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TIME SERIES MODELING USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

An Artificial Intelligent technique exists in human brain for observation Of behavior of neurons in human brain. A neural network achieves the intelligent results by using massively parallel computations rather than by using rules or other logical structures. A set of elements begins by being randomly connected. Then network is trained to recognize a pattern by strengthening signals that lead to appropriate results and weakening incorrect or inefficient signals. An Artificial Neural Network(ANN) has procedural rules or formulas for only what kinds of input data the neural network can use to make an association with desired output. The approach of ANN has several advantages over conventional statistical and deterministic` approaches. One of the most important algorithms of ANN is "Back Propagation Algorithm"(BPA) which learns by computing an error signal and than propagating the error backward throw the network. The BPA method is applied to statistical model(ARIMA) to test its efficiency and then applied to some actual geophysical data. The result of the analysis shows that the ANN is fast and efficient method for simulating/modeling large amount of data.

Keywords: *ANN, Back Propagation Algorithm, ARIMA, Neurons in Human Brain*

1. INTRODUCTION

The Artificial Neural Network(ANN) processing techniques are based on the analogy with functions of human brain neural networks. The ANN consists Of large number of simple processing elements with large number of interconnections among them and is able to collectively solve complicated problems. This has alsom provided fast solutions for several problems in fields Of science. In particular , ANN has been applied to geophysical problems since the Late 1908s (Raiche 1991) and is increasingly being used for the interpretation of the geophysical data. ANN is a computer based data processing technique, which is used for forecasting, seismic waveforms recognition and pattern recognition. There are numerous kinds of neural neural networks to solve problems. The main categorization of these methods is the distinction between supervised and unsupervised learning (Nigrin 1993). However, the main aim is to find the network that performs best on new data. The most common one back-propagation , adaptive response theory(Carpenter et al. 1987), Hopfield Nets(Hopfield 1984), self-organizing feature maps(kohonem 1989). The main difference among these methods are calculating training time, weights etc. In the present studies we discussed and implemented one of the techniques called back-propagation for forecasting the data.

Our interest is to implement ANN technique for forecasting the data. We also compared its results with that obtained by statistical models(one of the technique for forecasting the non-stationary data is ARIMA which is developed Box-Jenkins) to determine the efficiency of an ANN technique over the statistical models.

2. ARTIFICIAL NEURAL NETWORKS

Artificial Neural Networks(ANN) refers to the computing systems whose central theme is borrowed from the analogy of 'biological neural networks'. Many tasks involving intelligence or pattern recognition are extremely difficult to automate, but appear to be performed easily by animals. Practically every non-mechanical task performed by animals requires the interaction of Neural Networks. For instance, animals recognize various objects & make sense out of the large amount of visual information in their surroundings, apparently requiring very little effort. Tasks such as perception,recognition, memory, conscious thought and dreams requires

the interaction of Neural Networks through simulation. The desire to simulate some or all of these tasks has motivated the development of Artificial Neural Networks. The ANN is used in the following applications: Classification, Clustering, Vector Quantization, Pattern Association, Function Approximation, Forecasting, Control Applications, Search, etc.,

3. ANALOGY OF HUMAN BRAIN

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The elementary computing units of the nervous system are 10 to 10 Neurons. Each neuron in the human brain has on the order of hundreds or thousands of connections to other neurons. Nervous system also contains other classes of cells called glue cells which are intermixed with the neurons in the central nervous system. Glue cells do not do important information processing but acts as support functions for neurons.

The figure 1.1 shows neuron having a nucleus called 'soma'. One end of the cell, the input end has a number of fine processes called 'dendrites'. Most neurons have a long thin process transmission line known as 'axon' that leaves the cell body & may run for meters. When axons reach their final destination they branch again in 'axon arborization'. Basically, a biological neuron receives inputs from other sources, combines them in some way, performs a generally nonlinear operation on the result, and then outputs the final result. Dendrites accept the inputs, Soma processes the input, and axon hillock turns the input into outputs. At the ends of axonal branches are complex, highly specialized structures called "synapses". The soma & dendrites process and integrate the inputs; the information is transmitted along the axon to synapses, whose outputs provide input to other neurons[1,3].

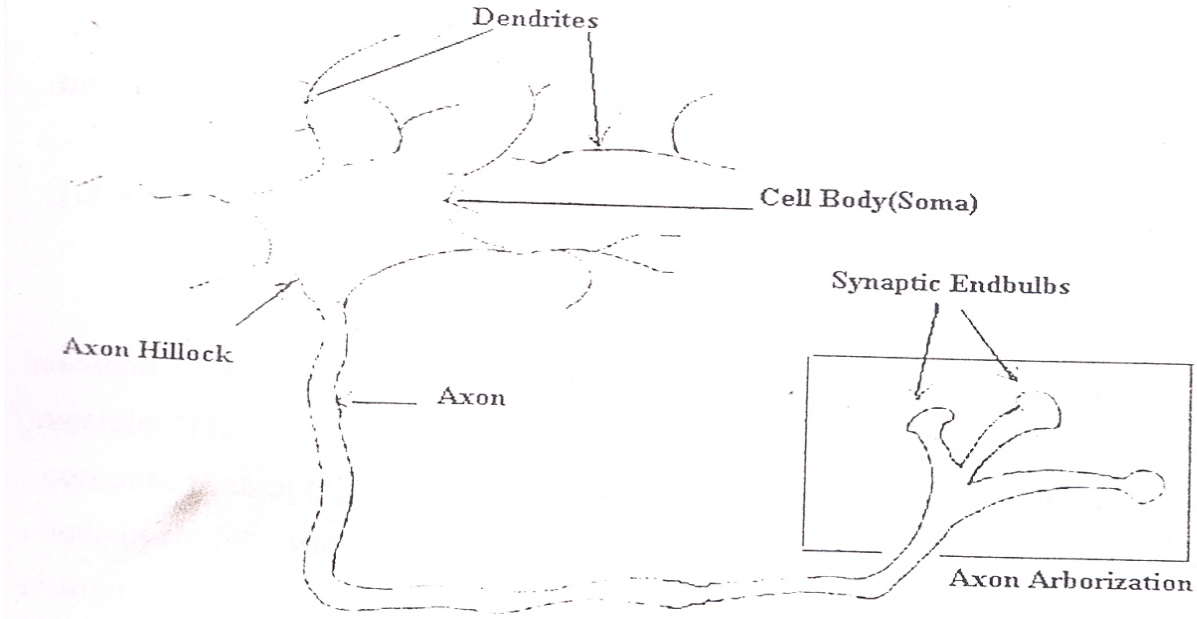

figure 1.1: Neuron

4. SYNAPSE

A neuron is totally enclosed by it's membrane. The excitation of a neuron affects other neurons through contacts of it's end bulbs i.e., Synapse vesicle. The general Synapse is illustrated in the figure 1.2. The communication between the neurons is mainly dependent on the contacts that occur between the synaptic vesicles or end bulbs of two different neuron membranes. These contacts are called synapses.

figure 1.2: Synapse

The membrane on the end bulb is called pre – synaptic membrane. The membrane upon which the end bulb impinges is called post-synaptic membrane. The small space between neurons is facilitated by the release of small packets of chemicals into their gap. One particular neuron may communicate with over 1,00,000 other neurons.

An action potential propagated to the end bulb causes the release of the chemical substances called Neurotransmitters from the little packets known as synaptic vesicles into the pre – synaptic membrane.

Neurotransmitters diffuse across the synaptic cleft to post - synaptic membrane and cause a change of potential(electrical) across the post – synaptic membrane.

In a neural network, each mode 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 a connection.

5. GENERAL NEURON MODEL

The figure 1.3 shows the general model encompassing almost every artificial neuron model. The following assumptions we can make:

1) The portion on the neuron of incoming synapse is irrelevant.
2) Each node has a single o/p value, distributed to other nodes via links irrespective of their positions.
3) All inputs at the same time are remain activated at the same level long enough for computation to occur.

Inputs to a neuron that differ very little are expected to produce approximately the same output, i.e., the neuron output can be written as

$$f(w_1 x_1 + w_2 x_2 + \ldots\ldots\ldots\ldots + w_n x_n)$$

The tasks performed using Neural Networks can be classified as those requiring Supervised and Unsupervised Learning. In Supervised Learning a teacher is

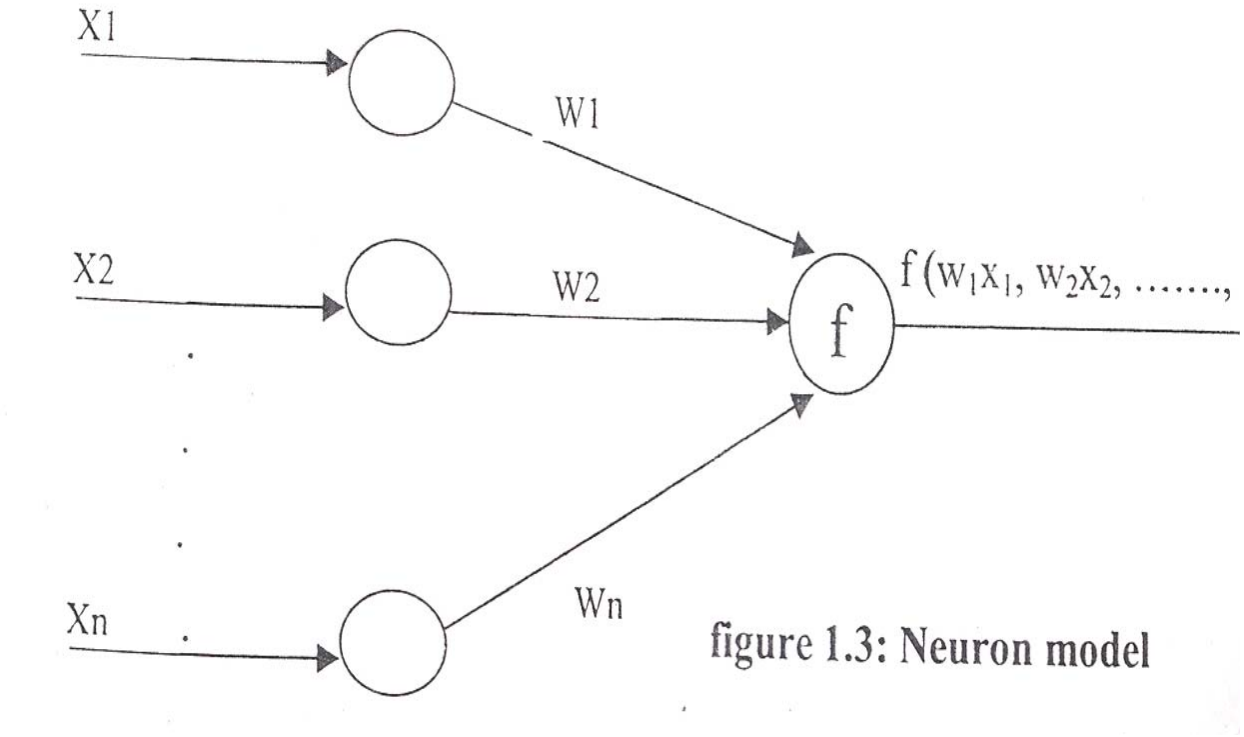

figure 1.3: Neuron model

available to indicate whether a system is performing correctly or to indicate a desired response or to validate the acceptability of a systems's responses or to indicate the amount of error in system performance. But, in unsupervised learning no teacher is available and learning must rely in guidance obtained heuristically by the system examining different sample data or environment.

6. BACK PROPOGATION ALGORITHM

The ANS(Artificial Neural Systems) that is useful in addressing problems requiring recognition of complex patterns & performing non-trivial mapping functions is the BACK PROPOGAGTION NETWORK(BPN). The general BPN network is as shown in the figure 1.4.

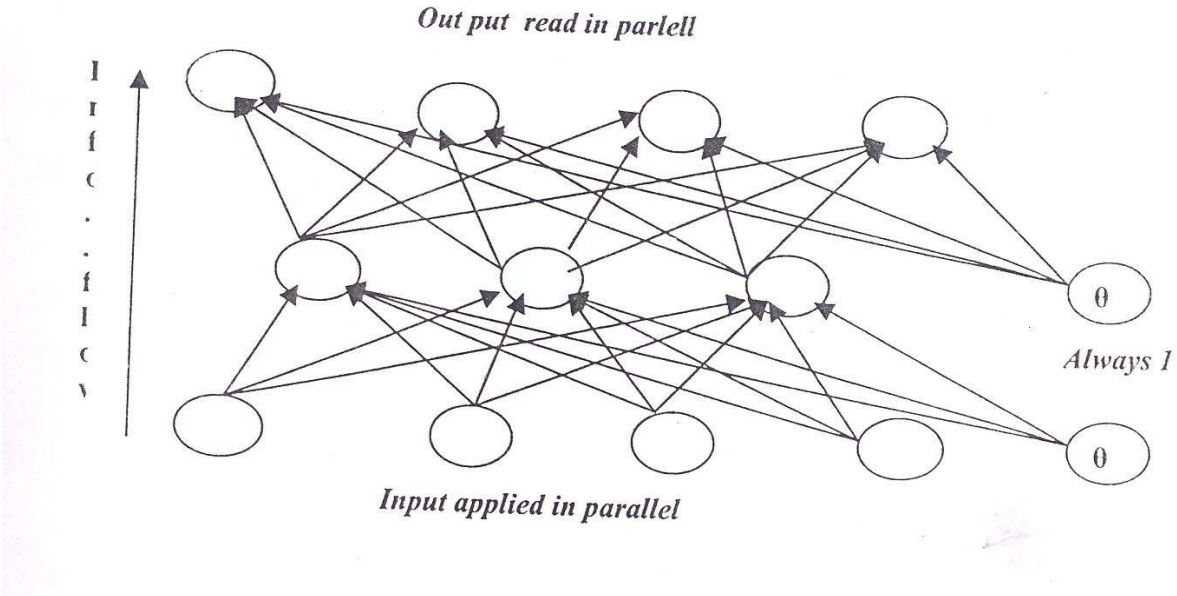

Figure 1. 4*: GENERAL BPN*

The BPN Network is designated to operate as a multi layer feed forward network using the supervised mode of learning. The Back Propogation algorithm assumes feed forward neural network architecture.

Weights are modified in a direction that corresponds to the negative gradient of error measure in the Back Propogation based on Gradient Descent. The major advantage of BPN over other algorithms such as LMS(Least Mean Squares) and Perceptron algorithms is in expressing how an error at a higher(or outer) layer of multi layer network can be propogated backwards to nodes at lower layers of network[4,5]. The gradient of backward – propogated error measure can then be used to determine the desired weight modifications for connections that lead into hidden nodes. The BPN has had a major impact on field of Neural Networks and has been applied to a large number of problems in many disciplines such as classification , function approximation and forecasting.

7. CONCLUSION

The results obtained by applying both ANN approach and Statistical model are given in the following table

Model Applied	Back Propagation	ARIMA
Root Mean Square Error	0.049344	12.36781

From the above RMS error values of Back Propagation and ARIMA it is concluded Back Propagation Technique is more efficient than ARIMA-model . Back-propogation algorithm is very fast compared to the statistical models.

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