Utilization of Neural Network for Disease Forecasting

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Predicting future disease incidence is important and will be beneficial in the planning and management of a suitable policy to reduce the number of cases. Generally, information systems play a central role in the development of an effective and comprehensive approach to prevent, detect, respond, and manage infectious disease outbreaks in human. The application of artificial intelligence has motivated the use of artificial neural network in epidemiological area. This paper will present the use of neural network to learn the historical patterns of disease incidence to forecast future incidence. Some works related to the implementation of neural network for disease projection have been done for the past several years. Different implementations of disease forecasting using neural network are analyzed and evaluated. The results show the advantages of neural network for supporting policy/decision makers in developing long term strategies regarding the number of disease incidence.

Key Words: disease incidence, forecasting, neural network

1. Introduction

Neural network provides a very general way of approaching problems. When the output of the network is continuous, it will perform prediction and when the output has discrete values,it will do classification. The advantages of a neural network are as follow. A neural network can perform tasks that cannot be done by a linear program, when an element of the neural network fails, it can continue without any problem by their parallel nature, a neural network learns and does not need to be reprogrammed, it can be implemented in any application and it can be implemented without any problem [1]. Forecasting disease or medical diagnosis is one of major problem in medical applications. Different implementations of disease forecasting using neural network are analyzed and evaluated. The results will show the advantages of neural network for supporting policy/decision makers in developing long term strategies regarding to the number of disease incidence. Secondly, it has the potential to cover rare conditions, since no clinical expert can be expected to possess encyclopedic knowledge of all of the exceptional manifestations of diseases, even within a specialist domain. Thirdly, the expanding range of patient information that is made available in electronic form, makes it feasible to more accurately quantify important clinical indicators, such as the relative likelihood for competing diagnoses or the clinical outcome. In some cases, computer-assisted diagnoses have been claimed to be even more accurate than those by clinicians.

Several research groups are working world wide on the development of neural networks in medical diagnosis. Neural networks are used to increase the accuracy and objectivity of forcasting disease. 'Neural networks' research and application have been studied for a half of hundred years.

This paper aims to provide the introduction theory of neural network. It also provides different implementation of neural network on disease forecasting and result of case study. The remainder of the paper is structured as follows. Section 2 introduces theory of Artificial Neural Network. Section 3 presents a comparative study of different disease forecasting cases using neural network. Section 4 reports implementation of case study. Finally, Section 5 presents conclusion.

2. Artificial Neural Networks

Artificial Neural Networks (ANNs) are non-linear mapping structures based on the function of the human brain. They are powerful tools for modeling, especially when the underlying data relationship is unknown. ANNs can identify and learn correlated patterns between input data sets and corresponding target values. After training, ANNs can be used to predict the outcome of new independent input data. ANNs imitate the learning process of the human brain and can process problems involving non-linear and complex data even if the data are imprecise and noisy. An ANN is a computational structure that is inspired by observed process in natural networks of biological neurons in the brain. It consists of simple computational units called neurons, which are highly interconnected. ANNs have become the focus of much attention, especially because of their wide range of applicability and the ease with which they can treat complicated problems. ANNs are parallel computational models comprised of densely interconnected adaptive processing units. These networks are fine-grained parallel implementations of nonlinear static or dynamic systems. A very important feature of these networks is their adaptive nature, where "learning by example" replaces "programming" in solving problems. This feature makes such computational models very appealing in application domains where one has little or incomplete understanding of the problem to be solved but where training data is readily available. ANNs are now being increasingly recognized in the area of classification and prediction, where regression model and other related statistical techniques have traditionally been employed [2].

Neural network processes the calculation that involving training the network with a representative data. The network consists of a number of inputs and outputs. Between these 2 layers, there are hidden layers consist of some hidden nodes. The number of hidden nodes and layers is empirically determined to optimize the performance of network and to obtain the better result. Multi layer perceptron (MLP) of feed forward neural network using the backpropagation algorithm is commonly used in some applications [3]. The general architecture of MLP is presented in Figure 1.

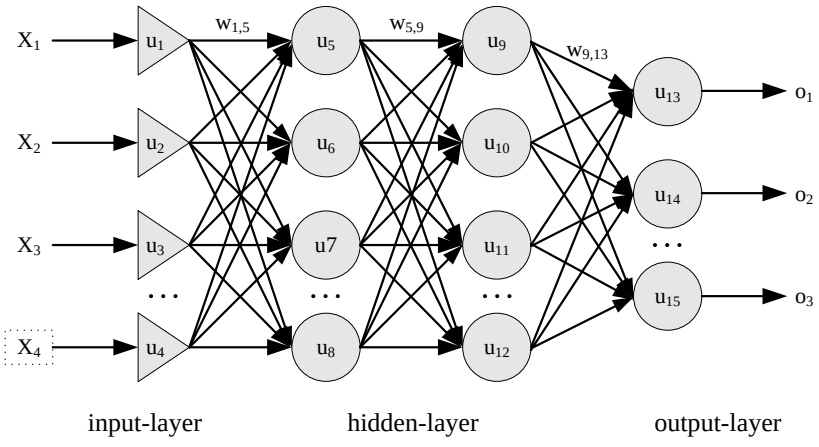

Figure 1. Architecture of Multi Layer Perceptron (MLP)

Refer to Figure 1, u_n are nodes ordered in layer, x_n are inputs, o_n are outputs, and $w_{n,n}$ are unidirectional connections with trainable weight. MLP can be formulated as the following:

$$y_t = b_0 + w_{t1}x_1 + w_{t2}x_2 + ... + w_{n1}x_n \qquad (1)$$

Where y_t is the predicted value at t and w_{tj} is the weight related to the jth input at time t. The well-known algorithm of ANN training is back propagation network (BPN). In

back propagation, the mean square error between calculated output and the desire value is back propagated into the previous layer to minimize error. It is done by adjusting the node weight.

3. Utilization ANN Disease Forcasting

A detailed study on some Artifical Neural Network (ANN) for disease is shown in Table 1.

Table 1. A comparative study of ANN application for disease forecasting

No	Title	Method	Results
1	Extract Knowledge from Site-sampled Data Sets and Fused Hierarchical Neural Networks for Detecting Cardiovascular Diseases [4]	Fuzzy neural networks (FNNs) algorithm	Method of variance analysis was used to attain knowledge and categorize features
2	Diabetes Mellitus Forecast Using Various Types of Artificial Neural Network [5]	Back-propagation algorithm	The best performance was observed as 82.10% in the MLP with 8-20-1 structure.
3	Recognition and prediction of leukemia with Artificial Neural Network (ANN) [6]	Levenberg-Marquardt learning algorithm	It resulted high performance 0.967 (the area under ROC curve) for the output from trained network related to real results.
4	Prediction of Diabetes by using Artificial Neural Network [7]	Regression plots of all algorithms.	Prediction accuracy of Bayesian Regulation was 88.8%
5	Heart disease Classification using Neural Network and Feature Selection [8]	Back-propagation algorithm	The accuracy of in training data set was 89.56%, in the validation data set was 80.99%
6	Decision Support System for Congenital Heart Disease Diagnosis based on Signs and Symptoms using Neural Networks [9]	Backpropagation multi layered Feed Forward	The accuracy achieved through the proposed system was 90%.
7	An Artificial Neural Network Model for Neonatal Disease Diagnosis [10]	Multi Layer Perceptron with a BP learning algorithm	Predictive accuracy acquired was 75%
8	Designing an Artificial Neural Network Model for the Prediction of Thrombo-embolic Stroke [11]	Back-Propagation algorithm	Predictive accuracy obtained was 89%
9	Forecasting of Salmonellosis Incidence in Human using Artificial Neural Network (ANN) [12]	Back propagation Algorithm	The empirical result indicated that the model was able to represent the historical data with Theil's U with the value 0.209.
11	Impact of Preprocessing for Diagnosis of Diabetes Mellitus Using Artificial Neural Networks [13]	Back propagation algorithm	It compared different techniques of missing value and pre-processing. Thus, it achieved an excellent classification accuracy of 99%

No	Title	Method	Results
12	Application of Neural Networks in Diagnosing Cancer Disease Using Demographic Data[14]	back propagation algorithm	The accuracy was 87%
13	A Biomedical System Based on Artificial Neural Network and Principal Component Analysis for Diagnosis of the Heart Valve Diseases[15]	Multi-Layer Perceptron (MLP).back-propagation algorithm	Have been classified at correctness rates of 95%.
14	Intelligent and Effective Heart Attack Prediction System Using Data Mining and Artificial Neural Network[16]	multi-layer perceptron (MLP) with back-propagation (BP) algorithm	The results illustrated that the designed prediction system is capable of predicting the heart attack effectively

Neural network has been widely used in the medical field for forcasting disease. Neural network has been established of their potentials in many domains related with medical forcasting and diagnosis disease, Although, Neural networks never replace the human experts instead they can helpful for decision making, classifying, screening and also can be used by domain experts to cross-check their diagnosis.

4. Implementation of Case Study

In this paper, the use of forecasting method was applied to predict the number of Tubercolosis disease in US based on the monthly data. Datasets taken from monthly number of Tuberculosis incidence were selected. The data was obtained from the summary of notifiable diseases in United States from the Morbidity and Mortality Weekly Report (MMWR) that published by Centers for Disease Control and Prevention (CDC).

The adjusted model prediction was developed by using neural network model based on the historical data. Different neural network models were tested to select the most appropriate model. The result determined three layers of MLP 9 nodes input, 4 nodes hidden, and 1 node output as the best model among them. The selected network achieved as presented the network in Figure 2. The performances of all algorithms are presented in Figure 3.

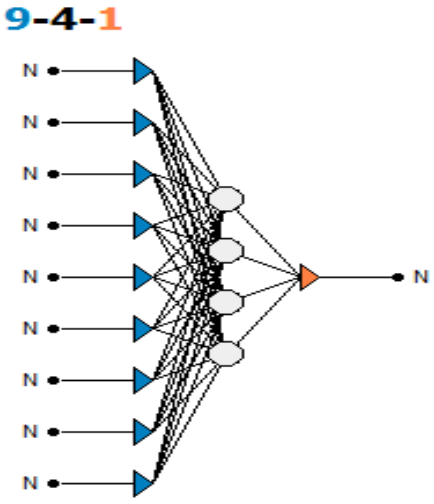

Figure 2. ANN architecture for Tuberculosis forecast

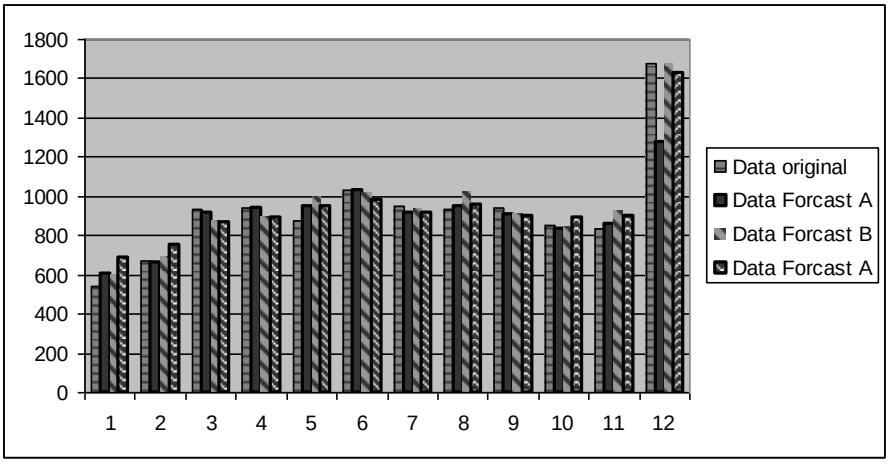

Figure 3. Performance of different training algorithms.
(a) Quick Propagation (b) Quasi-Newton (c) Lavenberg-Marquardt

Table 2 summarizes the values of parameter based on the performance of all algorithms. Three different training algorithms were applied: Quick Propogation, Quasi-Newton and Lavemberg-Marquardt. The results indicate Quick Algorithm as the most accurate algorithm since the value of correlation and R-squared close to 1. It also produces an average RE value of 0.0291 which indicate a good correlation between the targets and predicted outputs

Table 2. Network simulation parameters

Architecture	Training algoritma	Correlation	R-squared	Average RE
[9-4-1]	Quick Propogation	0,986929	0,955427	0,0291
[9-4-1]	Quasi-Newton	0,955143	0,87995	0,0465
[9-4-1]	Lavenberg-Marquardt	0,955734	0,38240	0,0804

4. Conclusion

The implementation of neural networks for forecasting is now becoming more quickly. This paper presents various neural network algorithms for the use on disease area. A case study of the number disease incidence was used to compare different neural network techniques and then selected the best result among them. For this particular application in forecasting of the disease, the author believes the results are interesting and will lead to further research on how the technique can be used for statistical testing purposes. If more data is used by the network, it will make the network more intelligent.

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