Unit 6

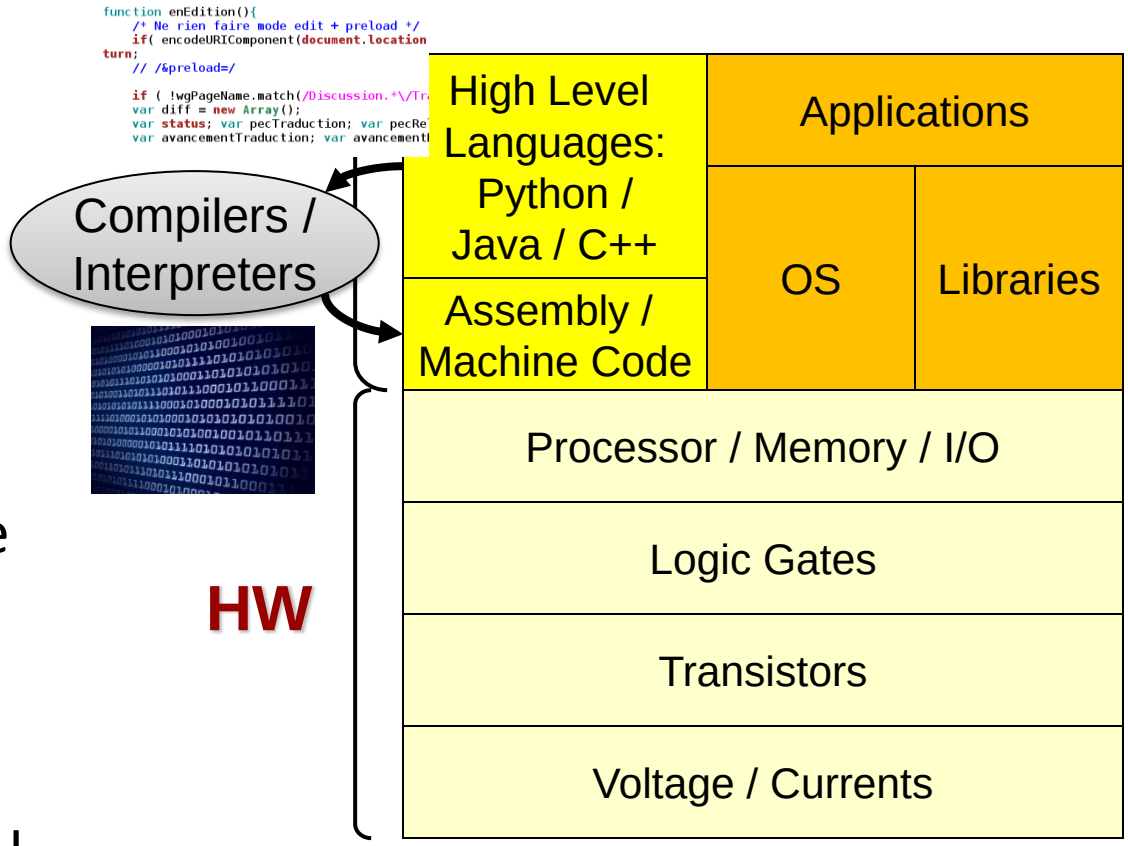
Python

(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

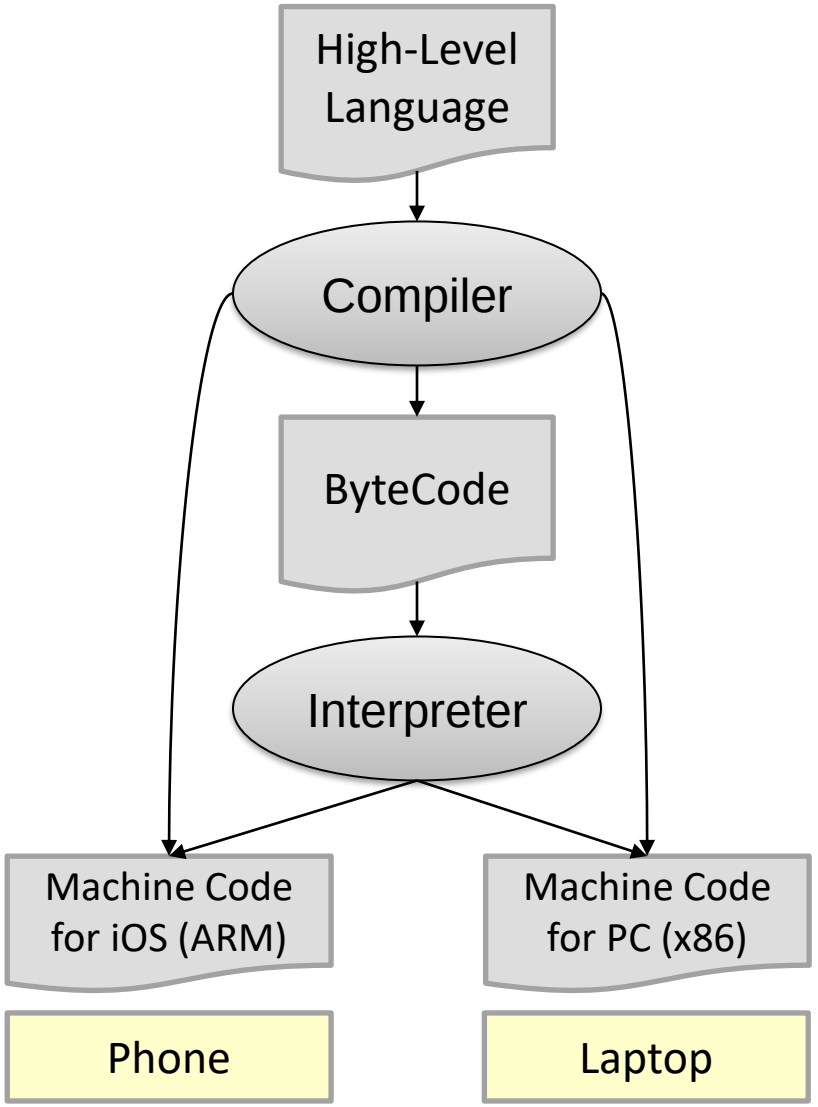
Interpreted

- 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

```
>>> 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"
'Concatenate'

>>> 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

```
>>> 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)

```
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

```
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
7.75

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

>>> x.append(11)
['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

```
# 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 1st and last integers entered

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