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APPLICATION OF BIPOLAR INTUITIONISTIC FUZZY MATRICES IN DOCUMENT RETRIEVAL SYSTEMS.

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Abstract: In this paper, the index and period of bipolar intuitionistic fuzzy matrix (BIFM)is determined in terms of its membership parts and non- membership parts, which leads to the definition of transitive closure of the concept BIFM. The knowledge- based BIF information retrieval method based on concept BIF network is determined by using the transitive closure of the BIFM and illustrated with suitable example.

Key words: Bipolar intuitionistic fuzzy matrices, transitive closure of BIFM, Document retrieval systems..

1.Introduction

Zadeh [12] introduced fuzzy set theory and Atanassov [1,2,3,4] generalized it as IFS. Kim et al. [5]studied determinants of fuzzy square matrices. Shyamal et al. [10]defined two new binary fuzzy operators for fuzzy matrices. Khan et al. [6]developed the concept of IFM. Rajarajeswari et al. [9] developed the concept of IFSM theory and applied it in DM problem. The concept of bipolar fuzzy set was first introduced by Zhang [11]. Pal et al. [8] defined the concept of BFM. Zulqarnian et al. [13] introduced the comparison fuzzy soft matrix and interval valued fuzzy soft matrix in decision making.

Motivated by these theories, bipolar intuitionistic fuzzy matrices, operations of BIFM and decision making problem on BIFM has been developed. Comparison technique between the +ve- membership,-ve membership and +ve non-membership, -ve non- membership entries of BIFMs is introdced. An algorithms for solving decision making problems are designed and suitable examples are given to establish the working of these algorithms. Finally these approaches are extended to a decision making problem where a score value is constructed and depending on the total score value the alternatives are ranked.

2. Transitive closure of BIFM

In this section the concept of index and period for an BIFM is defined and the relations between the index and period of an BIFM A with the index periods of +ve,-ve membership and +ve,-ve non-membership matrices (A_μ^+, A_μ^-) and (A_ν^+, A_ν^-) is found.

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Definition 2.11 For $A \in (BIFM)_n$, $(A^+)^{k+d}(A^-)^{k+d} = (A^+, A^-)^k$ holds for some $k, d > 0$, $k, d < 0$, then the least $k > 0, k < 0$ such that $(A^+, A^-)^{k+d} = (A^+, A^-)^k$ for some k is called the index of (A^+, A^-), the least $d > 0, d < 0$ such that $(A^+, A^-)^{k+d} = (A^+, A^-)^k$ for some d is called the period of (A^+, A^-) denoted by $i(A^+, A^-)$ and $p(A^+, A^-)$ respectively.

Definition 2 2.2 Let M be a BIFM order n, then there exist an integer $p \le n-1$ such that under the composition of BIFM, $M^P = M^{P+1} = M^{P+2}$ and $T = m^p$ is called the transitive closure of BIFM, $m = (M_\mu^+, M_\mu^-)$, (M_v^+, M_v^-) is the BIFM whose +ve,-ve membership and +ve,-ve non-membership matrices are the transitve closure of (M_μ^+, M_μ^-) and (M_v^+, M_v^-) that is $M = [(M_\mu^+, M_\mu^-)(M_v^+, M_v^-)]$ then $M = [(T_\mu^+, T_\mu^-)(T_v^+, T_v^-)]$ the transitive closure of m.

$T = m^p$ $[(T_\mu^+, T_\mu^-)(T_v^+, T_v^-)] = [(M_\mu^+)^p, (M_\mu^-)^p)(M_v^+)^p, (M_v^-)^p]$

$T_\mu^+ = (M_\mu^+)^p, T_\mu^- = (M_\mu^-)^p, T_v^+ = (M_v^+)^p, T_v^- = (M_v^-)^p$,

3. BIF concept networks

Let $C = (c_{ij})$ denotes the relevant value from the concept c_i to the concept c_j. The relevant value from concept c_i to concept c_j and the relevant value from concept c_j to concept c_k are given, that is, c_{ij} and c_{ik} are known and c_{ik} is defined as follows:

$c_{ik}^- = \min\{c_{ij}^-, c_{jk}^-\}, c_{ik}^+ = \min\{c_{ij}^+, c_{jk}^+\}$ (3.1)

$c_{\mu_{ik}}^-, c_{v_{ik}}^- = \min\{(c_{\mu_{ij}}^-, c_{v_{ij}}^-), (c_{\mu_{jk}}^-, c_{v_{jk}}^-)\}$ (3.2)

$c_{\mu_{ik}}^+, c_{v_{ik}}^+ = \min\{(c_{\mu_{ij}}^+, c_{v_{ij}}^+), (c_{\mu_{jk}}^+, c_{v_{jk}}^+)\}$ (3.3)

$c_{\mu_{ik}}^- = \min\{c_{\mu ij}^-, c_{\mu_{jk}}^-, c_{\mu_{ik}}^+\} = \min\{c_{\mu ij}^+, c_{\mu_{jk}}^+\}$

and $c_{v_{ik}}^- = \min\{c_{vij}^-, c_{v_{jk}}^-\}, c_{v_{ik}}^+ = \min\{c_{vij}^+, c_{v_{jk}}^+\}$ (3.4)

Definition 3.13 Let $\{c_1, c_2, \ldots, c_n\}$ be a set of n concepts. A concept BIFM $C = (C_{ij})$ is an n× n BIFM, Where C_{ij} is the relavant value from the concept C_i to the concept C_j and $C_{ij} \in [1, 0]$ satisfying the following properties 1. Reflexitive 2. sysmentric 3. transitive

Definition 3.2 4 Let $\{d_1, d_2, \ldots, d_m\}$ be a set of documents and $\{c_1, c_2, \ldots, c_n\}$ be a set of concepts in a concept BIFM network with m documents and n concepts. A document descriptive BIFM $D = (D_{ij})$ is an m×n matrix where d_{ij} is the degree of relavance of document d_i with respect to the concept c_j.

The document descriptor bipolar intuitionistic fuzzy matrix $D^* = DT$, where D is the document descriptor of the bipolar intuitionistic fuzzy network and T is the BIF transitive closure of the concept bipolar intuitionistic fuzzy matrix.

$D^* = ((D_\mu^- .T_\mu^-), (D_\mu^+ .T_\mu^+), (D_\nu^- .T_\nu^-), (D_\nu^+ .T_\nu^+))$ indicates the degree of relevance of each document with respect to specific concepts and is used as a basis for similarity measures between queries and documents. Let the above basic concepts in a concept network be illustrated with suitable examples. Let the concept BIFM, Query descriptor, Document descriptor BIFM be illustrated and the transitive closure on BIFM be computed using the following examples.

Example 3.35 Let a network $N = (V, E)$ consisting of n nodes (cities) and m edges (roads) connecting the cities of a country be considered. If the vehicles on the roads of the network has to be measured at a particular time duration, it is quite impossible to measure the vehicles on a road as a single value because the vehicles at a particular time duration is not fixed, it varies from time to time. In this case, the network is called bipolar Intuitionistic Fuzzy networks. Let us consider a concept bipolar Intuitionistic Fuzzy network, where c_1, c_2, c_n are concepts, d_1, d_2, d_3 are the documents. If the query descriptor Q is $Q = (c_3, [-1,1])$ where $[-1,1]$ represents the relevant Bipolar Fuzzy value of the query descriptor Q with respect to the concept c_3, then the relevant bipolar Fuzzy value of document d_2 with respect to the concept c_3 is calculated as follows:

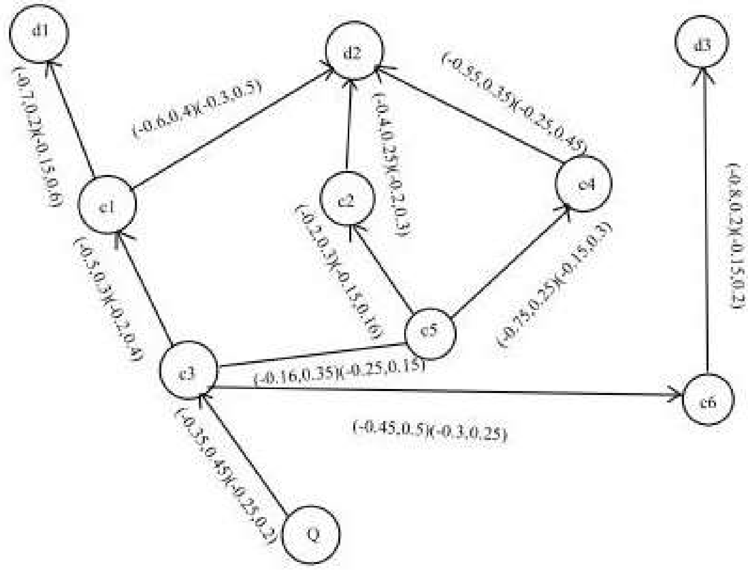

Figure 1: BIF Network

The first route

$c_3[(-0.5,0.3)(-0.2,0.4)]c_1[(-0.6,0.4)(-0.3,0.5)]d_2$

$c_3 = \min((-0.5,0.3)(-0.2,0.4)(-0.6,0.4)(-0.3,0.5))$

$= [(-0.6,0.3)(-0.3,0.4)].$

The 2nd route

$c_3[(-0.16, 0.35)(-0.25, 0.15)]c_5[(-0.2, 0.3)$

$(-0.15, 0.16)]c_2[(-0.4, 0.25)(-0.2, 0.3)]d_2$

$c_3 = \min((-0.16, 0.35)(-0.25, 0.15)(-0.2, 0.3)$

$(-0.15, 0.16)(-0.4, 0.25)(-0.2, 0.3))$

$= [(-0.4, 0.25)(-0.25, 0.15)].$

The 3rd route

$c_3[(-0.16, 0.35)(-0.25, 0.15)]c_5[(-0.75, 0.25)$

$(-0.15, 0.3)]c_4[(-0.55, 0.35)(-0.25, 0.45)]d_2$

$c_3 = \min((-0.16, 0.35)(-0.25, 0.15)(-0.75, 0.25)$

$(-0.15, 0.3)(-0.55, 0.35)(-0.25, 0.45))$

$= [(-0.75, 0.25)(-0.25, 0.15)].$

Then the relevant value of the document d_2 with respect to the concept c_3 is

$c_3 = \max((-0.6, 0.3)(-0.3, 0.4)(-0.4, 0.25)$

$(-0.25, 0.15)(-0.75, 0.25)(-0.25, 0.15))$

$= [(-0.4, 0.3)(-0.25, 0.4)].$

Thus $Q = (c_3, [-1, 1]) = [(-0.4, 0.3)(-0.25, 0.4)].$

Example 3.4 6 The concept of $BIFM(C)$ of the network in Fig (7.1) is calculated by using (3.1)(3.2)(3.3)

$$\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} (-1,0)(0,1) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) \\ (0,0)(0,0) & (-1,0)(0,1) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) \\ (-0.5,0.3)(-0.2,0.4) & (-0.2,0.3)(-0.25,0.15) & (-1,0)(0,1) & (-0.75,0.25)(-0.25,0.15) & (-0.16,0.35)(-0.25,0.15) & (-0.45,0.5)(-0.3,0.25) \\ (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (-1,0)(0,1) & (0,0)(0,0) & (0,0)(0,0) \\ (0,0)(0,0) & (-0.2,0.3)(-0.15,0.16) & (0,0)(0,0) & (-0.75,0.25)(-0.15,0.13) & (-1,0)(0,1) & (0,0)(0,0) \\ (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) & (-1,0)(0,1) \end{pmatrix} \end{array}$$

Cartisian product $C = ((C_\mu^-, C_\mu^+), (C_\nu^-, C_\nu^+))$

$$C_{\mu}^{-} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ -0.5 & -0.2 & -1 & -0.75 & -0.16 & -0.45 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & -0.2 & 0 & -0.75 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} \end{array}$$

$$C_{\mu}^{+} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0.3 & 0.3 & 0 & 0.25 & 0.35 & 0.5 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.3 & 0 & 0.25 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

$$C_{\nu}^{-} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -0.2 & -0.25 & 0 & -0.25 & -0.25 & -0.3 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -0.15 & 0 & -0.15 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

$$C_{\nu}^{+} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0.4 & 0.15 & 1 & 0.15 & 0.15 & 0.25 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0.16 & 0 & 0.3 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \end{array}$$

From the concept fuzzy matrix C_μ^-, C_μ^+ and C_ν^-, C_ν^+ it is seen that all the diagonal entries are (-1,0) and (0,1) respectively.

That is $C_{\mu_{ii}}^{-} = -1$ for $i = 1$ to 6. Here $C_{\mu_{23}}^{-} = 0$ but $C_{\mu_{32}}^{-} = -0.2$

and therefore $C_{\mu_{ij}}^{-} \neq C_{\mu_{ji}}^{-}$.

Similarly, $C_{\mu_{ij}}^{+} \neq C_{\mu_{ji}}^{+}, C_{\nu_{ij}}^{-} \neq C_{\nu_{ji}}^{-}$, and $C_{\nu_{ij}}^{+} \neq C_{\nu_{ji}}^{+}$..

Hence C is not symmetric.

Example 7 3.5 The document descriptor BIFM D for the concept BIF network in Fig (7.1) is computed as

$$D = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \\ \end{array}$$

$$D = \begin{array}{c} d_1 \\ d_2 \\ d_3 \end{array} \begin{pmatrix} (-0.7,0.2)(-0.15,0.6) & (0,0)(0,0) & (-0.7,0.2)(-0.2,0.4) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) \\ (-0.6,0.4)(-0.3,0.5) & (-0.4,0.25)(-0.2,0.3) & (-0.6,0.3)(-0.3,0.4) & (-0.55,0.35)(-0.25,0.45) & (-0.4,0.25)(-0.2,0.16) & (0,0)(0,0) \\ (0,0)(0,0) & (0,0)(0,0) & (-0.8,0.2)(-0.3,0.2) & (0,0)(0,0) & (0,0)(0,0) & (0,0)(0,0) \end{pmatrix}$$

Cartesian product $D = ((D_\mu^-, D_\mu^+), (D_\nu^-, D_\nu^+))$

$$D_\mu^- = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -0.7 & 0 & -0.7 & 0 & 0 & 0 \\ -0.6 & -0.4 & -0.6 & -0.55 & -0.4 & 0 \\ 0 & 0 & -0.8 & 0 & 0 & -0.8 \end{pmatrix} \end{array}$$

$$D_\mu^+ = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 0.2 & 0 & 0.2 & 0 & 0 & 0 \\ 0.4 & 0.25 & 0.3 & 0.35 & 0.25 & 0 \\ 0 & 0 & 0.2 & 0 & 0 & 0.2 \end{pmatrix} \end{array}$$

$$D_\nu^- = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -0.15 & 0 & -0.2 & 0 & 0 & 0 \\ -0.3 & -0.2 & -0.3 & -0.25 & -0.2 & 0 \\ 0 & 0 & -0.3 & 0 & 0 & -0.15 \end{pmatrix} \end{array}$$

$$D_\nu^+ = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 0.6 & 0 & 0.4 & 0 & 0 & 0 \\ 0.5 & 0.3 & 0.4 & 0.45 & 0.16 & 0 \\ 0 & 0 & 0.2 & 0 & 0 & 0.2 \end{pmatrix} \end{array}$$

Then 0 entries in the D_μ^-, D_μ^+ and D_ν^-, D_ν^+ indicate that the corresponding concepts are not relevant or can be neglected with respect to the particular document. For instance the concepts c_2, c_4, c_5 and c_6 are not relevant for the document d_1 in D_μ^-, D_μ^+ and D_ν^-, D_ν^+. To get the implicit relevant values of each document with respect to specific concepts, let the transitive closure of the concept matrix given in (3.7) be computed for the concept bipolar intuitionistic fuzzy network in Figure (7.1) $(C_\mu^-)^2 = \min(C_{\mu_{ij}}^-, C_{\mu_{ij}}^-)$

$$(C_\mu^-)^2 = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ -0.5 & -0.2 & -1 & -0.75 & -0.16 & -0.45 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & -0.2 & 0 & -0.75 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} \end{array}$$

Therefore $(C_\mu^-)^2 = C_\mu^-$.

Similary, $(C_\mu^+)^2 = C_\mu^+, (C_\nu^-)^2 = C_\nu^-, (C_\nu^+)^2 = C_\nu^+$.

Since $C = C^2$. Therefore C itself is the transitive closure of the concept bipolar intuitionistic fuzzy matrix. Since $C = T, T_\mu^- = C_\mu^-, T_\mu^+ = C_\mu^+, T_\nu^- = C_\nu^-, T_\nu^+ = C_\nu^+$.

$$D_\mu^- = D_\mu^-.T_\mu^- = \max(\min(D_{\mu_{ij}}^-, T_{\mu_{ij}}^-))$$

$$\begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -0.7 & -0.2 & -0.7 & -0.7 & -0.7 & -0.7 \\ -0.4 & -0.4 & -0.4 & -0.4 & -0.4 & -0.4 \\ -0.8 & -0.4 & -0.8 & -0.75 & -0.8 & -0.8 \end{pmatrix} \end{array}$$

$$D_\mu^+ = D_\mu^+.T_\mu^+ = \max(\min(D_{\mu_{ij}}^+, T_{\mu_{ij}}^+))$$

$$\begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} 0.2 & 0.2 & 0 & 0.2 & 0.2 & 0.2 \\ 0.3 & 0.3 & 0 & 0.25 & 0.3 & 0.3 \\ 0.2 & 0.2 & 0 & 0.2 & 0.2 & 0.2 \end{pmatrix} \end{array}$$

$$D_\nu^- = D_\nu^-.T_\nu^- = \max(\min(D_{\nu_{ij}}^-, T_{\nu_{ij}}^-))$$

$$\begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{pmatrix} -0.15 & -0.15 & -0.15 & -0.15 & -0.15 & -0.15 \\ -0.2 & -0.2 & -0.2 & -0.2 & -0.2 & -0.2 \\ -0.15 & -0.15 & -0.15 & -0.15 & -0.15 & -0.15 \end{pmatrix} \end{array}$$

$$D_{\nu}^{+} = D_{\nu}^{+}.T_{\nu}^{+} = \max(\min(D_{\nu_{ij}}^{+}, T_{\nu_{ij}}^{+}))$$

$$\begin{array}{c c} & \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{array}{c} d_1 \\ d_2 \\ d_3 \end{array} & \begin{pmatrix} 0.6 & 0.15 & 0.4 & 0.15 & 0.15 & 0.25 \\ 0.5 & 0.3 & 0.4 & 0.45 & 0.16 & 0.25 \\ 0.2 & 0.15 & 0.2 & 0.15 & 0.15 & 0.2 \end{pmatrix} \end{array}$$

Therefore $D^{*} = ((D_{\mu}^{-}.T_{\mu}^{-}),(D_{\mu}^{+}.T_{\mu}^{+}),(D_{\nu}^{-}.T_{\nu}^{-}),(D_{\nu}^{+}.T_{\nu}^{+}))$

$$\begin{array}{c c} & \begin{array}{cccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{array} \\ \begin{array}{c} d_1 \\ d_2 \\ d_3 \end{array} & \begin{pmatrix} (-0.7,0.2)(-0.15,0.6) & (-0.2,0.2)(-0.15,0.15) & (-0.7,0)(-0.15,0.4) & (-0.7,0.2)(-0.15,0.15) & (-0.7,0.2)(-0.15,0.15) & (-0.7,0.2)(-0.15,0.25) \\ (-0.4,0.3)(-0.2,0.5) & (-0.4,0.3)(-0.2,0.3) & (-0.4,0)(-0.2,0.4) & (-0.4,0.25)(-0.2,0.45) & (-0.4,0.3)(-0.2,0.16) & (-0.4,0.3)(-0.2,0.25) \\ (-0.8,0.2)(-0.15,0.2) & (-0.4,0.2)(-0.15,0.15) & (-0.8,0)(-0.15,0.2) & (-0.75,0.2)(-0.15,0.15) & (-0.8,0.2)(-0.15,0.15) & (-0.8,0.2)(-0.15,0.2) \end{pmatrix} \end{array}$$

The document descriptor $BIFMD^{*}$ gives the implicit values of each document more accurately. For instance $[0,0][0,0]$ entries in the first row of the document descriptor $BIFM$ are improved as $(-0.2,0.2)(-0.15,0.15),(-0.7,0.2)(-0.15,0.15),(-0.7,0.2)(-0.15,0.15)$ and $(-0.7,0.2)(-0.15,0.25)$ respectively, that is, the concepts c_2, c_4, c_5 and c_6 cannot be neglected for the document d_1. Thus the document descriptor bipolar intuitionistic fuzzy matrix D^{*} obtained by using the transitive closure T reveals more accurate results for the user.

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