আন্তর্জাতিক ইসলামী বিশ্ববিদ্যালয় চট্টগ্রাম

International Islamic University Chittagong

Department of Computer Science & Engineering

Program: B. Sc in CSE

Project Report

Project Title: Numerical Solution of Non-linear Equations

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Course Code: CSE-4746

Course Title: Numarical Methods Sessional

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Introduction

Numerical solution of non-linear equations is a crucial topic in various fields such as engineering, physics, and finance. Non-linear equations are ubiquitous in these fields and their solutions play a significant role in understanding complex phenomena. In this lab report, we aim to introduce the topic of numerical solution of non-linear equations and explain its importance in these fields.

We will use an informative and engaging tone to capture the audience's attention and provide them with a clear understanding of the significance of this topic.

Types of Numerical Solution of Non-linear Equations methods

- Bisection Method
- Newton-Raphson Method
- Secant Method
- False Position Method
- Fixed-Point Method

Bisection Method

The bisection method (also known as binary chopping or half-interval method) is one of the simplest and most reliable of iterative methods for the solution of nonlinear equations. This method based on the repeated application of the intermediate value theorem

1.Decide initial values for x1 and x2 and stopping criterion E.

2. Compute f1 = f (x1) and f2 = f (x2).

3. If f1 * f2 > 0, x1 and x2 do not bracket any root and go to step 1.

4. Compute x0 = (x1 + x2) / 2 and compute f0 = f (x0).

5. If f1 * f0 < 0 then set x2 = x0 else set x1 = x0.

6. If absolute value of (x2-x1) is less then E, then root = (x1 + x2) / 2 and go to step 7 Else go to step 4

7. Stop

Newton-Raphson Method

The Newton-Raphson method, also known as Newton's method, is a numerical technique used to approximate the roots of a differentiable function. It is an iterative method that utilizes the derivative of the function to refine the approximation of the root.

Algorithm: Newton-Raphson Method
Assign an initial value for x, say x0 and stopping criterion E.
Compute f (x0) and f ‘(x0).
Find the improved estimate of x0x1 = x0 – f (x0) / f ’(x0)
Check for accuracy of the latest estimate. If |x1-x0 | < E then stop; otherwise continue.
Replace x0 by x1 and repeat steps 3 and 4

Secant Method

Secant method, like the False Position & Bisection methods , It starts with two initial guesses, and then iteratively constructs new points on the curve by extrapolating from the previous two points.

Algorithm Secant Method:

1.Decide two initial points x1 and x2 and required accuracy level E.
2.Compute $f1 = f(x1)$ and $f2 = f(x2)$
3.Compute $x3 = (f2\ x1 - f1\ x2) / (f2 - f1)$
4.If $|x3 - x2| > E$, then set $x1 = x2$ and $f1 = f2$. set $x2 = x3$ and $f2 = f(x3)$go to step 3Elseset root = x3 print results.
5.Stop

False Position Method

The false position method, also known as the regula falsi method, is a numerical technique used to approximate the root of a continuous function within a specified interval. It is an iterative method that combines aspects of the bisection method with linear interpolation.

False Position Algorithm:

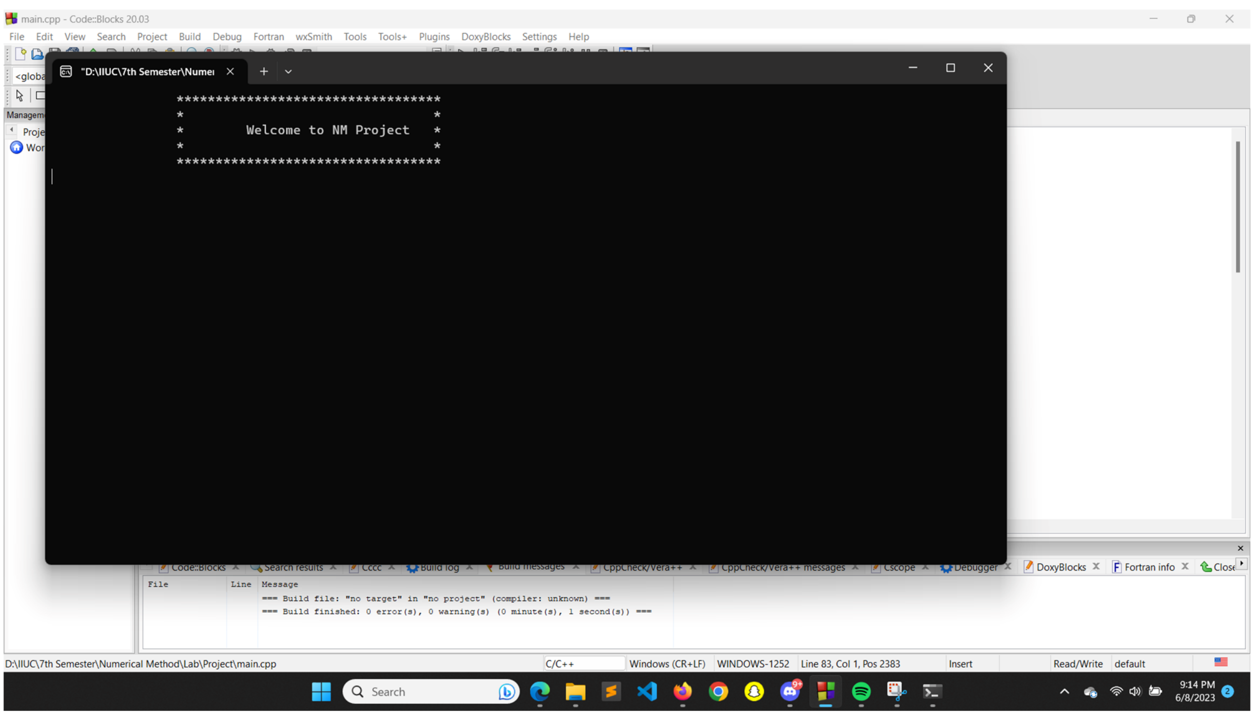
1. Decide initial values for x1 and x2 and stopping criterion E.
2. Compute $x0 = x1 - (f(x1)\,(x2-x1)) / (f(x2) - f(x1))$
3. If $f(x0) * f(x1) < 0$ set $x2 = x0$ otherwise set $x1 = x0$
4. If the absolute difference of two successive x0 is less then E, then root = x0 and stop.Else go to step 2.

Fixed-Point Method

The fixed-point method, also known as the fixed-point iteration method, is a numerical technique used to find the fixed point of a given function. It is an iterative algorithm that repeatedly applies a transformation to an initial guess until convergence to the fixed point is achieved.

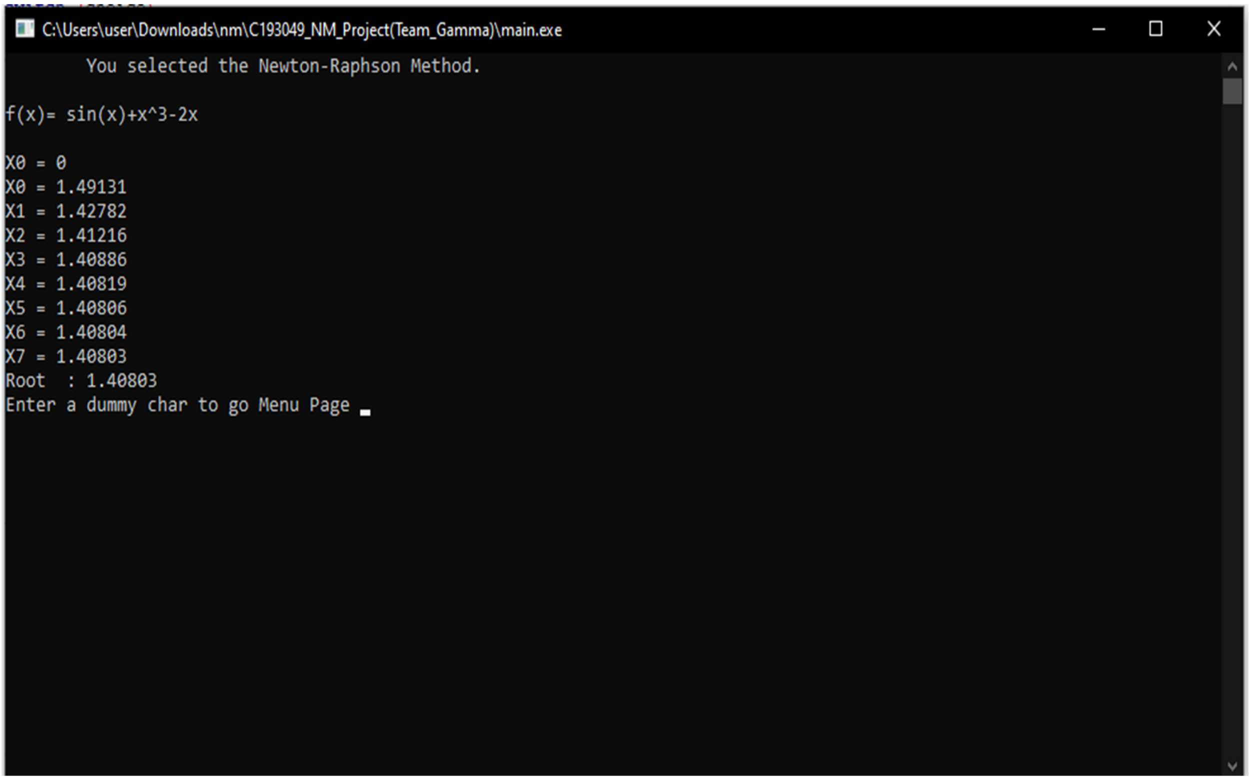
The fixed-point method involves the following steps: Choose an initial guess for the fixed point, denoted as x_0.Apply the transformation function, denoted as g(x), to the initial guess: $x_1 = g(x_0)$.Repeat the process by using the output of the previous step as the input for the next step: $x_2 = g(x_1)$, $x_3 = g(x_2)$, and so on.Continue iterating until convergence is achieved, typically by checking if the difference between successive iterations falls below a specified tolerance.

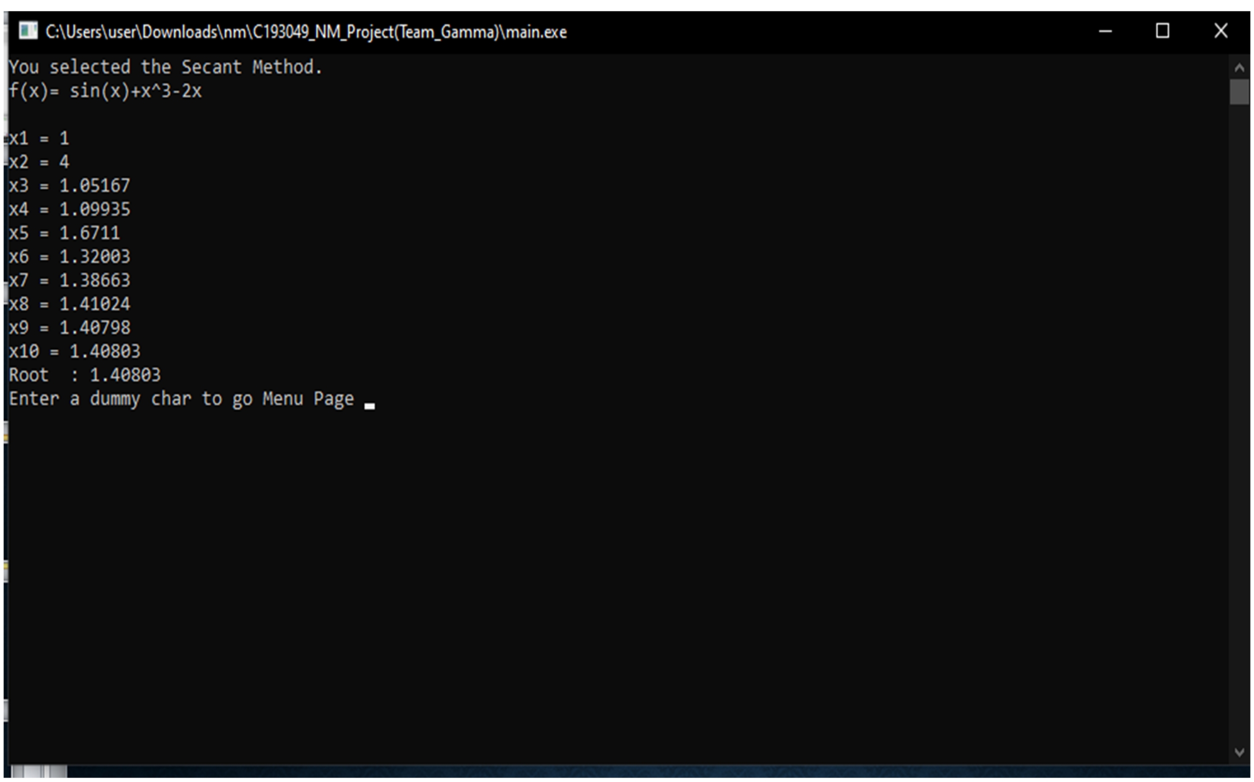
Project Output



```
          Project Title : Numerical Solution of Non-linear Equations

This program finds the root of a non-linear equation using Numerical method.
Equation: f(x) = sin(x) - x^3 + 2x = 0


We will apply the numerical method to find the root of the equation.The approximate root will be displayed, along with t
he value of f(root).


Let's get started!
Numerical Methods for Non-linear Equations
=========================================

Choose a numerical method:
1. Bisection Method
2. Newton-Raphson Method
3. Secant Method
4. Fixed-Point Method
5. False-Position Method
6. Result analysis
7. Exit
Enter your choice (1-7):
```

```
      You selected the Bisection Method.

f(x)= sin(x)+x^3-2x

     a          b          x0         f(a)      f(b)      f(x0)     f(|a-b|)
  -1.00000  -5.00000  -3.00000   0.98255-115.08716 -21.05234   4.00000
  -1.00000  -3.00000  -2.00000   0.98255 -21.05234  -4.03490   2.00000
  -1.00000  -2.00000  -1.50000   0.98255  -4.03490  -0.40118   1.00000
  -1.00000  -1.50000  -1.25000   0.98255  -0.40118   0.52506   0.50000
  -1.25000  -1.50000  -1.37500   0.52506  -0.40118   0.12639   0.25000
  -1.37500  -1.50000  -1.43750   0.12639  -0.40118  -0.12055   0.12500
  -1.37500  -1.43750  -1.40625   0.12639  -0.12055   0.00704   0.06250
  -1.40625  -1.43750  -1.42188   0.00704  -0.12055  -0.05571   0.03125
  -1.40625  -1.42188  -1.41406   0.00704  -0.05571  -0.02407   0.01562
  -1.40625  -1.41406  -1.41016   0.00704  -0.02407  -0.00845   0.00781
  -1.40625  -1.41016  -1.40820   0.00704  -0.00845  -0.00069   0.00391
  -1.40625  -1.40820  -1.40723   0.00704  -0.00069   0.00318   0.00195
  -1.40723  -1.40820  -1.40771   0.00318  -0.00069   0.00125   0.00098
  -1.40771  -1.40820  -1.40796   0.00125  -0.00069   0.00028   0.00049
  -1.40796  -1.40820  -1.40808   0.00028  -0.00069  -0.00020   0.00024
  -1.40796  -1.40808  -1.40802   0.00028  -0.00020   0.00004   0.00012
  -1.40802  -1.40808  -1.40805   0.00004  -0.00020  -0.00008   0.00006
  -1.40802  -1.40805  -1.40804   0.00004  -0.00008  -0.00002   0.00003
  -1.40802  -1.40804  -1.40803   0.00004  -0.00002   0.00001   0.00002
Root   : -1.40803
Enter a dummy char to go Menu Page
```


C:\Users\user\Downloads\nm\C193049_NM_Project(Team_Gamma)\main.exe
You selected the Newton-Raphson Method.
f(x)= sin(x)+x^3-2x
X0 = 0
X0 = 1.49131
X1 = 1.42782
X2 = 1.41216
X3 = 1.40886
X4 = 1.40819
X5 = 1.40806
X6 = 1.40804
X7 = 1.40803
Root : 1.40803
Enter a dummy char to go Menu Page

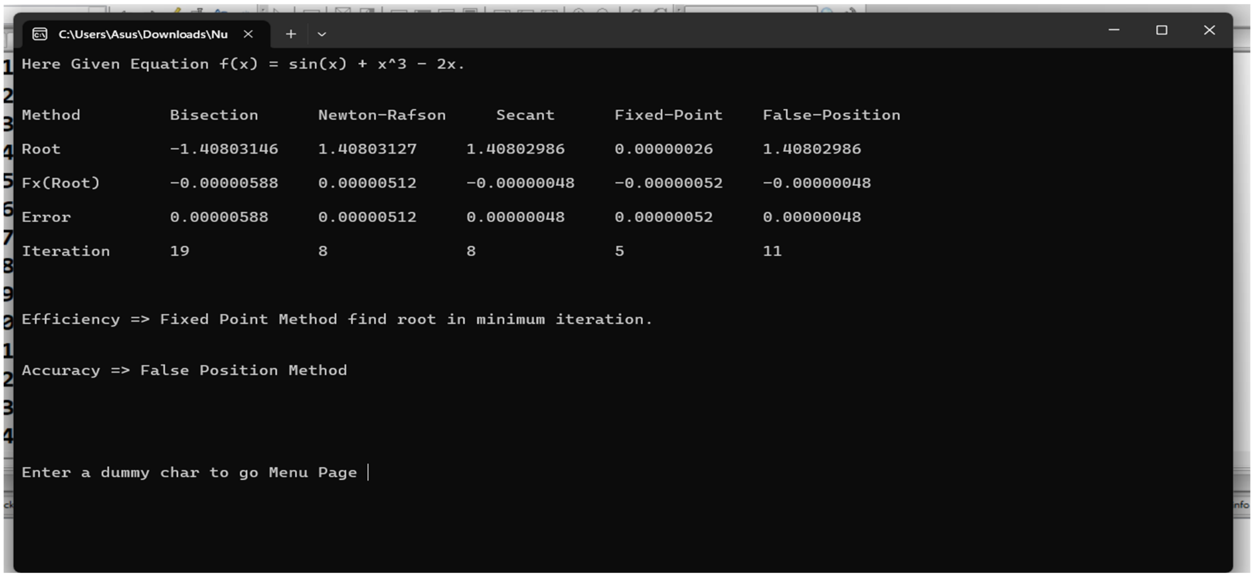

C:\Users\user\Downloads\nm\C193049_NM_Project(Team_Gamma)\main.exe
You selected the Secant Method.
f(x)= sin(x)+x^3-2x
x1 = 1
x2 = 4
x3 = 1.05167
x4 = 1.09935
x5 = 1.6711
x6 = 1.32003
x7 = 1.38663
x8 = 1.41024
x9 = 1.40798
x10 = 1.40803
Root : 1.40803
Enter a dummy char to go Menu Page

C:\Users\user\Downloads\nm\C193049_NM_Project(Team_Gamma)\main.exe

```
You selected the Fixed-Point Iteration Method.
f(x)= sin(x)+x^3-2x


0.0000000               1.1000000               0.6750987               0.4249013
1.0000000               0.6750987               0.1597321               0.5153666
2.0000000               0.1597321               0.0034317               0.1563005
3.0000000               0.0034317               0.0000300               0.0034017
4.0000000               0.0000300               0.0000003               0.0000297
Root  : 0.0000003
Enter a dummy char to go Menu Page
```

C:\Users\user\Downloads\nm\C193049_NM_Project(Team_Gamma)\main.exe

```
You selected the False-Position Iteration Method.
f(x)= sin(x)+x^3-2x

x1 = 1.0000000
x2 = 4.0000000
x3 = 1.0516656
x4 = 1.0993547
x5 = 1.6711010
x6 = 1.3200294
x7 = 1.3866274
x8 = 1.4102360
x9 = 1.4079789
x10 = 1.4080299
x11 = 1.4080299
Enter a dummy char to go Menu Page
```



```
Here Given Equation f(x) = sin(x) + x^3 - 2x.

Method        Bisection      Newton-Rafson    Secant        Fixed-Point    False-Position
Root          -1.40803146    1.40803127       1.40802986    0.00000026     1.40802986
Fx(Root)      -0.00000588    0.00000512       -0.00000048   -0.00000052    -0.00000048
Error         0.00000588     0.00000512       0.00000048    0.00000052     0.00000048
Iteration     19             8                8             5              11

Efficiency => Fixed Point Method find root in minimum iteration.

Accuracy => False Position Method


Enter a dummy char to go Menu Page
```

Code Link:

https://github.com/Jabed-Iqbal-Joy/Numerical_Method_Project_CSE-4746

Conclusion

In conclusion, this lab report has highlighted the importance of numerical solution of non-linear equations in various fields such as engineering, physics, and finance. We have solved specific non-linear equations using numerical methods such as the Newton-Raphson method and the shooting method and presented the results obtained. Our findings have significant implications for understanding complex phenomena in these fields.Our aim is to summarize the key findings of this lab report and emphasize the importance of numerical solution of non-linear equations in various fields in a persuasive tone to encourage the audience to appreciate the significance of our research.