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# MAGDM Problems with correlation coefficient of Intuitionistic Fuzzy Sets

John Robinson. P[1], Akila. S [2]

*Assistant Professor[1], Assistant Professor[2]*

*Bishop Heber College, Tiruchirappalli, India [1].*

*Theivanai Ammal College for women, Villupuram, India [2].*

*robijohnsharon@gmail.com [1], akila2829@gmail.com [2]*

**Abstract -** In this paper, the Multiple Attribute Group Decision Making (MAGDM) Problems with Intuitionistic Fuzzy Sets are investigated. The attribute weights are derived from the numerical methods of solutions of Trapezoidal rule, Simpon's rule and Romberg's method. The Intuitionistic Fuzzy Ordered Weighted Average (IFOWA) operator and the intuitionistic Fuzzy Hybrid Average (IFHA) operators are used to combine the decision matrices and derive a collective decision matrix for deciding the best alternative. The correlation coefficient of intuitionistic Fuzzy set is utilized to rank the best alternative. A new decision Making model based on numerical methods is proposed with illustrations. Some comparisons are also made with existing ranking methods.

**Keywords:** Intuitionistic Fuzzy Sets (IFS), MAGDM, Intuitionistic Fuzzy Ordered Weighted Average (IFOWA) Operator, Intuitionistic Fuzzy Hybrid Operator (IFHA) Operator, Numerical Methods.

## 1. INTRODUCTION

Atanassov .K. Proposed the concept of Intuitionistic Fuzzy sets. Atanassov.K [1,2] has developed the concept of Intuitionistic Fuzzy set(IFS) which is derived from the Fuzzy sets. It includes membership and non membership function. Li, D. F. [5, 6] developed some new decision making models and methods of Intuitionistic Fuzzy Sets with incomplete weight information. In this work, Numerical Integration Methods such as trapezoidal rule, Simpons rule and Romberg,'s method of solutions are used for determining weights of decision makers and also used for decision making problem. Arumugam S. & Thangapandi Isaac. A & Somasundaram. A and Jain M.K.,Iyengar.S.R.K & Jain R.K [7,8] solved the various Numerical differentiation and Integration Methods. Robinson. J. P. & Amirtharaj E. C. H [ 9,10,11 ] discussed the various decision making operators and correlation coefficient of Triangular and Trapezoidal Intuitionistic Fuzzy Sets for Multiple Attribute Group Decision Making Problems. Correlation co-efficient is an important tool to evaluate the distance between two sets. In Fuzzy circumstances correlation co-efficient is a principal value to calculate fuzziness of information in Fuzzy set theory and it has been developed. Correlation co-efficient of Intuitionistic Fuzzy Sets in the range 0,1 is proposed and utilized for ranking the alternatives. Ananthakanaga Jothi.K., Velusamy.S & Balasangu. K [12] discussed the several distance measures in Intuitionistic Fuzzy Sets. T.Gerstonkon and J.Manko & Z. Xu, J. Chen, J. Wu [13,14] correlation co-efficient of Intuitionistic Fuzzy sets are applied for finding the ranking the alternatives. Xu, Z. S. [15,16] developed some new aggregation operators in Intuitionistic and Interval valued intuitionistic Fuzzy environment. Xu, Z.S., & Yager, R. R [17,18,19] has introduced some aggregation operators for Multiple attribute decision making Problems. A distance function extended from the Hamming distance and Euclidean Hamming distance is also proposed for Intuitionistic Fuzzy Sets in ranking alternatives for Multiple Attribute Group Decision Making Problems. A numerical illustration is provided to demonstrate the alternatives and a comparison is made with an existing method.

## 2. PRELIMINARIES

In this section, some basic concepts about the IFSs and different classes of aggregation operators are presented.

### *2.1. Intuitionistic Fuzzy set*

An IFS A in X is **given** by A = $\{\langle \boldsymbol{x}, \boldsymbol{\mu_A}(\boldsymbol{x}), \frac{\gamma_A(x)}{x\epsilon X}\rangle\}$, where $\boldsymbol{\mu_A} : \boldsymbol{X} \to [\boldsymbol{0}, \boldsymbol{1}]$ $\boldsymbol{\gamma_A} : \boldsymbol{X} \to [\boldsymbol{0}, \boldsymbol{1}]$

with the condition $0 \leq \boldsymbol{\mu_A}$ (x)+$\boldsymbol{\gamma_A}(\boldsymbol{x}) \leq 1, \forall\, \boldsymbol{x} \in \boldsymbol{X}$. The numbers $\boldsymbol{\mu_A}$ $(\mathbf{x})$ **and** $\boldsymbol{\gamma_A}(\boldsymbol{x})$ represent, the membership degree and non-membership degree of the element x to the set A, respectively.

### *2.2. Hesitancy Degree of an IFS*

For each IFS A in X, if $\boldsymbol{\pi_A}$ (x) = 1- $\boldsymbol{\mu_A}$ (x) - $\boldsymbol{\gamma_A}$ (x), ∀ x∈ $\boldsymbol{X}$, then $\boldsymbol{\pi_A}$ (x) is called the degree of indeterminacy or hesitancy of x to A, where $0 \leq \boldsymbol{\pi_A}$ (x) ≤ 1, for all x∈ $\boldsymbol{X}$.

## 3. DIFFERENT CLASSES OF OPERATORS

### *3.1. Intuitionistic Fuzzy Weighted Averaging (IFWA) operator*

Let $\widetilde{\boldsymbol{a}} = (\boldsymbol{\mu_j}, \boldsymbol{\gamma_j})$ for all j = 1,2, ...,n be a collection of intuitionistic Fuzzy values.The intuitionistic Fuzzy Weighted Averaging (IFWA) operator, IFWA: $\boldsymbol{Q^n} \rightarrow$ Q is defined as $\boldsymbol{IFWA_\omega}(\widetilde{\boldsymbol{a_1}}, \widetilde{\boldsymbol{a_2}}, \dots, \widetilde{\boldsymbol{a_n}}) = \sum_{j=1}^{n} \boldsymbol{\omega_j} \widetilde{\boldsymbol{a}}_j$ = (1-$\prod_{j=1}^{n}(\mathbf{1} - \boldsymbol{\mu_j})^{\omega_j}$ , $\prod_{j=1}^{n} \boldsymbol{\gamma_j}^{\omega_j}$ ) where $\boldsymbol{\omega} = (\boldsymbol{\omega 1}, \boldsymbol{\omega\_2}, \dots, \boldsymbol{\omega\_n})^{\boldsymbol{n}}$ be the weight vector of $\widetilde{\boldsymbol{a}}_j$, $\boldsymbol{for\ all\ j} =$ 1,2,...,n such that $\boldsymbol{\omega_j} > 0$ and $\sum_{j=1}^{n} \boldsymbol{\omega_j}$ = 1.

### *3.2. Intuitionistic Fuzzy Ordered Weighted Averaging operator*

Let $\widetilde{a_j} = (\mu_j, \gamma_j)$ , foe all j = 1, 2, 3…, n be a collection of intuitionistic fuzzy values. The Intuitionistic Fuzzy Ordered Weighted Averaging (IFOWA) operator

$IFOWA: Q^n \rightarrow Q$ is defined as :

$(\widetilde{\boldsymbol{a_1}}, \widetilde{\boldsymbol{a_2}}, \dots, \widetilde{\boldsymbol{a_n}}) = \sum_{j=1}^{n} \boldsymbol{w}\widetilde{\boldsymbol{a}_{\sigma(J)}}$

$= \left(\mathbf{1} - \prod_{j=1}^{n}\left(\mathbf{1} - \boldsymbol{\mu_{\sigma(j)}}\right)^{w_j}, \prod_{j=1}^{n} \boldsymbol{\gamma_{\sigma(j)}}^{w_j}\right)$

Where $\boldsymbol{w} = (\boldsymbol{w_1}, \boldsymbol{w_2}, \dots, \boldsymbol{w_n})^{\mathrm{T}}$ is the associate weighting vector such that $\boldsymbol{w_j} > \mathbf{0}$ and $\sum_{j=1}^{n} \boldsymbol{w_j} = \mathbf{1}$. Furthermore, $(\boldsymbol{\sigma}(\mathbf{1}), \boldsymbol{\sigma}(\mathbf{2}), \dots, \boldsymbol{\sigma}(\boldsymbol{n}))$ is a permutation of (1, 2,…,n), such that $\widetilde{\boldsymbol{a}_{\sigma(J-1)}} \geq \widetilde{\boldsymbol{a}_{\sigma(J)}}$ for all j = 1,2,….,n.

### *3.3. Intuitionistic Fuzzy Hybrid Averaging (IFHA) Operator*

Let $a_j = (\mu_j, \nu_j)$, for all j = 1, 2, 3,…, n be a collection of Intuitionistic Fuzzy values. The Intuitionistic Fuzzy Hybrid Aggregation (IFHA) operator, IFHA : $Q^n \rightarrow Q$ is defined as:

$$\boldsymbol{IFHA_{\omega,w}}(\boldsymbol{a_1}, \boldsymbol{a_2}, \dots\ \boldsymbol{a_n}) = \sum_{j-1}^{n} \boldsymbol{a_{\sigma(j)} w_j}$$

$$= \left[\mathbf{1} - \prod_{j=1}^{n}(\mathbf{1} - \boldsymbol{\mu_{a_{\sigma(j)}}})^{w_j}, \prod_{j=1}^{n}(\boldsymbol{v_{a_{\sigma(j)}}})^{w_j}\right]$$

Where w = $(w_1, w_2, \dots, w_n)^{\mathrm{T}}$ is associated vector such that $w_j > 0$ and $\sum_{j=1}^{n} \boldsymbol{w_j} = \mathbf{1}$, and $\omega = (\omega_1, \omega_2, \dots, \omega_n)^{\mathrm{T}}$ is the weight vector of $a_j$ , for all j =1,2,..,n such that $\omega_j > 0$ and $\sum_{j=1}^{n} \omega_j = \mathbf{1}$. Furthermore $a_{\sigma(j)}$ is the jth largest of the weighted IFS $a_j = a_j^{n\omega_j}$ , j =1,2,..,n.

## 4. CORRELATION COEFFICIENT OF INTUITIONISTIC FUZZY SET (IFSS)

Let X= $(x_1, x_2, \dots, x_n)$ be the finite universal set and let A,B $\in IFS(X)$ , be given by

$$A = \{(x, \mu_A(x_i), \lambda_A(x_i), \pi_A(x_i)) / x \in X\},$$

$$B = \{(x, \mu_B(x_i), \gamma_B(x_i), \pi_B(x_i)) / x \in X\}.$$

The correlation of A,B ∈ IFS(X) is defined as follows:

$$C\ (A,B) = \frac{1}{n}\sum_{i=1}^{n}\begin{bmatrix}\mu_A(x_i)\mu_B(x_i) + \gamma_A(x_i)\gamma_B(x_i) + \\ \pi_A(x_i)\pi_B(x_i)\end{bmatrix}$$

and the correlations coefficients of A,B $\in IFS(X)$ , is defined as follows

$$K_{IFS}(A,B) = C_{IFS}(A,B) \Big/ \sqrt{C_{IFS}(A,A) C_{IFS}(B,B)}$$

The following propositions and theorems are true for the above defined the correlations coefficients.

## 5. DISTANCE MEASURES IN INTUITIONISTIC FUZZY SETS

Let ‘*X*’ be non-empty set. Such that IFS *A*,∈*X*. Then the distance measure ‘*d*’ between IFS *A* and *B* is a mapping *d*:*X*×*X*⟶ [0,1]; if *d*(*A*,*B*) satisfies the following axioms

*A*1. 0≤(*A*,*B*)≤1

*A*2. (*A*) =0⇔*A*=*B*

*A*3. *d*(*A*,*B*) =*d*(*B*,*A*)

*A*4. *d*(*A*,*C*) + *d*(*B*,*C*) ≥*d* (*A*,*B*) ;

*A*5. if *A*⊆*B*⊆*C*

Then (*A*, *C*) ≥(*A*,*B*) and *d* (*A*,*C*) ≥*d* (*B*,*C*) We make use of the four distance measures proposed. Let, $A = \{ x, \mu_A(xi), v_A(xi), \pi_A(xi) : x \in X\}$ and $B = \{x, \mu_B(xi), v_B(xi), \pi_B(xi) : x \in X\}$be two IFS’S in $X = \{x_1, x_2, \dots, x_n\}$ , $i = 1, 2, \dots, n$ based on the geometric interpretation of IFS Szmidt and Kacprzyk proposed.

### *5.1. Hamming Distance*

$d_H(A,B)$=

$$\frac{1}{2}\sum_{i=1}^{n}(|\mu_A(x_i) - \mu_B(x_i)| + |\nu_A(x_i) - \nu_B(x_i)| + (|\pi_A(x_i) - \pi_B(x_i)|)$$

### *5.2. The Euclidean Hamming Distance*

(*A*,*B*)=1/2X

$$\sqrt{\sum_{i=1}^{n}\left[(\mu_A(x_i)-\mu_B(x_i))^2+(\nu_A(x_i)-\nu_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2\right]}$$

### *5.3. Correlation Coefficient of Gerstenkorn & Manko, (1991) Method*

The Correlation Co-efficient of Intuitionistic Fuzzy Sets A and B in a finite set X = {$x_1$, $x_2$, ... $x_n$} is given by

$$C(A,B)=\frac{\sum_{i=1}^{n}\mu_A(x_i)\mu_B(x_i)+\gamma_A(x_i)\gamma_{\mathbf{B}}(x_i)}{\sqrt{(\mu_A{}^2(x_i)+\gamma_A{}^2(x_i))(\mu_B{}^2(x_i)+\gamma_B{}^2(x_i))}}$$

### *5.4. Z.Xu, J.Chen, J.Wu, Correlation Coefficient*

Let A and B be two IFS in the universe of discourse X = {$x_1, x_2, \ldots, x_n$} and

$$A=\{(x,\mu_A(x_i),\lambda_A(x_i),\pi_A(x_i))/x\in X\},$$

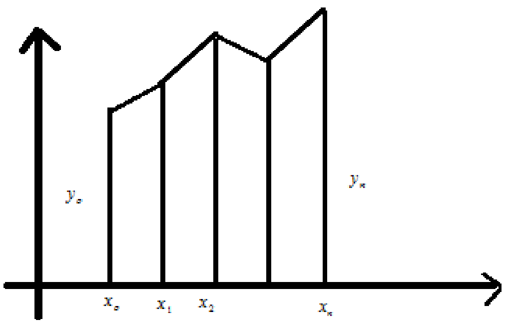
$$B=\{(x,\mu_B(x_i),\gamma_B(x_i),\pi_B(x_i))/x\in X\}.$$

Then the correlation coefficient of A and B is defined by

$$C(A,B)=\frac{\sum_{i=1}^{n}\left(\mu_A(x_i)\cdot\mu_{\mathbf{B}}(x_i)+\nu_A(x_i)\cdot\nu_{\mathbf{B}}(x_i)+\pi_A(x_i)\cdot\pi_{\mathbf{B}}(x_i)\right)}{\max\left(\sum_{i=1}^{n}(\mu^2_A(x_i)+\nu^2_A(x_i)+\pi^2_A(x_i)),\sum_{i=1}^{n}(\mu^2_B(x_i)+\nu^2_B(x_i)+\pi^2_B(x_i))\right)}$$

## 6. TRAPEZOIDAL RULE & SIMPSON'S RULE

The definite integral $\int_{x_0}^{x_n} f(x)dx$ represents the area bounded by the curve y = f(x), the coordinates x = $x_0$, x = $x_n$ and the x – axis. In trapezoidal rule the curve y = f(x) is replaced by n straight line segments joining the points ($x_0$, $y_0$) and ($x_1$, $y_1$); ($x_1$, $y_1$) and ($x_2$, $y_2$) ;…… ($x_{n-1}$, $y_{n-1}$) and ($x_n$, $y_n$) as shown in the figure.



Area $\int_{x_0}^{x_n} f(x)dx$ is approximately given by the sum of the area of the n trapeziums obtained. Hence this method is known as **trapezoidal rule.**

$$\int_{x_0}^{x_0+nh} f(x)dx$$

$$=h\left[ny_0 + \frac{n^2}{2}\Delta y_0+\frac{1}{2}\left(\frac{n^3}{3}-\frac{n^2}{2}\right)\Delta^2 y_0+\ldots\ldots\right]$$

Put n= 2 in Newton- cote's quadrature formula. Since x takes one of the three values $x_0, x_1$ *or* $x_2$, all the differences of third and higher order become zero.

$\therefore$

$$\int_{x_0}^{x_2} f(x)dx \approx h\left[2y_0+\frac{4}{2}\Delta y_0+\frac{1}{2}\left(\frac{8}{3}-\frac{4}{2}\right)\Delta^2 y_0\right]$$

$$=h\left[2y_0+2(y_1-y_0)+\frac{1}{3}(E-1)^2 y_0\right]$$

$$=h\left[2y_1+\frac{1}{3}(y_2-2y_1+y_0)\right]$$

$$=h\left[\frac{1}{3}y_2+\frac{4}{3}y_1+\frac{1}{3}y_0\right]$$

Thus $\int_{x_0}^{x_2} f(x)dx=\frac{h}{3}[y_0+4y_1+y_2]$.

Similarly $\int_{x_2}^{x_4} f(x)dx=\frac{h}{3}[y_2+4y_3+y_4]$

$$\int_{x_0}^{x_n} f(x)dx=\frac{h}{3}[(y_0+y_n)+2(y_2+y_4+\ldots\ldots+4(y_1+y_3+\ldots))]$$

This is know as Simpson`s rule.

## 7. ROMBERG'S METHOD

Consider $I=\int_a^b f(x)dx$ Let $I_1$, $I_2$ be the approximated values of I obtained by using the Trapezoidal rule with two different subintervals of with $h_1$ *and* $h_2$. Let $E_1$ and $E_2$ be the corresponding errors. Since the error in Trapezoidal rule is of order $h^2$.We have

$$I=I_1+E_1=I_1+kh_1^2$$

$$I=I_2+E_2=I_2+kh_2^2$$

$$I_1+kh_1^2=I_2+kh_2^2$$

$$\therefore k=\frac{I_1-I_2}{h_2^2-h_1^2}$$

$$\therefore I=\frac{I_1h_2^2-I_2h_1^2}{h_2^2-h_1^2}$$

Now we take $h_1$ = h and $h_2$= $\frac{h}{2}$. Then becomes, I =

$$\frac{I_1(\frac{h^2}{4}) - I_2 h^2}{(\frac{h^2}{4}) - h^2} = \frac{4I_2 - I_1}{3} = I_2 + (\frac{I_2 - I_1}{3})$$

$$I = I_2 + \frac{I_2 - I_1}{3}$$

## 8. PROBLEM PROPOSED BY THE DECISION MAKERS 1

**using Trapezoidal and Romberg's method**

The decision maker represents weighting vector about the behavior of the attributes in the form of the following integration $\int_0^1 \frac{dx}{1+x^2}$ , h = 0.25, 0.2.0.1,0.05 are identified and the numerical solutions at those points are chosen and normalized for obtaining the weight vector.

| H | Values of y(X) | Weight vector (W=$\frac{y}{\sum y}$) |
|---|---|---|
| 0.25 | 0.572943668 | 0.195747632 |
| 0.2 | 0.78373154 | 0.267763834 |
| 0.1 | 0.784981497 | 0.268190884 |
| 0.05 | 0.785293997 | 0.268297651 |

**Romberg's method**

| H | Values of Y(x | Weight vector(W=$\frac{y}{\sum y}$) |
|---|---|---|
| 0.5 | 0.785398125 | 0.333333322 |
| 0.2 | 0.785398163 | 0.333333338 |
| 0.025 | 0.785398165 | 0.333333339 |

## 9. PROBLEM PROPOSED BY DECISION MAKER 2 USING SIMPON'S RULE

The decision maker represents weighting vector about the behavior of the attributes in the form of the following integration $\int_0^{\frac{\pi}{2}} \sin x \, dx$ for n = 2, 4 & 6 are identified and the numerical solutions at those points are chosen and normalized for obtaining the weight vector.

| n | H | Values of y(X | Weight vector(W=$\frac{y}{\sum y}$) |
|---|---|---|---|
| 2 | $\frac{\pi}{4}$ | 1.00227988. | 0.333821698 |
| 4 | $\frac{\pi}{8}$ | 1.00013459 | 0.333107183 |
| 6 | $\frac{\pi}{12}$ | 1.00002631 | 0.333071119 |

## 10. ALGORTHIM FOR GROUP DECISION MAKING WITH INTUITIONISTIC FUZZY INFORMATION

**Step: 1**

Use the IFOWA operator to aggregate all individual intuitionistic fuzzy decision matrices $\boldsymbol{R}^{(k)} = \left(\boldsymbol{r}_{ij}^{(k)}\right)_{mxn}$ k = 1,2,3, into a collective intuitionistic fuzzy decision matrix .

**Step: 2**

Utilize the IFHA operator, $\tilde{r}_i = (\mu_i, \gamma_i) = IFHA_{v,w} = \left(\tilde{r}_i^{(1)}, \tilde{r}_i^{(2)}, ..., \tilde{r}_i^{(t)}\right), i = 1, 2, ...m$ to derive the collective overall preference intuitionistic fuzzy values $\tilde{r}_i\,(i = 1, 2, \ldots..m)$ of the alternative $A_i$ where $v = (v_1, v_2 \ldots v_n)$ be the weighting vector of decision makers, with: $V_k \in [0,1], \quad \sum_{k=1}^{t} V_k = 1; \quad w = (w_1, w_2 \ldots w_n)$ is the associated weighting vector of the IFHA operator with

$$w_j \in [0,1], \quad \sum_{j=-1}^{n} w_j = 1$$

**Step 3:**

Calculate the correlation coefficient between the collective overall preference values $r_i$ and the positive ideal value $\tilde{r}_i$ , where $\tilde{r}_i = (0,1)$ .

$$C_{ZL}(A,B) = \frac{1}{n}\sum_{i=1}^{n}\left[u_A(x_i)u_B(x_i) + \gamma_A(x_i)\gamma_B(x_i) + \pi_A(x_i)\pi_B(x_i)\right]$$

**Step 4 :**

The correlation coefficient of the IFSs, A and B is given by:

$$\rho_{ZL}(A,B) = \frac{C_{ZL}(A,B)}{\sqrt{C_{ZL}(A,A)C_{ZL}(B,B)}}$$

**Step 5:**

Rank all the alternatives $A_i$ (i = 1,2,…, n) and select the best one.

***Numerical Illustration:***

In order to demonstrate the applicability of the proposed method to multiple Attribute Group decision making, we consider below a University faculty Recruitment group decision making problem .The department of mathematics in a university wants to appoint outstanding mathematics teachers. The appointment is done by a committee of three decision makers, President $D_1$, Dean of Academics $D_2$, and Human Resource Officer $D_3$. After preliminary screening, five teachers $X_i$, i = 1, 2, 3, 4, 5, remains for further evaluation. Panel of decision makers made strict evaluation for five teachers $X_i$, i=1, 2, 3, 4, 5, according to the following four attributes: (1) $G_1$, the past experience, (2) $G_2$, the research capability, (3) $G_3$, subject knowledge, (4) $G_4$, the teaching skill. During this process, the university President has the absolute priority for decision-making, Dean of Academics comes next. The prioritization relationship for the attributes is as follows. The five possible alternatives are to be evaluated using intuitionistic Fuzzy sets by the three decision makers 1 whose weighting vector is obtained by normalizing the solution of Trapezoidal rule and Romberg's method are ( 0.1957476320, 0.267763834, 0.268190884, 0.268297651) and (0.333333322, 0.333333338, 0.333333339). The weighting vector is obtained by normalizing the solution of simpson's rule by decision maker 2 is (0.333821698, 0.333107183, 0.333071119)

$$R^{(1)} = \begin{bmatrix} (0.4325, 0.3543) & (0.5317, 0.3262) & (0.1672, 0.7321) & (0.2543, 0.5317) \\ (0.6514, 0.3212) & (0.2643, 0.6347) & (0.4375, 0.6542) & (0.1670, 0.7225) \\ (0.7145, 0.2433) & (0.4653, 0.2204) & (0.4621, 0.3526) & (0.4352, 0.2615) \\ (0.6312, 0.1461) & (0.1575, 0.4813) & (0.7432, 0.2162) & (0.5413, 0.4216) \\ (0.5231, 0.3425) & (0.7012, 0.1220) & (0.3512, 0.2462) & (0.3617, 0.3212) \end{bmatrix}$$

$$R^{(2)} = \begin{bmatrix} (0.1657, 0.2432) & (0.4532, 0.3217) & (0.5512, 0.3243) & (0.4315, 0.3562) \\ (0.2572, 0.3223) & (0.5162, 0.2631) & (0.7123, 0.1652) & (0.2233, 0.5463) \\ (0.4623, 0.1452) & (0.3025, 0.4312) & (0.6214, 0.2321) & (0.3672, 0.4324) \\ (0.7102, 0.2513) & (0.2614, 0.4233) & (0.4523, 0.3102) & (0.6253, 0.3142) \\ (0.5162, 0.2413) & (0.3440, 0.1762) & (0.3567, 0.2334) & (0.5317, 0.3320) \end{bmatrix}$$

$$R^{(3)} = \begin{bmatrix} (0.2562, 0.4327) & (0.5533, 0.2214) & (0.2216, 0.6332) & (0.4320, 0.1262) \\ (0.4127, 0.1462) & (0.4417, 0.3462) & (0.4312, 0.5162) & (0.3423, 0.2562) \\ (0.6251, 0.2334) & (0.6213, 0.1424) & (0.4526, 0.3211) & (0.1562, 0.6327) \\ (0.2555, 0.5413) & (0.2742, 0.3231) & (0.7120, 0.2334) & (0.5410, 0.2321) \\ (0.3364, 0.3425) & (0.3200, 0.4310) & (0.5522, 0.1462) & (0.6125, 0.1121) \end{bmatrix}$$

By using **step1** and **step2** of the proposed algorithm, the values are

$\widetilde{\boldsymbol{r_1}}$= (0.403243073511639, 0.359973316779332)
$\widetilde{\boldsymbol{r_2}}$ =(0.441092991426084 , 0.377459356714233)
$\widetilde{\boldsymbol{r_3}}$ = (0.505179903449850, 0.288225482338284)
$\widetilde{\boldsymbol{r_4}}$ =( 0.547190761989866 , 0.313209082017678)
$\widetilde{\boldsymbol{r_5}}$ = (0.483417745983077, 0.483417745983077)

By using **step 3** and **step 4** of the algorithm, the correlation coefficient as follows

$\boldsymbol{\rho_{zl}(r_1, \widetilde{r_1})}$ = 0.599002026609253
$\boldsymbol{\rho_{zl}(r_2, \widetilde{r_2})}$ = 0.620571359238529
$\boldsymbol{\rho_{zl}(r_3, \widetilde{r_3}) = 0.466972759073050}$
$\boldsymbol{\rho_{zl}(r_4, \widetilde{r_4})}$ = 0.485024041746800
$\boldsymbol{\rho_{zl}(r_5, \widetilde{r_5})}$ = 0.401076472805837

Ranking alternatives $A_i$, i = 1,2,... m from the highest closeness correlation coefficient obtained from **step-3**, the result is as follows

$$A_2 > A_1 > A_4 > A_3 > A_5$$

Hence, the best alternative is $\boldsymbol{A_2}$.

***Comparison Of Proposed Magdm With Existing Methods:***

Proceeding with the same numerical Illustration as above and replacing from step 3 onwards. with the method proposed by Hamming distance, Euclidean Hamming distance , Gerstenkorn and Manko(1991) Z. Xu, J. Chen, J. Wu,(2008) the ranking of alternatives and the results are listed in the table.

| RANKING METHODS | RANKING ALTERNATIVES |
|---|---|
| Proposed Method (correlation coefficient) | $A_2 > A_1 > A_4 > A_3 > A_5$<br>Hence, the best alternative is $\boldsymbol{A_2}$. |
| Hamming distance | $A_5 > A_3 > A_4 > A_1 > A_2$<br>Hence, the best alternative is $\boldsymbol{A_5}$. |
| Euclidean Hamming distance | $A_5 > A_3 > A_4 > A_1 > A_2$<br>Hence, the best alternative is $\boldsymbol{A_5}$. |
| Gerstenkon & Manko (1991)correlation coefficient | $A_1 > A_2 > A_4 > A_3 > A_5$<br>Hence, the best alternative is $\boldsymbol{A_1}$. |
| Z.Xu, J.Chen, J.Wu,(2008) correlation coefficient | $A_2 > A_1 > A_4 > A_3 > A_5$<br>Hence, the best alternativ is $\boldsymbol{A_2}$. |

## 11. CONCLUSION

In this paper, a new approach for determining weights of decision makers in group decision environment based on Numerical Methods is proposed. The decision maker weights are calculated using the Numerical solution of Trapezoidal rule, Simpson's rule and Romberg's method which is applied in MAGDM problems under Intuitionistic Fuzzy Set. In the IFOWA operator weights the ordered positions of the intuitionistic fuzzy arguments are placed instead of weighting the intuitionistic fuzzy arguments. The operator IFHA is also used for aggregating the decision matrices provided by the decision makers. Correlation Co-efficient, Hamming Distance and Euclidean Hamming distance function are introduced to choose the best alternative. Finally an illustrative example is presented to demonstrate and validate the effectiveness of the proposed method and comparisons are made with some of the existing methods to show the effectiveness of the proposed method.

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