WEEK 3: CORE MATHEMATICS FOR MACHINE LEARNING

DAY 11 (07/07/2025)

Linear Algebra for Machine Learning:

Machine learning relies heavily on **linear algebra**, as most models represent data as **vectors, matrices, and operations on them**. Understanding these basics helps in grasping how algorithms work behind the scenes and makes it easier to understand more advanced concepts like neural networks and regression.

1. Vectors

- A **vector** is an ordered list of numbers, often used to represent features of a single data point.
- **Example:** Marks of a student in three subjects are:

  Vector = [85,90,78]

  Here, 85 = Maths marks, 90 = Science marks, 78 = English marks.

- In ML, each feature of a data point is an element of the vector, and each data point is represented as a vector in feature space.

2. Matrices

- A **matrix** is a 2D array of numbers, essentially a collection of vectors stacked together.
- Matrices are used to store features, compute predictions, and represent model parameters.

- **Example:** Dataset of 3 students and 3 subjects:

Maths	Science	English
85	90	78
92	88	81
75	80	70

This dataset can be written as a **matrix**:

$$X = \begin{bmatrix} 85 & 90 & 78 \\ 92 & 88 & 81 \\ 75 & 80 & 70 \end{bmatrix}$$

Why matrices are important in ML:

- Store features for many data points efficiently
- Allow **fast computations** with multiple data points at once
- Represent **weights and transformations** in models like linear regression or neural networks

3. Key Operations

- **Addition/Subtraction:** Combine or compare vectors/matrices.
    - Example: Comparing marks of two students by subtracting their vectors.

- **Multiplication:** Multiply matrices to compute outputs, like weighted sums in linear regression.
    - Example: Multiplying feature matrix by weight vector to get predictions.
- **Transpose:** Swap rows and columns — used to align matrices for calculations.
    - Example: Changing a column vector to a row vector to match shapes for multiplication.
- **Determinant and Inverse:** Helps solve equations in models like linear regression and ensures unique solutions.

Reflection:

Today I learned that **vectors and matrices are the foundation of machine learning**. Every piece of data, every feature, and even model parameters are represented mathematically. By learning how to perform operations on them, we can understand how models process data and make predictions.