A Novel Method to Find the Optimism Index of Examiner in Students' Evaluation

Shilpa Ingoley, Jagdish Bakal

Abstract— This paper presents a novel method to find out the optimism index of the examiner. Optimism index gives us the idea about the type of examiner. Optimism index is used by some authors Wang and Chen (2008, 2009) in evaluating student answersheet using fuzzy numbers. There are different types of examiners such as lenient, strict and normal. These examiners may be strict or lenient but their degree of strictness and leniency will be different. This paper proposed a method to find the optimism index of examiner which can be helpful in evaluating students' answersheets more accurately. It makes use of fuzzy logic to do so.

Index Terms— Fuzzy Logic, Fuzzy Set, Fuzzy Inference System (FIS), Optimism Index, Student's Evaluation, Fuzzification, Defuzzification.

1 INTRODUCTION

IN recent years, many researchers have started using fuzzy logic, fuzzy sets, fuzzy inference system (FIS), fuzzy logic controller (FLC) in educational grading and evaluation systems. Biswas [2] highlighted the importance of evaluation in education system. He used fuzzy set theory in student evaluation and is finer than awarding grades or numbers when evaluating answerscipts. The method presented by him are fem and generalized fem. Chen and Lee[3] extended Biswas's work and presented methods which removes drawbacks of his' methods. Their methods do not transfer the different fuzzy marks into same letter grade and perform calculations in much faster manner and don't require complicated matching operations. Bai and Chen [16] uses fuzzy grading system which utilizes students' and instructor's performance measures in order to modify a set of collectively approved, a priori fuzzy grades, so as to produce a "fair" mark distribution. James Nolan [7] applied FL in an expert classification system for supporting the grading of student writing samples. Later on [9] proposed method for evaluating student answerscripts using fuzzy numbers associated with degree of confidence. They have considered degree of confidence of evaluator when awarding satisfaction level to questions of student answerscripts. Bai and Chen [15] proposed a method for automatically constructing grade membership functions of lenient-type grade, strict-type grade and normal-type grades given by teachers for students' evaluation. [1] Proposed a method for automatically generating the weights for several attributes with fuzzy reasoning capability. Fuzzy synthetic decision method through composite operations, in evaluating student's academic achievement for high school students is used by [19], in Taiwan. Combined effect of difficulty, complexity, importance on students' answersheet is considered by [4] and evaluation is done by using FIS. Concept of vagueness of question paper is introduced by [12]. Model of students' evalution system is given in [20], their design shows the recommended flow of students' evaluation system. In [21] used two- node structure in students' evaluation without considering "time" factor.

Wang and Chen have proposed fuzzy evaluation methods with degree of confidence of evaluator along with satisfaction level of examiners [9] and interval-value grade methods [17]. Experimental result shows that their proposed methods are more stable and flexible than Biswas's [2] and Chen and Lee's [3] methods used in evaluating students answersheets using fuzzy numbers.

Method proposed by Wang and Chen using fuzzy satisfaction levels in [9] and [17] respectively, has drawback– how to find the optimism index of examiner is not specified. As per them in [9] and [17], an index of optimism λ determined by the evaluator is used to indicate the degree of optimism of evaluator, where $\lambda \in [0, 1]$. That indicates the examiner will decide the value of index of optimism. We emphasize that it will be very much subjective decision because one may think that he/she may be very strict, but actually examiner may be less or much more strict than what he/she thinks. Examiner may be considering him/her as lenient but actually may belong to normal category. As per particular examiner he may be strict with optimism index value $\lambda = 0.4$ but actually he can be very strict with value of optimism index $\lambda = 0.3$ or $\lambda = 0.2$. Lenient examiner will consider that his/her optimism index is $\lambda = 0.6$ but actually that examiner may be very lenient with optimism index $\lambda = 0.8$ and vice a versa.

This paper proposed a new method in determining the values of optimism index. It makes uses of fuzzy logic to solve the above problem.

The rest of paper is organized as follows. In section 2, we briefly review Wang and Chen method of students' evaluation using fuzzy numbers associated with degree of confidence from [9]. In Section 3, we present a new method to find out index of optimism of evaluator which is required for methods proposed in [9] and [17]. Experimental results are shown in section 4. The conclusions are discussed in section 5.

2 A REVIEW OF WANG AND CHEN METHOD

In this section, we briefly reviews the Wang and Chen's method for students answersheets evaluation using fuzzy numbers associated with degree of confidence from [9]. For fuzzy assessment they have used triangular membership functions and nine satisfaction levels. Nine satisfaction levels are used to

award the degree of satisfaction to each question are shown below:

Extremely Good (EG) = (100, 100, 100)
Very Good (VG) = (90, 100, 100)
Good (G) = (70, 90, 100)
More or Less Good (MG) = (50, 70, 90)
Fair (F) = (30, 50, 70)
More or Less Bad (MB) = (10, 30, 50)
Bad (B) = (0, 10, 30)
Very Bad (VB) = (0, 0, 10)
Extremely Bad (EB) = (0, 0, 0).

When examiner is awarding satisfaction level to each question, then along with satisfaction level he/she has to award degree of confidence. Degree of confidence is nothing but degree of certainty i.e. how much examiner is confidence about awarding that satisfaction level to the answer of a question of a student's answersheet. Degree of confidence will be in the range of [0 1] . There is an uncertainty associated with the satisfaction level to the answer of a question of a student's answersheet. If examiner has full confidence in awarding satisfaction level he can give degree of satisfaction as one. Small degree of confidence indicates evaluator does not have full confidence to award a satisfaction level to the answer of the question of student's answersheet.

Authors have also introduces the concept of optimism index λ in their paper. Optimism index $\lambda \in [0,1]$, determined by evaluator/examiner. It is use to indicate the degree of optimism of the evaluator for evaluating students' answesheets. Some evaluator belong to pessimistic evaluators, where they award lower scores can be categorized as strict teacher will have optimism index value between $0 \leq \lambda < 0.5$. Some evaluator belongs to optimistic evaluators, where they award higher scores can be categorized as lenient teacher will have optimism index value between $0.5 < \lambda \leq 1$. If $\lambda = 0.5$, then evaluator is normal evaluator. The larger the value of λ more optimistic of the evaluator. The smaller the value of λ more pessimistic of evaluator.

Following are the step to evaluate student's answersheet:

Step 1: Calculate the α –cut $(F_1)_\alpha$ of the fuzzy number F_1, the β-cut $(F_2)_\beta$ of the fuzzy number F_2, the γ–cut $(F_3)_\gamma$ of the fuzzy number F_3, …. and the δ–cut $(F_n)_\delta$ of the fuzzy number F_n, respectively, where

$(F_1)_\alpha$ = [a1, a2]

$(F_2)_\beta$ = [b1, b2]

$(F_3)_\gamma$ = [c1, c2]

:

$(F_n)_\delta$ = [z1, z2]

$\alpha \in [0,1], \beta \in [0,1], \gamma \in [0,1], \ldots . and \ \delta \in [0,1].$

Step 2: Calculate the interval-valued total mark $[m1, m2]$ of the student's answerscript, where

$$[m_1, m_2] = [\frac{s1}{s1+s2+\cdots+sn} \times (F_1)\alpha + \frac{s2}{s1+s2+\cdots..+sn} \times (F_2)\beta + \frac{s3}{s1+s2+\cdots.+sn} \times (F_3)\gamma + \ldots.\frac{sn}{s1+s2+\cdots+sn} \times (F_n)\,\delta]$$

$$[m_1, m_2] = [\frac{s1}{s1+s2+\cdots+sn} \times [a1, a2] + \frac{s2}{s1+s2+\cdots.+sn} \times [b1, b2] + \frac{s3}{s1+s2+\cdots.+sn} \times [c1, c2] + \ldots\ldots\ldots + \frac{sn}{s1+s2+\cdots..+sn} \times [z1, z2].$$

…… (1)

Step 3: The total mark of the student is evaluated as follows for each question from i=1 to n.

$$Q_i = (1-\lambda) \times m_1 + \lambda \times m_2 \qquad \ldots\ldots\ldots\ldots(2)$$

Where λ denotes the optimism index determined by the evaluator and $\lambda \in [0\ 1]$.

$$\text{Total\_Marks} = \sum_{i=1}^{n} Q_i \qquad \ldots\ldots\ldots\ldots (3)$$

The degree of confidence of the total mark awarded to the student is equal to Min (α, β, γ,….,δ) where Min (α, β, γ,….δ) $\in$ [0,1]. Put this total mark and the degree of confidence in the appropriate box at the bottom of the fuzzy grade sheet.

3 Novel Method to Find the Optimisim Index

In the proposed method assessment of students answersheets can be done in either by traditional method in which numbers are awarded or in case of fuzzy assessment, satisfaction level are awarded by examiners but marks should be converted into numbers.

Following are the steps to find the optimism index of examiner.

Step 1: Select 'm' numbers of students' answersheets randomly as sample answersheet (for example three, five, seven etc.). Now these selected 'm' numbers of answersheet should be given to 'n' number of examiners, who will be doing the assessment of these answersheet and will award marks to each answersheets as per their judgment.

Now, find the average of marks given by them to each answersheet by following formula,

$$AvgA_i = \frac{\sum_{j=1}^{n} A_{ij}}{n}, \qquad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where i=1 .. m and j=1..n .

Step 2: Calculate the average marks given by each 'n' examiner to 'm' answesheets, which will be indivisual teacher's average.

$$AvgT_j = \frac{\sum_{i=1}^{m} A_{ij}}{m} \quad \ldots\ldots\ldots (5)$$

Where $i = 1..m$ and $j = 1..n$.

To have more fair judgment in deciding the type of examiner, calculate the average of average marks of students 'm' answersheets. This will be summation of average marks got to each ansewersheet divided by number of answersheets (m), that will give average of average (AvgAvg).

$$\text{AvgAvg} = \frac{\sum_{i=1}^{m} AvgA_i}{m} \quad \ldots\ldots\ldots (6)$$

Where $i = 1..m$.

Step 3: Calculate the difference between $AvgT_j$ and AvgAvg. When we are calculating difference between the average marks given by each examiner to all the answersheets and average of average marks got to all answersheets, this difference will help in finding type of examiners more accurately.

$$D_j = AvgT_j - \text{AvgAvg} \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where $j = 1..n$.

If difference of examiner (D_i) is negative, when subtracting from $AvgT_j$ and average of average marks (AvgAvg), then the examiner is pessimistic evaluator and can be consider as strict type examiner and will have optimism index value tween $0 \leq \lambda < 0.5$. But if difference is positive then examiner is considered as optimistic evaluator and can be considered as lenient type evaluator with optimism index value between $0.5 < \lambda \leq 1$. Normal type examiner will have difference zero or very small value of either positive or negative difference and optimism index value will be $\lambda = 0.5$.

Step 4: To find the optimism index of examiner it will go through three phases:

- Fuzzification
- Inference
- Defuzzification

Mamdani's fuzzy inference method is used for evaluation. Input is fuzzified by using triangular membership function. Defuzzification is done by using center of gravity (COG) defuzzification technique.
Input to FIS is given as difference (D_j) of each examiner. To fuzzify the crisp input following eleven fuzzy set are used. Fuzzy sets used are represented by triangular fuzzy numbers which are also shown in Fig 1.

Negative Extremely Large (NEL) = (-24 -21 -18)
Negative Large (NL) = (-20 -17 -14)
Negative Medium (NM) = (-16 -13 -10)
Negative Small (NS) = (-12 -9 -6)
Negative Very Small (NVS) = (-8 -5 -2)
Moderate = (-4 0 4)
Positive Very Small (PVS) = (2 5 8)
Positive Small (PS) = (6 9 12)
Positive Medium (PM) = (10 13 16)
Positive Large (PL) = (14 17 20)
Positive Extremely Large (PEL) = (18 21 24).

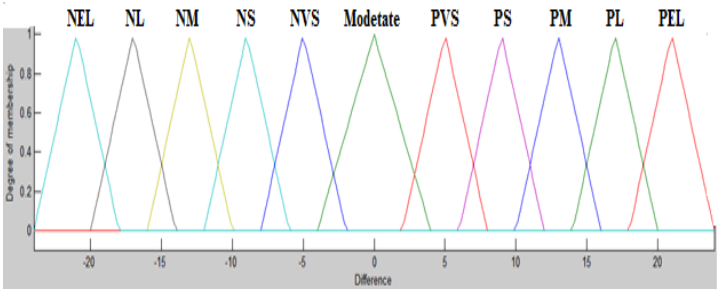

Fig. 1. Input Membership functions for Difference

On the basis of difference, we want to find out the type of examiner. To define the type of examiner as output, eleven fuzzy set are used. To find the value of optimism index of examiner, these eleven fuzzy sets will be map to input difference (D_j). Fig 2 also shows the values of output membership functions. For simplicity triangular Membership functions (MFs) are used, which are shown below:

Extremely Strict (ES) = (0 0 0.1)
Very Strict (VS) = (0 0.1 0.2)
Strict (S) = (0.1 0.2 0.3)
Medium Strict (MS) = (0.2 0.3 0.4)
Less Strict (LS) = (0.3 0.4 0.5)
Normal = (0.4 0.5 0.6)
Less Lenient (LL) = (0.5 0.6 0.7)
Medium Lenient (ML) = (0.6 0.7 0.8)
Lenient (L) = (0.7 0.8 0.9)
Very Lenient (VL) = (0.8 0.9 1)
Extremely Lenient (LL) = (0.9 1 1).

Second phase is inference. Following rulebase is used to map input to the output.

- 1. If (Difference is Moderate) then (Lamda is Normal)
- 2. If (Difference is NVS) then (Lamda is LS)

- 3. If (Difference is PVS) then (Lamda is LL)
- 4. If (Difference is NS) then (Lamda is MS)
- 5. If (Difference is PS) then (Lamda is ML)
- 6. If (Difference is NM) then (Lamda is S)
- 7. If (Difference is PM) then (Lamda is L)
- 8. If (Difference is NL) then (Lamda is VS)
- 9. If (Difference is PL) then (Lamda is VL)
- 10. If (Difference is PEL) then (Lamda is EL)
- 11. If (Difference is NEL) then (Lamda is ES)

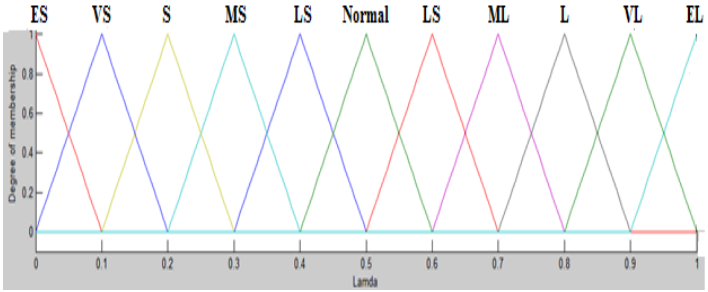

Fig. 2. Output Membership function for optimism index λ

Third phase is Defuzzification, to defuzzify COG method is used. This will generate the crisp value of optimism index (λ) of examiner.

4 Exprimental Results

This section discusses the experimental results. For Comparison purpose, at the end we have taken an example which is consided by [9].

Example: Assume that number of Teachers/Examiners is ten and number of sample ansersheets chosen randomly is five. Table 1 which represents marks of students' answersheets is taken from [5].

TABLE 1
Marks of Students' Answersheets

Marks	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
A_1	18	23	26	30	33	38	42	43	46	48
A_2	31	34	35	39	42	42	51	53	59	61
A_3	46	53	65	69	71	71	71	72	74	75
A_4	68	69	74	75	80	82	84	88	92	96
A_5	80	84	84	91	91	93	95	100	100	100

Step 1: To find the average of marks awarded to each answersheet as shown in Table 1 and by using formula (4) , output is shown in Table 2,

TABLE 2
Average Reference Marks For Each Student's Answersheet

Students Answersheet	A_1	A_2	A_3	A_4	A_5
AvgA	34.7	44.7	66.7	80.8	91.8

Step 2: Using formula (5), find the average marks given by each 'n' examiner to 'm' answesheets which is shown in Table 3.

TABLE 3
Average Reference Marks of Each Teacher Given to Answersheets

Teacher	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
AvgT	48.60	52.60	56.80	60.80	63.40	65.20	68.60	71.20	74.20	76.00

Formula (6) is used to evaluate average of average marks got to each answersheet, which is shown below:

AvgAvg=63.74

Step 3: Difference (D_j) of each examiner's average ($AvgT_j$) from average of average (AvgAvg) is calculated using formula (7).

TABLE 4
Difference (D_j) of Each Teacher's Average Marks From AvgAvg

Teacher	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
D_j	-15.14	-11.14	-6.94	-2.94	-0.34	1.46	4.86	7.46	10.46	12.26

Step 4: Perform the fuzzification as per Fig 1, use the rulebase, which has eleven rules. Defuzzification procedure will generate the value of optimism index (λ) as shown in Table 5.

TABLE 5
Optimism Index of Each Teacher

Teacher	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Optimism Index(λ)	0.14	0.24	0.35	0.45	0.5	0.5	0.6	0.67	0.72	0.8

Let us illustrate the example which is discussed in [9] and same has been shown in Table 6. In this example, satisfaction levels i.e. fuzzy marks awared by examiner and degree of confidence of examiner are kept same. Now to see the effect of different value of optimum index (λ) of examiner, we have taken different values of optimism index of examiner i.e. λ.

TABLE 6
A Fuzzy Grade Sheet of a Student

Question No.	Satisfaction Levels	Degree of Confidence of satisfaction level
Q.1	More or Less Good	0.75
Q.2	Good	1.0
Q.3	More or Less Bad	0.75
Q.4	Very Good	0.95

After inserting the values in formulae (1) to (3) from Table 6, we got the following result for different values of optimism index (λ) of examiner.

Total is = 72.15 ≈ 72 for optimism index $\lambda = 0.3$
Total is = 72.74 ≈ 73 for optimism index $\lambda = 0.4$
Total is = 75.08 ≈ 75 for optimism index $\lambda = 0.8$
Total is = 75.66 ≈ 76 for optimism index $\lambda = 0.9$

Above result gives the clear indication that though satisfaction level and degree of confidence of examiner is kept same, but if values of optimism index are different then the obtained total marks are also different.

5 Conclusion

In a scenario, where multiple evaluators or examiners do the assessments of students' answersheets, there is every possibility that some examiners may be strict, some may be lenient and some are of normal type. This paper presents a novel method to find out examiners degree of strictness or leniency and generate optimism index (λ) accordingly. Value of optimism index is used by some authors in fuzzy evaluation. This paper definitely provides method to generate more accurate optimism index of examiners which is helpful in evaluating students' answersheets in more fair and transparent manner.

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