SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 11 | November 2021 - Peer Reviewed Journal

IMPLEMENTATION OF DETERMINANTS IN THE VARIOUS FIELDS OF SCIENCE & ENGINEERING

Dr. Rakesh Kumar Verma[1], Suhani Sachdeva[2]
[1]*Prof & HOD, Applied Science, Yogananda College of Engineering & Technology, Jammu*

ABSTRACT

*Determinants can be used to see if **a system of n linear equations in n variables has a unique solution**. This is useful for homework problems and the like, when the relevant computations can be performed exactly. Can you apply determinant in real life situation? However, when solving real numerical problems, **the determinant is rarely used**, as it is a very poor indicator of how well you can solve a system of equations, and furthermore, it is typically very expensive to compute directly.*

KEY WORDS : *Determinants, Matrices, Linear Eqution, Matrix*

INTRODUCTION

The determinant is useful for **solving linear equations**, capturing how linear transformation change area or volume, and changing variables in integrals. The determinant can be viewed as a function whose input is a square matrix and whose output is a number. Determinants and matrices, in linear algebra, are **used to solve linear equations by applying Cramer's rule to a set of non-homogeneous equations which are in linear form**. Determinants are calculated for square matrices only.

The determinant is **useful for solving linear equations**, capturing how linear transformation change area or volume, and changing variables in integrals. The determinant can be viewed as a function whose input is a square matrix and whose output is a number.

Use determinants to determine whether a matrix has an inverse, and evaluate the inverse using cofactors. Apply Cramer's Rule to solve a 2×2 or a 3×3 linear system. Given data points, find an appropriate interpolating polynomial and use it to estimate points.

One application of matrix and determinant is that it can be used to solve linear equations in two or three variables. Matrices and determinants are also used to check the consistency of any system, whether they are consistent or not.

Solution of a system of linear equation using the inverse of a matrix: The solution of a system of linear equations can be found out using the inverse of a matrix. Let the equations are:

Attention reader! All those who say programming isn't for kids, just haven't met the right mentors yet.

$A^{-1}AX = A^{-1}B$
$IX = A^{-1}B$
$X = A^{-1}B$

This provides a unique solution for the unknown variables. The solution will be unique because any non-singular matrix has a unique inverse.

If A is a singular matrix then A^{-1} doesn't exist. In this case |A| = 0, so you will have to calculate (adj A)B.

1. If (adj A)B ≠ O, then any doesn't exist for the system of linear equations, and this system will be inconsistent.
2. If (adj A)B = O, then the system of linear equations will have either zero solution or infinitely many solutions, that's why the system may be inconsistent if it doesn't have any solution or maybe consistent if it has infinitely many solutions.

Consistency of a system

A system of equations is said to be consistent or inconsistent based on the number of solutions it possesses.

- **Consistent System:** A system of equations is said to be consistent if it possesses a solution.
- **Inconsistent System:** A system of equations is said to be inconsistent if it doesn't possess a solution.

Let us make one thing absolutely clear before I start. What is practical to me may not be practical to you, and what is practical to you may not be practical to me.

METHODOLOGY

For example, what is the practical use of juggling a ball with your legs? Zero practical use, for me. A soccer player, however, has quite a few practical uses for this.

This illustrates a point: that usually, when people ask for a practical use for something, they're asking for a practical use of that thing *for their own lives… not for someone else's lives.*

So I may give you two hundred million practical uses of juggling a ball with your legs, but they may all be irrelevant to you. Likewise for matrices, determinants, owning a dog, dancing, playing the guitar, reading poetry, and whatever else you may think of.Back to the question. What is the practical use of matrices and determinants?

First and foremost: matrices represent linear transformations. If I have a matrix AA and a column matrix xx, and I perform the multiplication AxAx, the end result is the column matrix of the linear transformation of xx by AA.

What if I multiply two matrices AA and BB by each other, and not a matrix AA by a column matrix xx? We may understand this in more than one way. The matrix ABAB is the matrix which, when applied to a column matrix xx, gives you the linear transformation of xx by first BB and then AA, in that order. Alternatively, you can consider ABAB as transforming several column matrices at one go: if BB has nn columns, then you're finding the linear transformation of those nn column matrices by AA by working out ABAB.

What is the inverse matrix? If AA transforms column xx to column yy, then A−1A−1 transforms column yy to column xx. Simple enough.

But, unfortunately, this inverse may either not exist, or not be unique. In both cases, A−1A−1 wouldn't be defined. And how do we know if the inverse exists and is unique? By finding the determinant of your matrix. If it is zero, or the determinant cannot be found (because the matrix is not square) then the inverse is either non-existent or non-unique. If the determinant is nonzero, then the inverse exists and is unique.

If, at this point, you're saying "yes, but what is the *practical* use of matrices and determinants?", then my answer is simple. *That's my practical use of matrices and determinants.* It may not be yours, but not everyone is a soccer player, or wants to become one.

Of course, there are other practical uses for matrices and determinants. For example, a determinant may be used to find the coordinates of the centre of a sphere given any four 3D coordinates on the surface of that sphere. Or matrices may be used to study graphs (networks) in algebraic graph theory. Or lots of other uses. But those are the uses I decided to share with you today: the uses that matrices and determinants were originally created for.

Simple 2 x 2 matrices are used in decision theory for the military. 3 x 3 matrices are used for generating rotations in simple video games and physics simulations. What you really should be asking is what is a matrix? A 3 x 3 matrix can be thought of as a set of 3 columns, where the columns are vectors. To multiply matrices, you do a dot product (piece by piece multiplication, followed by a sum) of the first row of the first matrix with the first column of the 2nd, and so on (consult your text and notes). To understand determinants, look at all the interpretations of how the determinant of 3 x 3 matrices are computed. There are interesting connections to combinatorics.

One common mistake is to ask why the rules are the ways they are. They could be different, but it wouldn't make the results any better.

Engineering Aspects: Matrices are a good way to represent multiple equations that need to be solved together. In this representation they are easy to analyze and easy to solve with computers. Determinants are just one of the important properties of matrices.
Such matrices appear in the solution of many practical problems. The behavior of electronic circuits can be represented by matrices. Images from a CT scanner or MRI are produced by solving large sets of equations by using matrices.
I am sure that many other areas of engineering arrive to practical solutions by using matrices. There are software packages built expressly to handle matrices: MATLAB is short for Matrix Laboratory and it is used in many areas of science and engineering.

What are Matrices?

- A matrix is defined as a rectangular array of numbers or symbols which are generally arranged in rows and columns.

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 11 | November 2021 - Peer Reviewed Journal

- The order of the matrix can be defined as the number of rows and columns.
- The entries are the numbers in the matrix known as an element.
- The plural of matrix is matrices.
- The size of a matrix is denoted as 'n by m' matrix and is written as m×n, where n= number of rows and m= number of columns.
- Example:

The matrix given above has 2 rows and three columns.

Types of Matrix

What are The Different Types of Matrix?

There are different types of matrices. Here they are –

1) Row matrix
2) Column matrix
3) Null matrix
4) Square matrix
5) Diagonal matrix
6) Upper triangular matrix
7) Lower triangular matrix
8) Symmetric matrix
9) Anti-symmetric matrix

Important Operations on Matrices

1. **Addition of Matrices:**

Let us suppose that we have two matrices namely A and B.

Both the matrices A and B have the same number of rows and columns (that is the number of rows is 2 and the number of columns is 3), so they can be added. In simpler words, you can easily add a 2 x 3 matrix with a 2 x 3 matrix or a 2 x 2 matrix with a 2 x 2 matrix. However, remember you cannot add a 3 x 2 matrix with a 2 x 3 matrix or a 2 x 2 matrix with a 3 x 3 matrix.

Applications of Matrices

Matrices have many applications in diverse fields of science, commerce and social science.

Matrices are used in:

(i) Computer Graphics
(ii) Optics
(iii) Cryptography
(iv) Economics
(v) Chemistry
(vi) Geology
(vii) Robotics and animation
(viii) Wireless communication and signal processing
(ix) Finance ices
(x) Mathematics

Use of Matrices In Computer Graphics

Earlier architecture, cartoons, automation were done by hand drawings but nowadays they are done by using computer graphics. Square matrices very easily represent linear transformation of objects. They are used to project three dimensional images into two dimensional planes in the field of graphics. In Graphics, digital image is treated as a matrix to start with. The rows and columns of the matrix correspond to rows and columns of pixels and the numerical entries correspond to the pixels' color values. Using matrices to manipulate a point is a common mathematical approach in video game graphics Matrices are also used to express graphs. Every graph can be represented as a matrix, each column and each row of a matrix is a node and the value of their intersection is the strength of the connection between them. Matrix operations such as translation, rotation and sealing are used in graphics. For transformation of a point we use the equation

Use of Matrices in Cryptography

Cryptography is the technique to encrypt data so that only the relevant person can get the data and relate information. In earlier days, video signals were not used to encrypt. Anyone with satellite dish was able to watch videos which results in the loss for satellite owners, so they started encrypting the video signals so that only those who have video ciphers can unencrypt the signals. This encryption is done by using an invertible key that is not invertible then the encrypted signals cannot be unencrypted and they cannot get back to their original form. This process is done using matrices. A digital audio or video signal is firstly taken as a sequence of numbers representing the variation over time of air pressure of an acoustic audio signal. The filtering techniques are used which depends on matrix multiplication.

Cryptography is the technique to encrypt data so that only the relevant person can get the data and relate information. In earlier days, video signals were not used to encrypt. Anyone with satellite dish was able to watch videos which results in the loss for satellite owners, so they started encrypting the video signals so that only those who have video ciphers can unencrypt the signals. This encryption is done by using an invertible key that is not invertible then the encrypted signals cannot be unencrypted and they cannot get back to their original form. This process is done using matrices. A digital audio or video signal is firstly taken as a sequence of numbers representing the variation over time of air pressure of an acoustic audio signal.

The filtering techniques are used which depends on matrix multiplication.

Use of Matrices in Wireless Communication

Matrices are used to model the wireless signals and to optimize them. For detection, extractions and processing of the information embedded in signals matrices are used. Matrices play a key role in signal estimation and detection problems. They are used in sensor array signal processing and design of adaptive filters. Matrices help in processing and representing digital images. We know that wireless and communication is an important part of the telecommunication industry. Sensor array signal processing focuses on signal enumeration and source location applications and presents a huge importance in many domains such as radar signals and underwater surveillance. Main problem in sensor array signal processing is to detect and locate the radiating sources given the temporal and spatial information collected from the sensors.

Use of Matrices in Science

Matrices are used in science of optics to account for reflection and for refraction. Matrices are also useful in electrical circuits and quantum mechanics and resistor conversion of electrical energy. Matrices are used to solve AC network equations in electric circuits.

Application of Matrices in Mathematics

Application of matrices in mathematics have an extended history of application in solving linear equations. Matrices are incredibly useful things that happen in many various applied areas. Application of matrices in mathematics applies to many branches of science, also as different mathematical disciplines. Engineering Mathematics is applied in our daily life.

Use of Matrices in Finding Area of Triangle

We can use matrices to find the area of any triangle where the vertices of the triangle have been given.
Let's suppose that we have a triangle ABC with vertices A(a,b) , B(c,d) , C(e,f)
Now the area of the triangle ABC .

Use of Matrices for Collinear Point

Matrices can be used to check where any three given points are collinear or not. Three points suppose A(a,b) , B(c,d)
C(e,f) are collinear if they do not form a triangle, that is the area of the triangle should be equal to zero.

CONCLUSIONS

There are various scope to implement Matrices in the field of Computer Graphics, Optics , Mathematics, Science, Cryptography ,Economics, Chemistry, Geology, Robotics and animation, surveying .

REFERENCES

1. *Maths Insite - https://mathinsight.org/determinant_matrix*
2. *Dr. Arvind Dewangan, "Importance of Study of Mathematics in Engineering Education" International Journal of Engineering Research And Management (IJERM)ISSN: 2349- 2058, Volume-05, Issue-07, July 2018*

BIOGRAPHY

Co-Author Suhani Sachdeva is currently studying in Higher secondary Schools.

BIOGRAPHY

Corresponding-author: Mr. Rakesh Kumar Verma is working as an Assistant Professor- HOD, in the Department of Applied Science in the **Yogananda College of Engineering & Technology, Jammu-180205 (J & K).** He has published 6- research (Out of 6, two papers are subjected to accepted in National Seminar which will be held in 28th Feb-2018) papers in International