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Performance Management and Evaluation Research to University Students

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For the past decades, conspicuous progress is demonstrated in all fields of China, such as economy, science and technology. Meanwhile, the comprehensive strength of China has been enhanced greatly. However, the quality of higher education should face some difficulties. It is an important Step that how to further realize and enhance the performance of higher education. An assessment framework is essential to be constructed to evaluate the performance of students in the higher school. Because of the difficulty of expressing the experts' opinions exactly, hesitant fuzzy sets are introduced to form a multiple attribute decision making model. A new distance measure is proposed to solve this evaluation problem under the framework of MAGDM. Finally, a case study is demonstrated to verify the reliability and applicability of the proposed method.

1. Introduction

From the perspective of all over the world, the competition of economy and comprehensive national strength between each country is indeed that of the capability of modern technology. In modern society, with the rapid development of knowledge economy, higher education is always a key point related to the modern technology of a country whether it is a developed country (Tarvid (2015)). Owing to the rapid growth of the number of students in higher education, the management of students is a more complex problem than ever (Yue (2015)). Up to 2014, there are 24,681,000 students in higher school related to China, which is from National Bureau of Statistics. The satisfaction for graduates to find a good job is very small. The most important issue of these phenomena is lack of self-perception for graduates when they are in college. The effective way to promote self-perception is to accept assessment from others or themselves (Wei and Peng (2015); Sheng (2014)).

Some higher education institute introduces Higher Education Information System to explore the possibility for predicting the success rate of students in higher school by using data mining technology (Natel and Zwilling (2014)). However, it is not comprehensive to realize the performance of students by higher education information system. Different mining technology can result different solution, which may miss some information. Then, a new assessment framework is essential to construct to help us realize the performance of students comprehensively. This assessment problem can be considered as a multiple attribute group decision making (MAGDM) problem in order to introduce some MAGDM methods (Liu, Chan and Ran (2013); Feng and Lai (2014)).

The multiple attribute group decision making problem is a type of multi-objective and multi-expert decision problem, which has applied widely in many fields such as economics (Merigo, Xu and Zeng (2013)), management (Liang, Pedrycz, Liu and Hu (2015)) and so on (Chen, Zhang and Dong (2015); Sassenberg, Landkammer and Jacoby (2014)). The essence of the MADGM problem is assembling decision-making information, sorting and selecting the outcome through definite means with multiple experts. Most of the proposals for solving MAGDM found in literature focus on cases where the information provided by experts represented in precise and accurate assessment values. However, in real-life, the experts have different cultural and educational backgrounds, experience and knowledge. Then, there are subjective and hesitant assessments provided by the experts, uncertain and imprecise are the basic characteristics of their preferences. For instance, for a selection problem of a new computer with different brand such as Microsoft, Lenovo, Thinkpad and others, different experts have different opinions which have the disagreements, which lead the difficulty for the decision maker to select appropriate brand.

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In other words, it is difficult to express the experts' preferences accurately. Because of this, fuzzy set is introduced in MAFDM to solve this problem. Zadeh defined the basic concept of fuzzy sets based on the theory of fuzzy mathematics whose main characteristic is that: the membership function assigns to each element *x* in a universe of discourse *X* a membership in interval [0,1] and the non-membership degree equals one minus the membership degree. Since fuzzy set was proposed, it has been a popular method to solve uncertain and imprecise of experts' preferences (Zadeh (1965); Zimmermann (1985)). Up to 2009, Torra and Narukawa asserted it was often difficult to give the membership or non-membership into one value and which may be exist a doubt among a set of different values. Thus, they defined hesitant fuzzy sets to deal with this problem, which allows the membership into a set demonstrated as several possible values between 0 and 1 (Torra and Narukawa (2009)). Moreover, in 2010, Torra proposed some simple arithmetic and geometric aggregation operators of hesitant fuzzy sets to aggregate the information of different experts or attributes]. Different operation may result different solution, so distance measure is introduced in this paper to aggregate the he information of different experts or attributes.

The main contributions of this paper include the following: (1) the construction of the assessment framework of student management; (2) the design of expressing expert's preference by hesitant fuzzy sets; (3) the introduction of Hausdorff distance measure to aggregate experts' preference; (4) the application of assessment framework based on the proposed method. The rest of this paper is organized as follows. In Section 2, we construct some assessment framework of student management. Section 3 introduces some concepts of hesitant fuzzy set and proposes Hausdorff distance measure to evaluate management performance. A case study is demonstrated in Section 4. Finally, Section 5 concludes this paper.

2. Proposed method

In this section, we introduce hesitant fuzzy multiple group decision making methods to evaluate management performance of students in higher school. Based on the basic concepts of hesitant fuzzy sets, we define Hausdorff distance measure to aggregate information in decision matrix.

2.1 Hesitant fuzzy sets

Torra proposed the concept of hesitant fuzzy set which is in terms of a function when applied to a fixed set returns a sunset of [0, 1]. Then, in order to easily understood, Xia and Xu expressed the hesitant fuzzy set by mathematical symbol.

Definition 1(Torra and Narukawa (2009)). Let *X* be a universe of discourse, then a hesitant fuzzy set *H* over *X* is defined as

$$H = \{< x, h_H(x) > | x \in X\}, \quad (1)$$

where $h_H(x)$ is a set of some values in [0, 1], symbolizing the possible membership degrees of the element *x* to *H*. For convenience, we call $h = h_H(x)$ a hesitant fuzzy element and *H* the set of all hesitant fuzzy elements.

2.2 Distance measures

1. Distance measure is fundamentally important in a variety of scientific fields such as decision making, pattern recognition, machine learning and marker prediction, lots of studies have been done on this issue.
2. By taking into account the discrete element of hesitant fuzzy sets , and following the basic lines of reasoning on which the definition of distances between intuitionistic fuzzy sets are based, we define the Hausdorff distance measure between the hesitant fuzzy sets.

Definition 2 Let $M = \{x, h_M(x) | x \in X\}$and $N = \{x, h_N(x) | x \in X\}$ be two hesitant fuzzy sets in $X=\{x_1, x_2, ..., x_n\}$, we define the generalized weighted Hausdorff distance measure between *M* and *N* as follows:

$$d_g(M, N) = \{\sum_{i=1}^{n} w_i \left[\max_j \left| h_M^{\sigma(j)}(x_i) - h_N^{\sigma(j)}(x_i) \right|^{\lambda} \right]\}^{1/\lambda} \quad (2)$$

where $\lambda > 0$, which can be obtained according to the decision maker's risk attitude.

Definition 3 Let $M = \{x, h_M(x) | x \in X\}$and $N = \{x, h_N(x) | x \in X\}$be twol hesitant fuzzy sets in $X=\{x_1, x_2, ..., x_n\}$, we define the weighted Euclidean- Hausdorff distance between *M* and *N* as follows:

$$d_e(M, N) = \{\sum_{i=1}^{n} w_i \left[\max_j \left| h_M^{\sigma(j)}(x_i) - h_N^{\sigma(j)}(x_i) \right|^{2} \right]\}^{1/2} \quad (3)$$

Definition 4 Let M = {x, $h_M(x)$ | $x \in X$}and N = {x, $h_N(x)$ | $x \in X$}be twol hesitant fuzzy sets in X={x_1, x_2, ..., x_n}, we define the weighted Hamming- Hausdorff distance between M and N as follows:

$$d_h(M, N) = \{\sum_{i=1}^{n} w_i \left[\max_j \left| h_M^{\sigma(j)}(x_i) - h_N^{\sigma(j)}(x_i) \right| \right]\} \quad (4)$$

Obviously, when λ=1, d_g reduces to d_h; when λ=2, d_g reduces to d_e.

Definition 5. Let M and N be two hesitant fuzzy sets on X = {x_1, x_2, ..., x_n}, then the distance measure between M and N is defined as $d(M, N)$, which satisfies the following properties:

1. (1) $0 \le d(M, N) \le 1$;
2. (2) $d(M, N) = 0$, if and only if $M = N$;
3. (3) $d(M, N) = d(N, M)$.

2.3 Decision method

When Hwang and Yoon proposed TOPSIS(technique for order preference by similarity to an ideal), whose basic principle is to choose the alternative with the shortest distance from the positive ideal solution(PIS) and the farthest distance from the negative ideal solution(NIS), it has been acquired great attention in MAGDM problems. In this paper, based on the characteristic of hesitant fuzzy sets, we use the ideal of TOPSIS to select the alternative with the shortest distance from the positive ideal solution (PIS).
Under hesitant fuzzy environment, the hesitant fuzzy PIS, denoted by A^+ can be defined as follows:

$$A^+ = \left\{ x_j, \max_i \left\langle h_{ij}^k \right\rangle \middle| j = 1, 2, \cdots, n \right\} \quad (5)$$

In order to simplify computation, the Eq. (6) is applied instead of the Eq. (5) as follows.

$$A_j^+ = \{1, 0 | j = 1, 2, \cdots, n\} \quad (6)$$

4. The relative closeness coefficient of an alternative A_i with respect to the hesitant fuzzy PIS A^+ and A^- is expressed as follows:

$$CC_i = d_i^+ , \quad (7)$$

where $0 \le CC_i \le 1, i = 1, 2, ...m$.

Obviously, when an alternative A_i is closer to the hesitant fuzzy PIS, CC_i will be closer to 1. Thus, based on the closeness coefficient CC_i, the ranking of all alternatives can be determined and the best alternative can be selected

2.4 Procedure of assessment model

Based on the framework demonstrated in section 2, we can propose a procedure to solve this problem, where attribute values take the form of the hesitant fuzzy values
Step 1. For a assessment problem, we firstly construct a decision matrix $D = [h_{ij}]_{m \times n}$, where all the arguments h_{ij} (i = 1, 2, ..., m; j = 1, 2, ..., n) are the hesitant fuzzy numbers, provided by the experts. As for every alternative A_i (i = 1, 2, ..., m), the experts is invited to express evaluation or preference according to each attribute C_j (j = 1, 2, ..., n) by a hesitant fuzzy number h_{ij} (i = 1, 2, ..., m; j = 1, 2, ..., n) and gives the relative weights of the n attributes denoted as $w = (w_1, w_2, \ldots, w_n)^T$ with $0 \le w_j \le 1$ (j = 1, 2, ..., n) and $\sum_{i=1}^{n} w_j = 1$.
Step 2. According to preference of the decision maker, the decision making matrix is obtained as follow:

$$D_{m \times n} = \begin{pmatrix} h_{11} & h_{12} & \cdots & h_{1n} \\ h_{21} & h_{22} & \cdots & h_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ h_{m1} & h_{m2} & \cdots & h_{mn} \end{pmatrix} \quad (8)$$

Step 3: Utilize Eq.(6) to determine the corresponding hesitant fuzzy PISA^+ and the dual hesitant fuzzy NISA^-.
Step 4: According to Eq. (7), the closeness coefficient of each alternative is acquired.

Step 5: Rank all alternatives A_i based on the closeness coefficient CC_i, where the greater the value CC_i, the better the alternative A_i.

3. Case study

In this section, we design a case study to demonstrate the applicability of the proposed method. 4 professors from different major are invited as the experts. A vice-president is invited as the decision maker chooses any five students as the alternatives denoted A_1, A_2, A_3, A_4, A_5 and four attributes (examination performance, campus activities, Evaluation and Social activity).

Firstly, the decision maker with the experts give the weight vector of these four attributes denoted as w = (0.3, 0.2, 0.2, 0.3)^T. Secondly, they give their preferences of every student on each attribute, respectively. Thus, the decision maker combines the opinions of these experts to provide a hesitant fuzzy decision matrix $D=[h_{ij}]_{5\times4}$ demonstrated in Table1.

Table 1: Transposition of original hesitant fuzzy decision matrix

	A_1	A_2	A_3	A_4	A_5
C_1	{0.1,0.3}	{0.5,0.6, 0.8}	{0.1,0.4, 0.5}	{0.3,0.5}	{0.5,0.7}
C_2	{0.5,0.6,0.7}	{0.2,0.4,0.7}	{0.1,0.4}	{0.3,0.4,0.6}	{0.4,0.5}
C_3	{0.4,0.6,0.8}	{0.1,0.3}	{0.2,0.3 }	{0.2,0.5,0.6}	{0.3,0.6,0.8}
C_4	{0.4,0.5,0.8}	{0.3, 0.6}	{0.1,0.3,0.4}	{0.5}	{0.3,0.6}

Based on Eqs. (6) and (7), it can be obtained distance of each alternative and the hesitant fuzzy PISA^+ in Figures 1.

Table 2: Distance measure between each alternative and the hesitant fuzzy PISA+

	d_i^+			
	$\lambda=1$	$\lambda=2$	$\lambda=6$	$\lambda=8$
α_1	0.67	0.6422	0.6101	0.5824
α_2	0.7	0.6915	0.6823	0.6778
α_3	0.88	0.8511	0.8369	0.8127
α_4	0.66	0.6337	0.6285	0.617
α_5	0.62	0.605	0.582	0.573

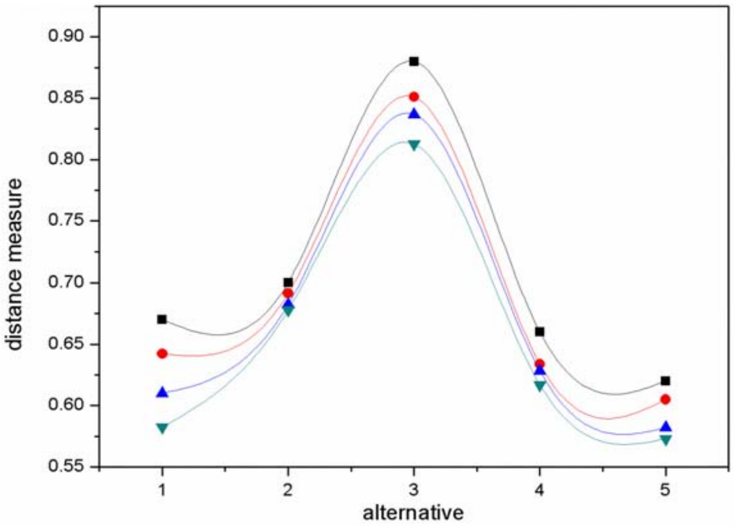

Figure 1: Distance of each alternative to positive ideal solution

In order to demonstrate the relationship of parameter λ with the rank-order, we select $\lambda \in [1, 8]$ to demonstrate the rule. It is obvious that different parameter λ has different rank. So, we interview these experts to realize their preference. Based on the most experts' preference, we select $\lambda = 2$.

Therefore, according to Eqs. 6-7 and parameter $\lambda = 2$, the closeness coefficient and rank-order can be computed as (0.6422, 0.6915, 0.8511, 0.6337, 0.605).

As mentioned above, the rank-order is demonstrated as $A_3 \succ A_2 \succ A_1 \succ A_4 \succ A_5$. It is obviously to select A_3 is the optimal student. This result considering the professors' risk attitude can help the students further realize themselves and understand the gap between them with the optimal student. After this, the student can acquire more motivation to enhance ability of not only examination but also social skill.

4. Conclusions and further study

Recently, with the fast development of higher school, student management has become an important issue for our country. As mentioned in section 1, to construct a new assessment framework is useful way to help us promote student management. The key problem of it is the actual expression of the experts' preference. Thus, according to existing studies, we introduce hesitant fuzzy set with multiple attribute group decision making method including distance measure of TOPSIS to handle this assessment problem. Based on the case study, it can further show the contributions and innovations of the assessment framework including the following aspects: (1) the construction of the assessment framework of student management; (2) the demonstration of expressing expert's preference by hesitant fuzzy sets; (3) the introduction of Hausdorff distance measure to aggregate experts' preference; (4) the application of assessment framework based on the proposed method.

Although the method is useful to evaluate management preference of students in higher school, it cannot solve the problems with more complex problems such as hesitant fuzzy linguistic information. In the future, we will extend the method to solve more complex problems.

References

Cheng Y. S. What are students' attitudes towards different management strategies: A cross-regional study [J]. Procedia-Social and Behavioral Sciences, 2014(141), 188-194.

Chen X., Zhang H. J., Dong Y. C., 2015, The fusion process with heterogeneous preference structures in group decision making: A survey [J]. Information Fusion, (24): 72-83.

Feng B., Lai F. J.. Multi-attribute decision making with aspirations: A case study [J]. Omega, 2014(44): 136-147.

Liang D. C., Pedrycz W., Liu D., Hu P., 2015, Three-way decisions based on decision-theoretic rough sets under linguistic assessment with the aid of group decision making [J]. Applied Soft Computing, (29), 256-269.

Liu S., Chan F. T. S., Ran W. X., 2013, Multi-attribute group decision-making with multi-granularity linguistic assessment information: An improved approach based on deviation and TOPSIS [J]. Applied Mathematical Modeling, (37), 10129-10140.

Merigo J. M., Xu Y. J, Zeng S. Z., 2013, Group decision making with distance measure and probabilistic information [J]. Knowledge-Based Systems, (40): 81-87.
Natel S., Zwilling M., 2014, Student data mining solution-knowledge management system related to higher education institutions [J]. Expert Systems with Applications, (41): 6400-6107.
Sassenberg K., Landkammer F., Jacoby J., 2014, The influence of regulatory focus and group vs. individual goals on the evaluation bias in the context of group decision making [J]. Journal of Experimental Social Psychology, (54): 153-164.
Tarvid A., 2015, The effectiveness of access restriction to higher education in decreasing overeducation [J]. Economic Analysis and Policy, (45): 11-26.
Torra V., Narukawa Y., 2009, on hesitant fuzzy sets and decision [J]. 2009 IEEE International Conference on Fuzzy Systems. (3): 1378-1382.
Wei H. C., Peng H., Chou C., 2015, Can more interactivity improve achievement in an online course? Effects of college and actual use of a course-management system on their learning achievement [J]. Computers & Education, (83): 10-21.
Yue C. J., 2015, Expansion and equality in Chinese higher education [J]. International Journal of Educational Development, (174): 759-767.
Zimmermann H. J., 1985, Fuzzy Set Theory and Its Applications [D]. Kluwer Academic Publishers, Dordrecht.
Zadeh L.A., 1965, Fuzzy sets [J]. Information and Control, (8): 338-356.