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Course Overview

This course introduces students to the fundamentals of Machine Learning (ML), focusing on core algorithms, their applications, and hands-on practice using Python libraries. By the end of the course, students will have a solid understanding of ML algorithms and the ability to apply them to real-world problems.

Module 1: Introduction to Machine Learning

- **Objective:** Provide an understanding of what machine learning is and how it fits into the broader scope of AI.
- **Topics Covered:**
  - What is Machine Learning?
  - Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning
  - Key Concepts: Model Representation, Training vs. Testing, Overfitting & Generalization
- **Learning Outcome:** Students will understand the types of ML and foundational concepts.

Module 2: Supervised Learning

- **Objective:** Explore algorithms for supervised learning, focusing on regression and classification.
- **Topics Covered:**
  - **Linear Regression:** Simple linear models, cost functions, gradient descent
  - **Classification Algorithms:**
    - Logistic Regression
    - Decision Trees
    - k-Nearest Neighbors (k-NN)
- **Learning Outcome:** Students will implement regression and classification models to predict outcomes based on labeled data.

Module 3: Unsupervised Learning

- **Objective:** Understand unsupervised learning techniques for clustering and dimensionality reduction.

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- **Topics Covered:**
  - **Clustering Algorithms:**
    - K-Means Clustering
    - Hierarchical Clustering
  - **Dimensionality Reduction:** Principal Component Analysis (PCA)
- **Learning Outcome:** Students will apply clustering techniques to uncover hidden patterns and reduce the dimensions of datasets.

Module 4: Introduction to Neural Networks & Deep Learning

- **Objective:** Introduce students to the basics of deep learning and artificial neural networks.
- **Topics Covered:**
  - **Artificial Neural Networks:** Structure, activation functions, backpropagation
  - **Convolutional Neural Networks (CNNs):** Introduction and applications in image processing
- **Learning Outcome:** Students will understand the structure and training of basic neural networks.

Module 5: Introduction to Reinforcement Learning

- **Objective:** Learn the basic principles of reinforcement learning and its applications.
- **Topics Covered:**
  - Markov Decision Processes
  - Rewards, policies, and value functions
  - Introduction to Q-Learning
- **Learning Outcome:** Students will grasp how machines learn from their environment to make decisions.

Module 6: Model Evaluation and Selection

- **Objective:** Teach students how to evaluate the performance of machine learning models.
- **Topics Covered:**
  - Performance Metrics: Precision, Recall, F1-Score, ROC Curves
  - Cross-Validation: k-Fold Cross-Validation for model accuracy

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- **Learning Outcome:** Students will be able to compare and select models using evaluation metrics.

Module 7: Introduction to Advanced Topics (Optional)

- **Objective:** Provide exposure to advanced machine learning concepts.
- **Topics Covered:**
  - Support Vector Machines (SVMs)
  - Introduction to Natural Language Processing (NLP)
- **Learning Outcome:** Students will gain familiarity with advanced ML techniques and their use cases.

Module 8: Tools and Practical Implementation

- **Objective:** Get hands-on experience with Python libraries and real-world datasets.
- **Topics Covered:**
  - **Python Libraries:** NumPy, Pandas, Scikit-learn, TensorFlow
  - **Working with Datasets:** Data cleaning and preprocessing, hands-on implementation using Kaggle datasets
- **Learning Outcome:** Students will be proficient in Python-based tools for machine learning.

Capstone Project: Build and Deploy a Machine Learning Model

- **Objective:** Apply all concepts learned throughout the course in a practical project.
- **Project Overview:**
  - Choose a real-world dataset
  - Preprocess the data, train a model, and evaluate it
  - Present the final model along with performance metrics
- **Learning Outcome:** By the end of the project, students will have the ability to solve a real-world problem using machine learning.

Recommended Textbooks & Resources

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- **Books:**
  - "Introduction to Machine Learning" by Ethem Alpaydin
  - "Pattern Recognition and Machine Learning" by Christopher M. Bishop