Introduction to Python
Part 1

COMPSCI 260
Fall 2019

Part 1 Topics:

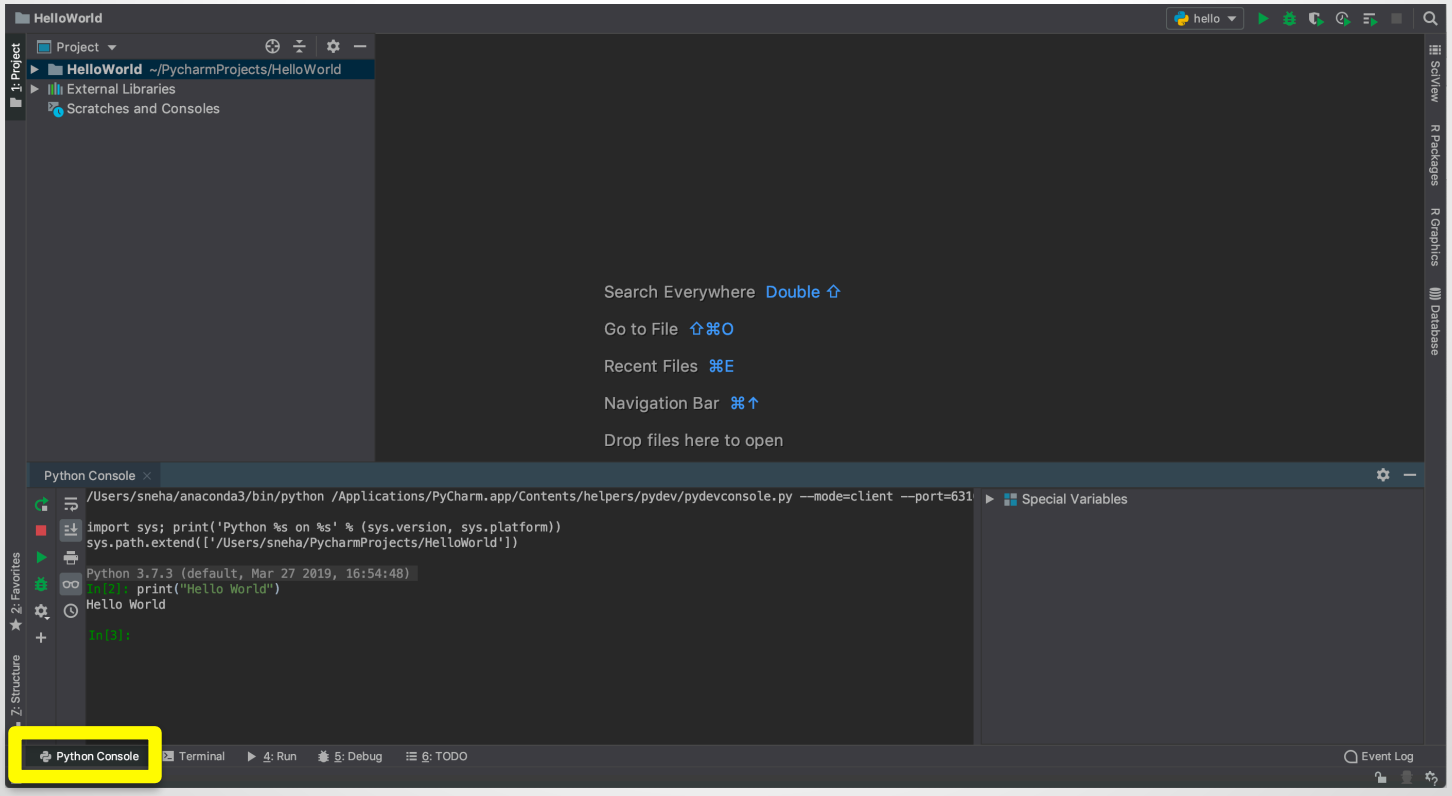
- Python language and how to run it
- Basic data types and syntax
- Control structures
- Important data structures in Python:
  - lists (strings), tuples, and dictionaries
- Function declarations

The Python Programming Language

- Dynamically vs. statically typed
- Automated memory management
- General purpose programming / scripting language
  - Thanks to a ton of modules and libraries
  - Python Package Index: https://pypi.python.org/
    - Currently **192,619** packages stored at PyPI (as of 8/19/2019 at 11:30am)

Python Interactive Shell

- Python interactive shell inside PyCharm



Python on Command Line

- Collect Python code into a text file
- Save it with .py suffix (e.g, script.py)
- Open a terminal on your machine
- Then type: python script.py Arg1 Arg2 …

Python Data Types & Syntax

- Numerical data types
  - a = 34 (integer)
  - a = 34.0 (floating point numbers – single & double precision)
  - a = True (boolean)

- Characters are strings of length 1 (more on strings later!)
  - c = “u” OR c = ‘u’

- Converting (casting) from one type to another
  - int(), float(), double(), boolean(), str()
  - i = int(“3”)

- Check type of variables with type()
  - type(34) = int

Python Data Types & Syntax (cont'd)

- Whitespace matters!
  - Think curly braces ('{') in C or Java
  - All lines with the same indentation are part of the same block/scope
  - Example:

```
if check1 == 1:
    do something...
else:
    if check2 == 1:
        do something...
```

- Comments (start with '#')
  - Example:

```
if check == 1:
    # comments can be on their own line
    do something... # or inline with code
```

Mathematical & Logical Operations

- Addition, subtraction, multiplication
  - 2 + 2, 42 – 6, 4 * 3
- Division
  - 3 / 2 = 1.5 (Dividing two integers yields floating point number)
  - 3//2 = 1 (Performs integer division)
- Modulus (Remainder)
  - 3 % 2 = 1
- Exponentiation
  - 3 ** 2 = 9
- Logical operators
  - and, or, not
  - ==, !=, <, <=, >, >=

`print` function

- Places output on the screen

```
i = 34
print(i)
```

- Use comma between variables you want printed on the same line (i.e., comma will suppress a newline)

```
print(i)
print(i,j)
```

- Can write to a file

```
print(i, file = open("output.txt", "w")
```

- Useful for debugging!

Control Structures

- `if-else` statement

```
if check == 1:
    do something...
elif (check == 2) and (not embarrassed):
    do something...
else:
    at least do something...
```

- `while` statement

```
while i < 40:
    do something
```

Control Structures (cont'd)

- `for` statement

```
for i in [1,2,4]:
    print(i)
```

- `break` and `continue`

```
for i in range(50):
    if (i == 0) or (i == 1):
        continue
```

```
for i in range(50):
    if i == 10:
        break
```

- http://docs.python.org/3.7/tutorial/controlflow.html

Lists

- Creating a list

```
list0 = []  # create empty list manually
```

```
list1 = ['a', 1, 324.3]  # create with values
```

```
list2 = list(list1) # creates a copy of list1
```

- Lists are mutable – can be changed in place

```
list1 = ['a', 1, 324.3]
list1[0] = 'b'
del list1[1]
```

- Can iterate over lists with for loops

```
for item in list1:
    print(item)
```

- List can group many different data types

```
a = [99, 'bottles of beer', ['on', 'the', 'wall']]
```

Lists (cont'd)

- List comprehension

```
[str(x) for x in [1,2,3]]
  → ['1', '2', '3']
```

- Slicing

```
a = [99, 'bottles of beer', ['on', 'the', 'wall']]
print(a[0:2])
 → [99, 'bottles of beer']
print(a[1:])
 → ['bottles of beer', ['on', 'the', 'wall']]
```

- Reverse indexing

```
print(a[-1])
 → ['on', 'the', 'wall']
print(a[-3:-1])
  → [99, 'bottles of beer']
```

- Delete elements

```
del a[1]
print(a)
 → [99, ['on', 'the', 'wall']]
```

Lists (cont'd)

```
a = [0, 1, 2]
b = [3, 4]
a + b  →    [0, 1, 2, 3, 4]
a * 3  →    [0, 1, 2, 0, 1, 2, 0, 1, 2]
```

```
a.append(5)          →  [0, 1, 2, 5]
a.pop(1)             →  [0, 2, 5]
a.insert(1, 42)      → [0, 42, 2, 5]
a.reverse()          →  [5, 2, 42, 0]
a.sort()             →  [0, 2, 5, 42]
sorted(a)            →  [0, 2, 5, 42]
```

```
print(len(a))
 →  4
```

Strings

- A string is similar to a list of characters

```
a = 'hello'
print(a[0])
 → 'h'
print(a[1:4])
 → 'ell'
print(a[-1])
 → 'o'
```

```
for c in a:
    print(c, end = ‘ ‘)
 →  h e l l o
```

- But a string is immutable
  - Test: Try to change a single character in a string variable

```
a[0] = 'j'
```

Strings

- To create a string

```
strvar1 = 'abc'

strvar2 = str(123) # can cast objects as strings
```

```
strvar5 = ''
strvar5 += 'cr'
strvar5 += 'ude' # concatenation
```

- String formatting

```
# using string formatting
strvar3 = 'Pi is about %.4f' % 3.142951
 →  'Pi is about 3.1430'

# more formatted strings
strvar4 = '%s Student #%d!' % ('Hello',42)
 →  'Hello Student #42!'
```

String Operations

```
'hello' + 'world'   →  'helloworld'         # concatenation

'hello' * 3         →  'hellohellohello'    # repetition
```

```
'hello'[::-1]       →  'olleh'              # reversing by slice

len('hello')        →      5                # size
```

```
'hello' < 'jello'         → True            # comparison

'e' in 'hello'            → True            # membership
```

```
'hello'.find('lo')         →    3           # finding substrings

'hello_world'.count('o')   →    2           # counting substrings
```

```
# splitting strings
'hello_world'.split('_')    →  ['hello','world']

# remove whitespace
'hello_world   \n'.strip()  →   'hello_world'
```

Practice Time:

- Use 15 minutes to practice with Part1.py in Tutorial 1
- Use 15 minutes to practice with Part2.py in Tutorial 1

Tuples

- Create a tuple

```
tup = ()
tup = ('32', 4, 'yes', 3.14)
```

- Quite similar to a list

```
tup[1:4]
 → (4, 'yes', 3.14)
```

- But tuples are immutable

```
tup[1] = 12  → error
```

- http://docs.python.org/3.7/library/functions.html#tuple

Dictionaries

- Dictionary are "associative arrays" mapping keys to values: {key: value}

```
d = {
    'Marky':'Mark', 'Funky':'Bunch', 3:'4', (1,2):[1,2,3]
    }
```

- Dictionary assignment & operations

```
print(list(d)) → print(list(d.keys())) → [(1, 2), 'Funky', 3,
'Marky']
print(list(d.values())) → [[1, 2, 3], 'Bunch', '4', 'Mark']
print(list(d.items()))
  →  [((1, 2), [1, 2, 3]), ('Funky', 'Bunch'), (3, '4'),
      ('Marky', 'Mark')]   # a list of key-value pairs in tuples
```

```
print(d['Marky']) → 'Mark'
d['Donnie']       → error      # raises KeyError exception
d['Donnie'] = 'Wahlberg'       # value assignment
```

```
# check for presence of key
'Donnie' in d
# item deletion
del d['Marky']
```

```
# iterate over keys
for dkey in d:
    print(dkey)
```

Practice Time:

- Use 15 minutes to practice with Part3.py in Tutorial 1

Function Declarations

```
def func1(arg1, arg2):
    function statements
    return val    # Optional
```

- Functions are pass-by-(object)-reference

```
def f1(a):
    a.append(4)

b = [1,2,3]
f1(b)
```

```
def f2(a):
    a = 4

b = [1,2,3]
f2(b)
```

Pointers (or Reference vs. Copy)

- Suppose you perform the following:

```
list1 = [1,3,4]
list2 = list1
list3 = list(list1)
list3.append(6)
list2.append(5)
```

  - What are list1, list2, and list3 now?

- Be careful not to confuse references with copies
  - Use casting functions like str(), list() when you need to make copies
  - For dictionaries, use copy() and deepcopy()

Practice Time:

- Use 20 minutes to practice with Part4.py in Tutorial 1