DOI:10.26524/jms.2017.7

Journal of Management and Science ISSN: 2249-1260 | e-ISSN: 2250-1819

Intuitionistic decagonal fuzzy number and its arithmetic operations

A. RAJKUMAR , N.JOSE PARVIN PRAVEENA,C.DHANUSH

[1]*FACULTY OF MATHEMATICS, HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE, CHENNAI-603103.*

[2] *FACULTY OF MATHEMATICS, K.C.G COLLAGE OF TECHNOLOGY, CHENNAI – 600097.*

[3]*B.TECH (MECHANICAL DEPARTMENT), HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE, CHENNAI-603103.*

Abstract:
This paper introduced a new conception Intuitionistic Decagonal fuzzy Number and defines fundamental arithmetic operations like addition, subtraction. Numerical examples for addition and subtraction between two Intuitionistic Decagonal fuzzy Numbers are given. Score function and accuracy function are also defined.

Keywords: Fuzzy Number, Decagonal fuzzy Number, Intuitionistic Decagonal fuzzy Numbers, arithmetic operation, Score function and accuracy function.

Introduction:
In 1965, L.A. Zadeh introduced fuzzy set theory to clear the vagueness of the real life problems. The idea of fuzzy number is the induction of the conception of the real number. In 2011, BansalAbdinav was developed Triangular and Trapezoidal fuzzy number. Pentagonal fuzzy number was developed by T. Pathinathan and K. Ponnivalavan. In 2014, Hexagonal, octagonal, Diamond reverse order fuzzy number was introduced by T. Pathinathan and K. Ponnivalavan.
In 1989Intuitionistic fuzzy sets was introduced by K.Atanassov as a generalization of Fuzzy sets. He explained two attribute function revealing the degree of membership and non-membership of elements in s fuzzy set. In 2013, MojganEsmailzadeh introduced –New distance between triangular Intuitionistic fuzzy numbers. This model issued in real life applications like decision making, pattern recognition and medical diagnosis. This paper consists of five sections. Section one begins with fuzzy set and fuzzy numbers. Section two describes different fuzzy numbers. The portion of three presents various Intuitionistic fuzzy Numbers and Decagonal Intuitionistic fuzzy Numbers. Next area describes the arithmetic operations on Intuitionistic decagonal fuzzy number. The portion of five presents the score and accuracy function of the Intuitionistic Decagonal fuzzy Numbers.

2. Definitions:

Definition 2.1: A fuzzy set e A in X is characterized by a membership function maps elements of a
given universal set X to the real numbers in [0,1].

A fuzzy set in universal set X is defined as ={(x,μ /xεX,}

$\mu_{A: x \to [0,2]}$. μ_A is called the membership value of $x \varepsilon X$ in the fuzzy set

Definition 2.2(Fuzzy Number)

A fuzzy set _is a fuzzy set on R must possess at least the following three properties.

(i) A must be a normal fuzzy set (ie) h(A)=1

Where h(A) of a fuzzy set A is the largest membership grade obtained by any element in that set

(ie) h(A)= ~~A(~~x)

(ii) αA must be a closed interval for every $\alpha \varepsilon (0,1]$

[For a fuzzy set A defined on x and any number $\alpha \varepsilon$ [0,1]. Then the α-cut is defined by $\alpha_A = \{x / A(x) \geq \alpha\}$

(iii) The support of A, s(A) must be bounded [support of a fuzzy set is the ordinary subset for which the membership function is non-zero].

$$\boxed{S(A)=\{x/ \mu(x)>0\}}$$

3. Intuitionistic Fuzzy Number:

Definition 3.1:

Let x denote a universal set, then the Intuitionistic fuzzy set A in X is given by

$A_I = \{0 \leq \mu_A(x)+\gamma_A(x) \leq 1, x \varepsilon X\}$

Where $\mu_{AI}(x)$, $\gamma_{AI}(x)$ are functions such that it represents the degree of membership functions and the degree of non-membership of the element $x \varepsilon X$

Definition 3.2: (Intuitionistic Fuzzy Number)

An Intuitionistic fuzzy set A_I is called an Intuitionistic fuzzy number if it satisfies the following condition

i) A_I is normal, (ie) there exists at least two prints x0, $x1 \varepsilon R$ such that μ_A (xo)=1 and γ_A(x1)=1

ii) A_I is convex (ie) its membership function is fuzzy convex and its non-membership function is concave.

iii) Its membership function is upper semi continuous and its non-membership function is lower semi continuous and the set A_I is bounded.

Definition 3.3: (Decagonal Fuzzy Number):

- A Decagonal fuzzy number of a fuzzy set is defined as (α1, α2, α3, α4, α5, α6, α7, α8, α9, α10) and the membership function is

0 $x<\alpha1$

– ——— $\alpha1\le x\le\alpha2$

– – ——— $\alpha2\le x\le\alpha3$

– – ——— $\alpha3\le x\le\alpha4$

$\mu_{IP}(x)=$ $\alpha4\le x\le\alpha5$

1 $\alpha5\le x\le\alpha6$

1 - $\alpha6\le x\le\alpha7$

– – ——— $\alpha7\le x\le\alpha8$

– – ——— $\alpha8\le x\le\alpha9$

– ——— $\alpha9\le x\le\alpha10$

0 $x\ge\alpha10$

Definition 3.4 (Intuitionistic Decagonal Fuzzy Number):

- An intuitionistic decagonal fuzzy number of a intuitionistic fuzzy set is defined as

  $_{ID}$ ={(α1, α2, α3, α4, α5, α6, α7, α8, α9, α10) (β1, β2, β3, β4, β5, β6, β7, β8, β9, β10)}

Where α1..... α10, β1....... β10 are real numbers

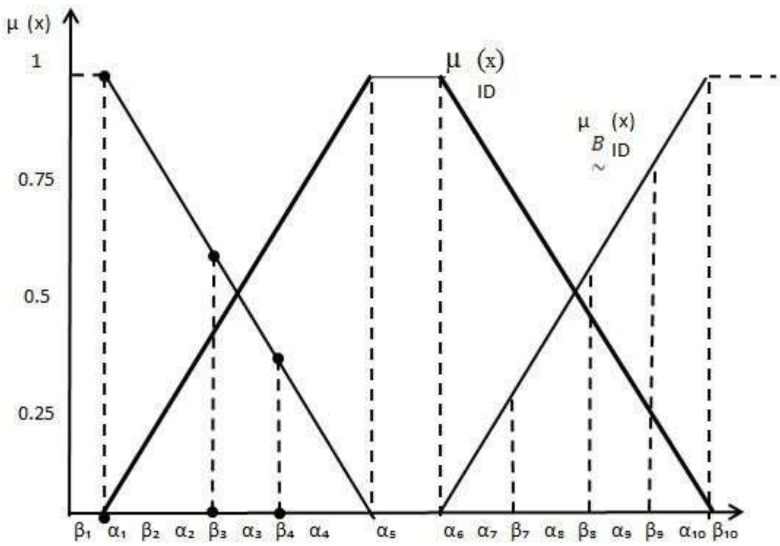

Figure: Graphical **symbolize** of Intuitionistic Decagonal Fuzzy Number (IDFN) the membership function$\mu_{ID}(x)$and non-membership function $\gamma_{ID}(x)$ of intuitionistic decagonal fuzzy number is given below

0 x<α1

– α1≤x≤α2

– – α2≤x≤α3

– – α3≤x≤α4

$\mu_{IP}(x)=$ ~~α4≤x≤α5~~

1 α5≤x≤α6

1 - ~~α6≤x≤α7~~

– – α7≤x≤α8

– – α8≤x≤α9

– α9≤x≤α10

0 x≥α10

1 x<β1

1- – β1≤x≤β2

– – β2≤x≤β3

– – β3≤x≤β4

$\gamma_{IP}(x)=$ ~~β4≤x≤β5~~

0β5≤x≤β6

– β6≤x≤β7

– – β7≤x≤β8

– – β8≤x≤β9

– – β9≤x≤β10

1x≥β10

4. Some Arithmetic Operations on Intuitionistic Decagonal Fuzzy Numbers:

4.1 Consider two Intuitionistic Decagonal Fuzzy Numbers

$_{ID}(x)$= {(α1, α2, α3, α4, α5, α6, α7, α8, α9, α10)(β1, β2, β3, β4, β5, β6, β7, β8, β9, β10)}

And

$_{ID}(x)$={(ɣ1, ɣ2, ɣ3, ɣ4, ɣ5, ɣ6, ɣ7, ɣ8, ɣ9, ɣ10)(K1, K2, K3, K4, K5, K6, K7, K8, K9, K10)

Then the addition of two Intuitionistic Decagonal Fuzzy Number is given by

$_{ID} + _{ID}$ ={($\alpha1+\gamma1$, $\alpha2+\gamma2$, $\alpha3+\gamma3$, $\alpha4+\gamma4$, $\alpha5+\gamma5$, $\alpha6+\gamma6$, $\alpha7+\gamma7$, $\alpha8+\gamma8$, $\alpha9+\gamma9$, $\alpha10+\gamma10$) ($\beta1+K1$, $\beta2+K2$, $\beta3+K3$, $\beta4+K4$, $\beta5+K5$, $\beta6+K6$, $\beta7+K7$, $\beta8+K8$, $\beta9+K9$, $\beta10+K10$)}

4.2 Then the subtraction of two Intuitionistic Decagonal Fuzzy Number is given by

$_{ID} - _{ID}$ = {($\alpha1-\gamma10$, $\alpha2-\gamma9$, $\alpha3-\gamma8$, $\alpha4-\gamma7$, $\alpha5-\gamma6$, $\alpha6-\gamma5$, $\alpha7-\gamma4$, $\alpha8-\gamma3$, $\alpha9-\gamma2$, $\alpha10-\gamma1$) ($\beta1-K10$, $\beta2-K9$, $\beta3-K8$, $\beta4-K7$, $\beta5-K6$, $\beta6-K5$, $\beta7-K4$, $\beta8-K3$, $\beta9-K2$, $\beta10-K1$)}

Numerical Examples:

(1) Addition of two Intuitionistic Decagonal Fuzzy Number:

If $_{ID}$={(0, 1, 2, 3, 4, 5, 6, 7, 8, 9) (-1, 0, 1, 2, 3, 4, 5, 6, 7, 8)}

$_{ID}$={(0, 1, 2, 3, 4, 5, 6, 7, 8, 9) (-1, 0, 1, 2, 3, 4, 5, 6, 7, 8)}

$_{ID} + _{ID}$=(0, 2, 4, 6, 8, 10, 12, 14, 16, 18)(-2, 0, 2, 4, 6, 8, 10, 12, 14, 16)

(2) Subtraction of two Intuitionistic Decagonal Fuzzy Number:

Consider two Decagonal Fuzzy Number

$_{ID}$={(-3, -2, -1, 0, 1, 2, 3, 4, 5, 6) (-1, 0, 1, 3, 4, 5, 6, 7, 8, 9)}

$_{ID}$={(-2, -1, 0, 1, 2, 3, 4, 5, 6, 7) (-1, 0, 1, 3, 4, 5, 6, 7, 8, 9)}

$_{ID} - _{ID}$={(-10, -8, -6, -4, -2, 0, 2, 4, 6, 8) (-10, -8, -6, -3, -1, 1, 3, 6, 8, 10)}

5. Score Function and Accuracy Function

Definition 5.1:

Score function of an Intuitionistic Fuzzy Number is defined as S($_I$)=$\mu_I(x) + \gamma_I(x)$

Definition 5.2:

Accuracy function of an Intuitionistic Fuzzy Number is defined as

H($_I$)= $\mu_I(x) + \gamma_I(x)$

Definition 5.3:

- Score function of an Intuitionistic Decagonal Fuzzy Number.

$_{ID}$= {($\alpha1$, $\alpha2$, $\alpha3$, $\alpha4$, $\alpha5$, $\alpha6$, $\alpha7$, $\alpha8$, $\alpha9$, $\alpha10$)($\beta1$, $\beta2$, $\beta3$, $\beta4$, $\beta5$, $\beta6$, $\beta7$, $\beta8$, $\beta9$, $\beta10$)}

S($_{ID}$)= ($\alpha1-\beta1$, $\alpha2-\beta2$, $\alpha3-\beta3$, $\alpha4-\beta4$, $\alpha5-\beta5$, $\alpha6-\beta6$, $\alpha7-\beta7$, $\alpha8-\beta8$, $\alpha9-\beta9$, $\alpha10-\beta10$)/10

S($_{ID}$)ε[-1, 1]

Numerical Example:

Consider two Intuitionistic Decagonal Fuzzy Numbers

$_{ID}$= {(0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9) (0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9)}

$_{ID}$= {(0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1) (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1)}

Then S($_{ID}$)= S($_{ID}$)= 0

To solve this we define accuracy function.

Definition 5.4:

- Accuracy function of an Intuitionistic Decagonal Fuzzy Number is

$_{ID}$= {(α1, α2, α3, α4, α5, α6, α7, α8, α9, α10)(β1, β2, β3, β4, β5, β6, β7, β8, β9, β10)}

Is defined by

H($_{ID}$)= (α1+β1, α2+β2, α3+β3, α4+β4, α5+β5, α6+β6, α7+β7, α8+β8, α9+β9, α10+β10)/10

Example:

$_{ID}$= {(0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1) (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1)}

$_{ID}$={(0.1,0.2, 0.3, 0.45, 0.46, 0.57, 0.58, 0.6, 0.65, 0.7) (0.1,0.2, 0.3, 0.45, 0.46, 0.57, 0.58, 0.6, 0.65, 0.7)}

Accuracy Function of $_{ID}$ is

H($_{ID}$)=

H($_{ID}$)= 1.2

Accuracy Function of $_{ID}$ is

H($_{ID}$)=

(0.1+0.1+0.2+0.2+0.3+0.3+0.45+0.45+0.46+0.46+0.57+0.57+0.58+0.58+0.6+0.6+0.65+0.65 +0.7+0.7)/10

H($_{ID}$)= 0.922

Definition 5.5 (Resemblance of score function and accuracy function):

1. If S($_{ID}$) >S($_{ID}$)then $_{ID}$>($_{ID}$

   $_{ID}$={(0.23, 0.28, 0.36, 0.41, 0.42, 0.52, 0.62, 0.72, 0.83, 0.88) (0.32, 0.35, 0.42, 0.48, 0.45, 0.48, 0.55, 0.65, 0.78, 0.89)}

   $_{ID}$={(0.15, 0.22, 0.31, 0.42, 0.53, 0.65, 0.72, 0.85, 0.88, 0.92) (0.23, 0.36, 0.45, 0.49, 0.58, 0.68, 0.78, 0.86, 0.89, 0.95)}

   S($_{ID}$)= -0.1

   S($_{ID}$)= -0.62

2. If S($_{ID}$) <S($_{ID}$)then

$_{ID}$< $_{ID}$

$_{ID}$= {(0.12, 0.25, 0.38, 0.39, 0.48, 0.52, 0.57, 0.62, 0.65, 0.72) (0.25, 0.28, 0.39, 0.41, 0.50, 0.53, 0.59, 0.63, 0.67, 0.71)}

$_{ID}$= {(0.21, 0.28, 0.40, 0.41, 0.49, 0.58, 0.61, 0.65, 0.68, 0.7) (0.28, 0.30, 0.40, 0.48, 0.55, 0.59, 0.63, 0.65, 0.70, 0.78)

$S(\ _{ID}) = -0.35$

$S(\ _{ID}) = -0.29$

$S(\ _{ID}) < S(\ _{ID})$

Then $_{ID} < \ _{ID}$

3. If $S(\ _{ID}) = S(\ _{ID})$ and $H(\ _{ID}) < H(\ _{ID})$ then

Then $_{ID} < \ _{ID}$

Example:

Consider two Intuitionistic Decagonal Fuzzy Number $_{ID}$ $_{ID}$

$_{ID}$= {(0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65) (0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65)}

$_{ID}$ = {(0.28, 0.27, 0.35, 0.38, 0.42, 0.49, 0.52, 0.57, 0.62, 0.66) (0.28, 0.27, 0.35, 0.38, 0.42, 0.49, 0.52, 0.57, 0.62, 0.66)}

$S(\ _{ID}) = 0, = S(\ _{ID})$

$H(\ _{ID}) = 0.85$

$H(\ _{ID}) = 0.912$

Here $H(\ _{ID}) < H(\ _{ID})$

$_{ID} < \ _{ID}$

4. If $S(\ _{ID}) = S(\ _{ID})$ and $H(\ _{ID}) > H(\ _{ID})$ then

$_{ID} > \ _{ID}$

Example: Consider Two Intuitionistic Decagonal Fuzzy Number:

$_{ID}$= {(0.28, 0.27, 0.35, 0.38, 0.42, 0.49, 0.52, 0.57, 0.62, 0.66) (0.28, 0.27, 0.35, 0.38, 0.42, 0.49, 0.52, 0.57, 0.62, 0.66)}

$_{ID}$= {(0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65) (0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65)}

$S(\ _{ID}) = 0$, $S(\ _{ID}) = 0$

(ie) $S(\ _{ID}) = S(\ _{ID})$

And H(ID)= 0.912

H(ID)= 0.85

H(ID) >H(ID)

Then ID> ID

5. If S(ID)= S(ID) and H(ID) = H(ID)

Then ID= ID

Example:
Consider two Intuitionistic Decagonal Fuzzy Numbers

ID= {(0.25, 0.28, 0.35, 0.38, 0.45, 0.48, 0.55, 0.58, 0.65, 0.68) (0.25, 0.28, 0.35, 0.38, 0.45, 0.48, 0.55, 0.58, 0.65, 0.68)}

ID = {(0.25, 0.28, 0.35, 0.38, 0.45, 0.48, 0.55, 0.58, 0.65, 0.68) (0.25, 0.28, 0.35, 0.38, 0.45, 0.48, 0.55, 0.58, 0.65, 0.68)}.

6. Conclusion

Thus a new intuitionistic decagonal fuzzy number had been considered and fully adjusted with certain conditions plays an acute role in several real problems were applicant in operation research, social problems, medical diagnosis, statistical and random process.

7. Reference

1. A. Felix and A. Victor Devadoss, A New Decagonal Fuzzy Number under Uncertain Linguistic Environment,International Journal of Mathematics And its Applications,Volume 3, Issue 1 (2015), 89–97. ISSN: 2347-1557, A p p l i c a t i o n s I S S N 2 3 4 7 - 1 5 5 7.
2. Jun Ye, (2013), ― Multicriteria Decision-Making Method Using Expected Values in Trapezoidal Hesitant Fuzzy Setting*",Journal of Convergence Information Technology(JCIT)Volume8, Number11.*
3. B.Kosko(1988),–Fuzzy Cognitive Maps‖, *International Journal of man-machine studies*,pp.62-75.
4. B.Kosko, (1988),–Hidden patterns in combined and Adaptive Knowledge Networks‖, Proc. Of the First, *IEEE*
5. *International Conference on Neural Networks* (ICNN)-86 377-393).
6. B.Kosko(1997), –*Neural Networks and Fuzzy systems: A Dynamical System Approach to Machine Intelligence*‖, Prentice Hall of India.
7. Axelrod,R.(1976).Structure of decision :The congnitive maps of political elites.Princeton University.

*****