Application of Matrix in modern Era

Kamaji Vitthalrao Deshmukh

Assistant Professor& Head, Department of Applied Science,

Matsyodari Shikshan Sanstha's College of Engineering Jalna(India).

Abstract

In this paper, my purpose is to create awareness of the applications and uses of matrices in different fields of science and engineering, the concept of matrix came through the study of system of linear simultaneous equation in about 300 B.C, initially the matrices were used to solve linear simultaneous equation in two variables, the progress in study of matrices was made at the end of 17th century, and now Matrices are used almost in all fields.

KEY WORDS

Matrix, Eigen values, Eigen vectors, Applications, Determinant.

Matrix in modern Era

Matrix is nothing but an arrangement of data (for our convenience) in rows and columns, the idea of such arrangement came from the study of linear simultaneous equations,

Consider linear system of equations $a_1x+ b_1y = c_1$, $a_2x+b_2y =c_2$,

Which are equivalent to $a_2a_1x+ a_2 b_1y = a_2c_1$, $a_1 a_2x+a_1b_2y = a_1c_2$

Solving above equations we get

$y = (a_2c_1-a_1c_2)/ (a_2b_1-a_1b_2)$ and similarly

$x= (b_2c_1-b_1c_2)/ (a_1b_2-a_2b_1)$

These values of x and y are not easy to remember, but it can be simple to remember if we arrange x and y as

$$x = \frac{\begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}}$$, and similarly $$y = \frac{\begin{vmatrix} c_1 & a_1 \\ c_2 & a_2 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}}$$

That’s how the determinant born and later on matrix, and so one may say that matrix is daughter of determinant.

Matrices are added, subtracted and multiplied. Matrix multiplication is possible if columns of first matrix and rows of second matrix are same in number; in matrix multiplication order of multiplication is material.

Matrices are used to solve physical related problems and are used in the study of electrical circuits, electromagnetic force, quantum electrodynamics, quantum physics, matrices helps in calculations of battery power outputs, matrices are also used to study the motion of rigid bodies, matrices are used to control 3D models and project them onto a 2-dimensional screen, matrices are used in automation for Controlling of robot movements. With the help of matrices problem related to Gustav-Kirchhoff law of voltage can be solved, Matrices can be used in geology for seismic survey. Oil companies often use Eigen value analysis to discover land for oil.

Use of Matrices in Geometry

Matrices can be used to determine area of triangle if vertices are given. Suppose the vertices are A (a, b), B(c, d) C (e, f). Then area is

Area of Δ ABC = $\begin{vmatrix} a & b & 1 \\ c & d & 1 \\ e & f & 1 \end{vmatrix}$

And therefore three points in the Plane are said to be collinear if Δ ABC = $\begin{vmatrix} a & b & 1 \\ c & d & 1 \\ e & f & 1 \end{vmatrix}$=0

Use of Matrices in Physics

Matrices are used to determine moments of inertia, formations of crystal, also used to calculate angles and distance of atoms in a crystal, to express spectrums frequency. In optics matrices are used to determine reflection and refraction, for decoupling three-phase systems eigen values and eigen vectors are used, Principal stresses in mechanics are the eigen values of the stress tensor.

Use of Matrices in Chemistry

Matrices are used to balance a chemical reaction, consider a simple reaction

MgO + Fe ---> Fe_2O_3 + Mg (Not Balanced)

To Balance above reaction insert unknowns a,b,c,d as

aMgO + bFe --->c Fe_2O_3 + dMg

Then comparing number of atoms with number of products in the reaction we get four linear equations

Mg: 1a + 0b +0c = 1d
Fe: 0a + 1b - 2c = 0d
O: 1a + 0b - 3c = 0d

Here matrix A = $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -2 \\ 1 & 0 & -3 \end{bmatrix}$ B= $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$

Then consider augmented matrix C (A/B) = $\begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & -2 & 0 \\ 1 & 0 & -3 & 0 \end{bmatrix}$

Reducing above matrix to its normal form and solving the system we get a=3, b=2,c=1,d=3

Hence balanced equation will be $3MgO + 2Fe \longrightarrow Fe_2O_3 + 3Mg$

Use of Matrices in Communication systems

Matrices are used to describe the channels of communication in a system, Eigen values of matrix are used to find theoretical limit to what proportion the data or information is transmitted through a communication medium through the air, and a "status" matrix is used to explain the allocation of information in the system.

Use of Matrices in computer graphics

In gaming industry, matrices are major tools to build and control a practical animation of a polygonal figure. Video gaming manufacturing may be the first industry which depends a lot on computer graphics.

Use of Matrices in Economics

Cramer's Rule is frequently used for solving problems in economics as well as to solve problems in business related to maximize earnings and minimize defeat. Matrices are used to discover variance as well as co- variance. The equilibrium of markets in IS-LM model is solved by using Matrix. In economics large matrices are used for optimization, for example to make best use of assets, whether labor or resources, in the manufacturing of a product and supervision large supply chains

Use of Matrices in IT companies

Matrices are used in IT companies as information structures to track consumer information, to execute search queries, and supervise databases. In information security system, many systems are planned to work with matrices. Matrices are used in the compacting of electronic information, for example in the storage of biometric information.

Use of Matrices in Medical Field

Matrix models are used to prescribe the most suitable medicine such matrix models have been implemented in many countries. In last several years, matrix models have developed to notify decisions in medicine prescribing in a clear, transparent and reproducible method.

Use of Matrices in Mechanical Engineering

Vibrations of a cantilever beam is an eigen value problem, the eigen values are the natural frequencies of vibration and the eigenvectors are the mode shapes of the vibration.

Use of Matrices in bioinformatics

A matrix in which each row and column represents one of the twenty standard amino acids is called PAM (A point accepted mutation**)** matrix

PAM matrices are often used as substitution matrices in proteins structure alignments

The BLOSUM matrices are the amino acid substitution matrices, in bioinformatics they are used for sequence alignment of proteins.

Use of Matrices in Radiology

The image matrix is used to improve spatial resolution; in image processing various changes can be made on the image by performing operations on the corresponding matrix.

Use of Matrices in Probability and statistics

A square matrix which describes the transitions of a Markov chain is called probability matrix, it is used to differentiate transitions for a finite Markov chain, in statistics a covariance matrix is used to display the variance and covariance of two sets together.

REFERENCES:

1. Matrix Analysis by Roger. A. Horn
2. The mathematics of matrices by Philip J Davis
3. Computer Graphics, Tata McGraw–Hill
4. Advanced Engineering Mathematics by H K Dass
5. Introduction to Matrix Analysis second Edition by Richard Bellman
6. Free Probability and Random Matrices by James A. Mingo and Roland Speicher
7. Mathematics for Economists by Malcolm Pemberton Nicholas Rau
8. Quantum mechanics in simple matrix form by Thomas Jordan
9. Mathematical Chemistry and Chemo informatics: Structure Generation, Elucidation and Quantitative Structure-Property Relationships by Adalbert Kerber, Emma Schymanski and Markus Meringer
10. Business Mathematics, Books a la Carte Edition by Gray Clendenen and Stanley A Salzman