New Technology in Agriculture Using Neutrosophic Soft Matrices with the Help of Score Function

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Abstract

Uncertainty is a big problem in our routine life. Many theories were developed to handle uncertain environments. This paper approaches the concept of neutrosophic soft matrices (NSM) and multiple types of NSM to achieve solutions to a possible problem and provide ideas to tackle other problems relating to uncertainties. Here, NSM has been utilized to demonstrate the performance of different farmers, and further score function has been implemented to solve a possible application of decision making in agriculture. It explains the selection of the best farmer by scientific experts through an algorithm in this paper. The selection based upon the better production of crop and nature, fertilizer, pesticides, etc. are used as attributes, which will contribute to the performance of each farmer. Finally, combining the attributes, which will help us achieve a conclusion to determine the best farmer.

Keywords: Neutrosophic Soft Set, NSM, Agriculture, Decision Making, Score function.

1. Introduction

Many researchers use different tools to solve the uncertainties and problematic issues in different fields like engineering, business administration, environment, medical sciences, etc., which are unable to solve, by using standard mathematical tools. To overcome the difficulties of standard tools, researchers work to apply different tools to deal with uncertain problems. Some of these are fuzzy sets, intuitionistic fuzzy sets, neutrosophic sets, etc. In 1965 Lotfi. A. Zadeh [1] proposed a wonderful theory named the fuzzy set theory to deal with uncertain issues. Further, in 1975, a more advanced interval-valued fuzzy set (IVFS) was proposed by Yang [2], which has a wide range than a simple fuzzy set. In 1982, Pawalk initiated another wonderful theory named rough set theory [3]. After that, the intuitionistic fuzzy set theory was coined by Atanassov [4] in 1983. In 1995 neutrosophic fuzzy set was proposed by Florentine Smarandache [5]. After that, in 1999, Molodtsov [6] developed the soft set theory, which is a major mathematical operator when dealing with decision-making problems in a vague environment. It has wide applications such as decision making in the medical field, economics, and social sciences. In 2001, Maji et al. [7] extended the Molodtsov [6] theory and defined different basics of soft sets. Later in 2004, Maji et al. [8] proposed the idea of intuitionistic fuzzy soft sets. Cagman [9] coined the idea of fuzzy soft matrices in 2010. Fuzzy soft matrices have a wide range of applications in decision-making problems. However, simple matrix theory fails when sometimes dealing with uncertainty problems. After that, in 2012, Das and Chetia [10] introduced intuitionistic fuzzy soft matrices (abbr. IFSMs) with different types of products and axioms on these products. Then, Mondal et al. [11, 12] introduced different types of IFSMs. In some real-world problems, we need to go with different tools to solve the uncertainty and abstruse problems, and furthermore, if we talk about intuitionistic fuzzy soft sets, we just have to deal with truth and false-membership values for a proper description of an object. The intuitionistic fuzzy sets can only handle the unclear info regarding both truth and false membership values. The neutrosophic soft set is a complete family of all neutrosophic sets, which is the generalized form of an intuitionistic fuzzy soft set with truth-value, indeterminate value, and false value. In 2013 P.K.Maji [13] defined different operators on neutrosophic fuzzy soft set and applied soft sets in unpredictable problems. In 2014, Broumi, et al. [14] defined interval-valued NSS and its applications in decision-making problems. In the same year, Broumi et al. [15] proposed different relations on interval-valued neutrosophic soft sets. It leads to decision making in various fields of life. In 2014, Broumi, et al. [16] applied different mappings on neutrosophic soft expert sets. In the same year, Irfan Deli and Broumi[17] defined neutrosophic soft matrices and used soft matrices in decision-making. Applications were requiring decision-making, having multiple selection criteria. Researchers applied these techniques in decision making in different fields of life. In 2019, Jafar et al. [18] applied intuitionistic soft set in medical diagnose. In 2019, Jafar et al. [19] worked on Sanchez's identification by trapezoidal fuzzy number. In 2020, Jafar et al. [20] discussed the application of soft-set relation and soft matrix in medical diagnosis by Sanchez. In 2019, Riaz et al. [21] studied the hardness of the water in laundry based on the fuzzy logic controller. The selection of smartphones in Pakistan decision making by Saqlain et al. [22] in 2018. In 2019, Saqlain et al. [23] predicted about 2019 Cricket world cup by TOPSIS Technique. Researchers [24-26] applied different strategies for problem solving and selection. In 2009, Mustafa et al. [27] applied fuzzy logic on sorting and grading in agriculture. After in 2013, Papageorgion et al. [28] proposed yield prediction using the fuzzy cognitive map. In 2014, Virgin and Riganabanu [29] proposed an application of an interval-valued fuzzy soft matrix for the detection of diseases in plants. In 2017, Neamatollah et al. [30] proposed an optimal cropping pattern of agriculture on the fuzzy system. In 2018, Mota et al. [31] defined fuzzy validity measures and their applications of decision making in agricultural engineering. In the same year, 2018, Loganathan and Pushpalatha [32] proposed an application in agriculture using fuzzy matrices. In 2019, Savarimuthu and Mahalaksmi [33] defined T-Conorm operators on IFSM and proposed its applications in agriculture. For more information on neutrosophic theory and their application, we refer the readers to the following references [34-37]. In this paper, the concept of neutrosophic fuzzy soft matrices, different types of fuzzy neutrosophic soft matrices, and some operators on soft matrices and its application in agriculture has been demonstrated. Several applications, studied under neutrosophic soft matrices, fuzzy neutrosophic matrices and neutrosophic fuzzy matrices, have been worked on and are being worked on as we speak. Conclusively, neutrosophic fuzzy soft matrices have been used in decision making to approach the desired result. The goal is to display the usage of the said concepts and ideas in the possible application of agriculture. In section 2, the discussion is about the soft set and its different types. In section 3, the discussion is about methodology, which is used in the application of neutrosophic soft matrices. In section 4 and 5, we discussed the algorithm and real-life example of an NSM.

2 Preliminaries

In this section, some basics will be under discussion; to understand the concepts of paper, you must know the following.

2.1 Soft Set [20]

Let K be a set of alternatives, and D is a set of attributes. Let P (K) denotes the set of all subsets of K and A is a subset of D. Then $(F\ ,A)$ is called a soft set over K where F is a mapping given by $F: A \to P(K)$.In fact soft set $(F\ ,A)$ is a family of subsets of K. For $e \in A$, $(F\ ,A)$ is defined as

$$(F\ ,A) = \{F(e) \in P(K): e \in D\ , F(e) = \emptyset\ if\ e \notin A\}$$

Example 2.1

Let $K = \{f_1, f_2, f_3, f_4\}$ be a set of houses of different colors (paints) and $D = \{Yellow\ (e_1), Green(e_2), Sky\ blue(e_3)\}$ is a set of attributes. If $A = \{e_1, e_3\} \subseteq D$. Let $F_A(e_1) = \{f_1, f_2, f_4\}$ and $F_A(e_3) = \{f_1, f_3, f_4\}$ then the soft set$(F_A\ , D) = \{(e_1, \{f_1, f_2, f_4\}), (e_3, \{f_1, f_3, f_4\})\}$, which describes the colors of houses. We write the soft set as follows

K	Yellow($\boldsymbol{e_1}$)	Green($\boldsymbol{e_2}$)	Sky blue($\boldsymbol{e_3}$)
$\boldsymbol{f_1}$	1	0	1
$\boldsymbol{f_2}$	1	0	0
$\boldsymbol{f_3}$	0	0	1
$\boldsymbol{f_4}$	1	0	1

2.2 Fuzzy Soft Set [21]

Let K be a universe, and D be a set of attributes and any set $A \subseteq D$. Let $P(K)$ denotes the set of all fuzzy sets of K. A set (F_A, D) is said to be fuzzy soft set over K such that F_A is a mapping given by $F_A: D \to P(K)$ such that $F_A(e) = \varphi$ if $e \notin A$ where φ is a null fuzzy set.

Example 2.2

See example 2.1, we give membership value in 0 or 1, but in FSS we choose membership value from interval [0,1] instead of crisp numbers 0 and 1.Then

$(F_A, D) = F_A(e_1) = \{(f_1, 0.5), (f_2, 0.3), (f_4, 0.8)\}$

$F_A(e_3) = \{(f_1, 0.2), (f_3, 0.9), (f_4, 0.6)\}$ is the fuzzy soft sets describe the colors of houses.

K	Yellow($\boldsymbol{e_1}$)	Green($\boldsymbol{e_2}$)	Sky blue($\boldsymbol{e_3}$)
$\boldsymbol{f_1}$	0.5	0.0	0.2

f_2	0.3	0.0	0.0
f_3	0.0	0.0	0.9
f_4	0.8	0.0	0.6

2.3 Fuzzy Soft Matrices (FSM) [18]

Let (F_A, D) be a fuzzy soft set and $K \times D$ is defined by a relation $G_A = \{(f, e): e \in A, f \in F_A(e)\}$.The function of G_A is written by $a_{GA}: K \times D \rightarrow [0,1]$ where $a_{GA}(f, e) \in [0,1]$ is the membership value.

If $[a_{ij}] = a_{ij}(f_i, e_j)$ then, the matrix is

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

Which is soft matrix of soft set (F, D) over K called the fuzzy soft matrix (FSS).

Example 2.3

Let $K = \{f_1, f_2, f_3, f_4, f_5\}$ is a universal set and $D = \{e_1, e_2, e_3, e_4\}$ is a set of all attributes then

$A = \{e_1, e_2, e_4\} \subseteq D$ Then the soft set $(F_D, A) = \{F_D(e_1), F_D(e_2), F_D(e_4)\}$ where

$F_D(e_1) = \{(f_1, 0.5), (f_2, 0.3), (f_3, 0.1), (f_4, 0.2), (f_5, 0.8)\}$

$F_D(e_2) = \{(f_1, 0.3), (f_2, 0.6), (f_3, 0.4), (f_4, 0.9), (f_5, 0.2)\}$

$F_D(e_4) = \{(f_1, 0.2), (f_2, 0.7), (f_3, 0.1), (f_4, 0.3), (f_5, 0.5)\}$.

Then, the soft matrix $[a_{ij}]$ is

$$[a_{ij}] = \begin{bmatrix} 0.5 & 0.3 & 0.0 & 0.2 \\ 0.3 & 0.6 & 0.0 & 0.7 \\ 0.1 & 0.4 & 0.0 & 0.1 \\ 0.2 & 0.9 & 0.0 & 0.3 \\ 0.8 & 0.2 & 0.0 & 0.5 \end{bmatrix}$$

2.4 Neutrosophic Soft Set (NSS) [17]

Suppose K be a universe with an element in K denoted by f and D be a set of attributes. A neutrosophic set N over K is characterized by a truthiness T_A, indeterminacy I_A, and a falsity value F_A where T_A, I_A and F_A are real standard subsets of [0, 1]. And $f_N: D \rightarrow N(K)$

$$A = \{(e, \{< f, (T_A(f), I_A(f), F_A(f))\} >): f \in U, e \in D, T_A(f), I_A(f), F_A(f) \in [0,1]\}$$

There is no restriction on the sum of $T_A(f), I_A(f), F_A(f)$. $^-0 \leq T_A(f) + I_A(f) + F_A(f) \leq 3^+$.

Example 2.4

Let $K = \{f_1, f_2, f_3, f_4\}$ be a set of houses of different colors (paints) and $D = \{Yellow\ (e_1), Green(e_2), Sky\ blue(e_3)\}$ is a set of attributes. If$B = \{e_1, e_3\} \subseteq D$.

Let $(F_B, D) = F_B(e_1) = \{(f_1, 0.5,0.2,0.3), (f_2, 0.3,0.4,0.2), (f_4, 0.4,0.1,0.3)\}$

$F_B(e_3) = \{(f_1, 0.2,0.4,0.3), (f_3, 0.5,0.1,0.4), (f_4, 0.6,0.3,0.1)\}$ Which describes the colors of houses. We write the neutrosophic soft set as follows

K	Yellow($\boldsymbol{e_1}$)	Green($\boldsymbol{e_2}$)	Sky blue($\boldsymbol{e_3}$)
$\boldsymbol{f_1}$	0.5,0.2,0.3	0.0,0.0,0.0	0.2,0.4,0.3
$\boldsymbol{f_2}$	0.3,0.4,0.2	0.0,0.0,0.0	0.0,0.0,0.0
$\boldsymbol{f_3}$	0.0,0.0,0.0	0.0,0.0,0.0	0.5,0.1,0.4
$\boldsymbol{f_4}$	0.4,0.1,0.3	0.0,0.0,0.0	0.6,0.3,0.1

2.5 Neutrosophic Soft Matrix (NSM)

Suppose $K = \{\dot{f}_1, \dot{f}_2, \dot{f}_3, \ldots..\}$ be the universe and $D = \{e_1, e_2, e_3, \ldots..\}$ be a set of attributes and$A \subseteq D$. A set $(F\ , A)$ be an NFSS over K. Then the subset of $K \times D$

Is defined as $R_A = \{(\dot{f}\ , e); e \in A, \dot{f} \in F_A(e)\}$ which is the relation form of$(F_A\ , D)$. The truthiness, indeterminacy and falsity values are:

$$T_{R_A}: K \times D \to [0\ ,1]\ , \qquad I_{R_A}: K \times D \to [0\ ,1]\ , \qquad F_{R_A}: K \times D \to [0\ ,1]$$

$T_{R_A}(f, e) \in [0,1]$, $I_{R_A}(f, e) \in [0,1]$, $F_{R_A}(f, e) \in [0,1]$ are the truthiness, indeterminacy, and falsity of $f \in K$ for each $e \in D$?

If $[(T_{ij}, I_{ij}, F_{ij})] = [T_{ij}(\dot{f}_i, e_j), I_{ij}(\dot{f}_i, e_j), F_{ij}(\dot{f}_i, e_j)]$ then

$$[\langle T_{ij}, I_{ij}, F_{ij}\rangle]_{m\times n} = \begin{bmatrix} \langle T_{11}, I_{11}, F_{11}\rangle & \langle T_{12}, I_{12}, F_{12}\rangle & \cdots & \langle T_{1n}, I_{1n}, F_{i1n}\rangle \\ \langle T_{21}, I_{21}, F_{21}\rangle & \langle T_{22}, I_{22}, F_{22}\rangle & \cdots & \langle T_{2n}, I_{2n}, F_{2n}\rangle \\ \vdots & \vdots & \vdots & \vdots \\ \langle T_{m1}, I_{m1}, F_{m1}\rangle & \langle T_{m2}, I_{m2}, F_{m2}\rangle & \cdots & \langle T_{mn}, I_{mn}, F_{mn}\rangle \end{bmatrix}$$

That is called $m \times n$ order neutrosophic soft matrix over K.

Example 2.5

Let $K = \{\dot{f}_1, \dot{f}_2, \dot{f}_3, \dot{f}_4, \dot{f}_5\}$ is a universal set and $D = \{e_1, e_2, e_3, e_4\}$ is a set of all attributes then

$A = \{e_1, e_2, e_4\} \subseteq D$ Then the soft set $(F_D\ , A) = \{F_D(e_1), F_D(e_2), F_D(e_4)\}$ where

$F_D(e_1) = \{(f_1, 0.5,0.2,0.2), (f_2, 0.3,0.4,0.1), (f_3, 0.1,0.6,0.3), (f_4, 0.2,0.3,0.5), (f_5, 0.2,0.1,0.4)\}$

$F_D(e_2) = \{(f_1, 0.3,0.5,0.1), (f_2, 0.6,0.2,0.2), (f_3, 0.4,0.3,0.3), (f_4, 0.3,0.1,0.5), (f_5, 0.2,0.5,0.1)\}$

$F_D(e_4) = \{(f_1, 0.2,0.3,0.5), (f_2, 0.7,0.1,0.1), (f_3, 0.1,0.6,0.3), (f_4, 0.3,0.4,0.1), (f_5, 0.5,0.2,0.2)\}$.

Then, the neutrosophic soft matrix is

$$[\langle T_{ij}, I_{ij}, F_{ij}\rangle] = \begin{bmatrix} (0.5,0.2,0.2) & (0.3,0.5,0.1) & (0.0,0.0,0.0) & (0.2,0.3,0.5) \\ (0.3,0.4,0.1) & (0.6,0.2,0.2) & (0.0,0.0,0.0) & (0.7,0.1,0.1) \\ (0.1,0.6,0.3) & (0.4,0.3,0.3) & (0.0,0.0,0.0) & (0.1,0.6,0.3) \\ (0.2,0.3,0.5) & (0.3,0.1,0.5) & (0.0,0.0,0.0) & (0.3,0.4,0.1) \\ (0.2,0.1,0.4) & (0.2,0.5,0.1) & (0.0,0.0,0.0) & (0.5,0.2,0.2) \end{bmatrix}$$

2.6 Complement of Neutrosophic Soft Matrices

Suppose $A = [\langle T_{ij}, I_{ij}, F_{ij}\rangle] \in NSM_{m\times n}$.Then the complement of A is doted by A° and is defined as $A^{\circ} = [\langle F_{ij}, 1 - I_{ij}, T_{ij}\rangle]$ for all i and j.

Example 2.6

See example 2.5

$$A^{\circ} = [\langle F_{ij}, 1 - I_{ij}, T_{ij}\rangle] = \begin{bmatrix} (0.2,0.8,0.5) & (0.1,0.5,0.3) & (0.0,0.0,0.0) & (0.5,0.7,0.2) \\ (0.1,0.6,0.3) & (0.2,0.8,0.6) & (0.0,0.0,0.0) & (0.1,0.9,0.7) \\ (0.3,0.4,0.1) & (0.3,0.7,0.4) & (0.0,0.0,0.0) & (0.3,0.4,0.1) \\ (0.5,0.7,0.2) & (0.5,0.9,0.3) & (0.0,0.0,0.0) & (0.1,0.6,0.3) \\ (0.4,0.9,0.2) & (0.1,0.5,0.2) & (0.0,0.0,0.0) & (0.2,0.8,0.5) \end{bmatrix}$$

2.7 Addition of Neutrosophic Soft Matrices

If $A = [(T_{ij}^A, I_{ij}^A, F_{ij}^A)] \in NSM_{m\times n}$, $B = [(T_{ij}^B, I_{ij}^B, F_{ij}^B)] \in NSM_{m\times n}$ then$C = [(T_{ij}^C, I_{ij}^C, F_{ij}^C)] \in NSM_{m\times n}$. Then the addition of A and B as

$$A + B = C = \left(max(T_{ij}^A, T_{ij}^B), \frac{I_{ij}^A + I_{ij}^B}{2}, min(F_{ij}^A, F_{ij}^B) \right) \text{ for all i and j.}$$

2.8 Subtraction of Neutrosophic Soft Matrices

If $A = [(T_{ij}^A, I_{ij}^A, F_{ij}^A)] \in NSM_{m\times n}$, $B = [(T_{ij}^B, I_{ij}^B, F_{ij}^B)] \in NSM_{m\times n}$ then$C = [(T_{ij}^C, I_{ij}^C, F_{ij}^C)] \in NSM_{m\times n}$. Then subtraction of A and B as $A - B = C = (T_{ij}^A - T_{ij}^B, I_{ij}^A - I_{ij}^B, F_{ij}^A - F_{ij}^B)$ for all i and j.

3 Neutrosophic Soft Matrix Application in Agriculture

3.1 Value Matrix

Suppose $A = [(T_{ij}^A, I_{ij}^A, F_{ij}^A)] \in NSM_{m\times n}$ then, A is called the value of NSM denoted by $V(A)$ and is defined by

$V(A) = [(T_{ij}^A + I_{ij}^A - F_{ij}^A)]$ for all i and j, respectively. Where $i = 1,2,3 \dots \dots m$ and $j = 1,2,3 \dots \dots n$.

3.2 Score Matrix

If $A = [(T_{ij}^A, I_{ij}^A, F_{ij}^A)] \in NSM_{m\times n}$,$B = [(T_{ij}^B, I_{ij}^B, F_{ij}^B)] \in NSM_{m\times n}$. Then, the score matrix of A and B is denoted by $S_{(A,B)}$ and is defined as $S_{(A,B)} = V(A) - V(B)$.

3.3 Total Score

If $A = [(T_{ij}^A, I_{ij}^A, F_{ij}^A)] \in NSM_{m\times n}$,$B = [(T_{ij}^B, I_{ij}^B, F_{ij}^B)] \in NSM_{m\times n}$. Then, their corresponding value matrix be $V(A), V(B)$ and their score matrix be$S_{(A,B)}$. Then the total score for each u_i in U as

$$S_i = \sum_{j=1}^{n} (V(A) - V(B))$$

Methodology

Let K is a set of farmers who produces a quality of wheat for better health of human beings to be chosen as the best farmer. This whole process and selection of the farmers will be made by agriculture experts, use of natural resources, fertilizers and pesticides will be taken into account. Suppose D is a set, which consists of parameters relative to the harvested products by farmers. First of all, compute NFSS(F_A, D) over K show the farmers' selection by agricultural experts T, Where F_A is a mapping $F_A: D \to N(K)$, is the collection of all neutrosophic subsets of K. Now, computation of another NFSS(G_B, D) over K demonstrate farmers' selection by the agriculture experts from another field Z, Where G_B is a mapping$G_B: D \to N(K)$, is the assortment of all neutrosophic subsets of K. Now develop the matrices A and B relative to the neutrosophic soft sets (F_A, D) and(G_B, D). Also, compute the complement matrices A° and B° from the complements of neutrosophic soft set $(F_A, D)^\circ$ and set$(G_B, D)^\circ$, respectively. After this, calculate $A + B$, the greater membership value of farmers that will be judged by the experts. Also, calculate $A^\circ + B^\circ$, the maximum membership value of non-selected farmers. Now calculate value matrices $V\langle A + B\rangle$ and $V\langle A^\circ + B^\circ\rangle$ and score matrix $S_{(\langle A+B\rangle,\langle A^\circ+B^\circ\rangle)}$ and the total score S_i for each farmer in K. At last $S_K = max(S_i)$ determines that the farmer f_k is selected as the best farmer by the experts.

4. Algorithm

Step 1: Compute the neutrosophic soft set $(F_A, D), (G_B, D)$ and then find the NSMs A and B corresponding to the $(F_A, D) and (G_B, D)$ respectively.

Step 2: Compute the neutrosophic soft complement sets $(F_A, D)^\circ, (G_B, D)^\circ$ and compute the NSMs $A^\circ and B^\circ$ corresponding to the $(F_A, D)^\circ and (G_B, D)^\circ$ respectively.

Step 3: Calculate$(A + B), (A^\circ + B^\circ)$,$V(A + B), V(A^\circ + B^\circ)$ and $S_{((A+B),(A^\circ+B^\circ))}$.

Step 4: Calculate the total score S_i for each f_i in K.

Step 5: FindS_k = max (S_i), and then conclude the best farmer f_k has the maximum value.

Step 6: If S_k has more than one value, then repeat the step 1 and so repeat the complete process.

5 Application in Decision Making

As traditional mathematical methods are limited for solving problems, so researchers use different techniques for problems involving decision-making. Neutrosophic soft matrix (NSM) is one of those techniques that is used in this paper as this tool is used by many researchers to solve their MCDM (Multi-Criteria Decision Making) problems. Let us try to solve an MCDM problem by using NSM. Suppose (F_A, D) and (G_B, D) are two NSS showing the set of four farmers who are selected from the universal set $K = \{f_1, f_2, f_3, f_4\}$ by the experts T and

Z. Suppose $D = \{e_1, e_2, e_3\}$ be the set of attributes representing the different manures like nature, fertilizer, pesticides, etc. will be considered to choose the best farmer by examining wheat that is better for human health.

Step 1: Construction of Neutrosophic Soft Sets

$(F_A, D) = \{F_A(e_1), F_A(e_2), F_A(e_3)\}$

$F_A(e_1) = \{(f_1, 0.5,0.2,0.2), (f_2, 0.4,0.3,0.1), (f_3, 0.3,0.5,0.2), (f_4, 0.6,0.2,0.1)\}$

$F_A(e_2) = \{(f_1, 0.2,0.4,0.3), (f_2, 0.7,0.2,0.1), (f_3, 0.2,0.5,0.3), (f_4, 0.4,0.5,0.1)\}$

$F_A(e_3) = \{(f_1, 0.6,0.1,0.2), (f_2, 0.5,0.3,0.2), (f_3, 0.3,0.5,0.2), (f_4, 0.7,0.1,0.2)\}$.

$(G_B, D) = \{G_B(e_1), G_B(e_2), G_B(e_3)\}$

$G_B(e_1) = \{(f_1, 0.6,0.3,0,1), (f_2, 0.4,0.3,0.2), (f_3, 0.2,0.6,0.1), (f_{4,} 0.6,0.2,0.1)\}$

$G_B(e_2) = \{(f_1, 0.5,0.3,0.2), (f_2, 0.7,0.2,0.1), (f_3, 0.4,0.3,0.2), (f_4, 0.6,0.2,0.1)\}$

$G_B(e_3) = \{(f_1, 0.4,0.2,0.3), (f_2, 0.2,0.5,0.3), (f_3, 0.6,0.2,0.2), (f_4, 0.7,0.2,0.1)\}$.

These are neutrosophic soft matrices of above soft sets:

$$A = \begin{bmatrix} (0.5,0.2,0.2) & (0.2,0.4,0.3) & (0.6,0.1,0.2) \\ (0.4,0.3,0.1) & (0.7,0.2,0.1) & (0.5,0.3,0.2) \\ (0.3,0.5,0.2) & (0.2,0.5,0.3) & (0.3,0.5,0.2) \\ (0.6,0.2,0.1) & (0.4,0.5,0.1) & (0.7,0.1,0.2) \end{bmatrix}$$

$$B = \begin{bmatrix} (0.6,0.3,0.1) & (0.5,0.3,0.2) & (0.4,0.2,0.4) \\ (0.4,0.3,0.2) & (0.7,0.2,0.1) & (0.2,0.5,0.3) \\ (0.2,0.6,0.1) & (0.4,0.3,0.2) & (0.6,0.2,0.2) \\ (0.1,0.5,0.2) & (0.6,0.2,0.1) & (0.7,0.2,0.1) \end{bmatrix}$$

Step 2

Then, the neutrosophic soft complement matrices are

$$A^{\circ} = \begin{bmatrix} (0.2,0.8,0.5) & (0.3,0.6,0.2) & (0.2,0.9,0.6) \\ (0.1,0.7,0.4) & (0.1,0.8,0.7) & (0.2,0.7,0.5) \\ (0.2,0.5,0.3) & (0.3,0.5,0.2) & (0.2,0.5,0.3) \\ (0.1,0.8,0.6) & (0.1,0.5,0.4) & (0.2,0.9,0.7) \end{bmatrix}$$

$$B^{\circ} = \begin{bmatrix} (0.1,0.7,0.6) & (0.2,0.7,0.5) & (0.3,0.8,0.4) \\ (0.2,0.7,0.4) & (0.1,0.8,0.7) & (0.3,0.5,0.2) \\ (0.1,0.4,0.2) & (0.2,0.7,0.4) & (0.2,0.8,0.6) \\ (0.2,0.5,0.1) & (0.1,0.8,0.6) & (0.1,0.8,0.7) \end{bmatrix}$$

Step 3: Construction of Value Matrix.

$$(A + B) = \begin{bmatrix} (0.6,0.25,0.1) & (0.5,0.35,0.2) & (0.6,0.15,0.2) \\ (0.4,0.3,0.1) & (0.7,0.2,0.1) & (0.5,0.4,0.2) \\ (0.3,0.55,0.1) & (0.4,0.4,0.2) & (0.6,0.35,0.2) \\ (0.6,0.35,0.1) & (0.6,0.35,0.1) & (0.7,0.15,0.1) \end{bmatrix}$$

$$(A^{\circ} + B^{\circ}) = \begin{bmatrix} (0.2,0.75,0.5) & (0.3,0.65,0.2) & (0.3,0.85,0.4) \\ (0.2,0.7,0.4) & (0.1,0.8,0.7) & (0.3,0.6,0.2) \\ (0.2,0.6,0.2) & (0.3,0.6,0.2) & (0.2,0.65,0.3) \\ (0.2,0.65,0.1) & (0.1,0.65,0.4) & (0.2,0.85,0.71) \end{bmatrix}$$

$$V(A+B) = \begin{bmatrix} 0.75 & 0.65 & 0.55 \\ 0.6 & 0.8 & 0.7 \\ 0.75 & 0.6 & 0.75 \\ 0.85 & 0.85 & 0.75 \end{bmatrix}$$

$$V(A^{\circ}+B^{\circ}) = \begin{bmatrix} 0.45 & 0.75 & 0.75 \\ 0.5 & 0.2 & 0.7 \\ 0.6 & 0.7 & 0.55 \\ 0.75 & 0.35 & 0.35 \end{bmatrix}$$

Now calculate score matrix as

$$S_{((A+B),(A^{\circ}+B^{\circ}))} = \begin{bmatrix} 0.3 & -0.1 & -0.2 \\ 0.1 & 0.6 & 0 \\ 0.15 & -0.1 & 0.2 \\ 0.1 & 0.5 & 0.4 \end{bmatrix}$$

Step 4: To find the Total Score

$$\textbf{Total Score :} \quad \begin{bmatrix} 0.0 \\ 0.7 \\ 0.25 \\ 1.0 \end{bmatrix}$$

Step 5: Best Selection using highest score

$$S_k = 1.0$$

As we can see above the last value is maximum so the farmer h_4 has gain more score so the farmer h_4 is selected as best farmer by the experts.

6. Conclusion

In this paper, the concept of neutrosophic soft matrices has been described, and the application of some new operations has been tested through neutrosophic soft matrices. A possible application has been tackled through the usage of NSM, which will not only prove useful by itself but will help researchers to solve other problems of uncertainties through similar procedures. The following paper demonstrated a new solution procedure to solve neutrosophic soft sets based on real-life decision-making problems. This procedure proves quite feasible in many real-life scenarios where ease of decision-making is the goal in mind.

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