BCB Python Workshop
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Welcome to intermediate Python workshop

- Organized by Bioinformatics and Computational Biology Graduate Student Organization (BCBGSO)

- Future workshops in Spring 2019. R, Unix, Python and bioinformatics

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Download workshop material

- Go to: https://tinyurl.com/bcb-python

OR

- git clone https://github.com/urmi-21/python3-dataScience18.git

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1. Chapter I: Conditionals and Loops

2. Chapter II: Functions

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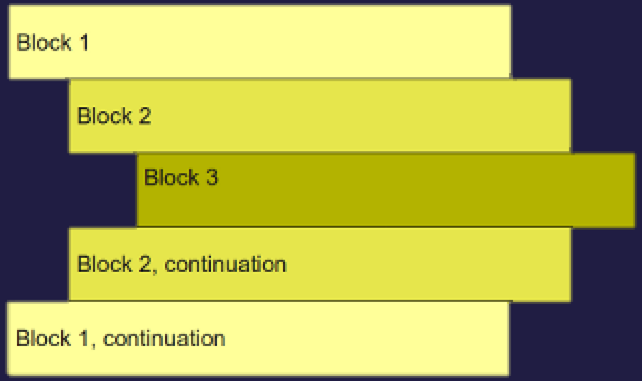
Chapter I

Conditionals and Loops

Indentation

- Python uses indentation to define code blocks
- A code block is a lexical structure of the source code
  - E.g. use *for* loop to repeat statement 10 times

```
i=0
for i in range(10):
        print i          #prints 0,1,2…9
print i                  #prints 9
```



Block 1

Block 2

Block 3

Block 2, continuation

Block 1, continuation

- Note the colon (:) and indentation after the *for* statement. All the statements having larger and equal margin from left are interpreted as a part of the *for* block.

If statements

- *If* statements or the *if/else* statements are used to execute/skip a code block based on a condition

- Basic syntax looks like

```
if(condition1):
        planA()
else:
        planB()
```

- Can have multiple conditions

```
if(condition1):
        planA()
elif(condition2):
        planB()
else:
        planC()
```

- Can be without else

```
if(condition1):
        planA()
```

Logical expressions

- The conditions checked by if statements are called logical expressions

- A logical expression can have a value “True” or “False” only

- If value for a condition is “True”, the corresponding code block will get executed otherwise it will be skipped

Comparison operators

Operator	Description	Example expression	Output
==	Equals to	‘str1’ == ‘str1’	True
!=	Not equal to	‘str1’ != ‘str1’	False
>	Greater than	3 > 3	False
>=	Greater than or equal to	3 >= 3	True
<	Less than	5 < 8	True
<=	Less than or equal to	5 <= 8	True

is	Is the same object	x=[‘1’,’2’]
		y=[‘1’,’2’]
		x is y
		y=x
		x is y
			False
			True

or	Boolean OR	5<8 or 5>8	True
and	Boolean AND	5<8 and 5>8	False
in	Membership test	‘s’ in ‘books’	True
not	Boolean NOT	not ‘s’ in ‘books’	False

Few examples on if-else

- Open the file “if-else.py” under the examples directory
- Run the “if-else.py” file and try to understand how if-else statements work.
- Make changes to the if-else conditions to allow the user to enter a power till 7 but limit the range of number from 0 till 5
- Add an additional 4th option to let user find the reciprocal of the number e.g. reciprocal of 5 is 1/5 = 0.2. What will be the reciprocal if user enters 0 ?? Can you handle this exception using an if-else statement

For Loop

- A loop is a structure which allows execution of a code block repeatedly until a terminating criteria is reached.
- For loop: repeat a block of code fixed number of times
  - Requires starting and ending criteria

```
for i in range(0,10):
    print i
```

  - range() is an in-built function. In python2, range(0,3) will generate a list [0,1,2] and so will range(3). range(1,10,3) will generate [1,4,7] last argument is the step.
  - In python3, range() returns an immutable sequence of numbers.

While loop

I call that running out of memory.
INFINITE LOOPS
Be sure to mind your repetitive control structures!

- While loops run until a certain condition is satisfied
  - Requires a stopping criteria

```
x=0
while(x<10):
    print x
    x=x+1                    #if x is not updated loop will never finish
```

- Note: Python doesn't support x++ use x=x+1 or x+=1

Break and continue

- *break* and *continue* are special statements. *break* is used to break out of the loop and *continue* is used to skip code below it and return to start of the *for* or *while* statement and start over.

```
mylist = [1,2,3,4,5,6,7,8]
for i in l:
    if (i % 2==0):                  #skips any even number
        continue
    if (i == 7):                    #exits when i is equal to 7
        break
    print i                         prints 1,3,5
```

Few examples on loops

- Open the file “loops.py” under the examples directory
- Run the “loop.py” file and try to understand how for and while loop statements work.
- Write a for or while loop that allows user to see the last n primes in the list. E.g. if input is 3 output should be 61, 67, 71.

Updating values inside loops

- Often we need to change values inside a loop depending on the computational problem
  - Be careful to initialize variables before the loop

```
l=[‘abc’, ‘def’]
string=‘’                         #important to initialize string to empty string
for x in l:
   string= string+x
print string                      #prints abcdef. Note: ‘’.join(l) does same thing
```

  - Example finding sum on first n natural numbers

```
n=5
totalsum=0                               #important to initialize totalsum =0
for x in range(n+1):
   totalsum=totalsum+x                   #adds numbers 0 till 5
print totalsum                           #prints 15
```

You are ready for exercise 1 !!!

- Go to the folder exercises and open ex1.py
- Read the questions and write your code in the space provided
- Run your code when done
- Estimated time to complete 15-20 mins

Chapter II

Functions

Functions

- Functions are modules of code that perform a specific task

- Functions promote reusability of code
  - E.g. Imagine if the built-in function “len()” was not defined. You would have to write your code every time you needed to get length of an object.

- Functions make development easier by splitting a large complex program into smaller modules

- Functions make it easier to detect bugs in the program

Functions in Python

- Function in Python begins with “def” keyword followed by function name and parentheses.
- The arguments the function takes are placed in the parentheses.
- The function block starts after a “:”
- “return” statement returns a value from the function. If “return” is absent the function returns “None”

```
def  funcSum(a,b):          #function name is funcSum, arguments are a and b
    return a+b     #returns a+b
print funcSum(5,2)          #calls the function funcSum with a=5 and b=2 and
                              prints 7
```

Lambda functions

- Lambda functions are anonymous function
- Defined without a name
- Can take any number of arguments, but can only have one expression
- Example

```
x = lambda a, b : a + b
print(x(5, 6))                #prints 11
```

- Anonymous functions are useful inside other functions.

Few examples on functions

- Open the file “functions.py” under the examples directory
- Run the “functions.py” file and try to understand how functions work.
- How many arguments each functions take ?
- Write a function “getAge” which will ask for user’s age and print it.

Global and local scope

- A variable with global scope can be accessed any where in the program
- A variable with local scope is valid only in the code-block it is defined

```
a=10                #a has global scope
def  func():
    b=10            #b is local to func
    a=5             #a is local to func
    print b         #prints b=10
    print a         #prints a=5, local scope
func()
print a             #prints a=10
print b             #error b is not defined, its scope ended with the function
```

You are ready for exercise 2 !!!

- Go to the folder exercises and open ex2.py
- Read the questions and write your code in the space provided
- Run your code when done
- Estimated time to complete 10-15 mins

Chapter III

Input/Output

Reading files in Python

- Data is usually stored in plain text files and to process/analyze data we need to first read it in our program
- Python provides a very good support via built-in functions to do file operations
- “open(‘filename’, ‘mode’)” function opens the file
  - Filename is the name of the file to open, mode is one of the following mode
    1. ‘r’: Read only mode
    2. ‘w’: Write only mode
    3. ‘a’: Append mode
    4. ‘r+’: Read and write both.
- Use close() functions to close the file when done.

Simple example (easy way)

```
with open(‘filepath/datafile.txt’) as f:      #f is a File object
        data=f.read().splitlines()     #read file line-by-line
print data                             #now file is in the list data
print len(data)                        #print total number of lines
```

- “with” allows for simpler syntax and make sure file is closed after reading is done. No need to use close()
- f.write() writes to file when opened in ‘w’, ‘a’ or ‘r+’ mode
- Note: Make sure to convert data from type “str” to int or float

Few examples on reading files

- Open the file “readfile.py” under the examples directory
- Run the “readfile.py” file and try to understand how it works.
- What happens if you use .readlines() instead of .read().splitlines() ?

You are ready for exercise 3 !!!

- Go to the folder exercises and open ex3.py
- Read the questions and write your code in the space provided
- Run your code when done
- Estimated time to complete 15-20 mins

Chapter IV

Introduction to Pandas

Pandas

- Pandas is an open-source python library
- Provides flexible data structures and tools for data analysis
- Key features
  - Easy to keep data with rows and columns as data-frames
  - Easy to mutate data frames
  - Handles missing data (as NaN)
  - Intuitive joining and merging of datasets
  - Pandas is fast
- NumPy is required by pandas

Wes McKinney
Original author of Pandas

Data structures in Pandas: Series

- A *series* is a data structure which can hold a number of objects.
- Equivalent to a one dimensional array.
- Series can hold an object of any type (int, float, string etc.)
- Can be created using the constructor:

  pandas.Series(data, index, dtype, copy)

Series example

```
import pandas as pd                              #important to import the library
ser1 = pd.Series([1, 2, 3])                      #creates series with the list [1,2,3]
print(ser1)

serA = pd.Series(['a', 'b', 'c'])
print(serA)

Ser1A = pd.Series(['a', 'b', 'c’, 22.0])
print(ser1A)
print(ser1A[1])                                  #prints b
print(ser1A[3]*2)

#define your own index
cars = ['NSX', 'R8', 'chiron', '488 GTB']
mpg = [22, 22, 14, 22]
serCars = pd.Series(mpg, index=cars)
print(serCars)
print(serCars[['NSX','chiron']])
```

Data structures in Pandas: Dataframe

- A *dataframe* (DF) can hold tabular data (2-dimensional) with rows and columns.
- Logically same as an excel sheet.
- Each column in a data frame is a series. DF is a dict-like container for Series objects.
- DF is size-mutable, labelled, and capable of arithmetic operations on rows and columns
- Constructor for DF:

  pandas.DataFrame(data, index, columns, dtype, copy)

Dataframe example

```
#using lists
states=['AZ','CA','IA','KS','NY']
statesFull=['Arizona','California','Iowa','Kansas','New York']
dfStates=pd. DataFrame(list(zip(states,statesFull))) #Creates 5 rows and 2 cols
print(dfStates)

#data frame from dict example
d = {'Col1' : pd. Series ([1. , 2., 3.] ,index =[ '1', 'b', 'c']) , 'Col2' : pd. Series ([2. , 9., 4.] ,index
=[ 'a', 'b', 'c'])}
df1 = pd. DataFrame (d)
print(df1)                              #prints some NaN values
```

Importing data with pandas

- Read .csv file into dataframe using pd.read_csv("data/iris.data.csv")
- Read files using a url pd.read_csv("https://raw.githubusercontent.com/urmi-21/python3-dataScience18/master/data/iris.data.csv")
- Get summary of data using df.describe()
- See data dimensions df.shape
- Print first 10 rows df.head(10)

Pandas examples

- Open the file pandas notebook (“pandas.ipynb”)

You are ready for exercise 4 !!!

- Open “ExpresssionAnalysisEx.ipynb”
- Read the questions and write your code
- Estimated time to complete 15-20 mins

Epilogue

What you have learned

- If/else and loops
- Defining functions
- Reading data from files
- Pandas
- You can access all the workshop material at https://github.com/urmi-21/python3-dataScience18

What's next …

- Try out these really great (free) sources of python knowledge
  - The Python Tutorial: https://docs.python.org/3/tutorial/
  - Pandas Tutorial: https://pandas.pydata.org/pandas-docs/stable/tutorials.html
- If you get stuck or need help, **Google it!** Or post your questions to forums such as stackoverflow.com only if you couldn't find an answer online
- Always write comments in you code to make it more readable

That's all Folks