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Application of Interval Valued Fuzzy Soft Matrices in Decision Making Problem Using Similarity Measures

[1,]Dr.N.Sarala and [2,]M.prabhavathi
[1,]Department of mathematics, A.D.M.collegefor women (Auto),Nagai, India.
[2]Department of mathematics,E.G.S.PillayArts&science college,Nagai,India.

Abstract : *Similarity measure is an important topic in fuzzy set theory (L.A.Zadeh.1965). Similarity measure of fuzzy sets is now being extensively applied in many research fields such as fuzzy clustering, image processing, fuzzy reasoning, fuzzy neural network, pattern recognition, medical diagnosis, game theory, coding theory and several problems that contain uncertainties. The aim of this pape ris to introduce the concept of Similarity measure for interval valued fuzzy soft Matrices based on set theoretic approach, some examples and basic properties are aiso studied.Lastly an application in a decision Making probiem is illustrated.*

Keywords :*Fuzzy soft set , Fuzzy soft Matrices,Interval valued fuzzy soft Matrices, Similaritymeasure.*

I. Introduction

After the introduction of fuzzy set (L.A.Zadeh 1965) several researchers have extended this concept in many directions . similarity measures of fuzzy soft set or fuzzy soft sets or generalized fuzzy soft sets has wide applications in many problems which contains uncertainty such as fuzzy clustering, image processing, fuzzy reasoning fuzzy neural network, pattern recognition, medical diagnosis, game theory, coding theory etc. Similarity measure between vague sets (S.M.Chon 1985) Similarity measures fuzzy soft sets (P.Majundr and samanta 2011). Similarity measure for interval valued fuzzy sets (Hong – meijw and Feng – yingwang – 2011).

In this paper, To introduce the concept of Similarity measure for interval valued fuzzy soft matrices based on set theoritic approach . some examples and basic properties are also studied. Lastly an application in a decision makind proble is illustrated.

II. Preliminaries

In this section we briefly review some basic definitions and examples related to interval valued fuzzy soft set which will be used in the set in the rest of the paper.

Detinition:[Fuzzy soft set] 2.1

Let U be an initial Universe set and E be the set of parameters, let $A \subseteq E$. A pair (F,A) is called fuzzy soft set over U where F is a mapping given by $F: A \rightarrow I^U$, where I^U denotes the collection of all fuzzy subsets of U.

Fuzzy soft Matrices :2.2

Let $U = \{c_1, c_2, c_3 \ldots c_m\}$ be the Universe set and E be the set of parameters given by $E = \{e_1, e_2, e_3 \ldots e_n\}$. Let $A \subseteq E$ and (F,A) be a fuzzy soft set in the fuzzy soft class (U,E). Then fuzzy soft set (F,A) in a matrix form as $A_{mxn} = [a_{ij}]_{mxn}$ or $A=[a_{ij}]$ i=1,2,…m, j=1,2,3,…n

$$\text{Where } a_{ij} = \begin{cases} \mu_j(c_i) & \text{if } e_j \in A \\ 0 & \text{if } e_j \notin A \end{cases}$$

$\mu_j(c_i)$ represents the membership of c_i in the fuzzy set $F(e_j)$.

Interval valued fuzzy soft matrix 2.3[29] : Let U ={$c_1,c_2,c_3\ldots c_m$} be the Universe set and E be the set of parameters given by E ={$e_1,e_2,e_3\ldots e_n$}. Let A ⊆ E and (F,A) be a interval valued fuzzy soft set over U, where F is a mapping given by F: A→I^U, where I^U denotes the collection of all Interval valued fuzzy subsets of U. Then the Interval valued fuzzy soft set can expressed in matrix form as

$\tilde{A}_{mxn}=[a_{ij}]_{mxn}$ or $\tilde{A} = [a_{ij}]$ i= 1,2,…m, j=1,2,…n

$$a_{ij} = \begin{cases} [\mu_{jL}(c_i), \mu_{jU}(c_i)] & \text{if } e_j \in A \\ [0,0] & \text{if } e_j \notin A \end{cases}$$

Where a_{ij} =

$[\mu_{jL}(c_i), \mu_{ju}(c_i)]$ represents the membership of c_i in the Interval valued fuzzy set F (e_j).

Similarity measures for interval valued fuzzy soft sets : 2.4 :

Let U ={h_i :i=1,2,….m} be the universal set of elements hi and E = {e_j,j=1,2,…n} be the set of parameters ej. Let F = (F, E) and G = (G, E) be two interval valued intuitionistic fuzzy sot sets over U. Then F = {F(e_j)} ∈IVlFS^U , e_j ∈ E} and G = {G(e_j)} ∈ IVlFS^U , e_j ∈ E}. Where F(e_j) is called the e_j the approximation of F and G(e_j) is called the e_j the approximation of G and IVlFSU is the set of all interval – valued intuitionistic fuzzy set and. Let M (F, G) indicates the similarity measure between the IVlFS – sets F and G to find . The similarity measure F and G we first have to find similarity between their e_j^{th} approximations. Let Mj (F, G) defined. The similarity measure between the two e_j^{th} approximations of F (e_j) and G (e_j). Then Mj (F, G) is defined as follows .

$$S(F_1, G_1) = \frac{\sum_{i=1}^{m}(|\mu F(e_i)(x_j) - \mu G_1 L(e_i)(x_j)| \wedge |\mu F_1 U(e_i)(x_j) - \mu G_1 U(e_i)(x_j)}{\sum_{i=1}^{m}(|\mu F_1 L(e_i)(x_j) - \mu G_1 L(e_i)(x_j)| \wedge |\mu F_1 U(e_i)(x_j) - \mu G_1 U(e_i)(x_j)}$$

III. Similarity Measure of interval-valued fuzzy soft matrix

Definition 3.1.

Let U= {$C_1,C_2,C_3,\ldots\ldots C_n$} be the universe and E={$e_1,e_2,e_3,\ldots\ldots,e_m$}, be the set of parameters. Let Â and B̂ be two interval valued-fuzzy soft sets(IVFSSs) over the universe U and the set of parameters E. Then the similarity measure between Â and B̂ denoted by S(Â, B̂) is defined as

$$\hat{S}(\hat{A},\hat{B}) = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}|\mu_{AL}-\mu_{BL}| \wedge |\mu_{AL}-\mu_{BL}|}{\sum_{i=1}^{m}\sum_{j=1}^{n}|\mu_{AL}-\mu_{BL}| \wedge |\mu_{AL}-\mu_{BL}|}$$

…………………………….(3)

Example 3.11.

Let U= { C_1,C_2,C_3 } be the universe and E= { e_1,e_2,e_3 }be the set of parameters. We consider two IVFSMsÂ and B̂such that their tabular forms are as follows.

Tabular form of Â

	e_1	e_2	e3
$C1$	[0.7,0.9]	[0.6,0.7]	[0.5,0.8]
$C2$	[0.6,0.8]	[0.2,0.5]	[0.6,0.9]
$C3$	[0.5,0.6]	[0.0,0.7]	[0.2,0.1]

Tabular form of B̂

	e_1	e_2	e_3
$C1$	[0.2,0.8]	[0.4,0.9]	[0.3,0.6]
$C2$	[0.4,0.7]	[0.4,0.5]	[0.8,0.9]
$C2$	[0.0,1.0]	[0.2,0.5]	[0.8,1.0]

Now by definition 3.10 the similarity measure between Â and B̂isgiven by

$$\hat{S}(\hat{A},\hat{B}) = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} |\mu_{AL} - \mu_{BL}| \wedge |\mu_{AL} - \mu_{BL}|}{\sum_{i=1}^{m}\sum_{j=1}^{n} |\mu_{AL} - \mu_{BL}| \wedge |\mu_{AL} - \mu_{BL}|}$$

$$= \frac{(0.5\wedge 0.1)+(0.2\wedge 0.2)+(0.2\wedge 0.2)+(0.2\wedge 0.1)+(0.2\wedge 0)+(0.2\wedge 0)+(0.5\wedge 0.4)+(0.2\wedge 0.2)+(0.6\wedge 0)}{(0.5\vee 0.1)+(0.2\vee 0.2)+(0.2\vee 0.2)+(0.2\vee 0.1)+(0.2\vee 0)+(0.2\vee 0)+(0.5\vee 0.4)+(0.2\vee 0.2)+(0.6\vee 0)}$$

$$= \frac{0.1+0.2+0.2+0.1+0+0+0.4+0.2+0}{0.5+0.2+0.2+0.2+0.2+0.2+0.5+0.2+0.6}$$

$$= \frac{1.2}{2.8}$$

$\cong$ 0.42

Example 3.12.

Let U= {C_1,C_2,C_3, C_4} be the universe and E= {e_1,e_2,e_3}be the set of parameters. We consider two IVFSMs Â and B̂such that their tabular forms are as follows.

Tabular form of Â:

	e_1	e_2	e_3
$C1$	[0.2,0.9]	[0.0,1.0]	[0.2,0.8]
$C2$	[0.4,0.8]	[0.3,0.9]	[0.3,1.0]
$C3$	[0.4,1.0]	[0.3,0.7]	[0.0,0.7]
$C4$	[0.1,0.9]	[0.5,1.0]	[0.3,0.8]

Tabular form of B̂:

	e_1	e_2	e_3
$C1$	[0.1,0.9]	[0.4,1.0]	[0.0,0.8]
$C2$	[0.2,0.7]	[0.1,0.9]	[0.3,1.0]
$C3$	[0.0,0.8]	[0.4,0.9]	[0.2,0.7]
$C4$	[0.2,1.0]	[0.0,1.0]	[0.3,1.0]

Now by definition 3.10 the similarity measure between is given by

$$\hat{S}(\hat{A},\hat{B}) = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} |\mu_{AL} - \mu_{BL}| \wedge |\mu_{AL} - \mu_{BL}|}{\sum_{i=1}^{m}\sum_{j=1}^{n} |\mu_{AL} - \mu_{BL}| \wedge |\mu_{AL} - \mu_{BL}|}$$

$$= \frac{(0.1\wedge 0)+(0.4\wedge 0)+(0.2\wedge 0)+(0.2\wedge 0.1)+(0.2\wedge 0)+0\wedge 0)+}{(0\vee 0)+(0.1\vee 0)+(0.4\vee 0)+(0.2\vee 0)+(0.2\vee 0.1)(0.2\vee 0)+}$$

$$\frac{(0.4 \wedge 0.2) + (0.1 \wedge 0.2) + (0.2 \wedge 0) + (0.1 \wedge 0.1) + (0.5 \wedge 0) + (0 \wedge 0.2)}{(0.4 \vee 0.2) + (0.1 \vee 0.2) + (0.2 \vee 0) + (0.1 \vee 0.1) + (0.5 \vee 0) + (0 \vee 0.2)}$$

$$= \frac{(0+0+0+0.1+0+0+0.2+0.1+0+0.1+0+0)}{(0.1+0.4+0.2+0.2+0.2+0+0.4+0.2+0.2+0.1+0.5+0.2)}$$

$$= \frac{0.5}{2.7}$$

$\cong$ 0.185

Definition 3.13. : Let Â and B̂ be two IVFSSs over U. Then Â and B̂ are said be α–similar.denoted byÂ = B̂ if and only if S(Â, B̂) >αfor α∈ (0, 1). We call the two IVFSMs significantly similar if S(Â and B̂) $>\frac{1}{2}$.

Example 3.14. : Let us consider the example **3.4**. In this example the similarity measure between the IVFSMs Â and B̂, where A = B = E = {e_1, e_2, e_3} is S(F, G) = 0:2972 $<\frac{1}{2}$. Therefore Â and B̂are not significantly similar. But if we consider the example **3:5** then S(Â, B̂) = 0:847 $>\frac{1}{2}$. Therefore Â and B̂are significantly similar, where A = B = E = {e_1, e_2, e_3}.

IV. Decision Making Method

In this section we construct a decision making method based on similarity measure of two interval valued fuzzy soft matrices (IVFSMs). The algorithm of this method can be given as follows:

Step 1. Construct a IVFSM Âover the universe U based on an expert.

Step 2. Construct a IVFSMS B̂on a responsible for the problem.

Step 3. Calculate similarity measure of Â and B̂.

Step 4. Estimate result by using the similarity.

Now we are giving an example for the decision making method. The similarity measure of two IVFSSs based on Hamming distance can be applied to detect whether a ill person is suffering from a certain disease or not. In this problem we will try to estimate the possibility that an ill person having certain symptoms is suffering from typhoid. For this we first construct a IVFM$_S$ for illness and IVFSM$_S$ for ill person. Then we find the similarity measure of these two IVFSMs. If they are significantly similar then we conclude that the person is possibly suffering from cancer.

Example 4.1. : Assume that the universal set U contains only two elements C_1 (cancer) and C_2 (not cancer) i.e. U = {C_1, C_2}. Here the set of parameters E, is a setof certain visible symptoms. Let E = {e_1, e_2, e_3, e_4, e_5, e_6}, where e_1 = bone pain,e_2 = headache, e_3 = loss of appetite, e_4 = weight loss, e_5 = wounds, e_6 = chest pain.The following values are getting from government hospital.

Step 1: Construct the Â∈ IVFSM for typhoid as given below, which can be prepared with the help of a medical person.

$$\hat{A} = \begin{matrix} & e_1 & e_2 & e_3 & e_4 & e_5 & e_6 \\ C1 & \langle 0.2,0.7\rangle & \langle 0.3,0.8\rangle & \langle 0.7,1.0\rangle & \langle 0.4,0.8\rangle & \langle 0.5,0.7\rangle & \langle 0.2,0.6\rangle \\ C2 & \langle 0.1,0.3\rangle & \langle 0.2,0.5\rangle & \langle 0.4,0.6\rangle & \langle 0.3,0.4\rangle & \langle 0.5,0.6\rangle & \langle 0.3,0.5\rangle \end{matrix}$$

Step 2: Construct the B ∈ IVFSMfor typhoid as given matrices.

$$\hat{B} = \begin{matrix} & e_1 & e_2 & e_3 & e_4 & e_5 & e_6 \\ C1 & \langle 0.8,1.0\rangle & \langle 0,0.2\rangle & \langle 0.1`,0.3\rangle & \langle 0,0.2\rangle & \langle 0.1,0.2\rangle & \langle 0.7,1.0\rangle \\ C2 & \langle 0.8,0.9\rangle & \langle 0.7,1.0\rangle & \langle 0,0.1\rangle & \langle 0.9,1\rangle & \langle 0.9,1\rangle & \langle 0.4,1\rangle \end{matrix}$$

Where A = B = E = {e_1, e_2, e_3, e_4, e_5, e_6}.

Step 3: Calculate similarity measure between $\hat{A}$ and $\hat{B}$ is given by

$$S(\hat{A}, \hat{B}) = \frac{(0.6\wedge0.3)+(0.3\wedge0.6)+(0.6\wedge0.7)+(0.4\wedge0.6)+(0.4\wedge0.5)+(0.5\wedge0.4)}{(0.6\vee0.3)+(0.3\vee0.6)+(0.6\vee0.7)+(0.4\vee0.6)+(0.4\vee0.5)+(0.5\vee0.4)}$$

$$\frac{(0.7\wedge0.6)+(0.5\wedge0.5)+(0.4\wedge0.5)+(0.6\wedge0.6)+(0.4\wedge0.4)+(0.1\wedge0.5)}{(0.7\wedge0.6)+(0.5\wedge0.5)+(0.4\wedge0.5)+(0.6\wedge0.6)+(0.4\wedge0.4)+(0.1\wedge0.5)}$$

$$= \frac{0.3+0.3+0.6+0.4+0.4+0.4+0.6+0.5+0.4+0.6+0.4+0.1}{0.6+0.6+0.7+0.6+0.5+0.5+0.7+0.5+0.5+0.6+0.4+0.5}$$

$$= \frac{5}{6.7}$$

$$= 0.7462 > \frac{1}{2}$$

Step 5: Here the two IVFSMs i.e. two sets of symptoms $\hat{A}$ and $\hat{B}$ are significantly similar, therefore we conclude that the person is possibly suffering from cancer.

V. Conclusion

In this paper we have defined of similarity measure between two IVFSMs and proposed similarity measures of two IVFSMs. Then we construct a decision making method based on similarity measures. Finally we give two simple examples to show the possibilities of diagnosis of diseases. In these examples if we use the other distances, we can obtain similar results. Thus we can use the method to solve the problem that contain uncertainty such as problem in social, economic system, pattern recognition, medical diagnosis, game theory coding theory and so on. In future we will develop the theory of similarity measure of interval valued fuzzy soft matrices.

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