



Research of Education Evaluation Information Mining Technology Based on Gray Clustering Analysis and Fuzzy Evaluation Method

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Abstract

This paper has surveyed the education evaluation method and technology both at home and abroad, and studied on the question of education evaluation information's mining and synthesis processing. In view of the evaluation index system of high and secondary vocational education, on the basis of gray clustering analysis method this paper had established gray clustering model and applied fuzzy evaluation method to solve the question of education evaluation information synthesis processing. It provided a vastitude future of education evaluation information's mining and synthesis processing.

Keywords: Gray Clustering, Education Evaluation, Fuzzy Evaluation, Data Mining

1. Introduction

Education evaluation is that according to particular education value and education object, using operable science artifice, make value judgment on education action, processing and result by systemic collecting, analyzing and arranging information data. The result of judgment will provide a basis for continuous self-improvement and education decision. The issue of education evaluation information processing and data mining is an important issue of education evaluation research. The solution of this issue will not only promote education quality improvement but also provide valuable reference information for increasing university teaching innovation and implementing the quality education. At the abroad the theory and application of education evaluation had a quickly development from this century, but the method and theory of evaluation information's integrated processing and data mining was behindhand in development relative to education evaluation investigation. So far, it is three representative education evaluation patterns including object direction evaluation pattern, decision direction evaluation pattern, pluralistic evaluation pattern in the development of abroad education evaluation. The education evaluation pattern investigation noted very little in the method and theory of information integrated processing and data mining. Each education evaluation had a definite value orientation, and these value orientations or value judgment were dominated by the study and application of information integrated processing and data mining theory and method.

Education is a complex system, so the integrated evaluation of complex system was needed many index to weighing. A part of internal study on education evaluation and evaluation index system was based on analytical hierarchy process, and found more science evaluation index system. When more science evaluation index system was found, we must choose a more precisely computation method. Accordingly, the researcher who at abroad and home had pay more attention to how choose a more precisely computation method in the education evaluation processing. In 1982, the famous researcher named Julong Deng in our country had brought up the gray system theory. The research object of gray system theory was uncertainty system what is unknown part of information's small sample or poor information.

The gray clustering is the method that cluster several observation index or observation object into some definable classes by gray association matrix or gray number's whitely weight function. (Yannis Caloghirou. 1999)(Chen Z. 2001)(Qiu Jianrong, Zhang Xiaoping, Liu Hao, Wang Quanhai, Li Fan & Zeng Hancui. 2002)(Gu Zhaojun, He Xiaohui, Si Zhensheng & Fan Jingxin. 2007) A clustering can be considered as a set that observation was belonged same class. For the set what is constituted by all clustering object, we need not cluster by clustering index but also evaluate all evaluation object in a whole. For using data mining technology to point out the problem in the education evaluation and found the way to solve problem, this paper applies grey clustering analytic method as a basis and integration use fuzzy evaluation method(Sadaaki Miyamoto. 1990) to solve integration information processing in the education evaluation index system, thereby promote education evaluation's networking and informationization. At the same time according to high and secondary vocational education talented people training work level evaluation project, the paper use grey clustering method and fuzzy evaluation method to research and practice education evaluation in the evaluation project. The paper aspire after practicalness, pertinency and realistically in the content, materialize advanced and multiformity in the method, reach after science, justice and directional in the result. The research and solution of aforementioned problem will come about active effect and action for our country education evaluation technology.

2. Education evaluation information integration processing and data mining

The process of education evaluation data mining and information integration had three basic steps as follows:

2.1 Construct education evaluation index system hierarchy model and confirm index weight

After survey, education evaluation index system hierarchy's general model was confirmed by expert discussion again and again as figure 1 show:

We use AHP-GA method to confirm each index weight (also can be confirmed by experts researching). We assume that the weight vector what first index B_1, B_2, \dots, B_n relative to total object A is $b = (b_1, b_2, \dots, b_n)$. The weight vector what layer C's weight relative to layer B's element B_n is $c_n = (c_1, c_2, \dots, c_{cn})$. The cn means that the number of layer C's element relative to element B_n . And for the same reason, the weight vector what layer D's weight relative to layer C's element C_m is $d_m = (d_1, d_2, \dots, d_{cm})$.

2.2 Construct grey clustering model

2.2.1 Construct evaluation value matrix

It is assumed that the number of evaluation person was p , namely $t = 1, 2, \dots, p$. The number of evaluation object was q , namely $s = 1, 2, \dots, q$. From above index system, we assume that the number of first index was n , the number of second index was m and the number of third index was k_m .

The evaluation person evaluates some evaluation object by third index's evaluation rank standard. We assume that the grade what the evaluation person t evaluates on evaluation object s by third index's evaluation rank standard was

$d_{jt}^{(s)}$ ($i = 1, 2, \dots, m; j = k_1, \dots, k_i; t = 1, 2, \dots, p; s = 1, 2, \dots, q$), so the evaluation object s 's evaluation value matrix $D^{(s)}$ was:

$$D^{(s)} = \begin{bmatrix} d_{111}^{(s)} & d_{112}^{(s)} & \dots & d_{11p}^{(s)} \\ \dots & \dots & \dots & \dots \\ d_{1k_1}^{(s)} & d_{1k_2}^{(s)} & \dots & d_{1k_p}^{(s)} \\ \dots & \dots & \dots & \dots \\ d_{m11}^{(s)} & d_{m12}^{(s)} & \dots & d_{m1p}^{(s)} \\ \dots & \dots & \dots & \dots \\ d_{mk_m1}^{(s)} & d_{mk_m2}^{(s)} & \dots & d_{mk_mp}^{(s)} \end{bmatrix}$$

2.2.2 Confirm evaluation grey class

It should confirm the rank number of evaluation grey class, the grey number of grey class and grey class's whitely weight function by concretely education evaluation index system. It is assumed that the rank number of evaluation grey class was g , namely evaluation grey class was $e = 1, 2, \dots, g$. The grey number is not a number, but it is a number set, or a space, is noted \otimes .

2.2.3 Compute grey class's evaluation coefficient $\eta_{ije}^{(s)}$.

For the third index, by the whitely weight function $f_e(d_{ijk}^{(s)})$ and the evaluation object s 's value $d_{ijk}^{(s)}$, it computes grey evaluation coefficient $\eta_{ije}^{(s)}$ which valuation object s belongs to evaluation grey class e as follows

$$\eta_{ije}^{(s)} = \sum_{k=1}^p f_e(d_{ijk}^{(s)}) \tag{1}$$

2.2.4 Compute grey evaluation weight $r_{ije}^{(s)}$ and construct grey evaluation weight matrix.

The grey evaluation weight $r_{ije}^{(s)}$ what evaluation person maintained grey e on evaluation object s by third evaluation indexes was:

$$r_{ije}^{(s)} = \frac{\eta_{ije}^{(s)}}{\sum_{e=1}^g \eta_{ije}^{(s)}} \tag{2}$$

After colligating all grey class's evaluation object s toward third evaluation indexes, the grey evaluation weight vector $r_{ij}^{(s)}$ is:

$$r_{ij}^{(s)} = (r_{ij1}^{(s)}, r_{ij2}^{(s)}, \dots, r_{ijg}^{(s)}) \tag{3}$$

By colligating grey evaluation weight $r_{ije}^{(s)}$ in the all of second index C_i 's third index, it can be found that grey evaluation weight matrix $R_i^{(s)}$ of evaluation object s 's second index C_i toward each evaluation grey class is:

$$R_i^{(s)} = \begin{bmatrix} r_{i1}^{(s)} \\ r_{i2}^{(s)} \\ \vdots \\ r_{ik}^{(s)} \end{bmatrix} = \begin{bmatrix} r_{i11}^{(s)} & r_{i12}^{(s)} & \dots & r_{i1g}^{(s)} \\ r_{i21}^{(s)} & r_{i22}^{(s)} & \dots & r_{i2g}^{(s)} \\ \vdots & \vdots & \vdots & \vdots \\ r_{ik1}^{(s)} & r_{ik2}^{(s)} & \dots & r_{ikg}^{(s)} \end{bmatrix}$$

2.2.5 Compute grey integration evaluation vector $TT_i^{(s)}$ of second index C_i .

For the evaluation object s , according to $d_i = (d_1, d_2, \dots, d_{ci})$ that layer D's relatively weight vector corresponding layer C's element C_i and grey evaluation weight matrix of second index C_i toward each evaluation grey class, it can be evaluated integration, and then it found that grey integration evaluation vector $TT_i^{(s)}$ of evaluation object s 's second index C_i as follows:

$$TT_i^{(s)} = d_i \cdot R_i^{(s)} = (tt_{i1}^{(s)}, tt_{i2}^{(s)}, \dots, tt_{ig}^{(s)}) \tag{4}$$

2.2.6 Compute grey integration evaluation vector $LT_i^{(s)}$ of first index B_n .

For the evaluation object s , by colligating grey integration evaluation vector $TT_i^{(s)}$ in the each second index C_i , it can be found that grey evaluation weight matrix $L_i^{(s)}$ of evaluation object s 's first index B_n toward each evaluation grey class is:

$$L_i^{(s)} = \begin{bmatrix} TT_1^{(s)} \\ TT_2^{(s)} \\ \vdots \\ TT_m^{(s)} \end{bmatrix} = \begin{bmatrix} tt_{11}^{(s)} & tt_{12}^{(s)} & \dots & tt_{1g}^{(s)} \\ tt_{21}^{(s)} & tt_{22}^{(s)} & \dots & tt_{2g}^{(s)} \\ \vdots & \vdots & \vdots & \vdots \\ tt_{m1}^{(s)} & tt_{m2}^{(s)} & \dots & tt_{mg}^{(s)} \end{bmatrix}$$

According to $c_n = (c_1, c_2, \dots, c_{cn})$ that layer C's relatively weight vector corresponding layer B's element B_n and grey evaluation weight matrix of first index B_n toward each evaluation grey class, it can be evaluated integration, and then it found that grey integration evaluation vector $LT_i^{(s)}$ of evaluation object's first index B_n as follows:

$$LT_i^{(s)} = c_n \cdot L_i^{(s)} = (lt_{i1}^{(s)}, lt_{i2}^{(s)}, \dots, lt_{ig}^{(s)}) \tag{5}$$

2.2.7 Compute clustering result.

For the evaluation object s , by colligating grey integration evaluation vector $LT_i^{(s)}$ in the each first index B_i ($i=1, 2, \dots, n$), it can be found that grey evaluation weight matrix $Z^{(s)}$ of evaluation object s toward each evaluation grey class is:

$$Z^{(s)} = \begin{bmatrix} LT_1^{(s)} \\ LT_2^{(s)} \\ \vdots \\ LT_m^{(s)} \end{bmatrix} = \begin{bmatrix} lt_{11}^{(s)} & lt_{12}^{(s)} & \dots & lt_{1g}^{(s)} \\ lt_{21}^{(s)} & lt_{22}^{(s)} & \dots & lt_{2g}^{(s)} \\ \vdots & \vdots & \vdots & \vdots \\ lt_{m1}^{(s)} & lt_{m2}^{(s)} & \dots & lt_{mg}^{(s)} \end{bmatrix}$$

According to the weight vector $b = (b_1, b_2, \dots, b_n)$ of first index B_i ($i = 1, 2, \dots, n$) and grey evaluation weight matrix $Z^{(s)}$ of evaluation object s , it can be clustered integration, and then it found that clustering result $X^{(s)}$ of evaluation object as follows:

$$X^{(s)} = b \cdot Z^{(s)} = (x_1^{(s)}, x_2^{(s)}, \dots, x_g^{(s)}) \tag{6}$$

2.3 Apply fuzzy evaluation to finding evaluation result

It uses each grey class's threshold as rank value to compute the integration evaluation value of each evaluation object. For example, the grey class one's threshold is d_1 , the grey class two's threshold is d_2, \dots , the grey class g's threshold is d_g . So each grey class rank value vector is $F = (d_1, d_2, \dots, d_g)$. The integration evaluation value $G^{(s)}$ of evaluation object s is:

$$G^{(s)} = X^{(s)} \cdot F^T \tag{7}$$

It can be made an order by the value of $G^{(s)}$ after computing each evaluation object's integration evaluation value $G^{(s)}$.

3. Demonstration test

We use the evaluation process of high and secondary vocational education talented people training work level evaluation index system as example to explain the process of education evaluation information integration processing and data mining. According to the model of figure 1, firstly we have to confirm evaluation index's weight. Secondly, it evaluated on school A by five experts (data in table 1), then it found evaluation value matrix as follows:

$$D = \begin{pmatrix} 8 & 7.5 & 8.5 & 8 & 7 \\ 7 & 6.5 & 7 & 6 & 7 \\ 6 & 6.5 & 7 & 6 & 6 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 8 & 8.5 & 9 & 8 & 7.5 \\ 7.5 & 8 & 7 & 6 & 7 \end{pmatrix}$$

According to grade standard of high and secondary vocational education talented people training work level evaluation project, it can be confirmed that the evaluation grey number is $e = 5$, the whitely weight function is $f_1(x), f_2(x), f_3(x), f_4(x), f_5(x)$ as follows:

$$f_1(x) = \begin{cases} 1 & x \in [9, +\infty); \\ \frac{1}{9}x & x \in [0, 9] \end{cases} \quad f_2(x) = \begin{cases} 1 & x \in [8, 9]; \\ \frac{1}{8}x & x \in [0, 8] \cup [9, +\infty] \end{cases}$$

$$f_3(x) = \begin{cases} 1 & x \in [7, 8]; \\ \frac{1}{7}x & x \in [0, 7] \cup [8, +\infty] \end{cases} \quad f_4(x) = \begin{cases} 1 & x \in [6, 7]; \\ \frac{1}{6}x & x \in [0, 6] \cup [7, +\infty] \end{cases}$$

$$f_5(x) = \begin{cases} 1 & x \in [0, 6]; \\ \frac{1}{6}x & x \in [6, +\infty] \end{cases}$$

It can be found that school A's all second index toward each evaluation grey class $R_i^{(s)}$ is (use first second index as example):

$$R_1 = \begin{bmatrix} r_{11} \\ r_{12} \\ r_{13} \end{bmatrix} = \begin{bmatrix} 0.587 & 0.205 & 0.102 & 0.100 & 0.006 \\ 0.532 & 0.247 & 0.112 & 0.102 & 0.007 \\ 0.514 & 0.234 & 0.152 & 0.100 & 0 \end{bmatrix}$$

Then, it can be found that grey evaluation weight matrix $L_i^{(s)}$ of first index's each evaluation grey class is (use first of first index as example):

$$L_1 = \begin{bmatrix} TT_1 \\ TT_2 \end{bmatrix} = \begin{bmatrix} 0.524 & 0.245 & 0.143 & 0.080 & 0.008 \\ 0.562 & 0.217 & 0.115 & 0.102 & 0.004 \end{bmatrix}$$

Final, school A’s clustering result is:

$$X^{(A)} = (0.5521, 0.2548, 0.1821, 0.007, 0.004)$$

Namely school A was belonged to first clustering (general comment above nine points), then it can be used fuzzy evaluation method to compute concretely general comment value as follows:

$$G^{(A)} = 9.3751$$

According to above computing, it can be found that school A’s evaluation result as table1 shows:

4. Conclusion

To sum up, in the practice application grey clustering method was relative agility. We had colligated fuzzy evaluation method and grey clustering method to clustering analyze and fuzzy evaluate on experts data; take integration analysis and advisement on evaluation index system’s data. This method was more exactitude, more applied and more abundant what information shows compare with weighted averages method and other computation method. Foreign and Chinese had worked hard on the theory and application of grey clustering method. So we try to use this method to integrate process on education evaluation information in this paper, and the result was reasonable. The research result aspires after practicalness, pertinency and realistically in the content, materialize advanced and multiformity in the method, reach after science, justice and directional in the result, provide more strict and scientific method for the research of high and secondary vocational education evaluation information integration processing. At the same time, based on the research result building education evaluation database, evaluation model database and education evaluation information integration processing system on the Web was feasible and necessary. The research result was established stability basic for the development of our country’s education evaluation technology.

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Table 1. School A’s experts grading and General comment

	E 1	E 2	E 3	E 4	E 5
School orientation and develop programming	8	7.5	8.5	8	7
Education thinking concept	7	6.5	7	6	7
Teaching center position	6	6.5	7	6	6
Study and teaching	8	7.5	9	9	8
proportion between student and teacher	8	8	8.5	8	7.5
Non-plurality teacher proportion	9	8.5	9	8	8.5
plurality teacher’s quantity and structure	8	8.5	9	8	7.5
Quality	8	8.5	9	7.5	8

Construction and development	9	8.5	9	8.5	8
Teaching administration house	7	8	8.5	9	8
Teaching instrument equipment	8	9	8.5	8	7.5
Library and campus net	7	6	6.5	8	7.5
Athletic sports establishment	9	8.5	8	7.5	8.5
Practice condition in school	8	8.5	8.5	9	7.5
Practice base out of school	7	8	8.5	7.5	7.5
Profession skill appraisal	6	8	7	6.5	7
Outlay pledge complexion	8.5	9	9.5	8	8.5
Teaching outlay proportion	6.5	7	7.5	6	7
Major setting	7	8.5	8	7.5	9
Teaching plan	8	8.5	9	7.5	8.5
Major teaching innovation	9.5	9	8.5	9	9.5
Teaching content and course innovation	8.5	9	8.5	8	9
Teaching material construction	7	8	8.5	7	9
Teaching method	7.5	8.5	8	7.5	8
Practice training system	8	8.5	9	7.5	8
Profession ability checking	8.5	8	8.5	9	8
Work state and impact on all around education	7.5	8	8.5	9	8
Teaching manage and student manage	8	9	8	9	9.5
Teaching bylaw's construction and perform	8.5	8	9	8.5	8
Quality standard of major teaching tache	7	7	7	8	7.5
Teaching quality monitor and student quality research	7.5	8	8.5	7	7.5
Profession ability	6	8	6.5	6	7
Necessary knowledge	8.5	8.5	8.5	9	7
Basic diathesis	7	7.5	6	8	7
Register rate and employment rate	8	8.5	9	8	7.5
Graduate evaluation	7.5	8	7	6	7
General comment	9.3751				

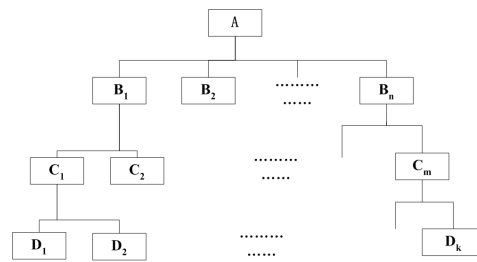


Figure 1. Education evaluation system hierarchy diagram