A Decision-making Problem as an Applications of Intuitionistic Fuzzy Set

Hemlata Aggarwal, H.D. Arora, Vijay Kumar

Abstract: ***The fuzzy sets and Intuitionistic fuzzy sets are very useful concepts to elaborate the vagueness in real world problems. The objective of our study is to apply fuzzy set theory and Intuitionistic fuzzy set theory in decision making process. In this paper, we identify in which society a person has to purchase a house in order to fulfil his requirement to maximum extent. In our study we use intuitionistic fuzzy sets to find a relation between the societies and the parameters. And then we find a relation between a person and the parameters. We calculate Normalized Euclidean distance between two Intuitionistic fuzzy sets to make a decision of purchasing house in a society.***

Keywords: Fuzzy sets, Intuitionistic fuzzy sets, distance between two intuitionistic fuzzy sets.

I. INTRODUCTION

Term fuzzy set was firstly defined by L.A. Zadeh in 1965[1]. He defined the fuzzy sets for the ambiguity in the real life. He overcomes the problem of confusion about inclusion and exclusion of any element to a set. He defined membership value for each element of a set in between zero and one and the non-membership value is one minus the membership value. The term intuitionistic fuzzy set is the extension of fuzzy sets was defined by K..Atanassov in 1986 [2]. He defines membership value, non-membership value as well as the hesitation index. He says that the sum of membership value and non-membership value is lies between zero and one and the hesitation index is one minus the sum of membership value and non-membership value of an element of asset. The hesitation index for a fuzzy set is zero. The fuzzy sets and intuitionistic fuzzy sets are very useful tools in real life application areas like decision making problems, medical problems, engineering problems, control systems and various fields [3]. In this work we use the concept of distance between two intuitionistic fuzzy sets [4-6] in decision making process. The decision has been taken by measuring the smallest Euclidean distance between a person and a society. Many real-world decision-making problems such as academic career of the students, high school determination problem, medical problems, student performance determination of a course, career determinations etc. have been carried out by various researchers by using intuitionistic fuzzy sets [7-10].

Revised Manuscript Received on December 30, 2019.
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II. PRELIMINARIES

In this section, we present the basic definitions.

2.1 Definition

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 [1].

2.2 Definition

[2,3] Let X be a non-empty set. An intuitionistic fuzzy set A drawn from X is defined as

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

where

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

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

$0 \le \mu_A(x) + \nu_A(x) \le 1$ for all $x \in X$.

Furthermore, we have $\pi_A(x) = 1 - \{\mu_A(x) + \nu_A(x)\}$ called the hesitation index of x in X.

$\pi_A(x)$ express the lack of knowledge about inclusion and exclusion of x in X.

2.3 Definition

Let X be a non-empty set and P, Q, R be intuitionistic fuzzy sets of X. A function $d: X \times X \to [0,1]$ is said to be distance measure between two intuitionistic fuzzy sets [6] if it satisfies the following axioms:

1. $0 \le d(P,Q) \le 1$
2. $d(P,Q) = 0$ if and only if $P = Q$
3. $d(P,Q) = d(Q,P)$
4. If $P \subseteq Q$ and $Q \subseteq R$ then
$$d(P,R) \ge d(P,Q) \text{ and } d(P,R) \ge d(Q,R)$$

Retrieval Number: A1053109119/2019©BEIESP
DOI: 10.35940/ijeat.A1053.129219
Journal Website: www.ijeat.org

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2.4 Definition

Let $A = \{(x_i, \mu_A(x_i), \nu_A(x_i), \pi_A(x_i)): x_i \in X\}$ and $B = \{(x_i, \mu_B(x_i), \nu_B(x_i), \pi_B(x_i)): x_i \in X\}$ be two intuitionistic fuzzy sets in X. Szmidt and Kacprzyk [4,5] proposed the following four distance measures between A and B:

The Hamming distance;

$$d_H(A,B) = \frac{1}{2}\sum_{i=1}^{n}(|\mu_A(x_i) - \mu_B(x_i)| + |\nu_A(x_i) - \nu_B(x_i)| + |\pi_A(x_i) - \pi_B(x_i)|)$$

The Euclidean distance;

$$d_E(A,B) = \sqrt{\frac{1}{2}\sum_{i=1}^{n}\left[(\mu_A(x_i) - \mu_B(x_i))^2 + (\nu_A(x_i) - \nu_B(x_i))^2 + (\pi_A(x_i) - \pi_B(x_i))^2\right]}$$

The Normalized Hamming distance;

$$d_{n-H}(A,B) = \frac{1}{2n}\sum_{i=1}^{n}(|\mu_A(x_i) - \mu_B(x_i)| + |\nu_A(x_i) - \nu_B(x_i)| + |\pi_A(x_i) - \pi_B(x_i)|)$$

The Normalized Euclidean distance;

$$d_{n-E}(A,B) = \sqrt{\frac{1}{2n}\sum_{i=1}^{n}\left[(\mu_A(x_i) - \mu_B(x_i))^2 + (\nu_A(x_i) - \nu_B(x_i))^2 + (\pi_A(x_i) - \pi_B(x_i))^2\right]}$$

III. APPLICATION

In this section, we present an application of intuitionistic fuzzy set. Many researchers present the applications of intuitionistic fuzzy sets by Normalized Euclidean distance method [11,12]. We also present an application of intuitionistic fuzzy sets. The problem we consider is as follows:

Suppose a set of persons want to purchase a house in a society. Let $\{S_1, S_2, S_3\}$ be the set of societies and $\{A_1, A_2\}$ be the set of persons who want to purchase a house in the said societies. The parameters for purchasing a house are wooden work, cheap, green surroundings, parking facility and water supply. Let $\{E_1, E_2, E_3, E_4, E_5\}$ be the set of parameters where E_1 stands for wooden work, E_2 stands for cheap, E_3 stands for green surroundings, E_4 stands for parking facility and E_5stands for water supply.

The linguistic terms can be converted into a number between zero and one with the help of following table.

Table 1

Linguistic Terms	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

Any value in between the given values represents the opinion on particular parameter is somewhat, in between the given linguistic terms.

Let $X = \{E_1, E_2, E_3, E_4, E_5\}$ be the set of parameters.

We define the intuitionistic fuzzy sets S_1 over X as follows:

$$S_1 = \{(E_1, 0.6,0.3,0.1), (E_2, 0.5,0.2,0.3), (E_3, 0.5,0.1,0.4), (E_4, 0.1,0.1,0.8), (E_5, 0.5,0.4,0.1)\}$$

$(E_1, 0.6,0.3,0.1) \in S_1$ represents that the society S_1 satisfy the parameter E_1(wooden work) with membership value 0.6, non-membership value 0.3 and hesitation index 0.1.

In similar way we can define the intuitionistic fuzzy sets S_2, S_3, S_4, S_5 over X as follows:

Table 2

	E_1	E_2	E_3	E_4	E_5
S_1	(0.6,0.3, 0.1)	(0.5,0.2, 0.3)	(0.5, 0.1, 0.4)	(0.1,0.1, 0.8)	(0.5,0.4, 0.1)
S_2	(0.8,0.1, 0.1)	(0.5,0.3, 0.2)	(0.6, 0.2, 0.2)	(0.5,0.1, 0.4)	(0.2,0.2, 0.6)
S_3	(0.3,0.1, 0.6)	(0.7,0.1, 0.2)	(0.5, 0.1, 0.4)	(0.7,0.2, 0.1)	(0.3,0.4, 0.3)

Also we define the intuitionistic fuzzy sets A_1 over X as follows:

$$A_1 = \{(E_1, 0.5,0.2,0.3), (E_2, 0.6,0.2,0.2), (E_3, 0.7,0.1,0.2), (E_4, 0.1,0.5,0.4), (E_5, 0.5,0.4,0.1)\}$$

$(E_1, 0.5,0.2,0.3) \in A_1$ represents that the person A_1 satisfy the parameter E_1(wooden work) with membership value 0.5, non-membership value 0.2 and hesitation index 0.3.

In similar way we can define the intuitionistic fuzzy sets A_2, A_3, A_4, A_5, A_6 over X as follows:

Retrieval Number: A1053109119/2019©BEIESP
DOI: 10.35940/ijeat.A1053.129219
Journal Website: www.ijeat.org

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Table 3

	E_1	E_2	E_3	E_4	E_5
A_1	(0.5, 0.2, 0.3)	(0.6 ,0.2, 0.2)	(0.7, 0.1, 0.2)	(0.1, 0.5, 0.4)	(0.5 ,0.4, 0.1)
A_2	(0.6, 0.2, 0.2)	(0.6, 0.3, 0.1)	(0.5 ,0.3, 0.2)	(0.2, 0.3, 0.5)	(0.4, 0.2, 0.4)

Now we calculate the Normalized Euclidean distance between S_i and A_j ,

where $i = 1,2,3 \quad and j = 1,2$.

The table given below calculates the Normalized Euclidean distance between $\{S_1, S_2, S_3\}$ and $\{A_1, A_2\}$ by considering the five parameters $\{E_1, E_2, E_3, E_4, E_5\}$.

Table 4

	S_1	S_2	S_3
A_1	0.2191	0.2966	0.2932
A_2	0.2098	0.1789	0.2966

From the above table we analyze that the distance between the person A_1 and the society S_1 is lesser than the distance between the person A_1 and the society S_2 and with society S_3also. It shows that if a person A_1 wants to purchase a house in society then he can choose a house in society S_1. Similarly, if a person A_2 wants to purchase a house in society then he can choose a house in society S_2.

IV. RESULT

In this paper, we discussed an application of intuitionistic fuzzy sets in decision making problem. We took an example to explain the process. We took a set of persons who want to purchase a house in a society and a set of shortlisted societies with a set of parameters. From the above calculations we analyzed that the society S_1 is more suitable for the person $A_1$with his parameters and the society S_2 is more suitable for the person $A_2$with his parameters.

Table 5

Person	Suitable Society
A_1	S_1
A_2	S_2

V. CONCLUSION

In this paper we have studied the application of intuitionistic fuzzy sets in decision making. In this paper two persons were randomly selected who wants to purchase a house in shortlisted three societies with some parameters. We calculated the Normalized Euclidean distance between a person and a society. Lesser the distance will provide the better choice for a person to decide in which society he can purchase a house with defined parameters. This method can be applied for various decision-making problems. The above method gives the sensible results.

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