Machine learning is a branch of artificial intelligence that enables computer systems to learn patterns from data and improve performance without being explicitly programmed. Instead of following fixed rules, machine learning models use statistical techniques to identify relationships within datasets. These models are widely used in applications such as image recognition, natural language processing, and recommendation systems.

Machine learning can be broadly classified into supervised learning, unsupervised learning, and reinforcement learning. Supervised learning involves training models on labeled datasets, where the correct output is known. Common supervised learning algorithms include linear regression, logistic regression, decision trees, and support vector machines.

Unsupervised learning deals with unlabeled data and focuses on discovering hidden patterns or structures. Clustering algorithms like k-means and hierarchical clustering group similar data points together, while dimensionality reduction techniques such as principal component analysis reduce data complexity.

Reinforcement learning is based on agents interacting with an environment to maximize cumulative rewards. The agent learns by trial and error, receiving feedback in the form of rewards or penalties. Reinforcement learning has been successfully applied in robotics, game playing, and autonomous systems.

Data quality plays a crucial role in machine learning performance. Biased, incomplete, or noisy data can lead to inaccurate models. Feature engineering significantly impacts model accuracy. Model evaluation metrics such as accuracy, precision, recall, and mean squared error help assess performance.

Despite its success, machine learning has limitations. Models often lack interpretability, making it difficult to understand how decisions are made. Overfitting is another challenge. Ongoing research aims to improve transparency, robustness, and ethical use of machine learning systems.