Mathematical & Statistical Foundations for ML

- Linear Algebra Essentials

Vectors

- • A vector is an ordered collection of numbers.
- • Can be represented as a row or column.
- • Used to represent features in ML.

- Example: v = [2, 5, 7]

Matrices

- • A matrix is a 2D array of numbers arranged in rows and columns.
- • Used to store datasets, transformations, etc.

- Example:
- [1 2 3]
- [4 5 6]
- [7 8 9]

Matrix Operations

- • Addition: Element-wise.
- • Multiplication: Dot product or matrix multiplication.
- • Transpose: Flips rows to columns.
- • Inverse: Exists if matrix is square and non-singular.

Eigen Decomposition

- • Decomposes matrix into eigenvalues and eigenvectors.
- • Used for understanding variance, dimensionality reduction.

- If A*v = λ*v
- Then:
- λ = eigenvalue
- v = eigenvector

Singular Value Decomposition (SVD)

- • Decomposes matrix A into U, Σ, and V^T:
- A = U Σ V^T

- • U: Left singular vectors
- • Σ: Diagonal matrix of singular values
- • V^T: Right singular vectors

- Applications: Image compression, recommendation systems

Use in Machine Learning

- • Linear algebra is foundational to:
- - Principal Component Analysis (PCA)
- - Support Vector Machines (SVM)
- - Neural networks (weight matrices)
- - Optimization algorithms