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MACHINE LEARNING AND DEEP LEARNING FOR MULTIPLE DOMAINS

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Abstract: Artificial intelligence is starting to be used in engineering and experimental research, much like statistics and mathematics. The three pillars of data science—deep learning, machine learning, and artificial intelligence—are fast gaining ground among academics. This paper explains the link between these data science fundamentals. Machine learning is necessary for any form of analysis. A first-hand description of machine learning is presented in this article. Additionally, it highlights deep learning. Deep learning is sometimes referred to as the "new trend in machine learning." An overview of the basic architecture of Deep Learning is given in this article. A comparative examination of deep learning and machine learning is also included in the paper, providing researchers with a broad overview of both methodologies and assisting them in determining which would be the most appropriate choice in a given circumstance.

1. INTRODUCTION

Machine learning and deep learning are the technologies that artificial intelligence utilizes in the era of data sciences to help it accomplish its objective of providing a computer with human-level intelligence. The area of artificial intelligence known as "machine learning" deals with teaching robots how to learn. A constrained kind of machine learning is called deep learning. It contributes to raising the bar for the learning environment. Machine learning and deep learning are crucial for transforming computer systems into expert systems that can make decisions and forecasts without human input.

The study of artificial intelligence enables computer systems to think and act intelligently. Deep learning facilitates the more methodical achievement of machine learning objectives on the system, while machine learning aids in the implementation of artificial intelligence on the system. Figure 1 illustrates it visually.

It explains the many techniques and algorithms that each one employs. A comparison of deep learning and various traditional machine learning techniques is presented in section IV..

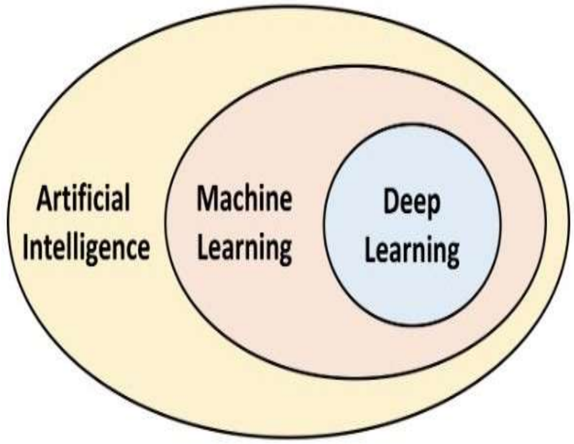

Fig. 1. AI, machine learning and deep learningparadigm

2. MACHINE LEARNING

The idea that a system can learn from data, identify patterns, and make judgments with the least amount of human input is the basis of machine learning [2]. This is the scientific study of statistical models and algorithms that enable computer systems to carry out certain tasks without the need for guidance, deduction, or pattern recognition. After constructing a mathematical model using sample data, machine learning algorithms arrive at a conclusion.

2.1 Machine learning procedure

Four stages are involved in machine learning, which are listed below (as shown in figure 2):

Step 1. “Feature extraction.
Step 2. Selecting corresponding machine learning algorithm.
Step 3. Training and evaluation the data model’s efficiency.
Step 4. Using trained model for prediction.”

2.2 Requirements to Create Good Machine Learning Systems

- Basic and Advanced algorithms
- Data preparation capabilities
- Various processes i.e. Automation and Iterative
- Scalability
- Ensemble modeling

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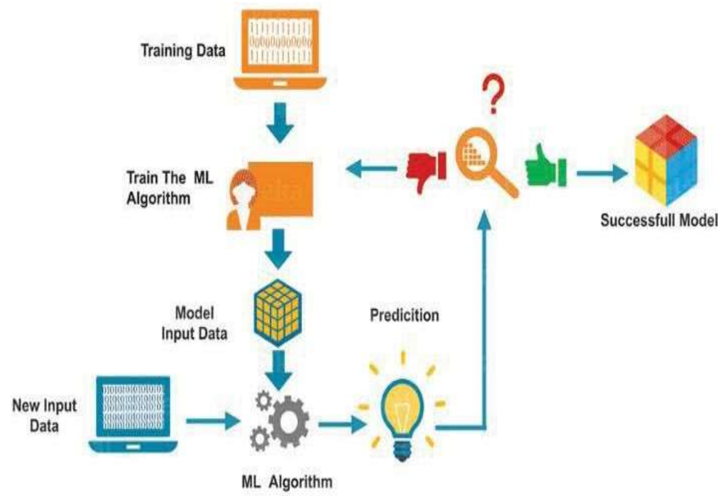

Fig. 2. Machine learning model

2.3 Relationship with Other Fields*:*

Artificial intelligence is said to include machine learning. When artificial intelligence first emerged as a field of study, scientists were curious about machine learning. They tried using a variety of symbolic approaches in addition to the connectionist technique, which makes use of neural networks and pattern recognition. Machine learning is structured as a distinct discipline in the 1990s. It moved the emphasis from symbolic approaches to probability theory and statistics models and procedures [4].

Relation to data mining: Both of these often use the same techniques and cross over. However, data mining concentrates on finding unknown qualities, while machine learning concentrates on prediction based on known features. While both machine learning and data mining utilize similar techniques, they do so for distinct purposes, such as increasing learner accuracy.

Relation to optimization: Optimization is closely related to machine learning. Learning issues are expressed as loss function minimization. Loss functions display the difference between the model's forecast and the real issue.

Relation to statistics: It has a tight relationship with statistics as well. The concepts of machine learning have been linked to statistics via theoretical instruments like the modeling paradigm as well as practical guidelines.

2.4 Machine Learning Application Sectors

As the sectors grow, massive volumes of data have been found. To manage the data, machine learning technology is required. Businesses may now function more efficiently thanks to machine learning. Machine learning is used in the following domains:

Financial services: Machine learning technology is utilized in the financial services industry to find valuable insights in data and stop fraud. The insights assist in locating potential investments

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or assisting investors in timing trades. Additionally, high-risk customer profiles may be identified using data mining ideas, as can early warning indicators of fraud.

Government sector: Government organizations like equipment and sensors used to evaluate patients' health in real time employ machine learning to harvest the data for insights. Medical professionals may also use machine learning to find patterns in the data they study. This might result in better medical diagnosis and care.

Health Care: This is the main use for wearable technology and sensors to provide real-time patient health assessments. Medical professionals may also use machine learning to find patterns in the data they study. This might result in better medical diagnosis and care. Data comes from several sources, including utilities and public safety. Analyzing sensor data saves costs and improves efficiency. Additionally, machine learning may be used to security, such as assisting in the detection of fraud and reducing identity theft.

Retail sector: Machine learning is utilized in the retail industry to examine clients' past purchases. Machine learning is used by retailers to collect, evaluate, and apply data in order to customize the shopping experience. Implementing the marketing campaign, improving the pricing, and obtaining client feedback are also beneficial.

Transportation: Routes are made more profitable by using machine learning to anticipate issues and make them more efficient. Following data analysis to find patterns and trends, it may be completed. For delivery services and transportation enterprises, data analysis and modeling are essential components.

Oil and gas: In this field, machine learning is used to evaluate ground minerals and discover new energy sources. Furthermore, refinery sensor failure is predicted using it. Oil distribution may be made more economical and effective by streamlining it.

2.5 Processes and Techniques associated with machine learning

Machine learning is utilized in this field to evaluate ground minerals and discover new energy sources. Refinery sensor failure is another use for it. It is more economical and effective to streamline the delivery of oil.

- Anomaly detection
- Association rules
- Decision tree
- Feature learning
- Sparse dictionary learning

2.6 Applications of Machine learning

There are many applications of machine learning such as:

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- Adaptive websites
- Bioinformatics
- Brain-machine interface
- Computer vision
- Data quality
- DNA sequence classification handwriting recognition
- Machine learning control
- User behavior analytics etc.

3. MACHINE LEARNING APPROACHES

In general, machine learning techn 0iques may be divided into two groups: shallow learning and deep learning [16]. Deep learning employs neural networks with several hidden layers, while shallow learning mostly uses neural networks with one layer, or SVMs (Support Vector Machines). According to figure 3:

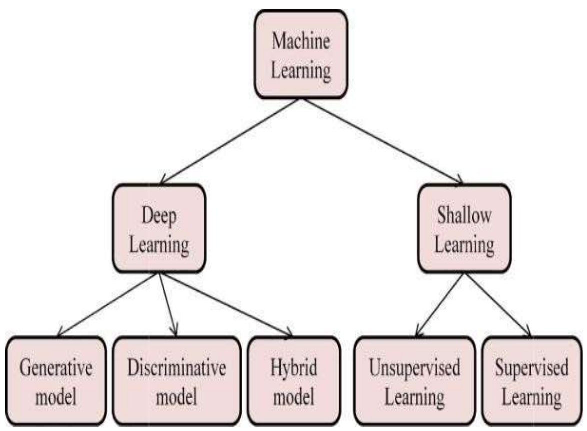

Fig. 3. Different approach of machine learning

3.1 Shallow Learning

Supervised and Unsupervised Learning are the two main categories into which shallow learning falls. However, there are further machine learning techniques. An outline of common techniques is provided below.:

Supervised learning: An algorithm creates a mathematical model for supervised learning by using a collection of data that includes both the input and the intended outputs. Labeled examples—in which the input and intended outputs are known—are used to train these algorithms. An algorithm is given a set of inputs and the correspondingly accurate outputs in this learning process. An algorithm gains knowledge by identifying faults by comparing its actual output with the proper output. The model is then updated appropriately. supervised learning techniques like as classification, regression, prediction, and gradient boosting employ patterns to forecast values.

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This kind of learning is often used to situations where past data predicts future outcomes. Regression and classification are the tasks that supervised learning handles. Naïve Bayes, Regression trees, Decision trees, and closest neighbor algorithms are a few instances of supervised machine learning. Figure 4 provides a visual representation of many supervised learning techniques.

Unsupervised learning: A mathematical model is to be constructed from a collection of data that solely consists of inputs in unsupervised learning. This kind of learning does not provide desired output labels. Unsupervised learning is applied to data that lacks prior label information. Examples of these algorithms include K-means and association rules. Figure 5 outlines some unsupervised learning techniques..

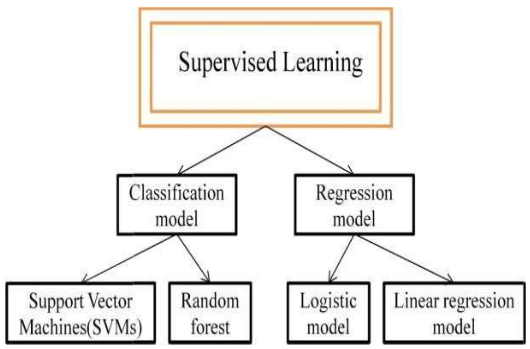

Fig. 4. Supervised Learning

Semi-supervised learning: Building a mathematical model from a collection of data that consists only of inputs is the goal of unsupervised learning. In this kind of learning, desired output labels are absent. When dealing with data that lacks prior labels, unsupervised learning is used. These algorithms include K-means and association rules. Various techniques for unsupervised learning are shown in Figure 5.

Reinforcement learning: This field of study focuses on how software agents behave in a given setting to maximize the total reward. Feedback for this kind of learning is to be provided in a dynamic setting as either positive or negative reinforcement. These are often used in driverless cars or while learning how to play video games against real opponents [3]. One application of reinforcement learning is Q-learning.

Active learning: A restricted set of inputs may access desired outcomes. Budget-based inputs are used in this learning process to optimize the selection of inputs for the intended outcome.

Meta learning: In this case, algorithms use past experiences to teach themselves inductive bias. Examples of meta-learning include Random Forest, Boosting, and Bagging.

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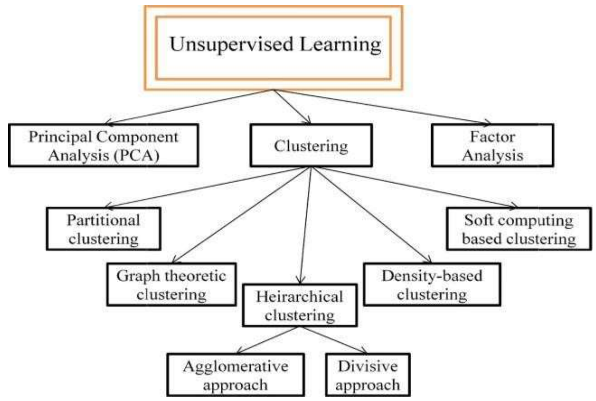

Fig. 5. Unsupervised Learning

3.2 Deep Learning

A collection of machine learning methods known as "deep learning" employ numerous layers, each of which corresponds to a different degree of abstraction[17]. There are other hidden layers in addition to the input and output layers. Voice synthesis, image processing, object identification, handwriting recognition, predictive analytics, and decision-making are among the applications for it. [10] Three major categories may be used to categorize deep learning (figure 6).

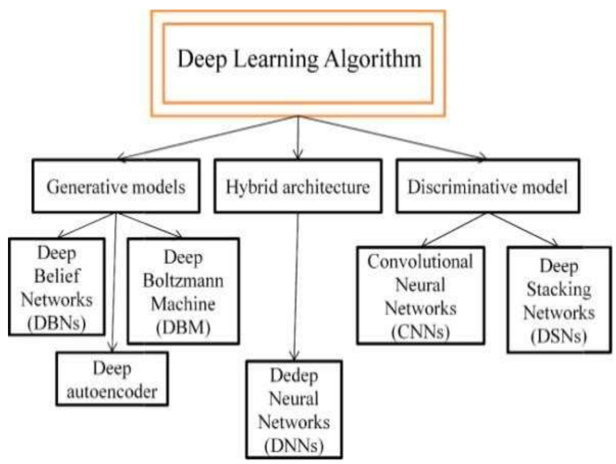

Fig. 6. Deep learning

Generative models: To enable unsupervised learning, generative models are used. It contains techniques such as "Deep Boltzmann (DBM), Deep auto-encoders, and Deep Belief Network (DBN)".

Discriminative models: Typically, discriminative models provide supervised learning strategies. It involves "Convolution Neural Network (CNN), Deep Stacking Network (DSN)".

Hybrid models: The advantages of both generative and discriminative models are combined in hybrid models. One kind of hybrid model is the deep neural network (DNN).

An artificial neural network is created when these artificial neurons are allocated successively,

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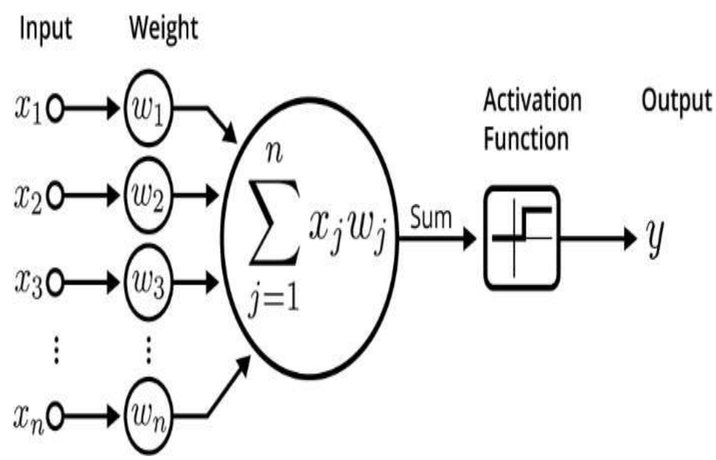
creating a chain where the output of one neuron becomes the input of the next neuron, and so on. Deep Learning Neural Networks include several hidden layers, as Figure 8 below illustrates.

3.3 Deep Learning Comparison withConventional Machine Learning Techniques

Deep learning is a new chapter in machine learning. Deep learning encompasses both supervised and unsupervised machine learning methods. The system's intelligence is enhanced by deep learning and machine learning, which allow it to predict future occurrences based on previous data.[12]

- Raw data cannot be used by conventional machine learning algorithms to learn directly. To properly extract features from raw data and highly categorized domain knowledge, they need rigorous engineering. These features are then employed in internal representations to find patterns in the data. The first stage of the machine learning process is absent in deep learning. Deep learning automates this phase. From unprocessed data, Deep Learning can automatically extract new characteristics. This point is elucidated in Figure 9 [13].
- When working with larger datasets, deep learning algorithms perform more precisely.
- Using traditional algorithms for machine learning. However, for small to medium-sized datasets, machine learning algorithms outperform deep learning methods. [14]
- Inferring a problem with deep learning algorithms is faster than using traditional machine learning methods.



- While most traditional machine learning algorithms may operate on low-end computers, deep learning requires a strong engine, either a GPU (Graphical Processing Unit) or a specifically built TPU (Tensor Processing Unit). Deep learning does a large number of matrix multiplication.
- Interpreting deep learning algorithms is challenging, if not impossible. While certain machine learning algorithms, like SVM, are almost hard to understand, others, like decision trees and logistics, are relatively comprehensible. [15]

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- Compared to other machine learning techniques, deep learning requires a longer training period for data in order to construct a model.

4. CONCLUSION

The principles of machine learning were covered in this essay. These days, academics are paying close attention to machine learning because of its unique characteristics. First, the post outlined the components of a strong machine learning system. This was followed by an explanation of the applications and uses of machine learning in this article. However, the road to machine learning is more complicated than it first seems. There are several obstacles in this subject that must be overcome in order to get the desired results, such as incomplete data, data bias, resource shortages, privacy concerns, and evaluation challenges. This work divides machine learning into two categories: shallow learning and deep learning, which provides a researcher with a comprehensive perspective. Since supervised and unsupervised machine learning methods employ fewer hidden layers or SVMs, they are said to fall under the shallow learning umbrella. Although deep learning is regarded as a distinct field because to its deeply nested architecture, which is covered in the article.

Predictive analytics has a burgeoning subject called deep learning. This work offers a comparative analysis of deep learning and standard machine learning techniques, assisting novice researchers in selecting the appropriate strategy to use in a given setting. For example, machine learning algorithms should be used instead of deep learning if one is working with a small training dataset. Similarly, machine learning techniques should be used if a dataset is needed to select features, as deep learning automates this process and relieves researchers of this burden. This work provides a foundation for researchers wishing to work in the fields of predictive analytics and artificial intelligence.

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