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An Application of Generalized Intuitionistic Fuzzy Set using Max-Min Composition Algorithm for Predicting the Best Quality of Two-Wheelers

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Abstract - In this paper we introduce a condition called Generalized Intuitionistic fuzzy condition (GIFC). Using this condition a new technique called Fuzzy Max-Min composition algorithm is used to obtain the best level quality of two – wheelers of various companies among the customers.

Keywords-Fuzzy subset, Intuitionistic fuzzy set(IFS), Generalized Intuitionistic fuzzy set(GIFS), Intuitionistic fuzzy relation (IFR), Generalized Intuitionistic fuzzy relation (GIFR)

I. INTRODUCTION

The Two-wheeler industry today has a significant role in the Indian Economy. The consumer who wants to be mobile today considers personal transportation as one of his basic needs. In Indian, the two-wheeler is used in variety of purposes particularly in urban areas communicating to work, visiting people, carrying loads, outdoors jobs like selling and the like. In rural areas, it enables people to travel more frequently to nearby towns for their daily needs. Most of the leading players such as Hero motocrop, Honda, Bajaj, TVS auto gearing up to strengthen their presence in this segment with a range of new products that will address the needs of specific consumer demand. India is the second largest producer of two-wheelers in the world. In the last few years, the Indian two-wheeler industry has seen spectacles growth. The country stands next to china and Japan in terms of production and sales respectively. Large variety of two-wheelers is available in the market, known for their latest technology and enhanced mileage. Indian bikes, scooters and mopeds represent style and class for both men and women in India. Two-wheelers would have several quality-related specifications such as mileage, design, colour, and cost. In this section the quality of two-wheeler from the viewpoint of various customers such as students, self-employed, working men as the opinions of customers regarding quality are subjective. Generalized Intuitionistic Fuzzy set (GIFS) are being used to give an integrated view that satisfies each of the customers involved.Generalized Intuitionistic Fuzzy set (GIFS) are one of the interesting and it is generalization of Intuitionistic fuzzy set. Mondal and Samanta [4] give an idea about Generalized Intuitionistic Fuzzy set (GIFS) it having membership (μ_A) and non-membership (ν_A) that satisfy the condition $\mu_A(x) \wedge \nu_A(x) \leq 0.5$, for all $x \in X$. Generalized Intuitionistic Fuzzy set (GIFS) are Intuitionistic Fuzzy set (IFS) but the converse is not true.

II. PRELIMINARIES

We give some basic definitions, which are used, in our next section.

A. Definition

A Generalized Intuitionistic Fuzzy Set (GIFS) A of X is an object having the form

$A = \{< x, \mu_A(x), \nu_A(x) > \mid x \in X\}$ Where the function μ_A: $X \to [0, 1]$ and ν_A: $X \to [0, 1]$ define respectively the degree of membership and degree of non- membership of the element $x \in X$ to the set A, which is a subset of E and for every $x \in X$ satisfy the condition

$\mu_A(x) \wedge \nu_A(x) \leq 0.5$, for all $x \in X$ (*)

This condition (*) is called Generalized Intuitionistic Fuzzy Condition (GIFC). The maximum value of $\mu_A(x)$ and $\nu_A(x)$ is 1.0, therefore Generalized Intuitionistic Fuzzy Condition (GIFC) imply that`$0 \leq \mu_A(x) \wedge \nu_A(x) \leq 0.5$, for all $x \in X$

B. Definition

Let A, B, $A_i \in C(X)$. Then inclusion, equality, complementation, arbitrary union and arbitrary intersection on C(X) are defined as follows.

1. $A \subset B \Leftrightarrow \mu_A(x) \leq \mu_B(x)$ and
2. $\nu_A(x) \geq \nu_B(x)$, $\forall\ x \in X$
3. $A = B \Leftrightarrow A \subset B$ and $B \subset A$
4. $\bar{A} = \{< x, \nu_A(x), \mu_A(x) > \mid x \in X\}$
5. $\bigcup_i A_i = (\bigvee_i \mu_{A_i}, \bigwedge_i \nu_{A_i})$
6. $\bigcap_i A_i = (\bigwedge_i \mu_{A_i}, \bigvee_i \nu_{A_i})$
7. Let X, Y, Z be three ordinary non-empty sets.

C. Definition

A generalized intuitionistic fuzzy relation (GIFR) is defined as a generalized fuzzy subset of $X \times Y$, having the form

$R = \{< (x, y), \mu_R(x, y), \nu_R(x, y) >: x \in X, y \in Y\}$

Where μ_R: $X \times Y \to [0, 1]$,

ν_R: $X \times Y \to [0, 1]$

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Satisfy the condition $\mu_R(x, y) \wedge \nu_R(x, y) \leq 0.5 \quad \forall (x, y) \in X \times Y$,

The collection of all generalized intuitionistic fuzzy relations on X × Y is denoted by GR(X × Y).

D. Definition

Let R ∈ GR(X × Y) and P ∈ GR(X × Y). Then we define composed relation on X × Z denoted by P∘R and defined by

P∘R = {< (x, z), $\mu_{PoR}(x, z)$, $\nu_{PoR}(x, z)$ >: x ∈ X, z ∈ Z}

Where

$$\mu_{PoR}(x,z) = \bigvee_y \{(\mu_R(x,y) \wedge \mu_p(x,z)\}$$

$$\nu_{PoR}(x,z = \bigwedge_y \{(\nu_R(x,y) \vee \nu_p(x,z)\}$$

III. ANALYSING THE BEST QUALITY OF TWO-WHEELER

In this section we present an application of GIFS to quality model of two-wheeler that addresses various types of quality in terms of various companies. GIFS have been employed to capture the subjectiveness associated with quality criteria specified by various customers.Suppose, C = set of quality criteria
T = set of two-wheeler companies
S = set of customers involved

Determination of best quality for two-wheeler involves the following steps:

- Determination of quality criteria C, set of two-wheeler companies T
- Formulation of GIFR Q between C and customers S
- Formulation of GIFR R between T and customers C
- Determination of GIFR T = R∘Q, consisting of values of companies corresponding to various customers.

A. Algorithm

- Compute T=R∘Q
- Compute W,
- {Where W= {$\mu_T(s_i,t_j)$, $\mu_T{}^c(s_i,t_j)$} non-members in T is $\mu_T{}^c(s_i,t_j)$=1- $\nu_T(s_i,t_j)$} converting as members in W.
- Find Min {$\mu_T(s_i,t_j)$, $\mu_T{}^c(s_i,t_j)$}] Find Max {Min {$\mu_T(s_i,t_j)$, $\mu_T{}^c(s_i,t_j)$}} then we conclude that the customers s_i are preferring the best two-wheeler companies t_j (i.e., j= 1, 2, 3, 4 and i=1, 2, 3)

IV. CASE STUDY

The survey was held with 100 customers of various types such as students, self-employed, working men. The customers were asked to give their recommendation about quality criteria using GIFS that capture the recommendation in the form of (μ,ν) satisfying the condition $\mu_A(x) \wedge \nu_A(x) \leq 0.5$.Table 1 present relation Q regarding opinion of customer to quality criteria using GIFS. Table 2 present relation R regarding opinion of quality regarding to companies using GIFS. Table 3 obtains the relation T contains customer opinion in term of two-wheeler companies using Table 1 and Table 2.Let there are 3 types of customers such as students, self-employed, working men that is S = {students, self-employed, working men} and the set of quality criteria C = {Mileage, Design, Color, Cost} and the set of two-wheeler companies T = {Hero Moto crop, Honda, Bajaj, TVS}.

Table- 1

R	Hero	Honda	Bajaj	TVS
Mileage	(0.74, 0.44)	(0.72, 0.38)	(0.64, 0.44)	(0.69, 0.45)
Design	(0.85, 0.42)	(0.78, 0.45)	(0.71, 0.36)	(0.82, 0.42)
Color	(0.76, 0.36)	(0.66, 0.38)	(0.48, 0.65)	(0.70, 0.40)
Cost	(0.78, 0.46)	(0.75, 0.42)	(0.68, 0.48)	(0.75, 0.35)

Table- 2

T	Hero	Honda	Bajaj	TVS
Students	(0.76, 0.36)	(0.72, 0.38)	(0.70, 0.44)	(0.70, 0.40)
Self-Employed	(0.80, 0.36)	(0.78, 0.38)	(0.71, 0.44)	(0.80, 0.40)
Students	(0.78, 0.36)	(0.75, 0.38)	(0.75, 0.40)	(0.75, 0.35)

Table-3

W	Hero	Honda	Bajaj	TVS
Students	(0.76, 0.64)	(0.72, 0.62)	(0.70, 0.56)	(0.70, 0.50)
Self-Employed	(0.80, 0.64)	(0.78, 0.62)	(0.71, 0.56)	(0.80, 0.50)
Students	(0.78, 0.64)	(0.75, 0.62)	(0.75, 0.50)	(0.75, 0.55)

Table-4

M	Hero	Honda	Bajaj	TVS
Students	0.64	0.62	0.56	0.50
Self-Employed	0.64	0.62	0.56	0.50
Students	0.64	0.62	0.50	0.55

Table-5

Q	Mileage	Design	Color	Cost
Students	(0.80, 0.40)	(0.70, 0.50)	(0.80, 0.20)	(0.60, 0.50)
Self-Employed	(0.70, 0.40)	(0.80, 0.50)	(0.70, 0.30)	(0.60, 0.50)
Working men	(0.40, 0.60)	(0.50, 0.40)	(0.70, 0.30)	(0.80, 0.30)

V. CONCLUSION

From Table 5 it is obvious that the customers are preferring the Hero Motocrop as the best Two-Wheeler company. In the 21st century, the motorcycle industry is mainly dominated by Japanese companies. In addition to the large capacity motorcycles, there is a large market in smaller capacity (less than 300 cc) motorcycles, mostly concentrated in Asian and African countries. An example is the 1958 Honda Super cub, which went on to become the biggest selling vehicle of all time, with its 60 millionth unit produced in April 2008.Today, this area is dominated by mostly Indian companies with Hero Motocrop emerging as the world's largest manufacturer of two wheelers. Its Splendour model has sold more than 8.5 million to date. Other major producers are Bajaj and TVS motors.

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