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Data Mining in Medical Quality Supervision Based on Improved BP Neural Network

Zhentian Liu

School of Economics and Management, Fuzhou University, Fuzhou 350002, Fujian, China

Abstract
The current data mining is confronted with many problems in its application in medical quality and safety monitoring based on traditional BP neural network. This paper is aimed at proposing a scheme based on improved BP neural network while providing an analysis of issues concerning data mining based on improved BP neural network in medical quality supervision. For medical quality supervision, the use of improves BP neural network mining, not only improves the level of medical treatment regulation, resulting in medical claims expenses decreased by 8% and infectious disease infection rate decreased by 12%, but exerts positive effects in application as well. In general, in medical quality supervision, the application data mining based on improved BP neural network plays a positive role in two aspects: on the one hand, it can effectively dig out useful data and information; on the other hand, it can guarantee the quality of medical quality supervision.
Keywords: MEDICAL QUALITY SUPERVISION, IMPROVED BP NEURAL NETWORK, DATA MINING

1. Introduction

Foreign research on medical quality supervision has attracted the devotion of many experts since the US Association for Computing Machinery (ACM) proposed the concept of data mining in 1995 [1]. However, data mining has occupies an important position in medical supervision since Knowledge Discovery and in Database (KDD) was first proposed in the 11th International Joint Conference on Artificial Intelligence in 1989, no more than ten years before ACM's proposition.

Along with the development of hospital information technology, the information management platform based on cloud computing and big data has been built in China recently. Thus, domestic research focuses on issues as how to enable hospital information construction to keep pace with social development and to meet the needs of information technology services in the medical quality supervision in the future hospital development.

However, current research is still insufficient in some aspects. Firstly, there is massive unstructured data in the medical industry, which poses a new challenge to data mining in medical supervision. But in practice, as long as conventional BP network is used, hospital information data processing level cannot be effectively improved, nor can medical service data be effectively integrated. These problems have led to poor hospital management [2]. Firstly, in terms of big medical data inside current hospitals, there are no standards and norms for defining relevant information system terms and statistical calibers. Secondly, important information within medical data, sometimes left unused and scattered, is mainly stored in the business system of each hospital. Therefore, it is hard to carry out statistical analysis and cross-system utilization, let along all the incomprehensive information content. This situation hinders a comprehensive display of information within one system for management, as it is not conducive to enhance the level of medical industry upgrading and reducing the level of medical quality supervision.

With a view to the above shortages, the improved scheme has the following advantages. Firstly, in medical quality supervision, the scheme using improved BP neural network to carry out data mining can effectively cope with problems concerning medical quality supervision. Secondly, it suggests an effective mining analysis method, an accurate description of medical quality monitoring indicators, thus effectively avoiding the influence of network vulnerabilities and virus invasion upon medical quality supervision. Thirdly, the application of improved BP neural network features the use of scientific information-based management, which can ensure the safety of medical quality monitoring and mining, improve the speed of mining based on the analysis of clinical trial data and helps to improve the accuracy of medical quality supervision and mining.

2. Medical data mining

In the medical industry, there has been a big data tendency emerging in medical data mining. Data mining in medical services is to rapidly collect valuable information among data of various types in all kinds of hospitals. This capability can not only turn massive internal original medical data of the hospitals into wealth, but also reutilize the medical information of them [3]. Medical data mining not only involves data of outpatient registration, inpatients, medicine-taking of patients, testing and inspection but also includes medical records of patients, etc. In medical data mining, the scheme based on improved BP neural network can build a model of big data mining system centered on Internet so as both to provide customers with safe, fast and convenient data storage and network computing services and to fully excavate useful data in medical quality supervision [4].

3. Basic algorithm

3.1. Principle of BP neural network

At the beginning, the forming of BP neural network is based on the forms of information processing in human brain. Then, after mathematical model matching, the network is configured for the study of the structure and activities of brain cells and the characteristics of human biological neurons. Later, along with the development of computer technology, based on the neural network model, not only the learning mechanism of neural network has been added, but also a sensor model based on neural network has been put forward, which is applied in engineering construction. Then, the self-organizing mapping network model comes into being that uses the topological properties of mapping and its simulation is carried out in computers.

3.2. BP neural network algorithm

Neural network classification learning employs the back propagating algorithm. In BP neural network, the training samples (labeled as samples) are inputted; the learning rate is set as 1 and the multilayer feedforward neural network as network. At the same time, a BP neural network of training and sample classification can be outputted for data mining. The specific algorithm codes are shown below:

```
------
While terminating unsatisfied conditions {
In samples for each training sample X {
```

// forward propagating input here
In hidden layer and output layer for each unit j {
$I_j = \sum_i W_{ij} O_i + B_j$; //Meanwhile, for i in the previous layer, calculate the net input value of unit j
$O_j = 1 / (1 + e - I_j)$; } // and calculate the input of each unit j
// in back propagating error
for each unit j in output layer
$Err_j = O_j (1- O_j)(T_j- O_j)$; // calculate error
for each unit j from the last to the first hidden layer
$Errj = O_i (1- O_j) \sum kErr_k W_j k$;
In network for each weight Wi j{
$\Delta W_{ij} = (1) E_{rrj} O_j$;
$W_{ij} = W_{ij} + \Delta W_{ij}$;} //
In network for each weight B_j{
$\Delta B_j = (1) E_{rrj}$; //bias increment
$B_j = B_j + \Delta B_j$; } ///bias update
}}
---

4. Data mining based on improved BP neural network algorithm

4.1 Defining BP network structure

In preparation for data mining for medical quality supervision in a hospital, its current index system of risk prediction should be analyzed in terms of eight risk factor indexes (X1-X8). These evaluating indicators can be taken as input nodes in the BP neural network with n=8. Detailed description is shown in Table 1 below:

Table 1. Supervision risk evaluation indexes

Variable	Risk factor	Risk score	Description
x1	Severity of illness	5	Physical condition of patient at admission
x2	Patient status	5	Current physical condition of patient
x3	Surgery and treatment	10	Surgical grade or drug administration
x4	Nursing quality	7	Nursing quality rating
x5	Patient awareness	3	Whether patient has been inform of relevant information adequately
x6	Implant cases	3	Whether relevant implants have a quality problem
x7	Nature of patient	3	With(out) health care, with(out) reimbursement of expenses
x8	With(out) complications	5	With(out) complications, with(out) severe impact

4.2 BP network learning algorithm

The mining learning process of medical supervision in BP neural network is as follows:

Firstly, initialize weight and learning parameters, and input forward propagation:

$$I_j = \sum_i W_{ij} O_i + B_j \quad (1)$$

Backward propagation error:

$$E_{rrj} = O_j(1 - O_j)(T_j - O_j) \quad (2)$$

Error of unit j in the hidden layer:

$$E_{rrj} = O_j(1 - O_j) \sum_k E_{rrk} W_{jk} \quad (3)$$

Weight and bias are renewed via the following formulas:

$$\Delta W_{ij} = (1) E_{rrj} O_j \quad (4)$$

$$W_{ij} = W_{ij} + \Delta W_{ij} \quad (5)$$

$$\Delta B_j = (1) E_{rrj} \quad (6)$$

$$B_j = B_j + \Delta B_j \quad (7)$$

Set weight coefficient of data mining neural network W_{ij} to its initial value and in the neural network set $W_{i,n+1} = -\theta$.

Input a sample of data mining neural network $X = (X_1, X_2, \dots, X_n, 1)$ and get the output $Y = (Y_1, Y_2, \dots, Y_n)$ in terms of its corresponding expectation.

In the light of neuron i at layer k in the network, when its output reaches X_{ik}, the corresponding formula will be:

$$U_i^k = \sum_{j=1}^{n+1} W_{ij} X_j^{k-1} \quad (8)$$

$$X_{n+1}^{k-1} = 1, W_{i,n+1} = -\theta \quad (9)$$

$$X_i^k = f(U_i^k) \quad (10)$$

For the output layer, learning error is calculated as:

$$d_i^m = X_i^m (1 - X_i^m)(X_i^m - Y_i) \quad (11)$$

For the hidden layer, only that of the winning neuron is calculated, for example, if i is the winning neuron, as below:

$$d_i^k = X_i^k(1 - X_i^k)\sum_l W_{li} d_i^{k+1} \quad (12)$$

Revise local weight coefficient W_{ij} and threshold θ.

Adjust the neural network, and the weight and threshold of the arc connecting to the winning neuron by:

$$W_{ij}(t+1) = W_{ij}(t) - \eta d_i^k \cdot X_j^{k-1} + \alpha \Delta W_{ij}(t) \quad (13)$$

where in

$$\Delta W_{ij}(t+1) = -\eta d_i^k \cdot X_j^{k-1} + \alpha \Delta W_{ij}(t). \quad (14)$$

When the weight coefficient of each layer in the data mining neural network is obtained, it can be given quality indicators to determine whether the medical quality meets the requirements of current medical safety supervision. If the requirements have been met, the BP neural network algorithm can be terminated. Otherwise, recalculations have to be performed.

4.3. Establishing BP network model

In medical quality supervision, BP neural network is employed to carry out iterative mining data till the training stops. After the first sample data is trained by BP neural network, the second sample can be selec- ted and trained, and the above steps can be repeated till the end of all sample data training. At this point, the BP neural network prediction model can be established according to permissible error for medical quality supervision to be carried out. The model is shown in Table 2.

Table2. Establishing BP neural network Model

Ordinal	Network training value	Actual evaluation value	Rank
1	0.821	0.8	good
2	0.392	0.4	excellent
3	0.496	0.5	excellent
4	0.866	0.9	excellent
5	0.441	0.4	pass
6	0.311	0.3	good
7	0.805	0.8	excellent
8	0.693	0.7	excellent
9	0.611	0.6	good
10	0.715	0.7	good
…	…	…	…

In terms of the network model above, we can establish an improved three layer BP neural network, and equip it with 8 neurons at the input layer, 5 at the hidden layer and 1 at the output layer. When the learning rate reaches the standard level of 1, the mining target error is only 0.001 by adopting BP neural network technology. For medical quality supervision, clinical data of patients at hospital can be mined for quality supervision. After BP neural network training and learning, we can effectively avoid too large difference of risk factor value and achieve high accuracy in data mining for medical quality supervision. Experiments show that claims expenses have decreased by 12% and infection rate decreased by 8%. Therefore, it can be safely concluded that data mining based on improved BP neural network plays a positive role and has better application value in medical quality supervision.

5. Analysis with data mining in medical quality and safety monitoring

5.1. Data feature analysis

Firstly, the improved scheme enables management staff to be aware of data complexity in current hospital information management. By optimizing the integration of big data information in medical supervision and carrying out data mining and analysis of medical quality supervision, it deeply improves the accuracy of mining structure [5]. Secondly, it realizes information storage and updating of medical monitoring data, from which it is able to excavate useful information for the improvement of logical connection between medical quality supervision and management information. Thirdly, it can fully integrate the use of medical quality supervision resources [6-8] and enable the entities in database to form data stream through inte- raction, thus improving the secondary utilization efficiency of medical data, realizing cooperative work and resource sharing. Therefore, it can be said to have advantages in both efficiency and safety.

5.2. Classification of inpatient death

By adopting the improved scheme in carrying out inpatient death data mining, it has been found that three categories of inpatients are easy to die. The first category is patients in hospital with infectious diseases. The death proportion reaches 12% of those who are infected with infectious diseases that extremely

easily lead to death. The second one is patients undergoing major surgery. Patients in need for surgical treatment for, such as intracranial injury, cardiac surgery and ectopic pregnancy account for 6.0% of dead cases, due to surgical trauma and physical factors that reduce the quality of their life, even resulting in their death in hospital. The third one is those inpatients who suffer from machine cutting injury, accidental injury, puncture wounds, traffic accident injury, etc. Their clinical death ratio reaches 4.0%. For clinical practice, after medical quality mining based on improved BP neural network, we can find out the factors that affect the safety of patients. It can reduce the burden caused by the death of patients and improve the quality of medical supervision.

5.3. Decision support for medical quality improvement

The improved scheme can provide excavation analysis in terms of risk factors in medical treatment, and predict the factors that affect medical quality [9]. Real-time and accurate monitoring over medical data can also help to get a well detailed understanding of the service and load condition of big data resources and to carry out real-time monitoring over hospital information resources. At the same time, it can provide medical subsystems with performance information service and improve the accuracy of system resource allocation. The introduction of improved BP neural network, which is based on a number of indicators in medical management, can excavate and analyze massive information in medical quality supervision, so as to provide a reference value for data mining of modern medical institutions. Meanwhile, in medical quality supervision, the application based on improved BP neural network can not only monitor and configure each resource server by periodically feeding back the service condition of resources to the data warehouse [10], tracking its availability, ruling out problem of resources, carrying out balanced allocation of information resources provided by the system and effectively monitoring the change of medical data, but also provide decision support for medical quality improvement. In a word, it improves the quality of hospital management.

6. Conclusions

In summary, it is feasible to apply the technology based on improved BP neural network in medical quality supervision. The improved scheme can not only effectively avoid the drawbacks of traditional medical quality supervision, but also introduce the neural network technology, which can be used to optimize the neural network, so as to ensure the accuracy and objectivity of the results of medical quality supervision. In general, it plays with a positive application value in actual performance.

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