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Neural Network Based Tuberculosis Disease Classification

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ABSTRACT

Symptoms based Tuberculosis disease diagnosis is one of the challenging tasks in the medical field. So many techniques are availabe for classification of data such as Artificial Neural Network, Support vector machine and Genetic Algorithm. The objective of this paper is to construct a Multiplayer Feed Forward Neural Network model for the diagnosis of Tuberculosis. The trained network serves as a knowledge base of the system. The construction of the system is presented in this paper. This model correctly classifies 92.3%.

KEYWORDS: Artificial Neural Network, Tuberculosis, Multiplayer Feed Forward Neural Netwrk.

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INTRODUCTION

Tuberculosis is an infectious disease caused by bacteria whose scientific name is Mycobacterium tuberculosis. It was first isolated in 1882 by a German physician named Robert Koch who received the Nobel Prize for this discovery. TB most commonly affects the lungs but also can involve almost any organ of the body. According to WHO estimates[1,2]. India has the world's largest tuberculosis epidemic. India accounts for one-fifth of the global TB incident cases. Each year nearly 2 million people in India develop TB, of which around 0.87 million are infectious cases. It is estimated that annually around 330,000 Indians die due to TB. In India, the prevalence is 3.1 million at best and 4.3 million at high. In China, the figures are 1.4 million and 1.6 million respectively. Tuberculosis is not a hereditary disease. It is an infectious disease. Any person can get afflicted with TB. Whenever, a patient having active tuberculosis coughs or sneezes in an open manner, bacteria causing TB come out in the aerosol. This aerosol can infect any person who happens to inhale it. Characteristic symptoms of TB are persistent cough of more than three weeks duration, cough with expectoration of sputum, fever, weight loss or loss of appetite etc. If any of these symptoms persist beyond three weeks, the person concerned should visit the nearest DOTS TB Center or Health Center and get his sputum examined.

NEURAL NETWORK

The aim of Neural Network is to mimic the human ability to adapt to changing circumstances and the current environment. This depends heavily on being able to learn from events that have happened in the past and to be able to apply this to future situations. Every neuron operates independently, processing the input received, adjusting weights, propagating its computed output thus a neuron is a natural level of parallelization for neural networks. Every neuron is treated as a parallel processor. If the network consists of many hidden layers, the processing time can be reduced at each layer in the network and thus the overall training time of the network can be reduced drastically. Hence the parallel concept in this to speed up the training process of the net to perform the classification task.

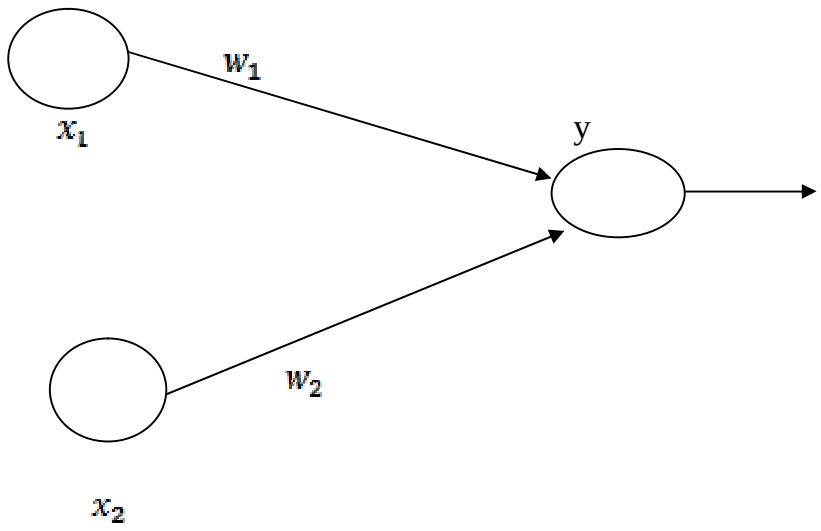
ARTIFICAL NEURAL NETWORKS

Artificial neural network consists of many nodes processing units analogous to neuron in the brain. Each node has a node function associated with it which along with a set of local parameter determines the output of the nodes, given an input modifying the local parameters alter the node function. Artificial neural network is an information processing system. In this information processing system, the elements called neurons, process the information. The signals are transmitted

by means of connection links. The links possess an associated weight, which is multiplied along with the incoming signal for any typical neural net. The output signal is obtained by applying activations to the net input.

The neural net can generally be single layer or a multilayer net. Thus artificial neural network represents the major extension to computation. They perform the operations similar to that of the human brain. Hence it is reasonable to except a rapid increase in our understanding of artificial neural network leading to improved neural network paradigms and a host of application opportunities.

A simple artificial neural net with two input neurons (x_1 ,x_2) and one output neuron(y).The interconnected weights are given by w_1 and w_2.In a single layer net there is a single layer of weighted interconnections.



Neural Networks for classification

Neural Network consists of composition of single nonlinear processing units that are organised in a densely interconnected graph. A set of parameters, called weights are assigned to each of edges of the graph[3]. These parameters are adapted through local interactions of processing units in the network. By repeatedly adjusting these parameters the neural network is able to construct a representation of the given data set. The adaption process is known as Training. Neural Network is able to solve highly complex problems due to non linear processing capabilities of neurons. The inherent modularity of the Neural Network structure makes it adaptable to a wide range of application.

FEED FORWARD NETWORKS

There is network where in for every input vector laid on the network an output vector is calculated and this can be read from the output neurons. There is no feedback. Hence only a forward flow of information is present. Network having this structure are called as feed forward network. The important types of feed forward network is the Back propagation network.

BACK PROPAGATION NETWORK (BPN)

Back propagation is a systematic method for training multilayer artificial neural network. It is a multilayer forward network using extend gradient descent based delta learning rule, commonly known as back propagation rule. Back propagation provides a computationally efficient method for changing the weights in a feed forward network with differentiable activation function units to learn a training set of input –output examples. The aim of this network is to train the net to achieve a balance between the ability to respond correctly to the input patterns that are used for training and the ability to provide good responses to the input that are similar.

The total squared error of the output computed by net is minimized by a gradient descent method known as back propagation or generalized delta rule. Back propagation learning consists of two passes through the different layers to the network: a forward pass and backward pass. In forward pass input vector is applied to the sensory nodes of the network and its effect propagates through the network layer by layer. A set of outputs is produced as the actual response of the network. During the forward pass the synaptic weights of the network are all fixed. During the backward pass the synaptic weights are all adjusted in accordance with an error correction rule. The actual response of the network is subtracted from a target response to produce an error signal. This error signal is then back propagated through the network, against the direction of synaptic conditions[4].

NEURAL NETWORKS IN MEDICAL FIELD

Keeping in view of the significant characteristics of NN and its advantages for the implementation of the classification problem, Neural Network technique is considered for the classing of data related to medical field in this study. Owing to their wide range of applicability and their ability to learn complex and nonlinear relationships including noisy or less precise information Neural Networks are very well suited to solve problems in biomedical engineering. By their nature, Neural Networks are capable of high-speed parallel signal processing in real time. They have an advantage over conventional technologies because they can solve problems that are too complex problems that do not have an algorithmic solution or for which an algorithmic solution is too complex. Neural Networks are trained by examples instead of rules and are automated. This is one of the major advantages of neural networks over traditional expert systems[5, 6]. When NN is used in

medical diagnosis they are not affected by factors such as human fatigue, emotional status and habituation. They are capable of rapid identification, analyses of conditions, and diagnosis in real time. With the spread of Neural Networks in almost all fields of science and engineering, it has found extensive application in biomedical engineering field also. The applications of neural networks in biomedical computing are numerous. Various applications of ANN techniques in medical expert system, cardiology, neurology, rheumatology, mammography and pulmonology were studied [7, 8]. In this study, medical data related to Tuberculosis is considered for classification purpose to identify the disease.

As the neural networks are inherently parallel in nature, this technique is considered in this study to implement parallelism for calculating the output at each node in different node in different layers of the network. The basic unit of modularity in a network is neuron.

METHODS AND MATERIAL

Every neuron operates independently, processing the input receive, adjusting weights, and propagating its computed output thus a neuron is a natural level of parallelization for neural networks. Every neuron is treated as a parallel processor. For example a layer other than the input layer consists of 'm' neurons and assume that processing time't units' to calculate the output at each neuron is similar. If the parallel concept is not adopted in neural network 'mt units' of time is needed to calculate the output. The needed time can be reduced by 'm' times, if parallel concept is implemented at neuron level. If the network consists of many hidden layers, the processing time can be reduced at each layer in the network and thus the overall training time of the network can be reduced drastically. Hence, we adopted the above said parallel concept in this thesis to speed up the training process of the net to perform the classification task.

DATA COLLECTION

For the purpose of the study and analysis the data was taken from the records of National Institute for Research in Tuberculosis. Totally we collected 220 cases with six variables. The attributes are cough, fever, Hameoptisis, chestpain, weightloss, and Breathe restlessness. In this paper used MATLAB software for disease classification. The incidence of Tuberculosis is considered as the output feature while all the other six features are taken as input features. The value attached on the title of each column represents the maximum point that a patient can score on such symptoms. As a patient is examined for any of the symptoms a score that represents the medical practitioner in respect of the system is recorded for the patient. Based on all the recorded values, the patient is diagnosed.

TRAINING THE NEURAL NETWORK

The training mode begins with arbitrary values of the weights they might be random number and proceeds iteratively. Each iteration of the complete training set is called an epoch. In each epoch the network adjusts the weights in the direction that reduces the error. As the iterative process of incremental adjustment continues, the weights gradually converge to the locally optimal set of values. Many epochs are usually required before training is completed. The Neural Network is trained with different sample sizes of the database to achieve a high degree of accuracy by using feed forward Neural Network Model and Back propagation learning Algorithm using Levenberg Marquardt Back propagation Learning Algorithm.

RESULTS AND DISCUSSION

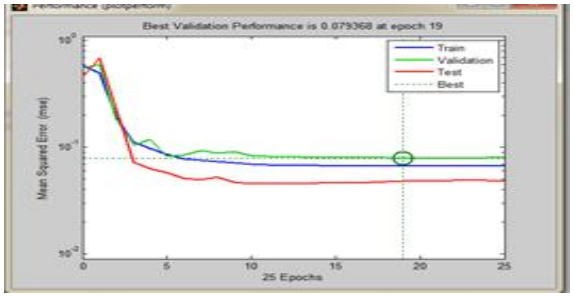


Figure .1 Performance Plot

Training: 70%

Validation: 15%

Testing: 15%

Best validation performance is 0.079368 at epoch 19

Table 1: Comparison of the training, validation, testing results

% of Training	% of Validation	% of Testing	Number of hidden layer	Result
55	25	20	10	85.5%
75	15	10	05	87.7%
65	25	10	10	89.5%
60	25	15	10	90.0%
70	15	15	08	89.1%
70	15	15	05	**92.3%**
70	15	15	20	90.9%
85	25	20	15	90.5%
90	20	15	10	91.8%

As the comparison of each trial the maximum value can be obtained by training as 70%, validation 15%, and testing 15%.

Figure. 2 Plot Confusion Matrix

No of True positives(t_p)	116
No of True Negatives(t_n)	87
No of False Positives(f_p)	15
No of False negatives(f_n)	2

Correct classification Rate = (t_p+t_n)/ (t_p+t_n+f_p+f_n)*100

Error rate= (f_p +f_n)/ (t_p+t_n+f_p+f_n)*100

Sensitivity= (t_p)/ (t_p+f_n)*100

Specificity= (t_n)/ (t_n+f_p)* 100

Rates	%
Correct classification Rate	**92.3%**
Error Rate	7.7%
True Positive Rate(Sensitivity)	98.3%
True Negative Rate(Specificity)	85.3%

CONCLUSION

In this study, a Neural Network Model for classification of medical data set and is used to develop predictive model for classification. The Model is developed with feed forward network using Back propagation algorithm with variable learning rate to train the network. In this study, the data is transferred into the knowledge that the symptoms are the significant ones in diagnosis Tuberculosis. The presented results revealed that the multilayer Neural Network Model gives the classification accuracy is 92.3%.

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