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Deep Learning: (Present and Future)

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Abstract: Deep Learning is an advance and emerging area of machine learning research. Deep learning is a manifold of several unseen layers of artificial neural networks. In this area of research, model abstractions of high level in large databases and nonlinear transformations are used. In the area of artificial intelligence significant contributions are made by progressive developments in the architecture of deep learning. In the present era, Deep learning techniques are playing a vivacious role in almost all areas of the real life. There is a significant contribution of deep learning in almost every field, such as speech recognition cancer diagnosis, self-driving cars, precision medicine and predictive forecasting. The limitations of traditional learning techniques are overcome by deep learning techniques. In this manuscript, a brief discussion of all algorithms of deep learning and their future development is presented in a summarized form. The basic concept of deep learning and its advantages and disadvantages are presented in the first part of this manuscript. Various algorithms of deep learning and their discussion is revealed by the second part of this research paper. The third part of research paper presents the application areas of deep learning. To discover the successive development of deep learning, above-mentioned algorithms and their applications are combined and discussed in detail. A complete summary of the entire research paper is presented in the last part of the manuscript.

Keywords: Applied Deep Learning, Deep Learning, Machine Learning, Review Algorithms

1. INTRODUCTION

A program for learning checkers was developed by IBM's Arthur Samuel in 1952. This program has the capacity to shape up the new models by witnessing the moves of the pieces and practice them to progress their playing skills. In 1959, an idea (Machine Learning) came into existence which was projected as a field of study by which a certain skill could be given to a machine without any deterministic programming. Several machine learning and deep learning models have been projected during the developmental stages of machine learning. Deep Learning models had not been paid attention at the beginning due to its intricate structure, complexity in calculation and high computing cost. Though, with the countless improvement in computer performance and the exceptional performance of deep learning made it one of the hottest research areas. In this research paper, the most important

deep learning models will be discussed in brief and analytical conclusion of development prospects of deep learning will be presented at the end.

2. RELATED WORK

Deep learning always focuses on finding various levels of distributed representations [1]. A type of artificial neural network [2] which is generative in nature and is used for unsupervised learning. An algorithm among deep learning [3] is deep belief network which is an effective method of solving the problems from a neural network along with deep layers. In [4], author has proposed a new framework for estimating generative models via adversarial nets, in which he trained two models. One of the most popular deep neural networks is the convolutional neural network [6] which derives its name from mathematical linear operation between matrices called convolution. Due to the dynamic nature and variations in real world problems and data, building of Deep Learning model is a challenging task.[11]. In the present scenario, three main reasons are there for booming of deep learning [12] which are GPU Units, lowered cost of computing hardware and adequate advancements in machine learning algorithms.

INTRODUCTION TO DEEP LEARNING

2.1 What is Deep Learning

Deep learning is a subset of machine learning [1] methods which is based on neural network and representation learning. Here the **'deep'** refers the multiple layers in the network. Methods used for deep learning could be supervised, semi supervised and unsupervised. It is a type of machine learning based on artificial neural network in which multiple layers of processing are used to extract higher level features from raw data. It can also be considered as an algorithm which is based on characterizing learning data in machine learning. The two concepts i.e., Shallow Learning and Deep Learning are relative to each other. In 1990, two shallow learning models i.e., Logistic Regression and Support Vector Machines were introduced. There were only one layer or no hidden layer nodes in these shallow learning models as shown in Fig 1.

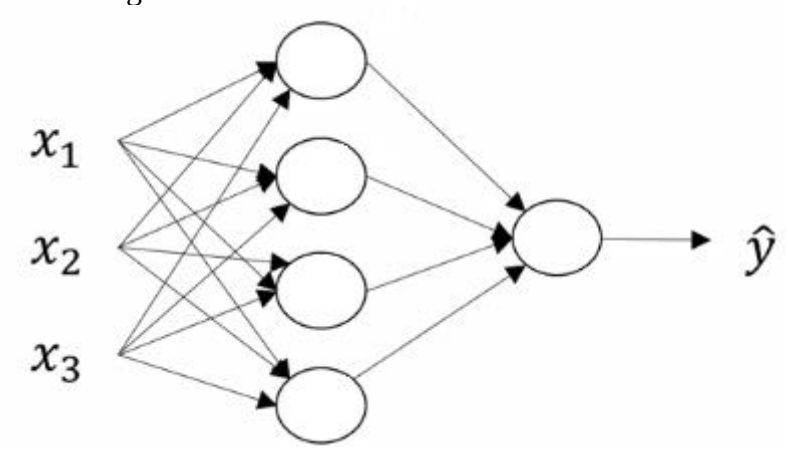

Fig.1 A Single layer Neural Network

There are numerous hidden layer nodes in a deep learning model. A multi-layer neural network is an essence of deep learning. To learn highly abstract data features, deep learning

uses input of the previous layer as the output of the next layer. Three categories i.e., supervised learning, semi-supervised learning, and unsupervised learning are used by a single-layer neural network Like machine learning, deep learning etc. Convolutional Neural Networks [6] [7], Restricted Boltzmann Machines [2], Deep Belief Networks [3], and Generative Adversarial Networks [4] are used by the classical deep learning framework. Brief introduction of these algorithms is given in the next section.

2.2 Advantages and disadvantages of deep learning

Various benefits/merits can be reckoned while using deep learning as compared to traditional machine learning methods. In [8], importance of deep learning discussed along with the Deep Learning Techniques and its network. It also discussed the challenges and suggested solutions to help the researchers to understand the existing gap. Some of them are listed below:

1. **Automatic feature learning:** Features can be learnt from data automatically by deep learning algorithms which shows that there is no requirement for the hand-engineered features. This is applicable in those cases where defining of features are difficult, such as image recognition.
2. **Handling large and complex data:** Large and complex datasets can be easily handled by deep learning algorithms which is not easy for traditional machine learning algorithms to process.
3. **Improved performance:** Multifaceted areas of research like image and speech recognition, natural language processing, and computer vision can be easily handled by deep learning algorithms.
4. **Handling non-linear relationships:** Deep learning can uncover non-linear relationships in data that would be difficult to detect through traditional methods.
5. **Handling structured and unstructured data:** Structured and unstructured both kind of data such as images, text, and audio can be handled by deep learning algorithms.
6. **Predictive modeling:** Predictions about future actions or inclinations can be made by deep learning which is helpful for the organizational planning and strategic decisions.
7. **Handling missing data:** Predictions through incomplete data is also handled by deep learning algorithms which is useful in real-world scenario where data is often incomplete.

Yet, there are numerous advantages of deep learning algorithms but still it has some disadvantages which are describing below:

1. **High Computational Cost:** Significant computational resources like powerful GPUs and large amount of memory are required to train deep learning models which leads to more cots and more time.
2. **Overfitting:** If a model is trained well with the training data and accomplishes poor performance on new, unseen data. Overfitting is a very common problem in deep learning which is caused due to lack of incomplete data or a lack of regularization.
3. **Lack of interpretability:** Deep learning models can be complex and difficult to interpret particularly models having numerous layers. Due to this it is problematic to comprehend about the predictions made by the model and to recognize any error.

4. **Dependence on data quality:** Quality of data is an important parameter to train deep learning algorithms. The performance of the model will be negative if there will be noisy, incomplete or biased data.
5. **Data privacy and security concerns:** Data security and its privacy is a big apprehension as deep learning models often rely on large amounts of data. MATEC Web

3. INTRODUCTION TO DEEP LEARNING ALGORITHMS

3.1 Convolutional Neural Network

A deep learning neural network architecture that is mostly used in Computer Vision. It is a field of Artificial Intelligence that makes a computer to recognize and understood the image or visual data. In [9], author has discussed the summary of the algorithms for deep learning and a brief discussion of its future development along with its merits and limitations. It is a type of feedforward neural network (Fig. 2) where peripheral units are covered by its neurons within the convolutional kernel. Due to this, it has excellent performance in large image processing.

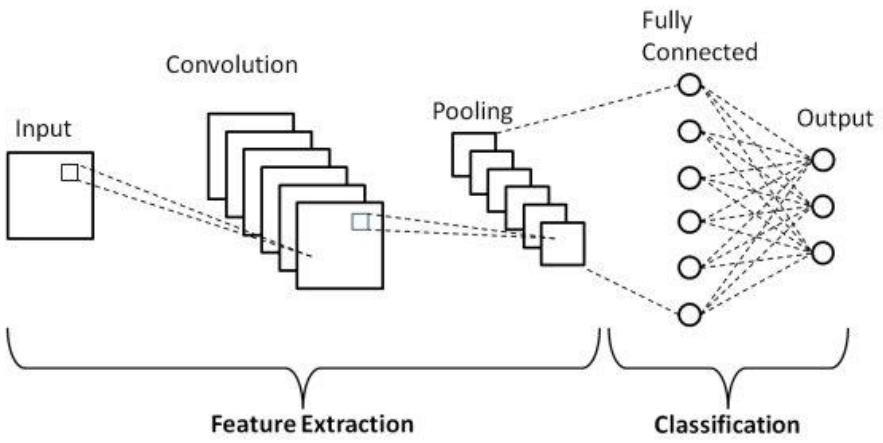

Fig. 2(Basic Convolutional Network)

Generally, a convolutional neural network comprises a fully connected layer and one or more convolutional layer. This fully connected layer includes a pooling layer for integration. Convolutional neural networks are better used in the area of research of image and speech recognition. A few parameters are considered by CNN as compared to other deep neural networks. The advantages of convolutional neural networks make it one of the most commonly used deep learning models. The basic structure of the convolutional neural network is briefly in the Fig. 2. Convolutional Neural Network, Van Hie Phung-5[5]

3.1.1 Convolutional Layer

The convolutional layer is the main building block of CNN. It contains a set of filters (kernels), which requires training to learn them. Usually, size of the filters is small than the actual image. This neural network twists data using multiple convolution kernels in the convolutional layer to generate a plurality of feature maps corresponding to the convolution kernel.

3.1.2 Pooling Layer

After the procurement of feature extraction for the purpose of classification, a large volume of data is obtained and that data is prone to over-fitting. Therefore, some statistical features must be aggregated on data at different locations. This aggregation operation is called pooling.
The main purpose of pooling layer is filtration of features after image convolution so that the operability of the classification could be better.

3.1.3 Fully connected layer

Below the pooling layer, there is a fully connected layer. It is used to wrench the feature map into a one-dimensional vector. Functionality of the fully connected layer is analogous to that of a traditional neural network. Approximately 90% parameters of the convolutional neural network are occupied by the fully connected layer.

3.2 Deep Belief Network

This network is a probability generation model. By comparing it with the traditional discriminative model (Neural Network), this model is much better as it creates a joint distribution between observation data and labels, and evaluates both P (Observation|Label) and P (Label|Observation) while the traditional model has only evaluated the latter, that is, P (Label|Observation). This network is used for unsupervised learning tasks such as functionality reduction, generative modelling etc.

3.3 Restricted Boltzmann Machine

A Restricted Boltzmann Machine is a type of artificial neural network that is used for unsupervised learning. Probability distribution can be learnt by this neural network through the input data set. It was introduced in the mid-2000s by Hinton to get the solution of unsupervised learning problem. There are two layers i.e. visible layer and hidden layer in this neural network. Visible layer is used to represent input data whereas a set of features learned by the network is epitomized by hidden layer.

It is called restricted as connection between the same neurons are not allowed. This network is trained by a process called contrastive divergence. It is used in wide range of fields like speech recognition, computer vision and natural language processing. The restricted Boltzmann machine can be trained using supervised learning or unsupervised learning.

3.4 Generative Adversarial Network (GAN)

The Generated Adversarial Network was proposed in 2014. Two models i.e., a generative model and a discriminative model are used by GAN. It is called adversarial because it trains two different networks. One network produces new data by taking an input data sample and try to make maximum modifications in it. Generated data and its relation with the original data can be predicted by another network. To ensure whether the given picture is a real picture or not is done by the discriminative model while the generative model generates an image which is much closer to the ground truth. A

picture was generated by the generated model that can take off the discriminative model. Distinguish between real picture and generated picture is the task of discriminative model. Training time of these two models is same. With passage of time, performance of the two models becomes stronger and stronger in the process of confrontation amongst two models.

Construction and use of a network is very adaptable not only for the purpose of generation and discrimination of images but also for other kinds of data.

4 DEEP LEARNING APPLICATIONS

In [10], author has introduced deep learning techniques from various aspects, including common models of deep learning and their optimization methods, commonly used open-source frameworks, existing problems and future research directions. Below are some significant applications of deep learning:

4.1 Image processing

Manual selection of features is a very arduous method. It is very time-consuming process. As we know that there is always a variability in manual selection, so it's better to learn the features by computer automatically which can be done by deep learning. For pre-processing step in image recognition, deep learning exploits the outlines of multi-layer neural networks, extract features and process them for an image.

Complete architecture of convolutional neural network could be understood as an example i.e., a multi-layer neural network is established by the convolutional neural network which uses convolutional layer to do convolutional operations for feature retrieval. After that the data training and processing is done by the fully connected layer and pooling layer.

At present, neural network image recognition can't be easily done by human eye as the large amount of image data is processed by neural network and the results are much effective than manual recognition. Manual processing of huge amount of data leads inefficiency which can be avoid using the neural network and it shows a splendid improvement. Face recognition technology is also provided by deep learning. There are numerous application areas like finance, justice, military, public security, border inspection, government, aerospace, electric power, factories, education, medical care and many enterprises and institutions. Neural network avoids excessively complex feature extraction when applied to face recognition.

4.2 Audio data processing

Deep learning has a thoughtful impression on speech processing. Embedded algorithms on the basis of neural models, provide almost every solution in the field of speech recognition. Speech recognition is basically divided into three main parts:

a) Signal level
b) Noise level
c) Language level

Speech signals are extracted by the signal level. These signal levels improve the signal, and performs suitable steps for pre-processing like cleaning, and feature extraction. Different features are divided into different sounds by noise level. Combination of sound into words and then into sentences by language level.

On the basis of neural model, numerous techniques are used for extracting and enhancing the speech itself from the signal. At the same point of time, it is also possible to substitute the classical feature extraction method with a more multifaceted and effectual neural network-based method which greatly progresses the efficiency and accuracy. A variety of different depth learning techniques are included in noise and language levels. Sound level classification and language level classification is done by different types of neural model-based architectures.

5 FUTURE WITH DEEP LEARNING

5.1 Representation Learning

The essential of deep learning is understanding of features and abstraction. Thus, feature learning has a significant role in deep learning. Since the crux of deep learning is a multi-layer neural network and due to this type of network some significant information is mislaid at the time of feature extraction and conveying them to the lower layer. By extracting too much features of an image over-fitting could be possible. So, it is one of the major concerns in deep learning research. Therefore, representation learning is required which postulate how to precisely excerpt the required features to evade the problem of over-fitting. Progress in this area of research will also be significant for classification and generalization task of neural networks.

5.2 Unsupervised Learning

A large amount of labelled data needed to train a supervised neural network which leads to extra cost. Hence, machines are required to do this and it also leads to the reduction of cost. Go evaluation program such as AlphaGo Zero can also run successfully by using unsupervised learning. It has been proven in some applications that if the preceding knowledge of a human being is zero, even then machines can attain exceptional training results. For this, unsupervised learning is used to mechanize the machine's learning from the human knowledge base and it may contribute to the technological development in these areas. Furthermore, the research area of unsupervised learning has not been expanded yet as most peoples are focused towards the research on supervised learning. Thus, there is a vast scope in the research area of unsupervised learning. In future, the core research area of deep learning could be unsupervised learning as researchers are more focused towards this.

5.3 Theory Complement

One of the major limitations of deep learning is that there is no provision of theoretical concepts and the absence of theory hamper the expansion of deep learning. As a promising area of research, deep learning is getting attention. Due to incessant research in deep learning the theory of deep learning is continuously refining. However, for the thorough discussion of inner principles of deep learning theory is still not enough. At

present, the research in deep learning practices theory and practical tests (actual test and the experiment-based tests). To improve the model's performance, the theory can't be further researched, only the parameters can be adjusted. Hence, complete theoretical support is required for the future development of deep learning.

5.4 Perspective of Deep Learning Applications

The two main application areas of deep learning are image recognition and speech processing. In addition to that, deep learning has also been used in natural language processing. Some précised applications like intelligent dialogue robots such as Siri, image classification, medical image processing, autonomous driving etc. are also using dep learning. Some frameworks of deep learning have specific application situations, like convolutional neural networks, mainly used in the area of image processing. In the work of medical image processing, for example, the use of convolutional neural networks for brain tumour segmentation has achieved an accuracy of more than 90%. Also, in medical applications, convolutional neural networks can be used to recognize Alzheimer's disease brain image, and more accurate diagnostic results can be obtained combined with manual judgement. Medicine is only a part of deep learning applications. To save people's workload and to improve the quality of result, well-trained machines can often calculate some details that are hard to be solved by human. Viewing of images manually and recording them is a very tedious job and is not so much effective. Therefore, deep learning is used for image recognition which not only saves manpower, but also enhances the effectiveness of the result.

6. CONCLUSION

In this research paper, some of the main algorithms of deep learning are introduced and some inferences for future development of deep learning are discussed. Deep learning has already had a detailed research area and a wide range of field of application and has been put into practical use in real life with exceptional performance. Still, more research is required to feat in the area of deep learning and neural network.

3 REFERENCES

1. Guo Y , Liu Y , Oerlemans A , et al. Deep learning for visual understanding: A review[J]. Neurocomputing, 2016, 187(C):27-48.

2. Chun-Xia Z , Nan-Nan J I , Guan-Wei W . Restricted Boltzmann Machines[J]. Chinese Journal of Engineering Mathematics, 2015.

3. Hinton G E , Osindero S , Teh Y W . A Fast Learning Algorithm for Deep Belief Nets[J]. Neural Computation, 2014, 18(7):1527-1554.

4. Goodfellow I J , Pouget-Abadie J , Mirza M , et al. Generative Adversarial Networks[J]. Advances in Neural Information Processing Systems, 2014, 3:2672-2680.

5. Phung H.V., Eun R.J, "A High accuracy model average ensemble of convolutional network for classification of cloud image patches on small datasets". MDPI, 2019, 9(21).

6. Albawi S., Mohammad A.T., Zawi S.A, "Understanding of a convolutional network", IEEE explore international conference on Engineering and Technology (ICET),2017.

7. Taye M.M, "Theoretical Understanding of Convolutional Neural Network: Concepts, Architecture, Applications and Future Directions", MDPI, 2023, 11(3), 52; **doi.org/10.3390/computation11030052**

8. Alzubaidi L., Zhang J, "Review of deep learning: Concepts, CNN architectures, challenges, applications and future directions", Journal of Big Data, 2021, 53(2021).

9. Hao Z "Deep learning review and discussion of its future development", MATEC, Web of conferences 277, 02035, 2019.

10. Mu R., Zeng X "A review of deep learning research", KSII transactions on internet and information systems, 13(4), 2019, **doi:10.3837/tiis.2019.04.001.**

11. Sarker I.H. "Deep Learning: A Comprehensive overview on techniques, taxonomy, applications and research directions", SN Computer Science, Vol. 2, 420(2021)

12. Guo Y, Liu Y, Wu S, "Deep Learning for visual understanding: A Review", Neurocomputing (Elsevier Journal), Vol. 187, 2016, pp. 27-48.