This sheet is to be returned at the conclusion of the lab session.

Student Name:_____ Student Number:_____

ENG 1D04, Lab 7, Marked Assignment 3, Methods, Loops, and Arrays, Tuesday

This assignment has to be submitted via ELM before 2:10 pm. **Assignments will not be accepted after this time.** Please remember to submit your work early and resubmit often. **You should not wait until the end of the lab to start submitting.** You must do the assignment on your own. Conversations between students will not be permitted. You cannot bring reference material into the lab or access information through the Internet. You may use the Visual C# help, Notepad, and the Calculator program.

Background

Let $\mathbf{R}$ be the set of real numbers, $f : \mathbf{R} \to \mathbf{R}$ be a continuous function that maps real numbers to real numbers, and $[a, b]$ be a closed interval of real numbers (i.e., a set $\{x \in \mathbf{R} \mid a \leq x \leq b\}$). The function f *crosses the x-axis* on the closed interval $[a, b]$ if there are x_1 and x_2 in the closed interval such that $f(x_1) < 0 < f(x_2)$.

Overview

Assume the function f is specified by the equation

$$f(x) = x^2 - 4.$$

Your program will check whether this function crosses the x-axis on a given closed interval $[x_0, x_{19}]$. The closed interval will be represented by an evenly spaced, increasing finite sequence $[x_0, \ldots, x_{19}]$ of 20 sample points.

Design, implement and test the application described in the requirements below. Name the application

MacID_StudentNumber_LabSection`_Lab7`

where *MacID*, *StudentNumber*, and *LabSection* are your MacID, student number, and lab section (written as L*xy*), respectively. When done, compress the project and similarly name the zip file

MacID_StudentNumber_LabSection`_Lab7.zip`

Details of what you must submit are specified below.

Requirements

1. A method with the heading `double f(double x)` that computes the function f specified above.

2. A graphical user interface (GUI) consisting of a form with the controls described below. The text `Check the Crosses X-Axis Property` is at the top of the form. (The placement of the controls is your decision.)

3. One input label box with the label `Left Point =` , followed by a text box to accept the left point x_0 of the closed interval.

4. One input label box with the label `Right Point =` , followed by a text box to accept the right point x_{19} of the closed interval.

5. An output label box with label `Result` to show the result of checking whether the function f crosses the x-axis on the closed interval.

6. A `Build Input Array` button that when clicked (1) creates an array of type `double [ ]` of length 20 that holds the values $x_0, \ldots, x_{19}$ and (2) displays the values of the array in a message box with one value per line. The x_i are evenly spaced from x_0 to x_{19} (i.e., the distance between x_i and x_{i+1} should be the same for all i with $0 \leq i \leq 18$). Note: The user only inputs x_0 and x_{19}; the other x_i are computed by your program.

7. A `Build Output Array` button that when clicked (1) creates an array of type `double [ ]` of length 20 that holds the values $f(x_0), \ldots, f(x_{19})$ and (2) displays the values of the array in a message box with one value per line.

8. A `Check Property` button that when clicked replaces the label `Result` by `Definitely Crosses the X-Axis` if the array of outputs shows that f crosses the x-axis on $[x_0, x_{19}]$. Otherwise the output label `Result` is replaced by `Likely does not Cross the X-Axis`.

9. A `Clear` button that when clicked causes the input text boxes to be cleared of their values. It also restores the output label box back to the original value of `Result`.

10. When the application starts, the two input text boxes are empty.

Design

In your project folder include a separate text document (using Notepad) with the file name *Name_LabNumber*`_Lab7.txt` where *Name* is your name and *LabNumber* is your lab section. The report will answer two questions, one related to design and the other related to testing. The testing question is given below. The design question is:

> A weakness of this program is that the `Check Property` result may be `Likely does not Cross the X-Axis` when the function does indeed cross the x-axis. Explain how this can happen.

Implementation in Visual C#

Implement the requirements listed above.

Testing

In the *Name_LabNumber*`_Lab7.txt` file, answer the following testing question:

> The program should test closed intervals that includes a point x such that $f(x) = 0$. How many such points are there? Give a closed interval for each such point.

Side Remark

Since f is a continuous function, your program can be used to determine if the polynomial $x^2 - 4$ has a root in a given closed interval.