YILDIZ TECHNICAL UNIVERSITY

COMPUTER ENGINEERING DEPARTMENT

Final Project

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Numerical Analysis BLM1022 Gr-2 Course Instructor: **Lect. Ahmet ELBİR**

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0) Menu

```
--------------------------------------------------------------------------------
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6) Gauss Seidel
7) Numerical Differentation
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9) Simpson 1/3 method
10) Gregory-Newton Interpolation
0) Exit

Select one of the options above:
```

1) Bisection

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->1
enter 2. coefficient --->-7
enter 3. coefficient --->14
enter 4. coefficient --->-6
please enter epsilon: 0.01
enter a: 0
enter b: 1

Root = 0.500000
Root = 0.750000
Root = 0.625000
Root = 0.562500
Root = 0.593750
Root = 0.578125
Root = 0.585938


--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = x^3 - 7x^2 + 14x - 6$

[a,b] → interval

2) Regula-Falsi

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->1
enter 2. coefficient --->-2
enter 3. coefficient --->0
enter 4. coefficient --->-5
please enter epsilon: 0.01
enter a: 2
enter b: 3

Root = 2.555556
Root = 2.669050
Root = 2.687326
Root = 2.690140


--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = x^3 - 2x^2 - 5$

[a,b] → interval

3) Newton-Raphson

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->1
enter 2. coefficient --->-7
enter 3. coefficient --->14
enter 4. coefficient --->-6
enter a: 0
enter epsilon: 0.0000001

Iteration:1   Root=0.428571    Error=613566757.000000
Iteration:2   Root=0.569724    Error=784896854.000000
Iteration:3   Root=0.585592    Error=1825696768.000000
Iteration:4   Root=0.585786    Error=1948762112.000000
Iteration:5   Root=0.585786    Error=201326592.000000
Iteration:6   Root=0.585786    Error=0.000000


--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = x^3 - 7x^2 + 14x - 6$

a→ first guess

4) Inverse of NxN Matrix

```
#define N 3             // number of rows of NxM matrix. can be changed from here
#define M 4             // number of columns of NxM matrix. can be changed from here
```

Size of the Matrix using Macros

```
--------------------------------------------------------------------------------
enter 1x1 element: 1
enter 1x2 element: 0
enter 1x3 element: 4
enter 2x1 element: 1
enter 2x2 element: 1
enter 2x3 element: 6
enter 3x1 element: -3
enter 3x2 element: 0
enter 3x3 element: -10

the adjoint matrix is :
| -10   0       -4
| -8    2       -2
| 3     0       1

determinant is: 2

Inverse matrix is:
| -5.000000     0.000000        -2.000000
| -4.000000     1.000000        -1.000000
| 1.500000      0.000000        0.500000


--------------------------------------------------------------------------------
```

The Matrix used in the example:

$$\begin{pmatrix} 1 & 0 & 4 \\ 1 & 1 & 6 \\ -3 & 0 & -10 \end{pmatrix} \xrightarrow{A^{-1}} \begin{pmatrix} -5 & 0 & -2 \\ -4 & 1 & -1 \\ \frac{3}{2} & 0 & \frac{1}{2} \end{pmatrix}$$

5) Gauss Elimination

```
--------------------------------------------------------------------------------
enter 1x1 element: 3.6
enter 1x2 element: 2.4
enter 1x3 element: -1.8
enter 1x4 element: 6.3
enter 2x1 element: 4.2
enter 2x2 element: -5.8
enter 2x3 element: 2.1
enter 2x4 element: 7.5
enter 3x1 element: 0.8
enter 3x2 element: 3.5
enter 3x3 element: 6.5
enter 3x4 element: 3.7

Upper-Triangular matrix:
|3.600000       2.400000        -1.800000       |       6.300000
|0.000000       -8.600000       4.200000        |       0.150000
|-0.000000      0.000000        8.348837        |       2.351744

The solution is:

x1=1.810759
x2=0.120125
x3=0.281685

--------------------------------------------------------------------------------
```

The Equations used in the example:

$$3{,}6\,x + 2{,}4\,y - 1{,}8\,z = 6{,}3$$
$$4{,}2\,x - 5{,}8\,y + 2{,}1\,z = 7{,}5$$
$$0{,}8\,x + 3{,}5\,y + 6{,}5\,z = 3{,}7$$

$$z = 0{,}281$$
$$y = 0{,}120$$
$$x = 1{,}81$$

6) Gauss Seidel

```
enter number of equations: 3
enter elements of matrix:
1x1: 27
1x2: 6
1x3: -1
1x4: 85
2x1: 6
2x2: 15
2x3: 2
2x4: 72
3x1: 1
3x2: 1
3x3: 54
3x4: 110

enter initial values of variables:
enter x1: 0
enter x2: 0
enter x3: 0

Enter the epsilon:
0.0001

Iter    x1                      x2                      x3
--------------------------------------------------------------------------------
        3.148148                3.540741                1.913169

        2.432175                3.572041                1.925848

        2.425689                3.572945                1.925951

        2.425492                3.573010                1.925954

        2.425478                3.573015                1.925954

        2.425476                3.573016                1.925954

        2.425476                3.573016                1.925954

        2.425476                3.573016                1.925954

        2.425476                3.573016                1.925954

Final Solution:  x1=2.425476    x2=3.573016     x3=1.925954

--------------------------------------------------------------------------------
```

$$\begin{bmatrix} 27 & 6 & -1 & 85 \\ 6 & 15 & 2 & 72 \\ 1 & 1 & 54 & 110 \end{bmatrix}$$

7) Numerical Differentation

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->2
enter 2. coefficient --->-6
enter 3. coefficient --->3
enter 4. coefficient --->9

please enter x: 2.5
please enter h: 0.01

1) Forward differentiation
2) Backward differentiation
3) Central differentiation
Choose one of the options above: 2

df = 10.410200
Real df = 10.500000
Error = -0.089800

--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = 2x^3 - 6x^2 + 3x + 9$

8) Trapezoidal Method

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->2
enter 2. coefficient --->-4
enter 3. coefficient --->8
enter 4. coefficient --->3
enter n: 6
enter lower interval: 1
enter upper interval: 3

h = 0.333333

x1 = 1.333333   y1 = 11.296296
x2 = 1.666667   y2 = 25.777778
x3 = 2.000000   y3 = 44.777778
x4 = 2.333333   y4 = 70.074074
x5 = 2.666667   y5 = 103.888889

Calculated Integral = 43.629630          Exact Integral = 43.333333      Error = 0.296296

--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = 2x^3 - 4x^2 + 8x + 3$

9) Simpson 1/3 method

```
--------------------------------------------------------------------------------
Please enter degree of polynomia (max 9): 3
enter 1. coefficient --->2
enter 2. coefficient --->-4
enter 3. coefficient --->8
enter 4. coefficient --->3
enter n: 6
enter lower interval: 3
enter upper interval: 5

h = 0.333333

x1 = 3.333333   y1 = 59.296296
x3 = 4.000000   y3 = 158.296296
x5 = 4.666667   y5 = 314.777778

x2 = 3.666667   y2 = 77.148148
x4 = 4.333333   y4 = 202.444444

Calculated Integral = 211.333333        Exact Integral = 211.333333     Error = 0.000000

--------------------------------------------------------------------------------
```

The Function used in the example: $f(x) = 2x^3 - 4x^2 + 8x + 3$

10) Gregory-Newton Interpolation

```
#define nTable 5              // number of (x,y) in Newton-Gregory Interpolation
```

Number of Points using Macro 

```
--------------------------------------------------------------------------------
please enter x0: 2
please enter x1: 4
please enter x2: 6
please enter x3: 8
please enter x4: 10
please enter y0: 10
please enter y1: 50
please enter y2: 122
please enter y3: 226
please enter y4: 362
please enter value of x in F(x): 8

10.000000
50.000000       40.000000
122.000000      72.000000       32.000000
226.000000      104.000000      32.000000       0.000000
362.000000      136.000000      32.000000       0.000000        0.000000


F(8.000000) = 226.000000



--------------------------------------------------------------------------------
```

The Points used in the example: