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Machine Learning Algorithms: A Review

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Abstract

Machine learning is one of the artificial intelligence's most well-liked sub-domains, which is currently the most popular area of study. Its mechanism relies on the system becoming intelligent through prior encounters. Pattern recognition, image classification, model prediction, data mining, search engines, sentiment analysis, time series forecasting, structural health monitoring, and virtual personal assistants like Siri, Alexa, and Google Now are just a few of the many uses for machine learning techniques. This paper's main objective is to present a summary of various machine-learning techniques.
Keywords -format, style, design, enter, and component.

1.Introduction

In both study and business, machine learning is currently the most famous and complex computer vision method. In the fields of health care, banking, security, data management, trend analysis, and prediction, it is currently the most popular creative topic. Making a system clever enough to make decisions on its own, without the aid of outside software, is the foundation of machine learning. (1,2)

The first computer system, ENIAC, was created in 1946. The first self-playing game program created by Arthur Samuel (IBM) in 1952 gives birth to the first machine learning idea. The perceptron model, a simplified approach to the neuron model, was then put forth by Rosenblatt in 1957. The closest neighbor method, also known as pattern detection, was developed in 1967. Due to the fusion of computer science and statistical methods in the 1990s, the machine learning discipline attracted interest from a variety of subjects (3). The world of today is one of artificial intelligence, making machine learning and its related fields the most promising areas for study at the moment. In addition to artificial intelligence, a computer can think. An area of artificial intelligence (AI) called machine learning (ML) enables computers to "self-learn" from training data and get better over time without having to be explicitly programmed. Detecting patterns in data and learning from them allows machine learning algorithms to develop their own predictions. In summary, algorithms, and models for machine learning gain knowledge via experience. In conventional programming, an engineer for computers creates a set of instructions that tell a machine how to change input data into a desired output. The majority of instructions follow an IF-THEN structure: when particular criteria are satisfied, the program performs a particular action. In contrast, machine learning is a process that is automated and gives computers the ability to solve issues with little to no human involvement and make decisions based on prior experiences. You may give machine learning algorithms examples of labeled data (referred to as training data) instead of programming them to carry out specific tasks, which enables them to calculate, analyze data, and recognize patterns automatically.

Although the terms artificial intelligence and machine learning are frequently used synonymously, they are actually two distinct ideas. Machine learning, a subset of AI that enables intelligent systems to autonomously learn new things from data, is the notion that encompasses robots making decisions, acquiring new skills, and solving problems in a comparable fashion to people. AI is the more general term.

AI greatly increases the intelligence of the computer. The study of AI's area of machine learning. According to a number of researchers, intelligence cannot develop in the absence of learning. Machine learning techniques come in supervised, unsupervised, semi-supervised,

reinforcement, evolutionary, and deep learning varieties. The data set is classified using these methods.

1) Supervised learning: On the basis of a training set of examples with appropriate targets, algorithms respond correctly to all possible inputs. Supervised learning is another term for studying models. Regression and classification are two examples of supervised learning.

Classification: It provides a Yes/No prediction, such as "Does this cookie meet our quality standards?" or "Is this tumor cancerous?"

Regression: It provides the "How much" and "how many" answers.

2) Unsupervised learning: No targets or correct replies are given. The unsupervised learning technique attempts to identify patterns of similarity among the input data and then uses these patterns to classify the data. This also goes by the name of the density estimate. Clustering occurs during unsupervised learning. Creating clusters based on similarities is known as clustering.

3) Semi-supervised learning: This supervised learning technique falls under the category of semi-supervised learning. Unlabelled data were also used in this approach for training purposes. (Generally, a minimum amount of labeled data with a huge amount of unlabeled data). Unsupervised learning (learning from unlabelled data) and supervised learning are separated by semi-supervised learning. (Labelled-data).

4) Reinforcement learning: Behaviourist psychology supports this type of learning. The algorithm informs the user when the response is incorrect, but it does not tell them how to fix it. Before it discovers the correct solution, it must investigate and test many options. Another name for it is "learning with a critic."

2.Machine learning model

The fundamental idea behind machine learning is the automated learning of a computer system or machine using the provided data, also known as raw data or datasets. There are typically two main stages in this process: Model training (I) (II) Model testing or decision-making.

The two different dataset types—training data and test data—are for this purpose. Before training the model, training data are utilized to do data preparation and feature extraction. The resultant trained model is used to predict the outcome of unlabelled datasets, (fig 1) also known as test data. (Fig 1) The decision-making process for test data for which we already know the outcome may likewise be used to assess the model's correctness [4].

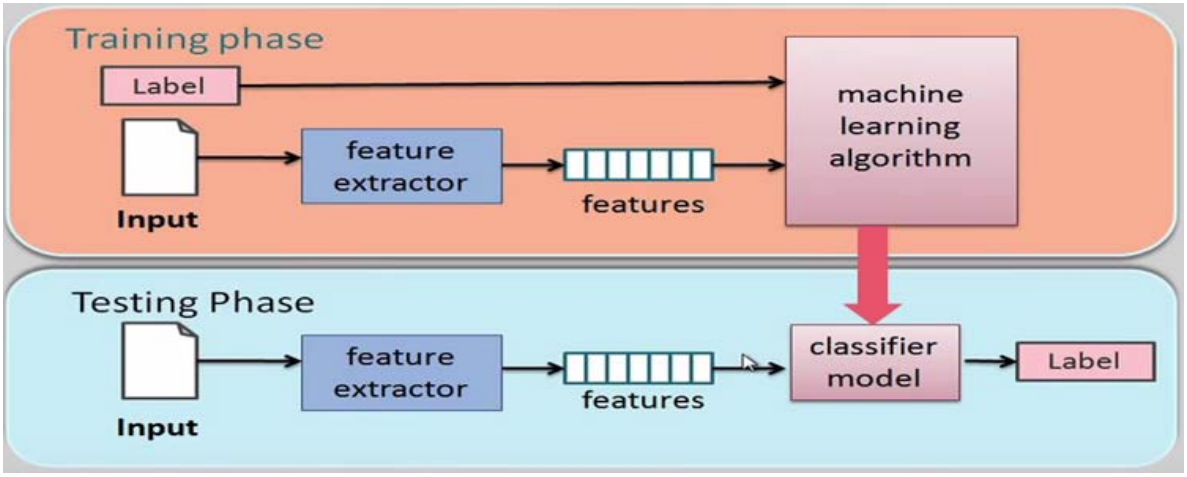

Fig 1 training and testing mode in ml

3.Classification of machine learning algorithm

The three learning techniques used in machine learning are supervised, unsupervised, and reinforcement learning. Below, we go over each of these strategies in more depth [4].

3.1. Supervised learning

As the name implies, this algorithm needs guidance while making predictions or decisions. The input dataset is split into training and test data in this instance. (Fig 2) Target or output values are pre-assigned to training data in supervised learning in order to train the model. (Fig 2) The most common applications of supervised learning are to solve classification and regression issues. Regression methods are utilized for decision-making in continuous-value situations, whereas classification approaches are employed for discrete-value problems [4, 5].

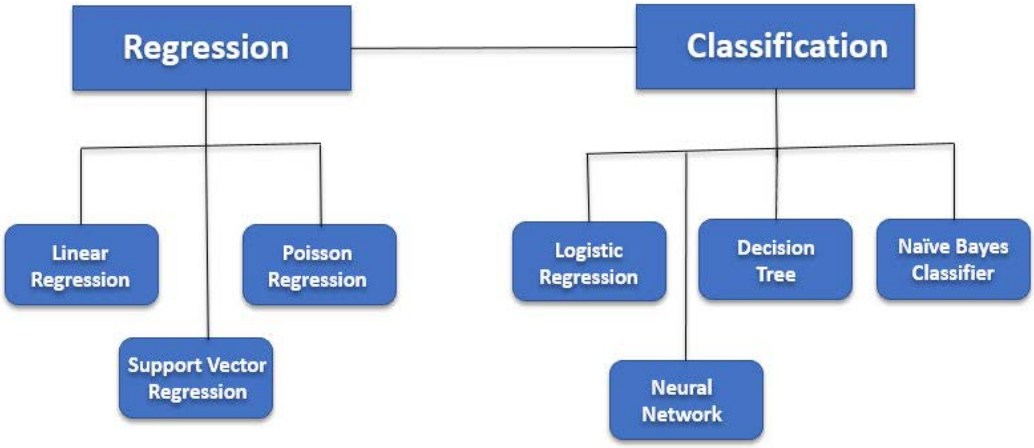

Fig -2: classification of supervised learning algorithms

3.1.1. Support vector machine (SVM)

This approach to categorization issues is very common. It basically operates using the margin calculation approach. This method divides characteristics with high dimensional data into a single hyperplane or a series of hyperplanes to distinguish objects into various classes. (Fig 3) The technique to address multi-class issues was subsequently refined by utilizing a series of hyperplanes, (Fig 3) but initially SVM could only handle two-class problems or binary-classification problems [6, 7, 8].

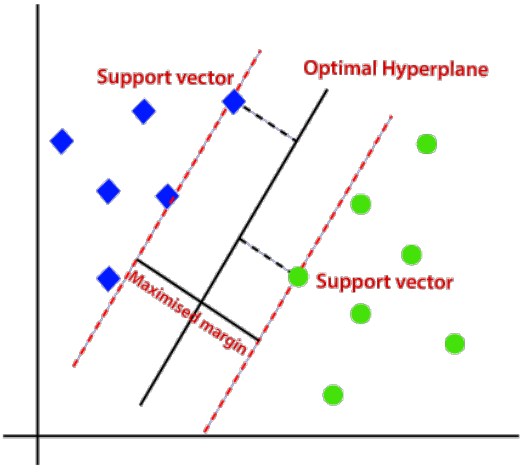

Fig – 3 working of support vector machine

3.1.2. Discriminant analysis

Reducing the dimension of the data is a useful strategy for dealing with the dimensionality problem. The number of dimensions increases together with a positive increase in space volume, which leads to sparsity in the presented dataset and issues with statistical computations. In order to categorize the data into different classes using discriminant analysis, objects are clustered together based on how similar their attributes are. This is a prime illustration of the dimensionality reduction strategy [5]. Popular dimensional reduction-based discriminative methods include [5, 9].

- Linear Discriminant Analysis (LDA)
- Multidimensional Scaling (MDS)
- (FDA) Flexible Discriminant Analysis,
- Mixture Discriminant Analysis (MDA),
- Quadratic Discriminant Analysis (QDA)

3.1.3. Naïve bayes

The conditional probability technique is mostly used in Naive Bayes, another classification-based machine learning strategy, to assess whether an item belongs to a given class or not. A tree network, sometimes referred to as a Bayesian network, is built based on the likelihood of belonging to a given class [10]

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$$

(Likelihood, Prior, Posterior, Normalizing constant)

$$P(B) = \sum_{Y} P(B \mid A)P(A) \quad (1)$$

3.1.4. Nearest neighbor

The K-closest neighbor (KNN) algorithm, often known as the nearest neighbor, is an instance-based technique. This method simply bases the prediction for test data on the item with the closest comparable feature to the other features present in training datasets. When there is a bigger training dataset, (Fig 4) the results are more accurate [4, 5].

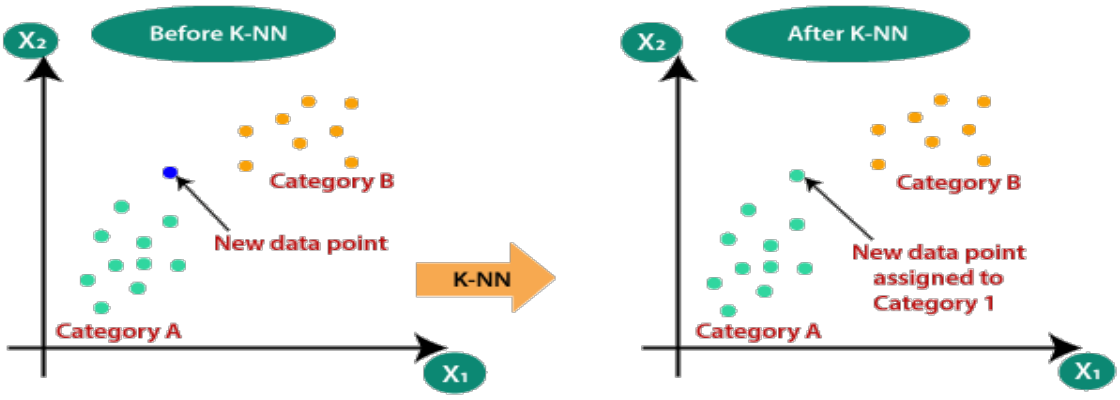

Fig -4 KNN process

3.1.5. Regression algorithm

Regression analysis is focused on fitting a curve using training data to determine the best course of action for situations involving continuous values. It creates a reciprocal link between the parameters based on the mistake that the trained model predicts. (Fig 5) When a forecast needs to be produced and the solution space is huge or infinite, regression methods are utilized. There are several well-known regression methods [2, 5]:

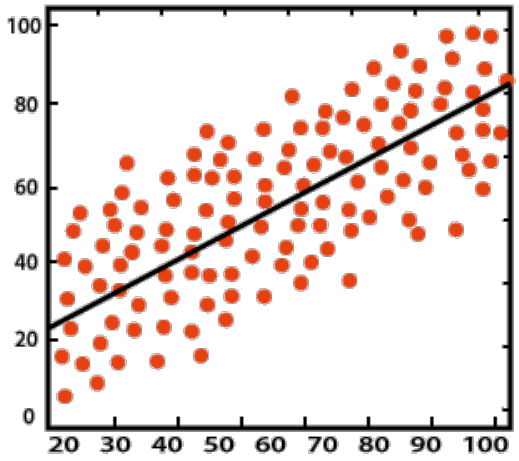

Fig - 5 Regression algorithm process

- Regression using Ordinary Least Squares (OLSR)
- Support Vector Regression; Logistic Regression; Linear Regression
- Splines for Multivariate Adaptive Regression (MARS)
- Smoothing of scatterplots using local estimates (LOESS)

3.1.6. Ensembles method

Individual learning strategies persisted in popularity up until the 1990s, but it has since been discovered that using a combination of different learning strategies, also known as an ensemble learning approach, yields significantly better results for all problems than using a single learning algorithm [5]. The two main methods for creating ensembles are:

1. Boosting: This technique relies on lowering bias and variance. A variety of ineffective learning strategies that seldom result in an accurate and efficient outcome are combined to create an effective learning strategy.
2. Bagging, also known as bootstrapping, is a technique used with machine learning methods to provide more precise and reliable results. This may be applied to both classification and regression issues using supervised approaches. Bootstrapping is also utilized to address the overfitting problem and lessen the invariance problem [5, 13].

3.1.7. Decision tree

A model that generates a mapping between observations and conclusions for an item and its goal value is part of decision tree learning. Classification tree models are often used to describe decision tree models with defined goal values. Although the leaf nodes in the decision tree indicate class labels, the interior nodes in the decision tree reflect the feature for a specific item. When the goal values are continuous in nature, regression trees are such. Hence, (Fig 6) decision trees may be employed for both classification and regression issues [4, 14].

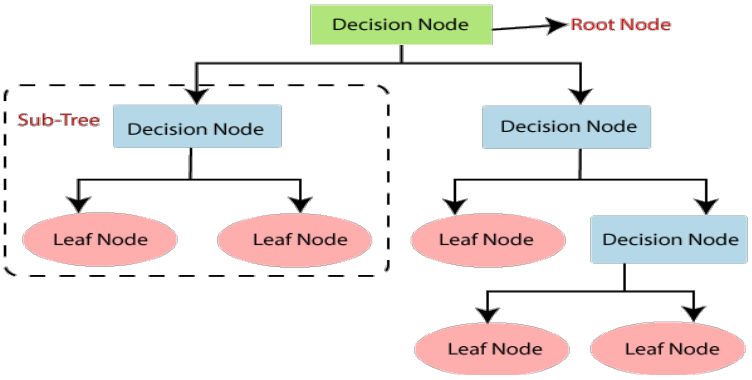

Fig – 6 Decision tree process

3.1.8. Neural network

The biological theory of neurons serves as the basis for the artificial neural network model (Primary unit of a cell in the human brain). It is made up of several interconnected nodes (neurons), much like the human brain, in the forms of an input layer, a hidden layer, and an output layer. In the neural network, the neurons of one layer are completely linked to the neurons of the subsequent layer [4, 5, 15].

Both classification and regression analysis may be done using a neural network model. Based on the projected output and actual target value, the supervised neural model makes use of error correction to update the weights associated with neuron connections and so further enhance performance. (Fig 7)

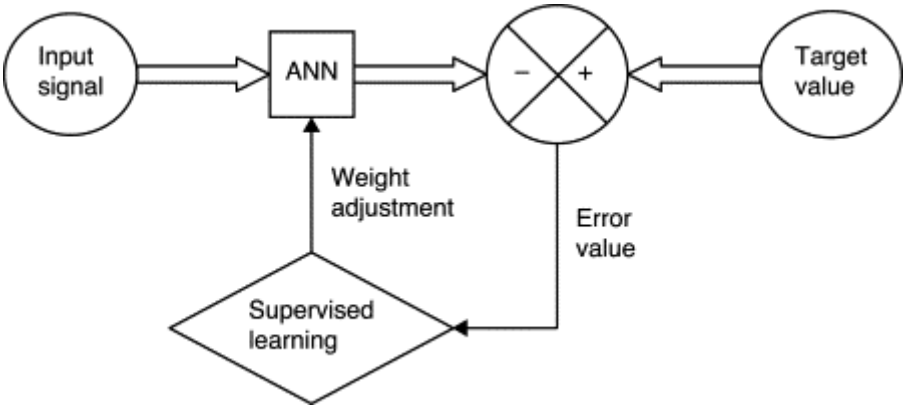

Fig – 7 Neural network process

3.2. Unsupervised learning

Unsupervised learning is a subset of machine learning that uses inferred tasks to identify the hidden layout in a dataset that has not been labeled. Here, the model is trained using the characteristics of unlabelled data before a choice is made based on the available test data. (Fig 8) Unsupervised learning often concentrates on dimensionality reduction and clustering issues [3, 16]. K-means clustering, Principal Component Analysis (PCA), Hierarchical Model, Hidden Markov Model, Neural Network, etc. are the most often used unsupervised techniques [4].

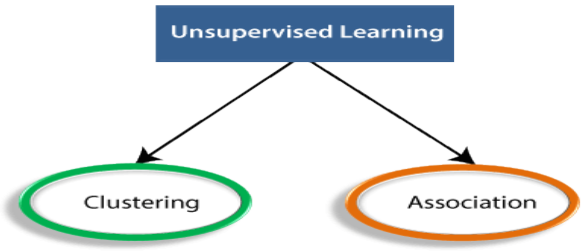

Fig – 8 Unsupervised learning process

3.2.1. K-means clustering

The clustering method groups things into different clusters according to comparable qualities. This divides the given data into several groups or clusters so that each group contains the data with the fewest distinguishing characteristics within a set distance. Using K-clusters and a centroid-based method, the K-means model places the mean value at the center of each cluster [4, 17] (Fig 9)

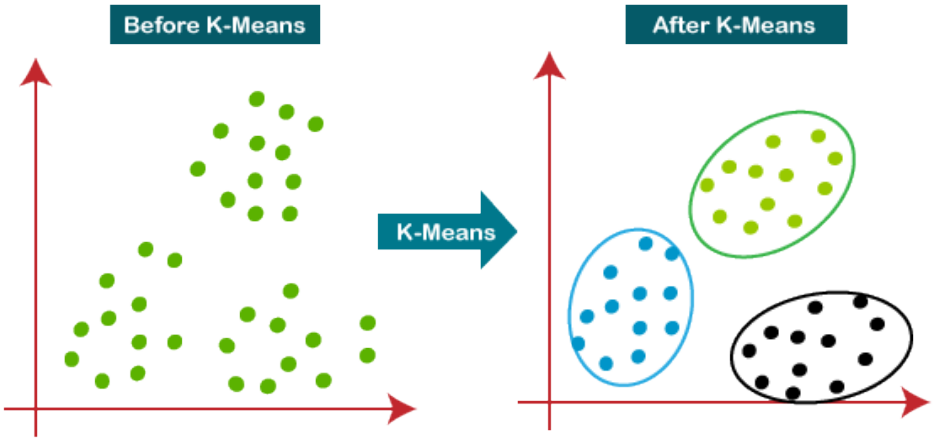

Fig – 9 K-means clustering

3.2.2. Principal component analysis

In comparison to other approaches, PCA is the quickest and most straightforward. PCA is a dimensionality reduction-based method that converts high-dimensional data into low-dimensional data, but its capacity for linear translation from one space to another is constrained. (Fig 10) It ignores less significant qualities in favor of those that are very significant. In order to minimize the dimensions of the data, comparable features are deleted while the features of objects with different information are kept [4, 18].

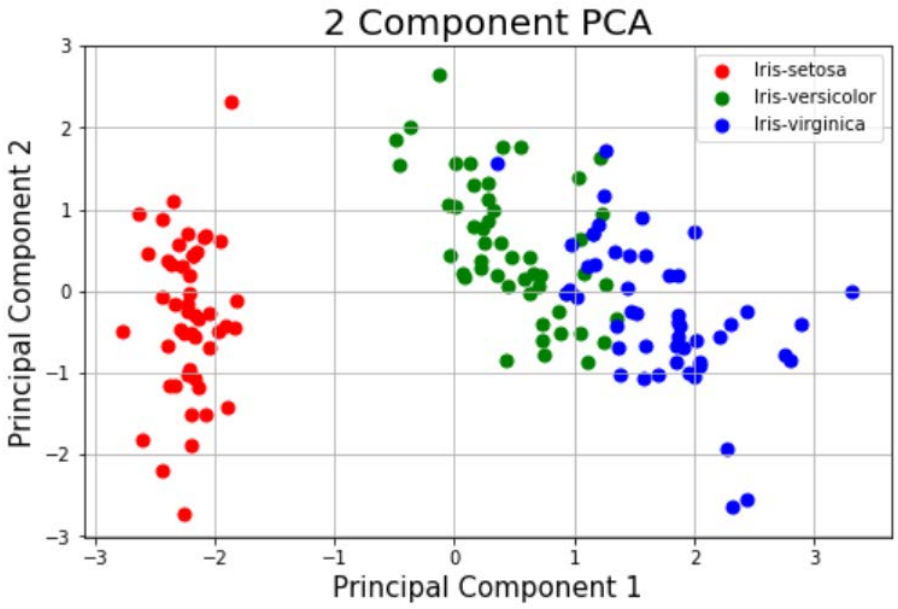

Fig -10 Principal component process

3.2.3. Neural network

The use of neural networks in unsupervised learning methods is also possible. The neural model in this case has no knowledge of the intended result. Based on how closely related the parameters in the data are, this network divides the data into several classes (Fig-11). The input properties of numerous objects are correlated by the unsupervised neuron model, which classifies them into different categories [16].

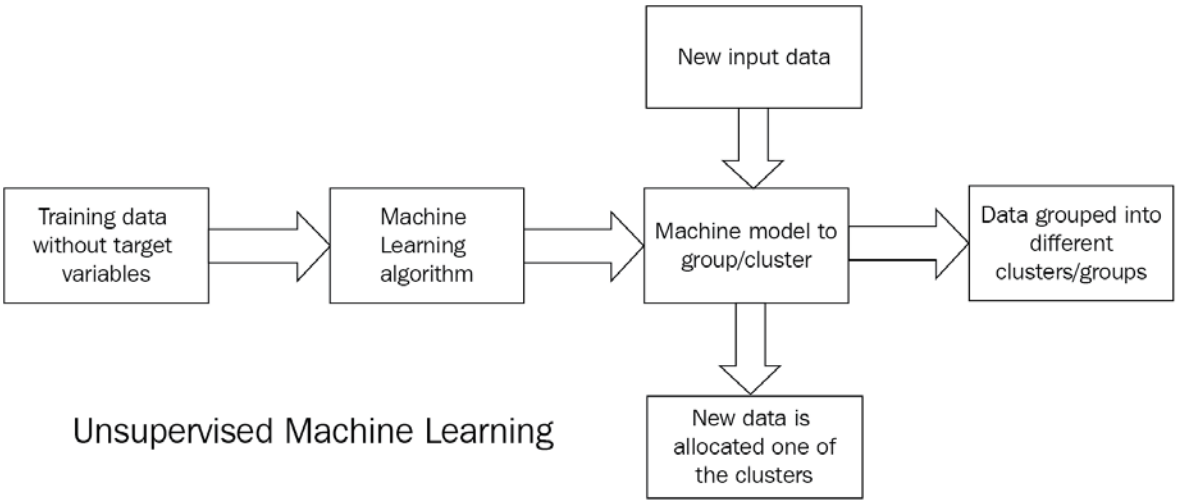

Fig -11 Unsupervised learning neural network

3.3. Reinforcement learning

The usage of this kind of learning is preferred in the fields of robotics and automation, video games, navigation, and several other applications. This dynamic learning strategy establishes a setting for achieving a certain result without clearly stating how close the aim is. The try-and-hit strategy is the foundation of the reinforcement model, which chooses the action that will result in the greatest amount of positive reinforcement (closer to the target). It combines supervised and unsupervised learning methods in some way. (Fig 12) It starts the learning process with a few arbitrary acts and

then offers feedback to positively correct the activity [19]. The basis of the reinforcement neuron model is feedback on whether or not the network's activity was corrective. If the adjustment is positive, the network makes a decision to move on and offer a more accurate result. It should be remembered that the network has no prior information about the target [21].

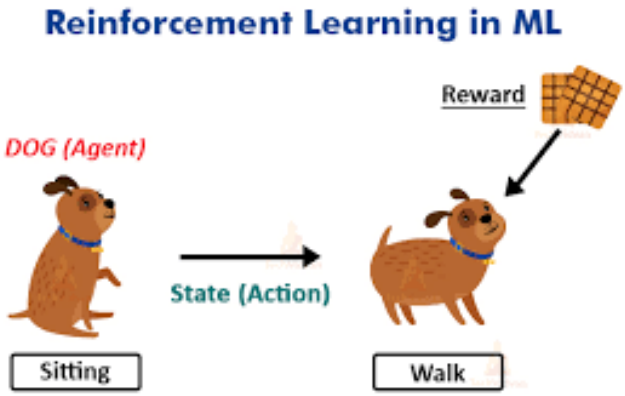

Fig – 12 Reinforcement leaning process

4.Conclusion

In this work, we examined the most well-liked machine learning models. Humans now use machine learning-based intelligent systems for a variety of direct and indirect purposes in daily life. This study offers a comprehensive description of these cutting-edge machine learning models that may be used in a number of different applications and improvements to these methods.

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