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A New Method for Cardiovascular Disease Clinical Diagnosis Based on Artificial Neural Network Model

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Abstract: Diagnosis. In order to improve the accuracy of Clinical Diagnosis for Cardiovascular Disease, ANN(Artificial Neural Network is introduced in this paper. 200 cases of cardiovascular disease which have similar symptom and different diagnosis are sampled from our database. BP Network model in Matlab environment is created for these cases. Simulation results show that the Diagnosis after training is much better than that with the doctor' diagnosis opinion. It can be concluded that this new method is of important value for realistic scale in clinical.

Key words: Cardiovascular disease, clinical diagnosis, artificial neural network

INTRODUCTION

In recent years, cardiovascular disease has become a serious threat to human health. A diagnosis with more accuracy is crucial to effective treatment. Modern medical diagnosis is a clinical thinking logic judgment of the patient's disease. Doctors can finally arrive at a modern medical diagnosis through evaluation on large of clinical data. This process is a comprehensive use of the basic inspections since it is a non-linear process which includes inspection, palpation, percussion, auscultation and olfactory examination. The disease diagnosis is one of the doctor's most important and most basic clinical practice activities. There will be similar symptoms in different type of patients with different diseases. The correct diagnosis of the disease should depend on the extensive clinical experience and related knowledge of the doctor. Only if this logic diagnosis is according with the objective existence of the disease, the diagnosis should be correct. However the case sometime not exists with the limits of clinical experience or related knowledge.

An Artificial Neural Network model is proposed to get arbitrary precision approximation of arbitrarily complex non-linear process in this paper. The clinical diagnosis for cardiovascular disease is described by using our model. Simulation applications are discussed in detail and the results show that this new method is of important value for realistic scale in clinical.

BP NEURAL NETWORK STRUCTURE FOR CARDIOVASCULAR DISEASE DIAGNOSIS

ANN is set up as an abstract mathematical model of the biological neural network of the human brain from the point of view of information processing with mathematical and physical methods which is the most active branch of computational intelligence and machine learning research. In recent years, the neural network has achieved notable results in the research of clinical application. In literature (Luo, 2010; Lu, 2008), artificial neural network are used in Chinese medicine Pulmonary syndrome diagnosis and Chinese medicine face consultation and factor differentiation; literature (Yang *et al*., 2008) use UML modeling method to study the design and implementation of electronic medical record system and so on.

BP neural network is the most widely used artificial neural network. In the 80% -90% of the practical applications of artificial neural networks, artificial neural networks are based on the BP neural network or its modified form. It has a wide range of applications in pattern recognition, image analysis and processing, control and other fields.

BP neural network is a multilayer feedforward network using error back propagation algorithm. The basic idea is that if the network output error, error feedback to adjust the weights of the network so that future network output develop to make smaller error, to achieve a mapping relationship between given input and output. It has an input layer, hidden layer and output layer, layers are fully connected, in the same layer unit dose not connected mutually, shown in Fig. 1.

Assuming the BP neural network input vector $x \in R^n$, $x = (x0, x1, \ldots, xn-1)T$, the output layer has m neurons, each computing node in the middle of the BP neural network is

$$u_j = \sum_{i=1}^{n} \omega_i . x_i - \theta_j \quad (1)$$

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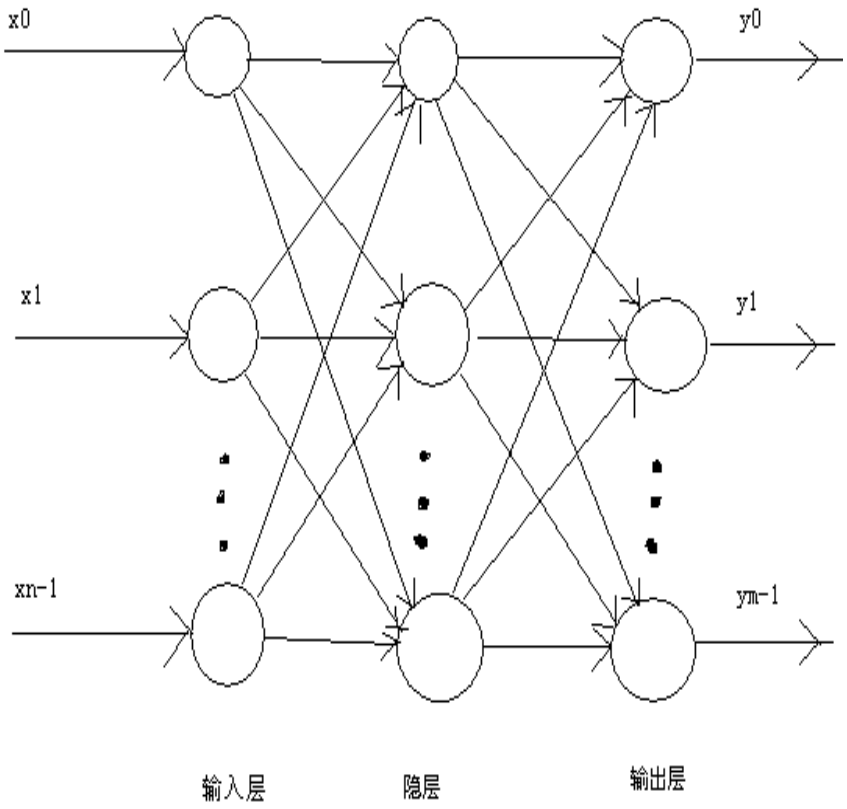

Fig. 1: BP neural network structure

where, ω_i is weights form the input layer to the hidden layer, θ_j for threshold from the input layer to the hidden layer, for each output node

$$y_j = f(u_j) = \frac{1}{1+\exp(-\lambda u_j)} \quad (2)$$

Weight adjustment using the following formula:

$$\omega_{ij}(t+1) = \omega_{ij}(t) - \eta\frac{\partial E}{\partial \omega},\ \eta > 0 \quad (3)$$

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where, ω_{ij} is the iterative weighted matrix of (t+1), ω_{ij} (t) is the weight matrix of the t iterations, E is the error function, $\eta\frac{\partial E}{\partial \omega}$ is the correction amount of the weight value.

The BP neural network structure for cardiovascular disease diagnosis in simulation system is giving in the following.

Design of input layer: The simulation system diagnosis of cardiovascular disease is built by using Matlab BP neural networks which its input layer nodes depends on the dimension of the input vector, that is, the dimension of feature vectors. Disease-related variables are selected in the diagnosis of cardiovascular disease: age x1, symptoms (chest pain, x2, the chest tightness x3, shortness of breath x4, the weakness x5, x6 palpitations, heart murmur x7), check (color ultrasound x8, the radiological examination x9) as input data, data obtained after pretreatment, the result is a 9-dimensional feature vector. Therefore the network input layer nodes is 9.

Design of the hidden layer: Deviations and at least one S-shaped hidden layer and a network of linear input layer, the network can achieve a continuous function of the accuracy of any square error approximation(Cotter, 1990). According to this principle, one hidden layer is enough. In addition, according to the Kolmogorov theorem, if the number of input variables is n, the hidden layer nodes generally can take $\sqrt{n+m}+a$ or n1=log2n (n is the number of input neurons, m is the number of output neurons, a is a constant between 1 to 10). In order to improve the

training precision, using a hidden layer and increaseing neurons get much simpler than increaseing more hidden layers in the network structure.

Specific hidden layer nodes selected in conjunction with the relevant experiment: Change the hidden nodes compare the convergence rate of the network in the same training set, in the case of each hidden layer nodes until the network converges, the test sample input to the network, to observe the recognition rate. After extensive testing, we finally used to identify the hidden layer nodes is 10.

Design of the output layer: BP neural network output layer is only one layer, the number of nodes is determined by the number of the output vector, in this study, diagnosis of cardiovascular disease related to cardiovascular disease coronary heart disease, rheumatic heart disease, congenital heart disease, so output layer nodes take 3.

Choice of transfer function: BP neural network in the diagnosis of cardiovascular disease simulation system transfer function S (sigmoid) type function: f (x) =.

For nonlinear BP neural network system, the initial weights for the great relationship between learning fast convergence as well as the time spent by the training. Initial values generally do not choose too, because it makes the weighted input to fall into the saturated zone of the activation function, usually always want to close to zero after the initial weighted value of the output of each neuron, so you can guarantee the weights of each neuron s-type activation function can change the maximum at mediation. Based on the above considerations, the initial weights of the network settings in [0, 0.2], in which the maximum value does not exceed 0.2; initial threshold is set at [0, 0.3], thus avoiding the initial weights and threshold Ambassador training hard to converge.

EXPERIMENTAL RESULTS

Based on above-mentioned BP neural network model, the diagnosis of cardiovascular disease is simulated by using Matlab experimental study. There are 200 cases of cardiovascular disease being sampled from some hospital which select from this study of cardiovascular disease-related variables age x1 symptoms (chest pain, x2, the chest tightness x3, shortness of breath x4, fatigue x5, palpitations x6, heart murmur x7), examination (color ultrasound x8, the radiological examination x9), output may have coronary heart disease, rheumatic heart disease, congenital heart disease. Therefore, the diagnostic

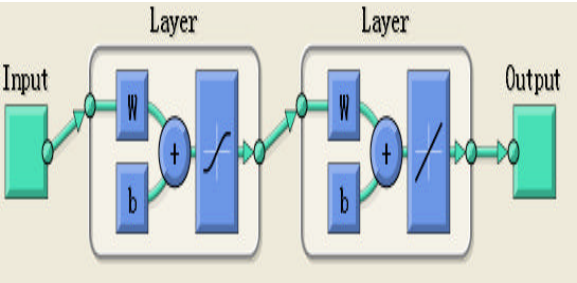

Fig. 2: BP neural network model for cardiovascular disease diagnosis

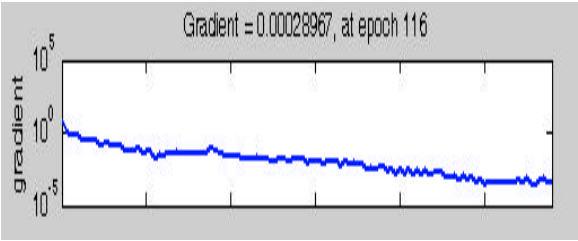

Fig. 3: Training results of cardiovascular disease diagnostic model

process can be seen as some kind of non-linear function of the input variables and diagnostic results, you can establish a BP neural network model based on this. the following Table 13 shows the encoding of cases related data, Fig. 2 shows P neural network model for cardiovascular disease diagnosis:

Table 4 shows the training case data of BP neural network in the diagnosis of cardiovascular disease simulation system, including eight parameter data, they are chest pain, chest tightness, short breath, fatigue, palpitations, heart murmur, color doppler ultrasound and radiographic examination.

Through normalization process of the above-mentioned data, the transformed input and output information can be in the (0, 1) and then use the Matlab BP neural network to start the simulation training.

From Fig. 3, you can see only run 116 times to meet the requirements, in a fast way. Then use the trained network test data of 100 cases for simulation diagnostic, the contrast between experimental results and the experienced doctor's diagnosis, as shown in Table 5.

It is show in Table 5 that cardiovascular disease diagnosis model based on BP neural network diagnostic have the same results with the doctor diagnosed with respect to 96 cases, only 4 cases the results are different which result in the diagnosis coincidence rate being 96%.

Table 1: Main symptoms of cardiovascular disease coding

Chest-distress	Chest-pain	Short-breath	Fatigue	Heart-murmur	Palpitations
1	2	3	4	5	6

Table 2: Examination coding

Color-Doppler(+)	CD-of-Rheumatic-heart(+)	CD-of-Congenital-heart(+)	CD-of-Coronary-heart(+)
1	2	3	4

Table 3: Disease diagnosis coding

Rheumatic-heart-disease	Congenital-heart-disease	Coronary-heart-disease
1	2	3

Table 4: Case data for training

No.	Input output	Chest-pain	Chest-distress	Short-breath	Fatigue	Palpitations	Heart-murmur	CD	RE
1	1	2	3	4	0	0	1	2	1
2	1	0	3	0	0	6	0	2	2
3	0	0	3	0	0	6	0	0	2
4	1	0	3	0	0	0	0	5	2
5	1	2	0	0	0	0	1	0	1
6	0	0	0	0	5	0	3	0	3
.	.	.	.	.	.	.	.	.	.
100	1	2	3	0	0	6	1	0	1

Table 5: Diagnosis result

Disease	Diagnosis-based-on-BP-neural-network-model	Diagnosis-of-cardiovascular doctor
Coronary	Artery disease	44 45
Rheumatic	Heart disease	36 37
Congenital	Heart disease	18 18
Others		2

CONCLUSION

As long as the training sample number of cases is large enough, the sample data is real, reliable and correct, the BP neural network model citied to cardiovascular disease diagnosis simulation system can finish the network structure building. How the training be affected depend on the value of sample. It is because that the value of the non-sample tests can also make a reasonable diagnosis. It is obvious that neural network technology is much helpful for the cardiovascular disease diagnosis. So its clinical application is of great feasible.

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