LAB EXPERIMENT # 11: Study of numerical differentiation (Euler's Differential Equation)

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11.1 Objectives

- To understand the numerical differentiation method and its MATLAB implementation
- To understand Euler's method of differentiation method and its MATLAB implementation
- To analyze of results using different values

11.2 Theory

Conventional differentiation is difficult to solve, especially for large amounts of data such as data engineering. As a result, numerical differentiation is applied. The derivative is found using a simple algebraic formula in this numerical differentiation method. Numerical differentiation is the process of finding the numerical value of a derivative of a given function at a given point.

The Euler technique (also known as the forward Euler method) is a first-order numerical procedure for solving ordinary differential equations (ODEs) with a given initial value in mathematics and computing science. It is the simplest Runge-Kutta method and the most fundamental explicit method for numerical integration of ordinary differential equations.

For this experiment, given equation is,

$$\frac{dy}{dx} = -xy$$

And, $y(0) = 1$; $x = 0{:}0.25$; $h = 0.05$

11.3 Apparatus

- MATLAB

11.4 Algorithm

Step: 1 Start

Step: 2 Define function

Step: 3 Calculate the values of x_0, y_0, h, $s = 0$, and x_n

The initial conditions are x_0 and y_0 in this case, h denotes the interval, while x_n is the needed value.

Step: 4 Determine 'n' using equation, $n = x/h$

Step: 5 Calculate the value of *x(i)*

Step: 6 Calculate the value of *y(i)* and *y(i* + 1*)*, where *y(i)* = *y(i)* + *h*f(x,y)*

Step: 7 Display the value of *x(i)*, *y(i*+1*)*

Step: 8 Stop

11.5 Pseudocode

```
Define function
input x0, h, y0
n = x/h
for i=1:n+1
      x(i)=0;
      x(i)=x(i)+h;
end
for i=1:n
      y(i);
      y(i+1)= y(i)+h*(f(i,i));
end
D=[x' y']
```

11.6 MATLAB Code

```
clc;
clear all;
f=@(x,y) (-x)*y
x=0.25;
h=0.05;
n=x/h;
x=zeros(1,n+1);
x(1)=0;
for i=1:n+1
    x(i)=0
    x(i)=x(i)+h;
end
y=zeros(1,n);
y(1)=1;
for i=1:n
    y(i);
    y(i+1)=y(i)+(h*f(i,i));
end
D = [x' y']
```

11.7 MATLAB Output

```
f = function_handle with value:
    @(x,y)(-x)*y
x = 1×6
      0     0     0     0     0     0

x = 1×6
     0.0500         0         0         0         0         0

x = 1×6
     0.0500    0.0500         0         0         0         0

x = 1×6
     0.0500    0.0500    0.0500         0         0         0

x = 1×6
     0.0500    0.0500    0.0500    0.0500         0         0

x = 1×6
     0.0500    0.0500    0.0500    0.0500    0.0500         0

D = 6×2
     0.0500    1.0000
     0.0500    0.9500
     0.0500    0.7500
     0.0500    0.3000
     0.0500   -0.5000
     0.0500   -1.7500
```

11.8 Discussion & Analysis

In this experiment, Euler's approach to solve the value of *'y'* from a given differential equation for a particular function and conditions. Here, the initial value of *'y'* and *'x'* is given. Thus, we solved *'y'* for the corresponding value of *'x'* and created a table for the value of *'y'* for the corresponding '*x*'.

Thus, the experiment was done was successfully and MATLAB implementation of the method was carried out accordingly.