

Complete Machine Learning Overview

1. What is Machine Learning?

Machine Learning (ML) is a branch of Artificial Intelligence (AI) focused on building applications that learn from data and improve their performance over time without being explicitly programmed.

2. Types of Machine Learning

- Supervised Learning: Learns from labeled data (e.g., regression, classification).
- Unsupervised Learning: Finds patterns in unlabeled data (e.g., clustering, dimensionality reduction).
- Semi-supervised Learning: Mix of labeled and unlabeled data.
- Reinforcement Learning: Learns through trial and error using rewards and penalties.

3. Key Algorithms

- Supervised: Linear Regression, Logistic Regression, Decision Trees, SVM, KNN, Naive Bayes, Random Forest, Gradient Boosting.
- Unsupervised: K-Means, DBSCAN, PCA, Hierarchical Clustering.
- Neural Networks: MLP, CNN, RNN, LSTM, GRU.

4. Deep Learning

A subset of ML using deep neural networks. Popular frameworks include TensorFlow and PyTorch. Deep Learning powers applications like image recognition, natural language processing, and autonomous driving.

5. Model Evaluation Metrics

- Classification: Accuracy, Precision, Recall, F1 Score, ROC-AUC.
- Regression: MSE, RMSE, MAE, R-squared.

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- Cross-validation and confusion matrices help validate performance.

6. Model Deployment

Models can be deployed using Flask, FastAPI, Docker, and cloud services (AWS, Azure, GCP). Deployment includes saving the model, creating APIs, and monitoring performance.

7. Advanced Topics

- CNN: Convolutional layers used for image data.
- RNN: Sequence modeling for text, time-series.
- Transformers: State-of-the-art in NLP and vision.
- RAG: Retrieval-Augmented Generation for grounding LLMs in external knowledge.
- AI Agents: Autonomous systems that interact with environments using planning and memory.