



Safari Academy

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2022/23 Academic Year

Mathematics Lesson Note

For Grade 11

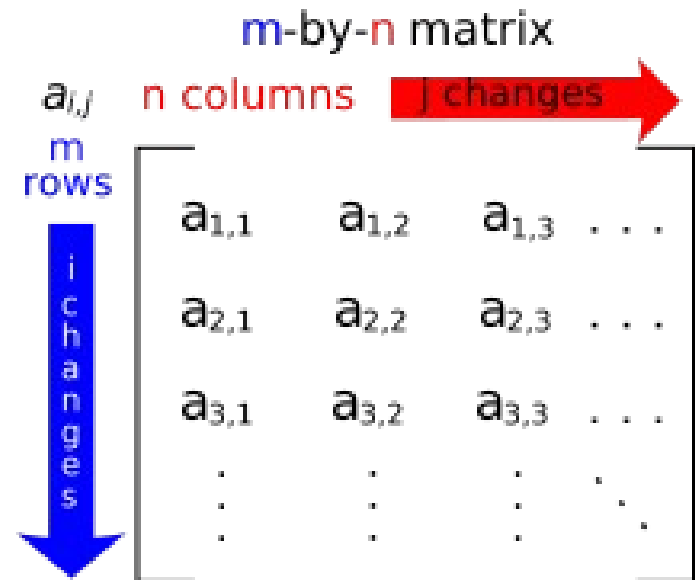
Matrices

Outline

- What is a matrix?
- Size of matrices
- Addition of matrices
- Scalar multiplication
- Matrices multiplication

What is a matrix?

- A matrix is a collection of numbers represent in a tabular format (with rows and columns).



Matrices have many uses including encryption, computer graphics, and computer animation

Examples of Matrices

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad C = \begin{bmatrix} 1 & -5 & -5 \\ -2 & 0 & 2 \\ 1 & 3 & 1 \end{bmatrix}$$

$$B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Every Matrix can be Described by its Size

- Determine the number of rows
- Determine the number of columns
- A has 2 rows
- A has 3 columns
- A is a 2x3 matrix
- What is the size of B?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix}$$

$$B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

Adding Matrices

- Rule #1 : You can only add matrices that are the same size
- Rule #2: Add corresponding locations in the two matrices to create a new matrix with the same size

Examples

- What is $A+B$?
 - Can't be done A is a 2×3 and B is a 3×2
- What is $A+D$?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \end{bmatrix}$$

Examples

- What is $A+B$?
 - Can't be done A is a 2×3 and B is a 3×2
- What is $A+D$?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \end{bmatrix}$$

$$A + D = \begin{bmatrix} 6 & 4 & -1 \\ 0 & -1 & 6 \end{bmatrix}$$

Examples

- What is $A+B$?
 - Can't be done A is a 2×3 and B is a 3×2
- What is $A+D$?
- What is $A+C$?
 - Can't be done A is a 2×3 C is a 3×2
- What is $B+C$?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \end{bmatrix}$$

$$B+C = \begin{bmatrix} 9 & 3 \\ -4 & 3 \\ -1 & -1 \end{bmatrix}$$

Scalar Multiplication

- Multiply a single integer (the scalar) times an entire matrix.
- This works exactly how you think it might, you create a new matrix by multiplying the scalar against each entry of the matrix.

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix}$$

$$3 \times A = \begin{bmatrix} 15 & 9 & -6 \\ 3 & 0 & 21 \end{bmatrix}$$

Matrix Multiplication

- Here we want to multiply two matrices with one another.
- Rule #1 : You can only multiply two matrices if the number of columns in the first matrix is the same as the number of rows in the second matrix.

Examples

- Can we multiply A x B?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

- Yes it is a 2x3 multiplied by a 3x2. The number of columns in the first one (3) matches the number of rows in the second one (3).

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

Examples

- Can we multiply D x A?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

- No it is a 3x3 multiplied by a 2x3. The number of columns in the first one (3) does not match the number of rows in the second one (2).

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

Examples

- Can we multiply B x D?

- No it is a 3x2 multiplied by a 3x3. The number of columns in the first one (2) does not match the number of rows in the second one (3).

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

Examples

- Can we multiply D x B?
 - Yes is a 3x3 multiplied by a 3x2. The number of columns in the first one (3) matches the number of rows in the second one (3).

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

Doing the multiplication

- What is $A \times B$?
- First rewrite them matrices so that the first one is on the left and the second one is above it but shifted to the right

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix}$$

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

Your
answer
will be
created
here

Doing the multiplication

- What is $A \times B$?
- Start with the first row on the left matrix and the first column on the above matrix.
- Multiply the first terms, the second terms, the third terms, etc... and add them together

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix}$$

Doing the multiplication

- What is $A \times B$?
- Start with the first row on the left matrix and the first column on the above matrix.
- Multiply the first terms, the second terms, the third terms, etc... and add them together

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad \begin{bmatrix} ? & ? \\ ? & ? \end{bmatrix}$$

Doing the multiplication

- What is $A \times B$?
- Start with the first row on the left matrix and the first column on the above matrix.
- Multiply the first terms, the second terms, the third terms, etc... and add them together
- $5 \times 6 + 3 \times 0 + -2 \times 0 = 30$
- Place this value in the position in the answer matrix where the row and column intersect.

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad \begin{bmatrix} 30 & ? \\ ? & ? \end{bmatrix}$$

Doing the multiplication

- Still with the first row on the matrix on the left, move on to the next column of the above matrix and do it again.

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad \begin{bmatrix} 30 & 10 \\ ? & ? \end{bmatrix}$$

- $5 \times 1 + 3 \times 1 + -2 \times -1 = 10$
- Place the value 10 in the answer matrix where the row and column intersect

Doing the multiplication

- When you have gone through every column in the above matrix using the first row in the left matrix, then move on the next row of the left matrix and begin the process again.

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad \begin{bmatrix} 30 & 10 \\ ? & ? \end{bmatrix}$$

Doing the multiplication

- When you have gone through every column in the above matrix using the first row in the left matrix, then move on the next row of the left matrix and begin the process again.

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad \begin{bmatrix} 30 & 10 \\ 6 & ? \end{bmatrix}$$

Doing the multiplication

- When you have gone through every column in the above matrix using the first row in the left matrix, then move on the next row of the left matrix and begin the process again.
- Repeat until all slots in the answer matrix are filled.

$$\begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$\begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \begin{bmatrix} 30 & 10 \\ 6 & -6 \end{bmatrix}$$

Examples

- What is $D \times B$?
- What is $A \times C$?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} ? & ? \\ ? & ? \\ ? & ? \end{bmatrix}$$

EXERCISE

1. What is $A \times B$ and $C \times D$ if its possible

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix}$$

$$B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$

$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix}$$

$$D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

- 2 What is $A \times C$?
- 3 What is $C \times A$?
- 4 What is $A \times D$?
- 5 What is $D \times A$?

$$A = \begin{bmatrix} 5 & 3 & -2 \\ 1 & 0 & 7 \end{bmatrix} \quad B = \begin{bmatrix} 6 & 1 \\ 0 & 1 \\ 0 & -1 \end{bmatrix}$$
$$C = \begin{bmatrix} 3 & 2 \\ -4 & 2 \\ -1 & 0 \end{bmatrix} \quad D = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$