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A NEW APPROACH ON AGGREGATION OPERATORS OF INTERVAL-VALUED FUZZY SOFT MATRIX AND ITS APPLICATIONS IN MCDM

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ABSTRACT

Fuzzy Soft Set theory is a general mathematical tool for dealing with the uncertainties present in most of our real life situations. In our daily life we are facing some problems in which the correct decision making is essential. In other side we have confused about the correct solution. In this paper, to overcome this problem, the Multi-Criteria Decision Making (MCDM) approach based on aggregation operators of interval-valued fuzzy soft matrix have been discussed. Some relevant properties have also been studied. Finally the algorithm based on aggregation operators of interval-valued fuzzy soft matrix is proposed with example to illustrate the new approach.

Keywords: *Fuzzy Soft Set, Fuzzy Soft Matrix, Interval-Valued Fuzzy Soft Matrix, Aggregation Operators, Decision Making Problem.*

1. INTRODUCTION

Lotfi A.Zadeh [12] introduced fuzzy set theory in 1965, which is an excellent mathematical tool to handle the uncertainty arising due to vagueness. Fuzzy set theory has wider scope of applicability in almost all the branches of science. Molodtsov [8] introduced the concept of soft set that can be seen as a new mathematical theory for dealing with uncertainty. The soft set theory has been applied to many different fields with great success. Maji *et al.* [6] worked on theoretical study of soft set in detail and presented an application of soft set in the decision making problem using the reduction of rough sets. Soft set theory has a rich potential for applications in several directions, few of which has been explained by Molodtsov in his pioneer work. Ali *et al.* [1] introduced the analysis of several operations on soft set. Maji *et al.* [5] introduced the concept of fuzzy soft set (FSS) by combining fuzzy set and soft set. Cagman and Enginoglu [2] defined soft matrices which were a matrix representation of soft set and constructed a soft max-min decision making method. Cagman and Enginoglu [4] defined fuzzy soft matrices and constructed a decision making problem. Yang *et al.* [11] combined interval-valued fuzzy set and soft set models to introduce the concept of interval-valued fuzzy soft set (IVFSS). Mitra Basu *et al.* [7] presented the concept of Matrices in Interval-valued fuzzy soft set theory and its application. Rajarajeshwari *et al.* [9] have introduced a new concept by the combination of interval-valued fuzzy soft set and soft matrices with examples and different properties which are called Interval-Valued Fuzzy Soft Matrix (IVFSM). They also introduced some new operations on IVFSM such as arithmetic mean, weighted arithmetic mean, geometric mean, harmonic mean and weighted harmonic mean with some properties of IVFSM in decision making. Multiple criteria decision making (MCDM) problem is a well-known branch of decision theory. It has been found in real life decision situations. Stephen Dinagar and Rajesh [10] presented On t-Conorm operators of interval-valued fuzzy soft matrix and its application in MCDM. Cagman *et al.* [3] presented Fuzzy Soft Set Theory and its applications. Also in this work the concept of a new approach on aggregation operators of interval-valued fuzzy soft matrix and its applications in multi criteria decision making have been studied. In this paper the sections are organized as follows: In section 2, we considered some formal definitions and important notations that are very useful to develop the concept of this article. In section 3, we presented some basic properties of aggregation operators of interval-valued fuzzy soft set. In section 4, we presented algorithm based on aggregation operators of interval-valued fuzzy soft matrix. In section 5, application of a decision making problem is discussed. In section 6, we conclude the paper with a summary and outlook for further research.

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2. PRELIMINARIES

In this section, we present the basic definitions of fuzzy soft set, fuzzy soft matrix [4] and interval-valued fuzzy soft matrix [3] that are useful for subsequent discussions. Throughout this work, U refers to an initial universe, E is a set of parameters and $A \subseteq E$. From now on, a set of all fuzzy sets over U will be denoted by $F(U)$. $\Gamma_A, \Gamma_B, \Gamma_C$......, etc. and $\gamma_A, \gamma_B, \gamma_C$......, etc. will be used for f s-sets and their fuzzy approximate functions respectively.

Definition 2.1: Let U be an initial universe, E be the set of all parameters, $A \subseteq E$ and $\gamma_A(x)$ be a fuzzy set over U for all $x \in E$. Then, an f s-set Γ_A over U is a set defined by a function γ_A representing a mapping $\gamma_A : E \to F(U)$ such that $\gamma_A(x) = \phi$ if $x \notin A$

Here, γ_A is called fuzzy approximate function of the f s-set Γ_A, the value $\gamma_A(x)$ is a fuzzy set called x-element of the f s-set for all $x \in E$, and ϕ is the null fuzzy set. Thus, an f s-set Γ_A over U can be represented by the set of ordered pairs

$$\Gamma_A = \{(x, \gamma_A(x)) : x \in E, \gamma_A(x) \in F(U)\}.$$

Note that from now on, the sets of all f s-sets over U will be denoted by $FS(U)$.

Example 2.1: Assume that $U = \{u_1, u_2, u_3, u_4, u_5\}$ is a universal set and $E = \{x_1, x_2, x_3, x_4\}$ is a set of all parameters. If $A = \{x_2, x_3, x_4\}$, $\gamma_A(x_2) = \{0.5/u_2, 0.8/u_4\}$, $\gamma_A(x_3) = \phi$ and $\gamma_A(x_4) = U$, then the f s-set Γ_A is written by $\Gamma_A = \{(x_2, \{0.5/u_2, 0.8/u_4\}), (x_4, U)\}$.

Definition 2.2: Let $\Gamma_A \in FS(U)$. Then a fuzzy relation form of Γ_A is defined by

$$R_A = \{(\mu_{R_A}(u,x)/(u,x)) : (u,x) \in U \times E\},$$

where the membership function of μ_{R_A} is written by

$$\mu_{R_A} : U \times E \to [0,1], \ \ \mu_{R_A}(u,x) = \mu_{\gamma_A(x)}(u).$$

If $U = \{u_1, u_2, u_3, ..., u_m\}$, $E = \{x_1, x_2, x_3, ..., x_n\}$ 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_n
u_1	$\mu_{R_A}(u_1, x_1)$	$\mu_{R_A}(u_1, x_2)$	$\cdots$	$\mu_{R_A}(u_1, x_n)$
u_2	$\mu_{R_A}(u_2, x_1)$	$\mu_{R_A}(u_2, x_2)$	$\cdots$	$\mu_{R_A}(u_2, x_n)$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
u_m	$\mu_{R_A}(u_m, x_1)$	$\mu_{R_A}(u_m, x_2)$	$\cdots$	$\mu_{R_A}(u_m, x_n)$

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

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

which is called an $m \times n$ f s-matrix of the f s-set Γ_A over U.

Example 2.2: Let us consider Example 2.1. Then the relation form Γ_A is written by

$$R_A = \{0.5/(u_2, x_2), 0.8/(u_4, x_2), 1/(u_1, x_4), 1/(u_2, x_4), 1/(u_3, x_4), 1/(u_4, x_4). 1/(u_5, x_4)\}$$

Hence, the f s-matrix $[a_{ij}]$ is written by

$$[a_{ij}] = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 0 & 0.5 & 0 & 1 \\ 0 & 0 & 0 & 1 \\ 0 & 0.8 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Definition 2.3: Let $\Gamma_A \in IVFS(U)$. Assume that $U = \{u_1, u_2, u_3, ..., u_m\}$, $E = \{x_1, x_2, x_3, ..., x_n\}$ and $A \subseteq E$, then the Γ_A can be presented by the following table,

Γ_A	x_1	x_2	$\cdots$	x_n
u_1	$[\mu_{\gamma_{AL(x_1)}}(u_1), \mu_{\gamma_{AU(x_1)}}(u_1)]$	$[\mu_{\gamma_{AL(x_2)}}(u_1), \mu_{\gamma_{AU(x_2)}}(u_1)]$	$\cdots$	$[\mu_{\gamma_{AL(x_n)}}(u_1), \mu_{\gamma_{AU(x_n)}}(u_1)]$
u_2	$[\mu_{\gamma_{AL(x_1)}}(u_2), \mu_{\gamma_{AU(x_1)}}(u_2)]$	$[\mu_{\gamma_{AL(x_2)}}(u_2), \mu_{\gamma_{AU(x_2)}}(u_2)]$	$\cdots$	$[\mu_{\gamma_{AL(x_n)}}(u_2), \mu_{\gamma_{AU(x_n)}}(u_2)]$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
u_m	$[\mu_{\gamma_{AL(x_1)}}(u_m), \mu_{\gamma_{AU(x_1)}}(u_m)]$	$[\mu_{\gamma_{AL(x_2)}}(u_m), \mu_{\gamma_{AU(x_2)}}(u_m)]$	$\cdots$	$[\mu_{\gamma_{AL(x_n)}}(u_m), \mu_{\gamma_{AU(x_n)}}(u_m)]$

Where $\mu_{\gamma_{A(x)}}$ is the membership function of γ_A. If $a_{ij} = [\mu_{\gamma_{AL(x_j)}}(u_i), \mu_{\gamma_{AU(x_j)}}(u_i)]$ for $i = 1, 2, 3, ..., m$ and $j = 1, 2, 3, ..., n$, then the interval-valued fuzzy soft set Γ_A is uniquely characterized by a matrix,

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

is called an $m \times n$ interval-valued f s- matrix of the interval-valued f s-set Γ_A over U.

Definition 2.4: Let $\Gamma_A \in IVFS(U)$. Then, the interval-valued cardinal set of Γ_A, denoted by $c\Gamma_A$ and defined by

$$c\Gamma_A = \{\mu_{c\Gamma_{AL}}(x), \mu_{c\Gamma_{AU}}(x) / x : x \in E\},$$

is a interval-valued fuzzy set over E. The membership function $\mu_{c\Gamma_A}$ of $c\Gamma_A$ is defined by

$$[\mu_{c\Gamma_{AL}}, \mu_{c\Gamma_{AU}}] : E \to [0,1], \quad [\mu_{c\Gamma_{AL}}(x), \mu_{c\Gamma_{AU}}(x)] = \left[\frac{|\gamma_{AL}(x)|}{|U|}, \frac{|\gamma_{AU}(x)|}{|U|}\right]$$

Where $|U|$ is the cardinality of universe U, and $\left[|\gamma_{AL}(x)|, |\gamma_{AU}(x)|\right]$ is the scalar cardinality of interval-valued fuzzy set $\left[\gamma_{AL}(x), \gamma_{AU}(x)\right]$.

Note that the set of all interval-valued cardinal sets of the interval-valued f s-sets over U will be denoted by $cIVFS(U)$. It is clear that $cIVFS(U) \subseteq IVF(E)$.

Definition 2.5: Let $\Gamma_A \in IVFS(U)$ and $c\Gamma_A \in cIVFS(U)$. Assume that $E = \{x_1, x_2, x_3, ..., x_n\}$ and $A \subseteq E$, then $c\Gamma_A$ can be presented by the following table

E	x_1	x_2	$\cdots$	x_n
$\mu_{c\Gamma_A}$	$[\mu_{c\Gamma_{AL}}(x_1), \mu_{c\Gamma_{AU}}(x_1)]$	$[\mu_{c\Gamma_{AL}}(x_2), \mu_{c\Gamma_{AU}}(x_2)]$	$\cdots$	$[\mu_{c\Gamma_{AL}}(x_n), \mu_{c\Gamma_{AU}}(x_n)]$

If $a_{1j} = [\mu_{c\Gamma_{AL}}(x_j), \mu_{c\Gamma_{AU}}(x_j)]$ for $j = 1,2,3,.....,n,$ then the interval-valued cardinal set $c\Gamma_A$ is uniquely characterized by a matrix,

$$[a_{1j}]_{1\times n} = [(a_{11}^{-}, a_{11}^{+}), (a_{12}^{-}, a_{12}^{+}), ..., (a_{1n}^{-}, a_{1n}^{+})]$$

which is called the interval-valued cardinal matrix of the interval-valued cardinal set $c\Gamma_A$ over $E.$

Definition 2.6: Let $\Gamma_A \in IVFS(U)$ and $c\Gamma_A \in IVFS(U).$ Then interval-valued f s-aggregation operator, denoted by $IVFS_{agg}$, is defined by $IVFS_{agg} : cIVFS(U) \times IVFS(U) \to IVF(U),\ IVFS_{agg}(c\Gamma_A, \Gamma_A) = \Gamma^*{}_A$ where $\Gamma^*{}_A = \{(\mu_{\Gamma^*{}_{AL}}(u), \mu_{\Gamma^*{}_{AU}}(u)) / u : u \in U\}$ is a interval-valued fuzzy set over $U.$ $\Gamma^*{}_A$ is called the aggregate interval-valued fuzzy set of the interval-valued f s-set $\Gamma_A.$ The membership function $\mu_{\Gamma^*{}_A}$ of $\Gamma^*{}_A$ is defined as follows:

$$[\mu_{\Gamma^*{}_{AL}}, \mu_{\Gamma^*{}_{AU}}] : U \to [0,1],\ \ [\mu_{\Gamma^*{}_{AL}}(u), \mu_{\Gamma^*{}_{AL}}(u)] : \frac{1}{|E|}\sum_{x\in E}[(\mu_{c\Gamma_{AL}}(x)(\mu_{\gamma_{AL(x)}}(u)), (\mu_{c\Gamma_{AU}}(x)(\mu_{\gamma_{AU(x)}}(u))]$$

where $|E|$ is the cardinality of $E.$

Definition 2.7: Let $\Gamma_A \in IVFS(U)$ and $\Gamma^*{}_A$ be its aggregate interval-valued fuzzy set. Assume that $U = \{u_1, u_2, ..., u_m\},$ then the $\Gamma^*{}_A$ can be presented by the following table

Γ_A	$\mu_{\Gamma^*{}_A}$
u_1	$[\mu_{\Gamma^*{}_{AL}}(u_1), \mu_{\Gamma^*{}_{AU}}(u_1)]$
u_2	$[\mu_{\Gamma^*{}_{AL}}(u_2), \mu_{\Gamma^*{}_{AU}}(u_2)]$
$\vdots$	$\vdots$
u_m	$[\mu_{\Gamma^*{}_{AL}}(u_m), \mu_{\Gamma^*{}_{AU}}(u_m)]$

If $a_{i1} = [\mu_{\Gamma^*{}_{AL}}(u_i), \mu_{\Gamma^*{}_{AU}}(u_i)]$ for $i = 1,2,3,.....,m,$ then $\Gamma^*{}_A$ is uniquely characterized by the matrix,

$$[a_{i1}]_{m\times 1} = \begin{bmatrix} (a_{11}^{-}, a_{11}^{+}) \\ (a_{21}^{-}, a_{21}^{+}) \\ \vdots \\ (a_{m1}^{-}, a_{m1}^{+}) \end{bmatrix}$$

which is called the aggregate matrix of $\Gamma^*{}_A$ over $U.$

Definition 2.8: The associated real number of an interval number $A = (\mathrm{a}, \mathrm{b})$ is denoted by $R(A)$ and is defined as $R(\mathrm{A}) = \dfrac{a+b}{2}$.

Example 2.8: An associated real number of the interval number $A = (4,5)$ is $R(A) = \dfrac{4+5}{2} = 4.5$

Theorem 2.9: Let $\Gamma_A \in IVFS(U)$ and $A \subseteq E.$ If $M_{\Gamma_A}, M_{c\Gamma_A}, M_{\Gamma^*{}_A}$ are representation matrices of Γ_A, $c\Gamma_A$ and $\Gamma^*{}_A$ respectively, then $|E| \times M_{\Gamma^*{}_A} = M_{\Gamma_A} \times M^T{}_{c\Gamma_A}$

where $M^T{}_{c\Gamma_A}$ is the transposition of $M_{c\Gamma_A}$ and $|E|$ is the cardinality of $E.$

Proof: It is sufficient to consider $\left[a_{i1}\right]_{m\times 1} = \left[a_{ij}\right]_{m\times n} \times \left[a_{1j}\right]^T_{1\times n}.$

Theorem 2.9 is applicable to computing the aggregate interval-valued fuzzy set of an interval- valued f s-set.

3. SOME PROPERTIES OF AGGREGATION OPERATOR OF INTERVAL-VALUED FUZZY SOFT SET

Definition 3.1: Let $\Gamma_A \in IVFS(U)$. Then, the complement $\Gamma^c{}_A$ of Γ_A is an interval-valued f s-set such that $\gamma_{A^{\tilde{c}}}(x) = \gamma^c{}_A(x)$, for all $x \in E$, where $\gamma^c{}_A(x)$ is complement of the set $\gamma_A(x)$.

Proposition 3.1: Let $\Gamma_A \in IVFS(U)$. Then,

(i) $(\Gamma^{\tilde{c}}{}_A)^{\tilde{c}} = \Gamma_A$

(ii) $\Gamma^{\tilde{c}}{}_\Phi = \Gamma_{\tilde{E}}$

Proof: By using the fuzzy approximate functions of the interval-valued f s-set, the proofs are straightforward.

Definition 3.2: Let $\Gamma_A, \Gamma_B \in IVFS(U)$. Then, the union of Γ_A and Γ_B, denoted by $\Gamma_A \tilde{\bigcup} \Gamma_B$, is defined by its fuzzy approximate function

$$\gamma_{A\tilde{\cup}B}(x) = \gamma_A(x) \bigcup \gamma_B(x) \text{ for all } x \in E.$$

Proposition 3.2: Let $\Gamma_A, \Gamma_B, \Gamma_C \in IVFS(U)$. Then,

(i) $\Gamma_A \tilde{\bigcup} \Gamma_A = \Gamma_A$

(ii) $\Gamma_A \tilde{\bigcup} \Gamma_\Phi = \Gamma_A$

(iii) $\Gamma_A \tilde{\bigcup} \Gamma_{\tilde{E}} = \Gamma_{\tilde{E}}$

(iv) $\Gamma_A \tilde{\bigcup} \Gamma_B = \Gamma_B \tilde{\bigcup} \Gamma_A$

(v) $(\Gamma_A \tilde{\bigcup} \Gamma_B) \tilde{\bigcup} \Gamma_C = \Gamma_A \tilde{\bigcup} (\Gamma_B \tilde{\bigcup} \Gamma_C)$

Proof. The proofs can be easily obtained from Definition 3.2.

Definition 3.3: Let $\Gamma_A, \Gamma_B \in IVFS(U)$. Then, the intersection of Γ_A and Γ_B, denoted by $\Gamma_A \tilde{\bigcap} \Gamma_B$, is defined by its fuzzy approximate function

$$\gamma_{A\tilde{\cap}B}(x) = \gamma_A(x) \bigcap \gamma_B(x) \text{ for all } x \in E.$$

Proposition 3.3: Let $\Gamma_A, \Gamma_B, \Gamma_C \in IVFS(U)$. Then,

(i) $\Gamma_A \tilde{\bigcap} \Gamma_A = \Gamma_A$

(ii) $\Gamma_A \tilde{\bigcap} \Gamma_\Phi = \Gamma_\Phi$

(iii) $\Gamma_A \tilde{\bigcap} \Gamma_{\tilde{E}} = \Gamma_A$

(iv) $\Gamma_A \tilde{\bigcap} \Gamma_B = \Gamma_B \tilde{\bigcap} \Gamma_A$

(v) $(\Gamma_A \tilde{\bigcap} \Gamma_B) \tilde{\bigcap} \Gamma_C = \Gamma_A \tilde{\bigcap} (\Gamma_B \tilde{\bigcap} \Gamma_C)$

Proof: The proofs can be easily obtained from Definition 3.3.

Proposition 3.4: Let $\Gamma_A, \Gamma_B \in IVFS(U)$. Then, De Morgan's laws are valid as follows:

(i) $(\Gamma_A \tilde{\bigcup} \Gamma_B)^{\tilde{C}} = \Gamma^{\tilde{C}}{}_A \tilde{\bigcap} \Gamma^{\tilde{C}}{}_B$

(ii) $(\Gamma_A \tilde{\bigcap} \Gamma_B)^{\tilde{C}} = \Gamma^{\tilde{C}}{}_A \tilde{\bigcup} \Gamma^{\tilde{C}}{}_B$

Proof: The proofs can be obtained by using the respective approximate functions. For all $x \in E$,

(i) : $\gamma_{(A\tilde{\cup}B)^{\tilde{c}}}(x) = \gamma^c{}_{A\tilde{\cup}B}(x)$

$$
\begin{aligned}
&= (\gamma_A(x) \cup \gamma_B(x))^c \\
&= (\gamma_A(x))^c \cap (\gamma_B(x))^c \\
&= \gamma^c{}_A(x) \cap \gamma^c{}_B(x) \\
&= \gamma_{A^{\tilde{c}}}(x) \cap \gamma_{B^{\tilde{c}}}(x) \\
&= \gamma_{A^{\tilde{c}} \tilde{\cap} B^{\tilde{c}}}(x)
\end{aligned}
$$

The proof of (ii) is similar.

Proposition 3.5: Let $\Gamma_A, \Gamma_B, \Gamma_C \in IVFS(U)$. Then,

(i) $(\Gamma_A \tilde{\cup} (\Gamma_B \tilde{\cap} \Gamma_C) = (\Gamma_A \tilde{\cup} \Gamma_B) \tilde{\cap} (\Gamma_A \tilde{\cup} \Gamma_C)$

(ii) $(\Gamma_A \tilde{\cap} (\Gamma_B \tilde{\cup} \Gamma_C) = (\Gamma_A \tilde{\cap} \Gamma_B) \tilde{\cup} (\Gamma_A \tilde{\cap} \Gamma_C)$

Proof: For all $x \in E,$

(i) :
$$
\begin{aligned}
\gamma_{A \tilde{\cup} (B \tilde{\cap} C)}(x) &= \gamma_A(x) \cup \gamma_{B \tilde{\cap} C}(x) \\
&= \gamma_A(x) \cup \gamma_{B \tilde{\cap} C}(x) \\
&= \gamma_A(x) \cup (\gamma_B(x) \cap \gamma_C(x)) \\
&= (\gamma_A(x) \cup \gamma_B(x)) \cap (\gamma_A(x) \cup \gamma_C(x)) \\
&= \gamma_{A \tilde{\cup} B}(x) \cap \gamma_{A \tilde{\cup} C}(x) \\
&= \gamma_{(A \tilde{\cup} B) \tilde{\cap} (A \tilde{\cup} C)}(x).
\end{aligned}
$$

The proof of (ii) is similar.

4. ALGORITHM BASED ON AGGREGATION OPERATORS OF INTERVAL-VALUED FUZZY SOFT MATRIX

Step-1: Construct an interval-valued f s-set Γ_A over U.

Step-2: Find the interval-valued cardinal set $c\Gamma_A$ of Γ_A.

Step-3: Find the aggregate interval-valued fuzzy set Γ_A^* of Γ_A.

Step-4: Find the best alternative from this interval-valued set that has the largest membership grade by $\max \mu_{\Gamma_A^*}(c)$.

Step-5: Select the candidate according to the maximum value of $R(c)$ and verify that they will get the high interval value.

5. APPLICATION OF A DECISION MAKING PROBLEM

Suppose a company wants to fill position. There are six candidates who form the set of alternatives, $U = \{c_1, c_2, c_3, c_4, c_5, c_6\}$. The hiring committee consider a set of parameters, $E = \{e_1, e_2, e_3, e_4, e_5\}$ ={young age, high percentage, computer knowledge, friendly approach, fluency in language} respectively. After a serious discussion each candidate is evaluated from the goals and constraint point of view of according to a chosen subset $A = \{e_2, e_3, e_5\}$ of E. Finally, the committee applies the following steps:

Step-I: The committee constructs an interval-valued f s-set Γ_A over U.

$$
\begin{aligned}
\Gamma_A = \{&(e_2, \{(0.2,0.7)/c_1, (0.3,0.8)/c_3, (0.1,0.5)/c_5, (0.4,0.9)/c_6\}), \\
&(e_3, \{(0.1,0.6)/c_1, (0.2,0.5)/c_2, (0.3,0.7)/c_4\}), \\
&(e_5, \{(0.3,0.9)/c_1, (0.4,1)/c_3, (0.2,0.9)/c_4, (0.3,0.8)/c_5\})\}.
\end{aligned}
$$

Step-II: The interval-valued cardinal is computed,

$$c\Gamma_A = \{(0.1, 0.4)/e_2, (0.1, 0.3)/e_3, (0.2, 0.6)/e_5\}$$

Step-III: The aggregate interval-valued fuzzy set is found by theorem 2.9,

$$M\Gamma_A^* = \frac{1}{5}\begin{bmatrix} 0 & (0.2,0.7) & (0.1,0.6) & 0 & (0.3,0.9) \\ 0 & 0 & (0.2,0.5) & 0 & 0 \\ 0 & (0.3,0.8) & 0 & 0 & (0.4,1) \\ 0 & 0 & (0.3,0.7) & 0 & (0.2,0.9) \\ 0 & (0.1,0.5) & 0 & 0 & (0.3,0.8) \\ 0 & (0.4,0.9) & 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} 0 \\ (0.1,0.4) \\ (0.1,0.3) \\ 0 \\ (0.2,0.6) \end{bmatrix} = \begin{bmatrix} (0.018,0.200) \\ (0.004,0.030) \\ (0.022,0.184) \\ (0.014,0.150) \\ (0.014,0.136) \\ (0.008,0.072) \end{bmatrix}$$

that means,

$$\Gamma_A^* = \{(0.018, 0.200)/c_1, (0.004, 0.030)/c_2, (0.022, 0.184)/c_3, (0.014, 0.150)/c_4, (0.014, 0.136)/c_5, (0.008, 0.072)\}.$$

Step-IV: The largest membership grade is chosen by $\max \mu_{\Gamma_A^*}(c) = (0.018, 0.200)$.

Step-V: Finally by using the definition 2.8, we verified that c_1 is the suitable candidates for the company, as $R(c_1) > R(c_3) > R(c_4) > R(c_5) > R(c_6) > R(c_2)$.

6. CONCLUSION

In this paper, we have discussed the concept based on aggregation operators of interval-valued fuzzy soft matrix in decision making problem. Also we proposed an algorithm based on aggregation operators of interval-valued fuzzy soft matrix to solve the discussed notion with a new approach and relevant illustration is added to justify the above said concept.

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