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LU Factorization using Java Programming: Solving Systems of Linear Equation

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***Abstract* - The purpose of this thesis is to contribute a GUI program that assist in solving LU Factorization efficiently and easier than manual computing using JavaScript. Generally, the LU factorization is the most efficient technique for solving linear equation with 3 or more variables as this method is significantly present in matrix factorization in Numerical analysis and linear algebra. With this program, it enables an individual to solve from 2x2 up to 10x10 dimension. Thus, contributing to the accuracy and facilely of the computation.**

Keywords: Matrices, Systems of Linear Equation, Java, LU Factorization, Linear Algebra.

I. INTRODUCTION

In a field of linear algebra, there are variety of ways in solving systems of linear equations, where yielding to different engineering applications. Using matrices, there are numerous ways such as Cramer's Rule, Gaussian Elimination, Gauss-Jordan Elimination Method and Cholesky's method. LU factorization is one of the prominent solutions that provide an algorithmic way of solving systems of linear equation that provides an easy connection through programming.

a) Java Programming

Different programming languages are known for different application development, and Java programming is one of the noticeable language that provides, portability and flexibility in running different application platforms. The application of LU factorization in Java programming provides a gateway of showing an in-depth solution in how a simple system of linear equation is being solved.

b) LU Factorization

LU Factorization is part of numerical analysis and linear algebra, where LU stands for 'lower upper'. The LU factorization was introduced by a mathematician Banachiewicz' in 1938. It factors a matrix as the product of lower triangular matrix. L unit is the lower triangular and the U unit is the upper triangular. The LU Factorization can be viewed as the matrix form of Gaussian elimination. Square system of linear equation using the LU factorization can usually solve by a computer. One of the most important matrix factorizations in numerical analysis is LU factorization. If you need a lot of calculation on a particular matrix, obtaining its LU factorization will likely speed things up. So how can we define LU Factorization? First Let A be a square matrix. An LU factorization refers to factorization of A, with proper row and columns ordering or permutation, into two factors, a lower triangular matrix L and an upper triangular matrix.

The formula used is "$u_y = a_y / a_{11}$", where "a" is given by the user based on the input and "u" is what the program function will do and solve for the while the "i" is the value of the row and "j" is value of the column. Next, $L_{ij} = a_y - \sum_{k=1}^{j-1}(lik * ukj)$", where "a" is given by the user based on the input and "u" is what the program function will do and solve for while the "i" is the value of the row and "j" is value of the column. After that, "$u_{ij} = a_y - \sum_{k=1}^{j-1}(lik * ukj)$", where "a" is given by the user based on the input and "u" is what the program function will do and solve for while the "i" is the value of the row and "j" is value of the column.

II. RELATED STUDIES

Based from Demmel et. al., many of the currently popular 'block algorithms' are scalar algorithms in which the operations have been grouped and reordered into matrix operations. One genuine block algorithm in practical use is block LU factorization, and this has recently been shown by Demmel and Higham to be unstable in general. It is shown here that block LU factorization is stable if A is block diagonally dominant by columns. [2] In some article by Dureisseix, the paper deals with the case where the left hand side may be singular. In such a case, kernels are required to test a solvability condition and to derive the general form of the solutions. The complete fraction-free algorithms are therefore extended to deal with singular systems and to provide the kernels with exact computations on the same integral domain where the initial data take their entries. [1] On

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the other hand, the purpose of this work is to solve Linear Programming (LP) problems using LU factorization. LU method is based on the fact that a square matrix can be factorized into the product of unit lower triangular matrix (L) and upper triangular matrix (U), and the direct solution was obtained without iterations. [3] In applications, LU factorization with partial pivoting is a canonical numerical procedure and the main component of the High Performance LINPACK benchmark. [4] Lastly, a paper from Tanabe, the method can be interpreted as a product-form iterative refinement of inverse of a matrix. In this paper we introduce an additive-form iterative refinement of LU factorization of an ill-conditioned matrix, in which the triangular factor matrices are approximated by sums of matrices with row precision entries. [5]

III. RESULTS AND DISCUSSIONS

In the LU Factorization, the first step is to identify the dimensions. The dimension refers to the number of equations with the same number of variables to be solve. The first interface use in the program is the selection of dimension which ranges from "2 by 2" up to "10 by 10". Each is customized uniquely since there is a big difference in each of them. Upon knowing which dimension is to be used, each dimension have specific button assigned to them and when clicked will cause another interface to open while closing the old interface with the code "dispose()". The interface is already arranged and ready to use based on the format of the specific dimension.

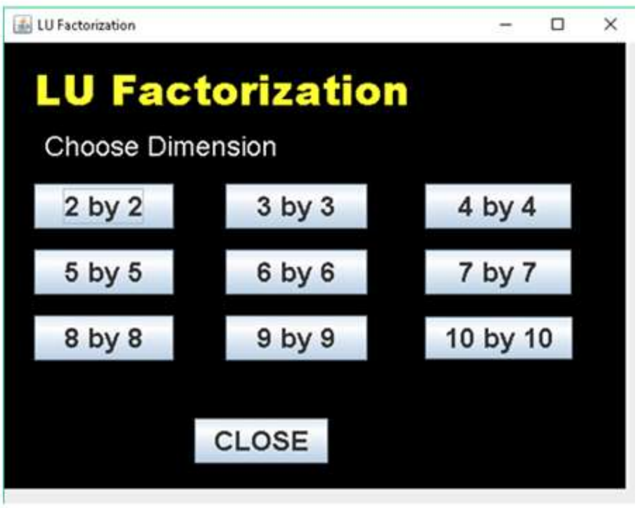

Figure-1: Main Menu

The LU Factorization has three components regardless of the it's dimension. The three components of matrices are the A-component, L-component, and the last is the U component.The A-component is the co-efficient of systems of linear equations and its constant values. In A-component, the all fields should completely filled for validating the content of the initial matrix.

By solving 3x3 linear equation, x -2y + 1 = -4, 2x + y + 2z = 7 and x - 5y + 2z = -14.

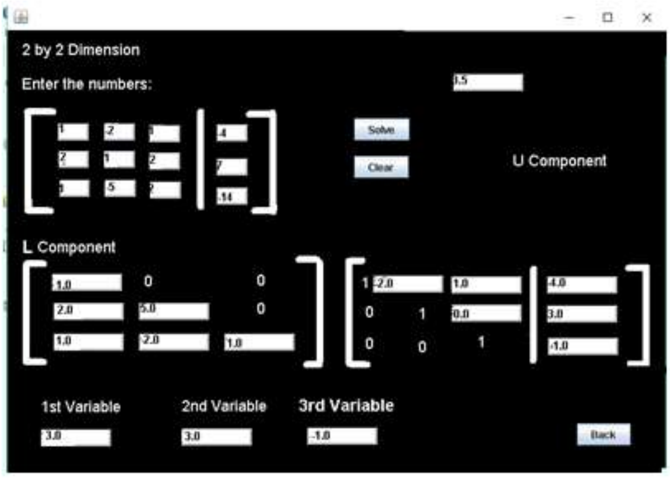

Figure-2: Simulation of 3x3 LU Factorization

The program was accurate and mostly the same compared to the manual solving. The only difference is that in the manual solving when the answer is not in whole number it expresses in improper fraction while in the program the answer is express in decimal.

IV. CONCLUSION

LU Factorization is one of the prominent ways in solving systems of linear equation. Using Java programming, math instructors can basically simulate solutions of LU factorization in a very simple way. In manual solution, it is laborious to simulate LU matrices that will consume time for instructors in keeping solution for a numerical problem.

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