Project Proposal

On

System of Linear Equations

Course Title: **Numerical Methods**
Course Code: **CSE-4746**

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Team Name: **Team Crammer's Fan**

Submitted to-

Prof. Mohammed Shamsul Alam
Professor, Computer Science and Engineering, IIUC
Mobile: 01711941680 **Mail:** alam_cse@yahoo.com , msa@iiuc.ac.bd

Submitted by-

Team Crammer's Fan

Team Leader: C201042 - Jobair Uddin Jesan, 7AM
Deputy Leader: C201041 - Emdadul Islam, 7AM
Member- 01: C201032 – Sorowar Mahabub, 7AM
Member- 02: C191039 – Sakif Azwad, 7AM
Dept. of ***Computer Science and Engineering***, IIUC

Remarks:

Introduction

Linear equations are the backbone of mathematics and have wide-ranging applications across various disciplines, from engineering to economics. In the course "Numerical Methods" (CSE-4746), we explore methods and techniques for solving complex systems of linear equations. This project proposal aims to delve into the practical and theoretical aspects of these numerical methods, their applications, and the development of efficient algorithms for solving real-world linear systems. By undertaking this project, we aim to deepen our understanding of the significance of numerical methods for linear equations and their practical implications.

Objectives

The primary objectives of our project are as follows:

1. **Comprehensive Understanding**: To develop a deep understanding of various numerical methods for solving systems of linear equations, including direct and iterative approaches.

2. **Algorithm Implementation**: To implement and analyze the selected numerical methods, including Matrix Inversion, Cramer's Rule, Gauss Elimination (with and without pivoting), Gauss-Jordan Elimination, and iterative methods like Jacobi and Gauss-Seidel.

3. **Performance Evaluation**: To evaluate the performance of these methods, including their accuracy, computational efficiency, and convergence properties.

4. **Real-World Applications**: To apply these numerical methods to real-world problems from diverse fields, such as engineering, economics, and physics.

5. **Comparison and Analysis**: To compare and analyze the advantages and disadvantages of different methods in terms of applicability and efficiency.

6. **Numerical Stability**: To investigate numerical stability and potential issues, especially with large and ill-conditioned systems.

7. **Documentation and Reporting**: To document the project's findings, methodologies, and results in a clear and organized manner.

By achieving these objectives, we aim to gain a strong foundation in numerical methods for solving linear systems and to provide valuable insights into the practical applications and limitations of these techniques. Additionally, we hope that this project will serve as an educational resource and reference for future studies in the field of numerical methods.

Project Scope

Our project focuses on a comprehensive exploration of various numerical methods for solving linear systems of equations. We will primarily employ the following techniques:

1. **Matrix Inversion Method:** Exploring the principles and application of matrix inversion to solve linear systems.
2. **Cramer’s Rule:** Investigating the use of Cramer's rule for solving systems of linear equations.
3. **Basic Gauss Elimination Method:** Understanding the fundamental Gaussian elimination method for solving linear systems.
4. **Gauss Elimination Method with Pivoting:** Extending the basic Gauss elimination to account for pivoting and numerical stability.
5. **Gauss-Jordan Elimination Method:** Studying the Gauss-Jordan elimination method for solving linear systems and its applications.
6. **Gauss-Jordan Matrix Inversion Method:** Utilizing the Gauss-Jordan method for matrix inversion and system solution.
7. **Jacobi Iteration Method:** Analyzing the Jacobi iteration as an iterative approach to solving linear systems.
8. **Gauss-Seidel Method:** Exploring the Gauss-Seidel iteration method and its role in solving linear equations.

These methods will serve as the foundation for our project, enabling us to comprehensively study the techniques, algorithms, and applications associated with solving linear systems of equations. The combination of direct and iterative methods provides a well-rounded perspective on numerical solutions for linear systems.

Methodology

Our project methodology will consist of the following key steps:

1. **Conceptual Understanding**: Begin with a comprehensive study of linear systems of equations, focusing on fundamental concepts, properties, and associated numerical methods.
2. **Implementation of Numerical Methods**: Implement various numerical methods for solving systems of linear equations, including the Matrix Inversion method, Cramer's Rule, Gauss Elimination (with and without pivoting), Gauss-Jordan Elimination, Jacobi Iteration, and Gauss-Seidel Iteration
3. **Method Comparison**: Apply these methods to different linear systems to assess their effectiveness, accuracy, and computational efficiency.
4. **Testing and Validation**: Rigorously test the program on a range of linear systems with varying sizes and complexities to ensure the developed solver's accuracy and versatility.

Possible Additional Features

Our project can potentially include the following additional features:

- **Visualization of Results**: Develop visualization tools to provide a clear representation of the solutions and solution processes.
- **Performance Comparison**: Include a comprehensive performance comparison of the different numerical methods to determine the most efficient approach for specific scenarios.
- **Extension to Higher Dimensions**: Extend the project's capabilities to handle higher-dimensional linear systems, enhancing its versatility.
- **User-Friendly Interface**: Create a user-friendly interface for the numerical solver, making it accessible to users with varying levels of expertise.
- **Contribution to Research**: Explore the potential to contribute to research in numerical methods for solving linear systems by conducting in-depth analysis and providing new insights.

Expected Project Outcomes

- Deep understanding of numerical methods for solving linear systems.
- Proficiency in implementing key numerical techniques, including Gauss Elimination and Gauss-Jordan Elimination.
- Comprehensive analysis of method performance, focusing on accuracy, efficiency, and convergence properties.
- Application of numerical methods to real-world problems, enhancing practical problem-solving skills.
- Comparative evaluation of method advantages and limitations for diverse problem types.

Conclusion

Upon completion, this project is expected to provide us with a solid foundation in numerical methods for solving linear systems. It will not only enhance our problem-solving skills but also serve as a valuable resource for future studies and applications in scientific, engineering, and computational domains. The pursuit of this project represents a crucial step towards mastering the art of solving linear systems of equations and underscores our commitment to advancing the field of numerical methods.

Thank You. Assalamualaikum Waa Rahmatullah.