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The Role of Operators on Soft Sets in Decision Making Problems

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Abstract

In this paper, we construct soft min-max decision making method by defining soft min-max decision function. We discuss the role of operators in decision making problems with suitable examples.

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1. Introduction

Most of the problems we are meeting in everyday life are vague rather than precise, in recent years Scientists and Engineers have become interested in modelling vagueness because many problems in the field of Engineering, Agricultural, Social Science and Medical Science involve data containing various types of uncertainities. In 1999, Molodstov [8] initiated soft set theory as a general Mathematical tool for dealing with uncertainities. Soft sets have been used extensively for decision making problems. Research on soft sets based decision making has received much attention in recent years.

Decision making is very sensitive in today's fast moving world. It takes significant role in the field of selection of best fit in different alternatives. Different parameters and their values help decision makers to take right decision at right time. Maji et al. [6] gave first practical applicaion of soft sets in decision making problems. Maji et al. [7] defined soft binary operations like AND, OR, Union, Intersection of two soft sets. Xiao et al. [10], in his paper, an appropriate definition and method was designed for recognizing soft information patterns by establishing the information table based on soft sets theory. Mappings on soft sets are defined by A. Kharal and B. Ahmad [1]. Naim Cagman and Serdar Enginoglu. [4] redefined the operations of Molodstov's soft sets to make them more functional for improving several new results. They also constructed uni-int decision making method for the AND product by using uni-int decision making function. Molodstov et al. [9] introduced the soft sets technique and its applications. Aktas and Cagman [2] defined soft sets and soft groups. In 2009, Ali et al. [3] gave some operations in the soft sets. Further, Cagman and Serdar [5] defined soft matrices and their operations. Consequently, we construct $min - max$ decision making methods for OR, AND, AND-NOT and OR-NOT product operators of the soft sets and discuss the applications with suitable examples in the field of Agriculture, Medicine and Social science.

2. Preliminaries

Definition 2.1. [8] Let U be an initial universe,$P(U)$ be the power set of U,E be the set of all parameters and $A \subseteq E$.A soft set (f_A, E) on the universe U is defined by the set of ordered pairs $(f_A, E) = \{(e, f_A Ł(e) : e \in E, f_A(e) \in P(U)\}$,where $f_A : E \to P(U)$ such that $F_A(e) = 0$,if $e \notin A$.Here,f_A is called an approximate function of the soft set $f_A(e)$.The set $f_A(e)$ is called e-approximate value set or e-approximate set which consists of related objects of the parameter $e \in E$.

Definition 2.2. [5] Let (f_A, E) be a soft set over U.Then a subset of $U \times E$ is uniquely defined by,$R_A = \{(u, e) : e \in E, u \in f_A(e)\}$,which is called a relation form of (f_A, E).The characteristic function of R_A is written by $\chi_{R_A} : U \times E \to \{0, 1\}$,

$$\chi_{R_A}(u, e) = \begin{cases} 1, & (u, e) \in R_A \\ 0, & (u, e) \notin R_A \end{cases}$$

If $U = \{u_1, u_2, \ldots, u_m\}$,$E = \{e_1, e_2, \ldots, e_n\}$ and $A \subseteq E$, then the set R_A can be presented by a table as in the following form,

R_A	e_1	e_2	$\dots$	e_n
u_1	$\chi_{R_A}(u_1, e_1)$	$\chi_{R_A}(u_1, e_2)$	$\dots$	$\chi_{R_A}(u_1, e_n)$
u_2	$\chi_{R_A}(u_2, e_1)$	$\chi_{R_A}(u_2, e_2)$	$\dots$	$\chi_{R_A}(u_2, e_n)$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
u_m	$\chi_{R_A}(u_m, e_1)$	$\chi_{R_A}(u_m, e_2)$	$\dots$	$\chi_{R_A}(u_m, e_n)$

If $a_{ij} = \chi_{R_A}(u_i, e_j)$, we can define a matrix

$$[a_{ij}]_{m\times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

which is called an $m \times n$ soft matrix of the soft set (f_A, E) over U.
According to this definition,a soft set (f_A, E) is uniquely characterized by the matrix $[a_{ij}]_{m\times n}$. It means that a soft set (f_A, E) is formally equal to its soft matrix $[a_{ij}]_{m\times n}$.Therefore, we shall identify any soft set with its soft matrix and these two concepts as interchangeable. The set of all $m \times n$ soft matrices over U will be denoted by $SM_{m\times n}$. We shall delete the subscripts $m \times n$ of $[a_{ij}]_{m\times n}$, we use $[a_{ij}]$ instead of $[a_{ij}]_{m\times n}$, since $[a_{ij}] \in SM_{m\times n}$ means that $[a_{ij}]$ is an $m\times n$ soft matrix for $i = 1, 2, \dots, n$ and $j = 1, 2, \dots, m$.

Definition 2.3. [5] Let $[a_{ij}], [b_{ij}] \in SM_{m\times n}$. Then the soft matrix $[c_{ij}]$ is called

(a) union of $[a_{ij}]$ and $[b_{ij}]$, denoted by $[a_{ij}]\tilde{\cup}[b_{ij}]$, if $[c_{ij}] = \max\{a_{ij}, b_{ij}\}$ for all i and j.

(b) intersection of $[a_{ij}]$ and $[b_{ij}]$, denoted by $[a_{ij}]\tilde{\cap}[b_{ij}]$,if $[c_{ij}] = \min\{a_{ij}, b_{ij}\}$ for all i and j.

(c) complement of $[a_{ij}]$, denoted by $[a_{ij}]^{\circ}$, if $c_{ij} = 1 - a_{ij}$ for all i and j.

Definition 2.4. [5] Let $[a_{ij}], [b_{ik}] \in SM_{m\times n}$. Then $\wedge$-product(AND operator) of $[a_{ij}]$ and $[b_{ik}]$ is defined by
$\wedge : SM_{m\times n} \times SM_{m\times n} \to SM_{m\times n^2}$,

$$[a_{ij}] \wedge [b_{ik}] = [c_{ip}]$$

where $c_{ip} = \min\{a_{ij}, b_{ik}\}$ such that $p = n(j-1) + k$.

Definition 2.5. [5] Let $[a_{ij}], [b_{ik}] \in SM_{m\times n}$. Then $\vee$-product(OR operator) of $[a_{ij}]$ and $[b_{ik}]$ is defined by

$$\vee : SM_{m\times n} \times SM_{m\times n} \to SM_{m\times n^2}, [a_{ij}] \vee [b_{ik}] = [c_{ip}]$$

where $c_{ip} = \max\{a_{ij}, b_{ik}\}$ such that $p = n(j-1) + k$.

Definition 2.6. [5] Let $[a_{ij}], [b_{ik}] \in SM_{m\times n}$. Then $\bar{\wedge}$-product(AND-NOT operator) of $[a_{ij}]$ and $[b_{ik}]$ is defined by

$$\bar{\wedge} : SM_{m\times n} \times SM_{m\times n} \to SM_{m\times n^2}, [a_{ij}]\bar{\wedge}[b_{ik}] = [c_{ip}]$$

where $c_{ip} = \min\left\{a_{ij}, 1 - b_{ik}\right\}$ such that $p = n(j-1) + k$.

Definition 2.7. [5] Let $[a_{ij}], [b_{ik}] \in SM_{m\times n}$. Then $\underline{\vee}$-product(OR-NOT operator) of $[a_{ij}]$ and $[b_{ik}]$ is defined by

$$\underline{\vee} : SM_{m\times n} \times SM_{m\times n} \to SM_{m\times n^2}, [a_{ij}]\bar{\vee}[b_{ik}] = [c_{ip}]$$

where $c_{ip} = \max\left\{a_{ij}, 1 - b_{ik}\right\}$ such that $p = n(j-1) + k$.

Definition 2.8. [5] Let $[c_{ip}] \in SM_{m\times n^2}$, $I_k = \left\{p : \exists i, c_{ip} \neq 0, (k-1)n < p \leq kn\right\}$ for all $k \in I = \{1, 2, \ldots, n\}$. Then soft max-min decision function, denoted Mm, is defined as follows

$$Mm : SM_{m\times n^2} \to SM_{m\times 1}, Mm[c_{ip}] = [\max_{k\in I}\{t_k\}]$$

where

$$t_k = \begin{cases} \min\limits_{p\in I_k}\left\{c_{ip}\right\}, & if\, I_k \neq \phi \\ 0, & if\, I_k = \phi \end{cases}$$

The one column soft matrix $Mm[c_{ip}]$ is called max-min decision soft matrix.

Definition 2.9. [5] Let $U = \{u_1, u_2, \ldots, u_m\}$ be an initial universe and $Mm[c_{ip}] = [d_{i1}]$. Then a subset of U can be obtained by using $[d_{i1}]$ as in the following way

$$opt_{[d_{i1}]}(U) = \{u_i : u_i \in U, d_{i1} = 1\}$$

which is called an optimum set of U.

3. Soft min-max decision making

In this section, we construct a soft min-max decision making (SmMDM) method by using soft min-max decision function which is also defined here. The method selects optimum alternatives from the set of alternatives.

Definition 3.1. Let $[c_{ip}] \in SM_{m\times n^2}$, $I_k = \left\{p : \exists i, c_{ip} \neq 0, (k-1)n < p \leq kn\right\}$ for all $k \in I = \{1, 2, \ldots, n\}$. Then soft min-max decision function, denoted mM, is defined as follows

$$mM : SM_{m\times n^2} \to SM_{m\times 1}, mM[c_{ip}] = [\min_{k\in I}\{t_k\}]$$

where

$$t_k = \begin{cases} \max\limits_{p\in I_k}\left\{c_{ip}\right\}, & if\, I_k \neq \phi \\ 0, & if\, I_k = \phi \end{cases}$$

The one column soft matrix $mM[c_{ip}]$ is called min-max decision soft matrix.

Definition 3.2. Let $U = \{u_1, u_2, \ldots, u_m\}$ be an initial universe and $mM[c_{ip}] = [d_{i1}]$. Then a subset of U can be obtained by using $[d_{i1}]$ as in the following way

$$opt_{[d_{i1}]}(U) = \{u_i : u_i \in U, d_{i1} = 1\}$$

which is called an optimum set of U.

Now, by using the definitions we can construct a $SmMDM$ method by the following algorithm.

Step 1: Choose feasible subsets of the set of parameters,

Step 2: construct the soft matrix for each set of parameters,

Step 3: find a convenient product of the soft matrices,

Step 4: find a min-max decision soft matrix,

Step 5: find an optimum set of U.

4. Applications

In this section, we analyse the role of operators defined on soft sets in decision making problems. At first we apply different operators to a single real life problem and we obtain different decisions. Then we apply the operators to analyse the practical problems in different fields like Social Science and Agriculture, to get the right decision to that problems.

4.1. In Medicine

Cancer is a common health problem in today's hectic and stressful life style. Cancer is a manageable condition and cancer patients can live an almost normal life, if the right steps are followed. Creating awareness of cancer, alternate healing methods and sensitizing people on various ways of being healthy is a prime aim. Focussing on this,we construct a model using soft sets with suitable parameters. Using min-max decision method for the operators $\wedge$, $\bar{\wedge}$ and $\underline{\vee}$, we can get the relevant conclusions.

Consider a set of patients $U = \{u_1, u_2, u_3, u_4, u_5\}$, $i = 1, 2, 3, 4, 5$ $u_i's$ stands for patients with different habits "smoking", "taking healthy balanced diet", "practicing yoga", "chewing tobacco" and "using organic food" respectively, which may be characterized by a set of parameters $E = \{e_1, e_2, e_3, e_4\}$ for $j = 1, 2, 3, 4$ the parameter $e_j's$ stands for "lung cancer patients", "mouth cancer patients", "set of people above 50 years" and "set of people below 50 years", respectively.

$\wedge$-operator on soft sets

Suppose that two Doctors X and Y analyse the causes of the cancer with their own set of parameters, then $smMDm$ gives a right decision for the patients on the basis of their set of parameters using the $\wedge$ operator by $smMDM$.This helps to identify the **risk factors** for cancer.

Assume that $U = \{u_1, u_2, u_3, u_4, u_5\}$ is the universal set and $E = \{e_1, e_2, e_3, e_4\}$ is the set of all parameters.

Step 1: First, Dr.X and Dr.Y have to choose the sets of their parameters, $A = \{e_1, e_2, e_3\}$ and $B = \{e_1, e_2, e_4\}$, respectively.

Step 2: Then we can write the following soft matrices which are constructed according to their parameters.

$$[a_{ij}] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} [b_{ik}] = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Step 3: Now, we can find a product of the soft matrices $[a_{ij}]$ and $[b_{ik}]$ by using $\wedge$-product as follows

$$[a_{ij}] \wedge [b_{ik}] = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

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

$$mM([a_{ij}] \wedge [b_{ik}]) = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Step 5: Finally, we can find an optimum set of U according to $mM([a_{ij}] \wedge [b_{ik}])$

$$opt_{mM([a_{ij}]\wedge[b_{ik}])}(U) = \{u_1, u_4\}$$

where u_1 and u_4 are the optimum choices to the problem.

The above analysis shows that **smoking** and **chewing tobacco** causes the cancer irrespective of their age according to Dr. X and Dr.Y.

$\bar{\wedge}$-operator on soft sets

Consider the same set of parameters as above,then we give a right decision for the patients on the basis of the parameters using $\bar{\wedge}$ operator by $smMDM$. This gives **preventive measures** for cancer.

Assume that $U = \{u_1, u_2, u_3, u_4, u_5\}$ is the universal set and $E = \{e_1, e_2, e_3, e_4\}$ is the set of all parameters.

Step 1: Suppose that Dr. X and Dr. Y choose the same sets of their parameters,

$$A = \{e_1, e_2, e_3\}$$

and

$$B = \{e_1, e_2, e_4\},$$

respectively.

Step 2: Then we can write the following soft matrices which are constructed, according to their parameters.

$$[a_{ij}] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} [b_{ik}] = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Step 3: Now, we can find a product of the soft matrices $[a_{ij}]$ and $[b_{ik}]$ by using $\bar{\wedge}$-product as follows

$$[a_{ij}]\bar{\wedge}[b_{ik}] = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

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

$$mM([a_{ij}]\bar{\wedge}[b_{ik}]) = \begin{bmatrix} 0 \\ 1 \\ 1 \\ 0 \\ 1 \end{bmatrix}$$

Step 5: Finally, we can find an optimum set of U according to $mM([a_{ij}]\bar{\wedge}[b_{ik}])$

$$opt_{mM([a_{ij}]\bar{\wedge}[b_{ik}])}(U) = \{u_2, u_3, u_5\}$$

where u_2, u_3 and u_5 are the optimum choices to the problem.

The above analysis shows that taking **healthy balanced diet**, **practicing yoga** and **using organic food** are the preventive measures of cancer according to Dr. X and Dr. Y.

$\underline{\vee}$-operator on soft sets

Consider the same set of parameters as above,then we give a right decision for the patients on the basis of the parameters by using $OR - NOT$ operator by $smMDM$.This gives an **awareness** of cancer.

Assume that $U = \{u_1, u_2, u_3, u_4, u_5\}$ is the universal set and $E = \{e_1, e_2, e_3, e_4\}$ is the set of all parameters.

Step 1: Suppose that Dr.X and Dr.Y choose the same sets of their parameters, $A = \{e_1, e_2, e_3\}$ and $B = \{e_1, e_2, e_4\}$, respectively.

Step 2: Then we can write the following soft matrices which are constructed according to their parameters.

$$[a_{ij}] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} [b_{ik}] = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Step 3: Now, we can find a product of the soft matrices $[a_{ij}]$ and $[b_{ik}]$ by using $\underline{\vee}$-product as follows

$$[a_{ij}]\bar{\vee}[b_{ik}] = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

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

$$mM([a_{ij}]\bar{\vee}[b_{ik}]) = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

Step 5: Finally, we can find an optimum set of U according to $mM([a_{ij}]\bar{\vee}[b_{ik}])$

$$opt_{mM([a_{ij}]\bar{\vee}[b_{ik}])}(U) = \{u_1, u_2, u_3, u_4, u_5\}$$

where u_1, u_2, u_3, u_4 and u_5 are the optimum choices to the problem.

From the above result, we conclude that smoking and chewing tobacco will cause cancer, even when we practice yoga and take healthy food. This is an **awareness** of cancer using $\underline{\vee}$ operator according to Dr. X and Dr. Y.

4.2. In Social Science

Hospitals play a critical role in all types of disaster. Hospital management is important, not only for the patients but also for medical professionals and the health care system. Patients arriving spontaneously at the unit will be passed onto an emergency physician who will assess the urgency of the condition. The responsible doctor may be able to treat the patients immediately. Let us consider a situation that 10 people who met an accident rushes to a multi-speciality hospital with multiple injuries. The following model helps to refer the patient to the doctor immediately according to their injuries.

Consider the set of patients $U = \{u_1, u_2, u_3, u_4, u_5, \ldots, u_{10}\}$ for $i = 1, 2, \ldots, 10$ $u_i's$ who met with an accident and require immediate medical treatment which may be characterized by a set of parameters $E = \{e_1, e_2, e_3, e_4, e_5, e_6\}$ for $j = 1, 2, 3, 4, 5, 6$ the parameter $e_j's$ stands for "Ortho", "Surgeon", "Ophthalmologist", "Cardiologist", "Neurologist" and "Nephrologist", respectively. The situation is handled by two units, unit A and unit B of the Hospital. Unit A is parametrized with the set of Doctors, $A = \{e_1, e_3, e_4, e_5\}$ and unit B is parametrized with the set of Doctors, $B = \{e_2, e_4, e_5, e_6\}$.

We give a right decision for the patients on the basis of parameters using soft sets by $smMDM$ as follows.

Assume that $U = \{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8, u_9, u_{10}\}$ is a universal set and $E = \{e_1, e_2, e_3, e_4, e_5, e_6\}$ is a set of all parameters.

We can use $\vee$-operator to check whether the patient is admitted or to be treated as out-patients.

Step 1: Let us choose the set of parameters, $A = \{e_1, e_3, e_4, e_5\}$ and $B = \{e_2, e_4, e_5, e_6\}$.

Step 2: Then we can write the following soft matrices which are constructed according to the parameters.

$$[a_{ij}] = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix} \quad [b_{ik}] = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

Step 3: Now, we can find a product of the soft matrices $[a_{ij}]$ and $[b_{ik}]$ by using $\vee$-product as follows

$$[a_{ij}] \vee [b_{ik}] = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \tag{4.1}$$

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

$$mM([a_{ij}] \vee [b_{ik}]) = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 1 \\ 1 \\ 1 \\ 0 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

Step 5: Finally, we can find an optimum set of U according to $mM([a_{ij}] \vee [b_{ik}])$

$$opt_{mM([a_{ij}] \vee [b_{ik}])}(U) = \{u_1, u_2, u_4, u_5, u_6, u_8, u_9, u_{10}\}$$

where $u_1, u_2, u_4, u_5, u_6, u_8, u_9$ and u_{10} are the optimum choices to the problem.

We conclude that eight patients amongst the ten have to be admitted in the emergency unit while two patients $\{u_3, u_7\}$ may be treated as out-patients.

4.3. In Agriculture

Now we study the case for the agricultural problem using $\wedge$ operator. Since 1975, the area of cultivated land world wide expanded by only 4%, while the world's population increased by 40%. The present and expected future rate of world population growth, expanding cultivated arable land is not a viable solution for producing a substainable world food supply. So an alternative to meet world demand for food is **multiple cropping**. The two major categories of multiple cropping are succession cropping and intercropping. In both categories two or more crops are grown on the same land. Selecting the right crop for the given soil is a primary key that can optimise yields. Soft sets can be used to model this problem with appropriate parameters and we apply $SmMDM$ method to have right decision.

Consider the different types of crops $U = \{u_1, u_2, u_3, u_4, u_5\}$ for $i = 1, 2, 3, 4, 5$ $u_i's$ “coconut”, “banana”, “tea/coffee”, “rice” and “wheat,” respectively which may be characterized by a set of parameters $E = \{e_1, e_2, e_3, e_4, e_5\}$ for $j = 1, 2, 3, 4, 5, 6$ the parameter $e_j's$ stands for “alluvial soil”, “black soil”, “red soil”, “laterite soil” and “mountain soil” respectively.

Assume that $U = \{u_1, u_2, u_3, u_4, u_5\}$ is the universal set and $E = \{e_1, e_2, e_3, e_4, e_5, \}$ is the set of all parameters.

Step 1: Let us choose the set of parameters, $A = \{e_1, e_2, e_3\}$ and $B = \{e_2, e_4, e_5\}$.

Step 2: Then we can write the following soft matrices which are constructed according to the parameters.

$$[a_{ij}] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix} [b_{ik}] = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

Step 3: Now, we can find a product of the soft matrices $[a_{ij}]$ and $[b_{ik}]$ by using $\wedge$-product as follows

$$[a_{ij}] \wedge [b_{ik}] = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

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

$$mM([a_{ij}] \wedge [b_{ik}]) = \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Step 5: Finally, we can find an optimum set of U according to $mM([a_{ij}] \wedge [b_{ik}])$

$$opt_{mM([a_{ij}] \wedge [b_{ik}])}(U) = \{u_1, u_2\}$$

where u_1 and u_2 are the optimum choices to the problem.

From the above analysis, we can decide **coconut** and **banana** can be chosen for inter-cropping.

5. Conclusion

This paper is a continuation of Naim Cagman and Serdar Enginoglu work. The authors in [2] provided a soft decision making model on the soft set theory and applied it to real life problem. Based on their method, we analyse a real life problem with different operators and we observe that choice of operator is important to get the needful decision. Hence, we conclude that the use of operators on soft sets play an important role in decision making which is flexible.

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