

Image Processing and Computer Vision

Brief History of Machine Learning

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History of Machine Learning

Machine learning has evolved over several decades through contributions from statistics, artificial intelligence, and computer science.

- Early ideas originated from probability theory and statistical inference.
- The development of digital computers made automated learning possible.
- Over time, machine learning evolved from simple statistical models to complex deep learning systems.
- Today, machine learning powers applications in computer vision, speech recognition, robotics, and data analysis.

Early Mathematical Foundations (Before 1950)

Before the emergence of machine learning, important theoretical foundations were established.

- **Probability theory** laid the groundwork for reasoning under uncertainty.
- **Statistical inference** enabled learning patterns from observed data.
- **Optimization methods** were developed to estimate model parameters.

Important contributors include:

- Thomas Bayes – Bayesian probability
- Ronald Fisher – statistical estimation and hypothesis testing
- Alan Turing – early concepts of intelligent machines

These ideas later became fundamental to machine learning algorithms.

Birth of Machine Learning (1950s)

The 1950s marked the beginning of machine learning as a research field.

- In 1950, Alan Turing proposed the concept of machines that could learn.
- Early research focused on building systems capable of recognizing patterns.
- One of the first learning algorithms was the **Perceptron**.

Perceptron (1957)

- Introduced by Frank Rosenblatt
- Inspired by biological neurons
- Used weighted inputs to produce an output
- Applied to simple image recognition tasks

Although limited, it demonstrated that machines could learn from data.

Early Pattern Recognition Research (1960s)

During the 1960s, research focused on pattern recognition and classification.

Common approaches included:

- Nearest Neighbor methods
- Decision trees
- Early neural network models

Applications included:

- character recognition
- speech recognition experiments
- simple image analysis

However, computing power and available datasets were still very limited.

Limitations and the AI Winter (1970s)

Progress slowed during the 1970s due to several challenges.

- Neural networks had limited capability.
- Large-scale datasets were unavailable.
- Computers were not powerful enough to train complex models.

A major influence was the book:

- *Perceptrons* (1969) by Marvin Minsky and Seymour Papert

This work showed the limitations of single-layer neural networks, which discouraged further research in neural networks for several years.

Revival of Neural Networks (1980s)

Research in neural networks resumed in the 1980s with new training methods. The most important breakthrough was the **Backpropagation algorithm**.

- Developed by David Rumelhart, Geoffrey Hinton, and Ronald Williams
- Allowed training of multi-layer neural networks
- Enabled networks to learn complex patterns

Other developments included:

- Hopfield networks
- Boltzmann machines
- Early neural network applications in pattern recognition

Statistical Machine Learning Era (1990s)

In the 1990s, machine learning became strongly influenced by statistics and optimization theory.

Key developments included:

- Support Vector Machines (SVM)
- Decision Trees
- Random Forest algorithms
- Bayesian Networks

Research focused on:

- generalization and model accuracy
- statistical learning theory
- efficient optimization methods

Many of these models were widely used in early computer vision systems.

Machine Learning in Practice (2000s)

During the 2000s, machine learning became widely used in real-world applications.

Key enabling factors included:

- growth of large datasets
- faster processors
- development of more efficient algorithms

Applications included:

- spam filtering
- search engines
- handwriting recognition
- recommendation systems

Many systems relied on classical models such as SVM and decision trees.

Deep Learning Revolution (2010s)

A major breakthrough occurred in 2012 when deep learning significantly improved image recognition performance.

Important factors:

- availability of large datasets (e.g., ImageNet)
- use of GPUs for faster training
- development of deep convolutional neural networks

Key models included:

- AlexNet
- VGGNet
- ResNet
- YOLO for object detection

Deep learning quickly became the dominant approach in computer vision.

Modern Machine Learning (2020s)

Recent developments focus on large-scale models and new architectures.

Important trends include:

- Transformer-based architectures
- Vision Transformers (ViT)
- Diffusion models for image generation
- Large foundation models

Modern machine learning systems combine:

- massive datasets
- powerful hardware
- advanced neural network architectures

These technologies enable applications such as autonomous driving, medical imaging, and generative AI.

Summary of Machine Learning Evolution

- Machine learning originated from statistical and mathematical research.
- Early models such as the perceptron demonstrated the possibility of learning algorithms.
- Research progressed through periods of rapid development and setbacks.
- Statistical machine learning dominated during the 1990s and early 2000s.
- Deep learning revolutionized the field in the 2010s.
- Modern research focuses on large-scale neural networks and transformer architectures.