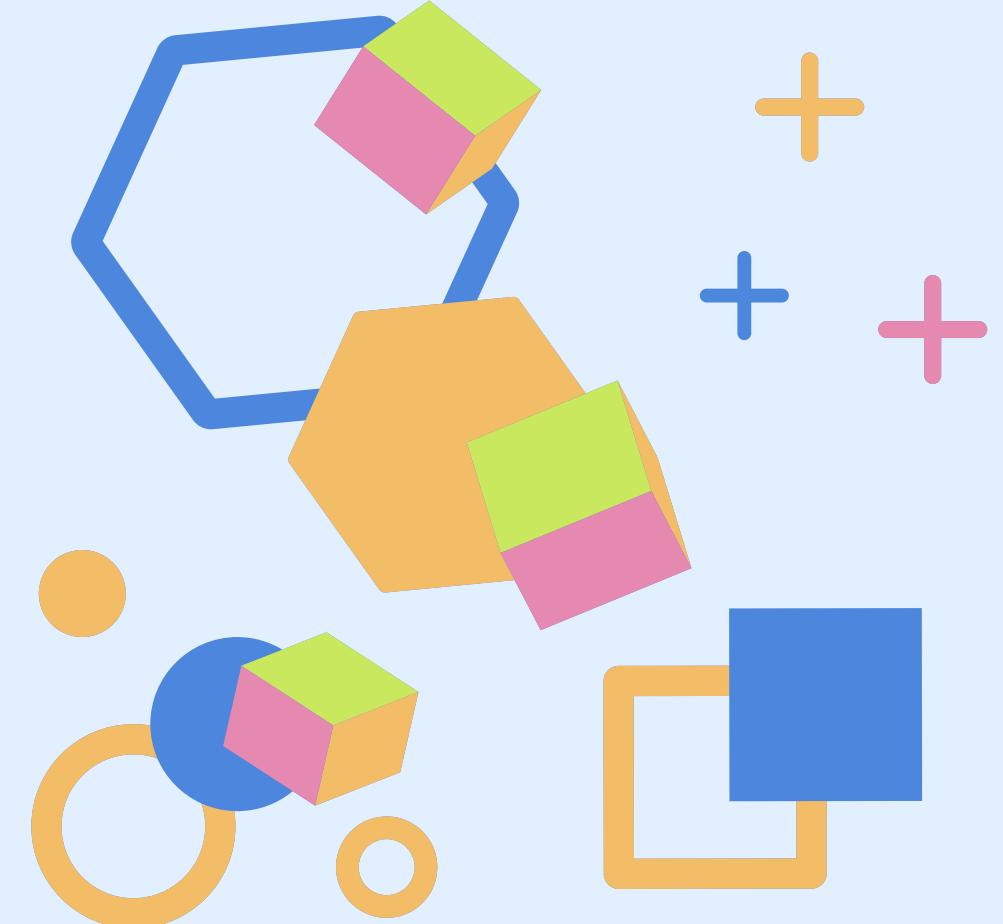


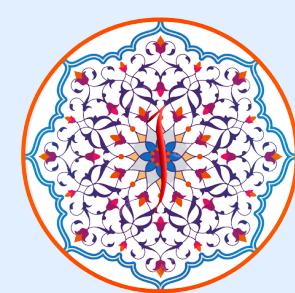
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Let's Start





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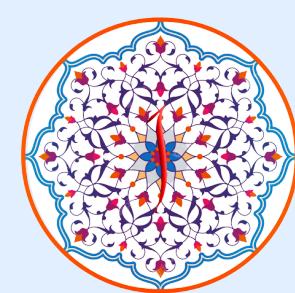
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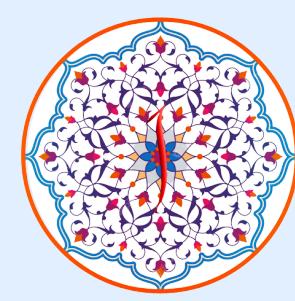
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Linear algebra

Linear algebra is crucial for understanding the mechanics of machine learning and AI. Here's a simple breakdown for freshers, with examples to help clarify the concepts.





Vectors

A vector is a list of numbers that can represent a point in space.

Example:

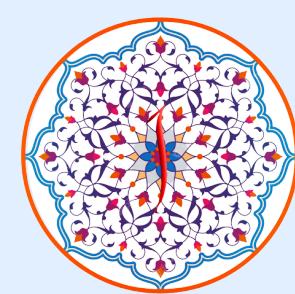
Let's take a 2-dimensional vector:

$$\mathbf{v} = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

This represents a point in a 2D plane, where $x=2x = 2$ and $y=3y = 3$.

In AI:

- Vectors represent data points, such as features of a dataset (e.g., height, weight, etc.).
- In Natural Language Processing (NLP), vectors can represent words (word embeddings).



Matrices

A matrix is a collection of vectors. It's essentially a grid of numbers, where each row is a vector.

Example:

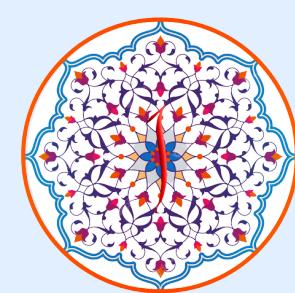
A 2x3 matrix:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$$

This matrix has 2 rows and 3 columns.

In AI:

- Matrices can represent data, like multiple data points or images (grayscale images are represented as matrices where each value is a pixel intensity).
- Matrices are also used in transforming data, such as rotating an image or changing its scale.



Matrix Multiplication

One of the most important operations in linear algebra. You multiply two matrices to combine transformations or apply operations to data.

Example:

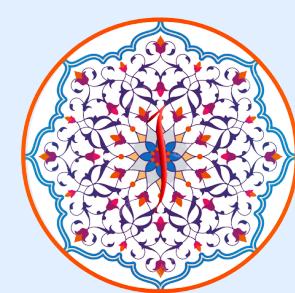
Let's multiply two matrices:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \quad B = \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$$

$$C = \begin{bmatrix} (1 \times 5 + 2 \times 7) & (1 \times 6 + 2 \times 8) \\ (3 \times 5 + 4 \times 7) & (3 \times 6 + 4 \times 8) \end{bmatrix} = \begin{bmatrix} 19 & 22 \\ 43 & 50 \end{bmatrix}$$

This represents a point in a 2D plane, where $x=2x = 2 \times 1 = 2$ and $y=3y = 3 \times 3 = 9$.

Matrix multiplication is used in neural networks. For example, multiplying a weight matrix with an input vector is a basic operation in layers of a neural network.



Dot Product

The dot product of two vectors returns a single number, calculated by multiplying the corresponding entries of the vectors and summing them.

Example:

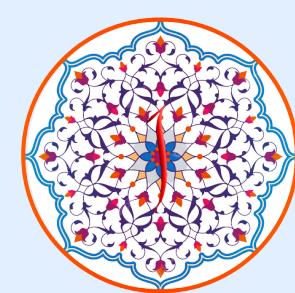
Given two vectors:

$$\mathbf{u} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad \mathbf{v} = \begin{bmatrix} 3 \\ 4 \end{bmatrix}$$

The dot product $\mathbf{u} \cdot \mathbf{v} = 1 \times 3 + 2 \times 4 = 3 + 8 = 11.$

In AI:

- Dot products are used to compute similarity between data points or vectors, such as in recommendation systems or in the attention mechanism of transformers.



Identity Matrix

An identity matrix acts like the number 1 in matrix operations. Multiplying a matrix by an identity matrix doesn't change it.

Example:

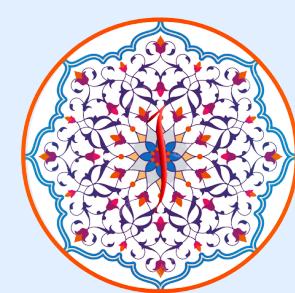
The identity matrix for a 2x2 matrix is:

$$I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

If you multiply a matrix A by the identity matrix I , the result is A .

In AI:

- Identity matrices are used when initializing certain transformations or operations to maintain the integrity of data.



Inverse Matrix

An inverse matrix undoes the effect of matrix multiplication, just as dividing a number undoes multiplication in basic arithmetic.

Example:

Let's say:

$$A = \begin{bmatrix} 4 & 7 \\ 2 & 6 \end{bmatrix}$$

The inverse of A is

$$A^{-1} = \frac{1}{(4 \times 6 - 7 \times 2)} \begin{bmatrix} 6 & -7 \\ -2 & 4 \end{bmatrix} = \frac{1}{10} \begin{bmatrix} 6 & -7 \\ -2 & 4 \end{bmatrix}$$

Multiplying $A \times A^{-1}$ gives the identity matrix

In AI:

- Inverse matrices are used in solving systems of linear equations, such as in least squares methods for regression.