Unit 6

Python
(Optional – Instructor may skip due to time constraints)

PROGRAMMING LANGUAGES
Computer Abstractions

• Recall that all computer programs must be converted to 1's and 0's (aka machine code)
• Similar to translating from one spoken language to another
• Imagine you need to give a speech in front of a crowd that does not speak your native language. How could you do it?
Compiled vs. Interpreted Languages

Compiled (Natively)

• Requires code to be converted to the native machine language of the processor in the target system before it can be run
• Analogy: Taking a speech and translating it to a different language ahead of time so the speaker can just read it
• Faster
• Often allows programmer closer access to the hardware

Interpreted

• Requires an interpreter program on the target system that will interpret the program source code command by command to the native system at run-time
• Analogy: Speaking through an interpreter where the speaker waits while the translator interprets
• Better portability to different systems
• Often abstracts HW functionality with built-in libraries (networking, file I/O, math routines, etc.)

https://www.youtube.com/watch?v=qaj7nO1HUqA
Best of Both Worlds?

- Many languages used for web and desktop apps (e.g. Java and Python) will compile their code to an intermediate form (aka bytecode)
  - Then an interpreter can be used to execute the byte code faster than interpreting the high-level language directly
  - New interpreters can be provided for new devices (platforms)
- Other languages like C/C++ compile their code directly to a form that can be executed and run on the device
A Live Demo

• Sort an array of integers from N-1 to 0
  – [9,999 9,998 9,997 ... 3 2 1] =>
  – [1 2 3 ... 9,997 9,998 9,999]

• With a Python script (interpreted)
• With C++ (compiled natively)
• With a "built-in" Python library function that does the same task we just wrote manually (different algorithm)
  – a = range(N)
  – a.reverse()
  – a.sort() // built-in sort implementation (non-interpreted)

• Note: Algorithms can make all the difference!
PYTHON
Credits

• Many of the examples below are taken from the online Python tutorial at:
  – http://docs.python.org/tutorial/introduction.html
Python in Context

- Two major versions with some language differences
  - Python 2.x
  - Python 3.x (we will focus on this version)
- Interpreted, not compiled like C++
  - Can type in single commands at a time and have them execute in "real time"
  - Somewhat slower
  - Better protection (no memory faults)
Interactive vs. Scripts

• Can invoke python and work interactively
  – % python  #python 2.x
  – % python3  #python 3.x
     >>> print("Hello World")
  Ctrl-D (Linux/Mac) [Ctrl-Z Windows] at the prompt will exit.

• Can write code into a text file and execute that file as a script
  – % python3 myscript.py

# python2.x
>>>print "Hello world"

# python3.x
>>> print("Hello world")

myscript.py
Types

• Types
  – **Bool**: True/False (not true/false)
  – Integers
    • Integer division => see examples
  – Floats
  – Complex
  – Strings

• Dynamically typed
  – No need to "type" a variable
  – Python figures it out based on what it is assigned
  – Can change when re-assigned

```python
>>> 3 / 2  # default to float
1.5

>>> 3 // 2  # integer division
1

>>> 1.25 / 0.5
2.5

>>> 2+4j + 3-2j
(5+2j)

>>> "Hello world"
'Hello world'

>>> 5 == 6
False

>>> x = 3
>>> x = "Hi"
>>> x = 5.0 + 2.5
```
Strings

• Enclosed in either double or single quotes
  – The unused quote type can be used within the string
• Can concatenate using the ‘+’ operator
• Can convert other types to string via the `str(x)` method
• Compare with `==`, `!=`, etc.

```
>>> 'spam eggs'
'spam eggs'

>>> "doesn't"
"doesn't"

>>> "'Yes," he said.'
"'Yes," he said.'

>>> "Con" + "cat" + "enate"
'Conenate'

>>> i = 5
>>> j = 2.75
>>> "i is " + str(i) + " & j is" + str(j)
'i is 5 & j is 2.75'
```
Simple Console I/O

• **Python3.x**
  – Output using `print()`
    • Must use parentheses
    • Use `end=''` argument for ending options
  – Input using `input(prompt)`
    • Returns a string of all text typed until the newline

• **Conversion to numeric types:**
  – `int(string_var)` convert to an integer
  – `float(string_var)` convert to a float

```python
>>> print("A new line will")
>>> print('be printed')
A new line will be printed

>>> print('A new line will', end='')
>>> print(' not be printed')
A new line will be printed

# Getting input
>>> response = input("Enter text: ")
Enter text: I am here

>>> print(response)
I am here

>>> response = input("Enter a num: ")
Enter a num: 6

>>> x = int(response)
>>> x = float(response)
```
Selection Structures

- **if...elif...else**
- Ends with a : on that line
- Blocks of code delineated by indentation (via tabs/spaces)

```python
myin = input("Enter a number: ")
x = int(myin)
if x > 10:
    print("Number is greater than 10")
elif x < 10:
    print("Number is less than 10")
else:
    print("Number is equal to 10")
```
Iterative Structures

• `while <cond>`:

• Again code is delineated by indentation

```python
secret = 18
attempts = 0
while attempts < 10:
    myin = input("Enter a number: ")
    if int(myin) == secret:
        print("Correct!")
        break
    attempts += 1
```
Lists

• Lists are like arrays from C++ but can have different (heterogenous) types in a single list object

• Comma separated values between square brackets

• Basic operations/functions:
  – append(value)
  – pop(loc)
  – len(list)

```
>>> x = ['Hi', 5, 6.5]
>>> print(x[1])
5

>>> y = x[2] + 1.25
>>> print(y)
7.75

>>> x[2] = 9.5
>>> x
['Hi', 5, 9.5]

>>> x.append(11)
>>> x
['Hi', 5, 9.5, 11]

>>> y = x.pop(1)
>>> x
['Hi', 9.5, 11]

>>> print(y)
5

>>> len(x)
3
```
Iterative Structures

- **for <item> in <collection>:**
  - collection can be list or some other collection
  - For a specific range of integers just use range() function to generate a list
    - Start is inclusive, stop is exclusive
    - `range(stop)`
      - 0 through stop-1
    - `range(start, stop)`
      - start through stop-1
    - `range(start, stop, step)`
      - start through stop in increments of stepsize

```python
# Prints 0 through 5 on separate lines
x = [0,1,2,3,4,5]  # equiv to x = range(6)
for i in x:
    print(i)

# Prints 0 through 4 on separate lines
x = 5
for i in range(x):
    print(i)

# Prints 2 through 5 on separate lines
for i in range(2,6):
    print(i)

x = ["hi", "world", "bye"]
mystring = ""
for word in x:
    mystring += word + " "
```
Exercise 1

• Get integers from the user until they type `quit`
• Output only the sum of the 1\textsuperscript{st} and last integers entered

```
7
2
-4
9
quit
16
```