COM6115: Text Processing

Python Introductory Materials

Introduction

Algorithms, Control and Conditionals

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Working with the Python Interpreter

- Python is an *interpreted language*
  - can be accessed directly in *interactive mode* (a.k.a. *shell mode*)
- Can access python in shell mode in various ways:
  - using IDLE, Python's basic IDE (Interactive Development Environment)
  - directly in a terminal/CMD window, by entering "python"
  - with an advanced editor/IDE, such as Spyder — *recommended*
- Interactive shell at start up might look like:

```
Python 3.5.2 |Anaconda 4.1.1 (x86_64)| (default, Jul  2 2016, ..
[GCC 4.2.1 Compatible Apple LLVM 4.2 (clang-425.0.28)] on ......
Type "help", "copyright", "credits" or "license" for more info..
>>>
```

- In the above, ">>>" is the Python prompt
  - can enter instructions one by one at prompt
  - Python will convert and execute them

Working with the Python Interpreter (ctd)

- Simplest use: can enter arithmetic expressions
  - ◇ Python will evaluate them, and print result
  - ◇ bit like a glorified calculator

```
>>> 2 + 3
5
>>> 2.9 + 3.2
6.1
>>> 3 / 2 + 7
8.5
>>> (3.2 / 2.0) + 7
8.6
```

- the above illustrates some of Python's basic *types*:
  - ◇ integers and floats
- Arithmetic Operators:

  plus: + minus: - divide: / multiply: *

Alternative Python Shell — the IPython Console

There's an alternative form of 'shell': the IPython Console

```
Python 3.5.2 |Anaconda custom (x86_64)| (default, Jul  2 2016, ...
Type "copyright", "credits" or "license" for more information.

IPython 4.2.0 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object', use 'object??' for extra ...
%guiref   -> A brief reference about the graphical user interface.

In [1]: 2 + 3
Out[1]: 5

In [2]: 3 / 2 + 7
Out[2]: 8.5

In [3]: 2.9 + 3.2
Out[3]: 6.1

In [4]:
```

Alternative Python Shell — the IPython Console (ctd)

```
In [1]: 2 + 3
Out[1]: 5

In [2]: 3 / 2 + 7
Out[2]: 8.5

In [3]: 2.9 + 3.2
Out[3]:
```

- IPython Console is widely used in 'numeric processing' labs
  - e.g. for maths, stats, physics, etc
- IPython Console has a few differences to standard interpreter shell
  - e.g. has some preloaded libraries
  - e.g. displays graphics 'in-line' in Console (rather than a separate window)
  - but mostly these differences won't matter

Python Strings and Basic Printing

- Another key Python type is string
  - ◇ a string is just a sequence of *characters*, e.g. letters, spaces, etc
  - ◇ surrounded by *paired* quote characters
    - either single (') or double (") quotation chars

  e.g `"hello world"` and `'see this'` are both strings

- The Python `print` function will print a value to the screen
  - ◇ the value might be a string, integer or float
  - ◇ can print *multiple values*, separated by commas

```
>>> print("Hello world!")
Hello world!
>>> print("Our combined wealth is", 22.55 + 11.33, 'pounds.')
Our combined wealth is 33.88 pounds.
>>>
```

Using Variables

- Can store values using variables, so can reuse
  - a variable is like a *named bucket* which can hold values
    - can later use that bucket's name to *access* the stored value
  - can *change* the value stored in a variable — *hence the name*
- Use "=" to *assign* value to variable, e.g. statement:

  `<varname> = <expression>`
  - assigns result of evaluating `<expression>` to variable `<varname>`

```
>>> x = 12.5
>>> x
12.5
>>> y = 3 * x + 2
>>> y
39.5
>>> x = x + 1.1
>>> x
13.6
```

Using Variables (ctd)

- It's good practice to use *meaningful* variable names
  - ◇ helps to make your code more *readable*
  - ◇ makes it easer to spot *errors* in your code
  - ◇ an important practice for being a good programmer

e.g. *converting* distance in *miles* to distance in *kilometers*

- where each kilometer is $\frac{5}{8}$ of a mile

```
>>> miles = 28.5
>>> kilometers = (miles * 8.0) / 5.0
>>> print("Distance in miles:", miles)
Distance in miles: 28.5
>>> print("Distance in kilometers:", kilometers)
Distance in kilometers: 45.6
>>>
```

Storing Code for Reuse

- There are many tasks that we may want to *repeat*
  - commands entered to Python shell are *'lost to time . . . '*
  - better to *store* the commands in a file for later *reuse*
- Example: use Spyder as an editor, to create a file with contents:

```
# Converts distance in miles to kilometers
miles = 22.7
kilometers = (miles * 8.0) / 5.0
print("Converting distance in miles to kilometers:")
print("Distance in miles:     ", miles)
print("Distance in kilometers:", kilometers)
```

  - such a file is called a *code file* or *script*
  - line beginning "#" is a *comment* — it is ignored by the interpreter
  - with the code open in Spyder, can run it just by pressing `F5`
    - NB: on *first run*, should press "`ctrl + F6`" to configure run, so a fresh python interpreter is used

Storing Code for Reuse (ctd)

- *Example continued . . .*
  - For this example, when the code is run, we see the following in the interpreter window:

```
>>>
Converting distance in miles to kilometers:
Distance in miles:      22.7
Distance in kilometers: 36.32
>>>
```

  - might now use editor to set different values for the `miles` variable, and re-run to compute a range of results

Defining Functions

- Can store commands in a code file for later reuse
- BUT often want to be able to reuse some functionality *within* the same program
  - this is achieved by *defining a function*
- Function definitions use keyword def and have following form:

```
def NAME( LIST-OF-PARAMETERS ):
    BLOCK-OF-STATEMENTS
```

where:

- `NAME` is the name of the defined function
- `LIST-OF-PARAMETERS` allow us provide inputs to the function
  - parameters sometimes referred to as *arguments*
  - list may be *empty*
- `BLOCK-OF-STATEMENTS` is some series of commands
  - whose limit is identified by *indentation*

Defining Functions (ctd)

- For example, a function to convert distances in miles to kilometers might be:

```
def convertDistance(miles):
    kilometers = (miles * 8.0) / 5.0
    print('Distance in miles:', miles)
    print('Distance in kilometers:', kilometers)
```

where:

- the function defined has *name* `convertDistance`
- input value (no. of miles) is provided via a *parameter*
- the block of statements that make up the *body* of the definition are all *indented*
  - shows that they belong to the *body* of the definition

Defining Functions (ctd)

- To *call* this function, we:
  - ◇ invoke it by name
  - ◇ in an appropriate context (where it will be evaluated)
  - ◇ and with a series of *argument values*
    - one for each parameter
    - arguments within parentheses, immediately after function name (no space between name and open bracket)
    - NB: parentheses needed even if there are *zero* arguments/parameters

e.g. might call as:

```
>>> convertDistance(10)
Distance in miles: 10
Distance in kilometers: 16.0
>>>
```

Defining Functions (ctd)

- The above example function *prints* its results
- More commonly want a function to *return* its result

  i.e. so this can be used elsewhere

- Use keyword return to do this, e.g.

```
def convertDistance(miles):
    kilometers = (miles * 8.0) / 5.0
    return kilometers
```

- Then, can *use result value* for some further purpose

  e.g. to assign to some variable, or use in a calculation

```
>>> k = convertDistance(10)
>>> k
16.0
>>> 2 + convertDistance(10)
18.0
>>>
```

Indentation

- Note the importance of *indentation* in preceding function definitions
  - serves to indicate which command statements make up the *code block* forming the body of the function
- In the following code, for example:

```
def helloGoodbye():
    print("Hello.")
    print("Goodbye.")

print("Au revoir.")
```

  - first two print statements are indented — belong to definition
  - third print statement ('Au revoir.') is not — so, is not part of definition
- In Python, indentation is used to signal code blocks throughout
  - this is a distinctive, and somewhat controversial, feature of Python
  - helps to give Python its clean, readable syntax

Indentation (ctd)

- Most languages use *parentheses* to signal code blocks
  - e.g. braces "`{..}`" used in Java and various other languages
    - for such languages, indentation does not affect the *meaning* of code
      - although 'good indentation' encouraged for readability
- For Python, good indentation is *compulsory*
  - incorrectly indented code *will not run*
  - crucial, therefore, to use an *indentation aware* editor, such as Spyder
  - with such an editor, using `TAB/DEL` in 'indentation area' should move cursor in/out by 'one level of indentation'
  - by convention, 'one level of indentation' corresponds to 4 spaces (but you shouldn't have to think about that with a good editor)

Functions revisited — using `return`

- In lab, saw examples of functions that *print* their result
- More commonly want a function to *return* its result

  i.e. to '*hand back*' the result, so this can be used elsewhere
- Use keyword return to do this, e.g.

```
def convertDistance(miles):
    kilometers = (miles * 8.0) / 5.0
    return kilometers
```

- Then, can assign result to some variable, e.g.

```
>>> k = convertDistance(10)
>>> k
16.0
>>>
```

Functions revisited — using `return` (ctd)

- Python functions *always* return a value
  - even if there's no explicit `return` command
  - in that case, just returns `None` (special Python 'null' value)
- Executing a `return` command, always *terminates* the function call
  - hence, makes no sense to have code such as:

```
def myfunction():
    return 1
    return 2
```

    - second `return` command would never be reached
- Sometimes, may use `return` for specific *purpose* of terminating function execution
- Note: can use `return` on its own

  i.e. without a return value being specified
  - in this case, function returns `None` by default

Functions revisited — using `return` (ctd)

- It's important to realise that `print` cannot be used in place of `return`
  - ◇ WARNING: a common mistake is for students not to grasp this
  - ◇ Following definition has `print` instead of `return`

```
def convertDistance(miles):
    kilometers = (miles * 8.0) / 5.0
    print(kilometers)
```

  - ◇ behaviour may sometimes appear similar, e.g.:

```
>>> convertDistance(10)
16.0
```

  - ◇ but value just sent to screen — can't get hold of it for further use

```
>>> k = convertDistance(22)
35.2
>>> k
>>> print(k)
None
```

Programs and Algorithms

- A computer *program* is a set of instructions that tell a computer how to carry out a task
- The instructions are written in a special *formal* language
  - ◇ a programming language
- In order to solve a programming problem, we need a step-by-step specification of the actions that must be taken to compute result
  - ◇ this specification is called an *algorithm*
- A algorithm should be:
  - ◇ *precise* and *unambiguous*
  - ◇ *correct*, i.e. finish and deliver correct result
  - ◇ *efficient*, but this depends on task
- Same algorithm can be implemented in different languages, or even stated in (pseudo) *English*

  i.e. algorithm idea more general than specific piece of code

Algorithms — Examples

- Algorithms can be expressed in English-like 'pseudocode'
- Task: making a cup of (instant) coffee

```
1. Fill kettle
2. Boil kettle
3. Put spoon of coffee in cup
4. Fill cup (nearly) with water from kettle
5. Add a dash of milk
```

- This 'algorithm' is just a single fixed sequence of actions
- Can handle more complex tasks by allowing:
  - *conditionals*: actions that happen only under certain conditions
  - *loops*: (groups of) actions that repeat over until result achieved

Algorithms — Examples (ctd)

- Task: supermarket shopping

```
1. Get a trolley
2. While there are items on shopping list
   2.1 Read first item on shopping list
   2.2 Get that item from shelf
   2.3 Put item in trolley
   2.4 Cross item off shopping list
3. Pay at checkout
```

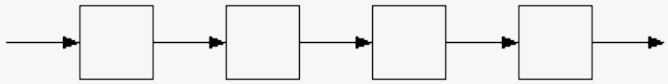
Algorithms — Examples (ctd)

- Task: supermarket shopping *on a budget*!!

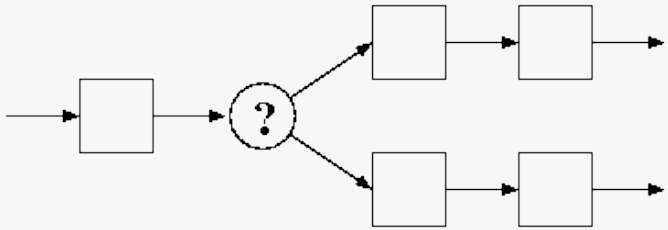
```
1. Get a trolley
2. While there are items on shopping list
   2.1 Read first item on shopping list
   2.2 Get that item from shelf
   2.3 IF item costs less than £3
      2.3.1 Put item in trolley
   2.4 ELSE
      2.4.1 Put item back on shelf
   2.5 Cross item off shopping list
3. Pay at checkout
```

Control Structures

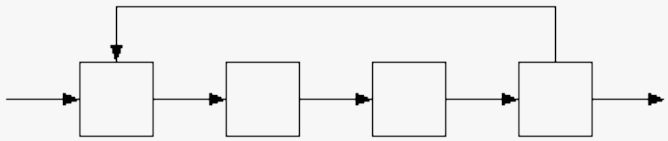
- The way that program execution moves from statement to the next is called the *flow of control* within a program
- The major control structures are sequence, selection and repetition:
  - ◇ Sequence: simply do one statement after the next



  - ◇ Selection: flow of control is determined by a simple decision



  - ◇ Repetition: execute a statement or block of statements more than once



Boolean type and expressions

- We have seen Python basic types such as integer and float
- A further basic type is boolean
  - has only *two values*: True and False
- A *boolean expression* is one that evaluates to True or False
  - the 'decision' of a *selection structure* is typically formulated as a *boolean expression*
- Simple boolean expressions commonly involve a *comparison operator*:

==	: *equal to*
>	: *greater than*
>=	: *greater than or equal to*
<	: *less than*
<=	: *less than or equal to*
!=	: *not equal to*

Boolean type and expressions (ctd)

- For example:

```
>>> 3 == 3
True
>>> "this" == 'this'
True
>>> 3 >= 4
False
>>> 3 >= 2
True
>>> 5 != 3
True
>>> 5 != 'some string'
True
>>>
```

- *Beware*: it's easy to use "==" in place of "=", and *vice versa*
  - ◇ a very common coding error

Boolean type and expressions (ctd)

- Can form *more complex conditions* by using the *boolean operators*:
  - ◇ they are: and, or *and* not
- Given boolean expressions `E1`,`E2` then:
  - ◇ `E1 and E2`
    - is True if *both* E1 *and* E2 are True, and False otherwise
  - ◇ `E1 or E2`
    - is True if *either* E1 *or* E2 is True, and False otherwise
  - ◇ `not E1`
    - is True if E1 is False, and False otherwise
- Example: testing for teenagers!

```
>>> age = 15
>>> isaTeen = age >= 13 and age <= 19
>>> isaTeen
True
>>> age = 22
>>> isaTeen = age >= 13 and age <= 19
>>> isaTeen
False
```

Conditionals

- Selection control structures achieved by use of *if-else* constructions
  - ◇ known as *conditionals*
- Key form:

```
if CONDITION:
    CODE-BLOCK-1
else:
    CODE-BLOCK-2
```

- Example:

```
if age >= 18:
    print("Congratulations!")
    print("You're an adult!")
else:
    print("Even better!")
    print("You're an child!")
```

Conditionals (ctd)

- The *else* is *optional* — can be omitted, e.g. in:

```
if altitude < 100:
    print("Warning!")
    print("Time to bail out.")
```

- Can also *chain* a series of cases, using keyword elif, e.g.:

```
if age < 13:
    print('child')
elif age < 18:
    print('teen')
elif age < 65:
    print('adult')
else:
    print('pensioner')
```

Conditionals (ctd)

- Note in preceding case that the *order of the cases* matters:
  - reordering them would give incorrect behaviour
  - consider what would happen with code having reordered cases:

```
if age < 65:
    print('adult')
elif age < 18:
    print('teen')
elif age < 13:
    print('child')
else:
    print('pensioner')
```