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An Application of Interval Valued Fuzzy Matrices for Finding the Disease in Plants

A.Virgin raj[1] , A.Riganabanu[2]
[1,2]PG and Research Department of Mathematics
St.Joseph's College of Arts & Science (Autonomous), Cuddalore, India.
E-Mail:avirginraj@gmail.com[1],riganabanu@yahoo.in[2]

Abstract- In this paper, we extend Sanchez's approach in agricultural field to find the disease of the plant by using the representation of an interval valued fuzzy matrix as an interval matrix of two fuzzy matrices.

Keywords- Fuzzy matrix, Interval Valued Fuzzy Matrix (IVFM)

I. INTRODUCTION

The concept of Interval Valued fuzzy matrix (IVFM) is one of the recent topics developed for dealing with the uncertainities present in most of our real life situations. The parameterization tool of Interval valued fuzzy matrix enhances the flexibility of its applications. Most of our real life problems in Agriculture fertilizer, management environment and Social Sciences often involve data which are not necessarily crisp, precise and deterministic in character due to various uncertainities associated with these problems, such uncertainties are usually being handled with the help of the topics like probability, fuzzy sets, intuitionistic fuzzy sets, interval mathematics and rough sets etc. The concept of IVFM as a generalization of fuzzy matrix was introduced and developed by Shyamal and pal [4],by extending the max. min operations on Fuzzy algebra F = [0,1], for elements a, b∊F, a+b=max {a,b} and a. b=min {a,b}.letF_{mn}be the set of all m× n Fuzzy Matrices over the Fuzzy algebra with support [0,1].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 ijthentry is the interval [a_{ijL}, a_{ijU}], where the lower limit A_L=(a_{ijL}) and the upper limit A_U = (a_{ijU}) are fuzzy matrices such that A_L≤A_U.

II. PRELIMINARIES

A. Definition

Let a matrix A = [a_{ij}] $_{mxn}$ wherea_{ij}∊ [0,1], 1≤ i ≤ m and l ≤ j ≤ n. Then A is fuzzy matrix.Note:-All fuzzy matrices are matrices but every matrix is not a fuzzy matrix.

B. Definition

The IVFM denote the set of all interval valued fuzzy matrices, that is, fuzzy matrices whose entries are all subintervals of the interval [0,1].

C. Definition

For a pair of fuzzy matrices [E,F] where E & F are fuzzy mxn matrices. i.e., E=(e_{ij}), F=(f_{ij}) and e_{ij}, f_{ij}∊[0,1] further e_{ij}≤$f_{ij}$for 1≤i≤ m and 1≤ j ≤ n. Thus the fuzzy interval matrices or interval fuzzy matrices contain all matrices G=(g_{ij}) such that (g_{ij}) takes its value in between e_{ij}&f_{ij}. i.e, G∊ [E,F] implies e_{ij}≤g_{ij}≤f_{ij}.The interval matrix denoted as [E,F], whose ijth entry is the interval with lower limit e_{ij} and upper limit f_{ij}, that is [e_{ij}, f_{ij}]The basic operation on IVFM

For A = (a_{ij}) = ([a_{ijL}, a_{ijU}]) and
B=(b_{ij}) = ([b_{ijL}, b_{ijU}]) of orderm x n 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}}] (2.1)
For A = (a_{ij}) $_{m\,x\,n}$ and B = (b_{ij}) $_{n\,x\,p}$their product denoted as AB is defined as
AB=(c_{ij}) = $\sum_{n}^{K=1} a_{ik}\, b_{kj}$,i=1, 2 . . . .m
j=1,2 . . . . p
$=\left[\sum_{n}^{K=1}(a_{ikL}\,.\,b_{kjL}), \sum_{n}^{K=1}(a_{ikU}\,.\,b_{kjU})\right]$ =
$\left[\max\min(a_{ikL}\,.\,b_{kjL}), \max\min(a_{ikU}\,.\,b_{kjU})\right]$ (2.2)

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, $A_U B_U$](2.3)
A≥B if and only if a_{ijL}≥b_{ijL} and a_{ijU}≥b_{ijU}if and only ifA+B=A(2.4)
In particular if a_{ijL}=a_{ijU} and b_{ijL} = b_{ijU} Then (2.1) reduces to the standard max.min composition of Fuzzy matrices.

III. APPLICATION OF INTERVAL VALUED FUZZY MATRICES FOR FINDING THE DISEASE IN PLANTS.

Suppose S is a set of plant growth, D is a set of diseases and C is a set of cultivation, construct an interval valued fuzzy matrix (F, D) over S, where F is a mapping F:D $\rightarrow \tilde{F}$ (s), $\tilde{F}$ (s) is a set of all interval valued fuzzy sets of S. A relation matrix, R_1 is constructed from the interval valued fuzzy matrix (F,D) and called plant growth – disease matrix. Similarly its compliment (F, D)^C gives another relation matrix, say R_2, called non plant growth – disease matrix.Again we construct another interval valued fuzzy matrix (F_1, S) over C, where F_1 is a mapping given by F_1:S→ $\tilde{F}$ (c). This interval valued fuzzy matrix gives another relation matrix Q called cultivation plant growth matrix. Then we obtain two new relation matrices T_1 = Q R_1

and $T_2 = Q\ R_2$ called plant growth cultivation matrix and non plant growth cultivation matrix respectively.

Now, $T_1 = Q.\ R_1$ (3.1)

$T_2 = Q.\ R_2$ (3.2)

Let $T_1 = [T_{1L}, T_{IU}]$, $Q = [Q_L, Q_U]$, $R_1 = [R_{1L}, R_{1U}]$, $T_2= [T_{2L}, T_{2U}]$ and$R_2 =[R_{2L}, R_{2U}]$, be the representation of the form (2.1) for the IVFM T_1, Q, R_1, T_2 and R_2. Then by using the IVFM operation (2.4) in (3.1) and (3.2) we get,

$T_{1L} = Q_L.\ R_{1L}$ and $T_{1U} = Q_U\ .R_{1U}$ (3.3)

$T_{2L} = Q_L\ .\ R_{2L}$ and $T_{2U} = Q_U\ .\ R_{2U}$ (3.4)

Let us define the Non – disease matrices T_{3L}, T_{3U}, T_{4L} and T_{4U}corresponding to T_{1L}, T_{1U}, T_{2L} and T_{2U}respectively as

$T_{3L} = Q_L\ .(J - R_{1L})$ and $T_{3U} = Q_U\ .(J - R_{3U})$ (3.5)

$T_{4L} = Q_L\ .\ (J - R_{2L})$ and $T_{4U} = Q_U\ .\ (J - R_{2U})$ (3.6)

Where J is the matrix with all entries '1' now

$S_{T1L} = \max_{i,j} [T_{1L}(C_i, d_j), T_{4L}(c_i, d_j)]$ and

$S_{T1U} = \max_{i,j} [T_{1U}(C_i, d_j), T_{4U}(c_i, d_j)]$ (3.7)

$\forall i=1,2,3$ and $j=1,2$

$S_{T2L} = \max_{i,j} [T_{2L}(C_i, d_j), T_{3L}(c_i, d_j)]$ and

$S_{T2U} = \max_{i,j} [T_{2U}(C_i, d_j), T_{3U}(c_i, d_j)]$ (3.8)

$\forall i=1,2,3$ and $j=1,2$

We calculate the score S_{T1} and S_{T2} for and against the diseases respectively.

$S_{T1}= \max_{i,j} [S_{T1U}(C_i, d_j), S_{T2L}(c_i, d_j)]$ (3.9)

$\forall i=1,2,3$ and $j=1,2$

$S_{T2}= \max_{i,j} [S_{T1L}(C_i, d_j), S_{T2U}(c_i, d_j)]$ (3.10)

$\forall i=1,2,3$ and $j=1,2$

Now if $\max_{j} [S_{T1}(C_i, d_j) - S_{T2}(C_i, d_j)]$ (3.11)

occurs for exactly (c_i, d_k) only, then we conclude that the acceptable hypothesis for cultivation c_i is the disease d_k. In case there is a tie, the process has to be repeated for cultivation c_i by reassessing the plant growth.

A. Algorithm

- Input the interval valued fuzzymatrices (F,D) and $(F,D)^C$ over the set S of plant growth where D is the set of diseases. Also write the Agriculture knowledge matrixR_1 and R_2 representingthe relation
- matrices of the IVFM (F,D) and$(F,D)^C$ respectively.
- $R_2 = 1 - R_1 = [1-R_{1U}, 1-R_{1L}]$
- Input the IVFM (F1,S) over the set C of cultivation and write its relation matrix Q.
- To find the relation matrices
- $T_{1L}= Q_L.R_{1L}$ and $T_{1U}= Q_U.R_{1U}$
- (ii)$T_{2L}=Q_L.R_{2L}$ and $T_{2U}= Q_U.R_{2U}$
- Then we get
- (iii)$T_{3L}=Q_L.\ (J - R_{1L})$ and
- $T_{3U} = Q_U.\ (J-R_{1U})$
- (iv) $T_{4L}= Q_L\ .\ (J-R_{2L})$ and
- $T_{4U} = Q_U\ .\ (J - R_{2U})$
- To find S_{T1L}, S_{T1U}, S_{T2L} and S_{T2Us}
- To findthe Scores S_{T1} and S_{T2}

Find

$S_K = \max_{j} \{S_{T1}(C_i, d_j) - S_{T2}(c_i, d_j)\}$

Then we conclude that the cultivation c_i is affected from the disease d_k.

(8) If $S_k>1$ then go to step one and repeat the process, if $S_K<1$ then stop.Case Study -Suppose there are three cultivations paddy, wheat and moongdal in an Agriculture with plant growths Dwarf plant, Tall plant, no leaf, no growth problem. Let the possible diseases relating to the above plant growth be triticale disease and nematodes. We consider the set S={e_1, e_2, e_3, e_4} as universal set, where e_1, e_2, e_3, and $e_4$represent the plant growth Dwarf plant, Tall plant, no leaf, no growth problem respectively and the set D={d_1, d_2} where d_1 and $d_2$represent the parameters triticale and nematodes respectively.

Suppose that,

F(d_1)={<e_1,[.7,1]>,<e_2,[.1, .4]>,<e_3,[.5, .6]>, <e_4,[.2,.4]>}F(d_2)={<e_1,[.6,.9]>,<e_2,[.4,.6]>, <e_3,[.3,.6]>,<e_4,[.8,.1]>}.The Interval valued fuzzy matrix (F,D) is a parameterized family [F(d_1), F(d_2)] of allinterval valued fuzzy matrix over the set S and are determined from expert Agriculture documentation. Thus the fuzzy matrix (F,D) gives an approximate description of the interval valued fuzzy matrix agriculture knowledge of the two diseases and their plant growth. This interval valued fuzzy matrix (F,D) and its complement $(F,D)^C$ are represented by two relation matrices R_1 and R_2 called plant growth – disease matrix and non plant growth disease matrix respectively. given by,

$$R_1 = \begin{array}{c} \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{pmatrix} [0.7,1] & [0.6,0.9] \\ [0.1,0.4] & [0.4,0.6] \\ [0.5,0.6] & [0.3,0.6] \\ [0.2,0.4] & [0.8,0.1] \end{pmatrix} \end{array}$$

and

$$R_2 = \begin{array}{c} \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{pmatrix} [0.0,0.3] & [0.1,0.4] \\ [0.6,0.9] & [0.4,0.6] \\ [0.4,0.5] & [0.4,0.7] \\ [0.6,0.8] & [0.0,0.2] \end{pmatrix} \end{array}$$

By our representation (2.1) we have,

$$R_{1L} = \begin{array}{c} \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{pmatrix} .7 & .6 \\ .1 & .4 \\ .5 & .3 \\ .2 & .8 \end{pmatrix} \end{array} \& R_{1U} = \begin{array}{c} \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{array} \begin{array}{c} \begin{array}{cc} d_1 & d_2 \end{array} \\ \begin{pmatrix} .1 & .9 \\ .4 & .6 \\ .6 & .6 \\ .4 & .1 \end{pmatrix} \end{array}$$

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$$R_{2L}=\begin{array}{c} e_1\\ e_2\\ e_3\\ e_4\end{array}\begin{pmatrix} .0 & .1\\ .6 & .4\\ .4 & .4\\ .6 & .0\end{pmatrix} \ \& \ R_{2U}=\begin{array}{c} e_1\\ e_2\\ e_3\\ e_4\end{array}\begin{pmatrix} .3 & .4\\ .9 & .6\\ .5 & .7\\ .8 & .2\end{pmatrix}$$

Again we take C={C_1, C_2, C_3} as the universal set where C_1, $C_2$and C_3 represent cultivation respectively and S={e_1, e_2, e_3, e_4} as the set of parameters suppose that,

F_1 (e_1) = {<C_1, [.6, .9]>, <C_2, [.3, .5]>, <C_3, [.6, .8]>}
F_2 (e_2) = {<C_1, [.3, .5]>, <C_2, [.3, .7]>, <C_3, [.2, .6]>}
F_3 (e_3) = {<C_1, [.8, .1]>, <C_2, [.2, .4]>, <C_3, [.5, .7]>} and
F_4 (e_4) = {<C_1, [.6, .9]>, <C_2, [.3, .5]>, <C_3, [.2, .5]>}.

The Interval valued fuzzy matrix (F_1,S) is another parameterized family of all interval valued fuzzy matrices and gives a collection of approximate description of the cultivation – plant growth in the Agriculture. This interval valued fuzzy matrix (F_1,S) represents a relation matrix Q called cultivation plant growth matrix given by,

$$Q=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4\end{array}\\ \begin{pmatrix} [.6,.9] & [.3,.5] & [.8,.1] & [.6,.9]\\ [.3,.5] & [.3,.7] & [.2,.4] & [.3,.5]\\ [.6,.8] & [.2.6] & [.5,.7] & [.2,.5]\end{pmatrix}\end{array}$$

By our representation (2 .1) we have, Q= [Q_L, Q_U]

$$Q_L=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4\end{array}\\ \begin{pmatrix} .6 & .3 & .8 & .6\\ .6 & .3 & .2 & .3\\ .6 & .2 & .5 & .2\end{pmatrix}\end{array} \text{ and}$$

$$Q_U=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4\end{array}\\ \begin{pmatrix} .9 & .5 & 1 & .9\\ .5 & .7 & .4 & .5\\ .8 & .6 & .7 & .5\end{pmatrix}\end{array}$$

Then combining the relation matrices R_{1L}, R_{1U} and R_{2L}, R_{2U} Separately with Q_L and Q_U we get the matrices T_1 = [T_{1L}, T_{1U},] and T_2 = [T_{2L}, T_{2U}]From equations (3.3), (3.4), (3.5) and (3.6) we have,

$$T_{1L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .6\\ .3 & .3\\ .6 & .6\end{pmatrix}\end{array} \ \& \ T_{1U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .9 & .9\\ .5 & .6\\ .8 & .8\end{pmatrix}\end{array}$$

$$T_{2L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .4\\ .3 & .3\\ .4 & .4\end{pmatrix}\end{array} \ \& \ T_{2U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .8 & .7\\ .7 & .6\\ .6 & .7\end{pmatrix}\end{array}$$

$$T_{3L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .7\\ .3 & .3\\ .5 & .5\end{pmatrix}\end{array} \ \& \ T_{3U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .4\\ .6 & .4\\ .6 & .4\end{pmatrix}\end{array}$$

$$T_{4L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .6\\ .3 & .3\\ .6 & .6\end{pmatrix}\end{array} \ \& \ T_{4U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .7 & .8\\ .5 & .5\\ .7 & .6\end{pmatrix}\end{array}$$

Now, from equations (3.7) and (3.8) we have,

$$S_{T1L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .6\\ .3 & .3\\ .6 & .6\end{pmatrix}\end{array} \ \& \ S_{T1U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .9 & .9\\ .5 & .6\\ .8 & .8\end{pmatrix}\end{array}$$

$$S_{T2L}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .6 & .7\\ .3 & .3\\ .5 & .5\end{pmatrix}\end{array} \ \& \ S_{T2U}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .8 & .7\\ .7 & .6\\ .6 & .7\end{pmatrix}\end{array}$$

We calculate the score for and against the diseases S_{T1} and S_{T2} from equations (3.9)
and (3.10) we have,

$$S_{T1}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .9 & .9\\ .5 & .6\\ .8 & .8\end{pmatrix}\end{array} \ \& \ S_{T2}=\begin{array}{c} \\ c_1\\ c_2\\ c_3\end{array}\begin{array}{c} \begin{array}{cc} d_1 & d_2\end{array}\\ \begin{pmatrix} .8 & .7\\ .7 & .6\\ .6 & .7\end{pmatrix}\end{array}$$

Now, for equation (3.11) we have the difference for and against the diseases by IVFM method.

Table 1

S_{T1} ~ S_{T2}	d_1	d_2
C_1	.1	.2
C_2	.2	.0

We conclude that cultivation C_3 is affected from the disease d_1 and cultivations C_1 and C_2 both affected from disease d_2.From the above table 1, we conclude that Sanchez's approach can be applied to studythe various diseases in plants by using the representation of an interval valued fuzzy matrix as an interval matrix of two fuzzy matrices.

REFERENCES

[1]. Meenakshi, A.R.,and Kaliraja, M. (2010). *Regular Interval valued fuzzy matrices, Advances in Fuzzy Mathematics*, Vol.5 (1) , 7-15
[2]. Meenakshi, A.R., and Kaliraja, M. *Regular Interval Valued fuzzy relational equations*, Int.J.comp.cognition (accepted).
[3]. Sanchez, E. (1976). *Resolution of composite fuzzy relation equations, Information and control* , 30, 38 - 48.
[4]. Shyamal, A.K., and Pal. (2006). *Interval valued fuzzy matrices , Journal of FuzzyMathematics* , Vol. 14(3) , 582 -592.
[5]. J.G., Klir, and Bo, Yuan *Fuzzy Sets and Fuzzy Logic, Theory and Application*, PHI Private Ltd., New Delhi (2000).
[6]. X. Yang, T. Y. Lin, J. Yang, Y.Li and D. Yu, *Combination of interval-valued fuzzy set and soft set, Computers and Mathematics with Application*.58(2009), 521-527.