



A Comprehensive Study of Artificial Neural Networks

Vidushi Sharma
MTech, GGSIPU
India

Sachin Rai
MCA, GGSIPU
India

Anurag Dev
MCA, GGSIPU
India

Abstract: In this survey paper, we are elaborating Artificial Neural Network or ANN, its various characteristics and business applications. In this paper we also show that “what are neural networks” and “Why they are so important in today’s Artificial intelligence?” Because numerous advances have been made in developing Intelligent system, some inspired by biological neural networks. ANN provides a very exciting alternatives and other application which can play important role in today’s computer science field. There are some Limitations also which are mentioned

Keywords:-Artificial Neural Network, ANN, Feedback Network, Feed Forward Network, Artificial Neuron, Characteristics and Application.

I. Introduction

The concept of ANN is basically introduced from the subject of biology where neural network plays a important and key role in human body. In human body work is done with the help of neural network. Neural Network is just a web of inter connected neurons which are millions and millions in number. With the help of this interconnected neurons all the parallel processing is done in human body and the human body is the best example of Parallel Processing .

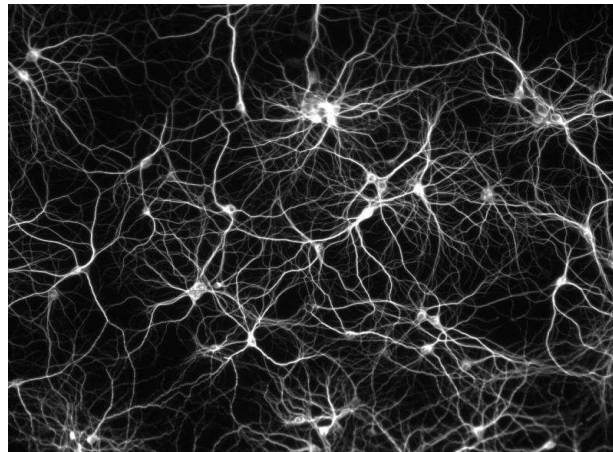


Fig 1 Neural Network in Human Body [9]

A neuron is a special biological cell that process information from one neuron to another neuron with the help of some electrical and chemical change. It is composed of a cell body or soma and two types of out reaching tree like branches: the axon and the dendrites. The cell body has a nucleus that contains information about hereditary traits and plasma that holds the molecular equipments or producing material needed by the neurons [4].

The whole process of receiving and sending signals is done in particular manner like a neuron receive signals from other neuron through dendrites. The Neuron send signals at spikes of electrical activity through a long thin stand known as an axon and an axon splits this signals through synapse and send it to the other neurons [7].

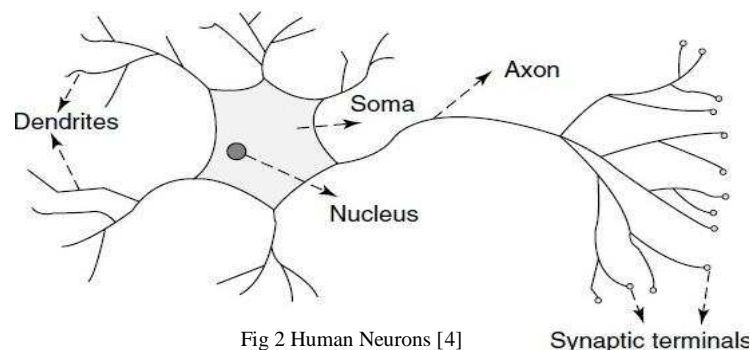


Fig 2 Human Neurons [4]

A. What is Artificial Neural Network ?

An Artificial Neuron is basically an engineering approach of biological neuron. It have device with many inputs and one output. ANN is consist of large number of simple processing elements that are interconnected with each other and layered also. [6,7]

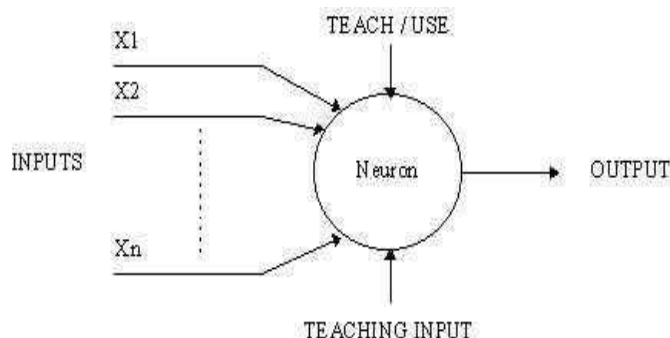


Fig 3 Artificial Neuron [7]

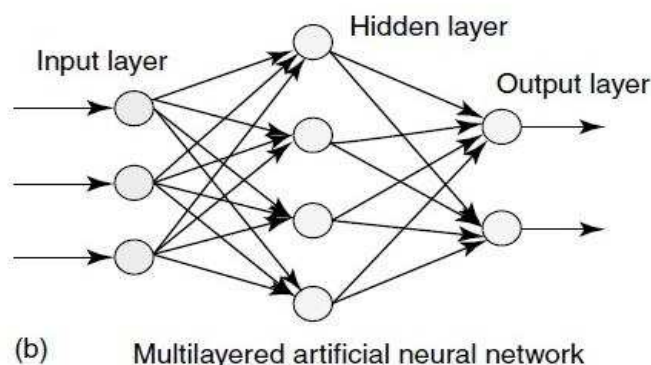


Fig 4 Multilayered ANN [2]

Similar to biological Neuron Artificial Neural Network also have neurons which are artificial and they also receive inputs from the other elements or other artificial neurons and then after the inputs are weighted and added, the result is then transformed by a transfer function into the output. The transfer function may be anything like Sigmoid, hyperbolic tangent functions or a step. [6]

B. Why ANN ?

The long evolution has given many best and excellent characteristics to brain of human being which are not present in modern computers which are :- [4]

- 1) Massive Parallelism
- 2) Distributed representation and computation
- 3) Adaptability
- 4) Learning Ability
- 5) Generalization Ability
- 6) Inherent Contextual Information Processing
- 7) Fault Tolerance
- 8) Low Energy Consumption

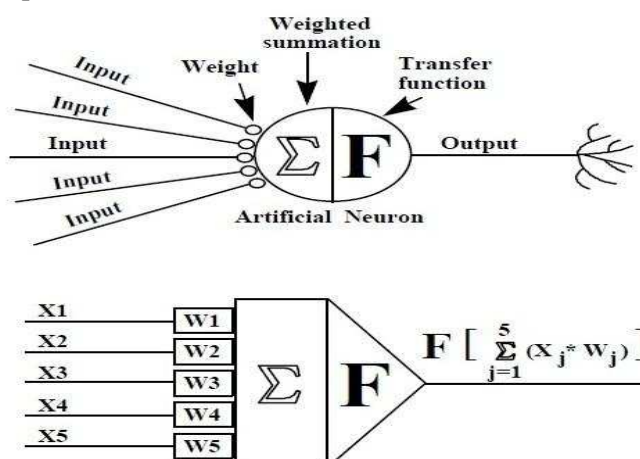


Fig 5 Functions of an Artificial Neuron [6]

C. Differences

Modern Computers:-

- 1) Contain one or few Processors which are high speed but complex.
- 2) Having Localized Memory separate from processor.
- 3) Computing is done with stored programs in an sequential and centralized manner.
- 4) In terms of reliability it is very Vulnerable.
- 5) The Operating Environment is well defined and well constrained. [4]

Biological Neural system:-

- 1) Contains a large number of processor which have low speed but simple in structure.
- 2) Having Distributed Memory but integrated into processor.
- 3) Computing is done with self learning in a parallel and distributed manner.
- 4) In terms of reliability it is robust.
- 5) The operating environment is poorly defined and unconstrained. [4]

II. ANN Characteristics

Basically Computers are good in calculations that basically takes inputs process then and after that gives the result on the basis of calculations which are done at particular Algorithm which are programmed in the software's but ANN improve their own rules, the more decisions they make, the better decisions may become. [6]

The Characteristics are basically those which should be present in intelligent System like robots and other Artificial Intelligence Based Applications.

There are six characteristics of Artificial Neural Network which are basic and important for this technology which are showed with the help of diagram:-

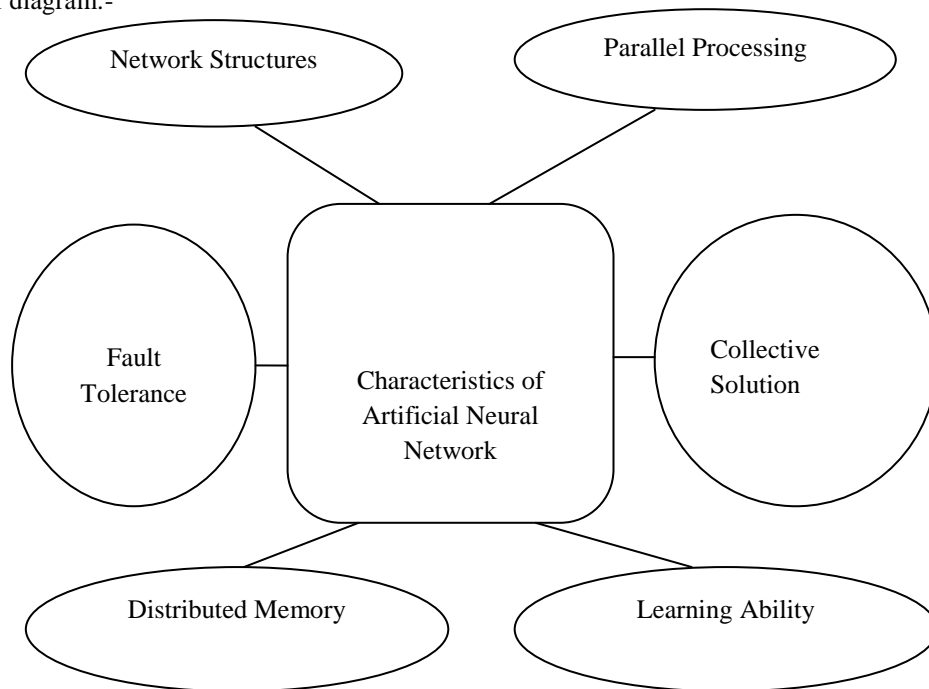


Fig 6 Characteristics [6]

A. The Network Structure:-

The Network Structure of ANN should be simple and easy. There are basically two types of structures recurrent and non recurrent structure. The Recurrent Structure is also known as Auto associative or Feedback Network and the Non Recurrent Structure is also known as Associative or Feed forward Network. [6,7,20,21]

In Feed forward Network, the signal travel in one way only but in Feedback Network, the signal travel in both the directions by introducing loops in the network. The Figures are given below which shows the direction of signals in both the network structures Feed forward and feedback. [6,7,20,21]

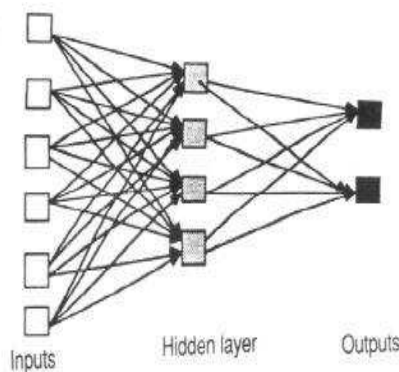


Fig 7 Feed Forward Network [7]

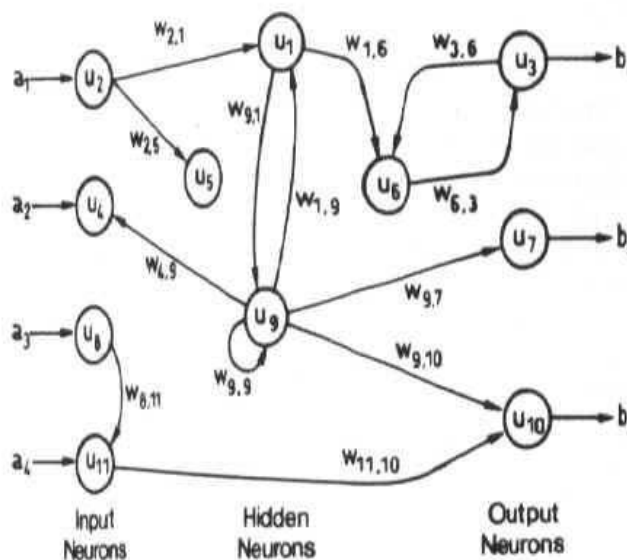


Fig 8 Feed Back Network [7]

B. Parallel Processing Ability:-

ANN is only introduced to enlarge the concept of parallel processing in the computer field. Parallel Processing is done by the human body in human neurons are very complex but by applying basic and simple parallel processing techniques we implement it in ANN like Matrix and some matrix calculations. [7]

C. Distributed Memory:-

ANN is a very huge system so single place memory or centralized memory cannot fulfill the need of ANN system so in this condition we need to store information in weight matrix which is form of long term memory because information is stored as patterns throughout the network structure. [7]

D. Fault Tolerance Ability:-

ANN is a very complex system so it is necessary that it should be a fault tolerant. Because if any part becomes fail it will not affect the system as much but if the all parts fails at the same time the system will fails completely. [7]

E. Collective Solution:-

ANN is a interconnected system the output of a system is a collective output of various input so the result is summation of all the outputs which comes after processing various inputs. The Partial answer is worthless for any user in the ANN System. [7]

F. Learning Ability:-

In ANN most of the learning rules are used to develop models of processes, while adopting the network to the changing environment and discovering useful knowledge. These Learning methods are Supervised, Unsupervised and Reinforcement Learning. [7]

III. Activation Function

Activation Functions are basically the transfer function which is output from a artificial neuron and it send signals to the other artificial neuron. There are four form of Activation Functions Threshold, Piecewise Linear, Sigmoid and

Gaussian all are different from each other . In Below figures 9,10,11,12 you can see the Activation function with its demonstration[4]

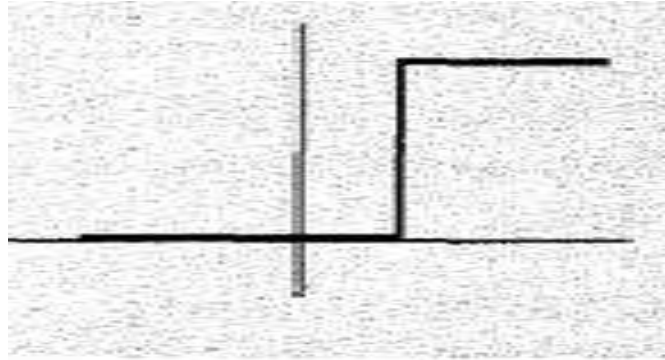


Fig 9 Threshold [4]

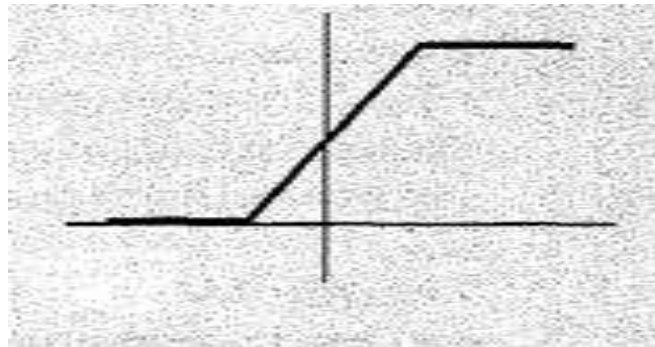


Fig 10 Piecewise Linear [4]

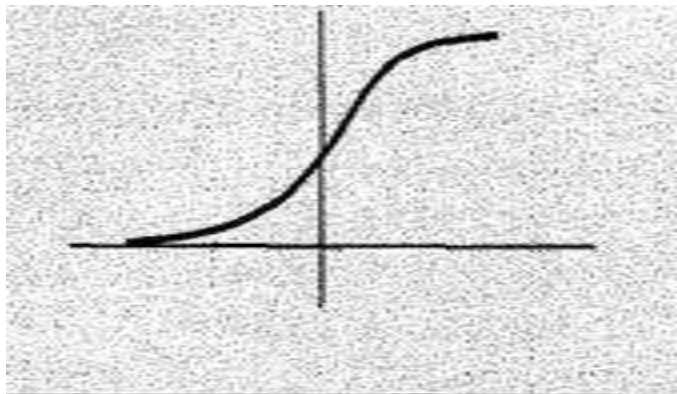


Fig 11 Sigmoid [4]

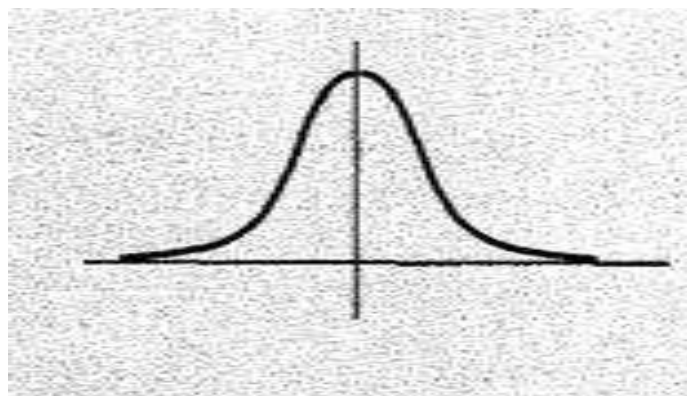


Fig 12 Gaussian [4]

IV. Network Architectures:-

There are further divisions of Feedback and Feed Forward Network architecture which are shown in below Figure:-
[4]

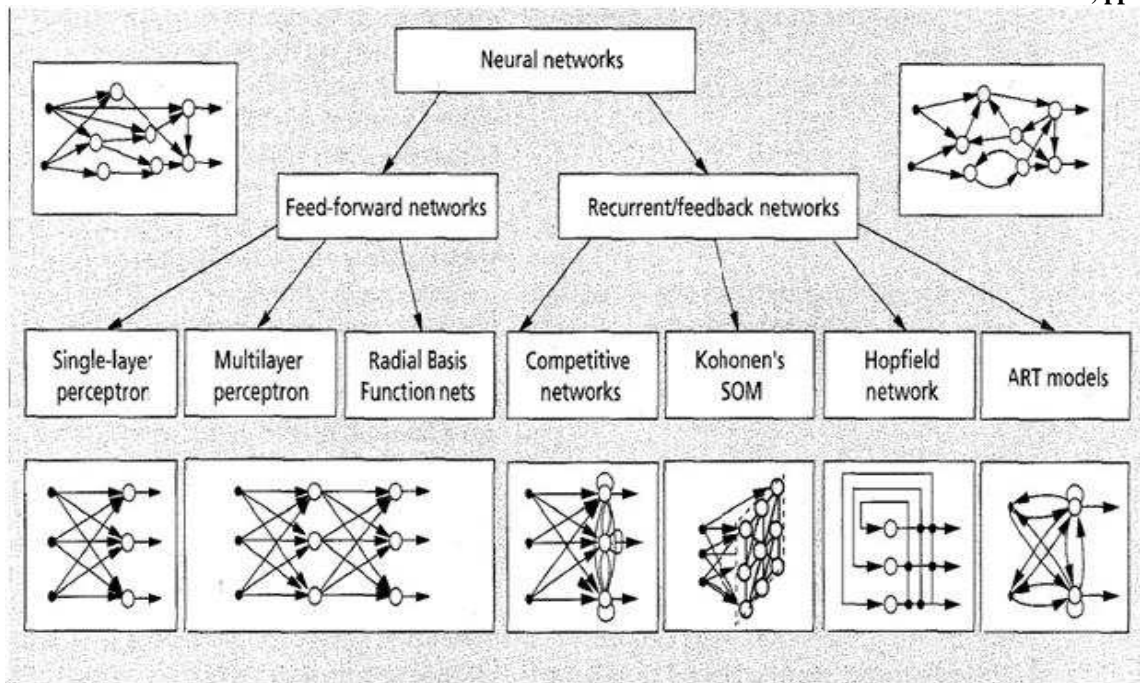


Fig 13 Taxonomy of Network Architecture [4]

V. Applications

There are various business applications of artificial neural network. Every sector in this world want a system which is itself intelligent to solve any problem according to the inputs. In this paper we have discussed various Business Applications which are listed below:- [4,6,7]

- 1) Airline Security Control.
- 2) Investment Management and Risk Control.
- 3) Prediction of Thrift Failures.
- 4) Prediction of Stock Price Index.
- 5) OCR Systems.
- 6) Industrial Process Control.
- 7) Data Validation.
- 8) Risk Management.
- 9) Target Marketing.
- 10) Sales Forecasting.
- 11) Customer Research.

The above applications have ability to predict any type of problem by its own with the help Artificial Neural Network phenomenon with the help of various algorithms like Perception Learning Algorithm, Back Propagation Algorithm, SOM Learning Algorithm and ART1 Learning Algorithm . [4,6,7]

VI. Limitations of Artificial Neural Network

In this technological era every has Merits and some Demerits in others words there is a Limitation with every system which makes this ANN technology weak in some points. The various Limitations of ANN are:- [6]

- 1) ANN is not a daily life general purpose problem solver.
- 2) There is no structured methodology available in ANN.
- 3) There is no single standardized paradigm for ANN development.
- 4) The Output Quality of an ANN may be unpredictable.
- 5) Many ANN Systems does not describe how they solve problems.
- 6) Black box Nature
- 7) Greater computational burden.
- 8) Proneness to over fitting.
- 9) Empirical nature of model development.

VII. Conclusion and Future works

By studying artificial Neural Network we had concluded that as per as technology is developing day by day the need of Artificial Intelligence is increasing because of only parallel processing. Parallel Processing is more needed in this present time because with the help of parallel processing only we can save more and more time and money in any work related to computers and robots. If we talk about the Future work we can only say that we have to develop much more algorithms and other problem solving techniques so that we can remove the limitations of the Artificial Neural Network. And if the Artificial Neural Network concepts combined with the Computational Automata and Fuzzy Logic we will definitely solve some limitations of this excellent technology.

References

- [1] Herve Debar, Monique Becker and Didier Siboni “ A Neural Network Component for an Intrusion Detection System”, Les Ulis Cedex France, 1992,
- [2] Ajith Abraham, “Artificial Neural Networks”, Stillwater,OK, USA, 2005.
- [3] Carlos Gershenson, “Artificial Neural Networks for Beginners”, United kingdom.
- [4] Anil K Jain, Jianchang Mao and K.M Mohiuddin, “Artificial Neural Networks: A Tutorial”, Michigan State university, 1996.
- [5] Ugur HALICI, “ Artificial Neural Networks”, Chapter 1, ANKARA
- [6] Eldon Y. Li, “ Artificial Neural Networks and their Business Applications”, Taiwan, 1994.
- [7] Christos Stergiou and Dimitrios Siganos, “Neural Networks”.
- [8] Limitations and Disadvantages of Artificial Neural Network from website <http://www.ncbi.nlm.nih.gov/pubmed/8892489>
- [9] Image of a Neuron from website <http://transductions.net/2010/02/04/313/neurons/>
- [10] About Artificial Neural Network from website [http:// en.wikipedia.org/wiki/Artificial_neural_network](http://en.wikipedia.org/wiki/Artificial_neural_network)
- [11] RC Chakraborty, “Fundamentals of Neural Networks”, myreaders.info/html/artificial_intelligence.html, june 01, 2010.
- [12] Prof. Leslie Smith, “ An Introduction to Neural Networks”, University of Stirling., 1996,98,2001,2003.
- [13] Prof. Dr. Eduardo Gasca A., “ Artificial Neural Networks”, Toluca
- [14] Kishan Mehrotra, Chilukuri K Mohan and Sanjay Ranka “Elements of artificial neural network”, 1996
- [15] Weyiu Yi 339229, “ *Artificial Neural Networks*”, 2005.
- [16] Vincent Cheung and Kevin Cannons, “ An Introduction of Neural Networks ”, Manitoba, Canada, May 27, 2002.
- [17] Howard Demuth and Mark Beale, “ Neural Network Toolbox”, With the help of matlab, user guide version 4.
- [18] Girish Kumar Jha, “Artificial Neural Network and its Applications”, IARI New delhi.
- [19] About Neural Network from website [http://en.wikipedia.org / wiki/Neural_network](http://en.wikipedia.org/wiki/Neural_network) .
- [20] About Feed Back Network from website [http://www.idsia.ch/ ~juergen/rnn.html](http://www.idsia.ch/~juergen/rnn.html) .
- [21] Sucharita Gopal, “Artificial Neural Networks for Spatial Data Analysis”, Boston, 1988.