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TRANSITIVE CLOSURE OF AN INTERVAL VALUED FUZZY MATRIX AND ITS APPLICATION IN DOCUMENT RETRIEVAL SYSTEMS

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ABSTRACT

In this paper, we determine the index and period of an Interval Valued Fuzzy Matrix (IVFM) in terms of that of its lower and upper limit fuzzy matrices, which leads to the definition of transitive closure of the concept IVFM. We discuss knowledge-based interval valued fuzzy information retrieval method based on concept interval networks by using the transitive closure of the IVFM and Illustrate with suitable examples.

Keywords: *Transitive Closure, Fuzzy Matrix, Interval valued fuzzy matrix, Document retrieval systems.*

MSC Subject Classification: *15B15, 97R20.*

1. INTRODUCTION

Thomason [12], has established that for $A \in F_n$ is a Fuzzy Matrix of order n, $A^{k+d} = A^k$ holds for some k, d >0, then the least k >0 such that $A^{k+d} = A^k$ is called the index of A, the least d >0 such that $A^{k+d} = A^k$ is called the period of A, that is, every fuzzy matrix has an index and period. Further, for $A \in F_n$, there exist a positive integer $p \leq n-1$, such that $A^P = A^{P+1} = A^{P+2}$ and A^P is called the transitive closure of A. The transitive closure of the relation matrices, relevance matrices and document descriptor matrices reveal more accurate results for the system's user in document retrieval systems based on concept networks and extended fuzzy concept network. In recent years, several fuzzy information retrieval methods based on fuzzy set theory [14] have been proposed for improving the disadvantage of the Boolean logic model such as [4, 5, 6, and 8]. In [7], Lucarella et al. presented a fuzzy information retrieval system (FIRST) based on concept networks. Many researchers have presented techniques to deal with document retrieval using knowledge-based fuzzy information retrieval techniques and the system's users to perform simple queries, weighted queries, interval queries and weighted interval queries in [1, 2, 3, 9 and 13]. Recently the concept of Interval valued fuzzy matrices (IVFM) as a generalization of fuzzy matrix was introduced by Shyamal and Pal [11], by extending the max. min operations on Fuzzy algebra $\mathcal{F} = [0,1]$, for elements a, $b \in \mathcal{F}$, a + b = max {a, b} and a . b = min {a, b}. Let $\mathcal{F}_{mn}$ be the set of all mxn Fuzzy Matrices over the Fuzzy algebra with support [0, 1], that is matrices whose entries are intervals and all the intervals are subintervals of the interval [0, 1] then by introducing the operations on the intervals max $\{a_{ij}, b_{ij}\}$ = [max $\{a_{ijL}, b_{ijL}\}$, max $\{a_{ijU}, b_{ijU}\}$] and min $\{a_{ij}, b_{ij}\}$ = [min $\{a_{ijL}.b_{ijL}\}$, min $\{a_{ijU}.b_{ijU}\}$] In our earlier work [10], we have represented an IVFM A= (a_{ij}) = $([a_{ijL}, a_{ijU}])$ where each a_{ij} is a subinterval of the interval [0, 1] as the interval matrix A = $[A_L, A_U]$ whose ij^{th} entry is the interval $[a_{ijL}, a_{ijU}]$, where the lower limit $A_L = (a_{ijL})$ and upper limit $A_U = (a_{ijU})$ are fuzzy matrices such that $A_L \leq A_U$ that is $a_{ijL} \leq a_{ijU}$ under the usual ordering of real numbers.

In this paper, we compute the Transitive closure of Interval valued fuzzy matrices (IVFM) in Document retrieval systems as a generalization of that of fuzzy document retrieval systems and as extension of an IVFM discussed in [10]. In section 2, we present the basic definition, notations and required results an IVFM. In section 3, we determine the index and period on an IVFM in terms of that of its lower and upper limit fuzzy matrices, which leads to the definition of transitive closure of the concept IVFM. We discuss knowledge-based interval valued fuzzy information retrieval method based on concept interval networks by using the transitive closure of the IVFM and Illustrate with suitable examples.

2. PRELIMINARIES

In this section, some basic definitions and notations are given. Let IVFM denotes the set of all interval valued fuzzy matrices, that is, fuzzy matrices whose entries are all subintervals of the interval [0, 1].

Definition 2.1: For a pair of fuzzy matrices E= (e_{ij}) and F= (f_{ij}) in $\mathcal{F}_{mn}$ such that $E \leq F$, let us define the interval matrix denoted as [E, F], whose ij^{th} entry is the interval with lower limit e_{ij} and upper limit f_{ij}, that is, $[e_{ij}, f_{ij}]$.

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In particular for E = F, IVFM [E, E] reduces to the fuzzy matrix $E \in \boldsymbol{F}_{mn}$.

For $A = (a_{ij}) = ([a_{ijL}, a_{ijU}]) \in (IVFM)_{mxn}$, let us define $A_L = (a_{ijL})$ and $A_U = (a_{ijU})$ clearly A_L and A_U belongs to $\boldsymbol{F}_{mn}$ such that $A_L \leq A_U$. Therefore A can be written as

$$A = [A_L, A_U] \tag{2.1}$$

where A_L and A_U are called the lower and upper limits of A respectively.

Here we shall follow the basic operation on IVFM as given in [7].

For $A = (a_{ij}) = ([a_{ijL}, a_{ijU}])$ and $B = (b_{ij}) = ([b_{ijL}, b_{ijU}])$ of order mxn their sum denoted as A+B is defined as

$A+B = (a_{ij}+b_{ij}) = [(a_{ijL}+b_{ijL}), (a_{ijU}+b_{ijU})]$, then addition is

$$A+B = \max\{a_{ij}, b_{ij}\} = [\max\{a_{ijL}, b_{ijL}\}, \max\{a_{ijU}, b_{ijU}\}] \tag{2.2}$$

For $A = (a_{ij})_{mxn}$ and $B = (b_{ij})_{nxp}$ their product denoted as AB is defined as

$$AB = (C_{ij}) = [\Sigma^n_{k=1} a_{ik} b_{kj}] \qquad i = 1,2,\ldots \ldots m \quad \text{and} \quad j = 1,2,\ldots \ldots p$$

$$= [\Sigma^n_{k=1}(a_{ikL} . b_{kjL}), \Sigma^n_{k=1}(a_{ikU} . b_{kjU})]$$

If $A = [A_L, A_U]$ and $B = [B_L, B_U]$ then $A+B = [A_L + B_L, A_U + B_U]$

$$AB = [A_LB_L, A_UB_U] = [\max\min(A_LB_L), \max\min(A_U.B_U)] \tag{2.3}$$

$$A \geq B \text{ if and only if } a_{ijL} \geq b_{ijL} \text{ and } a_{ijU} \geq b_{ijU} \text{ if and only if } A+B = A \tag{2.4}$$

In particular if $a_{ijL} = a_{ijU}$ and $b_{ijL} = b_{ijU}$ then (2.2) reduces to the standard max. min composition of Fuzzy Matrices[9].

It is well known that [12], every fuzzy matrix has an index and period, that is, for $A \in F_n$, the least k >0 such that $A^{k+d} = A^k$ is called the index of A, the least d >0 such that $A^{k+d} = A^k$ is called the period of A, these are denoted as i(A) and p(A) respectively.

Lemma 2.2: For $A \in F_n$, if $A^{k+d} = A^k$ for some k. d >0, then $k \geq i(A)$ and p(A)/d.

3. TRANSITIVE CLOSURE OF AN IVFM

In this section, here we extend the concept of index and period for an IVFM and find the relations between the index and period of an IVFM A with the indices and periods of the lower and upper limit fuzzy matrices A_L and A_U.

Definition 3.1: For $A \in (IVFM)_n$, $A^{k+d} = A^k$ holds for some k, d >0, then the least k >0 such that $A^{k+d} = A^k$ for some k is called the index of A, the least d >0 such that $A^{k+d} = A^k$ for some d is called the period of A, denoted as i(A) and p(A) respectively.

Theorem 3.2: For $A \in (IVFM)_n$, if $A = [A_L, A_U]$ then $i(A) = \max\{i(A_L), i(A_U)\}$ and $p(A) = \text{lcm}\{p(A_L), p(A_U)\}$.

Proof: Let i(A) = k and p(A) = d, then $A^{k+d} = A^k$.

Since $A = [A_L, A_U]$, by (2.3), $[A_L^{k+d}, A_U^{k+d}] = [A_L^k, A_U^k]$.

Comparing the corresponding blocks we get, $A_L^{k+d} = A_L^k$ and $A_U^{k+d} = A_U^k$.

If $i(A_L) = k_1$, $i(A_U) = k_2$, $p(A_L) = d_1$ and $p(A_U) = d_2$, then by Lemma (2.2) we get $k \geq k_1$, $k \geq k_2$ and both $p(A_L) = d_1$ and $p(A_U) = d_2$ divides d.

$$\text{Therefore } i(A) = k \geq \max\{k_1, k_2\} = \tilde{k} \text{ and lcm}\{d_1, d_2\}/d = \tilde{d} \tag{i}$$

On the other hand, if $\tilde{k}$ is max $\{k_1, k_2\}$, then $\tilde{k} \geq k_1$ and k_2 and $\tilde{d}$ is lcm $\{d_1, d_2\}$/Ã

By Lemma (2.2), $A_L^{\tilde{k}+\tilde{d}} = A_L^{\tilde{K}}$ and $A_U^{\tilde{k}+\tilde{d}} = A_U^{\tilde{K}}$.

By (2.3) we get, $A^{\tilde{k}+\tilde{d}} = A^{\tilde{K}}$

Again by Lemma (2.2), it follows that, $A^{\tilde{k}+\tilde{d}} = A^{\tilde{K}}$. (ii)

Thus (i) and (ii) yields Thus $i(A) = \max\{i(A_L), i(A_U)\}$ and $p(A) = \text{lcm}\,\{p(A_L), p(A_U)\}$.

Hence the Theorem

Now, the Definition (3.1) and Theorem (3.2) leads to the following definition.

Definition 3.3: Let M be an interval valued fuzzy matrix of order n. Then there exist an integer $p \leq n-1$, such that under the composition of interval valued fuzzy matrices $M^P = M^{P+1} = M^{P+2}$ and $T = M^P$ is called the transitive closure of an IVFM M. Thus the transitive closure of an IVFM $M = [M_L, M_U]$ is the interval matrix whose lower and upper limit fuzzy matrices are the transitive closure of M_L and M_U, that is, $M = [M_L, M_U]$ then $T = [T_L, T_U]$ is the transitive closure of M.

$$T = M^P$$

$$[T_L, T_U] = [M_L^P, M_U^P] \quad \text{(By (2.3))}$$

$$T_L = M_L^P \text{ and } T_U = M_U^P.$$

Interval Valued Concept Networks

A concept interval network includes nodes and directed links. Each node represents a concept (or) a document. Each directed link connects concept to concept (or) directs from one concept to a document. Let us consider an interval network with n concepts $\{c_1, c_2, c_3 \ldots\ldots c_n\}$ and m documents $\{d_1, d_2 \ldots. d_m\}$.

If $c_i \xrightarrow{\mu} c_j$, then it indicates that the degree of relevance from concept c_i to concept c_j is μ, where μ is a subinterval of [0, 1]. If $c_i \xrightarrow{\mu} d_j$, then it indicates that the degree of relevance of document dj with respect to the concept c_i is μ,

where $\mu = c_{ij} = [c_{ijL}, c_{ijU}]$ (3.1)

is an interval of [0, 1], the relevant interval value from the concept c_i to the concept c_j. The relevant interval value from concept c_i to concept c_j and the relevant interval 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:

$c_{ik} = \min\{c_{ij}, c_{jk}\}$ (3.2)

$[c_{ikL}, c_{ikU}] = \min\{[c_{ijL}, c_{ijU}], [c_{jkL}, c_{jkU}]\}$ (By (3.1))

$c_{ikL} = \min\{c_{ijL}, c_{jkL}\}$ and $c_{ikU} = \min\{c_{ijU}, c_{jkU}\}$ (By (2.3)) (3.3)

Similarly, if $c_{12}, c_{23} \ldots\ldots.. c_{(n-1)n}$ are known, then, (3.4)

By (3.1) and (2.3) we have, $c_{1nL} = \min\{c_{12L}, c_{23L} \ldots\ldots. c_{(n-1)nL}\}$ and

$$c_{1nU} = \min\{c_{12U}, c_{23U} \ldots\ldots. c_{(n-1)nU}\} \quad (3.5)$$

Definition 3.4: Let $\{c_1, c_2 \ldots c_n\}$ be a set of n concepts. A concept interval valued fuzzy matrix $C = (c_{ij})$ is an nxn interval valued fuzzy matrix, where c_{ij} is the relevant interval value from the concept c_i to the concept c_j and c_{ij} is a subinterval of [0, 1] satisfying the following properties.

(i) Reflexivity: $c_{ii} = [1, 1]$ for each i = 1 to n

$$[c_{iiL}, c_{iiU}] = [1, 1] \quad \text{By (3, 1)}$$

$$c_{iiL} = 1 \text{ and } c_{iiU} = 1 \quad \text{By(2.3)}$$

for each i = 1 to n.

(ii) Non-Symmetric: $c_{ij} \neq c_{ji}$

$[c_{ijL}, c_{ijU}] \neq [c_{jiL}, c_{jiU}]$ (By (3.1))

$c_{ijL} \neq c_{jiL}$ and $c_{ijU} \neq c_{jiU}$. (By (2.3))

(iii) Transitivity: $c_{ik} \geq \max_j \min\{c_{ij}, c_{jk}\}$

$[c_{ikL}, c_{ikU}] \geq \max_j \min\{[c_{ijL}, c_{ijU}]. [c_{jkL}, c_{jkU}]\}$ (By (3.1))

$c_{ikL} \geq \max_j \min\{c_{ijL}, c_{jkL}\}$ and $c_{ikU} \geq \max_j \min\{c_{ijU}, c_{jkU}\}$ (By (2.3))

Definition 3.5: 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 interval network with m documents and n concepts. A document descriptor interval matrix $D = (d_{ij})$ is an mxn matrix, where d_{ij} is the degree of relevance of document d_i with respect to the concept c_j.

The document descriptor interval valued fuzzy matrix $D^* = DT$, where D is the document descriptor of the interval network and T is the transitive closure of the concept interval matrix. By (2.3), $D_L^* = D_L.T_L$ and $D_U^* = D_U.T_U$. 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. We shall illustrate the above basic concepts in a concept interval network with suitable examples.

Let us illustrate the concept IVFM, Query descriptor, Document descriptor IVFM and compute the transitive closure on an IVFM in the following examples.

Illustration 3.6: We consider a network N = (V, E) consisting n nodes (cities) and m edges (roads) connecting the cities of a country. If we measure the vehicles an the roads of the network for a particular time duration, it is quite impossible to measure the vehicles on a road as a single value because the vehicles in a duration is not fixed, it varies from time to time. So, appropriate technique to gradation of vehicles is an interval and not a point. In this case, the network (3.1) is called interval valued fuzzy networks.

Let us consider a concept interval network in Figure 3.1 where $c_1, c_2, \ldots c_n$ 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 interval fuzzy value of the query descriptor Q with respect to the concept $c_{3,}$ then the relevant interval fuzzy value of document d_2 with respect to the concept c_3 is calculated as follows:

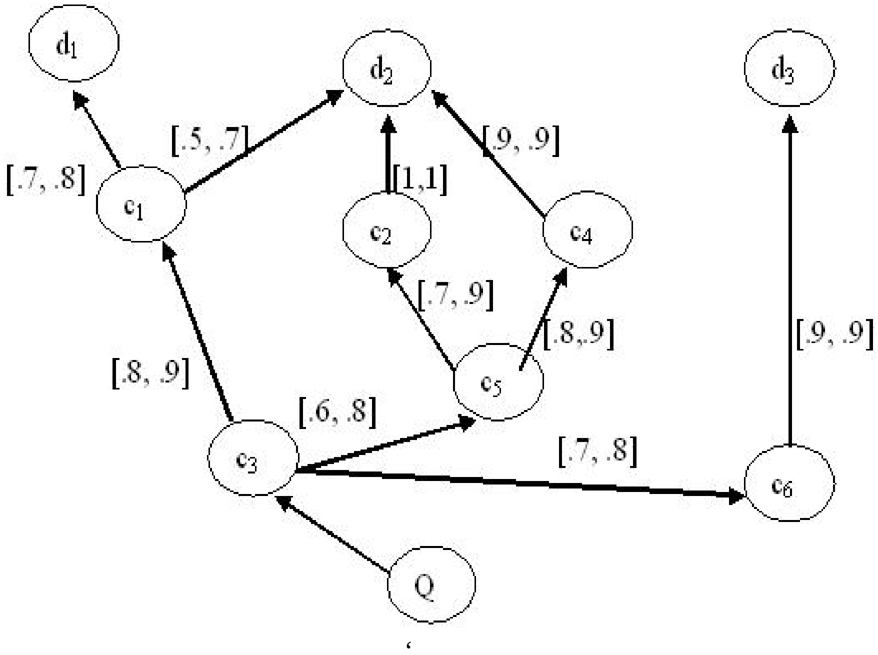

Figure 3.1

From Figure 3.1 we see there are three distinct routes from the concept c_3 to the document d_2

1. The first route is $c_3 \xrightarrow{[.8,\ .9]} c_1 \xrightarrow{[.5,\ .7]} d_2$. The relevant interval fuzzy value of the document' d_2' with respect to concept c_3 is calculated by using (3.2) as min{[.8, .9], [.5, .7]} = [.5, .7].

2. The second route is $c_3 \xrightarrow{[.6,\ .8]} c_5 \xrightarrow{[.7,\ .9]} c_2 \xrightarrow{[1,\ 1]} d_2$. The relevant interval fuzzy value of the document' d_2' with respect to concept c_3 is min {[.6, .8], [.7, .9], [1, 1]} = [.6, .8].

3. The third route is $c_3 \xrightarrow{[.6,\ .8]} c_5 \xrightarrow{[.8,\ .9]} c_4 \xrightarrow{[.9,\ .9]} d_2$. The relevant interval fuzzy value of the document' d_2' with respect to concept c_3 is min {[.8, .9], [.8, .9], [.9, .9]} = [.6, .8].

Then the relevant interval value of the document d_2 with respect to the concept c_3 is max {[.5, .7], [.6, .8], [.6, .8]} = [.6, .8].

Thus Q = (c_3, [1, 1]) = [.6, .8].

Example 3.7: The concept interval valued matrix C of the interval network in Figure (3.1) is calculated by using (3.2), (3.3), (3.4).

$$C = \begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} [1,1] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] \\ [0,0] & [1,1] & [0,0] & [0,0] & [0,0] & [0,0] \\ [.8,.9] & [.6,.8] & [1,1] & [.6,.8] & [.6,.8] & [.7,.8] \\ [0,0] & [0,0] & [0,0] & [1,1] & [0,0] & [0,0] \\ [0,0] & [.7,.9] & [0,0] & [.8,.9] & [1,1] & [0,0] \\ [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [1,1] \end{pmatrix} \end{array}$$

By our representation (2.1) we have, C = [C_L, C_U]

$$C_L = \begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .8 & .6 & 1 & .6 & .6 & .7 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .7 & 0 & .8 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \end{array} \quad \text{and}$$

$$C_U = \begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .9 & .8 & 1 & .8 & .8 & .8 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .9 & 0 & .9 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \end{array}$$

From the concept fuzzy matrix C_L and C_U we see that all the diagonal entries are 1. That is, c_{iiL} =1 for i = 1 to 6. Here c_{23L} = 0 but c_{32L} = 0.6 and therefore $c_{ijL} \neq c_{jiL}$ and c_{iiU} = 1 for i = 1 to 6. Here c_{23U} = 0 but c_{32U} = 0.8 and therefore $c_{ijU} \neq c_{jiU}$

Hence, by (2.3) we have, c_{ii} = [1, 1] for i = 1 to 6. Here c_{23} = [0, 0] but c_{32} = [.6, .8] and therefore $c_{ij} \neq c_{ji}$

Hence C is not symmetric.

Example 3.8: The document descriptor interval valued fuzzy matrix D for the concept interval network in Figure (3.1) is computed as in Example (3.6).

$$D = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} [.7,.8] & [0,0] & [.7,.8] & [0,0] & [0,0] & [0,0] \\ [.5,.7] & [1,1] & [.6,.8] & [.9,.9] & [.8,.9] & [0,0] \\ [0,0] & [0,0] & [.7,.8] & [0,0] & [0,0] & [.9,.9] \end{pmatrix} \end{array}$$

By our representation (2.1) we have, $D = [D_L, D_U]$

$$D_L = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} .7 & 0 & .7 & 0 & 0 & 0 \\ .5 & 1 & .6 & .9 & .8 & 0 \\ 0 & 0 & .7 & 0 & 0 & .9 \end{pmatrix} \end{array} \quad \text{and} \quad D_U = \begin{array}{c} \\ d_1 \\ d_2 \\ d_3 \end{array} \begin{array}{c} \begin{array}{cccccc} c_1 & c_2 & c_3 & c_4 & c_5 & c_6 \end{array} \\ \begin{pmatrix} .8 & 0 & .8 & 0 & 0 & 0 \\ .7 & 1 & .8 & .9 & .9 & 0 \\ 0 & 0 & .8 & 0 & 0 & .9 \end{pmatrix} \end{array}$$

Then '0' entries in the D_L and D_U 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_L and D_U. To get the implicit relevant values of each document with respect to specific concepts, let us compute the transitive closure of the concept matrix given in Example (3.7) for the concept interval network in Figure (3.1).

$$C_L^2 = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .8 & .6 & 1 & .6 & .6 & .7 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .7 & 0 & .8 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .8 & .6 & 1 & .6 & .6 & .7 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .7 & 0 & .8 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .8 & .6 & 1 & .6 & .6 & .7 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .7 & 0 & .8 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= C_L$$

Similarly $C_U^2 = C_U$.

By (2.1) we have, $C = C^2$. Therefore C itself is the transitive closure of the concept interval valued fuzzy matrix. Since $C = T$, $T_L = C_L$ and $T_U = C_U$

$$D_L^* = D_L.T_L = \begin{pmatrix} .7 & 0 & .7 & 0 & 0 & 0 \\ .5 & 1 & .6 & .9 & .8 & 0 \\ 0 & 0 & .7 & 0 & 0 & .9 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ .8 & 6 & 1 & .6 & .6 & .7 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & .7 & 0 & .8 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} .7 & .6 & .7 & .6 & .6 & .7 \\ .6 & 1 & .6 & .9 & .8 & .6 \\ .7 & .6 & .7 & .6 & .6 & .9 \end{pmatrix} \text{ and}$$

$$D_U^* = D_U.T_U = \begin{pmatrix} .8 & .8 & .8 & .8 & .8 & .8 \\ .8 & 1 & .8 & .9 & .9 & .8 \\ .8 & .8 & .8 & .8 & .8 & .9 \end{pmatrix}$$

By (2.1) we have,

$$D^* = D.T = \begin{pmatrix} [.7, .8] & [.6, .8] & [.7, .8] & [.6, .8] & [.6, .8] & [.7, .8] \\ [.6, .8] & [1, 1] & [.6, .8] & [.9, .9] & [.8, .9] & [.6, .8] \\ [.7, .8] & [.6, .8] & [.7, .8] & [.6, .8] & [.6, .8] & [.9, .9] \end{pmatrix}$$

The document descriptor interval valued fuzzy matrix D* gives the implicit values of each document more accurately. For instance '[0, 0]' entries in the first row of the document descriptor IVFM in Example (3.8) are improved as [.6, .8], [.6, .8], [.6, .8] and [.7, .8] 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 interval valued fuzzy matrix D* obtained by using the transitive closure 'I 'reveals more accurate results for the user.

4. CONCLUSION

We have determined the index, period and the transitive closure of an IVFM, in terms of that of its lower and upper limits fuzzy matrices. These concepts are illustrated with the help of a simple interval valued fuzzy document retrieval method as a generalization of the results found in [1, 2, 3 and 14].

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