## **What is a vector? Explain the difference between a row vector and a column vector.**

A vector is a mathematical object that has both magnitude(size) and direction, often represented as an array of numbers. A **row vector** is a horizontal arrangement of numbers, while a **column vector** is a vertical arrangement. Essentially, the difference is in their orientation: one is a row, and the other is a column.

---------------------------------------------------------------------------------------------------------------------

## **What is a matrix? How is it different from a vector?**

A matrix is a rectangular array of numbers arranged in rows and columns. Unlike a vector, which is a single row or column of numbers, a matrix consists of multiple rows and columns, allowing it to represent more complex data or transformations. In simple terms, a matrix is like a grid of numbers, while a vector is just a single row or column from that grid.

---------------------------------------------------------------------------------------------------------------------

## **How do you add two matrices? What conditions must be met for matrix addition to be possible?**

To add two matrices, you add their corresponding elements together. For example, if you have two matrices A and B, their sum C=A+B is found by adding each element of A to the corresponding element of B.

For matrix addition to be possible, both matrices must have the same dimensions, meaning they must have the same number of rows and the same number of columns.

---------------------------------------------------------------------------------------------------------------------

## **What is matrix multiplication? Explain how it is different from element-wise multiplication.**

-------------------------------------------------------------------------------------------------------------------------------

## **What is the transpose of a matrix? How does it change the dimensions of the matrix?**

-------------------------------------------------------------------------------------------------------------------------------

### 2. **Matrix Operations**

* **What is the determinant of a matrix?** What does it signify?
* **What is the inverse of a matrix?** When does a matrix have an inverse?
* **What is the trace of a matrix?** How is it calculated?
* **Explain Eigenvalues and Eigenvectors.** How are they computed, and what do they represent?
* **What is Singular Value Decomposition (SVD)?** How is it useful in data science?

### 3. **Linear Transformations**

* **What is a linear transformation?** Provide an example.
* **How do you represent a linear transformation using matrices?**
* **Explain the concept of rank of a matrix.** How is it related to the solutions of linear systems?
* **What is a projection matrix?** How do you project one vector onto another?

### 4. **Systems of Linear Equations**

* **What is a system of linear equations?** How can it be represented using matrices?
* **What are the methods to solve a system of linear equations?** Describe Gaussian elimination and LU decomposition.
* **What does it mean for a system of equations to be underdetermined, overdetermined, or exactly determined?**

### 5. **Applications in Data Science**

* **How is Principal Component Analysis (PCA) related to linear algebra?** Explain the role of Eigenvectors and Eigenvalues in PCA.
* **What is the role of linear algebra in machine learning algorithms like linear regression?**
* **Explain the concept of a covariance matrix.** How is it used in statistics and machine learning?
* **How is the concept of vector norms used in machine learning?** Discuss different types of norms (L1, L2) and their applications.
* **What is a positive definite matrix?** Why is it important in optimization problems?

### 6. **Advanced Topics**

* **What is the Moore-Penrose pseudoinverse?** When and why would you use it?
* **Explain the concept of orthogonality in the context of vectors and subspaces.**
* **What is the Frobenius norm?** How does it differ from other matrix norms?
* **What is the difference between a covariance matrix and a correlation matrix?**
* **Describe QR decomposition and its applications.**