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# An Application of Trapezoidal Bipolar Intuitionistic Fuzzy Soft Sets in A Decision Making Problem

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**ABSTRACT:** Problem solving is the process of finding potential solutions to a problem. This process is complicated and so judgment calls or choices had to be taken during the process by finding the best solution which is the primary objective. The soft set theory can be applied in smoothness, game theory, operations research, probability, measurement theory, and some of the fields in which the theory of soft sets can be applied. Regarding its use in the problem of decision-making here we discuss on how to solve a real-world phenomenon by applying a decision-making problem.

**KEYWORDS:** Soft Set, Fuzzy Soft Set, Bipolar Fuzzy Set, Bipolar Intuitionistic Fuzzy Set, Bipolar Intuitionistic Fuzzy Soft Set.

## I. INTRODUCTION

One of the most important and useful aspects in our day-to-day lives is making decisions. However, in these environments, it is challenging for the decision-maker to make the right choice due to the increasing complexity of the systems. A soft set and the idea of a trapezoidal bipolar intuitionistic fuzzy set are combined in this paper. The Trapezoidal bipolar intuitionistic fuzzy soft set is discussed. A general algorithm for solving a decision-making problem and an application of Trapezoidal bipolar intuitionistic fuzzy soft sets are provided. A general algorithm and an application of the Trapezoidal bipolar intuitionistic fuzzy soft set to a decision-making problem are provided for its solution.

## II. RELATED WORK

The fuzzy set theory of Zadeh [13] and the intuitionistic fuzzy set theory of Atanassov [4] have been defined as tools for handling it. In economics, engineering, environmental science, sociology, and information science, the traditional theoretical approaches have made it difficult for the classical methods to successfully model uncertain data due to their inherent difficulties. Molodtsov [11] introduced the idea of soft set theory as a brand-new, trouble-free mathematical tool for dealing with uncertainties. This was done to get around these issues. Maji et.al [10] looked at a decision making problem where soft set theory was used. Acar et.al [2] introduced the soft set and soft ring. Zadeh [13] characterized a number of system identification issues as essentially nonprobabilistic in nature. In 1965, Zadeh [14] presented fuzzy set theory as an alternative to probability theory in response to this circumstance. Some decision-making problem applications were investigated by Roy and Maji [9]. Aslam et.al [3] studied bipolar fuzzy soft set and Graph theory in 2013, Abdullah et.al [1] and Naz et.al [12] presentation of the bipolar fuzzy soft set and its application to the problem of decision making, Garg [6] investigated the characteristics of fuzzy Number Intuitionistic fuzzy soft sets. Additionally, the concept of a bipolar intuitionistic fuzzy set was introduced by Ezhilmaran and Sankar [5].

III. METHODOLOGY

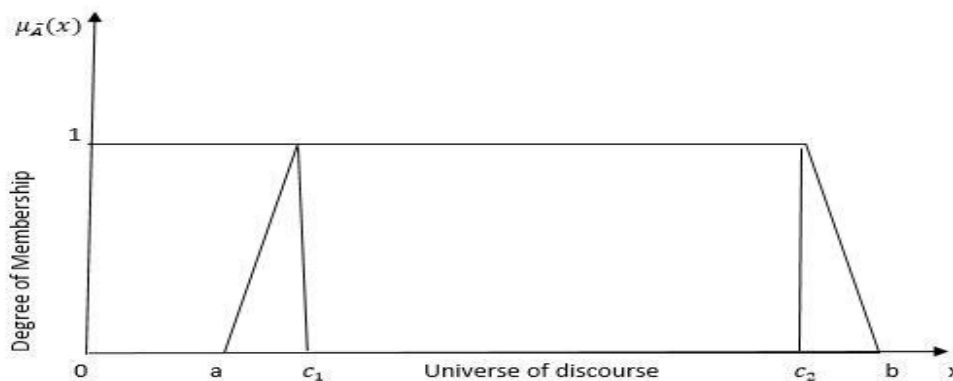


Figure 1: Trapezoidal fuzzy number in the interval (a, b)

Consider the trapezoidal fuzzy number  $\tilde{A} = (a, c_1, c_2, b)$ .

The interval (a, b) is split as follows:

$$(a, b) = X_1 \cup X_2 \cup X_3,$$

where  $X_1 = (a, c_1)$ ,  $X_2 = [c_1, c_2]$  and  $X_3 = (c_2, b)$ . We define the triangular fuzzy numbers corresponding to  $X_1$  and  $X_3$  as  $\tilde{A}_1 = (a, c_1, c_1)$  and  $\tilde{A}_3 = (c_2, c_2, b)$  and then obtain their corresponding real numbers denoted by  $A_1$  and  $A_3$  as follows:

$$A_1 = \frac{a + c_1 + c_1}{3}$$

$$A_3 = \frac{c_2 + c_2 + b}{3}$$

In order to obtain the real number  $A_2$  corresponding to the interval  $X_2 = [c_1, c_2]$ , we use the uniform distribution and calculate its mean value via the relation  $\mu = \frac{p+q}{2}$ . The mean of the real numbers  $A_1, A_2$  and  $A_3$  is considered as the crisp real number corresponding to the trapezoidal fuzzy number. The crisp real number  $\mu_{\tilde{A}}$  corresponding to the trapezoidal fuzzy number

$\tilde{A} = (a, c_1, c_2, b)$  is obtained by the following relation:

$$\mu_{\tilde{A}} = \frac{2a + 7c_1 + 7c_2 + 2b}{18}$$

We define accuracy function to defuzzify a given trapezoidal Intuitionistic fuzzy number is

$$\text{Accuracy Function} = \frac{2(a + d) + 7(b + c)}{18}$$

ALGORITHM

1. Input Trapezoidal bipolar intuitionistic fuzzy soft set (F, A) and choice parameters set A ⊂ E.
2. Fuzzy values converted into crisp values using accuracy function.
3. Compute comparison tables for positive membership function, negative membership function, positive non-membership function and negative non-membership function.
4. Compute positive score and negative score function.
5. Compute final score which is obtained by subtracting from positive score to negative score.
6. Find maximum score of  $S_i$ , where  $Maximum\ score = \max\{S_i\}$  and  $1 \leq i \leq 3$ .



IV. EXPERIMENTAL RESULTS

Let us consider that  $U = \{l_1, l_2, l_3\}$  be a set of three agriculture lands with the status of the parameter set  $E = \{\alpha_1, \alpha_2, \alpha_3, \alpha_4\}$  where,  $\alpha_1$  stands for Soil Nutrition,  $\alpha_2$  stands for Plant Protection,  $\alpha_3$  stands for Farm Management,  $\alpha_4$  stands for Climate Patterns. Suppose a farmer wants to buy an agriculture land on the basis of the above parameters. Our knowledge is to find out Permanent Pastures for farmer. Suppose the set of parameters that are Permanent Pastures to farmer be  $A \subset E$ , where  $A = \{\alpha_1, \alpha_2, \alpha_3\}$ . We consider Trapezoidal bipolar intuitionistic fuzzy soft sets that are as follows:

$$F(\alpha_1) = \begin{pmatrix} l1, (0.5,0.3,0.3,0.3)(-0.4, -0.1, -0.5, -0.4)(0.6,0.3,0.4,0.2)(-0.2, -0.4, -0.4, -0.3) \\ l2, (0.7,0.2,0.5,0.3)(-0.4, -0.2, -0.5, -0.3)(0.3,0.6,0.4,0.2)(-0.2, -0.3, -0.4, -0.1) \\ l3, (0.3,0.4,0.5,0.3)(-0.4, -0.2, -0.5, -0.2)(0.3,0.2,0.3,0.2)(-0.5, -0.4, -0.3, -0.0) \end{pmatrix}$$

$$F(\alpha_2) = \begin{pmatrix} l1, (0.8,0.9,1.0,1.0)(-0.0, -0.1, -0.3, -0.2)(0.5,0.6,0.6,0.7)(-0.3, -0.3, -0.4, -0.5) \\ l2, (0.8,0.9,1.0,1.0)(-0.0, -0.1, -0.2, -0.2)(0.6,0.7,0.8,0.8)(-0.0, -0.1, -0.2, -0.2) \\ l3, (0.5,0.3,0.3,0.3)(-0.4, -0.1, -0.5, -0.4)(0.6,0.3,0.4,0.2)(-0.2, -0.4, -0.4, -0.3) \end{pmatrix}$$

$$F(\alpha_3) = \begin{pmatrix} l1, (0.5,0.5,0.5,0.3)(-0.3, -0.2, -0.5, -0.1)(0.8,0.2,0.4,0.2)(-0.4, -0.3, -0.4, -0.3) \\ l2, (0.3,0.4,0.5,0.3)(-0.1, -0.2, -0.5, -0.2)(0.3,0.2,0.3,0.2)(-0.5, -0.4, -0.3, -0.0) \\ l3, (0.7,0.2,0.5,0.3)(-0.4, -0.2, -0.5, -0.2)(0.3,0.6,0.4,0.2)(-0.2, -0.3, -0.4, -0.1) \end{pmatrix}$$

$$F(\alpha_1) = \begin{pmatrix} l1, (0.32, -0.32)(0.36, -0.36) \\ l2, (0.38, -0.33)(0.44, -0.30) \\ l3, (0.41, -0.30)(0.25, -0.32) \end{pmatrix}$$

$$F(\alpha_2) = \begin{pmatrix} l1, (0.88, -0.13)(0.60, -0.36) \\ l2, (0.88, -0.13)(0.73, -0.13) \\ l3, (0.32, -0.32)(0.36, -0.36) \end{pmatrix}$$

$$F(\alpha_3) = \begin{pmatrix} l1, (0.47, -0.31)(0.34, -0.35) \\ l2, (0.41, -0.30)(0.25, -0.32) \\ l3, (0.38, -0.33)(0.44, -0.30) \end{pmatrix}$$

Table 1. Tabular presentation for positive membership function

Parameters \ Lands	$\alpha_1$	$\alpha_2$	$\alpha_3$
$l1$	0.32	0.88	0.47
$l2$	0.38	0.88	0.41
$l3$	0.41	0.32	0.38

Table 2. Comparison table for positive membership function

Lands \ Lands	$l1$	$l2$	$l3$
$l1$	3	2	2
$l2$	2	3	1
$l3$	1	1	3



Table 3. Table for positive membership score

Row	Column	Positive Membership
Sum( $r_i'$ )	sum( $c_i'$ )	score( $P_i$ )
7	6	1
6	6	0
5	6	-1

Table 4. Tabular presentation for negative membership function

Parameters Lands	$\alpha_1$	$\alpha_2$	$\alpha_3$
$l_1$	-0.32	-0.13	-0.31
$l_2$	-0.33	-0.13	-0.30
$l_3$	-0.30	-0.32	-0.38

Table 5. Comparison table for negative membership function

Lands	$l_1$	$l_2$	$l_3$
$l_1$	3	2	1
$l_2$	2	3	1
$l_3$	2	2	3

Table 6. Table for negative membership score

Row	Column	Negative Membership
Sum( $r_i^2$ )	sum( $c_i^2$ )	score( $N$ )
6	7	-1
6	7	-1
7	5	2

Table 7. Tabular presentation of positive non-membership function

Parameters Lands	$\alpha_1$	$\alpha_2$	$\alpha_3$
$l_1$	0.36	0.60	0.34
$l_2$	0.44	0.73	0.25
$l_3$	0.25	0.36	0.44

Table 8. Comparison table for positive non-membership function

Lands	$l_1$	$l_2$	$l_3$
$l_1$	3	1	1
$l_2$	2	3	2
$l_3$	1	1	3



Table 9. Table for positive non-membership score

Row	Column	Positive Non- Membership
Sum( $r_i^3$ )	sum( $c_i^3$ )	score( $P_i'$ )
5	6	-1
7	5	2
5	6	-1

Table 10. Tabular presentation of negative non-membership function

Parameters Lands	$\alpha_1$	$\alpha_2$	$\alpha_3$
$l_1$	-0.36	-0.36	-0.35
$l_2$	-0.30	-0.13	-0.32
$l_3$	-0.32	-0.36	-0.30

Table 11. Comparison table for negative non-membership function

Lands	$l_1$	$l_2$	$l_3$
$l_1$	3	3	3
$l_2$	0	3	1
$l_3$	1	2	3

Table 12. Table for negative non-membership score

Row	Column	Negative Non-Membership
Sum( $r_i'$ )	sum( $c_i'$ )	score( $N_i'$ )
9	4	5
4	8	-4
6	7	-1

Table 13. Table for final score

Lands	Positive Sum( $S^p$ )	Negative sum( $S^n$ )	Final score( $S_i$ ) = ( $S^p - S^n$ )
$l_1$	9	4	5
$l_2$	4	8	-4
$l_3$	6	7	-1

The farmer buys  $S_i, 1 \leq i \leq 3$  if its maximum scored occur at  $i^{\text{th}}$  position. In this problem, farmer buys  $l_1$  agriculture land because its score is 5 which is maximum.

### V. CONCLUSION

Throughout the course of a day, people frequently make decisions that are straightforward and do not require much thought. In any case, it is not difficult to experience feelings of uncertainty or reluctance when circumstances are more complex and have longer-term influences. In this article, we demonstrate how a trapezoidal bipolar intuitionistic fuzzy soft set can be applied to the problem of decision making. The outcomes might reveal a lot about the dynamic cycle, the decision's suitability, and the execution interaction itself. When it comes time to make a comparison decision again, this information will be of great assistance in further developing the agriculture response.





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