A Study On Research Trends In Deep Learning In Various Engineering Fields

K. Sabeetha, P. Pradeepa, P. Muneeshwari

Abstract: Deep learning comes under the broader concept of machine learning where the computers learn through examples. Deep learning includes many smart-world systems that are human-centred. These systems vary from self-driving vehicle systems, natural language assistants to targeted advertisements. Deep learning has been incorporated into many research areas to solve lot of problems. In this paper, deep learning is investigated thoroughly across different mechanisms and applications in smart systems. New areas for deep learning research are outlined. This paper would be of immense help to newcomers in deep learning.

Keywords: Deep learning,neural networks,human-centred smart systems,Internet of things, emergent applications

1.INTRODUCTION

Deep learning is applicable to different types of data like audio, text, numbers, video or a combination of any of the data types. Deep learning in conjunction with cyber-physical systems[10],Internet of things[IOT][11] and bigdata analytics[9] has rich potential in minimizing complex large datasets into very accurate smart-systems for human usage. The sophisticated platforms for deep learning are mostly open for public utilization. Heavy investments are made by Amazon, Microsoft, Apple, Google etc. for innovations in software and hardware to develop smart-products for the next generation [3].Implementations of deep learning have shown good results in terms of accurate predictions. Supervised learning in deep learning applications like image recognition and handwriting recognition have shown better results than humans [8]. Unsupervised learning on large datasets has given interesting results of significant commercial value using statistical analysis. In reinforcement learning where the learning happens without human supervision is highly suitable for computer vision and robotics. This work makes a broad outline of areas where deep learning has been applied.

2.DEEP LEARNING OVERVIEW

Deep learning imitates the human neuron's learning procedure in order to create neuronal structures that are interconnected in a complex manner. Deep learning has its origin from information theory and cognitive theory. The generic neuron has the ability to work with any type of data. The neural model of computing neurons has the capability to learn indiscriminately [14]. The neural model has a general structure that is applicable for all problems.The training data is fed to a deep learning algorithm to learn based on the contribution of a set of features or it could be for a distribution of a single feature. The validation of the training data is done using validation set. The validation set improves the accuracy by turning the parameters used in the learning algorithm. The test set of untrained and unobserved data is the final factor in determining the overall accuracy of the algorithm.

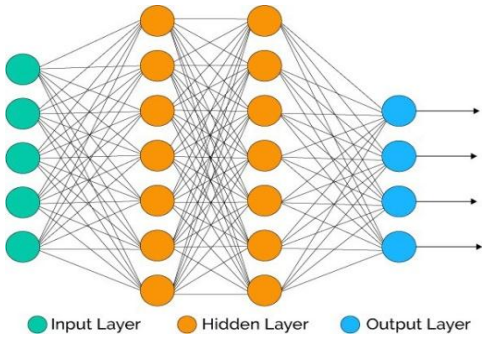

Figure 1: *Neural network representation*

Deep learning is a real world application of a neural network that has multiple neurons and is multi-layered. The neural network has an input layer, one or more hidden layers and an output layer as shown in figure 1. The raw input data from the input layer is fed into the hidden layer. There may be the multiple hidden layers in the network based on necessity or the applied function. The final output comprising regressive data values comes out of the output layer. The layer in the network may be fully connected or partially connected between layers. Few connections may be removed randomly in order to eliminate over-fitting.

3. DEEP LEARNING CATEGORIES

The different categories of deep learning are supervised, unsupervised and reinforcement learning depending on the learning mechanism as shown in figure 2.In Supervised learning, clear labelling of investigative data is required. The output result may be declared as incorrect or correct clearly. Supervised learning is a predictive mechanism where the data is split into training set, validation set and final test set to check for accuracy. For generalization of new data, statistical techniques like recall, precision etc., are used. Classification and regression are the important learning tasks. Classification maybe in the form of binary, multi-class, multi-label or all pairs. Malware detection[7] and handwritten number classification are examples of classification[14].The learning through regression provides continuous-valued numbers as output. The application area of regression includes object recognition and localization[13].

- *K. Sabeetha, P. Muneeshwari, are Assistant Professor in Department of Information Technology,PSNA College of Engineering and Technology, India. E-mail:myphdreserach@outlook.com*
- *P. Pradeepa is Associate Professor in Department of Information Technology,PSNA College of Engineering and Technology, India*.

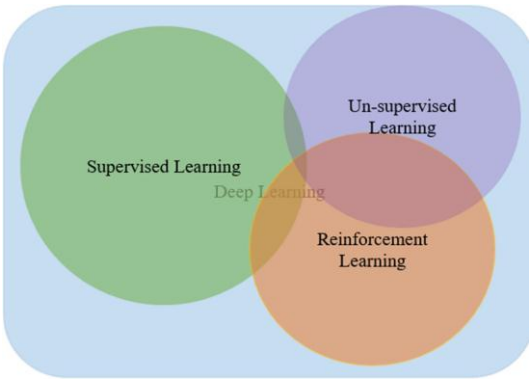

Figure 2: *Deep learning categories*

In unsupervised learning, the input datasets for learning cannot be determined as correct or otherwise. The accuracy of the learning algorithm is found through human visualization. The different learning techniques in unsupervised learning are dimensionality reduction, clustering and density estimation. Discriminate analysis and component analysis are used to carry out dimensionality reduction. Data and storage space compression is achieved by input transformation using auto encoders. The elimination of redundant and noisy datain video files[15] and the use of deep belief networks in order to minimizehyperspectral image dimensions[5] are some examples of dimensionality reduction. The grouping of data statistically is done through clustering. Actually, this grouping is accomplished through fuzzy cluster membership and cluster centroids. A fuzzy data could be a member of multiple clusters as the edge clusters are also fuzzy. Real-time registration of image using self-oriented feature maps[6] is a good example.The feature extraction from a data distribution using statistical means or approximation is defined as density estimation. Examples of density estimation include estimation of vehicular traffic density using heterogeneously distributed video content[16] and reduction of noise in assisted learning devices[12]. The intermediate between the unsupervised and supervised learning is reinforcement learning. There is direct interaction with the environment in reinforcement learning. Hence any change in environment would be given a reward. The aim of reinforcement learning is to make each state transition to be very high. The two main techniques for reinforcement learning are value function and policy search. Policy search may be either backpropagation or gradient-based and evolutionary or gradient-free. Example for policy search is AlphaGo program of Google. Value function tries to increase the expected value to a maximum point taking into account every action of a state.

4. PLATFORMS FOR DEEP LEARNING

There are many open source deep learning platforms like tensor flow from Google, deeplearning4J (DL4J) by skymind[4], Theano, Microsoft cognitive toolkit, MXNET from Apache[1] and CAFFE2[2].

5. APPLICATIONS OF DEEP LEARNING

The applications of deep learning bring the disillusioning thing into real by solving and exploring problems in various domains.

5.1 Speech and Audio

The traditional methods are used for speech recognition for long time. Typically it reduces the performance compared with the state-of-the-art systems. The deep learning technique is used by integrating with the powerful discriminative techniques for phonetic recognition. The success of speech recognition depends on minimum requirement of decoder changes, lesser errors, simplicity of training to use big data. It organizes events in musical time i.e. in time series, that modifies the rhythm and expression. The signals are measured and combined by mixing short-term and long-term dependencies. By applying biologically motivated techniques for processing the complexity is reduced.

5.2 Self-Driving-Cars

The technology integration of deep learning brings autonomous driving to real life by using datasets to feed the system, make the system to learn and test in safe environment. Deep learning algorithms are used to test and implement for different scenarios. Data is gathered fromsensors, cameras and geo-mapping to create sophisticated models to identify paths, traffic volume, pedestrian routes and road-blockages. A regular research is going on in AI labs for implementing other purposes like food delivery, goods delivery and providing emergency services for sick persons in healthcare industry also.

5.3 DETECTION OF DEFECTS IN SEMICONDUCTORS

In wafers and dies manufacturing, defects cannot be identified until the product is packaged. The use of deep learning helps to pinpoint the defects in earlier stage as shown in figure 3. It also helps to improve the production process.

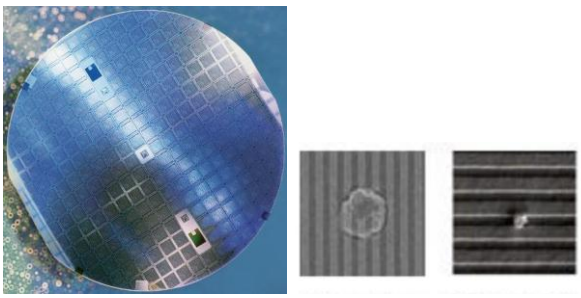

Figure 3: *Defects in silicon wafers*

5.4 NEWS AGGREGATION AND FRAUD NEWS DETECTION

The classifiers are developed to detect fraud and biased news using deep learning technique. It removes that type of fraudulent news and take efforts to avoid customization of news as per readers. Classification and regression techniques of machine learning used to detect fraud.

5.5 VIRTUAL ASSISTANTS

The popular virtual assistant is from Alexa to Siri to Google Assistant. It creates the opportunity to learn from voice and accent by providing human interaction experience. It uses deep learning to learn about human preferences in visited places, favourite songs and favourite readings. The applications are capable to understand human language and execute them. They can do auto-responding for

specific calls and capable to coordinate tasks and send an appropriate mail copy also.

5.6 ENTERTAINMENT

Nowadays cameras are ready to study human body language by using deep learning artificial intelligence concepts. In video analysis by using these concepts to recognize the face and pattern for editing and creating the content in reality.

5.7 HEALTHCARE

In healthcare industry this technique is used for analyzing genome pattern and involves discovering new medicines and improving the life time by early helping and diagnosing speedily.Artificial intelligence concepts are used in research centers to find cure for untreatable diseases. Early detection methods are used to find autism,speech disorders,developmental disorders and provide treatment for differently-abled children.

5.8 MARKET ANALYSIS

Deep learning techniques are employed to predict and analyze the market fluctuation. Stock market prediction is done by using neural tensor network. It helps to increase the accuracy and profit in stock prediction.

6. PERFORMANCE RESULTS

Deep learning needs a larger training data to understand the exact scenario. Hence the performance of deep learning algorithms in terms of actual execution time is good when compared with older machine learning algorithms as shown in figure 4. The deep learning algorithms require higher end machines for execution and provide highly accurate results quickly.

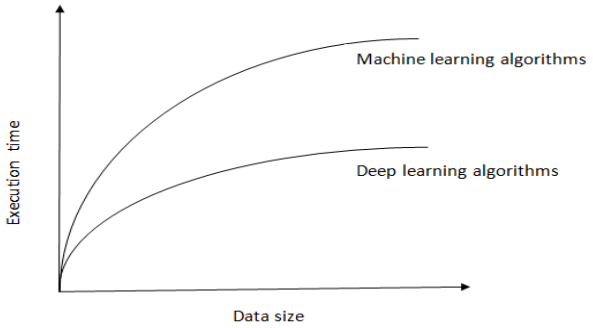

Figure 4: *Deep learning vs Machine learnig*

7. CONCLUSION

Deep learning technology gets mature every day as it is applied to whole lot of varied domains and for different applications. The research in deep learning has been investigated thoroughly in this paper and would be of immense help to practitioners and the researchers in computer science (2017).

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