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A Comprehensive Review on Applications, Techniques and Frameworks of Deep Learning

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ABSTRACT

Deep learning in a refined "machine learning" algorithm that far surpasses a considerable lot of its forerunners in its capacities to perceive syllables and picture. Deep learning is as of now a greatly dynamic examination territory in machine learning and example acknowledgment society. It has increased colossal triumphs in an expansive zone of utilizations, for example, speech recognition, computer vision and natural language processing and numerous industry item. Neural network is used to implement the machine learning or to design intelligent machines. Deep learning is a set of learning methods attempting to model data with complex architectures combining different non-linear transformations. The elementary bricks of deep learning are the neural networks, that are combined to form the deep neural networks. This paper gives a detailed review on applications, techniques and frameworks of deep learning.

Keywords : Deep Learning, models, applications

I. INTRODUCTION

Deep learning achieves higher power and flexibility due to its ability to process a large number of features when it deals with unstructured data. Deep learning algorithm passes the data through several layers; each layer is capable of extracting features progressively and passes it to the next layer. Initial layers extract low-level features, and succeeding layers combines features to form a complete representation. Learning is a process in which association of events with consequences is done. Thus basically learning is a way to substantiate the cause and effect principle. The science of designing the intelligent machine is referred to as machine learning and the tool used to design such intelligent machine is neural networks. Neural network may considered as black-box which gives some desired output for the given input. It is achieved through process called training.

In contrast to most conventional learning methods, which are considered using shallow-structured learning architectures, deep learning refers to machine learning techniques that use supervised and/or unsupervised strategies to automatically learn hierarchical representations in deep architectures for classification. Inspired by biological observations on human brain mechanisms for processing of natural signals, deep learning has attracted much attention from the academic community in recent years due to its state-of-the-art performance in many research domains such as speech recognition, collaborative filtering, and computer vision. Deep learning has additionally been effectively connected in industry items that exploit the expansive volume of advanced information. Companies like Google, Apple, and Facebook, who collect and analyse massive amounts of data on a daily basis, have been aggressively

pushing forward deep learning related projects. For example, Apple's Siri, the virtual personal assistant in iPhones, offers a wide variety of services including weather reports, sport news, answers to user's questions, and reminders etc. by utilizing deep learning and more and more data collected by Apple services. Google applies deep learning algorithms to massive chunks of messy data obtained from the Internet for Google's translator.

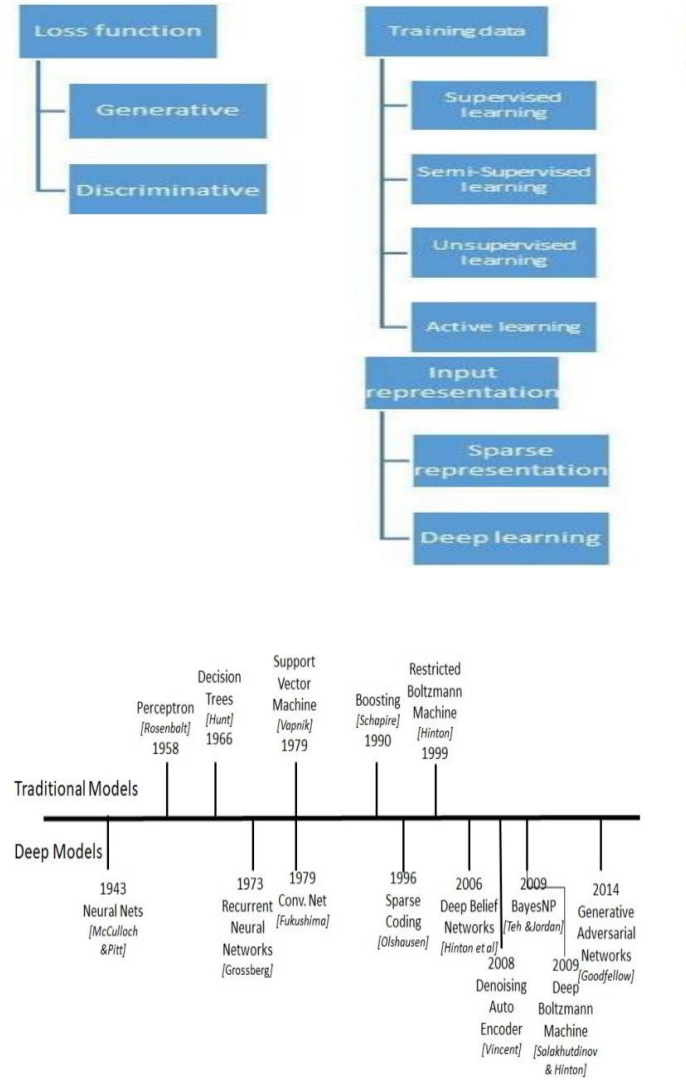

Figure 1: Evolution of Deep Models

Deep learning refers to a class of ML techniques, where many layers of information processing stages in hierarchical architectures are exploited for unsupervised feature learning and for pattern classification. It is in the intersections among the research areas of neural network, graphical modelling, optimization, pattern recognition, and signal processing. Two important reasons for the popularity of deep learning today are the significantly lowered cost of computing hardware and the drastically increased chip processing abilities (e.g., GPU units). Since 2006, researchers have demonstrated the success of deep learning in diverse applications of computer vision, phonetic recognition, voice search, spontaneous speech recognition, speech and image feature coding, semantic utterance classification, hand-writing recognition, audio processing, information retrieval, and robotics. Before going to deal with different machine learning paradigm in detail a brief classification is here. We use four key attribute to classify the machine learning paradigm.

II. DEEP LEARNING APPROACHES

Deep neural networks are successful in Supervised learning, Unsupervised learn- ing, Reinforcement learning, as well as hybrid learning.

Supervised Learning

In supervised learning, the input variables represented as X are mapped to out- put variables represented as Y by using an algorithm to learn the mapping function f.

$$Y = f(X) \quad (1)$$

The aim of the learning algorithm is to approximate the mapping function to predict the output (Y) for a new input (X). The error from the predictions made during training can be used to correct the output. Learning can be stopped when all the inputs are trained to get the targeted output. Regression for solving regression problems, Support Vector machines used for classification, Random forest for classification as well as regression problems.

Unsupervised Learning

In unsupervised learning, we have the input data only and no corresponding out- put to map. This learning aims to learn about data by modeling the distribution in data. Algorithms can be able to discover the exciting structure present in the data. Clustering problems and association problems use Unsupervised learning. The unsupervised learning algorithms such as K-means algorithm is used in clustering problems [1], Apriori algorithm is used in association problems [2].

Reinforcement Learning

Reinforcement learning uses a system of reward and punishment to train the algorithm. In this, the algorithm or an agent learns from its environment. The agent gets rewards for correct performance and penalty for incorrect performance. For example, consider the case of a self-driving car, the agent gets a reward for driving safely to destination and penalty for going off-road. Similarly, in the case of a program for playing chess, the reward state may be winning the game and the penalty for being checkmated. The agent tries to maximize the reward and minimize the penalty. In reinforcement learning, the algorithm is not told how to perform the learning; however, it works through the problem on its own [3].

Hybrid Learning

Hybrid learning refers to architectures that make use of generative (unsupervised) as well as discriminative (supervised) components. The combination of different architectures can be used to design a hybrid deep neural network. They are used for action recognition of humans using action bank features and are expected to produce much better results [4].

Method	Description	Merits	Demerits
Back propagation	Used in Optimization problem	For calculation of gradient	Sensitive to noisy data
Stochastic Gradient Descent	To find optimal minimum in optimization problems	Avoids trapping in local minimum	Longer convergence time, computationally expensive
Learning Rate Decay	Reduce learning rate gradually	Increases performance, Reduces training time	Computationally expensive
Dropout	Dropsout units/ connection during training	Avoids overfitting	Increases number of iterations required to converge
Max-Pooling	Applies a max filter	Reduces dimension and computational cost	Considers only the maximum element which may lead to unacceptable result in some cases
Batch Normalization	Batch-wise normalization of input to a layer	Reduces covariant shift, Increases stability of the network, Network trains faster, Allows higher learning rates	Computational overhead during training
Skip-gram	Used in word embedding algorithms	Can work on any raw text, Requires less memory	Softmax function is computationally expensive, Training Time is high
Transfer learning	Knowledge of first model is transferred to second problem	Enhances performance, Rapid progress in training of second problem	Works with similar problems only

Table 1: Comparison of Deep learning methods

III. IMPLEMENTATION TECHNIQUES

Learning can be implemented by various methodology or techniques depending upon the requirement. Basically learning can be categorized in two types:

1. Supervised learning
2. Unsupervised learning

In supervised learning two technique is used

1. Regression
2. Classification

While unsupervised learning is implemented by clustering algorithms

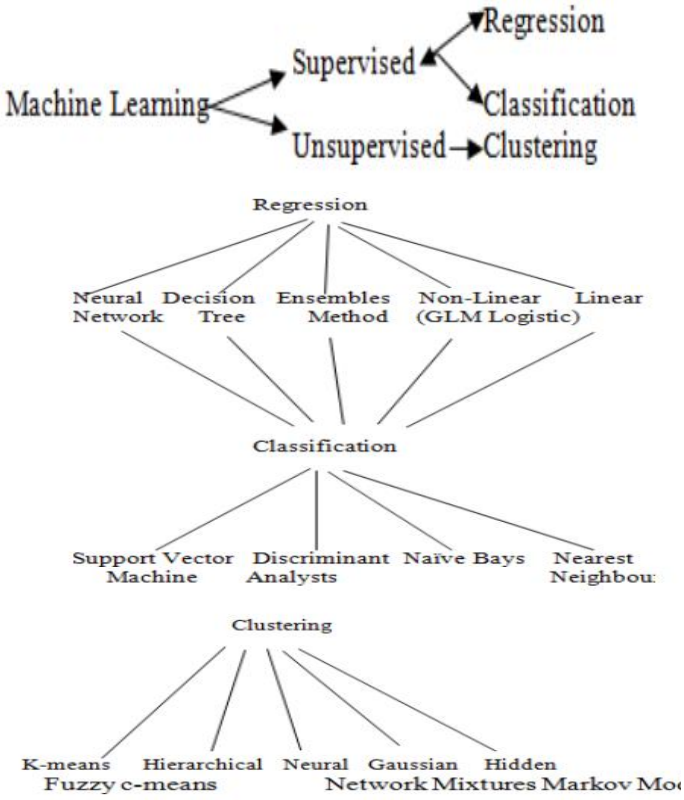

Figure 2: Learning Categories

IV. DEEP LEARNING FRAMEWORKS

A deep learning framework helps in modeling a network more rapidly without going into details of underlying algorithms. Each framework is built for different purposes differently.

TensorFlow TensorFlow, developed by Google brain, supports languages such as Python, C++and R. It enables us to deploy our deep learning models in CPUs as well as GPUs.

Keras Keras is an API, written in Python and run on top of TensorFlow. It enables fast experimentation. It supports both CNNs and RNNs and runs on CPUs and GPUs.

PyTorch PyTorch can be used for building deep neural networks as well as ex- ecuting tensor computations. PyTorch is a Python-based package that provides Tensor computations. PyTorch delivers a framework to create computational graphs.

Caffe Yangqing Jia developed Caffe, and it is open source as well. Caffe stands out from other frameworks in its speed of processing as well as learning from images. Caffe Model Zoo framework facilitates us to access pre-trained models, which enable us to solve various problems effortlessly.

Deeplearning4j Deeplearnig4j is implemented in Java, and hence, it is more efficient when compared to Python. The ND4J tensor library used by Deeplearning4j provides the capability to work with multi-dimensional arrays or tensors. This framework supports CPUs and GPUs. Deeplearnig4j works with images, csv as well as plaintext.

V. APPLICATIONS

According to [1] neural networks model can be used for demand forecasting in deregulated environment. Neural networks are designed and trained on the basis of aggregate demands of the groups of surveyed customers of different categories.

The most frequently encountered decision making tasks of human activity is classification. Classification problem occurs when an object needs to be assigned into a predefined class based on a number of observed attributes related to that object. Many problems in business, science, industry, and medicine can be treated as classification problems. Examples include bankruptcy prediction, credit scoring, medical diagnosis, quality control, handwritten character recognition, and speech recognition.

Neural network and genetic algorithms are used for web mining. [3] describe web mining in soft computing framework.

Soft computing paradigm like fuzzy sets (FS), artificial neural networks (ANN) and support vector machines (SVMs) is used in Bioinformatics.

The research community has stated looking for IP traffic classification techniques that do not rely on „well known" TCP or UDP port numbers, or interpreting the contents of packet payloads. New work is emerging on the use of statistical traffic characteristics to assist in the identification and classification process. This survey paper looks at emerging research into the application of Machine Learning (ML) techniques to IP traffic classification - an inter-disciplinary blend of IP networking and data mining techniques.

It is crucial for financial institutions, the ability to predict or forecast business failures, as incorrect decisions can have direct financial consequences. There are the two major research problems in the accounting and finance domain are Bankruptcy prediction and credit scoring. In the literature, a number of models have been developed to predict whether borrowers are in danger of bankruptcy and whether they should be considered a good or bad credit risk. Since the 1990s, machine-learning techniques, such as neural networks and decision trees, have been studied extensively as tools for bankruptcy prediction and credit score modelling.

Learning methods that have been applied to CRs classifying them under supervised and unsupervised learning. Some of the most important, and commonly used, learning algorithms was provided along with their advantages and disadvantages are discussed in this literature.

VI. CONCLUSION

Even though a full understanding of the working of deep learning is still a mystery, we can make machines smarter using Deep learning, sometimes even smarter than human. Now the aim is to develop deep learning models that work with mobile to make the applications smarter and more intelligent. Let deep learning be more devoted to the betterment of humanity and thus making our domain a better place to live. It is also concluded that Neural Network and Support vector machine is most popular techniques to implement the machine learning paradigm. Deep learning is extended version of supervised learning. It is finally concluded that Convolution neural network and Deep Belief network are two powerful techniques which may be used to solve various complex problems using deep learning. This paper given a detailed review on applications, techniques and frameworks of deep learning

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