Applied Research of Fuzzy Neural Network Algorithm in Teaching Evaluation

Chunyi Lou, Liang Lu, Ying Shi & Yan Ding
Department of Foreign Languages, Qinghuangdao Institute of Technology, Qinhuangdao, Hebei, China

ABSTRACT: In order to improve the teaching level of the current colleges and universities in China, and establish the international first-class schools, various education classes carry out the college teaching quality assessment. In view of the limitations and progressiveness of the teaching quality assessment in the neural networks, this paper with a plenty of fuzzy information proposes a fuzzy neural network model, and organically combines self-adaption, recognition with fuzzy information processing, and carries out verification by the use of simulating calculation methods. Finally, the authors through this paper obtains that the fuzzy neural network has a better evaluation, and proves the scientificity, simplicity and operability of the method, thus achieving that the model has a broad application prospect.

Keywords: teaching evaluation; fuzzy neural network; college

1 INTRODUCTION

With the rapid development of China’s education, the primary education and higher education present an upward trend, the number of people enrolled increases year by year, and the teaching scale increases constantly, thus providing a broader development space for the development of the school. Meanwhile, it brings a lot of problems, of which the teaching quality assessment currently becomes a major problem. The teaching quality directly determines the future development of the students. Therefore, in terms of the teaching ethics or China’s long-term interests in the future, the reasonable and effective education assessment has an important significance on the improvement of the teaching level and teaching quality.

Due to many factors in the teaching evaluation and many subjective factors in the evaluation, a lot of teaching evaluations have major one-sidedness. Therefore, in order to reduce unreasonable assessment, some scholars carry out the research. For example, Wang Zhengwu applied the neural network to the classroom teaching quality evaluation. This method lays a foundation to the development of the neural network in the teaching evaluation in terms of the idea and technology. However, considering the limitations of the neural network, this paper proposes a fuzzy neural network model according to the characteristics of the teaching assessment, and applies the documentary method and mathematical statistical method for data analysis and processing, and finally carries out verification.

2 FUZZY NEURAL NETWORK SYSTEM

The fuzzy system is a theory based on the fuzzy set, which mainly handles complex problems, such as fuzzy control, fuzzy reasoning, fuzzy recognition and fuzzy measurement and so on. In the traditional theory, the characteristic function can only take two values, 0 and 1. The fuzzy set adopts the concept of membership function, and its characteristic function is extended to [0, 1].

Fuzzy set: assuming that $A : U \rightarrow [0,1], U \in U(x)$ is a universal set $(U)$, a fuzzy set is $U$, and $U(x)$ is $A$, the membership function of $U(x)$ reflects the membership of $x$ in the fuzzy set.

The fuzzy system has the capability on the information expression and the analysis and processing, which is fuzziness based on the precise description of the mathematical linguistics. The basic calculation unit of the neural network is an artificial neuron, which simulates the structure and function of the cerebral neurons, with a strong self-learning ability. It finally puts forward the specific structure network of
2.1 Data mining of fuzzy neural network

For multi-attribute database, the attribute of each database is a continuous variable. If you want to extract the attribute of relations between rules n and other attributes, the input number (n) can be expressed as \(x_1, x_2, \cdots, x_n\), and the corresponding output \(x_1, x_2, \cdots, x_n, \cdots, x_m\) can be expressed as \(y_1, y_2, \cdots, y_m\). In this type of problem, by the use of membership functions, they can be converted to fuzzy input and fuzzy output of the corresponding membership values. These are used as a training sample, and the following forms may be obtained:

If \((x_i, \theta_{i1}, \cdots, x_i, \theta_{in})\) \((x_j, \theta_{j1}, \cdots, x_j, \theta_{jm})\) \((y_i, \theta_{i1}, \cdots, y_i, \theta_{in})\), \((y_j, \theta_{j1}, \cdots, y_j, \theta_{jm})\) and \(\theta(=, <, >, \leq, \geq, \#)\) are symbolic relations, \(\nu_i\) and \(\zeta_i\) are fuzzy attributes (which are big, medium, small and so on).

The steps extracted by the use of the fuzzy neural network system are as follows:

2.2 Standardization of sample data

The processing of data standardization refers to pre-processing of sample data. The eigenvalue is mapped to the region \([0, 1]\), and the main fuzzy steps are as follows:

First, there is a need to determine the evaluated object. It affects the variables by \(y\) factors, and its factor set is \(\alpha\), then the first-grade evaluation indicator is defined as:

\[\alpha = (\alpha_1, \alpha_2, \cdots, \alpha_n)\]  
(1)

So the corresponding second-grade evaluation indicator is:

\[\{\alpha_1, \alpha_2, \cdots, \alpha_n\}\]  
(2)

The third-grade evaluation indicator is:

\[\{\alpha_1^1, \alpha_2^2, \alpha_3^3, \cdots, \alpha_n^n\}\]  
(3)

And specify that, \(\alpha_i^j, (j = 1, 2, 3, \cdots, y, n = 1, 2, 3, \cdots, m)\)

The weight of each variable is different, so the degree of impact is different for the determined evaluation level. We assume that its evaluation set is:

\[b_i = (b_{i1}, b_{i2}, b_{i3}, \cdots, b_{in})\]  
(4)

Where: \(b_i (i = 1, 2, 3, \cdots, y)\)

For the weight value in the above formula, based on common sense, we know that \(b_i \geq 0\), and:

\[\sum_{i=1}^{y} b_i = 1\]

If each factor \(b_i\) contains \(n\) sub-factors, its factor set is:

\[\alpha_i = (\alpha_{i1}, \alpha_{i2}, \cdots, \alpha_{in})\]  
(5)

The corresponding weight value is:

\[b_i = (b_{i1}, b_{i2}, b_{i3}, \cdots, b_{in})\]  
(6)

For the weight value \(b_i\) of \(\alpha_{ij}\), based on common sense, we know that \(b_{ij} \geq 0\), and:

\[\sum_{j=1}^{n} b_{ij} = 1\]  
(7)

According to the above formula, the first-grade weight is 100%, and the second-grade weight is:

\[b_j = (b^1_j, b^2_j, b^3_j, \cdots, b^n_j)\]  
(8)

The corresponding third-grade weight set is:

\[b_i = (b^1_i, b^2_i, b^3_i, b^4_i, b^5_i)\]  
(9)

Assuming that the vector set of the evaluation membership is:

\[g^j = \{g^j_1, g^j_2, g^j_3, g^j_4, g^j_5\}\]  
(10)

Then the corresponding membership matrix is:

\[
\begin{pmatrix}
g^1 & g^{11} & g^{12} & g^{13} & g^{14} & g^{15} \\
g^2 & g^{21} & g^{22} & g^{23} & g^{24} & g^{25} \\
g^3 & g^{31} & g^{32} & g^{33} & g^{34} & g^{35} \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
g^n & g^{n1} & g^{n2} & g^{n3} & g^{n4} & g^{n5}
\end{pmatrix}
\]  
(11)
After integration of the above process, the first-grade evaluation result is:

\[ g^n = H^n \cdot (g^n j1, g^n j2, g^n j3, g^n j4, g^n j5) \]

Then the second-grade evaluation result is:

\[ g = H \cdot (g^1, g^2, g^3, \ldots, g^n) \]

The above process is normalized.

Assuming that \( f \) samples, \( x_1, x_2, \ldots, x_f \), each sample \( x_i \) has \( n \) sample indicators, \( z_1, z_2, \ldots, z_n \), \( x_{ij} \) refers to the quantity sample \( i \) of the quantity indicator \( j \), and then the sample indicator \( n \) of the sample \( f \) is shown in Table 1:

<table>
<thead>
<tr>
<th>Factor</th>
<th>( z_1 )</th>
<th>( z_2 )</th>
<th>( \cdots )</th>
<th>( z_n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_1 )</td>
<td>( x_{11} )</td>
<td>( x_{12} )</td>
<td>( \cdots )</td>
<td>( x_{1n} )</td>
</tr>
<tr>
<td>( x_2 )</td>
<td>( x_{21} )</td>
<td>( x_{22} )</td>
<td>( \cdots )</td>
<td>( x_{2n} )</td>
</tr>
<tr>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \vdots )</td>
<td>( \cdots )</td>
<td>( \vdots )</td>
</tr>
<tr>
<td>( x_f )</td>
<td>( x_{f1} )</td>
<td>( x_{f2} )</td>
<td>( \cdots )</td>
<td>( x_{fn} )</td>
</tr>
</tbody>
</table>

The average value and standard derivation of the quantity indicator \( j \) of the sample \( f \):

\[ x_j = \frac{1}{f} \sum_{i=1}^{f} x_{ij} \]  
(12)

\[ s_j = \sqrt{\frac{1}{f} \sum_{i=1}^{f} (x_{ij} - x_j)^2} \]  
(13)

Standardization of raw data is:

\[ x_{ij}^* = (x_{ij} - x_j) / s_j \]  
(14)

The data in the compression specification \([0, 1]\) uses the extreme value standardization formula, namely:

\[ x_{ij} = \frac{x_{ij} - x_{ij}^{\min}}{x_{ij}^{\max} - x_{ij}^{\min}} \]  
(15)

In this formula, \( x_{ij}^{\min}, x_{ij}^{\max}, \ldots, x_{ij} \) are between the minimum value \( x_{ij}^{\min} \) and maximum value \( x_{ij}^{\max} \), \( x_{ij} \) is a standardized indicator.

2.3 Structure of fuzzy neural network

The structure of fuzzy neural network is shown in the following diagram. The first layer is an input layer, which can put the input value into the next layer, and the number of nodes at this layer is \( n \). The second layer is a membership function layer, the member education of each input element can calculate the membership function of the corresponding fuzzy set of linguistic variables at this layer, and each node represents a linguistic variable value. The third layer is the matching of fuzzy rules, which calculates the extent of application of each rule, and the number of nodes at this layer is \( m \). The third and fourth layers are fully connected, the data at the third layer achieves standardization at the fourth layer, and the number of nodes at this layer is \( m \). The fifth layer is an output layer; the output data at this layer can be determined by output of fuzzy linguistic variables through weighting coefficients and membership functions.

To input data, the membership function is selected as the normal distribution function:

\[ u_{ij}(x) = e^{-\frac{(x-x_j)^2}{2\sigma_j^2}} \]  
(16)

![Figure 2. Fuzzy neural network structure.](image)

\( i = 1, 2, \ldots, n \), \( n \) is a dimension of the input variables. \( j = 1, 2, \ldots, m \), \( m \) is a division of fuzzy classification. \( x_{ij} \) and \( \sigma_{ij} \) are respectively the center and the width of the membership function, that is, to respectively convert the input value into linguistic variables (which are big, medium and small and so on) at the second layer.

The first layer is an input layer, \( x = (x_1, x_2, \cdots, x_n) \) can be transformed into the next layer.

The second layer can calculate a fuzzy set under the jurisdiction of the input value of the membership function \( \mu_{ij} \).

Each node at the \( e \) layer represents a fuzzy rule. The application program can calculate the degree of each rule, which is minimized calculation:

\[ \alpha_j = \min\{\mu_{ij}, \mu_{j2}, \cdots, \mu_{jm}\}, j = 1, 2, \cdots, m \]  
(17)

Normalization calculation is achieved at the \( d \) layer:
\[ \alpha_j = \frac{1}{\sum_{j=1}^{m} \alpha_j}, \quad j = 1, 2, \ldots, m \]  \hspace{1cm} (18)

Clarity calculation is achieved at the e layer:
\[ y_e = \sum_{j=1}^{m} \omega_{ij} \pi_j, \quad i = 1, 2, \ldots, r \]  \hspace{1cm} (19)

The output data can be transformed into fuzzy linguistic variables through the membership function. Between the fourth layer and the fifth layer, \( \omega_{ij} \) is the membership of the fourth layer \( \pi_j \) and the fifth layer \( y_e \).

2.4 Network learning

The learning process of the fuzzy neural network is a multi-variable optimization process. For the parameters of the fuzzy neural network, there is a need to learn the central value \( c_{ij} \) and the width \( \sigma_{ij} \) of the connection weight \( \omega_{ij} \) at the fifth layer and the fuzzy membership function.

The error function of the system is:
\[ E = \frac{1}{2} \sum_{i=1}^{r} (Y_i - y_i)^2 \]  \hspace{1cm} (20)

\( Y_i \) and \( y_i \) are respectively the expected output and actual output, of which \( r \) is the number of output.

The nature of the calculation from the input layer to the output layer is a multilayer feed-forward back-propagation network. It can be designed through the error back propagation method, the simulation of BP neural network and the adjustment of \( \omega_{ij} \), \( c_{ij} \) and \( \sigma_{ij} \).

For each sample data, the first step is to calculate each input node before the output value of each node, and then use the back propagation algorithm from the output node to calculate the partial derivatives of all hidden nodes.

Use the optimization and adjustment algorithm at the first step, and finally learn the algorithm parameter adjustment, thus we can obtain:
\[ \omega_{ij}(k+1) = \omega_{ij}(k) - \beta \frac{\partial E}{\partial \omega_{ij}} \]  \hspace{1cm} (21)
\[ x_{ij}(k+1) = x_{ij}(k) - \beta \frac{\partial E}{\partial c_{ij}} \]  \hspace{1cm} (22)
\[ \sigma_{ij}(k+1) = \sigma_{ij}(k) - \beta \frac{\partial E}{\partial \sigma_{ij}} \]  \hspace{1cm} (23)

\( \beta > 0 \) is the learning rate.

When the system error reaches the given minimum error range and after the finish of learning fuzzy neural network, the data mining can be used.

2.5 Rules selection

After the success of the network training, there is a need to summarize the required fuzzy neural network with fuzzy rules. According to the membership function values of the value output of the center, and the transformation output values of the membership function of the fuzzy language values, fuzzy language values and the maximum membership degree, they are selected as the output values. If \( (x_1 = \nu_1), \quad (x_2 = \nu_2), \ldots \) and \( (x_n = \nu_n) \), and then \( (y = \zeta) \), the rule extraction can be calculated.

If the input variables are converted into fuzzy linguistic variables, the rules of \( f = m \times n \) can be extracted from \( n \) input, and the same rules are deleted, there are also \( nn - m \) rules. However, we are not interested in \( mn - h \) rules. In other words, these rules are not always meaningful. We need to find redundant rules, and extract interesting rules. Through setting up a threshold \( \lambda \) rule, we need practical significance.

\[ \lambda_k = \frac{n}{N}, \quad k = 1, 2, \ldots, mn - h \]  \hspace{1cm} (24)

The rules which are less than a threshold can be used as redundant rules. Therefore, the interesting rules and the rules with practical significance can select a large number of rules. The values can be different according to different needs. Therefore, the number of rules extraction is different. Based on the needs, the rules extraction is a valid conclusion of data mining.

3 APPLICATION OF FUZZY NEURAL NETWORK ALGORITHM IN TEACHING EVALUATION

Through looking up the relevant literature, and practical test of the scholars, experts and other personnel, combined with the actual situation of a college, seven indicators that can be determined are mainly shown as follows:

1) The indicator of teaching efficiency is determined according to the teaching objectives, student testing and feedback;
2) The indicator of teaching ability is determined according to the teaching quality, accuracy of the experimental operation, analyzing problems and accurate narration.
3) The indicator of teaching method is determined according to the degree of utilization of multimedia teaching, the pertinence of the organizational teaching and the enlightening and guidance of the educational mode.
4) The indicator of teaching content is determined according to the emotional attitude, permeation of the perspective on value, cultivation of learning ability, and practicality, advancement and scientificity of the reserved knowledge;

5) The indicator of teaching design is determined according to the design of teaching process, specificity of the teaching strategies and teaching objectives;

6) The indicator of teaching attitude is determined according to the degree of course familiarity, earnest teaching, upright teaching attitudes, counseling and homework correcting;

7) The indicator of teacher quality is determined according to the graceful appearance and mandarin level of the teachers.

Later, the teachers, leaders, relevant experts and scholars are recruited to attend a lecture, and a comprehensive and objective score is given to the lectures of the teachers according to seven indicators. In addition, a certain number of students are randomly selected to give a score. Finally, compare the score of the students, teachers, leaders, scholars and experts, and select consistent results as a research case. Among the selected data, one part is as the test standard of the neural network results, and the remaining part is as the training data of the neural network. According to the characteristics of fuzzy neural network, the data is input after processing, as shown in the Table 2.

The former fifteen values in the above table are input values of the samples. The remaining five values are the testing sample values of the fuzzy neural network results. The data is analyzed according to the above algorithm and trained by the use of multi-layer fuzzy neural network, with the results as shown in the Table 3.

As can be seen from the Table 3, the error between the fuzzy neural network running result and original data is very small. If more samples are adopted, the fuzzy neural network can be completely applied to the evaluation of teaching quality.

4 CONCLUSION

The college teaching evaluation plays an important role in training high-level teachers in universities and

<table>
<thead>
<tr>
<th>Overall sample value</th>
<th>Evaluation target</th>
<th>Evaluation indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial number</td>
<td>Teaching quality</td>
<td>Teaching effectiveness</td>
</tr>
<tr>
<td>1</td>
<td>0.625</td>
<td>0.675</td>
</tr>
<tr>
<td>2</td>
<td>0.75</td>
<td>0.6</td>
</tr>
<tr>
<td>3</td>
<td>0.75</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>0.675</td>
<td>0.35</td>
</tr>
<tr>
<td>5</td>
<td>0.625</td>
<td>0.4</td>
</tr>
<tr>
<td>6</td>
<td>0.8</td>
<td>0.75</td>
</tr>
<tr>
<td>7</td>
<td>0.725</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>0.65</td>
<td>0.4</td>
</tr>
<tr>
<td>9</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>0.75</td>
<td>0.7</td>
</tr>
<tr>
<td>11</td>
<td>0.65</td>
<td>0.4</td>
</tr>
<tr>
<td>12</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>13</td>
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</tr>
<tr>
<td>14</td>
<td>0.65</td>
<td>0.4</td>
</tr>
<tr>
<td>15</td>
<td>0.625</td>
<td>0.4</td>
</tr>
<tr>
<td>16</td>
<td>0.65</td>
<td>0.6</td>
</tr>
<tr>
<td>17</td>
<td>0.675</td>
<td>0.75</td>
</tr>
<tr>
<td>18</td>
<td>0.725</td>
<td>0.6</td>
</tr>
<tr>
<td>19</td>
<td>0.75</td>
<td>0.55</td>
</tr>
<tr>
<td>20</td>
<td>0.675</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 2. Sample data.

<table>
<thead>
<tr>
<th>Sample serial number</th>
<th>Evaluation objectives</th>
<th>Neural network identification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.75</td>
<td>0.74997</td>
</tr>
<tr>
<td>16</td>
<td>0.85</td>
<td>0.84986</td>
</tr>
<tr>
<td>17</td>
<td>0.625</td>
<td>0.62057</td>
</tr>
<tr>
<td>18</td>
<td>0.675</td>
<td>0.67513</td>
</tr>
<tr>
<td>19</td>
<td>0.625</td>
<td>0.62573</td>
</tr>
<tr>
<td>20</td>
<td>0.8</td>
<td>0.79945</td>
</tr>
</tbody>
</table>

Table 3. Comparison with the multi-layer fuzzy neural network system results and original data identification values.
colleges. And this paper applies the fuzzy neural network model to evaluation of the teaching level, and proves that the use of this method has a certain advancement and scientificity through case verification. The utilization of the fuzzy neural network enables the colleges and universities to carry out an objective evaluation of the teaching quality, thus playing a positive role in the improvement of China’s college teaching quality.

REFERENCES


