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Evaluation of Pre-Diploma Students using Fuzzy Approach

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Abstract

This paper discusses the comprehensive evaluation of Pre-Diploma (Science) students in recent semesters using fuzzy approach. It focuses on how we can select the best students based on both academic performance and soft skills for university recognition purposes. The approach utilizes membership functions to derive the membership values for the entire course which registered for first semester. Then the approach employs the intersection of fuzzy goals and constraints concept to identify the best students among the best in terms of academic performance, soft skills as well as their attitude. A case study was conducted based on session intake of November 2013 - March 2014. It was found that our proposed approach has unique advantage in the sense that it can distinguish clearly for every single score marks obtained by the students. Also, the results show that the approach is highly beneficial for problem solving under uncertainty data sets environment.

Keywords: Fuzzy approach, Pre-Diploma (Science), students' evaluation

Introduction

Evaluating students' academic performance using appropriate techniques is important in ensuring a fair assessment of their qualities. A good evaluation system provides grounds for individual improvement and ensures that students receive fair grading so as not to limit students' present and future opportunities (Saleh and Kim, 2009). Since employers are concerned about soft skills (i.e. speaking, teamwork etc), these factors also need to be included in the evaluation of the student performance. Thus, evaluating student's performance, which takes into consideration both academic achievement and soft skills, has become a challenge for universities to ensure that the students are rewarded accordingly (Arbaiy *et al*., 2006).

In conventional methods, the performance of the students is numerically accessed through examination results, coupled with on-going assessments such as tests, assignments and quizzes by using simple arithmetic and statistical analysis (percentages and averages). Finally, students would be given a single-letter grade (A, B or C) based on numerical interval-value that refers to a certain category of achievements. The categories are expressed in linguistic terms such as "excellent", "good", "pass" or "fail" etc. However, these traditional methods of classifying and grading student academic performance do not necessarily offer the best way to evaluate human acquisition of knowledge and skills (Rasmani *et al*., 2013). Furthermore, in some cases, the quality which defined in linguistics terms is associated with imprecision and vagueness (Patil *et al*., 2012).

Therefore, due to the drawbacks of the traditional grading system, in recent years, the application of fuzzy sets theory (Zadeh, 1965) for evaluating student's academic performance has been presented. Many studies have been done to deal with the fuzziness and vagueness in the process of students' evaluation (Saleh and Kim, 2009; Chen and Li, 2011, Patel *et al*., 2012; Yildz *et al*., 2012; Ingoley and Bakal, 2012; Rasmani *et al*., 2013; Chen and Li, 2013; Yadav *et al*., 2014).

Saleh and Kim (2009) presented a fuzzy system for evaluating students' learning achievement. However, their method was not sensitive enough to reflect students' learning achievement and get unfair result in some situations. Subsequently, Chen and Li (2011) presented a new method to deal with the evaluation of students' learning achievement using fuzzy memberships function and fuzzy rules. The proposed method provides more fair and reasonable results for students' learning achievement evaluation compared to the previous study.

Moreover, Patil *et al*. (2012) presented a fuzzy based approach to find the best student based on

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feedback given by teachers. The results show the potential application of the fuzzy logic in the student performance evaluation. Yildiz *et al.* (2012) applied fuzzy logic and genetic algorithms to evaluate and predict the students' performance in distance education. Ingoley and Bakal (2012) presented a method which applies fuzzy inference system and fuzzy logic to evaluate students' performance. The proposed method provides more transparent and fairer results to all students.

Another study carried out by Chen and Li (2013) proposed a method for students' answer scripts evaluation based on interval-valued intuitionistic fuzzy sets, where the fuzzy marks awarded to the answers of students' answer scripts are represented by interval-valued intuitionistic fuzzy sets. Recently, Yadav *et al*. (2014) proposed a new fuzzy expert system for students' academic performance evaluation based on fuzzy logic and fuzzy rule induction approach. The proposed technique is found to be more suitable for students' performance evaluation in comparison to classical fuzzy logic.

From the literatures above, it can be observed that the existing researches rarely explore the advantages of intersection operators, especially using fuzzy concept which related in uncertainty environment. Thus, the objective of this work is to propose the intersection of fuzzy goal and constraints to identify the best pre-diploma (science) students which combines both academic performance and soft skills for UiTM recognition purposes. To do so, this paper is structured as follows: Section 2 briefly discusses the problem statement. Section 3 and 4 provide the background theory and empirical study for illustration purposes, respectively. Lastly in Section 5 the conclusion was carried out.

Problem Statement

Universiti Teknologi MARA (UiTM) is one of the largest universities in Malaysia who are still practicing grading system based on interval marks in terms of assessing their academic performance. Nowadays, analysis using a statistics mean and percentage is a common practice to evaluate student's performance. Using a pass or fail grades in the exam may not reflect the genuine of their performance. The traditional method is quite imprecise in terms to representing the actual performance and ability of the students. For instance, the performance of students in the final exam, quizzes, monthly tests and assignments can be evaluated quantitatively and qualitatively by means of fuzzy logic with a more equitable and fair to the students. Thus this study suggests that the fuzzy approach particularly the so-called intersection of fuzzy goal and constraints is employ as an alternative tool specifically to evaluate combining the both student's academic performance and soft skills, concurrently.

The Theoretical Background and Evaluation Approach

Preliminaries

Definition 1 A fuzzy set $\tilde{A}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{A}}(x)$ which associates with each element x in X a real number in the interval [0,1]. The function value $\mu_{\tilde{A}}(x)$ is termed the grade of membership of x in $\tilde{A}$.

Definition 2 A fuzzy number is a fuzzy subset in a universe of discourse X is called a normal fuzzy set implying that $\exists\, x_i \in X,\ \mu_{\tilde{A}}(x_i) = 1$.

Definition 3 A triangular fuzzy number (TFN) $\tilde{A}$ as shown in Figure 1, can be defined by a triplet (a, b, c). The membership function $\mu_{\tilde{A}}(x)$ is defined as (Kaufmann and Gupta, 1988):

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x < a, \\ \dfrac{x-a}{b-a}, & a \le x \le b, \\ \dfrac{x-c}{b-c}, & b \le x \le c, \\ 0, & x > c \end{cases}$$

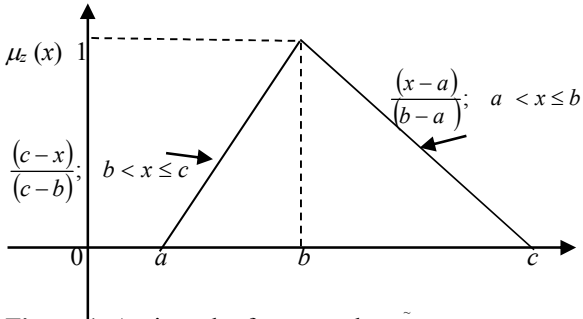

Figure 1: A triangular fuzzy number $\tilde{A}$

Our Evaluation Approach

In this study we propose the similar approach which employed by Zamali *et al*. (2014) the so-called intersection of fuzzy goal and constraints method. However, in this paper we adopt this method in difference problem and environment specifically for

choosing the best Pre-Diploma (Science) students for UiTM Sabah recognition purposes.

Suppose that a simple decision-making model consisting of a goal described by a fuzzy set G with membership function $\mu_G(x)$. A constraint described by a fuzzy set K with membership function $\mu_K(x)$ where x is an element of the crisp set of alternatives A_{alt}. Hence, the decision is a fuzzy set M with membership function $\mu_D(x)$, expressed as intersection of G and K.

$$M = G \cap K = \{(x, \mu_M(x)/x \in [\delta_1,\delta_2],\ \mu_M(x) \in [0, h \leq 1]\} \quad (1)$$

where $[\delta_1,\delta_2]$ is the crisp set of selection from the set of alternatives (S_{alt}). $\mu_M(x)$ is the degree to which any $x \in [\delta_1,\delta_2]$ belongs to the decision M

Here, the operation intersection of P and Q denoted as $P \cap Q$ is defined by

$$\mu_{P \cap Q}(x) = \min(\mu_P(x), \mu_Q(x)), \ x \in U; \quad (2)$$

if $\mu_P(x) = \alpha_1 < \alpha_2 = \mu_Q(x)$, $\min(\alpha_1,\alpha_2) = \alpha_1$

Using the membership functions and intersection operator from Eq.-(2), the Eq.–(1) gives

$$\mu_M(x) = \min(\mu_G(x), \mu_K(x)), \ x \in S_{alt} \quad (3)$$

Hence, the goal and constraint in Equation-(1) can be formally interchanged as follows:

$$M = G \cap K = K \cap M \quad (4)$$

To obtain $[\delta_1,\delta_2]$ with the highest degree of membership in the set M, the maximization decision is expressed by

$$X_{max} = \{x/\max \mu_M(x) = \max \min(\mu_G(x), \mu_K(x))\} \quad (5)$$

Thus, equation-(1), (3)-(4) have been generalized with many goals and constraints. For goals G_i, $i = 1,2,3, \ldots,n$, and constraints K_j, $j = 1,2,3, \ldots,m$, the decision is given by

$$M = (G_1 \cap G_2 \cap G_3 \cap \ldots G_n) \cap (K_1 \cap K_2 \cap K_3 \ldots \cap K_m) \quad (6)$$

The membership function of M is

$$\mu_M(x) = \min(\mu_{G1}(x), \ldots, \mu_{Gm}(x), \mu_{k1}(x), \ldots, \mu_{km}(x))$$

and the maximization decision is given by

$$X_{max} = \{x/\mu_M(x) \text{ is max}\} \quad (7)$$

The entire evaluation process above can be summarized as depicted in Figure 2.

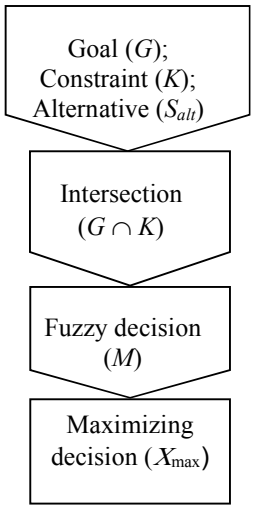

Figure 2: The evaluation process by intersection operator

An Empirical Study

For the illustration purpose, an empirical study of Pre-Diploma (Science) programme has been conducted at UiTM Sabah based on the current semester during this study (i.e., semester Nov. 2013 – Mac 2014). The Academic Affairs Department of UiTM Sabah has identified 31 (S_i; $i = 1, 2,3, \ldots,31$) Pre-Diploma (Science) students qualified to shortlisted for this study purpose. UiTM Sabah has decided to choose only one (i.e., the best) candidates for rewarding/recognition purposes. There are six specific objectives (goals) which the candidates have to satisfy/achieved; G_1(~MAT081/MAT084), G_2(~PHY081); G_3(~BIO081), G_4(~CHM081), and G_5 (ELC010) must score at least 70 marks or above (i.e., grade B+), and for G_6 (~CTU001) the student should pass on-going assessment through out of the semester due to no final examination provided. Thus, we constructing the membership function for above 5 main objectives (i.e., $\mu_{\underset{SUB}{\sim}}(x)$) and one objective specifically for CTU001 (i.e., $\mu_{\underset{CTU}{\sim}}(x)$), respectively. Given two membership functions as follows:

$$\mu_{\underset{SUB}{\sim}}(x) = \begin{cases} 0 & ; \ x < 70 \\ \dfrac{x}{100} & ; \ x \geq 70 \end{cases} \quad (8)$$

$$\mu_{\underset{CTU}{\sim}}(x) = \begin{cases} 0 & ; \ if \ \ fail \\ 1 & ; \ if \ \ pass \end{cases} \quad (9)$$

Also, UiTM Sabah has an additional condition/constraint, the candidates should free from any misconduct of UiTM regulations during their studies. In addition, the soft skills level is also evaluated to ensure that the selected best students are able or at least have minimum soft skills such as leadership, active in society and/or sport, etc. This evaluation has been indentified via their involved in co-curriculum. For the both constraints, we also decided to categorize the disciplinary status and the soft skills using three difference scores (i.e., membership values) depend on how serious the students involved or misconduct of UiTM regulations and how they well in soft skills. Table 1 and 2 provide the detail description, respectively.

Table 1: The three difference definitions of disciplinary status

Membership values	Description
0.3	If the student has received once show cause letter for light misconduct university regulations
0.8	If the student free from any disciplinary actions by university
1	If the student free from any disciplinary actions by university plus received any related excellent certificates/awards

Table 2: The three difference levels of student's soft skills

Membership values	Description
0.6	If the student members and active in internal society (i.e., club, faculty, hostel, etc.)
0.8	If the student members and active in external society (i.e., university, state, etc.)
1	If the student members of both *Majlis Perwakilan Pelajar* (MPP) and active in an external society

Based on the results, it was found that only six (S_i ; i = 1, 2,3, …,6) out of 31 students are qualifying for further evaluation. This is because the rest that not qualify to further consideration due to got at least two subject below B+ grade (i.e., 70 scores). Table 3 shows the raw information for 6 qualify students. Here, we substitute 6 objectives (i.e., G_1, G_2, G_3, …,G_6) from raw data in Table 3 using Eq. -(8) and -(9) memberships function, respectively. Meanwhile, for both constraint (K_1 and K_2), we derive directly the membership values based on Table 1 and 2 definition, respectively. Then, we obtain all the membership values as shown in Table 4.

Table 3: The raw data for six objective attributes and two constraints

Students Objectives/Courses	S_1	S_2	S_3	S_4	S_5	S_6
G_1: MAT081	89	70	65	63	75	76
G_2: PHY081	85	70	74	76	72	74
G_3: IO081/MAT084	80	76	80	74	72	84
G_4: CHM081	87	88	83	80	86	86
G_5: ELC010	85	80	84	70	60	74
G_6: CTU001	83	68	81	88	93	88
K_1: Disciplinary status	0.8	1	0.8	0.8	0.8	0.8
K_2: Soft skills	0.8	0.8	0.3	1.0	0.6	0.8

Table 4: The membership values derived from Table 3

Students Objectives/Courses	S_1	S_2	S_3	S_4	S_5	S_6
G_1: MAT081/084	0.89	0.70	0	0	0.75	0.76
G_2: PHY081	0.85	0.70	0.74	0.76	0.72	0.74
G_3: 081/MAT084	0.80	0.76	0.80	0.74	0.72	0.84
G_4: CHM081	0.87	0.88	0.83	0.80	0.86	0.86
G_5: ELC010	0.85	0.80	0.84	0.70	0	0.74
G_6: CTU001	1.0	0	1.0	1.0	1.0	1.0
K_1: Disciplinary status	0.80	1.0	0.80	0.80	0.80	0.80
K_2: Soft skills	0.80	0.80	0.30	1.0	0.60	0.80

Based on membership values in Table 4 above, both the six objectives and two constraints can be obtain as

$$\tilde{M} = \begin{bmatrix} 0.89 & 0.70 & 0 & 0 & 0.75 & 0.76 \\ 0.85 & 0.70 & 0.74 & 0.76 & 0.72 & 0.74 \\ 0.80 & 0.76 & 0.80 & 0.74 & 0.72 & 0.84 \\ 0.87 & 0.88 & 0.83 & 0.80 & 0.86 & 0.86 \\ 0.85 & 0.80 & 0.84 & 0.70 & 0 & 0.74 \\ 1 & 0 & 1 & 1 & 1 & 0.74 \\ 0.80 & 1 & 0.80 & 0.80 & 0.80 & 0.80 \\ 0.80 & 0.80 & 0.30 & 1 & 0.60 & 0.80 \end{bmatrix};$$

or, the entire objectives (G_i ; i = 1,2,3, …, 6) can be written as

$$G_1 = \{0.89/S_1, 0.70/S_2, \ldots, 0.76/S_6\}$$
$$G_2 = \{0.85/S_1, 0.70/S_2, \ldots, 0.74/S_6\}$$
$$\ldots = \ldots\ldots$$
$$G_6 = \{1/S_1, 0/S_2, \ldots, 0.74/S_6\}$$

and for both 2 constraints (K_i ; i = 1,2) given as

$$K_1 = \{0.80/S_1, 1/S_2, \ldots, 0.80/S_6\}$$
$$K_2 = \{0.80/S_1, 0.80/S_2, \ldots, 0.80/S_6\}$$

Next, from Eq.-(6) we have

$$\mu_M(x) = \min(\mu_{G1}(x), \ldots, \mu_{G6}(x), \mu_{k1}(x), \mu_{k2}(x))$$
$$= \{0.80/S_1, 0/S_2, 0/S_3, 0/S_4, 0/S_5, 0.74/S_6\}$$

and finally from Eq.-(7) we obtain as

$$\boldsymbol{X}_{max} = \{x/\mu_M(x) \text{ is max}\}$$
$$\boldsymbol{X} = \{0.80/S_1\}$$

Thus, from the calculation above it shows that the student S_1 is the most preferred candidates as compared to the rest due to highest score of the membership values. Apparently in this case study the candidate S_1 is the best pre-diploma (Science) students for UiTM Sabah.

Conclusion

In this study we have applied the intersection of fuzzy goals and constraints concept in evaluation process for choosing the best Pre-Diploma (Science) students at UiTM Sabah. Since the evaluation generally involve uncertainty, it is important to incorporate the fuzzy approach to derive precise results in any proposed method. From the numerical example, it can be clearly seen that the proposed method is beneficial in terms of evaluation perspective. The extremely significant fuzzy environment have been utilized to derive the membership values in the range of [0, 1] which provide some straightforward procedures by constructing the relevant membership functions. Furthermore, although the given empirical study may derive a different and/or same result for other cases, it still depends greatly on how the evaluators evaluate the relevant attributes during the judgment process. Also, the approach has unique advantage in the sense that it can distinguish clearly for every single score marks obtained by the students. Thus, it gives highly beneficial for problem solving under uncertainty data sets environment.

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References

Saleh, I., and Kim, S. (2009). A fuzzy system for evaluating students' learning achievement. *Expert Systems with Applications*, *36*(3): 6236–6243.

Arbaiy, N., Suradi, Z. and Yusoff, N. S. (2006). Fuzzy Approach for Student's Performance Evaluation. In *International Conference on Islamic world, Information Technology and Information Society (IC3I 2006)*, *11–13 Dec 2006*, *Isfahan, Iran*.

Rasmani, K. A., Shahari, N. A., Garibaldi, J. M., and Shen, Q. (2013). Practicality Issues in Using Fuzzy Approaches for Aggregating Students' Academic Performance. *Procedia - Social and Behavioral Sciences*, *83*, 398–402.

Patil, S., Mulla, A. and Mudholkhar R. R. (2012). Best Student Award – A fuzzy Evaluation Approach. *International Journal of Computer Science and Communication*, *3*(1): 9–12.

Zadeh, L. (1965). Fuzzy Sets, *Information and Control*, *3*(8): 338 – 353.

Chen, S.-M., and Li, T.-S. (2011). Evaluating students' learning achievement based on fuzzy rules with fuzzy reasoning capability. *Experts Systems with Applications*, *38*, 4368–4381.

Yıldız, O., Bal, A., GŸlseçen, S., and Kentli, F. D. (2012). A Genetic-Fuzzy Based Mathematical Model to Evaluate The Distance Education Students' Academic Performance. *Procedia - Social and Behavioral Sciences*, *55*, 409–418.

Ingoley, S. N. and Bakal, J. W. (2012). Evaluating Students's Performance using Fuzzy Logic. *IJCA Proceedings on International Conference on Recent Trends in Information Technology and Computer Science* 2012, ICRTITCS (9), 15–20.

Chen, S.-M., and Li, T.-S. (2013). Evaluating students' answerscripts based on interval-valued intuitionistic fuzzy sets. *Information Sciences*, *235*, 308–322.

Yadav, R. S. Soni A. K., and Pal, S. (2014). A study of academic performance evaluation using fuzzy logic techniques. In *Proc. of IEEE International Conference on Computing for sustainable global development (INDIACom)*, 5–7 March 2014, 48–53.

Kaufman, A. and Gupta, M. M. (1988). *Fuzzy Mathematical Models in Engineering and Management Sc*ience, North-Holland, Amsterdam.

Zamali, T., Nasrah, N., Tammie, & Ling-Ling, U. (2014). Fuzzy based-approach for Selecting MDAB Students, *in* Rosdiana, S., Zamali, T., Haijon, G. & Dg Ku Habibah, A. K. (edit.), Chapter(s) in book, MDAB: Issues and Challenges, *UiTM Sabah Press*, 118–125.