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A NEW DECISION MAKING THEORY IN SOFT MATRICES

S. Vijayabalaji[1], A. Ramesh[2]
[1]Department of Mathematics
University College of Engineering
(A Constituent College of Anna University - Chennai),
Panruti, 607 106, TamilNadu, INDIA
[2]Department of Mathematics
C. Abdul Hakeem College of Engineering and Technology
Melvisharam, 632 509, TamilNadu, INDIA

Abstract: In 1999, Molodtsov introduced the concept of soft sets as a general mathematical tool for the dealing with uncertainty. The solution of such problems involves the use of mathematical principles based on uncertainty and imprecision. N. Cagman and S. Enginoglu [6] introduced the notion of soft matrices in 2010 from the theory of soft sets. They also constructed a soft max-min decision making method which can be successfully applied to the decision making for two person in soft matrix approach. Inspired by the soft matrices we are interested to find a new decision making theory which involves more than two persons or three persons. As an outcome in this paper, we apply the decision making for three persons in soft matrix approach and provide some interesting results on it.

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1. Introduction

In 1999, Molodstov [13] initiated a novel concept know as Soft Set as a new

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mathematical tool for dealling with uncertainties. He pointed out that the important existing theories viz. Probability Theory, Fuzzy Set Theory, Intuitionistic Fuzzy Sets, Rough Set Theory etc., which can be considered as mathematical tools for dealing with uncertainties, have their own diffculties. These theories cannot be successfully used to solve complicated problems in the fields of Engineering, Social Science, Economies, Medical Science etc. He further pointed out that the reason for these difficulties is, possibly, the inadequacy of the parameterization tool of the theory. The Soft Set Theory introduced by Molodstov [13] is free of the difficulties present in these theories. The absence of any restrictions on the approximate description in Soft Set Theory makes thies theory very convenient and easily applicable. It has been demonstrated that Soft Set Theory brings about a rich potential for applications in many fields like functions smoothness, Riemann integration, decision making, measurement theory, game theory, etc.

By using the rough sets, P. K. Maji [10] first defined some operations on soft sets and introduced the soft set into the decision making problems [11]. D. Chen [7] introduced a new definition of Soft Set parameterization reduction. Kong et al. [8] introduced the definition of normal parameter reduction into Soft Sets. Ali [3] gave some new operations in Soft Set Theory. Cagman and Enginoglue [5] defined the new operations of soft sets and constructed the uni -int decision making method which selects a set of optimum elements from the alternatives. Cagman [6] defined soft matrices which were a matrix representation of the soft sets. This representation has several advantages. It is easy to store and manipulate matrices and hence the soft sets represented by them in a computer. They alse construct a soft decision making which is more practical and can be sucessfully applied to many problems that contain uncertainites without using the rough sets and Fuzzy Soft Sets.

In this paper, we first recall the definition of soft set thory and the example of soft sets theory. In section 3, we define the soft matrix theory and $max-max$ decision making method for two persons and also three persons.

2. Preliminaries

We recall some basic notions in soft set theory. Molodtsov [13] defined soft set in the following way. Throughout the paper, let U be an initial universe set and E be a set of parameters. Let $P(U)$ denotes the power set of U and $A, B, C \subseteq E$.

Definition 2.1. [13]A soft set F_A over U is a set defined by a function

f_A representing a mapping f_A:$E \to P(U)$ such that f_A=ϕ if $x \notin A$. Here, f_A is called approximate function of the soft set F_A. A soft set over U can be represented by the set of ordered pairs

$$F_A = \{(x, f_A(x)) : x \in E, f_A(x) \in P(U)\}.$$

Note that the set of all soft sets over U will be denoted by $S(U)$.

Remark 2.2. The subscript A in the notation f_A indicates that f_A is the approximate function of F_A. It can be defined more than one soft set in a subset A of the set of parameters E. In this time the approximate functions of F_A, G_A, H_A etc. must be f_A, g_A, h_A etc., respectively.

From now on, each soft set is often defined on a different subset of the parameters set whenever there is no confusion.

Example 2.3. A soft set F_A describes the various companies mobile. Suppose that there are five mobiles in the universe $U = \{m_1, m_2, m_3, m_4, m_5\}$ under consideration, and $E = \{x_1, x_2, x_3, x_4\}$ is the set of parameters. The $x_i (i = 1, 2, 3, 4)$ stand for the parameters expensive, beautiful, branded, cheap, respectively. In this case, to define a soft set means to point out expensive mobile, beautiful mobile, and so on.

Assume that $A = x_1, x_2, x_3$ and $B = x_2, x_3, x_4 \subseteq E$.

$$f_A(x_1) = \{m_1, m_3, m_4, m_5\}, f_A(x_2) = \{m_2, m_3, m_5\}, f_A(x_3) = \{m_4\},$$

$$g_A(x_1) = \{\phi\}, g_A(x_2) = \{m_1, m_3, m_4\}, g_A(x_3) = \{U\},$$

$$f_B(x_2) = \{m_1, m_3, m_5\}, f_B(x_3) = \{m_2, m_3\}, f_B(x_4) = \{m_2\}.$$

Then we can view the soft sets F_A, G_A and F_B as consisting of the following collection of approximations:

$$F_A = \{(x_1, \{m_1, m_3, m_4, m_5\}), (x_2, \{m_2, m_3, m_5\}), (x_3, \{m_4\})\},$$

$$G_A = \{(x_2, \{m_1, m_3, m_4\}), (x_3, \{U\})\},$$

$$F_B = \{(x_2, \{m_1, m_3, m_5\}), (x_3, \{m_2, m_3\}), (x_4, \{m_2\})\}.$$

Here, $g_A(x_1) = \phi$ means that there is no element in U related to the parameter $x_1 \in E$. Therefore, we do not display such elements in the soft sets.

Using operation with soft sets defined by Molodtstov [13], the Cartesian product and relation between two soft sets are defined below.

Definition 2.4. [11] Let (F,A) and (G,B) be two soft sets over a common universe U, then the Cartesian product of these two soft sets is denoted by $(F, A) \times (G, B)$ and is defined by $(F, A) \times (G, B) = (H, A \times B)$ where $A \times B$ is the Cartesian product of sets$A$ and B. $H(\alpha, \beta)$=$F(\alpha) \times G(\beta)$,$\alpha \in A$, $\beta \in B$, $A \times B$ is the Cartesian product of sets A and B.

Definition 2.5. [11] Let (F, A) and (G, B) be two soft sets then $(F, A)AND$ (G, B) denoted by $(F, A)\wedge(G, B)$ and is defined by $(F, A)\wedge(G, B) = (H, A\times B)$, where $H(\alpha, \beta) = F(\alpha) \cap G(\beta)$ for all $(\alpha, \beta) \in A \times B$.

Definition 2.6. [11] Let(F, A) and (G, B) be two soft sets then $(F, A)OR$ (G, B) denoted by $(F, A)\vee(G, B)$ and is defined by $(F, A)\vee(G, B) = (H, A\times B)$, where $H(\alpha, \beta) = F(\alpha) \cup G(\beta)$ for all $(\alpha, \beta) \in A \times B$.

Definition 2.7. [11] A soft relation may be defined as a soft set over the power set of the cartesian product of two crisp sets. If X and Y are two non-empty crisp sets of some universal set and E is a set of parameters then a soft relation denoted as (R, E) is defined as a mapping from E to $P(X \otimes Y)$.

Definition 2.8. [11] Let(F, A) and (G, B) be two soft sets over a common universe U, then the relation R of these two soft sets is defined as $(R, A\times B) \subset (F, A)\times(G, B)$ such that$F(\alpha)\times G(\beta) \in (R, A\times B)$ implies that $F(\alpha)$ is related with $G(\beta)$ where $\alpha \in A, \beta \in B$.

Using operation with soft sets defined by Molodtstov [13], and Maji [10], the soft matrix and its operations defined below:

Definition 2.9. [6] Let F_A be a soft set over U. Then, a subset of $U \times E$ is uniquely defined by $R_A = \{(m, x) : x \in A, m \in f_A(x)\}$ which is called a relation from of F_A. The characteristic function of R_A is written by $\wr R_A : U \times E \to \{0, 1\}$,

$$\wr R_A(m, x) = \begin{cases} 1, & (m, x) \in R_A \\ 0, & (m, x) \notin R_A \end{cases}$$

If $U = \{m_1, m_2, m_3, m_4, \cdots, m_n\}, E = \{x_1, x_2, x_3, \cdots, x_p\}$ and $A \subseteq E$, then the R_A can be presented by a table as in the following form

R_A	x_1	x_2	$\cdots$	x_p
m_1	$\wr R_A(m_1, x_1)$	$\wr R_A(m_1, x_2)$	$\cdots$	$\wr R_A(m_1, x_p)$
m_2	$\wr R_A(m_2, x_1)$	$\wr R_A(m_2, x_2)$	$\cdots$	$\wr R_A(m_2, x_p)$
$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
m_n	$\wr R_A(m_n, x_1)$	$\wr R_A(m_n, x_2)$	$\cdots$	$\wr R_A(m_n, x_p)$

If $a_{ij} = \wr R_A(m_i, x_j)$, we define a matrix $SM_{m\times p} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1p} \\ a_{21} & a_{22} & \dots & a_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{np} \end{pmatrix}$, which is called an $n \times p$ soft matrix of the soft set F_A over U.

Example 2.10. Let $F_A = \{((x_1), \{m_1, m_3, m_5\}), ((x_2), \{m_2, m_3\}), ((x_3), \{m_4\})\}$. Then, the relation form of F_A is written by $R_A = \{(m_1, x_1), (m_2, x_2), (m_3, x_1), (m_3, x_2), (m_4, x_3), (m_5, x_1)\}$.

Hence, the soft matrix $[a_{ij}] = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix}$

Definition 2.11. [6] Let $[a_{ij}] \in SM_{n\times p}$. Then $[a_{ij}]$ is called a zero soft matrix, denoted by $[0]$, if $a_{ij} = 0$ for all i and j.

Definition 2.12. [6] Let$[a_{ij}] \in SM_{n\times p}$. Then $[a_{ij}]$ is called an a universal soft matrix, denoted by $[1]$, if $a_{ij} = 1$ for all i and j.

Definition 2.13. [16] Let (F, A) be a soft set defined on the universe U. Then a soft matrix over (F, A) is denoted by $[M(F, A)]$ is a matrix whose elements are the elements of the soft set (F, A). Mathematically, $[M(F, A)] = (m_{ij})$ where $m_{ij} = F(x)$ for some $x \in A$.

Example 2.14. Let us consider $A = E = \{x_1, x_2, x_3, x_4\}$ and $U = \{m_1, m_2, m_3, m_4, m_5\}$ where $(F, A) = \{F(x_1)$ =expensive mobiles= $\{m_1, m_3, m_5\}$, $F(x_2)$ =beautiful mobiles= $\{m_1, m_3, m_4, m_5\}$, $F(x_3)$ =branded mobiles= $\{m_2, m_3, m_4\}$, $F(x_4)$ =cheapest mobiles= $\{m_2\}\}$. Let

$$[M(F, A)] = \begin{bmatrix} \text{expensive mobiles} = \{m_1, m_3, m_5\} & \text{branded mobiles} = \{m_2, m_3, m_4\} \\ \text{beautiful mobiles} = \{m_1, m_3, m_4, m_5\} & \text{cheapest mobiles} = \{m_2\} \end{bmatrix}$$

Here we see that all the elements of the matrix $[M(F, A)]$ are of the soft set (F, A). Hence the above matrix is a soft matrix.

3. Product Soft Matrices

In this section, using the theory of soft matrix introduced by N. Cagman[5] and Cartesian product of two soft sets introduced by M. Pal[16], we define a new notion of soft matrices called **product soft matrices**.

Definition 3.1. Let U be the universal set. Let (F, A) and (G, B) be a two soft sets over common universe U. Then the Cartesian product soft sets $(F, A) \times (G, B) = (H, A \times B)$.

Example 3.2. Let us consider two soft sets A and B over a common universe U. Let $U = \{m_1, m_2, m_3, m_4, m_5\}, A = \{x_1, x_2\} \subseteq E$ and $B = \{x_2, x_3\} \subseteq E$. Then $F(x_1) = \{m_1, m_3, m_4\}, F(x_2) = \{m_2, m_3, m_5\}, G(x_2) = \{m_1, m_3\}$ and $G(x_3) = \{m_2, m_3\}$. Here $A \times B = \{(x_1, x_2), (x_1, x_3), (x_2, x_2), (x_2, x_3)\}$. Then, the relation form of

$$
\begin{aligned}
&R_{(H,A\times B)} = \\
&\{((x_1, x_2), \{(m_1, m_1), (m_1, m_3), (m_3, m_1), (m_3, m_3), (m_4, m_1), (m_4, m_3)\}), \\
&((x_1, x_3), \{(m_1, m_2), (m_1, m_3), (m_3, m_2), (m_3, m_3), (m_4, m_2), (m_4, m_3)\}), \\
&((x_2, x_2), \{(m_2, m_1), (m_2, m_3), (m_3, m_1), (m_3, m_3), (m_5, m_1), (m_5, m_3)\}), \\
&((x_2, x_3)\{(m_2, m_2), (m_2, m_3), (m_3, m_2), (m_3, m_3), (m_5, m_2), (m_5, m_3)\})\}.
\end{aligned}
$$

Definition 3.3. Let U be the universal set. Let (F, A) and (G, B) be a two soft sets over common universe. Then the Cartesian product soft sets $(F, A)\times(G, B) = (H, A\times B)$. We define the relation of $(H, A\times B)$ is $R_{(H,A\times B)} = \{(h, e) : h \in H(\alpha, \beta), e \in A\times B\}$. The special function of $R_{(H,A\times B)}$ is written by
$\tilde{C}R_{(H,A\times B)} : U \times E \to \{0, \frac{1}{2}, 1\}$, $\tilde{C}R_{(H,A\times B)} = \begin{cases} 1, & if(h, e) \in A \cap B \\ \frac{1}{2} = 0.5, & if(h, e) \in A\Delta B \\ 0, & if(h, e) \notin A \cup B \end{cases}$

If $(d_{ij}) = d(h, e)$, we define a matrix $(d_{ij})_{(n\times p)} = \begin{pmatrix} d_{11} & d_{12} & \dots & d_{1p} \\ d_{21} & d_{22} & \dots & d_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ d_{n1} & d_{n2} & \dots & d_{np} \end{pmatrix}$ is called as a **product soft matrices**, where n is the number of elements is U

and p is the product of the number of element in the set A and the number of element in the set B.

Definition 3.4. Let $(F, A) = (a_{ij})$ and $(G, B) = (b_{ij})$ are two soft matrices. Then $(F, A)AND(G, B)$ is denoted by $[(F, A)] \wedge [(G, B)] = [H, A \times B] = (d_{ij})$ is a soft matrix, is defined by $(d_{ij}) = (a_{ij}) \cap (b_{ij})$.

Example 3.5. Let $U = \{m_1, m_2, m_3, m_4, m_5\}$ and $E = \{x_1, x_2, x_3, x_4\}$. Assume that $A = \{x_1, x_2, x_3\}$ and $B = \{x_2, x_3, x_4\} \subseteq E$. Let

$$(F, A) = \{((x_1), \{m_1, m_3, m_4, m_5\}), ((x_2), \{m_2, m_3, m_5\}), ((x_3), \{m_4\})\}$$

$$(F, B) = \{((x_2), \{m_1, m_3, m_5\}), ((x_3), \{m_2, m_3\}), ((x_4), \{m_2\})\}.$$

Hence

$$\begin{aligned}(F, A) \wedge (F, B) = \{&((x_1, x_2), \{m_1, m_3, m_5\}), ((x_1, x_3), \{m_3\}), ((x_1, x_4), \{\phi\}),\\ &((x_2, x_2), \{m_3, m_5\}), ((x_2, x_3), \{m_2, m_3\}), ((x_2, x_4), \{m_2\}),\\ &(x_3, x_2), \{\phi\}), ((x_3, x_3), \{\phi\}), ((x_3, x_4), \{\phi\})\}.\end{aligned}$$

Hence, the product soft matrices is $(d_{ij})_{(5\times 9)} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$

Definition 3.6. Let$(F, A) = (a_{ij})$ and $(G, B) = (b_{ij})$ are two soft matrices. Then $(F, A)OR(G, B)$ is denoted by $[(F, A)] \vee [(G, B)] = [H, A \times B] = (d_{ij})$ is a soft matrix, is defined by $(d_{ij}) = (a_{ij}) \cup (b_{ij})$.

Example 3.7. Let $U = \{m_1, m_2, m_3, m_4, m_5\}$ and $E = \{x_1, x_2, x_3, x_4\}$. Assume that $A = \{x_1, x_2, x_3\}$ and $B = \{x_2, x_3, x_4\} \subseteq E$. Let
$(F, A) = \{((x_1), \{m_1, m_3, m_4, m_5\}), ((x_2), \{m_2, m_3, m_5\}), ((x_3), \{m_4\})\}$
$(G, B) = \{((x_2), \{m_1, m_3, m_5\}), ((x_3), \{m_2, m_3\}), ((x_4) = \{m_2\})\}$.

Hence

$$(F,A)\cup(G,B) = \{((x_1,x_2),\{m_1,m_3,m_4,m_5\}),((x_1,x_3),\{m_1,m_2,m_3,m_4,m_5\}),\\ ((x_1,x_4),\{m_1,m_2,m_3,m_4,m_5\}),((x_2,x_2),\{m_1,m_2,m_3,m_5\}),\\ ((x_2,x_3),\{m_2,m_3,m_5\}),((x_2,x_4),\{m_2,m_3,m_5\}),((x_3,x_2),\\ \{m_1,m_3,m_4,m_5\}),((x_3,x_3),\{m_2,m_3,m_4\}),((x_3,x_4),\{m_2,m_4\})\}.$$

Hence, the product soft matrices is

$$(d_{ij})_{(5\times 9)} = \begin{pmatrix} 1 & 0.5 & 0.5 & 0.5 & 0 & 0 & 0.5 & 0 & 0 \\ 0 & 0.5 & 0.5 & 0.5 & 1 & 1 & 0.5 & 0.5 & 0.5 \\ 1 & 1 & 0.5 & 1 & 1 & 0.5 & 0.5 & 0.5 & 0 \\ 0.5 & 0.5 & 0.5 & 0 & 0 & 0 & 0.5 & 0.5 & 0.5 \\ 1 & 0.5 & 0.5 & 1 & 0.5 & 0.5 & 0.5 & 0 & 0 \end{pmatrix}$$

Definition 3.8. The Choice value of an Object $d_j \in U$ is defined by d_j=max{max(d(h,e))}, where $d(h,e)$ are the entries of d_{ij}.

Definition 3.9. Let $U = \{m_1, m_2, m_3, \ldots, m_n\}$ be an initial universe and max{max(d(h,e))} $= [u_{i1}]$. Then a subset of U can be obtained by using $[u_{i1}]$ as in the following way $opt_{[u_{i1}]} = \{u_i : u_i \in U, u_{i1} = max(1 \ or \ \frac{1}{2})\}$, which is called an optimum set of U.

Assume that a set of alternative and a set of parameters are given. Now, we can construct a soft $max - max$ decision making method by the following algorithm.
Step 1: Choose feasible subsets of the set of parameters,
Step 2: Construct the Cartesian product soft set,
Step 3: Find a Cartesian or product of the soft matrices,
Step 4: Compute the $max - max$ decision matrix of the product.
Step 5: Find an optimum set of U.

Example 3.10. Assume that a mobile shop has a set of different types of mobiles $U = \{m_1, m_2, m_3, m_4, m_5\}$ which may be characterized by a set of parameters $E = \{x_1, x_2, x_3, x_4\}$. For $j = 1, 2, 3, 4$, the parameters x_j stand for expensive, beautiful, branded, cheap, respectively.

Step 1: Suppose that the two friends $Mr.X$ and $Mr.Y$ have the choose the sets of their parameters, $A = \{x_1, x_2, x_3\}$ and $B = \{x_2, x_3, x_4\}$, respectively.

Step 2: The Cartesian product soft set are
$(F, A) = \{((x_1), \{m_1, m_3, m_4, m_5\}), ((x_2), \{m_2, m_3, m_5\}), ((x_3), \{m_4\})\}$
$(G, B) = \{((x_2), \{m_1, m_3, m_5\}), ((x_3), \{m_2, m_3\}), ((x_4), \{m_2\})\}$.

The "OR product" of cartesian set is defined as

$$\begin{aligned}(F, A)\vee(G, B) = \{&((x_1, x_2), \{m_1, m_3, m_4, m_5\}), ((x_1, x_3), \{m_1, m_2, m_3, m_4, m_5\}),\\ &((x_1, x_4), \{m_1, m_2, m_3, m_4, m_5\}), ((x_2, x_2), \{m_1, m_2, m_3, m_5\}),\\ &((x_2, x_3), \{m_2, m_3, m_5\}), ((x_2, x_4), \{m_2, m_3, m_5\}), ((x_3, x_2),\\ &\{m_1, m_3, m_4, m_5\}), ((x_3, x_3), \{m_2, m_3, m_4\}), ((x_3, x_4), \{m_2, m_4\})\}.\end{aligned}$$

Step 3: Now, we can find a cartesian product of the soft matrix A and B by using $Or - product$ as follows

$$(d_{ij})_{(5\times9)} = \begin{pmatrix} 1 & 0.5 & 0.5 & 0.5 & 0 & 0 & 0.5 & 0 & 0 \\ 0 & 0.5 & 0.5 & 0.5 & 1 & 1 & 0.5 & 0.5 & 0.5 \\ 1 & 1 & 0.5 & 1 & 1 & 0.5 & 0.5 & 0.5 & 0 \\ 0.5 & 0.5 & 0.5 & 0 & 0 & 0 & 0.5 & 0.5 & 0.5 \\ 1 & 0.5 & 0.5 & 1 & 0.5 & 0.5 & 0.5 & 0 & 0 \end{pmatrix}$$

Step 4: We can find a max-max decision soft matrix as

$$\begin{aligned}&Max\{\text{Max values in every column}\}\\ &\qquad = Max\{\{m_1, m_3, m_5\}, \{m_3\}, \{m_1, m_2, m_3, m_4, m_5\},\end{aligned}$$

$\{m_3, m_5\}, \{m_2, m_3\}, \{m_2\}, \{m_1, m_2, m_3, m_4, m_5\}, \{m_2, m_3, m_4\}, \{m_2, m_4\}\} = m_3$.
And $(d_j) = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \end{pmatrix}^T$.

Step 5: Finally, we can find an optimal set of U according to

$$Max\{Max(d(h,e))\} = [u_{i1}] = m_3,$$

where m_3 is an optimum mobile to buy for $Mr.X$ and $Mr.Y$.

Definition 3.11. Let $(F, A) = (a_{ij}), (G, B) = (b_{ij})$ and (M, C) are three soft matrices. Then $(F, A)OR(G, B)OR(M, C)$ is denoted by $[(F, A)] \vee [(G, B)] \vee [(M, C)] = [H, A \times B \times C] = (d_{ij})$ is a soft matrix, is defined by $(d_{ij}) = (a_{ij}) \cup (b_{ij}) \cup (c_{ij})$.

Example 3.12. Assume that a mobile shop has a set of different types of mobiles $U = \{m_1, m_2, m_3, m_4, m_5\}$ which may be characterized by a set of parameters $E = \{x_1, x_2, x_3, x_4\}$. For$j = 1, 2, 3, 4$ the parameters x_j stand for expensive, beautiful, branded, cheap, respectively.

Step 1: The three friends $Mr.X, Mr.Y$ and $Mr.Z$ have the choose the sets of their parameters, $A = \{x_1, x_2, x_3\}, B = \{x_2, x_3, x_4\}$ and $C = \{x_1\}$ respectively.

Step 2: The cartesian product of the three soft sets are
$(F, A) = \{((x_1), \{m_1, m_3, m_4, m_5\}), ((x_2), \{m_2, m_3, m_5\}), ((x_3), \{m_4\})\}$
$(G, B) = \{((x_2), \{m_1, m_3, m_5\}), ((x_3), \{m_2, m_3\}), ((x_4), \{m_2\})\}$ and
$(H, C) = \{((x_1), \{m_1, m_3\})\}$.
The Or product of cartesian set is defined as $(F, A) \vee (G, B) \vee (H, C)$

$$\begin{aligned}
=\{&((x_1, x_2, x_1), \{m_1, m_3, m_4, m_5\}), ((x_1, x_3, x_1), \{m_1, m_2, m_3, m_4, m_5\}),\\
&((x_1, x_4, x_1), \{m_1, m_2, m_3, m_4, m_5\}), ((x_2, x_2, x_1), \{m_1, m_2, m_3, m_5\}),\\
&((x_2, x_3, x_1), \{m_1, m_2, m_3, m_5\}), ((x_2, x_4, x_1), \{m_1, m_2, m_3, m_5\}),\\
&((x_3, x_2, x_1), \{m_1, m_3, m_4, m_5\}), ((x_3, x_3, x_1), \{m_1, m_2, m_3, m_4\}),
\end{aligned}$$

$((x_3, x_4, x_1), \{m_1, m_2, m_3, m_4\})\}$

Step 3: Now, we can find a cartesian product of the soft matrix A , B and C by using OR-product as follows

$$(d_{ij})_{(5\times 9)} = \begin{pmatrix} 1 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 \\ 0 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0 & 0.5 & 0.5 \\ 1 & 1 & 0.5 & 1 & 1 & 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0 & 0 & 0 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0.5 & 0 & 0 \end{pmatrix}$$

Note: Let p_1 be the maximum element in the sets {A,B and C} and let p_2 be the next maximum element in the sets {A,B and C}. Let $p = p_1 \times p_2$.

Step 4: We can find a max-max decision soft sets as
Max {Max values in every column}= Max $\{\{m_1, m_3\}, \{m_3\}, \{m_1, m_2, m_3, m_4, m_5\}, \{m_3\}, \{m_3\}, \{m_1, m_2, m_3, m_5\}, \{m_1, m_3, m_4, m_5\}, \{m_1, m_2, m_3, m_4\}, \{m_1, m_2, m_3, m_4\}\} = m_3$, and $(d_j) = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \end{pmatrix}^T$.

Step 5: Finally, $Mr.X, Mr.Y$, and $Mr.Z$ combinations buy the Mobile m_3.

4. Conclusion

Thus, we have presented a new algorithm using the product soft marix and proposed a new "OR" operations of soft matrix to solve soft matrix based decision making problems. The advantage of this new suggested method is that it is very convenient and easy to apply when compared with the other methods. This new method is also used to apply for soft sets and soft matrices based on decision making problems involving any number of decision makers.

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