Utilization of fuzzy logic methodology for the selection of class representative

Ashima Kanwar[1]* and Sonam Sharma[2]

Abstract

Classical set theory is very important when a situation deals with certainty, but when there are some uncertain conditions arise classical set theory fail. There are endless applications of fuzzy logic. In this paper the one of its significant application has been studied. There are some qualitative characteristics which play a vital role in the selection of class representative and these characteristics are in vague form. In this paper, a survey was conduct on students for selecting the deserving student for class representative. The input of this survey passes through fuzzification and defuzzification process with the help of which, output in terms of the final fuzzy score was determined and this FFS (final fuzzy score) is compared with the score of other volunteers.

Keywords

Fuzzy logic, Class representative selection process, Centroid method, Fuzzification, Defuzzification.

AMS Subject Classification

03B52.

[1] *Department of Physical Sciences, Sant Baba Bhag Singh University, Jalandhar, Punjab, India.*
[2] *Research Scholar, Department of Physical Sciences, Sant Baba Bhag Singh University, Jalandhar, Punjab, India.*
Corresponding author: [1] kanwar.ashima87@gmail.com
©2020 MJM.

Contents

1. Introduction and Preliminaries

The concept of fuzzy set theory was firstly coined by [1] in 1965. The main purpose of this theory to extend classical set theory. Dzitac *et al*. [2] studied that in classical set theory rules of logic are represented by operations on the set with only two category:true and false (0 and 1). In the universe of all sets was called it as classifier. But when we tried to find the category of fuzzy sets, it was hardly possible to find a similar classifier. In set theory there are two state: membership and equality and in generalized sets, both can be fuzzy, but in fuzzy set theory only membership is allowed to be. This fact confused a lot of people and this creates a fuzziness problem in different field because of which there is a high degree error in making a decision by human.

Pau and Salerno [6] developed a new mechanism to improve the lifetime of devices in Wireless Sensor Networks (WSN) for smart homes. Burhanuddin *et al*. [7] studied that the coaches must have seen different attributes in a player to make an efficient and good coordination team and in most of the games there are more than two players. Therefore, it is very difficult for coaches to examine every single player and select the appropriate one. Fuzzy logic imitates human thinking to select an appropriate player for a team.

Remanufacturing technologies are selected with the help of different method which reduces vagueness and provide an appropriate result. Kafuku *et al*. [8] uses fuzzy logic method on six technologies for cleaning cylinder head of an engine are calculated under three criteria of technology (cost , operating cost , disposal effect). Technologies performances were mainly affected by criteria far beyond the technology itself.

Beljkas *et al*. [9] studied that the selection of the good contractor is a very important stage for the construction of high rise building and this selection is based on three main goals: quality, price and time. With the help of the fuzzy expert system, the collected experiences of the expert has been defined in the forty fuzzy rules have been defined and two output which depicts that whether to engage the contractor or not. In short, in which a project is implemented, professional approach in the selection of a contractor was based on past

detailed analysis of particular conditions.

Onyejebu and Oke [3] was studied that fuzzy logic made a very vast contribution in designing and development of traffic light control system. On the basis of performance between fuzzy control system and conventional fixed-time controller, it concludes that fuzzy logic control system is better than conventional fixed-time controller. This FL control system was mainly design on a 4 - Lane traffic intersection. In the formulation of FL control system, Java programming is used. Greeda *et al.* [10] discussed components of fuzzy logic system. Fuzzy logic is used to measure the heart rate, tidal volume, breathing frequency and oxygen saturation to fulfil the requirement for pressure support ventilation in intensive care. Fuzzy expert system plays an important role in medicine for symptomatic diagnostic cures. Fuzzy rule based system is used to diagnose the disease like tuberculosis, cancer, lung cancer diabetes, anaesthesia etc.

Goksen *et al.* [5] discussed about the qualitative characteristics and significance level which could be used for the candidate selection process in political parties is study in this paper. The input is analyzed by fuzzy logic methodology is clear and efficient and this will increase the truth worthiness and the positive impression of that political party among its members and the citizens. The fuzzification and defuzzification methods can be applied to candidate selection process conveniently.

Definition 1.1. *[1]: Let A is any subset of a universal set X, then the membership function of A is denoted by*

μ_A *and defined as* $\mu_A: X \to [0, 1]$

where each element x of X is mapped between 0 and 1. This value is called membership value or a degree of membership.

Definition 1.2. *[1]: Let X be a non - empty set. A fuzzy set A of set X is defined as*

$A = (x, \mu_A(x)): x \in X$

where $\mu_A(x)$ *is the membership degree or we can say how much involvement of x in A.*

Operations on Fuzzy set [1] :

Union: Let A and B are two fuzzy sets having degree of membership are μ_A and μ_B respectively then the union of two sets A and B is defined as the maximum of a two individual degree of membership. It is usually denoted as $\vee$ or max - operation.

$\mu_{A \cup B} = \max.(\mu_A, \mu_B)$

Intersection: Let A and B are two fuzzy sets having degree of membership are μ_A and μ_B respectively then the union of two sets A and B is defined as the minimum of a two individual degree of membership. It is denoted as $\wedge$ or min - operation.

$\mu_{A \cap B} = \min. (\mu_A, \mu_B)$

Complement: Let A be a fuzzy set having degree of membership is μ_A. Then the complement of A is defined as the negation of the specified degree of membership.

$\mu_{\overline{A}} = 1 - \mu_A$

Centroid method [4]: The fuzzy values are converted into crisp values with the help of centroid method. This method is generally used in defuzzification process and which can be defined as

$$\sum_{k=1}^{k=n} \mu_c(w_k) w_k / \sum_{k=1}^{k=n} \mu_c(w_k)$$

Fuzzy logic: "Fuzzy logic is not fuzzy. Basically, fuzzy logic is a precise logic of imprecision and approximate reasoning" (L.A. Zadeh). Fuzzy logic is a system prepared by human itself through which we solve imprecise situation and provide different solution for a same problem under different conditions. Fuzzy Logic brings an easy way with the help of which human decisions in terms of linguistic variables are very clear that is so complex and it is hard to express mathematically.

2. Result and Discussion

As we know in a classroom different students possesses different characteristics. Some students have good communication skill; some have a high level of intelligence as compare to others and some students take interest in social activities and many more.Mostly, all these good characteristics cannot be seen in a single student and it is difficult for the class teacher to choose the student who has much of these qualities which he/she can be nominated as class representative for the class. Earlier, the selection of the class representative for the class is only depending on the teacher which student teacher wants to select he / she as coordinator of the class. But now other students of the class also take part in this selection procedure. It is difficult and time consuming task for every student to analyze class representative volunteers in order to select the appropriate class representative and as human has its limitation, there is a high degree of error in judgement in decision making. Generally, in school, colleges class representatives are selected without using any quantative method. In other we can say that without keeping in mind the criteria and sub - criteria for class representative, teacher as well as students select the class representative randomly. Due to which we had been missed the opportunity to select a good leader for the development of class as well as for school. So the main aim of this paper to un-riddle this error in decision making.

2.1 Methodology:

2.1.1 Data collection: The data collected for this study was done in the form of a questionnaire, which was distributed between 60 students for reputed college. With the help of teacher's qualitative features in class representative was selected and divide into criteria and sub - criteria. The essential qualities of the class representative which should be kept in

mind while choosing the class representative were described in this questionnaire. During the class this questionnaire was distributed between five groups having 12 students in each group. The time duration to full fill these questionnaires was around 1 hour. Each group gives their opinion with mutual understanding either they strongly agree, agree, neutral, disagree or strongly disagree. The linguistic terms (strongly agree, agree, neutral, disagree or strongly disagree) converted into mathematical values using defuzzification process in which we obtain a single number from the fuzzy output.

2.1.2 Implementation and Evaluation:

In questionnaire, all questions lies under criteria and sub criteria set by a teachers. In the survey each concerned teacher gave a score between 0 and 100 for each of the criteria as well as sub - criteria which should make up a total of 100. Scores given by a teachers to criteria and sub criteria are represented in tabular form:

Criteria	Mean score of criteria	Sub criteria	Mean score of sub criteria
Human Skills	23	Strong communication	23
Human Skills		positive attitude	22
Human Skills		Motivational skill	28
Human Skills		Leadership quality	27
		Total	100
Personal Skills	20	helpful and sympathetic	30
Personal Skills		Honest and courageous	30
Personal Skills		Not indulge in illegal activities	22
Personal Skills		soft and commanding voice	18
		Total	100
General Skills	20	Capability of maintaining standardization	26
General Skills		Presenting his/her own view points	26

Criteria	Mean score of criteria	Sub criteria	Mean score of sub criteria
General Skills		Take part in the development of college	20
General Skills		High level of intelligence	28
		Total	100
Urban Strategies	18	Involve in social activities	30
Urban Strategies		Knowledge about technology and Science	25
Urban Strategies		Taking part in seminars, workshops ,etc	23
Urban Strategies		A good relationship with peer group and teacher	22
		Total	100
Good health and hygiene	19	Hygienic	24
Good health and hygiene		Free from drug	24
Good health and hygiene		Take nutritious food	26
Good health and hygiene		Healthy environment	26
		Total	100

From criteria mean scores generalized weight matrix is obtained as

$$B = \begin{bmatrix} 0.23 & 0.20 & 0.20 & 0.18 & 0.19 \end{bmatrix}$$

For each of the criteria with their respective weights is denoted as B1, B2, B3, B4, B5.These weight matrices are denoted by

$$B1 = \begin{bmatrix} 0.23 & 0.22 & 0.28 & 0.27 \end{bmatrix}$$
$$B2 = \begin{bmatrix} 0.30 & 0.30 & 0.22 & 0.18 \end{bmatrix}$$
$$B3 = \begin{bmatrix} 0.26 & 0.26 & 0.20 & 0.28 \end{bmatrix}$$
$$B4 = \begin{bmatrix} 0.30 & 0.25 & 0.23 & 0.22 \end{bmatrix}$$
$$B5 = \begin{bmatrix} 0.24 & 0.24 & 0.26 & 0.26 \end{bmatrix}$$

2.1.3 Scores Given to X by 60 Students: In implementation step, it is assumed that there are 5 groups of 60 students and there are 4 volunteers for class representative (W,X,Y and Z). Keep in mind class representatives feature, each group give scores to each class representative among a scale of 1 to 5(strongly agree = 5, agree = 4 ,neutral= 3 ,disagree= 2, strongly disagree =1.)

Criteria	Sub criteria	Score given by group (G_1)	G_2	G_3	G_4	G_5
Human Skills	Strong communication	5	4	5	5	4
Human Skills	positive attitude	5	4	5	4	4
Human Skills	Motivational skill	5	5	5	5	4
Human Skills	Leadership quality	4	5	4	4	4
Personal Skills	helpful and sympathetic	5	5	5	5	4
Personal Skills	Honest and courageous	4	5	4	4	5
Personal Skills	Not being involved in illegal activities	5	4	5	5	4
Personal Skills	soft and commanding voice	4	4	4	4	5
General Skills	Capability of maintaining standardization	4	4	4	4	5
General Skills	Presenting his/her own view points	4	4	5	4	4
General Skills	Take part in the development of college	3	3	4	4	4
General Skills	High level of intelligence	5	4	5	4	4

Criteria	Sub criteria	Score given by Group (G_1)	G_2	G_3	G_4	G_5
Urban Strategies	Involve in social activities	5	4	4	5	4
Urban Strategies	Knowledge about technology and Science	3	3	3	4	5
Urban Strategies	Taking part in seminars , workshops ,etc.	3	4	3	4	5
Urban Strategies	A good relationship with peer group and teacher	4	4	4	4	5
Good health and Hygienic	Hygienic	4	5	5	5	4
Good health and Hygienic	Free from drug	4	5	5	4	4
Good health and Hygienic	Take nutritious food	4	4	5	5	3
Good health and Hygienic	Healthy environment	4	3	4	5	4

2.1.4 Fuzzification and Defuzzification of Sample Score: The sample score of A taken from 60 students in 5 groups is represented as below. In this section each sub - criteria of a class representative selection passes through fuzzification and defuzzification process. After this fuzzy methodology was used so as to obtain the final cumulative score of the X.

Hu-man Skills	Strong Communi-cation	5	4	5	5	4
	Positive at-titude	5	4	5	4	4
	Motivational Skill	5	5	5	5	4
	Leadership Quality	4	5	4	4	4

Keeping in view the communication sub criteria of a class representative, 36 students gave 5 point and remaining 24 students gave 4 point. The sub criteria of each class representative is analyzed in the same way. This process is the fuzzification of Human skills of a class representative selection.

2.1.5 Fuzzification of Human Skills:

	Strongly agree	Agree	Neutral	Disagree	Strongly dis-agree
Strong com-muni-cation	3(0.6)	2(0.4)	0(0.0)	0(0.0)	0(0.0)
pos-itive atti-tude	2(0.4)	3(0.6)	0(0.0)	0(0.0)	0(0.0)
Mo-tiva-tional skill	4(0.8)	1(0.2)	0(0.0)	0(0.0)	0(0.0)
Lead-ership quality	1(0.2)	4(0.8)	0(0.0)	0(0.0)	0(0.0)

Human Skills Matrix is

$$C_1 = \begin{bmatrix} (0.6) & (0.4) & (0.0) & (0.0) & (0.0) \\ (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \\ (0.8) & (0.2) & (0.0) & (0.0) & (0.0) \\ (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \end{bmatrix}$$

Personal Skills Matrix is

$$C_2 = \begin{bmatrix} (0.8) & (0.2) & (0.0) & (0.0) & (0.0) \\ (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \\ (0.6) & (0.4) & (0.0) & (0.0) & (0.0) \\ (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \end{bmatrix}$$

General Skills Matrix is

$$C_3 = \begin{bmatrix} (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \\ (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \\ (0.0) & (0.6) & (0.4) & (0.0) & (0.0) \\ (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \end{bmatrix}$$

Urban Strategies Matrix is

$$C_4 = \begin{bmatrix} (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \\ (0.2) & (0.2) & (0.6) & (0.0) & (0.0) \\ (0.2) & (0.4) & (0.4) & (0.0) & (0.0) \\ (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \end{bmatrix}$$

Good Health and Hygiene Matrix is

$$C_5 = \begin{bmatrix} (0.6) & (0.4) & (0.0) & (0.0) & (0.0) \\ (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \\ (0.4) & (0.4) & (0.2) & (0.0) & (0.0) \\ (0.2) & (0.6) & (0.2) & (0.0) & (0.0) \end{bmatrix}$$

The union operation and the weight matrices processed each of these matrices. The union operation is defined as below:

$$D_i = B_i . C_i$$

$$D_1 = \begin{bmatrix} 0.23 & 0.22 & 0.28 & 0.27 \end{bmatrix} \otimes$$

$$\begin{bmatrix} (0.6) & (0.4) & (0.0) & (0.0) & (0.0) \\ (0.4) & (0.6) & (0.0) & (0.0) & (0.0) \\ (0.8) & (0.2) & (0.0) & (0.0) & (0.0) \\ (0.2) & (0.8) & (0.0) & (0.0) & (0.0) \end{bmatrix}$$

D1 = [(0.23 ∧ 0.6)∨(0.22 ∧ 0.4) ∨(0.28 ∧0.8) ∨(0.27 ∧ 0.2)

(0.23 ∧ 0.4)∨(0.22 ∧ 0.6) ∨(0.28∧0.2) ∨(0.27 ∧ 0.8)

(023 ∧ 0.0)∨(0.22 ∧ 0.0) ∨(0.28 ∧0.0) ∨(0.27 ∧ 0.0)

(0.23 ∧ 0.0)∨(0.22 ∧ 0.0) ∨(0.28 ∧0.0) ∨(0.27 ∧ 0.0))

D1 = ((0.23 ∨ 0.22 ∨ 0.28 ∨ 0.2)

(0.23 ∨ 0.22 ∨ 0.2 ∨ 0.27)

(0.0 ∨ 0.0 ∨ 0.0 0.0)

(0.0 ∨ 0.0 ∨ 0.0 ∨ 0.0))

(0.0 ∨ 0.0 ∨ 0.0 ∨ 0.0)]

$$D1 = \begin{bmatrix} 0.28 & 0.27 & 0.0 & 0.0 & 0.0 \end{bmatrix}.$$

The degree of membership for Human skills are (0.28 0.27 0.0 0.0 0.0) and for other criteria the membership degrees is obtained by similar way

$$D2 = \begin{bmatrix} 0.30 & 0.30 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$
$$D3 = \begin{bmatrix} 0.28 & 0.28 & 0.0 & 0.0 & 0.0) \end{bmatrix}$$
$$D4 = \begin{bmatrix} 0.30 & 0.30 & 0.25 & 0.0 & 0.0 \end{bmatrix}$$
$$D5 = \begin{bmatrix} 0.26 & 0.26 & 0.2 & 0.0 & 0.0) \end{bmatrix}$$

The matrix D is obtained by taking the above values. It is denoted as

$$D = \begin{bmatrix} (0.28) & (0.27) & (0.0) & (0.0) & (0.0) \\ (0.30) & (0.30) & (0.0) & (0.0) & (0.0) \\ (0.28) & (0.28) & (0.20) & (0.0) & (0.0) \\ (0.30) & (0.30) & (0.25) & (0.0) & (0.0) \\ (0.26) & (0.26) & (0.2) & (0.0) & (0.0) \end{bmatrix}$$

The Union operation is applied on matrix B and matrix D for obtaining the final fuzzy score and it is defined as

$$FFS = B.\, D$$

$$= \begin{bmatrix} 0.23 & 0.20 & 0.20 & 0.18 & 0.19 \end{bmatrix} \otimes$$

$$\begin{bmatrix} (0.28) & (0.27) & (0.0) & (0.0) & (0.0) \\ (0.30) & (0.30) & (0.0) & (0.0) & (0.0) \\ (0.28) & (0.28) & (0.20) & (0.0) & (0.0) \\ (0.30) & (0.30) & (0.25) & (0.0) & (0.0) \\ (0.26) & (0.26) & (0.2) & (0.0) & (0.0) \end{bmatrix}$$

$$= \begin{bmatrix} 0.23 & 0.23 & 0.20 & 0.0 & 0.0 \end{bmatrix}$$

The values in the matrix show the weights corresponding to the previous qualitative scale for this candidate, and are denoted as below;
Strongly agree (0.23), Agree (0.23), Neutral (0.20), Disagree (0.0) and Strongly disagree (0.0).
The final fuzzy score matrix of the candidate passes through the defuzzification process which is to be evaluated with the help of Centroid method which can be formalised as below and this final fuzzy score is quantative value whose range lies between 0 and 1

$$\sum_{k=1}^{k=5} (FFS_i)\overline{Z} / \sum_{k=1}^{k=5} (FFS_i)$$

$$= ((0.23) * 20 + (0.23) * 40 + (0.20) * 60 + (0.0) * 80 + (0.0)*100))/(0.23) + ((0.23) + (0.20) + (0.0) + (0.0))$$

$$= (\,(4.6) + (9.2) + (12.0) + (0.0) + (0.0))/0.66 = 25.8/0.66$$

$$= 39.09.$$

From these calculations, we found that the final score of X is 39.09. This score is compared with the scores of other candidate (W,Y and Z) and through the use fuzzy methodology, we got the final score of W,Y and Z are 20.91 ,20.0 , 20.0 . From this, we examine that the final score of X is greater than the other competitors. So, we conclude that appropriate class representative for the class is X.

3. Conclusion

The result we achieve depicts that the method we use for selection of class representative is very useful for the teacher to choose a deserving student for class representative position. The collected data in the form of questionnaire passes through Fuzzification and defuification process. The teacher's decision is very effective and positive as we get a numerical value. This

survey was conducted on 60 students for reputed college, and the criteria and sub - criteria in the table as mentioned above was selected with the help of a teachers. As we conduct this survey on 60 students which we divide into 5 groups to choose an appropriate class representative. Similarly, we can use similar method on more or below than 60 students to select an appropriate class representative in class in any other colleges.

References

[1] L. A. Zadeh, Fuzzy Sets, *Information and Control,* 8(1965), 338–353.

[2] I. Dzitac, F. G. Filip, M. J. Manolescu, Fuzzy Logic Is Not Fuzzy: World-renowned Computer Scientist Lotfi A. Zadeh, *International Journal of computers communication and control,* 12(6)(2017), 748–789.

[3] L N. Onyejebu , V. P. Oke, A Traffic Control and Offense Reporting System Using Fuzzy Logic, *International Journal of Advanced Research in Computer Science and Software Engineering,* 5(12)(2015), 823–827.

[4] P. Murray, H. Morrey, Jr. B. Charles, *College Calculus with Analytic Geometry*, Addison Wesley , 1970.

[5] Y. Goksen, O. Dogan, M. Eminagaoglu, A proposed model for candidate selection process in Political parties based on fuzzy logic methodology, *Mathematical and Computational Applications*, 17(2)(2012), 152–163.

[6] G. Pau and V. Salerno, Wireless Sensor Network for Smart Homes : A Fuzzy-Based Solution for an Energy-Effective Duty Cycle, *Electronics*, 8(2)(2019), 131.

[7] M. Burhanuddin, M. Suhaimi, M. Isa , U. Yusof and M. Khalid, Football Player Selection using Fuzzy Logic, *An Asean Conference on Information System (ACIS2015)*, Malaysia, 2015.

[8] J. M. Kafuku, M. Saman, S. Yusof, Application of fuzzy logic in the selection of remanufacturing technology , *Procedia Manufacturing,* 33(2019), 192–199.

[9] Z. Beljkas, Z. Prascevic, N. Ivanisevic, M. Knezevic, M.Cvetkovska, Application of Fuzzy Logic on Selection of Contractors for Construction of High Rise Buildings , *IOP Conf. Ser.: Earth Environ. Sci.*, 222(2019), 1–14.

[10] J. Greeda, A. Mageswari, R. Nithya, A study on Fuzzy Logic and its applications in Medicine , *International Journal of Pure and Applied Mathematics,* 119(16)(2018), 1515–1525.