Statistics and Mathematics for Machine Learning

Course Content

Lesson 1 - Introduction to Machine Learning Mathematics

- Why math is critical for ML
- Overview of mathematical foundations

Lesson 2 - Linear Algebra Essentials

- Vectors and vector operations
- Matrices, matrix multiplication
- Identity, inverse, transpose
- Eigenvalues and eigenvectors
- Applications in ML (e.g., PCA, embeddings)

Lesson 3 - Calculus for Machine Learning

- Functions, limits, and continuity
- Differentiation fundamentals
- Partial derivatives
- Gradients and gradient descent
- Optimization and cost functions
- Introduction to backpropagation

Lesson 4 - Probability Theory

- Random variables and probability distributions
- Conditional probability & Bayes theorem
- Expectation, variance, standard deviation
- Common distributions (Normal, Bernoulli, Binomial, Poisson)
- Central Limit Theorem

Lesson 5 - Descriptive Statistics

- Measures of central tendency (mean, median, mode)

- Measures of dispersion (variance, standard deviation, range)
- Percentiles and quantiles
- Outliers and data cleaning
- Visualization tools (histograms, boxplots, scatterplots)

Lesson 6 - Inferential Statistics
- Sampling and sampling distributions
- Hypothesis testing fundamentals
- Confidence intervals
- p-values and statistical significance
- Correlation vs causation

Lesson 7 - Regression and Correlation Analysis
- Simple linear regression
- Multiple regression basics
- Residuals and goodness-of-fit
- Correlation coefficients (Pearson, Spearman)

Lesson 8 - Introduction to Statistical Learning Theory
- Bias-Variance tradeoff
- Underfitting vs overfitting
- Regularization concepts (L1, L2)
- Cross-validation

Lesson 9 - Probability Distributions in Depth
- Gaussian distribution properties
- Multivariate distributions
- Exponential and Gamma distributions
- Distribution fitting in practice

Lesson 10 - Case Studies & Practical Applications
- Applying statistical concepts to real datasets
- Building a basic regression model from scratch

- Exploratory data analysis (EDA)
- Preparing data for machine learning

Capstone Project

- Exploratory data analysis on a sample dataset
- Descriptive + inferential statistics reporting
- Simple regression or classification model
- Presentation of insights and conclusions