Soft computing model for students’ evaluation in educational institute

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Abstract. Now a day’s higher education is become more competitive. Students are the main pole of today’s education. All educational institutions are focusing on the quality improvement and change in the traditional evaluation methods. Due to the high competition among Private Universities and existing National Universities the scenario of evaluation methods has important role so that the students shall be kept on track as an active learner through their modified methods of evaluation. Consequently, the evaluation of students through traditional methods has limitations as it is based on the crisp boundaries. The students having a very small difference of marks can be placed into different grades. Also the students who have missed the chance of appearing for one of the subject head may be fail due to absolute method of grading. A soft computing model for students’ evaluation of student in educational institute using subject wise and other activities performance is developed in this paper. To consider uncertainties occur during the semester fuzzy logic technique is applied.

Keywords: Fuzzy Sets, Fuzzy Expert System, students’ performance, Decision Making.

1. Introduction

Traditional method of absolute grading is used on wide basis to evaluate the students’ academic achievement since many decades. Some institutions have changed their method of evaluation from absolute grading to a relative grading on the basis of students score in particular subject. Fuzzy logic (FL) approach is the new idea for students’ academic performance evaluation in educational field. The evaluation of students’ performance using fuzzy techniques is adapted for evaluation based on obtained numerical scores in the assessment by Ramjeet Sing Yadav (2011) [4]. Mahmood Othman et al (2008) [2] used the multicriteria decision making in ranking the quality of teaching quality with the help of fuzzy rule.

The government and the higher educational organizations are very keen about the satisfaction and the quality of education and its evaluation to maintain the standards. This resulted into the use of different advanced techniques for teaching learning and in evaluating the students by academic institutions. Therefore the universities have introduced reliable evidences of the quality evaluation methods for the teachers and students evaluation. The evaluation of students’ performance thus depends on several parameters and the criteria decided according to situation for the regular practice. Thus there is a need to use fuzzy logic based approach in analyzing multicriteria based student’s performance evaluation methods as a regular practice.
The main aim of this research paper is to evaluate the students’ academic performance for a subject into grade. Using the past experience of a teacher and knowledge of researchers, policy makers & experts from renowned educational institutions the approach of a FL techniques and fuzzy rule inference is used in this study. During the academic session or semester many uncertainties occur while executing the examination and continuous evaluation activities from both side i.e. a student or a teacher/institute. To handle such type of imprecise data for evaluation of students performance FL technique gives the more suitable and reliable result. Thus FL provide an alternative way of evaluation of student’s performance in the educational institute for handling the all kinds of uncertainties occur during the session.

2. Tools and Techniques used

2.1 Fuzzy Logic

The concept of Fuzzy set and FL was introduced by Lofty A. Zadeh [5], Professor in Computer Science at University of California in Barkeley.

Ordinary crisp set has the exact boundaries whereas fuzzy set has the flexible boundaries. This shows that fuzzy set allows sharply defined boundaries as it determines from generalization of a characteristic function to a membership function. FL is used to represent specially designed knowledge and human reasoning in such a way that it enables the processing by computer for the further application and inferences. This is also introduced in artificial intelligence, control engineering, and expert systems discussed by Padhy N P (2005) [32].

Traditional methods do not allow for the degree of imprecision indicated by words of phrases or the characteristic such as very good, good, average, poor and very poor instead of truth values like true or false. This type of predicate or the characteristic sentences or phrases along with any uncertainties are possible to introduce in the multivalued logic such as FL which can consider the words of phrases or the characteristics like unsatisfactory, satisfactory, average, good, and excellent.

A set or a group which admits the possibility of partial membership in it is called a Fuzzy Set Zadeh L A (1965) [5][6].

Let \( X = \{x\} \) denote a space of objects. Then a fuzzy set \( A \) in \( X \) is a set of ordered pairs eqn (2.1)

\[
A = \{x, \mu_A(x) \}, \quad x \in X \quad ....... \quad ......... \quad ........(2.1)
\]

Where, \( \mu_A(x) \) is the grade of membership of \( x \) in set \( A \)

i.e. \( \mu_A(x) \in [0, 1] \)

2.2 Membership Function

For any set the member or an object is belong to the some or more extent is represented by the degree of membership. Thus membership function represents the grade of membership of a particular element in the particular set or the group. The accuracy of the FL application is more if the shape and boundary of the membership function is correct.

There are different types of the membership function (MF) like triangular MF, trapezoidal MF function, Gausian MF etc. Zadeh L A [5][6][7]. In established model, trapezoidal MF were formed for input variables Students score in End Semester Examination (ESE), Students Score in Unit Test, Teachers Assessment Score and output variable students’ performance of the subject.

3. Fuzzy model for the present study

Concentrating on the students’ performance based on the teaching learning activities in the institute, we feel that it is important to consider the influence of factors with uncertainties occurs during
the semester. The parameters like Students score in End Semester Examination (ESE), Students Score in Unit Test and Teachers Assessment Score have valuable contribution in measuring the students’ performance of the subject.

The model representation of FL system by using three inputs whose output is the students’ performance in the subject as the final output in terms of the grades Chaudhari O K et al (2012) [1] is given in Figure (3.1)

For the present study three input variables are used as given below.

i. Students score in End Semester Examination (ESE)
ii. Students Score in Unit Test
iii. Teachers Assessment Score

And output variable is the students’ performance of the subject.

3.1 Fuzzification of Input Variables

The inputs of fuzzy system as mentioned above in terms of students score in End Semester Examination (ESE), Students Score in Unit Test, and Teachers Assessment Score. These scores are categorized into linguistic terms as outstanding, excellent, very good, good, average, poor, very poor and worst. These linguistic terms are compared with the grade points as in relative grading AA, AB, BB, BC, CC, CD, DD & FF respectively. Trapezoidal membership function are formed by assigning the suitable range to respective linguistic term.

The crisp values of scores of linguistic terms then converted into fuzzy values using trapezoidal membership function as mentioned by eqn. (3.1)
3.1.1. Students Score in End Semester Examination (ESE)

The grades are divided into fuzzy linguistic variable ranges with trapezoidal MF for input variable Students Score in ESE as in Table (3.1).

Table 3.1. Linguistic variable ranges for Input Variable F₁.

| Input Variable (F₁) | Fuzzy Linguistic Variable | Crisp Input Range |
|---------------------|---------------------------|-------------------|
| Students Score in ESE | AA | [50, 52, 60, 60] |
|                     | AB | [47, 49, 51, 53] |
|                     | BB | [41, 43, 48, 50] |
|                     | BC | [35, 37, 42, 44] |
|                     | CC | [29, 31, 36, 38] |
|                     | CD | [23, 25, 30, 32] |
|                     | DD | [17, 19, 24, 26] |
|                     | FF | [0, 0, 18, 20] |

From above data for input variable Students Score in ESE the trapezoidal MF in MATLAB is as given by Figure (3.2).

3.1.2. Students Score in Unit Test

Fuzzy linguistic variable ranges with trapezoidal MF for input variable Students Score in Unit Test given by Table (3.2).
Table 3.2: Linguistic variable ranges for Input Variable $F_2$.

| Input Variable ($F_2$) | Fuzzy Linguistic Variable | Crisp Input Range |
|-------------------------|---------------------------|-------------------|
| Students Score in Unit Test |
| AA                      | [26, 27, 30, 30]          |
| AB                      | [24, 25, 26, 28]          |
| BB                      | [21, 22, 24, 25]          |
| BC                      | [18, 19, 21, 22]          |
| CC                      | [15, 16, 18, 19]          |
| CD                      | [12, 13, 15, 16]          |
| DD                      | [9, 10, 12, 14]           |
| FF                      | [0, 0, 9, 11]             |

From above data for input variable Students Score in Unit Test the trapezoidal MF in MATLAB is as given in Figure (3.3).

Figure 3.3. Membership function of input variable $F_2$.

3.1.3. Teachers Assessment Score

The grades are divided into fuzzy linguistic variable ranges with trapezoidal MF for input variable Teachers Assessment Score mentioned by Table (3.3).

Table 3.3: Linguistic variable ranges for Input Variable $F_3$.

| Input Variable ($F_3$) | Fuzzy Linguistic Variable | Crisp Input Range |
|-------------------------|---------------------------|-------------------|
| Teachers Assessment Score |
| AA                      | [8.5, 9, 10, 10]          |
| AB                      | [7.5, 8, 9, 9.5]          |
| BB                      | [6.5, 7, 8, 8.5]          |
| BC                      | [3.5, 4, 7, 7.5]          |
| CC                      | [2.5, 3, 4, 4.5]          |
| CD                      | [1.5, 2, 3, 3.5]          |
| DD                      | [0.5, 1, 2, 2.5]          |
| FF                      | [0, 0, 1, 1.5]            |
From above data for input variable Students Score in Teachers Assessment Score the trapezoidal MF in MATLAB is as given by Figure (3.4).

![Figure 3.4. Membership function of input variable F3](image)

**Figure 3.4. Membership function of input variable F3**

### 3.2 Students’ Performance as fuzzy output and defuzzification

The students’ performance in terms of output variable is categorised into the linguistic terms. From the fuzzy values the performance is then converted into the grades. The degree of membership functions for the output variable students’ performance are determined by equation (3.3).

\[
\mu_F(x) = \max_b \left[ \min \left[ \mu_1(f_1), \mu_2(f_2), \ldots \right] \right], \quad k = 1, 2, 3, 4, \ldots n
\]

From above equation using the fuzzy rules defined in section (3.3) are determined by equation (3.3). The input variables are connected with the conjunction AND in fuzzy interface system to find out the final output result as students’ performance. Crisp output range for the output variable in terms of fuzzy linguistic terms is given by Table (3.4).

| Input Variable (F3) | Fuzzy Linguistic Variable | Crisp output Range |
|---------------------|---------------------------|--------------------|
| Students Performance in Subject | AA | [84, 86, 100, 100] |
|                      | AB | [79, 81, 85, 87] |
|                      | BB | [69, 71, 80, 82] |
|                      | BC | [59, 61, 70, 72] |
|                      | CC | [49, 51, 60, 62] |
|                      | CD | [39, 41, 50, 52] |
|                      | DD | [29, 31, 40, 43] |
|                      | FF | [0, 0, 25, 30] |

Figure (3.5) shows the trapezoidal membership function for output variable Students Performance in Subject.
3.3 Fuzzy Rule Base and Inference Mechanism

As mentioned in the section (3.2), input and output variables of fuzzy system are defined in terms of fuzzy variable. When the relation between various components of the system are not known exactly, or if for analysis the data is insufficient and uncertain then the fuzzy rule base modeling is very important.

Using different linguistic terms the rules for the rule base system can be framed by using “If – Then” and the different mathematical operators like “AND”. After discussion and brainstorming sessions with the academicians and experts in the field of teaching, fuzzy rules are constructed. The experience of the respective teacher also considered while framing the rules. In present study the rules framed are as shown in Table 3.5.

| SN | ESE | UTS | TAS | SF |
|----|-----|-----|-----|----|
| 1  | CD  | BC  | BB  | CC |
| 2  | CD  | BC  | BC  | CC |
| 3  | CC  | BB  | AB  | BC |
| 4  | AB  | AA  | AA  | AA |
| 5  | BB  | AB  | AB  | AB |
| 6  | CC  | BB  | AB  | BC |
| 7  | FF  | FF  | BC  | FF |
| 8  | CC  | BB  | AB  | BC |
| 9  | CC  | BC  | BC  | BC |
| 10 | FF  | FF  | BC  | FF |
| 11 | BC  | AB  | AB  | BB |
| 12 | BB  | AA  | AB  | AB |
| 13 | BB  | CC  | AB  | BC |
| 14 | BB  | CC  | BB  | CD |
| 15 | BB  | AB  | AB  | AB |
| 16 | AB  | BB  | BC  | AB |
| 17 | AA  | AB  | AB  | AA |
| 18 | BC  | AB  | AB  | BB |
| 19 | CC  | AB  | AB  | BC |
| 20 | FF  | FF  | BC  | FF |
| 21 | BB  | AB  | BB  | BB |
| 22 | DD  | CC  | BC  | CD |
| 23 | FF  | CD  | BC  | DD |
| 24 | CD  | BC  | BB  | CC |
| 25 | DD  | FF  | BB  | DD |

After executing the above constructed rule in fuzzy expert system, the rule viewer of the present study for the evaluation of overall student’s performance is shown in Figure (3.6).
Figure 3.6. Rule Viewer of Fuzzy Expert System

From the rule viewer Figure 3.6, the fuzzy interface system of the students’ overall academic performance shows surface viewer as in Figure (3.7).

Figure 3.7. Surface viewer of proposed FIS

4. Result and Discussion

In order to test the above model by using the fuzzy expert system and the rules defined in the present study the small data from one of the engineering college have been used. From the input data the output variable student’s subject performance is determined by Relative Grading and also by using the fuzzy model developed in the study. Last two columns of Table 4.1 show the values of student’s subject performance by Relative Grading and Fuzzy Expert System respectively.
Table 4.1. Student’s Performance by Fuzzy System

| SN | ESE (60) | UTS (30) | TAS (10) | Total (100) | Grading Relative | Grading Fuzzy |
|----|----------|----------|----------|-------------|----------------|--------------|
| 1  | 30       | 21       | 8        | 59          | CC             | CC           |
| 2  | 29       | 20       | 7        | 56          | CC             | CC           |
| 3  | 32       | 22       | 9        | 63          | BC             | BC           |
| 4  | 48       | 28       | 10       | 86          | AA             | AA           |
| 5  | 46       | 26       | 9        | 81          | AB             | BB           |
| 6  | 32       | 23       | 9        | 64          | BC             | BC           |
| 7  | 7        | 6        | 5        | 18          | FF             | FF           |
| 8  | 31       | 23       | 9        | 63          | BC             | BC           |
| 9  | 35       | 20       | 7        | 62          | BC             | BC           |
| 10 | 10       | 3        | 7        | 20          | FF             | FF           |
| 11 | 41       | 25       | 9        | 75          | BB             | BB           |
| 12 | 47       | 27       | 9        | 83          | AB             | AB           |
| 13 | 44       | 25       | 16       | 69          | BC             | BC           |
| 14 | 24       | 18       | 8        | 50          | CD             | CD           |
| 15 | 44       | 25       | 9        | 78          | BB             | BB           |
| 16 | 51       | 23       | 7        | 81          | AB             | AB           |
| 17 | 52       | 25       | 9        | 86          | AA             | AA           |
| 18 | 39       | 25       | 9        | 73          | BB             | BB           |
| 19 | 36       | 25       | 9        | 70          | BC             | BC           |
| 20 | 13       | 7        | 5        | 25          | FF             | FF           |
| 21 | 44       | 25       | 8        | 77          | BB             | BB           |
| 22 | 24       | 18       | 7        | 49          | CD             | CD           |
| 23 | 18       | 15       | 7        | 40          | DD             | DD           |
| 24 | 29       | 20       | 8        | 57          | CC             | CC           |
| 25 | 20       | 10       | 8        | 38          | DD             | DD           |

It is observed that there is no wide difference in the grades of student determined by using fuzzy model and relative grading except the cases of ambiguity. Since the boundaries of the fuzzy set are not crisp the student performance in a subject by fuzzy model is more realistic than the direct values through relative grading.

5. Conclusion

To maintain quality in higher education there is a need to do students regular assessment on the basis of continuous evaluation. FL and fuzzy expert system in decision making process is successfully used in educational institute for evaluation purpose. FL with fuzzy expert system gives the interesting results for evaluation on the basis of qualitative and quantitative facts or data to measure students’ performance. The various activities or tools used in teaching learning process for the continuous evaluation in crisp data form are used to evaluate students’ performance using fuzzy expert system through experts in academic institutes. The results of the students by using FL and traditional method of relative grading are compared and it is found that the results of FL are more realistic than traditional method of relative grading.
6. References

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