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Artificial Intelligence and its Subsets: Machine Learning and its Algorithms, Deep Learning, and their Future Trends

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***Abstract*:** Artificial intelligence (AI) is a broad branch of computer science. The goal of AI is to function a system intelligently and independently. AI enables the machine to think and take its own decision. Artificial Intelligence in a whole consists of Machine Learning as it's subset and Deep Learning further as a subset of Machine Learning. Artificial intelligence is the capability of a program to analyse the current scenario and adapt to it and take decisions or perform a set of actions accordingly. Machine Learning being a subset of Artificial Intelligence, include a good number of pre-developed algorithms which can be used on datasets to gain informative insights of data, etc. These algorithms have been optimized over time to work on a huge variety of different datasets, etc.

***Keywords*:** Artificial Intelligence, Predictive Analysis, Convolution neural network, Recurrent neural network.

I. Introduction

In many areas of AI is an imitation of the natural intelligence. A comparison of natural intelligence and artificial intelligence is presented in the table (1).

Table 1. Comparison of Natural Intelligence and Artificial Intelligence

Natural Intelligence	Artificial Intelligence
Huaman can speak and communicate	Is the field of speech recognition. Much of the speech recognition is statistically based. Hence it is called statistical learning
Human can write and read natural language	This is natural language processing
Human can see with their eyes and process what they see.	This is the field of computer vision. It falls under the category of computerized process recognition.
Human recognizes the seen around them through their eyes.	This field is image processing. Even though it is not directly related to AI but still required for computer vision.
Human can understand their environment and move around frequently.	This is the field of robotics.
Human can see the patterns	This process of grouping the like objects is the field of pattern recognition. Machine can do better in pattern recognition because it can use machine learning.
Human brain is the network of neurons used for learning things.	If we replicate the structure and functions of the human brain, we might be able to get cognitive capabilities in machines. This is the field of neural network. This network is more complex and deeper, used to learn more complex things. This filed is known as deep learning. It adopts different techniques to replicate what the human brain dose.
If we get the brain to scan image from left to right, top-to bottom.	It is convolution neural network (CNN). The CNN is used to recognize the objects seen. This is how the computer vision fix in an object recognition accomplished by AI.

Machine Learning can be considered as a very important aspect of Artificial Intelligence. Machine Learning forms a very large group as a subset of AI. The basic concept of Machine Learning is to make a machine understand the data, that is the environment around it, analyse the situation and take decisions accordingly. The main objective of Machine Learning is to train the Machine on pre-described dataset and then make it interpret the scenario and take the necessary actions which are in-accordance with the surroundings as well as are beneficial to them.

As these Machine Learning Algorithms are applied to real world problems, i.e, to dynamic changes in the datasets or n number of different datasets, the efficiency of the decision take or the accuracy of predictive analysis increase exponentially in the beginning and gradually keeps on improving with time as more data is fed. The performance also increases with time as in when more amount of data is fed and more experience the model gains. With each new experience, the Machine Learning Algorithm can refer to a previous decision or an action when a similar scenario occurs. This decreases the time take for predictive analysis drastically. The Machine Learning Algorithm are basically segregated into supervised based, unsupervised based, semi-supervised based and reinforcement-based learning. If we train an ML algorithm with data it is known as supervised learning, if it is trained with data and pattern then it is unsupervised learning. These are further divided into classification, regression, decision tree, neural networks, etc. The application of any of these machine learning algorithms on any dataset depends upon the nature of the dataset and varies for every single dataset and instance. It is also influenced by the target outcome. When the nature of the target variable changes, it directly changes the need for a different algorithm.

Deep learning makes up a substantial size of Machine Learning. Deep learning can be considered as the most independent performing algorithms from Artificial Intelligence as whole. Deep Learning Algorithms automatically extract the features from the data that has been provided as an input to them. They use these extracted features to learn and adapt to the scenario in which they have to act and are repetitively trained across the same data and extract more and more relevant and important features from the given data and use this to learn and act accordingly to perform the required action.

II. Review Work

Artificial Intelligence as whole has progressed over the last few years in terms of efficiency and performance. Its application is not limited for few industries [5]. In [15] the authors used machine learning to analyse COVID-19 data set for the prediction of the mutation of the disease. Machine Learning being a subset of AI has also grown exponentially in the above-mentioned terms. The basic objective of machine learning algorithms is for the machine to learn from the dataset provided or to learn from its environment and to take decisions based on the experience it has achieved. Most of the machine learning algorithms when trained over a very vast dataset in terms of uniqueness and its size, achieve a very high accuracy. Even though the accuracy achieved is very high, no machine learning algorithms accuracy can be 100%.

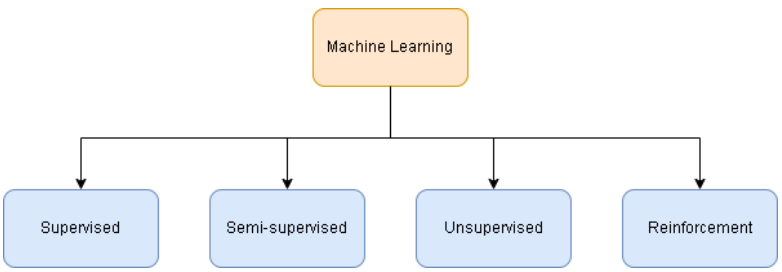

Fig. 1. Machine Learning Segregation

Machine Learning algorithms as specified above can be divided into supervised, semi-supervised, unsupervised, and reinforcement-based algorithms as in figure (1). Supervised learning algorithms are taken into consideration when there is previously labelled data available. Labelled data in this case means the data is pre-classified into categories or every data point within the dataset is mapped or tagged to the exact category they belong to. It includes providing the machine with both the input and

output data. A supervision agent supervises and helps the machine predict the output on test data. Supervised learning can be further divided into classification and regression-based machine learning algorithms. Classification based algorithm are intended to be used when the target variable is a discrete variable and can be classified into categories, i.e, there are categories into which the data points can be segregated and made a part of. Regression based algorithm are used when the target variable is continuous in nature. This algorithm is mostly used in predictive analysis where we want to know exactly a data point will lie among the other data points in the dataset.

Other Supervised Machine Learning Algorithms Include:
1. Naive Bayesian Networks
2. Support Vector Machines
3. Decision Tree

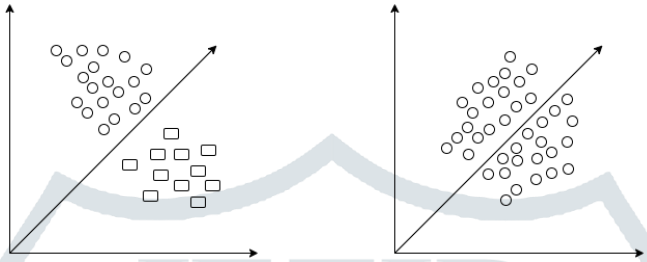

Fig. 2. Classification and Regression

The classification differs from regression are represented in figure (2). The classification is done on a dataset in which the data points belong to two or more classes. Whereas regression is applied to those where we have to predict where exactly a point lies using the best line of fit for predictive analysis. Semi-Supervised learning algorithm are those machine learning algorithms which includes data that has both labels as well as unlabelled data. It is somewhere between Supervised and Unsupervised learning. This includes General Adversarial Networks.

Unsupervised Learning Algorithm work mostly on non-linear data where there are no labels present and mostly include all the deep learning algorithms. A model based on unsupervised learning algorithm is usually trained on data where the outcomes are not available to train the model. The model is used for extraction useful features from the data that cannot be easily perceptive and discover the underlying patterns in the data. Deep Learning Algorithms require an extensive amount of data.

A simple Deep Learning Algorithm architecture includes a feature extraction module followed by a classifier module. The general structure of any Deep Learning Algorithm is similar to the structure of the brain and hence are called as artificial neural networks. Deep Learning Algorithms include Convolutional Neural Networks, Recurrent Neural Networks, Long Short-Term Memory Networks, etc [6]. The biggest advantage of Deep Learning Algorithms is that they work with almost any variety of data such as images, text, etc. The different layers of CNN model are shown in figure (3).

These networks are made up of multiple convolutional layers, pooling layers, transfer and activation function and a fully connected layer. Most of these neural networks such as Convolutions Neural Networks, Recurrent Neural Networks, LSTMs, etc are most suited and work best with non-linear, unlabelled data. For example, in a convolutional neural network, when images are passed as training data, they extract all the possible important and necessary features from the images and use the data for classification. The extracted features are the decision-making factors.

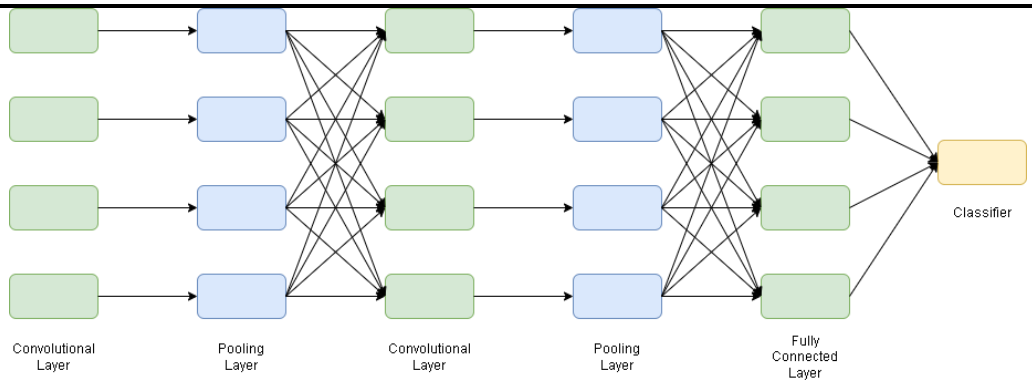

Fig. 3. Structure or a Neural Network (Convolutional)

Unsupervised Learning Algorithms include algorithms such as
1. Clustering
2. Anomaly Detection
3. Association
4. Radial Basis Function Network
5. Multilayer Perceptron

Reinforcement Based Learning is a type of machine learning technique where the agent reacts to the environment, takes decision with respect to its surroundings and the decision is rewarded either positively or negatively based on the outcome. Whenever the agent is rewarded positively, it is encouraged to make similar decisions. Whenever the agent is awarded negatively, it avoids taking similar decisions. With more and more positive rewards, the performance and efficiency of the model increases.

III. Workflow of Machine Learning Algorithms: The sequence of operations performed for the implementation of machine learning algorithm is as shown in figure (4).

1. Data Collection:

For us to apply any of the machine learning algorithms be it supervised, unsupervised, semi-supervised or reinforcement-based algorithm, we first need the data to which we have to apply these algorithms. Data can be collected from multiple sources such as surveys, etc. There are many open-source dataset providing organizations such as Kaggle, etc where open-source contributors have generated a large variety of datasets and made available publicly. Datasets are usually divided into three separate modules, i.e, the training module, testing module, validation module.

2. Data Cleaning:

This essentially is the first step of data pre-pre-processing. This involves removal of any null values, garbage values, in some cases also the outliers from the dataset. Data Cleaning process is different for every single dataset and hence there is no exact hard written process that can be followed. All the data cleaning techniques has to be sought before applying them to the data, based on the type of data that we are working with.

Reasons for Data Cleaning:

1. Overall accuracy of the model increase.
2. Performance is also affected positively.
3. Efficiency of the model also increases.

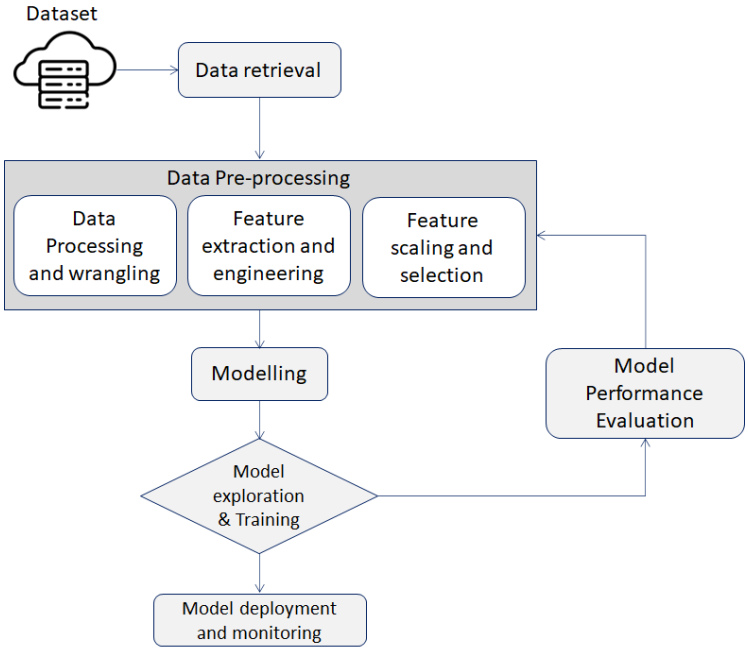

Fig. 4. Workflow of Machine Learning Algorithm

4. Data Visualization:

Sometimes is it of utmost importance to visualize the data that you are working with. It makes it very easy to understand the data. This also helps in identifying any hidden patterns. This is also beneficial in terms of deciding exactly which machine learning algorithm we are intending to apply.

5. Model Training:

Based on what type of data that we are operating on; we decide which algorithm is best suited for building the model. We train the model on the data that had been collected and cleaned. The model uses this provided data to learn from and extract the important features and based on this learning, it correlates to the test data and makes decision accordingly. The accuracy of the model increases as more and more data is fed to it. The accuracy also improves with model fitting, as it repeats the same process again and again to learn more and more patterns and features from the data in the form of epochs.

IV. Conclusion

This paper discusses the basic concepts of Artificial Intelligence, its subsets and different types of algorithms The machine learning algorithms are inevitable and find it's applications in almost every possible field. They can be applied for analysing data coming from a variety of data sources and also from different industries. All these algorithms are helping us to analyse the data with a very high level of accuracy and improve the efficiency. We have also discussed about the Machine Learning techniques such as supervised, unsupervised, semi-supervised and reinforcement based learning and deep learning algorithms.

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