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**Deogiri Institute of Engineering and Management Studies,
Aurangabad**

Seminar Report

On

Neural Network

Submitted By

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**Deogiri Institute of Engineering and Management Studies,
Aurangabad**
(2019- 2020)

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In partial fulfillment of
Bachelor of Technology
(Computer Science & Engineering)

Guided By
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(2019- 2020)

CERTIFICATE

This is to certify that, the Seminar entitled “**Neural Network**” submitted by **Kharad Saurabh Vikram** is a bonafide work completed under my supervision and guidance in partial fulfillment for award of Bachelor of Technology (Computer Science and Engineering) Degree of Dr. Babasaheb Ambedkar Technological University, Lonere.

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Abstract

This report presents an emergence of an Artificial Neural Network (ANN) as a tool for analysis of different parameters of a system. An Artificial Neural Network (ANN) is an information-processing paradigm that is inspired by the way biological nervous systems such as brain, process information. ANN consists of multiple layers of simple processing elements called as neurons. 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 models, definitions and style of Computation. The mathematical model of network throws the light on the concept of inputs, weights, summing function, activation function and outputs. Then ANN helps to decide the type of learning for adjustment of weights with change in parameters. Finally the analysis of a system is completed by ANN implementation & ANN training and prediction quality.

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List of Abbreviation

Sr.No.	Acronym	Abbreviation
1	ANN	Artificial Neural Network
2	MLNN	Multi-Layer Neural Networks
3	RBF	Radial Basis Function
4	LMS	least mean square

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1. Introduction

1.1 What is a Neural Network?

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well.

Artificial Neural Networks are biological emulations of human nervous systems. They are best known as universal approximators in approximating a function. It is their highly non-linear mapping ability which makes them find applications in many areas like pattern recognition and classification, speech recognition, function approximation, prediction of currency exchange rates, sonar signal processing, maximizing the yields of chemical processes and in medical diagnosis.

first wave of interest in neural networks (also known as connectionist models or parallel Distributed processing emerged after the introduction of simplified neurons by McCulloch and Pitts in 1943 (McCulloch & Pitts 1943) .These neurons were presented as models of biological neurons and as conceptual components for circuits that could perform computational tasks. When Minsky and Papert published their book *Perceptron's* in 1969 (Minsky and Papert 1969) in which they showed the deficiencies of perceptron models most neural network funding was redirected and researchers left the field. Only a few researchers continued their efforts, most notably Teuvo Kohonen, Stephen Grossberg, James Anderson, and Kunihiko Fukushima. The interest in neural networks re-emerged only after some important theoretical results were attained in the early eighties (most notably the discovery of error back-propagation) and new hardware developments increased the processing capacities. This renewed interest is reflected in the number of scientists, the amounts of funding, the number of large conferences, and the number of journals associated with neural networks, nowadays most universities have a neural networks group, within their psychology, physics, computer science, or biology departments. Artificial neural networks can be most adequately characterized as computational models with particular properties such as the ability to adapt or learn, to generalize, or to cluster or organize data, and which operation is based

On parallel processing. However, many of the above-mentioned properties can be attributed to existing (non-neural) models, the intriguing question is to which extent the neural approach proves to be better suited for certain applications than existing models. To date an equivocal answer to this question is not found. Often parallels with biological systems are described. However, there is still so little known (even at the lowest cell level) about biological systems, that the models we are using for our artificial neural systems seem to introduce an oversimplification of the biological models. Data mining is process of identify patterns and establish relationships Data Mining defined as The nontrivial extraction of implicit, previously unknown, and potentially useful information from data. Data mining is the process of analyzing large amount of data stored is a data warhorse for useful information which makes use of artificial intelligence techniques ,neural network ,and advance statistical tools (such as cluster analysis) to reveal trends, patterns and relationship, which otherwise may be undetected.

Though the network can be easily designed to work with, there is always the problem of huge size of the network. To reduce the number of inputs to the network a new technique is presented which makes use of cross-correlation of two images or signals. It is a technique to find the known target in an image. The correlation of input dataset with each bifurcation gives us a set of images in which the aerial location or distribution of the respective bifurcation in the image. [4]

1.2 Historical background

Neural network simulations appear to be a recent development. However, this field was established before the advent of computers, and has survived at least one major setback and several eras. Many important advances have been boosted by the use of inexpensive computer emulations. Following an initial period of enthusiasm, the field survived a period of frustration and disrepute. During this period when funding and professional support was minimal, important advances were made by relatively few researchers. These pioneers were able to develop convincing technology which surpassed the limitations identified by Minsky and Papert. Minsky and Papert, published a book (in 1969) in which they summed up a general feeling of frustration (against neural networks) among researchers, and was thus accepted by most without further analysis. Currently, the neural network field enjoys a resurgence of interest and a corresponding increase in funding. The first artificial neuron was produced in 1943 by the neurophysiologist Warren McCulloch and the logician Walter Pitts. But the technology available at that time did not allow them to do too much.

Recently neural networks have been employed and compared to conventional classifiers for a number of classification problems. The neural network method is capable of rapid classification. A feedforward multi-layer neural networks (MLNN) is used as a classifier instead of the classical mean square error classifier. A Radial Basis Function (RBF) network is a two layer network that has different types of neurons in the hidden layer and the output layer. The RBF network performs similar Face Recognition using Radial Basis Function Network based on function mapping with the MLNN, however its structure and function is much different. A RBF is a local network that is trained in a supervised manner. This contrasts with a MLNN that is a global network. The distinction between local and global is made through the extent of input surface covered by the function approximation. An MLNN performs a global mapping, meaning all inputs cause an output, while an RBF performs a local mapping, meaning only inputs near a receptive field produce an activation

1.3 Why use neural networks?

Neural networks, 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 ANN can create its own organization or representation of the information it receives during learning time.
3. Real Time Operation: ANN 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.

Data mining is the semi-automatic discovery of patterns, associations, changes, anomalies, and statistically significant structures and events in data. Traditional data analysis is assumption driven in the

sense that a hypothesis is formed and validated against the data. Data mining, in contrast, is data driven in the sense that patterns are automatically extracted from data. The goal of this tutorial is to provide an introduction to data mining techniques. The focus will be on methods appropriate for mining massive datasets using techniques from scalable and high performance computing. The techniques covered include association rules, sequence mining, decision tree classification, and clustering. Some aspects of pre-processing and post processing are also covered. The problem of Predicting contact maps for protein sequences is used as a detailed case study. [1]

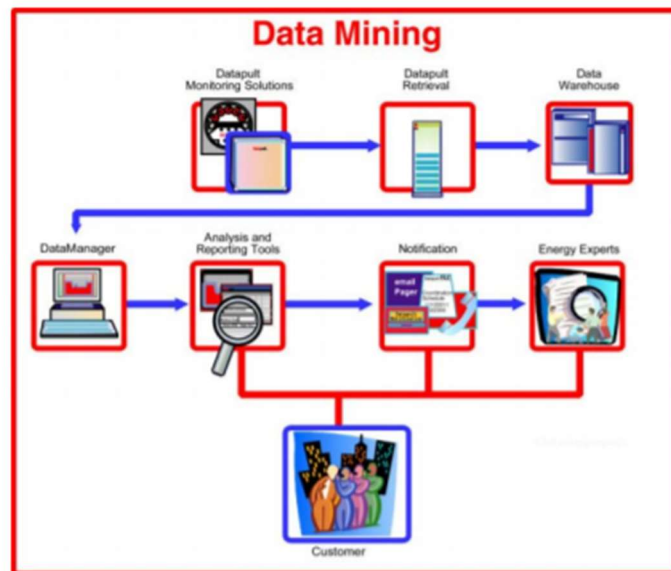


Figure 1.1: General Scheme of Genetic Algorithm

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1.4 Neural networks versus conventional computers

Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach i.e. the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are known the

computer cannot solve the problem. That restricts the problem solving capability of conventional computers to problems that we already understand and know how to solve. But computers would be so much more useful if they could do things that we don't exactly know how to do. Neural networks process information in a similar way the human brain does. The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. The examples must be selected carefully otherwise useful time is wasted or even worse the network might be functioning incorrectly. The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable. On the other hand, conventional computers use a cognitive approach to problem solving; the way the problem is to be solved must be known and stated in small unambiguous instructions. These instructions are then converted to a high level language program and then into machine code that the computer can understand. These machines are totally predictable; if anything goes wrong is due to a software or hardware fault. Neural networks and conventional algorithmic computers are not in competition but complement each other. There are tasks more suited to an algorithmic approach like arithmetic operations and tasks that are more suited to neural networks. Even more, a large number of tasks, require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

2. LITERATURE SURVEY

2.1 Human and Artificial Neurons - investigating the similarities

2.1.1 How the Human Brain Learns?

Much is still unknown about how the brain trains itself to process information, so theories abound. In the human brain, a typical neuron collects signals from others through a host of fine structures called dendrites. The neuron sends out spikes of electrical activity through a long, thin strand known as an axon, which splits into thousands of branches. At the end of each branch, a structure called a synapse converts the activity from the axon into electrical effects that inhibit or excite activity from the axon into electrical effects that inhibit or excite activity in the connected neurons. When a neuron receives excitatory input that is sufficiently large compared with its inhibitory input, it sends a spike of electrical activity down its axon. Learning occurs by changing the effectiveness of the synapses so that the influence of one neuron on another changes. [2]

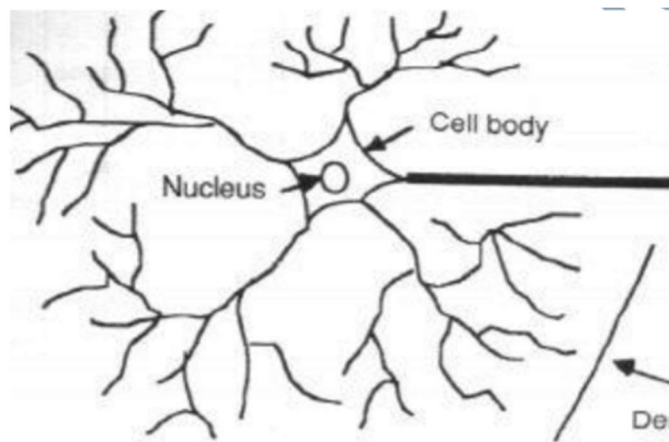


Figure 2.1: Components of Neuron

2.1.2 from Human Neurons to Artificial Neurons

We conduct these neural networks by first trying to deduce the essential features of neurons and their interconnections. We then typically program a computer to simulate these features. However because our knowledge of neurons is incomplete and our computing power is limited, our models are necessarily gross idealizations of real networks of neurons. [1]

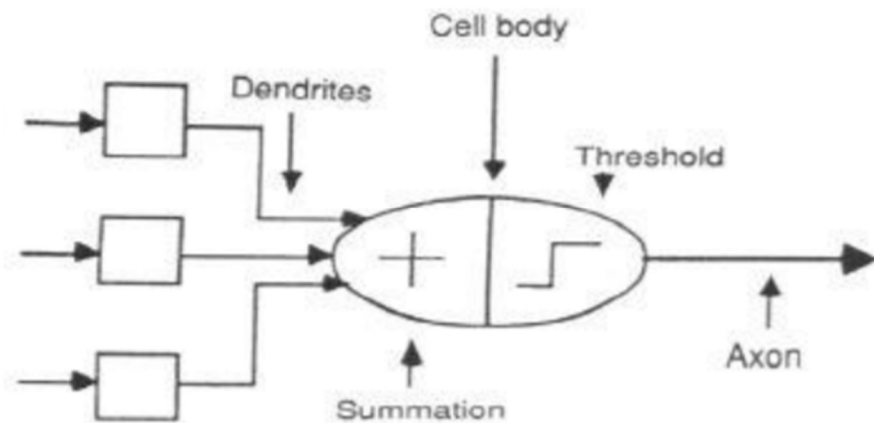


Figure 2.2: The Neuron Model

2.2. An engineering approach

2.2.1 A simple neuron

An artificial neuron is a device with many inputs and one output. The neuron has two modes of operation; the training mode and the using mode. In the training mode, the neuron can be trained to fire (or not), for particular input patterns. In the using mode, when a taught input pattern is detected at the input, its associated output becomes the current output. If the input pattern does not belong in the taught list of input patterns, the firing rule is used to determine whether to fire or not. [2]

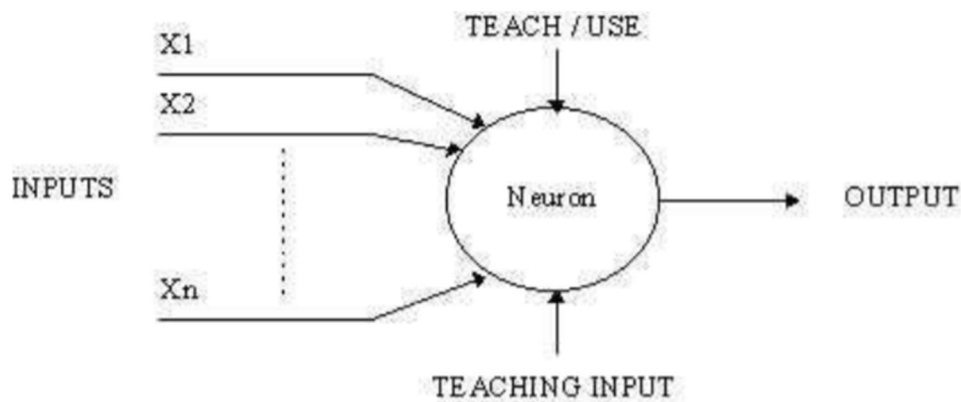


Figure 2.3: A Simple Neuron

2.2.2 Firing rules

The firing rule is an important concept in neural networks and accounts for their high flexibility. A firing rule determines how one calculates whether a neuron should fire for any input pattern. It relates to all the input patterns, not only the ones on which the node was trained.

A simple firing rule can be implemented by using Hamming distance technique. The rule goes as follows:

Take a collection of training patterns for a node, some of which cause it to fire (the 1-taught set of patterns) and others which prevent it from doing so (the 0-taught set). Then the patterns not in the collection cause the node to fire if, on comparison, they have more input elements in common with the 'nearest' pattern in the 1-taught set than with the 'nearest' pattern in the 0-taught set. If there is a tie, then the pattern remains in the undefined state.

For example, a 3-input neuron is taught to output 1 when the input (X1, X2 and X3) is 111 or 101 and to output 0 when the input is 000 or 001. Then, before applying the firing rule, the truth table is:

X1	0	0	0	0	1	1	1	1
X2	0	0	1	1	0	0	1	1
X3	0	1	0	1	0	1	0	1
OUT	0	0	0/1	0/1	0/1	1	0/1	1

Table 2.1: Truth Table before firing rule

As an example of the way the firing rule is applied, take the pattern 010. It differs from 000 in 1 element, from 001 in 2 elements, from 101 in 3 elements and from 111 in 2 elements. Therefore, the 'nearest' pattern is 000 which belongs in the 0-taught set. Thus the firing rule requires that the neuron should not fire when the input is 001. On the other hand, 011 is equally distant from two taught patterns that have different outputs and thus the output stays undefined (0/1).

By applying the firing in every column the following truth table is obtained:

X1	0	0	0	0	1	1	1	1
X2	0	0	1	1	0	0	1	1
X3	0	1	0	1	0	1	0	1
OUT	0	0	0	0/1	0/1	1	1	1

Table 2.2: Truth Table after firing rule

The difference between the two truth tables is called the generalization of the neuron. Therefore the firing rule gives the neuron a sense of similarity and enables it to respond 'sensibly' to patterns not seen during training.

3. BRIEF ON SYSTEM

3.1 Architecture of neural networks

3.1.1 Feed-forward networks

Feed-forward ANNs (figure 1) allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down

3.1.2 Feedback networks

Feedback networks (figure 1) can have signals travelling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point. They remain at the equilibrium point until the input changes and a new equilibrium needs to be found. Feedback architectures are also referred to as interactive or recurrent, although the latter term is often used to denote feedback connections in single-layer organizations. [2]

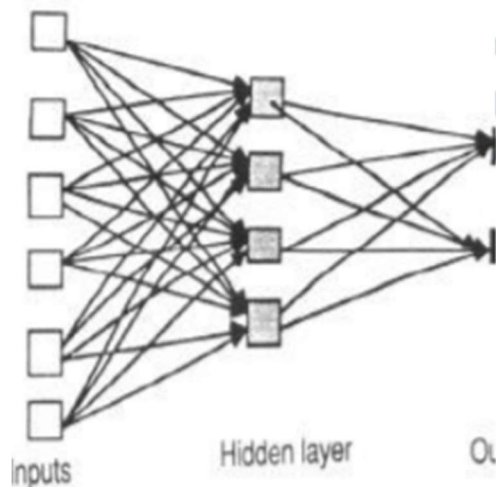


Figure 3.1:FeedForward Network

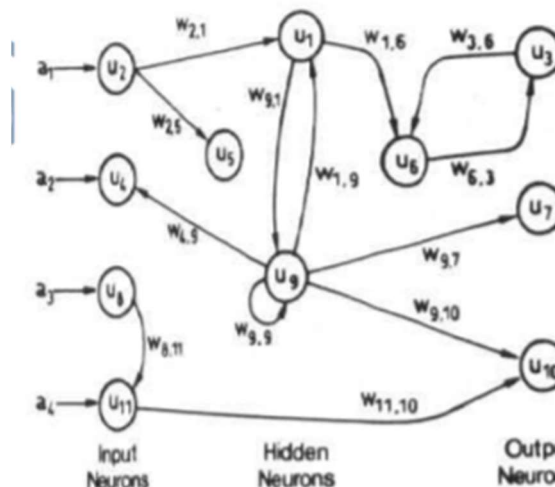


Figure 3.2 Complicated Network

3.1.3 Network layers

The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units. (See Figure 3.1)

The activity of the input units represents the raw information that is fed into the network.

The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.

The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

This simple type of network is interesting because the hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents.

We also distinguish single-layer and multi-layer architectures. The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations. In multilayer networks, units are often numbered by layer, instead of following a global numbering.

3.1.4 Perceptron's

The most influential work on neural nets in the 60's went under the heading of 'perceptron's' a term coined by Frank Rosenblatt. The perceptron (figure 4.4) turns out to be an MCP model (neuron with weighted inputs) with some additional, fixed, preprocessing. Units labelled A1, A2, A_j, A_P are called association units and their task is to extract specific, localized features from the input images. Perceptron's mimic the basic idea behind the mammalian visual system. They were mainly used in pattern recognition even though their capabilities extended a lot more. [3]

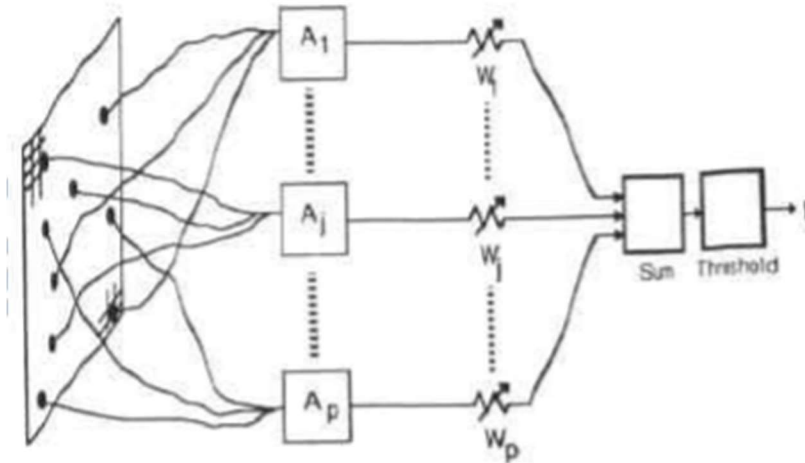


Figure 3.3: Perceptron Model

In 1969 Minsky and Papert wrote a book in which they described the limitations of single layer Perceptron's. The impact that the book had was tremendous and caused a lot of neural network researchers to lose their interest. The book was very well written and showed mathematically that single layer perceptron's could not do some basic pattern recognition operations like determining the parity of a shape or determining whether a shape is connected or not. What they did not realized, until the 80's, is that given the appropriate training, multilevel perceptron's can do these operations.

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Learning algorithms for neural networks a learning algorithm is an adaptive method by which a network of computing units self-organizes to implement the desired behavior. This is done in some learning algorithms by presenting some examples of the desired input/output mapping to the network. A correction step is executed iteratively until the network learns to produce the desired response. The learning algorithm is a closed loop of presentation of examples and of corrections to the network parameters, as shown in Figure

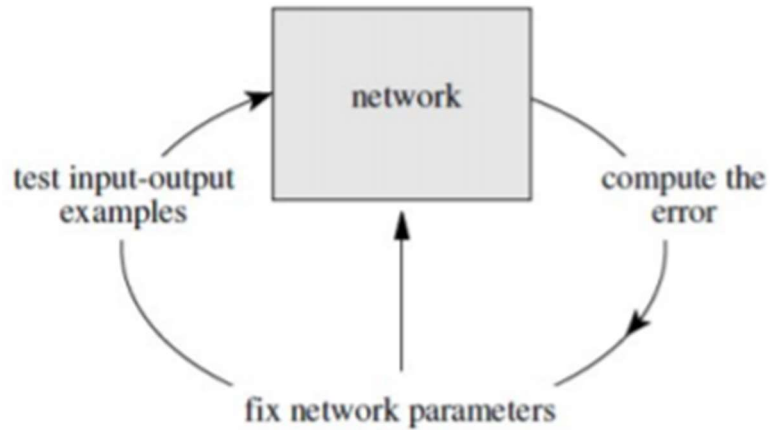


Figure 3.4: Learning Process in Parametric System

3.2. The Learning Process

The memorization of patterns and the subsequent response of the network can be categorized into two general paradigms:

Associative mapping in which the network learns to produce a particular pattern on the set of input units whenever another particular pattern is applied on the set of input units. The associative mapping can generally be broken down into two mechanisms:

1. auto-association: an input pattern is associated with itself and the states of input and output units coincide. This is used to provide pattern competition, i.e. to produce a pattern whenever a portion of it or a distorted pattern is presented. In the second case, the network actually stores pairs of patterns building an association between two sets of patterns.

2. hetero-association: is related to two recall mechanisms:

Nearest-neighbor recall, where the output pattern produced corresponds to the input pattern stored, which is closest to the pattern presented, and

Interpolative recall, where the output pattern is a similarity dependent interpolation of the patterns stored corresponding to the pattern presented. Yet another paradigm, which is a variant associative mapping is classification, i.e. when there is a fixed set of categories into which the input patterns are to be classified.

Regularity detection in which units learn to respond to particular properties of the input patterns. Whereas in associative mapping the network stores the relationships among patterns, in regularity detection the response of each unit has a particular 'meaning'. This type of learning mechanism is essential for feature discovery and knowledge representation. Every neural network possesses knowledge which is contained in the values of the connections weights. Modifying the knowledge stored in the network as a function of experience implies a learning rule for changing the values of the weights.

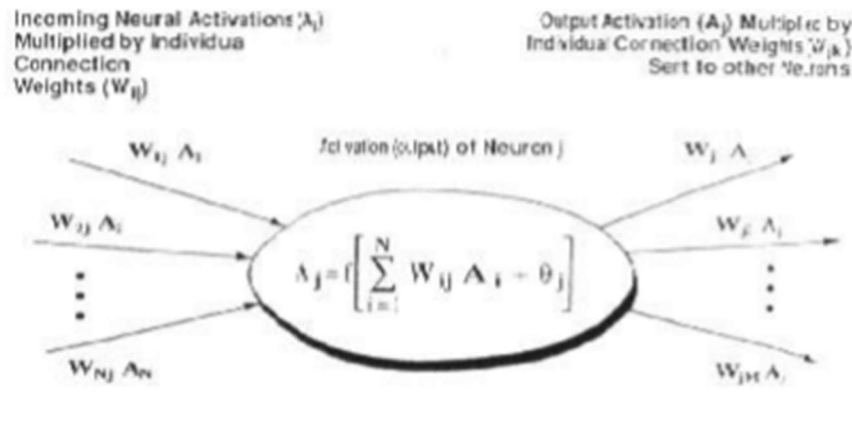


Figure 3.5 Learning Model

All learning methods used for adaptive neural networks can be classified into two major categories:

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 learning 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.

Unsupervised learning uses no external teacher and is based upon only local information. It is also referred to as self-organization, in the sense that it self-organizes data presented to the network and detects their emergent collective properties. Paradigms of unsupervised learning are Hebbian learning and competitive learning. Another aspect of learning concerns the distinction or not of a separate phase, during which the network is trained, and a subsequent operation phase. We say that a neural network learns off-line if the learning phase and the operation phase

are distinct. A neural network learns on-line if it learns and operates at the same time. Usually, supervised learning is performed off-line, whereas unsupervised learning is performed on-line.

3.2.1 Transfer Function

The behavior of an ANN (Artificial Neural Network) depends on both the weights and the input-output function (transfer function) that is specified for the units. This function typically falls into one of three categories:

- linear (or ramp)
- threshold
- sigmoid

For linear units, the output activity is proportional to the total weighted output.

For threshold units, the output is set at one of two levels, depending on whether the total input is greater than or less than some threshold value.

For sigmoid units, the output varies continuously but not linearly as the input changes. Sigmoid units bear a greater resemblance to real neurons than do linear or threshold units, but all three must be considered rough approximations.

To make a neural network that performs some specific task, we must choose how the units are connected to one another (see figure 4.1), and we must set the weights on the connections appropriately. The connections determine whether it is possible for one unit to influence another. The weights specify the strength of the influence.

We can teach a three-layer network to perform a particular task by using the following procedure:

1. We present the network with training examples, which consist of a pattern of activities for the input units together with the desired pattern of activities for the output units.
2. We determine how closely the actual output of the network matches the desired output.

3. We change the weight of each connection so that the network produces a better approximation of the desired output.

3.3 The Back-Propagation Algorithm

In order to train a neural network to perform some task, we must adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivative of the weights (EW). In other words, it must calculate how the error changes as each weight is increased or decreased slightly. The back propagation algorithm is the most widely used method for determining the EW.

The back-propagation algorithm is easiest to understand if all the units in the network are linear. The algorithm computes each EW by first computing the EA, the rate at which the error changes as the activity level of a unit is changed. For output units, the EA is simply the difference between the actual and the desired output. To compute the EA for a hidden unit in the layer just before the output layer, we first identify all the weights between that hidden unit and the output units to which it is connected. We then multiply those weights by the EAs of those output units and add the products. This sum equals the EA for the chosen hidden unit. After calculating all the EAs in the hidden layer just before the output layer, we can compute in like fashion the EAs for other layers, moving from layer to layer in a direction opposite to the way activities propagate through the network. This is what gives back propagation its name. Once the EA has been computed for a unit, it is straight forward to compute the EW for each incoming connection of the unit. The EW is the product of the EA and the activity through the incoming connection.

Note that for non-linear units, (see Appendix C) the back-propagation algorithm includes an extra step. Before back-propagating, the EA must be converted into the EI, the rate at which the error changes as the total input received by a unit is changed. [1]

4. CONCLUSIONS

4.1 Conclusion

The computing world has a lot to gain from neural networks. Their ability to learn by example makes them very flexible and powerful. Furthermore there is no need to devise an algorithm in order to perform a specific task; i.e. there is no need to understand the internal mechanisms of that task. They are also very well suited for real time systems because of their fast response and computational times which are due to their parallel architecture. Neural networks also contribute to other areas of research such as neurology and psychology. They are regularly used to model parts of living organisms and to investigate the internal mechanisms of the brain. Perhaps the most exciting aspect of neural networks is the possibility that someday 'conscious' networks might be produced. There is a number of scientists arguing that consciousness is a 'mechanical' property and that 'conscious' neural networks are a realistic possibility. Finally, I would like to state that even though neural networks have a huge potential we will only get the best of them when they are integrated with computing, AI, fuzzy logic and related subjects.

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.

4.2 Applications

4.2.1 Neural Networks in Practice

Given this description of neural networks and how they work, what real world applications are they suited for? Neural networks have broad applicability to real world business problems. In fact, they have already been successfully applied in many industries.

Since neural networks are best at identifying patterns or trends in data, they are well suited for prediction or forecasting needs including:

- Sales forecasting
- Industrial process control
- Customer research
- Data validation
- Risk management
- Target marketing

But to give you some more specific examples; ANN are also used in the following specific paradigms: recognition of speakers in communications; diagnosis of hepatitis; recovery of telecommunications from faulty software; interpretation of multimeaning Chinese words; undersea mine detection; texture analysis; three-dimensional object recognition; hand-written word recognition; and facial recognition. [1]

4.2.2 Neural networks in medicine

Artificial Neural Networks (ANN) are currently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. At the moment, the research is mostly on modelling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The quantity of examples is not as important as the 'quality'. The examples need to be selected very carefully if the system is to perform reliably and efficiently

4.2.2.1 Modelling and Diagnosing the Cardiovascular System

Neural Networks are used experimentally to model the human cardiovascular system. Diagnosis can be achieved by building a model of the cardiovascular system of an individual and comparing it with the real time physiological measurements taken from the patient. If this routine is carried out regularly, potential harmful medical conditions can be detected at an early stage and thus make the process of combating the disease much easier.

A model of an individual's cardiovascular system must mimic the relationship among physiological variables (i.e., heart rate, systolic and diastolic blood pressures, and breathing rate) at different physical activity levels. If a model is adapted to an individual, then it becomes a model of the physical condition of that individual. The simulator will have to be able to adapt to the features of any individual without the supervision of an expert. This calls for a neural network.

Another reason that justifies the use of ANN technology, is the ability of ANNs to provide sensor fusion which is the combining of values from several different sensors. Sensor fusion enables the ANNs to learn complex relationships among the individual sensor values, which would otherwise be lost if the values were individually analyzed. In medical modelling and diagnosis, this implies that even though each sensor in a set may be sensitive only to a specific physiological variable, ANNs are capable of detecting complex medical conditions by fusing the data from the individual biomedical sensors. [3]

4.2.2.2 Electronic noses

ANNs are used experimentally to implement electronic noses. Electronic noses have several potential applications in telemedicine. Telemedicine is the practice of medicine over long distances via a communication link. The electronic nose would identify odors in the remote surgical environment. These identified odors would then be electronically transmitted to another site where a odor generation system would recreate them. Because the sense of smell can be an important sense to the surgeon, tele smell would enhance tele present surgery. [4]

4.2.2.3 Instant Physician

An application developed in the mid-1980s called the "instant physician" trained an auto associative memory neural network to store a large number of medical records, each of which includes information on symptoms, diagnosis, and treatment for a particular case. After training, the net can be presented with

input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment. [2]

4.2.3 Neural Networks in business

Business is a diverted field with several general areas of specialization such as accounting or financial analysis. Almost any neural network application would fit into one business area or financial analysis.

There is some potential for using neural networks for business purposes, including resource allocation and scheduling. There is also a strong potential for using neural networks for database mining that is, searching for patterns implicit within the explicitly stored information in databases. Most of the funded work in this area is classified as proprietary. Thus, it is not possible to report on the full extent of the work going on. Most work is applying neural networks, such as the Hopfield-Tank network for optimization and scheduling.

4.2.3.1 Marketing

There is a marketing application which has been integrated with a neural network system. The Airline Marketing Tactician (a trademark abbreviated as AMT) is a computer system made of various intelligent technologies including expert systems. A feedforward neural network is integrated with the AMT and was trained using back-propagation to assist the marketing control of airline seat allocations. The adaptive neural approach was amenable to rule expression. Additionally, the application's environment changed rapidly and constantly, which required a continuously adaptive solution. The system is used to monitor and recommend booking advice for each departure. Such information has a direct impact on the profitability of an airline and can provide a technological advantage for users of the system. [Hutchison & Stephens, 1987]

While it is significant that neural networks have been applied to this problem, it is also important to see that this intelligent technology can be integrated with expert systems and other approaches to make a functional system. Neural networks were used to discover the influence of undefined interactions by the various variables. While these interactions were not defined, they were used by the neural system to develop useful conclusions. It is also noteworthy to see that neural networks can influence the bottom line.

4.2.3.2 Credit Evaluation

The HNC Company, founded by Robert Hecht-Nielsen, has developed several neural network applications. One of them is the Credit Scoring system which increase the profitability of the existing model up to 27%. The HNC neural systems were also applied to mortgage screening. A neural network automated mortgage insurance underwriting system was developed by the Nestor Company. This system was trained with 5048 applications of which 2597 were certified. The data related to property and borrower qualifications. In a conservative mode the system agreed on the underwriters on 97% of the cases. In the liberal model the system agreed 84% of the cases. This is system run on an Apollo DN3000 and used 250K memory while processing a case file in approximately 1 sec.

4.2.4 Other Applications

Integration 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. [6]

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.

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