Math 105 Lab Report 5

Jingyang Qiu ID:47674821

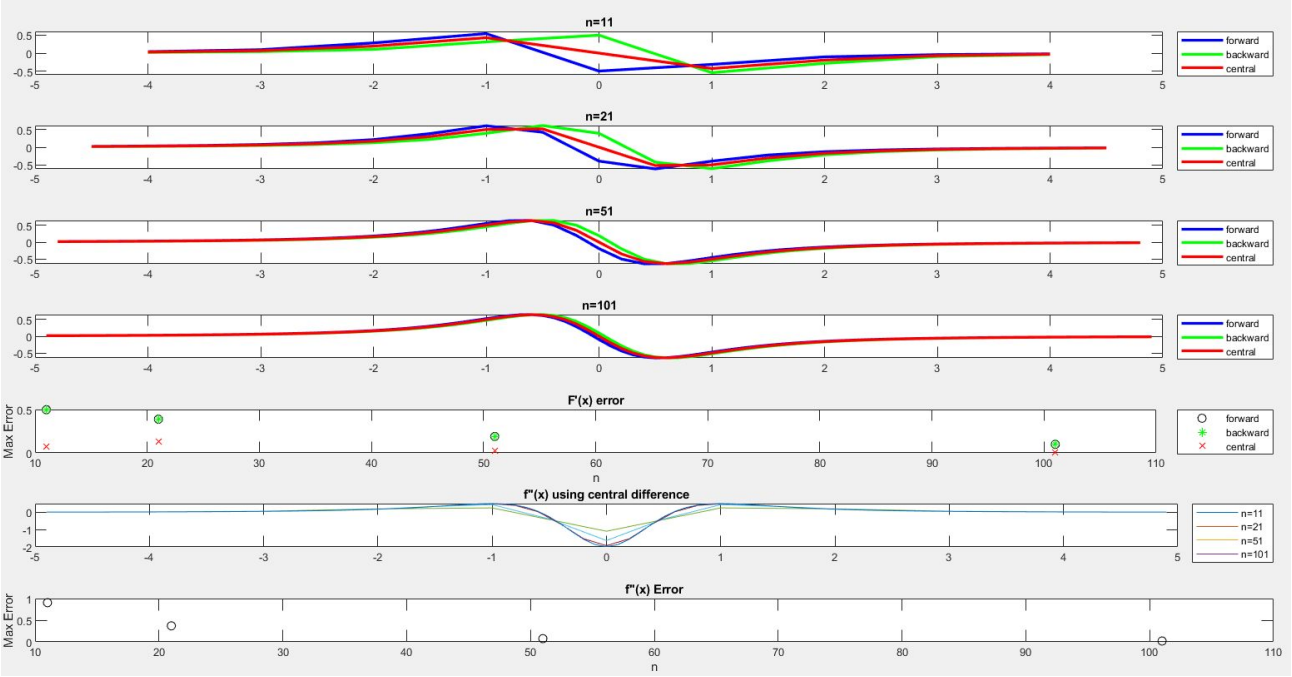
Purpose/Objective: As stated in the assignment, the objective of this lab is to test the accuracy of several finite difference formulas for approximating derivatives. The formulas include first derivative forward difference, backward difference, central difference, and second derivative central difference. I will also explore the relationship between absolute errors and the value n, and compare the max absolute errors with their corresponding error bound.

Introduction: In this lab, we will use the function f(x)=1/(1+x^2) and generate equally spaced points in the interval [-5,5] based on four different n and h values. We will then plot various numerical approximations excluding the end points, in order to avoid extrapolation. We will also plot the maximum absolute error from the actual function values against the value n, so we get four points in total in each graph. We could then contrast them from the computed error estimates. Last but not least, we will observe how n impacts the accuracy of the forward difference formula.

Algorithm: For this assignment, I mainly focused on plotting techniques, like setting up subplots and applying legends and titles to each graph to make them more clear. One thing I kept in mind while coding was that h changes with n, so I had to define forward, backward, and central difference formulas over and over again in each part. Another thing that I found useful was adding a dot before each operation when defining anonymous functions. It means that I can do component wise operations on the entire array, not just a single point.

Result/Graph:

```
Command Window
>> M105B_assignment5

max_error1 =

    0.4977    0.3882    0.1888    0.0980

error_estimate =

    0.9091    0.4762    0.1961    0.0990

The actual error is about the same size as the error estimate, and it is less than the error estimate as

max_error =

    0.9050    0.3697    0.0740    0.0194

error_estimate =

    1.6529    0.4535    0.0769    0.0196

The actual error is about the same size as the error estimate, and it is less than the error estimate as

D_N_list =

   -0.0990   -0.0100   -0.0000         0         0         0

As n increases, DN f(0) converges to 0 by the forward difference formula. This agrees with our actual va
fx >>
```



Conclusion: As we have hypothesized, our numerical approximations get better and better as n increases. Our max absolute error also decreases as n increases, so we are getting more accurate results.