BASIC TRAINING

Outline:

- Hello World!
- calculator/basic math
- strings
- variables
- basic control statements
  - indentation!

Hello, World.

follow along the code at:
`http://bit.ly/bootcamp-lecture1`

C++

file: hello.cpp

```
#include <iostream>
int main()
{
  std::cout << "Hello World!" << std::endl;
}
```

```
BootCamp> g++ -o hello hello.cpp
BootCamp> ./hello
Hello World!
BootCamp>
```

FORTRAN

file: hello.f

```
      PROGRAM HELLO
      WRITE (*,100)
      STOP
  100 FORMAT (' Hello World! ' /)
      END
```

```
BootCamp> g77 -o hello hello.f
BootCamp> ./hello
Hello World!
BootCamp>
```

Java

file: hello.java

```
class HelloWorld {
  static public void main( String args[] ) {
    System.out.println( "Hello World!" );
  }
}
```

```
BootCamp> javac hello.java
BootCamp> java HelloWorld
Hello World!
BootCamp>
```

example compiled languages

http://www.roesler-ac.de/wolfram/hello.htm

interactive

```
BootCamp> python
>>> print "Hello World!"
Hello World!
>>>
```

scripted

file: hello.py

```
print "Hello World!"
```

```
BootCamp> python hello.py
Hello World!
BootCamp>
```

2 points:

1. Python provides both an interactive way to develop code and a way to execute scripts

2. What you do interactively is basically the same thing you (can) do in your scripts

Calculator

there are int & floats (but not doubles)

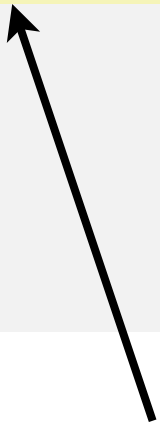
```
>>> print 2 + 2
4
>>> 2 + 2
4
>>> print 2.1 + 2
4.1
>>> 2.1 + 2 == 4.099999999999996
True
```

- Python stores floats as their byte representation so is limited by the same 16-bit issues as most other languages
- in doing calculations, unless you specify otherwise, Python will store the results in the smallest-byte representation

Notes:

1. Indentation matters!
2. When you mess up, python is gentle
3. # starts a comments (until the end of the line)

```
>>> 2 + 2
4
>>>  2 + 2
  File "<stdin>", line 1
    2 + 2
    ^
IndentationError: unexpected indent
>>> 2 # this is a comment and is not printed
2
>>> # this is also a comment
>>>
```



handy error message!

Calculator

there are also longs & complex types

```
>>> 2L
2L
>>> 2L + 2
4L
>>> 2L/2
1L
>>> 2L/2.0
1.0
>>> complex(1,2)
(1+2j)
>>> 1+2j
(1+2j)
>>> 1 + 2j - 2j
1+0j
```

Calculator

```
>>> (3.0*10.0 - 25.0)/5.0
1.0
>>> print 3.085e18*1e6  # this is a Megaparsec in units of cm!
3.085e+24
>>> t = 1.0   # declare a variable t (time)
>>> accel = 9.8  # acceleration in units of m/s^2
>>> # distance travelled in time t seconds is 1/2 a*t**2
>>> dist = 0.5*accel*t*t
>>> print dist # this is the distance in meters
4.9
>>> dist1 = accel*(t**2)/2
>>> print dist1
4.9
>>> dist2 = 0.5*accel*pow(t,2)
>>> print dist2
4.9
```

-**variables** are assigned on the fly

-multiplication, division, exponents as you expect

Calculator

```
>>> 6 / 5 ; 9 / 5 #  integer division returns the floor
1
1
>>> 6 % 5 # mod operator
1
>>> 1 << 2 ## shift: move the number 1 by two bits to the left
           ##        that is make a new number 100 (base 2)
4
>>> 5 >> 1 ## shift: move the number 5 = 101 (base 2) one to
           ## to the right (10 = 2)
2
>>> x = 2 ; y = 3  ## assign two variables on the same line!
>>> x | y          ## bitwise OR
3
>>> x ^ y          ## exclusive OR (10 ^ 11 = 01)
1
>>> x & y          ## bitwise AND
2
>>> x = x ^ y ; print x
1
>>> x += 3 ; print x
4
>>> x /= 2.0
>>> print x
2.0
```

we'll see a lot more mathy operators and functions later

Calculator

relationships

```
>>> # from before dist1  = 4.9 and dist = 4.9
>>> dist1 == dist
True
>>> dist < 10
True
>>> dist <= 4.9
True
>>> dist < (10 + 2j)
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)

/Users/jbloom/<ipython console> in <module>()

TypeError: no ordering relation is defined for complex numbers

>>> dist < -2.0
False
>>> dist != 3.1415
True
```

More on Variables & Types

None, numbers and truth

```
>>> 0 == False
True
>>> not False
True
>>> 0.0 == False
True
>>> not (10.0 - 10.0)
True
>>> not -1
False
>>> not 3.1415
False
>>> x = None    # None is something special. Not true or false
>>> None == False
False
>>> None == True
False
>>> False or True
True
>>> False and True
False
```

More on Variables & Types

```
>>> print type(1)
<type 'int'>
>>> x = 2 ; type(x)
<type 'int'>
>>> type(2) == type(1)
True
>>> print type(True)
<type 'bool'>
>>> print type(type(1))
<type 'type'>
>>> print type(pow)
<type 'builtin_function_or_method'>
```

we can test whether something is a certain type with `isinstance()`

```
>>> isinstance(1,int)
True
>>> isinstance("spam",str)
True
>>> isinstance(1.212,int)
False
```

builtin-types: `int, bool, str, float, complex, long`....

Strings

Strings are a sequence of characters

- they can be indexed and sliced up as if they were an array
- you can glue strings together with + signs

Strings are **immutable** (unlike in C), so you cannot change a string in place (this isn't so bad...)

Strings can be formatted and compared

```
>>> x = "spam" ; print type(x)
<type "str">
>>> print "hello!\n...my sire."
hello!
...my sire.
>>> "hello!\n...my sire."
'hello!\n...my sire.'
>>> "wah?!" == 'wah?!'
True
>>> print "'wah?!' said the student"
'wah?!' said the student
>>> print "\"wah?!\" said the student"
"wah?!" said the student
```

backslashes (\) start special (escape) characters:

`\n` = newline (`\r` = return)

`\t` = tab

`\a` = bell

http://docs.python.org/reference/lexical_analysis.html#string-literals

string literals are defined with double quotes or quotes.
the outermost quote type cannot be used inside the string
(unless it's escaped with a backslash)

```
>>> # raw strings don't escape characters
>>> print r'This is a raw string...newlines \r\n are ignored.'
This is a raw string...newlines \r\n are ignored.
>>> # Triple quotes are real useful for multiple line strings
>>> y = '''For score and seven minutes ago,
    you folks all learned some basic mathy stuff with Python
    and boy were you blown away!'''
>>> print y
For score and seven minutes ago,
you folks all learned some basic mathy stuff with Python
and boy were you blown away!
```

- prepending `r` makes that string "raw"
- triple quotes allow you to compose long strings
- prepending `u` makes that string "unicode"

http://docs.python.org/reference/lexical_analysis.html#string-literals

```
>>> s = "spam" ; e = "eggs"
>>> print s + e
spameggs
>>> print s + " and " + e
spam and eggs
>>> print "green " + e + " and\n " + s
green eggs and
 spam
>>> print s*3 + e
spamspamspameggs
>>> print "*"*50
**************************************************
>>> print "spam" is "good" ; print "spam" is "spam"
False
True
>>> "spam" < "zoo"
True
>>> "s" < "spam"
True
```

- you can concatenate strings with + sign
- you can do multiple concatenations with the * sign
- strings can be compared

```
>>> print 'I want' + 3 + ' eggs and no ' + s
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)

/Users/jbloom/<ipython console> in <module>()

TypeError: cannot concatenate 'str' and 'int' objects
>>> print 'I want ' + str(3) + ' eggs and no ' + s
I want 3 eggs and no spam
>>> pi = 3.14159
>>> print 'I want ' + str(pi) + ' eggs and no ' + s
I want 3.14159 eggs and no spam
>>> print str(True) + ":" + ' I want ' + str(pi) + ' eggs and no ' + s
True: I want 3.14159 eggs and no spam
```

you must concatenate only strings, coercing ("casting") other variable types to str

Getting input from the user: always a string response

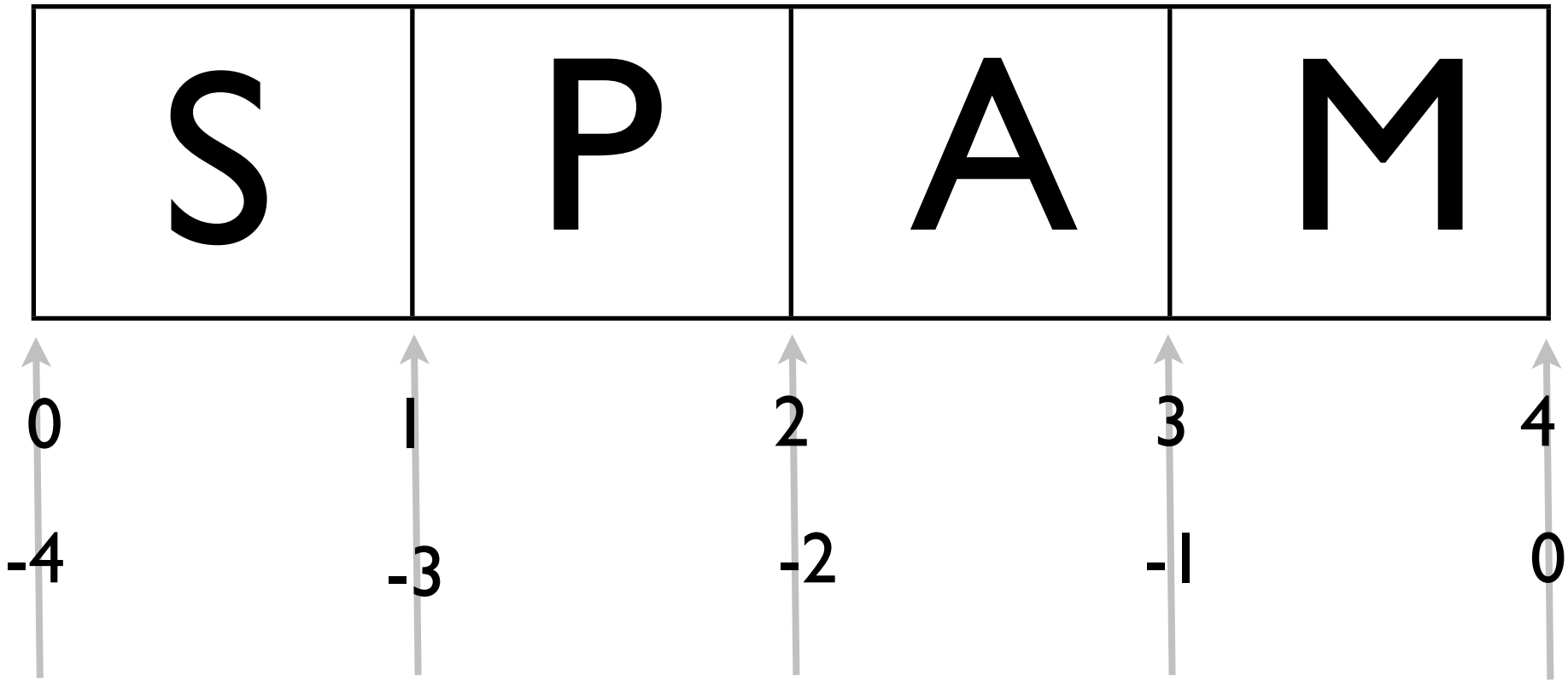
```
>>> faren = raw_input("Enter the temperature (in Fahrenheit): ")
Enter the temperature (in Fahrenheit): 71
>>> cent = (5.0/9.0)*(faren - 32.0)
...
TypeError: unsupported operand type(s) for -: 'str' and 'float'
>>> faren = float(faren)
>>> cent = (5.0/9.0)*(faren - 32.0) ; print cent
21.6666666667
>>> faren = float(raw_input("Enter the temperature (in Fahrenheit): "))
Enter the temperature (in Fahrenheit): 71
>>> print (5.0/9.0)*(faren - 32.0)
21.6666666667
>>> faren = float(raw_input("Enter the temperature (in Fahrenheit): "))
Enter the temperature (in Fahrenheit): meh!
...
ValueError: invalid literal for float(): meh!
```

We can think of strings as arrays (although, unlike in C you never really need to deal with directly addressing character locations in memory)

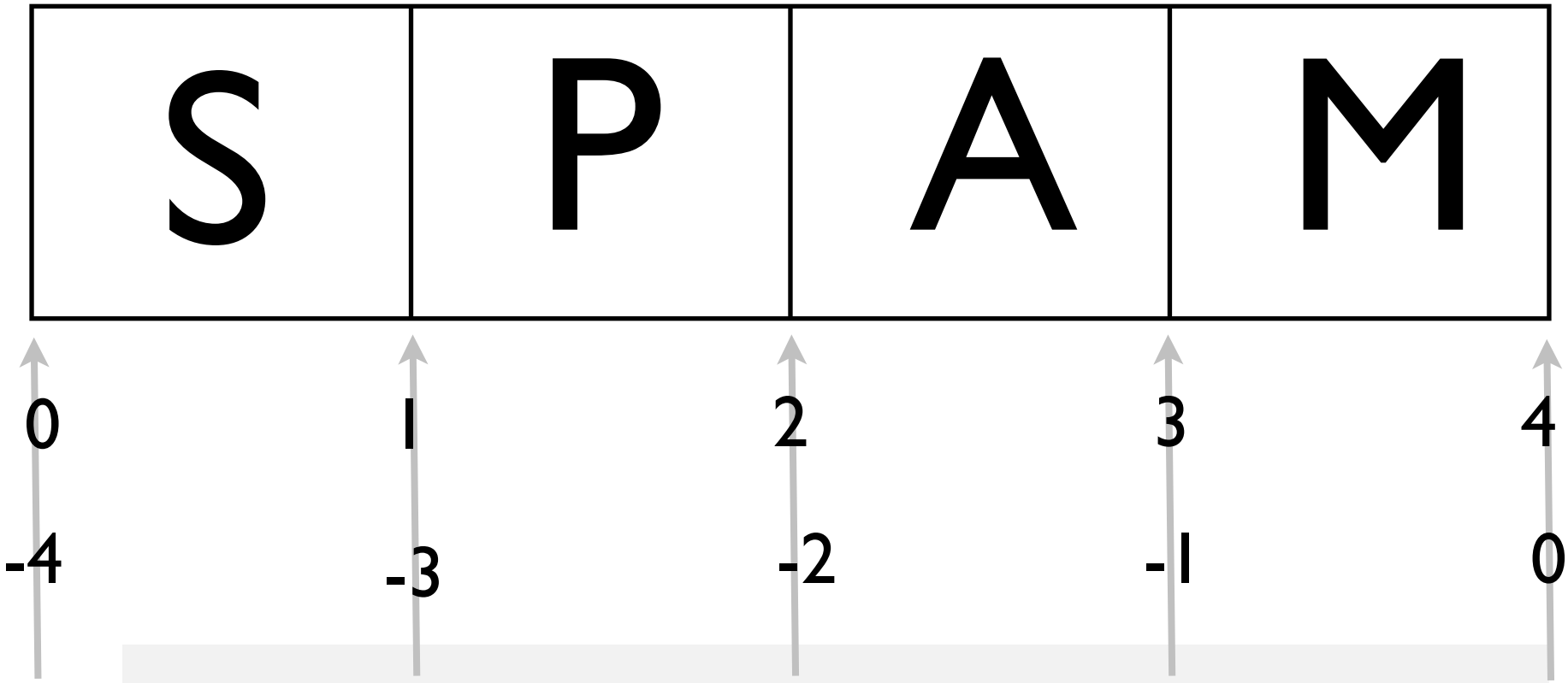
```
>>> s ="spam"
>>> len(s)
4
>>> len("eggs\n")
5
>>> len("")
0
>>> s[0]
's'
>>> s[-1]
'm'
```

- `len()` gives us the length of an array
- strings are zero indexed
- can also count backwards

We can think of strings as arrays
(although, unlike in C you never really need to deal with directly addressing character locations in memory)



useful for slicing: indices are between the characters




```
>>> s[0:1]  # get every character between 0 and 1
's'
>>> s[1:4]  # get every character between 1 and 4
'pam'
>>> s[-2:-1]
"a"
>>> ## slicing [m:n] will return abs(n-m) characters
>>> s[0:100] # if the index is beyond the len(str), you dont segfault!
'spam'
>>> s[1:]  # python runs the index to the end
'pam'
>>> s[:2]  # python runs the index to the beginning
'sp'
```

`s = s[:n] + s[n:]` for all n

Basic Control (Flow)

Python has pretty much all of what you use:

`if...elif...else,` `for,` `while`

As well as:

`break, continue` (within loops)

Does not have

case (explicitly), goto

Does have

`pass`

Flow is done within blocks (where indentation matters)

```
>>> x = 1
>>> if x > 0:
        print "yo"
    else:
        print "dude"

yo
```

Note colons & indentations (tabbed or spaced)

```
>>> x = 1
>>> if x > 0:
      print "yo"
    else:
            print "dude"

yo
```

Indentations with the same block must be the same but not within different blocks (though this is ugly)

one-liners

```
>>> print "yo" if x > 0 else "dude"
"dude"
```

a small program...

```
>>> x = 1
>>> while True:
        print "yo" if x > 0 else "dude"
        x *= -1
yo
dude
yo
dude
...
yo
dude
yo
^Cdude
Traceback (most recent call last):
  File "<stdin>", line 2, in <module>
KeyboardInterrupt
```

Control-C usually drops you back to the prompt

case statements can be constructed with just a bunch of `if, elif,...else`

```
>>> if x < 1:
        print "t"
    elif x > 100:
       print "yo"
    else:
       print "dude"

dude
```

ordering matters. The first block of `True` in an if/elif gets executed then everything else does not.

blocks cannot be empty

```
>>> x = "fried goldfish"
>>> if x == "spam for dinner":
       print "I will destroy the universe"
    else:
       # I'm fine with that. I'll do nothing

  File "<stdin>", line 5

    ^
IndentationError: expected an indented block
>>>
```

`pass` is a "do nothing" statement

```
>>> if x == "spam for dinner":
       print "I will destroy the universe"
    else:
       # I'm fine with that. I'll do nothing
       pass

>>>
```

```
# set some initial variables. Set the initial temperature low
faren = -1000

# we dont want this going on forever, let's make sure we cannot have too many attempts
max_attempts = 6
attempt = 0

while faren < 100:
     # let's get the user to tell us what temperature it is
     newfaren = float(raw_input("Enter the temperature (in Fahrenheit): "))
     if newfaren > faren:
             print "It's getting hotter"
     elif newfaren < faren:
             print "It's getting cooler"
     else:
         # nothing has changed, just continue in the loop
         continue
     faren = newfaren # now set the current temp to the new temp just entered
     attempt += 1 # bump up the attempt number
     if attempt >= max_attempts:
         # we have to bail out
         break

if attempt >= max_attempts:
     # we bailed out because of too many attempts
     print "Too many attempts at raising the temperature."
else:
     # we got here because it's hot
     print "it's hot here, man."
```

file: temp1.py

```
BootCamp> python temp1.py
Enter the temperature (in Fahrenheit): 1
It's getting hotter
Enter the temperature (in Fahrenheit): 2
It's getting hotter
Enter the temperature (in Fahrenheit): 3
It's getting hotter
Enter the temperature (in Fahrenheit): 4
It's getting hotter
Enter the temperature (in Fahrenheit): -1
It's getting cooler
Enter the temperature (in Fahrenheit): 10
It's getting hotter
Too many attempts at raising the temperature.
BootCamp>
```

```
BootCamp> python temp1.py
Enter the temperature (in Fahrenheit): 3
It's getting hotter
Enter the temperature (in Fahrenheit): -45
It's getting cooler
Enter the temperature (in Fahrenheit): 101
It's getting hotter
it's hot here, man.
BootCamp>
```

```
# set some initial variables. Set the initial temperature low
faren = -1000

# we dont want this going on forever, let's make sure we cannot have too many
attempts
max_attempts = 6
attempt = 0

while faren < 100 and (attempt < max_attempts):
     # let's get the user to tell us what temperature it is
     newfaren = float(raw_input("Enter the temperature (in Fahrenheit): "))
     if newfaren > faren:
             print "It's getting hotter"
     elif newfaren < faren:
             print "It's getting cooler"
     else:
         # nothing has changed, just continue in the loop
         continue
     faren = newfaren # now set the current temp to the new temp just entered
     attempt += 1 # bump up the attempt number

if attempt >= max_attempts:
     # we bailed out because of too many attempts
     print "Too many attempts at raising the temperature."
else:
     # we got here because it's hot
     print "it's hot here, man."
```

file: temp2.py

Exercise for the Breakout

Write a program which allows the user to build up a sentence one word at a time, stopping when they enter a period (.), exclamation (!), or question mark (?)

example interaction:

```
Please enter a word in the sentence (enter . ! or ? to end.): My
...currently: My
Please enter a word in the sentence (enter . ! or ? to end.): name
...currently: My name
Please enter a word in the sentence (enter . ! or ? to end.): is
...currently: My name is
Please enter a word in the sentence (enter . ! or ? to end.): Slim
...currently: My name is Slim
Please enter a word in the sentence (enter . ! or ? to end.): Shady
...currently: My name is Slim Shady
Please enter a word in the sentence (enter . ! or ? to end.): !
--->My name is Slim Shady!
```