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Application of Biological Process in Neural Nets

S.Chitra[1], R.Arunadevi[2], R.Dhivya[3]

PG Scholar, Dept. of CS &IT, Dhanalakshmi Srinivasan College of Arts & Science for Women, Perambalur, Tamil Nadu, India[1,3]

Assistant Professor, Dept. of CS &IT, Dhanalakshmi Srinivasan College of Arts & Science for Women, Perambalur, Tamil Nadu, India[2]

ABSTRACT: This paper presents an emergence of an Artificial Neural Network(ANN) as a tool for analysis of different parameter of a system. An Artificial Intelligence In Neural Network is an information processing paradigm that is inspired by the way nervous system, process information. ANN consists of multiple layers of simple processing elements called a nervous. The neuron performs two functions, namely, collection of inputs & generation of an output. Use of ANN provides overview of the theory, learning rules and applications of the most important neural network model, definitions and style of computation. The mathematical model of network throws the light on the concept of inputs, weights, summing function, activation function & outputs. Then ANN helps to decide the type of learning . in a real sense, neural networks are still a solution in search of a few good problems. The ANN is development of neural networks application.

KEYWORD: Artificial Neural Network, Nervous, Intelligence, Learning, Application.

I. INTRODUCTION

Artificial Intelligence(AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans . An Artificial Neural Network(ANN) is an information processing paradigm that is inspired by nervous systems. Its composed of a large number of highly interconnected processing elements called neurons. An ANN is configured for a specific application. Such as pattern recognition or data classification. Artificial Neural Network(ANN) or Neural Network(NN) has provide an excitedly alternative method for solving a variety of problems in different fields of science and engineering. Many tasks involving intelligence or pattern recognition are extremely difficult to automate, but appear to be performed very easily by system. For instance, various objects and make sense out of the large amount of visual information in their surroundings, apparently requiring very little effort. It stands to reason that computing systems that attempt similar tasks will profit enormously from understanding how humans perform these tasks, and simulating these processes to the extent allowed by physical limitations. This necessitates the study and simulation of Neural Networks. Neural networks offer improved performance over conventional technologies in areas which includes: Machine Vision, Robust Pattern Detection, Signal Filtering, Virtual Reality, Artificial Life and more. A method of computing based on the interaction of multiple connected processing elements. The neural network of an Human is part of its nervous system, containing a large number of interconnected neurons (nerve cells). "Neural" is an adjective for neuron, and "Network" denotes a graph like structure. Artificial Neural Network refers to computing systems whose central them e is borrowed from the analogy of biological neural networks. Artificial Neural Networks are also referred to as "Neural Nets", artificial neural systems "parallel distributed processing systems" and "connectionist systems". For a computing system to be called by these pretty names, it is necessary for the system to have a labeled directed graph structure where nodes perform some simple computations. From elementary graph theory we recall that a "Directed Graph" consists of a set of "Nodes" (vertices) and a set of "Connections" (edges/links/arcs) connecting pairs of nodes.

Artificial Neural Network(Ann) are programs designed to solve any problem by trying to mimic the structure and the function of our nervous system. Neural Network are based on simulated neurons, which are joined together in a variety of way to form networks. Neural network resembles the human brain in the following two ways:

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- A Neural network acquires knowledge through learning.
- A Neural network's knowledge is stored within the inter connection strengths known as synaptic weight.

In a neural network, each node performs some simple computations, and each connection conveys a signal from one node to another, labeled by a number called the "Connection Strength" or "Weight" indicating the extent to which a signal is amplified or diminished by connection. This system is the alternative for human expertise and knowledge.
An Artificial Neural Network is a network of many very simple process, each possibility having a local memory. The units are connected by unidirectional communication channels, which carry numeric data. The units operate only on their local data and on the inputs they receive via the connection. Biological approach to AI developed in 1943. Comprised of one or more layers of neurons'. Artificial Neural Networks are modeled closely following the brain and therefore a great deal of terminology is borrowed from neuroscience. The ability to deal with incomplete information. A powerful techniques to solve many real world problem. This generally involves borrowing characteristics from human intelligence and a 1958pplying them as algorithms in a computer friendly way.

II. LITERATURE SURVEY

Human brain has many incredible characteristics such as massive parallelism, distributed representation and computation, learning ability, adaptively, which seems simple but is really complicated. It has been always a dream for computer scientist to create a computer which could solve complex perceptual problems this fact. ANN models was an effort to apply the same method as human brain uses to solve perceptual problems. Three periods of development for ANN: 1940:Mcculloch and pitts: Initial works, 1941: DEVELOPMENT OF THE ELECTRONIC COMPUTER, some trace the origin to John Atanasoft and Clifford Berry at Iowa State University required large, separate air-conditioned rooms ,required separate configuration of thousands of wires, data fed into system by punched cards.1949: first commercial, stored program computer: Made job of entering a program easier, Advancements in computer theory by computer science(and eventually to AI), Invention of a means of processing data makes AI possible. 1956: DARTMOUTH CONFERENCE: John McCarthy ("father of AI") organizes conference. A month of brainstorming in VT. Talent and expertise of others interested in machine intelligence, biggest gain: field now called "Artificial Intelligence". 1958 : LISP Language Developed: still used today (McCarthy announces new development LISP language) LISP processing language of choice among AI developers. 1960: Rosenblatt: Perceptron convergence theorem, Minsky & papert: work showing the limitations of a simple perceptron. "machines will be capable, within 20 years, of doing any work a man can do". 1963: Start of DoD's Advanced Research Projects MIT receives 2.2 million dollar grant from US govt. to research Machine –Aided Cognition(AI) from department of defense US wants to stay ahead of soviet union. Two years later, MIT researcher Marvin Minsky Predicted, "within a generation… the problem of creating 'Artificial Intelligence' will substantially be solved."(artificial intelligence innovator Herbert simon.1965).
1968: MICROWORLD PROGRAM, SHRDLU Created to SHRDLU part of micro worlds project research & programming in small worlds. When confined to small subject matter, computer program solve spatial & logic problems. 1970: FIRST EXPERT SYSTEM predict the probability of a solution under set conditions, potential to interpret statistics, formulate rules. Over course of 10 years, can forecast stock market, aid doctors in diagnosis, show miners promising mineral locations. Large applications in market place, conditional rules & storage of information. 1972: PROLOG Language Revealed general logic programming language, represented as facts and rules, developed in France , remains one of most popular programming languages today. 1980:Hopfield/Verbose and Rumelhart: Hopfield' energy approach/back-propagation learning algorithm. 1986: AI – Based Hardware Sells $425 Million to Companies expert system in particular demand, General Motors, Boeing rely heavily on expert system. Companies develop that specialize in creating software that aids in producing expert systems. 1991: AI System Beats human Chessmaster AI goes home, public interest, growing, AI system placed against a human chessmater to see who would win, AI wins-shows skills & abilities. Chess & AI if they can create a computer that can outsmart humans I this obviously strategic, thinking- based game , then it would be a major milestone on the road to the intelligent computer.
In recent years there has been a great resurgence of interest in a method of computing that was originally pioneered in the 1940s. This method is modeled generally after biological nervous systems (wetware) and is called neural networks (NN), artificial neural networks (ANN), parallel distributed processing (PDP) and perhaps others. In view of the large

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amount of research and application activity going on in this area, it seems appropriate to make a high level overview of the field to see if this approach can be usefully applied to computing applications at SLAC. An artificial neural network are non-linear mapping systems with a structure loosely based on principles observed in the biological nervous systems. In greatly simplified terms from, a typical real neuron has a branching dendrite tree that collects signals from many other neurons in a limited area; a cell body that integrates collected signals and generates a response signal (as well as manages metabolic functions); and along branching axon that distributes the response through contacts with dendrites trees of many other neurons. The response of each neuron is a relatively simple non-linear function of its inputs and is largely determined by the strengths of the connections from its inputs. In spite of the relative simplicity of the individual units, systems containing many neurons can generate complex and intersecting behaviors. In general terms, a NN consists of large number of simple processors linked by weighted connection ns. By analogy, the processing nodes may be called "neurons". Each node output depends only on the information that is locally available at the node, either stored internally or arriving via the weighted connections. Each unit receives inputs from many other nodes and transmits its output to other nodes. By itself, a single processing element is not very powerful; it generates a scalar output with a single numerical value, which is a simple non -linear function of its inputs. The power of the system emerges from the combination of many units in an appropriate way. A network is utilized different function by varying the connection topology and the values of the connecting weights. Complex functions can be implemented by connecting the units together with appropriate weights. It has been shown that a sufficiently large network with an appropriate structure and property chosen weights can approximate with arbitrary accuracy any function satisfying certain broad constraints. This model is a drastically simplified approximation of real nervous systems. The intent is to capture the major characteristics important in the information processing functions of real networks without varying too much about the physical constraints imposed by biology. Artificial NN are made up of simple, highly interconnected processing units called neurons, each of which performs two functions, namely, aggregation of its inputs from other neurons or the external environment and generation of an output from the aggregated inputs.

III. ANN METHODOLOGY

ANNs are basically massive parallel computational models that imitate the function of human brain. An ANN consists of large number of simple processors linked by weighted connections. By analogy, the processing nodes may be called "neurons". Each node output depends only on the information that is locally available at the node, either stored internally or arriving via the weighted connections. Each unit receives inputs from many other nodes transmits its output to yet another nodes. By itself, a single processing element is not very powerful; it generates a scalar output with single numerical value, which is a simple non-linear function of its inputs.
Artificial Neural Network basic is incorporate the two fundamental components of biological neural nets:

- Neurons (nodes)
- Synapses (weight)

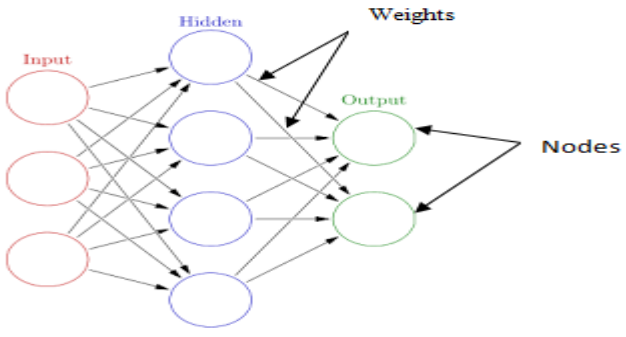

Fig.2 Artificial Neural network

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The power of the system emerges The ANNs have been widely used in complex non linear function mapping, image processing, pattern recognition & classification & so on. Feed-forward networks are common type of neural networks. A feed forward network comprises an input layer, where the inputs of the problem are received, hidden layers, where the relations hip between the inputs & outputs are determined & represented by synaptic weights, & an output layer which emits the outputs of the problem. The neural feed forward network is modeled with three basic elements: a) A set of synapses characterized by synaptic weights. b) An adder or linear combiner for summing the input signals. c) An activation function for limiting the amplitude of the output of neuron to some finite value. So, it is difficult to bring a priori information into the design, and when the system does no t work properly it is also hard to incrementally refine the solution. But ANN based solutions are extremely efficient in terms of development time and resources, and in many difficult problems artificial neural networks provide performance that is difficult to match with other technologies.

A. MATHEMATICAL MODEL

When creating a functional model of the biological neuron, there are three basic components of importance. First, the synapses of the neuron are modeled as weights. The strength of the connection between an input and a neuron is noted by the value of the weight. Negative weight values reflect inhibitory connections, while positive values designate excitatory connections. The next two components model the actual activity within the neuron cell. An adder sums up all the inputs modified by their respective weights. This activity is refer red to as linear combination. Finally, an activation function controls the amplitude of the output of the neuron. An acceptable range of output is usually between 0 and 1, or -1 and 1. Mathematically, this process is described in the figure,

B. FEED FORWARD NETWORKS

This is a subclass of acrylic networks in which a connection is allowed from a node in layer i only to nodes in layer i+1 as shown in Fig.4. These networks are succinctly described by a sequence of numbers indicating the number of nodes in each layer. For instance, the network shown in Fig. 4 is a 3-2-3-2 feed forward network; it contains three nodes in the input layer (layer 0), two nodes in the first hidden layer (layer 1), three nodes in the second hidden layer (layer 2), and two nodes in the output layer (layer 3). These networks, generally with no more than four such layers, are among the most common neural nets in use, so much so that some users identify the phrase “neural networks” to mean only feed forward networks. Conceptually, nodes in successively higher layers abstract successively higher level features from preceding layers. In the literature on neural networks, the term “feed forward” has been used sometimes to refer to layered or acrylic networks.

C. NEURAL LEARNING

It is reasonable to conjecture that neurons in an animal’s brain are “hard wired.” It is equally obvious that animals, especially the higher order animals, learn as they grow. How does this learning occur? What are possible mathematical models of learning? In this section, we summarize some of the basic theories of biological learning and their daptations for artificial neural networks. In artificial neural networks, learning refers to the method of modifying the weights of connections between the nodes of a specified network. Learning is the process by which the random-valued parameters (Weights and bias) of a neural network are adapted through a continuous process of simulation by the environment in which network is embedded . Learning rate is defined as the rate at which network gets adapted. Type of learning is determined by the manner in which parameter change takes place. Learning may be categorized as supervised learning, unsupervised learning and reinforced learning. In Supervised learning, a teacher is available to indicate whether a system is performing correctly, or to indicate a desired response, or to validate the acceptability of a system’s responses, or to indicate the amount of error in system performance. This is in contrast with unsupervised learning, where no teacher is available and learning must rely on guidance obtained heuristically by the system examining different sample data or the environment. Learning is similar to training i.e. one has to learn something which is analogous to one has to be trained. A neural network has to be configured such that the application of a set of inputs produces (either 'direct' or via a relaxation process) the desired set of outputs. Various methods to set the strengths of the connections exist. One way is to set the weights explicitly, using a priori knowledge. Another way is to 'train' the

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neural network by feeding it teaching patterns and letting it change its weights according to some learning rule. We can categorize the learning situations in two distinct sorts. These are,

1.Supervised Learning

Supervised learning or Associative learning in which the network is trained by providing it with input and matching output patterns. a teacher is available to indicate whether a system is performing correctly, or to indicate the amount of error in system performance. here a teacher is a set of training data. The training data consist of pairs of input and desired output values that are traditionally represented in data vectors. Supervised learning can also be referred as classification , were we have a wide range of classifiers, (multilayer perception, k nearest neighbor…etc). supervised learning which incorporates an external teacher, so that each output unit is told what its desired response to input signals ought to be. During the learning process global information may be required. Paradigms of supervised learning include error correction learning, reinforcement learning and stochastic learning. An important issue concerning supervised is the problem of error convergence, i.e the minimization of error between the desired and computed unit values. The aim is to determine a set of weights which minimizes the error. One well-known method, which is common to many learning paradigms is the least mean square(LMS) convergence.

2 .Unsupervised Learning

Unsupervised learning or Self-organization in which an (output) unit is trained to respond to clusters of pattern within the input. In this paradigm the system is supposed to discover statistically salient features of the input population. Unlike the supervised learning paradigm, there is no a priori set of categories into which the pat terns are to be classified; rather the system must develop its own representation of the input stimuli. Example: In a different situation, the archaeologist has to determine whether a set of skeleton fragments belong to the same dinosaur species or need to be differentiated into different species. For this task, no previous data may be available to clearly identify the species for each skeleton fragment. The archaeologist has to determine whether the skeletons (that can be reconstructed from the fragments) are sufficiently similar to belong to the same species, or if the differences between these skeletons are large enough to warrant grouping them into different species. This is an unsupervised learning process, which involves estimating the magnitudes of differences between the skeletons. One archaeologist may believe the skeletons belong to different species, while another may disagree, and there is no absolute criterion to determine who is correct.

D. BACK PROPAGATION NETWORK

The back propagation algorithm (Rumelhart and McClelland, 1986) is used in layered feed-forward ANNs. This means that the artificial neurons are organized in layers, and send their signals “forward”, and then the errors are propagated backwards. The network receives inputs by neurons in the input layer, and the output of the network is given by the neurons on an output layer. There may be one or more intermediate hidden layers. The back propagation algorithm uses supervised learning, which means that we provide the algorithm with examples of the inputs and outputs we want the network to compute, and then the error (difference between actual and expected results) is calculated. The idea of the back propagation algorithm is to reduce this error, until the ANN learns the training data. The training begins with random weights, and the goal is to adjust them so that the error will be minimal. Back propagation network has gained importance due to the shortcomings of other available networks. The network is a multi layer network (multi layer perception) that contains at least one hidden layer in addition to input and output layers. Number of hidden layers & numbers of neurons in each hidden layer is to be fixed based on application, the complexity of the problem and the number of inputs and outputs. Use of non -linear log-sigmoid transfer function enables the network to simulate non-linearity in practical systems. Due to this numerous advantages, back propagation network is chosen for present work. Implementation of back propagation model consists of two phases. First phase is known as training while the second phase is called Testing. Training, in back propagation is based on gradient decent rule that tends to adjust weights and reduce system error in the network. Input layer has neurons equal in number to that of the inputs. Similarly, output layer neurons are same in the number as number of outputs.

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E. ANN DEVELOPMENT & IMPLEMENTATION

In this work, both ANN implementation & training is developed, using the neural network toolbox of Mat Lab. Different ANNs are build rather than using one large ANN including all the output variables. This strategy allowed for better adjustment of the ANN for each specific problem, including the optimization of the architecture for each output.

IV. ADVANTAGES

Artificial Intelligence(AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans . An Artificial Neural Network(ANN) is an information processing paradigm that is inspired by biological nervous systems.

- ✓ Adapt to unknown situations.
- ✓ Robustness: fault tolerance due to network redundancy.
- ✓ Autonomous learning and generalization.
- ✓ It involves human like thinking.
- ✓ They handle noisy or missing data
- ✓ They can work with large number of variables or parameters.
- ✓ They provide general solutions with good predictive accuracy.
- ✓ System has got property of continuous learning.
- ✓ They deal with the non-linearity in the world in which we live.

V. CONCLUSION

As the ANN is an emerging technology it can be used for data analysis in applications such as pattern recognition, prediction, system identification & control. From above theories it can be seen that ANN is a radial basis function back propagation network. The network is capable of predicting the parameters by experimental system. The network has parallel structure and fast learning capacity. The collected experimental data such as speed, load & values of pressure distribution etc. are also employed as training and testing data for an artificial neural network. The neural network is a feed forward three layered network. Quick propagation algorithm is used to update the weight of the network during the training. The ANN has a superior performance to follow the desired results of the system and is employed to analyze such systems parameters in practical applications. Neural networks provide ability to provide more human-like AI. Takes rough approximation and hard-coded reactions out of AI design. Still require a lot of fine-tuning during development.

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BIOGRAPHY

Ms.S.CHITRA is presently pursuing M.Sc., Final year the Department of Computer Science & Information Technology in Dhanalakshmi Srinivasan College of Arts and Science for Women, perambalur, Tamil Nadu, India. She has published paper in IJET journal like Rethinking Permission Enforcement Mechanism on Mobile System.

Ms.ARUNADEVI.R - Received M.Sc., M.Phil Degree in Computer Science. She is currently working as Assistant Professor in Department of Computer Science & Information Technology in Dhanalakshmi Srinivasan College of Arts and Science for Women, Perambalur Tamil Nadu, India. She has Published papers in various journals like Mobile Communication in 4G Technology, DNS Support for Load Balancing, Securing Wireless Sensor Networks with Public Key Techniques.

Ms.R.DHIVYA is presently pursuing M.Sc., Final year the Department of Computer Science & Information Technology From Dhanalakshmi Srinivasan College of Arts and Science for Women, perambalur, Tamil Nadu, India.