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# Advantages and Characteristic Features of Human Life in Villages by using Fuzzy Soft Matrices

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**Abstract.** In this paper, we emerge the theme that village life is more advantages for Human beings so as to lead a healthy life, because it is mingled with the beauty of nature in all aspects. But at the same time modern life in towns and cities will not have natural embedded life. We create awareness to migrants people of towns and cities to avoid dense populations in the city and in spite of it to stay in the village itself by utilising the available facilities and thereby we extend the field by using fuzzy soft matrices. Further we also approach in the sector of addition and multiplication factors of fuzzy soft matrices based on reference function.

*Keywords:* Soft set, fuzzy soft set, fuzzy soft matrices, complement, addition, multiplication and transpose of fuzzy soft matrices.

#### AMS Mathematics Subject Classification (2010):

#### 1. Introduction

In 1965, Zadeh [15] first introduced the concept of fuzzy set theory. In 1999, soft set theory was firstly introduced by Molodtsov [5] as a general mathematical tool for dealing with uncertain, fuzzy, not clearly defined objects. In 2001, Maji, Biswas and Roy [3] studied the theory of soft sets initiated by Molodtsov [5] and developed several basic notions of soft set theory. In 2009, Ahmad and Kharal [1] revised the result of Maji[3]. In 2011, Neog and Sut [13] have defined the addition operation for fuzzy soft matrices and an attempt has been made to apply our notion in solving a decision making problem. In 2012, Cagman and Enginoglu [2] defined fuzzy soft matrices and constructed decision making problem. In 2012, Rajarajeswari and Dhanalakshmi [6] introduced the application of similarity between two fuzzy soft sets based on distance. In 2012, Neog, Bora and Sut [14] Combined fuzzy soft set based on reference function with soft matrices. In 2013, Dhar [4] applied this concept to fuzzy square matrix and developed some interesting properties as determinant, trace and so on. In 2013, Broumi et al. and Dhar [7] introduced an application of fuzzy soft matrix based on reference function in decision making problem is given. In 2014, Sarala and Rajkumari [8] introduced intuitionistic fuzzy soft matrices in agriculture and issued [9] intuitionistic fuzzy soft matrices in medical diagnosis and also introduced [10] Role model service rendered to orphans by using

fuzzy soft matrices and also[11] established characters of fuzzy soft matrices. Further, In 2015, Sarala and Rajkumari [12] introduced drug addiction effect in medical diagnosis by using fuzzy soft matrices. In this paper, we proposed fuzzy soft matrix theory and extended its characteristic features of human life by using fuzzy soft matrices.

#### 2. Preliminaries

In this section, We recall some basic important notion of fuzzy soft set and defined different types of fuzzy soft set.

**Soft set.** [5] Let *U* be an initial universe set and *E* be a set of parameters. Let P(U) denotes the power set of *U*. Let  $A \subseteq E$ . A pair  $(F_A, E)$  is called a soft set over *U*, where  $F_A$  is a mapping given by  $F_A: E \to P(U)$  Such that  $F_A(e) = \varphi$  if  $e \notin A$ .

Here  $F_A$  is called approximate function of the soft set  $(F_A, E)$ . The set  $F_A(e)$  is called e-approximate value set which consist of related objects of the parameter  $e \in E$ . In other words, a soft set over U is a parameterized family of subsets of the universe U.

**Example 2.1.** Let  $U = \{u_1, u_2, u_3, u_4\}$  be a set of four types of ornaments and  $E = \{Costly(e_1), Medium(e_2), Cheap(e_3)\}$  be the set of parameters. If  $A = \{e_1, e_3\} \subseteq E$ . Let  $F_A(e_1) = \{u_1, u_2, u_4\}$  and  $F_A(e_3) = \{u_1, u_2, u_3, u_4\}$ . Then we write the soft set  $(F_A, E) = \{(e_1, \{u_1, u_2, u_4\}), (e_3, \{u_1, u_2, u_3, u_4\})\}$  over U which describe the

"Quality of Ornaments" Which Mr.Z is going to buy. We may represent the soft set in the following form:

U	$Costly(e_1)$	$Medium(e_2)$	$Cheap(e_3)$						
$u_1$	1	0	1						
$u_2$	1	0	1						
$u_3$	0	0	1						
$u_4$	1	0	1						

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**Fuzzy soft set [3]** Let *U* be an initial universe set and *E* be a set of parameters. Let  $A \subseteq E$ . A pair ( $\tilde{F}_A, E$ ) is called a fuzzy soft set (FSS)over*U*, where  $\tilde{F}_A$  is a mapping given by,  $\tilde{F}_A: E \to I^U$ , where  $I^U$  denotes the collection of all fuzzy subsets of *U*.

**Example 2.2.** Consider the **example 2.1.**, 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  $(\tilde{F}_A, E) = \{\tilde{F}_A(e_1) = \{(u_1, 0.7), (u_2, 0.6), (u_4, 0.5)\},\$ 

 $\tilde{F}_A(e_3) = \{(u_1, 0.3), (u_2, 0.4), (u_3, 0.1), (u_4, 0.8)\}\}$  is the fuzzy soft set representing the "Quality of Ornaments" which Mr.Z is going to buy.

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U	$Costly(e_1)$	$Medium(e_2)$	$Cheap(e_3)$								
$u_1$	0.7	0.0	0.3								
$u_2$	0.6	0.0	0.4								
$u_3$	0.0	0.0	0.1								
$u_4$	0.5	0.0	0.8								
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**Table 2.2.2:** 

**Fuzzy soft class [6]** Let U be an initial universe set and E be the set of attributes. Then the pair (U, E) denotes the collection of all fuzzy soft sets on U with attributes from E and is called a fuzzy soft class.

**Fuzzy soft subset [6]** For two fuzzy soft sets  $(\tilde{F}_A, E)$  and  $(\tilde{G}_B, E)$  over a common universe U, we have  $(\tilde{F}_A, E) \subseteq (\tilde{G}_B, E)$  if  $A \subset B$  and  $\forall e \in A, \tilde{F}_A(e)$  is a fuzzy subset of  $\tilde{G}_B(e)$ . i.e,  $(\tilde{F}_A, E)$  is a fuzzy soft subset of  $(\tilde{G}_B, E)$ .

**Fuzzy Soft Complement set [13]** The complement of fuzzy soft set  $(\tilde{F}_A, E)$  is denoted by  $(\tilde{F}_A, E)^\circ$  is defined by  $(\tilde{F}_A, E)^\circ = (\tilde{F}_A^\circ, E)$ , where  $\tilde{F}_A^\circ: E \to I^U$  is a mapping given by  $\tilde{F}_A^\circ(e) = [\tilde{F}_A(e)]^\circ, \forall e \in E$ .

#### 3. Feature of fuzzy soft matrices

In this section, we put forward the notion of fuzzy soft matrices with several types based on reference function.

**Matrix representation of a fuzzy soft set:** Let  $U = \{u_1, u_2, u_3, \dots, u_m\}$  be the universal set and E be the set of parameters given by  $E = \{e_1, e_2, e_3, \dots, e_n\}$ . Then the fuzzy soft set( $\tilde{F}_A, E$ ) can be expressed in matrix form as  $\tilde{A} = [a_{ij}^{\tilde{A}}]_{m \times n}$  or simply by  $[a_{ij}^{\tilde{A}}]$ ,  $i = 1, 2, 3, \dots, m; j = 1, 2, 3, \dots, n$  and  $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]$ ; where  $\mu_{ij}^{\tilde{A}}$  and  $\gamma_{ij}^{\tilde{A}}$  represent the fuzzy membership function and fuzzy reference function respectively of  $u_i$  in the fuzzy set  $\tilde{F}_A(e_j)$  so that  $\delta_{ij}^{\tilde{A}} = \mu_{ij}^{\tilde{A}} - \gamma_{ij}^{\tilde{A}}$  gives the fuzzy membership value of  $u_i$ . We shall identify a fuzzy soft set with its fuzzy soft matrix and use these two concepts interchangeable. The set of all  $m \times n$  fuzzy soft matrices over U will be denoted by  $FSM_{m \times n}$ . For usual fuzzy sets with fuzzy reference function 0, it is obvious to see that  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, 0) \forall i, j$ .

**Example 3.1.** Let  $U = \{u_1, u_2, u_3\}$  be the universal set and *E* be the set of parameters given by  $E = \{e_1, e_2, e_3\}$ . we consider a fuzzy soft set

$$\begin{aligned} (F_A, E) &= \{F_A(e_1) = \{(u_1, 0.5, 0), (u_2, 0.3, 0), (u_3, 0.2, 0)\}, \\ \tilde{F}_A(e_2) &= \{(u_1, 0.7, 0), (u_2, 0.1, 0), (u_3, 0.9, 0)\}, \\ \tilde{F}_A(e_3) &= \{(u_1, 0.4, 0), (u_2, 0.6, 0), (u_3, 0.8, 0)\}\} \end{aligned}$$

We would represent this fuzzy soft set in matrix form as

$$[a_{ij}^{\tilde{A}}]_{3\times 3} = \begin{bmatrix} (0.5,0) & (0.7,0) & (0.4,0) \\ (0.3,0) & (0.1,0) & (0.6,0) \\ (0.2,0) & (0.9,0) & (0.8,0) \end{bmatrix}_{3\times 3}$$

**Membership value matrix:** The membership value matrix corresponding to the matrix  $\tilde{A}$  as  $MV(\tilde{A}) = [\delta_{ij}^{\tilde{A}}]_{m \times n}$ , where  $\delta_{ij}^{\tilde{A}} = \mu_{ij}^{\tilde{A}} - \gamma_{ij}^{\tilde{A}} \forall i = 1,2,3,\cdots, mandj = 1,2,3,\cdots, n$ , where  $\mu_{ij}^{\tilde{A}}$  and  $\gamma_{ij}^{\tilde{A}}$  represent the fuzzy membership function and fuzzy reference function respectively of  $u_i$  in the fuzzy set  $\tilde{F}_A(e_i)$ .

**Zero fuzzy soft matrix:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}] \in FSM_{m \times n}$ , where  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ . Then  $\tilde{A}$  is called a fuzzy soft zero (or Null) matrix denoted by  $[\tilde{0}]_{m \times n}$ , or simply by $[\tilde{0}]$ , if  $\delta_{ij}^{\tilde{A}} = \tilde{0}$  for all *i* and *j*. For usual fuzzy sets,  $\delta_{ij}^{\tilde{A}} = \mu_{ij}^{\tilde{A}} \forall i, j$ .

**Identify fuzzy soft matrix:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}] \in FSM_{m \times n}$ , where  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ . Then  $\tilde{A}$  is called a fuzzy soft unit or identity matrix denoted by  $[\tilde{I}]$  if  $m = n, a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$  for all  $i \neq j$  and  $a_{ij}^{\tilde{A}} = (1,0)$  i.e,  $\delta_{ij}^{\tilde{A}} = 1, \forall i = j$ .

**Fuzzy soft square matrix:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}] \in FSM_{m \times n}$ , where  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ . If m = n, then  $\tilde{A}$  is called a fuzzy soft square matrix.

**Complement of Fuzzy Soft Matrix:** Let  $\tilde{A} = [(\mu_{ij}^{\tilde{A}}, 0)] \in FSM_{m \times n}$ , according to the definition in [4], then  $\tilde{A}^{\circ}$  is called fuzzy soft complement matrix if  $\tilde{A}^{\circ} = [(1, \mu_{ij}^{\tilde{A}})]_{m \times n}$  for all  $\mu_{ij}^{\tilde{A}} \in [0.1]$ .

**Example 3.6.** Let  $\tilde{A} = \begin{bmatrix} (0.6,0) & (0.5,0) \\ (0.4,0) & (0.3,0) \end{bmatrix}$  be fuzzy soft matrix based on reference

function, then the complement of this matrix is  $\tilde{A}^{\circ} = \begin{bmatrix} (1,0.6) & (1,0.5) \\ (1,0.4) & (1,0.3) \end{bmatrix}$ .

Addition of fuzzy soft matrices: Let  $U = \{u_1, u_2, u_3, \dots, u_m\}$  be the universal set and E be the set of parameters given by  $E = \{e_1, e_2, e_3, \dots, e_n\}$ . Let the set of all  $m \times n$  fuzzy soft matrices over U be  $FSM_{m \times n}$ . Let  $\tilde{A}, \tilde{B} \in FSM_{m \times n}$ , where  $\tilde{A} = [a_{ij}^{\tilde{A}}]_{m \times n}, a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$  and  $\tilde{B} = [b_{ij}^{\tilde{B}}]_{m \times n}, b_{ij}^{\tilde{B}} = (\mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}})$ . To avoid degenerate cases we assume that  $\min(\mu_{ij}^{\tilde{A}}, \mu_{ij}^{\tilde{B}}) \ge \max(\gamma_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{B}})$  for all i and j. We define the operation 'addition(+)' between  $\tilde{A}$  and  $\tilde{B}$  as  $\tilde{A} + \tilde{B} = \tilde{C}$ , where

 $\tilde{C} = [C_{ij}^{\tilde{C}}]_{m \times n}, \qquad C_{ij}^{\tilde{C}} = (max(\mu_{ij}^{\tilde{A}}, \mu_{ij}^{\tilde{B}}), \min(\gamma_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{B}})).$ 

**Product of fuzzy soft matrices:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}]_{m \times n}, a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ ; where  $\mu_{ij}^{\tilde{A}}$  and  $\gamma_{ij}^{\tilde{A}}$  represent the fuzzy membership function and fuzzy reference function respectively of  $u_i$ , so that  $\delta_{ij}^{\tilde{A}} = \mu_{ij}^{\tilde{A}} - \gamma_{ij}^{\tilde{A}}$  gives the fuzzy membership value of  $u_i$ . Also let  $\tilde{B} = [b_{jk}^{\tilde{B}}]_{n \times p}, b_{jk}^{\tilde{B}} = (\mu_{jk}^{\tilde{B}}, \gamma_{jk}^{\tilde{B}})$ ; where  $\mu_{jk}^{\tilde{B}}$  and  $\gamma_{jk}^{\tilde{B}}$  represent the fuzzy membership function and fuzzy reference function respectively of  $u_i$ , so that  $\delta_{jk}^{\tilde{B}} = \mu_{jk}^{\tilde{B}} - \gamma_{jk}^{\tilde{B}}$  gives the fuzzy membership function and fuzzy reference function respectively of  $u_i$ , so that  $\delta_{jk}^{\tilde{B}} = \mu_{jk}^{\tilde{B}} - \gamma_{jk}^{\tilde{B}}$  gives the fuzzy membership value of  $u_i$ . We now define  $\tilde{A} * \tilde{B}$ , the product of  $\tilde{A}$  and  $\tilde{B}$  as  $\tilde{A} * \tilde{B} = [d_{ik}^{\tilde{AB}}]_{m \times p} = [maxmin(\mu_{ij}^{\tilde{A}}, \mu_{jk}^{\tilde{B}}), minmax(\gamma_{ij}^{\tilde{A}}\gamma_{jk}^{\tilde{B}})]_{m \times p}, 1 \le i \le m, 1 \le k \le p$  for j = 1, 2, 3, ..., n.

**Transpose of fuzzy soft matrix:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}]_{m \times n}$ ,  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ ; where  $\mu_{ij}^{\tilde{A}}$  and  $\gamma_{ij}^{\tilde{A}}$  represent the fuzzy membership function and fuzzy reference function respectively of  $u_i$ , so that  $\delta_{ij}^{\tilde{A}} = \mu_{ij}^{\tilde{A}} - \gamma_{ij}^{\tilde{A}}$  gives the fuzzy membership value of  $u_i$ . Then we define  $\tilde{A}^T = [a_{ij}^{\tilde{A}}]_{n \times m}^T \in FSM_{n \times m}$ , where  $[a_{ij}^{\tilde{A}}]^T = [a_{ji}^{\tilde{A}}]$ .

Symmetric fuzzy soft matrix: Let  $\tilde{A} = \left[a_{ij}^{\tilde{A}}\right]_{m \times n}$ ,  $a_{ij}^{\tilde{A}} = (\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})$ . Then  $\tilde{A}$  is said to be a fuzzy soft symmetric matrix if  $\tilde{A}^T = \tilde{A}$ .

#### 4. Essential properties of fuzzy soft matrices

In this section, we see the properties of addition, multiplication, Transpose of fuzzy soft matrices with some examples.

**Proposition:** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}], \tilde{B} = [b_{ij}^{\tilde{B}}], \tilde{C} = [c_{ij}^{\tilde{C}}] \in FSM_{m \times n}$ , where

 $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})], [b_{ij}^{\tilde{B}}] = [(\mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}})], [c_{ij}^{\tilde{C}}] = [(\mu_{ij}^{\tilde{C}}, \gamma_{ij}^{\tilde{C}})].$  Then the following results hold. law) (ii)  $(\tilde{A} + \tilde{B}) + \tilde{C} = \tilde{A} + (\tilde{B} + \tilde{C})$  $\tilde{A} + \tilde{B} = \tilde{B} + \tilde{A}$ (commutative (i)  $\tilde{C}$  (Associative law) (ii)  $\tilde{A} + [\tilde{0}] = \tilde{A}.$ **Proof:** (i) Let  $\tilde{A} = \left[ \left( \mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}} \right) \right], \tilde{B} = \left[ \left( \mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}} \right) \right]$ Now  $\tilde{A} + \tilde{B} = [(\max(\mu_{ij}^{\tilde{A}}, \mu_{ij}^{\tilde{B}}), \min(\gamma_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{B}}))]$ =  $[(\max(\mu_{ii}^{\tilde{B}}, \mu_{ii}^{\tilde{A}}), \min(\gamma_{ii}^{\tilde{B}}, \gamma_{ii}^{\tilde{A}}))]$  $= \tilde{B} + \tilde{A}.$ Hence  $\tilde{A} + \tilde{B} = \tilde{B} + \tilde{A}$ (ii) Let  $\tilde{A} = \left[ \left( \mu_{i,i}^{\tilde{A}}, \gamma_{i,i}^{\tilde{A}} \right) \right], \tilde{B} = \left[ \left( \mu_{i,i}^{\tilde{B}}, \gamma_{i,i}^{\tilde{B}} \right) \right], \tilde{C} = \left[ \left( \mu_{i,i}^{\tilde{C}}, \gamma_{i,i}^{\tilde{C}} \right) \right]$ Now  $(\tilde{A} + \tilde{B}) + \tilde{C} = [(\max(\mu_{ii}^{\tilde{A}}, \mu_{ij}^{\tilde{B}}), \min(\gamma_{ii}^{\tilde{A}}, \gamma_{ij}^{\tilde{B}}))] + [(\mu_{ii}^{\tilde{C}}, \gamma_{ij}^{\tilde{C}})]$  $= [(\max(\mu_{ij}^{\tilde{A}}, \mu_{ij}^{\tilde{B}}), \mu_{ij}^{\tilde{C}}), \min(\gamma_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{B}}), \gamma_{ij}^{\tilde{C}}))]$  $= [(\max(\mu_{ii}^{\tilde{A}}, (\mu_{ii}^{\tilde{B}}, \mu_{ii}^{\tilde{C}})), \min(\gamma_{ii}^{\tilde{A}}, (\gamma_{ii}^{\tilde{B}}, \gamma_{ii}^{\tilde{C}})))]$  $= \tilde{A} + (\tilde{B} + \tilde{C}).$ Hence  $(\tilde{A} + \tilde{B}) + \tilde{C} = \tilde{A} + (\tilde{B} + \tilde{C})$ (iii)Let  $\tilde{A} = \left[ \left( \mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}} \right) \right]$ , Also  $\left[ \tilde{0} \right] = \left[ \left( \mu_{ij}^{\tilde{0}}, \gamma_{ij}^{\tilde{0}} \right) \right]$  so that  $\delta_{ij}^{\tilde{0}} = \tilde{0} \forall i, j$ . It is clear that  $\mu_{ij}^{\tilde{0}} = \gamma_{ij}^{\tilde{A}} \le \mu_{ij}^{\tilde{A}}, \forall i, j$ . Now  $\tilde{A} + \tilde{0} = [(\max(\mu_{ij}^{\tilde{A}}, \mu_{ij}^{\tilde{0}}), \min(\gamma_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{0}}))]$  $= [(\max(\mu_{ii}^{\tilde{A}}, \gamma_{ii}^{\tilde{A}}), \min(\gamma_{ii}^{\tilde{A}}, \gamma_{ii}^{\tilde{0}}))]$  $= [(\mu_{i\,i}^{\tilde{A}}, \gamma_{i\,i}^{\tilde{A}})] = \tilde{A}$ Hence  $\tilde{A} + [\tilde{0}] = \tilde{A}$ .

**Property 4.2.** Let  $\tilde{A} = [a_{ij}^{\tilde{A}}], \tilde{B} = [b_{ij}^{\tilde{B}}] \in FSM_{m \times n}$ , where  $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})], [b_{ij}^{\tilde{B}}] = [(\mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}})].$ 

Then (i)  $\tilde{A} * \tilde{B} \neq \tilde{B} * \tilde{A}$ **Proof:** Let the following example may be taken into account for proof.

#### Example 4.2.

Let 
$$\tilde{A} = \begin{bmatrix} (0.5,0) & (0.3,0) & (0.4,0) \\ (0.6,0) & (0.2,0) & (0.1,0) \\ (0.7,0) & (0.5,0) & (0.8,0) \end{bmatrix}$$
, and  $\tilde{B} = \begin{bmatrix} (0.2,0) & (0.5,0) & (0.3,0) \\ (0.4,0) & (0.6,0) & (0.7,0) \\ (0.9,0) & (0.1,0) & (0.3,0) \end{bmatrix}$ 

are two fuzzy soft matrices, then the product of these two matrices is

$$\tilde{A} * \tilde{B} = \begin{bmatrix} (0.4,0) & (0.5,0) & (0.3,0) \\ (0.2,0) & (0.5,0) & (0.3,0) \\ (0.8,0) & (0.5,0) & (0.5,0) \end{bmatrix}; \tilde{B} * \tilde{A} = \begin{bmatrix} (0.5,0) & (0.3,0) & (0.3,0) \\ (0.1,0) & (0.5,0) & (0.7,0) \\ (0.5,0) & (0.3,0) & (0.4,0) \end{bmatrix}$$
  
Hence  $\tilde{A} * \tilde{B} \neq \tilde{B} * \tilde{A}$ 

Property 4.3. Let  $\tilde{A} = [a_{ij}^{\tilde{A}}], \tilde{B} = [b_{ij}^{\tilde{B}}] \in FSM_{m \times n}$ , where  $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})], [b_{ij}^{\tilde{B}}] = [(\mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}})]$ . Then the following results hold: (i)  $(\tilde{A}^{\circ})^{T} = (\tilde{A}^{T})^{\circ}$ , (ii) $(\tilde{A}^{T})^{T} = \tilde{A}$ , (iii)  $(\tilde{A} + \tilde{B})^{T} = \tilde{A}^{T} + \tilde{B}^{T}$ , (iv)  $(\tilde{A}^{\circ} + \tilde{B}^{\circ})^{T} = (\tilde{A}^{T})^{\circ} + (\tilde{B}^{T})^{\circ}$ Proof: (i) Let  $\tilde{A} = [a_{ij}^{\tilde{A}}] \in FSM_{m \times n}$ , where  $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]$ , then  $\tilde{A}^{\circ} = [(1, \mu_{ij}^{\tilde{A}})], (\tilde{A}^{\circ})^{T} = [(1, \mu_{ji}^{\tilde{A}})]$ For  $\tilde{A}^{T} = [(\mu_{ji}^{\tilde{A}}, \gamma_{ji}^{\tilde{A}})]$ We have  $(\tilde{A}^{T})^{\circ} = [(1, \mu_{ji}^{\tilde{A}})]$ Hence  $(\tilde{A}^{\circ})^{T} = (\tilde{A}^{T})^{\circ}$ (ii) Let  $\tilde{A} = [a_{ij}^{\tilde{A}}] \in FSM_{m \times n}$ , where  $[a_{ij}^{\tilde{A}}] = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]$ , Here  $\tilde{A}^{T} = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]^{T} = [(\mu_{ji}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]$   $(\tilde{A}^{T})^{T} = [(\mu_{ji}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})]^{T} = [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}})] = \tilde{A}$ Hence  $(\tilde{A}^{T})^{T} = \tilde{A}$ Similarly, we can prove for other results.

## 5. New techniques adopted for fuzzy soft matrices

**Score matrix:** Let  $\tilde{A}, \tilde{B} \in FSM_{m \times n}$ .Let the corresponding membership value matrices be  $MV(\tilde{A}) = [\delta_{ij}^{\tilde{A}}]_{m \times n}$  and  $MV(\tilde{B}) = [\delta_{ij}^{\tilde{B}}]_{m \times n}, i = 1, 2, 3, ..., m; j = 1, 2, 3, ..., n$ . Then the score matrix  $S_{(\tilde{A},\tilde{B})}$  would be defined as  $S_{(\tilde{A},\tilde{B})} = [\rho_{ij}]_{m \times n}$ , where  $\rho_{ij} = \delta_{ij}^{\tilde{A}} - \delta_{ij}^{\tilde{B}}$ .

**Total score matrix:** Let  $\tilde{A}, \tilde{B} \in FSM_{m \times n}$ . Let the corresponding membership value matrices be  $MV(\tilde{A}) = [\delta_{ij}^{\tilde{A}}]_{m \times n}$  and  $MV(\tilde{B}) = [\delta_{ij}^{\tilde{B}}]_{m \times n}$  respectively and the score

matrix be  $S_{(\tilde{A},\tilde{B})} = \delta_{ij}^{\tilde{A}} - \delta_{ij}^{\tilde{B}}$ , i = 1,2,3,...,m; j = 1,2,3,...,n. Then the total score for each  $u_i$  in U would be calculated by the formula  $S_i = \sum_{j=1}^n [\delta_{ij}^{\tilde{A}} - \delta_{ij}^{\tilde{B}}] = \sum_{j=i}^n [(\mu_{ij}^{\tilde{A}}, \gamma_{ij}^{\tilde{A}}) - (\mu_{ij}^{\tilde{B}}, \gamma_{ij}^{\tilde{B}})].$ 

**Methodology:** Suppose U is a set of four types of living condition of the people in different areas like village, Town, City and Metropolis. Let E is a set of parameters related to mankind which lead to healthy harmonious life. We construct a fuzzy soft set  $(\tilde{F}_A, E)$  over U represent the selection of area by the field expert X analyse the situation, where  $\tilde{F}_A$  is a mapping  $\tilde{F}_A: E \to I^U$ , where  $I^U$  is the collection of all fuzzy subsets of U. We further construct another fuzzy soft set  $(\tilde{G}_B, E)$  over U represent the selection of healthy people among the four types of areas by the field expert Y, where  $\tilde{G}_B$  is a mapping  $\tilde{G}_B: E \to I^U$ , where  $I^U$  is the collection of all fuzzy subsets of U. The matrices  $\tilde{A}$  and  $\tilde{B}$  corresponding to the fuzzy soft sets  $(\tilde{F}_A, E)^\circ$  and  $(\tilde{G}_B, E)$  are constructed. We compute the complements  $(\tilde{F}_A, E)^\circ$  and  $(\tilde{G}_B, E)^\circ$  and their matrices  $\tilde{A}^\circ$  and  $\tilde{B}^\circ$  corresponding to  $(\tilde{F}_A, E)^\circ$  and  $(\tilde{G}_B, E)^\circ$  respectively. Compute  $\tilde{A} + \tilde{B}$ , which is the maximum membership of selection of candidates living in the four different areas as mentioned above have been considered by the judges. Compute  $\tilde{A}^\circ + \tilde{B}^\circ$ , which is the maximum membership of non selection of candidates prescribed in four different areas by the judges. Using **definition 3.2**, compute  $MV(\tilde{A} + \tilde{B}), MV(\tilde{A}^\circ + \tilde{B}^\circ), S_{((\tilde{A}+\tilde{B}),(\tilde{A}^\circ+\tilde{B}^\circ)))}$  and the total score  $S_i$  for each candidate in U. Finally find  $S_k = \max(S_i)$ , then we conclude that the people living in the area  $u_k$  has been selected by the judges. If  $S_k$  has more than one value the process is repeated by reassessing the parameters.

## Algorithm

**Step 1:** Input the fuzzy soft matrices  $(\tilde{F}_A, E)$  and  $(\tilde{G}_B, E)$ . Also write the fuzzy soft matrices  $\tilde{A}$  and  $\tilde{B}$  corresponding to  $(\tilde{F}_A, E)$  and  $(\tilde{G}_B, E)$  respectively.

**Step 2:** Write the fuzzy soft matrices  $(\tilde{F}_A, E)^\circ$  and  $(\tilde{G}_B, E)^\circ$ . Also write the fuzzy soft matrices  $\tilde{A}^\circ$  and  $\tilde{B}^\circ$  corresponding to  $(\tilde{F}_A, E)^\circ$  and  $(\tilde{G}_B, E)^\circ$  respectively.

**Step 3:** Compute  $(\tilde{A} + \tilde{B}), (\tilde{A}^{\circ} + \tilde{B}^{\circ}), MV(\tilde{A} + \tilde{B}), MV(\tilde{A}^{\circ} + \tilde{B}^{\circ})$  and  $S_{((\tilde{A} + \tilde{B}), (\tilde{A}^{\circ} + \tilde{B}^{\circ}))}$ .

**Step 4:** Compute the total score  $S_i$  for each  $u_i$  in U.

**Step 5:** Find  $S_k = \max(S_i)$ , then we conclude that the man kind living in the different area  $u_k$  has maximum healthy livelihood.

**Step 6:** If  $S_k$  has more than one value, then go to **step1** and repeat the process by reassessing the parameters with regard to the nature of living condition.

**Case study:** Let  $(\tilde{F}_A, E)$  and  $(\tilde{G}_B, E)$  be two fuzzy soft sets representing the selection of four category of areas from the universal set  $U = \{u_1, u_2, u_3, u_4\}$  by the experts X and Y. Let  $E = \{e_1, e_2, e_3\}$  be the set of parameters which stands for living condition of the people having proximity with nature because they are free from pollution, meaningful relationship have more depth, blessed with healthy life for they are free from dense population.

$$\begin{split} & (\tilde{F}_A, E) = \{\tilde{F}_A(e_1) = \{(u_1, 0.7, 0), (u_2, 0.5, 0), (u_3, 0.4, 0), (u_4, 0.2, 0)\} \\ & \tilde{F}_A(e_2) = \{(u_1, 0.9, 0), (u_2, 0.7, 0), (u_3, 0.6, 0), (u_4, 0.3, 0)\} \\ & \tilde{F}_A(e_3) = \{(u_1, 0.8, 0), (u_2, 0.6, 0), (u_3, 0.5, 0), (u_4, 0.4, 0)\}\} \\ & (\tilde{G}_B, E) = \{\tilde{G}_B(e_1) = \{(u_1, 0.6, 0), (u_2, 0.4, 0), (u_3, 0.3, 0), (u_4, 0.1, 0)\} \\ & \tilde{G}_B(e_2) = \{(u_1, 0.8, 0), (u_2, 0.9, 0), (u_3, 0.7, 0), (u_4, 0.6, 0)\} \\ & \tilde{G}_B(e_3) = \{(u_1, 0.7, 0), (u_2, 0.5, 0), (u_3, 0.4, 0), (u_4, 0.3, 0)\} \} \\ & \text{These two fuzzy soft sets are represented by the following fuzzy matrices respectively. } \end{split}$$

		$e_1$	<i>e</i> <sub>2</sub>	<i>e</i> <sub>3</sub>		$e_1$	<i>e</i> <sub>2</sub>	<b>e</b> 3	
	$u_1$	(0.7,0)	(0.9,0)	(0.8,0)	<b>U</b> 1	(0.6,0)	(0.8,0)	(0.7,0)	
$\tilde{A} =$	<b>u</b> 2	(0.5,0)	(0.7,0)	(0.6,0)	and $\tilde{B} = u_2$	(0.4,0)	(0.9,0)	(0.5,0)	
	<b>U</b> 3	(0.4,0)	(0.6,0)	(0.5,0)	<i>U</i> 3	(0.3,0)	(0.7,0)	(0.4,0)	
	<b>U</b> 4	(0.2,0)	(0.3,0)	(0.4,0)	<b>U</b> 4	(0.1,0)	(0.6,0)	(0.3,0)	

Then the fuzzy soft complement matrices are

		$e_1$	<b>e</b> 2	e	3				$e_1$		<b>e</b> 2	<i>e</i> <sub>3</sub>	
l	u1[(	1,0.7)	(1,0.9	) (1,0	).8)]			<b>U</b> 1	(1,0.6	) (	(1,0.8)	(1,0.7)	]
$\tilde{A}^{\circ} = \iota$	u2 (	1,0.5)	(1,0.7	) (1,0	).6)	and	$\tilde{B}^{\circ} =$	<b>U</b> 2	(1,0.4	) (	(1,0.9)	(1,0.5)	
ı	u3 (	1,0.4)	(1,0.6	) (1,0	).5)			<b>U</b> 3	(1,0.3	) (	(1,0.7)	(1,0.4)	
ı	u4[(	1,0.2)	(1,0.3	) (1,0	).4)			<b>U</b> 4	(1,0.1)	) (	(1,0.6)	(1,0.3)	
Then t	he a	ddition	matric	es are									
		e	1	<i>e</i> <sub>2</sub>	e	23					$e_1$	<b>e</b> 2	ез
	l	<i>u</i> 1[(0.7	,0) (0	0.9,0)	(0.	8,0)	]		и	1[(1	,0.6)	(1,0.8)	(1,0.7)
$\tilde{A} + \tilde{B}$	= ı	<i>i</i> <sup>2</sup> (0.5	,0) (0	0.9,0)	(0.	6,0)	$; \tilde{A}$	° + İ	$\tilde{B}^{\circ} = u$	2 (1	,0.4)	(1,0.7)	(1,0.5)
	ı	<i>ı</i> 3 (0.4	,0) (0	0.7,0)	(0.	5,0)			и	3 (1	,0.3)	(1,0.6)	(1,0.4)
	ı	14 (0.2	,0) (0	0.6,0)	(0.	4,0)			и	4 (1	l,0.1)	(1,0.3)	(1,0.3)

$$MV(\tilde{A} + \tilde{B}) = \begin{array}{cccc} e_1 & e_2 & e_3 \\ u_1 \begin{bmatrix} 0.7 & 0.9 & 0.8 \\ 0.5 & 0.9 & 0.6 \\ u_3 \\ u_4 \end{bmatrix}; \qquad MV(\tilde{A}^\circ + \tilde{B}^\circ) = \begin{array}{cccc} u_1 \begin{bmatrix} 0.4 & 0.2 & 0.3 \\ 0.4 & 0.7 & 0.5 \\ u_4 \end{bmatrix}; \qquad MV(\tilde{A}^\circ + \tilde{B}^\circ) = \begin{array}{cccc} u_1 \begin{bmatrix} 0.4 & 0.2 & 0.3 \\ 0.6 & 0.3 & 0.5 \\ u_3 \\ u_4 \end{bmatrix} \begin{array}{cccc} 0.6 & 0.4 \end{bmatrix}; \qquad MV(\tilde{A}^\circ + \tilde{B}^\circ) = \begin{array}{cccc} u_1 \begin{bmatrix} 0.4 & 0.2 & 0.3 \\ 0.6 & 0.3 & 0.5 \\ u_3 \\ u_4 \end{bmatrix} \begin{array}{ccccc} 0.7 & 0.4 & 0.6 \\ 0.9 & 0.7 & 0.7 \end{bmatrix}$$

Calculate the score matrix and the total score for selection  $\begin{array}{cc} e_1 & e_2 & e_3 \end{array}$ 

$$S_{((\tilde{A}+\tilde{B}),(\tilde{A}^{\circ}+\tilde{B}^{\circ}))} = \begin{array}{c} u_{1} \begin{bmatrix} 0.3 & 0.7 & 0.5 \\ -0.1 & 0.6 & 0.1 \\ u_{3} \\ -0.3 & 0.3 & -0.1 \\ u_{4} \begin{bmatrix} -0.7 & -0.1 & -0.3 \end{bmatrix} \text{ and } \operatorname{Total \, score} = \begin{array}{c} S_{1} \begin{bmatrix} 1.5 \\ 0.6 \\ S_{3} \\ -0.1 \\ S_{4} \begin{bmatrix} -0.1 \\ -1.1 \end{bmatrix} \end{array}$$

We see that the first criteria people has the maximum value and thus from both the experts opinion, that a sound mind in a sound body and blessed healthy life exist in villages only and so  $S_1$  is selected for mankind healthy and harmonious of life.

#### 6. Conclusion

In this paper, we evaluate the concept of fuzzy soft matrices and enhance some essential properties of fuzzy soft matrices of different types with new techniques adopted in the field. We create awareness among the village people that all type of developmental activities should be turned to villages so as to avoid migrants to cities. We put forward that our work would enrich the scope and characteristic features of human life by using fuzzy soft matrices.

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