Application of Fuzzy Neural Network in Diagnosis of Gastrointestinal System Diseases

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Abstract. Objective: Use the fuzzy neural network (FNN) model to diagnose four kinds of digestive tract diseases. Methods: 70 cases were randomly selected from 100 cases of gastrointestinal system diseases as training set, with 15 cases as a verification set and 15 cases as a test set. First, the FNN is trained, and then the trained FNN is used to test the validation set and test set. Results: The accuracy rate of FNN in diagnosing gastrointestinal system diseases was more than 95.2%. Conclusion: FNN model can be used for clinical diagnosis.

Introduction

Fuzzy logic and artificial neural networks are the current research hotspots, and they have their own characteristics. Fuzzy information processing is based on fuzzy logic, to grasp the ambiguity of human thinking characteristics and mimic the fuzzy comprehensive judgment reasoning to solve the problem of fuzzy information processing that is difficult to deal with the conventional methods. Artificial neural network is a biological neural network as a simulation object, trying to simulate reasoning, self-learning and other aspects to develop forward, so that artificial intelligence become closer to the human brain self-organization and parallel processing and other functions. Fuzzy neural network (FNN) is a combination of fuzzy logic reasoning and artificial neural network. It uses the error signal to propagate backwards, adjust the weight, which has a good adaptability, self-organization and strong self-learning ability. It is a powerful tool for data classification and pattern recognition. At present, fuzzy neural network is widely used in the diagnosis of clinical diseases[1-4]. There are many similar symptoms and signs in acute pancreatitis, cholecystitis (cholelithiasis), acute gastroenteritis and other diseases of the digestive tract system, which is very likely to cause misdiagnosis. In order to be able to accurately diagnose these diseases, In this paper, the diagnostic techniques of acute pancreatitis, cholecystitis (cholelithiasis), acute gastroenteritis and other diseases in the digestive tract system are introduced into the fuzzy neural network, and the fuzzy neural network is used to diagnose.

Materials and methods

Materials.

Various test results of 100 cases of gastrointestinal system diseases from Nanchang University Fourth Affiliated Hospital from January 2014 to October 2015 are collected. There are 30 cases of gallstones accompanied by cholecystitis, 10 cases of acute cholecystitis, 32 cases of acute gastroenteritis, and 28 cases of acute pancreatitis in 100 cases, therefore the diagnosis results were confirmed by pathological examination.

Methods.

First, extract 39 test data of cholecystitis patients, acute cholecystitis patients, acute gastroenteritis patients, acute pancreatitis patients including blood analysis and biochemical screening, and 7 clinical symptoms for the first layer of input vector. Seven clinical symptoms were assigned by using the logarithmic function of the "semi-trapezoidal" structure of fuzzy

mathematics:

$$y_{ji}=\begin{cases}\dfrac{x_k(i)}{\lambda_j^{(1)}(i)}, & x_k(i)\le\lambda_j^{(1)}(i)\\ 1, & \lambda_j^{(1)}(i)<x_k(i)<\lambda_j^{(2)}(i)\\ \dfrac{\lambda_m^{(2)}(i)-x_k(i)}{\lambda_m^{(2)}(i)-\lambda_j^{(1)}(i)}, & x_k(i)>\lambda_j^{(2)}(i)\end{cases}\quad j=2,3,\cdots m-1$$

Among them, y_{ji} is the membership function of the i-th object to the jth class, and its domain is $[0,\lambda_m^{(2)}(i)]$.

Secondly, a fuzzy neural network model is established. The network model consists of three layers of forward BP neural network. The first layer is the data pretreatment layer, with the 46 eigenvalues of the patients extracted and then blurred; the second layer is the hidden layer, the third layer is the output layer which is the four diseases of the digestive tract system. Its structure is as shown below (Fig.1):

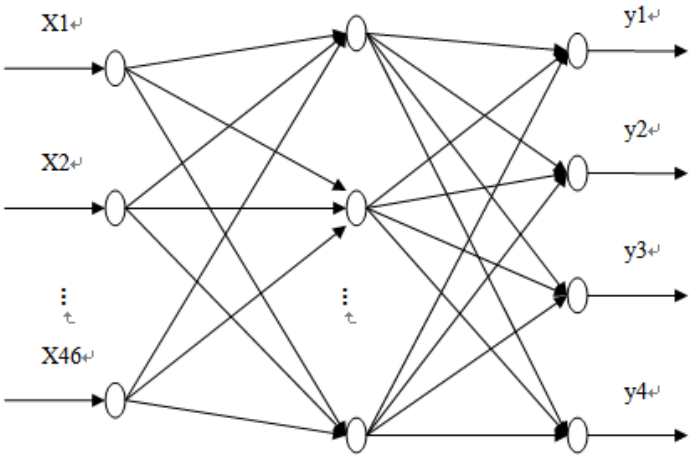

Fig.1 BP network diagram

Finally, network training is carried out 70 cases (21 cases of gallstones accompanied by cholecystitis, 6 cases of acute cholecystitis, 23 cases of acute gastroenteritis and 20 cases of acute pancreatitis) were randomly selected from all the samples were used as training group and 15 cases (6 cases of gallstones accompanied by cholecystitis, 3 cases of acute cholecystitis, 2cases of acute gastroenteritis and 4 cases of acute pancreatitis) as verification group, 15 cases (3 cases of gallstones accompanied by cholecystitis, 1 cases of acute cholecystitis, 7 cases of acute gastroenteritis and 4 cases of acute pancreatitis) as the test group. Programmed by MATLAB 2012a, FNN is trained, and after being trained FNN is used for verification and testing. The training function of the network is “trainlm”, the learning function is “learngdm”, the error performance function is “mse”, the transfer function of each layer is “logsig”, and the training frequency is set to 1000. See Figure 2

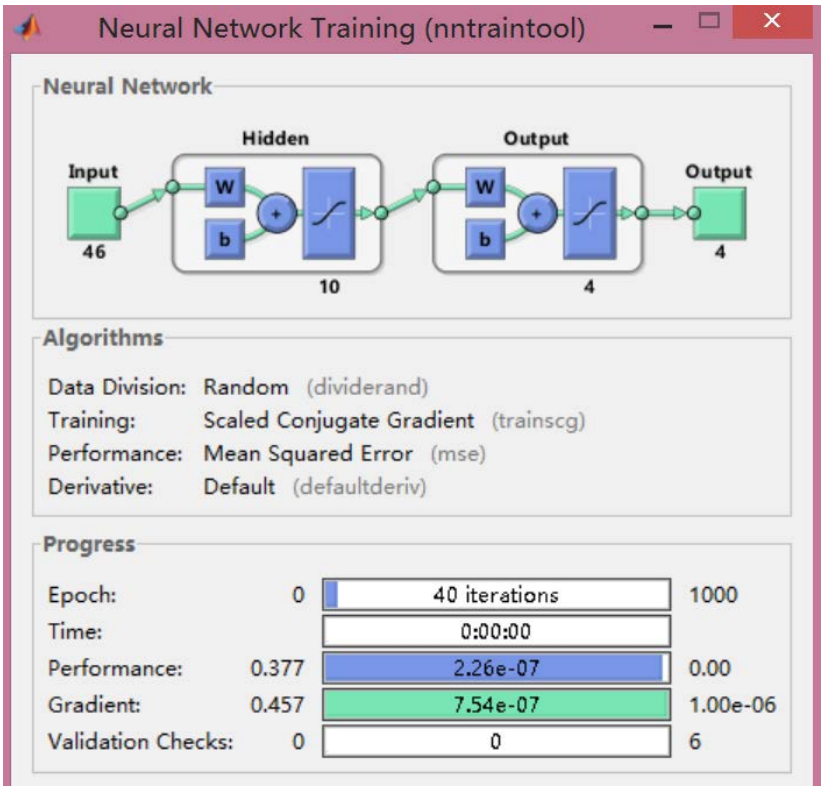

Fig. 2 Neural network training chart

Results

Through the training, verification and testing of neural networks, the training, verification and testing errors are minimized at the time of training. The verification error is slightly larger, but only 2.99, see Fig.3:

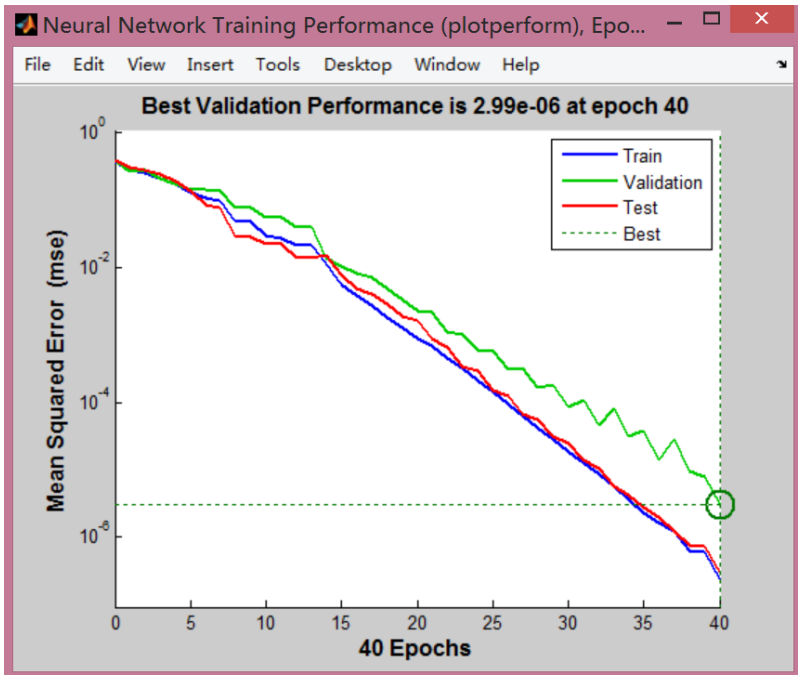

Fig.3 Neural network training error

It can be seen from Fig.3 that the fuzzy neural network (FNN) has a faster convergence rate, and only after 40 trainings, the training error, verification error, test error are the smallest, so that the simulation diagnostic test accuracy rate can be greatly improved.

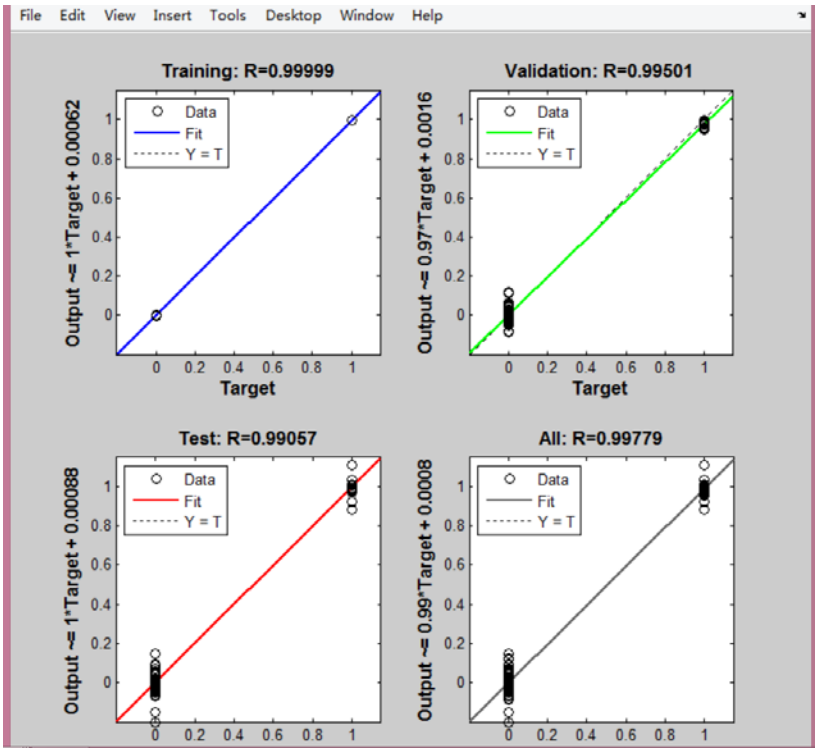

Fig.4 Regression coefficient R value of fuzzy neural network simulation

It can be seen in Figure 4, training, validation, and testing results of the R values were 0.99999, 0.99501, 0.99057, three of the total R value is 0.99779, the regression effect is very good, the error simulation of neural network system is also very small, can effectively simulate the diagnostic test.

In order to understand the effect of clinical diagnosis of fuzzy neural network, the results from the training group, validation group and test group are contrasted. The contrasting results are shown in Table 1 (Notes: number of diagnostics(ND); actual number (AN); percentage of brackets for diagnostic accuracy).

Table 1: training, validation, test results

Disease Type	Training Group		Verification Group		Test Group	
	ND	AN	ND	AN	ND	AN
Gallstones with cholecystitis	20 (95. 2%)	21	6 (100%)	6	3 (100%)	3
Acute cholecystitis	6 (100%)	6	3 (100%)	3	1 (100%)	1
Acute gastroenteritis	23 (100%)	23	2 (100%)	2	7 (100%)	7
Acute pancreatitis	20 (100%)	20	4 (100%)	4	4 (100%)	4

It can be seen from Table 1 that the fuzzy neural network (FNN) has a good ability to identify, with an accuracy rate of 95.2% in the disease diagnosis of training group, and with an accuracy rate of 100% in the disease diagnosis of validation group and test group.

Discussion

In clinical work, most doctors diagnose and treat patients based on some clinical data such as symptoms, signs and test results, and clinical experience conclusion, but the special and opposite cases abound, the sources of information are incomplete and borrowed, and uncertainty information is often encountered. So the value of those information should be taken carefully into consideration, which should be seen only a secondary consideration. In addition, doctor's advices are sometimes inconsistent, which often result in conflicting or irrational decision. The traditional method of diagnosis is not ideal, although the development and application of expert system has made great progress, but there are some bottleneck problem in achieving similar to the human brain to learn and associate. While FNN's self-learning and associative memory, highly parallel and fault-tolerant function can break through the barriers and make a reasonable judgment according to the existing

knowledge and experience. FNN is suitable for the diagnosis of diseases in the medical field, and there have been many successful examples at home and abroad [5-9]. FNN has many advantages, such as self-learning, adaptive and nonlinear processing, which can make the disease diagnosis operation intelligent and have high reliability. But there are still some problems to be solved in the application. The complexity of disease diagnosis provides a fertile land for the further development of FNN, and the advantages and characteristics of FNN will make it an effective tool for disease diagnosis and prediction in medicine. Therefore, the fuzzy neural network technology is introduced to the medical diagnosis. Based on the analysis of historical cases, establishing a neural network system with good structure to assist the doctor's diagnosis, can greatly improve the accuracy and reliability of diagnosis. But the identification ability of the fuzzy neural network system is limited. Firstly the sample neural network training should be as much as possible to include a variety of typical cases and a large number of symptoms, and only in this way, the neural network can greatly improve the recognition ability of the system; secondly when the samples of the case are accompanied with a variety of diseases at the same time and symptoms are diversified, the fuzzy neural network can't identify cases, so we should treat it rationally. It can only be used as a diagnostic tool in clinical practice, and can't completely replace the role of the doctor.

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