1E3 Practical 11
6th April 2016

Objectives: More practice on arrays, functions, and loops.

Task#1:
Marks: 3
Summary: Write a program to compute the mean, variance, standard deviation and number of zero crossings for a sequence of numbers.

Details: You MUST use a separate function to compute each of the statistical measures, as well as to read in the number sequence. Each of these functions should take in only the array of numbers and the size of the array. **Do not** be tempted to pass the mean value to the variance function or the variance value to the standard deviation function!!

The sequence of numbers is terminated by 9999. Use an array that holds up to 100 values, but your program must not crash if the sequence has more than 100 numbers in it. Use a **readtosentinel** type function to correctly read in an unknown number of values.

There are two sample data files on the web page.

Notes/Hints/Additional Details:
The mean (or average), μ (Greek letter mu), is the sum of all the numbers divided by N, the number of numbers.

The variance, denoted σ^2 (sigma squared), is the average squared deviation from the mean:

$$\frac{\Sigma (x_i - \mu)^2}{(N-1)}$$

This looks complicated, but you take each number, subtract the mean of the sequence, square that difference, and add that on to a running total. Then divide the total by (N-1).

The standard deviation is the square root of the variance. For the sqrt function you will need to include the cmath library.

The number of zero crossings is a measure used in speech signal analysis. It is the number of times in the sequence that x_i and x_{i-1} are opposite sides of 0. The easiest way to test if there is a zero crossing between x_i and x_{i-1} is if

$$x_i * x_{i-1} < 0$$

Take care not to attempt to calculate this when i = N since then slot i+1 is off-limits!

Marks: 2

Summary: This is called "The Apartment Problem" (Exercise 26 in Chapter 5 of Malik textbook). This is an example of a discrete optimisation problem. It doesn't require arrays.

Details: As a specific example of the problem, a property management office handles, say, 50 apartment units. When the rent is, say, €600 per month, all units are occupied. However, for each, say, €40 increase in rent, one unit becomes vacant. Moreover, each occupied unit requires an average of, say, €27 per month for maintenance. How many units should be rented to maximise the profit?

Write a program to solve the rent maximization problem for values provided by the user. Prompt the user to enter the total number of units, the rent that results in all units being rented, the increase in rent that results in one extra vacant unit, and the average maintenance per rented unit. Print out **what the rent should be to maximise profit**.

Notes/Hints/Additional Details:
- You will obviously need a loop. I recommend that on each iteration of your loop you print the rent, how many units will be rented and the profit. For the numbers used above the first iterations will look as follows:

Rent	Units	Profit
600	50	28650
640	49	30037
680	48	31344
…		

- You need to stop when the profit starts to decrease, and print out the rent before the decrease.