

# A Survey on Deep Learning Techniques, Applications and Challenges

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## Abstract

*Deep learning is a developing examination region in the machine learning and example acknowledgment field. Profound learning alludes to machine learning procedures that utilization administered or unsupervised techniques to naturally learn various leveled portrayals in profound structures for grouping. The goal is to find more extract includes in the more elevated amounts of the portrayal, by utilizing neural systems which effectively isolate the different informative factors in the information. In the ongoing years, it has pulled in much consideration because of its cutting edge execution in various territories like question discernment, discourse acknowledgment, PC vision, community-oriented separating and regular dialect handling. As the information continues to get greater, profound learning is coming to assume a key part in giving enormous information prescient examination arrangements. This paper exhibits a short outline of profound learning, procedures, ebb and flow look into endeavors and the difficulties associated with them.*

**Keywords:** *Auto-encoders, Convolutional neural networks, Deep learning, RBM*

## 1. Introduction of Deep Learning

Profound taking in originates from the idea of the human mind having numerous sorts of portrayals with less difficult highlights at the lower levels and abnormal state reflections based over that. People orchestrate their thoughts and ideas progressively [2][3]. People initially learn basic ideas and after that make them speak to more digest ones. The human cerebrum resembles a profound neural system, comprising of numerous layers of neurons that go about as highlight indicators, recognizing more theoretical highlights as the levels go up. Along these lines of speaking to data more dynamically is simpler, to sum up for the machines [5]. The fundamental preferred standpoint of profound learning is its smaller portrayal of a bigger arrangement of capacities than shallow systems utilized by most ordinary learning strategies.

Profound engineering is more expressive than a shallow one gave a similar number of non-direct units. Be that as it may, works minimalistically spoke to in  $k$  layers may require exponential size when communicated in 2 layers [5]. Formally, it can be demonstrated that a  $k$ -layer system can speak to capacities minimally yet a  $(k - 1)$ -layer organize can't speak to them unless it has an exponentially vast number of shrouded units. A ton of elements like quicker CPUs, parallel CPU structures, GPU processing empowered preparing of profound systems and

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made them computationally plausible [7]. Neural systems are frequently spoken to as a network of weight vectors and GPUs are upgraded for quick framework duplication.

Perceptrons were created in the 1960's and when Papert and Minsky [1] demonstrated that perceptrons can just figure out how to show straightly distinct capacities, the enthusiasm for perceptrons quickly declined. There was the restoration of enthusiasm for neural systems because of the development of back engendering for preparing numerous layers of non-direct highlights [5]. Back proliferation takes mistakes from the yield layer and spreads them back through the concealed layers. Numerous analysts abandoned back engendering as it couldn't make effective utilization of different concealed layers. In mid 2000 Geoffrey Hinton [2] prepared profound conviction systems layer by layer on un-named information utilizing back proliferation to adjust weights on named information. Bengio [3] in 2006 analyzed profound auto-encoders as another option to Deep Boltzmann Machines.

## 2. Motivation for Deep Learning

Machine learning has effectively become a noteworthy software engineering discipline with broad applications in science and designing for a long time [7][8]. The PC removes information through directed understanding, where a human administrator is associated with helping the machine learn by giving it hundreds or thousands of preparing cases and physically revising its missteps. While machine learning has turned out to be driving inside the field of AI, it has its issues. It is especially tedious as yet not a genuine measure of machine knowledge as it depends on human creativity to think of the reflection that enables PC to learn. An essential test to machine learning is the absence of satisfactory preparing information to construct precise and dependable models in numerous reasonable circumstances [6]. At the point when quality information is hard to come by, the subsequent models can perform ineffectively on another area, regardless of whether the learning calculations are best picked. Unlabeled information is modest and abundant, not at all like named information which is costly to get [5]. Self-trained learning guarantees that by misusing the monstrous measure of unlabeled information, much better models can be learned. By utilizing unlabeled information to take in a decent beginning an incentive for the weights in every one of the layers, the calculation can take in and find designs from gigantic measures of information than absolutely regulated methodologies. This now and again brings about much better classifiers being found out.

Profound learning is for the most part unsupervised differentiating machine realizing which is regulated. It includes making largescale neural nets that enable the PC to learn and process independently from anyone else without the requirement for coordinate human intercession [10]. Learning in machine learning applications relies upon hand-designing highlights where the analyst physically encodes significant data about the job that needs to be done and afterward there is learning over that. This diverges from profound realizing which tries and gets the framework to design its particular highlights as much as is feasible [11]. The ongoing Google investigates profound learning have demonstrated that it is conceivable to prepare a vast unsupervised neural system to consequently create highlights for perceiving feline appearances [13]. The information shortage issue related to amazingly huge scale suggestion frameworks gives solid inspiration to finding better approaches to exchange learning from assistant information sources.

## 3. Literature Study

There were endeavors at preparing profound structures previously 2006 however fizzled because the preparation profound managed to bolster forward neural system yielded more

regrettable outcomes both in preparing and in test mistake than shallow ones with 1 or 2 concealed layers. The situation was changed by three imperative papers by Hinton, Bengio and Ranzato [2][3][4]. The key standards found in every one of the three papers are on unsupervised learning of portrayals used to pre-prepare each layer. The unsupervised preparation in these works is completed one layer at once, over the beforehand prepared ones. The portrayal learned at each level is the contribution for the following layer. At that point, regulated preparing is utilized to calibrate every one of the layers.

Geoffrey Hinton [2] prepared profound conviction organizes by stacking Restricted Boltzman Machines (RBMs) over each other as profound conviction arrange. The Deep Belief Networks utilize RBMs for unsupervised learning of portrayal at each layer. The Bengio [3] paper investigates and thinks about RBMs and auto-encoders.

The Ranzato [4] et al paper utilizes inadequate auto-encoder with regards to a convolutional design. As of late eminent advances have been made to reduce the difficulties identified with high information volumes. At the point when there is an enormous volume of information usually difficult to prepare a profound learning calculation with a focal processor and capacity. Consequently, disseminated structures with parallelized machines are perfect. Deng et al. [5] proposed a changed profound design called Deep Stacking Network (DSN), which can be parallelized. A DSN is a mix of a few particular neural systems with a solitary concealed layer. Stacked modules with inputs made out of crude information vector and the yields from past modules shape a DSN. A new profound design called Tensor Deep Stacking Network (T-DSN), which depends on the DSN, is actualized utilizing CPU bunches for adaptable parallel registering. Ongoing models influence the utilization of bunches of CPUs or GPUs to build the preparation to speed. Profound learning calculations have one of the remarkable qualities of utilizing unlabeled information amid preparing [5]. Preparing with tremendously more information is desirable over utilizing a more modest number of correct, clean, and painstakingly curated information, however, inadequacy and loud marks are a piece of information. To address the impact of boisterous marks, a more effective cost capacity and novel preparing system might be required.

#### 4. About Deep Learning Technique

The greater part of the present profound learning structures comprises of learning layers of RBM's or Auto-Encoders both of which are 2 layer neural systems that figure out how to demonstrate their information sources [3]. RBM's model their contributions as a likelihood dispersion while Auto-Encoders figure out how to replicate contributions as their yields.

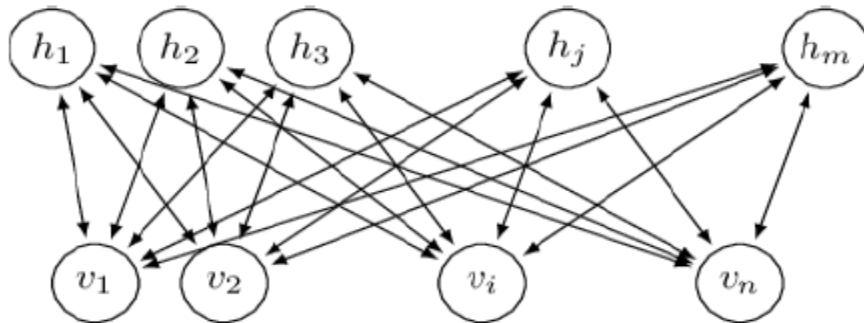


Figure 1. Visible and Hidden layers in RBM

RBM is a two layer undirected neural system comprising of a noticeable layer and concealed layer. There are no associations inside each layer, however, associations run obviously to cover up. It is prepared to augment the normal log-likelihood of the information. The data sources are double vectors as it learns Bernoulli disseminations over each information. The initiation work is registered an indistinguishable route from in a customary neural system and the strategic capacity typically utilized is between 0-1 [5]. The yield is dealt with as likelihood and every neuron is initiated if actuation is more noteworthy than irregular variable. The concealed layer neurons take unmistakable units as sources of info. Obvious neurons take paired information vectors as beginning information and afterward shrouded layer probabilities.

In the preparation stage, Gibbs Sampling (MCMC system) is performed and is likened to registering a likelihood dispersion utilizing a Markov Chain Monte Carlo approach. In PASS 1 shrouded layer probabilities  $h$  is registered from inputs  $v$  [1][3][4]. In PASS 2 those qualities withdraw to the noticeable layer, and go down to the concealed layer to get  $v'$  and  $h'$ . The weights are refreshed utilizing the distinctions in the external results of the covered up and obvious enactments between the first and second passes. To approach the ideal model, an immense number of passes are required, so this approach gives proximate induction, yet functions admirably practically speaking. In the wake of preparing, the shrouded layer initiations of an RBM can be utilized as scholarly highlights.

An autoencoder is traditionally an encouraged forward neural system which intends to take in a compacted, circulated portrayal of a dataset. An auto-encoder is a 3 layer neural system, which is prepared to remake its contributions by utilizing them as the yield. It needs to learn highlights that catch the fluctuation in the information so it can be imitated [6][8]. It can be appeared to be equal to PCA if direct enactment capacities are just utilized and can be utilized for dimensionality decrease. Once prepared, the concealed layer initiations are utilized as the educated highlights, and the best layer can be disposed of. Autoencoders are prepared to utilize the methodologies like de-noising, compression and meager condition. Amid de-noising, in Auto-Encoders some irregular clamor is added to the info. The encoder is required to recreate the first information [7]. Haphazardly deactivating contributions amid preparation will enhance the speculation execution of normal neural systems. In contractive Auto-Encoders, setting the number of hubs in the shrouded layer to be much lower than the number of information hubs powers the system to perform dimensionality diminishment. This keeps it from taking in the character work as the shrouded layer has deficient hubs to just store the information. Meager Auto-Encoders are prepared by applying a sparsity punishment to the weight refresh work [9]. It punishes the aggregate size of the association weights and makes most weights have little qualities.

RBM's or Auto-Encoders can be prepared layer by layer. The highlights gained from one layer are nourished into the following layer, so initial a system with 1 shrouded layer is prepared, and simply after that is done, a system with 2 concealed layers is prepared, et cetera[7][8]. At each progression, the old system with  $k-1$  shrouded layers are taken and an extra  $k$ -th concealed layer is included that takes as info the past shrouded layer  $k - 1$  that was prepared. Preparing can either be managed, however more as often as possible it is unsupervised [5]. The best layer enactments can be dealt with as highlights and encouraged into any appropriate classifier like Random Forest, SVM, and so forth. The weights from preparing the layers independently are then used to introduce the weights in the last profound system, and after that, the whole engineering is fine-tuned. Then again, an extra yield layer can be put to finish everything, and the system calibrated with back proliferation [11]. Back engendering functions admirably in profound systems just if the weights are instated near a decent arrangement. The layer shrewd

pre-preparing guarantees this. Numerous different methodologies like dropout, max out exist for adjusting profound systems [12].

Convolutional Neural Networks (CNN) are naturally propelled variations of MLPs. An ordinary Convolutional Neural Network comprises numerous layers of a chain of importance with a few layers for include portrayals and others as a sort of traditional neural systems for grouping. There are two modifying kinds of layers called convolution and sub-sampling layers. The convolutional layers perform convolution activities with a few channel maps of equivalent size while subsampling layers lessen the sizes of continuing layers by averaging pixels inside a little neighborhood.

The info is first convoluted with an arrangement of channels. This 2D separated information is called highlight maps. After a nonlinear change, a subsampling is additionally performed to decrease the dimensionality. The grouping of convolution or subsampling can be rehashed commonly. The most reduced level of this engineering is the information layer. With neighborhood responsive fields, upper layer neurons separate some basic and complex highlights. Each convolutional layer is made out of numerous element maps, which are built by convolving contributions with various channels. As it were, the estimation of every unit in a component outlines the outcome relying upon a neighborhood open field in the past layer and the channel. CNN calculations take in various leveled highlight portrayals by using procedures like neighborhood responsive fields, shared weights, and subsampling. Each channel bank can be prepared with either administered or unsupervised techniques.

## 5. Applications of deep learning

Profound learning is commonly connected to PC vision, discourse acknowledgment, and NLP. These are non-straight order issues where the data sources are exceptionally hierarchal. In 2011, Google Brain venture made a neural system prepared with profound learning calculations, which perceived abnormal state ideas, similar to felines, in the wake of observing just YouTube recordings and without being told what a “feline” is. Facebook is making arrangements utilizing profound learning skills to better distinguish faces and protests in the photographs and recordings transferred to Facebook every day. Another case of profound learning in real life is voice acknowledgment like Google Now and Apple’s Siri. As indicated by Google, the voice blunder rate in the new form of Android remains at 25% lower than past renditions of the product in the wake of including bits of knowledge from profound learning.

Another rising territory of use is regular dialect handling because the likelihood of understanding the significance of the content that individuals write or say is essential for giving better UIs, promotions, and posts. Gaining from content, sound, and video is developing into another outskirts of profound getting the hang of, starting to be acknowledged by investigating groups including discourse handling, common dialect preparing, PC vision, machine learning, data recovery, psychological science, counterfeit consciousness and information administration. The exceptional development of information as of late has prompted a surge in enthusiasm for powerful and adaptable parallel calculations for preparing profound models. The utilization of awesome registering energy to accelerate the preparation procedure has indicated huge potential in Big Data profound learning. Various CPU centers can be utilized to scale up DBNs with each center managing a subset of preparing information. These executions can supplement the execution of present day CPUs more for profound learning.

## 6. Applications of machine learning

As per [2], machine learning innovation has been generally utilized as a part of advertising, fund, media communications, and system investigation. In the field of promoting, this learning innovation is all the more generally utilized as a part of undertakings arrangement and other related exercises. In the field of the fund, this innovation is more utilized for estimating purposes. In the field of system, machine learning has been utilized to relate errands and in the broadcast communications area, it has been generally utilized as a part of the assignments of characterizations and expectation. [2] specified that we are in a time of modern development that joins PCs, sensors, information archives, high transmission capacity systems, cell phones, independent machines, and information examination that drive mechanical advancement and development. An ever increasing number of mechanical information is being gathered and put away by these modern frameworks. Thus, Industrial Analytics requires all the more effective and savvy machine learning apparatuses, systems, and situations to properly extricate information from the vast volumes of modern information to release its awesome potential esteem.

They began their examination on prescient machine learning investigation for Big Data by leading a writing overview of machine learning libraries and apparatuses for enormous information examination. They initialed considers on the most proficient method to conjecture substation blames and power stacking. Moreover, their outcomes demonstrated that it is plausible to estimate substations blame occasions and power stack utilizing Naïve Bayes calculation in MapReduce worldview or machine learning devices particular for Big Data. They gathered more mechanical information for their examination with a large portion of it given two cases and more modern investigation spaces in ABB. More measurable and machine learning calculations will be produced, used and checked to mine more qualities from their mechanical information. Table 1 demonstrates the diagram of open source machine learning apparatuses for enormous information.

One of the significant difficulties looked at by [2] was the usage of complex machine learning calculations, for example, neural systems, in the MapReduce worldview. Mahout made a proposition to actualize the Neural Network with back spread learning on Hadoop, however had been never executed up until now. A moment challenge confronted was that before building machine-learning models, we more often than not have to direct fundamental insights to look at the dataset for better understanding. Open source devices, researched by them, needed intense measurement functionalities for Big Data. They composed projects to figure middle, mode, connection and quartiles in the Scala programming dialect utilizing Spark shell content.

As per [14], Big Data machine learning and chart examination have been generally utilized as a part of the industry, the scholarly community and government. Ceaseless headways in these regions have been vital in numerous organizations' achievement, logical disclosures, and in addition digital security. In this paper, the creator introduces the present undertakings and proposes some cutting edge processing frameworks for huge information machine learning and chart examination require, imaginative plans, in both equipment and programming that give a decent match between huge information calculation and the fundamental figuring and capacity asset.

## 7. Conclusion

Superior registering foundation-based frameworks together with hypothetically stable parallel learning calculations and novel designs are expected to fabricate the future profound learning framework. As there is constant development in PC memory and computational power through parallel or dispersed figuring condition, additionally research and exertion on tending

to issues related to calculation and correspondence administration are required for scaling up to huge informational collections. There will be challenges associated with thinking and deduction over unpredictable, progressive connections and information sources including various elements and semantic ideas. In the coming year's answers to address the versatility, unwavering quality and flexibility of the unsupervised learning models will take the focal stage. These exploration challenges postured are convenient, and will likewise bring sufficient open doors for profound getting the hang of, giving significant advances in science, prescription, and business.

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