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A Study on Signless Laplacian Energy of an Intuitionistic Fuzzy Graphs with Applications to Group Decision Making

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Abstract:

Introduction: Group decision-making shows a critical job while designating with dynamic issues of quick development of society. Decision make is the manner about discovering the beneficial option among the possible alternatives. In first-rate multiple-criteria choice construction methods, the rankings or the weights of the standards are recognized precisely. However, if selection makers are now not capable in conformity with involve doubt within the defining on linguistic variables based concerning fuzzy sets (FSs) and the intuitionistic fuzzy set (IFS) theory is useful to this job well. The first assurance of this paper is to show the sensibility of some Group decision-making on the Signless Laplacian energy of intuitionistic fuzzy diagrams. We present numerical models, flexibly chain associations in the construction business problem based on extended VIKOR method and Evaluation of the schemes for development of agriculture and farmers' welfare problem based on MULTIMOORA method to light up the introductions of our arranged ideas in result making to rank the best one. Choice makes is the way about finding the valuable choice among the potential other options. In top mark numerous rules decision development techniques, the rankings or the weights of the guidelines are perceived exactly. In any case, on the off chance that determination creators are currently not skilled in congruity with include question inside the characterizing on semantic factors based concerning fuzzy sets (FSs) and the intuitionistic fuzzy set (IFS) hypothesis is valuable to this work well.

Conclusions: An Intuitionistic fuzzy model is pushed off in PC innovation, correspondence, organizing, when the idea of indeterminacy is current. In this paper, we have acquainted persuaded original thoughts requesting in group decision-making dependent on IFIRs is introduced to delineate the relevance of the proposed ideas of Intuitionistic Fuzzy Graphs. This paper covers the EXTENDED VIKOR method and MULTIMOORA method to resolve the problem of evaluation and ranking the potential alternatives based on Signless laplacian energy of Intuitionistic fuzzy graphs. At long last, mathematical models show a use of the VIKOR technique, EXTENDED VIKOR strategy and MULTIMOORA strategy. These insights are furthermore shown with genuine stage outline. Furthermore, we see the situation with the best one. Furthermore, it gives another aspect in the gathering assessment processes and these strategies can be applied to different circumstances too. Despite the fact that our proposed techniques give another aspect to the calculation viewpoint, the issue on how genuine the contentions are permitted along the judgment cycle actually needs further examination. This issue is left for additional exploration sooner rather than later.

Keywords: Intuitionistic fuzzy graphs (IFGs), Signless laplacian energy (SLE), VIKOR method, EXTENDED VIKOR method and MULTIMOORA method.

1. Introduction

In many real-life situations uncertainty and fuzziness have ample applications. The notion regarding fuzzy sets for gathering the uncertainty of information reported by Zadeh and much extensions about fuzzy sets have been suggested for better communicating complex information such that intuitionistic fuzzy sets, picture fuzzy sets and neutrosophic sets. Major research consequences regarding their decision-making theories and techniques have been acquired via researchers. Although, there are few results regarding research that report the purposes of fuzzy sets and also extensions in related work. In 1965, Lotfi Zadeh presented the idea of fuzzy sets, the intuitionistic fluffy sets created by Atanassov [1]. In 1978 Gutman [2-3] characterized the energy of a graph G as the amount of outright upsides of the eigenvalues of graph Sasanka and Ravindra [4] have set up the Laplacian energy of graph G. Choice emotionally supportive networks use private assets in a way with PC abilities to further develop choice outcomes, so this is a PC based emotionally supportive network for dynamic that arrangements with semi issues organized by Risawandi and Rahim [5].The VIKOR technique centres around positioning and looks over a bunch of tests with various rules, which can help chiefs to get a last assurance Syamsudin and Rahim [6]. The utilization of VIKOR technique is utilized on the grounds that the strategy it can pick exceptionally successful and productive measures for deciding choice results with numerous traits and various models was developed by Wang and Pang [7]. We can understand that Intuitionistic fuzzy set is an extremely helpful apparatus to manage vulnerability. In addition, when giving the enrolment level of a component, the trouble of building up the participation degree isn't on the grounds that we have a room for mistakes, or some chance conveyance on the chance qualities, but since we have a few potential qualities. For such cases, the Intuitionistic fuzzy set is exceptionally helpful in keeping away from such issues in which every rule can be portrayed as an Intuitionistic fuzzy set characterized as far as the assessments of chiefs. An ever-increasing number of different standards dynamic speculations and techniques under Intuitionistic fuzzy climate have been created. Thusly, we broaden the idea of VIKOR strategy and foster a technique for tackling GDM issues with Intuitionistic fuzzy component was developed by Vahdani et al. [8], also Opricovic and Tzeng [9]. The drawn out VIKOR technique's positioning is acquired through correlation of stretch numbers and for doing the examinations between spans was developed by Sayad et al. [10] whereas Vahdani et al. [11]. The MOORA technique is one of the multi objective advancement strategies and it was first evolved by Brauers and Zavadskas [12]. It requires a lattice of reactions of the options in contrast to the destinations. Then, at that point, a proportion framework is created in which every reaction of an option on a goal is contrasted with a denominator, which is the agent for all alternatives worried that level headed. There are two distinct strategies under the name of the MOORA as the proportion framework and the reference point approaches was developed Achebo and Odinikuku [13]. In the writing, the MOORA strategy has been applied effectively to numerous choice issues. In this paper, we foster the VIKOR technique, EXTENDED VIKOR strategy and MULTIMOORA technique to tackle the GDM issues with intuitionistic fuzzy set data by working out Signless laplacian energy.

Group decision–making is one among the pre-owned apparatus in person exercises, which determined the ideal option from a given limited arrangement of choices utilizing the information given by gathering of chiefs or experts Sałabun et al. [14]. The interval fuzzy preference relation is more suitable to expressing the decision maker's uncertain preference information was presented by Xu [15]. Group dynamic assumes an urgent job when dealing with choosing issues with the fast advancement of society. Earlier many scholars have examined the methodologies for Group decision–making bolstered different methods. Be that as it may in order to mirror the connections among the choices, we'd prefer to shape pair shrewd comparisons for all designations inside the procedure of dynamic. Inclination connection might be an amazing quantitative choice method that underpins specialists in communicating their inclinations over the given other options. For a lot of options Z=$\{z_1, z_1, \dots, z_2\}$ the specialists think about each pair of options and develop inclination relations of each component in the inclination relations is intuitionistic fuzzy number, at that point the idea of an Intuitionistic inclination relationship (IIR) can be defined as follows.

Definition: An Intuitionistic fuzzy inclination relation on the set Z=$\{z_1, z_1, \dots, z_2\}$ is represented by a matrix M=$[\gamma_{jK}]_{n\times n}$, where$\gamma_{jk} = \left(z_j z_k, T\left(z_j z_k\right), F\left(z_j z_k\right)\right)$,$\forall j, k = 1,2,3,\dots, n$. For convenience, let $\gamma_{jk} = (T_{jk}, F_{jk})$where T_{jk}indicates the degree to which the object $z_j$is prepared to the object z_k and $F_{JK}$is prepared as membership degree with the conditions

$$T_{jk}, F_{jk} \in [0,1], T_{jk} = F_{jk} = T_{jj} = F_{jj} = 0 \; for\ all\ k = 1,2,\dots,n.$$

A group decision-making problem issue concerning the "Alliance partner selection of an Auto mobile company", "Flexibly chain associations in the construction business" and "Evaluation of the schemes for development of agriculture and farmers' welfare" is settled for example the relevance of the proposed ideas of Signless laplacian energy of an intuitionistic fuzzy diagram in sensible situation.

In this paper we addressed new methods with applications that are associated by intuitionistic fuzzy graphs. The paper is structured as follows: Section 2 affords some preliminary definitions which are essential for our work. Section 3 provides two applications by different methods which are new study in intuitionistic fuzzy graphs. The paper is concluded in Section 4.

2. Preliminaries

2.1. Intuitionistic Fuzzy graph (IFG)

An IFG is defined as G= (V, E, μ, γ) where V is the set of vertices and E is the set of edges, μ is a fuzzy relationship function defined on V×V and γ is a fuzzy non relationship function we define $\mu(v_i, v_j)$ by μ_{ij} and $\gamma(v_i, v_j)$ by γ_{ij} such that

(i) $0 \le \mu_{ij} + \gamma_{ij} \le 1$

(ii) $0 \le \mu_{ij}, \gamma_{ij}, \pi_{ij} \le 1$, Where $\pi_{ij} = 1 - \mu_{ij} - \gamma_{ij}$

2.2. Signless Laplacian Energy (SLE)

Let $\tilde{G} = (V, E, \sigma, \mu)$ be an intuitionistic fuzzy graph with set $|V|$=n Vertices and $\tilde{\lambda}_1 \ge \tilde{\lambda}_2 \ge .. \ge \tilde{\lambda}_n$ is the Eigen values. The intuitionistic fuzzy graph Signless Laplacian energy for membership and non-membership values is defines as,

$$SLE\left(\tilde{\mu}_{ij}(IG)\right) = \left| \tilde{\lambda}_i - \frac{2\sum_{1\le i\le j\le n} \tilde{\mu}\left(u_i, u_j\right)}{n} \right|$$

3. Methods and Applications

3.1 Flexibly Chain Associations in the Construction Business

Consider an issue in regards to the determination of critical factors used to get to the likely partners of the organization. Gracefully chain the executives relies upon vital connection between organizations identified with flexibly chain. By successful coordination, organizations profit by lower cost, lower stock levels, data sharing and in this way more grounded serious edge. Critical factors may affect the coordination of organizations. Among them coming up next is the rundown of four critical factors.

Cf_1 : Information integration

Cf_2 : Collaboration and coordination

Cf_3 : Focus on the client

Cf_4 : Strategic planning

So as to rank the over four critical factors $Cf_i\,(i = 1,2,3,4)$ we welcomed advisory group of three decision makers $e_k\,(k = 1,2,3)$. These leaders think about each pair of these components and give intuitionistic fuzzy preferences contained in the IFPRS

$M_k = \left[\gamma_{ij}^k\right]_{4\times 4}\left(k = 1,2,3\right)$ Respectively

$$M_1 = \begin{bmatrix} (0,0) & (0.6,0.2) & (0.9,0) & (0.7,0.2) \\ (0.5,0.4) & (0,0) & (0.3,0.7) & (0.8,0) \\ (0,0.9) & (0.8,0.2) & (0,0) & (0.1,0.9) \\ (0.4,0.6) & (0.5,0.4) & (0.9,0.1) & (0,0) \end{bmatrix}$$

$$M_2 = \begin{bmatrix} (0,0) & (0.3,0.2) & (0.7,0.3) & (0.5,0.5) \\ (0.9,0) & (0,0) & (0.7,0.2) & (0.1,0.7) \\ (0.6,0.3) & (0.4,0.6) & (0,0) & (0.3,0.6) \\ (0.8,0.2) & (0.7,0.1) & (0.6,0.3) & (0,0) \end{bmatrix}$$

$$M_3 = \begin{bmatrix} (0,0) & (0.4,0.9) & (0.6,0.3) & (0.7,0.2) \\ (0.9,0.1) & (0,0) & (0.7,0.3) & (0.1,0.2) \\ (0.4,0.5) & (0.6,0.2) & (0,0) & (0.4,0.2) \\ (0.5,0.2) & (0.6,0.2) & (0.4,0.5) & (0,0) \end{bmatrix}$$

$$M^{SL}_{1}\left[\mu(G)\right] = \begin{bmatrix} 2.2 & 0.6 & 0.9 & 0.7 \\ 0.5 & 1.6 & 0.3 & 0.8 \\ 0 & 0.8 & 0.9 & 0.1 \\ 0.4 & 0.5 & 0.9 & 1.8 \end{bmatrix}, \quad M^{SL}_{1}\left[\gamma(G)\right] = \begin{bmatrix} 0.4 & 0.2 & 0 & 0.2 \\ 0.4 & 1.1 & 0.7 & 0 \\ 0.9 & 0.2 & 2.0 & 0.9 \\ 0.6 & 0.4 & 0.1 & 1.1 \end{bmatrix}$$

The Signless laplacian energy (SLE) of M_1 (G) is determined as:

$$\textit{Spectrum of } M_1^{SL}\left[\mu(G)\right] = \{6.5703+0.0000i, 4.7545+0.0000i, 4.0876+0.3326i, 4.0876-0.3326i\}$$

$$\textit{Spectrum of } M_1^{SL}\left[\gamma(G)\right] = \{5.0458+0.0000i, 2.4981+0.0000i, 3.1281+0.30821i, 3.1281-0.30821\}$$

$$SLE\left[M_1(G)\right] = [6.6272, 4.7110]$$

$$M^{SL}_{2}\left[\mu(G)\right] = \begin{bmatrix} 1.5 & 0.3 & 0.7 & 0.5 \\ 0.9 & 1.7 & 0.7 & 0.1 \\ 0.6 & 0.4 & 1.3 & 0.3 \\ 0.8 & 0.7 & 0.6 & 2.1 \end{bmatrix}, \quad M^{SL}_{2}\left[\gamma(G)\right] = \begin{bmatrix} 1.0 & 0.2 & 0.3 & 0.5 \\ 0 & 0.9 & 0.2 & 0.7 \\ 0.3 & 0.6 & 1.5 & 0.6 \\ 0.2 & 0.1 & 0.3 & 0.6 \end{bmatrix}$$

The Signless laplacian energy (SLE) of M_2 (G) is determined as:

$$\textit{Spectrum of } M_2^{SL}\left[\mu(G)\right] = \{6.5895+0.0000i, 4.5257+0.2679i, 4.5257-0.2679i, 4.1591+0.0000i\}$$

$$\textit{Spectrum of } M_2^{SL}\left[\gamma(G)\right] = \{4.2382, 2.4141, 2.6000, 2.7477\}$$

$$SLE\left[M_2(G)\right] = [6.6579, 4.0000]$$

$$M_3^{SL}\left[\mu(G)\right]=\begin{bmatrix}1.7 & 0.4 & 0.6 & 0.7\\ 0.9 & 1.7 & 0.7 & 0.1\\ 0.4 & 0.6 & 1.4 & 0.4\\ 0.5 & 0.6 & 0.4 & 1.5\end{bmatrix},\quad M_3^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.4 & 0.9 & 0.3 & 0.2\\ 0.1 & 0.6 & 0.3 & 0.2\\ 0.5 & 0.2 & 0.9 & 0.2\\ 0.2 & 0.2 & 0.5 & 0.9\end{bmatrix}$$

The Signless laplacian energy (SLE) of M3 (G) is determined as:

$$Spectrum\ of\ M_3^{SL}\left[\mu(G)\right]=\begin{Bmatrix}6.4176+0.0000i,\\ 4.3000+0.0000i,\\ 4.0912+0.1436i,\\ 4.0912-0.1436i\end{Bmatrix}$$

$$Spectrum\ of\ M_3^{SL}\left[\gamma(G)\right]=\begin{Bmatrix}4.0192+0.0000i,\\ 2.5898+0.1914i,\\ 2.5898-0.1914i,\\ 2.2012+0.0000i\end{Bmatrix}$$

$$SLE\left[M_3(G)\right]=\left[6.3218, 3.8521\right]$$

The weight of each decision maker $e_k\left(k=1,2,3\right)$ can be determined as

$$W_i=\left(\frac{SLE\left(M_1^{SL}(e_1)\right)}{\sum_{i=1}^{n} SLE\left(M_i(e_k)\right)_i},\frac{SLE\left(M_2^{SL}(e_1)\right)}{\sum_{i=1}^{n} SLE\left(M_i(e_k)\right)_i},\frac{SLE\left(M_3^{SL}(e_1)\right)}{\sum_{i=1}^{n} SLE\left(M_i(e_k)\right)_i}\right)$$

$$W_1=\left(0.3380\ ,0.3750\right)\ ,W_2=\left(0.3396\ ,0.3184\right)\ ,W_3=\left(0.3224, 0.3066\right)$$

Based on which using Intuitionistic fuzzy weighted averaging (IFWA) operator, the fused IFIR is calculated as shown in Table 1.

Use the total administrator to combine all the individual IFIRS $M_k=\left(\gamma_{ij}^{(k)}\right)_{4\times 4}\left(k=1,2,3\right)$ into the aggregate IFIR $M=\left(\gamma_{ij}\right)_{4\times 4}$ Here we apply the intuitionistic fuzzy weighted averaging (IFWA) administrator to meld the individual IFIR by utilizing**' EXTENDED VIKOR'** method. Thus, we have

$$IFWA\,\gamma_{ij}=\left(\frac{\pi_{i=1}^{n}\left(\mu_{\alpha_i}\right)^{w_i}}{\pi_{i=1}^{n}\left(\mu_{\alpha_i}\right)^{w_i}+\pi_{i=1}^{n}\left(1-\mu_{\alpha_i}\right)^{w_i}},\frac{\pi_{i=1}^{n}\left(\gamma_{\alpha_i}\right)^{w_i}}{\pi_{i=1}^{n}\left(\gamma_{\alpha_i}\right)^{w_i}+\pi_{i=1}^{n}\left(1-\gamma_{\alpha_i}\right)^{w_i}}\right)$$

Table 1: The collective IFIR of all the above individual IFPRS

M	Cf_1	Cf_2	Cf_3	Cf_4
Cf_1	(0,0)	(0.43010, 0.42859)	(0.76154, 0)	(0.63635, 0.27991)
Cf_2	(0.81070, 0)	(0, 0)	(0.56820, 0.40529)	(0.27170, 0)
Cf_3	(0, 0.63510)	(0.61338, 0.30665)	(0, 0)	(0.23845, 0.62902)
Cf_4	(0.58266, 0.32863)	(0.60930, 0.21811)	(0.67909, 0.25091)	(0, 0)

In the coordinated system comparing to an aggregate IFIR above, we select those intuitionistic numbers whose membership degrees $T_{jk} \geq 0.5\left(j,k=1,2,3,4\right)$ and resulting partial diagram is appeared in the Fig.1.

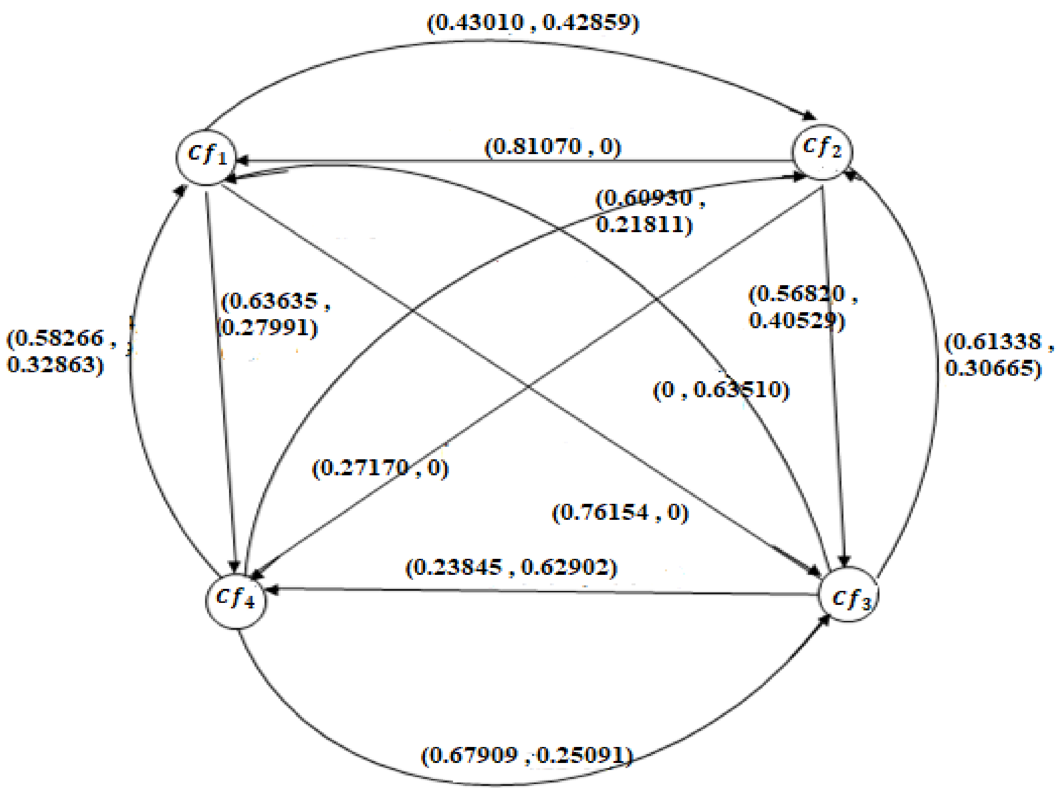

Fig.1 Relations of collective IFIR

Ascertain the out degrees $Out-d\left(Cf_j\right)\left(j=1,2,,3,4\right)$ of all criteria in a partial directed network as follows: $Out-d\left(Cf_1\right)=\left(1.82799, 0.70850\right)$,

$Out-d\left(Cf_2\right)=\left(1.65060, 0.40529\right)$,

$Out-d\left(Cf_3\right)=\left(0.85138, 1.57077\right)$,

$Out-d\left(Cf_4\right)=\left(1.87105, 0.79765\right)$.

As per membership degrees of $Out-d\left(Cf_j\right)\left(j=1,2,,3,4\right)$, we have the positioning of the factors $Cf_j\left(j=1,2,,3,4\right)$as: $Cf_4 > Cf_1 > Cf_2 > Cf_3$

Thus, the best choice is Cf_4 .

i.e, Strategic planning.

3.2 Evaluation of the Schemes for Development of Agriculture and Farmers' Welfare

In this section we focus on evaluations of schemes for development of agriculture and farmers' welfare. The department of agriculture & cooperation was earlier implementing many schemes for development of agriculture and farmer's welfare in the country. The government of India has introduced schemes to meet the requirements of farmers for storing farm produce, processed farm produce, agricultural inputs and marketing. Now we are recommended five agricultural schemes S_1, S_2, S_3, S_4 and S_5 .

S_1: National Food Security Mission (NFSM)

S_2: National Mission on Sustainable Agriculture (NMSA)

S_3: National Mission on Oilseeds and Oil palm (NMOOP)

S_4: National Mission on agricultural Extension and Technology (NMAET)

S_5: Integrated Scheme for Agriculture Marketing (ISAM)

To select the optimal scheme, the government selected four experts $e_k\left(k=1,2,3,4\right)$to evaluate the five schemes. Based on their investigation, the experts compare each pair of schemes and individual judgements using following IFPRs

$M_k=\left[\gamma_{ij}^{(k)}\right]_{5\times 5}\left(k=1,2,3,4\right)$.

$$M_1=\begin{bmatrix} (0,0) & (0.5,0.3) & (0.4,0.2) & (0.6,0.3) & (0.5,0.1) \\ (0.7,0.2) & (0,0) & (0.4,0.5) & (0.6,0.4) & (0.5,0.3) \\ (0.5,0.3) & (0.4,0.5) & (0,0) & (0.6,0.2) & (0.3,0.4) \\ (0.3,0.5) & (0.6,0.4) & (0.6,0.3) & (0,0) & (0.7,0.1) \\ (0.4,0.3) & (0.5,0.2) & (0.6,0.4) & (0.2,0.6) & (0,0) \end{bmatrix}$$

$$M_2 = \begin{bmatrix} (0,0) & (0.6,0.3) & (0.7,0.2) & (0.4,0.4) & (0.5,0.3) \\ (0.4,0.5) & (0,0) & (0.5,0.3) & (0.7,0.1) & (0.2,0.6) \\ (0.5,0.5) & (0.8,0.2) & (0,0) & (0.4,0.5) & (0.7,0.3) \\ (0.7,0.3) & (0.4,0.5) & (0.6,0.2) & (0,0) & (0.3,0.3) \\ (0.8,0.2) & (0.6,0.4) & (0.4,0.3) & (0.3,0.1) & (0,0) \end{bmatrix}$$

$$M_3 = \begin{bmatrix} (0,0) & (0.5,0.3) & (0.7,0.1) & (0.4,0.2) & (0.6,0.4) \\ (0.6,0.3) & (0,0) & (0.3,0.4) & (0.4,0.2) & (0.5,0.1) \\ (0.3,0.5) & (0.6,0.1) & (0,0) & (0.4,0.6) & (0.7,0.2) \\ (0.5,0.2) & (0.7,0.1) & (0.6,0.3) & (0,0) & (0.5,0.4) \\ (0.3,0.7) & (0.5,0.4) & (0.4,0.3) & (0.3,0.6) & (0,0) \end{bmatrix}$$

$$M_4 = \begin{bmatrix} (0,0) & (0.7,0.2) & (0.5,0.3) & (0.6,0.1) & (0.4,0.5) \\ (0.5,0.2) & (0,0) & (0.2,0.4) & (0.4,0.5) & (0.6,0.2) \\ (0.2,0.7) & (0.4,0.3) & (0,0) & (0.8,0.1) & (0.5,0.2) \\ (0.4,0.5) & (0.3,0.3) & (0.2,0.6) & (0,0) & (0.5,0.2) \\ (0.6,0.3) & (0.4,0.1) & (0.2,0.5) & (0.8,0.2) & (0,0) \end{bmatrix}$$

The Signless laplacian matrices of IFDGs $SL(D_k) = M_k^{SL}\ (k = 1,2,3,4)$

$$M_1^{SL}[\mu(G)] = \begin{bmatrix} 2.0 & 0.5 & 0.4 & 0.6 & 0.5 \\ 0.7 & 2.2 & 0.4 & 0.6 & 0.5 \\ 0.5 & 0.4 & 1.8 & 0.6 & 0.3 \\ 0.3 & 0.6 & 0.6 & 2.2 & 0.7 \\ 0.4 & 0.5 & 0.6 & 0.2 & 1.7 \end{bmatrix}, \quad M_1^{SL}[\gamma(G)] = \begin{bmatrix} 0.9 & 0.3 & 0.2 & 0.3 & 0.1 \\ 0.2 & 1.4 & 0.5 & 0.4 & 0.3 \\ 0.3 & 0.5 & 1.4 & 0.2 & 0.4 \\ 0.5 & 0.4 & 0.3 & 1.3 & 0.1 \\ 0.3 & 0.2 & 0.4 & 0.6 & 1.5 \end{bmatrix}$$

The Signless laplacian energy (SLE) of M_1 (G) is determined as

$$\textit{Spectrum of } M_1^{SL}[\mu(G)] = \{8.0188 + 0.0000i, 5.1636 + 0.2145i, 5.1636 - 0.2145i, 5.7734 + 0.0000i, 5.5806 + 0000i\}$$

$$\textit{Spectrum of } M_1^{SL}[\gamma(G)] = \{5.3221 + 0.0000i, 2.9546 + 0.0000i, 3.7854 + 0.1477i, 3.7854 - 0.1477i, 3.6525 + 0.0000i\}$$

$$SLE[M_1(G)] = [9.9397, 6.5183]$$

$$M_{2}^{SL}\left[\mu(G)\right]=\begin{bmatrix}2.2&0.6&0.7&0.4&0.5\\0.4&1.8&0.5&0.7&0.2\\0.5&0.8&2.4&0.4&0.7\\0.7&0.4&0.6&2.0&0.3\\0.8&0.6&0.4&0.3&2.1\end{bmatrix},\ M_{2}^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.2&0.3&0.2&0.4&0.3\\0.5&1.5&0.3&0.1&0.6\\0.5&0.2&1.5&0.5&0.3\\0.3&0.5&0.2&1.3&0.3\\0.2&0.4&0.3&0.1&1.0\end{bmatrix}$$

The Signless laplacian energy (SLE) of M_2 (G) is determined as:

$$Spectrum\ of\ M_2^{SL}\left[\mu(G)\right]=\{8.5518+0.0000i,6.2422+0.0000i,5.4550+0.0000i,$$
$$5.6255+0.2210i,5.6255-0.2210i\}$$

$$Spectrum\ of\ M_2^{SL}\left[\gamma(G)\right]=\{5.2676+0.0000i,3.2577+0.0000i,3.5645+0.0000i,$$
$$3.7051+0.0756i,3.7051-0.0756i\}$$

$$SLE\left[M_2(G)\right]=\left[10.5341,6.5052\right]$$

$$M_{3}^{SL}\left[\mu(G)\right]=\begin{bmatrix}2.2&0.5&0.7&0.4&0.6\\0.6&1.8&0.3&0.4&0.5\\0.3&0.6&2.0&0.4&0.7\\0.5&0.7&0.6&2.3&0.5\\0.3&0.5&0.4&0.3&1.5\end{bmatrix},\quad M_{3}^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.0&0.3&0.1&0.2&0.4\\0.3&1.0&0.4&0.2&0.1\\0.5&0.1&1.4&0.6&0.2\\0.2&0.1&0.3&1.0&0.4\\0.7&0.4&0.3&0.6&2.0\end{bmatrix}$$

The Signless laplacian energy (SLE) of M_3 (G) is determined as:

$$Spectrum\ of\ M_3^{SL}\left[\mu(G)\right]=\{7.8405+0.0000i,5.5128+0.2214i,5.5128-0.2214i,$$
$$5.5995+0.0000i,4.9344+0.0000i\}$$

$$Spectrum\ of\ M_2^{SL}\left[\gamma(G)\right]=\{5.6054,4.0118,2.8268,3.5053,3.2507\}$$

$$SLE\left[M_3(G)\right]=\left[9.8306,6.4000\right]$$

$$M_{4}^{SL}\left[\mu(G)\right]=\begin{bmatrix}2.2&0.7&0.5&0.6&0.4\\0.5&1.7&0.2&0.4&0.6\\0.2&0.4&1.9&0.8&0.5\\0.4&0.3&0.2&1.4&0.5\\0.6&0.4&0.2&0.8&2.0\end{bmatrix},\ M_{4}^{SL}\left[\gamma(G)\right]=\begin{bmatrix}1.1&0.2&0.3&0.1&0.5\\0.2&1.3&0.4&0.5&0.2\\0.7&0.3&1.3&0.1&0.2\\0.5&0.3&0.6&1.6&0.2\\0.3&0.1&0.5&0.2&1.1\end{bmatrix}$$

The Signless laplacian energy (SLE) of M_4 (G) is determined as:

$$Spectrum\ of\ M_4^{SL}\left[\mu(G)\right]=\{7.4882,5.4512,4.7137,5.0043,4.9426\}$$

$Spectrum\ of\ R_4^L\left[\gamma(G)\right]=\{5.2241+0.0000i, 3.9138+0.0000i, 3.5449+0.0000i,$
$3.2572+0.0895i, 3.2572-0.0895i\}$

$SLE\left[M_4(G)\right]=\left[9.2000, 6.4114\right]$

Then the weight of each expert can compute as:

$$W_k=\left((W_\mu)_k,(W_\gamma)_k\right)=\left[\frac{SLE\left((D_\mu)_k\right)}{\sum_{l=1}^{4}SLE\left((D_\mu)_k\right)_l},\frac{SLE\left((D_\gamma)_k\right)}{\sum_{l=1}^{4}SLE\left((D_\gamma)_k\right)_l}\right]$$

$W_1=(0.2516, 0.2523), W_2=(0.2667, 0.2518),$

$W_3=(0.2489, 0.2477), W_4=(0.2329, 0.2482)$

Based on which using Intuitionistic fuzzy weighted averaging (IFWA) operator, the fused IFIR is calculated as shown in Table 2.

Utilize the aggregation operator to fuse all the individual IFIRs $R_k=\left(\gamma_{ij}^{(k)}\right)_{5\times5}(k=1,2,3,4)$ into the collective IFIR $M=\left(\gamma_{ij}\right)_{5\times5}$, here we apply the intuitionistic fuzzy weighted averaging (IFWA) operator to fuse the individual IFPR by using MULTIMOORA method. Thus, we have

$$IFWA\gamma_{ij}=\left(\underset{k=1}{\overset{s}{\pi}}\left(\mu_{ij}^{(k)}\right)^{w_k},1-\underset{k=1}{\overset{s}{\pi}}\left(\gamma_{ij}^{(k)}\right)^{w_k}\right)$$

Table 2: The collective IFIR of all the above individual IFPRs

	S_1	S_2	S_3	S_4	S_5
S_1	(0,0)	(0.56766, 0.66406)	(0.56221, 0.81371)	(0.48678, 0.77790)	(0.49668, 0.72282)
S_2	(0.53649, 0.72148)	(0,0)	(0.33624, 0.60640)	(0.51421, 0.74884)	(0.40855, 0.75394)
S_3	(0.35566, 0.52217)	(0.53227, 0.63413)	(0,0)	(0.52051, 0.72158)	(0.52295, 0.73617)
S_4	(0.45658, 0.64962)	(0.47612, 0.72053)	(0.46452, 0.67942)	(0,0)	(0.47484, 0.77920)
S_5	(0.49228, 0.66585)	(0.49829, 0.76194)	(0.37689, 0.63381)	(0.34038, 0.70906)	(0,0)

In the coordinated system comparing to an aggregate IFPR above, we select those intuitionistic numbers whose membership degrees $T_{jk} \geq 0.5(j,k=1,2,3,4,5)$ and resulting partial diagram is appeared in the Fig.2.

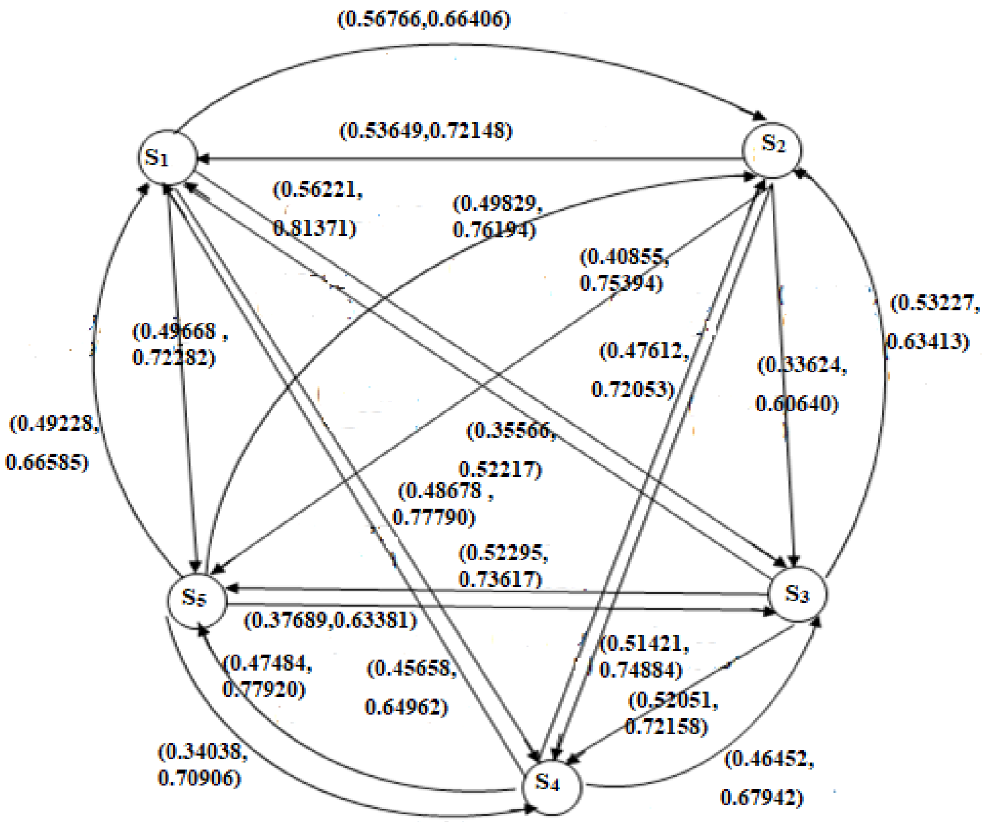

Fig.2 Relations of collective IFIR

Ascertain the out degrees $Out-d(x_j)(j=1,2,,3,4,5)$ of all criteria in a partial directed network as follows:

$Out-d(S_1)=(2.11333,2.97849)$, $Out-d(S_2)=(1.79549,2.83066)$,
$Out-d(S_3)=(1.93139,2.61405)$, $Out-d(S_4)=(1.87206,2.82877)$,
$Out-d(S_5)=(1.70784,2.77066)$

As per membership degrees of $Out-d(S_j)(j=1,2,,3,4,5)$, we have the positioning of the factors $x_j(j=1,2,,3,4,5)$ as:

$$S_1 > S_3 > S_4 > S_2 > S_5$$

Thus, the best choice is S_1

i.e., National Food Security Mission (NFSM)

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