Study Material

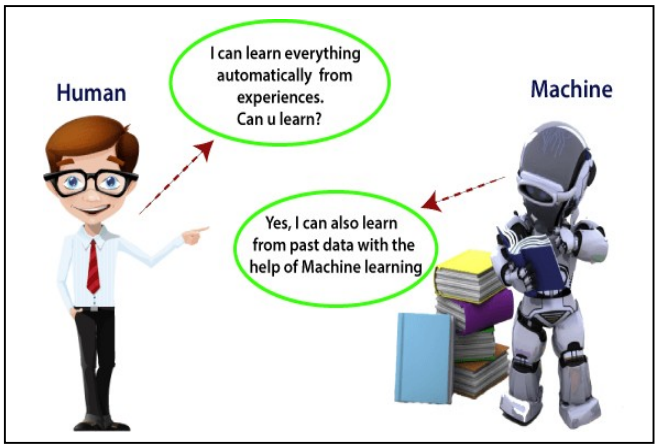
Module I: Introduction to Machine Learning [Part - 1]

Machine Learning

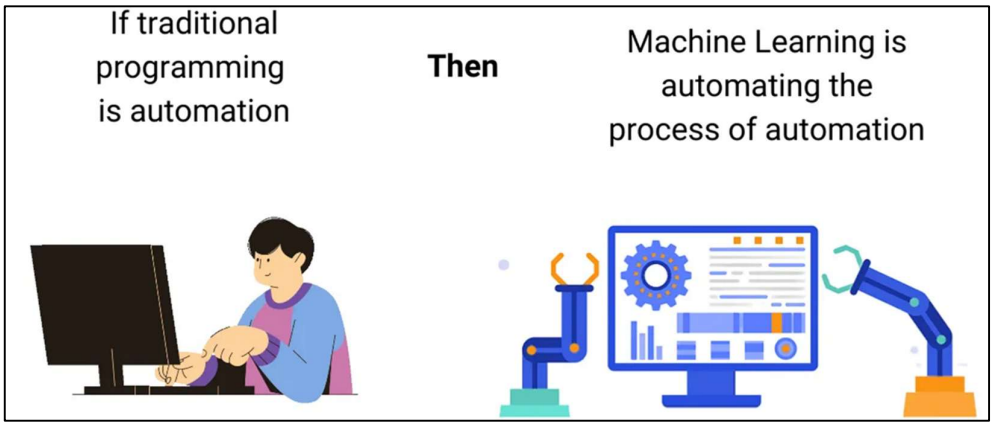
Machine learning is a growing technology that enables computers to learn automatically from past data. Machine learning uses various algorithms for building mathematical models and making predictions using historical data or information. Currently, it is being used for various tasks such as image recognition, speech recognition, email filtering, Facebook auto tagging, recommender systems, and many more.

What is Machine Learning?

In the real world, we are surrounded by humans who can learn everything from their experiences with their learning capability, and we have computers or machines that work on our instructions. But can a machine also learn from experiences or past data like a human does? So here comes the role of Machine Learning.



Machine Learning is said as a subset of artificial intelligence that is mainly concerned with the development of algorithms that allow a computer to learn from data and past experiences on its own. The term machine learning was first introduced by Arthur Samuel in 1959. We can define it in a summarized way as: "*Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed.*"



With the help of sample historical data, which is known as **training data**, machine learning algorithms build a **mathematical model** that helps in making predictions or decisions without being explicitly programmed. Machine learning brings computer science and statistics together to create predictive models. Machine learning constructs or uses algorithms that learn from historical data. The more information we provide the information, the higher the performance will be.

A machine can learn if it can improve its performance by gaining more data.

History of Machine Learning

For some years (about 40-50 years), machine learning was science fiction, but today it is a part of our daily life. Machine learning is making our day-to-day life easy, from **self-driving cars** to **Amazon's virtual assistant, "Alexa"**. However, the idea behind machine learning is so old and has a long history. Below are some milestones that have occurred in the history of machine learning:

The early history of Machine Learning (Pre-1940):

- **1834:** In 1834, Charles Babbage, the father of the computer, conceived a device that could be programmed with punch cards. However, the machine was never built, but all modern computers rely on its logical structure.
- **1936:** In 1936, Alan Turing gave a theory that how a machine can determine and execute a set of instructions.

The era of stored program computers:

- **1940:** In 1940, the first manually operated computer, "ENIAC" was invented, which was the first electronic general-purpose computer. After that stored program computer such as EDSAC in 1949 and EDVAC in 1951 were invented.
- **1943:** In 1943, a human neural network was modeled with an electrical circuit. In 1950, the scientists started applying their idea to work and analyzed how human neurons might work.

Computer machinery and intelligence

- 1950: In 1950, Alan Turing published a seminal paper, "Computer Machinery and Intelligence," on the topic of artificial intelligence. In his paper, he asked, "Can machines think?"

Machine intelligence in Games:

- 1952: Arthur Samuel, who was the pioneer of machine learning, created a program that helped an IBM computer to play a checkers game. It performed better more it played.
- 1959: In 1959, the term "Machine Learning" was first coined by Arthur Samuel.

The first "AI" winter:

- The duration from 1974 to 1980 was a tough time for AI and ML researchers, and this period was called as **AI winter**.
- In this period, the failure of machine translation occurred, and people reduced their interest in AI, which led to reduced funding by the government for research.

Machine Learning from theory to reality

- **1959:** In 1959, the first neural network was applied to a real-world problem to remove echoes over phone lines using an adaptive filter.
- **1985:** In 1985, Terry Sejnowski and Charles Rosenberg invented a neural network, **NETtalk**, which was able to teach itself how to correctly pronounce 20,000 words in one week.
- **1997:** IBM's **Deep Blue** intelligent computer won the chess game against the chess expert Garry Kasparov, and it became the first computer which had beat a human chess expert.

Machine Learning in the 21st Century

- 2006: In the year 2006, computer scientist Geoffrey Hinton gave a new name to neural net research as "deep learning," and nowadays, it has become one of the most trending technologies.
- 2012: In 2012, Google created a deep neural network that learned to recognize the image of humans and cats in YouTube videos.
- 2014: In 2014, the Chabot "Eugen Goostman" cleared the Turing Test. It was the first chatbot that convinced 33% of human judges that it was not a machine.
- 2014: DeepFace was a deep neural network created by Facebook, and they claimed that it could recognize a person with the same precision as a human can.
- 2016: AlphaGo beat the world's number second player Lee Sedol at the Go game. In 2017, it beat the number one player of this game Ke Jie.
- 2017: In 2017, Alphabet's Jigsaw team built an intelligent system that was able to learn the online trolling. It used to read millions of comments on different websites to learn to stop online trolling.

Machine Learning at present:

Now, machine learning has made great advancements in its research, and it is present everywhere around us, such as self-driving cars, Amazon Alexa, Catboats, recommender systems, and many more. It includes Supervised, unsupervised, and reinforcement learning with clustering, classification, decision tree, SVM algorithms, etc.

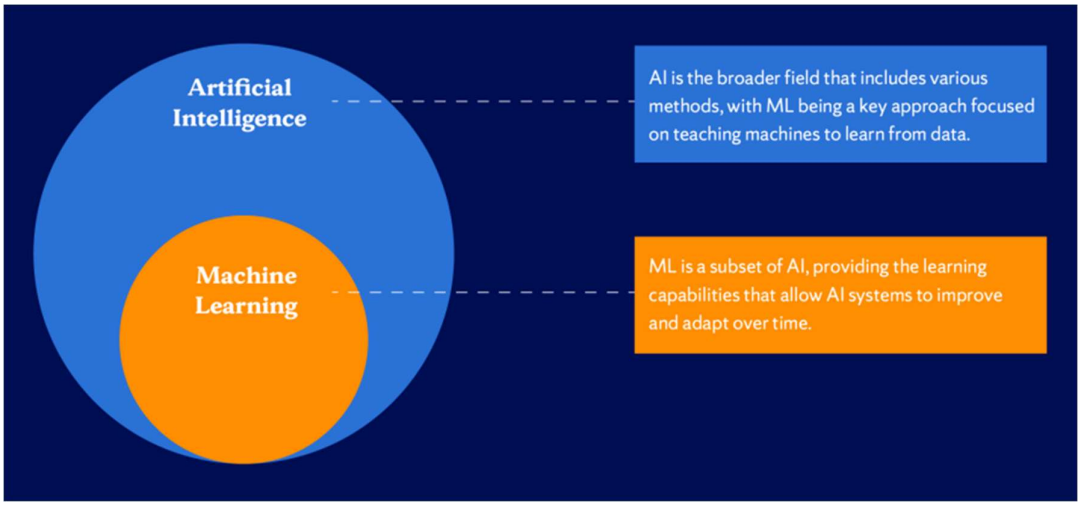
Modern machine learning models can be used for making various predictions, including weather prediction, disease prediction, stock market analysis, etc.

Difference between Artificial intelligence and Machine learning

Artificial intelligence and machine learning are parts of computer science that are closely related to each other. These two technologies are the most trending technologies that are used for creating intelligent systems. Although these are two related technologies and sometimes people use them as synonyms for each other, but still, both are different terms in various cases.

On a broad level, we can differentiate both AI and ML as:

"AI is a bigger concept to create intelligent machines that can simulate human thinking capability and behavior, whereas machine learning is an application or subset of AI that allows machines to learn from data without being programmed explicitly."



Below are some main differences between AI and machine learning, along with an overview of Artificial Intelligence and machine learning.

Artificial Intelligence

Artificial intelligence is a field of computer science that makes a computer system that can mimic human intelligence. It is comprised of two words, "**Artificial**" and "**intelligence**", which means "a human-made thinking power." Hence, we can define it as,

"Artificial intelligence is a technology using which we can create intelligent systems that can simulate human intelligence."

The Artificial intelligence system does not require to be pre-programmed, instead, they use algorithms that can work with their intelligence. It involves machine learning algorithms such as the Reinforcement learning algorithm and deep learning neural networks. AI is being used in multiple places, such as Siri, Google's AlphaGo, AI in Chess playing, etc.

Based on capabilities, AI can be classified into three types:

- **Weak AI**
- **General AI**
- **Strong AI**

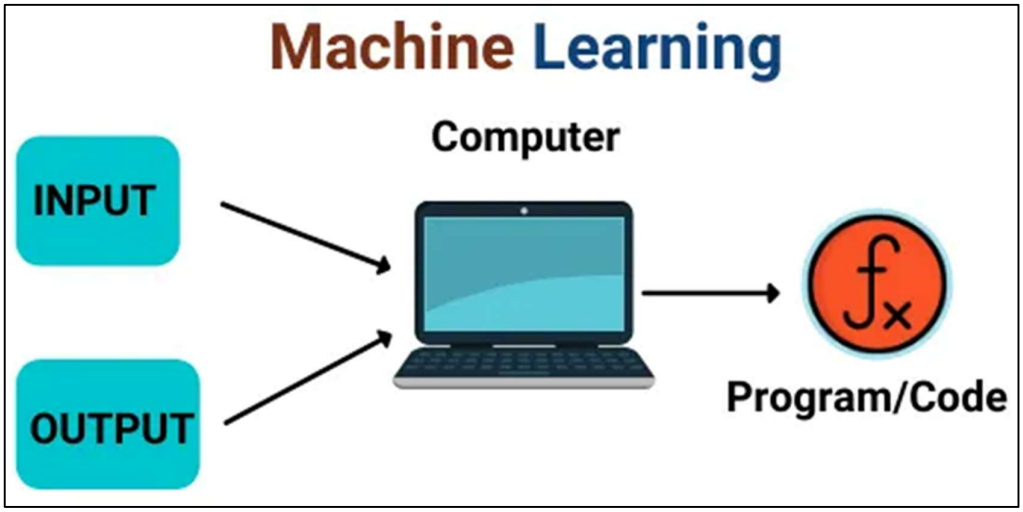
Currently, we are working with weak AI and general AI. The future of AI is Strong AI for which it is said that it will be intelligent than humans.

Machine learning

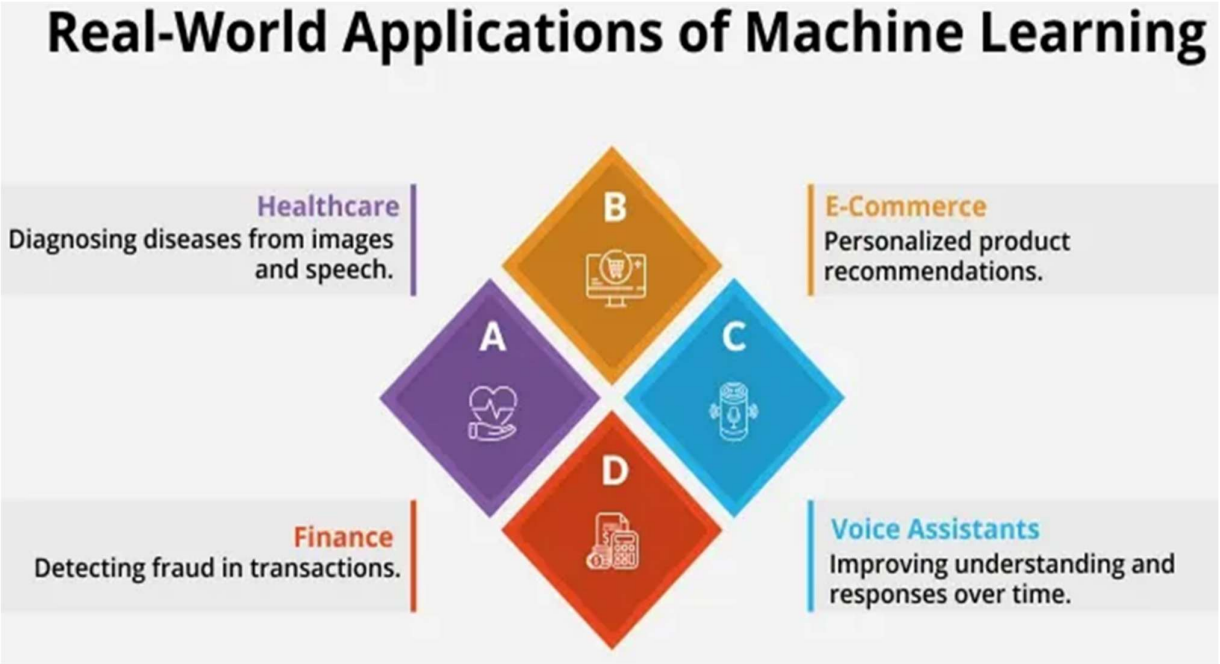
Machine learning is about extracting knowledge from the data. It can be defined as,

"Machine learning is a subfield of artificial intelligence, which enables machines to learn frompast data or experiences without being explicitly programmed."

Machine learning enables a computer system to make predictions or take decisions using historical data without being explicitly programmed. Machine learning uses a massive amount of structured and semi-structured data so that a machine learning model can generate accurate results or give predictions based on that data.



Machine learning works on algorithms that learn by using historical data. It works only for specific domains, such as if we are creating a machine learning model to detect pictures of dogs, it will only give results for dog images, but if we provide new data like a cat image, then it will become unresponsive. Machine learning is being used in various places, such as for online recommender systems, for Google search algorithms, Email spam filters, Facebook Auto friend tagging suggestions, etc.



Key differences between Artificial Intelligence (AI) and Machine learning (ML):

Artificial Intelligence	Machine learning
Artificial intelligence is a technology that enables amachine to simulate human behavior.	Machine learning is a subset of AI that allows a machine to automatically learn from past data without programming explicitly.
The goal of AI is to make a smart computer system like humans to solve complex problems.	The goal of ML is to allow machines tolearn from data so that they can give accurate output.
In AI, we make intelligent systems to perform any task like a human.	In ML, we teach machines with data toperform a particular task and give an accurate result.
Machine learning and deep learning are the two mainsubsets of AI.	Deep learning is a main subset of machine learning.
AI has a very wide range of scope.	Machine learning has a limited scope.
AI is working to create an intelligent system which can perform various complex tasks.	Machine learning is working to createmachines that can perform only those specific tasks for which they are trained.
AI system is concerned about maximizing the chances of success.	Machine learning is mainly concerned about accuracy and patterns.
The main applications of AI are Siri, customer support using catboats, Expert System, Online game playing, intelligent humanoid robot, etc.	The main applications of machine learningare Online recommender system, Google search algorithms, Facebook auto friend tagging suggestions, etc.
On the basis of capabilities, AI can be divided into three types,which are, Weak AI, General AI, and Strong AI.	Machine learning can also be divided intomainly three types that are Supervised learning, Unsupervised learning, and Reinforcement learning.
It includes learning, reasoning, and self-correction.	It includes learning and self-correction when introduced with new data.
AI completely deals with Structured, semi-structured, and unstructured data.	Machine learning deals with Structured and semi-structured data.