

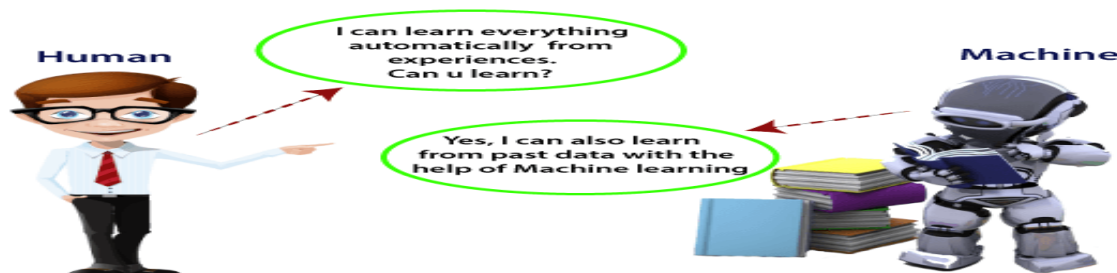
Chapter 1

Overview

Machine learning is a growing technology which 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 system, 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 which 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 to be a subset of **artificial intelligence** that is mainly concerned with the development of algorithms which allow a computer to learn from the data and past experiences on their own.

The term machine learning was first introduced by **Arthur Samuel** in **1959**. Arthur Samuel, an early American leader in the field of computer gaming and artificial intelligence, coined the term “Machine Learning” in 1959 while at IBM. He defined machine learning as “the field of study that gives computers the ability to learn without being explicitly programmed.” However, there is no universally accepted definition for machine learning. Different authors define the term differently. Here are more definitions.

1. Tom Mitchell (1998): a computer program is said to learn from experience E with respect to some class of tasks T and performance measure P , if its performance at tasks in T , as measured by P , improves with experience E .

Examples i) Handwriting recognition learning problem, Task T : Recognizing and classifying handwritten words within images, Performance P : Percent of words correctly

classified, Training experience E: A dataset of handwritten words with given classifications

ii) A robot driving learning problem, Task T: Driving on highways using vision sensors, Performance measure P: Average distance traveled before an error, training experience: A sequence of images and steering commands recorded while observing a human driver

iii) A chess learning problem, Task T: Playing chess, Performance measure P: Percent of games won against opponents, Training experience E: Playing practice games against itself

2. Machine learning is programming computers to optimize a performance criterion using example data or past experience. We have a model defined up to some parameters, and learning is the execution of a computer program to optimize the parameters of the model using the training data or past experience. The model may be predictive to make predictions in the future, or descriptive to gain knowledge from data, or both.

3. The field of study known as machine learning is concerned with the question of how to construct computer programs that automatically improve with experience.

4. A computer program which learns from experience is called a machine learning program or simply a learning program. Such a program is sometimes also referred to as a learner.

5. Machine Learning is defined as the study of computer algorithms for automatically constructing computer software through past experience and training data.

6. It is a branch of Artificial Intelligence and computer science that helps build a model based on training data and make predictions and decisions without being constantly programmed.

7. Machine Learning is the study of learning algorithms using past experience and making future decisions.

8. Machine Learning is defined as the branch of Artificial Intelligence and computer science that focuses on learning and improving the performance of computers/machines through past experience by using algorithms.

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 for creating predictive models. It constructs or uses the algorithms that learn from historical data. The more we will provide the information, the higher will be the performance. A machine has the ability to learn if it can improve its performance by gaining more data.

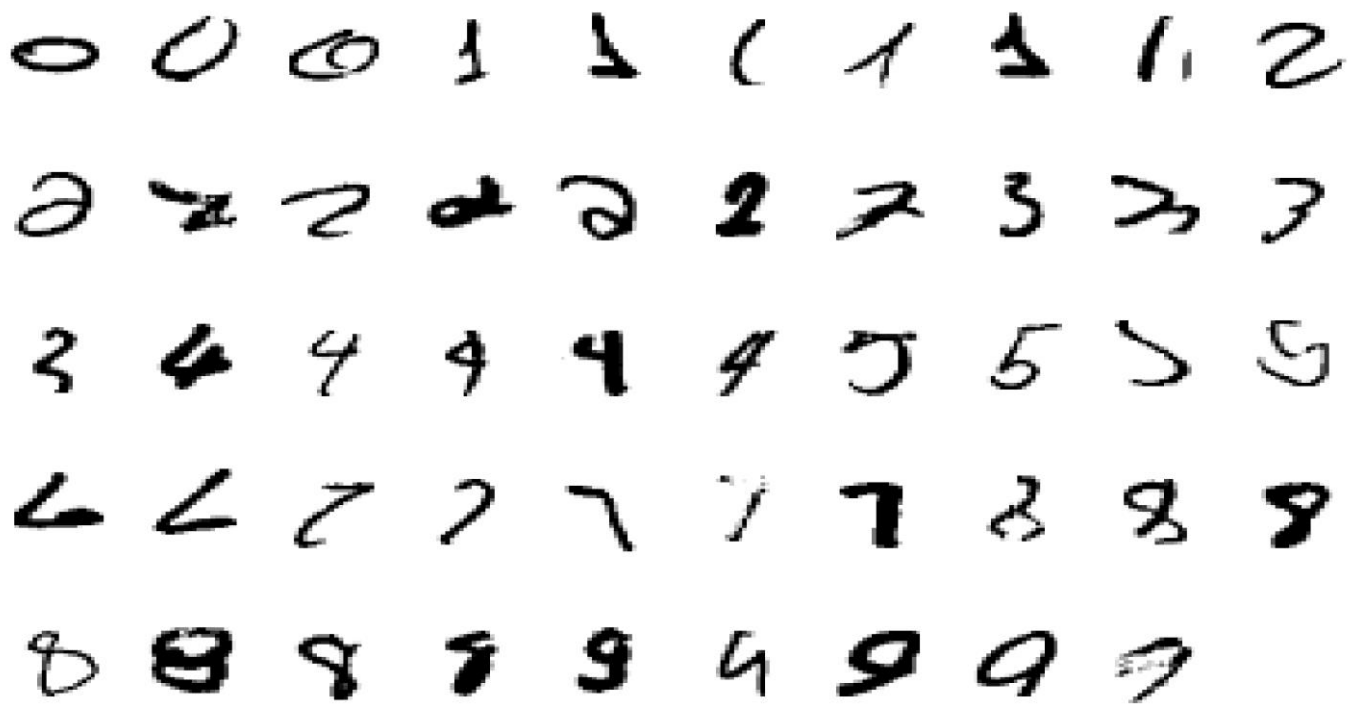
Machine learning is a part of artificial intelligence and the subfield of Data Science. It is a growing technology that enables machines to learn from past data and perform a given task automatically. It allows the computers to learn from the past experiences by its own, it uses statistical methods to improve the performance and predict the output without being explicitly programmed.

- A) It is very hard to write programs that solve problems like recognizing a face.
 - We don't know what program to write because we don't know how our brain does it.
 - Even if we had a good idea about how to do it, the program might be horrendously complicated.
- B) Instead of writing a program by hand, we collect lots of examples that specify the correct output for a given input.
- C) A machine learning algorithm then takes these examples and produces a program that does the job.
 - The program produced by the learning algorithm may look very different from a typical hand-written program. It may contain millions of numbers.
 - If we do it right, the program works for new cases as well as the ones we trained it on.

Some more examples of tasks that are best solved by using a learning algorithm.

- A) Recognizing Patterns:
 - Facial identities or facial expressions
 - Handwritten or Spoken words
 - Medical images
- B) Generating Patterns:
 - Generating images or motion sequences
- C) Recognizing Anomalies:
 - Unusual sequences of credit card transactions
 - Unusual patterns of sensor readings in a nuclear power plant or unusual sound in your car engine.
- D) Prediction:
 - Future stock prices or currency exchange rates

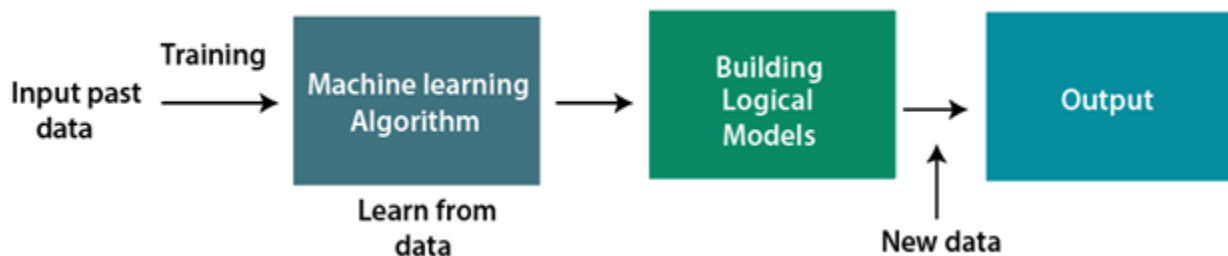
A classic example of a task that requires machine learning: It is very hard to say what makes a 2.



How does Machine Learning Work?

A Machine Learning system **learns from historical data, builds the prediction models, and whenever it receives new data, predicts the output for it.** The accuracy of predicted output depends upon the amount of data, as the huge amount of data helps to build a better model which predicts the output more accurately.

Suppose we have a complex problem, where we need to perform some predictions, so instead of writing a code for it, we just need to feed the data to generic algorithms, and with the help of these algorithms, machine builds the logic as per the data and predict the output. Machine learning has changed our way of thinking about the problem. The following block diagram explains the working of Machine Learning algorithm:



What is Machine Learning?

Machine Learning is defined as the branch of Artificial Intelligence and computer science that focuses on learning and improving the performance of computers/machines through past experience by using algorithms.

AI is used to make intelligent machines/robots, whereas machine learning helps those machines to train for predicting the outcome without human intervention.

How does Machine Learning Work?

Machine Learning uses algorithms and techniques that enable the machines to learn from past experience/trends and predict the output based on that data.



However, machine learning access a huge amount of data using data pre-processing. This data can be either structured, semi-structured, or unstructured. Further, this data is fed through some techniques and algorithms to machines, and then based on previous trends; it predicts the outputs automatically.

Features of Machine Learning:

- Machine learning uses data to detect various patterns in a given dataset.
- It can learn from past data and improve automatically.
- It is a data-driven technology.
- Machine learning is much similar to data mining as it also deals with the huge amount of the data.

Need for Machine Learning

The need for machine learning is increasing day by day. The reason behind the need for machine learning is that it is capable of doing tasks that are too complex for a person to implement directly. As a human, we have some limitations as we cannot access the huge amount of data manually, so for this, we need some computer systems and here comes the machine learning to make things easy for us.

We can train machine learning algorithms by providing them huge amount of data and let them explore the data, construct the models, and predict the required output automatically. The performance of the machine learning algorithm depends on the amount of data, and it can be determined by the cost function. With the help of machine learning, we can save both time and money.

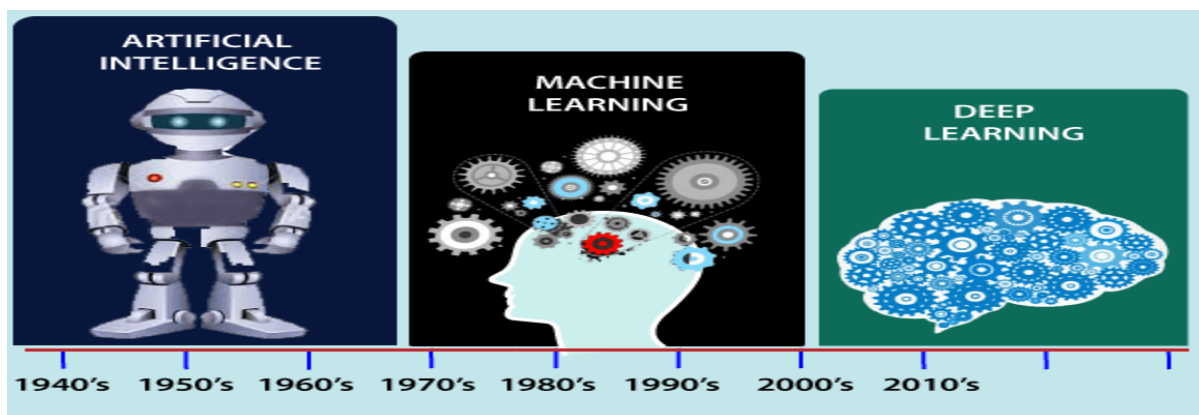
The importance of machine learning can be easily understood by its uses cases. Currently, machine learning is used in self-driving cars, cyber fraud detection, face recognition, and friend suggestion by Facebook, etc. Various top companies such as Netflix and Amazon have built machine learning models that are using a vast amount of data to analyze the user interest and recommend product accordingly.

Following are some key points which show the importance of Machine Learning:

- Rapid increment in the production of data
- Solving complex problems, which are difficult for a human
- Decision making in various sector including finance
- Finding hidden patterns and extracting useful information from data.

History of Machine Learning

Before some years (about 40-50 years), machine learning was science fiction, but today it is the part of our daily life. Machine learning is making our day to day life easy from **self-driving cars** to **Amazon virtual assistant "Alexa"**. However, the idea behind machine learning is so old and has a long history. The following are some milestones which 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 of 1974 to 1980 was the tough time for AI and ML researchers, and this duration was called as **AI winter**.
- In this duration, failure of machine translation occurred, and people had reduced their interest from AI, which led to reduced funding by the government to the researches.

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:** The IBM's **Deep blue** intelligent computer won the chess game against the chess expert Garry Kasparov, and it became the first computer which had beaten a human chess expert.

Machine Learning at 21st century

- **2006:** In the year 2006, computer scientist Geoffrey Hinton has given 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 which 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 Chabot who convinced the 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 do.
- **2016: AlphaGo** beat the world's number second player **Lee sedol** at **Go game**. In 2017 it beats the number one player of this game **Ke Jie**.
- **2017:** In 2017, the Alphabet's Jigsaw team built an intelligent system that was able to learn the **online trolling**. It used to read millions of comments of different websites to learn to stop online trolling.

Machine Learning at Present:

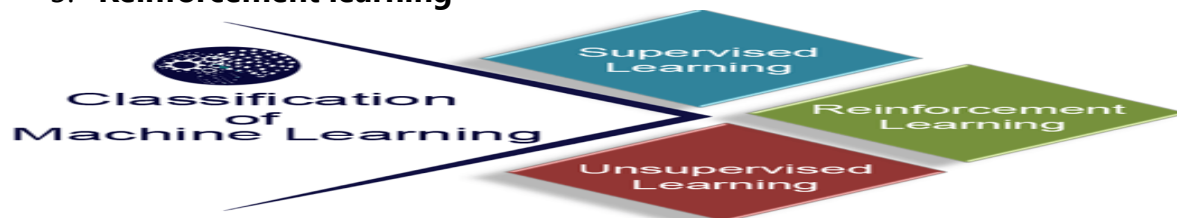
Now machine learning has got a great advancement in its research, and it is present everywhere around us, such as self-driving cars, Amazon Alexa, Catboats, recommender system, and many more. It includes Supervised, Unsupervised, and Reinforcement learning with clustering, classification, decision tree, SVM algorithms, etc.

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

Classification of Machine Learning

At a broad level, machine learning can be classified into three types:

1. **Supervised learning**
2. **Unsupervised learning**
3. **Reinforcement learning**



1) Supervised Learning

Supervised learning is a type of machine learning method in which we provide sample labeled data to the machine learning system in order to train it, and on that basis, it predicts the output.

The system creates a model using labeled data to understand the datasets and learn about each data, once the training and processing are done then we test the model by providing a sample data to check whether it is predicting the exact output or not.

The goal of supervised learning is to map input data with the output data. The supervised learning is based on supervision, and it is the same as when a student learns things in the supervision of the teacher. The example of supervised learning is spam filtering.

Supervised learning can be grouped further in two categories of algorithms:

- ❖ **Classification**
- ❖ **Regression**

2) Unsupervised Learning

Unsupervised learning is a learning method in which a machine learns without any supervision.

The training is provided to the machine with the set of data that has not been labeled, classified, or categorized, and the algorithm needs to act on that data without any supervision. The goal of unsupervised learning is to restructure the input data into new features or a group of objects with similar patterns.

In unsupervised learning, we don't have a predetermined result. The machine tries to find useful insights from the huge amount of data. It can be further classified into two categories of algorithms:

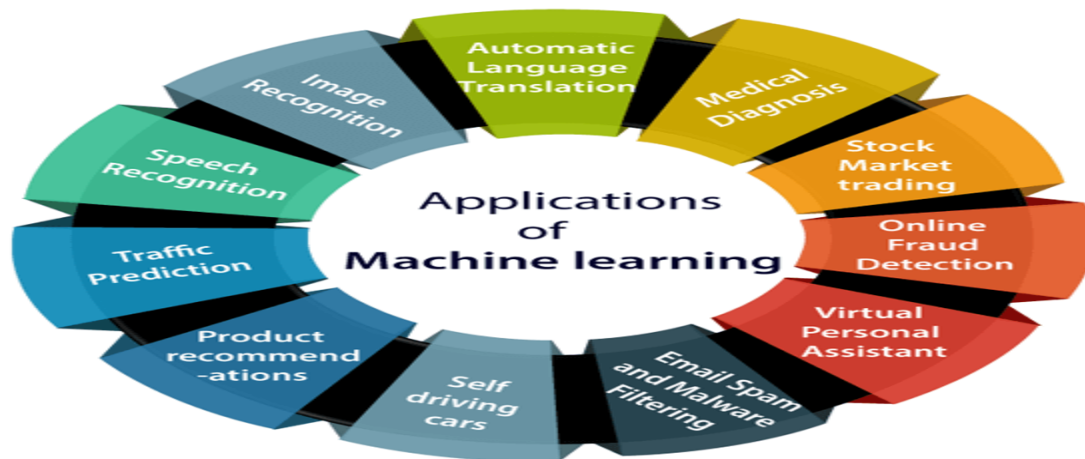
- ❖ **Clustering**
- ❖ **Association**

3) Reinforcement Learning

Reinforcement learning is a feedback-based learning method, in which a learning agent gets a reward for each right action and gets a penalty for each wrong action. The agent learns automatically with these feedbacks and improves its performance. In reinforcement learning, the agent interacts with the environment and explores it. The goal of an agent is to get the most reward points, and hence, it improves its performance. The robotic dog, which automatically learns the movement of his arms, is an example of Reinforcement learning.

Applications of Machine learning

Machine learning is a buzzword for today's technology, and it is growing very rapidly day by day. We are using machine learning in our daily life even without knowing it such as Google Maps, Google assistant, Alexa, etc. The following are some of the most trending real-world applications of Machine Learning.



1. Image Recognition:

Image recognition is one of the most common applications of machine learning. It is used to identify objects, persons, places, digital images, etc. The popular use case of image recognition and face detection is **Automatic friend tagging suggestion**:

Facebook provides us a feature of auto friend tagging suggestion. Whenever we upload a photo with our Facebook friends, then we automatically get a tagging suggestion with name, and the technology behind this is machine learning's **face detection** and **recognition algorithm**.

It is based on the Facebook project named "**Deep Face**," which is responsible for face recognition and person identification in the picture.

2. Speech Recognition

While using Google, we get an option of "**Search by voice**," it comes under speech recognition, and it's a popular application of machine learning. Speech recognition is a process of converting voice instructions into text, and it is also known as "**Speech to text**", or "**Computer speech recognition**." At present, machine learning algorithms are widely used by various applications of speech recognition. **Google Assistant**, **Siri**, **Cortana**, and **Alexa** are using speech recognition technology to follow the voice instructions.

3. Traffic prediction:

If we want to visit a new place, we take help of Google Maps, which shows us the correct path with the shortest route and predicts the traffic conditions.

It predicts the traffic conditions such as whether traffic is cleared, slow-moving, or heavily congested with the help of two ways:

- **Real Time location** of the vehicle from Google Map app and sensors
- **Average time has taken** on past days at the same time.

Everyone who is using Google Map is helping this app to make it better. It takes information from the user and sends back to its database to improve the performance.

4. Product recommendations:

Machine learning is widely used by various e-commerce and entertainment companies such as **Amazon**, **Netflix**, etc., for product recommendation to the user. Whenever we search for some product on Amazon, then we started getting an advertisement for the same product while Internet surfing on the same browser and this is because of machine learning.

Google understands the user interest using various machine learning algorithms and suggests the product as per customer interest. Similarly, when we use Netflix, we find some recommendations for entertainment series, movies, etc., and this is also done with the help of machine learning.

5. Self-driving cars:

One of the most exciting applications of machine learning is self-driving cars. Machine learning plays a significant role in self-driving cars. Tesla, the most popular car manufacturing company is working on self-driving car. It is using unsupervised learning method to train the car models to detect people and objects while driving.

6. Email Spam and Malware Filtering:

Whenever we receive a new email, it is filtered automatically as important, normal, and spam. We always receive an important mail in our inbox with the important symbol and spam emails in our spam box, and the technology behind this is Machine learning. Below are some spam filters used by Gmail:

- Content Filter
- Header filter
- General blacklists filter
- Rules-based filters
- Permission filters

Some machine learning algorithms such as Multi-Layer Perceptron, Decision tree, and Naïve Bayes classifier are used for email spam filtering and malware detection.

7. Virtual Personal Assistant:

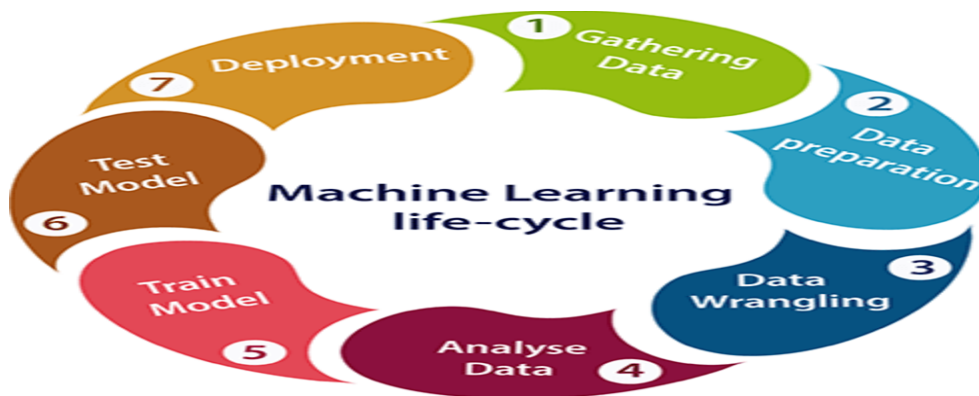
We have various virtual personal assistants such as **Google assistant**, **Alexa**, **Cortana**, **Siri**. As the name suggests, they help us in finding the information using our voice instruction. These assistants can help us in various ways just by our voice instructions such as Play music, call someone, Open an email, Scheduling an appointment, etc. These virtual assistants use machine learning algorithms as an important part.

Machine learning Life cycle

Machine learning has given the computer systems the abilities to automatically learn without being explicitly programmed. But how does a machine learning system work? So, it can be described using the life cycle of machine learning. Machine learning life cycle is a cyclic process to build an efficient machine learning project. The main purpose of the life cycle is to find a solution to the problem or project.

Machine learning life cycle involves about seven major steps.

- **Gathering Data**
- **Data preparation**
- **Data Wrangling**
- **Analyze Data**
- **Train the model**
- **Test the model**
- **Deployment**



The most important thing in the complete process is to understand the problem and to know the purpose of the problem. Therefore, before starting the life cycle, we need to understand the problem because the good result depends on the better understanding of the problem.

In the complete life cycle process to solve a problem, we create a machine learning system called "model", and this model is created by providing "training". But to train a model, we need data. Hence, life cycle starts by collecting data.

1. Gathering Data:

Data gathering is the first step of the machine learning life cycle. The goal of this step is to identify and obtain all data-related to the problem.

In this step, we need to identify the different data sources, as data can be collected from various sources such as files, database, Internet, **or** mobile devices. It is one of the most important steps of the life cycle. The quantity and quality of the collected data will determine the efficiency of the output. The more will be the data, the more accurate will be the prediction.

This step includes the following tasks:

- **Identify various data sources**
- **Collect data**
- **Integrate the data obtained from different sources**

By performing the above task, we get a coherent set of data, also called as a **dataset**. It will be used in further steps.

2. Data Preparation

After collecting the data, we need to prepare it for further steps. Data preparation is a step where we put our data into a suitable place and prepare it to use in our machine learning training.

In this step, first, we put all data together, and then randomize the ordering of data.

This step can be further divided into two processes:

- **Data exploration:** It is used to understand the nature of data that we have to work with. We need to understand the characteristics, format, and quality of data. A better understanding of data leads to an effective outcome. In this, we find Correlations, general trends, and outliers.
- **Data pre-processing:** Now the next step is preprocessing of data for its analysis.

3. Data Wrangling

Data wrangling is the process of cleaning and converting raw data into a useable format. It is the process of cleaning the data, selecting the variable to use, and transforming the data in a proper format to make it more suitable for analysis in the next step. It is one of the most important steps of the complete process. Cleaning of data is required to address the quality issues.

It is not necessary that data we have collected is always of our use as some of the data may not be useful. In real-world applications, collected data may have various issues, including:

- **Missing Values**
- **Duplicate data**
- **Invalid data**
- **Noise**

So, we use various filtering techniques to clean the data. It is mandatory to detect and remove the above issues because it can negatively affect the quality of the outcome.

4. Data Analysis

Now the cleaned and prepared data is passed on to the analysis step. This step involves:

- **Selection of analytical techniques**
- **Building models**
- **Review the result**

The aim of this step is to build a machine learning model to analyze the data using various analytical techniques and review the outcome. It starts with the determination of the type of the problems, where we select the machine learning techniques such as **Classification, Regression, Cluster Analysis, Association**, etc. then build the model using prepared data, and evaluate the model.

Hence, in this step, we take the data and use machine learning algorithms to build the model.

5. Train Model

Now the next step is to train the model. In this step we train our model to improve its performance for better outcome of the problem. We use datasets to train the model using various machine learning algorithms. Training a model is required so that it can understand the various patterns, rules, and, features of the data.

6. Test Model

Once our machine learning model has been trained on a given dataset, then we test the model. In this step, we check for the accuracy of our model by providing a test dataset to it. Testing the model determines the percentage accuracy of the model as per the requirement of project or problem.

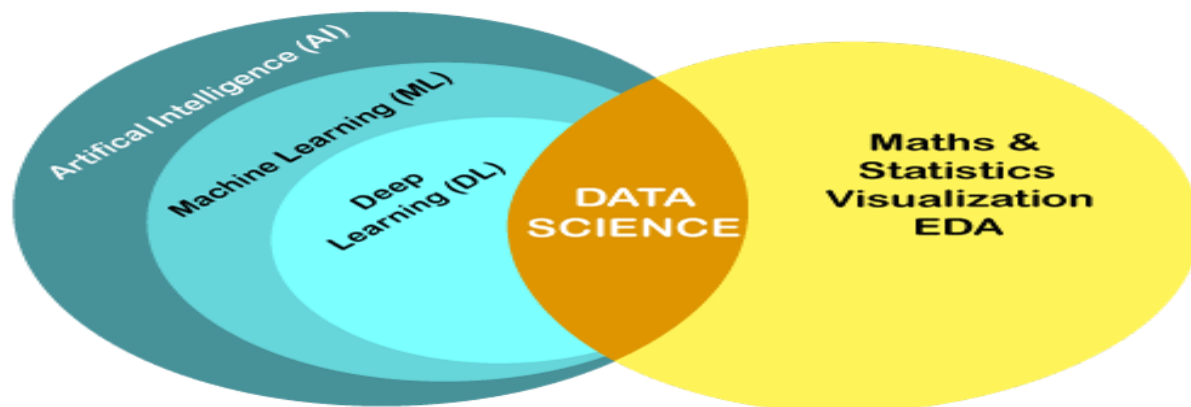
7. Deployment

The last step of machine learning life cycle is deployment, where we deploy the model in the real-world system. If the above-prepared model is producing an accurate result as per our requirement with acceptable speed, then we deploy the model in the real system. But, before deploying the project, we will check whether it is improving its performance using available data or not. The deployment phase is similar to making the final report for a project.

Difference between Data Science and Machine Learning

Data Science is the study of *data cleansing, preparation, and analysis*, while machine learning is a branch of AI and subfield of data science. Data Science and Machine Learning are the two popular modern technologies, and they are growing with an immoderate rate. But these two buzzwords, along with artificial intelligence and deep learning are very confusing term, so it is important to understand how they are different from each other.

Data Science and Machine Learning are closely related to each other but have different functionalities and different goals. At a glance, *Data Science is a field to study the approaches to find insights from the raw data. Whereas, Machine Learning is a technique used by the group of data scientists to enable the machines to learn automatically from the past data.* To understand the difference in-depth, let's first have a brief introduction to these two technologies.



Note: Data Science and Machine Learning are closely related to each other but cannot be treated as synonyms.

What is Data Science?

Data science, as its name suggests, is all about the data. Hence, we can define it as, *"A field of deep study of data that includes extracting useful insights from the data, and processing that information using different tools, statistical models, and Machine learning algorithms."*

It is a concept that is used to handle big data that includes data cleaning, data preparation, data analysis, and data visualization.

A data scientist collects the raw data from various sources, prepares and pre-processes the data, and applies machine learning algorithms, predictive analysis to extract useful insights from the collected data. For example, Netflix uses data science techniques to understand user interest by mining the data and viewing patterns of its users.

Skills required to become a Data Scientist

- An excellent programming knowledge of **Python, R, SAS, or Scala**.
- Experience in SQL database Coding.
- Knowledge of Machine Learning Algorithms.
- Deep Knowledge of Statistics concepts.
- Data Mining, cleaning, and visualizing skills.
- Skills to use Big data tools such as Hadoop.

What is Machine Learning?

Machine learning is a part of artificial intelligence and the subfield of Data Science. It is a growing technology that enables machines to learn from past data and perform a given task automatically. It can be defined as:

Machine Learning allows the computers to learn from the past experiences by its own, it uses statistical methods to improve the performance and predict the output without being explicitly programmed.

The popular applications of ML are *Email spam filtering, product recommendations, online fraud detection, etc.*

Skills Needed for the Machine Learning Engineer:

- Understanding and implementation of Machine Learning Algorithms.
- Natural Language Processing.
- Good Programming knowledge of Python or R.
- Knowledge of Statistics and probability concepts.
- Knowledge of data modeling and data evaluation.

Where is Machine Learning used in Data Science?

The use of machine learning in data science can be understood by the development process or life cycle of Data Science. The different steps that occur in Data science lifecycle are as follows:



1. **Business Requirements:** In this step, we try to understand the requirement for the business problem for which we want to use it. Suppose we want to create a recommendation system, and the business requirement is to increase sales.
2. **Data Acquisition:** In this step, the data is acquired to solve the given problem. For the recommendation system, we can get the ratings provided by the user for different products, comments, purchase history, etc.
3. **Data Processing:** In this step, the raw data acquired from the previous step is transformed into a suitable format, so that it can be easily used by the further steps.
4. **Data Exploration:** It is a step where we understand the patterns of the data, and try to find out the useful insights from the data.
5. **Modeling:** The data modeling is a step where machine learning algorithms are used. So, this step includes the whole machine learning process. The machine learning process involves importing the data, data cleaning, building a model, training the model, testing the model, and improving the model's efficiency.
6. **Deployment & Optimization:** This is the last step where the model is deployed on an actual project, and the performance of the model is checked.

Comparison between Data Science and Machine Learning

The following table describes the basic differences b/n Data Science and Machine Learning (ML)

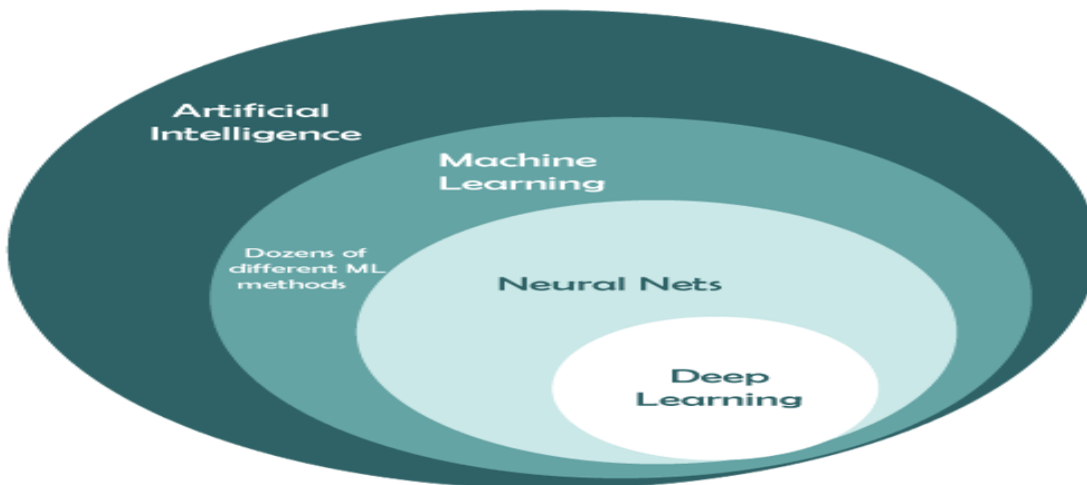
Data Science	Machine Learning
It deals with understanding and finding hidden patterns or useful insights from the data, which helps to take smarter business decisions.	It is a subfield of data science that enables the machine to learn from the past data and experiences automatically.
It is used for discovering insights from the data.	It is used for making predictions and classifying the result for new data points.
It is a broad term that includes various steps to create a model for a given problem and deploy the model.	It is used in the data modeling step of the data science as a complete process.
A data scientist needs to have skills to use big data tools like Hadoop, Hive and Pig, statistics, programming in Python, R, or Scala.	Machine Learning Engineer needs to have skills such as computer science fundamentals, programming skills in Python or R, statistics and probability concepts, etc.
It can work with raw, structured, and unstructured data.	It mostly requires structured data to work on.
Data scientists spent lots of time in handling the data, cleansing the data, and understanding its patterns.	ML engineers spend a lot of time for managing the complexities that occur during the implementation of algorithms and mathematical concepts behind that.

Deep learning vs. Machine Learning vs. Artificial Intelligence

Deep Learning, Machine Learning, and Artificial Intelligence are the most used terms on the Internet for IT folks. However, all these three technologies are connected with each other. Artificial Intelligence (AI) can be understood as an umbrella that consists of both machine learning and deep learning. Or We can say deep learning and machine learning both are subsets of artificial intelligence.

As these technologies look similar, most of the persons have misconceptions about 'Deep Learning, Machine learning, and Artificial Intelligence' that all three are similar to each other. But in reality, although all these technologies are used to build intelligent machines or applications that behave like a human, still, they differ by their functionalities and scope.

It means these three terms are often used interchangeably, but they do not quite refer to the same things. Let's understand the fundamental difference among Deep Learning, Machine Learning, and Artificial Intelligence with the following image.



With the above image, you can understand Artificial Intelligence is a branch of computer science that helps us to create smart, intelligent machines. Further, ML is a subfield of AI that helps to teach machines and build AI-driven applications. On the other hand, Deep learning is the sub-branch of ML that helps to train ML models with a huge amount of input data and complex algorithms and mainly works with neural networks.

What is Artificial Intelligence (AI)?

Artificial Intelligence is defined as a field of science and engineering that deals with making intelligent machines or computers to perform human-like activities. Mr. **John McCarthy** is known as the godfather of this amazing invention. There are some popular definitions of AI, which are as follows:

"AI is defined as the capability of machines to imitate intelligent human behavior."

"A computer system able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."

Applications of Artificial Intelligent

- Language Translations
- AI in healthcare
- Speech recognition, text recognition, and image recognition
- AI in astronomy
- AI in gaming
- AI in finance
- AI in data security
- AI in social media
- AI in travel and transport
- AI in Automotive Industry
- AI in robots
- AI in Entertainment, agriculture, E-commerce, education, etc.

We have discussed machine learning and artificial intelligence basics, and it's time to move towards the basics of deep learning.

What is Deep Learning?

"Deep learning is defined as the subset of machine learning and artificial intelligence that is based on artificial neural networks". In deep learning, the deep word refers to the number of layers in a neural network.

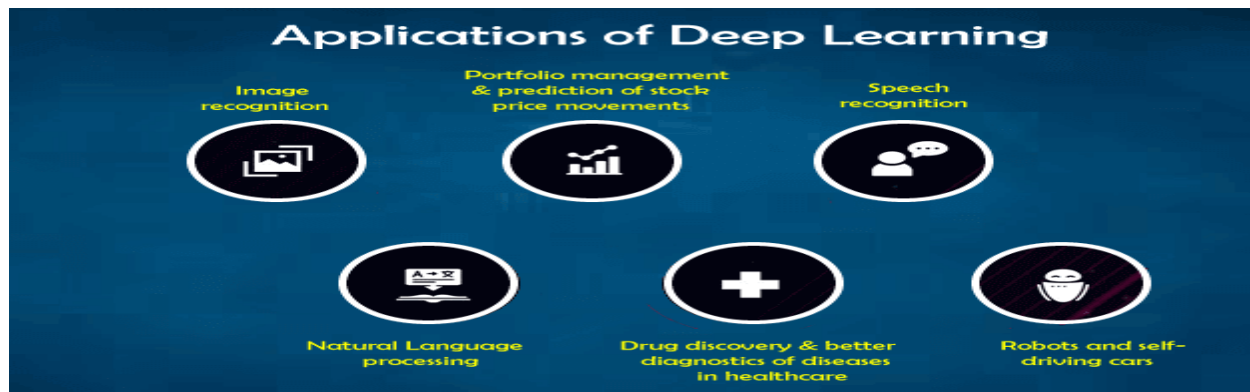
Deep Learning is a set of algorithms inspired by the structure and function of the human brain. It uses a huge amount of structured as well as unstructured data to teach computers and predicts accurate results. The main difference between machine learning and deep learning technologies is of presentation of data. Machine learning uses structured/unstructured data for learning, while deep learning uses neural networks for learning models.

In machine learning, if a model predicts inaccurate results, then we need to fix it manually. Further, in deep learning techniques, these problems get fixed automatically, and we do not need to do anything explicitly. A self-driving vehicle is one of the best examples to understand deep learning.

Deep learning can be useful to solve many complex problems with more accurate predictions such as **image recognition, voice recognition, product recommendations systems, natural language processing (NLP)**, etc.

Applications of Deep Learning

Deep learning can be applied in various industries such as:



- Self-driving vehicles
- Fraud detection
- Natural Language Processing
- Virtual Personal Assistance
- Text, Speech, and Image recognition
- Healthcare, infrastructure, banking & finance, marketing
- Entertainment
- Education
- Automatic game playing
- Auto handwriting generation
- Automatic language translation
- Pixel restoration and photo description & tagging
- Demographic and election predictions, etc.

Conclusion

Artificial intelligence is one of the most popular 5th generation technologies that is changing the world using its subdomains, machine learning, and deep learning. AI helps us to create an intelligent system and provide cognitive abilities to the machine. Further, machine learning enables machines to learn based on experience without human intervention and makes them capable of learning and predicting results with given data. At the same time, deep learning is the breakthrough in the field of AI that uses various layers of artificial neural networks to achieve impressive outputs for various problems such as image recognition and text recognition.