Please save the programs that you write to solve the exercises. We may ask you to show us the code and run it to re-generate the results.

1. Reading and analyzing 2 column data [1 ½ marks]

The file "data.txt" contains a two column set of data with a header. Edit your straight line fitting code to:

a. Use the correct x and y labels, based on the header in the file. There is no need to write code to do this -- you can just open the file with a text editor, read the header and enter the values in your code manually.
b. Read in the data from the rest of the file
c. Use this information to make a plot of the data (with labelled axes) and add a best fit line to it.
d. **Create an output** text file which contains the following information:
    - The names of the input data columns
    - The length of the data
    - Maxima and minima of the x and y data
    - The calculated intercept and gradient of the best fit line along with their errors.
    - The resistance in the circuit

Use string formatting techniques to write out an appropriate number of decimal places in your answers

2. Plotting 2-d arrays [2 marks]

Recall that the formula for the height of a wave with amplitude A, wavenumber k and angular frequency ω is **y=A sin(kx-ωt)** for a wave travelling to the right and **y=A sin(kx+ωt)** for a wave travelling to the left.

a. Using `mgrid()`, generate 2-dimensional arrays for x and t both between 0 and 2 in steps of 0.01.
b. Generate, a 2-dimensional array y giving the height of a wave with unit amplitude while the wavenumber and angular frequency are equal 2π.
c. Make a contour plot using `contourf()` of the wave amplitude against x (on x-axis) and t (on y-axis).
d. Make a 1-d plot of amplitude vs x at t=0, 0.25 and 0.5. (**Hint:**, it's OK to use, e.g. t==0.25 to select the appropriate entries)
e. Generate a standing wave by adding a second wave to y with same amplitude, wavenumber and frequency, but moving right.
f. Make a contour plot of the standing wave amplitude against x and t.
g. Make a 1-d plot of amplitude vs x at t=0, 0.25 and 0.5.

3. Matrix Manipulation [1 ½ marks]

Matrices A and B are given by:

$$A = \begin{pmatrix} 1.50 & 2 \\ 0.5 & 1 \end{pmatrix} \quad B = \begin{pmatrix} 3 & -2 \\ -7 & 5 \end{pmatrix}$$

Write a program that asks the user for 8 numbers on one line. Split them, and put them into matrices A and B. The program should then calculate the following, and print out the answer.

a. A^{-1}
b. B^{-1}

c. AB

d. $(AB)^{-1}$

e. B^{-1} A^{-1}

f. The eigenvalues and eigenvectors for A

Note: we have not learned how to print matrices using string formatting from week 5 (i.e. the "{:.2f}" notation), so don't worry about this. Also, make sure you define A and B as matrices, not arrays.

When the demonstrator comes to mark this, they will put in different data than the A and B as defined above. The matrices above are reasonable "test" data to ensure your program works.