Web Science

Lecture 2

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Original Lectures

CS 495 Python and Web Mining

http://www.cs.odu.edu/~hany/teaching/cs495-f12/

By **Hany SalahEldeen Khalil**

Lecture Outline

Python Programming

- We will learn how to:
  - program in Python
  - write high quality code
  - utilize numerous libraries and APIs

Python

Taming the beast!

Python

- It’s an open source programming language
- Compiled and Interpreted
- Slower than C/C++ but with the difference in speed is negligible for most applications
- Developed in the late 1980s

Why Python?

- It is a scripting language
- Fast in development and prototyping
- Fast in testing functionality
- Pluggable to other C/C++/Java code
- Object oriented
- Has hundreds of libraries
- Automatically convert variable types
- Clean and easy to read as white space is part of the syntax!

Expression vs. Statement

Expression

- Represents something
- Python *Evaluates* it
- Results in a value

- Example:
  - 5.6
  - (5/3)+2.9

Statement

- Does something
- Python *Executes* it
- Results in an action

- Example:
  - print("Barcelona FC is Awesome!")
  - import sys

Similarity with C Syntax

- **Mostly similar to C/C++ syntax but with several exceptions.**
- **Differences:**
  - White spaces for indentation
  - No “{}” for blocks
  - Blocks begin with “:”
  - NO type declaration
  - No ++, -- operators
  - Keywords
  - No && and ||
  - No switch/case

Starting & Exiting Python REPL

```
[user@host ~]$ python
Python 2.6.5 (r265:79063, Jan 21 2011,
12:09:23)
[GCC 4.4.4 20100726 (Red Hat 4.4.4-13)] on
linux2
Type "help", "copyright", "credits" or "license" for
```

```
>>>    ctrl + D
[user@host ~]$
```

Our Hello World!

```
[user@host ~]$ python
Python 2.6.5 (r265:79063, Jan 21 2011,
12:09:23)
[GCC 4.4.4 20100726 (Red Hat 4.4.4-13)] on
linux2
Type "help", "copyright", "credits" or "license" for
more information.
```

```
>>> print "hello world"
hello world
```

Simple Data Types

Integer:	7
Float:	87.23
String:	"abc", 'abc'
Boolean:	False, True

Simple Data Types: String

- Concatenation: "Python" + "Rocks" → "PythonRocks"
- Repetition: "Python" * 2 → "PythonPython"
- Slicing: "Python"[2:3] → "th"
- Size: len("Python") → 6
- Index: "Python"[2] → 't'
- Search: "x" in "Python" → False
- Comparison: "Python" < "ZOO" → True (lexicographically)

Compound Data Types: List

- The equivalent of array or vector in c++.
- X = [0, 1, 2, 3, 4]
    - Creates a pre-populated array of size 5.
- Y = [ ]
- X.append(5)
    - X becomes [0, 1, 2, 3, 4, 5]
- len(X)
    - Gets the length of X which is 6

Compound Data Types: List

```
>>> mylist = [0, 'a', "hello", 1, 2, ['b', 'c', 'd']]
>>> mylist [1]
a
>>> mylist [5][1]
c
>>> mylist[1:3]
['a', "hello", 1]
>>> mylist[:2]
[0, 'a', "hello"]
```

Compound Data Types: List

```
>>> mylist = [0, 'a', "hello", 1, 2, ['b', 'c', 'd']]
>>> mylist[3:]
[1, 2, ['b', 'c', 'd']]
>>> mylist.remove('a')
>>> mylist
[0, "hello", 1, 2, ['b', 'c', 'd']]
```

Compound Data Types: List

>>> mylist.reverse() → Reverse elements in list
>>> mylist.append(x) → Add element to end of list
>>> mylist.sort() → Sort elements in list ascending
>>> mylist.index('a') → Find first occurrence of 'a'
>>> mylist.pop() → Removes last element in list

Compound Data Types: Tuple

- X = (0, 1, 2, 3, 4)
  - Creates a pre-populated array of fixed size 5.
- print(X[3])   #=> 3

Compound Data Types: Tuple vs. List

- Lists are mutable, tuples are immutable.
- Lists can be resized, tuples can't.
- Tuples are slightly faster than lists.

Compound Data Types: Dictionary

- An array indexed by a string.
- Denoted by { }

```
>>> marks = {"science": 90, "art": 25}
>>> print(marks["art"])
25

>>> marks["chemistry"] = 75
>>> print(marks.keys())
["science", "art", "chemistry"]
```

Compound Data Types: Dictionary

- dict = { "fish": 12, "cat": 7}
- dict.has_key('dog') → False (To check if the dictionary has 'dog' as a key)
- dict.keys() (Gets a list of all keys)
- dict.values() (Gets a list of all values)
- dict.items() (Gets a list of all key-value pairs)
- dict["fish"] = 14 → Assignment

Variables

- Everything is an object.
- No need to declare.
- No need to assign.
- Not strongly typed.
- Assignment = reference
  - Ex:

```
>>> X = ['a', 'b', 'c']
>>> Y = X
>>> Y.append('d')
>>> print(X)
['a', 'b', 'c', 'd']
```

Input / Output

- Input:
  - **Without a Message:**

    ```
    >>> x = input()
    3
    >>> x
    3
    ```

  - **With a Message:**

    ```
    >>> x = input('Enter the number: ')
    Enter the number: 3
    >>> x
    3
    ```

Input / Output

- Input:

```
>>> x = input()
3+4
>>> x
"3+4"
>>> eval(x)
7
```

File: Read

- Input:
  - `>>> f = open("input_file.txt", "`**`r`**`")`

    File handle — Name of the file — Mode
  - `>>> line = f.readline()`

    Read one line at a time
  - `>>> f.close()`

    Stop using this file and close

File: Write

- Output:
  - >>> f = open ("output_file.txt", "**w**")

    File handle — Name of the file — Mode
  - >>> line = f.write("Hello how are you?")

    Write a string to the file
  - >>> f.close()

    Stop using this file and close

Control Flow

- Conditions:
    - if
    - if / else
    - if / elif / else
- Loops:
    - while
    - for
    - for loop in file iterations

Conditions

- The condition must be terminated with a colon ":"
- Scope of the loop is the following indented section

```
>>> if score == 100:
        print("You scored a hundred!")
    elif score > 80:
        print("You are an awesome student!")
    else:
        print("Go and study!")
```

Loops: while

```
>>> i = 0
>>> while i < 10:
        print(i)
        i = i + 1
```

- Do not forget the **:** at the end of the condition line!

Loops: for

```
>>> for i in range(10):
        print(i)

>>> myList = ['hany', 'john', 'smith', 'aly', 'max']
>>> for name in myList:
        print(name)
```

- Do not forget the **:** at the end of the condition line!

Loops: Inside vs. Outside

```
for i in range(3):
    print("Iteration {}".format(i))
    print("Done!")
```

```
Iteration 0
Done!
Iteration 1
Done!
Iteration 2
Done!
```

```
for i in range(3):
    print("Iteration {}".format(i))
print("Done!")
```

```
Iteration 0
Iteration 1
Iteration 2
Done!
```

Loops: for in File Iterations

```
>>> f = open ("my_ file.txt", "r")
>>> for line in f:
            print(line)
```

Control Flow Keywords: pass

- It means do nothing
-
```
>>> if x > 80:
        pass
    else:
        print("You are less than 80!")
```

Control Flow Keywords: break

- It means quit the loop
-
```
>>> for name in myList:
        if name == "aly":
            break
        else:
            print(name)
```

→This will print all names before “aly”

Control Flow Keywords: continue

- It means skip this iteration of the loop
- >>> for name in myList:

```
            if name == "aly":
                    continue
            else:
                    print(name)
```

→This will print all names except "aly"

Now, let’s dig some more into ***Python*** …

Functions

- So far you have learned how to write regular small code in python.

- Code for finding the biggest number in a list:

```
mylist = [2,5,3,7,1,8,12,4]
maxnum = 0
for num in mylist:
    if (num>maxnum):
            maxnum = num
print("The biggest number is: {}".format(maxnum))
```

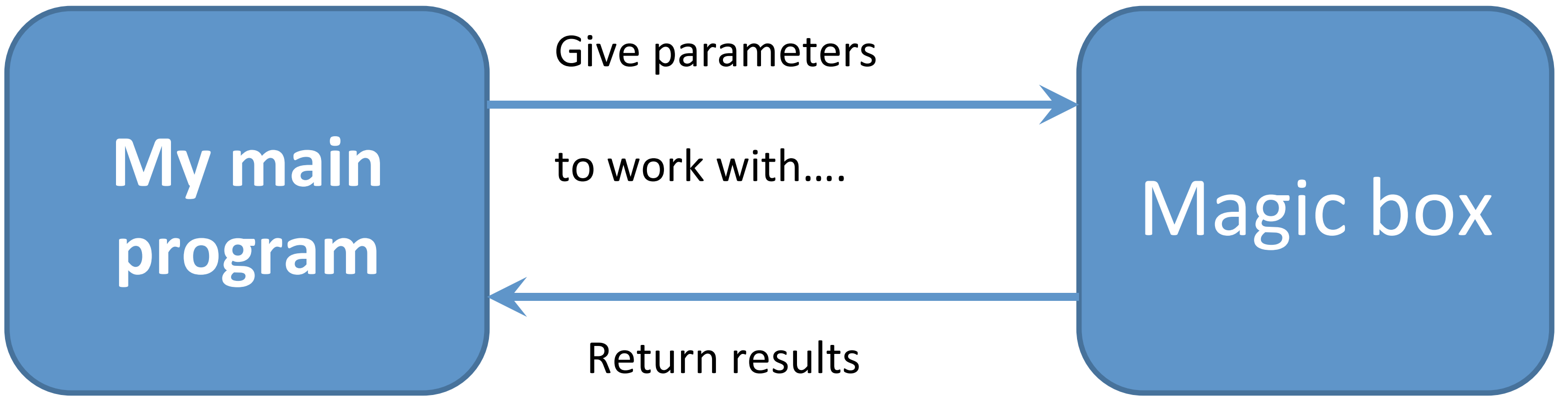
Functions

- But what if the code is a bit more complicated and long?

- Writing the code as one blob is bad!
  - Harder to read and comprehend
  - Harder to debug
  - Rigid
  - Non-reusable

Functions

```
def my_funtion(parameters):
        do stuff
```



Functions

- Back to our example:

```
mylist = [2,5,3,7,1,8,12,4]
maxnum = getMaxNumber(mylist)
print("The biggest number is: {}".format(maxnum))
```

Functions

- While you can make the function getMaxNumber as you wish

```
def getMaxNumber(list_x):
    maxnum = 0
    for num in list_x:
        if (num>maxnum):
            maxnum = num
    return maxnum
```

Testing

```
def getMaxNumber(list_x):
    """
    Returns the maximum number from the supplied list
    >>> getMaxNumber([4, 7, 2, 5])
    7
    >>> getMaxNumber([-3, 9, 2])
    9
    >>> getMaxNumber([-3, -7, -1])
    -1
    """
    maxnum = 0
    for num in list_x:
        if (num>maxnum):
            maxnum = num
    return maxnum

if __name__ == '__main__':
    import doctest
    doctest.testmod()
```

Testing

```python
def getMaxNumber(list_x):
    """
    Returns the maximum number from the supplied list
    >>> getMaxNumber([4, 7, 2, 5])
    7
    >>> getMaxNumber([-3, 9, 2])
    9
    >>> getMaxNumber([-3, -7, -1])
    -1
    """
    maxnum = 0
    for num in list_x:
        if (num>maxnum):
            maxnum = num
    return maxnum

if __name__ == '__main__':
    import doctest
    doctest.testmod()
```

```
$ python max_num.py
**********************************************************************
File "max_num.py", line 8, in __main__.getMaxNumber
Failed example:
    getMaxNumber([-3, -7, -1])
Expected:
    -1
Got:
    0
**********************************************************************
1 items had failures:
   1 of   3 in __main__.getMaxNumber
***Test Failed*** 1 failures.
```

Functions

- Or…

```
def getMaxNumber(list_x):
    return max(list_x)
```

Functions

- Remember:
  - All arguments are passed by value
  - All variables are local unless specified as global
  - Functions in python can have several arguments or none
  - Functions in python can return several results or none

Functions

- Remember:
  - All arguments are passed by value
  - All variables are local unless specified as global
  - Functions in python can have several arguments or none
  - Functions in python can return several results or none
    - This is *AWESOME!*

Functions

- Example of returning several values

```
def getMaxNumberAndIndex(list_x):
    maxnum = 0
    index = -1
    i = 0
    for num in list_x :
        if (num>maxnum):
            maxnum = num
            index = i
        i = i + 1
    return maxnum, index
```

Functions

- And you call it like this:

```
mylist = [2,5,3,7,1,8,12,4]
maxnum, idx = getMaxNumberAndIndex(mylist)
print("The biggest number is: {}".format(maxnum))
print("It’s index is: {}".format(idx))
```

Class

```
class Student:
        count = 0
        # class variable
        def __init__(self, name):                    # Initializer
                self.name = name
                self.grade = None
                Student.count += 1
        def updateGrade(self, grade):    # Instance method
                self.grade = grade
if __name__ == "__main__":               # Execute only if
script
        s = Student("John Doe")
        s.updateGrade("A+")
        s.grade
```

Writing Clean Code

- Programmers have a terrible short term memory

Writing Clean Code

- Programmers have a terrible short term memory

You will have to learn to live with it!

Writing Clean Code

- To fix that we need to write clean readable code with a lot of comments.

Writing Clean Code

- To fix that we need to write clean readable code with a lot of comments.

- You are the narrator of your own code, so make it interesting!

- Ex: Morgan Freeman

http://www.youtube.com/watch?v=lbIqL-lN1B4&feature=player_detailpage#t=77s

Writing Clean Code

- Comments start with a # and end at the end of the line.

```
mylist = [2,5,3,7,1,8,12,4]
# The function getMaxNumberAndIndex will be called next to retrieve
# the biggest number in list "mylist" and the index of that number.
maxnum, idx = getMaxNumberAndIndex(mylist)
print("The biggest number is: {}".format(maxnum))
print "It's index is: {}".format(idx))
```

Creating Python Files

- Python files end with ".py"
- To execute a python file you write:

```
>>> python myprogram.py
```

Creating Python Files

- To make the file “a script”, set the file permission to be executable and add this shebang in the beginning:

```
#!/usr/bin/python
```

$\longleftarrow$ The path to Python installation

or better yet

```
#!/usr/bin/env python
```

Building on the Shoulders of Giants!

- You don’t have to reinvent the wheel….. *someone has already done it better!*

Modules

- Let's say you have this awesome idea for a program, will you spend all your time trying to figure out the **square root** and how it could be implemented and utilized?

Modules

- Let's say you have this awesome idea for a program, will you spend all your time trying to figure out the **square root** and how it could be implemented and utilized?

No!

Modules

- We just call the math library that has the perfect implementation of square root.

```
>>> import math
>>> x = math.sqrt(9.0)
```

Or

```
>>> from math import sqrt
>>> x = sqrt(9.0)
```

Modules

- To import all functions in a library we use the wildcard: *

>>> from string import *

Note: *Be careful upon importing "from" several files, there might be two modules named the same in different libraries.*

Your Programs are Your Butlers!

- You are Batman! Your programs are your Alfreds!
- *Send them work:*

Command-Line Arguments

- To get the command line arguments:
- *>>> import sys*

- The arguments are in *sys.argv* as a *list*

What Happens When Your Program Goes

Kabooom!?

Bad Scenario

```
>>> sum_grades = 300
>>> number_of_students = input()
>>> average = sum_grades / number_of_students
```

→ What if the user wrote 0?

Bad Scenario

```
>>> sum_grades = 300
>>> number_of_students = input()
0
>>> average = sum_grades / number_of_students
```

→ Error! Divide by Zero

Bad Scenario

```
>>> sum_grades = 300
>>> number_of_students = input()
0
>>> average = sum_grades / number_of_students
```

→ Error! Divide by Zero

Remember: User input is evil!

Precautions: Exception Handling

You can just say:

```
try:
        average = sum_grades / number_of_students
except:
        # this catches if something wrong happens
        print("Something wrong happened, please check it!")
        average = 0
```

Precautions: Exception Handling

Or if you have an idea what exception could it be:

```
try:
        average = sum_grades / number_of_students
except ZeroDivisionError:
        # this catches if a number was divided by zero
        print("You Evil User!.....you inserted a zero!")
        average = 0
```

Precautions: Exception Handling

Or several exceptions you are afraid of:

```
try:
        average = sum_grades / number_of_students
except ZeroDivisionError:
        # this catches if a number was divided by zero
        print("You Evil User!.....you inserted a zero!")
        average = 0
except IOError:
        # this catches errors happening in the input process
        print("Something went wrong with how you enter words")
        average = 0
```

Generators

```
def fib():
    a = b = 1
    while True:
        yield a
        a, b = b, a + b

f = fib()
print(next(f))  #=> 1
print(next(f))  #=> 1
print(next(f))  #=> 2
print(next(f))  #=> 3
print(next(f))  #=> 5
```

Python Tips and Tricks

- range(start, end, increment)

  You can design a specific loop with that
- Swap variable values using multiple assignment

  a, b = b, a

Python Tips and Tricks

“in” and “not in” operators

- In loops
  - for line in lines
  - for line not in lines
- In conditions
  - if item in list
  - if item not in list

Python Tips and Tricks

List comprehensions

```
squares = []
for x in range(10):
    squares.append(x**2)

# Can be written like this
squares = [x**2 for x in range(10)]

# A more complex example
[(x, y) for x in [1,2,3] for y in [3,1,4] if x != y]
```

Python Tips and Tricks

- Manipulating files:

  - readline() → reads a line from file
  - readlines() → reads all the file as a list of lines
  - read() → reads all the file as one string.
  - seek(offset, start) → start could be:
    - 0 → beginning
    - 1 → current location
    - 2 → end of file

Python Libraries: urllib

- **urllib** is a Python module that can be used for interacting with remote resources

```
import urllib.request
with urllib.request.urlopen('http://www.cs.odu.edu/') as res:
    html = res.read()
    # do something
```

urllib Response Headers

```python
import urllib.request
with urllib.request.urlopen('http://python.org/') as res:
    print("URL: {}".format(res.geturl()))
    print("Response code: {}".format(res.code))
    print("Date: {}".format(res.info()['date']))
    print("Server: {}".format(res.info()['server']))
    print("Headers: {}".format(res.info()))
```

urllib Requests

```python
import urllib.request
url = 'http://www.cs.odu.edu/'

# This puts the request together
req = urllib.request.Request(url)

# Sends the request and catches the response
with urllib.request.urlopen(req) as res:
    # Extracts the response
    html = res.read()
```

urllib Request Parameters

```python
import urllib.request
import urllib.parse

url = 'http://www.cs.odu.edu/'
query_args = {'q': 'query string', 'foo':'bar'}

data = urllib.parse.urlencode(query_args).encode('ascii')

req = urllib.request.Request(url, data)

with urllib.request.urlopen(req) as res:
    # Extracts the response
    html = res.read()
```

What Happens When the Server Tells, “You Can't Get This Page!”

urllib Request Headers

```
import urllib.request
import urllib.parse

url = 'http://www.cs.odu.edu/'
query_args = {'q': 'query string', 'foo':'bar'}

headers = {'User-Agent': 'Mozilla 5.10'}

data = urllib.parse.urlencode(query_args).encode('ascii')

req = urllib.request.Request(url, data, headers)

with urllib.request.urlopen(req) as res:
    # Extracts the response
    html = res.read()
```

# Try a nicer third-party HTTP library named ‘requests’

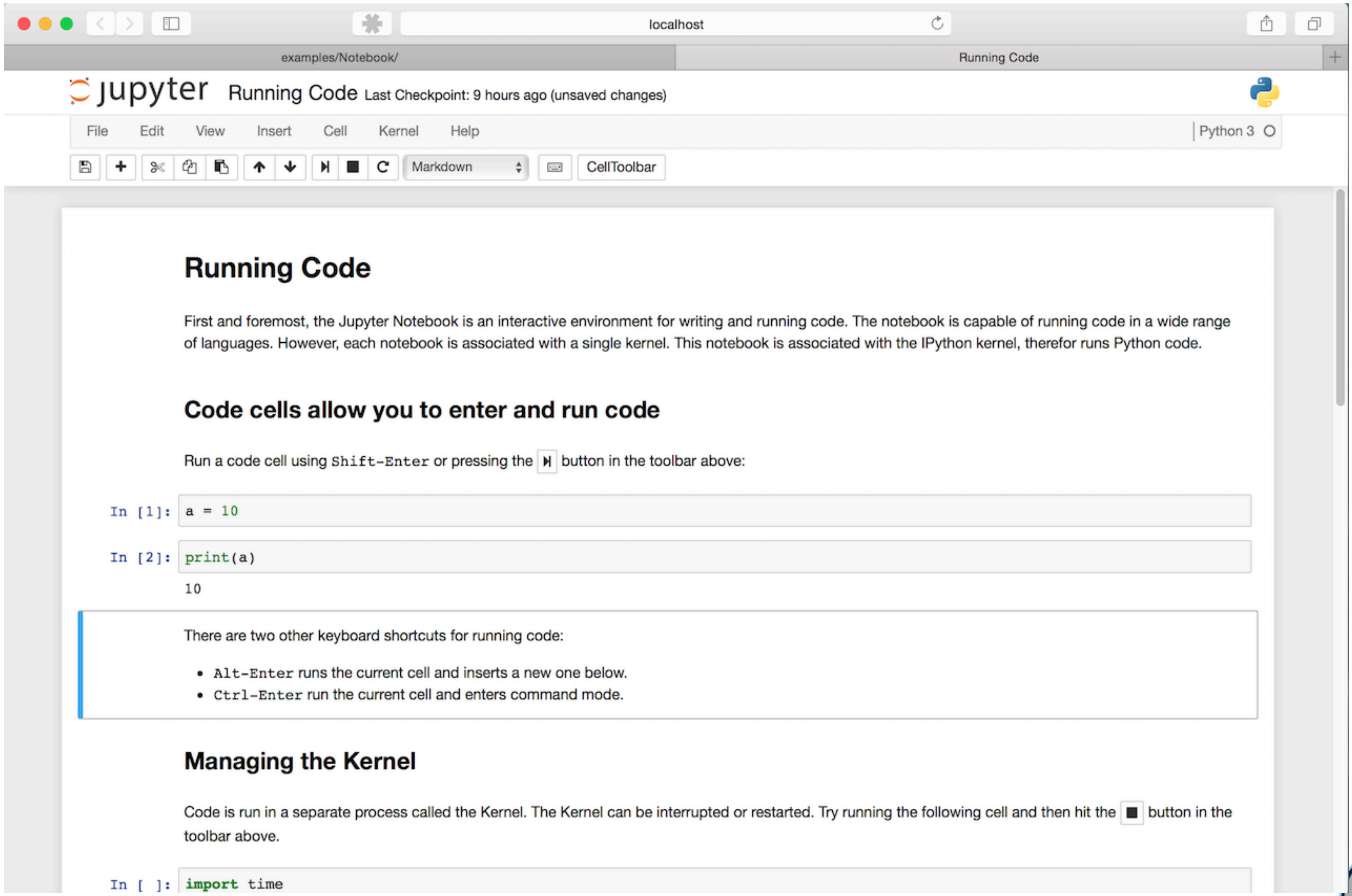
Beautiful Soup: HTML/XML Parser

```
# Installation is needed before you could use any third-party library
$ pip install beautifulsoup4
```

```python
from bs4 import BeautifulSoup
import urllib.request

with urllib.request.urlopen('http://www.reddit.com') as res:
    redditHtml = res.read()
    soup = BeautifulSoup(redditHtml)
    for links in soup.find_all('a'):
        print(links.get('href'))
```

Jupyter Notebook



Running Code Last Checkpoint: 9 hours ago (unsaved changes)

Running Code

First and foremost, the Jupyter Notebook is an interactive environment for writing and running code. The notebook is capable of running code in a wide range of languages. However, each notebook is associated with a single kernel. This notebook is associated with the IPython kernel, therefor runs Python code.

Code cells allow you to enter and run code

Run a code cell using `Shift-Enter` or pressing the ⏭ button in the toolbar above:

```
In [1]: a = 10

In [2]: print(a)

10
```

There are two other keyboard shortcuts for running code:

- `Alt-Enter` runs the current cell and inserts a new one below.
- `Ctrl-Enter` run the current cell and enters command mode.

Managing the Kernel

Code is run in a separate process called the Kernel. The Kernel can be interrupted or restarted. Try running the following cell and then hit the ■ button in the toolbar above.

```
In [ ]: import time
```

References

- http://introtopython.org/
- http://www.cs.cornell.edu/courses/cs1110/2012fa/
- http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-189-a-gentle-introduction-to-programming-using-python-january-iap-2011/lectures/
- http://courses.cms.caltech.edu/cs11/material/python/index.html
- http://www.cs.cornell.edu/courses/cs2043/2012sp/
- http://www-cs-faculty.stanford.edu/~nick/python-in-one-easy-lesson/
- http://www.pythonforbeginners.com/python-on-the-web/how-to-use-urllib2-in-python/
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- **Python in a Nutshell, 2nd Edition** By Alex Martelli