SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

23AMB201 - MACHINE LEARNING

II YEAR IV SEM

UNIT I – INTRODUCTION

TOPIC 1 – Probability distribution –

Decision Tree

INTRODUCTION

- Overview of probability distribution, decision theory, and bias-variance tradeoff.
- Importance in statistics, machine learning, and real-world decision-making.

PROBABILITY DISTRIBUTION BASICS

- Definition: A probability distribution describes how probabilities are distributed over values of a random variable.
- Types:
- - Discrete: Binomial, Poisson, etc.
- - Continuous: Normal, Exponential, etc.
- Real-Time Example: Customer purchase behavior in an e-commerce platform follows a normal distribution.

COMMON PROBABILITY DISTRIBUTIONS

- - Normal Distribution: Bell-shaped curve.
- - Binomial Distribution: Used for binary outcomes.
- - Poisson Distribution: Models count-based events.
- Real-Time Example: Traffic flow in a city follows a Poisson distribution.

APPLICATIONS OF PROBABILITY DISTRIBUTIONS

- - Risk assessment: Insurance, financial markets.
- - Machine learning: Predictive modeling.
- - Quality control: Manufacturing defects.
- Real-Time Example: Credit card fraud detection systems use probability distributions.

INTRODUCTION TO DECISION THEORY

- Definition: Framework for making optimal decisions under uncertainty.
- Key Components: Alternatives, probabilities, outcomes, and utility.
- Real-Time Example: Autonomous vehicles use decision theory to determine actions.

TYPES OF DECISION-MAKING MODELS

- - Deterministic Models: No uncertainty.
- - Probabilistic Models: Account for uncertainty.
- Real-Time Example: AI-powered medical diagnosis systems predict disease probability.

BAYESIAN DECISION THEORY

- Concept: Using Bayes' Theorem to update beliefs.
- Formula: Posterior = (Likelihood * Prior) / Evidence.
- Applications: Medical diagnosis, spam filtering.
- Real-Time Example: Email spam filters update probability models based on user feedback.

BIAS IN DECISION MAKING

- Definition: Systematic error due to incorrect assumptions.
- - Cognitive Biases: Confirmation bias, anchoring bias.
- - Statistical Bias: Sampling bias, selection bias.
- Real-Time Example: AI hiring algorithms may favor specific backgrounds due to biased training data.

VARIANCE AND MODEL COMPLEXITY

- Definition: Variance measures model sensitivity to training data fluctuations.
- High Variance Issue: Leads to overfitting, poor generalization.
- Real-Time Example: A deep learning model predicting stock prices may overfit past data.

BIAS-VARIANCE TRADEOFF

- Concept: Balancing bias and variance to optimize model performance.
- High Bias: Underfitting, overly simplistic models.
- High Variance: Overfitting, models too sensitive to noise.
- Real-Time Example: Weather forecasting with different complexity models.

GRAPHICAL REPRESENTATION OF TRADEOFF

- Graph: Error vs. Model Complexity.
- Optimal Point: Where bias and variance are balanced.
- Real-Time Example: Fraud detection systems balance bias and variance to minimize errors.

REAL-TIME EXAMPLE OF BIAS-VARIANCE TRADEOFF

- - Machine Learning: Deep learning models adjusting complexity.
- - Stock Market Prediction: Simple vs. complex models.
- - Healthcare: Predicting patient recovery probabilities.
- Real-Time Example: Self-driving cars fine-tune decision models for real-world conditions.

CHALLENGES & FUTURE PERSPECTIVES

- - Challenges:
- - Handling real-world data noise.
- - Overcoming biases in automated decision-making.
- - Future Trends:
- - AI-driven decision models.
- - Improved probabilistic models.
- Real-Time Example: AI assistants like Siri improve through continuous probabilistic learning.