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Deep Analysis of Learning Methods in Artificial Neural Network

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Abstract---An Artificial Neural Network (ANN) is an information processing system that is inspired by the biological nervous systems, such as the brain, process information. The key element of this system is the structure of the information processing system. It is composed of a large number of highly interconnected processing neurons working in unison to solve specific problems. ANNs, like human, learns by example. ANN is configured for a specific application, suchas pattern recognition or data classification, through a learning method. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well. This paper gives overview of Artificial Neural Network, working & learning method of ANN. It also explains the application and advantages of ANN.

Keywords:-*ANN (Artificial Neural Network), neurons, pattern recognition.*

INTRODUCTION

The study of the brain is thousands years old. Advent of modern electronics, it was only natural to this thinking process. The first step toward artificial neural networks came a neurophysiologist, and Walter Pitts, wrote a paper on how neurons might work. They modelled a neural network with electrical circuits. Can be used to extract patterns and detect trends that are too complex by either humans or other computer techniques.

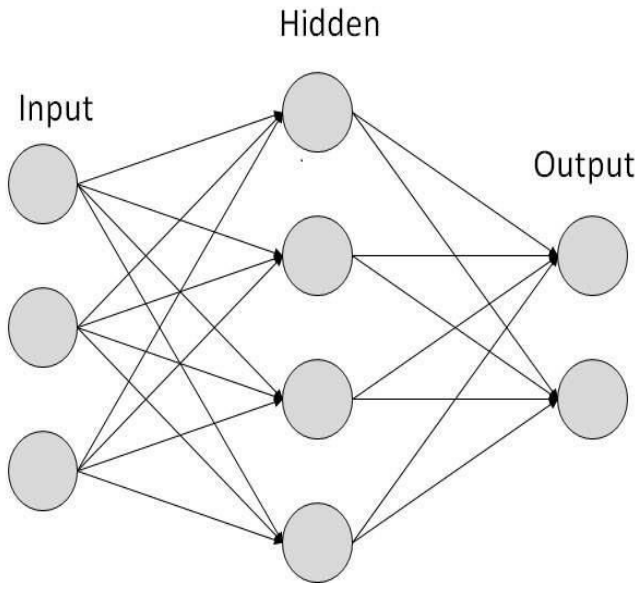
The neural network derived its orison of human brain. The artificial neural network a large number of very simple processing neuron-like processing elements and it is a large number of weighted connections between the elements distributed representation of knowledge over the connections is acquired by network through a learning process. A neural network is a series of algorithms that endeavours underlying relationships in a set of data through a process that mimics the way the human brain operates. In this sense, neural networks refer to systems, either organic or artificial in nature. Neural networks can adapt to changing input; so the neural network generates the best possible result without needing to redesign the output criteria. The concept of neural network, which has its roots in artificial intelligence, is gaining popularity in the development of trading systems. Neural networks, in the world of finance, assist in the development of such process as time-series forecasting, algorithmic trading, securities classification, credit risk modelling and constructing proprietary indicators and price derivatives. A neural network contains layers of interconnected nodes. Each node is a perception and is a multiple linear regression. The perception feeds the single produced by a multiple linear regression into an activation function that may be nonlinear.

In a multi-layered perception (MLP), Perceptions are arranged in interconnected layers. The input layer collects input patterns. The output layer has classifications to which input patterns may map. For instance, the patterns may comprise a list of quantities for technical indicators about a security; potential outputs could be “buy”, “hold” or “sell”. Hidden layers fine-tune the input weightings until the neural network of error is minimal. It is hypothesized that hidden layers extrapolate salient features in the input data that have predictive power regarding the outputs.

What is Artificial Neural Network?

Artificial Neural Networks are relatively crude electronic models based on the structure of the brain. The brain basically learns from experience. It is natural proof problems that are beyond the scope of current computers are indeed solvable by small energy efficient packages. This brain is modelling also promises a less technical way to develop machine solutions. This new approach to computing also provides a more degradation during system overload than its more traditional counterparts. These biologically inspired

methods of computing are thought to be the next major advancement. Even simple animal brains are capable of functions
that are currently impossible for computers. Computers do rote things well, performing complex math. But computers have trouble recognizing simple patterns much less generalizing those patterns actions of the future. Now, advances in biological research promise an initial understanding of the natural thinking mechanism. This research shows that brains store information. Some of these patterns are very complicated and allow us the ability to recognize individual faces from many different sides. This process of storing information utilizing those patterns, and then solving problems encompasses a new field in computing. This field, as mentioned before, does not utilize traditional programming but involves the creation of massively parallel networks and the training of those neural networks to solve specific problems. This field also utilizes words very different from traditional computing, words like behave, react, self organize, learn, generalize, and forget. Whenever we talk about a neural network, we should more popularly say ―Artificial Neural Network (ANN)‖, ANN are computers whose architecture is modelled after the brain. They typically consist of hundreds of simple processing units which are wired together in a complex communication network. Each unit or node is a simplified model of real neuron which sends off a new signal or fires if it receives a sufficiently strong Input signal from the other nodes to which it is connected.



Traditionally neural network was used to refer as network or circuit of biological neurones, but modern usage of the term often refers to ANN. ANN is mathematical model or computational model, an information processing paradigm i.e. inspired by the way biological nervous system, such as brain information system. ANN is made up of interconnecting artificial neurones which are programmed like to mimic the properties of m biological neurons. These neurons working in unison to solve specific problems. ANN is configured for solving artificial intelligence problems without creating a model of real biological system. ANN is used for speech recognition, image analysis, adaptive control etc. These applications are done through a learning process, like learning in biological system, which involves the adjustment between neurones through synaptic connection. Same happen in the ANN.

Working of ANN.

The other parts of the ―art‖ of using neural networks revolve around the myriad of ways these individual neurons can be clustered together. This clustering occurs in the human mind in such a way that information can be processed in a dynamic, interactive, and self-organizing way. Biologically, neural networks are constructed in a three-dimensional world from microscopic components. These neurons seem capable of nearly unrestricted interconnections. That is not true of any proposed, or existing, man-made network. Integrated circuits, using current technology, are two dimensional devices with a limited number of layers for interconnection. This physical reality restrains the types, and scope, of artificial neural networks that can be implemented in silicon. Currently, neural networks are the simple clustering of the primitive artificial neurons. This clustering occurs by creating layers which are then connected to one another. How these layers connect is the other part of the "art" of engineering networks to resolve real world problems.

These lines of communication from one neuron to another are important aspects of neural networks. They are the glue to the system. They are the connections which provide a variable strength to an input. There are two types of these connections. One causes the summing mechanism of the next neuron to add while the other causes it to subtract. In more human terms one excites while the other inhibits. Some networks want a neuron to inhibit the other neurons in the same layer. This is called lateral inhibition. The most common use of this is in the output layer. For example in text recognition if the probability of a character being a "P" is .85 and the probability of the character being an "F" is .65, the network wants to choose the highest probability and inhibit all the others. It can do that with lateral inhibition. This concept is also called competition. Another type of connection is feedback. This is where the output of one layer routes back to a previous layer.

What is Learning?

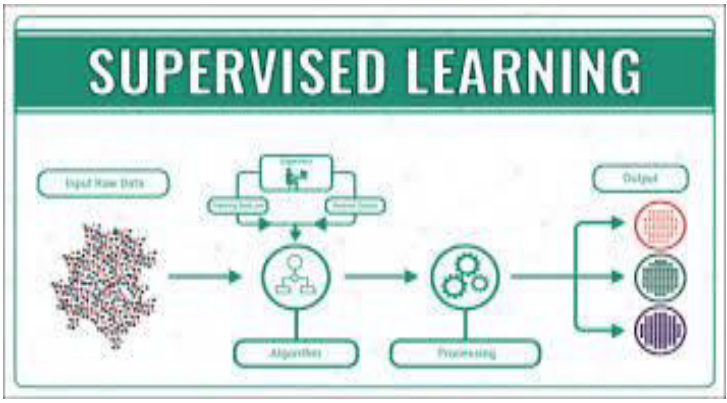
Remember that a neural network is made up of neurons connected to each other; at the same time, each connection of our neural network is associated with a weight that dictates the importance of this relationship in the neuron when multiplied by the input value. Each neuron has an activation function that defines the output of the neuron. The activation function is used to introduce non-linearity in the modelling capabilities of the network. We have several options for activation functions that we will present in this post. Training our neural network, that is, learning the values of our parameters (weights *wij* and *bj* biases) is the most genuine part of Deep Learning and we can see this learning process in a neural network as an iterative process of "going and return" by the layers of neurons. The "going" is a forward propagation of the information and the "return" is a back propagation of the information. Once the loss has been calculated, this information is propagated backwards. Hence, its name: back propagation. Starting from the output layer, that loss information propagates to all the neurons in the hidden layer that contribute directly to the output. However, the neurons of the hidden layer only receive a fraction of the total signal of the loss, based on the relative contribution that each neuron has contributed to the original output. This process is repeated, layer by layer, until all the neurons in the network have received a loss signal that describes their relative contributiozn to the total loss.

Learning An Artificial Neural Network.

Once a network has been structured for a particular application, that network is ready to be trained. To start this process the initial weights are chosen randomly. Then, the training, or learning, begins. There are two approaches to training - supervised and unsupervised. Supervised training involves a mechanism of providing the network with the desired output either by manually "grading" the network's performance or by providing the desired outputs with the inputs. Unsupervised training is where the network has to make sense of the inputs without outside help. The vast bulk of networks utilize supervised training. Unsupervised training is used to perform some initial characterization on inputs. However, in the full blown sense of being truly self learning, it is still just a shining promise that is not fully understood, does not completely work, and thus is relegated to the lab.

1. Supervise learning.

In supervised training, both the inputs and the outputs are provided. The network then processes the inputs and compares its resulting outputs against the desired outputs. Errors are then propagated back through the system, causing the system to adjust the weights which control the network. This process occurs over and over as the weights are continually tweaked. The set of data which enables the training is called the "training set." During the training of a network the same set of data is processed many times as the connection weights are ever refined. The current commercial network development packages provide tools to monitor how well an artificial neural network is converging on the ability to predict the right answer. These tools allow the training process to go on for days, stopping only when the system reaches some statistically desired point, or accuracy. However, some networks never learn. This could be because the input data does not contain the specific information from which the desired output is derived. Networks also don't converge if there is not enough data to enable complete learning. Ideally, there should be enough data so that part of the data can be held back as a test. Many layered networks with multiple nodes are capable of memorizing data. To monitor the network to determine if the system is simply memorizing its data in some non significant way, supervised training needs to hold back a set of data to be used to test the system after it has undergone its training. If a network simply can't solve the problem, the designer then has to review the input and outputs, the number of layers, the number of elements per layer, the connections between the layers, the summation, transfer, and training functions, and even the initial weights themselves. Those changes required to create a successful network constitute a process wherein the "art" of neural networking occurs. Another part of the designer's creativity governs the rules of training. There are many laws (algorithms) used to implement the adaptive feedback required to adjust the weights during training. The most common technique is backward-error propagation, more commonly known as back-propagation. These various learning techniques are explored in greater depth later in this report. Yet, training is not just a technique. It involves a "feel," and conscious analysis, to insure that the network is not over trained. Initially, an artificial neural network configures itself with the general statistical trends of the data. Later, it continues to "learn" about other aspects of the data which may be spurious from a general viewpoint. When finally the system has been correctly trained, and no further learning is needed, the weights can, if desired, be "frozen." In some systems this finalized network is then turned into hardware so that it can be fast. Other systems don't lock themselves in but continue to learn while in production use.

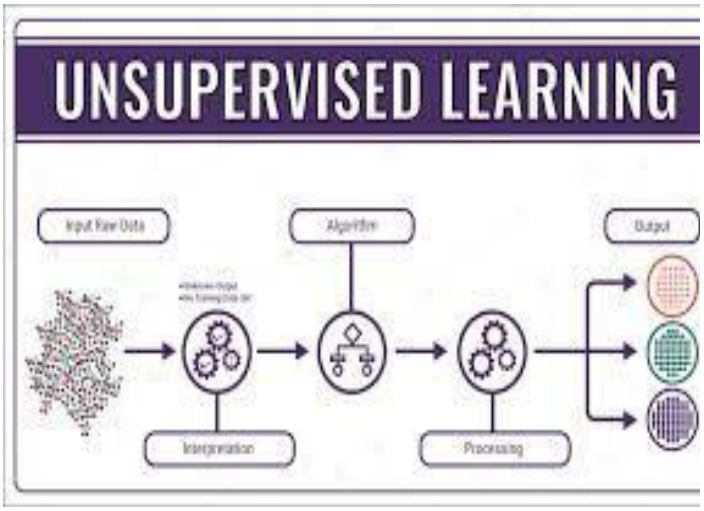


2. Unsupervised Learning.

The other type of training is called unsupervised training. In unsupervised training, the network is provided with inputs but not with desired outputs. The system itself must then decide what features it will use to group the input data. This is often referred to as self organization or adaption. At the present time, unsupervised learning is not well understood. This adaption to the environment is the promise which would enable science fiction types of robots to continually learn on their own as they encounter new situations and new environments. Life is filled with situations where exact training sets do not exist. Some of these situations involve military action where new combat techniques and new weapons might be encountered. Because of this unexpected aspect to life and the human desire to be prepared, there continues to be research into, and hope for, this field.

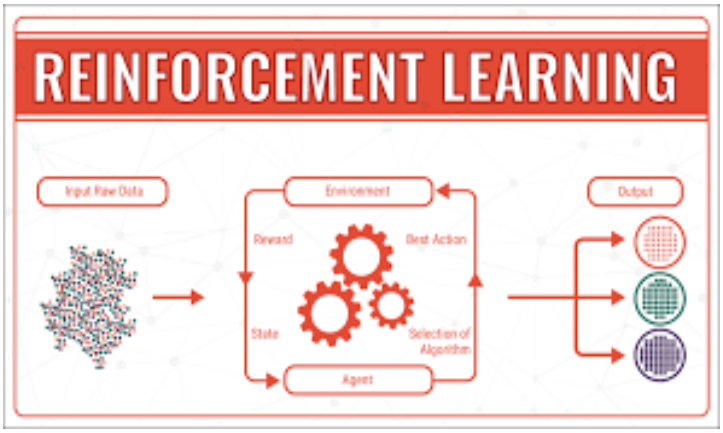
Unsupervised learning is a machine learning technique, where you do not need to supervise the model. Instead, you need to allow the model to work on its own to discover information. It mainly deals with the unlabelled data.

Unsupervised learning algorithms allow you to perform more complex processing tasks compared to supervised learning. Although, unsupervised learning can be more unpredictable compared with other natural learning methods.



3. Reinforced Learning.

Reinforced learning is the training of machine learning models to make a sequence of decisions. The agent learns to achieve a goal in an uncertain, potentially complex environment. In reinforcement learning, an artificial intelligence faces a game-like situation. The computer employs trial and error to come up with a solution to the problem. To get the machine to do what the programmer wants, the artificial intelligence gets either rewards or penalties for the actions it performs. Although the designer sets the reward policy–that is, the rules of the game–he gives the model no hints or suggestions for how to solve the game. It's up to the model to figure out how to perform the task to maximize the reward, starting from totally random trials and finishing with sophisticated tactics and superhuman skills. By leveraging the power of search and many trials, reinforcement learning is currently the most effective way to hint machine's creativity. In contrast to human beings, artificial intelligence can gather experience from thousands of parallel game plays if a reinforcement learning algorithm is run on a sufficiently powerful computer infrastructure.



CONCLUSION

Artificial Neural Networks (ANN) are adaptive networks. Adaptive nature of ANN enables them to make connections between input and output values in such a way that the generated network becomes capable to predict the expected trend of future. In this paper, back propagation multilayered NN is trained by Liebenberg-Marquardt algorithm. Unique feature of this study is that all networks (either large cap, midcap or small cap) constructed here are so effective in predictions that they very efficiently predict the Indian stock market prices both before and after demonetization. Demonetization does have a great impact on stock market prices as in short term period investors start to withdraw capital from stocks, which results in high volatility. Also, variation of neurons in hidden layers does not affect MSE much and it is found that ten numbers of neurons are sufficient for obtaining accurate results. Additionally, regression values obtained is 0.999, which depicts increased efficiency of the network proposed. The network proposed here efficiently predicts the closed price of any day and especially works the best for high volatile market conditions, as is presented in our study for before and after demonetization data. In addition, the efficiency of the proposed network has been proved for all variety of stocks and NIFTY50 index.

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