FIT1045 Algorithmic Problem Solving – Workshop 1.

Objectives

The **objectives of this workshop** are:

- To get familiar with the python interpreter.
- To be able to execute a file using IDLE.
- To be able to perform basic string and numerical manipulation.
- To be able to import from the math and random packages.
- To be able to do simple input/output.

Useful Material

Introduction to Numbers and Python: `https://docs.python.org/3.0/tutorial/introduction.html`

Getting Started: This website contains a guide for installing and running python and IDLE under windows. `http://usingpython.com/running-a-python-program/`. You do not need to install python on the univeristy computers.

Things to try before your workshop.

Python, being an interpreted language has an interactive shell. This allows us to quickly and easily test small snippets of code from within a python environment without having to worry about complicated files. For simplicity we will be using an online python shell.[1] Navigate to `https://www.python.org/shell/`.

Task 0: A Simple Calculator

Using your keyboard, enter numbers and operators (* + - /) into the shell using the return key to execute these simple calculations.

Once you are comfortable with this you may want to use attempt to use some of the operators presented in task 1(a).

Numerical Operations

Task 1

Using the python interactive shell that is local to your computer, compute the first column in Table 1. Compute the other columns by creating a program that takes as input x and y and performs the operation. What does each of these operations do?

Temperature Conversion

Task 2

Write a program that converts the temperature in Fahrenheit to the temperature in Celsius. Your program should prompt the user for the temperature and then print "The temperature is XXX degrees Celsius".

[1] Your workshop demonstrator will go through how to run a local shell in your workshop

Operator	x=3 y=2	x=4 y=4	x=5 y=6	Operation
$x + y$				Adds x and y together
$x - y$				
$x * y$				
$x * *y$				
$x\%y$				
x/y				
$x//y$				
$x > y$				
$\cos(x/y)$				

Table 1: Numerical Operators

For example:
Give the temperature in Fahrenheit? 100
The temperature is 37.7777777778 degrees Celsius.

NOTE: The conversion from F degrees Fahrenheit to C degrees Celsius is: $C = (F - 32) \times 5/9$.

Finding The n^{th} Root

Task 3

Write a program that when given as input from the user a number x and value n will find the n^{th} root of x. To make this task easier you will be requied to import pythons math library, see `https://docs.python.org/3/library/math.html`.

Background: The n^{th} root of a number x can be determined by using the natural logarithm and exponents. Let a be the n^{th} root of x, this gives $x = a^n$. Taking the logarithm of x gives,

$$\log(x) = \log(a^n) \tag{1}$$

We know from our log laws[2] that $\log(a^n) = n\log(a)$. If we divide through (1) by n gives

$$\frac{\log(x)}{n} = \log(a). \tag{2}$$

We then solve (2) for a:

$$e^{\frac{\log(x)}{n}} = e^{\log(a)} = a.$$

Example:

```
Please enter a number: 390625
Please enter a value for n: 8
The 8th root of 390625 is 4.999999999999999.
```

NOTE: The output of your program

[2] `https://en.wikipedia.org/wiki/List_of_logarithmic_identities`

Flipping Coins

The goal of this task will be to simulate random coin tosses for both a biased and unbiased coin. To complete this task we will need to look at importing a second library, just like we did the math library. The library we will be importing is the random library allowing the programmer to access tools to generate pseudo-random number and perform operations that use these tools. See `https://docs.python.org/3.5/library/random.html`.

Task 4(a)

Write a program that generates and prints some random numbers using the 'random.random()' command. What values are generated by this command?

Note: What happens when you type 'random.random(' in Idle. Discuss with your programming partner what this information means. Ask you workshop tutor if you are not sure.

Using Selection

Lecture 3 introduces selection. Before Workshop 2, modify your program in **Task 4(a)** and using selection complete Task **(4b)** and **(4c)**.

Task 4(b)

Write a program that simulates an unbiased coin flip. Your program should print true if the coin flip results in a head and false if the coin flip results in a tail. [3]

Task 4(c)

Now consider a biased coin. Write a program that takes a value p, with range between 0 and 1, as input from the user and tests a number of coin flips where p is the probability of the flip resulting in a result of heads.

Example

```
What kind of bias do your coins have? 0.5
Coin flip 1 has a value of heads: True
Coin flip 2 has a value of heads: False
Coin flip 3 has a value of heads: True
```

Note: This program may be made easier using the 'random.randrange(a)' function, if time permits, have a look at this function using the link above. We will be meeting the 'range(a)' function in detail next week.

Strings

Task 5

Write a program that takes as input a string representing a user's name. Your program should output the length of the name and the number of times each vowel occurs in it.

Extension Questions

All questions contained here either extend on the current week or look into topics that will be introduced in depth in the future. They may require a certain level of self study to complete during thier prescribed lab. If you have completed all other work, we highly recommend that you have go at these questions. **These problems as they appear here are not examinable. Any examinable content will be covered in the main section of later workshops.**

[3] For a problem with two possible outcomes, A and B, and a random number x we say that x belongs to outcome A if the $x < P_A$ and to outcome B otherwise.

Task 6: Strings? Or just letters?

In this task we will look at the relationship between strings and characters. We will be performing an operation known as *indexing*.

A string may be indexed by placing square brackets after the string with a value, the index ("hello"[0]). Write a program where you change the index given to the string and attempt to predict the output. Did certain values produce errors where others didn't? What about negative numbers?

Task 7: Three Sided Coins

Extend your program to flip coins that have 3 sides: heads, tails and other.

Hint: You can use numbers to represent the states rather than booleans.

```
Flipped a 3 sided coin which landed on side: 1
Flipped a 3 sided coin which landed on side: 3
Flipped a 3 sided coin which landed on side: 1
Flipped a 3 sided coin which landed on side: 2
```

Task 8: Escaping the Earth

Warning: Physics

The escape velocity of an object v_e is the velocity required to prevent the object falling back to the ground under the influence of earth's gravity. We define the escape velocity such that it is the minimum required velocity. As such the object should be at rest once it has left the influence of the earth's gravity. To do this we will use two quantities, the kinetic energy,

$$E_k = \frac{1}{2} m_o v^2, \tag{3}$$

and the gravitiational potential energy,

$$U = \frac{-GM_E m_o}{r}. \tag{4}$$

From the conservation of energy, we know that the total energy before is equal to the total energy after and if the object is to remain at rest and not fall back to the surface of the earth, it will have a final velocity of 0.

$$(E_k + U)_b = (E_k + U)_a \tag{5}$$
$$(E_k + U)_b = 0 \tag{6}$$

By substituting (3) and (4) into (6) we can solve for v, our escape velocity.
Write a program to calculate the escape velocity of an apple using the following values.

- $G = 6.67408 \times 10^{-11}$, the universal gravitational constant.
- $M_E = 5.972 \times 10^{24}$, the mass of the earth in kilograms.
- $r = 6.371 \times 10^{6}$, the radius of the earth in meters.
- $m_o = 0.1$, the mass of an apple in kilograms.