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An Introduction to the Theory of Fuzzy Rhotrix

A. Aminuand M. Aminu

Department of Mathematics,Kano University of Science and Technology, Wudil, P.M.B: 3244, Kano, Nigeria.

Abstract

A fuzzy matrix is a matrix which has its elements from [0,1], called the fuzzy unit interval. In this paper we introduce the basic concept of fuzzy rhotrix theory, we also presents some types of fuzzy rhotrices and some operations carried on them.

Keywords: Rhotrix, Rhotrix multiplication, Fuzzy Rhotrix,Row and column fuzzy rhotrices.
AMS Subject Classifications [2010]: 15B15

1.0 Introduction

The idea of rhotrix as an object that has its elements arranged in a rhomboidal nature wasfirst introduced by Ajibade [1] as an extension of the initiative on matrix-tertions and matrix-noitretsof Atanassov and Shannon [2]. Matrices are either square or rectangular depending on the number of rows and columnswhile rhotrices always have the same number of rows and columns.The binary operations of addition (+) and multiplication (∘) over rhotrices are defined by Ajibade in [1]. Another multiplication method for rhotrices called row-column multiplication was introduced by Sani [3] in an effort to answer some questions raised by Ajibade, the row-column multiplication method is in a similar way as that ofmultiplication of matrices.A generalization of the row-column multiplication method for n-dimensional rhotrices was given by Sani [4]. That is: given n-dimensional rhotrices $R_n = \langle a_{ij}, c_{lk} \rangle$ and $Q_n = \langle b_{ij}, d_{lk} \rangle$ the multiplication of R_n and Q_n is as follows:

$$R_n \circ Q_n = \langle a_{i_1 j_1}, c_{l_1 k_1} \rangle \circ \langle b_{i_2 j_2}, d_{l_2 k_2} \rangle = \left\langle \sum_{i_2 j_1 = 1}^{t} (a_{i_1 j_1} b_{i_2 j_2}), \sum_{l_2 k_1 = 1}^{t-1} (c_{l_1 k_1} d_{l_2 k_2}) \right\rangle,\ t = (n+1)/2 .$$

The method of converting a rhotrix to a special matrix called 'coupled matrix' was suggested by Sani [5].This idea was used to solve systems of $n \times n$ and $(n-1)\times(n-1)$ matrix problems simultaneously. The system $R_n x = b$for which R_n is an n-dimensional rhotrix, x the unknown n-dimensional rhotrix vector and b the right-hand-side rhotrix vector was introduced by Aminu in [6], in this article, Aminu discuss the necessary and sufficient condition for the solvability of systems of the form$R_n x = b$, if a system is solvable it was shown how a solution can be found.Vector spaces, linear mappings and square root of a rhotrix were discussed by Aminu in [7, 8,9]. Determinant method for solving system of equations was presented by Aminu in [10], this method uses cramer's rule to solve rhotrix system of equations. Cayley-Hamilton is one of the well-known theorems that is formulated and proved in linear algebra on matrices. Aminu in [11] extends this theorem to the concept of rhotrix and also present some properties that are attached to it. Minimal polynomial of a rhotrix was presented by Aminu [12].Aminu and Michael [13] introduced the concept of paraletrix which is a structure that is a generalization of rhotrix.

In this article we will introduce the basic concept of fuzzy rhotrix theory and presents some types of fuzzy rhotrices and operations carried on them.Rhotrix has applications several applications in coding theory, cryptography, combinatorial design graph theory, see Kumar and Sharma [14, 15].

Corresponding author: A. Aminu, E-mail: abdulaamin77@yahoo.com, Tel.: +2348035185235

2.0 Basic Definitions and Operations

Definition 1: If X is a collection of objects denoted generically by x, then a fuzzy set$\tilde{A}$in X is a set of ordered pairs:

$$\tilde{A} = \{(x, \mu_{\tilde{A}}(x)|x\epsilon X)\}$$

$\mu_{\tilde{A}}(x)$is called the membership function (generalized characteristic function) which maps X to the membership space M. Its range is the subset of nonnegative real numbers whose supremum is finite. For sup $\mu_{\tilde{A}}(x)= 1$: normalized fuzzy set.

In Definition 1, the membership function of the fuzzy set is a crisp (real-valued) function.

To be more non technical, a fuzzy set can be defined mathematically by assigning to each possible individual in theuniverse of discourse a value representing its grade ofmembership in the fuzzy set.

Definition 2: A finite fuzzy set $\tilde{A}$, is a set with cardinality $|\tilde{A}|$ defined as

$$|\tilde{A}| = \sum_{x\epsilon X} \mu_{\tilde{A}}(x)$$

and

$\left||\tilde{A}|\right| = \frac{|\tilde{A}|}{|X|}$ is called the relative cardinality of $\tilde{A}$.

A fuzzy set which is not finite is called an infinite fuzzy set.

Definition 3: A fuzzy set $\tilde{A}$ is convex if

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min\{\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\}$$

$x_1, x_2 \epsilon X, and \lambda \epsilon [0,1]$.

The interval [0,1] denote the unit interval and is also called the fuzzy interval.

Operations on Fuzzy Sets

Zadeh[16] define the following operations for fuzzy sets.

Intersection (logical and): the membership function of the intersection of two fuzzy sets $\tilde{A}$ and $\tilde{B}$ is defined as:

$$\mu_{\tilde{A}\cap\tilde{B}}(X) = \min\left(\mu_{\tilde{A}}(X), \mu_{\tilde{B}}(X)\right) \forall x\epsilon X$$

Union (exclusive or): the membership function of the union is defined as:

$$\mu_{\tilde{A}\cup\tilde{B}}(X) = \max\left(\mu_{\tilde{A}}(X), \mu_{\tilde{B}}(X)\right) \forall x\epsilon X$$

Complement (negation): the membership function of the complement is defined as:

$$\mu_{\tilde{A}}(X) = 1 - \mu_{\tilde{A}}(X) \forall x\epsilon X$$

3.0 Fuzzy Rhotrix Theory

Here we define a fuzzy rhotrix to be a kind of rhotrix which has its elements from [0,1] (the fuzzy interval). Now consider a rhotrix $R_n = \langle a_{ij}, c_{lk}\rangle$ where $a_{ij}, c_{lk} \in [0,1]$, then R_n is a fuzzy rhotrix.

For example

$$R_5 = \left\langle \begin{array}{ccccc} & & 0.2 & & \\ & 1 & 0.1 & 0.4 & \\ 0.1 & 0.8 & 1 & 0.7 & 0.2 \\ & 0.9 & 0.3 & 0.5 & \\ & & 0.2 & & \end{array} \right\rangle$$

is a fuzzy rhotrix since all the entries in R_5 come from the fuzzy interval [0,1].

Thus we have that all fuzzy rhotrices are rhotrices but not every rhotrix in general is a fuzzy rhotrix.The rhotrix

$$P_5 = \left\langle \begin{array}{ccccc} & & 0.1 & & \\ & 1 & 0.3 & 0.4 & \\ 0.4 & 7 & 1 & 2 & 2 \\ & 3 & 8 & 0.1 & \\ & & 6 & & \end{array} \right\rangle$$

is not a fuzzy rhotrix, because some of its entries does not come from the fuzzy interval [0,1]. For example 2,3,6,7,8 are entries inP_5, but $2,3,6,7,8 \notin [0,1]$, hence rhotrix P_5 is not a fuzzy rhotrix. A rhotrix in general is not a fuzzy rhotrix, and since the unit interval [0,1] is contained in the set of reals, we see that all fuzzy rhotrices are rhotrices.

Two fuzzy rhotrices are said to be equal if and only if the two rhotrices are of the same dimension and their entries in the corresponding positions are equal.

3.1 Some Types of Fuzzy Rhotrices

(i) Fuzzy Row Rhotrix:

Let

$$R_n = \langle a_{ij}, c_{lk} \rangle = \left\langle \begin{array}{ccccccc} & & & a_{11} & & & \\ & & 0 & 0 & a_{12} & & \\ & 0 & 0 & 0 & 0 & a_{13} & \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & \cdots & \cdots & \cdots & \cdots & \cdots & a_{1t} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ & 0 & 0 & 0 & 0 & 0 & \\ & & 0 & 0 & 0 & & \\ & & & 0 & & & \end{array} \right\rangle \text{ where } a_{11}, a_{12}, a_{13} \ldots a_{1t} \in [0,1]$$

Since only the first row of the rhotrix contains non-zero entries, then R_n is called an n-dimension fuzzy row rhotrix.
An example of a fuzzy row rhotrix is:

$$R_3 = \left\langle \begin{array}{ccc} & 1 & \\ 0 & 0 & 0.1 \\ & 0 & \end{array} \right\rangle$$

(ii) Fuzzy Column Rhotrix:

Let

$$P_n = \langle a_{ij}, c_{lk} \rangle = \left\langle \begin{array}{ccccccc} & & & a_{11} & & & \\ & & a_{21} & 0 & 0 & & \\ & a_{31} & 0 & 0 & 0 & 0 & \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{t1} & \cdots & \cdots & \cdots & \cdots & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ & 0 & 0 & 0 & 0 & 0 & \\ & & 0 & 0 & 0 & & \\ & & & 0 & & & \end{array} \right\rangle \text{ where } a_{11}, a_{21}, a_{31} \ldots, a_{t1} \in [0,1]$$

The first column of the rhotrix P_n is the only column with entries other than zero, hence we call the rhotrix P_n as a fuzzy column rhotrix.
Example of a fuzzy column rhotrix is:

$$P_3 = \left\langle \begin{array}{ccc} & 0.3 & \\ 0.5 & 0 & 0 \\ & 0 & \end{array} \right\rangle$$

(iii) Fuzzy Zero Rhotrix:

Since $0 \in [0,1]$, we call the zero rhotrix a fuzzy zero rhotrix. Therefore a fuzzy zero rhotrix is a rhotrix with all its entries been zero.
Example of a fuzzy zero rhotrix is:

$$R_3 = \left\langle \begin{array}{ccc} & 0 & \\ 0 & 0 & 0 \\ & 0 & \end{array} \right\rangle$$

(iv) Fuzzy Unit Rhotrix:

A rhotrix whose entries are all 1's is called a unit rhotrix, in case of fuzzy rhotrices we called this type of rhotrix as a fuzzy

unit rhotrix.
Example of fuzzy unit rhotrix is:

$$R_3 = \left\langle \begin{array}{ccc} & 1 & \\ 1 & 1 & 1 \\ & 1 & \end{array} \right\rangle$$

(v) Fuzzy Diagonal Rhotrix:
A rhotrix $R_n = \langle a_{ij}, c_{lk} \rangle$ is called a fuzzy diagonal rhotrix if $a_{ij} = 0$ when $i \neq j$ and also $c_{lk} = 0$ when $l \neq k$, where $a_{ij}, c_{lk} \in [0,1]$.
Example of a fuzzy diagonal rhotrix is:

$$R_5 = \left\langle \begin{array}{ccccc} & & 0.1 & & \\ & 0 & 0.5 & 0 & \\ 0 & 0 & 1 & 0 & 0 \\ & 0 & 0.2 & 0 & \\ & & 0.6 & & \end{array} \right\rangle$$

(vi) Fuzzy scalar rhotrix:
A fuzzy diagonal rhotrix is called a fuzzy scalar rhotrix if all its diagonal entries are equal.
Thus a fuzzy rhotrix $R_n = \langle a_{ij}, c_{lk} \rangle$is said to be a fuzzy scalar rhotrix if:

$$\begin{cases} a_{ij} = 0 \ \ wheni \neq jandc_{lk} = 0 \ \ whenl \neq k \\ a_{ij} = \alpha wheni = jandc_{lk} = \alpha whenl = k \end{cases}$$

Where $\alpha \in [0,1]$.
Example of fuzzy scalar rhotrix is

$$R_3 = \left\langle \begin{array}{ccc} & 0.5 & \\ 0 & 0.5 & 0 \\ & 0.5 & \end{array} \right\rangle$$

3.2 Operations on Fuzzy Rhotrices

Addition of two fuzzy rhotrices with respect to the usual addition of rhotrices is not necessarily a fuzzy rhotrix.
For example

$$R_3 = \left\langle \begin{array}{ccc} & 0.5 & \\ 0.1 & 0.2 & 1 \\ & 0.6 & \end{array} \right\rangle \quad \text{and} \quad P_3 = \left\langle \begin{array}{ccc} & 0.2 & \\ 0.7 & 0.1 & 0.5 \\ & 0.3 & \end{array} \right\rangle$$

are all fuzzy rhotrices, but

$$R_3 + P_3 = \left\langle \begin{array}{ccc} & 0.7 & \\ 0.8 & 0.3 & 1.5 \\ & 0.9 & \end{array} \right\rangle$$

is not a fuzzy rhotrix since 1.5 is an entry in $R_3 + P_3$ and $1.5 \notin [0,1]$.
So in the case of fuzzy rhotrices we will define the max or min operations. Under the max or min operation the resultant rhotrix is again a fuzzy rhotrix which is in some way analogous to the usual addition of rhotrices. Here we will define the following three operations on fuzzy rhotrices:
(i) maximum of a rhotrix (max)
(ii) minimum of a rhotrix (min)
(iii) max min of a rhotrix (max min)
(i) Maximum of a Rhotrix (max)
As we see above, the addition of two fuzzy rhotrices with respect to the usual addition of rhotrices is not necessarily a fuzzy rhotrix, so here we define a new operation on fuzzy rhotrices called the max operation which is in some way analogous to our

usual addition of rhotrices.
Let $R_n = \langle a_{ij}, c_{lk} \rangle$ and $P_n = \langle b_{ij}, d_{lk} \rangle$ be two fuzzy rhotrices.
Then the max of R_n andP_n, denoted by $\max\{R_n, P_n\}$, is a rhotrix $Q_n = \langle e_{ij}, g_{lk} \rangle$

$$where \begin{cases} e_{ij} = \max(a_{ij}, b_{ij}) for\, i,\, j = 1, 2, \ldots, t \\ g_{lk} = \max(c_{lk}, d_{lk})\ for\, k, l = 1, 2\ldots, t-1 \end{cases}$$

For example:
Let

$$R_5 = \left\langle \begin{array}{ccccc} & & 0.3 & & \\ & 0.2 & 0.5 & 0.1 & \\ 0.7 & 0.9 & 1 & 0.3 & 0.4 \\ & 0.4 & 0.2 & 0.8 & \\ & & 0.6 & & \end{array} \right\rangle \text{ and } P_5 = \left\langle \begin{array}{ccccc} & & 0.4 & & \\ & 0.1 & 0.8 & 0.1 & \\ 0.8 & 0.3 & 0.5 & 0.7 & 0.3 \\ & 0.2 & 0.5 & 0.9 & \\ & & 0.6 & & \end{array} \right\rangle$$

Then

$$\max\{R_5, P_5\} = \left\langle \begin{array}{ccccc} & & \max(0.3, 0.4) & & \\ & \max(0.2, 0.1) & \max(0.5, 0.8) & \max(0.1, 0.1) & \\ \max(0.7, 0.8) & \max(0.9, 0.3) & \max(1, 0.5) & \max(0.3, 0.7) & \max(0.4, 0.3) \\ & \max(0.4, 0.2) & \max(0.2, 0.5) & \max(0.8, 0.9) & \\ & & \max(0.6, 0.6) & & \end{array} \right\rangle$$

$$= \left\langle \begin{array}{ccccc} & & 0.4 & & \\ & 0.2 & 0.8 & 0.1 & \\ 0.8 & 0.9 & 1 & 0.7 & 0.4 \\ & 0.4 & 0.5 & 0.9 & \\ & & 0.6 & & \end{array} \right\rangle$$

(ii) Minimum of a Rhotrix (min)
Let $R_n = \langle a_{ij}, c_{lk} \rangle$ and $P_n = \langle b_{ij}, d_{lk} \rangle$ be two fuzzy rhotrices.
Then the min of R_n andP_n, denoted by $\min\{R_n, P_n\}$, is a rhotrix $Q_n = \langle e_{ij}, g_{lk} \rangle$

$$where \begin{cases} e_{ij} = \min(a_{ij}, b_{ij}) for\, i,\, j = 1, 2, \ldots, t \\ g_{lk} = \min\ (c_{lk}, d_{lk}) for\, k, l = 1, 2\ldots, t-1 \end{cases}$$

For example:
Let

$$R_5 = \left\langle \begin{array}{ccccc} & & 0.2 & & \\ & 1 & 0.1 & 0.4 & \\ 0.1 & 0.8 & 1 & 0.7 & 0.2 \\ & 0.9 & 0.3 & 0.5 & \\ & & 0.2 & & \end{array} \right\rangle \text{ and } P_5 = \left\langle \begin{array}{ccccc} & & 0.1 & & \\ & 1 & 0.3 & 0.4 & \\ 0.4 & 0.4 & 0 & 0.3 & 0.2 \\ & 0.3 & 0.8 & 0.1 & \\ & & 0.6 & & \end{array} \right\rangle$$

Then

$$\min\{R_5, P_5\} = \left\langle \begin{array}{ccccc} & & \min(0.2, 0.1) & & \\ & \min(1, 1) & \min(0.1, 0.3) & \min(0.4, 0.4) & \\ \min(0.1, 0.4) & \min(0.8, 0.4) & \min(1, 0) & \min(0.7, 0.3) & \min(0.2, 0.2) \\ & \min(0.9, 0.3) & \min(0.3, 0.8) & \min(0.5, 0.1) & \\ & & \min(0.2, 0.6) & & \end{array} \right\rangle$$

$$= \left\langle \begin{array}{ccccc} & & 0.1 & & \\ & 1 & 0.1 & 0.4 & \\ 0.1 & 0.4 & 0 & 0.3 & 0.2 \\ & 0.3 & 0.3 & 0.1 & \\ & & 0.2 & & \end{array} \right\rangle$$

Also the minimum operator can be use to find the product of a fuzzy rhotrix by a scalar.

Let $R_n = \langle a_{ij}, c_{lk} \rangle$ be a fuzzy rhotrix and $\lambda \in [0,1]$ (fuzzy unit interval). Then the scalar product of R_n by λ, denoted by $\lambda R_n$is given by

$$\lambda R_n = \left[\min\left(\lambda \langle a_{ij}, c_{lk} \rangle\right)\right] where \lambda, a_{ij}, c_{lk} \in [0,1]$$

For example:

Let $\lambda = 0.5$ and $R_3 = \left\langle \begin{array}{ccc} & 0.5 & \\ 0.9 & 0.7 & 0.2 \\ & 0.1 & \end{array} \right\rangle$

Then

$$\lambda R_3 = \left\langle \begin{array}{ccc} & \min(0.5, 0.5) & \\ \min(0.5, 0.9) & \min(0.5, 0.7) & \min(0.5, 0.2) \\ & \min(0.5, 0.1) & \end{array} \right\rangle$$

$$= \left\langle \begin{array}{ccc} & 0.5 & \\ 0.5 & 0.5 & 0.2 \\ & 0.1 & \end{array} \right\rangle$$

(iii) Max Min of a Rhotrix (max min)

Now when we wish to find the product of two fuzzy rhotrices R_n andP_n . Using the usual definition of product of rhotrices, we may not have the product $R_n P_n$ to be a fuzzy rhotrix. For take

$R_3 = \left\langle \begin{array}{ccc} & 1 & \\ 1 & 0.5 & 0.8 \\ & 0.3 & \end{array} \right\rangle$ and $P_3 = \left\langle \begin{array}{ccc} & 1 & \\ 0.6 & 0.3 & 1 \\ & 1 & \end{array} \right\rangle$

be two fuzzy rhotrices. Under the usual rhotrix product we have

$$R_3 P_3 = \left\langle \begin{array}{ccc} & 1.48 & \\ 1.18 & 0.15 & 1.8 \\ & 1.3 & \end{array} \right\rangle$$

$R_3 P_3$ is not a fuzzy rhotrix. Thus the product of two fuzzy rhotrices under usual rhotrix multiplication is not necessarily a fuzzy rhotrix. So here we define a compatible operation analogous to product so that the product of two fuzzy rhotrices will happen to be another fuzzy rhotrix.

Let $R_n = \langle a_{i_1 j_1}, c_{l_1 k_1} \rangle$ and $P_n = \langle b_{i_2 j_2}, d_{l_2 k_2} \rangle$ be two fuzzy rhotrices. Then their product$R_n P_n$, would be the fuzzy rhotrix $Q_n = \langle e_{ij}, g_{lk} \rangle$

where $\begin{cases} e_{ij} = \max\left\{ \min\limits_{i_2 j_1 = 1}^{t} (a_{i_1 j_1} b_{i_2 j_2}), i_1 = i, j_2 = j \right\} \\ g_{lk} = \max\left\{ \min\limits_{l_2 k_1 = 1}^{t-1} (c_{l_1 k_1} d_{l_2 k_2}), l_1 = l, k_2 = k \right\} \end{cases}$

For example:

Let

$$R_5 = \left\langle \begin{array}{ccccc} & & 0.2 & & \\ & 1 & 0.1 & 0.4 & \\ 0.1 & 0.8 & 1 & 0.7 & 0.2 \\ & 0.9 & 0.3 & 0.5 & \\ & & 0.2 & & \end{array} \right\rangle \quad \text{and} \quad P_5 = \left\langle \begin{array}{ccccc} & & 0.1 & & \\ & 1 & 0.3 & 0.4 & \\ 0.4 & 0.4 & 0 & 0.3 & 0.2 \\ & 0.3 & 0.8 & 0.1 & \\ & & 0.6 & & \end{array} \right\rangle$$

Then the product of R_5 and P_5 is

$$R_5P_5 = \left\langle \begin{array}{ccccc} & & e_{11} & & \\ & e_{21} & g_{11} & e_{12} & \\ e_{31} & g_{21} & e_{22} & g_{12} & e_{13} \\ & e_{32} & g_{22} & e_{23} & \\ & & e_{33} & & \end{array} \right\rangle$$

Where$e_{11} = \max\{\min(0.2,0.1)\,,\min(0.4,1)\,,\min(0.2,0.4)\}$

$$= \max\{0.1,0.4,0.2\}$$
$$= 0.4$$
$$e_{12} = \max\{\min(0.2,0.4)\,,\min(0.4,0)\,,\min(0.2,0.3)\}$$
$$= \max\{0.2,0,0.2\}$$
$$= 0.2$$
$$e_{13} = \max\{\min(0.2,0.2)\,,\min(0.4,0.1)\,,\min(0.2,0.6)\}$$
$$= \max\{0.2,0.1,0.2\}$$
$$= 0.2$$
$$e_{21} = \max\{\min(1,0.1)\,,\min(1,1)\,,\min(0.5,0.4)\}$$
$$= \max\{0.1,1,0.4\}$$
$$= 1$$
$$e_{22} = \max\{\min(1,0.4)\,,\min(1,0)\,,\min(0.5,0.3)\}$$
$$= \max\{0.4,0,0.3\}$$
$$= 0.4$$
$$e_{23} = \max\{\min(1,0.2)\,,\min(1,0.1)\,,\min(0.5,0.6)\}$$
$$= \max\{0.2,0.1,0.5\}$$
$$= 0.5$$
$$e_{31} = \max\{\min(0.1,0.1)\,,\min(0.9,1)\,,min(0.2,0.4)\}$$
$$= \max\{0.1,0.9,0.2\}$$
$$= 0.9$$
$$e_{32} = \max\{\min(0.1,0.4)\,,\min(0.9,0)\,,\min(0.2,0.3)\}$$
$$= \max\{0.1,0,0.2\}$$
$$= 0.2$$
$$e_{33} = \max\{\min(0.1,0.2)\,,\min(0.9,0.1)\,,\min(0.2,0.6)\}$$
$$= \max\{0.1,0.1,0.2\}$$
$$= 0.2$$
$$g_{11} = \max\{\min(0.1,0.3)\,,\min(0.7,0.4)\}$$
$$= \max\{0.1,0.4\}$$
$$= 0.4$$
$$g_{12} = \max\{\min(0.1,0.3)\,,\min(0.7,0.8)\}$$
$$= \max\{0.1,0.7\}$$
$$= 0.7$$
$$g_{21} = \max\{\min(0.8,0.3)\,,\min(0.3,0.4)\}$$
$$= \max\{0.3,0.3\}$$
$$= 0.3$$
$$g_{22} = \max\{\min(0.8,0.3)\,,\min(0.3,0.8)\}$$
$$= \max\{0.3,0.3\}$$

$$= 0.3$$

Thus

$$R_5P_5 = \left\langle \begin{array}{ccccc} & & 0.4 & & \\ & 1 & 0.4 & 0.2 & \\ 0.9 & 0.3 & 0.4 & 0.7 & 0.2 \\ & 0.2 & 0.3 & 0.5 & \\ & & 0.2 & & \end{array} \right\rangle$$

4.0 Conclusion

In this paper, we introduce a special type of rhotrix called fuzzy rhotrix, we define what is meant by a fuzzy rhotrix and presents some types of fuzzy rhotrices together with some basic operation on this special rhotrix..

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