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Design of Classifier Using Artificial Neural Network for Patients Survival Analysis

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Abstract – The aim of this paper is to develop the design of classifier using Artificial Neural Network for patients survival analysis based on echocardiography dataset. Survival analysis can be considered a classification problem in which the application of machine learning methods is appropriate. Survival analysis plays an important role not only for health care policy markers, but also for the clinician. Echocardiography is used for diagnosis of cardiac diseases and to arrive at precise diagnosis experienced cardiologists need complementary assistance from intelligent decision system. Artificial Neural Networks have emerged as an important tool for classification. The advantage of Artificial Neural Network helps for efficient classification of given data. In this research paper, design the classifiers Back Propagation Neural Network (BPNN) and Radial Basis Function Neural Network (RBFNN) for patient's survival analysis. The performance of classifiers is measured in terms of classification accuracy. Experimental result showed that the good design of classifier for patients survival analysis based on Echocardiogram database is Back propagation neural network (BPNN) with training set classification accuracy 93% and testing set classification accuracy 84% and design of Radial Basis function neural network (RBFNN) classifier training set classification accuracy 88% and testing set classification accuracy 69%.

Keywords **– Artificial Neural Networks (ANN), Echocardiogram, BPNN, RBFNN, Classification, survival Analysis.**

I. INTRODUCTION

Machine learning methods for classification provide inexpensive means to perform diagnosis, classification of certain outcomes in health care research .Classification is one of the important decision making tasks for many real world problems. Classification will be used when an object needs to be classified into a predefined class or group based on attributes of that object. There are many real world applications that can be categorized as classification problems such as weather forecast, credit risk evaluation, medical diagnosis, bankruptcy prediction, speech recognition, handwritten character recognition [1] and Survival analysis [11]. Artificial Neural Networks have been applied for a variety of purposes in biomedical research. Neural Networks are computational techniques used to represent and process information by means of networks of interconnected processing elements, similar to neurons. Echocardiography, or echo, is a painless test that uses sound waves to create moving pictures of heart. The pictures show the size and shape of heart. They also show how well your hearts chambers and valves are working. The echocardiography is widely used to assess cardiovascular functionalities such as valvular regurgitation and stenosis [2]. It is captured by an ultrasound transducer that employs the Doppler Effect to determine blood is moving towards or away from the ultrasound probe, and its relative velocity [3, 4]. The echocardiogram database is open source and it gives the information of patient's survival after heart attacks. The database chosen in this research paper, have numerical attributes, since we are focusing on learning for numerical data using Echocardiogram Database [5].This data set contains echocardiogram data on a group of people who have had heart attacks in the past. The objective of this dataset is to try to use features of an echocardiogram such as left ventricular end diastolic dimension and E-point septal separation to predict whether a person will still be living a year after their heart attack, based on features of echocardiogram [6].

In literature survey reported that all patients suffered heart attacks at some point in the past. Some are still alive and some are not. The survival and still-alive variables, when taken together, indicate whether a patient survived for at least one year following the heart attack. The problem address by researchers using echocardiogram database such as Salzburg's (1988), gives concept of exemplar –based learning techniques for prediction of survival that is life or death, with 65.91% survival classification accuracy [7].

Kan G, Visser C, Kooler J & Dunning A (1986),presents statistical KNN techniques for survival classification and their statistical test recorded 61% accuracy in predicting that a patient will die[8].

Elvin Kinney reported that a Cox regression techniques for death prediction of patients and achieved 60% accuracy for death [9].

In paper [11], discusses performances of self organizing features map (SOFM) and Jordan Neural network approaches for classification of different datasets. Principal component analysis method was used for dimensionality reduction of echocardiogram database and totals 62 patients samples used and classified into

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training dataset as 56 samples and 06 samples as testing dataset. A SOFM NN artificial neural network out performs JORDAN NN and offers a useful for developing diagnostic algorithms for chest pain patients.

In this paper, Neural Networks are used as classifiers for survival analysis of patients with improved classification accuracy shown after experimentation. This paper is outlined in various sections such as section II gives materials and methods, section III discuss neural networks with Back propagation neural network and Radial Basis Function neural network. In section IV experimentation on design NN classifiers and performance of the network is analyzed based on classification accuracy measure for good classifier design. Finally sections V & VI conclude the papers with results and discussions.

II. MATERIALS AND METHODS

Echocardiogram dataset has taken from publically available UCI repository machine learning [5]. Data set contains 132 patient's records and each patient's condition defined by 13 attributes. The data set size is reduced by ignoring the one attributes from given dataset and finds 12 attributes including one target value for classifying patients survive after heart attacks. Table 1 below shows the data partitioning in training set and testing set.

Table 1 Echocardiogram Data Set Partition Scheme

Dataset	Attributes	Total Samples	Training set Samples	Testing Set samples
Echo-Cardiogram	12	132	100	32

In this research work, proposed neural network classifiers as Back propagation NN and Radial basis function NN for classification of patient's survival at least one year that is death or life after a heart attack. The design of classifiers are s have train and test using training dataset and testing dataset. MATLAB is specifically used for obtaining results. An exhaustive and careful study has been carried out to determine the good classifier configuration.

III. NEURAL NETWORKS CLASSIFIER

Many types of Neural Networks can be used for classification but most popular NN is Back propagation NN and RBF NN.

A) Backpropagation Neural Network

It is shown that from the literature review a BPNN having single layer of neurons could classify a set of points perfectly if they were linearly separable. BPNN having three layers of weights can generated arbitrary decision regions which may be non convex and disjoint. BPNN is based on processing elements, which compute a nonlinear function of the scalar product of the input vector and a weight vector. Its configuration is determined by the number of hidden layers, numbers of the neurons in each of the hidden layers as well as the type of the activation function used for the neurons. Train Levenberg Marquart algorithm is used for determined the connection weights from the samples. The BPNN structure is evaluated on training set and test set. The test data are then used to accesses how well the network has generalized. Figure 1 shows structure of BPNN Architecture.

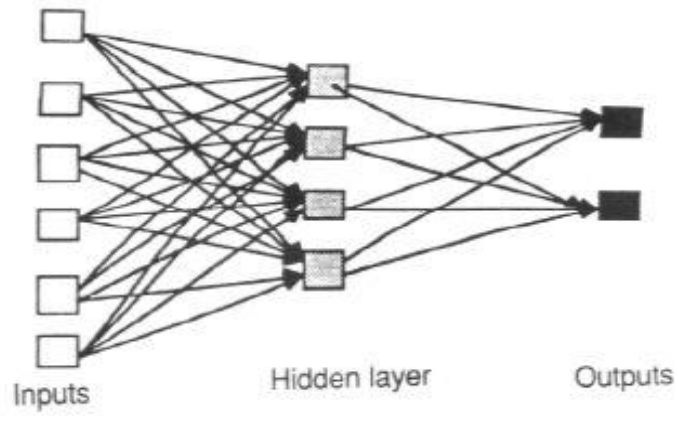

Fig 1 BPNN Architecture

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B) Radial Basis Neural Network

A radial basis function (RBF) is a real valued function whose value depends only on the distance from the origin, so that $\Phi(x) = \Phi(\|x\|)$; or alternatively on the distance from some other point *C*, called a center. RBF NN is a nearest neighbor classifier. It uses Gaussian transfer function having radial symmetry. The centers coefficient vector *W=[W1,W2,W3,…,Wn]*, f(*x*) being a real valued vector and *x=[x1,x2,x3,..xn]* implements the input-output map of the RBFNN. Any arbitrary continuous function can be approximated with an RBFNN if localized Gaussian is placed to cover the space, and the width of each Gaussian is controlled the amplitude of each Gaussian is set. Figure 2 shows RBF NN architecture.

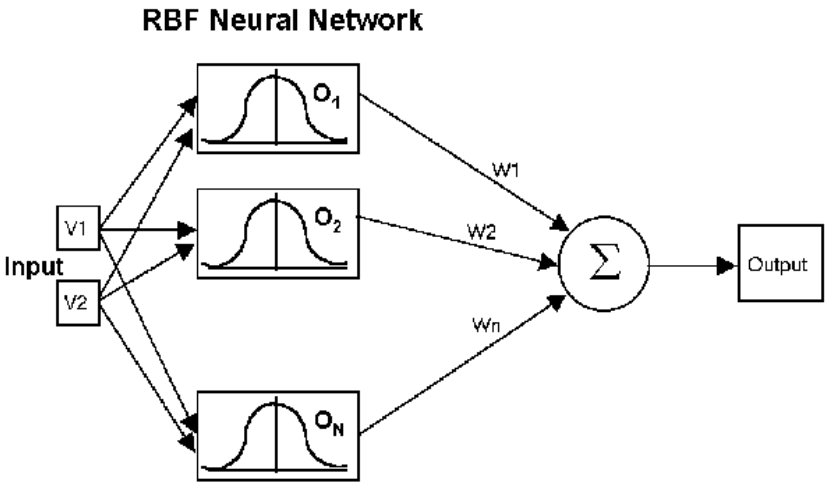

Fig 2 RBFNN Architecture

IV. DESIGN NN CLASSIFIER AND EXPERIMENTATION

A. BPNN Model

The Back propagation Neural network model is design using training set with input layer, one hidden layer and output layer .The input layer size is fixed with training data set size and number of hidden neurons in hidden layer are varied from 2-20 and one node in output layer. The architecture of BPNN classifier design with 11 inputs, 20 hidden neurons, 1 output neuron .This network is trained using Levenberge Marquart (LM) algorithm and Tanh transfer function for hidden layer and purlin function for output layer. Figure 3 shows the relation between number of epochs and Mean Squared Error (MSE) during training process of designed BPNN. Table 2 shows the performance measure of BPNN classifier for training and testing sets.

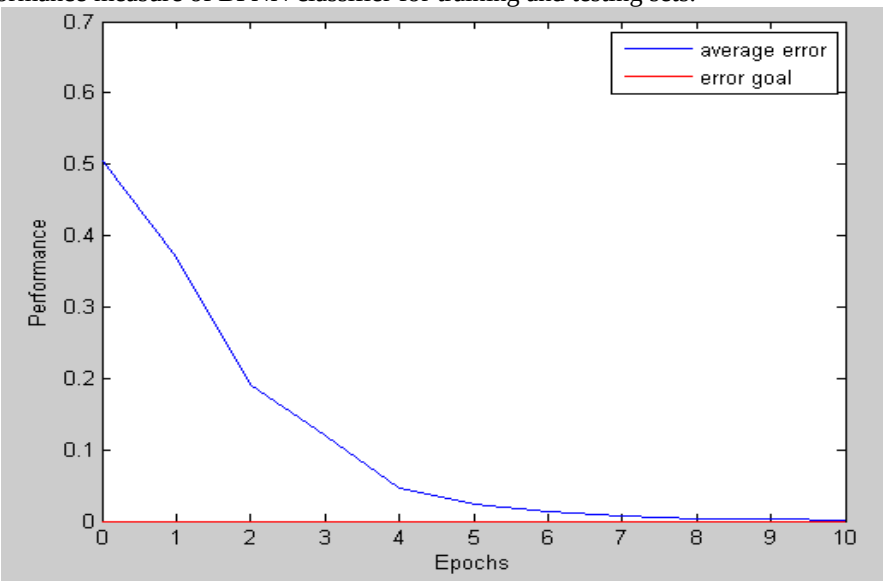

Fig 3 Performance Curve Of BPNN Model

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Table 2 Experimental Results of BPNN

	Training set Accuracy	Testing set Accuracy	MSE	No. of Epochs
BPNN Classifier	**93 %**	**84 %**	**0.00469**	**10**

B. RBFNN Model

Radial Basis Function NN model designed with one input layer, one hidden layer and one output layer. The hidden layer initially has no hidden neurons and the neurons are calculated by Gaussian Function. The Gaussian function spread constant is varied from 1 to 10. Design RBF NN with spread constant value one and Purelin function in output layer. This network is train on training dataset and test on testing dataset. Performance of the network achieved in terms of classification accuracy. The number of hidden neurons calculated is 100 and Mean Squared Error (MSE) achieved is 2.18293e-030. Figure 4 shows the performance curve and Table 3 shows performance of RBFNN for both training set and testing set.

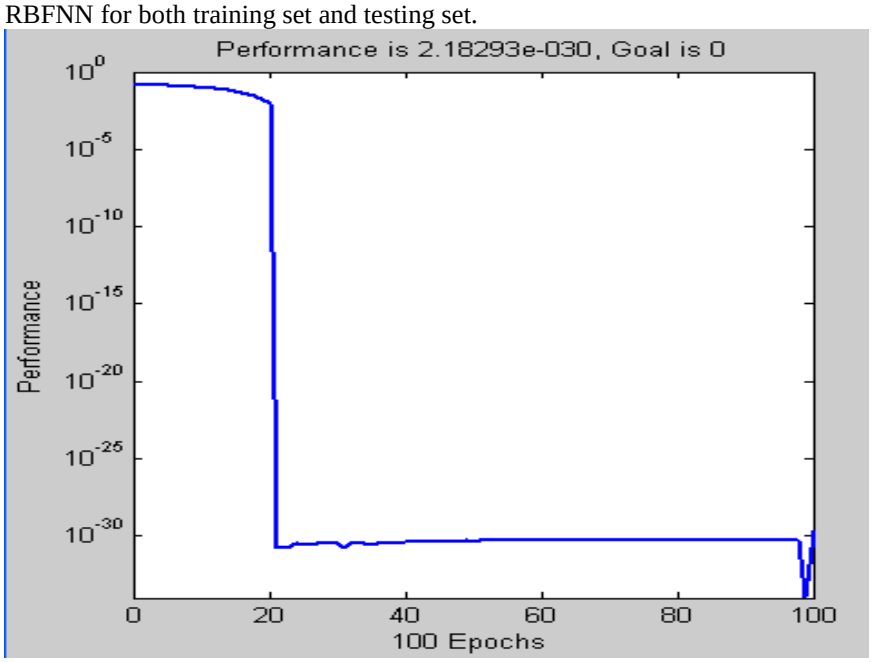

Fig 4 Performance Curve RBFNN Classifier

Table 3 Experimental Results of RBF NN

	Training set Accuracy	Testing set Accuracy	MSE	No. of Epochs
RBFNN Classifier	88 %	15 %	2.18293e-030	100

V. RESULT AND DISCUSSION

Experimentation is performed on BPNN and RBF NN design model. The good design classifier model for this Echocardiogram dataset for survival analysis is Back propagation Neural Network (BPNN). Figure 5 gives the comparison of BPNN and RBFNN classifiers with classification accuracy of training set and testing set.

The Back propagation neural network classifier is gives 93 % classification accuracy on training set and for generalization of network test on testing set with 84 % classification accuracy. The BPNN classifier requires 10 epochs to train the network and Mean squared Error (MSE) is obtained 0.00469. Radial Basis Function neural network (RBF NN) classifier gives 88% classification accuracy on training set and 69 % on testing data set. The RBF NN model requires 100 epochs to train the network and Mean Squared Error (MSE) is obtained 2.18293e-030.This comparison gives the BPNN artificial neural network classifier model is good classifier out performs RBF NN classifier model.

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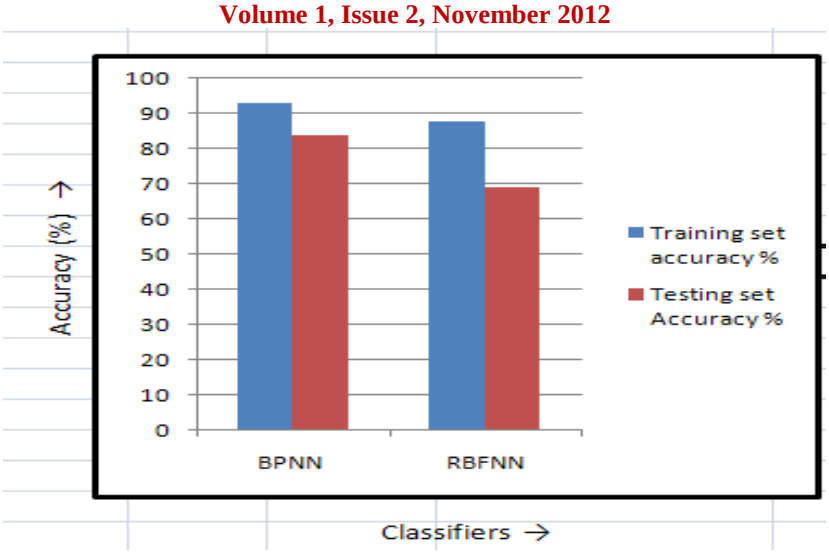

Fig 5 Comparisons of BPNN and RBFNN Classifiers

VI. CONCLUSION

We have proposed and implements BPNN and RBFNN classifier for patient's survival after heart attacks. Neural network approach is used for design the good classifier. The experimentation results showed that BPNN classifier achieved better accuracy compared to RBFNN classifier. This proposed method is not address by previous study because previous study presents the statistical method for patient's survival analysis. As compared to previous study, BPNN is novel and good classifier design with 93% classification accuracy on training set for patient's survival analysis.

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