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Fuzzy Integrative Evaluating Model of Teaching Quality

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Abstract

The appropriate estimation method plays a significant role in different kinds of teaching process. In order to overcome the disadvantages of the conventional teaching estimation methods, an integrative evaluating model, which is based on the fuzzy logic, is proposed to deal with the evaluating process with multiple variables in this paper. The design process of constructing the model based on the fuzzy logic is discussed in detail. A satisfactory estimating result has been obtained on the basis of the practical data. The evaluating effect shows that the fuzzy estimating model is effective in processing the multi-variable plant.

Keywords: Teaching quality; Estimating methods; Fuzzy algorithm; Sum-product method.

1. Introduction

The teaching quality is very important for different levels and different kinds of teaching process, including both fulltime and extracurricular ones. A proper evaluating method of the teaching quality is quite significative for improving the teachers' teaching and students' learning enthusiasm. Nevertheless, there are no appropriate, objective, and comprehensive estimating methods in practice. In essence, there exists an

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urgent requirement of setting up an effective estimating model for a specific teaching process. In this paper, we will make our efforts to provide a satisfactory solution.

There are plenty of estimating models of teaching quality at present, still there are some disadvantages in the practical application. From this point of view, we make a try to construct a practical evaluating model of the teaching quality so as to estimate the multi-variable process by means of the comprehensive evaluating method based on the fuzzy reasoning.

2. Fundamentals of Fuzzy Reasoning

Fuzzy logic was first proposed by Prof. L. A. Zadeh of the University of California at Berkeley in 1965. After that, the fuzzy controller was first implemented by Mamdani on a steam engine in 1974 [1, 2]. In the following years, fuzzy logic has come into wide uses in many successful applications and has obtained significant achievements.

Fuzzy Reasoning (FR) uses linguistic information to denote and process the relevant variables without the requirement for the mathematical model of the object, and it is able to adjust the parameters to adapt to the change of the system in-line, and possesses such advantages as robustness, universal approximation theorem, model-free, and rule-based algorithm, etc. Fuzzy logic is able to process incomplete data and provides approximate solutions to problems [3, 4].

In addition to the automatic control field, research and development is also continuing on fuzzy applications in software design, including fuzzy expert systems and integration of fuzzy logic with neural network [5-7].

Fuzzy set theory defines fuzzy operators on fuzzy sets. Fuzzy logic usually utilizes IF-THEN rules, or constructs that are equivalent, such as fuzzy associative matrices. Fuzzy rules are usually expressed in the form [8]:

IF variable IS *property* THEN *action*.

There are also other operators, called hedges that can be applied. Usually these are such adverbs as very, or somewhat, which modify the meaning of a set using a mathematical formula [9].

3. Design Process

3.1. Description of Algorithm

In constructing the estimating model of the teaching quality, the first thing is to define the estimation index set U, the level set V, and the weights of the estimation index, the membership can be confirmed according to the maximum membership principle in the comprehensive evaluation [10-12].

U = {Teaching attitude, Teaching content, Teaching method, Teaching effect}

V = {Very good, Better, ordinary, Worse, Bad}

Here we utilize the sum-product method to compute the eigenvector of every evaluation index. The concrete computing procedure is as follow:

(1) Normalize the elements in the judgment matrix, and the ordinary element is

$$\overline{b_{ij}} = \frac{b_{ij}}{\sum nb_{ij}}, i, j = 1,2,\cdots,n \tag{1}$$

(2) Add every column of the judgment matrix by rows which has been normalized

$$\overline{W_i} = \sum_{j=1}^{n} n\overline{b_{ij}}, i = 1,2,\cdots,n \tag{2}$$

(3) Normalize the vector W according to formula (3)

$$\overline{\overline{W_i}} = \frac{\overline{W_j}}{\sum_{j=1}^{n} n\overline{b_j}}, i = 1,2,\cdots,n \tag{3}$$

(4) Compute the maximum eigenvector W and the result is the approximate solution.

$$W = (W_1, W_2, \cdots, W_n)^T \tag{4}$$

(5) Compute the maximum latent root $\lambda_{\max}$ of the judgment matrix according to formula (5)

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{n(BW)_i}{W_i} \tag{5}$$

(6) Judge the consistency index CI of the matrix according to formula (6)

$$CI = \frac{\lambda_{\max}}{n-1} \tag{6}$$

3.2. Design Process

Here A_1 denotes the teaching quality, B_1 denotes the teaching scope, B_2 denotes the classroom discipline, B_3 denotes the classroom atmosphere, C_1 denotes the teaching attitude, C_2 denotes the teaching content, C_3 denotes the teaching method, C_4 denotes the teaching effect, as shown in the following formulae.

$$A_1 = \begin{array}{c} \\ B_1 \\ B_2 \\ B_3 \end{array} \begin{array}{c} \begin{array}{ccc} B_1 & B_2 & B_3 \end{array} \\ \begin{bmatrix} 1 & 3 & 3 \\ 1/3 & 1 & 1 \\ 1/3 & 1 & 1 \end{bmatrix} \end{array} \qquad B_1 = \begin{array}{c} \\ C_2 \\ C_3 \\ C_4 \end{array} \begin{array}{c} \begin{array}{ccc} C_2 & C_3 & C_4 \end{array} \\ \begin{bmatrix} 1 & 5 & 3 \\ 1/5 & 1 & 1/3 \\ 1/3 & 3 & 1 \end{bmatrix} \end{array} \qquad B_2 = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & C_3 & C_4 \end{array} \\ \begin{bmatrix} 1 & 1/3 & 1/5 & 3 \\ 3 & 1 & 1/3 & 5 \\ 5 & 3 & 1 & 7 \\ 1/3 & 1/5 & 1/7 & 1 \end{bmatrix} \end{array}$$

$$B_3 = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & C_3 & C_4 \end{array} \\ \begin{bmatrix} 1 & 1/3 & 1/5 & 1/7 \\ 3 & 1 & 1/3 & 1/5 \\ 5 & 3 & 1 & 1/3 \\ 7 & 5 & 3 & 1 \end{bmatrix} \end{array}$$

The following computing results can be obtained according to the sum-product method.

$A_1 = (0.6, 0.2, 0.2)$

$B_1 = (0.63, 0.11, 0.26)$

$B_2 = (0.12, 0.26, 0.56, 0.06)$

$B_3 = (0.06, 0.12, 0.26, 0.56)$

So the elements of the weights set can be calculated as follows

$W_1 = 0.6 \times 0.63 + 0.2 \times 0.12 + 0.2 \times 0.06 = 0.2$

$W_2 = 0.6 \times 0.11 + 0.2 \times 0.26 + 0.2 \times 0.12 = 0.4$

$W_3 = 0.6 \times 0.26 + 0.2 \times 0.56 + 0.2 \times 0.26 = 0.1$

$W_4 = 0.6 \times 0 + 0.2 \times 0.06 + 0.2 \times 0.26 = 0.3$

And the corresponding weight set is $R = (0.2,0.4,0.1,0.3)$.

Below is a questionnaire of 100 students for a specific teacher.

Table 1. Evaluating results of 100 students for a teacher

Number / Estimation level / Estimation index	Very good	Better	Ordinary	Worse	Bad
Teaching attitude	11	23	36	20	10
Teaching content	10	40	34	14	2
Teaching method	1	40	44	12	3
Teaching effect	20	30	25	15	10

Thus we can get U_1= (0.11, 0.23, 0.36, 0.2, 0.1), U_2= (0.1, 0.4, 0.34, 0.14, 0.2), U_3= (0.01, 0.4, 0.44, 0.12, 0.03), U_4= (0.2, 0.3, 0.25, 0.15, 0.1).

$$A = \begin{bmatrix} 0.11 & 0.23 & 0.36 & 0.2 & 0.1 \\ 0.1 & 0.4 & 0.34 & 0.14 & 0.02 \\ 0.01 & 0.4 & 0.44 & 0.12 & 0.03 \\ 0.2 & 0.3 & 0.25 & 0.15 & 0.1 \end{bmatrix}$$

So we can obtain the following result according to the weighted mean model:

$$B = \begin{pmatrix} 0.2 & 0.4 & 0.1 & 0.3 \end{pmatrix} \begin{bmatrix} 0.11 & 0.23 & 0.36 & 0.2 & 0.1 \\ 0.1 & 0.4 & 0.34 & 0.14 & 0.02 \\ 0.01 & 0.4 & 0.44 & 0.12 & 0.03 \\ 0.2 & 0.3 & 0.25 & 0.15 & 0.1 \end{bmatrix}$$

And the final result is $B = \begin{pmatrix} 0.12 & 0.24 & 0.33 & 0.15 & 0.06 \end{pmatrix}$.

According to the principle of the maximum membership, we can see that the ratio of "better" is higher, thus the teaching quality of the teacher is ranked to be a better level.

4. Conclusion

The evaluation of the teaching quality is very important for a particular teacher, which is a typical multi-variable process, and there are lots of evaluation methods in the practical application. In this paper, a fuzzy integrative estimating model is proposed to get a reasonable evaluation result so as to overcome the disadvantages of the common estimating methods. By means of selecting the sum-product method to compute the eigenvector of every evaluation index, a proper estimating result has been obtained according to the fuzzy estimating model and the corresponding standardization procedure, which is on the basis of the practical application data. The overall results show that the fuzzy estimating model is quite effective for the multi-variable process.

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