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GROUP DECISION MAKING OF SELECTING PARTNER BASED ON SIGNLESS LAPLACIAN ENERGY OF AN INTUITIONISTIC FUZZY GRAPH WITH TOPSIS METHOD: STUDY ON MATLAB PROGRAMMING

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ABSTRACT. In this paper, MATLAB software for computing signless laplacian energy of an intuitionistic fuzzy matrix, weight characteristic of signless laplacian energies of an intuitionistic fuzzy graphs, the intuitionistic fluffy weighted averaging(IFWA) by the utilization of TOPSIS method are created. This has been detailed the utilization of the hypothetical perspectives that are demonstrated in [6]. These packages are demonstrated with appropriate illustrations. We installed the MATLAB programme for choosing the simplest alliance partner selection of automobile company.

1. INTRODUCTION

MATLAB perspectives for Matrix Laboratory. It is one kind of elevated level programming language and communicating state of affairs for mathematical calculation, imagining and programming. MATLAB is industrialized through Math Works. Cleve Moler is Chairman and Chief Scientist at the Math Works. In response to the need, the authors shared their capability in arithmetic, all designing, and automobile engineering to create MATLAB, a superior specialized processing condition. MATLAB joins far reaching math and designs capacities with a viable serious extent language (Math Works Inc.) and is normally a gadget for matrix calculations. It offers tremendous assortment of scientific capacities for polynomial math, straight variable based math, Fourier examination, sifting, enhancement,

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measurements, numerical combination and explaining standard differential conditions. MATLAB has a major gathering of tool compartments for fluctuation of uses. A tool compartment contains of capacities that might be utilized to get a few computations inside the tool stash domain. A portion of the MATLAB models tool stash are: control framework, insights, signal handling, neural system, photo preparing, improvement, emblematic science, and framework recognizable proof.

The fuzzy social analytics tool compartment was presented through K. Peeva. What's more, Y. Kyosev [10] and furthermore framed document for intuitionistic fuzzy set in fuzzy social math tool kit. There is a MATLAB program to discover roughly intuitionistic fuzzy diagram utilizing its vitality of connectedness, vitality of an intuitionistic fuzzy lattice and record framework of line intuitionistic fuzzy chart the utilization of the equivalent fuzzy social analytics tool compartment which become created by M. G. Karunambigai and O. K. Kalaivani [2]. Fuzzy connectedness strategy has accomplished great execution for photograph division. There are a few photo division techniques basically dependent on fuzzy idea among which fuzzyy connectedness is a notable procedures for this reason. In the calculation of fuzzy connectedness, these MATLAB applications likewise can be utilized to discover quality of connectedness for fuzzy chart by overlooking the non-enrollment certificate of vertices and edges. The hypothetical outcomes for composing such applications were taken from [5, 7], in which Atanassov brought the record grid outline of intuitionistic fuzzy charts and examined its activities in [1, 4]. O. Ramesh and S. Shariefbasha [9] talked about the organization dynamic difficulty concerning the 'Union accomplice choice of an Automobile Company', In convey chain the executives 'Partner decision' and estimation of the outlines of reservoir operation are lit up to exhibit the pertinence of the anticipated impression of signless laplacian intensity of an intuitionistic fuzzy diagram in exact turn of events.

In the Section 2, the basic definitions and MATLAB application for signless laplacian vitality of an intuitionistic fuzzy chart and weight highlight of signless laplacian energies of an intuitionistic fluffy diagrams, the intuitionistic fuzzy weighted averaging (IFWA) by the usage of TOPSIS Method had been developed with appropriate illustrations. In Section 3, a MATLAB program for deciding on the best alliance partner selection of a software company in deliver chain management, partner selection and calculation of the outlines of reservoir with suitable illustrations.

2. PRELIMINARIES WITH MATLAB PROGRAMMING

Definition 2.1. *[3] An intuitionistic fuzzy matrix (IFM) is a framework of request $m \times n$ and is defined as $A = \{< a_{\mu ij}; a_{\gamma ij} >\}_{m\times n}$, where $a_{\mu ij}\epsilon[0,1]$, $a_{\gamma ij}\epsilon[0,1]$ such that $0 \le a_{\mu ij} + a_{\gamma ij} \le 1, 1 \le i \le m$ and 1 $\le j \le n$. It can likewise be spoken to in the framework structure as*

$$A = \{< a_{\mu ij}; a_{\gamma ij} >\} = \begin{bmatrix} < a_{\mu 11}, a_{\gamma 11} > & < a_{\mu 12}, a_{\gamma 12} > & .... & < a_{\mu 1n}, a_{\gamma 1n} > \\ < a_{\mu 21}, a_{\gamma 21} > & < a_{\mu 22}, a_{\gamma 22} > & .... & < a_{\mu 2n}, a_{\gamma 2n} > \\ .... & .... & .... & .... \\ < a_{\mu m1}, a_{\gamma m1} > & < a_{\mu m2}, a_{\gamma m2} > & .... & < a_{\mu mn}, a_{\gamma mn} > \end{bmatrix}$$

Definition 2.2. *[8] An intuitionistic fuzzy nearness grid of an intuitionistic fuzzy diagram is characterized as the contiguousness framework of the relating intuitionistic fuzzy chart. That is for an intuitionistic fuzzy chart $G = (V, E, \mu, \gamma)$ an intuitionistic fuzzy nearness network is characterized by $A(IG) = [a_{ij}]$, where $a_{ij} = (\mu_{ij}, \gamma_{ij})$. Reminder that μ_{ij} denotes the potency of the correlation between v_i and v_j and also γ_{ij} the potency of non correlation between v_i and v_j .*

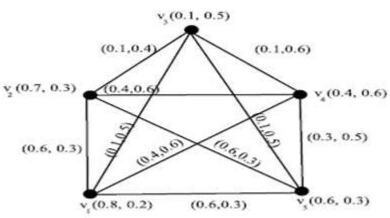

FIGURE 1. Intuitionistic fuzzy graph

The adjacency matrix for Figure 1 is

$$A(IG) = \begin{bmatrix} (0,0) & (0.6,0.3) & (0.1,0.5) & (0.4,0.6) & (0.6,0.3) \\ (0.6,0.3) & (0,0) & (0.1,0.4) & (0.4,0.6) & (0.6,0.3) \\ (0.1,0.5) & (0.1,0.4) & (0,0) & (0.1,0.6) & (0.1,0.5) \\ (0.4,0.6) & (0.4,0.6) & (0.1,0.6) & (0,0) & (0.3,0.5) \\ (0.6,0.3) & (0.6,0.3) & (0.1,0.5) & (0.3,0.5) & (0,0) \end{bmatrix}$$

The nearness network of an intuitionistic fuzzy diagram can be composed as two lattices one containing the sections as enrolment esteems and other containing non membership esteems i.e $A(I(G)) = [(\mu_{ij}), (\gamma_{ij})]$ where

$$A(\mu_{ij}) = \begin{bmatrix} 0 & 0.6 & 0.1 & 0.4 & 0.6 \\ 0.6 & 0 & 0.1 & 0.4 & 0.6 \\ 0.1 & 0.1 & 0 & 0.1 & 0.1 \\ 0.4 & 0.4 & 0.1 & 0 & 0.3 \\ 0.6 & 0.6 & 0.1 & 0.3 & 0 \end{bmatrix}$$

and

$$A(\gamma_{ij}) = \begin{bmatrix} 0 & 0.3 & 0.5 & 0.6 & 0.3 \\ 0.3 & 0 & 0.4 & 0.6 & 0.3 \\ 0.5 & 0.4 & 0 & 0.6 & 0.5 \\ 0.6 & 0.6 & 0.6 & 0 & 0.5 \\ 0.3 & 0.3 & 0.5 & 0.5 & 0 \end{bmatrix}$$

The adjacency matrix for Figure 2 is

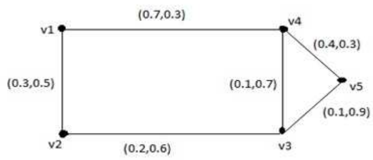

FIGURE 2. Intuitionistic fuzzy graph

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

$$A(\mu_{ij}) = \begin{bmatrix} 0 & 0.3 & 0.7 & 0 & 0 \\ 0.3 & 0 & 0.2 & 0 & 0 \\ 0 & 0.2 & 0 & 0.1 & 0.1 \\ 0.7 & 0 & 0.1 & 0 & 0.4 \\ 0 & 0 & 0.1 & 0.4 & 0 \end{bmatrix}$$

and

$$A(\gamma_{ij}) = \begin{bmatrix} 0 & 0.5 & 0.3 & 0 & 0 \\ 0.5 & 0 & 0.6 & 0 & 0 \\ 0 & 0.6 & 0 & 0.7 & 0.9 \\ 0.3 & 0 & 0.7 & 0 & 0.3 \\ 0 & 0 & 0.9 & 0.3 & 0 \end{bmatrix}$$

The adjacency matrix for Figure 3 is

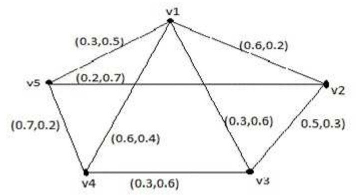

FIGURE 3. Intuitionistic fuzzy graph

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

$$A(\mu_{ij}) = \begin{bmatrix} 0 & 0.6 & 0.3 & 0.6 & 0.3 \\ 0.6 & 0 & 0.5 & 0 & 0.2 \\ 0.3 & 0.5 & 0 & 0.3 & 0 \\ 0.6 & 0 & 0.3 & 0 & 0.7 \\ 0.3 & 0.2 & 0 & 0.7 & 0 \end{bmatrix}$$

and

$$A(\gamma_{ij}) = \begin{bmatrix} 0 & 0.2 & 0.6 & 0.4 & 0.5 \\ 0.2 & 0 & 0.3 & 0 & 0.7 \\ 0.6 & 0.3 & 0 & 0.6 & 0 \\ 0.4 & 0 & 0.6 & 0 & 0.2 \\ 0.5 & 0.7 & 0 & 0.2 & 0 \end{bmatrix}$$

2.1. **Weight Function of Signless Laplacian energies of an IFGs.**

Definition 2.3. *Weights of n wide variety of Signless Laplacian energies calculating by using following formula (which is much like the Bayesian formula)*

$$W_i = ((W_\mu)_i, (W_\gamma)_i) = [\frac{SLE((D_\mu)_i)}{\sum_{k=1}^{m} SLE((D_\mu)_k)}, \frac{SLE((D_\gamma)_i)}{\sum_{k=1}^{m} SLE((D_\gamma)_k)}] .$$

2.2. **TOPSIS method for finding the IFPR.** It is a method of compensatory conglomeration that looks at a fixed of choices by recognizing loads for each criterion, normalizing appraisals for each rule and computing the geometric separation between each other option and the exact other option, which is the acceptable rating in every basis.

Computational Procedure For Topsis Method Problem

We look at m options $A_1, A_2, ..., A_m$.Every elective A_i regards n rules $x_1, x_2, ..., x_n$ which are communicated with positive numbers x_{ij}. The measures $x_1, x_2, ..., x_n$ are advantage (monotonically expanding inclination), and rules $x_{k+1}, x_{k+2}, ..., x_n$ are non-advantage (monotonically diminishing inclination). Weights w_j of the measures x_j are given so that $\sum_{j=1}^{n} w_j = 1$. It is necessary to select the most optimal alternative.

Initial Table and Decision Matrix

For better perceivability, the given other options, rules and its weights are put in the table (see Table 1).

CRITERIA	x_1 cr.1	x_2 cr.2	x_3 cr.3	....	x_n cr.n
Weights	w_1	w_2	w_3	....	w_n
A_1	x_{11}	x_{12}	x_{13}	....	x_{1n}
A_2	x_{21}	x_{22}	x_{23}	....	x_{2n}
....	....	....	....	....	....
A_m	x_{m1}	x_{m2}	x_{m3}	....	x_{mn}

TABLE 1. Initial table for TOPSIS method

The accumulated grid can be acquired by utilizing intuitionistic fuzzy weighted averaging (IFWA) collection administrator proposed by Ye for IFGs as follows

$$IFWA({\gamma_{ij}}^{(1)}, {\gamma_{ij}}^{(2)}, ..., {\gamma_{ij}}^{(3)}) = (1 - \pi_{k=1}^{s}(1 - (\mu_{ij}^{(k)})^{w_k}, \pi_{k=1}^{s}(\gamma_{ij}^{(k)})^{w_k}) ,$$

where w_k are weights of n number of signless laplacian energies calculating by using following formula (which is similar to the Bayesian formula):

$$W_i = ((W_\mu)_k, (W_\gamma)_k) = [\frac{SLE((D_\mu)_k)}{\sum_{r=1}^{m} SLE((D_\mu)_r)}, \frac{SLE((D_\gamma)_k)}{\sum_{r=1}^{m} SLE((D_\gamma)_r)}],$$

for $k = 1, 2, ..., m$

2.3. **The aggregated matrix obtained by using Intuitionistic fuzzy weighted averaging (IFWA) (TOPSIS Method) with MATLAB Programming.**

```
clc
clear
close all
m=input('Enter the number of matrices: ');
n=input('Enter the number of vertices: ');
for j=1:m
Am=input('Enter the matrix Am:');
Ar=input('Enter the matrix Ar:');
Amm(:,:,j)=Am;
Arr(:,:,j)=Ar;
Dm=zeros(n,n);
Dr=zeros(n,n);
fori=1:n
Dm(i,i)=abs(sum(Am(:,i)));
Dr(i,i)=abs(sum(Ar(:,i)));
end
SLm=Dm+Am;
SLr=Dr+Ar;
EvAm=eig(SLm);
EvAr=eig(SLr);
SAm=sum(sum(Am));
SAr=sum(sum(Ar));
SLeAm=sum(abs(EvAm-(SAm/n)));
SLeAr=sum(abs(EvAr-(SAr/n)));
SLE(j,1)=SLeAm;
SLE(j,2)=SLeAr;
end

SLE
for k=1:m
W(k,1)=SLE(k,1)/sum(SLE(:,1));
W(k,2)=SLE(k,2)/sum(SLE(:,2));
end

W
for p=1:n
for q=1:n
prod1=1;
prod2=1;
for r=1:m
prod1 = prod1*(1-Amm(p,q,r))^(W(r,1));
prod2 = prod2 * Arr(p,q,r)^(W(r,2));
end
Rm(p,q)=1-prod1;
Rr(p,q)=prod2;
end
end
s=ones(1,n-1);
fori=2:n
s = [s, i*ones(1,n-1)];
```

```
end
t=[]
fori=1:n
for j=1:n
ifi = j
t = [t, j]
end
end
end
fori=1:n
nameEdgei = ['a 'num2str(i)];
end

   k=1;
fori=1:n
for j=1:n
ifi = j
weightk=['('num2str(Rm(i,j))','
num2str(Rr(i,j)) ')'];
k=k+1;
end
end
end
D=digraph(s,t)
plot(D,'Layout','force','EdgeLabel',
weight,'NodeLabel',nameEdge)
set(gca,'YTickLabel',[]);
set(gca,'XTickLabel',[]);
```

INPUT:

Enter the number of matrices: 3,
Enter the number of vertices: 5
Enter the matrix Am:[0 0.6 0.1 0.4 0.6;0.6 0 0.1 0.4 0.6;0.1 0.1 0 0.1 0.1;0.4 0.4 0.1 0 0.3;0.6 0.6 0.1 0.3 0]
Enter the matrix Ar:[0 0.3 0.5 0.6 0.3;0.3 0 0.4 0.6 0.3;0.5 0.4 0 0.6 0.5;0.6 0.6 0.6 0 0.5;0.3 0.3 0.5 0.5 0]
Enter the matrix Am:[0 0.3 0.7 0 0;0.3 0 0.2 0 0;0 0.2 0 0.1 0.1;0.7 0 0.1 0 0.4;0 0 0.1 0.4 0]
Enter the matrix Ar:[0 0.5 0.3 0 0;0.5 0 0.6 0 0;0 0.6 0 0.7 0.9;0.3 0 0.7 0 0.3;0 0 0.9 0.3 0]
Enter the matrix Am:[0 0.6 0.3 0.6 0.3;0.6 0 0.5 0 0.2;0.3 0.5 0 0.3 0;0.6 0 0.3 0 0.7;0.3 0.2 0 0.7 0]
Enter the matrix Ar:[0 0.2 0.6 0.4 0.5;0.2 0 0.3 0 0.7;0.6 0.3 0 0.6 0;0.4 0 0.6 0 0.2;0.5 0.7 0 0.2 0]

OUTPUT:

SLE = 3.5555 3.9246
SLE = 2.2388 4.2768
SLE = 3.6875 3.6870

W = 0.3750 0.3301
W = 0.2361 0.3597
W = 0.3889 0.3101

2.4. **Alliance Partner Selection of a Automobile Company.** Maruti Suzuki is that the biggest automobile manufacturer in India. It proposals an upscale assortment of economic counting product engineering solutions, and associated to

Automobile products and stage and facilities. To progress the operation and attractiveness proficiency within the broad market, Maruti Suzuki methodologies to establish an arranged coalition with an overall partnership. Following plentiful discussions, five transnational company would really like to found a planned association with Maruti Suzuki ; they're Tata Motors (a_1) , Mahindra and Mahindra (a_2) , Hyundai India (a_3) , Bajaj Auto Limited (a_4) and Honda Motor Company (a_5). To choose the needed arranged coalition accomplice, three specialists are welcome to sponsor inside the choice examination, who start from designing administration office, the HR office and thusly the money division of Maruti Suzuki separately. Set up on their inclusions, the masters analyze every couple of substitutions and gives separate decisions utilizing the ensuing IFPRS.

$$R_i = [\gamma^i_{jk}]_{5\times 5}, (i = 1, 2, 3, ...)$$

TABLE 2. The collective IFPR of all the above individual IFPRS by TOPSIS Method

R	a_1	a_2	a_3	a_4	a_5
a_1	(0,0)	(0.5435,0.3179)	(0.3703,0.4403)	(0.4218,0)	(0.3826,0)
a_2	(0.5435,0.3179)	(0,0)	(0.3036,0.4233)	(0.1743,0)	(0.3497,0)
a_3	(0.1632,0)	(0.3036,0.4233)	(0,0)	(0.1838,0.6342)	(0.06236,0)
a_4	(0.5649,0.4123)	(0.1743,0)	(0.1838,0.6342)	(0,0)	(0.5145,0.3131)
a_5	(0.3826,0)	(0.3497,0)	(0.06236,0)	(0.5145 ,0.3132)	(0,0)

GRAPH:

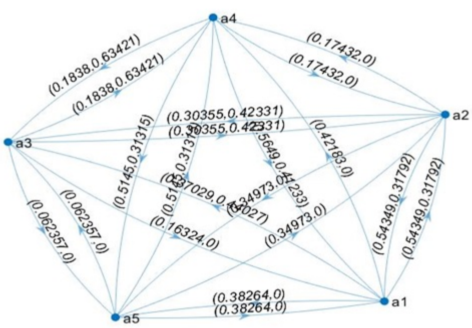

FIGURE 4. Intuitionistic fuzzy graph

Compute the out degrees $Out - d(a_j)(j = 1, 2, 3, 4, 5)$ of all measures in a fractional coordinated system as follows:
$Out - d(a_1) = 1.71825, 0.75819$, $Out - d(a_2) = 1.37109, 0.74123$
$Out - d(a_3) = 0.712947, 1.05752$, $Out - d(a_4) = 1.43752, 1.35969$
$Out - d(a_5) = 1.309227, 0.31315$
As per to membership degrees of $Out - d(a_j)(j = 1, 2, 3, 4, 5)$,we have the ranking of the factors $a_j(j = 1, 2, 3, 4, 5)$ as:
$a_1 > a_4 > a_2 > a_5 > a_3$ Thus the best choice is Tata Motors(a1) EMC a_1.

3. Conclusion

An intuitionistic fuzzy model is cast-off in technology, communication, networking, once the thought of in determination is current. Throughout this paper, we've adjusted convinced novel concepts solicitation in cluster decision-making supported ifprs is bestowed as an example the pertinence of the planned ideas of intuitionistic fuzzy graphs. These discernments are incontestable with actual stage illustration. Conjointly we tend to acknowledge the standing of the most effective one. the arranged matlab program is undemanding, prudent and takes less machine time in picture division. The creator trusts that this paper can benefit various scientists who are working in the field picture division, fuzzy graph hypothesis and intuitionistic fuzzy diagram hypothesis.

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