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1. INTRODUCTION

The field of numerical analysis is divided in different disciplines according to the problem that is to be solved. A fundamental problem is computing the solution of some given equation. Two cases are commonly distinguished, depending on whether the equation is linear or not. For instance, the equation $2x+5=3$ is linear while $2x^2+5=3$ is not.

Much effort has been put in the development of methods for solving systems of linear equations. The Gauss-elimination method, Gauss-Jordan method, LU Decomposition method and LU Decomposition from gauss elimination are direct methods. They are based on the elimination of variables in order to reduce the given system of equations to triangular form. When a linear system has a large number of unknowns, the Gaussian scheme becomes very unwieldy. Under such conditions it is more convenient to use iterative methods. The iterative methods are not applicable to all systems of equations. In order that the iteration may succeed, each equation of the system much contain one large coefficient and the large coefficient must be attached to different unknown in that equation. We shall discuss two particular methods for iteration: Jacobi method and Gauss- Seidel method. The convergence in Gauss- Seidel method is more rapid than in gauss- Jacobi method.

Root finding algorithms are used to solve non-linear equations. If the function is differentiable and the derivative is known, the Newton's method is a particular choice.

1.1 TRIANGULAR MATRICES

A square matrix is said to be *triangular* if the elements above (or below) of the main diagonal are zero. For example, the matrices

$$A=\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ 0 & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{bmatrix} \quad \text{and} \quad B=\begin{bmatrix} b_{11} & 0 & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

are triangular matrices where A is called an upper triangular matrix and B is a lower triangular matrix.

It is clear that in A, $a_{ij}=0$ for $i>j$, and $b_{ij}=0$ for $j>i$ in B. It is also easily seen that a triangular matrix is nonsingular only when all its diagonal elements are nonzero. The following properties hold for triangular matrices:

I. If A_1 and A_2 are two upper triangular matrices of the same order, then A_1+A_2 and A_1A_2 are also upper triangular matrices of the same order. Similar results hold good for lower triangular matrices also.

II. The inverse of a nonsingular lower triangular matrix is also a lower triangular matrix. Similar result holds good for an upper triangular matrix also. This property enables us to invert a triangular matrix easily.

Example 1: Find the inverse of the matrix

$$A=\begin{bmatrix}1 & 2 & 3\\ 0 & 1 & 2\\ 0 & 0 & 1\end{bmatrix}$$

Ans : Let $$A^{-1}=\begin{bmatrix}a_{11} & a_{12} & a_{13}\\ 0 & a_{22} & a_{23}\\ 0 & 0 & a_{33}\end{bmatrix}$$

Since $AA^{-1}=I$, we write

$$\begin{bmatrix}a_{11} & a_{12} & a_{13}\\ 0 & a_{22} & a_{23}\\ 0 & 0 & a_{33}\end{bmatrix}\begin{bmatrix}1 & 2 & 3\\ 0 & 1 & 2\\ 0 & 0 & 1\end{bmatrix}=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$$

Multiplying the matrices on the left side and equating corresponding elements on both sides, we obtain

$a_{11}=1, a_{22}=1$,

$2a_{11}+a_{12}=0, 2a_{22}+a_{23}=0,$

$a_{12}=-2, \quad a_{23}=-2,$

$3a_{11}+2a_{12}+a_{13}=0\ a_{33}=1.$

$a_{13}=1.$

Hence

$$A^{-1}=\begin{bmatrix}1 & -2 & 1\\ 0 & 1 & -2\\ 0 & 0 & 1\end{bmatrix}$$

Since the inverse of a triangular matrix is easily computed, it follows that the inverse of a nonsingular matrix A can be easily obtained if A is expressed as a product of two triangular matrices.

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