

Module 1: Introduction to Artificial Intelligence

- Overview of Artificial Intelligence:
 - Definition and history of AI.
 - Applications and impact of AI in various domains.
 - Introduction to intelligent agents and problem-solving.
- Foundations of AI:
 - Turing test and approaches to AI.
 - Symbolic AI vs. Machine Learning.
 - The role of logic and reasoning in AI.

Module 2: Mathematics for AI

- Linear Algebra for AI:
 - Vectors, matrices, and operations.
 - Eigenvalues and eigenvectors.
 - Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).
- Probability and Statistics for AI:
 - Probability theory and random variables.
 - Probability distributions and their properties.
 - Bayesian inference and probabilistic graphical models.

Module 3: Machine Learning Fundamentals

- Supervised Learning:
 - Regression: Linear regression, polynomial regression.
 - Classification: Logistic regression, decision trees, k-nearest neighbors.
 - Evaluation metrics: accuracy, precision, recall, F1-score.
- Unsupervised Learning:
 - Clustering: K-means clustering, hierarchical clustering.
 - Dimensionality reduction: Principal Component Analysis (PCA), t-Distributed Stochastic Neighbour Embedding (t-SNE).
 - Anomaly detection and outlier analysis.
- Neural Networks and Deep Learning:
 - Introduction to artificial neural networks (ANNs).
 - Activation functions, loss functions, and optimization algorithms.
 - Deep learning architectures: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs).

Module 4: Natural Language Processing (NLP)

- Text Processing and Representation:
 - Tokenization, stemming, and lemmatization.
 - Bag-of-words model, TF-IDF representation.
 - Word embeddings: Word2Vec, GloVe.

- Text Classification and Sentiment Analysis:
 - Naive Bayes classifier for text classification.
 - Sentiment analysis using machine learning and deep learning approaches.
 - Named Entity Recognition (NER) and Part-of-Speech (POS) tagging.
- Sequence Modeling:
 - Introduction to recurrent neural networks (RNNs).
 - Long Short-Term Memory (LSTM) networks for sequence modeling.
 - Sequence-to-sequence models for machine translation and text generation.

Module 5: Computer Vision

- Image Processing and Feature Extraction:
 - Image representation: pixels, color spaces.
 - Image filtering and convolution operations.
 - Feature extraction techniques: Histogram of Oriented Gradients (HOG), Scale-Invariant Feature Transform (SIFT).
- Convolutional Neural Networks (CNNs):
 - CNN architecture and operations.
 - Training CNNs for image classification, object detection, and segmentation.
 - Transfer learning and fine-tuning pre-trained CNNs.
- Advanced Topics in Computer Vision:
 - Object detection algorithms: Faster R-CNN, YOLO.
 - Semantic segmentation and instance segmentation.
 - Generative models for image synthesis and style transfer.

Module 6: Reinforcement Learning

- Introduction to Reinforcement Learning (RL):
 - Markov Decision Processes (MDPs) and the RL framework.
 - Exploration vs. exploitation trade-off.
 - Value iteration and policy iteration algorithms.
- Q-Learning and Deep Q-Networks (DQN):
 - Q-learning algorithm and its variants.
 - Deep Q-Networks (DQN) for approximating Q-values.
 - Experience replay and target networks.
- Policy Gradient Methods:
 - Policy gradients and the REINFORCE algorithm.
 - Actor-Critic methods for value estimation and policy improvement.
 - Proximal Policy Optimization (PPO) and Trust Region Policy Optimization (TRPO).

Module 7: Advanced Topics in AI

- Adversarial Machine Learning:
 - Introduction to adversarial attacks and defenses.

- Generative Adversarial Networks (GANs) for image generation and adversarial training.
- Adversarial examples in deep learning models.
- AI Ethics and Bias Mitigation:
 - Ethical considerations in AI development and deployment.
 - Addressing biases and fairness in AI systems.
 - Responsible AI principles and guidelines.

Module 8: Applications and Case Studies

- AI Applications in Industry:
 - Healthcare: medical imaging, disease diagnosis.
 - Finance: algorithmic trading, fraud detection.
 - Autonomous vehicles and robotics.
 - Natural language understanding and virtual assistants.
- Case Studies and Projects:
 - Real-world AI projects and applications.
 - Hands-on implementation of AI algorithms and models.
 - Solving AI-related challenges and competitions.