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Pre-Diagnosis of Hypertension Using Artificial Neural Network

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Pre-Diagnosis of Hypertension Using Artificial Neural Network

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Abstract : Artificial Neural Networks (ANNs) play a vital role in the medical field in solving various health problems like acute diseases and even other mild diseases. Earlier diagnosis of hypertension saves enormous lives, failing which may lead to other sever problems causing sudden fatal end. This paper deals with Artificial Neural Networks solving the problems of diagnosing hypertension using Back-Propagation learning algorithm. The network is constructed using various factors which are classified into some categories, to be trained tested and validated using the respective data sets. For construction, an input layer, a hidden layer and an output layer are used. Eight inputs have been given to the network and the network is trained with one hidden layer and one output layer. The back-propagation neural network model is systematically trained and with data sets.

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I. Introduction

Hypertension is a disease that affects a wide range of the population, particularly the elderly after the age of 55[1]. Hypertension is caused by Blood Pressure. Blood Pressure is the force of blood pushing against blood vessel walls. The heart pumps blood into the arteries (blood vessels), which carry the blood throughout the body [2]. If blood pressure is extremely high, there may be certain symptoms such as Severe headache, Fatigue, disorientation, Vision problems, Chest pain, Difficulty in breathing, irregular heartbeat and Blood in the urine [3, 4]. Hypertension can cause Stroke, Heart failure, Heart attack, Kidney failure and Vision problems.Men have a greater likelihood of developing high BP than women. This varies according to age and among various ethnic groups. In some cases, computer-based assisted diagnoses have been claimed to be even more accurate than those by clinicians. Predicting the outcome of it is one of the most interesting and challenging tasks in which a Neural Network application is developed [5, 6].Neural Networks are well suited to problems that people use good at solving but for which computers arenot. Neural Networks provide a very general way of approaching problems.

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When the output of the network is continuous, it is performing prediction and when the output has discrete values, then it is doing classification. Diagnosis involves the process of collection, analysis, recognition and classification of data. Data are obtained from interviews, examinations and tests. The physician, using his knowledge and experience, transforms the data into a diagnosis. Employing the technology especially artificial neural network (ANN) techniques in medical applications could result in reducing cost, time, medical error and need of human expertise. The backpropagation network is one of the several networks that is used for predicting the output and is successfully applied to the medical field. In this paper, neural network model is used to detect hypertension with the help of physical symptoms and risk factors. Once the neural network model is trained, it will predict the possibility of hypertension [7, 8].

II. Risk Factors of Hypertension

Initial assessment of the hypertensive patient should include a complete history and physical examination to confirm a diagnosis of hypertension. The main causes of hypertension are obesity, a passive lifestyle, excessive alcohol intake, history of hypertension in the family, genetic mutation, stress and high consumption of salt and fat. High Blood Pressure also known as hypertension, (HTN) is a condition in which the blood pressure of a person is abnormally high. Hypertension can be classified in to two types such as primary hypertension or essential hypertension and secondary hypertension. There is no specific cause for primary hypertension, most of the people may affected by primary hypertension. Although the exact cause of hypertension is unknown, there are several factors and conditions that may increase risk. The NHLBI (National Heart, Lung and Blood Institute) has identified several factors that increase the risk of hypertension. Certain factors are recognized as contributing to high Blood Pressure such as:

Factors that cannot be changed (uncontrollable)

- Age
- Gender
- Family history(heredity)
- Socioeconomic status

Factors that can be changed (controllable)

- Overweight (obesity)
- Smoking
- Lack of exercise (physical inactivity)
- Excess salt in the diet
- Alcohol consumption
- Stress
- Diabetes
- Blood Pressure
- High cholesterol
- Chronic kidney disease
- Thyroid disorders

These risk factors can be reduced or treated by changing the lifestyle. [7, 8].

III. Artificial NEURAL Network Architecture

Artificial Neural Networks are non-linear mapping structures based on the function of the human brain. Artificial Neural Networks can identify and learn correlated patterns between input data sets and corresponding target values. Neural Networks are made up of interconnected neurons. Each neuron has a certain number of inputs. There is a real number associated with each connection, which is called the weight of the connection, and is denoted by W. Each neuron has its own unique threshold value. The behaviour of an ANN depends on both the weights and input-output function (transfer function) that is specified for the units. The combination function and the transfer function make up the activation function of the node. Activation function defines the output of a neuron. The three common transfer functions are sigmoid, linear and hyperbolic functions. Out of these sigmoid function is most common form of activation function used in the construction of neural network. [10]. It produces the values between 0 and 1 for any input from the combination function. The hidden neuron act as feature detectors, as such they play a critical role in the operation of multilayer perceptron The most popular approach to find the optimal number of hidden layer is by trail and error. There are two decisions to be considered with regards to the hidden layers such as number of hidden layers and number of hidden neurons. Hidden layer automatically extracts the features of the input and reduces its dimensionality further. There is no specific rule that dictates the number of hidden layers. Usually, one hidden layer is used. The reason for this is that one hidden layer is sufficient to approximate any continuous function to an arbitrary precision [8]. This model is used one hidden layer with 4 neurons & sigmoid functions. The number of hidden neurons should be in the range between the size of the input layer and the size of the output layer. If the number of neuron in the hidden layer is more, the network becomes complicated. Results indicates that the present problem is not too complex to have a complicated network routing.Learning is a process by which the parameters of a neural network are adapted through a continuous process of simulation by the environment in which the network is embedded. The type of learning is determined by the manner in which the parameter changes take place [9, 10]. Supervised algorithm is also known as “error-based learning algorithms,” which employ an external reference signal (teacher) and generate an error signal by comparing the reference with the obtained response. Based on error signal, Neural Network modifies its synaptic connections to improve the system performance. Neural Network have the ability to adapt to any situation and therefore it learns how to solve a problem. Learning with a teacher is also called supervised learning. During the learning process global information may be required. An important issue concerning supervised learning is the problem of error convergence, that is the minimization of error between the desired response and actual response of the network. This adjustment is carried out iteratively in a step-by-step process. The aim is to determine a set of weights which minimizes the error as shown in Figure 1.

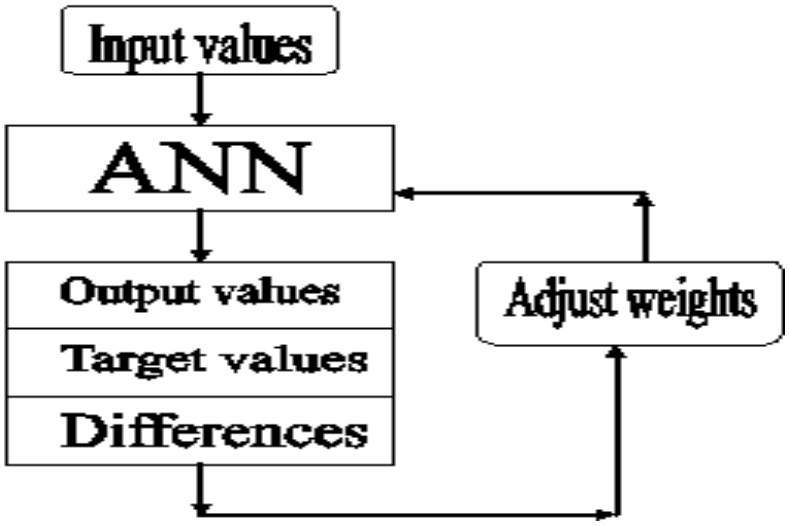

Figure 1: Artificial Neural Network Architecture

Back propagation Algorithm

The most widely used method is the back propagation algorithm and is a learning rule for multi-layered Neural Networks. Back-Propagation networks are fully connected, layered, feed forward networks, in which activations flow from the input layer through the hidden layer(s) and then to the output layer. Back propagation uses supervised learning in which the network is trained using data for which inputs as well as desired outputs are known. In order to train a neural network to perform some task, the weight of each unit must be adjusted , in such a way that the error between the desired output and the actual output is reduced. [11]. The algorithm gives a prescription for adjusting the initially randomized set of synaptic weights. Training algorithm of back propagation include four stages as

- Initialize the weight.
- Feed forward.
- Back propagation of errors.
- Updating of the weights and biases.

Begins by constructing a network with the desired number of hidden and output units and initializing all network weights to small random values. The main loop of algorithm then repeated over the training examples. For each training examples, calculate the error of the network output, computes the gradient with respect to the error, updates all weights in the network. Repeated until the network performs acceptably well. A unit in the output layer determines its activity by following two step procedures.

I. computes the total input I using the formula:

$$I = \sum_{i=1}^{n} W_i X_i$$

where $x_1, x_2, x_3, \ldots x_n$ are the n inputs to the artificial neuron and $w_1, w_2, w_3, \ldots w_n$ are the weights attached to the input links.

II. the unit calculates the activity X_i using some function of the total weighted input, the activation function used is the sigmoid function and is given by

$$\text{Sigmoid}(x) = 1/(1+e^{-x})$$

where x is the sum of weighted inputs to that particular node and e is the base of natural logarithms e = 2.718....

The output layer of the network is designed according to need of the application output. Since the output of the neural network is expected to predict the presence or absent of the hypertension. It is assume that the actual output is d_k and expected output is y_k. So the network error function E will be calculated by the expression:

$$E = \tfrac{1}{2} \left(\sum_{k=1}^{m} (y_k - d_k)^2 \right)$$

where m is the number of neurons in the output layer. So if output is 1 hypertension is present and if it is 0 hypertension is absent. [11, 12].

IV. Construction of Ann Model for Hypertension

Feed forward network has a layered structure. Feed the input in the network and propagate it forward to get an output are called feed forward networks. Feed forward ANNs allow signals to travel one way only, from input to

output. There is no feedback that is the output of any layer does not affect that same layer. They are extensively used in pattern recognition. Each input variable should be preprocessed so that its mean value, averaged over the entire training sample is close to zero, or else it will be small compared to its standard deviation. Artificial Neural Network is having 8 input variables and one output variable. The database is normalized to the input requirements of back propagation network using the formula

$$Y_{norm} = \frac{Y - Y_{min}}{Y_{max} - Y_{min}}$$

Where Y_{norm} is the normalized value
Y is the original value
Y_{max} is the maximum value
Y_{min} is the minimum value

The normalized data is used for training the network such that, the data will be in the range of 0 to 1.0. The accuracy of the technique is evaluated by splitting data into training and testing data set. When learning is stopped, the network is evaluated with the data from the test data set. The dataset is divided in to training set and test set. Training a neural network is the process of setting the best weights on the inputs of each of the units. The training set is a part of the input dataset used for neural network training, that is for adjustment of network weights. The test set is a part of the input data set used to test how well the neural network will perform on new data. The test set is used after the network is trained, to test what errors will occur during future network application .this set is not used for training.

The trained network has been tested with a test set, in which the outcomes are known but not provided to the network, to see how well the training has worked. Training patterns refers to the input data coupled with its desired outputs were prepared. When testing the network, various input data sets are applied to its input layer. The network generates the output. The network's output is compared with the desired outputs. These input data sets and desired outputs collectively known as test samples. The input values have been coded with numerical values ranging between 0 and 1 in order to give a contribution to the network independent from their real absolute values [13,14]. Supervised learning and back propagation training algorithm has been used in this study to adjust the weights of the network systematically such that the error between the output and the desired output is minimum. The actual training of the network is accomplished by back propagating the error from the output layer to the hidden layer and finally to the input layer. The error is the difference between the desired output and the output calculated during training. By using two parameters called learning rate and momentum factors the weights in the network are adjusted in each of the iterations so as to reduce the error [14].

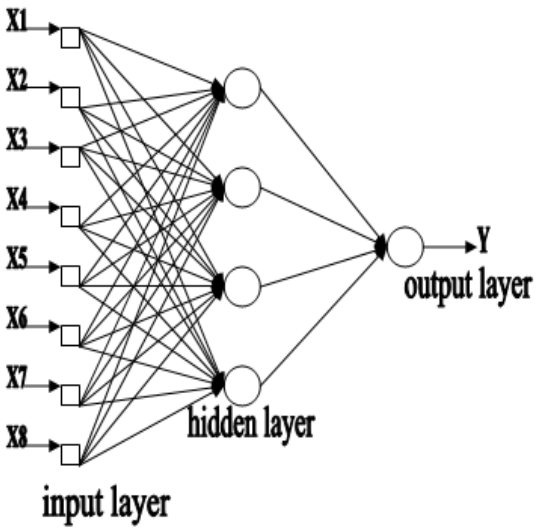

Figure 2: Artificial Neural Network Architecture for the diagnosis of hypertension

The proposed network created in this paper is a Back propagation neural network consists of 8 input neurons in the input layer which are the risk factors of hypertension, 4 hidden neurons in the hidden layer and 2 output neuron in the output layer. The node of the output layer is the one that gives the classification for the data. It classifies that are having hypertension or not having hypertension.. Artificial Neural Network model has been created and trained with learning algorithm. [14]. The ANN used in this study is a standard feed-forward back-propagation neural network with three layers: input layer, a hidden layer and an output layer as shown in Figure 2. Each neuron or node in the input layer contains known information. The number of neurons in the input layer is equal to the number of elements existing in one transaction in the database. The input layer of a neural network is determined from the characteristics of the application input. For diagnosis of hypertension 8 variables are used as the inputs to the network. The sample data are prepared on the basis of symptoms and risk factors. Line represent weights which connect the input layer to the hidden layer. The hidden layer is also made up of neurons, whose value is given on the basis of trail and error methods. The output layer consists of two neurons which represents hypertension or no hypertension. The activation of the neuron is computed by applying a sigmoid function. Each neuron receives a signal from the neurons in the previous layer, and each of those signals is multiplied by a separate weight value.[15]. The weighted inputs are summed, and passed through a

limiting function which scales the output to a fixed range of values. The network consists of 8 input neurons in the input layer,

V. Conclusion and Future Enhancement

This work described that the prediction of risk from hypertension and gives the best result on the dataset. The result generated by this system have been verified with the physicians and are found correct. This ANN based model has been used to develop a system in which people would be able to self-diagnose themselves and also it helps the doctor to plan for better medication and provide the patient with early diagnosis of hypertension. Prognosis of early diagnosis of hypertension with ANN models has the best performance in large data sets.

The result of the diagnosis is better comparing to physicians diagnosis as they may get confusion when their expertise level is low or there are some missing or noisy values. The main objective of this paper is to predict and diagnose the patients with hypertension to prevent them from sudden death. The hidden layer of a neural network plays an important role for detecting the relevant features. Due to the existence of irrelevant and redundant attributes, by selecting only the relevant attributes, higher predictive accuracy can be achieved. Some of the features may not be effective to the hidden layer. By extracting these features the training time may be minimized. To extend the algorithm for improving back propagation using feature selection will be the future work.

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