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# A Study on Fuzzy Relational Mapping (FRM)

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***Abstract***— The fuzzy model is a limited arrangement of fuzzy relations that frame a calculation for deciding the yields of a procedure from some limited number of past data sources and yields. Fuzzy model can be utilized as a part of connected mathematics, to contemplate social and mental issue and furthermore utilized by specialists, design, researchers, industrialists and analysts. There are different sorts of fuzzy models. In this paper we utilize two fuzzy models and give their application to a genuine issue. In this paper two methodologies of fuzzy capacity have been researched: the first distinguishes a fuzzy capacity with a special fuzzy relation (we call it an (E − F)- fuzzy capacity), and the second one characterizes a fuzzy capacity as a conventional mapping between fuzzy spaces. In our exchange the components of the area space are taken from the genuine vector space of measurement n and that of the range space are genuine vectors from the vector space of measurement (m when all is said in done need not be equivalent to n). We mean by R the arrangement of hubs R1, … , Rm of the range space, where Ri = {(x1, x2, … , xm)/xj = 0 or 1} for i = 1, … ,m. In the event that xi = 1 it implies that the hub Ri is in the ON state and if xi = 0 it implies that the hub Ri is in the OFF state. Additionally D signifies the hubs D1,… ,Dn of the area space where Di = {(x1,… , xn)/xj = 0 or 1} for I = 1, … , n. In the event that xi = 1, it implies that the hub Di is in the on state and if xi = 0 it implies that the hub Di is in the off state. A FRM is a directed graph or a guide from D to R with ideas like arrangements or occasions and so forth as hubs and causalities as edges. It speaks to easygoing relations between spaces D and R. Give Di and Rj a chance to signify the two hubs of a FRM.

***Keywords***— FRM, Fuzzy Logic, Binary Algorithm, Fuzzy Optimization.

## I. INTRODUCTION

FRMs are a directed graph or a map from domain space to range space with concepts and causalities as edges

Let, Domain space = n
Range space = m $[m \neq n]$
$R_1, R_2, \ldots, R_m$ be the nodes of range space.
$R = \{ (x_1, x_2, \ldots, x_m) \mid x_j = 0 \text{ or } 1\}$ for $j = 1,2\ldots,m$.
$x_j = 1$ i.e. $R_j$ is on state and $x_j = 0$ i.e. $R_j$ is off state
Similarly,
$D_1, D_2, \ldots, D_n$ be the nodes of domain space.
$D = \{ (x_1, x_2, \ldots, x_n) \mid x_i = 0 \text{ or } 1\}$ for $i = 1,2\ldots,n$.
$x_i = 1$ i.e. $D_i$ is on state and $x_i = 0$ i.e. $D_i$ is off state

## II. BASIC CONCEPTS OF FRM

The thought of Fuzzy Relational Mapping in view of the maximum min sythesis was first researched by Sanchez. He considered conditions and hypothetical strategies to determine fuzzy relations on fuzzy sets characterized as mappings from sets to. A few hypotheses for presence and assurance of arrangements of certain fundamental fuzzy relation conditions were given by him. However the arrangement acquired by him is just the best component (or the most extreme arrangement) got from the maximum min (or min-max) organization of fuzzy relations. Work has revealed some insight into this imperative subject. From that point forward numerous specialists have been endeavoring to investigate the issue and create arrangement methods.

The maximum min piece is ordinarily utilized when a framework requires traditionalist arrangements as in the integrity of one esteem can't repay the disagreeableness of another esteem. As a general rule there are circumstances that permit compensability among the estimations of an answer vector. In such cases the min administrator is not the best decision for the convergence of fuzzy sets, yet max item structure, is favored since it can yield better or if nothing else proportional outcome. Before we go into the dialog of these Fuzzy Relational Mapping (FRM) and its properties it uses and applications we simply depict them.

This segment manages the properties of FRM, strategies for understanding FRM utilizing calculations given by a few specialists and at times techniques for neural systems and hereditary calculation is utilized as a part of taking care of issues. A total arrangement of references is given toward the finish of the book refering to the names of all scientists whose exploration papers have been utilized.

## III. BINARY FUZZY RELATION AND THEIR PROPERTIES

It is verifiable truth that binary relations are summed up scientific capacities. In spite of capacities from X to Y, binary relations R(X, Y) may allocate to every component of X at least two components of Y. Some essential operations on capacities, for example, the converse and sythesis are pertinent to binary relations also.

Given a fuzzy relation R(X, Y), its area is a fuzzy set on X, dom R, whose enrollment work is characterized by

$$\text{dom } (R(x)) = \max_{y \in Y} R\,(x, y)$$

We delineate the sagittal diagram of a binary fuzzy relation R (X,Y) together with the comparing participation matrix in Figure 1.1.

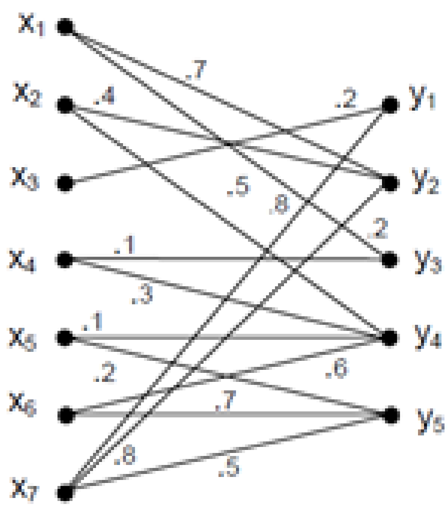


Fig.1

The reverse of a fuzzy relation R(X, Y) indicated by R-1(Y, X) is a relation on Y × X characterized by R-1 (y, x) = R (x, y) for all x ∈ X and for all y ∈ X. A participation matrix R-1 = [r-1yx] speaking to R-1 (Y, X) is the transpose of the matrix R for R (X, Y) which implies that the lines of R-1 break even with the segments of R and the sections of R-1 approach the columns of R.

Unmistakably (R-1)- 1 = R for any binary fuzzy relation. Along these lines a fuzzy binary relation can be spoken to by the sagittal diagram. The relating enrollment matrix:

$$\begin{array}{c c} & \begin{array}{ccccc} y_1 & y_2 & y_3 & y_4 & y_5 \end{array} \\ \begin{array}{c} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{array} & \begin{bmatrix} 0 & .7 & .5 & 0 & 0 \\ 0 & .4 & 0 & .1 & 0 \\ .2 & 0 & 0 & 0 & 0 \\ 0 & 0 & .1 & 1 & 0 \\ 0 & 0 & 0 & .3 & .7 \\ 0 & 0 & 0 & .6 & .7 \\ .2 & 0 & .8 & 0 & .5 \end{bmatrix} \end{array}$$

R is the membership matrix.

**Application of FRMs**

FRMs are used in the following areas: -

a) Relation amongst Doctor and Patient.
b) Relation between quality condition and scholarly state of student
c) Relational amongst educator and poor provincial understudies in City Colleges
d) Study of representative boss relationship
e) Finding out the ailments among different periods of rural workers because of concoction contamination.

A comparable operation on two twofold relations, which varies from the structure in that it yields triples rather than sets, is known as the relational join. For fuzzy relations P(X,Y) and Q(Y,Z), the relational join P * Q, comparing to the standard max-min piece is a ternary relation R(X, Y, Z) characterized by

R (x, y, z) = [P * Q] (x, y, z) = min [P (x, y), Q (y, z)] for each x ∈ X, y ∈ Y and z ∈ Z.

The fact that the relational join produces a ternary relation from two binary relations is a major difference from the composition, which results in another binary relation.

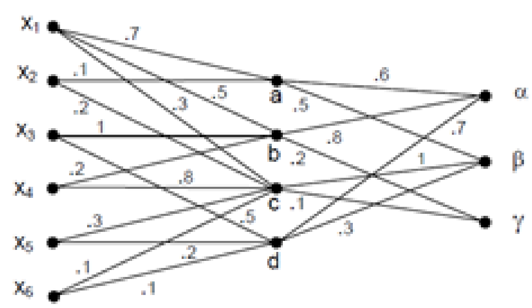


Fig.2

Formally [P °Q] (x, z) = max [P * Q] (x, y, z) for each x ∈ X and z ∈ Z. Now we just see what happens if the binary relation on a single set. Binary relation R (X, X) can be expressed by the same forms as general binary relations.

## IV. Solving Non-Linear Optimization Problem With FRM Constraints

J.Lu, S.C. Fang have utilized fuzzy relation condition limitations to examine the non-straight streamlining issues. They have given an enhancement model a nonlinear target work subject to an arrangement of fuzzy relation conditions. The investigation of the fuzzy relation conditions

 

$$x \text{ o } A = b \qquad (1)$$

where $A = (a_{ij})_{m \times n}$, $0 \le a_{ij} \le 1$ is a fuzzy matrix 1b = $(b_1,\ldots, b_n)$, $0 \le b_j \le 1$ is an n-dimensional vector and '0' is the max-min composition.

The determination of the condition x o A = b is a fascinating and on-going examination subject. In this paper as opposed to discovering all arrangement of x o A = b, let f(x) be the client's foundation work, they illuminate the accompanying nonlinear programming model with fuzzy relation obliges

$$\min f(x) \text{ s.t } x \text{ o } A = b \qquad (2)$$

A minimizer of Eq. (2) will give a "best" answer for the client in light of the target work f(x). Some related uses of this model with various target capacities can be found in for medicinal conclusion, and in for media transmission gear module test.

## V. Unattainable Solution Of FRM

Have gotten an essential and adequate condition for the presence of an in part feasible and an unattainable arrangement.

Give U and V a chance to be nonempty sets, and let L(U), L(V), and L(U × V) be the accumulations of fuzzy arrangements of U, V and U × V, individually. At that point a condition

$$X \text{ o } A = B \qquad (1)$$

is called a FRM, where A ∈ L (U × V) and B ∈ L (V) are given and X ∈ L (U) is unknown, and o denotes the ∧-∨ composition. A fuzzy set X satisfying the equation above is called a solution of the equation. If $\mu_x$: U → I, $\mu_A$ : U × V → I, and $\mu_B$: V → I are their membership functions where *I* denotes the closed interval [0, 1] Eq. (1) is as follows:

$$(\forall \upsilon \in V) \{ \bigvee_{\upsilon \in U} (\mu_X(u) \wedge \mu_A(u,\upsilon)) = \mu_B{}^{(\upsilon)} \qquad (2)$$

The arrangement set of FRM has been explored by numerous specialists, and a few essential properties are appeared. Especially, for the situation that U and V are both limited sets, it is demonstrated that the arrangement set is totally controlled by the best arrangement and the arrangement of negligible arrangements. Be that as it may, when the cardinality of either U of V is endless, a couple of properties about the arrangement set are researched. Here we utilize the idea of feasibility to clear up a few properties of the arrangement set of Eq. (1).

## VI. Fuzzy Relational Mapping Methods

The specificity move technique can be delegated an approach arranged in the middle of logical and numerical strategies for tackling FRM. It depends on the first structure of the arrangement beginning from the hypothesis and at the same time exploits some optimization instruments accessible in the organization of the parametric specificity move influencing the relational requirements shaping the FRM to be settled.

In this sense the ideal limit estimations of the change capacities furnish with a superior knowledge into the character of the information to be dealt with especially with regards to their general consistency level. In this investigation we are worried about a critical classification of FRM with the max-t creation.

$$X \,\square\, R = y, \qquad (1)$$

where "t" is thought to be a persistent t-standard while X, y and R are seen as fuzzy sets and a fuzzy relation characterized in limited universes of talk. The issue of diagnostic answers for these conditions has been sought after in the profundity; allude e.g. of the monograph by Di Nola et al. as accommodating hotspot for the most broad scope of the territory; On the connected side, these conditions call for estimated arrangements as regularly no expository arrangements can be created. This interest has been taken care of with the guide of different procedures.

The approach presented here falls under the classification of information preprocessing by proposing the utilization to the notable hypothetical outcomes to precisely preprocessed information (relational limitations). The developing embodiment is the thing that can be known as a specificity move of relational imperatives being gone for the higher reasonability of the subsequent FRM.

**New algorithms for solving FRM**

A new algorithm to solve the fuzzy relation equation

$$P \text{ o } Q = R \qquad (1)$$

with max-min structure and max-item organization. This calculation works efficiently and graphically on a framework example to get every one of the arrangements of P.

***DEFINITION 4.5.1:*** *If p (Q, r) denotes the set of all solutions of p o Q = r, we call $\bar{P} \in$ **p**(Q, r) the maximum solution of **p**(Q, r) if $p \le \bar{p}$ for all p ∈ **p**(Q, r). Meanwhile, $\underline{p} \in$ **p**(Q, r) is called a minimal solution of p(Q, r), if $p \le \underline{p}$ implies p = $\underline{p}$ for all p ∈ **p** (Q, r). The set of all minimal solutions of **p**(Q, r) is denoted by $\underline{p}$(Q, r) .*

**Main results**

Following are the main algorithms for solving (1) with max-min (or max-product) composition:

***Step 1:*** Check the existence of the solution.

***Step 2:*** Rank the elements of r with decreasing order and find the maximum solution $\overline{p}$.

***Step 3:*** Build the table $M = [m_{jk}]$, $j = 1, 2, \ldots, m$; $k = 1, 2, \ldots, n$, where $m_{jk} \underline{\Delta} (\overline{p}_j, q_{jk})$. This matrix M is called "matrix pattern".

***Step 4:*** Mark $m_{jk}$, which satisfies $\min(\overline{p}_j, q_{jk}) = r_k$ (or $p_j \cdot q_{jk} = r_k$), and then let the marked $m_{jk}$ be denoted by $\overline{m}_{jk}$.

***Step 5:*** If $k_1$ is the smallest k in all marked $\overline{m}_{jk}$, then set $\underline{p}_{j1}$ to be the smaller one of the two elements in $\overline{m}_{j1k1}$ (or set $\underline{p}_{j1}$ to be $\overline{p}$-$j1$).

***Step 6:*** Delete the $j_1$th row and the $k_i$th the column of M, and then delete all the columns that contain marked $\overline{m}_{j1k}$, where $k \neq k_1$.

***Step 7:*** In all remained and marked $\overline{m}_{jk}$, find the smallest k and set it to be $k_2$ , then let$\underline{p}_{j}2$ be the smaller one of the two elements in $\overline{m}_{j2k2}$ (or let $\underline{p}^{j}_{2}$ be $\overline{p}_j2$ ).

***Step 8:*** Delete the $j_2$th row and the $k_2$th column of M, and then delete all columns that contain marked $\overline{m}_{j2k}$, where $k \neq k_2$.

***Step 9:*** Repeat steps 7 and 8 until no marked $\overline{m}_{jk}$ is remained.

***Step 10:*** The other $\underline{p}_j$, which are not set in steps 5-8, are set to be zero.

## VII. CONCLUSION

Two ways to deal with the thought of fuzzy capacity have been researched: the first recognizes a fuzzy capacity with a special fuzzy relation (we call it an (E − F)- fuzzy capacity), and the second one characterizes a fuzzy capacity as a conventional mapping between fuzzy spaces. We consolidated both methodologies and examined properties of a fuzzy capacity determined by an (E − F)- fuzzy capacity. We discovered conditions that guarantee that reliant estimations of in this manner related fuzzy capacities correspond. These conditions depend on the presence of a center capacity of the separate (E − F)- fuzzy capacity. Additionally, we explored properties and relationship of related fuzzy capacities for the situation when they are "fuzzified" adaptations of a conventional center capacity.

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