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Fuzzy Procedure for the Selection of Car among Various Brands

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Abstract

In this paper, we propose a fuzzy method of distances for the selection of used and new car for a common man. This method is based on the relations between the factors as: length of ownership, physical testing and research, fuel economy / alternate fuels, ownership cost, technical specification, which are responsible for the purchase of a car and brands General Motors, Tata, Maruti Suzuki, Hyundai and Honda available in the market by using the measures of intuitionistic fuzzy sets. For this purpose, we have developed a hypothetical knowledge base with assigned degree of membership, degree of non-membership and hesitation index. The result among four customers shows that the customer p_1 choose brand General Motors, p_2 choose brand Tata, p_3 choose brand Maruti Suzuki and p_4 choose brand Honda.

Keywords: Intuitionistic fuzzy sets (IFS); Brands; Factors; Customers; Normalized Hamming distance.

1. Introduction

The selection of a car by an individual has become a complex and highly confusing task. The requirements of the customers are changing at a very fast pace along with the pace of the technology. Now a days, customers have a lot of choices among available brands. While selecting a car, many questions arises, but a common man's selection of a particular brand is based on his need. These question are usually vague but practically when a customer opt for a car which suits his purpose, the key factors for

that are: length of ownership, physical testing and research, fuel economy / alternate fuels, ownership cost, technical specification. The projected length of ownership may have a huge bearing on what kind of vehicle a customer is purchasing. Customers are keeping their cars longer than they used to, so the quality rating and after sales services remains an important parameter. Physical testing and research done by the customer have a great impact on his selection. The actual performance of the car is known when a person physically verifies and rates the car as per his expectation. People needs a car having maximum fuel efficiency. They don't stop to consider the monetary value that is equated with each km/litre and then compares the annual fuel cost that they will have to bear. For the purpose of fuel economy, other options of alternate fueled cars like battery cars, hybrid cars, CNG fueled cars etc. were also available. Ownership cost includes the value that a company offers to a customer such as depreciation, insurance, maintenance and other benefits. Learned costumers also looks on the technical specifications such as engine power, ground clearance, enclosed volume, steering and braking system etc. before making a purchase. Balakrishnan [2012], develop a model for studying consumer preferences of buying a car in the state of Kerala. Irani[2010], gives the important aspects of buying a car. Adlassnig[1986], described applications of fuzzy theory to medical decision making. Atanassov[1986], Kumar[2001, 2012], Gupta[2011], Szmidt[1997, 1999, 2000, 2003] described the concept of distances and other measures of generalized fuzzy theory and proposed various decision making methods. In this paper, a mathematical model for the selection of used and new car by using intuitionistic fuzzy sets(IFS) is proposed. The present study considers only the mid-segment cars which is generally used by a common man.

2. Brief Introduction to Intuitionistic Fuzzy Sets(IFS)

Atanassov [1986], For a fixed set X , an IFS of A is defined as :

$A = \{< x, \mu_A(x) , \nu_A(x) > | \, x \in X\}$, where $\mu_A(x) : X \to [0,1]$ and $\nu_A(x) : X \to [0,1]$ define the degree of membership and degree of non-membership of the element $x \in X$ to the set A. For every $x \in X$, $0 \le \mu_A(x) + \nu_A(x) \le 1$ and the amount $\pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$ is called the intuitionistic index or hesitation index, which may require to membership value, non-membership value or both. In this paper, we are using the Normalized Hamming distance between two intuitionistic fuzzy sets(IFSs) Q and R for all the j^{th} factors of the i^{th} customers from the k^{th} brands is:

$$d(s(p_i), d_k) = \frac{1}{2n} \sum_{j=1}^{n} \left[\left| \mu_j(p_i) - \mu_j(d_k) \right| + \left| \nu_j(p_i) - \nu_j(d_k) \right| + \left| \pi_j(p_i) - \pi_j(d_k) \right| \right] \quad (2.1)$$

where, $0 \le d(s(p_i), d_k) \le n$.

3. Fuzzy Sets Approach to Decision Making Processes

Human beings have a remarkable capability to reason and make decisions in an environment of uncertainty, imprecision, incompleteness of information, and partially of knowledge, truth and class membership. A vast amount of information in human communication involves natural terms which are often vague and imprecise. The principle objective of fuzzy is formalization/ mechanization of this capability. Some believe that fuzziness is just one facet of vagueness, but some other believes that it is the only expression of vagueness. Since vagueness is the basic property of our world, it makes sense to expect decision making processes to be vague. Decision making is the art of determining a best possible choice from an available set of findings. It is only possible by the intensive collaboration. Intuitionistic fuzzy sets, favored for their ability to cope with the imprecise and imperfect nature of information, successfully handle the intrinsic uncertainty carried by decision making process. In the next section, we will use Normalized Hamming distance method for Intuitionistic Fuzzy Sets for the selection of a car.

4. Selection of a Car of Particular Brand VIA Method of Distances for Intuitionistic Fuzzy Sets

Here, we are taking a hypothetical case study by taking into account all the factors characterize for each customer. We propose Szmidt and Kacprzyk [2000] method based on calculating distances for IFSs. Let *S={ Length of ownership, Physical testing and research, Fuel economy / Alternate fuels, Ownership cost, Technical specification}; P={* p_1, p_2 ,p_3 p_4*}* and *D= { Honda, General Motors, Maruti Suzuki, Tata, Hyundai }* be the finite set of factors, customers and brands respectively. Also, let $\mu_Q(p,s)$ indicate the degree to which the factor s affects the customer p, $\nu_Q(p,s)$ indicate the degree to which the factor s does not appears in customer p, $\mu_R(s,d)$ indicate the degree to which the factor s confirm the brand d and $\nu_R(s,d)$ indicate the degree to which the factor s does not confirms the brand d. To see the application of the method, let us frame a hypothetical case study of factors and the type of car for each customer as:

Suppose the intuitionistic fuzzy relation (IFR) $Q(P \to S)$ is given by (hypothetically):

Table 4.1: Membership and Non-Membership values of factors to the Corresponding type of brand.

R	Honda		General Motors		Maruti Suzuki		Tata		Hyundai	
Factors	μ_R	ν_R	μ_R	ν_R	μ_R	ν_R	μ_R	ν_R	μ_R	ν_R

length of ownership	0.4	0.0	0.7	0.0	0.3	0.3	0.1	0.7	0.1	0.8
physical testing and research	0.3	0.5	0.2	0.6	0.6	0.1	0.2	0.4	0.0	0.8
fuel economy / alternate fuels	0.1	0.7	0.0	0.9	0.2	0.7	0.8	0.0	0.2	0.8
ownership cost	0.4	0.3	0.7	0.0	0.2	0.6	0.2	0.7	0.2	0.8
technical specification	0.1	0.7	0.1	0.8	0.1	0.9	0.2	0.7	0.8	0.1

Suppose the IFR $R(S \rightarrow D)$ is given by (hypothetically):

Table 4.2: Membership and Non-Membership values of Customers and its affection to factor of a brand.

Q	length of ownership		physical testing and research		fuel economy / alternate fuels		ownership cost		technical specification	
Customers	μ_Q	ν_Q	μ_Q	ν_Q	μ_Q	ν_Q	μ_Q	ν_Q	μ_Q	ν_Q
p1	0.8	0.1	0.6	0.1	0.2	0.8	0.6	0.1	0.1	0.6
p2	0.0	0.8	0.4	0.4	0.6	0.1	0.1	0.7	0.1	0.8
p3	0.8	0.1	0.8	0.1	0.0	0.6	0.2	0.7	0.0	0.5
p4	0.6	0.1	0.5	0.4	0.3	0.4	0.7	0.2	0.3	0.4

From the table (4.1) and (4.2), our task is to take best decision for each customer p_i ,associated with the set of factors s_j , characterize for each brand d_k . The lowest distance obtained points out best decision. Szmidt and Kacprzyk([1997,2000]) gives the correct way of calculating distances for intuitionistic fuzzy sets by taking into account all the three parameters as: the membership function, non-membership function and the hesitation index. The distances (2.1) for each customer from the set of brands are given in the table (4.3) as:

Table 4.3: Membership values of Customers and their corresponding type of car.

	Honda	General Motors	Maruti Suzuki	Tata	Hyundai
p1	0.28	0.24	0.28	0.54	0.56
p2	0.40	0.50	0.31	0.14	0.42
p3	0.38	0.44	0.32	0.50	0.55
p4	0.28	0.30	0.38	0.44	0.54

From the table (4.3), we conclude that customer p_1 choose brand General Motors, p_2 choose brand Tata, p_3 choose brand Maruti Suzuki and p_4 choose brand Honda.

5. Conclusion

In this paper, we use generalized concept of fuzzy set theory. A study of selection of a car for a common man has been made on the basis of the calculation of distances from a considered set of factors and its associated brands. It is possible to classify the type of brand by using the above mentioned methods. Also we can differentiate customers according to the types of chosen brand.

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