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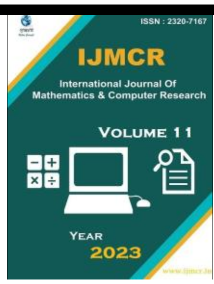

New Operations on Fuzzy Environment

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ABSTRACT

In this paper we introduce the operations Φ and $\bullet$ on interval valued intuitionistic fuzzy soft set and establish some properties of these operators. We also develop a decision-making method based on information measure of interval valued intuitionistic fuzzy soft set.

KEYWORDS: Interval valued intuitionistic fuzzy soft set, Φ and $\bullet$ operators, information measure, decision making technique.

1. INTRODUCTION

The theory of intuitionistic fuzzy set was introduced by Atanassov [1, 4]. The concept of interval valued intuitionistic fuzzy set was developed by the same author [2, 3]. Soft set theory was first introduced by Molodtsov [13]. Motivated by these theories, the theory of fuzzy soft set [9, 10, 14, 16] and the theory of intuitionistic fuzzy soft set [11, 12] have been developed. Yang et al. [15] presented the concept of interval valued fuzzy soft sets by combining the interval valued fuzzy set and soft set models [5, 6].

In this paper we define Φ and $\bullet$ operators on interval valued intuitionistic fuzzy soft set (IVIFSS) and investigate some properties of these operators. We introduce the notion of an information measure on IVIFSS and study its basic properties. We also develop a decision-making method based on information measure of IVIFSS.

2. PRELIMINARIES

In this section we recall some definitions and results needed for our study.

Definition 2.1 [8]. Let X be a non-empty set. A fuzzy set A is characterized by its membership function $\mu_A : X \to [0,1]$ and $\mu_A(x)$ is interpreted as the degree of membership of element x in X. A is completely determined by the set of tuples, $A = \{(x, \mu_A(x)) : x \in X\}$.

Definition 2.2 [1]. Let X be a non empty set. An intuitionistic fuzzy set A is an object of the form $A = \{(x, \mu_A(x), \nu_A(x)) : x \in X\}$, where the functions $\mu_A : X \to [0,1]$ and $\nu_A : X \to [0,1]$ define the degree of membership and degree of non-membership of the element $x \in X$ respectively, and for every $x \in X$, $0 \le \mu_A(x) + \nu_A(x) \le 1$.

Let U be the universe of objects and E the set of parameters in relation to objects in U. Parameters are often attributes, characteristics or properties of objects.

Definition 2.3 [9]. Let $\mathrm{F}(U)$ be the set of all fuzzy subsets of U and $A \subseteq E$. A pair (F, A) is called a fuzzy soft set over U, where F is a mapping given by $F : A \to \mathrm{F}(U)$.

For any parameter $\alpha \in A$, $F(\alpha)$ is a fuzzy subset of U and it is called fuzzy value set of the parameter $\alpha \in A, F(\alpha) = \{(x, \mu_{F(\alpha)}(x)) : x \in U\}$. $\mu_{F(\alpha)}(x)$ denotes the membership degree that an object x holds on the parameter α, where $x \in U$ and $\alpha \in A$.

Definition 2.4 [11]. Let U be an universe and E a set of parameters. Let $P(U)$ denote the set of all intuitionistic fuzzy subsets of U and $A \subseteq E$. A pair (F, A) is called an intuitionistic fuzzy soft set over U, where F is a mapping given by $F : A \to P(U)$.

Notation: For any set A of real numbers, we denote $\underline{A} = \inf A$ and $\overline{A} = \sup A$.

Definition 2.5 [2]. An interval valued intuitionistic fuzzy set on an universe X is an object of the form $A=\{(x,\mu_A(x),\nu_A(x)):x\in X\}$,

where $\mu_A(x)=[\underline{\mu}_A(x),\overline{\mu}_A(x)]$ and $\nu_A(x)=[\underline{\nu}_A(x),\overline{\nu}_A(x)]$,

$\underline{\mu}_A(x)=\inf\mu_A(x),\overline{\mu}_A(x)=\sup\mu_A(x),\mu_A(x),\nu_A(x):A\to D([0,1])$,

$D([0,1])$ stands for the set of all closed subintervals of [0, 1] which satisfy the condition,

$0\le\sup\mu_A(x)+\sup\nu_A(x)\le 1.$

Definition 2.6 [7]. Let U be the universe and E a set of parameters. Let $\text{IVIFS}(U)$ denote the set of all interval valued intuitionistic fuzzy sets over U and $A\subseteq E$. A pair (F,A) is an interval valued intuitionistic fuzzy soft set over U, where F is a mapping given by $F:A\to\text{IVIFS}(U)$. For any parameter $\alpha\in A, F(\alpha)$ is an interval valued intuitionistic fuzzy soft set.

Definition 2.7 [7]. The complement of an IVIFSS (F,A) denoted by $(F,A)^c$ is defined as

$$(F,A)^c=\left\{\left\langle x,[\underline{\nu}_A(x),\overline{\nu}_A(x)],[\underline{\mu}_A(x),\overline{\mu}_A(x)]\right\rangle:x\in U\text{ and }\alpha\in A\right\}.$$

Definition 2.8 [17]. For $A\in\text{IVIFS}(U)$, $U=\{x_1,x_2,\ldots,x_n\}$, an information measure to indicate the degree of fuzziness of A is defined as

$$IM(A)=\frac{1}{n}\sum_{i=1}^{n}\frac{\min\{\underline{\mu}_A(x_i),\underline{\nu}_A(x_i)\}+\min\{\overline{\mu}_A(x_i),\overline{\nu}_A(x_i)\}}{\max\{\underline{\mu}_A(x_i),\underline{\nu}_A(x_i)\}+\max\{\overline{\mu}_A(x_i),\overline{\nu}_A(x_i)\}}.$$

3. Φ and $\bullet$ operators on interval valued intuitionistic fuzzy soft set

In this section, we define Φ and $\bullet$ operators on IVIFSS and study some properties of these operators.

Definition 3.1. Let (F,A) and (G,B) be two IVIFSS over the same universe U. Then the operation Φ on (F,A) and (G,B) is denoted by $(F,A)\Phi(G,B)$ and is defined as $(F,A)\Phi(G,B)=(H,C)$, where $C=A\cup B$ and $\forall\alpha\in C$

$$(H,C)=\begin{cases}\left\{\left\langle m,\left[\frac{(\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m))}{2},\frac{(\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m))}{2}\right],\left[\frac{(\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m))}{2},\frac{(\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m))}{2}\right]\right\rangle\mid m\in U\right\} & if\ \alpha\in A\cap B\\ \left\{\left\langle m,[\underline{\mu}_{F(\alpha)}(m),\overline{\mu}_{F(\alpha)}(m)],[\underline{\nu}_{F(\alpha)}(m),\overline{\nu}_{F(\alpha)}(m)]\right\rangle\mid m\in U\right\} & if\ \alpha\in A-B\\ \left\{\left\langle m,[\underline{\mu}_{G(\alpha)}(m),\overline{\mu}_{G(\alpha)}(m)],[\underline{\nu}_{G(\alpha)}(m),\overline{\nu}_{G(\alpha)}(m)]\right\rangle\mid m\in U\right\} & if\ \alpha\in B-A.\end{cases}$$

Example 3.2. Let $U=\{x_1,x_2,x_3,x_4,x_5\}$ be the universal set and $E=\{$ beautiful, moderate, cheap, costly, wooden $\}$ be the set of parameters. Let $A=\{$ moderate, beautiful $\}$, $B=\{$ beautiful, cheap $\}$. IVIFSS (F,A) describes the attractiveness of the objects where as the IVIFSS (G,B) describes its cost. The tabular representation of IVIFSS (F,A) is as follows:

U	moderate	Beautiful
x_1	[0.6, 0.62], [0.2, 0.3]	[0.8, 0.85], [0.1, 0.13]
x_2	[0.82, 0.84], [0.05, 0.11]	[0.6, 0.64], [0.25, 0.3]
x_3	[0.14, 0.22], [0.3, 0.35]	[0.57, 0.61], [0.3, 0.36]
x_4	[0.75, 0.79], [0.15, 0.17]	[0.3, 0.35], [0.6, 0.63]
x_5	[0.6, 0.64], [0.3,0.34]	[0.5, 0.6], [0.3, 0.37]

Table 1

The tabular representation of IVIFSS (G,B) is as follows:

U	beautiful	Cheap
x_1	[0.85, .0.9], [0.02, 0.08]	[0.9, 0.94], [0.01, 0.05]
x_2	[0.6, 0.7], [0.2, 0.25]	[0.75, 0.8], [0.13, 0.15]
x_3	[0.7, 0.75], [0.1, 0.18]	[0.76, 0.87], [0.08, 0.12]
x_4	[0.68, 0.73], [0.2, 0.24]	[0.29, 0.34], [0.6, 0.63]
x_5	[0.24, 0.3], [0.6, 0.64]	[0.82, 0.86], [0.1, 0.12]

Table 2

The tabular representation of IVIFSS $(F,A)\Phi(G,B)$ is

U	moderate	beautiful	Cheap
x_1	[0.6, 0.62], [0.2, 0.3]	[0.825, 0.875], [0.06, 0.105]	[0.9, 0.94], [0.01, 0.05]
x_2	[0.82, 0.84],[0.05, 0.11]	[0.6, 0.67], [0.225, 0.275]	[0.75, 0.8], [0.13, 0.15]
x_3	[0.14, 0.22], [0.3, 0.35]	[0.635, 0.68], [0.2, 0.27]	[0.76, 0.87], [0.08, 0.12]
x_4	[0.75, 0.79], [0.15, 0.17]	[0.49, 0.54], [0.4, 0.435]	[0.29, 0.34], [0.6, 0.63]
x_5	[0.6, 0.64], [0.3, 0.34]	[0.37, 0.45], [0.45, 0.505]	[0.82, 0.86], [0.1, 0.12]

Table 3

Proposition 3.3. For any two non-empty IVIFSS (F,A) and (G,B) over U, we have the following:

(1) $(F,A)\Phi\ (G,B)=(G,B)\Phi\ (F,A)$;

(2) $\left[(F,A)^c\ \Phi\ (G,B)^c\right]^c=(F,A)\Phi\ (G,B)$.

Proof. (1) Proof is obvious.

(2) Let $(F,A)=\left\{\left\langle m,\left[\underline{\mu}_{F(\alpha)}(m),\overline{\mu}_{F(\alpha)}(m)\right],\left[\underline{\nu}_{F(\alpha)}(m),\overline{\nu}_{F(\alpha)}(m)\right]\right\rangle \mid m\in U\right\}$ and

$(G,B)=\left\{\left\langle m,\left[\underline{\mu}_{G(\alpha)}(m),\overline{\mu}_{G(\alpha)}(m)\right],\left[\underline{\nu}_{G(\alpha)}(m),\overline{\nu}_{G(\alpha)}(m)\right]\right\rangle \mid m\in U\right\}$ be two IVIFSS.

$$(F,A)^c\ \Phi\ (G,B)^c=\begin{cases}\left\{\left\langle m,\left[\frac{\left(\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m)\right)}{2},\frac{\left(\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m)\right)}{2}\right],\right.\right. & \\ \left.\left.\left[\frac{\left(\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m)\right)}{2},\frac{\left(\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m)\right)}{2}\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A\cap B\\ \left\{\left\langle m,\left[\underline{\nu}_{F(\alpha)}(m),\overline{\nu}_{F(\alpha)}(m)\right],\left[\underline{\mu}_{F(\alpha)}(m),\overline{\mu}_{F(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A-B\\ \left\{\left\langle m,\left[\underline{\nu}_{G(\alpha)}(m),\overline{\nu}_{G(\alpha)}(m)\right],\left[\underline{\mu}_{G(\alpha)}(m),\overline{\mu}_{G(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in B-A.\end{cases}$$

$$\left[(F,A)^c \,\Phi\, (G,B)^c\right]^c = \begin{cases} \left\{\left\langle m, \left[\dfrac{\left(\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m)\right)}{2}, \dfrac{\left(\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m)\right)}{2}\right], \left[\dfrac{\left(\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m)\right)}{2}, \dfrac{\left(\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m)\right)}{2}\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A\cap B \\ \left\{\left\langle m, \left[\underline{\mu}_{F(\alpha)}(m), \overline{\mu}_{F(\alpha)}(m)\right], \left[\underline{\nu}_{F(\alpha)}(m), \overline{\nu}_{F(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A-B \\ \left\{\left\langle m, \left[\underline{\mu}_{G(\alpha)}(m), \overline{\mu}_{G(\alpha)}(m)\right], \left[\underline{\nu}_{G(\alpha)}(m), \overline{\nu}_{G(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in B-A. \end{cases}$$

Hence the proof.

Definition 3.4. Let (F,A) and (G,B) be two non empty IVIFSS over U. Then the operation $\bullet$ is defined as $(F,A)\bullet(G,B)=(\mathrm{K},C)$, where $C=A\cup B$ and $\forall\,\alpha\in C$

$$(\mathrm{K},C) = \begin{cases} \left\{\left\langle m, \left[\dfrac{2\underline{\mu}_{F(\alpha)}(m).\underline{\mu}_{G(\alpha)}(m)}{\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m)}, \dfrac{2\overline{\mu}_{F(\alpha)}(m).\overline{\mu}_{G(\alpha)}(m)}{\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m)}\right], \left[\dfrac{2\underline{\nu}_{F(\alpha)}(m).\underline{\nu}_{G(\alpha)}(m)}{\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m)}, \dfrac{2\overline{\nu}_{F(\alpha)}(m).\overline{\nu}_{G(\alpha)}(m)}{\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m)}\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A\cap B \\ \left\{\left\langle m, \left[\underline{\mu}_{F(\alpha)}(m), \overline{\mu}_{F(\alpha)}(m)\right], \left[\underline{\nu}_{F(\alpha)}(m), \overline{\nu}_{F(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in A-B \\ \left\{\left\langle m, \left[\underline{\mu}_{G(\alpha)}(m), \overline{\mu}_{G(\alpha)}(m)\right], \left[\underline{\nu}_{G(\alpha)}(m), \overline{\nu}_{G(\alpha)}(m)\right]\right\rangle \mid m\in U\right\} & if\ \alpha\in B-A. \end{cases}$$

Example 3.5. The tabular representation of the IVIFSS $(\mathrm{K},C)=(F,A)\bullet(G,B)$ in Example 3.2 is given below:

U	moderate	beautiful	Cheap
x_1	[0.6, 0.62], [0.2, 0.3]	[0.824, 0.874], [0.033, 0.099]	[0.9, 0.94], [0.01, 0.05]
x_2	[0.82, 0.84],[0.05, 0.11]	[0.6, 0.669], [0.222, 0.273]	[0.75, 0.8], [0.13, 0.15]
x_3	[0.14, 0.22], [0.3, 0.35]	[0.628, 0.673], [0.15, 0.24]	[0.76, 0.87], [0.08, 0.12]
x_4	[0.75, 0.79], [0.15, 0.17]	[0.416, 0.473], [0.3, 0.348]	[0.29, 0.34], [0.6, 0.63]
x_5	[0.6, 0.64], [0.3, 0.34]	[0.324, 0.4], [0.4, 0.469]	[0.82, 0.86], [0.1, 0.12]

Table 4

Proposition 3.6. For any two non-empty IVIFSS (F,A) and (G,B) over U

(1) $(F,A)\bullet(G,B)=(G,B)\bullet(F,A)$;

(2) $\left[(F,A)^c\bullet(G,B)^c\right]^c=(F,A)\bullet(G,B)$.

Proof. The proof of (1) is obvious.

$$(2)\ (F,A)^c \bullet (G,B)^c = \begin{cases} \left\{\left\langle m, \left[\frac{2\underline{\nu}_{F(\alpha)}(m).\underline{\nu}_{G(\alpha)}(m)}{\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m)}, \frac{2\overline{\nu}_{F(\alpha)}(m).\overline{\nu}_{G(\alpha)}(m)}{\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m)}\right], \left[\frac{2\underline{\mu}_{F(\alpha)}(m).\underline{\mu}_{G(\alpha)}(m)}{\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m)}, \frac{2\overline{\mu}_{F(\alpha)}(m).\overline{\mu}_{G(\alpha)}(m)}{\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m)}\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in A\cap B \\ \left\{\left\langle m, \left[\underline{\nu}_{F(\alpha)}(m), \overline{\nu}_{F(\alpha)}(m)\right], \left[\underline{\mu}_{F(\alpha)}(m), \overline{\mu}_{F(\alpha)}(m)\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in A-B \\ \left\{\left\langle m, \left[\underline{\nu}_{G(\alpha)}(m), \overline{\nu}_{G(\alpha)}(m)\right], \left[\underline{\mu}_{G(\alpha)}(m), \overline{\mu}_{G(\alpha)}(m)\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in B-A. \end{cases}$$

$$\left[(F,A)^c \bullet (G,B)^c\right]^c = \begin{cases} \left\{\left\langle m, \left[\frac{2\underline{\mu}_{F(\alpha)}(m).\underline{\mu}_{G(\alpha)}(m)}{\underline{\mu}_{F(\alpha)}(m)+\underline{\mu}_{G(\alpha)}(m)}, \frac{2\overline{\mu}_{F(\alpha)}(m).\overline{\mu}_{G(\alpha)}(m)}{\overline{\mu}_{F(\alpha)}(m)+\overline{\mu}_{G(\alpha)}(m)}\right], \left[\frac{2\underline{\nu}_{F(\alpha)}(m).\underline{\nu}_{G(\alpha)}(m)}{\underline{\nu}_{F(\alpha)}(m)+\underline{\nu}_{G(\alpha)}(m)}, \frac{2\overline{\nu}_{F(\alpha)}(m).\overline{\nu}_{G(\alpha)}(m)}{\overline{\nu}_{F(\alpha)}(m)+\overline{\nu}_{G(\alpha)}(m)}\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in A\cap B \\ \left\{\left\langle m, \left[\underline{\mu}_{F(\alpha)}(m), \overline{\mu}_{F(\alpha)}(m)\right], \left[\underline{\nu}_{F(\alpha)}(m), \overline{\nu}_{F(\alpha)}(m)\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in A-B \\ \left\{\left\langle m, \left[\underline{\mu}_{G(\alpha)}(m), \overline{\mu}_{G(\alpha)}(m)\right], \left[\underline{\nu}_{G(\alpha)}(m), \overline{\nu}_{G(\alpha)}(m)\right]\right\rangle \mid m \in U\right\} & if\ \alpha \in B-A. \end{cases}$$

$$= (F,A) \bullet (G,B)$$

Hence the proof.

We now define an information measure on IVIFSS.

Definition 3.7. For any $IVIFSS\,(F,A)$, an information measure to indicate the degree of fuzziness of (F,A) is defined as

$$I_m(F,A) = \frac{1}{n}\sum_{i=1}^{n} \frac{\min\left\{\underline{\mu}_{F(\alpha)}(x_i), \underline{\nu}_{F(\alpha)}(x_i)\right\} + \min\left\{\overline{\mu}_{F(\alpha)}(x_i), \overline{\nu}_{F(\alpha)}(x_i)\right\}}{\max\left\{\underline{\mu}_{F(\alpha)}(x_i), \underline{\nu}_{F(\alpha)}(x_i)\right\} + \max\left\{\overline{\mu}_{F(\alpha)}(x_i), \overline{\nu}_{F(\alpha)}(x_i)\right\}}.$$

When $\left[\underline{\mu}_{F(\alpha)}(m), \overline{\mu}_{F(\alpha)}(m)\right] = [0,0]$, $\left[\underline{\nu}_{F(\alpha)}(m), \overline{\nu}_{F(\alpha)}(m)\right] = [0,0]\ \forall\, x_i \in U$ and $\alpha \in A$, we get $I_m(F,A) = 1$. Thus the better choice to the decision maker is to choose the alternative for which the information measure is the least.

4. Decision making method based on information measure of IVIFSS

In this section, we develop a decision making method based on the information measure of IVIFSS. The algorithm for decision making method is as follows:

Algorithm 4.1.

Step 1. Construct an IVIFSS (F,A) over U based on the previous records of the specific problem.

Step 2. Calculate the information measure of (F,A_k).

Step 3. Compare the values of $I_m(F,A_k)$ and conclude.

Example 4.2. A fund manager in a wealth management firm is assessing three potential investment alternatives $E = \{$ Alternative-I, Alternative-II, Alternative-III $\}$ over $U = \{x_1, x_2, x_3, x_4, x_5\}$ where x_1 = risk, x_2 = growth, x_3 = socio-political issues, x_4 = environmental impacts and x_5 = cost are the five factors affecting investments.

Step 1. Based on the information obtained from the fund manager pertaining to the factors influencing investment an IVIFSS over U to assess the alternatives are given below:

U	Alternative-I (F,A_1)	Alternative-II (F,A_2)	Alternative-III (F,A_3)
x_1	[0.77, 0.83], [0.11, 0.15]	[0.42, 0.48], [0.4, 0.5]	[0.41, 0.47], [0.39, 0.51]
x_2	[0.63, 0.73], [0.21, 0.24]	[0.61, 0.71], [0.16, 0.24]	[0.57, 0.64], [0.17, 0.21]

x_3	[0.67, 0.75], [0.15, 0.24]	[0.42, 0.51], [0.23,0.35]	[0.53, 0.64], [0.34, 0.43]
x_4	[0.49, 0.55], [0.21, 0.35]	[0.52, 0.73], [0.15, 0.25]	[0.59, 0.69], [0.13, 0.26]
x_5	[0,62, 0.71], [0.19, 0.24]	[0.62, 0.74], [0.18, 0.22]	[0.72, 0.77], [0.16, 0.22]

Table 5

Step 2. The $I_m(F,A)$ is estimated as follows:

$$I_m(F,A)=\frac{1}{5}\sum_{i=1}^{5}\frac{\min\{\underline{\mu}_{F(\alpha)}(x_i),\underline{\nu}_{F(\alpha)}(x_i)\}+\min\{\overline{\mu}_{F(\alpha)}(x_i),\overline{\nu}_{F(\alpha)}(x_i)\}}{\max\{\underline{\mu}_{F(\alpha)}(x_i),\underline{\nu}_{F(\alpha)}(x_i)\}+\max\{\overline{\mu}_{F(\alpha)}(x_i),\overline{\nu}_{F(\alpha)}(x_i)\}}$$

for $1\le k\le 3$.

$I_m(F,A_1)=0.326,$ $I_m(F,A_2)=0.441,$

$I_m(F,A_3)=0.493.$

Step 3. The better investment alternative is the one which has least information measure with respect to the five factors.

We have $I_m(F,A_3)<I_m(F,A_2)<I_m(F,A_1)$.

Therefore, ranking of the alternative is

$I_m(F,A_1)\succ I_m(F,A_2)\succ I_m(F,A_3)$.

i.e., Alternative-I is the better investment.

CONCLUSION

In this paper we have introduced the operations Φ and $\bullet$ on interval valued intuitionistic fuzzy soft set and established some properties of these operators. We have developed a decision making method based on information measure of interval valued intuitionistic fuzzy soft set. We have also given an algorithm for the decision making problem using information measure and illustrated the working of the algorithm by means of example.

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