Topic: Machine Learning Fundamentals
Category: Artificial Intelligence
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CONTENT:

Machine Learning (ML) is a subset of artificial intelligence that enables systems to learn and improve from experience without being explicitly programmed. The core principle involves identifying patterns in data and making decisions with minimal human intervention.

Key Concepts:

1. SUPERVISED LEARNING:
   - Definition: Learning with labeled training data
   - Algorithms: Linear Regression, Logistic Regression, Support Vector Machines (SVM), Random Forest, Gradient Boosting
   - Applications: Spam detection, image classification, price prediction
   - Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, ROC-AUC

2. UNSUPERVISED LEARNING:
   - Definition: Finding patterns in unlabeled data
   - Algorithms: K-Means Clustering, DBSCAN, Principal Component Analysis (PCA), t-SNE
   - Applications: Customer segmentation, anomaly detection, dimensionality reduction
   - Evaluation Metrics: Silhouette Score, Davies-Bouldin Index

3. REINFORCEMENT LEARNING:
   - Definition: Learning through trial and error using rewards
   - Components: Agent, Environment, State, Action, Reward
   - Algorithms: Q-Learning, Deep Q Networks (DQN), Policy Gradient Methods
   - Applications: Game playing, robotics, autonomous vehicles

MODEL EVALUATION TECHNIQUES:
- Cross-Validation: K-Fold, Stratified K-Fold, Leave-One-Out
- Bias-Variance Tradeoff: Underfitting vs Overfitting
- Regularization Methods: L1 (Lasso), L2 (Ridge), Elastic Net
- Hyperparameter Tuning: Grid Search, Random Search, Bayesian Optimization

CURRENT TRENDS (2024):
- Automated Machine Learning (AutoML)
- Explainable AI (XAI)
- Federated Learning
- TinyML for edge devices

Challenges:
- Data quality and quantity
- Model interpretability
- Computational resources
- Ethical considerations and bias mitigation

This document serves as foundational knowledge for all machine learning practitioners. Understanding these concepts is essential before diving into specialized areas like deep learning or natural language processing.