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An Overview of Deep Learning

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Abstract — *Learning is an ongoing process which paves the way for developing effective knowledge. The Deep learning is a young area in machine learning which obtained the basic intelligence from Artificial Intelligence. It includes the area of speech, pattern and visual object ecognition and many other domains like medical transcription and genomics. The algorithm of Deep leanings can be perfectly matched with the human brain workings which have many neural network layers and make differ from machine learning. This paper provides an overview of analysing the Deep Learning types, features, and comparisons towards machine learning.*

Keywords: Machine Learning, Deep Learning, Artificial Intelligence, Machine Learning.

1 INTRODUCTION

Machine Learning is used to make exact decisions based on observation and predictions. At present the concept of machine learning is used in many applications of intelligent systems. Machine learning systems are used to identify objects, images, record speech into text, game and news [2].They are also practiced in pattern recognition techniques such as fingerprint image, handwriting word, human face, speech signal and in DNA sequencing [3].

Deep learning is a set of machine learning algorithms [4]. It tries to represent the high-level abstraction of data model architectures. Deep Learning architectures are stimulated from the human vision system, these methods have become popular in the last few years due to the incredible results obtained in speech, visual object recognition and detection, natural language processing, etc.

Deep learning is evolved from Artificial Intelligence. This method provides computational model future to the collections of multiple processing layers to learn representation of data with multiple levels of abstraction [5]. This area provides solutions for arising problems in the current field of learning. Deep learning is required with corresponding to the human brain process in visual and audio input to create useful high level features for the higher- level learning problem to be solved [35].

Deep learning is a best increasing field of machine learning, which is used in layered Deep Neural Network (DNN), is to study the level of representation and concept of intelligence data such as image sound, text. Today more Deep Neural Network algorithms are used. In the big data computational authority of GPU changes these lively machines which are now able to learn at speed correct level. Dynamic Artificial Intelligence helps to solve many big data problems such as computer vision, speech recognition and natural language processing. This featured deep learning accurate in big data that is more powerful in automatic methods there is applied.

2 TYPES OF LEARNING

TABLE 1 - Types of Deep Learning

S.no	Types
1	Structure Learning
2	Hierarchical Learning
3	Reinforcement Learning

a. Structure Learning

Structured Learning is a significance of the empirical data in deep learning to predict the state –of –the art model. Deep learning structures in new features of the structured support vector machines [24]. Structured representation is training the data [25]. Deep learning is structured in a random graphs, that joint with deep features to form potentials within a Markov Random Field (MRF). Our approach will be efficient as it blends learning and inference, ensuring the algorithms which make use of GPU acceleration. It demonstrates the effectiveness of structured model. A new success in deep learning is to apply convolution of Deep Boltzmann machine and belief network to provide generic Structured Learning [26].

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Hierarchical Deep Learning

It architects the real world hierarchical visual features utilizing supervised and unsupervised learning approaches respectively [27]. "HD" stands for "Hierarchical-Deep," because they are derived by composing hierarchical nonparametric Bayesian models with deep networks. Two influential approaches from the recent unsupervised learning literature with complementary strengths. Recently introduced deep learning models, including deep belief networks (DBNs) [12], deep Boltzmann machines (DBM) [29].

b. Reinforcement Learning

Reinforcement Learning is a type of Machine Learning, and so also a branch of Artificial Intelligence. It allows machines and software agent too automatically to decide the perfect behavior within a specific context, in order to maximize its performance. Reinforcement Deep Learning in robotics features of machine learning in stochastic gradient descent using in minimizing the errors in end to end learning methods, and it combines the machine learning in artificial learning methods. The Reinforcement learning aim towards locating the actions of the agent that yields maximal payment for the task at hand. Deep Reinforcement Learning (DRL) get the authority Deep Neural Network which stand on the generic tasks of trial and error of the learning established on tasks such as video games using this methods.

II Generalized Deep learning Algorithm[31]

Step 1 - Identify the scientific goal for prediction / estimation.
Step 2 - Collect the data.
Step 3 - Explore the data for patterns.
Step 4 - Build and validate the model.
Step 5 - Communicate the results.

Table 2-Popular Deep Learning Algorithms

S.no	Algorithm	Author
1	Deep Boltzmann Machine DBM)	Jourgen Schmidhuber
2	Deep Belief Networks (DBN)	Geoffrey Hinton
3	Stacked Auto-Encoders	Andrew Ng
4	Convolution Neural Network(CNN)	Alexey Grigorevich Ivankhnenko
5	Recurrent Neural Network(RNN)	Stephen Grossberg

a. Deep Boltzmann Machine

Boltzmann machine is systematically connected to the network where Stochastic decisions like the neuron whether to be on or off [6]. The entire layer Undirected connected with high level representations built from unlabeled input. Slightly used label data fine rotates to the model. In multiple layer model undirected connection between the layers of complete Boltzmann machine. After the pre-training, the RBMs are to create deep network "unrolled", which is then modified to use the back-propagation on error derived as exposed. The use of the pre trained DBM is to initialize a Deep Neural Network and to train with back propagation as the stacked auto-encoder that explains the previous part on deep learning of compression on data. All the layers of undirected layers are connected between the units. A Boltzmann machine Learning is good generative model that performs on handwritten digit visible object recognition tasks [9].

A Boltzmann machine (BM) network is symmetrically stochastic unit of binary, in which visible unit v € set hidden units h € to learn model better kind correlations Among the visible units, in energy state {v,h} is called Boltzmann machine.

$$E\ (v, h;\ \theta)\ = -vT\ Wh - \tfrac{1}{2}\ vT\ Lv\ = \tfrac{1}{2}\ hT\ \ Kh$$

In θ{W,L,J} model represents hidden and visible systematic communication in biases equal to weight connection fixed in to state L, equal derivation respected to the weights.
In probability the model diagonal element L and K set of θ on visible vector [29].

$$P\ (v;\ \theta) = \frac{p*(v;\theta)}{Z(\theta)} = \frac{1}{Z(\theta)} + \sum h \exp\ (E\ (v,h;\theta)$$

$$Z(\theta)\ = \sum_{V} \sum_{h} exp(-E(V, h;\ \theta))$$

P*is renormalized probability and Z (θ) is partition function conditional distribution of this function.

$$P(v;\ \theta) = \frac{1}{Z(\theta)} \sum h1, h2 \exp\ (-E\ (V, h1, h2;\ \theta))$$

In multiple layer model undirected connection between the layer in complete Boltzmann machine [28].

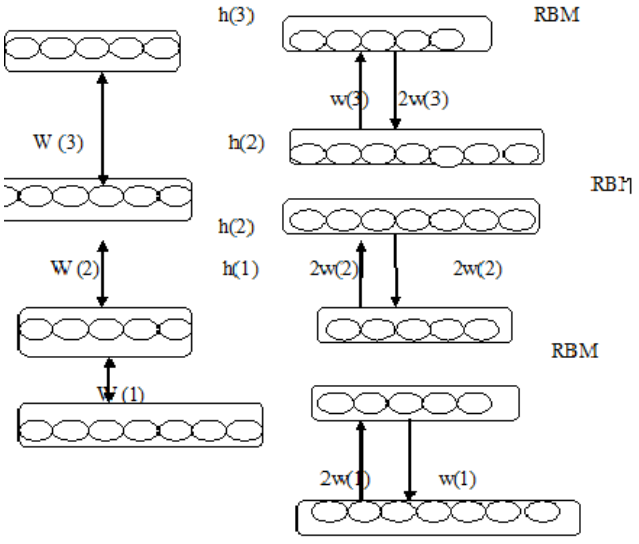

Figure-1 Pre-training in Deep Boltzmann machine

Boltzmann machine applications are two types (i) solving combinatorial optimization problems and (ii) transport out learning tasks. Further works on Numerical results of computer simulations are presented to demonstrate the characteristic Boltzmann machine.

b. Deep Belief Networks (DBN)

Deep Belief Networks is the basic form in Deep Neural Network architectures. DBN is the generative probabilistic representation in the visible layer of bottom and the hidden layers up to the output. Every hidden layer unit learns the statistical representation through the links of the lower layers. The more higher the layers, the more complex are the representations. To avoid this kind of problem in greedy layer wise the unsupervised pre-training can be used. After the pre-training it is potential to do a winning supervised learning. The pre-training initially weights values for actual supervised training period.

Deep Belief Network (DBN) in (MLP) Multi Layer Perception network is a combination of DBN by Linear Perception (LP) training to evaluate the performance by testing the whole motivation. Combining DBN in LP is the best performance in Linear Perception. Training the RBM stack with correct response labels in feedback and forward signaling. Differing from multi-layer perception DBNs is using many applications.

i. Multi Layer Perceptron

Multi layer perceptron is explained of its weights using a gradient descend advance like RBM. A two layer perceptron network is hugely adequate to estimated function or solving classification tasks between the primary input and output nodes [26].

$$\text{m}ui(1) = \sum \text{xkw}(1) - \theta\text{i}(1)$$
$$\text{K=1}yi(1) = f(ui(1))$$

The non linear transfer the function output nodes bias h (2) [< n, in output of hidden node

$$uj(2) = \sum i(1)wij(2) - \theta\text{j}(2)$$
$$y\ j(1) = f(uj(2))$$

Squre optimization using to layer weight

ii. Linear Perception

The linear perception in single node received the input of "network" x<m and weight threshold h<. The output layer in additional, lost the component liner perception.

$$\text{Y }\{1 \text{ if } \text{w x}< 0$$
$$0 \text{ if } \text{w x} > \text{o}$$

In 1, the learning rule means the weights and threshold value [30]. $Wt = 1 = Wt + (t - y)x$,

Deep Belief Network applications are as follows,

- Deep Belief Network is developed with the musical features that are applied to the model according to the emotion recognition.

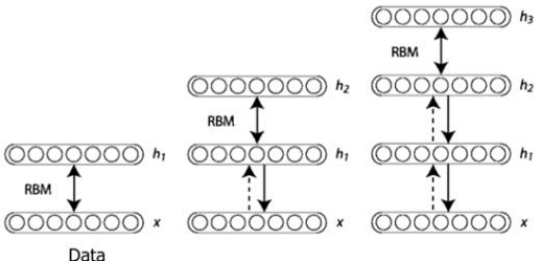

Figure-2 Deep Belief Network Architecture

- DBN in algorithm by using the phone recognition
- The other applications of the Deep Belief Network are Spam Filtering Preparation method. This method is used to detect spam with the help of DBN.
- Deep Belief Network is the model for the spectral variability [31].

The Deep Belief Network are developed using chi-squared based features. By selecting the language it decreases irrelevant features through filtered learning. The semi-supervised learning algorithm is well-known and compared with classification for its accurate speed.

c. Deep Stacked Auto encoders

Deep stacked auto encoded aims at to study the representation of data. Stacked Auto encoded is a learning generative model of the data [19]. Deep Neural Network auto encode the data target and output the tasks by itself. Auto Encoded is an Artificial Neural Network, used for learning efficient coding that and compressed Representation of data which means dimensionality and reduction of data density. The Auto encoded is intermediated from the layer of correct input to the uncorrected to use the encoding input. The Input layer uses the learning features to train the other layers of auto-encoder, by using the learned weights of Deep Neural Network. The neural network for using recognition model in difference auto encoded [16].

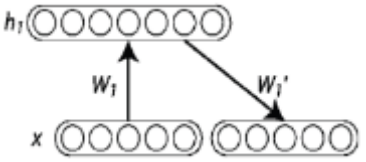

Figure -3 In Initialized the weight and hidden layer

Deep Stacked Auto Encoders feeds the forwarded Neural Network to predict the input and output. Architecture such as pre- training layer, each layer is trained with the Denoising Auto Encoders.[41] Denoising Deep Auto Encoders is a good representation to obtain robust features from the corrupted input to equivalent clean input. In the higher representation even robust corrects the input for the useful representation on extracting the features of input distribution. Similar to Deep Auto Encoder, we can load multiple Denoising Auto Encoders in a layer wise to form a Stacked Denoising. Deep Stacked Auto Encoder's applications are Dimensionality reduction, Dropout, Contractive Auto Encoders, Sparse Auto Encoders [43]. The features of Deep Stacked Auto Encoder's are Robustness [39].

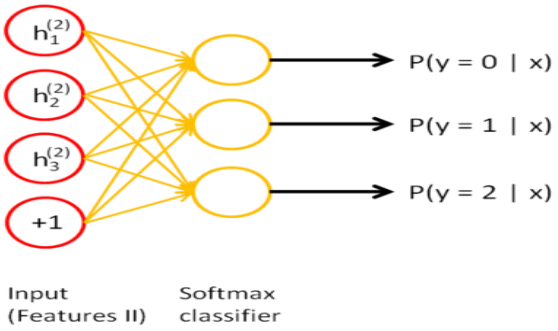

Figure-4 Auto-encoder is set to output and equals the input layer in order to train the network.

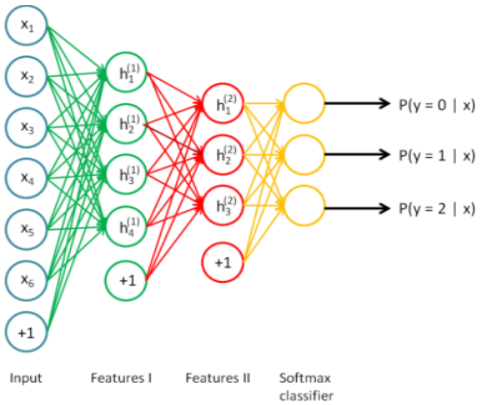

Figure-5 Stacked auto-encoder weights initialize Deep Neural Network.

Encoding in the various noisy images by exacting the same position is the features of Stacked Auto Encoders. It is used in automatic diagnosis, Medical image retrieval [40].

d. Convolution Neural Network

Convolution Neural Network is filtered and encoded by transformation. In this Conv olution Neural networks (CNN), every network layer acts a detection filter for the existence of patterns from the Convolutions Neural Network [14]. A Convolution Network Layer followed by a dynamic pooling layer and a non-linearity form a feature map. Convolution Network is used in object recognition. CNN is state- of- the-art in computer version of many tasks [15].In this Convolutions Neural Network last layer is made of ultra-specific. In recent years of achievement, Deep Convolution Neural Networks have unique performance in the field of face and image classification on location recognition. Trained to the image net the use of CNN [10] in every network layer acts of filter for the existence of specific features or pattern and present in original image, CNN is a success filed and image classification. In different areas the CNN is applied to solve the ultra-complex translated to image data.

The Convolution Neural Network is a feed Forward Neural Network in the field of sharing weights. The local accessible who fills the small portion of the data, in other words it is called the window shift. The local accessible field in small level of same parameterization and spatial sequential sub sampling in applied on convolution Neural Network.

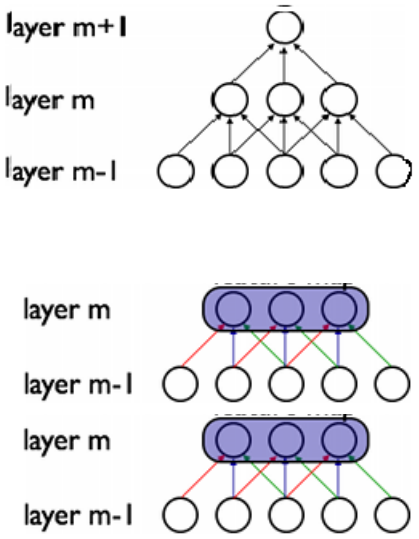

Figure-6 initializing the CNN sharing weight

CNN is share the weight in Convolution Neural Network by ordering process and sub sampling process of input and trainable filtering f x and trainable bias b x in convolution layer in sub sampling. Sums of in neighborhood(pixels)in weight scale Wx+1 and trainable bias bx+1 in sig model function to produce the smaller function in feature Sx+1 C x is comfort the input data, in converted features in smaller-dimensional function of maps Sx+1 using the sub sampling process.

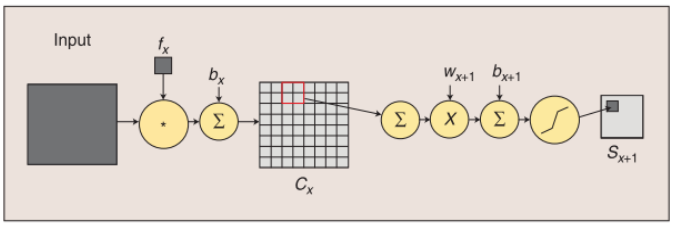

Figure 8 - Architecture of convolution neural network

In machine learning, a Convolution Neural Network (CNN or ConvNet) is a type of feed-forward Artificial Neural Network in which the connectivity pattern between its neurons is inspired by the organization of the animal visual cortex. Pooling layer is the maximum value of sub-regions, with this activation of the neuron hidden to representations determine the match among the feature and input field, the number of filter casual decodes each pixel on pooling layer Convolution Neural Network fits over in the pooling layer of the non-overlapping and input images in rectangles altogether such as sub-region in maximum value in features of region. The Application of Convolution Neural Network is Handwriting and numerical recognition. Image recognition takes in handwritten numerical network and many usages of banking check information, and postal codes, some documents, etc., handwriting numerical recognition. Convolution Neural Network is represented by Image Recognition System. Neural Network variation encoding technology is set further with krussul results in well such recognition used in everyday jobs as handwriting numerical recognition and facial recognition in object.

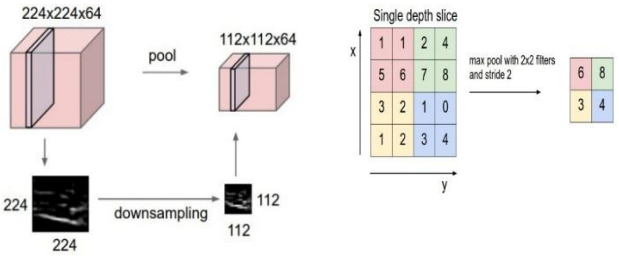

Figure- 7 CNN region and sub region of pooling Layer [35]

Convolution Neural Network latest research work, in future work applied to facial recognition [34]. Speech recognition, documentation analysis [35], newly via by continuous structure input data video data CNN, The achieved human recognition of video regularity [34].

e. Recurrent Neural Network

A Recurrent Neural Network (**RNN**) is a class of artificial neural network where the connections between the units form a directed cycle. This creates an internal state-of-the network which allows exhibiting the dynamic temporal behavior. Unlike Feed Forward Neural Networks, RNNs can use their internal memory to process arbitrary sequences of inputs. This makes them applicable to tasks such as non segmental connected handwriting recognition or speech recognition.

The idea behind RNNs is to make use of the sequential information. In a traditional Neural Network we assume that all inputs (and outputs) are independent to each other. But for many tasks it won't work out. If we want to predict the next word in a sentence, it is better know which words come before the previous one. RNNs are called *recurrent* because they perform the same task for every element of a sequence, with the output being depended on the previous computations. Another way to think about RNNs is that they have a "memory" which captures information about what has been calculated so far. In theory RNNs can make use of information in arbitrarily long sequences, but in practice they are limited to looking back only a few steps (more on this later a Recurrent Neural Network is an input sequence in predictive label in the entire step in back propagation of error updates the weights. Recurrent Neural Network is the hidden layer of the nodes [37]. It check the Neural Network, a looks in input X t is output value ht, looping information from the network [35].

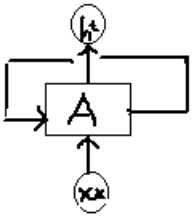

Figure 9 - Recurrent Neural Network in looping structures

Recurrent Neural Network applications are in the field of Machine translating, Speech recognition, Handwriting recognition, Opening mining and more.

Deep recurrent neural network (DRNN) is helpful for character level Language model, success in state-of-the-art performance for recurrent neural networks on a Corroborate Observation that deep recurrent architectures can boost performance one is to expand common pre-training scheme, such as the deep belief network approach and Deep auto encoders for DRNNs. The results in this paper can potentially add to the Ongoing discuss on training algorithms, Therefore, applying second order techniques Hessian-free training DRNNs seems an attractive line of future research in order to Get a hard comparison.

3 DEEP LEARNING APPLICATIONS

Artificial Intelligence in machine learning with deep learning techniques in successfully applied in the several filed such because image, sound, text and motion. Deep learning is a scientific activity that has been empirical and motivated successfully in the industry. Deep learning is created on Neural Network Training Deep Learning algorithm [21].

Table 3 – Applications

S.No	Applications
1	Object Recognitions
2	Speech Recognition and Signal Processing
3	Natural Language Processing
4	Recommendation System

a. Object Recognition

Object Recognition is a nontrivial computer tasks standard for several machines learning algorithms used in classification problem. MNIST digits image with deep learning is focused in support with vector machine and data set, which presents the state of art and the knowledge version of MINIST. In last few years deep learning is object recognition in natural image and extended from the digits. In latest advanced has been achieved on image set and data set.

b. Speech Recognition and Image Processing

Speech Recognition using image proccessing and Neural network be early now application. Speech Recognition is used in Convoluation Neural Network. In this Speech Recognition is transformed to the machine program. The speech recognition includes voice,dialling and call routing[23]. Speech recognition preprocesser in futures hand designed specilized input using most input of deep learning unprocessed input. Deep learning based on unsupervised toward speech recognition is applied in Speech Recognition with information processing problem,such as speech recognition,and machine translation, natural lanuauage understanding,and biomatic information processing.

c. Natural Language Processing

Natural Lanuguage Processing is a human language used in computer to translate to the machines Language. Natural Lanuguage Processing includes many application such as Machine Translation, language with in which the learner

should read a sentence. Individual human language produces an equal sentence. A chance of distributing more sequences of words for the more NLP model applications. The feature related NLP tasks includes part-of-speech. Deep Learning advances from NLP which draw from the wealthy set of sentence and hand-designed features which will be feed to a traditional little classification algorithm. The complete experimental procedure of Natural Language of example in support with vector machine, architecture deep neural network is trained into end-to-end method [26].

d. Recommendation System

In the Internet, where the number of choices are overwhelmed, there is a need of filter, prioritize and efficiently deliverance of relevant information in order to alleviate the problem of information overloaded, which has created a potential problem too many Internet users. Recommendation Systems solve this kind of problem through searching through large volume of dynamically generated information to provide users with personalized content and services. This paper explores the different characteristics and potentials of different prediction techniques in recommendation. Recommendation Systems are beneficial to both service providers and users. They reduce the transaction costs of searching and selecting an item in an online shopping environment. Recommendation systems have also proved to be in decision making process and quality. In e-commerce setting, Recommender Systems enhance revenues, by the effective means of selling more products. In scientific libraries, recommender systems support users by allowing them to move beyond catalog searches. Therefore, the need of using efficient and accurate Recommendation techniques within the system will provide relevant and dependable recommendations for the users that cannot be over-emphasized.

4 CONCLUSION

Deep learning is a new area of research in artificial intelligence which will be the focus for this decade and so it emphasized the authors to make a good survey of this area for the benefit of their research and as well of the others who are willing to migrate to it. This paper provides a good classification of the different types of deep learning, a generalized deep learning algorithm, explanation of the workings of popular deep learning algorithms and the possible areas of applications for deep learning. So the researchers believe that, this survey paper will enlighten the other researchers with knowledge provided in this research article.

REFERENCES

[1] Rob Schapire "machine learning algorithm for classifications" Princeton University,2010.
[2] Speaker Yi-Fan Chang Adviser Prof. J. J. Ding"An Overview of Machine Learning" 2011.
[3] Prof. Richard Zanibbi "Pattern Recognition an overview" by L. Kuncheva, Wiley, 2004.
[4] Rehana Rajam, K.G.sathish kumar, "Hybrid SVM for Automatic Detection of Tuberculosis" Volume 3, Issue 11, November 2015.
[5] Tianchuan du vijay k.shanker" Deep Learning for Natural Language Processing".
[6] Li Deng and Dong Yu" deep learning for signal and information processing" Microsoft Research one Microsoft way Redmond, WA98052.
[7] Yann LeCu Yoshua Bengio3 & Geoffrey Hinton "review Deep learning".
[8] Co-organizers: Yoshua Bengio, Geoff Hinton, Yann LeCun,Andrew Ng, and Marc'Aurelio Ranzato" Tutorial on Deep Learning and Applications" Bengio et NIPS 2007.
[9] Ruslan Salakhutdinov Geoffrey Hinton"Deep Boltzmann Machines" Department of Computer Science University of Toronto rsalakhu@cs.toronto.edu 2011.
[10] Yaniv Bar Idit Diamant, Lior Wolf Hayit Greenspan2 The Blavatnik School of Computer Science" Deep learning with non-medical training used for chest pathology identification".
[11] Christian Szegedy Vincent Vanhoucke vanhoucke Sergey Ioffe sioffe Jon Shlens "Rethinking the Inception Architecture for Computer Vision".
[12] Aaron van den Oord Nal Kalchbrenner Koray Kavukcuoglu "Pixel/ Recurrent Neural Networks" 29 Feb 2016.
[13] Yoon Kim new yeark university "Convolutional Neural Networks for Sentence Classification" 3 Sep 2014.
[14] Nal Kalchbrenner Edward Grefenstette Department of Computer Science University of Oxford Phil Blunsom "A Convolutional Neural Network for Modelling Sentences" Department of Computer Science University of Oxford 8 Apr 2014.
[15] Christian Szeged Vincent Vanhoucke Sergey Ioffe Jon Shlens "Rethinking the Inception Architecture for Computer Vision".
[16] Diederik P. Kingma diederik p.kingma "Auto-Encoding Variational Bayes"may 2014.
[17] Ruslan Salakhutdinov Geoffrey Hinton, "Deep Boltzmann Machines"Department of Computer Science University of Toronto.
[18] Sascha Lange and Martin Riedmiller, "Deep Auto-Encoder Neural Networks in Reinforcement Learning" 2010, ISBN: 978-1-4244-6918-5.
[19] http.Wikipedia in "Auto encoded ". Visited on 11.06.17.
[20] Ruslan Salakhutdinov and Geoffrey Hinton, "Using Deep Belief Nets to Learn Covariance Kernels for Gaussian Processes".
[21] Pream Sudha1 V, KowsalyaV "a survey on deep learning techniques, applications and challenges" IJARSE, Vol. No.4, Issue 03, March 2015.
[22] Mohamed, A., G. E. Dahl, et al. (2012). "Acoustic modeling using deep belief networks." Audio, Speech, and Language Processing, IEEE Transactions on 20(1): 14-22.
[23] Daixin Wang1, Peng Cui1, Wenwu Zhu "Structural Deep Network Embedding" August 2016.

[24] Neeraj Dhunge Gustavo Carneiroy Andrew P. Bradley "Deep Learning and Structured Prediction for the Segmentation of Mass in Mammograms" 2015.
[25] Ali Mousavi, Ankit B. Patel, Richard G. Baraniuk "A Deep Learning Approach to Structured Signal Recovery" 17 Aug 2015.
[26] Liang-Chieh Chen Alexander G. Schwing Alan L. Yuille Raquel Urtasun "Learning Deep Structured Models".
[27] Ruslan Salakhutdinov, Joshua B. Tenenbaum, and Antonio Torralba, Member, IEEE" "Learning with Hierarchical-Deep Models" 2013.
[28] Atul Laxman Katole, Krishna Prasad Yellapragada, Amish Kumar Bedi, Sehaj Singh Kalra, Mynepalli Siva Chaitanya "Hierarchical Deep Learning" Geoffrey Hinto 7 Sep 2015.
[29] Ruslan Salakhutdinov "An Efficient Learning Procedure for Deep Boltzmann Machines".
[30] Asja Fischer and Christian Ig22wfr46el "An Introduction to Restricted Boltzmann Machines".
[31] Florian Raudies*, Eric A. Zilli3, Michael E. Hasselmo1" Deep Belief Networks Learn Context Dependent Behavior," NO.e93250,Issue 3 ,Volume 9,March 2014.
[32] Amin emamzadeh esmaeili nejad "An application of deep belief networks for 3-dimensional image reconstruction" Indian J.Sci.Res. Volume No. 618-625, 2014.
[33] Joe blitzstein and hanspeter pfister."created for the harvad data science course" Dandan Mo "A survey on deep learning one small step toward AI" Issus December 4, 2012.
[34] Xiaofeng Han1 and Yan "The Application of Convolution Neural Networks in Handwritten Numeral Recognition" Vol.8, No.3 2015.
[35] Weifeng Li, Victor Benjamin, Xiao Liu, and Hsinchun Chen University of Arizona" Deep Learning: An Overview" 2015.
[36] Xiaogang Wang"Recurrent Neural network "March 7, 2015.Neural Network Leon Yao Derrick Liu "Wallace: Author Detection via Recurrent Neural Networks" 2015.
[37] Maarten Grachten "A very brief overview of deep learning".13 Mar 2016.
[38] Professor Qiang yang "Introduction to deep learning"2016.
[39] Sascha Lange and Martin Riedmiller "Deep Auto-Encoder Neural Networks in Reinforcement Learning" 18 July2010.ISBN: 978-1-4244-6918-5 LISA lab, University of Montreal "Deep Learning Tutorial" Issus September 01, 2015.
[40] Michiel Hermans, Benjamin Schrauwen "Training and Analyzing Deep Recurrent Neural Networks P.190-198, 05 Dec 2013".
[41] Olivier Sigaud, Alain Dronion "Toward Deep Developmental learning" Issus Nov,10 2015.