Machine Learning - Undergraduate Course Department of Computer Science Instructor: Dr. John Smith Semester: Fall 2025

Course Overview This course provides an introduction to the fundamental concepts of Machine Learning. Students will learn how computers can be trained to make decisions, identify patterns, and predict future outcomes based on data. The course emphasizes understanding basic principles, model types, and real-world applications rather than mathematical derivations.

Course Objectives Understand the concept and importance of Machine Learning. Learn the main types of learning techniques. Explore common algorithms and their real-world use cases. Recognize challenges like overfitting and model evaluation.

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Introduction to Machine Learning

Machine Learning is a branch of Artificial Intelligence that focuses on enabling computers to learn from data without being explicitly programmed. It aims to develop algorithms that can improve automatically through experience. Machine Learning systems are now used in various fields, including healthcare, finance, education, and e-commerce.

Types of Learning

There are primarily three types of learning in Machine Learning: **Supervised Learning:** The model learns from labeled data, where the output is known. **Unsupervised Learning:** The model explores the structure of unlabeled data to find hidden patterns. **Reinforcement Learning:** The system learns by interacting with its environment and receiving feedback.

Basic Terminologies

Before diving into algorithms, it's important to understand some key terms: **Dataset:** A collection of data used to train and test models. **Features:** Input variables or attributes that describe the data. **Labels:** The output or target value we aim to predict. **Training and Testing:** Training data teaches the model, while testing data checks its accuracy.

Linear Regression

Linear Regression is one of the simplest forms of Machine Learning. It is used to predict a continuous value based on input variables. For instance, predicting house prices based on area and location. The model assumes a straight-line relationship between the input and output.

Logistic Regression

Although called 'regression,' Logistic Regression is used for classification problems. It helps predict categorical outcomes such as 'Yes' or 'No,' 'Pass' or 'Fail.' The algorithm estimates the probability of an event occurring.

Decision Trees

Decision Trees are flowchart-like structures used for both classification and regression. They split data into branches based on feature values, creating a path from root to leaf that represents a decision rule. They are easy to interpret and widely used in educational data and business decision-making.

Clustering (K-Means)

Clustering is an unsupervised learning technique that groups similar data points together. The K-Means algorithm divides data into 'K' clusters by assigning each point to the nearest cluster center. It is often used in customer segmentation and image compression.

Evaluation Metrics

To assess how well a model performs, we use evaluation metrics such as accuracy, precision, recall, and F1-score. These measures provide insight into the model’s strengths and weaknesses, ensuring its reliability before deployment.

Overfitting and Underfitting

A model that performs perfectly on training data but poorly on new data is said to be overfitted. Conversely, if it fails to capture the underlying pattern, it is underfitted. Balancing complexity and generalization is a key challenge in Machine Learning.

Summary and References

This course introduced foundational Machine Learning concepts used in practical applications. Students should now understand the types of learning, core algorithms, and challenges faced when building predictive systems.

Recommended Readings: Tom M. Mitchell, “Machine Learning,” McGraw-Hill, 1997. Christopher Bishop, “Pattern Recognition and Machine Learning,” Springer, 2006. Andrew Ng, “Machine Learning” (Online Course, Coursera).