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A SURVEY ON DEEP LEARNING ALGORITHMS

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Abstract - *Natural language processing has a wide range of applications like voice recognition, machine translation, product review, aspect-oriented product analysis, sentiment analysis and text classification like email categorization and spam filtering. Several research works have been carried out in the Natural Language Processing (NLP) using deep learning methods. Deep learning refers to machine learning techniques that use supervised or unsupervised strategies to automatically study the hierarchical relationship in deep architectures for classification. The most popular deep learning methods employed include Convolution Neural Network (CNN) and Recurrent Neural Network (RNN) particularly the Long Short Term Memory (LSTM). Deep learning methods have made a significant breakthrough which can be appreciable performance in a wide variety of applications with useful security tools. Deep learning-based methods are responsible for controlling the complexities and challenges of image recognition The main intention of this paper is to explore a comprehensive survey of the major algorithms of deep learning covering a variety of areas, study of the methods and architectures and the contribution of that corresponding application in real-world applications.*

***Key Words*: Auto Encoder, Recurrent Neural networks, Long Short Term Memory, Artificial neural network.**

1. INTRODUCTION

Deep learning is the most effective, supervised, time and cost-efficient machine learning technique. Deep learning is not a restricted learning approach, but it abides various procedures that can be applied to an extremely large area of complicated problems. This technique learns the illustrative and different features in a very stratified way. Deep learning methods have made the significant breakthrough with great performance in a wide variety of applications with useful security tools. It is considered to be the best choice for discovering complex architecture in very high-dimensional data by employing them to the backpropagation algorithm. Deep learning is a subset of machine learning that is a subset of Artificial intelligence. Artificial intelligence is a technique that enables a machine to mimic human beings. Machine learning is a technique to achieve algorithm training with data and finally, deep learning is a type of machine learning inspired by the structure of the human brain in terms of deep learning. This structure of the network is known as an artificial neural network.

Deep Learning technology deals with the artificial neural network system. The efficiency and accuracy are dependent on the bigger data volumes. The training process is called 'deep' because the number of levels of the neural network increases with time. The working of the deep learning process is purely dependent on two phases which are called the training phase and inferring phase. The training phase includes labeling of large amounts of data and determining their matching characteristics and the inferring phase deals with data using their previous knowledge [1].

Deep-learning is such an algorithm that helps the system to understand complex perception tasks with maximum accuracy. Deep learning is also known as deep structured learning and hierarchical learning that consists of multiple layers which include nonlinear processing units for the purpose of conversion and feature extraction. The main advantage of deep learning is its set of functions than allow networks used by traditional learning methods. A deep architecture is more suggestive than a shallow one provided the same.

This paper mainly focuses on the deep learning concepts, to its basic and its advanced architectures, techniques, methods, comparison with other alternatives, characteristics, and limitations. The intention of this paper is to explore a new comprehensive survey of the major algorithms of deep learning covering a variety of areas, the study of the techniques and computing the contribution of that respective application in the real world [4].

2. DEEP LEARNING

Building a machine that can duplicate human brains that have been a dream of sages for long ages. The history of deep learning describes the model that was introduced and became known as the prototype of artificial deep neural network models. The deep neural network can be model convoluted and also non-linear relationships and

generates models in which the object is considered as a layered organization of primitives. These are such feed-forward networks that have no looping and the flow of data is from the object's input layer to the output layer. There are wide varieties of frameworks and algorithms that are helpful in implementing the abstraction of deep learning [5].

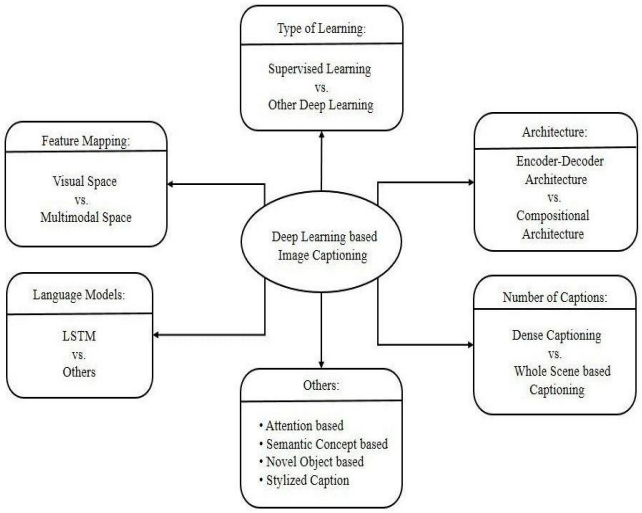

Fig -1: An overall taxonomy of deep learning image captioning [5].

The "deep learning" approach, the term "deep" describes the concept of numerous layers of techniques through which the data is analyzed and transformed. These systems consist of a very special dynamic path of depth which means the steps of transformations from input to output and represents the spontaneous connection between the input layer and the output layer. It must be noted that there is a contrast between deep learning & representational learning. Representational machine learning includes the set of techniques that helps the machine to take the raw behavioral data as input and determines the representations for the detection and to the classification purpose. Deep learning techniques are such kinds of learning techniques that have more levels of representation and at a more conceptual level. for example, the different layers in a system of deep learning-based image or object capturing as shown in [Fig 1]. Deep learning algorithms have one of the unique features of using untreated data during tutoring. Training with vastly more data is used for a smaller number of exact, clean, and carefully curated data [1].

Deep learning techniques use nonlinear conversions and model generalization at a high level, even in larger databases. It also describes that a machine converts its internal parameters, which are needed to enumerate the descriptions in each layer, by accepting the generalization and inputs from the former layer. This type of learning approach is widely used in the fields of adaptive machine testing, big data analysis, human cancer detection, data law, document analysis and recognition, health care, object detection, speech recognition and abstraction, image class-situation, moving pedestrian detection, natural language processing, and voice activity detection and many more. The Deep learning prototype uses an enormous ground truth delegated data to find the unique features, combinations of features and then it establishes an integrated feature extraction and classification model to figure out a variety of applications. The most relevant characteristic of deep learning is the data that uses general-purpose techniques, various extensive features and no intervention of engineers deep learning algorithms allow the feature of extraction in an automated way, which allows extracting properties with domain knowledge and human effort.

3. DEEP LEARNING TECHNIQUES

3.1 AUTO-ENCODER (AE)

An Auto-encoder (AE) could be a version of a deep neural network that depends on unsupervised learning ways and uses the backpropagation formula. The network initially finalizes the ultimate result values to be similar to the input values. Its structure consists of 3 layers that area unit input, a hidden conjointly referred to as cryptography layer, and a decryption layer [Fig 2]. The network tries to reconstitute its input, which forces the hidden layer to be told the most effective characterizations of the input. The hidden layer is employed to clarify the code that helps to represent the input. Auto-encoders are unit neural networks, they're conjointly deeply associated with PCA (Principal part Analysis) [1].

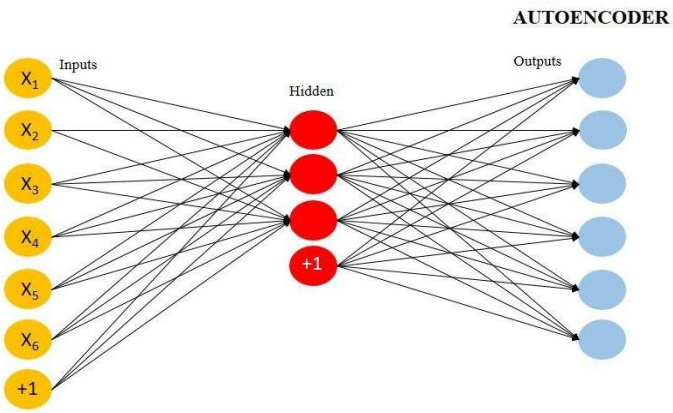

Fig -2: The Layers of an AutoEncoder.

Auto-encoders are accustomed to operating with high dimensional data and explain the illustration of collection information of knowledge of information via reduction. Auto-encoder (AE) uses primarily two structures, called Denoising Auto-encoder and thin Auto-encoder. For Denoising Auto-encoders, it uses knowledge from noise to expertise the network weight and for thin Auto-encoders,

they are sure of the activation state of hidden units. Operating Associate in Nursing Auto-encoder considers the input and afterward maps it to Associate in Nursing inherent transformation with the help of nonlinear mapping [2].

3.2 RBM

RBM may be a two-layer purposeless neural network consisting of a clear layer and hidden layer. There aren't any connections among every layer, however, connections run visible to hidden. it's trained to maximize the expected log-likelihood of the information.

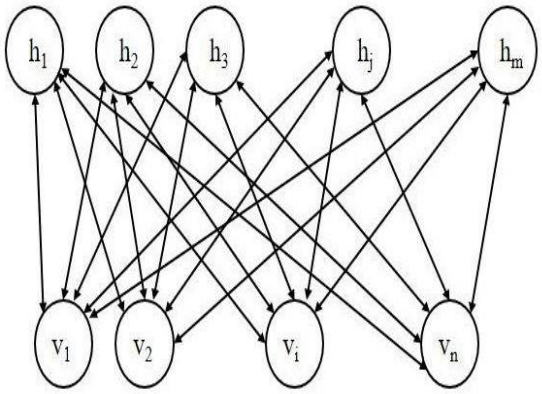

Fig -3: Visible and hidden layers in an RBM.

The inputs are binary vectors because it learns Bernoulli distributions over every input [Fig 3]. The Activation operation is computed with an equivalent means as in an exceedingly regular neural network and therefore the supplying operation sometimes used is between 0-1. The output is treated as a likelihood and every nerve cell is activated if activation is bigger than the variant. Visible neurons take binary input as initial input then hidden layer chances [1].

In RBM, there's no affiliation between associate degree input and the hidden layer. The deep belief network represents the multilayer spec that includes a unique training technique with several hidden layers. Here each combination of connected layers may be an RBM and is additionally called a stack of restricted Boltzmann machines. The input layer constitutes the basic sensory input, and also the hidden layer characterizing the abstract description of this input.

3.3 RECURSIVE NEURAL NETWORK (RvNN)

RvNN will build predictions during a data structure further as classify the outputs exploitation integrative vectors. The event of associate degree RvNN was primarily impressed by algorithmic Autoassociative Memory (RAAM), associate degree design created to method objects that were structured in associate degree absolute form, like trees or graphs. The approach was to require an algorithmic organization of the variable size and generate fixed-width distributed illustration. The Backpropagation through Structure (BTS) learning theme was introduced to coach the network. BTS follows the associate degree approach just like the quality backpropagation rule and additionally is able to support a tree-like structure. The network is trained by the machine association to breed the pattern of the input layer at the output layer [3].

RvNN has been particularly made in IP. RvNN design which will handle the inputs of various modalities. It shows 2 samples of exploitation RvNN to classify natural pictures and language sentences. whereas a picture is separated into totally different segments of interest, a sentence is split into words. RvNN calculates the score of an attainable try to merge them and builds a grammar tree. For every try of units, RvNN computes a score for the believability of the merge. The try with the very best score is then combined into an integrative vector. once every merge, RvNN can generate: (1) a bigger region of multiple units,(2) an integrative vector representing the region, and (3) the category label (e.g., if each units area unit 2 noun words, the category label for the new region would be a noun phrase).

3.4 RECURRENT NEURAL NETWORK

RNN comprises a large set of architecture and is the simplest network architecture. The important attributes of a repetitive network are that the recurrent network has an interrelation that can be given as response into former layers as compared to the finalized feed-forward connections . It takes the former memory of input and models the problems within time. These networks can be developed, practiced and elaborated with standard back-propagation known as back-propagation through time (BPTT). It explains the different application fields of the various architectures of deep neural networks of the system [3].

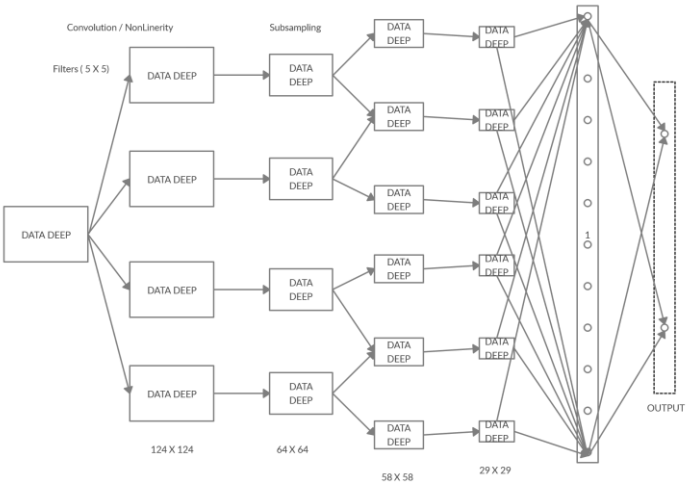

Fig -4: CNN architecture [3].

RNN uses backpropagation unlike CNN which is a feed-forward network. Along with the current inputs it also considers the previous inputs. RNNs can process sequential data with the help of internal memory. It is designed based on the principle that humans do not think from scratch every time. RNNs take the help of previous words in order to predict the next word in the context. RNNs are used in various NLP text analysis, voice recognition, and language translation applications.

3.5 CONVOLUTIONAL NEURAL NETWORK

CNN is also a popular and widely used algorithm in deep learning. CNN is a feed-forward network primarily used in image processing. The strength of the CNN depends on the number of hidden layers used between the input and the output layers. Each layer extracts a set of features. Feature maps are generated by applying a series of filters over the input. Each filter goes through the entire input and multiplies its weights by the input values. The result of which is passed to an activation function like Rectified Linear Unit (ReLU)or sigmoid. A loss function is used to evaluate the set of weights. The feature maps generated by the filters highlight different parts of the input. Although CNN is widely used in image and video processing, the recent approaches employ CNN in NLP. The text input in NLP is converted to matrix representation by a preprocessing step. The matrix structure uses sentence characters as rows and alphabet letters as columns [Fig 4]. In NLP, a filter slides over the words of the matrix.The drawback of CNN is that it cannot handle sequential data [4]. Hence by employing a sliding window technique, the words are recognized. CNN has four main layers which are:

1. Convolution layer
2. Rectified Linear Unit (ReLU) layer
3. Pooling layer
4. Fully connected layer.

3.6 LSTM/GRU NETWORK

LSTM is an extension of RNN that can remember inputs over a long period of time. Unlike RNN which has a simple internal memory, LSTM has an advanced memory. It can read, write and delete information from its memory. Thus it addresses the drawback of RNN which suffered from vanishing gradients. LSTM can decide which information is important which to retain and which ones to forget. In LSTM the memory can be gated. LSTM has larger memory space and RNN has small and not permanent memory. LSTM is used in -duration experiments which gives good results. The LSTM units are deployed in RNN. The limitations and issues of RNN are overcome by LSTM [6].

The Gated Recurrent Unit (GRU) includes two gates called as an update gate and a reset gate. The responsibility of an update gate is to describe the requirement of the contents of the former cell for the maintenance. The reset gate explains the handling process of former cell contents with the next input. The GRU represents a standard RNN by arranging the reset gate to 1 and update gate to 0. Working capability of the GRU model is simple as compared to the LSTM.

4. CONCLUSION

Deep learning methods along with a semantic concept centric approach will give rise to a new level of algorithms that can reason with language and contexts at a high level. The deep learning algorithms described can be put on speech, image and object recognition where it generates more perfect endings than available machine learning models [5]. The computing infrastructure-based systems together theoretically are sound parallel learning algorithms and novel architectures are needed to build a future deep learning system. As there is continuous growth in computer memory and computational power through parallel or distributed computing environments, further research and effort on addressing issues associated with computation and communication. In the coming years, solutions to address the scalability, reliability, adaptability of the unsupervised learning models will take the central stage.

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