Homework 11: Input, output

For the following exercises, write your code in one `.cpp` *file for each problem. Be sure to use a plain text editor (i.e., NOT Word).*

Make sure that your code compiles without error in order to get credit. Do not hesitate to ask for help if needed!

Do NOT submit executable files to me. If you are having trouble getting your code to compile, and you can't figure it out on your own, email me with your code attached and I'll try to help you debug. Better yet, come to office hours!

Problem 1 (6 pts)

Write a `C++` program that will do the following:

(a) Create an integer array (i.e., a `vector` of `int` variables) that will store the values `{-45, 72, 1024, 0, 97, 42, -534}`.

(b) Use a loop to print out every element of the array to the screen, one per line, preceded by its index (such as `a[2] = ...`).

(c) Change the value of 1024 to 768 and add two elements at the end of the array, with values 283 and 526 (again print the full array to the screen.)

Problem 2 (5 pts)

Write a `C++` program that will do the following:

(a) Prompt the user for the length of a `double` array (i.e., a `vector` of type `double`).

(b) Create an array of the specified length and populate its elements with the square root of the element's index plus 2. For example, element 10 should be $\sqrt{12}$.

(c) Use a loop to print the elements of the array to the screen; also, find the sum of all the elements and then print the result.

Problem 3 (10 pts)

Write a `C++` program that will create a data file containing pairs of values `x f(x)` in 2 columns for a function `f(x)` of your choice and for a finite range of values of `x`. Use a step for the `x` values that gives you a smooth curve. (Note that we don't have the convenience of something line `numpy.linspace` here so you will have to write your own algorithm for creating the discretized values of `x`; try to do this *without* using a floating point index in your loop.)

Import the data created into a `Python` script and use `matplotlib` to plot the function from it.

Submit your source code and your `Python` script. Create the data file in the current working directory so it will run easily for me.

Problem 4 (14 pts)

Write a second `C++` program that will read the data from your file generated in Problem 3 into an array (make one up, for example with `Python`, if you can't figure out Problem 3), and use it to calculate the slope

$$\text{slope} = \frac{\Delta f}{\Delta x} = \frac{f(x_2) - f(x_1)}{x_2 - x_1}$$

for each pair of consecutive points x_1, x_2.

Write the x values and corresponding slopes in 2 columns in a different data file, and use `matplotlib` to plot the slope as a function of x.

If you want to be fancy, note that the slopes you've calculated more reasonably correspond to values of x at the midpoints between the values generated in Problem 3.

Submit your source code and the `Python` script that creates the plot. You can use the same `Python` script for the plot as you did for Problem 3 or you can write a new one, though it might be instructive to see the function and its slope on the same set of axes.