Use of Neural Networks for Developing Clinical Decision Support System - A Review

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Abstract:- Various data mining techniques have been widely used in clinical decision support systems for diagnosis of various diseases. These techniques are very effective because of their ability to discover hidden patterns and relationships in medical data. One such a very effective technique is using artificial neural network. This technique is used by different researchers with different training algorithms and training parameters. This paper reviews the research work done for developing clinical decision support system using neural networks by different researchers. The study shows that artificial neural network based decision support system gives reliable predictions for various diseases when training parameters set correctly and trained using sufficient training data.

Categories and Subject Descriptors:- *Artificial Neural Networks.*

General Terms:- *Decision Support System, Artificial Neural Networks, Supervised Learning, Data Mining.*

Keywords:- *Artificial Neural Networks, Back propagation Algorithm, Clinical Decision Support Systems.*

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1. INTRODUCTION

The development of clinical decision support system is a complex task. For the predictions to be accurate the system needs to into account many symptoms, results of clinical and laboratory tests, the environmental, genetic and life style related information of the patient. Because of non-linear nature of factors leading to different diseases with the diagnosis it is extremely difficult, if not impossible to frame these relationships in structures of traditional programming[9]. To understand the complex, non-linear relationship between factors leading the different diseases and the actual disease the patient is suffering from it is necessary to study large number of cases and relate the factors with the diseases correctly. The process of finding these hidden patterns in the records is called as data mining[6].

Artificial neural networks is one of the very powerful data mining technique which very efficiently find out such patterns. Dr. Robert Hecht-Nielsen, the inventor of one of the first neurocomputers defines neural networks as "*.. a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs*" [15]. It has the potential of classifying the real world complex problems without having preliminary knowledge of the problem[16]. Artificial The neural networks (ANN) have been used effectively by the different researchers to find such patterns in the different application areas. This paper reviews the development of some decision support systems in the area of health care by different researchers.

The paper is organized in the following manner. First, the structure of ANN networks and there working is explained. After that one of the most widely used training algorithm, back propagation algorithm is explained. In the second section of the paper the development of decision support systems by various researchers in reviewed, the result obtained by them are discussed.

1.1 Artificial Neural Networks

An Artificial Neural Network is a computational system inspired from natural neural network. Natural neurons receive signals through synapses located on the dendrites or membrane of the neuron. When the signals received are strong enough (surpass a certain threshold), the neuron is activated and emits a signal though the axon. This signal might be sent to another synapse, and might activate other neurons. It is shown in figure 1.

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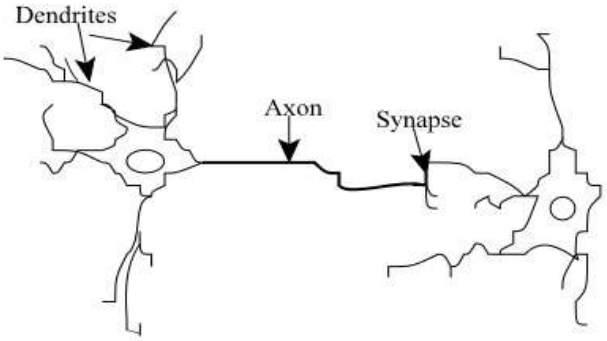

Figure 1 Natural Neurons

The artificial neuron consist of inputs (like synapses), which are multiplied by weights (strength of the respective signals), and then computed by a mathematical function which determines the activation of the neuron. Another function computes the output of the artificial neuron. The artificial neuron is shown in figure 2.

An ANN is constructed using the several layers of artificial neurons[2][7]. A typical ANN consists of an input layer which has the number of neurons equal to number of inputs, one or more processing layers called as hidden layers and an output layer which has number of neurons equal to number of outputs. Every neuron in the given layer is connected with every other neuron of it's preceding and following layer. The connections that connects two neurons have weights.

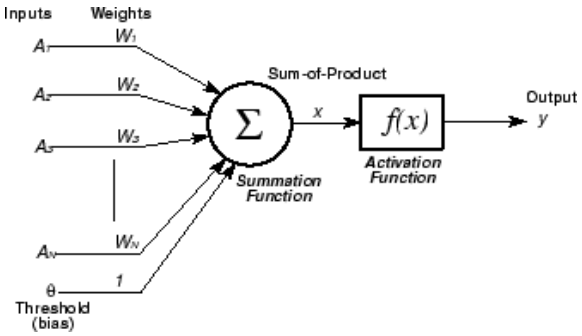

Figure 2 Artificial Neuron

The activation function is responsible for controlling the strength of the input signal and controlling an artificial neuron.[4]The net input signal is computed with respect to its weights and biases through a summation function. The net input signal is given as an input to transfer function which calculates the output signal of artificial neuron. Feed-forward ANNs are the networks that link inputs with outputs. These networks are used in pattern recognition. A typical ANN is shown in figure 3.

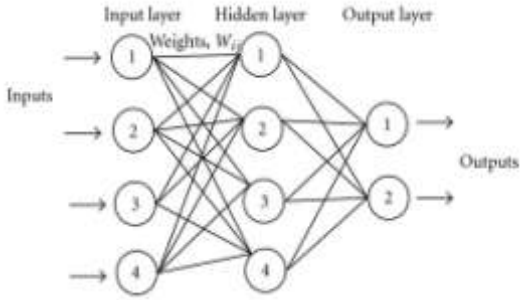

Figure 3 Artificial Neural Network

Initially the ANN is configured with the required number input and output neurons, number of hidden layers and number of neurons in them which are taken randomly. the weights are initialized randomly and input is provided. The inputs from different input neurons gets multiplied with their respective connections are summed up at the neuron in the next layer and activation function is applied to this net input. The output of this neuron is applied as an input to the neurons in the next layer where the same process is repeated. This is done until the output layer produces the output with it's neurons.

During the training phase the expected output is provided to the ANN which compares it with the output produced by it. The error is calculated and back propagated to preceding layers in each iteration until it fall below the acceptable level. In every iteration the network corrects the weights of its connections so that the error can be reduced.

Several training algorithms have been developed. Back propagation is one of the most efficient algorithm widely used in ANN[10]. It is discussed in the next section.

1.2 Back Propagation Algorithm

The backpropagation algorithm is developed by Rumelhart and McClelland in 1986. The back propagation algorithm uses supervised learning [1][5], which means that we provide the algorithm with examples of the inputs and outputs we want the network to compute, and then the error (difference between actual and expected results) is calculated. The idea of the back propagation algorithm is to reduce this error, until the ANN learns the training data. The flow chart for back propagation algorithm is shown in figure 4.

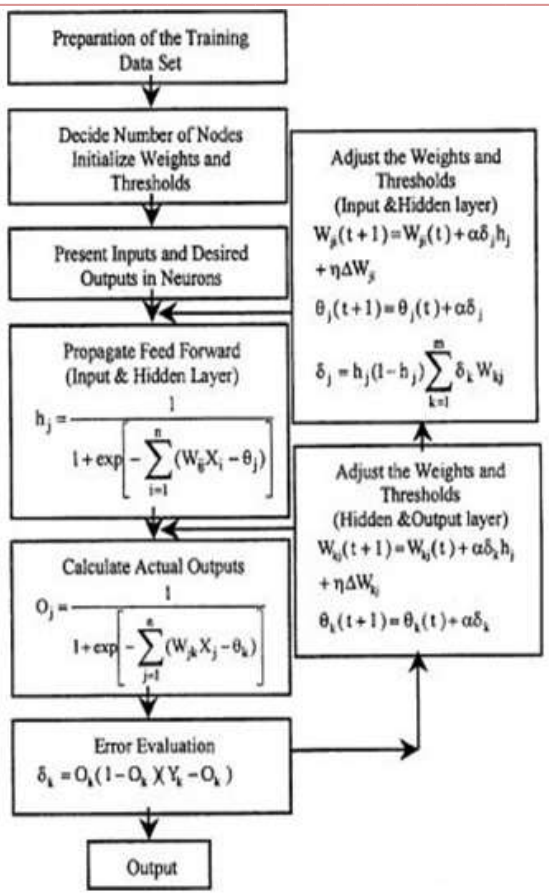

Figure 4 Flow Chart for Back Propagation Algorithm.

Once the required accuracy is achieved the ANN is presented with the test data. With the test data the ANN is presented only inputs. If the ANN has gained the required accuracy inthe predictions it can be deployed as a decision support system.

2 Review of Clinical Decision Support Systems:

For devising Clinical Decision Support Systems (CDSS), literature presents a number of researches that have made use of Artificial Intelligence and Data Mining techniques. Most of the works cover decision support for heart diseases and diabetes. A few of the significant researches obtainable in the literature are explained here:

Using Genetic algorithm to optimize neural network weights Syed Umar Amin [3] has developed a risk of heart disease prediction system. . They have taken into consideration 13 different factors that may lead to a heart disease. They are: age, sex, blood cholesterol, blood pressure, heredity, smoking, alcohol intake, physical activity, diabetes, diet, obesity, stress. The developers have used back propagation algorithm for learning and training of neural network. They have mentioned two major drawbacks of back propagation algorithm. First is that the initialization of the NN weights is a blind process hence it is not possible to find globally optimized initial weights and there is a danger that the network output will run towards local optima. Hence the overall tendency of the network to find global optima is greatly affected. Second problem is network's speed for convergence. It is very slow and there is a possibility that network will not converge. To deal with this problem they have used genetic algorithm. The developers have used Matlab to implement the system and report to get the accuracy of 89%.

T. Manju et al. [8] has developed a heart disease prediction system using neural network. The researchers have used multilayer feed forward neural network (MLFFNN) that integrates genetic algorithm (GA) and back propagation network (BPN) for heart attack prediction. GA is used to initialize and optimize connection weights of MLFFNN. They have considered the following factors for prediction: age, sex, chestpain, rest BP, cholesterol, bloodsugar, ECG, maxheartrate, angina, oldpeak, stslope, vessels, THAL. The accuracy reported is 85%.

Tsutomu Matsumotot et al. [15] have proposed Clinical Diagnosis Support System based on Symptoms and Remarks by Neural Networks. In his paper, parallel structure with large inputs and one output of a neural networks is proposed, where learning time for determining weighted coefficient is reduced by parallel distribution method. He uses back propagation algorithm for training the network. Experimental works for teaching the Neural Networks is made by signs, remarks and symptoms extracted from case records. His system consists of large number of neural networks working in parallel. One neural network corresponds to one disease. The software system consisted of one thousand above neural network in parallel.

Mrudula Gudadhe et al. [12] has presented in her paper the Decision support system for heart disease based on support vector machine (SVM) and ANN. A multilayer perceptron neural network (MLPNN) with three layers is employed to develop a decision support system for the diagnosis of heart disease. The multilayer perceptron neural network is trained by back-propagation algorithm. SVM is a useful technique for data classification. A Support Vector Machine is an algorithm that works as follows. It uses a nonlinear mapping to transform the original training data into higher dimension. Within this new dimension, it searches for the linear optimal separating hyperplane that is a "decision boundary" separating the tuples of one class from another. With an appropriate nonlinear mapping to a sufficient high dimension, data from two classes can always be separated by a hyperplane. The Support Vector Machine finds this hyperplane using support vectors ("essential" training tuples) and margins (defined by

the support vectors). Several advantages of SVM are mentioned. A few of them are: high accuracy, much less prone to over fitting than other methods, SVM can be used for prediction as well as classification etc.

Dr. Anooj P [13] has presented the work "Implementing Decision Tree Fuzzy Rules in Clinical Decision Support System after Comparing with Fuzzy based and Neural Network based systems." He uses a weighted fuzzy rule-based clinical decision support system (CDSS) is presented for the diagnosis of heart disease, automatically obtaining the knowledge from the patient's clinical data. His clinical decision support system for risk prediction of heart patients consists of two phases, (1) automated approach for generation of weighted fuzzy rules, and (2) developing a fuzzy rule-based decision support system.

Hongmei Yan et al. [14] has developed a a decision support system for heart disease diagnosis using multilayer perceptron fro the diagnosis of 5 major heart diseases. He used 38 input variable extracted from records of 352 patients. The researchers used back propagation learning algorithm augmented with mmentum term and adaptive learning rate and forgetting mechanics. The experimental results have shown that the adopted MIP based decision model can achieve high accuracy level (63.6- 82.9%) on the classification of heart diseases, qualifying it as a good decision support system deployable in clinics. The number of records for different heart diseases presented by them are shown in Table 1. The comparison of accuracy rate obtained by training set and test set is shown in figure 5.

Heart Disease Diagnosis	Number of Patients
Hypertension	86
Coronary heart disease	82
Rheumatic valvular heart disease	71
Chronic cor pulmonale	60
Congenital heart disease	53
Total	352

Table 1 The dislribution of heart diseases records

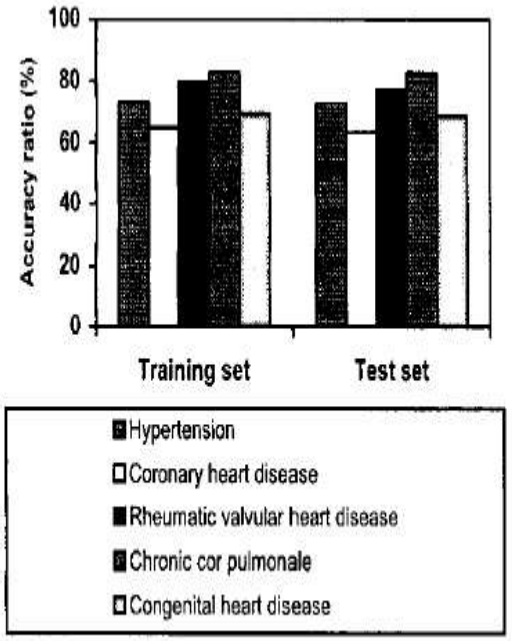

Figure 5 Comparison of the accuracy rate obtained by training set and test set.

3 Conclusion

The review of work done by different researchers shows that the artificial neural network can efficiently find the patterns present in the records and classify them accurately.

References

[1] Nikola Kasabov, Dec. 2001 "Evolving Fuzzy Neural Networks for Supervised/Unsupervised Online Knowledge-Based Learning", IEEE Trans. Systems, Man, and Cybernetics — Part B: Cybernetics, Vol. 31, pp. 902-918.

[2] Chin-Teng Lin et al, Dec. 1991, "Neural-Network-Based Fuzzy Logic Control and Decision System" , IEEE Trans. Computers, Vol. 40, pp. 1320-1336,

[3] Syed Umar Amin, 2013 "Genetic Neural Network Based Data Mining in Prediction of Heart Disease Using Risk Factors" , in Proc. IEEE Conference on Information and Communication Technologies (ICT), pp. 1227 – 1231.

[4] Emdad Khan et al., "Neufuz: Neural Network Based Fuzzy Logic Design Algorithms", Embedded Systems Division, National Semiconductor, Santa Clara, CA 95052, pp 647 – 654.

[5] Hideyuki Takagi et al., "Introduction to Fuzzy Systems, Neural Networks, and Genetic Algorithms", pp 1-13.

[6] D. Senthil Kumar et al., May 2011 "Decision Support System for Medical Diagnosis Using Data Mining", IJCSI International conference of Computer Science Issues,Vol. 8,. pp. 147-153.

[7] Kai Li et al., 2008 "Research of Intelligent Decision Support System Based on Neural Networks", IEEE

Computer Society Second International Conference on Genetic and Evolutionary Computing, , pp. 124-126.

[8] T. Manju et al., May 2013 "Heart Disease Prediction System Using Weight Optimized Neurla Network", International Journal of Computer Science and Magazine Research, Vol. 2, , pp. 2391-2397.

[9] Zbigniew Michalewicz, "Adaptive Business Intelligence", Springer.

[10] Ben-bo Zha et al., 2014, A study of the design and parameters optimization of BP neural network using improved GEP, IEEE 10th International Conference on Computational Intelligence and Security, , pp.714-719

[11] P. Jeatrakul et al., 2009 "Comparing the Performance of Different Neural Networks for Binary Classification Problems", IEEE Eighth International Symposium on Natural Language Processing, , pp. 111-115.

[12] Mrudula Gudadhe et al., 2010 " Decision Support System for Heart Disease based on Support Vector Machine and Artificial Neural Network", ICCCT, pp. 741-745.

[13] Anooj P.K , 2013 "Implementing Decision Tree Fuzzy Rules in Clinical Decision Support System after Comparing with Fuzzy based and Neural Network based systems", International Conference on IT Convergence and Security (ICITCS),

[14] Hongmei Yanet al, 2003 " Development of A Decision Support System For Heart Disease Diagnosis Using Multilayer Perceptron".

[15] Maureen Caudill Feb. 1989 "Neural Network Primer: Part I"

[16] Shivani Bhatia, May 20-21, 2016 "Feed Forward Neural Network Optimization using Self Adaptive Differential Evolution for Pattern Classification" IEEE International Conference On Recent Trends In Electronics Information Communication Technology