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Diabetes Diagnosis using Artificial Neural Network

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Abstract

In this paper, we present a study on the diagnosis of diabetes using different supervised learning algorithms of Artificial Neural Network. The network is trained using the data of about 250 diabetes patients between the age group,25 to 78 years. The performance of each algorithm is further compared through regression analysis. The prediction accuracy of the best algorithm is computed to validate accurate prediction.

Keywords: diabetes, neural network, regression..

Introduction

Diabetes is one of metabolic diseases where a patient has high blood sugar either caused by the body failure to produce enough insulin or the cells failure to respond to the produced insulin. Diabetes can be identified by studying on several readings taken from a patient such as fasting glucose, sodium, potassium, urea, creatinine, albumin and many others.

ANN has been widely used in medical research and studies. The network is implemented to identify schizophrenia, Parkinson's disease and Huntington's disease from Contingent Negative Variation (CNV) response in the electroencephalogram [1]. On the other hand a functional model is proposed to aid existing diagnosis methods for the prediction of Thrombo-embolic stroke disease with overall accuracy of 89% [2].

The performances of Probabilistic Neural Network (PNN) and Multilayer Perceptrons (MLPs) are studied for the osteoporosis risk factor prediction which could possibly avoid unnecessary further testing with bone densitometry [3]. Logical inference and generalized regression neural networks are implemented to diagnose Hepatitis B [4].

ANN is also a tool used in the analysis of censored survival data for breast cancer specific mortality and disease free survival [5]. Cox Regression and PLANN-ARD neural network specifically identify patients at the extremes of high and low risk.

The feasibility of using objective data at the time of diagnosis of Hodgkin's disease to predict whether the patients were likely to die of progressive disease within four years is assessed with ANN [6]. Principle Component Analysis (PCA) based backpropagation network is proposed for peripheral arterial occlusive diseases [7]. In this study the diagnostic performance of the proposed network is validated with Receiver Operating Characteristics (ROC) analysis to evaluate the sensitivity and specificity.

Methodology

Dataset

The data of 250 diabetes patients is obtained from Pusat Perubatan Universiti Kebangsaan Malaysia, Kuala Lumpur. The data consists of 27 variables such as blood pressure, creatinine, urine PH, fasting glucose and many others are coded as numeric values. The patients are among both male and female between 25 to 78 years old. The data is trained to identify the diabetes pattern using MATLAB neural network toolbox.

Multilayer Feedforward Network

The architecture of the network is referred to as multilayer feedforward network made of input, hidden and output layers as depicted in Fig. 1.

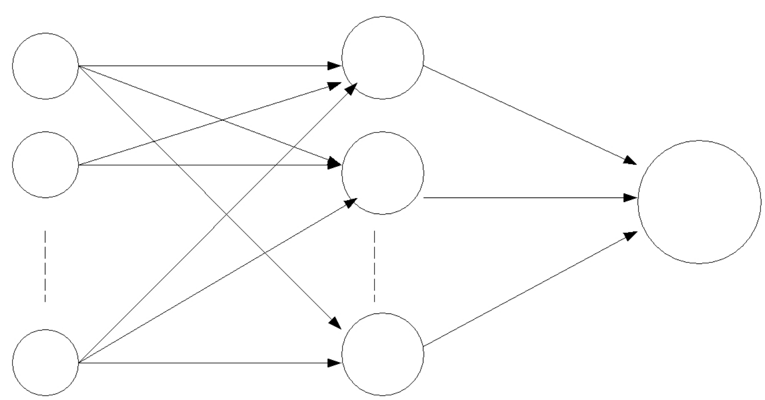

Fig. 1: Multilayer feedforward network architecture.

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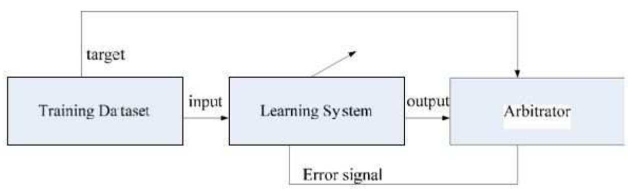
Supervised Learning

Supervised learning is an approach to find the input-output relationship based from the training using a set of data. Fig. 2 represents the block diagram of supervised learning. Learning system is fed with the input data and generates output, which is then compared with the target to compute the error signal by arbitrator. The error is sent to the learning system for further training until the minimum value of error is generated.



Backpropagation algorithm is an example of this type of learning and is widely implemented for various purposes. The learning process takes place by inputting the data to be trained by the network. The information from the input layer is distributed to the hidden layer for information process. Then the output layer will further process the information to obtain the results. The predicted outputs are then compared with the desired values for error computations.

Regression Analysis

Regression analysis is performed to investigate correlation between the desired and predicted results based on the value of correlation coefficient, R. The perfect fit between the training data and the produced results is indicated by the value of R which is equal to 1.

Results

The performances of all algorithms are presented in Fig. 3.

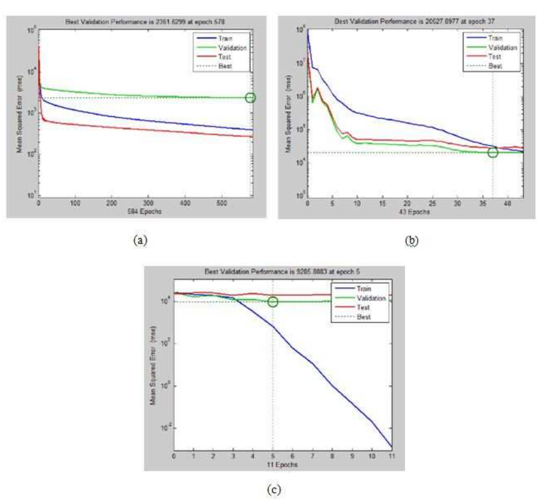


Fig. 3: Performance of different training algorithms. (a) BFGS Quasi-Newton algorithm (b) Bayesian Regularization (c) Levenberg-Marquardt

In a regression plot the perfect fit which shows the perfect correlation between the predicted and targets is indicated by the solid line. The dashed line indicates the best fit produced by the algorithm. Regression plots of all algorithms are shown in Fig. 4.

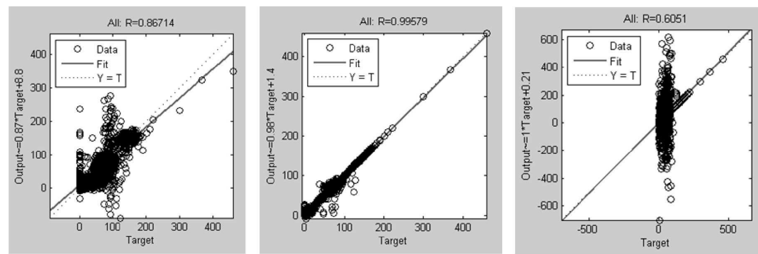


Fig. 4: Regression analysis plots. (a) BFGS Quasi Newton algorithm (b) Bayesian Regularization (c) Levenberg-Marquardt

Table 1 summarizes the values of parameter based on the performance and regression plots of all algorithms.

Table 1: Network simulation parameters.

Algorithm	Epochs	Correlation Coefficient, R
BFGS Quasi-Newton	578	0.86714
Bayesian Regulation	37	0.99579
Levenberg-Marquardt	5	0.6051

Based on the regression plot of all algorithms, the value of correlation coefficient, R of Bayesian Regularization algorithm is the closest to 1 compared to the other algorithms indicating accurate prediction.

The value of mean squared error, mse is also computed for all algorithms. The prediction accuracy is computed using the ratio of the total number of correct predictions to the total predictions. Bayesian Regulation algorithm produces more correct predictions with 88.8% prediction accuracy.

Conclusion

Based on the analysis conducted Bayesian Regulation algorithm produces the best performance in the prediction of diabetes compared to BFGS Quasi Newton and Levenberg Marquardt algorithms based on the values of R and the prediction accuracy. This algorithm produces R of 0.99576 which indicate a good correlation between the targets and predicted outputs. Prediction accuracy of Bayesian Regulation is 88.8% validate that this algorithm is suitable to perform the diabetes prediction task.

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