

The Application of Fuzzy Comprehensive Evaluation in College Human Resource Performance Evaluation

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Abstract. The competition of one college is determined by the overall quality of the teachers. Therefore one fair and scientific evaluation system designed by the human resource department will influence the long-term development of the college. Because of the fussiness of the factors in this evaluation system, one fuzzy comprehensive evaluation model of performance evaluation is built in this article. But due to the subjectivity of this model, the fuzzy comprehensive evaluation model combined with RBF neural network model and data envelopment analysis are adopted to improve the performance evaluation of the model more reliable and scientific and ensure the better development and benefit of the teachers. The performance evaluation not only can link the qualitative analysis with the quantitative analysis, but also can reflect the working situation of the teachers fairly and scientifically. At the same time this method is simple, applicable and can be improved in practice.

Introduction

Teachers and students construct the main part of colleges. With the increase speed of students enrollment is quicker than that of the teachers, the comprehensive quality of the students has been influenced. So the human resource department should properly arrange the teachers to solve the training problems of the students and protect the teachers' benefit as well. At present the competitive power of one college is determined by the overall quality of the teachers. The main functions of human resource department include performance evaluation, talent introduction, human resource planning, payment, welfare, social insurance, titles evaluation, teachers training, and management of personnel files, etc. Therefore, how to design a fair and scientific evaluation system has close relation with the future of the college. To evaluate the teachers' performance is one important method to improve the level of the college. But the performance evaluation involves a lot of factors which are subjective, so the evaluation may be fuzzy inevitably. So the mathematical fuzzy theory is applied in this article to build a fuzzy comprehensive evaluation model of performance evaluation.

Due to the subjectivity of the fuzzy comprehensive evaluation model, the fuzzy comprehensive evaluation model combined with RBF neural network model and data envelopment analysis are adopted to improve the performance evaluation of the model more reliable and scientific

The Fuzzy Comprehensive Evaluation Model of Data Envelopment Analysis

Data envelopment analysis is to use mathematical programming (such as linear programming and multi-objective programming) models to evaluate the relative effectiveness between the input and output decision making units. Its advantage lies in the accuracy of the data. But we couldn't find accurate index factor data in our daily life, so it shows fuzziness. The accuracy of data envelopment analysis complements the fuzziness of fuzzy comprehensive evaluation in this article and then the fuzzy comprehensive evaluation model of data envelopment analysis is got, which can be done in three steps. The first step is to calculate the non-quantitative index weights fuzzily; the second step is to calculate the quantitative index weights accurately by using data envelopment analysis and blur the result; the third step is to get the final result by using above result fuzzy comprehensive evaluation.

If there are m evaluation units in the model, $(c + d)$ evaluation indexes, c quantitative indexes and

d non-quantitative indexes, the following hypothesis can be found.

A. Calculating The Non-quantitative Index Weights Fuzzily

If $C = (c_1, c_2, \dots, c_q)$ is factors set, $V = (v_0, v_1, \dots, v_{p-1})$ is evaluation set, the comprehensive evaluation matrix is

$$R_j = \begin{bmatrix} r_{j10} & r_{j11} & \cdots & r_{j1(p-1)} \\ r_{j20} & r_{j21} & \cdots & r_{j2(p-1)} \\ \dots & \dots & \dots & \dots \\ r_{jq0} & r_{jq1} & \cdots & r_{jq(p-1)} \end{bmatrix}, \quad j = 1, 2, \dots, m,$$

$A_j = (a_{j1}, a_{j2}, \dots, a_{jq})$ is weight matrix. So the fuzzy calculation non-quantitative weight of the j^{th} decision-making unit is

$$B_j = A_j R_j = (a_{j1}, a_{j2}, \dots, a_{jq}) \begin{bmatrix} r_{j10} & r_{j11} & \cdots & r_{j1(p-1)} \\ r_{j20} & r_{j21} & \cdots & r_{j2(p-1)} \\ \dots & \dots & \dots & \dots \\ r_{jq0} & r_{jq1} & \cdots & r_{jq(p-1)} \end{bmatrix} = (b_{j1}, b_{j2}, \dots, b_{jp}).$$

B. The Quantitative Index Weight of Data Envelopment Analysis

Suppose $X_j = (x_{1j}, x_{2j}, \dots, x_{nj})^T$ and $Y_j = (y_{1j}, y_{2j}, \dots, y_{sj})^T$ is the input and output vector of the i^{th} evaluation unit $DMU_i (1 \leq i \leq m)$, among which $j = 1, 2, \dots, m$ and each vector coordinate is a positive number. If we use

$$v = (v_1, v_2, \dots, v_n)^T, u = (u_1, u_2, \dots, u_s)^T$$

to represent the input and output weight vector, by using Charnes—Cooper, the linear programming model which is shown below can be got

$$\begin{cases} \max \mu^T Y_{j0} \\ \text{s.t.} \quad \omega^T X_j - \mu^T Y_j \geq 0, j = 1, 2, \dots, m \\ \omega^T X_{j0} = 1 \\ \omega \geq 0, \mu \geq 0 \end{cases}$$

If we input the data into this model, the best solution B_j' which is the accurate calculating quantitative index weight can be got.

Although data got from the envelopment analysis method is more objective and persuasive, the data has no membership form in the fuzzy comprehensive evaluation and perception such as excellence. This article uses membership functions to blur the result.

The results of data envelopment analysis calculation can correspond to the degree of the memberships of the evaluation set $V = (v_0, v_1, \dots, v_{p-1})$ respectively

$$r_j = \begin{cases} \frac{x - (j-1)\frac{1}{p-1}}{\frac{1}{p-1}}, & (j-1)\frac{1}{p-1} \leq x < j\frac{1}{p-1} \\ \frac{(j+1)\frac{1}{p-1} - x}{\frac{1}{p-1}}, & j\frac{1}{p-1} \leq x < (j+1)\frac{1}{p-1} \\ 0 & \end{cases}, \quad r_j \in [0, 1], j = 0, 1, \dots, p-1.$$

Input B_j' into the above formula and the membership $B_j = (b_{j1}, b_{j2}, \dots, b_{jp})$ can be got.

C. The Comprehensive Evaluation

Evaluate the above results comprehensively. The comprehensive evaluation matrix is as follows,

$$R_j = \begin{bmatrix} B_{j1} \\ B_{j2} \\ \dots \\ B_{jk} \end{bmatrix}, j = 1, 2, \dots, m$$

And k is the number of the items of all the indexes (non-quantitative and quantitative). Suppose $A_j = (a_{j1}, a_{j2}, \dots, a_{jk}), j = 1, 2, \dots, m$ is the weight, then $B = A$ and

$$R \Rightarrow B_j = (a_{j1}, a_{j2}, \dots, a_{jk}) \begin{bmatrix} B_{j1} \\ B_{j2} \\ \dots \\ B_{jk} \end{bmatrix} = (b_{j1}, b_{j2}, \dots, b_{jp}), j = 1, 2, \dots, m.$$

By using the maximum membership principle, the final result of comprehensive evaluation is v_i which is got from the correspondence of the maximum b_{ji} of $B_j = (b_{j1}, b_{j2}, \dots, b_{jp})$ to $(v_0, v_1, \dots, v_{p-1})$.

The Fuzzy Comprehensive Evaluation Model of RBF neural network model

RBF neural network can imitate the receiving domain of human brain. There is no local minimum problem. It is easy for people to study and has high fitting precision. It can change the weight value of fuzzy comprehensive evaluation model to make it more practical. In the fuzzy comprehensive evaluation model, to ensure the weight value is of great importance.

A. The introduction of RBF neural network

RBF neural network is forward neural network. The structure of it is similar to the multi-layer forward network. It is a three layer forward network. The first layer is input layer which consists of signal source nodes. The second layer is hidden layer where the number of nodes is determined by the described problem. The transformation function, radial basis function, is a non-negative and non-linear function which is a declining and radially symmetric to the central point function. This function is partial response function, but the previous forward network transformation function is global response function. The third layer is output layer, which will make response to output mode.

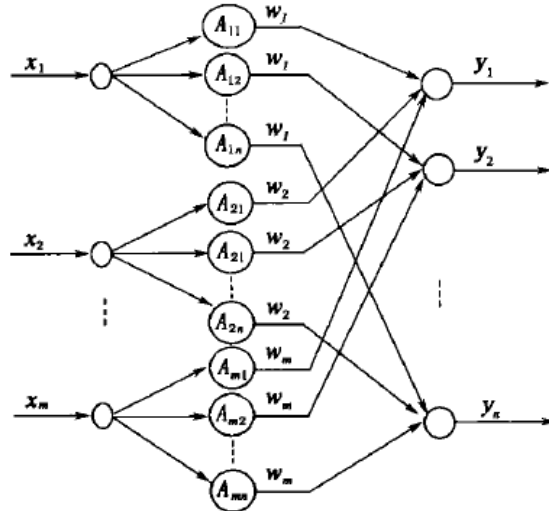


Figure 1. RBF Neural Network Structure

B. RBF neural network fuzzy comprehensive evaluation model structure

Suppose $X = (x_1, x_2, \dots, x_m)$ is network output, then there are m input, n output and evaluation levels. In the network, the connection weight of the second and third layer w_i is the index weight of the fuzzy comprehensive evaluation model.

1) The first layer: input layer

From Fig. 1, we can see that there are m neurons and its input and output are as follows,

$$I_i^1 = x_i$$

$$O_{ij}^1 = x_i, \quad i = 1, 2, \dots, m, \quad j = 1, 2, \dots, n.$$

2) The Second Layer: The second layer: hidden layer

RBF neural network has n evaluation levels. From Fig. 1, there are $m \times n$ neurons in the hidden layer. We have four evaluation levels in this article which are $\{A_{ij}\} = \{\text{excellent, good, pass, failed}\}$. When $n = 4$, four fuzzy subsets need four parameters a_1, a_2, a_3, a_4 . We use a trigonometric function to represent a membership function $\mu(x)$, which is shown in Fig. 2.

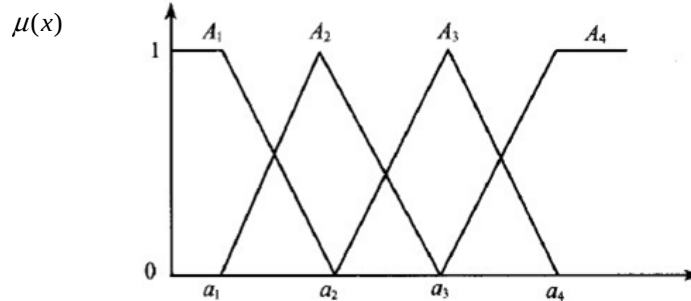


Figure 2. Membership Function

When $I_{ij}^2 = O_{ij}^1$ is input, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$, the hidden layer will output the membership values of each level.

$$O_{ij}^2 = A_{ij}(x_j).$$

3) The Third Layer: The output layer

The main task of the output layer is to comprehensively evaluate the input indexes and we can get the evaluation level and vector.

$$\text{Input } I_{ij}^3 = O_{ij}^2$$

$$\text{Output } O_i^3 = \sum_{j=1}^m w_j I_{ij}^3$$

And $i = 1, 2, \dots, m$, and $j = 1, 2, \dots, n$.

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