International Journal of Control and Automation
Vol. 13, No. 2s, (2020), pp. 79-83

Deep Learning Applications and Challenges

Dr. R. Beaulah Jeyavathana
Assistant Professors (SG), Computer Science and Engineering,
Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai
mahimajesus008@gmail.com

Abstract

Currently, deep learning is a current and a stimulating field of machine learning. Deep learning is the most effective, supervised, time and cost-efficient machine learning approach. Deep learning is not a constrained learning approach, but it bears various measures and features which can be applied to a massive speculum of intricate problems. The technique learns the explanatory and discrepancy features in a very stratified way. Deep learning methods have made a significant break- through with appreciable performance in a widespread variety of applications with useful security tools. It is considered to be the best choice for determining complex architecture in high-dimensional data by engaging back propagation algorithm. As deep learning has made significant developments and incredible performance in numerous applications, the widely used domains of deep learning are business, science and government which further includes adaptive testing, biological image classification, computer vision, cancer detection, natural language processing, object detection, face recognition, handwriting recognition, speech recognition, stock market analysis and many more. This paper emphases on the concepts of deep learning, its basic and advanced architectures, techniques, motivational aspects, characteristics and the limitations. The paper also presents the major differences between the deep learning, classical machine learning and conventional learning approaches and the major challenges ahead. The main intention of this paper is to explore and present chronologically, a comprehensive survey of the major applications of deep learning covering variety of areas, study of the techniques and architectures used and further the contribution of that respective application in the real world. Finally, the paper ends with the conclusion and future aspects.
Keywords: back propagation, object detection, speech recognition, image classification, super- vised

1 Introduction

Machine learning is a subdivision of Artificial Intelligence (AI) that conveys the system, the benefits to repeatedly learn from the perceptions and facts without being explicitly programmed. It starts with observations such as the direct experiences to prepare for the features and patterns in data and producing better results and decisions in the future. A deep learning technology works on the artificial neural network system (ANNs). These ANNs continuously take learning algorithms and by uninterruptedly increasing the amounts of data, the effectiveness of training processes can be enhanced. The efficacy is hooked on on the larger data volumes. The training process is called deep because the number of levels of neural network increases with the time. The working of the deep learning process is purely dependent on two phases which are called the working out phase and inferring phase. The training phase includes tagging of large amounts of data and determining their matching features and the inferring phase deals with making inferences and label new unexposed data using their previous knowledge. Deep-learning is such an approach that helps the system to understand the complex perception tasks with the supreme accurateness. Deep learning is also known as deep structured learning and hierarchical learning that consists of multiple layers which includes nonlinear processing units for the purpose of conversion and feature extraction. Every succeeding layer takes the results from the preceding layer as the input. The learning process takes place in either supervised or unsupervised way by using idiosyncratic stages of abstraction and assorted levels of representations. Deep learning or the deep neural network uses the crucial computational unit, i.e. the neuron that takes multiple signals as input. It

ISSN: 2005-4297 IJCA

assimilates these signals linearly with the weight and transfers the combined signals over the nonlinear tasks to produce outputs.

In the "deep learning" methodology, the term "deep" tallies the concept of numerous layers through which the data is transformed. These systems consist of very special credit assignment path (CAP) depth which means the stages of conversions from input to output and embodies the impetuous linking between the input layer and the output layer. Deep learning practices are virtuously such kind of learning methods that have multiple levels of representation and at more abstract level. Figure 1 depicts the differences between the machine learning and deep learning.

Deep learning techniques use nonlinear transformations and model abstractions at a high level in large databases. It also describes that a machine transforms its internal attributes, which are mandatory to enumerate the descriptions in each layer, by accepting the abstractions and representations from the previous layer. This original learning approach is broadly used in the fields of adaptive testing, big data, cancer detection, data flow, document analysis and recognition, health care, object detection, speech recognition, image classification, and voice activity detection.

Deep learning paradigm uses an immense ground truth designated data to find the unique features, combinations of features and then constructs an combined feature extraction and classification model to figure out a variety of applications. The meaningful characteristic of deep learning is the data that uses general purpose methods, various extensive features and no involvement of human engineers. The key factors on which deep learning methodology is based are:

- Nonlinear processing in multiple layers or stages.
- Supervised or unsupervised learning.

Nonlinear processing in multiple layers refers to a hierarchical method in which the current layer receives the results from the previous layer and permits its output as input to the next layer. Grading is established among layers so as to establish the reputation of the data. Here supervised and unsupervised learning are linked to the class target label. Its availability means a supervised system and absence indicates an unsupervised system.

2 Basic Architectures of DeepNeural Network (DNN)

2.1 Recurrent Neural Network

RNN consists of a rich set of architecture and is the basic network architecture. The important representative of a recurrent network is that the recurrent network has a connection that can be given as feedback into preceding layers as compared to the complete feed-forward connections. It takes the previous memory of input and mockups the problems within time. These networks can be elevated, accomplished and extended with typical back-propagation called as back-propagation through time (BPTT). Table 2, describes the various application areas of different architecture of deep neural networks.

Table 2 Architectures of deep neural network and their major application Areas

Architecture	Major application areas
Auto-encoder	Natural language processing, understanding compact representation of data
Deep stacking networks	Continuous speech recognition, Information retrieval
LSTM/GRU networks	Gesture recognition, handwriting recognition, image captioning, natural language text compression, speech recognition
Recurrent neural networks	Handwriting and speech recognition

ISSN: 2005-4297 IJCA

2.2 Restricted Boltzmann Machines

Restricted Boltzmann Machine (RBM) is such an objectiveless graphical and modeled representation of the hidden layer, a visible layer and the symmetric linking between the layers. In RBM, there is no linking in between an input and the hidden layer. The deep belief network represents multilayer network architecture that integrates an innovative training method with many hidden layers. Here every pair of connected layers is a RBM and is also known as a stack of restricted Boltzmann machines. The input layer institutes the basic sensory input, and the hidden layer illustrating the abstract description of this input. The job of the output layer is to accomplish the network classification. The training part is done in two stages: Unsupervised pre training and supervised fine-tuning. In unsupervised pre training, from the first hidden layer, RBM is accomplished to renovate its input. The next RBM is competent similar to the first one, and the first hidden layer is taken as the input and visible layer, and the RBM is controlled by taking the outputs from the first hidden layer. Hence, every layer is pre capable or pre-trained. Now when the pre training is completed, steps of supervised fine-tuning start. In this step, the nodes representing the output are marked with the values or labels so that they can aid in the learning process and later on full network training is done with the gradient descent learning or back-propagation algorithm.

2.3 Deep Stacking Networks

Deep Stacking Networks (DSN) is also recognized as deep convex networks. DSN is dissimilar from other traditional deep learning structures. It is called deep because of the fact that it contains a large number of deep individual networks where each network has its own hidden layers. The DSN be certain of that training is not a particular and isolated problem, but it holds the amalgamation of individual training problems. The DSN is made up of a combination of modules which are part of the network and present in the architecture. There are three modules that work for the DSN. Here every module in the model is having an input zone, a single hidden zone and an output zone. Subroutines are positioned one over the top of another with the input to every module is taken as the outputs of the preceding layer and the authentic input vector. Figure 3 illustrates the process of working of the layers that helps to tenacity the complex classifications. In DSN, every module is trained in isolation so as to make it productive and knowledgeable with the capability to work in harmonization. The process of supervised method of training is trained as the back-propagation for each mod- ule and not for the entire network. DSNs works higher than typical DBNs making it appropriate and recognized network architecture.

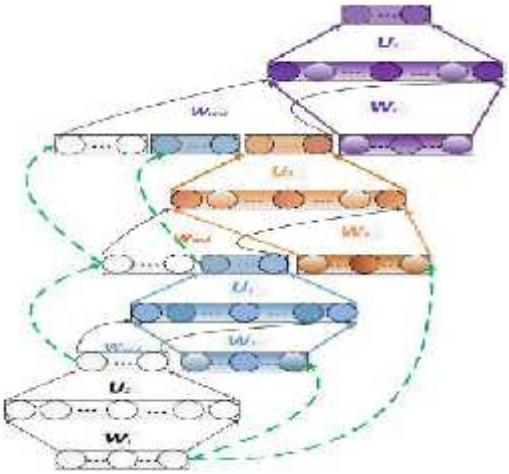

Fig. 3 **Working of DSN**

ISSN: 2005-4297 IJCA

3 Advanced Architectures of Deep Neural Network

Due to many suppleness provided by the neural network, deep neural network can be articulated by a diverse set of models. These architectures are called deep models and consist of:

AlexNet: The net is christened for the researchers. It was the original deep learning architecture and was developed by Alex Krizhevsky, Geoffrey Hinton and his colleagues, who gave pulverized breach research in deep learning. The architecture consists of the convolutional layers and the pooling layers which are slanted on one another and then trailed by entirely interweaved layers on the top. The reimbursements and dominance lie in the fact that the scalability and the use of GPU are unsurpassed. AlexNet has high speed of processing and training because of the use of GPU.

GoogleNet*:* The architecture was familiarized by the researchers at Google and hence the name of the Net. It involves 22 layers whereas VGG had 19 layers. Google Net is based on the novel technique which is known as the inception module. When numerous of these inception modules are stacked one over the other, it becomes the final one. The model congregates faster because of the joint and the parallel training. Training of GoogleNet is quicker than VGG with small size of the pre-trained GoogleNet.

YoLo (You only look once): This architecture unravels image detection problems. To recognize the class of the object, the image is divided into bounding box and then a rec- ognition algorithm is implemented which is communal for all the boxes. After proof of identity of the classes, the boxes are amalgamated very cautiously to make a best bounding box around the objects. It is used in real time for handling day-to-day problems.

4 Challenges of Deep Learning

Although deep learning techniques are evidencing its best and has been solving various intricate applications with multiple layers and high level of abstraction. It is assuredly recognized that the accuracy, acuteness, accessibility and meticulousness of deep learning systems are almost equal or may sometimes better human experts. To feel the excitement of victory, in today's scenario, the technology has to accept many challenges. So, here is the list of challenges which deep learning has to overcome is:

- Deep learning algorithms have to uninterruptedly accomplish the input data.
- Algorithms need to guarantee the slide of the deduction.
- Resource is challenging technology like high performance GPUs, storage requirements.
- Amended methods for big data analytics.
- Presence of hyper parameters and complex design.
- Computationally intractable.
- Need a large amount of data.
- Exclusive for the complex problems and computations.
- No strong theoretical foundation.
- Difficult to find the topology, training parameters for the deep learning.

Deep learning affords new tools and structures for the calculation of the data and empowers computers to cram objects and representations.

5 Conclusion and Future Aspects

Deep learning is indeed a fast-growing request of machine learning. The swift use of the algorithms of deep learning in diverse fields really shows its success and flexibility. Accomplishments and enhanced accuracy rates with the deep learning clearly parades the application of this technology, clearly accentuate the growth of deep learning and the tendency for the future advancement and research. Additionally, it is very important to highlight that grading of layers and the supervision in learning are the major key factors to progress an efficacious application with deep learning. The reason behind is that the grading is essential for fitting data classification and the supervision trusts the reputation of maintaining database. Deep learning trusts on the optimization of existing

ISSN: 2005-4297 IJCA

applications in machine learning and its innovativeness on ordered layer processing. Deep learning can distribute effective results for the various applications such as digital image processing and speech recognition. During the current era and in coming future, deep learning can be implemented as a convenient security tool due to the facial recognition and speech recognition united. Besides this, digital image processing is a kind of research field that can be applied in multiple areas. For proving it to be a true optimization, deep learning is a fashionable and exhilarating subject in artificial intelligence.

References

[1] Stefan Jaeger, Alexandros Karargyris, Sema Candemir, Les Folio, Jenifer Siegelman, "Automatic Tuberculosis Screening Using Chest Radiographs"IEEE Transactions On Medical Imaging,Vol.33, No.2, February 2014.
[2] C.Bhuvaneswari, P.Aruna, D.Loganathan,"Classification of Lung Diseases by Image Processing Techniques Using Computed Tomography Images International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-4 Number-1 Issue-14 March-2014.
[3] Shuangfeng Dai, Ke Lu, Jiyang Dong "Lung segmentation with improved graph cuts on chest CT images" 2015 3rd IAPR Asian Conference on Pattern Recognition.
[4] Laurens Hogeweg*, Clara I. Sánchez, Pragnya Maduskar, Rick Philipsen, Alistair Story, Automatic Detection of Tuberculosis in Chest Radiographs Using a Combination of Textural, Focal and Shape AbnormalityAnalysis"IEEE TRANSACTIONS ON MEDICALIMAGING,VOL.34,NO.12,DECEMBER2015.
[5] Shenshen Sun, Wenbo Li , Yan Kang "Lung Nodule Detection Based on GA and SV 2015 8th International Conference on Bio Medical Engineering and Informatics (BMEI 2015).
[6] G. Vijaya, A. Suhasini, R. Priya "AUTOMATIC DETECTION OF LUNG CANCER IN CT IMAGES" IJRET: International Journal of Research in Engineering and Technology
[7] Elmar Rendon-Gonzalez and Volodymyr Ponomaryov "Automatic Lung Nodule Segmentation and Classification in CT Images Based on SVM"International conferences on 2016 IEEE.
[8] Sekar, B., Saranyan, R., Nirmal, R. M., Indrapriyadharshini, K., Murugesan, A., & Yoithapprabhunath, T. R. (2019). Cancer-associated fibroblast (CAF) expression in metastatic and non-metastatic oral squamous cell carcinoma (OSCC)-a determinant in cancer progression. International Journal of Advanced Science and Technology, 28(18), 714-719. Retrieved from www.scopus.com
[9] Mumini Olatunji Omisore proposed the genetic neuro-fuzzy inferential model for the diagnosis of tuberculosis.IEEE transactions on 2014.
[10] Girisha A , M C Chandrashekhar, Dr. M Z Kurian, "Texture Feature Extraction of Video Frames Using GLCM" International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 6- June 2013.
[11] Mohamed Fazze Basha, B., & Mohamed Surputheen, M. (2019). Hybrid feature extraction and firefly based feature selection technique for lung cancer computer aided diagnosis. International Journal of Advanced Science and Technology, 28(13), 587-596. Retrieved from www.scopus.com
[12] Sema Candemir*, Stefan Jaeger, Kannappan Palaniappan, Jonathan P. Musco, "Lung Segmentation in Chest Radiographs Using Anatomical Atlases With Non-rigid Registration IEEE Transactionson Medical Imaging, Vol.33, No.2, February 2014.
[13] Marius George Linguraru*, William J. Richbourg, Jianfei Liu, Jeremy M. Watt, "Tumor Burden Analysis on Computed Tomography by Automated Liver and Tumor Segmentation" IEEE.