A Comprehensive Study of Artificial Neural Networks

Md Anis Alam 1, Bintul Zehra 2, Neha Agrawal 3

123 Research Scholars, Department of Electronics & Communication Engineering, Al-Falah School of Engineering & Technology, Faridabad, Haryana, INDIA.

1 Email-anisalam87@gmail.com

Abstract- In this research 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. In this seminar paper, the features of biological and artificial neural networks were studied by reviewing the existing works of authorities in print and electronics on biological and artificial neural networks. The features were then assessed and evaluated and comparative analysis of the two networks were carried out. The metrics such as structures, layers, size and functional capabilities of neurons, learning capabilities, style of computation, processing elements, processing speed, connections, strength, information storage, information transmission, communication media selection, signal transduction and fault tolerance were used as basis for comparison. A major finding in the research showed that artificial neural networks served as the platform for neuro-computing technology and as such a major driver of the development of neuron-like computing system. It was also discovered that Information processing of the future computer systems would greatly be influenced by the adoption of artificial neural network model.

Keywords: Biological Neural Networks, Artificial Neural Networks, Neurons, Architecture, Characteristics and application.

I. INTRODUCTION

The concept of ANN is basically introduced from the subject of biology where neural network plays an important and key role in human body. In human bodywork 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.

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 equipment’s or producing material needed by the neurons. 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 sends signals at spikes of electrical activity through a long thin stand known as an axon and an axon splits these signals through synapse and sends it to the other neurons.
An Artificial Neuron is basically an engineering approach of biological neuron. It has device with many inputs and one output. ANN is consisting of large number of simple processing elements that are interconnected with each other and layered also.

II. MATERIALS AND METHODS

A. Methodology

The existing works of authorities in prints and electronics on biological and artificial neural networks were reviewed. The review work involves a study of the structure and function of both neural networks. The features of both biological and artificial neural networks were assessed, evaluated and compared with a view to drawing the matrix of equivalence of the features. Neural Networks metrics such as structures, layers, size of neurons, functional capabilities of neurons, their learning capabilities, style of computation, processing elements, processing speed, connections, strength, information storage, information transmission communication media selection, signal transduction and fault tolerance were used as basis for comparison. The principles and practice of
neuro-computing was studied with a view to showing the applications of neural networks in the development of human-like intelligent computer software system.

B. Objective of the research

The primary objective of this study is to establish the potential features of biological neural network that can be adapted for the development of human-like intelligent computer system.

III. General Overview

Research in the field of neural networks has been attracting increasing attention in recent years. Since 1943, when Warren McCulloch and Walter Pitts presented the first model of artificial neurons, new and more sophisticated proposals have been made from decade to decade. Mathematical analysis has solved some of the mysteries posed by the new models but has left many questions opened for future investigations. Needless 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 biology.

A. Models of Computation

Artificial neural networks can be considered as just another approach to the problem of computation. The first formal definitions of computability were proposed in the 1930s and ’40s and at least five different alternatives were studied at the time. The computer era was started, not with one single approach, but with a contest of alternative computing models. It is we all know that the von Neumann computer emerged as the undisputed winner in this confrontation, but its triumph did not lead to the dismissal of the other computing models.

Fig. The biological model (neural networks)
The explanation of important aspects of the physiology of neurons set the stage for the formulation of artificial neural network models which do not operate sequentially, as Turing machines do. Neural networks have a hierarchical multi-layered structure, which sets them apart from cellular automata, so that information is transmitted not only to the immediate neighbors but also to more distant units. In artificial neural networks one can connect each unit to any other. In contrast to conventional computers, no program is handed over to the hardware – such a program has to be created, that is, the free parameters of the network have to be found adaptively.

Although neural networks and cellular automata are potentially more efficient than conventional computers in certain application areas, at the time of their conception they were not yet ready to take center stage. The necessary theory for harnessing the dynamics of complex parallel systems is still being developed right before our eyes. In the meantime, conventional computer technology has made great strides.

Artificial neural networks have, as initial motivation, the structure of biological systems, and constitute an alternative computability paradigm. For that reason it is necessary to review some aspects of the way in which biological systems perform information processing. The fascination which still pervades this research field has much to do with the points of contact with the surprisingly elegant methods used by neurons in order to process information at the cellular level. Several million years of evolution have led to very sophisticated solutions to the problem of dealing with an uncertain environment. In this study, some elements of these strategies were discussed in order to determine what features to adopt in the abstract models of neural networks.

B. Biological Neural Networks

Nervous system

The nervous system as a network of cells specialized for the reception [7], integration and transmission of Information. It comprises the brain and spinal cord (the central nervous system; CNS) and sensory and motor nerve fibers that enter and leave the Central Nervous System (CNS) or are wholly outside the CNS (the peripheral nervous system; PNS). The fundamental unit of the nervous system is the neuron.

There are about 1011 neuron in the body. Their cell bodies tend to aggregate into compact groups (nuclei, ganglia) or into sheets (laminae) that lie within the grey matter of the central nervous system (CNS) or are located in specialized ganglia in the peripheral nervous system (PNS). Groups of nerve fibres running in a common direction usually form a compact bundle (nerve, tract, peduncle, brachium, and pathway). Sheaths of lipid material called myelin, which gives, raise to the characteristic appearance of the white matter surround many of these nerve fibres. In addition to neurons there are glial cells, which play a supporting role. There are about 10 times more glial cells than neurons and they occupy approximately half the volume of the brain.

Summarily neurons are specialized;

a. to receive information from the internal and external environment;
b. to transmit signals to other neurons and to effector organ;
c. to process information (integration) and
d. to determine or modify the differentiation of sensory receptor cells and effector cells.
c. **Motivations for Artificial Neural Networks**

Either humans or other computer techniques can use neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, to extract patterns and detect trends that are too complex to be noticed. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze. This expert can then be used to provide projections given new situations of interest and answer "what if’' questions.

Advantages of artificial neural networks include:

a. Adaptive learning  
b. Self-Organization  
c. Real Time Operation  
d. Fault Tolerance via Redundant Information Coding  
e. Collective Solution  
f. Distributed Memory  
g. Parallel Processing Ability

**Differences Between Modern computers and Biological neural systems**

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 a sequential and centralized manner.  
4) In terms of reliability it is very vulnerable.  
5) The Operating Environment is well defined and well constrained.
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.

IV. Network Architectures

There are further divisions of Feedback and Feed Forward Network architecture, which are shown in below Figure.

Fig Taxonomy of Network Architecture

A. Applications of Artificial Neural Networks

There are various business applications of artificial neural network. Every sector in this world wants a system which is it intelligent to solve any problem according to the inputs. In this paper we have discussed various Business Applications, which are listed below:

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.

B. 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:
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.

V. 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.

VI. REFERENCES