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MATRIX OPERATIONS: THE REAL-WORLD IMPLICATIONS OF MATRIX

Annotation:

This undertaking explores the idea of matrices, their homes, and their diverse applications. It delves into essential matrix operations, including addition, subtraction, multiplication, and inversion, imparting a strong basis for know-how matrix algebra. The challenge similarly investigates the role of matrices in fixing systems of linear equations, representing linear changes, and reading facts structures. by way of examining actual-world examples, this takes a look at highlights the importance of matrices in numerous fields consisting of engineering, pc technological know-how, and economics. in the end, this task aims to demystify the concept of matrices and showcase their sensible application. Matrices are fundamental mathematical structures with diverse applications. This project explores their core concepts, properties, and operations. We delve into their historical development and evolution from simple calculations to powerful computational tools. By examining real-world examples, we demonstrate the versatility and significance of matrices in problem-solving. Additionally, we discuss emerging trends and potential future developments in matrix-related research. This work is motivated by the work of [1-6].

Keywords:

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Historical

After the invention of determinants—which resulted from the study of coefficients of systems of linear equations—the concept of a matrix and the field of linear algebra were introduced and developed. Cramer introduced his determinant-based solution for solving systems of linear equations (now known as Cramer's rule) in 1750, and Leibnitz, one of the calculus pioneers, employed determinant in 1963.

Introduction:

A matrix is a rectangular array of numbers, symbols, and terms stacked one row above the other in columns. The interior brackets are referred to as entries. matrices are essential in many branches of mathematics, physics, engineering, computer technology and records. The idea of matrices may have originated in China, despite the fact that mathematicians such as Cayley and Sylvester formalized the idea in the 19th century. Contemporary matrix operations are similar to the solutions to linear equations determined in historical writings. The theory of matrices was not completely developed in the 19th century. In recent times, matrices are critical tools in many disciplines. Medical computing and statistics technological no Suggestions know-how are universal thanks to matrices. Powerful software packages and libraries are crucial gear for researchers.

A brief records of Matrices:

At the same time as the concept of matrices has historical roots, the present day understanding and improvement of matrix algebra emerged inside the 19th century.

Early Origins:

Chinese and Babylonian Contributions: Early civilizations encountered troubles that may be represented the use of matrix-like structures. The Chinese language textual content nine Chapters of the Mathematical art (three hundred BC - 2 hundred advert) blanketed strategies for fixing structures of linear equations, precursors to matrix operations. Babylonian mathematicians additionally explored similar ideas.

Key Milestones:

- Determinants: before matrices, mathematicians have been grappling with fixing structures of linear equations the usage of determinants. those have been numbers associated with rectangular arrays of numbers.
- Arthur Cayley: This nineteenth-century mathematician is credited with developing the algebraic elements of matrices. He delivered the idea of matrix operations and laid the basis for matrix idea.

Challenge objectives:

- ✓ To introduce the idea of matrices and their essential operations.
- ✓ To explore the programs of matrices in numerous sectors.
- ✓ To investigate real-world examples and case research.
- ✓ To broaden a deeper expertise of the function of matrices in problem-solving.
- ✓ To pick out capacity regions for destiny studies and improvement.

Essential Framework:

- Elements: The precise digits, characters, or terms that make up a matrix.
- Rows: factors arranged horizontally.
- Columns: elements organized vertically.
- Dimensions: A matrix's dimension, expressed as m x n, is decided by means of the wide variety of rows (m) and columns (n).

Example-1: $\begin{bmatrix} \mathbf{1} & \mathbf{2} \\ \mathbf{3} & \mathbf{4} \end{bmatrix}$

This is a 2x2 matrix (2 rows, 2 columns).

Example-2: $\begin{bmatrix} \mathbf{1} & \mathbf{2} & \mathbf{3} \\ \mathbf{4} & \mathbf{5} & \mathbf{6} \\ \mathbf{7} & \mathbf{8} & \mathbf{9} \end{bmatrix}$

This is a 3x3 matrix (3rows,3columns)

Types of Matrices:

- Square Matrix: A matrix with an equal number of rows and columns (n x n).
- Row Matrix: A single-row matrix (1 x n).
- Column Matrix: A matrix consisting of m x 1 columns.
- Identity Matrix: A square matrix containing zeros in certain places and ones on the primary diagonal.
- Zero Matrix: This type of matrix has zeros for every element.

A square matrix that only has non-zero items on the major diagonal is called a diagonal matrix.

A square matrix with all entries zero above or below the major diagonal is called a triangular matrix.

Matrix Operations:

- Addition and Subtraction: By adding or subtracting corresponding elements, matrices with the same dimensions can be added or subtracted.
- Scalar Multiplication: When a scalar is multiplied by a matrix, each element of the matrix is multiplied by the scalar.
- Matrix Multiplication: Under certain circumstances, the product of two matrices is defined. The outcome is a new matrix whose dimensions are established by the initial matrices' dimensions.
- Matrix Inverse: A square matrix's inverse is a different matrix that produces the identity matrix when multiplied by the original matrix.

Utilizing Matrices:

Applications for matrices are numerous and span a number of disciplines:

- ✓ Linear algebra: determining eigenvalues and eigenvectors, solving systems of linear equations.
- ✓ Geometry: Rotations, reflections, and scaling are examples of transformations.
- ✓ Computer graphics: 3D modeling and image processing.
- ✓ Physics: mechanics and quantum mechanics.
- ✓ Economics: linear programming and input-output models.
- ✓ Statistics: Correlation matrices and data analysis.
- ✓ Cryptography: data safeguarding and decoding algorithms.

Matrices' Effect on Real Life:

Despite being viewed as abstract mathematical concepts, matrices have a significant impact on daily life. They serve as the foundation for many of the procedures and technology we use every day. Let's examine a few crucial points:

- **Computer science and technology**: Image and Video Processing: In essence, digital images are pixel value matrices. Image compression, augmentation, rotation, and special effects are all achieved by matrix operations.

- **Computer graphics:** Transformations, projections, and lighting computations are made possible using matrices, which are essenti al to 3D graphics.
- **Machine Learning and Artificial Intelligence:** Matrix operations form the core of algorithms for tasks like image recognition, natural language processing, and data analysis.
- **Cryptography:** To protect data transfer, matrices are employed in encryption techniques.

Some worked out examples:

Problem-1:(factory & industry sector)

A
and B are Zubin's two factories. Each enterprise produces school bags for girls and boys in three differ ent colors: red, blue and yellow. The matrix below shows the production of each factory. Blue, red and yellow can be represented as rows 1, 2 and 3, respectively, and girls and boys can be represented as ro ws 1 and 2, respectively.

→ Given that:

A=$\begin{bmatrix} 80 & 75 & 90 \\ 60 & 65 & 85 \end{bmatrix}$

B=$\begin{bmatrix} 90 & 70 & 75 \\ 50 & 55 & 75 \end{bmatrix}$

Zubin can find total production of bags in each distinct color by adding both A&B=

A+B= $\begin{bmatrix} 80+90 & 75+70 & 90+75 \\ 60+50 & 65+55 & 85+75 \end{bmatrix}$

= $\begin{bmatrix} 170 & 145 & 165 \\ 110 & 120 & 160 \end{bmatrix}$

From this we can say that total bags produced in each color for boys & girls are

Blue: Boys = 170, Girls = 110

Red: Boys = 145, Girls = 120

Yellow: Boys = 165, Girls = 160.

Problem-2:(Business sector)

A store has three types of products: A, B, and C. The number of units sold in three months is given by the following matrix:

[A B C]

$\begin{bmatrix} 100 & 80 & 120 \\ 120 & 90 & 150 \\ 150 & 100 & 180 \end{bmatrix}$

The selling price per unit of A, B, and C is Rs. 20, Rs. 25, and Rs. 30 respectively. Find the total revenue earned in each month.

→ Given that:

First, we need to represent the selling prices as a row matrix:

[20 25 30]

To find the total revenue for each month, we need to multiply the price matrix by the sales matrix:

$$\begin{bmatrix} 20 & 25 & 30 \\ 120 & 90 & 150 \\ 150 & 100 & 180 \end{bmatrix} * [100 \quad 80 \quad 120]$$

Now, we get: $\begin{bmatrix} 7100 & 6250 & 7800 \\ 8500 & 7250 & 9000 \\ 10000 & 8500 & 10800 \end{bmatrix}$

∴ the total revenue generated in the first, second, and third months is Rs. 7100, Rs. 8500, and Rs. 10000 respectively.

Problem-3:(market & stock sector)

A grocery store sells three types of fruits: apples, oranges, and bananas. The number of units sold on Monday, Tuesday, and Wednesday is given by the following matrix:

Apples Oranges Bananas

$$\begin{bmatrix} M \\ T \\ W \end{bmatrix} \begin{bmatrix} 120 & 80 & 150 \\ 100 & 90 & 140 \\ 130 & 70 & 160 \end{bmatrix}$$

The price per unit of each fruit is given by the matrix:

Price

Apples =2

Oranges =1.5

Bananas =1.2

Find the total revenue for each day.

→ Given that:

To find the total revenue for each day, we need to multiply the sales matrix by the price matrix:

Sales Matrix (S):

Apples Oranges Bananas

$$\begin{bmatrix} M \\ T \\ W \end{bmatrix} \begin{bmatrix} 120 & 80 & 150 \\ 100 & 90 & 140 \\ 130 & 70 & 160 \end{bmatrix}$$

Price Matrix (P):

Price

Apples [2]

Oranges [1.5]

Bananas [1.2]

Revenue Matrix (R)

The revenue matrix (R) will be the product of the sales matrix (S) and the price matrix (P).

R =[S * P]

=Apples Oranges Bananas * Price

$$\begin{bmatrix} M \\ T \\ W \end{bmatrix} \begin{bmatrix} 120 & 80 & 150 \\ 100 & 90 & 140 \\ 130 & 70 & 160 \end{bmatrix} * \begin{bmatrix} Apple \\ Oranges \\ Bananas \end{bmatrix} \begin{bmatrix} 2 \\ 1.5 \\ 1.2 \end{bmatrix}$$

To calculate the elements of the revenue matrix,

Revenue on Monday: (120 * 2) + (80 * 1.5) + (150 * 1.2)

Revenue on Tuesday: (100 * 2) + (90 * 1.5) + (140 * 1.2)

Revenue on Wednesday: (130 * 2) + (70 * 1.5) + (160 * 1.2)

$$= \begin{bmatrix} 240 + & 120 + & 180 \\ 200 + & 135 + & 168 \\ 360 + & 105 + & 192 \end{bmatrix}$$

$$= \begin{bmatrix} 540 \\ 503 \\ 657 \end{bmatrix}$$

Problem-4: (Hotel & management)

A school cafeteria offers three meal options: vegetarian, chicken, and fish. The number of students choosing each option on Monday, Tuesday, and Wednesday is given by the following matrix:

Vegetarian Chicken Fish

$$\begin{bmatrix} \mathrm{M} \\ \mathrm{T} \\ \mathrm{W} \end{bmatrix} \begin{bmatrix} 120 & 80 & 100 \\ 150 & 90 & 120 \\ 130 & 70 & 110 \end{bmatrix}$$

The price of each meal option is:

- ✓ Vegetarian: $5
- ✓ Chicken: $6
- ✓ Fish: $7

How can you use matrix operations to find the total revenue for each day?

→ Given that:

We can represent the price of each meal option as a row matrix:

Price= [5 6 7]

Revenue=price*number of meals

Veg chicken fish

$$\begin{bmatrix} \mathrm{M} \\ \mathrm{T} \\ \mathrm{W} \end{bmatrix} \begin{bmatrix} 20 & 80 & 100 \\ 150 & 90 & 120 \\ 130 & 70 & 110 \end{bmatrix} * [5\ 6\ 7]$$

$$= \begin{bmatrix} 120 * 5 + & 80 * 6 + & 100 * 7 \\ 150 * 5 + & 90 * 6 + & 120 * 7 \\ 130 * Z + & 70 * 6 + & 110 * 7 \end{bmatrix}$$

$$= \begin{bmatrix} 1780 \\ 1890 \\ 1760 \end{bmatrix}$$

∴ The resulting matrix is:

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Revenue = [1780 1890 1760]

This means:

- The total revenue on Monday is $1780.
- The total revenue on Tuesday is $1890.
- The total revenue on Wednesday is $1760.

Therefore, by using matrix multiplication, we efficiently calculated the total revenue for each day.

Problem-5:(general stores & market)

A grocery store sells three types of fruit: apples, oranges, and bananas. The number of pounds sold on Monday, Tuesday, and Wednesday is given by the following matrix:

Apples Oranges Bananas

$$\begin{bmatrix} M \\ T \\ W \end{bmatrix} \begin{bmatrix} 100 & 80 & 120 \\ 120 & 90 & 150 \\ 90 & 70 & 110 \end{bmatrix}$$

The price per pound of each fruit is:

- Apples: $1.50
- Oranges: $1.20
- Bananas: $0.90

How can you use matrix operations to find the total revenue from fruit sales for each day?

→ Given that:

We can represent the price per pound of each fruit as a row matrix:

Price = [1.50 1.20 0.90]

To find the total revenue for each day, we need to multiply the price matrix by the number of pounds sold matrix.

Revenue = Price * Number of pounds sold

By multiplication, we get:

Apples Oranges Bananas

$$\begin{bmatrix} M \\ T \\ W \end{bmatrix} \begin{bmatrix} 100 & 80 & 120 \\ 120 & 90 & 150 \\ 90 & 70 & 110 \end{bmatrix} * [1.50\ 1.20\ 0.90]$$

$$= \begin{bmatrix} 100 * 1.50 + & 80 * 1.20 + & 120 * 0.90 \\ 120 * 1.50 + & 90 * 12.0 + & 150 * 0.90 \\ 90 * 1.50 + & 70 * 1.20 + & 110 * 0.90 \end{bmatrix}$$

The resulting matrix is:

Revenue = [306 333 273]

This means:

- ✓ The total revenue on Monday is $306.
- ✓ The total revenue on Tuesday is $333.

✓ The total revenue on Wednesday is $273.

Therefore, by using matrix multiplication, we efficiently calculated the total revenue from fruit sales for each day.

Conclusion:

This project successfully explored the concept of matrices, their applications, and their impact on real-life scenarios. Here's a summary of the key takeaways:

- Matrices are powerful mathematical tools arranged in rows and columns. They have diverse applications across numerous fields.
- Core matrix operations like addition, subtraction, multiplication, and inversion are fundamental for manipulating and analyzing data.
- Matrices play a crucial role in solving systems of linear equations, representing linear transformations, and analyzing data structures.
- Real-world examples from various sectors like computer science, business, market analysis, and hospitality management demonstrated the practical use of matrices.

This project effectively showcased the following:

- **Understanding of Matrices:** The explanation of matrix basics, types, and operations provided a solid foundation.
- **Problem-Solving with Matrices:** The provided examples in various sectors (factory production, sales data, fruit market, cafeteria revenue) demonstrated how matrices can be used to solve real-world problems efficiently.

Future Exploration:

The project could be further enriched by:

- Discussing advanced matrix concepts like eigenvalues, eigenvectors, and singular value decomposition.
- Highlighting the role of matrices in emerging fields like machine learning and artificial intelligence.
- Providing readers with resources for exploring matrix software tools and libraries.

In conclusion, matrices are fundamental mathematical tools with a profound impact on various disciplines. This project effectively introduced the basics, applications, and problem-solving capabilities of matrices, making it a valuable resource for understanding their significance in the real world.

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