November 18, 2018

CSCI/MATH 3180
Lab Assignment #9

1. Create a C++ console application project in Visual Studio 2015 and name your project YourLastName9.
2. Write a program that implements 1) the Bisection Method and 2) Secant Method for approximating a zero of a function, $f(x) = x^3 - 2x^2 - 5x + 6$.
3. Write a separate function for each of the following.
   - Evaluating *f*(*x*)
   - Bisection Method
   - Secant Method
4. Use the following parameters for both methods.

```
double x0:  starting approximation 0
double x1:  starting approximation 1
int maxIterations: maximum number of approximations generated
double xTolerance: max distance between last 2 approximations
double yTolerance: max distance from f(last approximation) to 0
```

   Function should iterate until both stopping criteria are met or it exceeds the maximum number of iterations.

5. Test your program using the following function calls.

```
secant(0, 4, 20, 0.001, 0.00001);
secant(0, 2, 20, 0.001, 0.00001);
secant(2, 4, 20, 0.001, 0.00001);
secant(0, 3, 20, 0.001, 0.00001);
secant(1, 2, 20, 0.001, 0.00001);
secant(2, 30, 20, 0.001, 0.00001);
secant(10, 30, 20, 0.001, 0.00001);
```

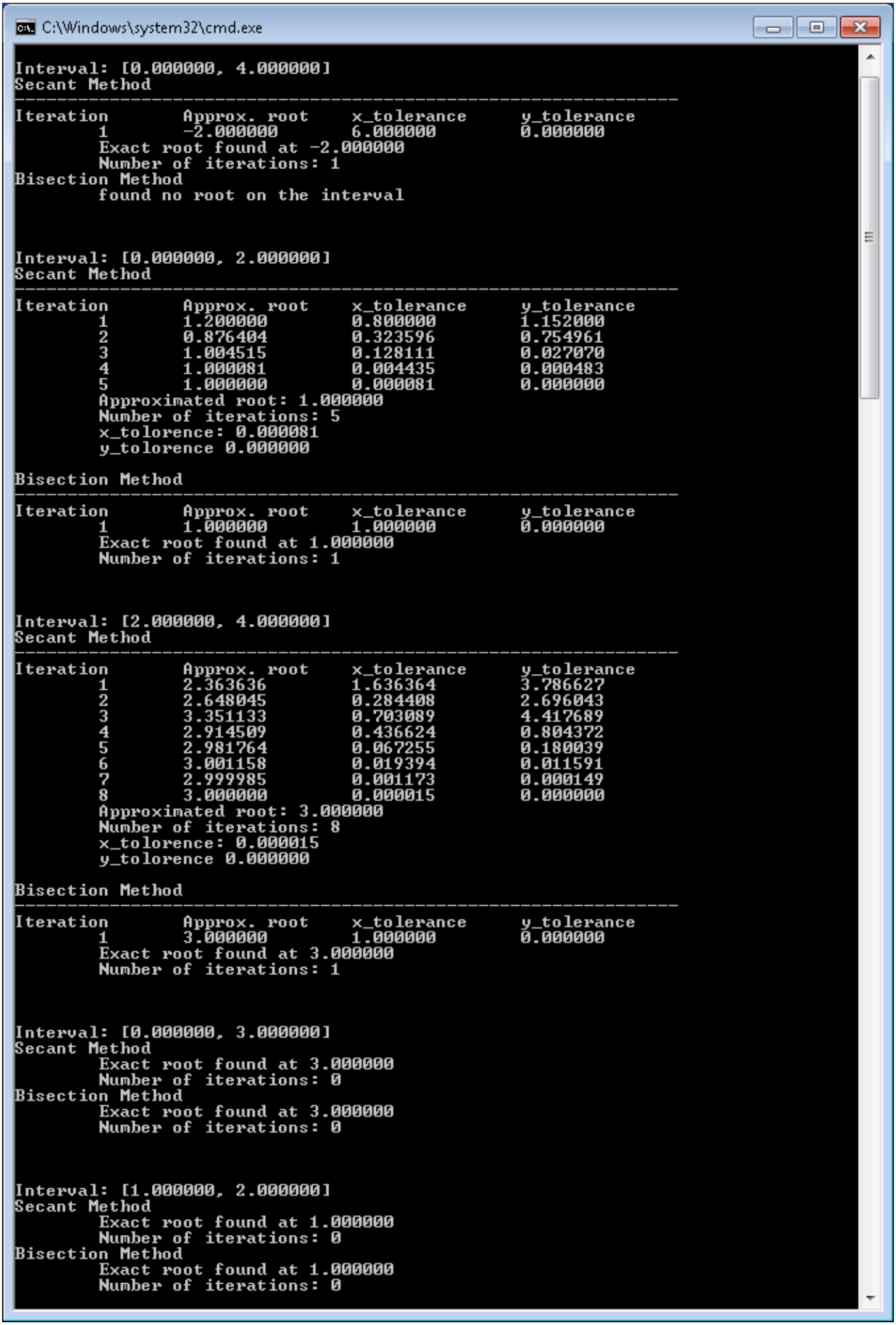
```
bisection(0, 4, 20, 0.001, 0.00001);
bisection(0, 2, 20, 0.001, 0.00001);
bisection(2, 4, 20, 0.001, 0.00001);
bisection(0, 3, 20, 0.001, 0.00001);
bisection(1, 2, 20, 0.001, 0.00001);
bisection(2, 30, 20, 0.001, 0.00001);
bisection(10, 30, 20, 0.001, 0.00001);
```

Make sure your program produces the results similar to the screen as shown below.

6. Analyze your output and write a short report (YourLastNameReport9.pdf) including the following
   - Output of the program
   - Comparison of the two methods along with the advantages and disadvantages based on your experiment.
   - Your conclusion and/or your recommendation

7. Submission
   - Delete the following from your project folder.
     - *Debug* sub-folder
     - *Debug* sub-sub-folder under your project folder(second level down)
     - *ipch* sub-folder
     - *sdf* file.
   - Save the following in a compressed (zipped) folder and submit it to D2L.
     - *main project folder* (YourLastName9)
     - *report* (YourLastNameReport9.pdf) on the experiment
   - Submit the compressed folder to D2L.

NOTE: <u>PROGRAMS MUST BE INDEPENDENT WORK.</u>


C:\Windows\system32\cmd.exe
Interval: [0.000000, 4.000000]
Secant Method
Iteration Approx. root x_tolerance y_tolerance
1 -2.000000 6.000000 0.000000
Exact root found at -2.000000
Number of iterations: 1
Bisection Method
found no root on the interval
Interval: [0.000000, 2.000000]
Secant Method
Iteration Approx. root x_tolerance y_tolerance
1 1.200000 0.800000 1.152000
2 0.876404 0.323596 0.754961
3 1.004515 0.128111 0.027070
4 1.000081 0.004435 0.000483
5 1.000000 0.000081 0.000000
Approximated root: 1.000000
Number of iterations: 5
x_tolorence: 0.000081
y_tolorence 0.000000
Bisection Method
Iteration Approx. root x_tolerance y_tolerance
1 1.000000 1.000000 0.000000
Exact root found at 1.000000
Number of iterations: 1
Interval: [2.000000, 4.000000]
Secant Method
Iteration Approx. root x_tolerance y_tolerance
1 2.363636 1.636364 3.786627
2 2.648045 0.284408 2.696043
3 3.351133 0.703089 4.417689
4 2.914509 0.436624 0.804372
5 2.981764 0.067255 0.180039
6 3.001158 0.019394 0.011591
7 2.999985 0.001173 0.000149
8 3.000000 0.000015 0.000000
Approximated root: 3.000000
Number of iterations: 8
x_tolorence: 0.000015
y_tolorence 0.000000
Bisection Method
Iteration Approx. root x_tolerance y_tolerance
1 3.000000 1.000000 0.000000
Exact root found at 3.000000
Number of iterations: 1
Interval: [0.000000, 3.000000]
Secant Method
Exact root found at 3.000000
Number of iterations: 0
Bisection Method
Exact root found at 3.000000
Number of iterations: 0
Interval: [1.000000, 2.000000]
Secant Method
Exact root found at 1.000000
Number of iterations: 0
Bisection Method
Exact root found at 1.000000
Number of iterations: 0

C:\Windows\system32\cmd.exe

```
Interval: [2.000000, 30.000000]
Secant Method
------------------------------------------------------------
Iteration       Approx. root    x_tolerance     y_tolerance
        1       2.004469        27.995531       4.004389
        2       2.008943        0.004473        4.008622
        3       -2.227552       4.236495        3.839298
        4       -98.286744      96.059192       968301.004265
        5       -2.227171       96.059573       3.832140
        6       -2.226791       0.000380        3.824998
        7       -2.023185       0.203606        0.352080
        8       -2.002543       0.020641        0.038199
        9       -2.000031       0.002512        0.000467
        10      -2.000000       0.000031        0.000001
        Approximated root: -2.000000
        Number of iterations: 10
        x_tolorence: 0.000031
        y_tolorence 0.000001

Bisection Method
------------------------------------------------------------
Iteration       Approx. root    x_tolerance     y_tolerance
        1       16.000000       14.000000       3510.000000
        2       9.000000        7.000000        528.000000
        3       5.500000        3.500000        84.375000
        4       3.750000        1.750000        11.859375
        5       2.875000        0.875000        1.142578
        6       3.312500        0.437500        3.839111
        7       3.093750        0.218750        0.999847
        8       2.984375        0.109375        0.154545
        9       3.039063        0.054688        0.401366
        10      3.011719        0.027344        0.118150
        11      2.998047        0.013672        0.019505
        12      3.004883        0.006836        0.048995
        13      3.001465        0.003418        0.014663
        14      2.999756        0.001709        0.002441
        15      3.000610        0.000854        0.006106
        16      3.000183        0.000427        0.001831
        17      2.999969        0.000214        0.000305
        18      3.000076        0.000107        0.000763
        19      3.000023        0.000053        0.000229
        20      2.999996        0.000027        0.000038
        Exceeded the maximum number of iterations.
        Approximated root: 2.999996
        was found at Iteration 20
        with x_tolorence: 0.000027
        with y_tolorence 0.000038



Interval: [10.000000, 30.000000]
Secant Method
------------------------------------------------------------
Iteration       Approx. root    x_tolerance     y_tolerance
        1       9.377778        20.622222       607.932927
        2       8.864979        0.512798        501.179151
        3       6.457535        2.407445        159.590418
        4       5.332775        1.124759        74.115223
        5       4.357501        0.975275        28.976272
        6       3.731438        0.626063        11.450703
        7       3.322386        0.409052        3.984897
        8       3.104054        0.218333        1.117452
        9       3.018969        0.085085        0.192212
        10      3.001293        0.017676        0.012940
        11      3.000017        0.001276        0.000170
        12      3.000000        0.000017        0.000000
        Approximated root: 3.000000
        Number of iterations: 12
        x_tolorence: 0.000017
        y_tolorence 0.000000

Bisection Method
        found no root on the interval
```

LAB #9 EVALUATION RUBRIC

1	Solve the assigned problem using methods described in program description.	__/3
2	Compilation/Execution ✓ Compile without errors. ✓ Execute without crashing. ✓ Work for all data and produce correct answers. ✓ The program output well formatted and properly labeled.	__/3
3	Main Comment Block includes the following. file name due date author course # program description input output	__/0.5
4	Documentation, indentation, and white space usage ✓ Meaning variable names are used and they are briefly described. ✓ Each section of statements in the program is well documented. ✓ Proper INDENTATION is used to make the program easier to read. ✓ WHITE SPACES are used in appropriate places for readability.	__/0.5
5	Contents of zipped folder ✓ Zip folder contains the project folder and the report. ✓ The project folder does NOT contain the following. ❖ Debug sub-folder ❖ Debug sub-sub-folder ❖ ipch sub-folder ❖ .sdf file	
6	Contents of report ✓ Output of the program ✓ Conclusion	__/3
	TOTAL	__/10