Evaluation of Teachers' Performance Based on Students' Feedback Using Aggregator Operator

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Abstract: - The objective of the research paper is to evaluate the teachers' performance using the concept of metric. For this purpose, we have prepared a questionnaire of fifteen questions which are broadly classified into six categories. The categories are assigned a weight depending on the importance. An aggregator operator is used to calculate the mean corresponding to different Teacher's and performance evaluation is done. Thus overall ranking is done for the teachers and it is shown in the final table. The technique developed will be very helpful to the management for evaluating faculties for each category and also helpful to the faculties to know their weakness and strength in each category so that it can be corrected.

Key-Words: - Linguistic hedges, Fuzzy sets, Metric, Aggregator operator, Euclidean distance.

1 Introduction

Fuzzy sets was first introduced by Zadeh [1] in 1965, which is an extension of crisp set; where each element of the well defined sets is assigned a membership value lies in the closed interval [0,1]. This fuzzy concept provides a simple way of dealing with problems which involves 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], students' evaluation [5], knowledge extraction systems [6], human resource management [7], academic staff performance evaluations [8], industrial engineering [9], 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.

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, image processing [11], morphology [12], etc. Bonissone [13] used distance measures in decision analysis and artificial intelligence. Turksen and Zhang [14] uses distance measure to demonstrate the applicability of similarity in fuzzy logic inference based on analogical reasoning. Lindblad et al. [15] in 2014 has shown distances are directly applicable for comparing gray level images or fuzzy segmented objects, and also for detecting patterns and matching parts of images. In 2017,

Palash [16] has used the distance measure to carry out medical diagnosis on picture fuzzy sets and shown the technique with a suitable case study.

In fuzzy theory aggregation operator is a tool for combining the available information. The notion of aggregation operators on fuzzy sets membership values is well defined by Dubois and Prade [17] 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 [18] defines aggregation operations between linguistic labels. Their application in decision making and optimization problems involving linguistic hedges without any reference to the semantic representation are shown. Yager [19] introduces the concept of ordered weighted aggregation (OWA) operator and investigates the properties of this operator in 1988. In continuation of the above Torra [20] gave the concept of weighted ordered aggregation operator. Torra introduced 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, 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 measure are Hamming distance, normalized Hamming distance, Euclidian distance [21], normalized Euclidian distance [21], etc. The landmark paper on fuzzy sets is given by Lin [22] in 2014 which defines distributive law, convex combination and convex fuzzy sets. The use of fuzzy sets on human psychology was recently shown by Stoklasa et al. [23]. A study on fuzzy sets and its applications were discussed in the recent paper by Mapari et al. [24].

In 2012, Patil et al. [25] using fuzzy based approach has developed a numerical grading system for giving best student award based on the feedback provided by the teachers. In fuzzy 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.

We can find one such kind of decision making problem in education system, for example at the time of recruitment of teacher or at the time of promotion of staff or faculty, this decision making aggregation operator becomes a powerful tool in calculating their performances. This analysis is very important in the sense that 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 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. The motivation for this paper is based on the fuzzy based numerical approach adopted for giving student award [25].

2 Preliminaries

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 $A = \{< y, \mu_A(y) >: y \in Y, \mu_A(y) \in [0,1]\}$.

Definition 2 (Metric for FS) [12]: A metric or distance d in a set X is a real function defined as $d : X \times X \to R$, 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) [21]: The Hamming distance between two sets A and B, dentoted by $d(A,B)$ is defined as:

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

where $\mu_A(y_i)$ and $\mu_B(y_i)$ denotes the membership values of the elements y_i.

Definition 4 (Normalized Hamming Distance) [21]: 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) [21]: 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) [21]: 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, we use Euclidean distance to calculate membership value. Similarly, 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) [20]: 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, $F(x_1, x_2, \dots, x_n) = w_1x_1 + w_2x_2 + \cdots + w_nx_n$

3 Methodology

The present study is carried out by collecting the data of Teachers' performance through a survey using 19 high ranker 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) and were asked to the students. 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.

4 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 lecture?

Q15. How attentive are you during the class?

The following Table shows the distance of each question from an arbitrary set having membership value as 1, which is calculated using Euclidean distance.

Table 1: Distance of each question from an arbitrary set having membership value 1

Teachers / Questions	T1	T2	T3	T4	T5
Q1	0.197	0.368	0.368	0.259	0.342
Q2	0.192	0.311	0.286	0.286	0.311
Q3	0.228	0.404	0.404	0.281	0.360
Q4	0.224	0.333	0.434	0.281	0.338
Q5	0.211	0.360	0.316	0.259	0.32
Q6	0.241	0.390	0.368	0.289	0.329
Q7	0.25	0.355	0.386	0.307	0.311
Q8	0.197	0.272	0.193	0.184	0.202
Q9	0.184	0.333	0.193	0.189	0.197
Q10	0.246	0.303	0.25	0.237	0.333
Q11	0.224	0.281	0.241	0.303	0.329
Q12	0.224	0.368	0.342	0.263	0.311
Q13	0.24	0.417	0.404	0.268	0.382
Q14	0.228	0.246	0.237	0.263	0.246
Q15	0.263	0.307	0.294	0.259	0.333

Here each category $(C1, C2, C3, C4, C5, C6)$ was assigned a weight $(0.25, 0.25, 0.15, 0.15, 0.1, 0.1)$ according to the importance of their relevance in the eyes of the authors. For aggregation, a weighted mean is used to calculate the values in Table 2.

Table 2: Teachers aggregation against Categories.

	C1	C2	C3	C4	C5	C6
T1	0.21021	0.23392	0.19079	0.23465	0.22368	0.24561
T2	0.35401	0.36842	0.30263	0.29167	0.39254	0.27632
T3	0.37296	0.35673	0.19298	0.24561	0.37281	0.26535
T4	0.27647	0.28509	0.18640	0.26974	0.26535	0.26097
T5	0.33756	0.32018	0.19956	0.33114	0.34649	0.28947

Table 3 shows the ranking of each category for every individual teacher from their best category with respect to the category which needs the most improvement. According to the student's feedback, it is seen for teacher T1, the best ranking is given to category C3 and the least is given to category C6. Similarly for teacher T2, the best category is assigned as C6 and improvement is needed in C5. In such a way, we can evaluate all five teachers in terms of category wise.

Table 3: Ranking of each category for every individual teacher with respect to the category needs the most improvement

T1	**C3**	**C1**	**C5**	**C2**	**C4**	**C6**
	0.1908	0.2102	0.2237	0.2339	0.2346	0.2456
T2	**C6**	**C4**	**C3**	**C1**	**C2**	**C5**
	0.2763	0.2917	0.3026	0.3540	0.3684	0.3925
T3	**C3**	**C4**	**C6**	**C2**	**C5**	**C1**
	0.1930	0.2456	0.2654	0.3567	0.3728	0.3730
T4	**C3**	**C6**	**C5**	**C4**	**C1**	**C2**
	0.18	0.26	0.26	0.26	0.27	0.28

	64	10	54	97	65	51
T5	**C3**	**C6**	**C2**	**C4**	**C1**	**C5**
	0.19 96	0.28 95	0.32 02	0.33 11	0.33 76	0.34 65

In Table 4, the overall aggregated value is evaluated using arithmetic mean which depicts the rank of individual teacher in comparison to other teacher. It is seen that the best teacher in overall categories is T1 and the least is T2.

Table 4: Overall Ranking of Teachers

Teacher	Overall	Ranking
T1	0.22178	**T1 ≻ T4 ≻ T5 ≻ T3 ≻ T2**
T2	0.33664	
T3	0.31203	
T4	0.26144	
T5	0.30764	

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

5 Conclusion

The primary purpose of this work is that, faculty should analyze their strength and weakness, so that they can improve themselves and becomes able 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 survey is concentrated to only for few faculties by taking 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 particular employee.

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