"STUDY AND ANALYSIS OF ARTIFICIAL NEURAL NETWORKS AND THEIR APPLICATIONS"

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ABSTRACT

An Artificial Neural Network (ANN) is a computational model inspired on the structure and functions of biological neural networks. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. Neural networks has broad applicability to real world problems. This paper is an introduction to Artificial Neural Networks (ANNs) and learning process of ANNs. Comparative study of biologically and artificial neural, AANs provides a very exciting alternatives, applications of neural networks, and other recent advances and future applications. We have analyzed that Neural Networks have some advantages and limitations

Keywords -*ANN (Artificial Neural Networks), Biologically Neurons, Learning*

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Introduction

The simplest definition of a neural network, more properly referred to as an 'artificial' neural network (ANN), is provided by the inventor of one of the first neurons computers, Dr. Robert Hecht-Nielsen. He defines a neural network as:

"...a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.[1]

An artificial neuron network is a computerized model influenced from natural neurons. Natural neurons catch signals from synapses, which is located on the dendrites or membrane of the neuron. When the signals received are strong enough, the neuron is activated and emits a signal .It emits signal though the axon. This signal sent to another synapse or activates other neurons.

The intricacy of real neurons is highly withdrawn in the process of modeling artificial neurons. These basically consist of some inputs ,The input (a1, a2, … , an) is multiplied by its corresponding weights (W1j, W2j, … , Wnj) and the node uses summation of these weighted inputs (W1j * a1, W2j * a2, … , Wnj * an) The other input to the node bj, is the node's internal approach, also called bias to estimate an output signal using a transfer function.

$$u_j = \sum_{i=1}^{n}(W_{ij} * a_i) + b_j$$

This mathematical formula determines the activation of the neuron and computes the output.

COMPARATIVE STUDY OF BIOLOGICALLY AND ARTIFICIAL NEURAL

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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 *[2]*.

The whole process of receiving and sending signals is done in particular manner like a neuron receives 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 *[3]*
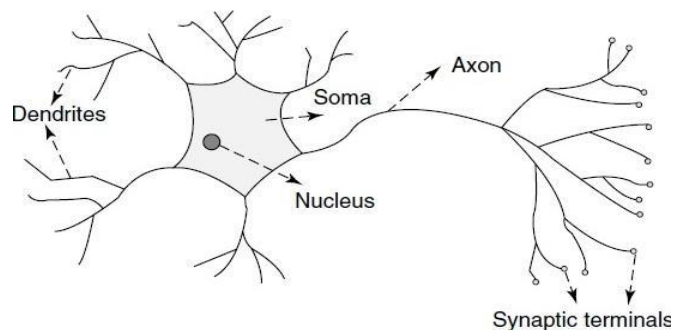

Fig 1 Human Neurons *[2]*

An Artificial Neuron is basically an engineering approach of biological neuron. It has device with many inputs and one output. ANNs is consisting of large number of simple processing elements that are interconnected with each other and layered also. *[3,4]*
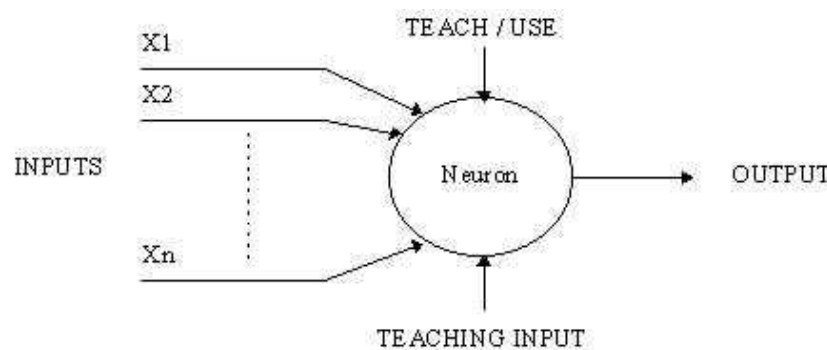

Fig 2 Artificial Neuron network *[3]*

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. *[4]*

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Finally neural networks explained the mathematical models involved are presented and demonstrated. With their remarkable 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. 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.

OTHER ADVANTAGES INCLUDE:

1. Adaptive learning: An ability to learn how to do tasks based on the data given for training or initial experience.
2. Self-Organization: An ANNs can create its own organization or representation of the information it receives during learning time.
3. Real Time Operation: ANNs computations may be carried out in parallel, and special hardware devices are being designed and manufactured which take advantage of this capability.
4. Fault Tolerance via Redundant Information Coding: Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.

Differences between Modern Computers Biological Neural system: - [2]

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

Biological Neural system:-

1) low speed but simple in structure by contains a large number of processor.
2) Having integrated into processor but Distributed Memory.
3) Computing is done with self learning in a parallel processing and distributed manner.
4) In terms of reliability it is durable.
5) The operating environment is badly defined and corrupt.

THE LEARNING PROCESS

Learning can refer to either acquiring or enhancing knowledge. As Herbert Simon says, Machine Learning denotes changes in the system that are adaptive in the sense that they enable the system to do the same task or tasks drawn from the same population more efficiently and more effectively the next time. ANNs learning pattern can be classified as supervised. [11]

Supervised Learning

Supervised learning paradigm of an ANNs is efficient and finds solutions to several linear and non-linear problems such as classification, plant control, forecasting, prediction, robotics etc. [5, 6]

Unsupervised Learning

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Self-Organizing neural networks learn using unsupervised learning algorithm to identify hidden patterns in unlabelled input data. This unsupervised refers to the ability to learn and organize information without providing an error signal to evaluate the potential solution. [7].

ADVANTAGES & LIMITATIONS OF ARTIFICIAL NEURAL NETWORKS

The most important advantages & **Limitations** of Artificial Neural Networks as follows: [8]

1. Artificial neural network is characterized with ability to solve new kind of difficult problems, this has opened new field to decision support applications that was difficult or impossible to be programmed in computer.
2. Artificial neural network is characterized with high speed in processing as it consists of a large number of processing elements which are highly communicated with each other and processed in a parallel manner in the same problem.
3. Artificial neural network has ability to deal with incomplete, confused or not well-determined data, it is able to deal with unexpected conditions (as human brain works) and it has ability to deal with a large amount of data to create models in case that no certain known rules, gives accurate results as long as accurately-built.
4. Artificial neural network is characterized with flexibility and maintenance easiness as it adapts itself with changes in environment and has ability to learn by experience and realize the relationship between variables and improve its performance.
5. Artificial neural network does not sufficiently test research hypotheses, and gives no important input variables, which makes results interpretation difficult and doubtful and needs a long time to be learned
6. Artificial neural network uses past data patterns for future predictions, this means that it supposes the future will be as the past, in case that change occurs in environment and surrounding circumstances, the networks patterns will not be better than statistical conventional patterns in predicting unless it is re-learned.

The researcher concludes that artificial neural networks are characterized by:

- Ability to solve difficult problems;
- Ability to deal with inaccurate data;
- Speed of processing and
- Ability to adapt with changes in environment and surrounding circumstances through re-learning, however, it lacks the ability to interpret the results reached.

APPLICATIONS OF ARTIFICIAL NEURAL NETWORKS

There are various applications of artificial neural network.

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

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12) Prediction of Stock Price Index.
The above applications have capability to estimate any type of problem by its own with the help Artificial Neural Network appearance with the help of various algorithms like Perception Learning Algorithm, Back Propagation Algorithm, SOM Learning Algorithm and ART1 Learning Algorithm. [2,3,4]

RECENT ADVANCES AND FUTURE APPLICATIONS OF ANNS INCLUDE:
Integrant of fuzzy logic into neural networks
- Fuzzy logic is a type of logic that recognizes more than simple true and false values, hence better simulating the real world. For example, the statement today is sunny might be 100% true if there are no clouds, 80% true if there are a few clouds, 50% true if it's hazy, and 0% true if rains all day. Hence, it takes into account concepts like -usually, somewhat, and sometimes.
- Fuzzy logic and neural networks have been integrated for uses as diverse as automotive engineering, applicant screening for jobs, the control of a crane, and the monitoring of glaucoma.[13]
  Pulsed neural networks
- "Most practical applications of artificial neural networks are based on a computational model involving the propagation of continuous variables from one processing unit to the next. In recent years, data from neurobiological experiments have made it increasingly clear that biological neural networks, which communicate through pulses, use the timing of the pulses to transmit information and perform computation. This realization has stimulated significant research on pulsed neural networks, including theoretical analyses and model development, neurobiological modeling, and hardware implementation." [14]

Hardware specialized for neural networks
- Some networks have been hardcoded into chips or analog devices? This technology will become more useful as the networks we use become more complex.
- The primary benefit of directly encoding neural networks onto chips or specialized analog devices is SPEED!
- ANN hardware currently runs in a few niche areas, such as those areas where very high performance is required (e.g. high energy physics) and in embedded applications of simple, hardwired networks (e.g. voice recognition).
- Many ANNs today use less than 100 neurons and only need occasional training. In these situations, software simulation is usually found sufficient
- When NN algorithms develop to the point where useful things can be done with 1000's of neurons and 10000's of synapses, high performance NN hardware will become essential for practical   operation.[15]
  Improvement of existing technologies
- All current ANN technologies will most likely be vastly improved upon in the future. Everything from handwriting and speech recognition to stock market prediction will become more sophisticated as researchers develop better training methods and network architectures.[9,10]

  ANNs might, in the future, allows:
  - robots that can see, feel, and predict the world around them

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- improved stock prediction
- common usage of self-driving cars
- composition of music
- handwritten documents to be automatically transformed into formatted word processing documents
- trends found in the human genome to aid in the understanding of the data compiled by the Human Genome Project
- self-diagnosis of medical problems using neural networks
- and much more![9,10]

CONCLUSION

In this paper we discussed on Artificial neural network, working of biological neural, process of learning ,advantages ,limitation and present and future application. we had concluded that , Neural networks described, presented and demonstrated with their incredible ability to derive meaning from complicated or unspecific data, can be used to extract patterns and recognize trends that are too complex to be noticed by either humans or other computer techniques. A well trained neural network can be concept of as an "expert" in the category of information it has been given to analyze. Another thing Parallel Processing is more needed in this present time and the need of Artificial Intelligence is increasing day by day. In future we have to develop much more algorithms and other problem solving techniques in the way remove the limitations of the Artificial Neural Network. With the help of Real-time intelligent automation Architectures, algorithms and techniques, Decision-support systems, Aspects of reasoning, Met heuristics, hybrid Fuzzy Logic we will definitely solve some limitations of Artificial Neural Network. Philip D. Wasserman of ANZA Research, Inc.envisions "artificial neural networks taking their place alongside of conventional computation as an adjunct of equal size and importance" [12]

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