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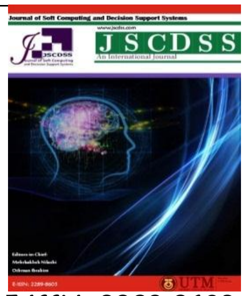

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Similarity Measure of Interval Valued Intuitionistic Fuzzy Soft Sets of Root Type in Decision Making

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Abstract

In this paper we introduce two topological operators on interval valued intuitionistic fuzzy soft set of root type and establish some theoretical properties of these operators. We define Hamming distance between interval valued intuitionistic fuzzy soft sets of root type and establish that it is a metric. Further we define a similarity measure based on interval valued intuitionistic fuzzy soft set of root type and also develop a new decision making method based on this similarity measure between interval valued intuitionistic fuzzy soft sets of root type using Hamming distance. Finally, we provide a numerical example to illustrate the working of this algorithm.

Keywords: Interval valued intuitionistic fuzzy soft set of root type, Operators, Hamming distance, Similarity measure, Decision making technique

1. Introduction

The theory of intuitionistic fuzzy sets was introduced by Atanassov (1983) and the concept of interval valued fuzzy set was introduced by Gorzalczany (1987). The concept of interval valued intuitionistic fuzzy set was developed by Atanassov and Gorgov (1989). Palaniappan et al. (2006) introduced some operations on intuitionistic fuzzy sets of root type. Soft set theory was first introduced by Molodtsov (1999). Motivated by these theories, the theory of fuzzy soft set Maji et al. (2001a) and the theory of intuitionistic fuzzy soft set Maji et al. (2001b) have been developed. Yang et al. (2009) developed the concept of interval valued fuzzy soft sets by combining the interval valued fuzzy set and soft set models. Anita Shanthi and Vadivel Naidu (2015) combined the concepts of interval valued intuitionistic fuzzy set, fuzzy soft set and intuitionistic fuzzy set of root type and introduced the notion of interval valued intuitionistic fuzzy soft set of root type (IVIFSSRT).

Atanassov (1986) was the first one to introduce different types of similarity measures between intuitionistic fuzzy sets. Li and Cheng (2002) initiated the study of pattern recognition problem using similarity measure. A technique for pattern recognition problem using similarity measure based on Hausdorff distance in intuitionistic fuzzy set was developed by Hung and Yang (2004). Xu (2007) addressed the similarity measure on interval valued intuitionistic fuzzy set and used it for tackling pattern recognition problems. The similarity measure based on distance between soft sets was introduced by Majundar and Samanta (2008). The same authors (2010) have also studied the similarity measure based on distance between intuitionistic fuzzy soft sets. A distance measure on interval valued intuitionistic fuzzy set for handling group decision making problems was proposed by Xu (2010). Further, Deli and Cagman (2013) proposed a distance based similarity measure on intuitionistic fuzzy soft sets. A general type of similarity measure for intuitionistic fuzzy set was proposed by Boran and Akay (2014). Song et al. (2015) proposed a similarity measure based on distance measure of intuitionistic fuzzy sets with the influence of hesitation degree and showed that this measure overcomes some of the drawbacks in the existing similarity measures. Chen and Chang (2015) introduced a similarity measure based on transformation techniques of IFS and established the need for this measure.

In this study Hamming distance between IVIFSSRT is defined and it is proved to be a metric. A new method for solving decision making problems in fuzzy environment using similarity measure based on this Hamming distance is established. An algorithm for solving decision making problems is developed and its working is explained by means of an example.

The rest of this paper is organized as follows. Section 2 provides the basic definitions needed for our study. In Section 3, we define two topological operators on interval valued intuitionistic fuzzy soft set of root type and discuss some of its properties. In Section 4, we define hamming distance on interval valued intuitionistic fuzzy soft set of root type and establish that it is a metric. We also define a similarity measure based on hamming distance and develop an algorithm for a new decision making method based on this similarity measure. Example is given to explain the working of this algorithm. In the last section we present a brief conclusion.

2. Preliminaries

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

Definition 1 (Atanassov, 1983)**.** 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 $x\in X$,
$0\le\mu_A(x)+\nu_A(x)\le 1.$

Definition 2 (Atanassov and Gargov, 1989). 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

$\mu_A(x)=\left[\underline{\mu}_A(x),\overline{\mu}_A(x)\right]$ and

$\nu_A(x)=\left[\underline{\nu}_A(x),\overline{\nu}_A(x)\right]$, $\mu_A(x),\nu_A(x):A\to D([0,1])$.

$D([0,1])$ stands for the set of all closed subintervals of [0, 1] which satisfy the condition, $0\le\overline{\mu}_A(x)+\overline{\nu}_A(x)\le 1$.

Remark 1. Atanassov's(1986) definition of intuitionistic fuzzy set imposes a condition on $\mu_A(x)$ and $\nu_A(x)$ as $0<\mu_A(x)+\nu_A(x)\le 1$, which in turn implies that $\nu_A(x)\le 1-\mu_A(x)$ for each $x\in X$. This goes against the spirit that $\mu_A(x)$ and $\nu_A(x)$ are assigned independently. As this independence criteria is more important, we relax the condition $0<\mu_A(x)+\nu_A(x)\le 1$ and hence there is possibility for $\mu_A(x)+\nu_A(x)\ge 1$. To make the assignments of membership $\mu_A(x)$ and non membership $\nu_A(x)$ more realistic, we impose a new condition $\sqrt{\mu_A(x)}+\sqrt{\nu_A(x)}\le 2$ and consider the more generalized intuitionistic fuzzy set namely the intuitionistic fuzzy set of root type.

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 3 (Maji et al., 2001a). 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 4 (Maji et al., 2001b). 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 $F:A\to P(U)$.

3. New operators on interval valued intuitionistic fuzzy soft set of root type

In this section, we define two topological operators on IVIFSSRT and discuss some properties of these operators.

Definition 5 (Anita Shanthi and Vadivel Naidu, 2015). Let U be an universe and E a set of parameters. Let $IVIFSRT(U)$ denote the set of all interval valued intuitionistic fuzzy sets of root type of U and $A\subseteq E$. A pair (F,A) is called an *IVIFSSRT* over U, where F is a mapping given by $F:A\to IVIFSRT(U)$ and

$$(F,A)=\left\{\left\langle x,\left[\underline{\mu}_{F(e)}(x),\overline{\mu}_{F(e)}(x)\right],\left[\underline{\nu}_{F(e)}(x),\overline{\nu}_{F(e)}(x)\right]\right\rangle:x\in U,e\in A\right\}.$$

For any parameter $e\in A, F(e)$ is an *IVIFSRT*.

Definition 6. Let U be a non empty finite set. For every IVIFSSRT (F,A), we define the following two operators

$$C(F,A)=\left\{\left\langle x,\left[\max_{y\in U}\underline{\mu}_{F(e)}(y),\max_{y\in U}\overline{\mu}_{F(e)}(y)\right],\left[\min_{y\in U}\underline{\nu}_{F(e)}(y),\min_{y\in U}\overline{\nu}_{F(e)}(y)\right]\right\rangle:x\in U \text{ and } e\in A\right\}.$$

$$I(F,A)=\left\{\left\langle x,\left[\min_{y\in U}\underline{\mu}_{F(e)}(y),\min_{y\in U}\overline{\mu}_{F(e)}(y)\right],\left[\max_{y\in U}\underline{\nu}_{F(e)}(y),\max_{y\in U}\overline{\nu}_{F(e)}(y)\right]\right\rangle:x\in U \text{ and } e\in A\right\}.$$

We call $C(F,A)$ and $I(F,A)$ respectively, as closure of and interior of (F,A) over U.

Theorem 1. For every IVIFSSRT (F,A) the following are true:
(1) $C(C(F,A))=C(F,A)$; (2) $C(I(F,A))=I(F,A)$;
(3) $I(C(F,A))=C(F,A)$; (4) $I(I(F,A))=I(F,A)$.

Proof. (1). $C(C(F,A))$

$$=C\left\{\left\langle x,\left[\max_{y\in U}\underline{\mu}_{F(e)}(y),\max_{y\in U}\overline{\mu}_{F(e)}(y)\right],\left[\min_{y\in U}\underline{\nu}_{F(e)}(y),\min_{y\in U}\overline{\nu}_{F(e)}(y)\right]\right\rangle:x\in U \text{ and } e\in A\right\}$$

$$=\left\{\left\langle x,\left[\max_{y\in U}\underline{\mu}_{F(e)}(y),\max_{y\in U}\overline{\mu}_{F(e)}(y)\right],\left[\min_{y\in U}\underline{\nu}_{F(e)}(y),\min_{y\in U}\overline{\nu}_{F(e)}(y)\right]\right\rangle:x\in U \text{ and } e\in A\right\}$$

$=C(F,A)$.

(2) $C(I(F,A))$

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$$= C\left\{\left\langle x, \left[\min_{y\in U} \underline{\mu}_{F(e)}(y), \min_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\max_{y\in U} \underline{\nu}_{F(e)}(y), \max_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= \left\{\left\langle x, \left[\min_{y\in U} \underline{\mu}_{F(e)}(y), \min_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\max_{y\in U} \underline{\nu}_{F(e)}(y), \max_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= I(F,A).$$

(3) $I(C(F,A))$

$$= I\left\{\left\langle x, \left[\max_{y\in U} \underline{\mu}_{F(e)}(y), \max_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\min_{y\in U} \underline{\nu}_{F(e)}(y), \min_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= \left\{\left\langle x, \left[\max_{y\in U} \underline{\mu}_{F(e)}(y), \max_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\min_{y\in U} \underline{\nu}_{F(e)}(y), \min_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= C(F,A).$$

(4) $I(I(F,A))$

$$= I\left\{\left\langle x, \left[\min_{y\in U} \underline{\mu}_{F(e)}(y), \min_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\max_{y\in U} \underline{\nu}_{F(e)}(y), \max_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= \left\{\left\langle x, \left[\min_{y\in U} \underline{\mu}_{F(e)}(y), \min_{y\in U} \overline{\mu}_{F(e)}(y)\right],\right.\right.$$
$$\left.\left.\left[\max_{y\in U} \underline{\nu}_{F(e)}(y), \max_{y\in U} \overline{\nu}_{F(e)}(y)\right]\right\rangle : x\in U \text{ and } e\in A\right\}$$
$$= I(F,A).$$

4. Decision making method based on similarity measure on IVIFSSRT

In this section we define a similarity measure on IVIFSSRT and establish that it is a metric. We also develop a new decision making method based on this similarity measure.

Definition 7. Let $U=\{x_1,x_2,...,x_n\}$ be an universal set, $E=\{e_1,e_2,...,e_m\}$ be a set of parameters and $(F,A),(G,B)$ two *IVIFSSRT* on U. Then the Hamming distance between (F,A) and (G,B) is defined as $\xi\langle(F,A),(G,B)\rangle$

$$= \left\{\frac{1}{4mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\Big(|\underline{\mu}_{F(e_i)}(x_j)-\underline{\mu}_{G(e_i)}(x_j)|+\right.$$
$$+|\overline{\mu}_{F(e_i)}(x_j)-\overline{\mu}_{G(e_i)}(x_j)|+|\underline{\nu}_{F(e_i)}(x_j)-\underline{\nu}_{G(e_i)}(x_j)|$$
$$\left.+|\overline{\nu}_{F(e_i)}(x_j)-\overline{\nu}_{G(e_i)}(x_j)|\Big)\right\}^{\frac{1}{2}}$$

Theorem 2. Let *IVIFSSRT*(U) denote the set of all *IVIFSSRT* over U. Then the distance function ξ from *IVIFSSRT*(U) to the set of non negative real numbers is a metric.

Proof. Let $(F,A),(G,B)$ and (H,C) be three IVIFSSRTs over U.

(i) $\xi\langle(F,A),(G,B)\rangle > 0$ follows from Definition 7.

(ii) $\xi\langle(F,A),(G,B)\rangle = 0 \Leftrightarrow$

$$|\underline{\mu}_{F(e_i)}(x_j)-\underline{\mu}_{G(e_i)}(x_j)|+|\overline{\mu}_{F(e_i)}(x_j)-\overline{\mu}_{G(e_i)}(x_j)|$$
$$+|\underline{\nu}_{F(e_i)}(x_j)-\underline{\nu}_{G(e_i)}(x_j)|+|\overline{\nu}_{F(e_i)}(x_j)-\overline{\nu}_{G(e_i)}(x_j)|$$
$$\Leftrightarrow \underline{\mu}_{F(e_i)}(x_j)=\underline{\mu}_{G(e_i)}(x_j), \overline{\mu}_{F(e_i)}(x_j)=\overline{\mu}_{G(e_i)}(x_j),$$
$$\underline{\nu}_{F(e_i)}(x_j)=\underline{\nu}_{G(e_i)}(x_j), \overline{\nu}_{F(e_i)}(x_j)=\overline{\nu}_{G(e_i)}(x_j)$$
$$\Leftrightarrow (F,A)=(G,B).$$

(iii) Clearly, $\xi\langle(F,A),(G,B)\rangle = \xi\langle(G,B),(F,A)\rangle$.

(iv) Assume that $(F,A),(G,B)$ and (H,C) are IVIFSSRT over U. Then for all $i\in\{1,2,...,m\}$, $j\in\{1,2,...,n\}$,

$$|\underline{\mu}_{F(e_i)}(x_j)-\underline{\mu}_{G(e_i)}(x_j)|+|\overline{\mu}_{F(e_i)}(x_j)-\overline{\mu}_{G(e_i)}(x_j)|$$
$$+|\underline{\nu}_{F(e_i)}(x_j)-\underline{\nu}_{G(e_i)}(x_j)|+|\overline{\nu}_{F(e_i)}(x_j)-\overline{\nu}_{G(e_i)}(x_j)|$$
$$=|\underline{\mu}_{F(e_i)}(x_j)-\underline{\mu}_{H(e_i)}(x_j)+\underline{\mu}_{H(e_i)}(x_j)-\underline{\mu}_{G(e_i)}(x_j)|$$
$$+|\overline{\mu}_{F(e_i)}(x_j)-\overline{\mu}_{H(e_i)}(x_j)+\overline{\mu}_{H(e_i)}(x_j)-\overline{\mu}_{G(e_i)}(x_j)|$$
$$+|\underline{\nu}_{F(e_i)}(x_j)-\underline{\nu}_{H(e_i)}(x_j)+\underline{\nu}_{H(e_i)}(x_j)-\underline{\nu}_{G(e_i)}(x_j)|$$
$$+|\overline{\nu}_{F(e_i)}(x_j)-\overline{\nu}_{H(e_i)}(x_j)+\overline{\nu}_{H(e_i)}(x_j)-\overline{\nu}_{G(e_i)}(x_j)|$$
$$\le|\underline{\mu}_{F(e_i)}(x_j)-\underline{\mu}_{H(e_i)}(x_j)|+|\underline{\mu}_{H(e_i)}(x_j)-\underline{\mu}_{G(e_i)}(x_j)|$$
$$+|\overline{\mu}_{F(e_i)}(x_j)-\overline{\mu}_{H(e_i)}(x_j)|+|\overline{\mu}_{H(e_i)}(x_j)-\overline{\mu}_{G(e_i)}(x_j)|$$
$$+|\underline{\nu}_{F(e_i)}(x_j)-\underline{\nu}_{H(e_i)}(x_j)|+|\underline{\nu}_{H(e_i)}(x_j)-\underline{\nu}_{G(e_i)}(x_j)|$$
$$+|\overline{\nu}_{F(e_i)}(x_j)-\overline{\nu}_{H(e_i)}(x_j)|+|\overline{\nu}_{H(e_i)}(x_j)-\overline{\nu}_{G(e_i)}(x_j)|$$
$$=\xi\langle(F,A),(H,C)\rangle+\xi\langle(H,C).(G,B)\rangle.$$

Therefore, we have $\xi\langle(F,A).(G,B)\rangle$
$\le \xi\langle(F,A),(H,C)\rangle+\xi\langle(H,C).(G,B)\rangle$.

Hence ξ is a metric.

Definition 8. Let (F,A) and (G,B) be two *IVIFSSRT* on U. Then using the hamming distance, the similarity measure of (F,A) and (G,B) denoted by $S_m\langle(F,A),(G,B)\rangle$ is defined as

$$S_m\langle(F,A),(G,B)\rangle = \frac{1}{1+\xi\langle(F,A),(G,B)\rangle}.$$

We call the two *IVIFSSRT* significantly similar if $S_m\langle(F,A),(G,B)\rangle \ge \frac{1}{2}$.

Theorem 3. Let E be a parameter set and (F,A) and (G,B) be two *IVIFSSRT* over U. Then the following are true:

(1) $0\le S_m\langle(F,A),(G,B)\rangle\le 1$;

(2) $S_m\langle(F,A),(G,B)\rangle = S_m\langle(G,B),(F,A)\rangle$;

(3) $S_m\langle(F,A),(G,B)\rangle = 1$ if and only if

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$(F, A) = (G, B)$.

Proof. Proof is obvious.

Now we develop a decision making method based on similarity measure of *IVIFSSRT*.

4.1 Algorithm for Decision making method

In this subsection, we develop a decision making method based on similarity measure of IVIFSSRT.

Step 1. Construct an IVIFSSRT (F, E) over U based on expert's evaluation.

Step 2. Construct an IVIFSSRT (G, E) over U based on the available data.

Step 3. Calculate the Hamming distance between (F, E) and (G, E).

Step 4. Calculate the similarity measure between (F, E) and (G, E).

Step 5. Conclude using the value of similarity measure.

Example 1. Certain areas of a state are affected by flood. A team of four members $U = \{m_1, m_2, m_3, m_4\}$ from Rehabilitation Department inspect the flood affected areas and the relief measures recommended by them are described by the parameter set $E = \{e_1, e_2, ..., e_6\}$ where $e_1 =$ relief for crop loss, $e_2 =$ relief for livestock, $e_3 =$ relief for fisherman, $e_4 =$ relief to loss of life, $e_5 =$ provision for alternate livelihood, $e_6 =$ relief for ecological damage. Based on these recommendations the government has to allocate funds according to the level of damage.

Step 1. IVIFSSRT (F, E) over U based on the previous records of relief measures in similar situation (see Table 1).

Step 2. IVIFSSRT (G, E) over U based on the recommendations of the team visiting Area I (see Table 2).

Step 3. Hamming distance between (F, E) and (G, E) calculated using Definition 7 is $\xi\langle(F, E), (G, E)\rangle = 0.04$.

Step 4. Similarity measure between (F, E) and (G, E) calculated using Definition 8 is

$$S_m\langle(F, E), (H, E)\rangle = 0.962.$$

Step 5. Similarity measure of (F, E) and (G, E) is greater than $\frac{1}{2}$. Since the two IVIFSSRT are significantly similar, we conclude that Area I is severely affected by flood.

For the above example, the IVIFSSRT (H, E) over U based on the recommendations of the expert team visiting Area II (see Table 3).

Then the Hamming distance between (F, E) and (H, E) is 1.023 and similarity measure between (F, E) and (H, E) is $S_m\langle(F, E), (H, E)\rangle = 0.494$.

As similarity measure of between (F, E) and (H, E) is $< \frac{1}{2}$, the two IVIFSSRT are not significantly similar and we conclude that Area II is not severely affected by flood.

Table 1
An IVIFSSRT (F, E) over U based on the previous records of relief measures in similar situation.

U	m_1	m_2	m_3	m_4
e_1	[0.67, 0.74], [0.26, 0.29]	[0.63, 0.68], [0.25, 0.33]	[0.69, 0.78], [0.23, 0.25]	[0.65, 0.71], [0.31, 0.34]
e_2	[0.48, 0.52], [0.38, 0.49]	[0.44, 0.57], [0.33, 0.47]	[0.52, 0.61], [0.36, 0.43]	[0.46, 0.53], [0.31, 0.48]
e_3	[0.33, 0.45], [0.51, 0.63]	[0.39, 0.55], [0.61, 0.68]	[0.35, 0.47], [0.65, 0.71]	[0.42, 0.52], [0.63, 0.66]
e_4	[0.56, 0.63], [0.34, 0.38]	[0.48, 0.59], [0.39, 0.43]	[0.52, 0.64], [0.31, 0.37]	[0.55, 0.65], [0.29, 0.37]
e_5	[0.63, 0.71], [0.31, 0.37]	[0.66, 0.75], [0.26, 0.33]	[0.64, 0.72], [0.29, 0.35]	[0.69, 0.78], [0.25, 0.29]
e_6	[0.39, 0.46], [0.52, 0.59]	[0.41, 0.49], [0.56, 0.61]	[0.44, 0.51], [0.46, 0.57]	[0.42, 0.48], [0.55, 0.59]

Table 2
IVIFSSRT (G, E) over U based on the recommendations of the expert team visiting Area I.

U	m_1	m_2	m_3	m_4
e_1	[0.66, 0.73],[0.27, 0.3]	[0.62, 0.67],[0.26, 0.34]	[0.68, 0.77],[0.24, 0.26]	[0.64, 0.7],[0.32, 0.35]
e_2	[0.47, 0.51],[0.39, 0.5]	[0.43, 0.56],[0.34, 0.48]	[0.51, 0.6],[0.37, 0.44]	[0.45, 0.52],[0.32, 0.49]
e_3	[0.32, 0.44],[0.52, 0.64]	[0.38, 0.54],[0.62, 0.69]	[0.34, 0.46],[0.66, 0.72]	[0.41, 0.51],[0.64,0.67]
e_4	[0.55, 0.62],[0.35, 0.39]	[0.47, 0.58],[0.4, 0.44]	[0.51, 0.63],[0.32, 0.38]	[0.54, 0.64],[0.3, 0.38]
e_5	[0.62, 0.7],[0.32, 0.38]	[0.65, 0.74],[0.27, 0.34]	[0.63, 0.71],[0.3, 0.36]	[0.68, 0.77],[0.26, 0.3]
e_6	[0.38, 0.45],[0.53, 0.6]	[0.4, 0.48],[0.57, 0.62]	[0.43, 0.5],[0.47, 0.58]	[0.41, 0.47],[0.56, 0.6]

An International Journal JSCDSS
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Table 3
IVIFSSRT (H,E) over *U* based on the recommendations of the expert team visiting Area II.

U	m_1	m_2	m_3	m_4
e_1	[0.31, 0.41], [0.63, 0.68]	[0.44, 0.49], [0.54, 0.64]	[0.39, 0.43], [0.49, 0.58]	[0.36, 0.42], [0.57, 0.63]
e_2	[0.69, 0.73], [0.27, 0.28]	[0.55, 0.68], [0.42, 0.46]	[0.63, 0.72], [0.25, 0.39]	[0.57, 0.64], [0.33, 0.37]
e_3	[0.64, 0.76], [0.33, 0.39]	[0.72, 0.56], [0.39, 0.48]	[0.61, 0.68], [0.35, 0.42]	[0.69, 0.73], [0.36, 0.46]
e_4	[0.17, 0.19], [0.83, 0.89]	[0.19, 0.23], [0.81, 0.88]	[0.23, 0.24], [0.77, 0.79]	[0.29, 0.31], [0.79, 0.81]
e_5	[0.44, 0.48], [0.48, 0.55]	[0.52, 0.55], [0.43, 0.49]	[0.45, 0.49], [0.48, 0.54]	[0.48, 0.52], [0.49, 0.52]
e_6	[0.72, 0.83], [0.26, 0.34]	[0.69, 0.72], [0.22, 0.33]	[0.65, 0.76], [0.25, 0.29]	[0.66, 0.77], [0.18, 0.25]

5. Conclusion

In this paper we have defined two topological operators on interval valued intuitionistic fuzzy soft set of root type and established some theoretical properties of these operators. The concept of Hamming distance between interval valued intuitionistic fuzzy soft set of root type is introduced and it is proved to be a metric. A similarity measure based on hamming distance between interval valued intuitionistic fuzzy soft sets root type is defined and a new decision making technique using this similarity measure is developed. We have given an algorithm for the decision making problem using similarity measure and illustrated the working of the algorithm by means of an example.

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