International Journal of Mathematics And its Applications
Volume 5, Issue 4–D (2017), 589–593.
ISSN: 2347-1557
Available Online: http://ijmaa.in/

International Journal of Mathematics And its Applications

Ranking Generalized Intuitionistic Pentagonal Fuzzy Number by Centroidal Approach

Research Article

G. Uthra[1], K. Thangavelu[2] and S. Shunmugapriya[1]*

1 P.G. & Research Department of Mathematics, Pachaiyappa's College for Men, Chennai, Tamilnadu, India.

2 Department of Mathematics, C. Kandaswami Naidu College for Men, Chennai, Tamilnadu, India.

Abstract: In this paper we define a Generalized Intuitionistic Pentagonal fuzzy number and propose a new ranking formula which includes the area of both membership and non membership parts of the fuzzy number. The membership and the non membership area of the fuzzy number is splitted into three plane figures and centroid of the centroids of these plane figures are calculated. The ranking formula is calculated by finding the area of this centroid from the origin. The advantage of this paper is that the ranking GIPFN by this approach yields better solution when compared with ranking by Accuracy function. This approach is illustrated with numerical examples.

Keywords: Generalized Pentagonal fuzzy number, Intuitionistic fuzzy number, centroid.

1. Introduction

Atanassov [1, 2] introduced the Intuitionistic fuzzy sets which is a generalization of the concept of fuzzy sets. Ranking of fuzzy numbers plays a vital role in fuzzy arithmetic and fuzzy decision making. An efficient method for ordering the fuzzy numbers is the ranking function which maps each fuzzy number into the real line, where a natural order exists. Nagoor Gani and Mohamed [3] proposed a method for Ranking the Generalized Trapezoidal Intuitionistic Fuzzy Numbers. Annie Christi and Kasthuri [4] obtained a solution for Transportation Problem with Pentagonal Intuitionistic Fuzzy Numbers using Ranking Technique and Russell's Method. Helen and Uma [5] introduced a new arithmetic operation and ranking on Pentagonal Fuzzy Numbers. Ponnivalavan and Pathinathan [6] introduced Intuitionistic Pentagonl fuzzy numbers with basic arithmetic operations and used the Accuracy function as a Ranking parameter. Siji and Selva Kumari [7] also developed an approach for solving Network problem with Pentagonal Intuitionistic Fuzzy numbers using Accuracy function as Ranking technique. In this paper, Generalized Intuitionistic Pentagonal fuzzy number has been introduced with basic arithmetic operations and a new Ranking technique using the centroid concept is developed in which the result is more efficient when compared to the other ranking techniques.

Definition 1.1 (Intuitionistic Fuzzy Sets). *Let X be the universal set. An Intuitionistic fuzzy set(IFS) A in X is given by $A = \{(x, (\mu_A(x), \gamma_A(x)) : x \in X\}$ where the functions $\mu_A(x)$, $\gamma_A(x)$ 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 X, and for every $x \in X$, $0 \leq \mu_A(x) + \gamma_A(x) \leq 1$. For each Intuitionistic fuzzy set $A = \{(x, (\mu_A(x), \gamma_A(x)) : x \in X\}$ in X, $\pi_A(x) = 1 - \mu_A(x) - \gamma_A(x)$ is called the hesitancy degree of x to lie in A. If A is a fuzzy set, then $\pi_A(x) = 0$ for all $x \in X$.*

* *E-mail: priya010978@gmail.com*

2. Intuitionistic fuzzy Number

Definition 2.1. *An IFS $A = \{(x, (\mu_A(x), \gamma_A(x)) : x \in X\}$ of the real line R is called an instutionistic fuzzy number if*

(a). A is convex for the membership function $\mu_A(x)$.

(b). A is concave for the non-member ship function $\gamma_A(x)$.

(c). A is normal, that is there is some $x_0 \in R$ such that $\mu_A(x_0) = 1$, $\gamma_A(x_0) = 0$.

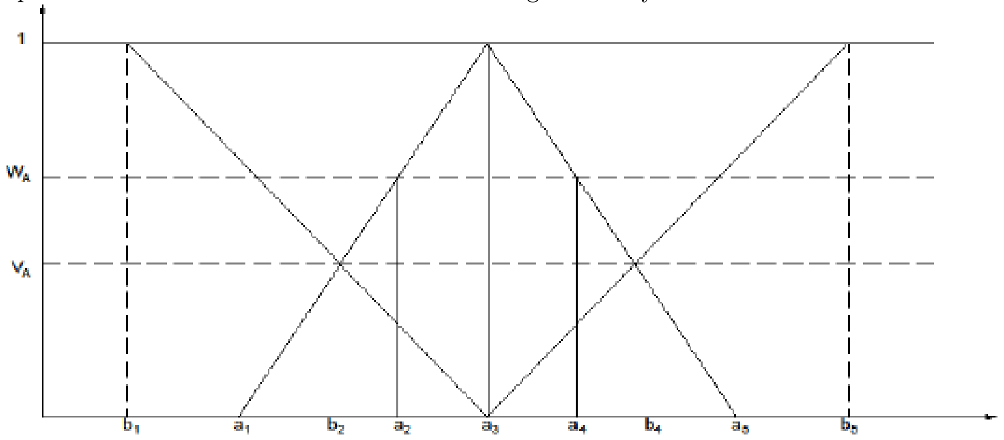
3. Proposed Definition (Generalized Intuitionistic Pentagonal Fuzzy Number)

We define an Intuitionistic fuzzy number A to be a generalized Intuitionistic pentagonal fuzzy number(GIPFN) in the parameter $b_1 \leq a_1 \leq b_2 \leq a_2 \leq a_3 \leq a_4 \leq b_4 \leq a_5 \leq b_5$ denoted by $A = \{(a_1, a_2, a_3, a_4, a_5), (b_1, b_2, a_3, b_4, b_5); W_A, V_A\}$, $0 \leq W_A, V_A \leq 1$ if its membership function and non membership function are as follows.

$$\mu_A(x) = \begin{cases} 0 & x < a_1 \\ W_A - \frac{W_A(x-a_2)}{a_1-a_2}, & a_1 \leq x \leq a_2 \\ 1 + \frac{(W_A-1)(x-a_3)}{a_2-a_3}, & a_2 \leq x \leq a_3 \\ 1 + \frac{(W_A-1)(x-a_3)}{a_4-a_3}, & a_3 \leq x \leq a_4 \\ W_A - \frac{W_A(x-a_4)}{a_5-a_4}, & a_4 \leq x \leq a_5 \\ 0, & x > a_5 \end{cases}$$

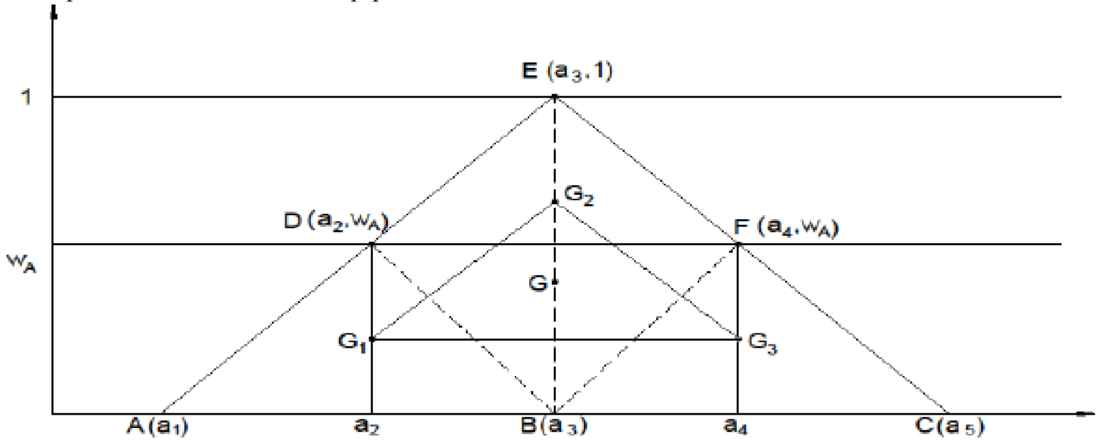
$$\gamma_A(x) = \begin{cases} 1 & x < b_1 \\ 1 + \frac{(V_A-1)(x-b_1)}{b_2-b_1}, & b_1 \leq x \leq b_2 \\ v_A - \frac{v_A(x-b_2)}{a_3-b_2}, & b_2 \leq x \leq b_3 \\ \frac{v_A(x-a_3)}{b_4-a_3}, & a_3 \leq x \leq b_4 \\ v_A + \frac{(1-v_A)(x-b_4)}{b_5-b_4}, & b_4 \leq x \leq b_5 \\ 1, & x > b_5 \end{cases}$$

The graphical representation of Generalized Intuitionistic Pentagonal Fuzzy number



4. The Proposed Method for Ranking Generalized Intuitionistic Pentagonal Fuzzy Numbers

The graphical representation of membership part of the GIPFN



Consider the GIPFN $A = \{(a_1, a_2, a_3, a_4, a_5), (b_1, b_2, a_3, b_4, b_5); W_A, V_A\}$. The centroid of a pentagon is considered to be the balancing point of the pentagon. Divide the membership part of pentagon into three plane figures. They are a triangle ABD, a quadrilateral BDEF(kite) and triangle BCF respectively. Let G_1, G_2, G_3 be the centroids of these three plane figures. The Centroid of these centroids G_1, G_2, G_3 is considered as the point of reference to define the ranking of generalized pentagonal Intuitionistic fuzzy numbers. As the centroid of these three plane figures are their balancing points , the centroid of these centroid points is a much better balancing point for a GIPFN.

The Centroids of these plane figures are

$$G_1 = \left(\frac{a_1 + a_2 + a_3}{3}, \frac{W_A}{3}\right); G_2 = \left(\frac{a_2 + a_3 + a_4}{3}, \frac{W_A + 1}{3}\right) \text{ and } G_3 = \left(\frac{a_3 + a_4 + a_5}{3}, \frac{W_A}{3}\right)$$

respectively. Equation of the line G_1G_3 is $\frac{W_A}{3}$ and G_2 does not lie on the line G_1G_3. Thus G_1, G_2 and G_3 are not collinear and they form a triangle. Thus the centroid of these centroids is

$$G(x_0, y_0) = \left(\frac{(a_1 + 2a_2 + 3a_3 + 2a_4 + a_5}{9}, \frac{3W_A + 1}{9}\right)$$

Now we define

$$S(\mu_A) = x_0.y_0 = \left(\frac{(a_1 + 2a_2 + 3a_3 + 2a_4 + a_5}{9}\right) \times \frac{3W_A + 1}{9}$$

This is the area between the centroid of the centroids and the original point. Similarly the pentagon corresponding to the non membership function is divided into three plane figures. In similar fashion, the centroid of the three plane figures and the centroid of these centroids are evaluated. The centroid of these plane figures are

$$G_1 = \left(\frac{b_1 + b_2 + a_3}{3}, \frac{2 + V_A}{3}\right); G_2 = \left(\frac{b_2 + a_3 + b_4}{3}, \frac{V_A + 1}{3}\right) \text{ and } G_3 = \left(\frac{a_3 + b_4 + b_5}{3}, \frac{2 + V_A}{3}\right).$$

The centroid of these centroids is

$$G'(x_0, y_0) = \left(\frac{(b_1 + 2b_2 + 3a_3 + 2b_4 + b_5}{9}, \frac{3V_A + 5}{9}\right)$$

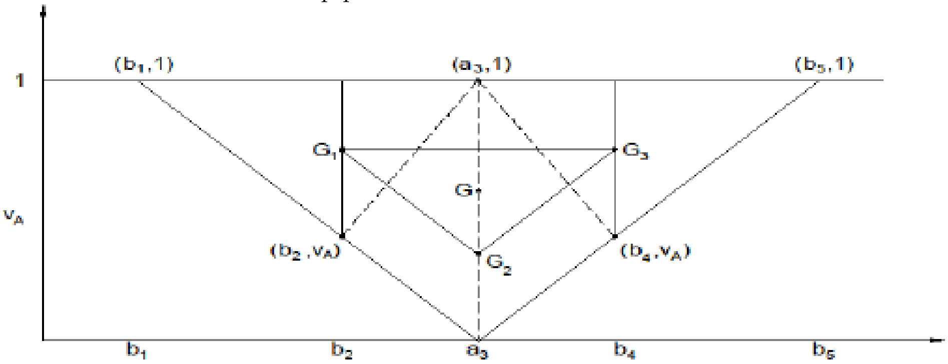
Now we define

$$S(\gamma_A) = x_0.y_0 = \left(\frac{(a_1 + 2a_2 + 3a_3 + 2a_4 + a_5}{9}\right) \times \frac{3V_A + 5}{9}$$

Using the above definitions, the rank of A is defined as follows:

$$R(A) = \frac{W_A S(\mu_A) + V_A S(\gamma_A)}{W_A + V_A}$$

The graphical representation of non membership part of GIPFN is as follows:



5. Arithmetic Operations on GIPFN

Let $A = \{(a_1, a_2, a_3, a_4, a_5), (b_1, b_2, a_3, b_4, b_5); W_A, V_A\}$, $0 \le W_A, V_A \le 1$ and $B = \{(c_1, c_2, c_3, c_4, c_5), (d_1, d_2, c_3, d_4, d_5); W_B, V_B\}$, $0 \le W_B, V_B \le 1$ be the two Generalized Intuitionistic Pentagonal Fuzzy numbers, then the arithmetic operations are as follows:

Addition operation:

$$A + B = \{(a_1 + c_1, a_2 + c_2, a_3 + c_3, a_4 + c_4, a_5 + c_5), (b_1 + d_1, b_2 + d_2, a_3 + c_3, b_4 + d_4, b_5 + d_5); W, V\}$$

where $W = \min(W_A, W_B)$, $V = \max(V_A, V_B)$.

Subtraction operation:

$$A - B = \{(a_1 - c_5, a_2 - c_4, a_3 - c_3, a_4 - c_2, a_5 - c_1), (b_1 - d_5, b_2 - d_4, a_3 - c_3, b_4 - d_2, b_5 - d_1); W, V\}$$

where $W = \min(W_A, W_B)$, $V = \max(V_A, V_B)$.

The two generalized pentagonal Intuitionistic fuzzy numbers are compared by using the following steps:

Step 1: Find $R(A)$ and $R(B)$

Step 2: If $R(A) > R(B)$ then $A > B$, if $R(A) < R(B)$, then $A < B$ and if $R(A) = R(B)$ then $A = B$.

6. Numerical Examples

1) Let $A = \{(2, 4, 6, 8, 10), (1, 3, 6, 9, 11); 0.5, 0.3\}$ and $B = \{(1, 3, 5, 7, 9), (0, 2, 5, 8, 10); 0.6, 0.1\}$. Then $S(\mu_A) = 1.666$ and $S(\gamma_A) = 3.9333$ and $R(A) = 2.51625$; $S(\mu_B) = 1.555$; $S(\gamma_B) = 2.9444$ then $R(B) = 1.7534$. Here $R(A) > R(B)$ therefore $A > B$.

2) Let $A = \{(1, 2, 3, 4, 5), (0, 1.5, 3, 4.5, 5.5); 0.7, 0.2\}$ and $B = \{(1, 2, 2.8, 4, 5)(0, 1.5, 2.8, 4.5, 5.5); 0.7, 0.2\}$; $S(\mu_A) = 1.03333$ and $S(\gamma_A) = 1.8320$ and $R(A) = 1.2107$; $S(\mu_B) = 1.01037$; $S(\gamma_B) = 1.7906$ then $R(B) = 1.1863$. Here $R(A) \sim R(B)$ implies $A \sim B$.

7. Conclusion

This paper proposes a generalized Intuitionistic pentagonal fuzzy number along with a new ranking technique which is simple and more efficient. This centroid ranking method gives more efficient result when compared to ranking of pentagonal intuitionistic fuzzy numbers by Accuracy function in [4] and ranking of pentagon fuzzy numbers in [5].

References

[1] K.Atanasssov, *Instutionistic Fuzzy sets*, Fuzzy Sets and Systems, 20(1986), 87-96.

[2] K.Atanasssov, *More on Instutionistic Fuzzy sets*, Fuzzy Sets and systems, 33(1989), 37-46.

[3] A.Nagoor Gani and V.N.Mohamed, *A method of Ranking Generalized Trapezoidal Intuitionistic Fuzzy Number*, International Journal of Applied Engineering Research, 10(2015), 25465-73.

[4] M.S.Annie Christi and B.Kasthuri, *Transportation Problem with Pentagonal Intuitionistic Fuzzy Numbers Solved Using Ranking Tecchnique and Russell's Method*, International Journal of Research and Applications, 6(2)(2016), 82-86.

[5] R.Helen and G.Uma, *A new operation and ranking on Pentagon Fuzzy Numbers*, International Journal of Mathematical Sciences and Applications, 5(2)(2015).

[6] K.Ponnivalavan and T.Pathinathan, *Intuitionistic Pentagonal fuzzy number*, ARPN Journal of Engineering and Applied Sciences, 10(12)(2015).

[7] S.Siji and K.Selva Kumari, *An approach for solving Network problem with Pentagonal Instutionistic Fuzzy numbers using Ranking technique*, Middle East Journal of Scientific Research, 24(9)(2016), 2977-2980.