Personalized Course Content by 2-Tuple Fuzzy Linguistic Model

Ming Li,Yueyun Chen

***Abstract*—It is inefficient for a teacher to illustrate all of the course content in details. Due to evaluate the course content and provide the fitting course, this paper proposed an approach based on 2-tuple fuzzy linguistic model. Firstly 2-tuple and its related operators is used to express and calculate the evaluation information. Then the weight of each studentis calculated and each part of the course are sorted. Teachers arrange the course by the evaluation result. Finally, an example of the information management course is given to demonstrate the calculation process of the proposed method.**

***Index Terms*—Personalized course content, multiple criteria group decision making, 2-Tuple linguistic model.**

I. INTRODUCTION

With the development of technology, the method of education has been changed. Teachers need to know what knowledge interests the students most. [1] The evaluation of course content is to use an index system to find the teaching point. There are many approaches, but due to the complexity of the evaluation index and the ambiguity and uncertainty of human thinking, it is most convenient and best to give the preference information in the form of linguistic.[2]

In the past, when the linguistic information is processed, the index value is transformed to varying degrees.[3] The index value will produce some information loss and distortion in the process of transformation, which will affect the accuracy of the result. [4]In order to solve the problem of information loss in the operation or processing of linguistic information, Herreraproposed a method of using 2-tuple linguistic term to describe linguistic evaluation information [5]. This method can express all the information obtained after the integration of linguistic evaluation information in a form of a predetermined set of phrases, which can effectively avoid the loss and distortion of information in the aggregation and operation of linguistic evaluation information.[5]In the paper, 2-tuple fuzzy linguistic model is used to evaluate course content.

II. EVALUATION INDEX SYSTEM FOR COURSE CONTENTS

Course contents evaluation is an approach to find out what knowledge about one course interests the students. The evaluation of the contents of the course is different depending on the purpose of the evaluation.[6]For example, focus may be put on learning efficiency, knowledge acquisition, and professional relevance. In order to construct a comprehensive evaluation index system, the following index is used.

Ability: When the teacher chooses to teach the student course contents, the higher the student's understanding of the course, the teaching process will be easier. Teachers do not need to prepare a lot of basic contents.[7]

Interest: Students 'interest in the course contents affects students' participation in class. Students are more interested in the contents of the course, and then the teaching contents are also easier to understand and improve the teaching efficiency.[8]

Practicality: The contents of the course can be combined with life practice to deal with the problems in life and work. [9]Use the course contents to propose a solution.

Correlation: The contents of the course and the students associated with the major, the use of course contents to solve the professional related issues.[10]

Technology: Describe the techniques that need to be used in this chapter.

Case: Course contents in the actual case of the specific use.

Background: Pre-knowledge and history of course contents.[11]

Difficulty: Students' Subjective Judgment of Difficulty in Course Contents.

III. 2-TUPLE FUZZY LINGUISTIC MODEL

2-tuple fuzzy linguistic model is a method based on concept of symbolic translation. [12]The method is to convert the preference information given by the decision maker into a 2-tuple linguistic variable as (S_i, α_i), where S_i is label from predefined linguistic term set $S = \{S_0, S_1, \ldots, S_g\}$, and α is a numerical value representing the symbolic translation.[13]And a set of five terms S to represent course content could be given as follows: $S = \{S_0, S_1, S_2, S_3, S_4\}$ which means {very little, little, middle, much, very much}. α_i denotes the difference between the evaluation result obtained after the aggregation of the evaluation information given by the decision maker and the closest linguistic phrase S_i in the initial linguistic evaluation set, and $\alpha\ [-0.5.0.5)$.

Definition 1[12].Let set S be a linguistic term set, and $s_i \in S$ be a linguistic label. The function θ used to obtain the corresponding 2-tuple linguistic information of s_i is defined as follows:

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$$\theta: S \rightarrow S \times [-0.5,0.5]$$
$$\theta(s_i) = (s_i, 0), s_i \in S \quad (1)$$

Definition 2[12].Let $\beta \in [0, g]$ is a number value representing the aggregation result of linguistic symbolic. The function Δ used to obtain the 2-tuple linguistic information equivalent to β is defined as:

$$\Delta: [0, g] \rightarrow S \times [-0.5,0.5]$$
$$\Delta(\beta) = (s_i, \alpha_i) \quad (2)$$

Where $i = \text{round}(\beta)$, 'round' is the round operation. s_i has the closest index label to β and α is the value of the symbolic translation. The interval of value α is derived from the number of linguistic terms.[14]

Definition 3[12].Let (s_i, α_i) be a 2-tuple linguistic term.There is always a function Δ^{-1}, which returns its equivalent numerical value $\beta \in [0, g]$:

$$\Delta^{-1}: S \times [-0.5,0.5] \rightarrow [0, g]$$
$$\Delta^{-1}(s_i, \alpha_i) = i + \alpha_i = \beta \quad (3)$$

Definition 4[12].Let (s_i, α_i) and (s_j, α_j) be two 2-tuples then:

(1)If $i > j$ then (s_i, α_i) is better than (s_j, α_j);

(2)If $i = j$ then $\alpha_i = \alpha_j$ then (s_i, α_i) is equal to (s_j, α_j);

(3)If $i = j$ then $\alpha_i < \alpha_j$ then (s_i, α_i) is worse than (s_j, α_j);

(4)If $i = j$ then $\alpha_i > \alpha_j$ then (s_i, α_i) is better than (s_j, α_j);

Definition 5[12].Let $L = \{(s_1, \alpha_1), (s_2, \alpha_2) \dots (s_m, \alpha_m)\}$ be a set of 2-tuple linguistic variable, $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_m)^T$ be the weight vectors, $\lambda_i \in [0, 1]$, $W = \{(w_1,\alpha_1), (w_2,\alpha_2) \dots (w_m,\alpha_m)\}$ be the 2-tuple weight vector, the weighted average operator φ_1 and φ_2 are defined as:

$$\varphi_1[(s_1,\alpha_1),(s_2,\alpha_2)\dots(s_m,\alpha_m)] = \Delta\left(\sum_{i=1}^{m} \lambda_i \Delta^{-1}(s_i,\alpha_i)\right)$$

$$\varphi_2((s_1,\alpha_1),(w_1,\alpha_1)),((s_2,\alpha_2),(w_2,\alpha_2))\dots((s_m,\alpha_m),(w_m,\alpha_m))$$
$$= \Delta\left(\frac{\sum_{i=1}^{m} \Delta^{-1}(s_i,\alpha_i)\Delta^{-1}(w_i,\alpha_i)}{\sum_{i=1}^{m} \Delta^{-1}(w_i,\alpha_i)}\right)$$
$$= \Delta\left(\frac{\sum_{i=1}^{m} \beta_i \beta_i}{\sum_{i=1}^{m} \beta_i}\right) \quad (4)$$

where $\beta_i = \Delta^{-1}(x_i, \alpha_i) = i + \alpha_i, \beta_i = \Delta^{-1}(w_i, \alpha_i) = i + \alpha_i$.

IV. EVALUATION PROCESS

Student evaluation information needs to be synthesized and the weight determination of each student is very important and will directly affect the accuracy of the results.[15]The students'assessment of a problem is related to the knowledge structure of the student, the familiarity of the decision-making problem, the experience, the comprehensive ability, the expectation and the preference, which will affect the credibility of the student evaluation information, so we can use these "Historical information" to calculate the weight of students, this weight is called "a priori weight." [16]In the actual evaluation process, the credibility of the evaluation made by the student is not necessarily consistent with his prior weight, so the quality of the evaluation can be given to the student according to the quality of the student's evaluation. This weight is called "Posterior weight". The prior weight and the posterior weights are combined to form the actual weight of the students.[17]

Let $X = (X_1, X_2, X_3, \dots, X_n)$ be s set of course content, $C = (C_1, C_2, C_3, \dots, C_m)$ be the set of criteria, $X = (x_1, x_2, x_3, \dots, x_t)$ be the set of students, the student's weight is $\lambda_s^k (k = 1, \dots, t), 0 \le \lambda_s^k \le 1, \sum_{k=1}^{i} \lambda_s^k = 1$. The student e_k gives the evaluation matrix $B^k = (b_{ij}^k)_{n\times m}, k = 1, \dots, t$, where $b_s^k \in S$ is the student 's evaluation of the j-th index of the i-th scheme. The distance between student x_k and student x_q is defined as:

$$dis(x_k, x_q) = \sum_{i=1}^{n}\sum_{j=1}^{m}(|\Delta^{-1}(s_{ij}^k, \alpha_{ij}^k) - \Delta^{-1}(s_{ij}^q, \alpha_{ij}^q)|) \quad (5)$$

The average distance between x_k and all students is defined as:

$$dis(x_k) = \frac{1}{t-1}\sum_{j-1, j\neq k}^{i} dis(x_k, x_j) \quad (6)$$

The a priori weight of each student is defined as:

$$\lambda_s^k = \frac{\frac{1}{dis(x^k)}}{\sum_{k=1}^{1}\frac{1}{dis(x^k)}} \quad (7)$$

The final weight of each student is defined as:

$$\lambda_s^k = \frac{\frac{1}{dis(x^k)}}{\sum_{k=1}^{1}\frac{1}{dis(x^k)}} \quad (8)$$

Then the evaluation information can be synthesized following these steps:

Let $T = (t_1, t_2, t_3, \dots, t_n)$ be s set of students, $\lambda = (\lambda_1, \lambda_2, \lambda_3, \dots, \lambda_n)$ be s set of student's weights, $W = (w_1, w_2, w_3, \dots, w_n)$ be set of criterion's weights.[18]

Students k select a term from the set S to evaluate the i-th object in j-th criteria, which defined as e_{ij}^k.

First step: According to the equation (1), transform the linguistic evaluation information e_{ij}^k into 2-tuple linguistic term $(e_{ij}^k, 0)$ to obtain the 2-tuple linguistic term matrix $E^i = ((b_{ij}, 0))_{n\times m}$, criterion's weight information into $(w_j^k, 0)$.

Second step: Calculate the students' weight byequations (5)(6)(7)(8).

Third step: Combine all the students' linguistic evaluation information, transform $(b_{ij}^k, 0)$ into $(\overline{b_{ij}}, \overline{\alpha_{ij}})_{n\times m}$.

Fourth step: Use equation (5) to calculate the aggregative criteria value $X_i^* = (b_i^*, \alpha_i^*)$.

Fifth step: Sort the final result by order of 2-tuple linguistic term.

V. ILLUSTRATE EXAMPLE

Five students $(t_1, t_2, t_3, t_4, t_5)$ were selected to evaluate the 7 chapters ($P_1, P_2, P_3, P_4, P_5, P_6, P_7$) of the information management course. The index system is proposed in part 2.

Table Ⅰ the criteria of evaluation

Criteria		C_1	C_2	C_3	C_4	C_5	C_6	C_7
(students)	t_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
	t_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3

t_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
t_4	s_3	s_3	s_3	s_4	s_3	s_4	s_4
t_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4

Table Ⅱthe evaluation information of t_1

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
P_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
P_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3
P_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
P_4	s_3	s_4	s_3	s_4	s_3	s_4	s_4
P_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4
P_6	s_3	s_2	s_3	s_4	s_4	s_3	s_4
P_7	s_2	s_4	s_4	s_4	s_2	s_4	s_4

Table Ⅲ the evaluation information of t_2

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
P_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
P_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3
P_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
P_4	s_3	s_4	s_3	s_4	s_3	s_4	s_4
P_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4
P_6	s_3	s_2	s_3	s_4	s_4	s_3	s_4
P_7	s_2	s_4	s_4	s_4	s_2	s_4	s_4

Table Ⅳ the evaluation information of t_3

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
P_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
P_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3
P_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
P_4	s_3	s_4	s_3	s_4	s_3	s_4	s_4
P_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4
P_6	s_3	s_2	s_3	s_4	s_4	s_3	s_4
P_7	s_2	s_4	s_4	s_4	s_2	s_4	s_4

Table Ⅴ the evaluation information of t_4

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
P_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
P_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3
P_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
P_4	s_3	s_4	s_3	s_4	s_3	s_4	s_4
P_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4
P_6	s_3	s_2	s_3	s_4	s_4	s_3	s_4
P_7	s_2	s_4	s_4	s_4	s_2	s_4	s_4

Table Ⅵthe evaluation information of t_5

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
P_1	s_4	s_2	s_3	s_4	s_2	s_4	s_3
P_2	s_4	s_3	s_4	s_3	s_4	s_3	s_3
P_3	s_4	s_4	s_2	s_2	s_4	s_2	s_2
P_4	s_3	s_4	s_3	s_4	s_3	s_4	s_4
P_5	s_4	s_2	s_4	s_2	s_3	s_4	s_4
P_6	s_3	s_2	s_3	s_4	s_4	s_3	s_4
P_7	s_2	s_4	s_4	s_4	s_2	s_4	s_4

Based on the equation **(**1), the information of the evaluation is transformed to the 2-tuple linguistic model. There is the matrixE^k:

$$E^1 = \begin{bmatrix} (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) \\ (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) & (s_3,0) \\ (s_2,0) & (s_4,0) & (s_3,0) & (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_2,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) \\ (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \end{bmatrix}$$

$$E^2 = \begin{bmatrix} (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) \\ (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) & (s_3,0) \\ (s_2,0) & (s_4,0) & (s_3,0) & (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_2,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) \\ (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \end{bmatrix}$$

$$E^3 = \begin{bmatrix} (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) \\ (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) & (s_3,0) \\ (s_2,0) & (s_4,0) & (s_3,0) & (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_2,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) \\ (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \end{bmatrix}$$

$$E^4 = \begin{bmatrix} (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) \\ (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) & (s_3,0) \\ (s_2,0) & (s_4,0) & (s_3,0) & (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_2,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) \\ (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \end{bmatrix}$$

$$E^5 = \begin{bmatrix} (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) \\ (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) & (s_4,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) & (s_3,0) \\ (s_2,0) & (s_4,0) & (s_3,0) & (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) \\ (s_4,0) & (s_2,0) & (s_3,0) & (s_4,0) & (s_2,0) & (s_4,0) & (s_2,0) \\ (s_3,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) & (s_4,0) \end{bmatrix}$$

The weight of each student:

$$W^1 = \{(s_3,0),(s_3,0),(s_4,0),(s_2,0),(s_3,0),(s_4,0),(s_3,0)\}$$
$$W^2 = \{(s_3,0),(s_2,0),(s_3,0),(s_3,0),(s_2,0),(s_4,0),(s_2,0)\}$$
$$W^3 = \{(s_3,0),(s_2,0),(s_3,0),(s_4,0),(s_2,0),(s_4,0),(s_3,0)\}$$
$$W^4 = \{(s_4,0),(s_2,0),(s_4,0),(s_4,0),(s_2,0),(s_4,0),(s_2,0)\}$$
$$W^5 = \{(s_4,0),(s_2,0),(s_3,0),(s_4,0),(s_4,0),(s_2,0),(s_4,0)\}$$

According to the students' background, structure of knowledge, preference, expectation, comprehensive ability, the previous weights of each student have been given as (0.3, 0.25, 0.2, 0.15, 0.1) , after calculating, the final weights of each students are (0.337,0.261,0.188,0.132,0.082).[19] The linguistic evaluation matrix E^* is:

$$E^* = \begin{bmatrix} (s_3,-0.23) & (s_4,-0.42) & (s_4,-0.12) & (s_4,-0.23) & (s_4,-0.32) & (s_4,0.21) & (s_4,0.12) \\ (s_4,-0.29) & (s_3,0.32) & (s_4,0.41) & (s_3,0.26) & (s_4,-0.35) & (s_3,-0.31) & (s_4,0.35) \\ (s_3,-0.27) & (s_4,-0.33) & (s_3,0.36) & (s_4,0.29) & (s_3,0.41) & (s_4,0.39) & (s_3,0.25) \\ (s_4,0.35) & (s_3,0.39) & (s_4,-0.39) & (s_2,0.26) & (s_4,-0.24) & (s_2,0.42) & (s_3,0.29) \\ (s_2,0.32) & (s_4,0.35) & (s_3,-0.49) & (s_3,0.37) & (s_4,-0.26) & (s_4,-0.38) & (s_4,-0.30) \\ (s_4,-0.20) & (s_2,0.32) & (s_3,0.40) & (s_4,0.41) & (s_2,0.30) & (s_4,-0.20) & (s_2,0.19) \\ (s_3,-0.32) & (s_4,-0.31) & (s_4,-0.40) & (s_4,-0.20) & (s_4,0.39) & (s_4,0.44) & (s_4,0.29) \end{bmatrix}$$

The aggregative indicator value of each chapter is:

E_1^*=(s_4, −0.102), E_2^*=(s_4, −0.391), E_3^*=(s_3, −0.311) E_4^*=(s_3, 0.003), E_5^*=(s_4, −0.219), E_6^*=(s_2, −0.351), E_7^*=(s_4, −0.15). According to the definition 4, the sequence is: E_1^*>E_7^*>E_5^*>E_2^*>E_4^*>E_3^*>E_6^*. And the matrix E^* also shows the strength and weakness of each chapter.

VI. Conclusion

Evaluating the course content is important for both teachers and students. Basic subject is hard to be comprehended for students. There are some background knowledge and previous experience being acquired. It wastes time to teach each chapter in details. It is an important and complicated problem because of the difficulty of processing the linguistic information. In the paper, an approach has been proposed. Teachers are able to find out what interests students most and make the course more efficient by the evaluation. And students also learn what they want. First, the criteria of the course content are measured by the students. Some students are selected to judge each criterion and give their score. Finally, represent the linguistic term and result by using 2-tuple linguistic model. It makes linguistic information process precise. The example shows that the approach is available and fit well for the evaluation of course content.

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