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An introduction to neural network

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Abstract
Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain basically learns from experience. It is natural proof that some problems that are beyond the scope of current computers are indeed solvable by small energy efficient packages. In this paper we propose the fundamentals of neural network topologies, activation function and learning algorithms based on the flow of information in bi-direction or uni-directions. We outline the main features of a number of popular neural networks and provide an overview on their topologies and their learning capabilities.

Keywords: Neural network, feed forward, recurrent, radial basic function network (RBFN), Kohonen self organizing map (KSOM)

1. Introduction
The human brain has capabilities in processing information and marking instantaneous decision. The many researchers shown that the human brain make computations in a radically different manner to that done by binary computers. The neurons is a massive network of parallel and distributed computing elements, many scientists are working last few decades to build computational system called neural network, which is also called as connectionist model. A neural network is composed of set of parallel and distributed processing units called nodes or neurons, these neurons are interconnected by means of unidirectional or bidirectional links by ordering them in layers.

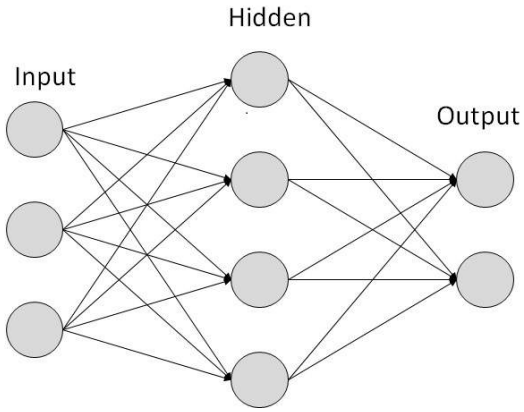

Fig 1: Basic Structure of Neural Network

The basic unit of neural network is neuron, it consist of N no of inputs to the network are represented by x(n) and each input are multiply by a connection weight these weights are represented by w(n). The product of input and weight are simply summed and feed through a transfer function (activation function) to generate the result (output)

2. Neural Network Design
Neural network mainly consist of three things

- Network Topology
- Network Transfer Function
- Network Learning Algorithm

2.1 Network Topology

the neural network topologies are classified based upon interconnection are arranged with in the layer, there two well-known neural network topologies are.

- Feed Forward Topology
- Recurrent Topology

2.1.1 Feed Forward Topology

In feed forward topology network, the nodes are hierarchically arranged in layers starting with the input layers and ending with output layers. In between the input layer and output layer the number of hidden layers provide most of the network computational power. The nodes in each layers connect to next layer through uni-direction paths starting from one layer (source) and ending at the subsequently layer (sink). The output of a given layers feed the nodes of the following layers in a forward directions and does not allow feedback flow of information in the structure. Application multilayer layer perception network and radial basic function network.

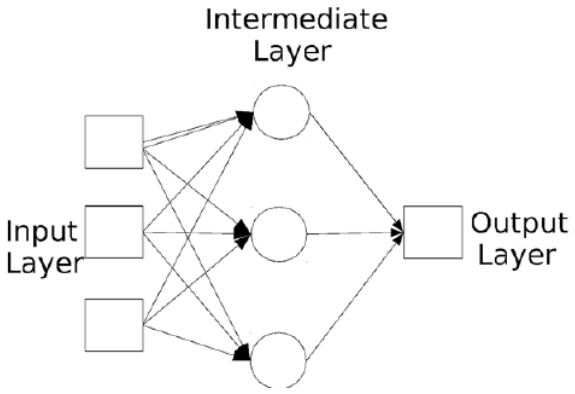

Fig 2: Feed Forward Topology

2.1.2 Recurrent Topology

In (RNT) allows flow of information in between the connected nodes in bi directions. i.e support both feed forward and feedback. In recurrent network, structure has some sort of memory which help to permit storage of information in their output nodes through dynamic states. The mapping of inputs and outputs are dynamic in nature. Application: Hopfield Network and Time Delayed Neural Network (TDNN).

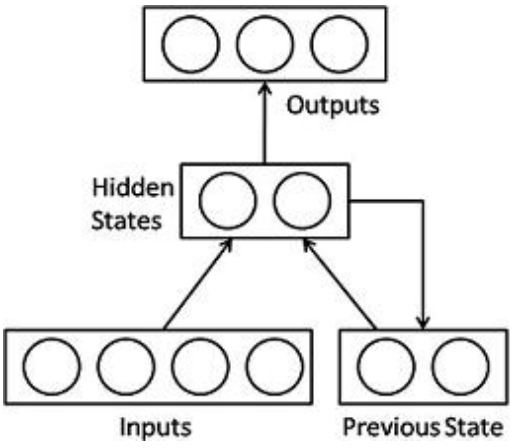

Fig 3: Recurrent Topology

2.2 Network Transfer Function

The basic unit of neural network is neuron, these are sorts of simple processors which take the weighted sum of their input from other node and apply to them non-linear mapping function called an activation function before delivering the output to the next to the next neuron

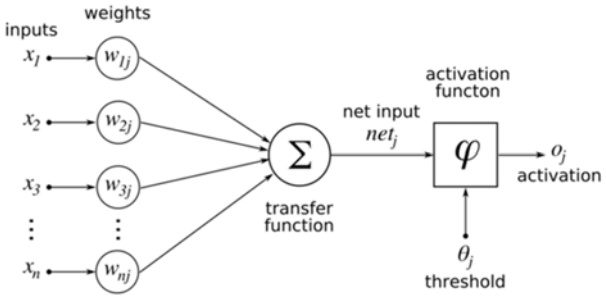

Fig 4: Transfer Function

2.3 Neural Network Learning Algorithm

Learning algorithm are used to update the Weight parameter of the input connections level of the neuron during the training processes of the network. There are three types of leaving algorithms are classified:

- Supervised
- Unsupervised and
- Reinforcement

2.3.1 Supervised Learning

In supervised learning mechanism, the external source provides the network ith a set of input stimulus for which the output is a priori known and during the running process the output results are continuously compared with the desire data. After number of iterations, the gradient descent rule uses the error between the actual output and the target data to adjust the connections weights so as to obtain the closest match between the target out and the actual out. Application: feed forward network.

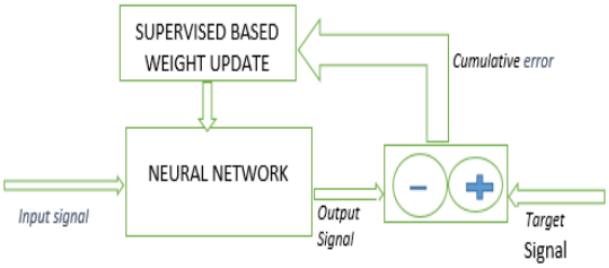

Fig 5: Supervised Learning

2.3.2 Unsupervised Learning Algorithm

It is also called as self-organizing learning algorithm because there is no any external source to provide the network and relies instead upon local information and internal control. The Training data and input pattern are presented to the system and system organization .the data into clusters or categories. A set of training data is presented to the system at the input layer level, the network connection weights are then adjusted through some sort of competition among the node of the output layer where the successful candidate will be the node with the highest value.

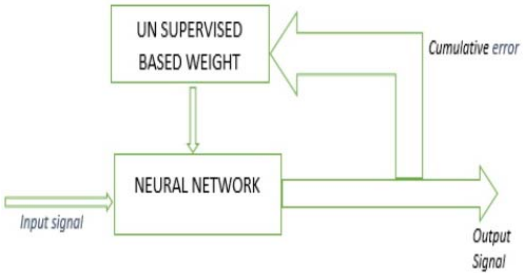

Fig 6: Unsupervised learning

2.3.3 Reinforcement Learning

The reinforcement learning algorithm also called as graded learning it has mimic in a way the adjusting behaviour of humans which interacting with a given physical environment .the network connections are modified according to feedback information provided to the network by its environment This information simply instructs the systems on whether or not a correct response has been obtained. In case of correct response the corresponding connections leading to that output are strengthened otherwise they are weakened. Reinforcement learning doesn't get information on what the output should be when the network is presented with a given input pattern.

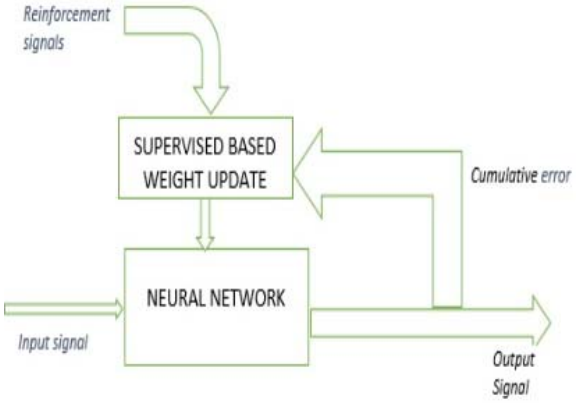

Fig 7: Reinforcement learning

3. Major Classes of Neural Networks

There are 4 types of neural network classes

- Multilayer Perception
- Radial Basis Function Network
- The Kohonen Self Organizing Map
- Hop Field Network

3.1 The Multilayer Perception:

Topology: The multilayer perceptron belong to the class of feed-forward networks, means that the information flows among the network nodes exclusively in the forward direction. the number of hidden layers required with in multi-layer perceptron depends in major part on the type of problem being addressed. for instances, a system with a single hidden layer able to solve the problem of XOR function or related problems in which the separate boundaries are relatively simple

Activation function: in multilayer perception network with one single hidden layer composed of an appropriate number of nodes with sigmoid activation function, as the activation function for all the neurons of the network defined as:

$$E_c = 1/2 \sum_{i=0}^{n} \sum_{k=1}^{q} 2(t_i(k) - o_i(k)).$$

Learning algorithm: The algorithm is based on the gradient descent technique for solving an optimization problem which involves the minimization of the network cumulative error E_c, E_c represents the sum of n squared errors

$E(k) = 1/2 \sum_{i=1}^{q} 2[t_i(k) - o_i(k)]$. Where the index represents the i-th neuron of the output composed of a total number of q neurons. The algorithm is designed in such a way as to update the weights in the direction of the gradient descent of the cumulative error. Applications: signal processing, weather forecasting, financial market prediction, pattern recognition, signal compression.

3.2 Radial Basis Function Networks

Topology: radial basis function network represent a special category of the feed forward neural network architecture. The basic RBFN structure consists of an input layer, hidden layer with activation function and output layer. The network structure use non liner transformations at its hidden layer but uses linear transformations between the hidden and the output layers. in general form of RBF function is given by $g_i(x) = r_i(\frac{||x-v_i||}{\sigma_i})$, where x is the input vector and v_i is the vector denoting the center of the receptive field unit g_i with σ_i as its unit width parameter.

Activation function

The logistic function of RBF is given by$g_i(x) = \left(\frac{1}{1+\exp\frac{(||x-v_i||^2)}{\sigma_i^2}}\right)$

Learning Algorithm: In RBF network is a two stage learning strategy:

Step1: train the RBFN layer to get the adaption of centres and scaling parameters using the unsupervised training.

Step2: adapt the weights of the output layer using the supervised training algorithm.

Applications: control system, audio and video signal processing and pattern recognition, weather and power load forecasting.

3.3 Kohonen's Self Organizing Network

Topology: The kohonen self-organizing network (KSON) also called self-organizing map (SOM) belongs to the class of unsupervised learning networks in KSON, the node distributed themselves across the input space to recognize groups of similar input vector while the output nodes compute among themselves to de fired one at a time in response to a Particular input vector this processes is called competitive learning. The nodes of the KSON can be recognize groups of similar input vector this generate a topographic mapping of the input vector to output vector which depends primarily on the pattern of the input vector and results in dimensionality reduction of the input space.

Learning algorithm: The learning here permits the clustering of input data into a smaller set of elements having similar characteristics. It is based on the competitive

learning technique also known as the winner take all strategy. Application: speech recognition, vector coding, texture segmentation, designing nonlinear controllers.

3.4 Hopfield Network Topology

The hope field is a recurrent topology and working of Hopfield is based on the associative memory concept that means the network is able to recognize newly presented pattern using an already stored complete version of that pattern. Hopfield defines as any physical system whose dynamics in phase space is dominated by a substantial number of locally stable states to which it is attached can therefore be regarded as a general content addressable memory.

Learning algorithm: The learning algorithm of Hopfield is based upon the Hebbain learning rule which is based on supervised learning algorithm. The Hebbian learning rule applied to a set of q presented patterns Pk (k=1,2,3,4.....q)each with dimension n, where n is the numbers of neurons unit in the Hopfield network.

Applications: It has been used to solve optimization problem, original optimization problem, combination tutorial optimization problem.

4. Application of Neural Networks

- Neural network for process monitoring and optimal control.
- Neural network is a semiconductor manufacturing process.
- Neural network is a power systems.
- Neural network in robotics.
- Network in communications
- Neural network in pattern recognition.

5. Conclusions

In this paper mainly we description of neural network main features in terms of topology, learning algorithm and activation functions. These include the feed forward and the recurrent based topologies, they also include network with supervised and unsupervised learning algorithm. We provide detailed descriptions of a numbers of the very often used neural network models the Multilayer Perceptron, Radial Basis Function network, Kohonen's Self-Organizing network, the Hopfield network along with highlights on their fields of applications.

References

1. Hop good A. knowledge –based systems for Engineer and scientists, Boca Raton, Florida, CRC Press, 1993, 159-85.
2. Jang J, Sun S, Mizutani Etice. Neuro-Fuzzy and Soft Computing, prentice Hall, Upper Saddle Rver, NJ. Uin, 1997.
3. Haynkin S. Neural Networks, A Comprehensive Foundation, MacMillan Publishing, Englewood Cliffs, NJ., 1994.
4. Werbos P. Beyond Regression: new tools for predicgions and analysis in the behavioral sciences. PhD dissertation, Harvard University, 1947.
5. Rumelhary D, Hinton G, Williams R. Learning representations by back propagation errors, Nature. 1986; 323:553-6.
6. Haykin S. Neural Networks, a Comprehensive Foundation, MacMillan Publishing, Englewood Cliffs, NJ., 1994.
7. Shar S, Palmieri F. MEKA. A fast local algorithm for training feed-forward neural networks, in proceedings of the International Joints Conference on Neural Networks, 1990.
8. Kattyama R, Kuwata K, Kajitani Y, Watanabe M. Embeding Functions networks, Fuzzy Sets and Systems. 1995; 72(3):311-27.
9. Hopfield J. Neurons with graded response have collective computational properties like those of two state neurons, in proceedings of the national properties like those of two state national Academy of science, 1984, 388-92.