International Journal of Engineering & Technology, 7 (2.33) (2018) 810-812

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Deep learning an overview

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Abstract

In recent years, deep learning approaches have gained significant approaches in machine learning. Deep Learning is an accurate and efficient method of recognition and classification. It imitates the working of human brain in processing data. In this paper, we presented a brief over-view of deep machine learning, its architecture and applications.

Keywords: *Deep Learning; Machine Learning; Artificial Neural Network; Convolutional Neural Networks; Learning.*

1. Introduction

Deep Learning is a powerful machine learning technique with artificial neural network (ANN). The main significance of ANN is its ability to imitate human brain. A human has intelligence with the help of brain. Human brain is made of approximately 100 billion nerve cells, called neurons. Neurons have the ability to gather and transmit electrochemical signals. Like human brain, an ANN consists of layers of neurons called nodes. These layers are interconnected. First layer consists of input neurons. These neurons send data on to the second layer, which in turn sends the output to the third layer. ANNs are simple mathematical models. It enables the computer to learn from a large set of observational data. In deep learning the number of layers increases and as it goes through many layers it learns more and more and can improve the accuracy of prediction of the system.
Using Deep learning techniques, many problems such as image recognition, speech recognition, natural language processing, robotics, provide best solutions.

2. Learning

Learning or training is a method by which neural networks learns to respond to the desired problem. It learns through experience by making proper parameter adjustments. Some of the currently used learning methods are supervised learning, unsupervised learning and reinforcement learning.
Supervised Learning
In supervised Learning, a set of inputs and desired outputs are given to the neural net. Then the algorithm learns how to associate the input to the target output by adjusting its parameters.
During training the input is given to the network. Based on the network parameters it produces some output. This output is compared with the desired or target output. If there exists a difference between the two then an error signal will be generated. This error signal is used for adjustment of parameters such as weight until a match occurs between the two outputs.
Multilayer perceptron, convolutional neural networks, recurrent neural networks are some of the models which uses supervised learning.
Unsupervised Learning
In ANN with unsupervised learning, the inputs of similar types are grouped without specifying how a member looks in each group. Here the network must itself find the input data's similarities and features to categorize it.
Deep Belief Neural networks allow learning in unsupervised manner. Unsupervised learning is capable of dealing with unlabelled data.
Reinforcement Learning
This type of learning is similar to supervised learning except that in reinforcement learning there is no correct information about the target output.
Robotic Problems [12] uses Reinforcement learning to perform task based operations

3. Brief history of deep learning

History of deep learning started in 1943 with model developed by Walter Pitts and Warrant Mac Calloch, based on human brain [6]. Basics of back propagation was developed by Henry.J.Kelley in 1960 and applied to Neural network (NN) in 1981. Back propagation based training of deep neural network was difficult by late 1980's [4]. The first Convolutional neural networks were used by Kunihiko Fakushima in 1980 with multiple pooling and convolutional layers and helped the computers to learn and recognize pattern. In 1989, Yann Lecum combines CNN with Back propagation to read handwritten digits. Long Short term memory (LSTM) for recurrent neural network was developed in 1997 by Sepp Hochreiter and Jurgen Schmidhuber [6] In mid-2000 scientists found the usefulness of deep NNs and have finally attracted by outperforming alternative machine learning methods [4] By 2011 deep learning becomes more popular with the increased computing power of GPU

4. Deep learning architectures

A deep NN consists of neural network with more than one hidden layer as shown in fig1 [9]. Each layer processes the data and learns using learning algorithms. The first phase of Deep learning is training. With large set of sample data the system learns to identify or classify something which we aim to do with the machine. As the number of samples increases it learns more. In the second phase we just need to give the input to the system. From the already learned knowledge the model itself identify the patterns and gives the output.

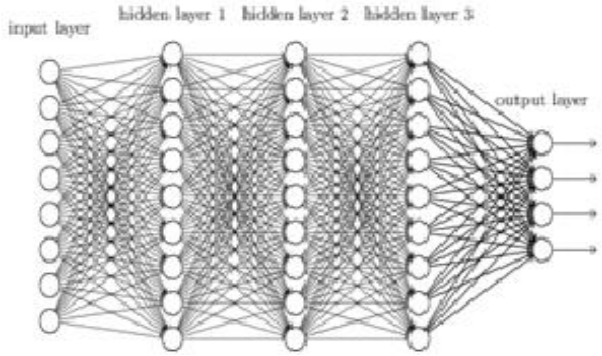

Fig. 1: A Deep Neural Network with Three Hidden Layers.

The training can be supervised or unsupervised. In supervised learning algorithm, it produces a learning model from a labelled training set. It has a known label or result. In unsupervised learning, input data is not labelled and does not have a known result. The learning is achieved by deciding the structures present in the input data. The output of these models may be binary or multi class. In binary classifier there are only two output nodes where as in multi class the output layer contains more nodes. Based on the interconnection of layers and its learning methods various deep learning architectures are there. Deep neural network (DNN), Convolutional neural network (CNN), deep belief Neural network (DBN), Convolutional deep belief neural network(CDBN), Recurrent neural network(RNN) etc. are some of the deep learning architectures.

4.1. Deep belief neural networks

It is a class of DNN with many hidden layers. There are connections between the layers but not between units within each layer. It can learn from both labelled data and unlabeled data. Here unsupervised learning is performed on data without using label information and supervised learning is performed on data with labelled information to create a model [7]. DBN stacks restricted Boltzmann Machines (RBM) or auto encoders.

4.2. Recurrent neural networks

RNN's are the deepest of all neural networks. They are more powerful than Feed forward Neural networks (FNN). RNN is efficient to learn from sequential data. It has a memory which stores information about the previous computations [4]. RNN performs the task for every element of a sequence and its output depends on the previously stored data.

4.3. Convolutional neural networks

It is composed of one or more convolutional layers followed by one or more fully connected layers. In the case of image, a filter slides over the image area and the corresponding pixel value of the respective area is operated mathematically with the filter parameters and summed up together to get a value. To reduce the dimensionality sub sampling can be performed. The sequence of convolution and sub sampling can be repeated many times [7]. CNN is very useful in classification of image, sound, and text. Fig.2 [5] shows a deep CNN architecture.

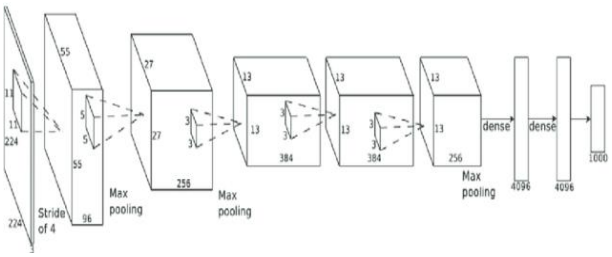

Fig. 2: Deep CNN.

5. Works on deep learning

In [3] they try to find out whether the personality trait and intelligence can be predicted from face images by deep learning. They train an end to end CNN to predict it. They design a multi task neural network and found that some of the personality trait can be predicted reliably while others not, because the traits may depend on different parameters such as genetic qualities and social environment. They also found that CNN performs better in predicting traits.

In [2] they stack their feature learning model into a deep architecture to exploit shared information among different face regions to improve the recognition performance.

Li Xinhua and Yu Qian [1] separate their system into three main stages. Image processing, face representation and face classification. Representation of face image is done using a large deep convolutional network. This work takes shorter time and a little better accuracy compared with other methods.

Reference [10] proposed a method to assess the stereoscopic image quality. In that they used a DBN to classify the wavelet domain features to distortion types.

In [8] they introduced deep learning algorithm to overcome the problems such as over fitting in Intruder Detection.

Reference [11] had made a review on uses and applications of deeplearning for Unmanned Aerial Vehicles including its performance and limitations.

6. Conclusion

From the study it is found that deep learning works better in many applications. Many researches proved that in the case of image representation deep learning works well. The main difficulty faced by researchers was the time it takes to train. Also some network works well for a problem that may not work well in another problem. Choosing of network model is thus a problem. Most of the survey papers used supervised learning. There is large number of unlabelled data available which are less expensive. So finding efficient ways to process this type of data in unsupervised learning is more beneficial. Now with the advancement in the processors such as GPU, processing power increases. Study also found that Deep Learning is a better approach in machine learning when the amount of dataset is large.

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