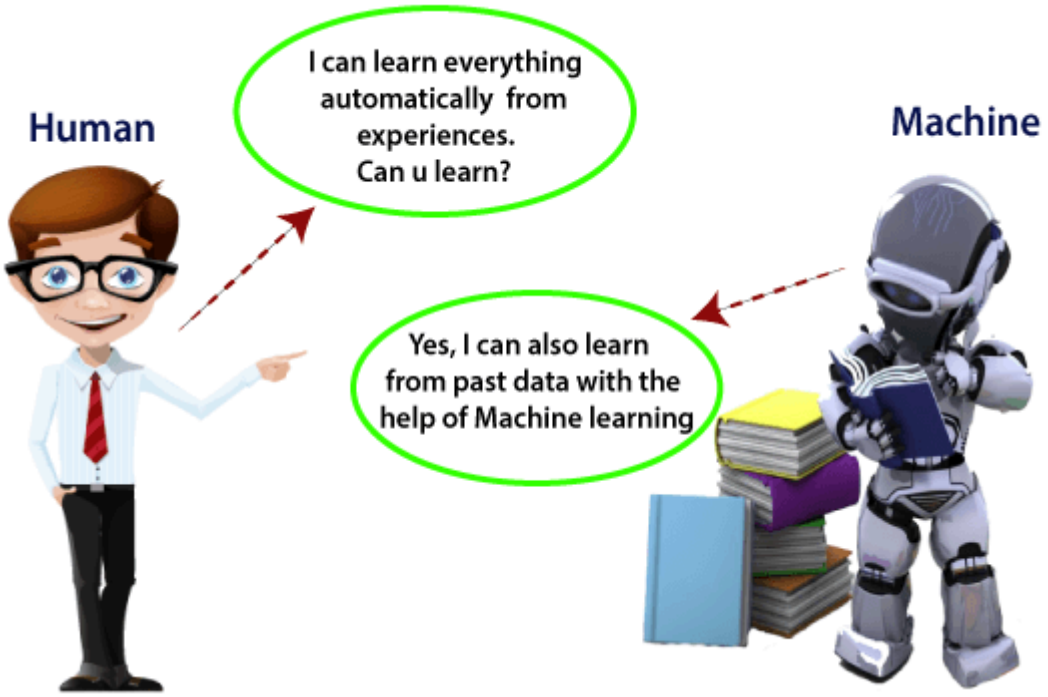
Unit-1

Machine Learning Defined

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 as 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**. 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.

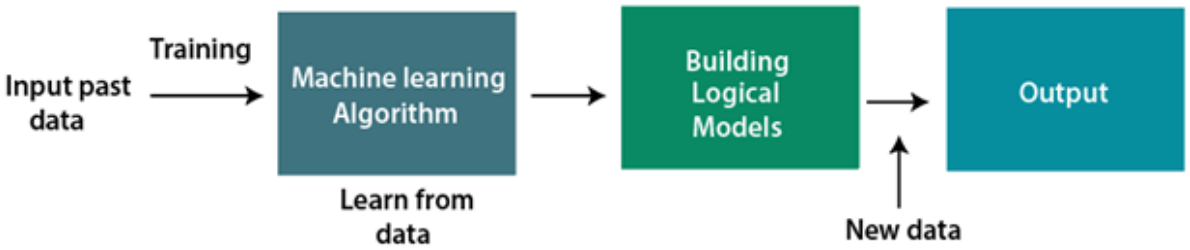
With the help of sample historical data, which is known as **training data**, machine learning algorithms build a **mathematical model** that helps in making predictions or decisions without being explicitly programmed. Machine learning brings computer science and

statistics together for creating predictive models. Machine learning constructs or uses the algorithms that learn from historical data. The more we will provide the information, the higher will be the performance.

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 below block diagram explains the working of Machine Learning algorithm:



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 the 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 build machine learning models that are using a vast amount of data to analyze the user interest and recommend product accordingly.

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.

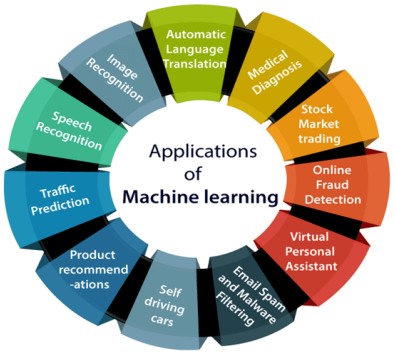
Classification of Machine Learning

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

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

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. Below are some 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 form 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.

As similar, 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.

These assistant record our voice instructions, send it over the server on a cloud, and decode it using ML algorithms and act accordingly.

8. Online Fraud Detection:

Machine learning is making our online transaction safe and secure by detecting fraud transaction. Whenever we perform some online transaction, there may be various ways that a fraudulent transaction can take place such as **fake accounts**, **fake ids**, and **steal money** in the middle of a transaction. So to detect this, **Feed Forward Neural network** helps us by checking whether it is a genuine transaction or a fraud transaction.

For each genuine transaction, the output is converted into some hash values, and these values become the input for the next round. For each genuine transaction, there is a specific pattern which gets change for the fraud transaction hence, it detects it and makes our online transactions more secure.

9. Stock Market trading:

Machine learning is widely used in stock market trading. In the stock market, there is always a risk of up and downs in shares, so for this machine learning's **long short term memory neural network** is used for the prediction of stock market trends.

10. Medical Diagnosis:

In medical science, machine learning is used for diseases diagnoses. With this, medical technology is growing very fast and able to build 3D models that can predict the exact position of lesions in the brain.

It helps in finding brain tumors and other brain-related diseases easily.

11. Automatic Language Translation:

Nowadays, if we visit a new place and we are not aware of the language then it is not a problem at all, as for this also machine learning helps us by converting the text into our known languages. Google's GNMT (Google Neural Machine Translation) provide this feature, which is a Neural Machine Learning that translates the text into our familiar language, and it called as automatic translation.

The technology behind the automatic translation is a sequence-to-sequence learning algorithm, which is used with image recognition and translates the text from one language to another language.

Cognitive Machine Learning

Cognitive machine learning refers to the combination of machine learning and brain cognitive mechanism, specifically, combining the achievements of machine learning we have studied

for many years with the mind model CAM [3] . Figure 1 shows the cognitive machine learning.

Cognitive machine learning mainly studies the following three aspects:

1) The emergency of learning: In the process of human cognition the first step is to begin to contact with the outside world, which belongs to the stage of perception. The second step is to sort out and transform the materials of comprehensive perception, which belongs to the stage of concept, judgment and reasoning. We raise perceptual knowledge through visual, auditory and tactile senses to rational knowledge. After acquiring a lot of perceptual knowledge, a new concept has been formed in the human brain, which is the emergence of learning.
2) Complementary learning system: how to construct the complementary learning system between short-term memory and semantic memory?
3) Evolution of Learning: As we all know, after hundreds of thousands of years of evolution, human brain capacity is also changing. Language plays an important role in it. So learning evolution is not only to adapt to changes in the outside world, but also to change its own structure. We think it is the most important in the world to change its-owns structure.



A cognitive computing system is trained to simulate human thought processes and learn based on interactions and outcomes rather than simply presenting information like you see when entering a keyword into a search engine. It's a cognitive system that can act almost like a human in its capacity to answer questions in a way that feels natural – and with remarkable speed and accuracy, reacting quickly and in real time.

Cognitive computing uses a massive quantity of information, including the complexities of an evolving language, and **provides answers and recommendations that are supported by existing data**. Adaptation is one of the primary characteristics and advantages of cognitive computing, as these technologies can learn from what they've already seen or done and can adapt on the fly and make changes where needed.

Cognitive technology helps businesses by sorting out what is relevant and what isn't, and gives sound, evidence-based advice and recommendations. And the kicker? These systems will continue to learn and get better over time**.**

The term "cognitive" is not uniformly defined. However, for the time being, we may state that it is a branch of computer science that replicates human brain processes using various methods such as natural language processing, data mining, and pattern classification. Cognitive technology is a part of the larger area of AI, which is a subdivision of biomimetics. To handle day-to-day issues, cognitive computing utilizes a combination of artificial intelligence, artificial neural, advanced analytics, natural language processing, sentiment analysis, and implementation of real.

Artificial Intelligence Vs Cognitive Technology

While the primary use case for artificial intelligence is to design an effective algorithm to resolve an issue, cognitive computing takes a step further and attempts to emulate human intellect and wisdom by examining several aspects. Cognitive computing is a completely distinct notion when compared to Artificial Intelligence.

Concepts of Cognitive Computing

In addition, cognitive computing is a completely separate discipline in which it acts as an assistant rather than the one who completes the work.

As a result, cognitive computing empowers people with the ability to do quicker and more effective data analysis without worrying about the machine learning system making incorrect conclusions. Moving further, let's check out some concepts used by cognitive technology while being the next wave of AI.

1. Cognitive technology mimics and learns from human cognitive processes

   Unlike AI technologies, which only deal with a single problem, cognitive computing learns by seeing patterns and recommending that people take appropriate action depending on its knowledge.

   In the context of AI, the program captures the entire control of a process and uses a pre-defined methodology to finish a job or avoid a situation.

2. Cognitive computing does not eliminate the need for people

The primary goal of cognitive computing is to facilitate humans in setting priorities. This provides people with higher analytical precision while assuring that everything is within their control. As an example, consider AI in the healthcare sector.

An AI-powered system will make all therapeutic decisions without consulting a human doctor, but cognitive computing would enhance human diagnoses with its own set of facts and analysis, therefore improving decision making and adding a human touch to important operations.

Advantages of Cognitive Technology

The contemporary computing system is poised to change current and legacy technologies in the field of process automation. As per Gartner, cognitive computing will have a greater impact on the digital world than any other technology launched in the previous 20 years.

Cognitive computing helps in the use of a computer network for meaningful real-life systems by allowing it to interpret and handle enormous volumes of volumetric data. Cognitive computing provides several advantages, including the following:

1. Business Processes that are simpler and more efficient

   On a real-time basis, cognitive computing can assess developing trends, identify business possibilities, and handle crucial process-centric challenges.

   A cognitive computer system, like Watson, can streamline operations, decrease risk, and pivot in response to changing conditions by analysing massive amounts of data. Though this prepares firms to design a good reaction to uncontrolled circumstances, it also aids in the creation of lean business processes.

   (Related Read: AI in Business**)**

2. Analyze Data accurately

   Cognitive systems are extremely efficient in gathering, contrasting, and cross-referencing data to efficiently understand a scenario.

   In the healthcare industry, cognitive systems such as IBM Watson help doctors in collecting and analysing information from diverse sources such as prior medical reports, journal articles, diagnostic tools, and historical data from the healthcare community.

   This in turn aids physicians in providing an information treatment recommendation that advantages both the patient and the physician. Cognitive computing, rather than replacing doctors, uses robotic process automation to accelerate data processing.

3. Customer Engagement Has Improved

   By incorporating robotic process automation, the technologies may be leveraged to improve client relations. Customers may get contextual information from robots without having to deal with other team members.

   Because cognitive computing enables businesses to give only relevant, contextual, and meaningful information to consumers, it enhances customer experience, making customers happier and more engaged with a company.

Cognitive Computing Issues: Prospects for a Better Future

During a new technology's lifespan, it will encounter several problems. Although cognitive computing can improve people's lives, humans are resisting it simply out of fear of change.

People are going to come up with many cognitive computing drawbacks that are posing substantial barriers to increased adoption, such as those listed below:

1. Adoption

   Voluntary adoption is the most significant impediment to the effectiveness of any new technology. To ensure the success of cognitive computing, it is critical to creating a long-term strategy of how the new technology can improve procedures and enterprises.

   The adoption process may be simplified by collaboration among multiple parties such as technology developers, corporations, governments, and individuals. Simultaneously, a data privacy system is necessary to accelerate the deployment of cognitive computing.

2. Security

   When digital tools handle sensitive information, the issue of security naturally arises. With the capacity to manage and analyse enormous amounts of data, cognitive computing faces substantial challenges in terms of data security and protection.

   As more digital technologies enter the picture, cognitive computing would have to consider the challenges associated with a breach of security by building a full-proof security strategy that also includes a method to detect suspicious behaviour to enhance data integrity.

3. Management of Change

   Another significant problem that cognitive computing will also have to solve is changing management. Many are hesitant to accept because of their innate human nature, and because cognitive computing can learn like humans, people are concerned

that computers would eventually replace humans. This has had a significant influence on growth prospects.

Cognitive technology, on the other hand, is designed to function in tandem with people. Humans will provide data into the systems, therefore nurturing the technology. As a result, it is an excellent illustration of a human-machine connection that people will have to embrace.

4. Prolonged Development Cycles

One of the most difficult difficulties is the time required to construct scenario-based functionalities using cognitive computing. Cognitive computing is presently being developed as a generalist solution, which implies that it cannot be deployed across many product lines without strong development teams and a significant time.

Long development cycles make it more difficult for smaller businesses to build cognitive skills on their own. As technology lifecycles decrease, cognitive computing will undoubtedly get a larger stage in the future.

Cognitive computing is unquestionably the next stage in the evolution of computing, which began with automation. It establishes a standard for computing systems to achieve the level of the human brain.

cognitive computing systems must have the following attributes:

- Adaptive. These systems must be flexible enough to learn as information changes and as goals evolve. They must digest dynamic data in real time and adjust as the data and environment change.
- Interactive. Human-computer interaction is a critical component in cognitive systems. Users must be able to interact with cognitive machines and define their needs as those needs change. The technologies must also be able to interact with other processors, devices and cloud platforms.
- Iterative and stateful. Cognitive computing technologies can ask questions and pull in additional data to identify or clarify a problem. They must be stateful in that they keep information about similar situations that have previously occurred.
- Contextual. Understanding context is critical in thought processes. Cognitive systems must understand, identify and mine contextual data, such as syntax, time, location, domain, requirements and a user's profile, tasks and goals. The systems may draw on multiple sources of information, including structured and unstructured data and visual, auditory and sensor data.

cognitive computing in various industries

- **Healthcare.** Cognitive computing can deal with large amounts of unstructured healthcare data such as patient histories, diagnoses, conditions and journal

research articles to make recommendations to medical professionals. This is done with the goal of helping doctors make better treatment decisions. Cognitive technology expands a doctor's capabilities and assists with decision-making.

- **Retail.** In retail environments, these technologies analyze basic information about the customer, along with details about the product the customer is looking at. The system then provides the customer with personalized suggestions.
- **Banking and finance.** Cognitive computing in the banking and finance industry analyzes unstructured data from different sources to gain more knowledge about customers. NLP is used to create chatbots that communicate with customers. This improves operational efficiency and customer engagement.
- **Logistics.** Cognitive computing aids in areas such as warehouse management, warehouse automation, networking and IoT devices.

IBM's Watson for Oncology is an example of a cognitive computing system. It provides oncologists at Memorial Sloan Kettering Cancer Center in New York with evidence-based treatment options for cancer patients. When medical staff input questions, Watson generates a list of hypotheses and offers treatment options for doctors to consider. Watson Health is another IBM tool that helps clients in medical and clinical research.

Advantages of cognitive computing

Advantages of cognitive computing include positive outcomes in the following areas:

- **Analytical accuracy.** Cognitive computing is proficient at juxtaposing and cross-referencing structured and unstructured data.
- **Business process efficiency.** Cognitive technology can recognize patterns when analyzing large data sets.
- **Customer interaction and experience.** The contextual and relevant information that cognitive computing provides to customers through tools like chatbots improves customer interactions. A combination of cognitive assistants, personalized recommendations and behavioral predictions enhances customer experience.
- **Employee productivity and service quality.** Cognitive systems help employees analyze structured or unstructured data and identify data patterns and trends.

Disadvantages of cognitive systems

Cognitive technology also has downsides, including the following:

- **Security challenges.** Cognitive systems need large amounts of data to learn from. Organizations using the systems must properly protect that data -- especially if it is health, customer or any type of personal data.
- **Long development cycle length.** These systems require skilled development teams and a considerable amount of time to develop software for them. The

systems themselves need extensive and detailed training with large data sets to understand given tasks and processes. Ena okay akka I’m

- **Slow adoption.** The slow development lifecycle is one reason for slow adoption rates. Smaller organizations may have more difficulty implementing cognitive systems and therefore avoid them.
- **Negative environmental impact.** The process of training cognitive systems and neural networks consumes a lot of power and has a sizable carbon footprint.