Numerical Methods 35006
Computer Lab 1: Intro to python, control structures and graphing functions

Go through each of the tasks in order. If you're stuck then ask the person sitting next to you - if you're both stuck then put your hand up and someone will come and help.

1. Log into your computer, and start Spyder (on Windows: click the Start icon and type "Spyder", then click on the app). You should see the Spyder console on the bottom right. Verify that python is working correctly by typing

   ```
   print('hello world')
   ```

   at the console prompt (`>>In [1]:`).

2. Create a new blank python script (`>>File>> New File ...`, and save it as `Lab1_Q2_[your name].py`. *Make sure you save it to a local directory, not to the Desktop.*

   Write code to print "hello world" exactly 10 times, and run the code twice, first by typing `run [filename].py` in the console, and then by clicking the "run" arrow in the command bar above the script.

3. For each of the following problems create a new python script:

   (a) Create code that adds up the first 100 integers and displays the answer.

   (b) Write a script that adds the squares of all the odd integers from 1 to 50.

   (c) Modify your code in part (c) above to sum all the squares *except* the ones divisible by 3.

   (d) Write a script that starts adding integers and then stops when the sum is 10,000. Which integer is the final integer in the sum?

4. Working in pairs: Pick one example (a-d) from Q3 above. Attempt to make your code as unreadable as possible. Give it to your partner, and have them try to work out which problem it solves.

5. Create a new script, and add the python modules `numpy` and `matplotlib.pyplot`.

   Using the numpy command `linspace`, plot the following functions:

   (a)
   $$f(x) = x^2 \quad \text{over the range } x \in [-2, 2]$$

   (b)
   $$f(x) = \frac{\sin(2x)}{x} \quad \text{over the range } x \in [-10, 10]$$

   (c)
   $$f(x) = e^{2x} \quad \text{over the range } x \in [0, 3]$$

   (c)
   $$f(x) = 4^{2x} \quad \text{over the range } x \in [0, 4]$$

6. The console command "`?`[foo]" can be used to access documentation on any python function or module. Look up the documentation for the matplotlib command `plt.semilogy`. Use this function to plot
   $$f(x) = e^{2x}$$
   over the range -10 to 10.

7. The numpy command `logspace` creates an array of numbers separated by powers of 10. Use the command logspace to generate values for the function
   $$f(x) = 4^{2x}$$
   in the range from 0.001 to 10. Plot this using the function `plt.loglog`. Try to plot this over the same range using `linspace` and `plt.plot`. What happens?

8. Write a script that uses a forward difference method to compute the numerical derivative of
   $$f(x) = \sin^2(x)$$
   for any value of x. Compute the derivative of this analytically. For various values of x, use `np.logspace` and `plt.loglog` to plot (a) the absolute error, and (b) the fractional error, as a function of the step-size. What is the optimum stepsize?

9. Write a script to compute the numerical derivative of

$$f(x) = x^2 \sin\left(\frac{1}{x}\right) \ .$$

Plot $f'(x)$ between -1 and 1.

10. * Write a script to compute the numerical *second order* derivative for a function $f(x)$. Test how well this works against a known analytic second order derivative.