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Prediction of Heart Disease using Neural Network with Back Propagation

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Abstract - several tools, software and algorithms are proposed by the researchers to develop effective medical decision support systems. New software, algorithms and tools are continuously emerging and upgraded depending on the real time situations. Detecting the heart disease is one of the major issues and it is investigated by many researchers. They have developed many intelligent DSS to improve the diagnosis of medical practitioners. Neural network is one among the tools to predict the heart disease. In this research paper, prediction of heart disease using Neural Network is presented. The proposed system used 13 attributes plus 2 additional attributes obesity and smoking for the heart disease prediction. The experiments conducted have shown a good performance.

Keywords - Decision Support System, Heart Disease, Neural Network, BackPropagation.

I. INTRODUCTION

Heart is main part of our body. Our life is dependent on the working of the heart. If the heart fails to work, it will affect the other parts of our body including brain, kidney etc. Heart disease is the term that indicates the non-functioning of the heart. Several factors increase the risk of Heart Disease which includes cholesterol, blood pressure, and lack of physical exercise, smoking and obesity. The World Health Organization (WHO) has estimated that by 2030, nearly 23.6 million people will die because of Heart Disease. In order to minimize the risk of Heart Disease prediction of Heart Disease is a must to discover the disease based on symptoms, physical check-up and signs of the patient body. Discovering and predicting disease is a tedious task in medical environment. Discovery is a multilayered problem which may have negative presumptions and unpredictable effects.

So the HealthCare Industry maintains huge amount of complex data about patients, resources of the hospital, disease diagnosis, electronic patient records, equipments etc. now this becomes the knowledge source for data extraction which can save negative presumptions and unpredictable effects. Figure 1 shows the complications in diagnosis that may lead to negative assumptions and side effects. The good advantage as a result of diagnosis by a doctor is very active and intelligent prediction. Neural Networks has been widely used in the medical field for forecasting disease. NN has been established of their potentials in many domains related with medical forecasting and diagnosis disease. NNs can never replace the human experts but can help them in decision making, classifying, screening and to cross-verify their diagnosis. The dataset has several attributes like age, sex, blood pressure and blood sugar which are used to predict the risk of patients getting a heart disease.

Figure 1 : complications in diagnosis by a doctor

II. LITERATURE REVIEW

An Intelligent Heart Disease Prediction System (IHDPS) on data mining techniques is proposed by SellappanPalaniappan [1]. The techniques used are decision trees, Naïve Bayes and Neural Network. It is developed on .Net platformShantakumarB.Patil as in [2] applied a methodology for the extraction of significant patterns from the heart disease warehouses for heart attack prediction. As a first step the data ware house is pre-processed in order to make it suitable for the mining process. K-means clustering algorithm has been applied to the data warehouse and the patterns are mined using MAFIA algorithm. Then neural network is trained with the selected patterns to predict heart disease efficiently.Dilip Roy Chowdhury [3] applied a back propagation neural network in predicting neonatal disease diagnosis. The authors applied back propagation algorithm to train a neural network on different categories of neonatal diseases. The accuracy is 75% with higher stability.Milan Kumari [4] has solved Cardiovascular Disease dataset using different data mining algorithms such as Support Vector Machine, Decision Tree,Artificial Neural Networks, and Ripper Classifier. The performance is analyzed by many factors such as: sensitivity, specificity, accuracy, error rate, and confusion matrix. Analysis shown that among the four classification models SVM predicts Cardiovascular Disease with least error rate and highest accuracy.A Decision Support System for diagnosis of congenital Heart Disease has been proposed by Vanisree K [5]. This again based on Back Propagation Neural network. The proposed system achieved an accuracy of 90%.Niti Guru [6] applied a neural network for prediction of Heart disease, blood pressure and sugar. The author used a supervised network for diagnosis of heart disease and trained using back propagation algorithm. If suppose unknown data is entered by doctor the system will find the unknown data from the training data and generate list of possible disease from which the patient can suffer.

Jun shi and Ming Chui [8] applied Fuzzy Neural Networks (FNNS) algorithm to attain knowledge and categorize features in the cardiovascular diseases.Designing an Artificial Neural Network model for the prediction of Thrombo-embolic Stroke was implemented by D. Shanthi, Dr. G.Sahoo and Dr. N.Saravanan [9] Using Back-propagation algorithm that had a

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predictive accuracy of 89%.A.Khemphila and V. Boonjing [10] has proposed a model for Heart Disease Classification using Neural Network and Feature selection implemented with Back-Propagation algorithm. The output of this has attained an accuracy of training data set as 89.56% and validation data set as 80.99%.A biomedical system based on Artificial Neural Network and Principal component analysis for Diagnosis of the Heart Valve Diseases has been proposed by HarunUguz [11]. This again based on multi-layer Perceptron (MLP) with back-propagation algorithm which achieved a classification correctness rate of 95%.

III. NEURAL NETWORKS

Neural Networks is a machine learning algorithm which can model human brain and consists of a number of artificial neurons. Artificial Neurons or Processing Elements (PE) are highly simplified models of biological neurons. As in biological neurons, each neuron in ANN receives a number of inputs and an output which can be connected to other artificial neurons. Artificial neural networks are densely interconnected networks of PEs, together with a rule (learningrule) to adjust the strength of the connection between the units in response to externally supplied data.The evolution of neural networks as a new computational model originates from the pioneering work of McCulloch and Pitts in 1943. They suggested a simple model which computed the output as 1 or 0, according to the threshold. A 0 may denote inhibitory state and 1 may denote excitatory state of the neuron. Consider the following figure 2 that illustrates a simple perceptron.

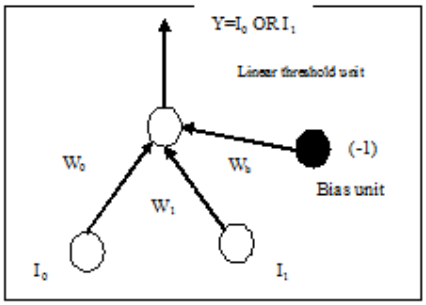

Figure 2: A simple Perceptron

The network has 2 binary inputs I_0 and I_1.
One binary output Y.
Connection Weights W_0 and W_1.
Total input: $W_0 I_0 + W_1 I_1 - W_b$

W_b is the threshold. The output takes value 1 if the total input is greater than 0 and, otherwise 0 if it is less than or equal to 0.An activation function is given in figure 3. Here n weighted inputs are combined through combination function and a transfer function calculates the corresponding output value. Together the combination function and the transfer function made up the activation function of the node.

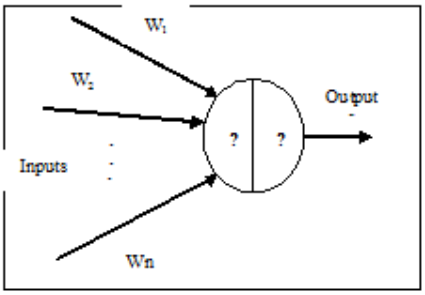

Figure 3: A typical neuron with Activation Function

Three common transfer functions are the sigmoid, linear and hyperbolic functions. The sigmoid function is widely used and produces values between 0 and 1 for any input from the combination function.Sigmoid $f(x) = 1/1+\exp(ax)$, $a > 0$

IV. BACKPROPAGATION NEURAL NETWORKS

The back propagation algorithm is a technique used in developing multilayerperceptron (MLP) neural networks in a supervised manner. The BP algorithm is also called to be Error back propagation algorithm which is based on the error correction learning rule [7].

The algorithm includes two passes: a forward pass and a backward pass.

- In forward pass an activity pattern is applied to the input nodes and it propagates through the network layer by layer. As a result a set of outputs is produced as the actual response of the network. The weights at the functional points of the network are fixed in the forward pass.
- During the backward pass, the synaptic weights are all adjusted in accordance with an error-correction rule. The actual response is subtracted from the desired output to produce an error signal. The error signal is propagated backward through the network. The synaptic weights are adjusted to have actual output nearer to the desired output. The weight adjustment is done according to the generalized delta rule to minimize the error.

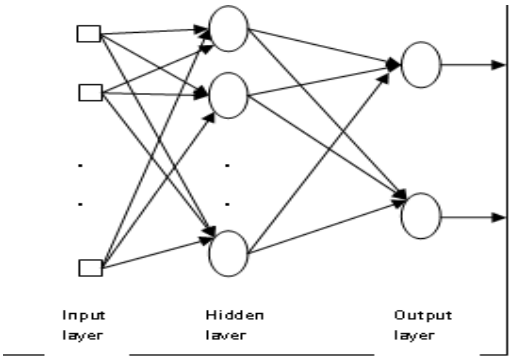

Figure 4: Multilayer Perceptron

V. PROBLEM DESCRIPTION

Here in this work the medical data related to heart disease is considered. The dataset is obtained from Cleveland database [8]. This is publicly available dataset in the internet. This dataset has

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classification of person into normal and abnormal person. .the dataset has 270 records which are partitioned into two sets training (180) and testing (90) Java is used for experiment. The data consists of 13 attributes and 4 classes.

1. Age
2. Sex
3. Chest pain type (4 values)
4. Resting blood pressure
5. Serum cholesterol in mg/dl
6. Fasting blood sugar > 120 mg/dl
7. Resting electrocardiographic results (Values 0, 1, 2)
8. Maximum heart rate achieved
9. Exercise induced angina
10. Old peak = ST depression induced by Exercise Relative to rest
11. The slope of the peak exercise ST Segment
12. Number of major vessels (0-3)
13. Thal: 3 = normal; 6 = fixed defect; 7 = Reverse defect

Classes:
Class 0 – normal person
Class 1 – first stroke
Class 2 – second stroke
Class 3 - end of life

Parameter setting:
Number of neurons in Input layer- 13
Number of neurons in Hidden layer- 8, 5, 2
Number of neurons in output layer- 1

VI. SIMULATION RESULTS

The proposed algorithm was programmed using Java. The parameter settings used for the proposed algorithm is shown above. The result is given in the table 1.

Table 1: Results of ten runs

Run	Testing	Training
1	91%	80%
2	87%	72%
3	71%	63%
4	90%	80%
5	88%	80%
6	89%	77%
7	90%	83%
8	78%	59%
9	92%	86%
10	88%	79%

Figure 5: Diagram for testing and training

The performance of the algorithm can be evaluated by confusion matrix refer Figure 6. They provide an efficient snapshot for dispalying the correct and incorrect instances.

Table 2

Prediction	Actual value		
		Positive	Negative
	True	True Positive	True Negative
	False	False Positive	False Negative

The performance of MLPNN can be evaluated by computing percentage of Sensitivity, Specificity and Accuracy as computed as follows.

$$\text{Sensitivity} = \frac{\text{True positive}}{(\text{True positive}+\text{False positve})} * 100 \quad (1)$$

$$\text{Specificity} = \frac{\text{True Negative}}{(\text{True Negative}+\text{False Negative})} * 100 \quad (2)$$

$$\text{Accuracy} = \frac{\text{True positive} + \text{True Negative}}{(\text{True positive}+\text{False positve}+ \text{True Negative}+\text{False Negative})} * 100 \quad (3)$$

Table 3: Training and Testing performance

TRAINING			TESTING		
Accu-racy	Sensiti-vity	Specifi-city	Accu-racy	Sensiti-vity	Specif-icity
92%	96%	89%	97%	95%	93%

VII. CONCLUSIONS

In this case study, we have presented an approach that is based on back propagation neural network to predict the heart disease. In this paper, the prediction of heart disease is developed using neural network. It has used 13 medical attributes and the experiment done using it have shown performance improvisation compared to similar approaches of the state of the art.

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