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Review of Machine learning: Views, Architectures or Techniques, Challenges and Future guidance and Real-world applications

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Abstract
In this digital world, the data is wealth, this data is analyzed, developed and applied to specific applications using some well-developed algorithms known as Machine learning (ML). Machine learning algorithms are supervised, unsupervised, semi-supervised and reinforcement types. Deep learning (DL) is also a method of analyzing the data on a large scale. Deep learning is a further subdivision of The subsection of ML is deep learning and measures a particular type of learning that involves the use of artificial neural networks (ANN). This paper provides group of different machine learning terminologies for quick reference. This study is important to focus on different machine learning techniques and their connection in various real-world applications such as smart cities, cyber security, healthcare, agriculture and intelligent transportation systems. In this paper, machine learning concepts, different types of architectures, the challenges, various real world applications are discussed.

Keywords: *Deep Learning (DL), Machine Learning (ML), Supervised, Unsupervised, Semi-supervised, Reinforcement, ANN, RvNN, RNN, CNN.*

1. Introduction
Machine learning is a procedure for a computing machine which recklessly upgrading with the occurrence and execute the learning procedure. In recent era, machine learning is a brook in AI that is obtaining demand in computing and information study, so the applications act wisely [2].

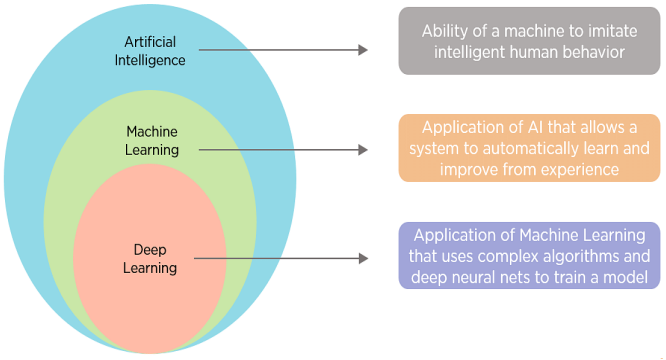

Figure 1 Relation between Artificial Intelligence, Machine Learning, and Deep Learning

This technology is very useful for the improvement of the system, which allows the application to study from the experience not from a particular program. That is why machine learning algorithms are very important for the growth of real time applications for various existent world problems by observing the data wisely [2]. Relationship between AI, Deep Learning and Machine Learning shown in Figure 1.

2. Machine Learning Techniques
Machine learning algorithms are mainly classified into four types (i) Unsupervised Learning (ii) Semi-Supervised Learning (iii) Supervised Learning(iv) Reinforcement Learning [5].

2.1 Unsupervised Learning
This unsupervised algorithm is used when the data is accessible only in the form of input and there are no corresponding output parameters. These algorithms consist of basic patterns to learn its

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characteristics [5]. The main types of unsupervised learning techniques are clustering, feature learning, finding association results etc. [7].In clustering technique, essential categories in the data are found and then used to forecast output for hidden inputs. Figures 2, 2a, 2b shows the machine learning techniques.

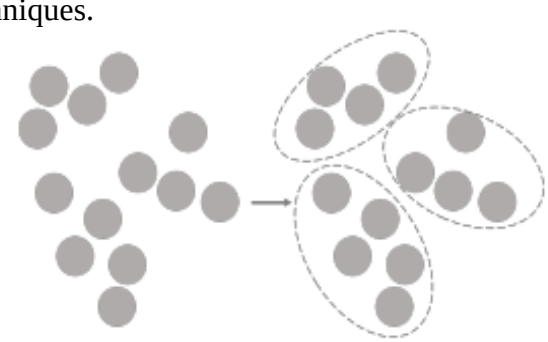

Figure 2 Overview of Unsupervised Learning Input Samples are grouped into Clusters Based on the Basic Patterns [2].

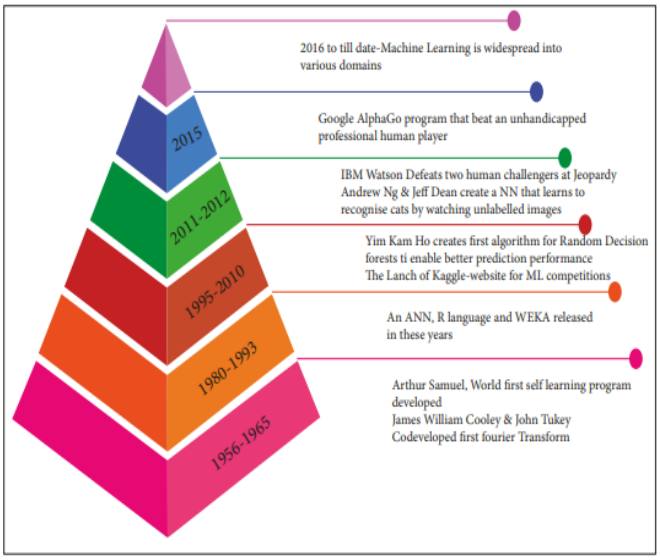

Figure 2a Machine Learning Time Line

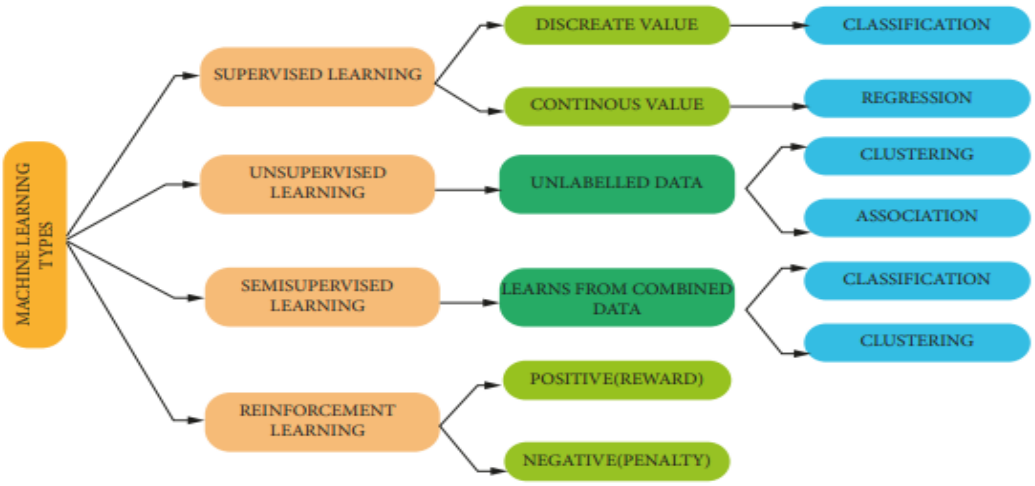

Figure 2b Machine Learning Techniques

2.2 Semi-Supervised Learning

Semi-supervised learning is interposed between supervised and unsupervised learning methods. These techniques instructed utilizing a mixture of tagged and untagged data. Normally in a usual position, there is a small quantity of tagged data and a huge quantity of untagged data. A fundamental method is implicated is that initially alike data is clustered by using an unsupervised learning technique and later living tagged data is used to tag the remaining of the untagged data [23].

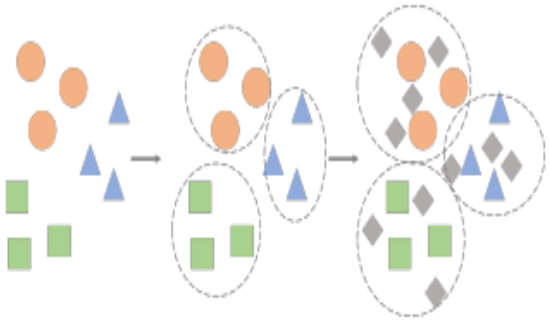

Figure 3 Overview of Semi-Supervised Learning

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Page No: 545-551

The clusters formed by a large amount of untagged data are used to classify a limited amount of tagged data. Figure 3 shows a survey of semi-supervised learning. The clusters are found by a large amount of untagged data are used to allot a finite quantity of tagged data.

2.3 Supervised Learning

If the information is shaped in input parameters and output target parameters, then supervised learning technique is used. This technique grasp the mapping function from the input to the output. The availability of huge scale data samples makes it as costly approach for the works where the data is short. Figure 4 shows supervised learning approaches can be widely classified into two major groups.

2.3.1 Classification

The output parameter is one of some known number of categories. For example, “dog” or”rat”,”positive” or “negative”.

2.3.2 Regression

The output parameter is a real or a continuous value. For example, “Daily temperature of a place”,”price”,”geographical location” [24].

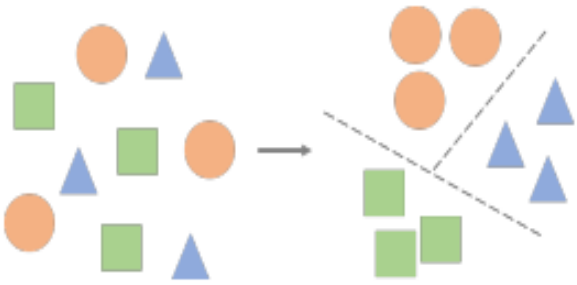

Figure 4 Overview of Supervised Learning Input Examples are Categorized into a Known Set of Classes

2.4 Reinforcement Learning.

The Figure 5 shows Reinforcement learning method is used when the task at hand is to make a sequence of decisions towards a final reward. During the study process, an artificial agent gets either rewards or penalties for the actions, it performs. Its goal is to maximize the total reward. Examples include teach agents to play computer games or performing robotics tasks with end goal [15].

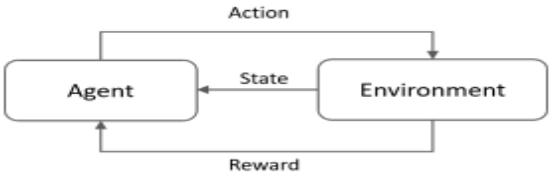

Figure 5 An Overview of Reinforcement Learning an Agent Observes the Environment State and Performs Actions to Maximize an Overall Reward

3. Deep Learning

Deep learning is a process of Machine learning. Among the different ML algorithms, deep learning (DL) is very commonly employed in different applications. DL is also known as representation learning (RL) [6]. The popular types of deep learning networks are recursive neural networks (RvNNs), recurrent neural networks (RNNs) and convolutional neural networks (CNNs).

3.1 Recursive neural networks

RvNN can be used to predict the structure using compositional vectors [6]. The RvNN is designed for processing objects like graphs, trees etc. from various ways. These variable-size recursive-data structures are represented with a fixed width using a BTS learning (back-propagation through structure) [26]. The BTS system is a general-back propagation algorithm and it supports a tree like structure. RvNN calculates a likely pair of scores for merging and construction of a tree. Next, the pair with the largest score is merged within a composition vector. Following every merge, RvNN creates a larger area of many units, a compositional vector of the area, and a label for the class. The root of the RvNN tree structure is the compositional vector for the entire area. An example RvNN tree is shown in Figure 6.

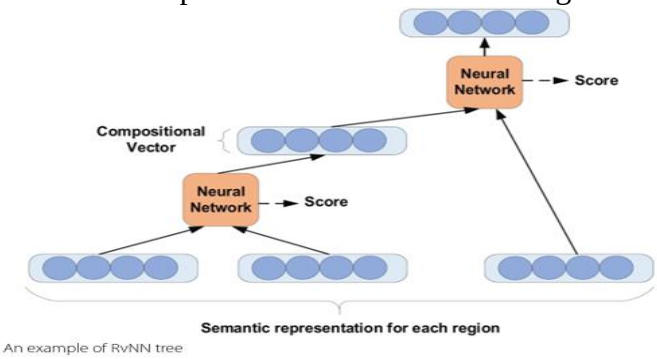

Figure 6 An Example of Rvnn Tree

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Issue: 03 March 2024
Page No: 545-551

3.2 Recurrent neural networks

One of the frequently employed and easy algorithm in deep learning is RNNs [6, 9&10]. The main application of RNN is in the area of speech processing [29, 30]. RNN uses sequential data in the network. So, it is considered as a unit of short-term memory. There are input layer, output layer and hidden layer in RNN. For a given input sequence, a typical unfolded RNN diagram is illustrated in Figure 7. RNN mainly based on three techniques, those are "Hidden-to-Hidden", "Hidden-to-Output", and "Input-to-Hidden" [3].

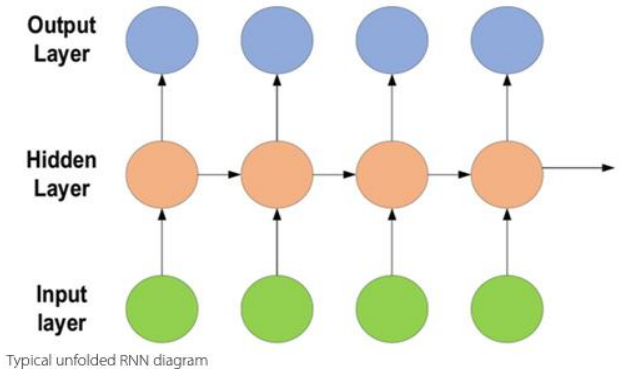

Figure 7 Typical Unfolded RNN Diagram

3.3 Convolutional neural networks

The most well-known and frequently employed algorithm in the area of deep earning is CNN. [6, 32, 33–37]. It is a powerful technique than RNN, which has less feature similarity compared with CNN. The main benefit of CNN is automatic identification of the relevant features without any human supervision [12]. CNNs can be applied in different fields, like Face Recognition [41], speech processing [4], computer vision [39], etc. The three important advantages identified by Good fellow et al. [13] are equivalent representations, sparse interactions, and parameter sharing. CNN are employed to make full use of 2D input-data structures like image signals. This operation uses small number of parameters, which simplifies the training process and speeds up the network. A commonly used type of CNN is multi-layer perceptron (MLP). It consists of many convolution layers foregoing sub-sampling (pooling) layers, while the ending layers are FC layers. An example of CNN architecture for image classification is illustrated in Figure 8.

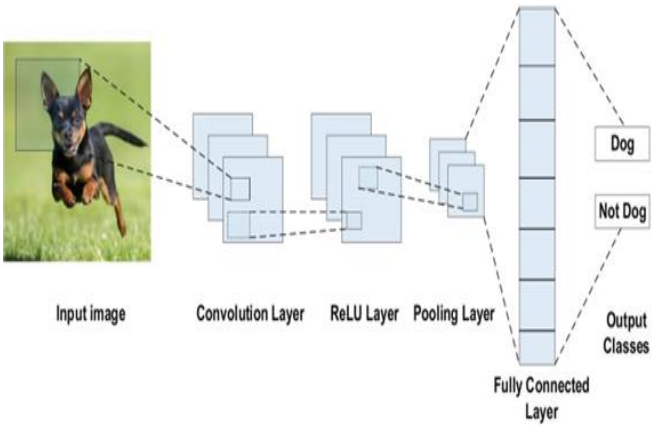

Figure 8 An Example of CNN Architecture for Image Classification

4. Algorithms

4.1 Introduction to Mainstream Supervised Learning Algorithms

4.1.1 Decision Tree

The decision tree mainly contains internal node, branch and leaf node. The internal node performs a test on an attribute, every branch gives the result of the test and every leaf node performs a class label. Decision tree structure used to replace and recognize the decision making criteria of a given issues [1].

4.1.2 Random Forests

An important object learning method for classification and regression based on bagging is Random forest. It is operated by the decision of individual trees, by considering unlabelled samples at the input and the results of classification at the output. The performance bottleneck problem faced by the decision tree is resolved by joining the bagging method to the decision tree.

4.1.3 Naive Bayes

It is an easy and finest method of Bayesian algorithms. The result of every attribute on its target parameter of the given allocation is unconstrained. The naive Bayes algorithm works based on Bayes Theorem:

4.1.4 Support Vector Machines (SVM)

By nonlinear transformation, The SVM algorithm maps the input space to a high dimensional feature space. The experimental risk is minimum if the given data set is linearly separable. Thus, while finding an optimal boundary plane, it separates the

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Page No: 545-551

data into two categories and also increases the classification duration between them. The support vector machine will have good induction ability if there is more classification gap.

4.2 Main Unsupervised Learning Algorithms [16]

4.2.1 The K-means Algorithm

K-Means algorithm is a famous for cluster study, introduced by Macqueen. The design of K-Means algorithm is as follows: Given n data points {x1, x2,..., xn}, K cluster centres {a1, a2,..., ak} is found so that the square sum of distance between each data point and its closest cluster centre is the smallest, and the square sum of the distance is called the objective function Wn whose mathematical expression is[8]:

$$W_n = \sum_{i=1}^{n} min_{1<j<k} |x_i - a_j|^2$$

The processing of its algorithm is:

- If there are K sample points in the sample dataset D, and then values of these sample points are assigned to the initial clustering centre $(mi)^{-}$(i=1,….k).
- The distance between each sample point from pj (i=1, n) and its clustering centre $(mi)^{-}$ calculated:

$$d(i,j)=\sqrt{|pj - \overline{mi}|2}$$

- The minimum distance min (d (i, j)) between pj and $(mi)^{-}$ is is found, and place pj in the cluster that is closest to $(mi)^{-}$.
- The clustering centre of each cluster again is calculate:

$$m_i = \frac{1}{n_i} \sum_{Ji=1}^{n_i^{-}} p^{Ji} \quad (i = 1, \ldots k)$$

- The squared difference E (t) of all points in dataset D is calculated according to step one and compared with the previous error E (t-1).
- E (t-1) is observed if below zero, otherwise the algorithm ends.

Due to the advantages of K-means algorithm like time efficient and easy to describe, this algorithm is well suited for large scale data processing.

4.3 Introduction to Main Semi-supervised Learning Algorithms

4.3.1 The Self-training Algorithm Based on the K-nearest Neighbour

The algorithm which is simple and uses a training set to split the feature space into different regions is called K-nearest neighbour algorithm for supervised learning and in this each sample is busy in certain region. A self-training K-nearest neighbour algorithm contains no training set.

4.3.2 The Semi-supervised Learning Algorithm Based on Divergence

The semi-supervised learning method is based on the divergence, actually begins with the below process. The classifier is used to classify and label the unlabelled test samples. Then these are attached to the training set of the classifier. This process is continuously happened till all the labelling is done. This easy and successful technique has relatively careful theoretical basis, detecting a wide range of applications.

5. Real-world Applications

Machine Learning Applications Machine learning methods are very famous in industry4.0, because it takes intelligent decisions and it has the capability to grasp from the old.

5.1 A Wise Decision Making and Predictive Analytics

In this, the widely used techniques are SVM, decision trees and ANN for inventory management, avoidance of out of stock situations, behaviour and preferences of customer etc. [2,14]. For example, credit card fraud detection and criminal detection after a crime situation.it will be helpful for an organization like healthcare, financial services, transportation, sales and marketing, telecommunication, e-commerce, social networking etc. to predict the result of outcome accurately.

5.2 Cyber-Security and Threat Intelligence

The duty of cyber security are safeguarding the data, systems, hardware and networks [2,15]. One of the important technologies of cyber-security is machine learning, it gives protection by securing information while browsing keeps people safe, are identified and adware is discovered in the traffic.

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Volume: 02
Issue: 03 March 2024
Page No: 545-551

5.3 Sustainable Agriculture

Sustainable Agriculture methods like mobile technologies, IOT and mobile devices are helpful to increase the agriculture results while reducing the negative environmental consequences [2, 58-60]. Different techniques of machine learning are applied in production planning, weed detection, soil nutrient management, weather prediction, inventory management, soil properties, etc. [2, 61].

5.4 Natural Language Processing

DNN methods are helpful than traditional natural processing techniques. Because these techniques separately process problems, such as language models and semantically related words, and there is no overall processing. In the year 2008, Colbert began to apply DNN method for the natural language processing and generating an error rate of 14.3% [11].

Conclusion

In this, article on machine learning comprehensive review is directed for a wise data analysis and real time applications. Various machine learning algorithms are discussed for intelligent data analysis. Next, Machine learning techniques, algorithms and deep learning are discussed. To generate intelligent decision-making, machine learning algorithms need to be familiarize with target application knowledge and trained with data collected from various real-world situations. At last, Challenges and future directions are discussed and summarised. This study works as a benchmark for the decision makers on a variety of application domains and various real-world situations. Preferably, it is spreading across a wide range of industries, including banking and finance, information technology, media and entertainment, gaming, and the automobile sector.

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