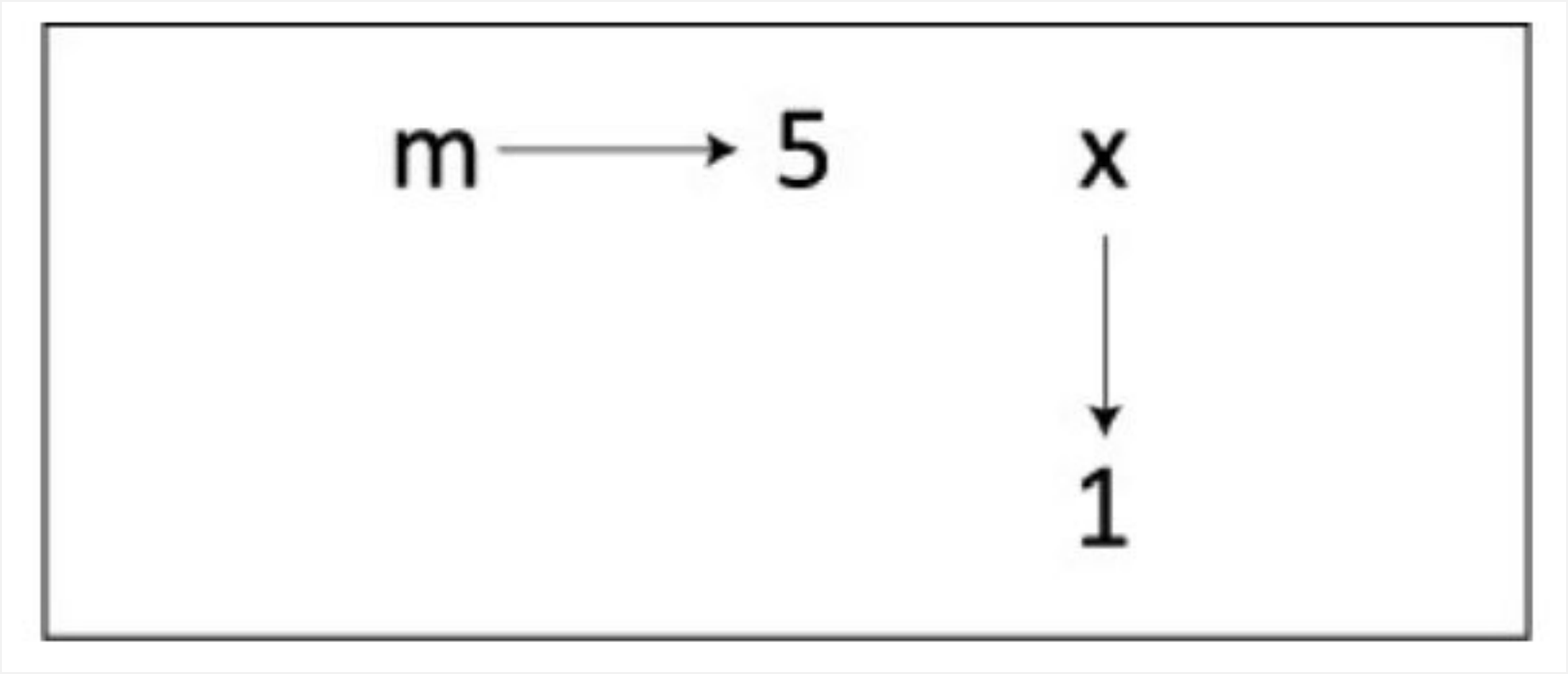
An important example

- The purpose of set1 is to set the value of the passed-in variable to 1.
- But when you try it, it does not work as expected:

```
>>> m = 5
>>> set1(m)
>>> m
5
```

An important example

- Assign 1 to m. Now the situation is as shown.



Default values

- It’s often useful to include a default value with a parameter.
- For example, here we have given the greeting parameter a default value of 'Hello’:

```
# greetings.py
def greet(name, greeting = 'Hello'):
print(greeting, name + '!')
```

Default values

- You can now call greet in two distinct ways:

```
>>> greet('Bob')
Hello Bob!
>>> greet('Bob', 'Good morning')
Good morning Bob!
```

Keyword parameters

- Another useful way to specify parameters in Python is by using keywords. For example:

```
# shopping.py
def shop(where = 'store',
         what = 'pasta',
         howmuch = '10 pounds'):
    print('I want you to go to the', where)
    print('and buy', howmuch, 'of', what + '.')
```

Keyword parameters

- To call a method that uses keyword parameters, pass data in the form param = value. For example:

```
>>> shop()
I want you to go to the store
and buy 10 pounds of pasta.
>>> shop(what = 'towels')
I want you to go to the store
and buy 10 pounds of towels.
>>> shop(howmuch = 'a ton', what = 'towels')
I want you to go to the store
and buy a ton of towels.
>>> shop(howmuch = 'a ton', what = 'towels', where = 'bakery')
I want you to go to the bakery
and buy a ton of towels.
```

Modules

- A module is collection of related methods and variables.

To create a Python module

- Simple module for printing shapes to the screen:

```
# shapes.py
"""A collection of functions
 for printing basic shapes.
"""
CHAR = '*'
def rectangle(height, width):
 """ Prints a rectangle.  """
 for row in range(height):
  for col in range(width):
   print(CHAR, end = '')
  print()
def square(side):
 """ Prints a square. """
 rectangle(side, side)
def triangle(height):
 """ Prints a right triangle. """
 for row in range(height):
  for col in range(1, row + 2):
   print(CHAR, end = '')
  print()
```

- To use a module, you simply import it.
- For example:

```
>>> import shapes
>>> dir(shapes)
['CHAR', '__builtins__', '__doc__', '__file__', '__name__', '__package__', 'rectangl
>>> print(shapes.__doc__)
A collection of functions
for printing basic shapes.
>>> shapes.CHAR
'*'
>>> shapes.square(5)
*****
*****
*****
*****
*****
>>> shapes.triangle(3)
*
**
***
```

To create a Python module

- You can also import everything at once:

```
>>> from shapes import *
>>> rectangle(3, 8)
********

********

********
```

Namespaces

- A very useful fact about modules is that they form namespaces.
- A namespace is essentially a set of unique variable and method names.
- The names within a module are visible outside the module only when you use an import statement.
- To see why this is important, suppose Jack and Sophie are working together on a large programming project.

Namespaces

- You can still run into name clashes as follows:

```
>>> from jack import *
>>> from sophie import *
```

The Series Object

This session covers:

- Instantiating Series objects from lists, dictionaries, and more
- Creating a custom index for a Series
- Accessing attributes and invoking methods on a Series
- Performing mathematical operations on a Series
- Passing the Series to Python's built-in functions

Populating the Series with Values

```
In  [3] ice_cream_flavors = ["Chocolate", "Vanilla", "Strawberry",
                             "Rum Raisin"]

        pd.Series(ice_cream_flavors)

Out [3] 0      Chocolate
        1        Vanilla
        2     Strawberry
        3     Rum Raisin
        dtype: object
```

Customizing the Index

```
In  [6] ice_cream_flavors = ["Chocolate", "Vanilla", "Strawberry",
                             "Rum Raisin"]
        days_of_week = ("Monday", "Wednesday", "Friday", "Wednesday")

        # The two lines below are equivalent
        pd.Series(ice_cream_flavors, days_of_week)
        pd.Series(data = ice_cream_flavors, index = days_of_week)

Out [6] Monday         Chocolate
        Wednesday        Vanilla
        Friday        Strawberry
        Wednesday     Rum Raisin
        dtype: object
```

Series Methods

This lesson covers:

- Importing CSV datasets
- Sorting Series values in ascending and descending order
- Retrieving the largest and smallest values in a Series
- Mutating a Series inplace
- Counting occurrences of unique values in a Series
- Applying an operation to every value in a Series

Importing a Dataset with the read_csv Method

- As always, our first step is to launch a fresh Jupyter Notebook and import pandas.

- Make sure to create the Notebook in the same directory as the CSV files you downloaded for this course.

```
In [1] import pandas as pd
```

```
In  [2] pd.read_csv(filepath_or_buffer = "pokemon.csv")
        pd.read_csv("pokemon.csv")

Out [2]
```

	Pokemon	Type
0	Bulbasaur	Grass / Poison
1	Ivysaur	Grass / Poison
2	Venusaur	Grass / Poison
3	Charmander	Fire
4	Charmeleon	Fire
…	…	…
804	Stakataka	Rock / Steel
805	Blacephalon	Fire / Ghost
806	Zeraora	Electric
807	Meltan	Steel
808	Melmetal	Steel

809 rows × 2 columns

Importing a Dataset with the read_csv Method

```
In  [3] pd.read_csv("pokemon.csv", index_col = "Pokemon")

Out [3]
                        Type
Pokemon
Bulbasaur      Grass / Poison
Ivysaur        Grass / Poison
Venusaur       Grass / Poison
Charmander             Fire
Charmeleon             Fire
```

Importing a Dataset with the read_csv Method

```
In  [4] pd.read_csv("pokemon.csv", index_col = "Pokemon", squeeze = True)

Out [4] Pokemon
        Bulbasaur       Grass / Poison
        Ivysaur         Grass / Poison
        Venusaur        Grass / Poison
        Charmander              Fire
        Charmeleon              Fire
                               ...
        Stakataka       Rock / Steel
        Blacephalon     Fire / Ghost
        Zeraora             Electric
        Meltan                 Steel
        Melmetal               Steel
        Name: Type, Length: 809, dtype: object
```

Importing a Dataset with the read_csv Method

The last step is to assign the `Series` to a variable so it can be reused throughout the Notebook.

```
In  [5] pokemon = pd.read_csv("pokemon.csv", index_col = "Pokemon", squeeze
        = True)
```

Curious if there are any `NaN` values in the `Series`? The `hasnans` attribute informs us there are no missing values in either the values or the index.

```
In  [6] pokemon.hasnans

Out [6] False

In  [7] pokemon.index.hasnans

Out [7] False
```

Importing a Dataset with the read_csv Method

```
In  [8] pd.read_csv("google_stocks.csv").head()

Out [8]
```

	Date	Close
0	2004-08-19	49.98
1	2004-08-20	53.95
2	2004-08-23	54.50
3	2004-08-24	52.24
4	2004-08-25	52.80

Importing a Dataset with the read_csv Method

```
In  [9] google = pd.read_csv("google_stocks.csv", index_col = "Date",
        parse_dates = ["Date"], squeeze = True)

        google.head()

Out [9] Date
        2004-08-19    49.98
        2004-08-20    53.95
        2004-08-23    54.50
        2004-08-24    52.24
        2004-08-25    52.80
        Name: Close, dtype: float64
```

Importing a Dataset with the read_csv Method

```
In  [10] pd.read_csv("revolutionary_war.csv").tail()
```

Out [10]

	Battle	Start Date	State
227	Siege of Fort Henry	9/11/1782	Virginia
228	Grand Assault on Gibraltar	9/13/1782	NaN
229	Action of 18 October 1782	10/18/1782	NaN
230	Action of 6 December 1782	12/6/1782	NaN
231	Action of 22 January 1783	1/22/1783	Virginia

Importing a Dataset with the read_csv Method

```
In  [11] pd.read_csv("revolutionary_war.csv",
                     index_col = "Start Date",
                     parse_dates = ["Start Date"]).tail()

Out [11]
```

Start Date	Battle	State
1782-09-11	Siege of Fort Henry	Virginia
1782-09-13	Grand Assault on Gibraltar	NaN
1782-10-18	Action of 18 October 1782	NaN
1782-12-06	Action of 6 December 1782	NaN
1783-01-22	Action of 22 January 1783	Virginia

Importing a Dataset with the read_csv Method

```
In  [12] pd.read_csv("revolutionary_war.csv",
                     index_col = "Start Date",
                     parse_dates = ["Start Date"],
                     usecols = ["State", "Start Date"],
                     squeeze = True).tail()

Out [12] Start Date
         1782-09-11    Virginia
         1782-09-13         NaN
         1782-10-18         NaN
         1782-12-06         NaN
         1783-01-22    Virginia
         Name: State, dtype: object
```

Importing a Dataset with the read_csv Method

```
In  [13] pokemon = pd.read_csv("pokemon.csv",
                               index_col = "Pokemon",
                               squeeze = True)

         google  = pd.read_csv("google_stocks.csv",
                               index_col = "Date",
                               parse_dates = ["Date"],
                               squeeze = True)

         battles = pd.read_csv("revolutionary_war.csv",
                               index_col = "Start Date",
                               parse_dates = ["Start Date"],
                               usecols = ["State", "Start Date"],
                               squeeze = True)
```

Sorting a Series

Sorting by Values with the sort_values Method

```
In  [14] google.sort_values()

Out [14] Date
         2004-09-03      49.82
         2004-09-01      49.94
         2004-08-19      49.98
         2004-09-02      50.57
         2004-09-07      50.60
                          ...
         2019-04-23    1264.55
         2019-10-25    1265.13
         2018-07-26    1268.33
         2019-04-26    1272.18
         2019-04-29    1287.58
         Name: Close, Length: 3824, dtype: float64
```

Sorting a Series

```
In  [15] pokemon.sort_values()

Out [15] Pokemon
         Illumise                 Bug
         Silcoon                  Bug
         Pinsir                   Bug
         Burmy                    Bug
         Wurmple                  Bug
                                  ...
         Tirtouga          Water / Rock
         Relicanth         Water / Rock
         Corsola           Water / Rock
         Carracosta        Water / Rock
         Empoleon         Water / Steel
         Name: Type, Length: 809, dtype: object
```

Sorting a Series

- In pandas, as in Python, lowercase characters are sorted after uppercase characters.
- In the example below, the string "adam" is placed after the string "Ben".

```
In  [16] pd.Series(data = ["Adam", "adam", "Ben"]).sort_values()

Out [16] 0    Adam
         2     Ben
         1    adam
         dtype: object
```

```
In  [17] google.sort_values(ascending = False).head()

Out [17] Date
         2019-04-29    1287.58
         2019-04-26    1272.18
         2018-07-26    1268.33
         2019-10-25    1265.13
         2019-04-23    1264.55
         Name: Close, dtype: float64

In  [18] pokemon.sort_values(ascending = False).head()

Out [18] Pokemon
         Empoleon       Water / Steel
         Carracosta      Water / Rock
         Corsola         Water / Rock
         Relicanth       Water / Rock
         Tirtouga        Water / Rock
         Name: Type, dtype: object
```

Sorting a Series

```
In  [19] battles.sort_values()

Out [19] Start Date
         1781-09-06    Connecticut
         1779-07-05    Connecticut
         1777-04-27    Connecticut
         1777-09-03       Delaware
         1777-05-17        Florida
                             ...
         1782-08-08            NaN
         1782-08-25            NaN
         1782-09-13            NaN
         1782-10-18            NaN
         1782-12-06            NaN
         Name: State, Length: 232, dtype: object
```

Sorting a Series

```
In  [20] battles.sort_values(na_position = "first")

Out [20] Start Date
         1775-09-17          NaN
         1775-12-31          NaN
         1776-03-03          NaN
         1776-03-25          NaN
         1776-05-18          NaN
                            ...
         1781-07-06     Virginia
         1781-07-01     Virginia
         1781-06-26     Virginia
         1781-04-25     Virginia
         1783-01-22     Virginia
         Name: State, Length: 232, dtype: object
```

Sorting a Series

```
In  [21] battles.dropna().sort values()

Out [21] Start Date
1781-09-06    Connecticut
1779-07-05    Connecticut
1777-04-27    Connecticut
1777-09-03       Delaware
1777-05-17        Florida
                  ...
1782-08-19       Virginia
1781-03-16       Virginia
1781-04-25       Virginia
1778-09-07       Virginia
1783-01-22       Virginia
Name: State, Length: 162, dtype: object
```

Sorting by Index with the sort_index Method

```
In  [22] pokemon.sort_index()

Out [22] Pokemon
         Abomasnow          Grass / Ice
         Abra                    Psychic
         Absol                      Dark
         Accelgor                    Bug
         Aegislash        Steel / Ghost
                                ...
         Zoroark                    Dark
         Zorua                      Dark
         Zubat           Poison / Flying
         Zweilous          Dark / Dragon
         Zygarde         Dragon / Ground
         Name: Type, Length: 809, dtype: object
```

Sorting by Index with the sort_index Method

```
In  [23] battles.sort_index(ascending = False, na_position = "first")

Out [23] Start Date
         NaT                New Jersey
         NaT                  Virginia
         NaT                       NaN
         NaT                       NaN
         1783-01-22           Virginia
                               ...
         1775-04-20           Virginia
         1775-04-19      Massachusetts
         1775-04-19      Massachusetts
         1774-12-14      New Hampshire
         1774-09-01      Massachusetts
         Name: State, Length: 232, dtype: object
```

Retrieving the Smallest and Largest Values with the nsmallest and nlargest Methods

```
In  [24] google.nlargest(n = 5) # is the same as
         google.nlargest()

Out [24] Date
         2019-04-29    1287.58
         2019-04-26    1272.18
         2018-07-26    1268.33
         2019-10-25    1265.13
         2019-04-23    1264.55
         Name: Close, dtype: float64
```

Retrieving the Smallest and Largest Values with the nsmallest and nlargest Methods

```
In  [25] google.nsmallest(n = 6) # is the same as
         google.nsmallest(6)

Out [25] Date
         2004-09-03    49.82
         2004-09-01    49.94
         2004-08-19    49.98
         2004-09-02    50.57
         2004-09-07    50.60
         2004-08-30    50.81
         Name: Close, dtype: float64
```

Overwriting a Series with the inplace Parameter

```
In  [26] battles.head(3)

Out [26] Start Date
         1774-09-01    Massachusetts
         1774-12-14    New Hampshire
         1775-04-19    Massachusetts
         Name: State, dtype: object

In  [27] battles.sort_values().head(3)

Out [27] Start Date
         1781-09-06    Connecticut
         1779-07-05    Connecticut
         1777-04-27    Connecticut
         Name: State, dtype: object

In  [28] battles.head(3)

Out [28] Start Date
         1774-09-01    Massachusetts
         1774-12-14    New Hampshire
         1775-04-19    Massachusetts
         Name: State, dtype: object
```

Overwriting a Series with the inplace Parameter

```
In  [29] battles.head(3)

Out [29] Start Date
         1774-09-01    Massachusetts
         1774-12-14    New Hampshire
         1775-04-19    Massachusetts
         Name: State, dtype: object

In  [30] battles.sort_values(inplace = True)

In  [31] battles.head(3)

Out [31] Start Date
         1781-09-06    Connecticut
         1779-07-05    Connecticut
         1777-04-27    Connecticut
         Name: State, dtype: object
```

Counting Values with the value_counts Method

```
In  [32] pokemon.value_counts()

Out [32] Normal              65
         Water               61
         Grass               38
         Psychic             35
         Fire                30
                  ..
         Fire / Dragon        1
         Dark / Ghost         1
         Steel / Ground       1
         Fire / Psychic       1
         Dragon / Ice         1
         Name: Type, Length: 159, dtype: int64
```

Counting Values with the value_counts Method

- The length of the value_counts Series will be equal to the number of unique values from the pokemon Series.
- As a reminder, the nunique method returns this piece of information.

```
In [33] len(pokemon.value_counts())
Out [33] 159
In [34] pokemon.nunique()
Out [34] 159
```

Counting Values with the value_counts Method

```
In  [35] pokemon.value_counts(ascending = True)

Out [35] Rock / Poison          1
         Ghost / Dark           1
         Ghost / Dragon         1
         Fighting / Steel       1
         Rock / Fighting        1
                               ..
         Fire                  30
         Psychic               35
         Grass                 38
         Water                 61
         Normal                65
```

Counting Values with the value_counts Method

- The normalize parameter can be set to True to return the frequencies of each unique value.
- The frequency represents what portion of the dataset a given value makes up.

```
In  [36] pokemon.value_counts(normalize = True)

Out [36] Normal          0.080346
         Water           0.075402
         Grass           0.046972
         Psychic         0.043263
         Fire            0.037083
```

Counting Values with the value_counts Method

```
In  [37] pokemon.value_counts(normalize = True) * 100

Out [37] Normal      8.034611
         Water       7.540173
         Grass       4.697157
         Psychic     4.326329
         Fire        3.708282
```

- Normal Pokémon make up 8.03% of the dataset, Water make up 7.54%, and so on.

Counting Values with the value_counts Method

```
In  [38] (pokemon.value_counts(normalize = True) * 100).round(2)

Out [38] Normal                 8.03
         Water                  7.54
         Grass                  4.70
         Psychic                4.33
         Fire                   3.71
                                ...
         Rock / Fighting        0.12
         Fighting / Steel       0.12
         Ghost / Dragon         0.12
         Ghost / Dark           0.12
         Rock / Poison          0.12
         Name: Type, Length: 159, dtype: float64
```

Counting Values with the value_counts Method

- A Series with numeric values will work similarly.
- In the example below, we can see that no stock price appears more than three times in our google dataset.

```
In  [39] google.value_counts().head()

Out [39] 237.04     3
         288.92     3
         287.68     3
         290.41     3
         194.27     3
```

Counting Values with the value_counts Method

- Let's begin by determining the smallest and largest values within the Series with the max and min methods.
- An alternative solution is to pass the Series into Python's built-in max and min functions.

```
In [40] google.max()
Out [40] 1287.58
In [41] google.min()
Out [41] 49.82
```

Counting Values with the value_counts Method

```
In  [42] bins = [0, 200, 400, 600, 800, 1000, 1200, 1400]
         google.value_counts(bins = bins)

Out [42] (200.0, 400.0]       1568
         (-0.001, 200.0]       595
         (400.0, 600.0]        575
         (1000.0, 1200.0]      406
         (600.0, 800.0]        380
         (800.0, 1000.0]       207
         (1200.0, 1400.0]       93
         Name: Close, dtype: int64
```

Counting Values with the value_counts Method

```
In  [43] google.value_counts(bins = bins).sort_index()

Out [43] (-0.001, 200.0]      595
         (200.0, 400.0]      1568
         (400.0, 600.0]       575
         (600.0, 800.0]       380
         (800.0, 1000.0]      207
         (1000.0, 1200.0]     406
         (1200.0, 1400.0]      93
         Name: Close, dtype: int64
```

Counting Values with the value_counts Method

- An alternative solution is to pass a value of False to the sort parameter of the value_counts method.
- This will yield the same result.

```
In  [44] google.value_counts(bins = bins, sort = False)

Out [44] (-0.001, 200.0]      595
         (200.0, 400.0]      1568
         (400.0, 600.0]       575
         (600.0, 800.0]       380
         (800.0, 1000.0]      207
         (1000.0, 1200.0]     406
         (1200.0, 1400.0]      93
         Name: Close, dtype: int64
```

Counting Values with the value_counts Method

```
In  [45] google.value_counts(bins = 6, sort = False)

Out [45] (48.581, 256.113]        1204
         (256.113, 462.407]       1104
         (462.407, 668.7]          507
         (668.7, 874.993]          380
         (874.993, 1081.287]       292
         (1081.287, 1287.58]       337
         Name: Close, dtype: int64
```

Counting Values with the value_counts Method

- What about our battles dataset? We can use the value_counts method to see which states had the most battles in the Revolutionary War.

```
In  [46] battles.value_counts().head()

Out [46] South Carolina    31
         New York          28
         New Jersey        24
         Virginia          21
         Massachusetts     11
         Name: State, dtype: int64
```

Counting Values with the value_counts Method

- NaN values will be missing from the list by default.
- Pass the dropna parameter an argument of False to count null values as a distinct category.

```
In  [47] battles.value_counts(dropna = False).head()

Out [47] NaN                70
         South Carolina     31
         New York           28
         New Jersey         24
         Virginia           21
         Name: State, dtype: int64
```

```
In  [48] battles.index

Out [48]

DatetimeIndex(['1774-09-01', '1774-12-14', '1775-04-19', '1775-04-19',
               '1775-04-20', '1775-05-10', '1775-05-27', '1775-06-11',
               '1775-06-17', '1775-08-08',
               ...
               '1782-08-08', '1782-08-15', '1782-08-19', '1782-08-26',
               '1782-08-25', '1782-09-11', '1782-09-13', '1782-10-18',
               '1782-12-06', '1783-01-22'],
              dtype='datetime64[ns]', name='Start Date', length=232,
              freq=None)

In  [49] battles.index.value_counts()

Out [49] 1775-04-19    2
         1781-05-22    2
         1781-04-15    2
         1782-01-11    2
         1780-05-25    2
                      ..
         1778-05-20    1
         1776-06-28    1
         1777-09-19    1
         1778-08-29    1
         1777-05-17    1
         Name: Start Date, Length: 217, dtype: int64
```

Invoking a Function on Every Series Value with the apply Method

- A function can be treated like any other object in Python.
- This is a tricky concept for some because a function is a more abstract data type than a concrete value like an integer.
- But anything that you can do with an object like a number, you can also do with a function.

Invoking a Function on Every Series Value with the apply Method

- The example below declares a funcs list that stores 3 of Python's built-in functions.
- Notice that the functions are not invoked within the list.
- These are references to the functions themselves.
- In analogous terms, we have a cookbook of 3 recipes here, but we haven't started baking anything yet.

```
In [50] funcs = [len, max, min]
```

Invoking a Function on Every Series Value with the apply Method

- For each iteration, we invoke the current function being referenced by func and pass in the google Series.
- The output thus includes the length of the Series followed by its maximum and minimum values.

```
In  [51] funcs = [len, max, min]

         for func in funcs:
             print(func(google))

Out [51] 3824
         1287.58
         49.82
```

Invoking a Function on Every Series Value with the apply Method

```
In  [52] round(99.2)

Out [52] 99

In  [53] round(99.49)

Out [53] 99

In  [54] round(99.5)

Out [54] 100
```

Invoking a Function on Every Series Value with the apply Method

```
In  [55] google.apply(func = round)
         google.apply(round)
```

```
Out [55] Date
         2004-08-19      50
         2004-08-20      54
         2004-08-23      54
         2004-08-24      52
         2004-08-25      53
                        ...
         2019-10-21    1246
         2019-10-22    1243
         2019-10-23    1259
         2019-10-24    1261
         2019-10-25    1265
         Name: Close, Length: 3824, dtype: int64
```

Invoking a Function on Every Series Value with the apply Method

- We can use the in operator to check for the presence of the substring "/" in the input string. If it is found,we'll return the string "Multi". Otherwise, we'll return the string "Single".

```
In  [56] def single_or_multi(types):
             if "/" in types:
                 return "Multi"

             return "Single"
```

Invoking a Function on Every Series Value with the apply Method

- Let's get ready to pass the single_or_multi function to the apply method. Here's a quick refresher of our pokemon dataset.

```
In  [57] pokemon.head(4)

Out [57] Pokemon
         Bulbasaur      Grass / Poison
         Ivysaur        Grass / Poison
         Venusaur       Grass / Poison
         Charmander             Fire
         Name: Type, dtype: object
```

Invoking a Function on Every Series Value with the apply Method

```
In  [58] pokemon.apply(single_or_multi)

Out [58] Pokemon
         Bulbasaur       Multi
         Ivysaur         Multi
         Venusaur        Multi
         Charmander     Single
         Charmeleon     Single
                          ...
         Stakataka       Multi
         Blacephalon     Multi
        Zeraora         Single
        Meltan          Single
        Melmetal        Single
        Name: Type, Length: 809, dtype: object
```

Invoking a Function on Every Series Value with the apply Method

- We have a new Series object now! Let's find out how many Pokémon fall into each classification by using value_counts.

```
In  [59] pokemon.apply(single_or_multi).value_counts()

Out [59] Multi     405
         Single    404
         Name: Type, dtype: int64
```

Demo / Use Case
Python with Data Analytics

Thanks for Your Time Today!