Compsci 6/101: PFTW

- What is Python? What is a programming language?
  - How are programs executed? What does that mean?
  - Why do you need to have an understanding of this?
  - What are functions, modules, return values, function calls
- What's an APT and how do you solve them?
  - Why are you writing a function?
  - Who calls the function you write?
- What is a list and what is a list comprehension?
  - How to create, modify, and use lists
  - Why lists will change your life … for the better!

Python (C, Javascript, Java, PHP, …)

- High level programming languages
  - *Translate* to lower-level languages: assembly, bytecode
  - *Executed* by a virtual machine or by a chip/real machine
  - *Compile* the high level language into lower level
  - Python compiler/interpreter written in C or Java (or …)
    - Compilers for platforms: Mac, Windows, Linux, …
- Abstractions: foundation of languages
  - Make it easier to think about problems and avoid details
  - Hide details, which can sometimes have issues
  - What is a loop, a list, an int, a String a function …

From high- to low-level Python

```
def reverse(s):
  r = ""
  for ch in s:
    r = ch + r
  return r
```

- Create version on the right using dissassembler

```
dis.dis(code.py)
```

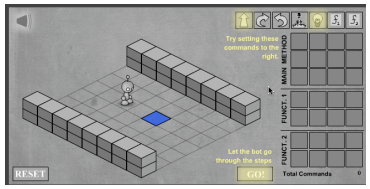
```
 7      0 LOAD_CONST      1 ('')
        3 STORE_FAST      1 (r)

 8      6 SETUP_LOOP     24 (to 33)
        9 LOAD_FAST       0 (s)
       12 GET_ITER
  >>   13 FOR_ITER       16 (to 32)
       16 STORE_FAST      2 (ch)

 9     19 LOAD_FAST       2 (ch)
       22 LOAD_FAST       1 (r)
       25 BINARY_ADD
       26 STORE_FAST      1 (r)
       29 JUMP_ABSOLUTE  13
  >>   32 POP_BLOCK

10  >>  33 LOAD_FAST       1 (r)
       36 RETURN_VALUE
```


High level, low level, abstractions

- Python byte-code is executed by…
  - Platform specific virtual machine/environment
  - Similar to Java
- Javascript code is executed by …
  - Platform specific browser (Firefox, IE, Chrome, Opera, …)
  - Is HTML executed?
- C++ code is executed by …
  - The CPU and the operating system, from compiled code
  - Compiler is platform specific
- Microsoft word is executed by …
  - Platform specific OS, CPU, from compiled executable

Reading and understanding Python

- When a program executes where does it start?
  - When you click the 'run' button, what happens?
  - What does it mean to 'execute sequentially'?
  - What happens when one function calls another (e.g., FileFilter.py or OldWoman.py)
- Simple illustration:
- http://www.kongregate.com/games/Coolio_Niato/light-bot



Lynn Conway

See Wikipedia and lynnconway.com

- Joined Xerox Parc in 1973
  - Revolutionized VLSI design with Carver Mead
- Joined U. Michigan 1985
  - Professor and Dean, retired '98
- NAE '89, IEEE Pioneer '09
- Helped invent dynamic scheduling early '60s IBM
- Transgender, fired in '68

Debugging APTs: Going green

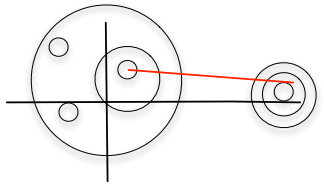
- TxMsg APT: from ideas to code to green
  - What are the main parts of solving this problem?
  - Transform words in original string
    - Abstract that away at first
  - Finding words in original string
    - How do we do this?

```
def getMessage(original):
    ret = ""
    for word in original.split():
        ret = ret + " " + transform(word)
    return ret   #initial space?
```


Debugging APTs: Going green

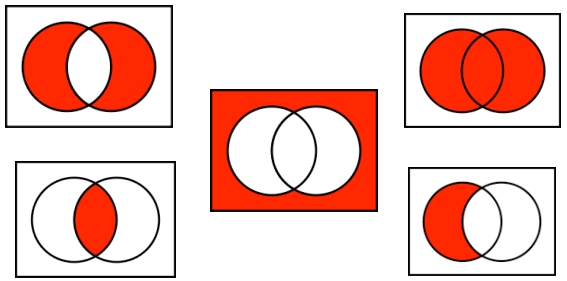
- CirclesCountry APT: from ideas to code to green
  - How do we solve the problem? May not be apparent
  - How do we loop over circles? What is a circle?
    - When is a piont inside a circle?

```
x = leastBorder([-3,2,2,0,-4,12,12,12],
[-1,2,3,1,5,1,1,1],[1,3,1,7,1,1,2,3],2,3,13,2)
```



Set, Logic Operations from pictures

- http://en.wikipedia.org/wiki/File:Venn0111.svg



Revisiting cgratio APT

- How do you count 'c' and 'g' content of a string?
  - Toward a transformative approach v. modification/mutate

```
def cgcount(strand):
    cg = 0
    for nuc in strand:
        if nuc == 'c' or nuc == 'g':
            cg += 1
    return cg

def cgcount2(strand):
 cg = [1 for ch in strand if ch == 'c' or ch == 'g']
 return sum(cg)
```


List Comprehensions

- Creating a list from another list, two decisions:
  - Is new list the same size as original, or smaller?
  - Are elements the same or related by some correspondence?

```
words = ["bear", "lion", "zebra", "python"]
w2 = [w for w in words if some_property(w)]
w3 = [f(w) for w in words]
w4 = [1 for w in words if some_property(w)]
```

- Once we have list can apply list functions
  - We have: len, sum, max, min
  - Can "invent" others by writing functions

List Comprehensions Again

- Transformative approach can scale differently
  - Functional programming: code generates and doesn't modify
  - Basis for (ultra) large scale mapreduce/Google coding

```
w = [expr for elt in list if bool-expr]
w = [f(w) for w in list if bool_expr(w)]
```

- Why are abstractions important?
  - Reason independently of concrete examples
  - Generalize from concrete examples
  - http://wapo.st/e5ZtkB