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Multi Attribute Decision Making Approach for Solving Fuzzy Soft Matrix Using Choice Matrix

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ABSTRACT

In this work, we investigate fuzzy soft matrix and their operations. We then investigate fuzzy soft algorithm that allows constructing those efficient decision making method. Finally, we give an example which shows that the method can be successfully applied to many problems that contains uncertainties.

KEY WORDS: Soft set, fuzzy soft set, fuzzy soft matrix, choice matrix, complement fuzzy soft matrix.

INTRODUCTION:

Molodtsov [11] introduced the concept of soft sets that can be seen as a new mathematical theory for dealing with uncertainty. Molodtsov applied this theory to several directions[11,12,13]. Majiet.al[9] worked on theoretical study of soft sets in detail, and presented an application of soft set in the decision making problem using the reduction of soft sets[11]. Chen et.al[5] proposed parameterization reduction of soft sets and then Kong et.al [6] presented the normal parameterization reduction of soft sets.

Aktas and cagman [3] introduced a definition of soft groups, and derived their basic properties. Majiet.al[9] presented the concept of fuzzy soft sets by embedding the ideas of fuzzy sets[16]. By using this definition of fuzzy soft sets many interesting applications of soft set theory have been expanded by some Researchers. Roy and Maji [14] gave some applications of fuzzy soft sets. Mukherjee and chakraborty [10] worked on Intuitionstic fuzzy soft relations. Aktas and cagman [3] compared soft sets with the related concepts of Fuzzy sets and Rough sets.

Yang et.al[15] defined the operations on fuzzy soft sets which are based on these fuzzy logic operators. Zou and Xiao [17] introduced the soft set and fuzzy soft set into the incomplete environment. Cagman et.al [4] defined a fuzzy parameterized soft set theory and its decision making method.

PRELIMINARIES:

This section, briefly reviews the basic characteristics of Fuzzy set and fuzzy soft sets.

Definition -2.1: (SOFT SET)

Let U be an initial universe, P (U) be the power set of U, E be the set of all parameters and A⊆ E. A soft set (f_A, E) on the universe U is defined by the set of order pairs (f_A, E) = {(e, f_A (e)): e∈ E, f_A∈ P (U)} where f_A : E → P (U) such that f_A (e) = ϕ if e ∉ A.

Here f_A is called an approximate function of the soft set.

Example:

Let U = {u_1,u_2,u_3,u_4} be a set of four shirts and E = {white(e_1),red(e_2),blue (e_3)} be a set of parameters. If A = {e_1 ,e_2} ⊆ E. Let $f_A(e_1)$ = {u_1, u_2 ,u_3, u_4} and $f_A(e_2)$= {u_1,u_2,u_3} then we write the soft set (f_A , E) = {(e_1, {u_1, u_2 ,u_3, u_4}), (e_2,{u_1,u_2,u_3})} over U which describe the "colour of the shirts" which Mr. X is going to buy. We may represent the soft set in the following form:

U	e_1	e_2	e_3
u_1	1	1	0
u_2	1	1	0
u_3	1	1	0
u_4	1	0	0

Definition -2.2: (FUZZY SOFT SET)

Let U be an initial universe, E be the set of all parameters and A⊆ E. A pair (F, A) is called a fuzzy soft set over U where F: A → P (U) is a mapping from A into P (U) , where P (U) denotes the collection of all subsets of U.

Example:

Consider the above example, here we cannot express with only two real numbers 0 and 1, we can characterized it by a membership function instead of crisp number 0 and 1, which associate with each element a real number in the interval [0,1].Then (f_A, E) = {$f_A(e_1)$ = {(u_1, 0.7), (u_2, 0.5), (u_3, 0.4), (u_4, 0.2)}, f_A (e_2) = {(u_1, 0.5), (u_2, 0.1), (u_3, 0.5)} is the fuzzy soft set representing the "colour of the shirts" which Mr. X is going to buy. We may represent the fuzzy soft set in the following

U	e_1	e_2	e_3
u_1	0.7	0.5	0
u_2	0.5	0.1	0
u_3	0.4	0.5	0
u_4	0.2	0	0

Definition- 2.3: (FUZZY SOFT MATRIX)(FSM)

Let (f_A, E) be fuzzy soft set over U. Then a subset of U × E is uniquely defined by R_A= {(u, e): e ∈ A, u ∈ f_A (e)}, which is called relation form of (f_A, E) .The characteristic function of R_A is written by μ_{RA} : U × E → [0, 1], where μ_{RA} (u, e) ∈ [0,1] is the membership value of u ∈ U for each e ∈ E.If $\mu_{ij} = \mu_{R_A}(u_i, e_j)$, we can write the matrix by,

$$[\mu_{ij}]_{m\times n} = \begin{pmatrix} \mu_{11} & \mu_{12} & \cdots & \mu_{1n} \\ \mu_{21} & \mu_{22} & \cdots & \mu_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \mu_{m1} & \mu_{m2} & \cdots & \mu_{mn} \end{pmatrix}$$

which is called an m x n soft matrix of the soft set (f_A,E) over U. Therefore we can say that a fuzzy soft set (f_A ,E) is uniquely characterized by the matrix $[\mu_{ij}]_{m\times n}$ and both concepts are interchangeable. The set of all $m\times n$ fuzzy soft matrices over *U* will be denoted by FSM$m\times n$.

Example:

Assume that U= {u_1,u_2, u_3,u_4,u_5} is a universal set and E= {e_1, e_2, e_3, e_4} is a set all parameters. If A ⊆ E= {e_2, e_3, e_4} and f_A (e_2) = $\left\{\frac{u_1}{0.4}, \frac{u_2}{0.5}, \frac{u_3}{1.0}, \frac{u_4}{0.3}, \frac{u_5}{0.6}\right\}$

f_A (e_3) = $\left\{\frac{u_1}{0.3}, \frac{u_2}{0.4}, \frac{u_3}{0.6}, \frac{u_4}{0.5}, \frac{u_5}{1.0}\right\}$, f_A (e_4) = $\left\{\frac{u_1}{0.5}, \frac{u_2}{0.5}, \frac{u_3}{0.4}, \frac{u_4}{0.3}, \frac{u_5}{0.9}\right\}$.

Then the fuzzy soft set *(f_A ,E)* is a parameterized family *{* f_A (e_2), f_A (e_3), f_A (e_4)*}*of all fuzzy sets over U. Then the relation form of *(f_A , E)* is written by

R_A	e_1	e_2	e_3	e_4
u_1	0	0.4	0.3	0.5
u_2	0	0.5	0.4	0.5
u_3	0	1.0	0.6	0.4
u_4	0	0.3	0.5	0.3
u_5	0	0.6	1.0	0.9

Hence the fuzzy soft matrix $[\mu_{ij}]$ is written as

$$[\mu_{ij}] = \begin{bmatrix} 0 & 0.4 & 0.3 & 0.5 \\ 0 & 0.5 & 0.4 & 0.5 \\ 0 & 1.0 & 0.6 & 0.4 \\ 0 & 0.3 & 0.5 & 0.3 \\ 0 & 0.6 & 1.0 & 0.9 \end{bmatrix}$$

Definition- 2.4: (ROW- FUZZY SOFT MATRIX)
A fuzzy soft matrix of order $1 \times n$ i.e., with a single row is called a row-fuzzy soft matrix.

Definition- 2.5: (COLUMN -FUZZY SOFT MATRIX)
A fuzzy soft matrix of order $m \times 1$ i.e., with a single column is called a column-fuzzy soft matrix.

Definition- 2.6: (COMPLEMENT FUZZY SOFT MATRIX)
Let (a_{ij}) be a $m \times n$ fuzzy soft matrix. Then the complement of (a_{ij}) is denoted by $(a_{ij})^{o}$ and defined by, $(a_{ij})^{o} = (c_{ij})$ is also an fuzzy soft matrix of order $m \times n$ and $c_{ij} = 1 - a_{ij}$ for all i, j.

Example :
Let

$$(a_{ij}) = \begin{bmatrix} 0 & 0.5 & 0.3 & 0.5 \\ 0 & 0.6 & 0.4 & 0.5 \\ 0 & 1.0 & 0.6 & 0.4 \\ 0 & 0.3 & 0.5 & 0.3 \\ 0 & 0.6 & 1.0 & 0.9 \end{bmatrix}.$$

The complement of

$$(a_{ij}) \text{ is } (a_{ij})^{o} = \begin{bmatrix} 1 & 0.5 & 0.7 & 0.5 \\ 1 & 0.4 & 0.6 & 0.5 \\ 1 & 0.0 & 0.4 & 0.6 \\ 1 & 0.7 & 0.5 & 0.7 \\ 1 & 0.4 & 0.0 & 0.1 \end{bmatrix}.$$

Definition- 2.7: (CHOICE MATRIX)
It is a square matrix whose rows and columns both indicate parameters. If C is a choice matrix, then its elements C (i,j) is defined as follows.

$$C_{ij} = \begin{cases} 1, \text{ when } i^{th} \text{ and } j^{th} \text{ parameters are both choice parameters of the decision makers.} \\ 0, \text{ otherwise when at least one of the } i^{th} \text{ or } j^{th} \text{ parameters be not under choice} \end{cases}$$

There are different types of choice matrices according to the number of decision makers. Like the choice matrices associated with a soft set based decision making problem; here also the choice matrices only contain the digits 0 and 1, the only difference is about the nature of the associated parameters. We may realize this by the following example.

Example:
Let U= {set of four factories} = $\{f_1, f_2, f_3, f_4\}$ and E= {costly, excellent work, assured production, good location, cheap}= $\{e_1, e_2, e_3, e_4, e_5\}$. Suppose Mr.X wants to buy a factory on the basis of his choice parameters excellent work, assured production and cheap which form a subset P of E. (i.e.): P=$\{e_2, e_3, e_5\}$. Therefore the choice matrix of Mr.X is

$$(C_{ij})_P = e_P \overset{e_P}{\begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 \end{pmatrix}}$$

Now suppose Mr.X and Mr.Y together wants to buy a factory according to their choice parameters. Let the choice parameter set of Mr.Y be, Q= $\{e_1, e_2, e_3, e_4\}$
Then the combined choice matrix of Mr.X and Mr.Y is

$$(C_{ij})_{(P,Q)} = e_P \overset{e_Q}{\begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 \end{pmatrix}}$$

[Here the entries e_{ij} = 1 indicates that e_i is a choice parameter of Mr.X and e_j is a choice parameter of Mr.Y. Now e_{ij} = 0 indicates either e_i fails to be a choice parameter of Mr.X or e_j fails to be a choice parameter of Mr.Y.]
Again the above combined choice matrix of Mr.X and Mr.Y may be also presented in its transpose form

$$(C_{ij})_{(P,Q)} = e_Q \overset{e_P}{\begin{pmatrix} 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}}$$

Definition- 2.8: (SUM OF THE FUZZY SOFT MATRICES)
Two fuzzy soft matrices A and B are said to be conformable for addition, if they be of the same order. The addition of two fuzzy soft matrices (a_{ij}) and (b_{ij}) of order $m\times n$ is defined by, $(a_{ij}) \oplus (b_{ij}) = (c_{ij})$ is also an $m\times n$ fuzzy soft matrix and c_{ij} = $\max\{a_{ij}, b_{ij}\}$ for all i, j.

Example :
Let U be the set of four cities, given by, U = {u_1 , u_2 , u_3 , u_4, u_5}. Let E be the set of parameters given by, E = { highly, immensely, moderately, average, less } = { e_1 ,e_2, e_3, e_4, e_5} (say). Let

$A\subset E$, given by, A= { e_1 ,e_2, e_3, e_5} and $F_A(e_1)=\left\{\frac{u_1}{0.2},\frac{u_2}{0.8},\frac{u_3}{0.4},\frac{u_4}{0.6},\frac{u_5}{0.7}\right\}$,
$F_A(e_2)=\left\{\frac{u_1}{0},\frac{u_2}{0.9},\frac{u_3}{0.3},\frac{u_4}{0.4},\frac{u_5}{0.6}\right\}$, $F_A(e_3)=\left\{\frac{u_1}{0.3},\frac{u_2}{0.4},\frac{u_3}{0.8},\frac{u_4}{0.8},\frac{u_5}{0.3}\right\}$, $F_A(e_5)=\left\{\frac{u_1}{0.9},\frac{u_2}{0.1},\frac{u_3}{0.5},\frac{u_4}{0.3},\frac{u_5}{0.1}\right\}$.

Hence the fuzzy soft matrix (a_{ij}) is written by,

$$(a_{ij})=\begin{pmatrix} 0.2 & 0.0 & 0.3 & 0 & 0.9 \\ 0.8 & 0.9 & 0.4 & 0 & 0.1 \\ 0.4 & 0.3 & 0.8 & 0 & 0.5 \\ 0.6 & 0.4 & 0.8 & 0 & 0.3 \\ 0.7 & 0.6 & 0.3 & 0 & 0.1 \end{pmatrix}.$$

Now consider another intuitionistic fuzzy soft matrix $(b_{ij}\ )$ associated with the intuitionistic fuzzy soft set over the same universe U. Let B = {e_1, e_4, e_5}$\subset E$ and
$F_B(e_1)=\left\{\frac{u_1}{0.3},\frac{u_2}{0.9},\frac{u_3}{0.4},\frac{u_4}{0.7},\frac{u_5}{0.6}\right\}$, $F_B(e_4)=\left\{\frac{u_1}{0.2},\frac{u_2}{0.3},\frac{u_3}{0.7},\frac{u_4}{0.2},\frac{u_5}{0.3}\right\}$, $F_B(e_5)=\left\{\frac{u_1}{0.8},\frac{u_2}{0.2},\frac{u_3}{0.6},\frac{u_4}{0.3},\frac{u_5}{0.2}\right\}$.

Hence the intuitionistic fuzzy soft matrix $(b_{ij}\ )$ is written by

$$(b_{ij}\ ) = \begin{pmatrix} 0.3 & 0 & 0 & 0.2 & 0.8 \\ 0.9 & 0 & 0 & 0.3 & 0.2 \\ 0.4 & 0 & 0 & 0.7 & 0.6 \\ 0.7 & 0 & 0 & 0.2 & 0.3 \\ 0.6 & 0 & 0 & 0.3 & 0.2 \end{pmatrix}$$

Therefore the sum of the intuitionistic fuzzy soft matrices (a_{ij}) and $(b_{ij}\ )$ is,

$$(a_{ij}\ )\oplus(b_{ij}\ )\begin{pmatrix} 0.3 & 0.0 & 0.3 & 0.2 & 0.9 \\ 0.9 & 0.9 & 0.4 & 0.3 & 0.2 \\ 0.4 & 0.3 & 0.8 & 0.7 & 0.6 \\ 0.7 & 0.4 & 0.8 & 0.2 & 0.3 \\ 0.7 & 0.6 & 0.3 & 0.3 & 0.2 \end{pmatrix}.$$

Definition- 2.9: (SUBTRACTION OF THE FUZZY SOFT MATRICES)
Two fuzzy soft matrices A and B are said to be conformable for subtraction, if they be of the same order. For any two intuitionistic fuzzy soft matrices $(a_{ij}\ )$ and $(b_{ij}\ )$ of order $m\times n$, the subtraction of (b_{ij}) from (a_{ij}) is defined as $(a_{ij}\ )\ominus(b_{ij}\ ) = (c_{ij}\ )$ is also an $m\times n$ fuzzy soft matrix and c_{ij} = min$\{a_{ij}, b_{ij}^0\}$ for all i, j, where (b_{ij}^0) is the complement of (b_{ij}).

Example :
Consider the fuzzy soft matrices $(a_{ij}\ )$ and $(b_{ij}\ )$ in the previous example,

$$(a_{ij})=\begin{pmatrix} 0.2 & 0.0 & 0.3 & 0 & 0.9 \\ 0.8 & 0.9 & 0.4 & 0 & 0.1 \\ 0.4 & 0.3 & 0.8 & 0 & 0.5 \\ 0.6 & 0.4 & 0.8 & 0 & 0.3 \\ 0.7 & 0.6 & 0.3 & 0 & 0.1 \end{pmatrix},\ (b_{ij}) = \begin{pmatrix} 0.3 & 0 & 0 & 0.2 & 0.8 \\ 0.9 & 0 & 0 & 0.3 & 0.2 \\ 0.4 & 0 & 0 & 0.7 & 0.6 \\ 0.7 & 0 & 0 & 0.2 & 0.3 \\ 0.6 & 0 & 0 & 0.3 & 0.2 \end{pmatrix}.$$

.

$$\text{Now } (b_{ij})^{o} = \begin{pmatrix} 0.7 & 1 & 1 & 0.8 & 0.2 \\ 0.1 & 1 & 1 & 0.7 & 0.8 \\ 0.6 & 1 & 1 & 0.3 & 0.4 \\ 0.3 & 1 & 1 & 0.8 & 0.7 \\ 0.4 & 1 & 1 & 0.7 & 0.8 \end{pmatrix}$$

∴ the subtraction of the fuzzy soft matrix (b_{ij}) from (a_{ij}) is

$$(a_{ij})\ominus(b_{ij})=\begin{pmatrix} 0.2 & 0.0 & 0.3 & 0 & 0.2 \\ 0.1 & 0.9 & 0.4 & 0 & 0.1 \\ 0.4 & 0.3 & 0.8 & 0 & 0.4 \\ 0.3 & 0.4 & 0.8 & 0 & 0.3 \\ 0.4 & 0.6 & 0.3 & 0 & 0.1 \end{pmatrix}$$

Definition- 2.10: (PRODUCT OF AN FUZZY SOFT MATRIX WITH A CHOICE MATRIX)

Let U be the set of universe and E be the set of parameters. Suppose that *A* be any fuzzy soft matrix and *B* be any choice matrix of a decision maker concerned with the same universe U and E. Now if the number of columns of the fuzzy soft matrix A be equal to the number of rows of the choice matrix B, then A and B are said to be conformable for the product (A⊗B) and the product (A⊗B) becomes a fuzzy soft matrix.

If A = $(a_{ij})_{m\times n}$ and B =$(b_{jk})_{n\times p}$, then (A⊗B) =(c_{ik}) where c_{ik}= $(max_{j=1}^{n}$ $\{\mu_{a_{ij}}, \mu_{b_{jk}}\})$.

Example :

Let U be the set of four dresses, given by, U = $\{d_1, d_2, d_3, d_4\}$. Let E be the set of parameters, given by, E = {*cheap, beautiful, comfortable, gorgeous*} = $\{e_1, e_2, e_3, e_4\}$ (say). Suppose that the set of choice parameters of Mr.X be, *A*= $\{e_1, e_3\}$. Now let according to the choice parameters of Mr.X, we have the intuitionistic fuzzy soft set (*F*, *A*) which describes the attractiveness of the dresses and the intuitionistic fuzzy soft matrix of the intuitionistic fuzzy soft set (*F*, *A*) be,

$$(a_{ij}) = \begin{pmatrix} 0.8 & 0.2 & 0.7 & 0.3 \\ 0.3 & 0.7 & 0.4 & 0.8 \\ 0.7 & 0.4 & 0.5 & 0.6 \\ 0.5 & 0.1 & 0.9 & 0.2 \end{pmatrix}$$

Again the choice matrix of Mr.X is,

$$(\beta_{ij})_A = \begin{pmatrix} 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Since the number of columns of the fuzzy soft matrix (a_{ij}) is equal to the number of rows of the choice matrix $(\beta_{ij})_A$, they are conformable for the product.

Therefore

$$(a_{ij}) \otimes (\beta_{ij})_A = \begin{pmatrix} 1.0 & 0.8 & 1.0 & 0.8 \\ 1.0 & 0.8 & 1.0 & 0.8 \\ 1.0 & 0.7 & 1.0 & 0.7 \\ 1.0 & 0.9 & 1.0 & 0.9 \end{pmatrix}.$$

THE STEPWISE SOLVING PROCEDURE:

To solve such type of fuzzy soft set based decision making problems, we are presenting the following stepwise procedure which comprises of the newly proposed choice matrices and operations on them.

ALGORITHM APPROACH:

STEP-1: First construct the combined choice matrix with respect to the choice parameter of the decision matrix.

STEP-2: Compute the product fuzzy soft matrices by multiplying each given FSM with the combined choice matrix as per the rule of multiplication of FS matrices.

STEP-3: Compute the sum of those product fuzzy soft matrices to have the result FSM (R_j).

STEP-4: Then compute the weight of each object (O_i) by adding the membership values of the entries of its concerned row of R_j and denote it as $w(O_i)$.

STEP-5: The object having the highest weight becomes the optimal choice object.

PROBLEM:

Let U= $\{M_1, M_2, M_3, M_4\}$ be a set of four candidates and C = {Highest qualification, Knowledge, Previous experience, Hard work} be the set of parameters, given by P = $\{P_1, P_2, P_3, P_4\}$. A set of three experts E = $\{e_1, e_2, e_3\}$ want to evaluate the best candidates as per knowledge base. The fuzzy decision matrices of experts e_1, e_2 *and* e_3 are given in the following table.

The fuzzy soft decision matrices of four candidates is given by X, Y and Z ,

$$X = \begin{pmatrix} 0.8 & 0.7 & 0.5 & 0.9 \\ 0.4 & 0.3 & 0.8 & 0.4 \\ 0.6 & 0.4 & 0.2 & 0.6 \\ 0.7 & 0.6 & 0.6 & 0.7 \end{pmatrix},\ Y = \begin{pmatrix} 0.7 & 0.6 & 0.6 & 0.8 \\ 0.3 & 0.3 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.7 & 0.6 \\ 0.6 & 0.6 & 0.9 & 0.6 \end{pmatrix},\ Z = \begin{pmatrix} 0.1 & 0.8 & 0.2 & 0.7 \\ 0.8 & 0.3 & 0.9 & 0.4 \\ 0.3 & 0.5 & 0.6 & 0.7 \\ 0.5 & 0.6 & 0.4 & 0.9 \end{pmatrix}.$$

Now the problems is to select the best candidate among the four candidates with satisfies choice parameter of these experts e_1, e_2, e_3 as much as possible.

$$e_1 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix},\ e_2 = \begin{pmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix},\ e_3 = \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{pmatrix}.$$

SOLUTION:

$$\mathrm{X} \times e_1 = \begin{pmatrix} 0.8 & 0.7 & 0.5 & 0.9 \\ 0.4 & 0.3 & 0.8 & 0.4 \\ 0.6 & 0.4 & 0.2 & 0.6 \\ 0.7 & 0.6 & 0.6 & 0.7 \end{pmatrix} \times \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{pmatrix}.$$

$$\mathrm{Y} \times e_2 = \begin{pmatrix} 0.7 & 0.6 & 0.6 & 0.8 \\ 0.3 & 0.3 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.7 & 0.6 \\ 0.6 & 0.6 & 0.9 & 0.6 \end{pmatrix} \times \begin{pmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 1 & 0.8 & 1 \\ 1 & 1 & 0.4 & 1 \\ 1 & 1 & 0.7 & 1 \\ 1 & 1 & 0.9 & 1 \end{pmatrix}.$$

$$\mathrm{Z} \times e_3 = \begin{pmatrix} 0.1 & 0.8 & 0.2 & 0.7 \\ 0.8 & 0.3 & 0.9 & 0.4 \\ 0.3 & 0.5 & 0.6 & 0.7 \\ 0.5 & 0.6 & 0.4 & 0.9 \end{pmatrix} \times \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{pmatrix} = \begin{pmatrix} 0.8 & 1 & 1 & 1 \\ 0.9 & 1 & 1 & 1 \\ 0.7 & 1 & 1 & 1 \\ 0.9 & 1 & 1 & 1 \end{pmatrix}.$$

$$\therefore \mathrm{Sum} = \begin{pmatrix} 2.8 & 3.0 & 2.8 & 3.0 \\ 2.9 & 3.0 & 2.4 & 3.0 \\ 2.7 & 3.0 & 2.7 & 3.0 \\ 2.9 & 3.0 & 2.9 & 3.0 \end{pmatrix}$$

Now the weights of the candidates are respectively.

$$\mathrm{W}(\mathrm{C}_1) = 2.8+3.0+2.8+3.0 = 11.6$$
$$\mathrm{W}(\mathrm{C}_2) = 2.9+3.0+2.4+3.0 = 11.3$$
$$\mathrm{W}(\mathrm{C}_3) = 2.7+3.0+2.7+3.0 = 11.4$$
$$\mathrm{W}(\mathrm{C}_4) = 2.9+3.0+2.9+3.0 = \mathbf{11.8}$$

Now the candidate C_4 associated with the fourth row of the resultant fuzzy soft matrix has the highest weight. Therefore the candidate C_4 has the best candidate as per the knowledge base.

CONCLUSION:

To develop the theory, in this work, first we explain FSM and their operations.
We then presented the decision making method for FSM. Finally we provided an example demonstrating the successfully application of this method.

FUTURE WORK:
It may be applied to many fields with problems that contain uncertainty, and it would be beneficial to extend the proposed method to subsequent studies.

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