

Fuzzy Sets: An effective approach for selection of a Machine to Enhance Decision Making Process

D.P. Semwal

DAV College, Sector 10, Chandigarh

Abstract

Life is so fast that a lot of changes are coming in daily routine. Every person wants that his profit should maximum and his cost should be minimum. In the fast growing economy new inventions are coming. In mechanical sector there are lots of machines in the market. If we are able to find that machine which is more suitable then we can get more benefit. Sanchez's approach is used to identify the type of suitable machine. This approach is based on relation in the features (can also say factors) and types of machines by intuitionistic fuzzy sets. A hypothetical case study is considered with assigned degree of membership / non membership and hesitation index containing some information about machines and their features.

Keywords: Fuzzy Sets, Intuitionistic Fuzzy Sets (IFS), Fuzzy Relations, Machine Information, Hypothetical Case Study.

Introduction

In modern days the industry is changing very rapidly. New inventions are coming very fastly especially in engineering sector. Mechanical sector is an evergreen sector and there are so many machines which are used for doing work in this sector. The selection of perfect machine which can be more profitable for an engineer or a customer is not an easy task. There are so many methods and techniques which may prove helpful in choosing a suitable machine. A person does work with interest and more energy if he gets success in selection of exact machine. By studying the features and factors of a machine a customer can know that whether he wants to purchase the machine or not. To overcome this difficulty, here we use the concept of maximum-minimum-maximum technique (composition) in intuitionistic fuzzy set theory.

A formal model is proposed in the process to find that type of machine which is more suitable as compare to others by using intuitionistic fuzzy set and intuitionistic fuzzy relation theory. Glaucoma diagnosis process using fuzzy sets is described by Losch [6]. Factors influencing teachers about laptop purchases are discussed in Tania [9]. Khan and Rohi [4] have investigated factors that affect the choice of youth for purchasing mobile phones. Kumar, Biswas and Roy [5], Ahn [2] has done the applications of IFS theory in diagnosis of various types of diseases. Adlassing [1] has used fuzzy set theory to diagnose medical conditions. Szmidt [8] proposed different measures for Intuitionistic Fuzzy Sets. Sata [7] told about those factors which affect consumer's buying behavior. While Gupta, Prince and Vijay [3] compared the intuitionistic fuzzy measure and fuzzy information measure for analysis of TB.

Methodology

In order to find the solution, we put some efforts to know about the market and influencing factors and features. Firstly, we establish IF relation between customers and features or factors, influencing a machine with membership / non membership degree – table (1.1). Also, table (1.2) discusses the IF relation between the types and features of machine. Finally, we apply Sanchez's approach and get results of table (1.3), then calculate hesitation index and find out the results of table (1.4) as weight elements. In case of a tie in weight elements then customer may purchase both kind of machines with their features and factors.

IFS and IFR

Sets with elements having degree of membership/ non-membership are called IFS. It was introduced by Krassimir Atanassov as an extension of Lofti Askar Zadeh's notion of fuzzy sets. IFS allow assessment of the elements by two functions say 'u' for membership and 'v' for non-membership. The sum of both the functions varies between the range 0 and 1. Like IFSs the IFRs are also the extension of crisp relations. In IFSs the degree of association can be represented by membership grade. We use the relations or operations like inclusion, equality, conjunction, disjunction etc. on intuitionistic fuzzy sets.

IFS of A is defined as: $A = \{ \langle x, u_A(x), v_A(x) \rangle \mid x \in X \}$, where $u_A(x): X \rightarrow [0,1]$ and $v_A(x): X \rightarrow [0,1]$ define the degree of membership and degree of non-membership of the element $x \in X$ to the set A, where X is a fixed set, Zadeh [10].

For every $x \in X$, $0 \leq u_A(x) + v_A(x) \leq 1$ and the amount $\pi_A(x) = 1 - u_A(x) - v_A(x)$ is the intuitionistic/ hesitation index. It may require both membership/ non-membership value.

Let A be an IFS of set X; R be an IF relation from $X \rightarrow Y$, then max-min-max composition of IFS X with the IF relation R ($X \rightarrow Y$) is defined as $B = R \circ A$ with membership and non-membership function defined as:

$$u_B(y) = \max_{x \in X} \{ \min [u_A(x), u_R(x, y)] \} \quad \&$$

$$v_B(y) = \min_{x \in X} \{ \max [v_A(x), v_R(x, y)] \}$$

Suppose $F = \{f_1, f_2, \dots, f_m\}$; $M = \{m_1, m_2, \dots, m_n\}$;

$C = \{c_1, c_2, \dots, c_q\}$; be the finite set of features, machines & customers resp.

Biswas [5] explained two Fuzzy relations (FR), Q and R as:

$$Q = \{ \langle (c, f), u_Q(c, f), v_Q(c, f) \rangle \mid (c, f) \in C \times F \}$$

$$R = \{ \langle (f, m), u_R(f, m), v_R(f, m) \rangle \mid (f, m) \in F \times M \}$$

Where $u_Q(c, f)$ indicate the degree that the machine is suitable for customer c using feature f and $v_Q(c, f)$ shows degree that machine is not suitable for customer c using feature f. $u_R(f, m)$ shows degree to which the feature f is present in the machine m and $v_R(f, m)$ shows degree to which feature f is not present in the machine m.

Composition T of IFRs R and Q ($T = R \circ Q$) indicate the interest of customer c_i for choosing the suitable machine from C to M using membership / non-membership as:

$$\mu_T(c_i, m) = \max_{f \in F} \{ \min [u_Q(c_i, f), u_R(f, m)] \} \quad \text{And}$$

$$v_T(c_i, m) = \min_{f \in F} \{ \max [v_Q(c_i, f), v_R(f, m)] \}, \forall c_i \in C \text{ and } m \in M$$

The case study shows which type of machine which is more beneficial for a customer. In the analysis, it is found that the information plays a major role specifically in case of diverse kinds of machines present in the market.

From Q & R, novel measures of IFR T can be completed for which, the selection tag of customer c from various machines m to satisfy the following:

- (i) $S_T = u_T - v_T \cdot \pi_T$ is maximum &
- (ii) Equality $T = R \circ Q$ is preserved.

Higher degree of association of features and lower degrees of intuitionistic index can be translated by T for analysis. Minimum intuitionistic index is chosen, if we obtain approximately equal values for any analysis procedure in T.

Case Study

Consider $C = \{c_1, c_2, c_3, c_4\}$ be the set of customers and $F = \{f_1, f_2, f_3, f_4\}$ be the set of features of the machines.

Now consider IFR $Q(C \rightarrow F)$ given by (hypothetically)

Table – I

Q	F ₁		F ₂		F ₃		F ₄	
customers	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q
C ₁	0.6	0.1	0.4	0.4	0.3	0.6	0.0	0.6
C ₂	0.5	0.2	0.7	0.1	0.5	0.5	0.3	0.5
C ₃	0.0	0.9	0.2	0.5	0.2	0.4	0.9	0.1
C ₄	0.4	0.3	0.3	0.6	0.1	0.8	0.2	0.7

Now $M = \{m_1, m_2, m_3, m_4\}$ be the set of machines, which a person wants to buy.

Let IFR $R(F \rightarrow M)$; given by (hypothetically)

Table – II

Q	M ₁		M ₂		M ₃		M ₄	
customers	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q
F ₁	0.3	0.0	0.5	0.1	0.3	0.3	0.1	0.8
F ₂	0.4	0.5	0.2	0.7	0.1	0.9	0.2	0.3
F ₃	0.7	0.1	0.3	0.4	0.5	0.5	0.0	0.7
F ₄	0.2	0.6	0.4	0.4	0.4	0.6	0.5	0.1

Let $T = R \circ Q$ follows as:

Table – III

Q	M ₁		M ₂		M ₃		M ₄	
customers	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q	u _Q	v _Q
C ₁	0.4	0.1	0.5	0.1	0.3	0.3	0.2	0.4
C ₂	0.5	0.2	0.5	0.2	0.5	0.3	0.3	0.3
C ₃	0.2	0.4	0.4	0.4	0.4	0.5	0.5	0.1
C ₄	0.3	0.3	0.4	0.3	0.3	0.3	0.2	0.6

Here $S_T = u_T - v_T * \pi_T$ is maximum and $\pi_T = 1 - u_T - v_T$ is the intuitionistic/ hesitation index.

Table – IV

S_T	M_1	M_2	M_3	M_4
C_1	0.35	0.46	0.18	0.04
C_2	0.44	0.44	0.44	0.18
C_3	0.04	0.32	0.35	0.46
C_4	0.18	0.31	0.18	0.08

Now from the above table we conclude that for customer C_1 , and C_4 machine M_2 is more profitable and for customer C_3 machine M_4 is suitable while for the customer C_2 the machines M_1, M_2, M_3 are beneficial. After knowing the type of suitable machine a customer can get more profit in comparison of others.

Conclusion

Generalized concept of crisp and fuzzy set theory is used in this paper. A Study by applying Max-min. and Min-max composition has been made with IFS theory. There are some other compositions like maximum, minimum etc. that can be also applied. This method is an effective tool and can be used for various decision making problems.

References

- [1] Adlassing K.P., Fuzzy set theory in medical diagnosis. IEEE Transactions on Systems, Man, and Cybernetics SMC; vol. 16: 260-265, 1986.
- [2] Ahn J.Y., Kim Y. H., Kim S. K., Oh S.Y., Han B. S., A fuzzy method for diagnosis of headache. IEICE Trans. INF. & SYST. Vol. E 91-D, No. 4: 1215-1217, 2008.
- [3] Gupta P., Prince, Kumar V.; Comparative analysis between intuitionistic fuzzy set theory and fuzzy information theory in medical diagnosis of TB. Mathematical Sciences International Research Journal; Vol. 3, Issue 1, 436-440, 2014.
- [4] Khan S., Rohi S.; Investigating the factors affecting youth brand choice for mobile phones purchase - A study of private universities students of Peshawar. Management and Marketing Challenges for the Knowledge Society; Vol. 8, No. 2, 369-384, 2013.
- [5] Kumar S., Biswas R., Roy A.R., An application of intuitionistic fuzzy sets in medical diagnosis. Fuzzy Sets and Systems; 117: 209-213, 2001.
- [6] Losch B., Application of Fuzzy Sets to the Diagnosis of Glaucoma. 18th Ann. Intel. Conf. of the IEEE Engg. In Medicine and Biology Society, Amsterdam, 1997.
- [7] Sata M.; Factors affecting consumer buying behavior of mobile phone devices. Mediterranean Journal of Social Sciences; Vol. 4, No. 12, 2013.
- [8] Szmidi E., Kacprzyk J., A measure for Intuitionistic Fuzzy Sets. Fuzzy sets and systems; 121, 2003.
- [9] Tania S.; Factors influencing teachers' laptop purchases. ULAB Journal of Science and Engineering; Vol. 3, No. 1, 2012.
- [10] Zadeh L.A., Fuzzy Sets. Information and control; 8: 338-353, 1965.