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Heart Diseases Diagnoses using Artificial Neural Network

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Abstract
In this paper, attempt has been made to make use of Artificial Neural network in Disease Diagnosis with high accuracy. Heart disease is the case we diagnose here. Classification is an important tool in medical diagnosis. Feed-forward back propagation neural network is used as a classifier to distinguish between absence and presence of disease. It consists of input layer with 13 neuron, a hidden layer with 20 neuron and an output layer with just 1 neuron. An Activation function and the number of neurons in the hidden layer is selected using test and error method. The data were obtained from UCI machine learning repository in order to diagnose the disease. The data is separated into input and target. The targets for the neural network will be classified with 0's as absence disease and with 1's as presence disease. The result shows that the network is able to classify 88% of the cases in the testing set.
Keywords: Artificial Neural Networks ANN, Heart Disease, Feed-forward, Back-Propagation learning algorithm, Medical Diagnosis.

1-Introduction

Artificial Neural Network provide a flexible and powerful tool to help doctors to analyze ,model, and make sense of complex clinical data across a broad range of medical application (Usha Rani, 2011).The advantages of NN lies in their ability to create its own organization of the information it receives during training time and solve complex tasks and problems based on the data given for training (Al-Shayea,2010).

There are many studies going on the field of medical diagnosis especially disease diagnosis like cancer, Diabetes, heart attack, kidney stone, thyroid disease using NN. (Al-Shayea, 2010) used ANN to diagnose urinary diseases. She used Feed forward back propagation NN with 9 neurons in input layer, 20 neurons in hidden layer and one output layer as a classifier to distinguish between infected or non-infected with two types of urinary diseases. The result shows that the proposed system was able to classify about 99 %. (Gharehchopogh, et al 2013) used MLP ANN and back-propagation learning algorithm to classify thyroid Disease. The architecture of ANN consists of 5 neurons input layer, 6 neurons hidden layer, 1 neuron output layer. They used test and error method to select activation function and the number of hidden neuron layer. The accuracy of performance in the network is about 98.6%. (Koushal, 2012) used three different NN algorithms to diagnose kidney stone disease namely LVG, MLP, and RBF. They compare the performance of all three NN on the basis of its accuracy, execution time, size of training dataset. They found that MLP with 2 hidden layer and back propagation learning algorithm is the best for kidney stone diagnosis. The accuracy of performance in the network is about 92%. (Rouhani, 2009) used several ANN architecture namely RBF, GRNN, PNN, LVQ, and SVM on Diagnosis Thyroid Disease. The performance of each of them has studied and they select the best model for classification. The accuracy of the best model is about 99%. (Gharehchopogh, et al 2011) used ANN to diagnose Heart Disease. They used MLP ANN with 60 node in the input layer, 4 node in the hidden layer, and 2 node in the output layer. The learning algorithm is back-propagation with learning rate 0.2 and momentum 0.3. The accuracy of the Network is 85%.

2-Artificial Neural Network in Medicine

An artificial neural network is computational networks which attempt to simulate the networks of nerve cell (neuron) of the biological central nervous system. The architecture of a neural network is formed by a number of processing units (neurons) and connection between them. The connections have weights associated with them, representing the strength of those connections. A subgroup of processing elements is called a layer in the network. It involves three different layers. The first layer is the input layer which represents an interface with the environment and the last layer is the output layer where output is stored. Between the input and output layer there may be one or more hidden layers (Danial Groupe, 2007) .There is no limitation on deciding the number of hidden layer. The number of neurons in a layer and the number of layers depends on the complexity of the system studied. Therefore, the optimal network architecture must be determined (Amato, et al , 2013). Fig. 1 represents the Typical Neural Network.

Artificial Neural Network has been widely used in medical diagnosis and health care application because of their predictive powerful classifier for tasks, fault tolerance, generalization, and learning from environment (Gharehchopogh, et al ,2011).

Nowadays, neural network can be applied to problems that do not have algorithmic solution or problem for which algorithmic solution are too complex to be found. In other words, the kind of problem in which inputs and outputs variables does not have a clear relationship between them (Amato, et al , 2013).

They can be divided into two learning types: supervised and un-supervised. In supervised learning, the network is trained by providing it with input and output. During this phase, the neural network is able to adjust the weights to match its output with the target until a desirable result is reached. An ANN of the unsupervised learning type, the neural network is provided only with inputs, but there are no known targets. It is a self-organization, means that the network itself must decide what features it will use to cluster the input data (Al-Shayea, 2010).

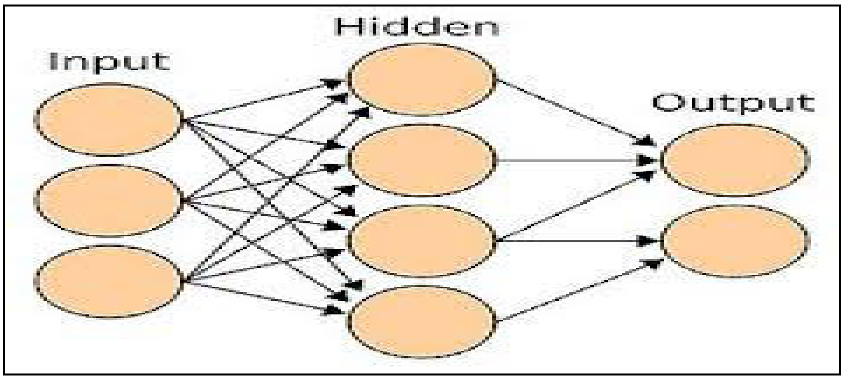

Figure 1: A typical Neural Network

3- Experimental Result

3-1 Data Analysis :(Heart Diseases Dataset)

The dataset is Cleveland Heart Disease Database taken from UCI machine learning Repository. This is publicly available dataset in the Internet. This dataset contains 303 instances and 76 attributes, but all published experiments refer to using a subset of 14 of them. The attributes are actually symptoms of heart disease in the basis of which we trained neural network for diagnosis. The attributes taken for diagnosis are presented in table 1. The last attribute is divided into two classes to determine the presence or absence of heart disease. Class 0 means absence of disease (normal person) and class 1 means presence of disease.

Table1: Diagnosis attributes of dataset

No.	Diagnosis attribute
1	Age
2	Sex (M=1)(F=0)
3	chest pain type --Value 1:typical angina --Value 2: atypical anginal --Value 3: non-anginal pain --Value 4: asymptotic
4	resting blood pressure
5	Cholesterol
6	fasting blood sugar (1=true; 0=false)
7	resting ECG --Value 0: normal --Value 1:having ST-T wave abnormality (T wave inversions and/or ST) --Value 2:showing probable or definite left ventricular Hypertrophy by Estes' criteria
8	maximum heart rate
9	exercise induced angina (1=yes;0=no)
10	old peak
11	Slop --Value 1: up sloping --Value 2: flat --Value 3:down sloping
12	number of vessels colored --(0-3)
13	Thal Normal, fixed defect, reversible defect --3,6,7

3-2 ANN Training and Learning:

The neural network is trained with heart disease database by using a typical feed forward neural network model and back-propagation learning algorithm which is the most popular learning algorithm in machine learning developed by David Rummelhart and Robert McLelland(1994). The proposed diagnosis model consists of three layers: the input layer, a hidden layer, and the output layer. The input layer in this model consists of 13 neuron because the Cleveland dataset consists of 13 attributes. The hidden layer consists of 20 neuron and the output layer with just 1 neuron. The proposed neural network is shown in Fig 2. The input and target samples are divided randomly into 60 % training set, 20% validation set, 20% test set. The training set is presented to the network and the network's weights and biases are adjusted according to its error during training. Validation set used to measure network generalization. Test set provide independent measure of network accuracy. Besides data division, proper selection of activation function increase network performance (Sonali ,2014). We used tangent sigmoid transfer function in hidden layer nodes and linear transfer function in the output layer nodes by using test and error method.

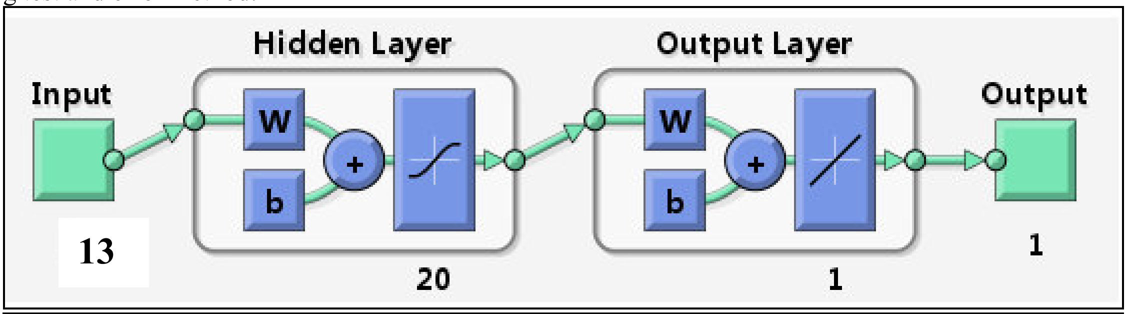

Figure2: The Proposed Heart Disease Diagnose Neural Network

3-3 ANN Performance and Testing:

The Mean Square Error (MSE) of trained network can be measured with respect to the testing set. This will give us a sense of how well the network will do when applied to data from real world. The mean squared error (MSE) is the average squared difference between outputs and targets. Lower values are better while zero means no error. In this paper, The MSE is equal to 0.1071 and the regression is equal to 0.73166 as shown in fig: 3.

The network was able to classify 88% of the cases in the testing set. Best validation performance is 0.14221 at epoch 8 as shown in fig: 4.

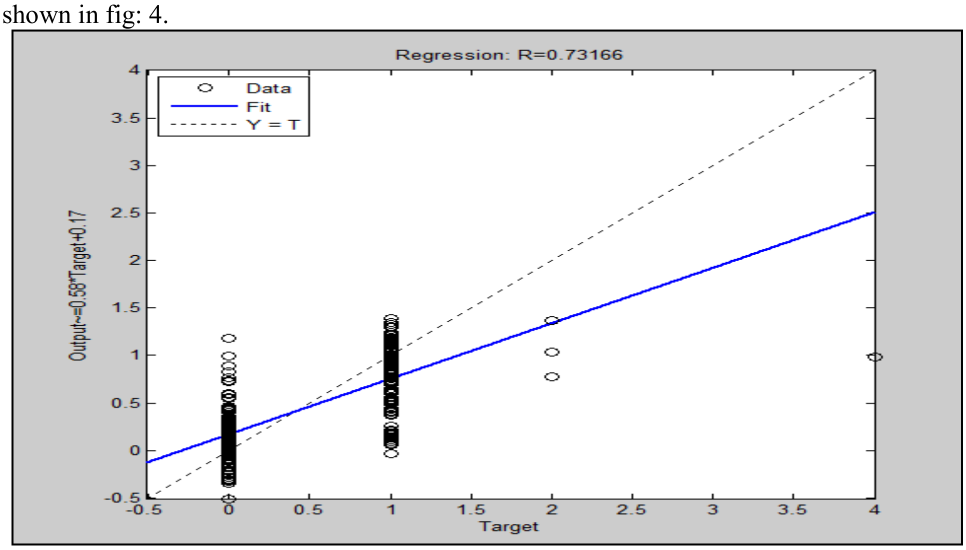

Figure 3: Regression between Target and Output

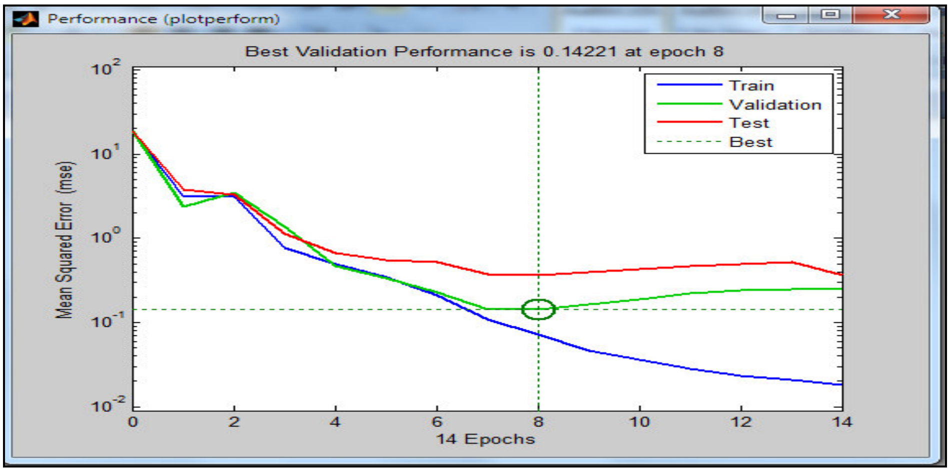

Figure4: Best validation performance

4- Conclusion

In this paper, we used Artificial Neural Network in disease diagnosis. Feed forward Back Propagation learning algorithm used to test the model based on their ability to diagnosis Heart disease. By considering appropriate activation function for hidden layer and 20 neurons in hidden layer, we can reach to the classification accuracy for heart disease to 88%. Artificial Neural Network showed significant results in heart disease diagnosis.

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