



ADVANCED DATA SCIENCE

Lecture 2: Machine Learning – Basic Concepts

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WHAT IS MACHINE LEARNING?

- Machine Learning (ML) is a subset of Artificial Intelligence (AI) that enables systems to learn and improve from experience automatically.
- It uses algorithms to identify patterns in data and make predictions or decisions without explicit programming.
- Key idea: Systems learn from data rather than following hardcoded instructions.



KEY COMPONENTS OF MACHINE LEARNING

- Data: The foundation of learning.
- Model: Mathematical representation of a real-world process.
- Algorithm: A method used to train the model on data.
- Training: Process of learning patterns from data.
- Testing: Evaluating the model's performance on unseen data.



WHY MACHINE LEARNING?

- Automates analytical model building.
- Handles complex and large-scale data efficiently.
- Enables accurate predictions and data-driven decisions.
- Widely used in various domains: healthcare, finance, energy, and education.



TYPES OF MACHINE LEARNING

- Supervised Learning – learns from labeled data.
- Unsupervised Learning – finds hidden patterns in unlabeled data.
- Semi-supervised Learning – combination of labeled and unlabeled data.
- Reinforcement Learning – learns from trial and error to maximize reward.



SUPERVISED LEARNING

- The model is trained using labeled datasets (input-output pairs).
- Goal: Predict outcomes for new, unseen data.
- Algorithms: Linear Regression, Decision Trees, Support Vector Machines.
- Applications: Email spam detection, credit scoring, image recognition.



UNSUPERVISED LEARNING

- Works on unlabeled data without predefined outputs.
- Finds hidden structures and relationships within data.
- Algorithms: K-Means Clustering, PCA, Hierarchical Clustering.
- Applications: Customer segmentation, anomaly detection, market basket analysis.



REINFORCEMENT LEARNING

- Learning by interacting with an environment to maximize reward.
- Key elements: Agent, Environment, Action, Reward.
- Algorithms: Q-Learning, Deep Q-Networks.
- Applications: Robotics, game AI, autonomous driving.



SUMMARY

- ML enables systems to learn from data.
- Key ML types: Supervised, Unsupervised, Semi-supervised, and Reinforcement.
- Applications span across multiple industries.
- Foundation for Data Science and AI-driven solutions.