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Machine Learning – A Survey

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ABSTRACT

Machine Learning is getting computers to program themselves. If programming is automation, then machine learning is automating the process of automation. Machine learning is the new big fastest growing field in the area of automation. Machine learning is the way to make programming scalable. It can significantly change the way we see Artificial Intelligence. Machine learning is widely used in computer science, artificial intelligence and other fields. To develop successful machine learning applications understanding of system and algorithms is required. Researchers have introduced Machine Learning as widely used concept in Artificial Intelligence. Machine Learning is an application of Artificial Intelligence. It allows software applications to become accurate in predicting outcomes. Machine Learning focuses on the development of computer programs, and the primary aim is to allow computers to learn automatically without human intervention. Scientists say "Machine Learning is the future," and the future of Machine Learning is going to be very bright. As humans become more addicted to machines, we're witnesses to a new revolution that's taking over the world, and that is going to be the future of Machine Learning. This paper gives survey on machine learning concept, different machine learning algorithms and machine learning applications.

Keywords: *Machine learning, Supervised and Unsupervised learning, neural network etc.*

1. INTRODUCTION

Machine learning attempts to tell how to automatically find a good predictor based on past experiences. Machine learning is used to teach machines how to handle the data more efficiently. Sometimes after viewing the data, we cannot interpret the pattern or extract information from the data. In that case, we apply machine learning[10].Machine algorithms adaptively improve their performance as the number of samples available for learning increases. Deep learning is a specialized form of machine learning. Deep learning has changed the entire landscape over the past few years. Deep learning techniques are used in healthcare, finance, human resources, retail, earthquake detection, and self-driving cars. The survey is organized as follows. In Section II, overview of some preliminary ML concepts is given. In Section III we discuss the different ML algorithms which are widely used. . In Section IV , we discuss ML applications in different areas.

II. MACHINE LEARNING

Machine learning is an interdisciplinary research area which combines ideas from several branches of science

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namely, artificial intelligence, statistics, information theory, mathematics, etc. The prime focus of machine learning research is on the development of fast and efficient learning algorithms which can make predictions on data. When dealing with data analytics, machine learning is an approach used to create models for prediction. Machine learning uses two types of techniques: supervised learning, which trains a model on known input and output data so that it can predict future outputs, and unsupervised learning, which finds hidden patterns or intrinsic structures in input data[2].

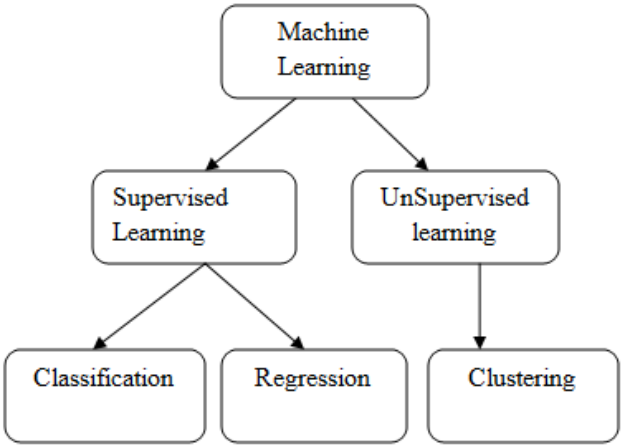

Fig.1: Machine learning techniques

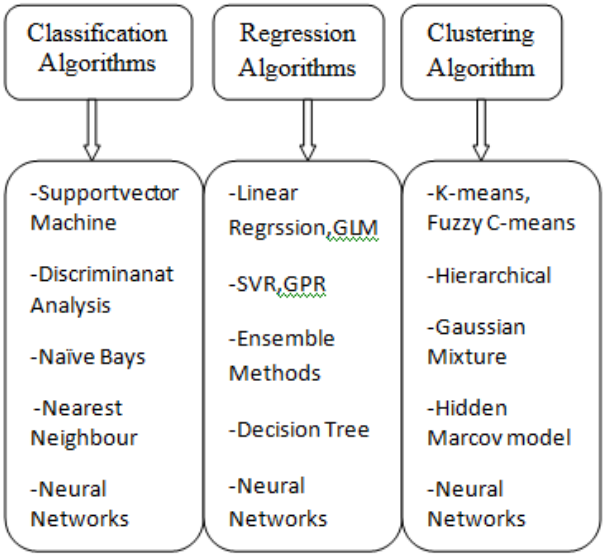

Fig2. : Machine learning algorithms

Use supervised learning if you have known data for the output you are trying to predict. Supervised learning uses classification and regression techniques to develop predictive models. Classification techniques predict discrete responses—for example, whether an email is genuine or spam, or whether a tumor is cancerous or benign. Classification models classify input data into categories. Typical applications include medical imaging, speech recognition, and credit scoring.Common algorithms for performing classification include support vector machine (SVM), boosted and bagged decision trees, *k*-nearest neighbor, Naïve Bayes, discriminant analysis, logistic regression, and neural networks. Regression techniques predict continuous responses—for example, changes in temperature or fluctuations in power demand. Typical applications include electricity load forecasting and algorithmic trading. Use regression techniques if you are working with a data range or if the nature of your response is a real number, such as temperature or the time until failure for a piece of equipment. Common regression algorithms include linear model, nonlinearmodel, boosted and bagged decision trees, neural networks, and adaptive neuro-fuzzy learning. From a data processing point of view, both supervised and unsupervised learning techniques are preferred for data analysis and reinforcement techniques are preferred for decision making problems [2]. Unsupervised learning finds hidden patterns or intrinsic structures in data. It is used to draw inferences from datasets

consisting of input data without labeled responses. Clustering is the most common unsupervised learning technique. It is used for exploratory data analysis to find hidden patterns or groupings in data. Applications for cluster analysis include gene sequence analysis, market research, and object recognition. Common algorithms for performing clustering include k-means and k-medoids, hierarchical clustering, Gaussian mixture models, hidden Markov models, self-organizing maps, fuzzy c-means clustering, and subtractive clustering. Here are some guidelines on choosing between supervised and unsupervised machine learning: Choose supervised learning if you need to train a model to make a prediction--for example, the future value of a continuous variable, such as temperature or a stock price, or a classification—for example, identify makes of cars from webcam video footage. Choose unsupervised learning if you need to explore your data and want to train a model to find a good internal representation, such as splitting data up into clusters.

III. MACHINE LEARNING ALGORITHMS

Here are few really Popular supervised and unsupervised machine learning algorithms, such as:

1. Decision Trees
2. Naive Bayes Classification
3. Support vector machines for classification problems
4. Ensemble Methods
5. Neural network
6. Linear regression
7. K-means clustering
8. Dimensionality reduction algorithm-PCA

1) Decision Tree: Decision trees are those type of trees which groups attributes by sorting them based on their values. Decision tree is used mainly for classification purpose. Each tree consists of nodes and branches. Each nodes represents attributes in a group that is to be classified and each branch represents a value that the node can take [10]. An example of decision tree is given in Fig. 3.

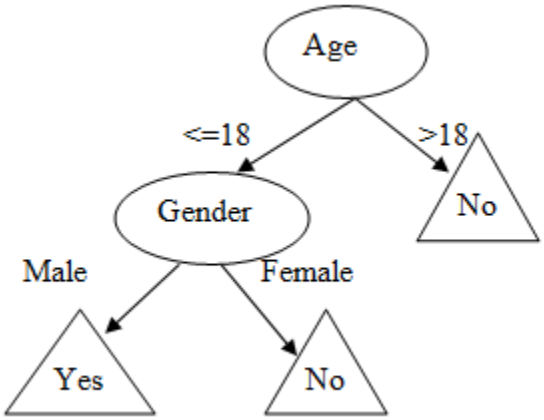

Fig.3: Decision tree[10]

2) Naïve Bayes: Naïve Bayes mainly targets the text classification industry. It is mainly used for clustering and classification purpose [4]. The underlying architecture of Naïve Bayes depends on the conditional probability. It creates trees based on their probability of happening. These trees are also known as Bayesian Network. An example of the network is given in Fig. 4.

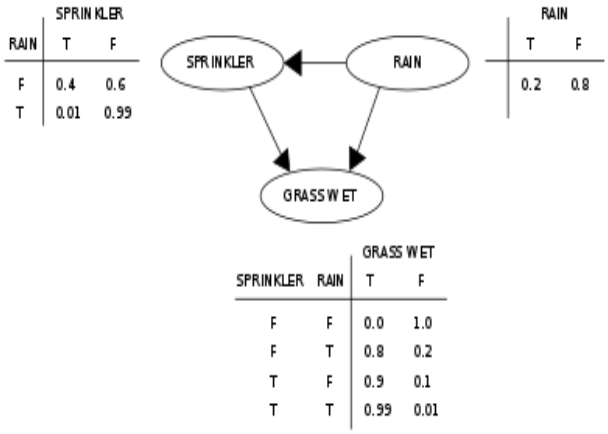

Fig.4 : An Example of Bayesian Network [5]

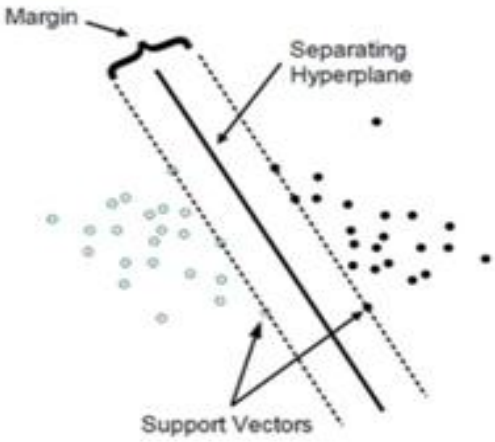

Fig.5: Working of Support Vector Machine [6]

3) Support Vector Machine: Another most widely used state-of-the-art machine learning technique is Support Vector Machine (SVM). It is mainly used for classification. SVM works on the principle of margin calculation. It basically, draw margins between the classes. The margins are drawn in such a fashion that the distance between the margin and the classes is maximum and hence, minimizing the classification error [10] . SVM performs classification by constructing an *N* dimensional hyper plane that optimally separates the data into two categories. SVM models are closely related to neural networks. In fact, a SVM model using a sigmoid kernel function is equivalent to a two layer,

perceptron neural network.Support Vector Machine (SVM) models are a close cousin to classical multilayer percepron neural networks[11]

4) Ensemble Methods:When various individual learners are combined to form only one learner then that particular type of learning is called ensemble learning. The individual learner may be Naïve Bayes, decision tree, neural network, etc. [10] .Ensemble methods are the meta-algorithms that combine several machine learning algorithms and techniques into one predictive model in order to decrease the variance (bagging), bias (boosting) or improve the predictions (stacking)[13]. Two popular Ensemble learning techniques are given below:

1) Boosting: Boosting is a technique in ensemble learning which is used to decrease bias and variance.Boosting creates a collection of weak learners and convert them to one strong learner. A weak learner is a classifier which is barely correlated with true classification. On the other hand, a strong learner is a type of classifier which is strongly correlated with true classification AdaBoost is most popular example of boosting [10] [14].

2) Bagging: Bagging or bootstrap aggregating is applied where the accuracy and stability of a machine learning algorithm needs to be increased. It is applicable in classification and regression. Bagging also decreases variance and helps in handling overfitting[10][15]. One way which is known to reduce the variance of an estimate is by the Average, to average together the multiple estimates. For example, we can train M the different trees on different subsets of the data (which is chosen randomly with replacement) and compute the ensemble as follows[13]:

$$f(x) = 1/M \sum_{m=1}^{M} f_m(x)$$

----------[13]

5) Neural Network: The neural network (or artificial neural network or ANN) is derived from the biological concept of neurons. A neuron is a cell like structure in a brain. To understand neural network, one must understand how a neuron works. An artificial neural network behaves the same way. It works on three layers. The input layer takes input . The hidden layer processes the input . Finally, the output layer sends the calculated output [16]. There are basically three types of artificial neural network: supervised, unsupervised and reinforcement [17].

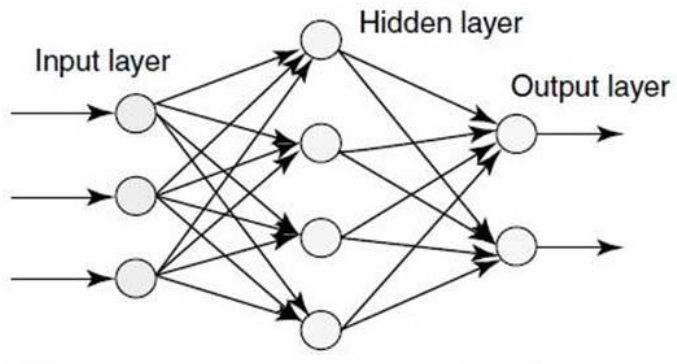

Fig.6:Structure of an Artificial Neural Network [16]

Neural networks can actually perform a number of regression and/or classification tasks at once, although commonly each network performs only one. In the vast majority of cases, therefore, the network will have a single output variable, although in the case of many-state classification problems, this may correspond to a number of output units. The best solution is usually to train separate networks for each output, then to combine them into an ensemble so that they can be run as a unit[11] .

6) Linear regression:It is used to estimate real values (cost of houses, number of calls, total sales etc.) based on continuous variable(s). Here, we establish relationship between independent and dependent variables by fitting a best line. This best fit line is known as regression line and represented by a linear equation Y= a *X + b.The best way to understand linear regression is to relive this experience of childhood. Let us say, you ask a child in fifth grade to arrange people in his class by increasing order of weight, without asking them their weights! What do you think the child will do? He / she would likely look (visually analyze) at the height and build of people and arrange them using a combination of these visible parameters. This is linear regression in real life! The child has actually figured out that height and build would be correlated to the weight by a relationship, which looks like the equation above. In this equation[12]: Y – Dependent Variable, a – Slope, X – Independent variable, b – Intercept. These coefficients a and b are derived based on minimizing the sum of squared difference of distance between data points and regression line. Linear Regression is of mainly two types: Simple Linear Regression and Multiple Linear Regression. Simple Linear Regression is characterized by one independent variable. And, Multiple Linear Regression(as the name suggests) is characterized by multiple (more than 1) independent variables. While finding best fit line, you can fit a polynomial or curvilinear regression. And these are known as polynomial or curvilinear regression.

7) K-Means Clustering: Clustering or grouping is a type of unsupervised learning technique that when initiates, creates groups automatically. The items which possesses similar characteristics are put in the same cluster. This algorithm is called k-means because it creates k distinct clusters. The mean of the values in a particular cluster is the center of that cluster [7]. A clustered data is represented in Fig. 7.

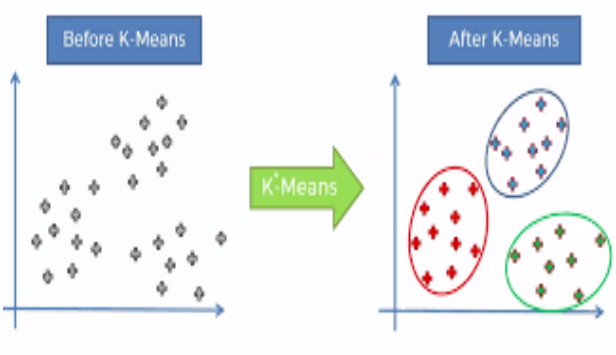

Fig. 7: k-means clustering [12]

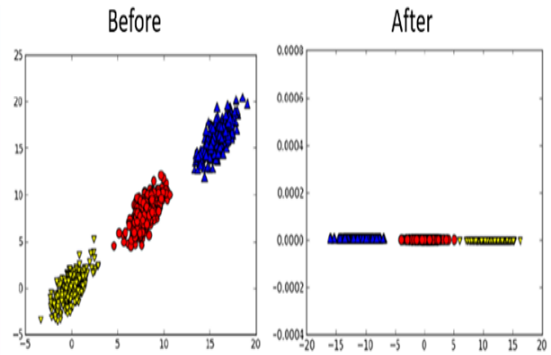

Fig.8: Visualization of data before and after applying PCA [8]

8. Dimensionality Reduction Algorithms: Dimensionality reduction is typically employed to reduce a larger data set to its most discriminative components to contain relevant information and describe it with fewer features. This gives a proper visualization for data with numerous features or of high dimensionality and helps in implementing supervised classification more efficiently. Examples: Principal Component Analysis (PCA), Principal Component Regression (PCR), Partial Least Squares Regression (PLSR), Sammon Mapping, Multidimensional Scaling (MDS)etc.[1]. In Principal Component Analysis or PCA, the dimension of the data is reduced to make the computations faster and easier. To understand how PCA works, let's take an example of 2D data. When the data is being plot in a graph, it will take up two axes. PCA is applied on the data, the data then will be 1D as shown in fig.8[10].

IV. MACHINE LEARNING APPLICATION

A. SPEECH RECOGNITION

All current speech recognition systems available in the market use machine learning approaches to train the system for better accuracy. In practise, most of such systems implement learning in two distinct phases: pre-shipping speaker independenttraining and post-shipping speaker-dependent training[1].

B. COMPUTER VISION.

Majority of recent vision systems, e.g., facial recognition softwares, systems capable of automatic classification microscopic images of cells, employ machine learning approaches for better accuracy[1]

C.CYBER SECURITY

Security of valuable information is always a very essential issue for modern digital world. Intrusion Detection System (IDS) and many security techniques is widely used against cyber attacks. Data mining and machine learning methods have also been used by researchers to obtain high detection rate and low false alarm rate [3].

D. ROBOT OR AUTOMATION CONTROL

ML methods are largely used in Artificial intelligence field for robot and automated systems. For example, consider the use of ML to obtain control tactics for stable flight and aerobatics of helicopter. The self driving cars uses ML to train from collected terrain data.

E. EMPIRICAL SCIENCE EXPERIMENTS

A large group data-intensive science disciplines use ML methods in several of it researches[1]. For example, ML is being implemented in genetics, to identify unusual celestial objects in astronomy, and in Neuroscience and psychological analysis. The other small scale yet important application of ML involves spam filtering, fraud detection, topic identification and predictive analytics (e.g., weather forecast, stock market prediction, market survey etc.).

V. CONCLUSION

This paper surveys basic machine learning concept, it's types, machine learning supervised and unsupervised algorithms, when to use which algorithms?, machine learning application etc. ML can be used in the field of Artificial intelligence, cyber security, Networks, Cloud computing, Data mining, Image processing, IOT, Automation etc. Deep learning is a subset of ML; in fact, it's simply a technique for realizing machine learning. In other words, DL is the next evolution of machine learning. DL algorithms are roughly inspired by the information processing patterns found in the human brain. Deep learning methods gives the significance performance improvements in many application domains.

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