Ranking of Teachers Based on Feedback from the Students using Multiple Subjects

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***Abstract*—** The purpose of this paper is to evaluate the teachers' performance by using the concept of metric. For the evaluation, we have prepared a questionnaire of fifteen questions divided in six categories. An aggregator operator is used to calculate the mean corresponding to different Teacher's and performance evaluation is done for multiple subjects. The overall evaluation is done for the teachers and the ranking is shown in the form of table.

***Keywords*—** Linguistic hedges; Aggregator operator; Euclidean distance; Ranking.

I. Introduction

FUZZY set theory was first introduced by Zadeh [1] in 1965, which is an extension of the crisp set theory; where each element of the well-defined sets is assigned a membership value lies in the closed interval [0, 1]. The non-membership is calculated by subtracting the membership value from one. This fuzzy concept provides a simple way of dealing with problems which involve vagueness, uncertainties, imprecise information, etc. Thus we can say that fuzzy sets provides us a precise knowledge or information using imprecise, inaccurate or from approximate data. We can easily find its application in almost every real-life problems, such as in decision making in a fuzzy environment [2], medical diagnosis [3], facial pattern recognition [4], handwriting recognition [5], students' evaluation [6], industrial engineering [7] and many more. Basically, this concept is extremely useful to almost every area of people, whether they are engineers, medical officers, mathematicians, physicists, computer software developers, businessman or agricultural. Thousands of research papers are published on the applications of Zadeh's fuzzy sets. Fuzzy set theory is further generalized in many ways such as intuitionistic fuzzy sets [8], inter-valued intuitionistic fuzzy sets, Pythagorean fuzzy sets [9] and many more. We can easily find several research articles dealing with applications in real life problems using these extensions.

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In real-world problems, distance measure [10] between two fuzzy sets is an important tool for measuring uncertain situations arising in fuzzy mathematics. Many researchers have used the concept of distance in various applications, for example, in image processing [11], in morphology [12], in fractals, in dynamical systems, etc. Bonissone [13] used distance measures in decision analysis and artificial intelligence, Turksen and Zhang [14] uses the distance measure to demonstrate the applicability of similarity in fuzzy logic inference based on analogical reasoning.

In fuzzy theory aggregation operator is a tool for combining the available information. The notion of aggregation operators on fuzzy sets membership values was well defined by Dubois and Prade [15] in 1985. They showed a new class of connectives from the fusion of data, wherein there is no data loss while calculating maximum and minimum operators, called the aggregation operators and also defined arithmetic, geometric and harmonic means for these aggregation operators. Delgado et al. [16] define aggregation operations between linguistic labels. Its application was shown in decision making and optimization problems involving linguistic hedges without any reference to the semantic representation. Yager [17] introduces the concept of ordered weighted aggregation (OWA) operator and investigates the properties of this operator in 1988. In continuation of the above Torra [18] gave the concept of weighted ordered aggregation operator. He introduces an innovative method to assign weights from a few pre-determined weights and interpolating a function through which the weights for all the membership values can be assigned. These aggregation operators are used in various real-life problems such as in decision making for buying a car, choosing a flight, choosing a good college for study, choosing a tourist spot for summer vacation and many more.

In all these kinds of real-life problems, a distance measure is a common tool for measuring the deviation in decision making. We can easily find a variety of distance measure in the literature dealing with several decision-making problems. The most commonly used distance measures are Hamming distance, normalized Hamming distance, Euclidian distance, normalized Euclidian distance, etc. In fuzzy set theory for all real-life problems, we assign some weight for each of our decisions. Distance measure provides us the information about the small or large deviation by aggregating the difference between the weights of each decision. In decision-making, a lot of work is done by

researchers [19-24]. Lee et al. [19] has shown application of fuzzy sets in Black Scholes option pricing model, Ma [21] in natural language analysis, Paladini [22] in total quality management.

With the concept generated by many scientists all over the world, we can find one such kind of decision-making problem in the education system, for example at the time of recruitment of teacher or at the time of promotion of staff or faculty. Thus decision making aggregation operator becomes a powerful tool in calculating their performances. This analysis is very important in the sense that the growth of any Institute or University is directly proportional to the ability of their staff and faculty. Beside this, it is very important to evaluate their performance, because the future of students depends on those faculties.

The present paper deals with evaluating the teacher's performance on the basis of their knowledge, their regularity and punctuality in the class, their ability to motivate their students for the betterment of their future, their communication skills, students' interest in the class on the basis of their attendance and their fairness in evaluating the results of the students.

II. Basic Definitions

In this section, we first define some basic concepts used in this paper.

Definition 1 (Fuzzy Sets) [1]:

Let us consider a non-empty set *Y*. A fuzzy set *A* defined on the elements of the set Y having the membership value $\mu_A(y)$, defined as $A = \{< y, \mu_A(y) >: y \epsilon Y, \mu_A(y) \in [0,1]\}$.

Definition 2 (Metric for FS) [12]:

A metric or distance d in a set X is a real function defined as $d : X \times X \rightarrow R$, which satisfies the following conditions for $x, y, z \in X$:
(i) $d(x,y) = 0 \Leftrightarrow x = y$
(ii) $d(x,y) = d(y,x)$ (Symmetry)
(iii) $d(x,z) + d(z,y) \geq d(x,y)$ (Triangle inequality)
The most widely used distance measures for fuzzy sets *A* in $Y = \{y_1, y_2, \dots, y_n\}$ are defined as follows:

Definition 3 (Hamming Distance) [25]:

The Hamming distance $d(A,B)$is defined as:

$$d(A,B) = \sum_{i=1}^{n} |\mu_A(y_i) - \mu_B(y_i)|$$

where *A* and *B* are two distinct arbitrary sets.

Definition 4 (Normalized Hamming Distance) [25]:

The formula for normalized Hamming distance $l(A,B)$ is given as follows:

$$l(A,B) = \frac{1}{n}\sum_{i=1}^{n} |\mu_A(y_i) - \mu_B(y_i)|$$

Definition 5 (Euclidean Distance) [25]:

The Euclidian distance is given as:

$$e(A,B) = \sqrt{\sum_{i=1}^{n} (\mu_A(y_i) - \mu_B(y_i))^2}$$

Definition 6 (Normalized Euclidean Distance) [25]:

The normalized Euclidian distance $q(A,B)$ is:

$$q(A,B) = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (\mu_A(y_i) - \mu_B(y_i))^2}$$

In this research paper, an aggregation operator is used to combine responses obtained from the survey of students about five teachers. This aggregation operator permits us to assign weight to the element of the data according to their relevance. The weighted mean aggregation operator [15] is defined as:

Definition 7 (Weighted mean) [18]:

A mapping F from $P^n \rightarrow P$, where P^n is the interval [0, 1] is called a weight of dimension n if a weighting vector w is associated with F, such that

1) $w_i \in [0,1]$
2) $\sum w_i = 1$.

where, $F(x_1, x_2, \dots, x_n) = w_1x_1 + w_2x_2 + \cdots + w_nx_n$

III. Methodology

The present study is carried out by collecting the data of Teachers' performance through a survey using 19 high ranking and above 75% attendance students. A questionnaire is generated for five teachers' (T1-T5) performance evaluation. It contains fifteen questions (Q1-Q15), which were spread across six categories (C1-C6) namely Communication Skills, Subject Knowledge, Regularity and punctuality, Fairness in Marks, Motivation, and the attendance of the students, was asked to the students, and the responses were recorded. The students' response from the sixth category, the attendance of the students, were used to temper the responses of the other categories, and is excluded from the evaluation and ranking of the teachers as such. The student responses were noted in the form of linguistic

hedges, namely Very Poor, Poor, Satisfactory, Fair, Good, Very Good, Excellent, which were then converted to membership values. T he responses of the students were further tempered by their year of study, i.e. first year students have a lower weight assigned while the fourth year have the highest weight assigned. In this the first subject is chosen from first year and second subject is chosen from the second year. The weights assigned are 0.85 and 0.9 respectively.

IV. Questionnaires

Communication Skills (C1)

Q1. How well does the faculty deliver the lecture?

Q2. Does the accent of the faculty delivering the lecture clear?

Q3. How well does the faculty present the ideas?

Q4. How well does the faculty clear your doubts?

Subject Knowledge (C2)

Q5. Does the faculty include all of the points mentioned in the syllabus?

Q6. Does the faculty explain the subject by going to the necessary depth?

Q7. Does the faculty explain the applications of the contents of the subject?

Regularity and Punctuality (C3)

Q8. Is the faculty punctual for lectures?

Q9. Does the faculty regularly take lectures?

Fairness in Marks (C4)

Q10. Does the faculty fairly give the Internal Marks?

Q11. Does the faculty fairly evaluate the written Papers?

Motivation (C5)

Q12. Does the faculty motivate you to participate in the class?

Q13. Does the faculty make you interested in the subject?

Attendance of students (C6)

Q14. Do you regularly attend the lecture?
Q15. How attentive are you during the class?

The following tables, i.e. 1 and 2, show the distance of each question from an arbitrary set having the membership value as 1 for an individual subject, whose membership has been tempered by the responses of students in category 6, which is calculated using Euclidean distance [25]. In table 1, the distances are calculated for subject 1 from 1st year . Similarly in table 2, the distances are calculated for subject 2 from 2nd year.

TABLE I
DISTANCE OF EACH QUESTION FROM AN ARBITRARY SET HAVING MEMBERSHIP VALUE 1 FOR SUBJECT 1

Teacher / Question	T1	T2	T3	T4	T5
Q1	0.367	0.463	0.557	0.483	0.505
Q2	0.545	0.612	0.647	0.652	0.642
Q3	0.384	0.497	0.577	0.521	0.507
Q4	0.384	0.441	0.586	0.497	0.485
Q5	0.378	0.457	0.513	0.484	0.502
Q6	0.403	0.490	0.563	0.507	0.477
Q7	0.414	0.467	0.578	0.527	0.497
Q8	0.366	0.389	0.398	0.443	0.449
Q9	0.361	0.440	0.397	0.442	0.418
Q10	0.409	0.438	0.465	0.469	0.451
Q11	0.397	0.434	0.463	0.501	0.464
Q12	0.379	0.455	0.511	0.485	0.468
Q13	0.379	0.489	0.542	0.497	0.497

TABLE III
DISTANCE OF EACH QUESTION FROM AN ARBITRARY SET HAVING MEMBERSHIP VALUE 1 FOR SUBJECT 2

Teacher / Question	T1	T2	T3	T4	T5
Q1	0.449	0.586	0.439	0.490	0.422
Q2	0.603	0.675	0.604	0.630	0.577
Q3	0.470	0.594	0.452	0.517	0.409
Q4	0.455	0.604	0.476	0.504	0.393
Q5	0.445	0.596	0.426	0.490	0.397
Q6	0.461	0.578	0.462	0.500	0.414
Q7	0.463	0.587	0.450	0.484	0.414
Q8	0.449	0.504	0.371	0.406	0.414
Q9	0.433	0.533	0.377	0.406	0.387
Q10	0.455	0.509	0.411	0.540	0.408
Q11	0.440	0.483	0.467	0.517	0.391
Q12	0.461	0.592	0.472	0.499	0.413
Q13	0.476	0.635	0.461	0.546	0.396

Here each category $(C1, C2, C3, C4, C5)$ was assigned a weight $(0.25, 0.25, 0.2, 0.2, 0.1)$ according to the importance of their relevance in the eyes of the authors. The weights assigned can be changed according to the importance of the category. For aggregation, a weighted mean [18] is used to calculate the values in Tables III and IV.

TABLE IIIII
TEACHERS AGGREGATION AGAINST CATEGORIES FOR SUBJECT 1

	C1	C2	C3	C4	C5
T1	0.4199	0.3985	0.3635	0.4028	0.3794
T2	0.5032	0.4713	0.4143	0.4361	0.4719
T3	0.5917	0.5512	0.3977	0.4639	0.5267
T4	0.5383	0.5059	0.4424	0.4847	0.4913
T5	0.5346	0.4919	0.4332	0.4575	0.4825

TABLE IVV
TEACHERS AGGREGATION AGAINST CATEGORIES FOR SUBJECT 2.

	C1	C2	C3	C4	C5
T1	0.4943	0.4561	0.4413	0.4478	0.4681
T2	0.6147	0.5870	0.5185	0.4961	0.6138
T3	0.4928	0.4461	0.3741	0.4394	0.4662
T4	0.5351	0.4913	0.4056	0.5287	0.5226
T5	0.4503	0.4085	0.4001	0.3999	0.4047

Table III shows the aggregated value of each category for every individual teacher for subject 1. Similarly, table IV depicts the aggregated value for each individual teacher for subject 2. From table III and IV, it is seen for teacher T1, the best ranking is given to category C3 and the least is given to category C1 for subject 1, whereas for subject 2 the best performance of teacher T1 is in category C3 and least in C1.The least distance values obtained in each row provides the best category-wise ranking for a teacher and the highest distance shows the least performance. Similarly, for teacher T2, we observe that the best performance is shown in category C3 for subject 1 and lest for category 1. For subject 2, the same teacher T2 the best performance is shown in category C4 and least in C1. shownwise ranking for two different subjects is shown for all five teachers in tables V and VI. For T3, T4 and T5, similar behavior is seen for subject 1. For subject 2, T3 and T4 the best category performance is C3 and worst is C1, where as for T5, the best is C4 and worst is C1.

TABLE V

RANKING OF EACH CATEGORY FOR EVERY INDIVIDUAL TEACHER WITH RESPECT TO THE CATEGORY NEEDS THE MOST IMPROVEMENT FOR SUBJECT 1

T1	**C3**	**C5**	**C2**	**C4**	**C1**	C3≻C5≻C2≻C4≻C1
	0.3635	0.3794	0.3985	0.4028	0.4199	
T2	**C3**	**C4**	**C2**	**C5**	**C1**	C3≻C4≻C2≻C5≻C1
	0.4143	0.4361	0.4713	0.4719	0.5032	
T3	**C3**	**C4**	**C5**	**C2**	**C1**	C3≻C4≻C5≻C2≻C1
	0.3977	0.4639	0.5267	0.5512	0.5917	
T4	**C3**	**C4**	**C5**	**C2**	**C1**	C3≻C4≻C5≻C2≻C1
	0.4424	0.4847	0.4913	0.5059	0.5383	
T5	**C3**	**C4**	**C2**	**C5**	**C1**	C3≻C4≻C5≻C2≻C1
	0.4413	0.4478	0.4561	0.44681	0.4943	

TABLE VI

RANKING OF EACH CATEGORY FOR EVERY INDIVIDUAL TEACHER WITH RESPECT TO THE CATEGORY NEEDS THE MOST IMPROVEMENT FOR SUBJECT 2

T1	**C3**	**C4**	**C2**	**C5**	**C1**	C3≻C4≻C2≻C5≻C1
	0.4413	0.4478	0.4561	0.4681	0.4943	
T2	**C3**	**C5**	**C2**	**C4**	**C1**	C4≻C3≻C2≻C5≻C1
	0.5185	0.5267	0.587	0.5961	0.6147	
T3	**C3**	**C4**	**C2**	**C5**	**C1**	C3≻C4≻C2≻C5≻C1
	0.0.3741	0.4394	0.4461	0.4662	0.4928	
T4	**C3**	**C2**	**C5**	**C4**	**C1**	C3≻C2≻C5≻C4≻C1
	0.4056	0.4913	0.5226	0.5287	0.5351	
T5	**C4**	**C3**	**C5**	**C2**	**C1**	C4≻C3≻C5≻C2≻C1
	0.3999	0.4001	0.4047	0.4085	0.4503	

In Table VII, the overall aggregated value is evaluated using the weighted arithmetic mean. It is seen that the best teacher in overall categories is T1 and the least is T2.

TABLE VII
OVERALL RANKING OF TEACHERS

Teacher	Overall	Overall Ranking
T1	0.4300	**T1 ≻ T5 ≻ T3 ≻ T4 ≻ T2**
T2	0.5143	
T3	0.4764	
T4	0.4957	
T5	0.4481	

In this research paper, we have shown one of the uses of distance measure and aggregation operator related to the teacher's individual wise and overall performance among different categories.

V CONCLUSION

The primary purpose of this work is that the faculty should analyze their strength and weakness so that they can improve themselves and enable themselves to help their students in making their future in a better way. Further, this kind of survey is very useful at the time of faculties' promotions or achieving other benefits. In this work, the survey is concentrated to only for few faculties by taking the review from few students. To know the effectiveness and usefulness of this method, one can increase the batches of the students and also this kind of survey is also useful for company employee, bank employee, etc. This becomes helpful in improving the knowledge, skill, and performance of a particular employee.

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