

## Artificial Neural Networks-A Study

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**Abstract:** Artificial neural networks commonly referred as the neural networks are the information or signal processing mathematical model that is based on the biological neuron. A neural network is a complex structure which consist a group of interconnected neurons which provides a very exciting alternatives for complex problem solving and other application which can play important role in today's computer science field so researchers from the different discipline are designing the artificial neural networks to solve the problems of pattern recognition, prediction, optimization, associative memory and control. In this paper we have presented the basic study of the artificial neural network, its characteristics and its applications.

**Keywords:** Artificial Neural Network (ANN), Feedback Network, Feed-Forward Network, Artificial Neuron, Biological Paradigm, Pattern Recognition.

### 1. INTRODUCTION

The study of brain is an interesting area since a long time. With advancement in the field of electronics and computer science, it was the assumed that we can use this natural way of this thinking process of brain to design some artificial intelligence system.

The first step toward artificial intelligence came into existence in 1943 when Warren McCulloch, a neurophysiologist, and a mathematician, Walter Pitts, wrote a paper on how neurons work. Mathematical analysis has solved some of the mysteries posed by the new models but has left many questions for future investigations. There is no need to say, the study of neurons, their interconnections, and their role as the brain's elementary building blocks is one of the most dynamic and important research fields in modern world of electronics and computer science.

### 2. ARTIFICIAL NEURAL NETWORKS

In electronics engineering and related fields, artificial neural networks (ANNs) are mathematical or computational models that are inspired by a human's central nervous system (in

particular the brain) which is capable of machine learning as well as pattern recognition. Whereas animal's nervous system is more complex than the human so the system designed like this will be able to solve more complex problems. Artificial neural networks are generally presented as systems of highly interconnected "neurons" which can compute values from inputs.

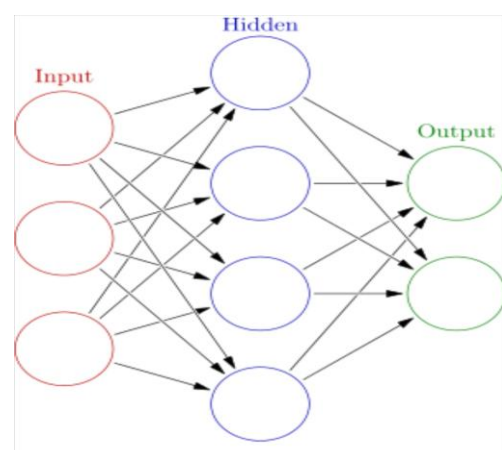


Fig.1 A Simple Neural Network

Neural Network is just like a website network of interconnected neurons which can be millions in number. With the help of these interconnected neurons all the parallel processing is being done

in body and the best example of Parallel Processing is human or animal's body.

Currently, artificial neural networks are the 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 the complex problems of the real world.

So neural networks, with their stronger ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques.

## 2.1 Background

The examination of the central nervous system of human brain was the inspiration of neural networks. In an Artificial Neural Network, simple artificial nodes, known as "neurons", "processing elements" or "units", are connected together to form a network which is called a biological neural network.

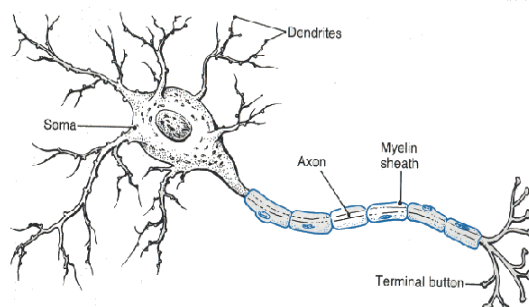


Fig.2 Genetic Neuron

There is no single formal definition of an artificial neural network. However, a class of statistical or mathematical or computational models may commonly be called "Neural Networks" if they possess the following characteristics:

1. Consist of sets of adaptive weights, i.e. numerical parameters that are tuned by a learning algorithms, and
2. Capable of approximating non-linear functions of their inputs.

The adaptive weights are conceptually connection strengths between neurons, which are activated during training and prediction.

Neural networks are similar to biological neural networks in performing functions collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned. The term "neural network" usually refers to models employed in statistics, cognitive psychology and artificial intelligence. Neural network models which emulate the central nervous system are part of theoretical neuroscience and computational neuroscience.

## 2.2 Working of Neural Networks

The working of neural networks revolves 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 in the case 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.

## 3. ANN MODELS

Neural network models in artificial intelligence are essentially simple mathematical models defining a function  $f: X \rightarrow Y$  or a distribution over  $X$  or both  $X$  and  $Y$ , but sometimes models are also intimately associated with a particular learning algorithm or learning rule.

A common use of the ANN model really means the definition of a class of such functions (where members of the class are obtained by varying parameters, connection weights, or specifics of the architecture such as the number of neurons or their connectivity).

### 3.1 Network function

The word network in the term 'artificial neural network' refers to the interconnections between the neurons in the different layers of each system. An example system has three layers. The first layer has input neurons which send data via synapses to the second layer of neurons, and then via more synapses to the third layer of output neurons. More complex systems will have more layers of neurons with some having increased layers of input neurons and output neurons. The synapses store parameters called "weights" that manipulate the data in the calculations. An ANN is typically defined by three types of parameters:

1. The interconnection pattern between the different layers of neurons
2. The learning process for updating the weights of the interconnections
3. The activation function that converts a neuron's weighted input to its output activation.

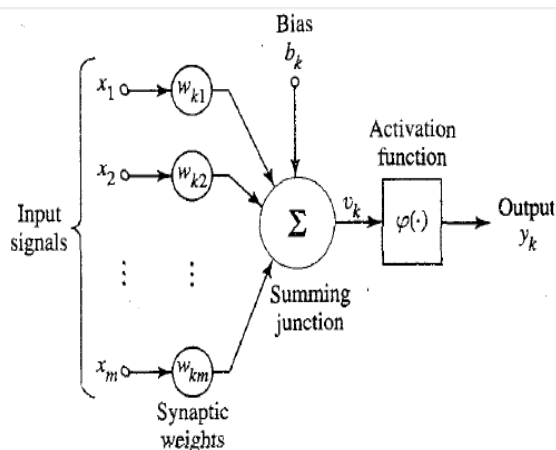


Fig.3 Nonlinear Model of Neuron

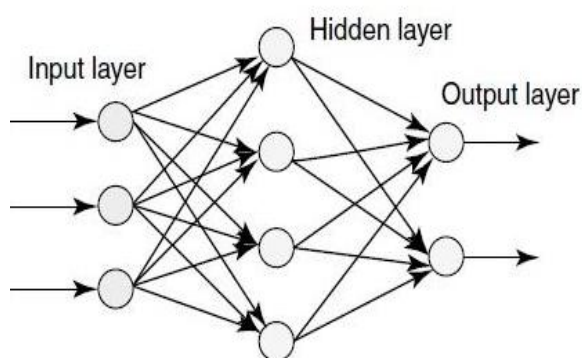


Fig.4 Multilayer Artificial Neural Network

## 4. CHARACTERISTICS OF NEURAL NETWORK

Basically Computers are good in calculations that takes inputs process then and gives the result as per the calculations which is done by using the particular Algorithm which are programmed in the software's but ANN uses its 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 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:

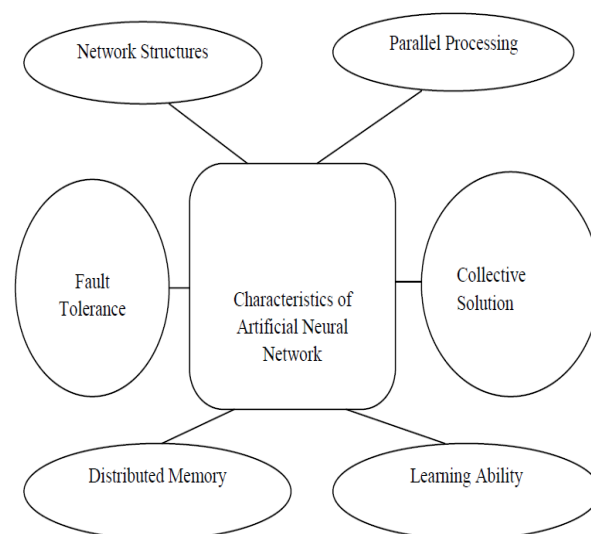


Fig.4 Characteristics of ANN

### 4.1 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. [3, 4, 6, 7] 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. As shown in the figures below:

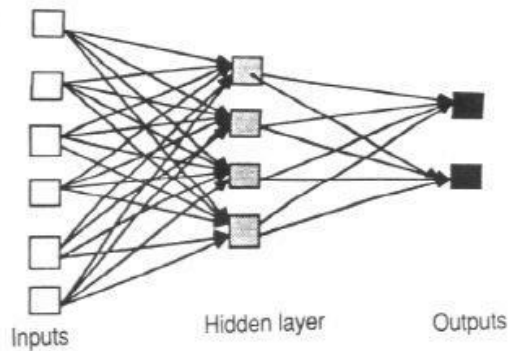


Fig. 5(a). Feed Forward Network

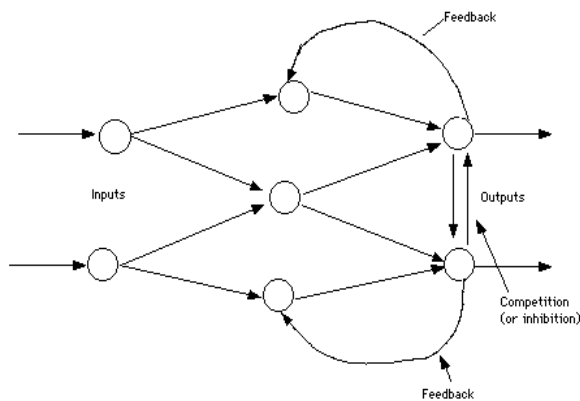


Fig. 5(b) Feedback Network

#### 4.2 Ability of Parallel Processing

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

#### 4.3 Distributed Memory

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

#### 4.4 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 fails it will not affect the system as much but if the all parts fails at the same time the system will fails completely. [7]

#### 4.5 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]

#### 4.6 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]

### 5. ADVANTAGES OF NEURAL NETWORKS

The neural networks have a lot of applications here we have discussed some of the most important applications of the neural networks [2]:

1. Adaptive learning: A neural networks have the ability to learn how to do things.
2. Self-Organisation: A neural network or ANN can create its own representation of the information it receives during learning.
3. Real Time Operation: In neural network or ANN computations can be carried out in parallel.
4. Pattern recognition is a powerful technique for the data security. Neural networks learn to recognize the patterns which exist in the data set.
5. The system is developed by learning rather than programming. Neural networks teach themselves the patterns in the data freeing the analyst for more interesting work.
6. Neural networks are flexible in a changing environment. Although neural networks may take some time to learn a sudden drastic change but they are excellent in adapting the constantly change in information.
7. Neural networks can build informative models whenever conventional approaches fail. Because neural networks can handle very complex interactions they can easily model data which is too difficult to model with traditional approaches such as inferential statistics or programming logic.

8. Performance of neural networks is very good and better on most of the problems. The neural networks can build models that are more complex in the structure of the data in significantly less time.

### 6. LIMITATIONS OF NEURAL NETWORK

In this world everything has some merits and demerits, so the neural network system also has some merits and demerits. The limitations of ANN [6] are:

1. ANN or Neural Networks is not a daily life problem solver.
2. There is no structured methodology available.
3. There is no single standardized paradigm for Neural Networks development.
4. The Output Quality of an ANN can be unpredictable.
5. Many ANN Systems does not describe how they solve the problems.
6. Nature of ANN is like a Black box.

### 7. APPLICATION

The real time applications of Artificial Neural Networks are:

1. Functional approximation, including time series prediction and modelling.
2. Call control- answer an incoming call (speaker-ON) with a swipe of the hand while driving.
3. Classification, including pattern and sequence recognition, pattern detection and sequential decision making.
4. Skip tracks or control volume on your media player using simple hand motions.
5. Data processing, including filtering, clustering, blind signal separation and compression.
6. Scroll Web Pages, or in an eBook with simple left and right hand gestures, this is ideal when touching the device is a barrier such as wet hands are wet, with gloves, dirty etc.
7. Application areas of ANNs include system identification and control

(vehicle control, process control), game-playing and decision making (chess, racing), pattern recognition (radar systems, face identification, object recognition, etc.), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications, data mining (or knowledge discovery in databases, "KDD").

8. Another interesting use is when using the Smartphone as a media hub; a user can dock the device to the TV and watch content from the device- while controlling the content in a touch-free manner from a far.
9. If your hands are wet or dirty or a person hates smudges, touch-free controls are a benefit.

### 8. CONCLUSION

In this paper we discussed about the artificial neural network, working of neural networks, characteristics of ANN, its advantages, limitations and applications of ANN. There are various advantages of ANN over conventional approaches. Depending on the nature of the application and strength of the internal data patterns you can generally expect a network to train quite well. This applies to problems where the relationships may be quite dynamic or non-linear. By studying Artificial Neural Network we had concluded that as the technology is increasing the need of Artificial Intelligence is also increasing because of parallel processing, because by using parallel processing we can do more than one task at a time. So Parallel Processing is needed in this present time because with the help of parallel processing we can save more and more time and money in any task related to electronics, computers and robotics. If we talk about the Future work we can say that we have to develop more algorithms and programs so that we can remove the limitations of the Artificial Neural Network and can make it more and more useful for the various kinds of applications. If the Artificial Neural Network concept is combined with the Computational Automata, FPGA and Fuzzy Logic we will definitely solve some of the limitations of neural network technology.

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