SOLVING ONE DIMENSIONAL POISSON EQUATION FYS 4150 – COMPUTATIONAL PHYSICS

Jeyalakshmi Thoppe Subramanian

September 9, 2019

`https://github.com/jeyalakt/4150COMP_PHY.git`

1 Abstract

In this Project one dimensional Poisson equation with Drichlet boundary conditions is solved with two algorithms -Gaussian Elimination and LU decomposition . It is observed that Gaussian elimination algorithm consumes less time and hence efficient than the LU decomposition. LU decomposition algorithm was used via pre built library function could not be used for discretion values above in the order of 10000 while Gaussian elimination algorithm can be used .

2 Introduction

Poisson equation describes the electrostatic potential generated by localised charge distribution in electromagnetism . This study intents to solve the Poisson equation using two different algorithms -first, Gaussian elimination algorithm and second LU decomposition method. We study how these two algorithms are used to solve the Poisson equation at different precision levels and how Gaussian elimination is more efficient that LU decomposition method. First, the how the second derivative of Poisson equation can be approximated to 3 point formula is presented followed by elaboration on the proposed algorithms .Then the results of the algorithms are presented . Finally, a brief discussion on the results and remarks are provided.

3 Snippets of algorithms

Figure 1: The Universe

4 Results

The results in terms of step size , exact function , numerical solution , relative error are stored in a file for each value of n . CPU time comparision The timings of the algorithms were observed to be of the following order (Note: timing includes memory read and write and on the other tasks being processed by CPU at that time)

5 Discussion

Normally we intend to choose large value for n , assuming that it will result in higher precision .But from figure 5 (for gaussian elimination algorithm)we observe that this is true upto certain value of n only . This is due to loss of precision in numerical representation in the computer.A suitable value of n =105 gives results at reasonable cost of CPU time and memory Also the LU decomposition algorithm consumes 8*1010 bytes (app. 80 GB) of memory for value n=105 which strongly affects our ability performing the calculation. So Gaussian elimination method is found more efficient.

6 Conclusion

The results show the importance of choosing suitable algorithm before solving a problem numerically within the constraints of time and memory and at reasonably accepted precision. Loss of numerical precision in numerical representation in computer also needs to to be considered. In this study it is found that Gaussian elimination algorithm is more efficient than LU decomposition .

7 References

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