Applied Mathematical Sciences, Vol. 7, 2013, no. 41, 2047 - 2053
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Modeling Multi Layer Feed-forward Neural Network Model on the Influence of Hypertension and Diabetes Mellitus on Family History of Heart Attack in Male Patients

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Abstract

According to previous research findings, both hypertension and diabetes mellitus increases the chance of having a stroke, heart attack, heart failure and kidney disease. Patients with diabetes and hypertension have a higher incidence of coronary artery disease compared to the patients with diabetes or hypertension alone. The aim of this study was to evaluate the influence of hypertension and diabetes mellitus on family history of heart attack in male patients from the view of Multi Layer Feed Forward (MLFF) neural network model. The input variables of MLFF neural network model are selected based on the significant variables of logistic regression (LR) model which were, incident (new) coronary heart disease (INCCHD), total cholesterol (CHOLTOT) and height (cm). These three variables also were significantly contributed to MLFF neural network model.

Keywords: Multi layer feed forward neural network model, multiple logistic regression, hypertension and heart attack

INTRODUCTION

Nowadays, most of people lifestyles have grown very hectic due to the busy lifestyles. Consequently, the time for rest and relaxation become very limited. Excess workload from office has caused psychological tensions. This situation in our body can be translated as tensions raise the adrenaline in the blood and this causes our blood pressure rise. When the blood pressure rise, the pressure force blood against the walls of arteries. This increases the risk of stroke, aneurysm, heart failure, heart attack and kidney damage [1]. High blood pressure and diabetes mellitus share certain physiological traits and they usually tend to occur together. Patient with diabetes mellitus will increases the amount of fluid in the body, when fluid in the body increase, it will lead to corresponding increases in blood pressure [2]. Besides that, diabetes also increased arterial stiffness and it decreases the ability of the blood vessels to stretch. As a result the averages of blood pressure increase. According to the previous research, researcher found that common biological traits of the two diseases are likely to occur together simply because they share a common set of risk factors [3].

Multilayer feed-forward (MLFF) neural network was applied to medical data [4, 5]. Norizan Mohamed et al. [4] develop a multiple linear regression (MLR) and two multilayer feed-forward (MLFF) neural network models of body mass index (BMI). Model 1 was developed based on all the independent variables which are systolic blood pressure (SBP), diastolic blood pressure (DBP), age, serum cholesterol (CHOLES), gender, pulse, height, weight, arm, leg, waist and wrist. Model 2 was developed based on four significant independent variables of multiple linear regression. The result shown that Model 2 was more accurate than Model 1. In 2012, they also applied the MLFF to lymphoma cancer data [6].

Recently, Nor Azlida Aleng et al. [7] applied MLFF neural network model on tuberculosis patients. The combinations of significant variables from multiple linear regression (MLR) model were used as input variables of MLFF neural network model. The MLR of tuberculosis showed that gender, married status, diseases genital and descendant were significant. Hence, four variables were used to develop the best (MLFF) neural network model of tuberculosis.

In this paper, patient with high blood pressure and diabetes mellitus have been analyzed in order to identify the factors that contribute to the heart attack. The objective of the current study is to study from the view of MLFF neural network model the most significant variables that influences of hypertension and diabete mellitus on family history of heart attack in male. The input variables of MLFF neural network model are selected based on the significant variables of logistic regression (LR) model. This study focus on male patients with high blood pressure and type II diabetes mellitus. A total of 92 eligible patients were selected and explanation of the variables as presented in Table 1. They were diagnosed to have diabetes mellitus and high blood pressure (140mmHg or higher) based on WHO criteria. A fasting plasma glucose level >126 mg/dl (7.0 mmol/l) or a casual plasma glucose >200 mg/dl (11.1 mmol/l) meets the threshold for the diagnosis of diabetes. The selected variables are: Family history of heart attack (Fhha), total cholesterol (Choltot), incident (new) coronary heart disease (Incchd) and Height (cm).

Table 1. Explanation of the Variables

Variables	Code	Explanation of the variables	Categorical
FHHA	Y	Family history of heart attack	0 = No 1 = Yes
INCCHD	X1	Incident (new) coronary heart disease during 6 years of follow-up	0 = No 1 = Yes
CHOLTOT	X2	Total cholesterol(mg/dl)	
HEIGHT	X3	Height (cm)	

METHOD

Multilayer Feed-forward Neural Network (MLFF)

Multilayer Feed-forward Neural Network (MLFF) consists of an input layer, one or several hidden layers and an output layer. The neurons in the feed-forward neural network are generally grouped into layers. Signals flow in one direction from the input layer to the next, but not within the same layer [8]. An essential factor of successes of the neural networks depends on the training network. Among the several learning algorithms available, back-propagation has been the most popular and most widely implemented [9]. Basically, the BP training algorithm with three-layer feed-forward architecture means that, the network has an input layer, one hidden layer and an output layer. In this research the output node is fixed at one since there is only one independent variable. Thus, for the feed-forward network with N input nodes, H hidden nodes and one output node, the values $\hat{Y}$ are given by:

$$\hat{Y} = g\left(\sum_{j=1}^{H} w_j h_j + w_0\right) \tag{1}$$

where w_j is an output *weight* from hidden node j to output node, w_0 is the bias for output node, and g is an activation function. The values of the hidden nodes h_j ,

$j = 1, \dots, H$ are given by:

$$h_j = k\left(\sum_{i=1}^{N} v_{ji} X_i + v_{j0}\right), \; j = 1, \dots, H \quad (2)$$

Here, v_{ji} is the input *weight* from input node i to hidden node j, v_{j0} is the bias for hidden node j, X_i are the independent variables where $i = 1, \dots, N$ and k is an activation function. The architecture of the multilayer feed-forward neural network model is illustrated in Figure 1.

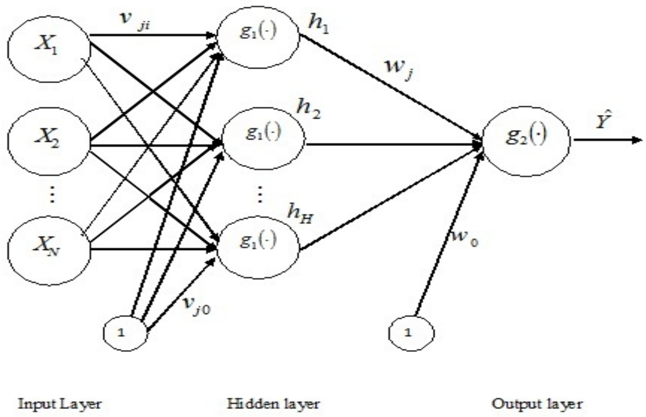

Fig. 1: The architecture of the multilayer feed-forward neural network model with N input nodes, H hidden nodes and one output node.

RESULT AND DISCUSSION

Logistic regressions are used extensively in the medical research and also help to make medical decisions. This paper extended the idea of LR to MLFF neural network to examine the significant variables that influencing the hypertension and diabetes mellitus on family history of heart attack.

In 2012, Wan Muhammad Amir et al. [10] found that three independent variables which incident of coronary heart disease (X_1), total of cholesterol (X_2) and height (X_3) significantly influence in the logistic regression model. Hence these three independent variables (X_1, X_2 and X_3) are used as the input variables of MLFF model. Norizan Mohamed et al. [4] used the significant variables from MLR model as input nodes of MLFF neural network model. Instead of significant variables from MLR model, the significant variables from LR model are used in this current study.

The output node in this study is one node since we have one dependent variable which is the family history of heart attack (FHHA). To find the appropriate number of hidden nodes and best combination of input variables, the model selection strategies which proposed by Norizan Mohamed [11] is followed. The best number of hidden nodes is one node. Using difference combination of significant variables, result shown that the best combination is three input variables as illustrated in Table 2.

The architecture of current study is composed of three input variables, one hidden node and one output node as presented in Figure 2. Thus, MLFF neural network model with three input variables, one hidden node and one output node, the values $\hat{Y}$ are given by:

$$\hat{Y} = g\left(w_1 h_j + w_0\right)\ j = 1 \tag{3}$$

where w_1 is an output *weight* from hidden node j to output node, w_0 is the bias for output node, and g is linear function. The values of the hidden nodes h_j, $j = 1$ are given by:

$$h_j = k\left(\sum_{i=1}^{3} v_{ji} X_i + v_{j0}\right)\ j = 1 \tag{4}$$

Here, v_{ji} is the input *weight* from input node i to hidden node j, v_{j0} is the bias for hidden node j, X_i are the independent variables where $i = 1,2,3$ and k is a sigmoid function. Equations 3 and 4 can also be represented as follows:

$$\hat{Y} = w_0 + w_1 h_1 \tag{5}$$

$$h_j = \left[1 + \exp\left[-\left(v_{j0} + v_{j1} X_1 + v_{j2} X_2 + v_{j3} X_3\right)\right]\right]^{-1},\ j = 1 \tag{6}$$

The architecture of MLFF neural network model is illustrated in Figure 2.

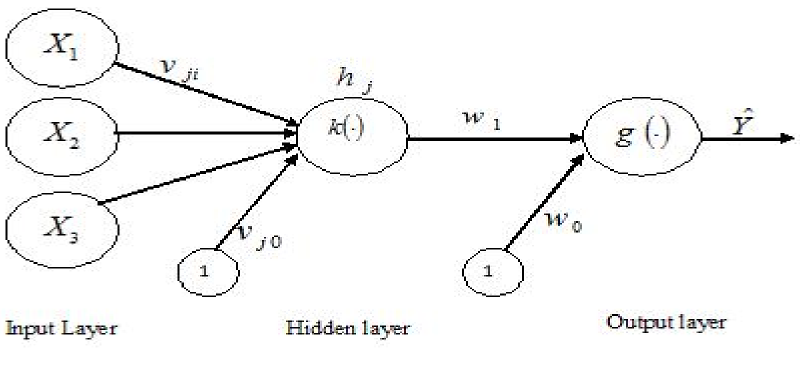

Fig. 2: The architecture of MLFF neural network model with three input variables, one hidden node and one output node.

Table 2: The results of MSE training and MSE testing.

Input Variables	MSE Training	MSE Testing
X_1, X_2, X_3	0.1894	0.1383
X_1, X_2	0.1944	0.1452
X_1	0.1985	0.1985

X_1, X_2, and X_3 are INCCHD, CHOLTOT and HEIGHT respectively

CONCLUSION

The purpose of the current study is to examine from the view of MLFF neural network model the most significant variable that contribute to family history of heart attack in male patients. The combinations of significant variables from logistic regression (LR) model are used as input variable of MLFF neural network model. Three variables were incident of coronary heart disease (X_1), total of cholesterol (X_2) and height (X_3) contribute significantly to LR model. Using the significant variables of LR model, the performance of MLFF neural network model for difference combinations are tested. The performance of MLFF was evaluated MSE of testing/out-sample. The combination of three input variables outperformance other combinations. Hence, these three variables also significantly contribute to MLFF neural network model.

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Received: December 21, 2012