An Introduction to Python

Day 1

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Why Python?

* Clear code
* Great beginner language
* Powerful text manipulation
* Wrangle large data files
* Great compliment to other languages
* Large user group
* Supports many advanced features

Warning: Spacing is important!

Wrong:

```
>>> def dna():
... nucs = 'AGCT'
```

Error:

```
  File "<stdin>", line 2
    nucs = 'AGCT'
        ^
IndentationError: expected an indented block
>>>
```

Correct:

```
>>> def dna():
...     nux = 'AGCT'
...     return nucs
...
>>>
```

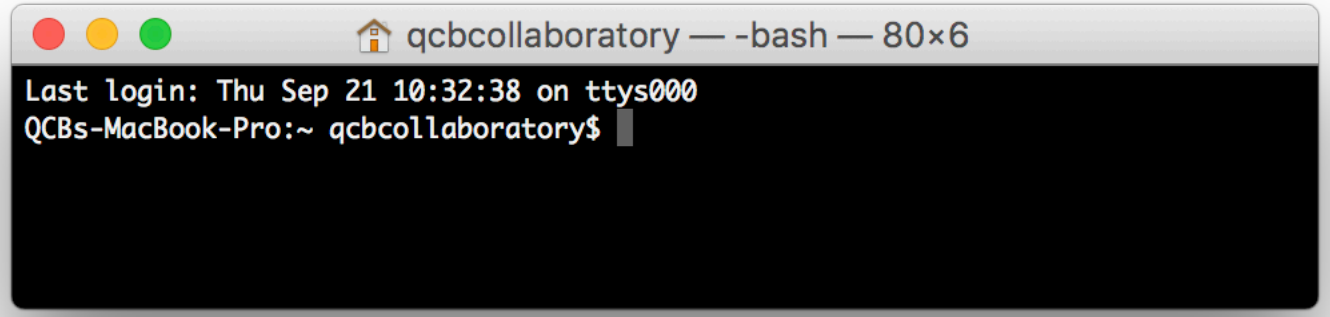
No Error:

Tip: Use **TAB** key

First steps

Open A Terminal

* Open a terminal:
  * Mac: cmd + space then type terminal and press enter
  * Windows: Start -> Program Files -> Accessories -> Command Prompt.
  * Ubuntu: Ctrl+Alt+T



Open Python3

* Open Python3: type **python3** (or **python** if it does not work)
* Exit Python: type **exit()**

This is python

qcbcollaboratory — -bash — 80×12

```
Last login: Thu Sep 21 11:20:57 on ttys001
QCBs-MacBook-Pro:~ qcbcollaboratory$ echo "this is the terminal"
this is the terminal
QCBs-MacBook-Pro:~ qcbcollaboratory$ python3
Python 3.6.2 (v3.6.2:5fd33b5926, Jul 16 2017, 20:11:06)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("this is python")
this is python
>>> exit()
QCBs-MacBook-Pro:~ qcbcollaboratory$
```

Python2 vs Python3

* Type: **python** or **python2**

Python 2

```
qcbcollaboratory — python — 80×24
QCBs-MacBook-Pro:~ qcbcollaboratory$ python
Python 2.7.10 (default, Feb  7 2017, 00:08:15)
[GCC 4.2.1 Compatible Apple LLVM 8.0.0 (clang-800.0.34)]
Type "help", "copyright", "credits" or "license" for mor
>>>
```

* Type: **python3**

Python 3

```
qcbcollaboratory — Python — 80×24
QCBs-MacBook-Pro:~ qcbcollaboratory$ python3
Python 3.6.2 (v3.6.2:5fd33b5926, Jul 16 2017, 20:11:06)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for mor
>>>
```

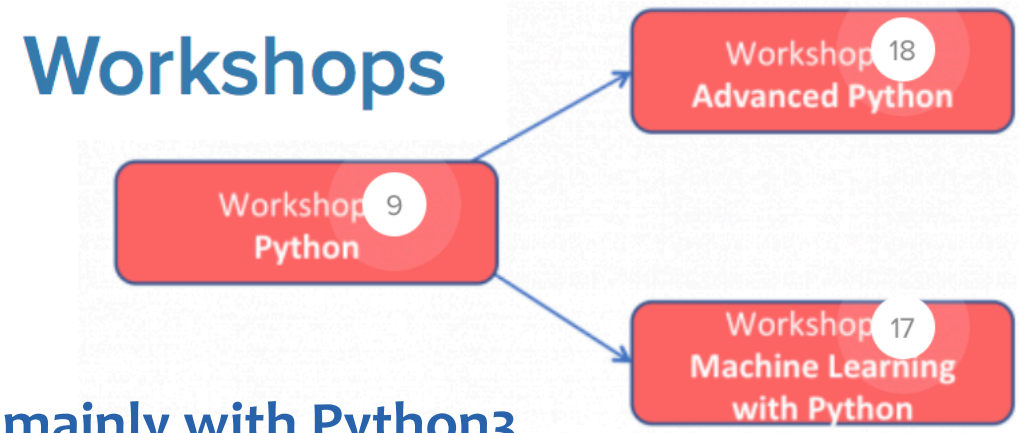
* **Differences between the two versions**

```
>>> print "hello"
hello
>>>
```

```
>>> print "hello"
  File "<stdin>", line 1
    print "hello"
                ^
SyntaxError: Missing parentheses in call to 'print'
>>>
```

Why working with Python3?

* It is the future ☺
* Autocomplete in the interpreter (with **TAB** key)
* UTF-8 by default (*Je suis Français*)
* More and more libraries soon not compatible with Python2
* Python3 used in the next Workshops



* **In this workshop: work mainly with Python3**
  * **Often the code is compatible with Python2**
  * **Will show the main differences with Python2.**

Hello World

Launch Python, type **print("Hello World")**

```
QCBs-MacBook-Pro:~ qcbcollaboratory$ python3
Python 3.6.2 (v3.6.2:5fd33b5926, Jul 16 2017, 20:11:06)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> print("Hello World")
```

Call the built in function *print*, which displays whatever comes after the command.
Put any message in quotes after the print command.
Then press **Return**

```
Hello World
>>>
```

The command has finished and python is ready for the next command.

`>>>` means: "tell me what to do now!"

Python2 vs 3: Print function

- Python2
  - Syntax with brackets

```
>>> print("Hello World")
Hello World
```

  - Syntax without brackets

```
>>> print "Hello World"
Hello World
```

- Python3
  - Syntax with brackets

```
>>> print("Hello World")
Hello World
```

  - Syntax without brackets: Error !!!

```
>>> print "Hello World"
  File "<stdin>", line 1
    print "Hello World"
                       ^
SyntaxError: Missing parentheses in call to
'print'
```

Getting help - interactive

```
>>> help()

Welcome to Python 3.6's help utility!

If this is your first time using Python, you should definitely check out
the tutorial on the Internet at http://docs.python.org/3.6/tutorial/.

Enter the name of any module, keyword, or topic to get help on writing
Python programs and using Python modules.  To quit this help utility and
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbols, or topics, type
"modules", "keywords", "symbols", or "topics".  Each module also comes
with a one-line summary of what it does; to list the modules whose name
or summary contain a given string such as "spam", type "modules spam".

help>
```

Getting help – single command

```
help> quit

You are now leaving help and returning to the Python interpreter.
If you want to ask for help on a particular object directly from the
interpreter, you can type "help(object)".  Executing "help('string')"
has the same effect as typing a particular string at the help> prompt.
>>> help("pprint")
```

But usually just Google!
If you got stuck on something, someone else probably has.

Let's get programming - Variables

Set a variable with equals

Display a variable by typing its name

Variables can be text, numbers, boolean (True/False) and many more things.

Capitalization is important for True/False

```
>>> someText = "Ssssso thissss isssssss a sssstring"
>>> someText
'Ssssso thissss isssssss a sssstring'
>>> someInteger = 42
>>> someInteger
42
>>> someFloat = 3.14159
>>> someFloat
3.14159
>>> aBoolean = True
>>> aBoolean
True
>>> aBoolean = FALSE
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'FALSE' is not defined
>>> aBoolean = False
>>> aBoolean
False
>>>
```

Working with numbers

Numeric Operators

Add +

Subtract –

Multiply *

Divide /

Power **

Modulo (remainder) %

```
>>> myNumber = 2
>>> myOtherNumber = 3
>>> myNumber = 4
>>> myNumber + myOtherNumber
7
```

```
>>> myNumber * 2
8
>>> myNumber / 2
2
>>> myNumber ** 2
16
>>> myNumber % 2
0
```

Reassigning Variables

Reassign with equals.
(Same as assigning)

```
>>> myNumber = 4
>>> myNumber = (myNumber * 2) + 1
>>> myNumber
?????
```

Python2 vs 3: Division of integers

- Python2
  - Division of integers, Euclidian division

```
>>> 7/2
3
```

  - Use float on o\ne of the integers for a float division

```
>>> 7/float(2)
3.5
```

- Python3
  - Division of integers, float division

```
>>> 7/2
3.5
```

  - Use two slashes // for the Euclidian division

```
>>> 7//2
3
>>>
```

Types of number

Integer:

Plus and minus.
No decimal points or commas

```
>>> -12
-12
>>> 13000
13000
>>> 13,000
(13, 0)
```

Float:

Decimal points or scientific notation okay.
2e-2 = 2 x 10^{-2}

```
>>> 2.5
2.5
>>> 2e4
20000.0
>>> 2e-2
0.02
>>> 2*10**-2
0.02
```

Working With Numbers

What is the **minimum** of these numbers:

What is the **maximum** of these numbers:

What **type** of variable is this?

Remember that str(anything) makes that variable into a string:

```
>>> min(5,7,3,5,8,2)
2
>>> max(5,7,3,5,8,2)
8
>>> abs(-10)
10
>>> type(-10)
<type 'int'>
>>> type(-10.4)
<type 'float'>
>>> type(str(-10))
<type 'str'>
```

Working with texts

Working With Text

Single or double quotes.
No *char* type. Just a single letter string.

```
>>> "Hey Python"
'Hey Python'
>>> 'Are single quotes okay?'
'Are single quotes okay?'
>>> 'What about sy;bols ! !@#$%&?~'
'What about sy;bols ! !@#$%&?~'
>>> 'What's the deal with quotes in text?'
  File "<stdin>", line 1
    'What's the deal with quotes in text?'
          ^
SyntaxError: invalid syntax
```

```
>>> 'That\'s better'
"That's better"
```

Escape character is \
\' types a quote.

Working With Text 2

Is a substring in a string?

Is a substring NOT in a string?

String concatenation:

```
>>> 'TATA' in 'TATATATA'
True
>>> 'AA' in 'TATATATA'
False
>>> 'AA' not in 'TATATATA'
True
>>> 'AC'+'TG'
'ACTG'
>>> 'aa'+'cc'+'tt'+'gg'
'aaccttgg'
```

Working With Text 3

- Multiply a string repeats it:

```
>>> 'TA'*6
'TATATATATATA'
>>> 6*'TA'
'TATATATATATA'
```

- Set variable *myString* to be 'python'
- Each character in a string is a number
  - We start counting from **zero**!

```
>>> myString='python'
>>> myString[0]
'p'
>>> myString[1]
'y'
>>> myString[5]
'n'
>>> myString[6]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: string index out of range
>>> len(myString)
6
```

- "String index out of range" error as we tried to reference a character beyond the end of the string.
- len(myString) gets the number of characters.

Working With Text 4

Negative index counts backwards from the last element.

You can get a range of characters from a string.

```
>>> myString[0]
'p'
>>> myString[-1]
'n'
>>> myString[-5]
'y'
>>> myString[1:4]
'yth'
```

Working With Text 4

- Set the variable *seq* to be 'AGCT':
  - Get the number of characters in *seq:*
- Return the variable *seq* in all lower case characters:
- Return the variable *seq* in all upper case characters:
- Return the number 3.14 as a string:
- Display the variable *seq* repeated 3 times:
- Count the occurrences of 'A' in *seq:*

```
>>> seq='AGCT'
>>> len(seq)
4
>>> seq.lower()
'agct'
>>> seq.upper()
'AGCT'
>>> str(3.14)
'3.14'
>>> print(seq+seq+seq)
AGCTAGCTAGCT
>>> seq.count('A')
1
```

Working With Text 5

- Set the variable *seq* to be 'AGCT':
- Count the occurrences of 'A' in *seq:*
- Find which index in *seq* contains 'C'
- Does *seq* start with 'AG'
- Does *seq* start with 'GC'
- Does *seq* start with 'GC' if you start at the second letter.

```
>>> seq='AGCT'
>>> seq.count('A')
1
>>> seq.find('C')
2
>>> seq.startswith('AG')
True
>>> seq.startswith('GC')
False
>>> seq.startswith('GC',1)
True
```

Python2 vs 3: Text input

- To ask some information from the user, use of an input function:

  - Python2: Function **raw_input**

```
>>> name = raw_input("What is your name ?")
What is your name ?
```

  - Python3: Function **input**

```
>>> name = input("What is your name?")
What is your name?
```

- Prints the text in quotes and waits for user input.
- Sets the variable on the left of to whatever the user types.

Working With Text 6

```
>>> name = input("What is your name?")
What is your name?
```

print("%s" % text-here)

Place a %s in a string to place a variable at that point in the string. The variables are given in order after a %.

```
>>> print("Your name is %s."%name)
Your name is Renaud.
>>> print("Your name is %s." % name)
Your name is Renaud.
>>> print("Your name is %s." % (name) )
Your name is Renaud.
>>> lang = "Python"
>>> print("My name is %s and I use %s" % (name,lang))
My name is Renaud and I use Python
```

Type of variables

Changing a Variables Type

```
>>> int(2.1)
2
>>> int('42')
42
>>> bool(1)
True
>>> bool(0)
False
>>> bool('')
False
>>> bool(' ')
True
>>> float(3)
3.0
```

Cast a variable to another type.

Note:
1 = True
0 = False

Empty strings = False
Any other string = True

True/False – conditional expressions

```
>>> 2-1 != 1
False
>>> 2 == 5//2
True
>>> 1<2
True
```

Equal to (==)
Not equal to (!=)
Less than (<)
Less than or equal to <=
Greater than (>)
Greater than or equal to (>=)

```
>>> not True
False
>>> True and True
True
>>> True and False
False
>>> True or False
True
>>> False or not (True and True)
False
```

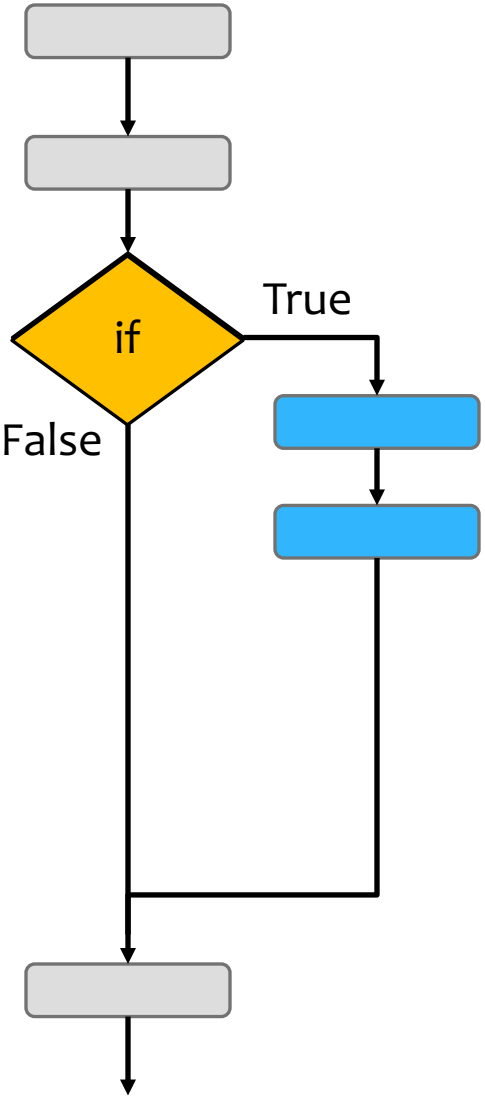
not
and
or

If-else statements

If statement

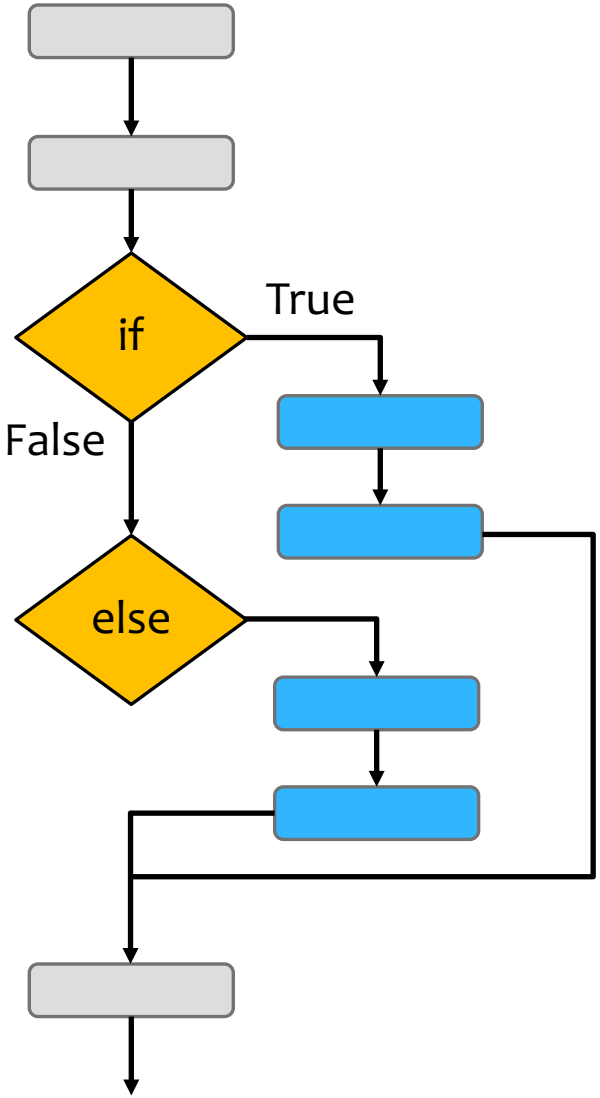
Main program statements

Conditional block of commands



Continue main program

If-else statement



If Else Statements.

```
>>> myNumber = 5
>>> if myNumber >= 2:
...     print('big number')
... else:
...     print('small number')
...
big number
```

If Else Statements

```
>>> seq = 'ATCCGGGG'
>>> if seq.startswith('ATC'):
...     print(seq)
... else:
...     print('no ATC')
...
ATCCGGGG
```

```
>>> seq = 'AGCCGGGG'
>>> if seq.startswith('ATC'):
...     print(seq)
... else:
...     print('no ATC')
...
no ATC
```

Functions

Write Code Once and Reuse

FUNCTIONS

- Might want to run the same code on million of sequences.
- Write a function once and use it whenever you have to do that task.

```
def function_name(parameter1,parameter2):
        any
        code
        here
        return result_of_function
```

Write Your First Function

```
>>> def myFirstFunction(myParameter):
...     print("Running my first function!")
...     return myParameter * 3
...
>>>
```

Returned values can be assigned to variables outside functions.

```
>>> myFirstFunction(2)
Running my first function!
6
>>> myNumber=myFirstFunction(998786656)
Running my first function!
>>> myNumber
2996359968
```

Your First USEFUL Function

Calculating GC Content:

- Let's write pseudocode

Input is a sequence
count G occurrences
count C occurrences
sum G and C occurrences
divide the sum by the total sequence length
return the result

```
>>> def gc_content(seq):
...     gCount=seq.count('G')
...     cCount=seq.count('C')
...     totalCount=len(seq)
...     gcContent=(gCount+cCount)/totalCount
...     return gcContent
...
>>> gc_content('ATCCCGGG')
0.75
```

Python2 vs 3: Who gets the right result?

Remember the integer division problem on Python 2 ??

```
>>> def gc_content(seq):
...     gCount=seq.count('G')
...     cCount=seq.count('C')
...     totalCount=len(seq)
...     gcContent=(float(gCount)+cCount)/totalCount
...     return gcContent
...
>>> gc_content('ATCCCGGG')
0.75
```

On Python2

3 Ways to Run Python Code

* Interactive environment
  * What we've been doing
* **Modules**
  * Groups of functions loaded into the interactive python session.
* **Scripts**
  * Run python code from outside the interactive python session. Typed into the Windows/OS X/Unix command line.

Importing Generic Modules

```
>>> sqrt(25)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'sqrt' is not defined
>>> import math
>>> math.sqrt(25)
5.0
>>> math.exp(1)
2.718281828459045
>>> math.log10(2)
0.3010299956639812
>>> math.pi
3.141592653589793
>>> from math import sqrt
>>> from math import *
```

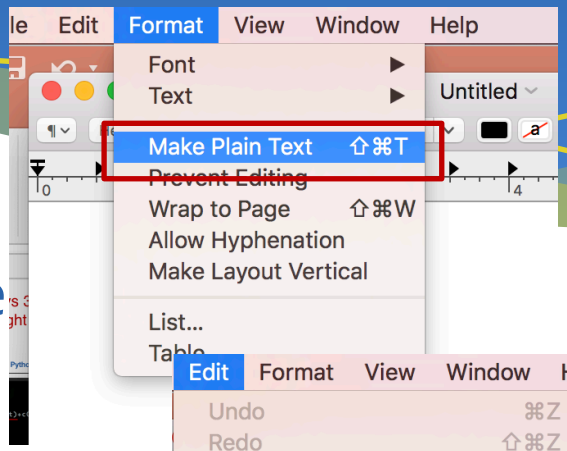
import MODULENAME

from MODULENAME import FUNCTION

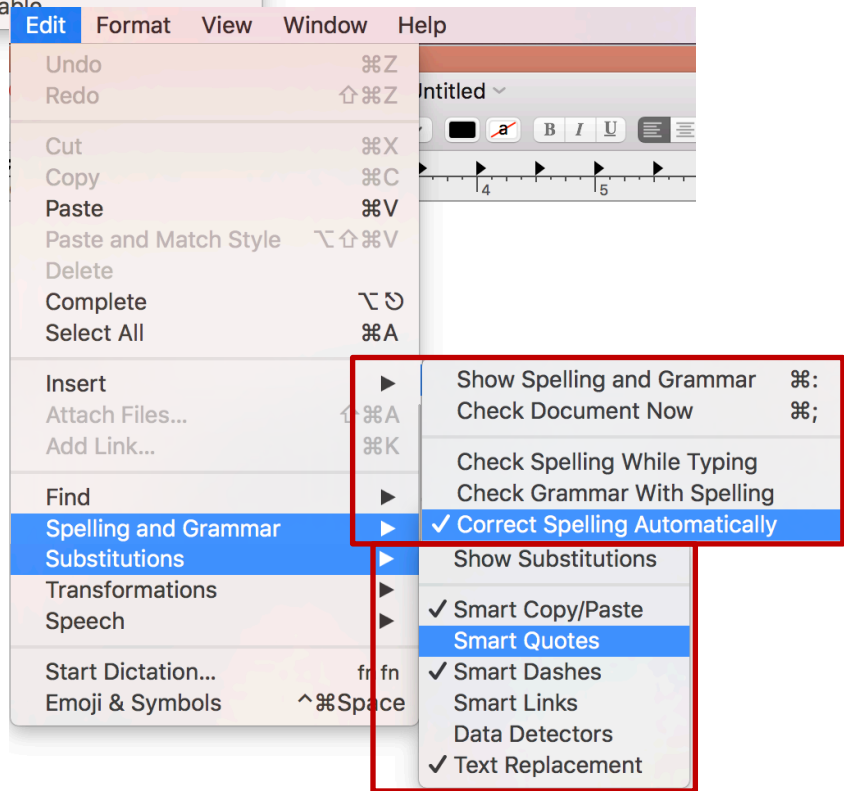
from MODULENAME import *
(everything - caution)

Working in a Text Editor

* Typing everything into the python environment can be inconvenient.
* Write your code into a text document
* Use a basic text editor
  * Notepad (windows)
  * TextEdit (Mac)
  * emacs/Vim/gedit (Ubuntu)
* Save with a .py extension.
* Careful with TextEdit on Mac!



TextEdit on Mac



Combining Everything We've Learnt

Let's write a function that:

* Takes a sequence as a parameter
* Prints the sequence if it starts with ATC
* If the sequence starts with AGC prints 'Starting with AGC'.
* If the sequence starts with neither print 'Starting with neither ATC or AGC'.

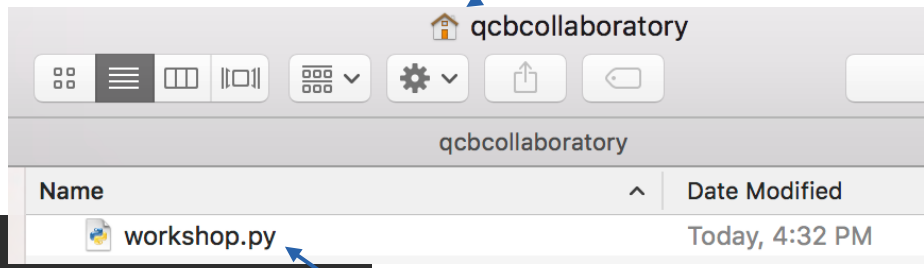
workshop.py

```python
def startsWithATC(seq):

        # Prints the sequence if it starts with ATC
        # Prints "Starting with AGC" if it starts with AGC
        # Else prints "Starting with neither"

        if seq.startswith('ATC'):
                print(seq)
        elif seq.startswith('AGC'):
                print('Starting with AGC')
        else:
                print('Starting with neither ATC or AGC')
```

In **home** directory




```
>>> startsWithATC
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'startsWithATC' is not defined
>>> from workshop import startsWithATC
>>> startsWithATC('ATCATCATC')
ATCATCATC
>>> startsWithATC('AGCATCATAAA')
Starting with AGC
>>> startsWithATC('GCTGCGCGCA')
Starting with neither ATC or AGC
```

File extension **.py** (not **.txt** or **.py.txt**, etc)