

# A Comprehensive Study of Artificial Neural Networks along with its vast range of Applications

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**Abstract**—The transition in intelligent system is inspired by biological neural networks which is soft take off for many sectors to get updated together. In this survey paper we are elaborating such Artificial Neural Networks or ANN which is the combination of biological neural network and technology that yields intelligent system. Here we will elaborate the study further about chief characteristics and the extensive applications of ANN.

**Keywords**—ANN, Artificial Neural Network, Artificial Neuron, multi-layer perceptron (MLP), Biological Neural System (BNS), Feed Forward Neural Network (FFNN) Characteristics and Applications.

## INTRODUCTION

Human brain is one of the great processor ever found by time. Those has a capability to beat the speed of computer chips by 100,000 times. It is even considered to crores of times more efficient in terms of resource and energy consumption as compared to computer chips. Researches on the encapsulation of human brain and computer processing networks got ignition since from 1943 with the research work by Warren McCulloch, a neurologist and Walter Pitts, a young mathematician on behavior of Neurons.

## BASIC EXPLANATION

Neural networks works on the concept of parallel processing. Here elements are assumed to connect in the manner of biological nervous systems. Concept of artificial neuron has evolved from biological neuron. It works on scenario where there are many inputs and a single output. It also includes many processing elements that are interconnected with each other in layered manner. [4]

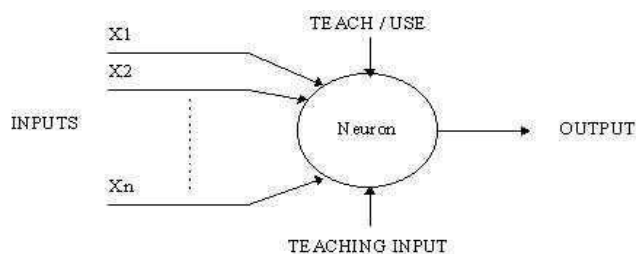


Fig 1: Artificial Neuron [7]

Actually, the network function is determined to be handling with connections among elements. A neural network considered to work on the principle of adjusting the weights of links between elements. Widely neural networks are trained to cope up with particular input that leads to a specific target output.

Rosenblatt developed perceptron as the next model to in which he used trial and error method and interconnected perceptron randomly to change the weights. The better model for the electrochemical process is the model developed by McCulloch and Pitts. This neuron is the key element in the field of modern day neural networks. Neuron works like a voltage-to-frequency translator due to electrochemical process of a neuron. Neuron discharges due to chemical reaction when the certain threshold is built by the neuron, then fires at a higher frequency. Though higher inputs come into the neuron but the magnitude of the output from the neuron is the same.

### 2.1 Biological Neural System over Modern Computers:

1. Modern Computers contains one or few processors which are high speed but complex while Biological Neural System (BNS) contains a large number of processor which have low speed with simple structure.
2. Modern Computers have localized memory separate from processor and in case of BNS distributed memory integrated into processor is available.
3. In case of Modern Computers computing is done in a centralized manner with stored programs while in BNS it is organized with self-learning in a parallel and distributed manner.
4. Modern Computers are very vulnerable and BNS are robust in terms of reliability.
5. Well suited operating environment for Modern Computers and is unconstrained with Biological Neural system.

### 2.2 ANN characteristics

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stored programs in a sequential and centralized manner while in BNS it is organized with self-learning in a parallel and distributed manner

4. Modern Computers are very vulnerable and BNS are robust in terms of reliability.
5. The Operating Environment is well defined and well constrained for Modern Computers and it is poorly defined and unconstrained with Biological Neural system.

### APPLICATIONS

The vast sector of applications for ANN consists of various advantageous and assisting applications as listed below:

#### A. Rainfall prediction using artificial Neural Network:

An Artificial Neural Network (ANN) can be used to study the behavior of highly non-linear and complicated phenomena such as rainfall for their accurate prediction using advanced computer modelling. The survey reports based on rainfall prediction using ANN technique are the evidence to prove that ANN technique is more suitable for customary, statistical and mathematical methods.

#### B. Forecasting financial market prices:

Here the potential of using artificial neural networks to predict the financial system is covered through various researches and survey. Focuses on the forecast of stock pricing based on a non-linear ANN model along with application of ANN in predicting exchange rates. Hawley, Johnson and Raina [1] and Refenes [2] provided a research result about neural network models used in this area.

#### C. In social computing in context of third world countries:

In this application the feed-forward Artificial Neural Network based on multi-layer perceptron (MLP) is used.

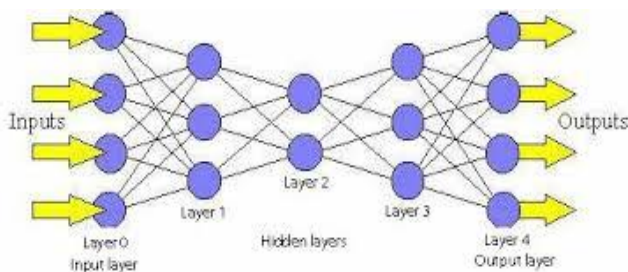


Fig 2: A Feed Forward Neural Network.[25]

This is popularly used tool which has inherent capability to discover hidden patterns in known (training) data and make almost accurate prediction later on in case of unknown (test) data.

#### D. Neural Networks in Control Applications:

Neural networks find its application in the area of control systems. When any methodology is applied controls has its own unique set of problems to solve. To conform to a set of specifications the performance needs to be changed, is the principle behind controls. Due to non-linearity and uncertainties the goal of the control becomes complicated so this is studied in detail in discrete dimensions. For nonlinear plants adaptive control schemes are initiated by Narendra and Parthasarathy. Identification and control of neural networks applications are dealt by many of Narendra's papers.

#### E. Character Recognition:[26]

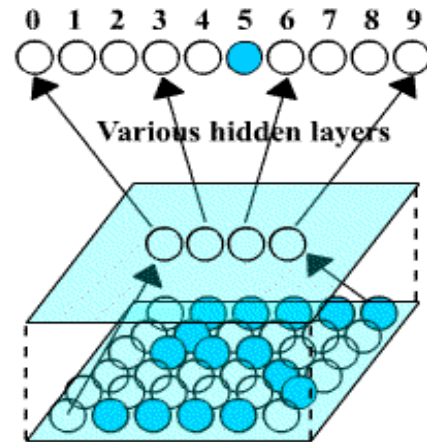


Fig 3: View of FNN for character recognition.[27]

The idea of using FNN to recognize handwritten characters is rather unique way. Over all in most of the research is based on working with handwritten character following the pattern of bitmap that is treated as an input that yields the letter or digit as the target output. Basically such programs need to run the network by giving the program in their handwritten manner.

#### F. Image Compression:[26]

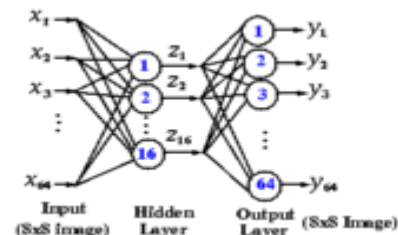


Fig 4: Bottleneck-type Neural Net Architecture for Image Compression[27]

The image compression problem is solved in very effective way through implementation of ANN in this area. The figure given above shows the bottleneck type network where an input layer and an output layer both are equal in size with many intermediate layers in between. And the ratio of the size of the input layer to the size of the intermediate layer is known

ascompression ratio.

#### G. Security:

In this sector the ignition has been achieved by introduction of initiative program called CATCH whose acronym is Computer Aided Tracking and Characterization of Homicides. Here the learn method starts with the study of existing crime, that is added with location and the characteristics of the of crime. The methodology is further divided into under falling tools, each of that includes certain group of characteristics.

#### H. Loans and Credit cards:

In this process the primary focus is on past experience. The emphasis on view to past experiences leads to judge the present or future decision which will overcome with diverse problems. Based on this application we can give an instance of bank or any other types of credit companies that has to display the decisions to their applicants based on their previous experiences. This research concentrates on decision making and leading ahead to specify the reason that how this particular experience had been justified is almost near to impossible. If we gaze into network era the reason of how decision is made is very tedious logic to describe. The research works in this topic discusses about the self-modified codes this codes are proven to be toughest to debug ever, this results the tracing of such codes next to impossible. It was guessed that conventional computing is the only method that made it possible for decision making process very convenient that may be used for future judgment.

#### I. Electronic noses:

Inspired by ANN combined with the principle of chemical sensing system (for instance spectrometer), electronic nose traces a patterns of chemicals that has some particular output patterns depending upon the sensation. In this case an odor is passed through chemical sensor array there after these chemicals are converted into such format which computer can understand. This pattern is used by ANN to identify the chemicals.

#### J. ALVINN, the self-driving car:[25]

The vital growth of this application works due to the principle inspired by back-propagation network, in which the images of the road in various condition and the modification in steering condition to be done according to such condition is focused. In this situation at the input layer the video image of car which is driving is taken through its injected onboard cameras. And at the output layer there is the role of steering commands those passed through network. This yields the direction as a guide that at which the steer is to be moved and can enjoy the freeway driving itself.

### LIMITATIONS

Every inventions have their own advantages and disadvantages, elaborating some of such small draw backing points in this part. Those limitation points are listed below:[6]

- 1) ANN is little complicated to deal with routine problems.
- 2) Perfect procedure in structural way is not available with ANN.
- 3) Greater computational burden.
- 4) Proneness to over fitting.
- 5) Singleparadigm is not available for ANN development.
- 6) Quality of output is not always guessed one.
- 7) Methodology of solving the problems is not specified in many of the ANN solutions.
- 8) Empirical nature of model development.

### CONCLUSION

Through this survey paper we can conclude that Artificial Neural Network is upgrading technology which deals with efficient usage of our resources. ANN all over deals with parallel processing concept where maximum utilization of resources can be done. The capability of parallel processing is used to save our money and time both. This crucial concept leads ANN to be constitute of vast range of vital applications in all sectors including medical, economics or either upcoming technologies. ANN not only deals with software improvisation instead inspired by human brain it always comes over with the maximum assisting wide range of applications for our day to day necessities also.

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