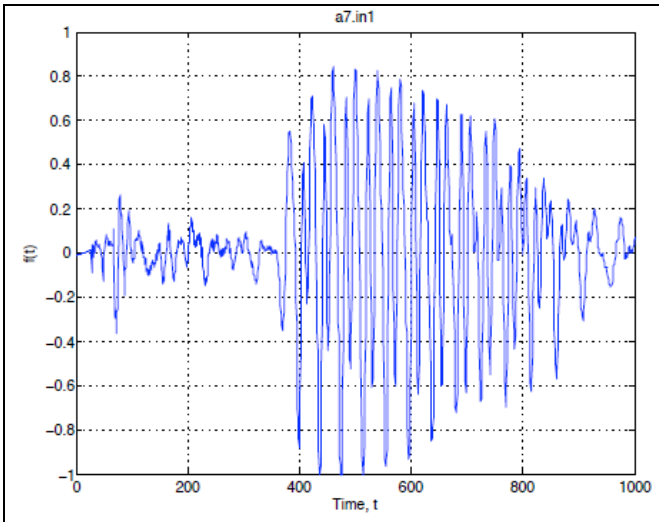
CS410C FALL 2020 DUE: 11/2/2020
PROGRAMMING ASSIGNMENT 5P

Purpose

The purpose of this assignment is to give you practice with single dimensional arrays as well as modularizing your program with more functions.

Scenario



An acoustical signal can be converted into an electrical signal by a microphone and the electrical signal can then be converted into a series of numbers representing the value of the electrical signal at discrete time intervals. These values have been stored in a data file. We are interested in analyzing this data to measure various aspects of the acoustical signal.

Problem

Read in a file containing a noise signal and print out several pieces of information on the signal.

Input

The input files consist of a series of a series of floating point numbers representing the acoustical signal. You should read these values into an array until end of file or until the array is full, use an array of data type double, of size 1500.

Output

The output should consist of a neat well labeled message with the following information in this order:

1. Number of sample points
2. The variance
3. The standard deviation
4. Average power
5. Average magnitude
6. Positive count
7. Number of zero crossings
8. Maximum change index

Details leading to computation of each output

1. The number of data points in the sample.
2. The **variance** (denoted σ^2) of the data points in the sample: the variance of a list of n values $x_0, x_1, x_2, \cdots, x_{n-1}$ is given by:

$$\sigma^2 = \frac{1}{n-1}\sum_{k=0}^{n-1}(x_k - \mu)^2$$

   where μ is the mean value ($\mu = \frac{1}{n}\sum_{k=0}^{n-1} x_k$).
3. The **standard deviation** of the data points in the sample: the standard deviation of a list of n values $x_0, x_1, x_2, \cdots, x_{n-1}$ is the square root of the variance.
4. The average power of the signal: the average power of a signal $x_0, x_1, x_2, \cdots x_{n-1}$ is defined as:

$$\frac{1}{n}\sum_{k=0}^{n-1} x_k^2$$

5. The average magnitude of the signal: the average magnitude of a signal $x_0, x_1, x_2, \cdots x_{n-1}$ is defined as:

$$\frac{1}{n}\sum_{k=0}^{n-1} |x_k|$$

6. The number of positive data points. The count of the number of data points that are greater than 0.
7. The number of zero crossings. The number of zero crossings is the number of times the signal changes from positive to negative or negative to positive. For this we will consider 0 as "positive", that is a change between a negative and 0 is a zero crossing while a change between a positive and 0 is not.
8. Index of maximum change. Find the index n for which $|x_n - x_{n+1}|$ is maximum. If there are less than two data points then return -1.

Other Details

- In this program you do not need to prompt for input or echo input. You should read the data from standard input as usual using scanf and use redirection to read the data from the input file.
- The array size (1500) must be defined as a constant. If there are more than 1500 input values (maximum size of the array) you should stop reading at 1500. Your program should handle empty input without crashing.
- You must use functions to modularize your solution, in particular you must write a function for each of the following:
    - Read the data into the array (function value returns actual size of the array)
    - Compute the mean
    - Compute the variance
    - One function to compute both the average power and the average magnitude and return them via output arguments
    - Compute the positive count
    - Compute the number of zero crossings
    - Compute the maximum change index
- The first function (reading data into the array) must return the size of the array as a function value. The function that computes both the average power and average magnitude must return these two computed values as output arguments (function return value is void). Each of the rest of the functions must return the computed value as a function return value. While the first function takes a single argument which is the array, the rest of the functions take two input arguments, the first being the array and the second being the size of the array.
- The header file provided shows you the function prototype declaration for each function
- Each function definition must have a boxed comment

- Sample input and output is available in the public folder. Use input redirection to read data since we are dealing with hundreds of data points

Input

The input will come from standard input, that is, but instead of entering it from the keyboard use input redirection and take it from a file present in the same folder (sample files in1, in2, in3 provided

Testing

You need to write your main() function to test your program, but you do not need to submit your file that contains this main() function. As and when you complete writing each function, add a call in your main() function, print and compare your results with mine as you go along. Since you do not submit your main() function you can print your results any way you want to verify results (keep in mind that my output samples are all using "%g" to print all floating point results as "double" data type).

Compiling your program

gcc main.c signals.c -lm -o main
(assuming you call your file containing main() as main.c)

Submission

Submit one file: signals.c (although you are being provided signals.h you do not need to submit it, you CANNOT change anything in the signals.h file!). Your file that contains your main() function does not need to be submitted because I am going to be testing your functions with my main() function.