A Decision Making Problem As An Application Of Fuzzy Sets

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Abstract Fuzzy sets are very useful tool to elaborate concept of uncertainty in decision making process. In this paper, we discuss theory of Fuzzy sets and apply this theory to solve a real world decision making problems. We solve the problem by defining choice value and also modify our algorithm by assigning weight to each parameter and then calculate the weighted choice value.

Keywords Fuzzy sets, membership value, choice value, weighted choice value.

1 INTRODUCTION

In real life problems, the class of objects do not have well defined criteria of membership that is confusion about inclusion or exclusion of objects in the class. This is reason of uncertainty in decision making problems. This uncertainty arises due to lack of knowledge about inclusion and exclusion of objects in a particular class or due to inherent vagueness. These types of problems can be solved by existing mathematical theories such as theory of probability, theory of fuzzy sets [1], theory of Intuitionistic fuzzy sets [2], theory of vague sets [3], theory of Rough sets [4] etc. Many researchers have worked on applications of fuzzy sets in decision making problems. Coroiu [8] presented advantages of fuzzy approach, in comparison with other paradigm and presents a particular way in which fuzzy logic can emerge in decision making process. Han xiao and Chen Shou [9] presented an application of fuzzy sets in reallocation of replaced water of the yellow river. Chiu-Chi Wei [10] presented a potential project selection model, which combines optimal aggregation method and effective fuzzy weighted average to assist decision maker to achieve the best consistency of fuzzy judgments, and generates a single synergistic index project fuzzy synthetic rating that considers both risk and performance. Chanqiou tan [11] discussed a new method for solving multi-criteria decision making problem in interval-valued intuitionistic fuzzy environments In this paper we present an application of fuzzy sets in a decision making problem with the help of choice value and weighted choice value of a fuzzy set. Now, we present the basic definitions of fuzzy sets introduced by Zadeh [1] and some related concepts.

Definition 1

Let X be a non-empty set. A fuzzy set A drawn from X is defined as

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

$where\ \mu_A(x): X \to [0,1]$ called the membership function of the fuzzy set A and $\mu_A(x)$ is called the membership value of the element x.

2 AN APPLICATION OF FUZZY SETS

In this section we present an application of fuzzy set. The problem we consider is as follows: Suppose a company wants to fill a post of HR Manager. For the said post there are ten candidates who apply for the same.

Let $U = \{A_1, A_2, A_3, A_4, A_5, A_6, A_7, A_8, A_9, A_{10}\}$ be the set of candidates. The committee of experts which take the interview consider a set of parameters for the post of HR Manager.

Let $E = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8\}$ be the set of parameters where the parameter x_i stand for experience, leadership, patience, good communication skills, sympathetic attitude, quick decision, integrity, and computer knowledge respectively for $i = 1,2,3,4,5,6,7,8$. The committee of experts will give their opinion in the form of linguistic terms and later can be converted into membership value with the help of table 1 given below

Table 1

Linguistic term	Membership value
Completely satisfy	1
Very strongly satisfy	0.9
Strongly satisfy	0.7
Satisfy	0.5
Strongly dissatisfy	0.3
Very strongly dissatisfy	0.1
Completely dissatisfy	0

For example an expert may say the statement that the candidate A_1 is strongly satisfy the parameter experience, very strongly the parameter leadership, very strongly dissatisfy the parameter patience, satisfy the parameter good communication skills, satisfy the parameter sympathetic attitude, strongly dissatisfy the parameter quick decision, very strongly satisfy the parameter integrity and completely satisfy the parameter computer knowledge. Then on the basis of experts opinion we construct a fuzzy set A_1as follows:

$$A_1 = \{(x_1, 0.7), (x_2, 0.9), (x_3, 0.9), (x_4, 0.5), (x_5, 0.5), (x_6, 0.3), (x_7, 0.9), (x_8, 1)\}$$

In a similar way on the basis of experts' opinion we can construct the following fuzzy sets

$$A_2 = \{(x_1, 0.5), (x_2, 0.3), (x_3, 0.7), (x_4, 0.5), (x_5, 0.5), (x_6, 0.1), (x_7, 0.5), (x_8, 0.5)\}$$

$$A_3 = \{(x_1, 0.3), (x_2, 0.7), (x_3, 0.3), (x_4, 0.3), (x_5, 0.7), (x_6, 0.1),$$

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$$(x_7, 0.3), (x_8, 0.3)\}$$
$$A_4 = \{(x_1, 0.3), (x_2, 0.7), (x_3, 0.5), (x_4, 0.4), (x_5, 0.3), (x_6, 0.3), (x_7, 0.3), (x_8, 0.5)\}$$
$$A_5 = \{(x_1, 0.5), (x_2, 0.3), (x_3, 0.3), (x_4, 0.1), (x_5, 0.5), (x_6, 0.3), (x_7, 0.1), (x_8, 0.3)\}$$
$$A_6 = \{(x_1, 0.1), (x_2, 0.3), (x_3, 0.5), (x_4, 0.1), (x_5, 0.1), (x_6, 0.3), (x_7, 0.1), (x_8, 0.1)\}$$
$$A_7 = \{(x_1, 0.5), (x_2, 0.1), (x_3, 0.3), (x_4, 0.5), (x_5, 0.3), (x_6, 0.3), (x_7, 0.1), (x_8, 0.3)\}$$
$$A_8 = \{(x_1, 0.7), (x_2, 0.7), (x_3, 0.5), (x_4, 0.5), (x_5, 0.5), (x_6, 0.3), (x_7, 0.9), (x_8, 0.5)\}$$
$$A_9 = \{(x_1, 0.3), (x_2, 0.5), (x_3, 0.5), (x_4, 0.1), (x_5, 0.1), (x_6, 0.3), (x_7, 0.5), (x_8, 0.0)\}$$
$$A_{10} = \{(x_1, 0.7), (x_2, 0.9), (x_3, 0.9), (x_4, 0.5), (x_5, 0.5), (x_6, 0.3), (x_7, 0.9), (x_8, 0.0)\}$$

The above fuzzy sets in terms of membership value can be written in the tabular form as follows:

Table 2

U	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
A_1	0.7	0.9	0.9	0.5	0.5	0.3	0.9	1.0
A_2	0.5	0.3	0.7	0.5	0.5	0.1	0.5	0.5
A_3	0.3	0.7	0.3	0.3	0.7	0.1	0.3	0.3
A_4	0.3	0.7	0.5	0.4	0.3	0.3	0.3	0.5
A_5	0.5	0.3	0.3	0.1	0.5	0.3	0.1	0.3
A_6	0.1	0.3	0.5	0.1	0.1	0.3	0.1	0.1
A_7	0.5	0.1	0.3	0.5	0.3	0.3	0.1	0.3
A_8	0.7	0.7	0.5	0.5	0.5	0.3	0.9	0.5
A_9	0.3	0.5	0.5	0.1	0.1	0.3	0.5	0.0
A_{10}	0.7	0.9	0.9	0.5	0.5	0.4	0.9	0.9

2.1 CHOICE VALUE OF A CANDIDATE A_i

The choice value of a candidate A_i is c_i given by

$$c_i = \sum_j A_{ij},$$

where A_{ij} are the entries in the table 2.

2.2 ALGORITHM FOR SELECTION OF THE CANDIDATE

The following algorithm may be followed by the committee of experts to select a more suitable candidate for the given post

1. Construct a linguistic term and membership value table.
2. Construct the fuzzy sets with membership value.
3. Calculate the choice value for each candidate.
4. Find k for which $c_k = max\ c_i$

Then A_k is the more suitable candidate for the said post.
Now we use the algorithm and calculate the choice value for each A_i , $i = 1,2,3,4,5,6,7,8,9,10$.

Table 3

U	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	Choice value
A_1	0.7	0.9	0.9	0.5	0.5	0.3	0.9	1.0	5.7
A_2	0.5	0.3	0.7	0.5	0.5	0.1	0.5	0.5	3.6
A_3	0.3	0.7	0.3	0.3	0.7	0.1	0.3	0.3	3.0
A_4	0.3	0.7	0.5	0.4	0.3	0.3	0.3	0.5	3.3
A_5	0.5	0.3	0.3	0.1	0.5	0.3	0.1	0.3	2.4
A_6	0.1	0.3	0.5	0.1	0.1	0.3	0.1	0.1	1.6
A_7	0.5	0.1	0.3	0.5	0.3	0.3	0.1	0.3	2.4
A_8	0.7	0.7	0.5	0.5	0.5	0.3	0.9	0.5	4.6
A_9	0.3	0.5	0.5	0.1	0.1	0.3	0.5	0.0	2.3
A_{10}	0.7	0.9	0.9	0.5	0.5	0.4	0.9	0.9	5.7

From the above table we see the choice value is maximum for the candidate A_1 and A_{10} . Hence the candidates $A_1$and A_{10} are more suitable for the said position.

2.3 WEIGHTED TABLE OF A FUZZY SET

Lin [5] discuss about the weighted value for a set and arise a very interesting question: should a membership value can be considered as the only characteristic property of fuzzy sets, while answering by himself he defines a new mathematical analysis theory “theory of weighted soft sets” A.R. Roy [6] also discuss the weighted value of soft sets and also give an application of soft sets using weighted choice value of an object.

2. 4 WEIGHTED CHOICE VALUE OF A CANDIDATE A_i

The weighted choice value of a candidate A_i is c_i given by

$$c_i = \sum_j d_{ij},$$

where $d_{ij} = w_j \times A_{ij}$.

2.5 REVISED ALGORITHM FOR SELECTION OF THE CANDIDATE

- Construct a linguistic term and membership value table.
- Construct the fuzzy sets with membership value.
- Find weighted table of the fuzzy sets according to the weights decided by the management of the company.
- Find k for which $c_k = max\ c_i$

Then A_k is the more suitable candidate for the said post.
Now we use the algorithm and calculate the choice value for each A_i , $i = 1,2,3,4,5,6,7,8,9,10$.
Suppose that the management decides the following weights for the parameters.

Table 4

Parameters	Weighted value (w_i)
x_1	0.4
x_2	0.4
x_3	0.5
x_4	0.8
x_5	0.5
x_6	0.6
x_7	0.5
x_8	0.9

Now we calculate the weighted choice value for each candidate.

Table 5

U	x_1 ($w_1 = 0.4$)	x_2 ($w_2 = 0.4$)	x_3 ($w_3 = 0.5$)	x_4 ($w_4 = 0.8$)	x_5 ($w_5 = 0.5$)	x_6 ($w_6 = 0.6$)	x_7 ($w_7 = 0.5$)	x_8 ($w_8 = 0.9$)	Weighted Choice value
A_1	0.7	0.9	0.9	0.5	0.5	0.3	0.9	1.0	3.27
A_2	0.5	0.3	0.7	0.5	0.5	0.1	0.5	0.5	2.08
A_3	0.3	0.7	0.3	0.3	0.7	0.1	0.3	0.3	1.62
A_4	0.3	0.7	0.5	0.4	0.3	0.3	0.3	0.5	1.9
A_5	0.5	0.3	0.3	0.1	0.5	0.3	0.1	0.3	1.3
A_6	0.1	0.3	0.5	0.1	0.1	0.3	0.1	0.1	0.86
A_7	0.5	0.1	0.3	0.5	0.3	0.3	0.1	0.3	1.44
A_8	0.7	0.7	0.5	0.5	0.5	0.3	0.9	0.5	2.54
A_9	0.3	0.5	0.5	0.1	0.1	0.3	0.5	0.0	1.13
A_{10}	0.7	0.9	0.9	0.5	0.5	0.4	0.9	0.9	3.24

From the above table we see the weighted choice value is maximum for the candidate A_1. Hence the candidate A_1 is more suitable for the said position.

3 CONCLUSION

In this paper ten candidates are considered for a single post of HR manager. Moreover, this research can be applicable for a large number of data in decision making process. Such type of applications can also be done by soft set theory given by Molodtsov [7]. A soft set is a mapping from parameters to crisp subsets of universal set. However, this situation is very difficult due to ambiguity and fuzziness in the real world. To overcome this difficulty N. Cagman [8] give the theory of fuzzy soft sets. In this paper we apply the fuzzy sets in decision making process. It may apply to many fields with problems containing uncertainty.

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