Journal
Of the
Oriental Institute
M.S. University of Baroda

ISSN: 0030-5324
UGC CARE Group 1

# DECISION MAKING IN STOCK MARKET USING FUZZY SOFT MATRIX

**Mrs. Namrata N. Nadgauda (1), Prof. Dr. Dharmendra Saxena (2)**

(1) Research scholar, University of Technology, Jaipur. Rajasthan.

(2) Professor, Head department of mathematics, University of Technology, Jaipur. Rajasthan.

## Abstract

In this paper, we study matrix representation of fuzzy soft sets, complement of fuzzy soft sets, product of fuzzy soft matrices, and application of fuzzy soft matrices in stock market. In addition, we present a new method (max-min-mean) based on the fuzzy reference function instead of the max-product method to extend Sanchez's technique to decision problems related to prediction of stock market. The result shows that the new method provides more information about the decision of selling, buying or holding the position.

**Keywords**: Soft Relation, Fuzzy Soft Relation, Decision Making, soft set, fuzzy soft set, fuzzy soft matrix, membership function; reference function, membership value.

**Introduction**

Ali et al. [1] pointed out some shortcomings of Maji et al. defined in the work of soft forces. [2] and they introduced some new features. In addition, in 2009, Ali et al. [3] presented some algebraic structures related to recently defined operations on soft sets. Since the remarkable beginning of soft sets, many researchers have contributed to the rapid development of concepts related to soft sets. Sezer and Ataguv [4] introduced soft vector spaces. In 2014, Cağman [5] introduced a new approach to soft set theory. As mentioned earlier, Maji et al. introduced the concept of a fuzzy soft set. [2], but Nas and Shabir [12] started the study of algebraic structures related to fuzzy soft series. Roy and Maji studied fuzzy soft sets in decision problems (see [7, 8] for details).In 2000, Lee [9] introduced the concept of bipolar fuzzy sets. In 2014, Abdullah [10] used Lee's idea in a decision problem. Shabir and Nas [11] introduced the idea of dipolar soft sets and later Nas and Shabir [12] studied the concept of f-dipolar soft sets and their algebraic structures and applications. Zadeh [13] was the first to introduce the theory of fuzzy sets (FS). In 1999, Molodtsov [14] introduced soft set theory (SS) to explain the concept of fuzzy set theory. Maji et al. [2] renewed the theory and introduced soft set operations. Maji et al. studied the concepts of soft sets, fuzzy soft sets (FSS) and intuitive fuzzy soft sets [2, 16, 15]. Matrices play an important role in many areas of science and technology. However, classical matrix theory sometimes fails to solve problems involving inaccuracies that occur in imprecise environments. In [17], Yong Yang and Chenli Ji pioneered the fuzzy soft matrix representation and successfully applied the proposed fuzzy soft matrix concept to certain decision problems.

**Fuzzy Soft Matrices**

Let (F, A) be a soft set defined over 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).

Let A be an n × m matrix defined by

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots\cdots & a_{1m} \\ a_{21} & a_{22} & \cdots\cdots & a_{2m} \\ a_{n1} & a_{n2} & \cdots\cdots & a_{nm} \end{pmatrix}$$

The matrix A is a fuzzy matrix if and only if $a_{ij} \in [0, 1]$ for $1 \leq i \leq n$ and $1 \leq j \leq m$. In other words, any n × m matrix A is a fuzzy matrix if the elements of A are in the interval [0, 1]. We define fuzzy addition (+), fuzzy multiplication (·), and fuzzy subtraction (−) as follows [47]:

1) $a + b = \max. (a, b)$,

2) $a \cdot b = \min. (a, b)$, and

3) $a - b = \begin{cases} a & \text{If } a > b \\ 0 & \text{If } a \leq b. \end{cases}$

Proposition1: Let A, B, C be n × n fuzzy matrices. With the fuzzy addition as follows:
(1) A + B = B + A (Commutativity),

(2) (A + B) + C = A + (B + C) (Associativity),

(3) A + 0 = 0 + A = A (Additive Identity).

Proposition2: Let A be an n × n fuzzy matrix. With the fuzzy subtraction as follows:

(1) 0 − A = 0,

(2) A − A = 0,

(3) A − 0 = A,

**Construction of a Fuzzy Soft Matrix**

Consider: A set of parameters $P= \{p_1, p_2, .......... p_n\}$, A set of objects $X= \{x_1, x_2, ........ x_m\}$. A fuzzy soft set $F$ is a set of fuzzy subsets of $X$ indexed by the parameters in $P$. The membership function $\mu_{pi}(x_j)$ gives the degree of association between the object $x_j$ and the parameter $p_i$, typically ranging between 0 and 1. The fuzzy soft matrix $F$ is a $n\times m$ matrix where each element $F_{ij}=\mu_{pi}(x_j)$.

Let U = $\{c_1\ c_2\ c_3 c_4\}$ be the universal set and E be the set of parameters given by E = $\{e_1, e_2, e_3, e_4, e_5\}$. Let P =$\{e_1, e_2, e_4\} \subseteq$ E and (F, P) is the fuzzy soft set $F(e_1) = \{(c_1, 0.7), (c_2, 0.6), (c_3, 0.7), (c_4, 0.5)\}$ , $F(e_2) = \{(c_1, 0.1), (c_2, 0.4), (c_3, 0.7), (c_4, 0.3)\}$ , $F(e_4) = \{(c_1, 0.2), (c_2, 0.4), (c_3, 0.6), (c_4, 0.3)\}$ The fuzzy soft matrix representing this fuzzy soft set would be represented in our notation as

$$A = \begin{pmatrix} 0.7 & 0.1 & 0.2 & 0.0 \\ 0.6 & 0.4 & 0.7 & 0.0 \\ 0.7 & 0.4 & 0.6 & 0.0 \\ 0.5 & 0.3 & 0.3 & 0.0 \end{pmatrix}$$

Let A = [aij], B = [bij ]∈ $FSM_{m\times n}$, . Then union of A, B is defined by $A_{m\times n} \cup B_{m\times n} = C_{m\times n} = [Cij]_{m\times n}$ where Cij = aij + bij – aij * bij

**Definitions**

a) Let [aij ], [bij ] ∈ $FSM_{m\times n}$. Then the fs-matrix [cij ] is called

(1) Union of [aij ] and [bij ], denoted [aij ]∪̃[bij ], if cij = max. {aij, bij} for all i and j.

(2) Intersection of [aij ] and [bij ], denoted [aij ]∩̃[bij ], if cij = min{aij , bij} for all i and j.

(3) Complement of [aij ], denoted by [aij ]$^{\circ}$ , if cij = 1 – aij  for all i and j

b) Let [aij ], [bij ] ∈ FSMm×n. Then [aij ] and [bij ] are disjoint, if

[aij ]∩̃[bij ] = [0] for all i and j.

$$[aij] = \begin{pmatrix} 0.6 & 0 & 0.7 & 0 \\ 0 & 0.1 & 0.4 & 0 \\ 0.2 & 0 & 0.3 & 0.1 \\ 0 & 0.3 & 0 & 0 \end{pmatrix} \qquad [bij] = \begin{pmatrix} 0 & 0.1 & 0 & 0 \\ 0.6 & 0 & 0 & 0.7 \\ 0.2 & 0 & 0.2 & 0 \\ 0.1 & 0.3 & 0 & 0.2 \end{pmatrix}$$

Then, [aij] ∩̃[bij ] = [0] and

$$[aij] \tilde{\cup} [bij] = \begin{pmatrix} 0.6 & 0.1 & 0.7 & 0 \\ 0.6 & 0.1 & 0.4 & 0.7 \\ 0.2 & 0.3 & 0.3 & 0.1 \\ 0.2 & 0.3 & 0.2 & 0 \end{pmatrix} \qquad [aij]^{o} = \begin{pmatrix} 0.4 & 1 & 0.3 & 1 \\ 1 & 0.9 & 0.6 & 1 \\ 0.8 & 1 & 0.7 & 0.9 \\ 1 & 0.7 & 1 & 1 \end{pmatrix}$$

**Products of fs-Matrices**

**Definition 1**.  Let [aij ], [bik] ∈ $FSM_{m\times n}$. Then **And-product** of [aij] and [bik] is defined by ∧: $FSM_{m\times n}$. × $FSM_{m\times n}$. → $FSM_{m\times n2}$.  , [aij] ∧ [bik] = [cip] where cip = min {aij, bik} such that p = n (j − 1) + k.

**Definition 2**. Let [aij], [bik] ∈ $FSM_{m\times n}$. Then Or-product of [aij ] and [bik] is defined by ∨ : $FSM_{m\times n}$. × $FSM_{m\times n}$. → $FSM_{m\times n2}$., [aij ] ∨ [bik] = [cip] where cip = max{aij , bik} such that p = n(j − 1) + k.

**Definition 3.** Let [aij], [bik] ∈ $FSM_{m\times n}$. Then And-Not-product of [aij ] and [bik] is defined by Z : $FSM_{m\times n}$.× $FSM_{m\times n}$.→ $FSM_{m\times n2}$.[aij ] Z [bik] = [cip] where cip = min{aij , 1− bik} such that p = n(j − 1) + k.

**Journal**
**Of the**
**Oriental Institute**
**M.S. University of Baroda**

**ISSN: 0030-5324**
**UGC CARE Group 1**

**Definition 4**. Let [aij], [bik] ∈ $FSM_{m\times n}$. Then Or-Not-product of [aij ] and [bik] is defined by Y : $FSM_{m\times n}$. × $FSM_{m\times n}$. → $FSM_{m\times n2}$., [aij ] Y [bik] = [cip] where cip = max{aij , 1− bik} such that p = n(j − 1) + k.

Example. Assume that

$$[aij] = \begin{pmatrix} 0 & 0 & 0.2 \\ 0 & 0.3 & 0.7 \end{pmatrix} \qquad [bik] = \begin{pmatrix} 0.4 & 0 & 0.5 \\ 0.3 & 0.6 & 0 \end{pmatrix}$$

[aij ], [bik] ∈ FSM2×3 are given as follows

To calculate [aij ] ∧ [bik] = [cip], we have to find [cip] for all i = 1, 2 and p = 1, 2, ..., 9. Let us find $c_{17}$. Since n = 3, i = 1 and p = 7, we get j = 3 and k = 1 from 7 = 3(j − 1) + k. Hence $c_{17}$. = min. {$a_{13}$, $b_{11}$} = min. {0.2, 0.4} = 0.2.

If the other entries of [cip] can be found similarly, then we can obtain the matrix as follows;

$$[aij] \wedge [bik] = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0.2 & 0 & 0.2 \\ 0 & 0 & 0 & 0.3 & 0 & 0 & 0.3 & 0 & 0 \end{pmatrix}$$

Similarly, we can also find products [aij ] $\underset{\smile}{\vee}$ [bik], [aij ] ∨ [bik] and [aij ] $\underline{\vee}$ [bik]. Note that the commutativity is not valid for the products of fs-matrices.

**Methodology**

We construct an fuzzy soft-Max-min Decision Making (FSMmDM) method by using fs-max-min decision function which is also defined here. The method selects optimum alternatives from the set of the alternatives. Let [cip] ∈ $FSMm\times n^2$, Ik = {p: ∃i, cip ≠ 0, (k − 1) n < p ≤ kn} for all k ∈ I = {1, 2... n}. Then fs-max-min decision function, denoted Mm, is defined as, Mm: $FSMm\times n^2$ →FSMm×1, Mm [cip] = [di1] = [max {tik}] where,

$$tik = \min_{p\in I_k} \{cip\}, \quad \text{if } I_k \neq \emptyset,$$
$$= 0, \quad \text{if } Ik = \emptyset.$$

The one column fs-matrix Mm [cip] is called max-min decision fs-matrix. Let S= {$s_1$, $s_2$, ..., $s_m$} be an initial universe and Mm [cip] = [di1]. Then a subset of S can be obtained by using [$di_1$] as follows, Opt. [$di_1$] (S) = {$di_1$/Si: Si ∈ S, $di_1$ ≠ 0} which is called an optimum fuzzy set on S. Thus we can use the following steps to make the decision.

Step 1: Select possible subsets of the parameter set, Step 2: Create an fs-matrix for each parameter set,

Step 3: Find the appropriate product of the fs matrices,

Step 4: Find the max-min decision of the fs matrix,

Step 5: Find the optimal fuzzy set for S.

Note that, by the similar way, we can define fs-min-Max, fs-min-min and fs-Max-Max decision making methods which may be denoted by (FSmMDM), (FSmmDM), (FSMMDM), respectively. One of them may be useful than the others according to the type of the problems. Here we are going to use fuzzy soft max min decision making method (FSMmDM).Assume that in a stock market a trader has some stocks in his portpholio. The set of stocks is given by $S = \{s_1, s_2, s_3, s_4, s_5\}$, which may be technically analysed by some parameters. The set of parameters is given by $P = \{p_1, p_2, p_3, p_4\}$where $p_i$ are 'strong fundamentals', 'high market capital', 'market dominance', 'promoters holding' respectively $i = \{1,2,3,4\}$.Suppose two experts A and B giving their own different opinions about the stocks using their own set of parameters. The trader can use the FSMmDM to select the stock for trading.

**Step1:** Experts A and B select their own set of parameters say, $A= \{p_1, p_2, p_3\}$ $B= \{p2, p3, p4\}$

**Step2**:

$$[aij] = \begin{pmatrix} 0.7 & 0.6 & 0.5 & 0 \\ 0.5 & 0.7 & 0.4 & 0 \\ 0.8 & 0.6 & 0.6 & 0 \\ 0.4 & 0.5 & 0.4 & 0 \\ 0.7 & 0.4 & 0.6 & 0 \end{pmatrix} \qquad [bij] = \begin{pmatrix} 0 & 0.1 & 0.7 & 0.6 \\ 0 & 0.2 & 0.5 & 0.7 \\ 0 & 0.6 & 0.4 & 0.3 \\ 0 & 0.2 & 0.1 & 0.5 \\ 0 & 0.7 & 0.5 & 0.3 \end{pmatrix}$$

**Step3**: Now we find the And-product of [aij] and [bij]

$$\begin{pmatrix} 0 & 0.7 & 0.7 & 0.6 & 0 & 0.6 & 0.6 & 0.6 & 0 & 0.5 & 0.5 & 0.5 & 0 & 0 & 0 & 0 \\ 0 & 0.2 & 0.5 & 0.5 & 0 & 0.2 & 0.5 & 0.7 & 0 & 0.2 & 0.4 & 0.4 & 0 & 0 & 0 & 0 \\ 0 & 0.6 & 0.4 & 0.3 & 0 & 0.6 & 0.4 & 0.3 & 0 & 0.6 & 0.4 & 0.3 & 0 & 0 & 0 & 0 \\ 0 & 0.2 & 0.1 & 0.4 & 0 & 0.4 & 0.4 & 0.3 & 0 & 0.6 & 0.5 & 0.3 & 0 & 0 & 0 & 0 \\ 0 & 0.7 & 0.5 & 0.3 & 0 & 0.4 & 0.4 & 0.3 & 0 & 0.6 & 0.5 & 0.3 & 0 & 0 & 0 & 0 \end{pmatrix}$$

**Step4:** To calculate Max min ( [aij] ^ [bij]) = [$d_{i1}$], for all i ϵ {1,2,3,4,5} and k = {1,2,3,4} $d_{11}$= max{$t_{1k}$} = max{$t_{11}$, $t_{12}$, $t_{13}$, $t_{14}$} To find $t_{1k}$ for all k, Let $I_1$={p: Cip ≠ 0,0 <p ≤ 4}={2,3,4} $I_2$={p: Cip ≠ 0,4<p ≤ 8}={ 6,7,8} for k=2 and n=4, Hence, $\mathbf{t_{11}}$=min.{$C_{12}$,$C_{13}$,$C_{14}$}={0.7,0.7,0.6}=**0.6** $\mathbf{t_{12}}$= min{$C_{16}$,$C_{17}$,$C_{18}$}= {0.6,0.6,0.6} = **0.6** . Similarly we can find $\mathbf{t_{13}}$ = **0.5** and $\mathbf{t_{14}}$ = **0.** $\mathbf{d_{11}}$**=** Max. {0.6, 0.6, 0.5, 0} = **0.6.** On the same way we can find $d_{21}$, $d_{31}$, $d_{41}$, $d_{51}$ as given $\mathbf{d_{21}}$ **= 0.2,** $\mathbf{d_{31}}$**= 0.3,** $\mathbf{d_{41}}$ **= 0.1,** $\mathbf{d_{51}}$ **= 0.3** **Step5:** Thus finally we get the fuzzy soft max min decision matrix as below,

$$[dij] = \begin{pmatrix} 0.6 \\ 0.2 \\ 0.3 \\ 0.1 \\ 0.3 \end{pmatrix}$$

Now write the optimum fuzzy set on S according to fuzzy soft decision matrix is Opt. (S) = {0.6/$s_1$, 0.2/$s_2$, 0.3$s_3$, 0.1/$s_4$, 0.3/$s_5$}. Thus $\mathbf{s_1}$ is a stock on which a trader can trade to gain a profit taking onto consideration the opinion of both the experts.

**Conclusion**

Fs set theory is applied in many fields from theoretical to practical. In this paper, we define fs-matrices, which are the matrix representation of fs-sets. We then define set-theoretic operations on fs-matrices that are more efficient in improving several new results. An fs decision model is then constructed for fs set theory. This new way of deciding relies on the ideas of fuzzy and soft sets. Its basic idea is similar to the decision method presented in [7], which depends only on soft sets. That's why this method is more useful than others because of its obfuscation. Finally, we give the application to the trader to choose the optimal stock to trade on.

**References**

[1] Ali, M.I.; Feng, F.; Liu, X.Y.; Min, W.K.; Shabir, M. On Some New Operations in Soft Set Theory. *Comput. Math. Appl.* 2009, *57*, 1547–1553. [Google Scholar] [CrossRef] [Green Version]

[2] Maji, P.K.; Biswas, R.; Roy, A.R. Fuzzy Soft Sets. J. Fuzzy Math. 2001, 9, 589–602. [Google Scholar]

[3] Ali, M.I.; Shabir, M.; Nas, M. Algebraic Structures of Soft Sets Associated with new Operations. *Comput. Math. Appl.* **2011**, *61*, 2647–2654. [**Google Scholar**] [**CrossRef**] [**Green Version**]

[4] Sezer, A.S.; Atagun, A.O. A new Kind of Vector Spaces. Southeast Asian Bull. Math. 2016, 40, 753–770. [Google Scholar]

[5] Cağman, N. Contribution to the Theory of Soft Sets. *J. New Results Sci.* **2014**, *4*, 33–41. [**Google Scholar**]

[6] Nas, M.; Shabir, M. Fuzzy Soft Sets and their Algebraic Structures. World Appl. Sci. J. 2013, 22, 45–61. [Google Scholar]

[7] Feng, F.; Li, C.; Davvaz, B.; Ali, M.I. Soft Sets Combined with Fuzzy sets and Rough Sets,: A tentative approach. *Soft Comput.* **2010**, *14*, 899–911. [**Google Scholar**] [**CrossRef**]

[8] Xiao, Z.; Gong, K.; Zou, Y. A Combined Forecasting Approach based on Fuzzy Soft Sets. J. Comput. Appl. Math. 2009, 228, 326–333. [Google Scholar] [CrossRef] [Green Version]

[9] Lee, K.M. Bipolar Valued Fuzzy sets and their Operations. In Proceeding of the International Conference on Intelligent Technologies, Bankok, Thailand, 12–14 December 2000; pp. 307–312. [**Google Scholar**]

[10] Abdullah, S.; Aslam, M.; Ullah, K. Bipolar Fuzzy Soft Sets and its Applications in Decision making Problem. *J. Intell. Fuzzy Syst.* **2014**, *27*, 729–742. [**Google Scholar**] [**CrossRef**] [**Green Version**]

[11] Shabir, M.; Nas, M. On bipolar Soft Sets. *arXiv* **2013**, arXiv:1303.1344. [**Google Scholar**]

[12] Nas, M.; Shabir, M. On Fuzzy bipolar Soft Sets, their Algebraic Structures and Applications. *J. Intell. Fuzzy Syst.* **2014**, *26*, 1645–1656. [**Google Scholar**]

[13] Zadeh, L.A. Fuzzy Sets. *Inf. Control* **1965**, *8*, 338–353. [**Google Scholar**] [**CrossRef**] [**Green Version**]

[14] Molodtsov, D. Soft Sets Theory, First Results. *Comput. Math. Appl.* **1999**, *37*, 19–31. [**Google Scholar**] [**CrossRef**] [**Green Version**]

[15] Maji, P.K.; Roy, A.R. Intuitionistic Fuzzy Soft Sets. *J. Fuzzy Math.* **2004**, *12*, 669–683. [**Google Scholar**]

[16] Maji, P.K.; Roy, A.R. Soft Sets Theory. *Comput. Math. Appl.* **2003**, *45*, 555–562. [**Google Scholar**] [**CrossRef**] [**Green Version**]

[17] Yong Yang and Chenli Ji " Fuzzy Soft Matrices and Their Applications" AICI 2011, Part I, LNAI 7002, pp. 618–627, 2011.