CORRELATION MEASURE FOR INTUITIONISTIC FUZZY MULTI SETS

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Abstract

In this paper, the Correlation measure of Intuitionistic Fuzzy Multi sets (IFMS) is proposed. The concept of this Correlation measure of IFMS is the extension of Correlation measure of IFS. Using the Correlation of IFMS measure, the application of medical diagnosis and pattern recognition are presented. The new method also shows that the correlation measure of any two IFMS equals one if and only if the two IFMS are the same.

***Keywords**: Intuitionistic fuzzy set, Intuitionistic Fuzzy Multi sets, Correlation measure.*

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1. INTRODUCTION

The Intuitionistic Fuzzy sets (*IFS*) introduced by Krasssimir T. Atanassov [1, 2] is the generalisation of the Fuzzy set (*FS*). The Fuzzy set (*FS*) proposed by Lofti A. Zadeh [3] allows the uncertainty belong to a set with a membership degree (μ) between 0 and 1. That is, the one and only membership function ($\mu \in [0,1]$) and the non membership function equals one minus the membership degree. Whereas *IFS* represent the uncertainty with respect to both membership ($\mu \in [0,1]$) and non membership ($\vartheta \in [0,1]$) such that $\mu + \vartheta \leq 1$. The number $\pi = 1 - \mu - \vartheta$ is called the hesitiation degree or intuitionistic index.

Several authors like Murthy and Pal [4] investigated the correlation between two fuzzy membership functions, Chiang and Lin [5] studied the correlation of fuzzy sets and Chaudhuri and Bhattacharya [6] discussed the correlation between two fuzzy sets on same universal discourse. As the Intuitionistic fuzzy sets is widely used in various fields like pattern recognition, medical diagnosis, logic programming, decision making, market prediction, etc. Correlation Analysis of *IFS* plays a vital role in recent research area. Gerstenkorn and Manko [7] defined and examined the properties the correlation measure of *IFS* for finite universe of discourse. Later the concepts of correlation and the correlation coefficient of *IFS* in probability spaces were derived by Hong, Hwang [8] for the infinite universe of discourse. Hung and Wu [9, 10] proposed a centroid method to calculate the correlation coefficient of *IFS*s, using the positively and negatively correlated values. The correlation coefficient of *IFS* in terms of statistical values, using mean aggregation functions was presented by Mitchell [11]. Based on geometrical representation of IFSs and three parameters, a correlation coefficient of IFSs was defined by Wenyi Zeng and Hongxing Li [12].

The Multi set [13] repeats the occurrences of any element. And the Fuzzy Multi set (*FMS*) introduced by R. R. Yager [14] can occur more than once with the possibly of the same or the different membership values. Recently, the new concept Intuitionistic Fuzzy Multi sets (*IFMS*) was proposed by T.K Shinoj and Sunil Jacob John [15].

As various distance and similarity methods of IFS are extended for IFMS distance and similarity measures [16, 17, 18 and 19], this paper is an extension of the correlation measure of *IFS* to *IFMS.* The numerical results of the examples show that the developed similarity measures are well suited to use any linguistic variables.

2. PRELIMINARIES

2.1 Definition:

Let X be a nonempty set. A **fuzzy *set*** *A* in *X* is given by

$$A = \{\langle x, \mu_A(x)\rangle / x \in X\} \quad \text{-- (2.1)}$$

where μ_A : X → [0, 1] is the membership function of the fuzzy set *A* (i.e.) $\mu_A(x) \in [0,1]$ is the membership of $x \in X$ in *A.* The generalizations of fuzzy sets are the Intuitionistic fuzzy *(IFS)* set proposed by **Atanassov [1, 2]** is with independent memberships and non memberships.

2.2 Definition:

An ***Intuitionistic fuzzy set** (IFS), A* in *X* is given by

$$A = \{\langle x, \mu_A(x), \vartheta_A(x) \rangle / x \in X\} \quad \text{-- (2.2)}$$

where μ_A : X → [0,1] and ϑ_A : X → [0,1] with the condition $0 \leq \mu_A(x) + \vartheta_A(x) \leq 1$, $\forall x \in X$ Here $\mu_A(x)$ *and* $\vartheta_A(x) \in [0,1]$ denote the membership and the non membership functions of the fuzzy set *A*;
For each Intuitionistic fuzzy set in *X*, $\pi_A(x) = 1 - \mu_A(x) - [1 - \mu_A(x)] = 0$ for all $x \in X$ that is

$\pi_A(x) = 1 - \mu_A(x) - \vartheta_A(x)$ is the hesitancy degree of $x \in X$ in *A*. Always $0 \le \pi_A(x) \le 1, \ \forall x \in X$.

The ***complementary set*** A^c of *A* is defined as

$$A^c = \{\langle x, \ \vartheta_A(x), \ \mu_A(x) \ \rangle / \ x \in X\} \qquad \text{-- (2.3)}$$

2.3 Definition:

Let X be a nonempty set. A ***Fuzzy Multi set (FMS)*** A in X is characterized by the count membership function Mc such that Mc : X → Q where Q is the set of all crisp multi sets in [0,1]. Hence, for any $x \in X$, Mc(x) is the crisp multi set from [0, 1]. The membership sequence is defined as

$(\mu_A^1(x) \ , \mu_A^2(x), \dots \dots \dots \mu_A^p(x))$ where $\mu_A^1(x) \ge \mu_A^2(x) \ge \dots \ge \mu_A^p(x)$.

Therefore, A *FMS A* is given by

$$A = \{\langle \ x, \ (\mu_A^1(x) \ , \mu_A^2(x), \dots \dots \dots \mu_A^p(x)) \ \rangle / \ x \in X \} \qquad 2.4)$$

2.4 Definition:

Let X be a nonempty set. A ***Intuitionistic Fuzzy Multi set (IFMS)*** *A* in X is characterized by two functions namely count membership function Mc and count non membership function NMc such that Mc : X → Q and NMc : X → Q where Q is the set of all crisp multi sets in [0,1]. Hence, for any $x \in X$, Mc(x) is the crisp multi set from [0, 1] whose membership sequence is defined as

$$(\mu_A^1(x) \ , \mu_A^2(x), \dots \dots \dots \mu_A^p(x))$$

Where $\mu_A^1(x) \ge \mu_A^2(x) \ge \dots \ge \mu_A^p(x)$ and the corresponding non membership sequence NMc (x) is defined as ($\vartheta_A^1(x) \ , \ \vartheta_A^2(x), \dots \dots \dots \vartheta_A^p(x)$) where the non membership can be either decreasing or increasing function. such that $0 \le \mu_A^i(x) + \vartheta_A^i(x) \le 1 , \forall x \in X \ and \ i = 1,2, \dots p.$

Therefore, An ***IFMS*** *A* is given by

$$A = \{\langle x, \mu A1x \ , \mu A2x, \dots \dots \dots \mu Apx \ , \ (\vartheta A1x \ , \vartheta A2x, \dots \dots \dots \vartheta Apx) / x \in X \qquad (2.5)$$

Where $\mu_A^1(x) \ge \mu_A^2(x) \ge \dots \ge \mu_A^p(x)$

The ***complementary set*** A^c of *A* is defined as

$$A^c = \{\langle x, \quad (\vartheta_A^1(x) \ , \vartheta_A^2(x), \dots \dots \dots \vartheta_A^p(x)), \ (\mu_A^1(x) \ , \mu_A^2(x), \dots \dots \dots \mu_A^p(x)), \rangle / \ x \in X\} \qquad - \ (2.6)$$
$$where \ \vartheta_A^1(x) \ge \ \vartheta_A^2(x) \ge \dots \ge \vartheta_A^p(x)$$

2.5 Definition:

The **Cardinality** of the membership function Mc(x) and the non membership function NMc (x) is the length of an element x in an *IFMS A* denoted as η, defined as η = | Mc(x)| = |NMc(x)|

If A, B and C are the *IFMS* defined on *X*, then their cardinality η = Max { η(A), η(B), η(C) }.

2.6 Definition:

$S(\boldsymbol{A}, \boldsymbol{B})$ is said to be the **similarity measure** between A and B, where A, B ∈ X and X is an *IFMS*, as $S(\boldsymbol{A}, \boldsymbol{B})$ satisfies the following properties

1. $S(\boldsymbol{A}, \boldsymbol{B}) \in [0,1]$
2. $S(\boldsymbol{A}, \boldsymbol{B})$ = 1 if and only if A = B
3. $S(\boldsymbol{A}, \boldsymbol{B}) = S(\boldsymbol{B}, \boldsymbol{A})$

3. CORRELATION MEASURE

3.1 Fuzzy Correlation Measure

Let A = { $\langle x_i, \ \mu_A(x_i) \rangle / \ x_i \epsilon X$ } and B = { $\langle x_i, \ \mu_B(x_i) \rangle / \ x_i \epsilon X$ } be two *FS*s on the finite universe of discourse X = { $x_1, \ x_2, \dots, \ x_n$ }, then the correlation coefficient of A and B **[5, 6]** is

$$\rho_{FS}(A, B) = \frac{C_{FS}(A, B)}{\sqrt{C_{FS}(A, A) * C_{FS}(B, B)}}$$

Where $C_{FS}(A, B) = \sum_{i=1}^{n} \mu_A(x_i) \, \mu_B(x_i)$ and $C_{FS}(A, A) = \sum_{i=1}^{n} \mu_A(x_i) \, \mu_A(x_i)$

3.2 Intuitionistic Fuzzy Correlation Measure

Let X = { $x_1, \ x_2, \dots, \ x_n$ } be the finite universe of discourse and A = { $\langle x_i, \ \mu_A(x_i), \vartheta_A(x_i) \rangle / \ x_i \epsilon X$ } , B = { $\langle x_i$, $\mu Bxi, \vartheta Bxi / \ \ xi \ \epsilon \ X$ } be two *IFS*s then the correlation coefficient of A and B introduced by **Gerstenkorn and Manko [7]** was

$$\rho_{IFS}(A, B) = \frac{C_{IFS}(A, B)}{\sqrt{C_{IFS}(A, A) * C_{IFS}(B, B)}}$$

Where
$C_{IFS}(A, B) = \sum_{i=1}^{n} \{ \mu_A(x_i) \, \mu_B(x_i) + \vartheta_A(x_i) \, \vartheta_B(x_i)$ and
$C_{IFS}(A, B) = \sum_{i=1}^{n} \{\mu_A(x_i) \, \mu_B(x_i) + \ \vartheta_A(x_i) \, \vartheta_B(x_i) \}$

The correlation coefficient of A and B in X, the infinite universe of discourse defined by **Hong and Hwang [8]** is

$$\rho_{IFS}(A, B) = \frac{C_{IFS}(A, B)}{\sqrt{C_{IFS}(A, A) * C_{IFS}(B, B)}}$$

Where
$C_{IFS}\,(A,B) = \int\big(\mu_A(x_i)\,\mu_B(x_i) + \vartheta_A(x_i)\,\vartheta_B(x_i)\big)dx$ and
$C_{IFS}\,(A,A) = \int\big(\mu_A(x_i)\,\mu_A(x_i) + \vartheta_A(x_i)\,\vartheta_A(x_i)\big)dx$

3.3 Proposed Correlation Similarity Measure for IFMS

3.3.1 Intuitionistic Fuzzy Multi Correlation Measure

Let X = { $x_1, x_2, \ldots, x_n$ } be the finite universe of discourse and A = { $\langle x_i,\ \mu_A^j(x_i),\ \vartheta_A^j(x_i)\rangle / x_i \in X$} , B = { $\langle x_i,\ \mu_B^j(x_i),\ \vartheta_B^j(x_i)\rangle / x_i \in X$ } be two *IFMS*s consisting of the membership and non membership functions, then the correlation coefficient of A and B

$$\rho_{IFMS}\,(A,B) = \frac{C_{IFMS}\,(A,B)}{\sqrt{C_{IFMS}\,(A,A) * C_{IFMS}\,(B,B)}}$$

Where $C_{IFMS}\,(A,B) = \frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_B^j(x_i) +$ $\vartheta Ajxi\,\vartheta Bjxi$ and
$C_{IFMS}\,(A,A) = \frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_A^j(x_i) +$ $\vartheta Ajxi\,\vartheta Ajxi$

Let A = {$\langle x_i,\ \mu_A^j(x_i),\ \vartheta_A^j(x_i),\ \pi_A^j(x_i)\ \rangle / x_i \in X$} and B = { $\langle x_i,\ \mu_B^j(x_i),\ \vartheta_B^j(x_i),\ \pi_A^j(x_i)\ \rangle / x_i \in X$ } be two *IFMS*s consisting of the membership, non membership functions and the hesitation functions, then the correlation coefficient of A and B

$$\rho_{IFMS}\,(A,B) = \frac{C_{IFMS}\,(A,B)}{\sqrt{C_{IFMS}\,(A,A) * C_{IFMS}\,(B,B)}}$$

Where $C_{IFMS}\,(A,B) = \frac{1}{\eta}\sum_{j=1}^{\eta}\Big\{\ \sum_{i=1}^{n}\Big(\ \mu_A^j(x_i)\,\mu_B^j(x_i) +$ $\vartheta Ajxi\,\vartheta Bjxi + \ \pi Ajxi\,\pi Bjxi$

and $C_{IFMS}\,(A,A) = \frac{1}{\eta}\sum_{j=1}^{\eta}\Big\{\ \sum_{i=1}^{n}\Big(\ \mu_A^j(x_i)\,\mu_A^j(x_i) +$ $\vartheta Ajxi\,\vartheta Ajxi + \ \pi Ajxi\,\pi Bjxi$

3.4 Proposition

The defined Similarity measure $\boldsymbol{\rho_{IFMS}(A,B)}$ between *IFMS A* and *B* satisfies the following properties

D1. $0 \le\ \rho_{IFMS}(A,B) \le\ 1$
D2. $\rho_{IFMS}(A,B)$= 1 if and only if $A = B$
D3. $\rho_{IFMS}(A,B)\ =\ \rho_{IFMS}(B,A\,)$

Proof

D1. $\mathbf{0} \le\ \rho_{IFMS}(A,B)\ \le\ \mathbf{1}$
As the membership and the non membership functions of the *IFMSs* lies between 0 and 1, $\rho_{IFMS}(A,B)$ also lies between 0 and 1.

D2. $\boldsymbol{\rho_{IFMS}(A,B)}$**= 1 if and only if $\boldsymbol{A = B}$**
(i) Let the two *IFMS* A and B be equal (i.e.) **A = B.** Hence for any $\mu_A^j(x_i) = \mu_B^j(x_i)$ and $\vartheta_A^j(x_i) =\ \vartheta_B^j(x_i)$ then
$C_{IFMS}\,(A,A) = C_{IFMS}\,(B,B) =$
$\frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_A^j(x_i) +\ \vartheta_A^j(x_i)\,\vartheta_A^j(x_i)\ \big)\}$
and $C_{IFMS}\,(A,B) =\ \frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_B^j(x_i) +$ $\vartheta_A^j(x_i)\,\vartheta_B^j(x_i)\ \big)\}$ =
$\frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_A^j(x_i) +\ \vartheta_A^j(x_i)\,\vartheta_A^j(x_i)\ \big)\}$ = $C_{IFMS}\,(A,A)$

Hence $\boldsymbol{\rho_{IFMS}(A,B)}$ =
$$\frac{C_{IFMS}\ (A,B)}{\sqrt{C_{IFMS}\ (A,A) * C_{IFMS}\ (B,B)}} =\ \frac{C_{IFMS}\ (A,A)}{\sqrt{C_{IFMS}\ (A,A) * C_{IFMS}\ (A,A)}} = \mathbf{1}$$

(ii) Let the $\boldsymbol{\rho_{IFMS}(A,B)}$ = 1

The unit measure is possible only if

$$\frac{C_{IFMS}\ (A,B)}{\sqrt{C_{IFMS}\ (A,A) * C_{IFMS}\ (B,B)}} =\ \mathbf{1}$$

this refers that $\mu_A^j(x_i) = \mu_B^j(x_i)$ and $\vartheta_A^j(x_i) =\ \vartheta_B^j(x_i)$ for all i, j values. Hence A = B.

D3. $\boldsymbol{\rho_{IFMS}(A,B) =\ \ \rho_{IFMS}(B,A\,)}$
It is obvious that $\rho_{IFMS}(A,B)\ =\ \frac{C_{IFMS}\ (A,B)}{\sqrt{C_{IFMS}\ (A,A) * C_{IFMS}\ (B,B)}} = \frac{C_{IFMS}\ (B,A)}{\sqrt{C_{IFMS}\ (A,A) * C_{IFMS}\ (A,A)}}$ = $\rho_{IFMS}(\,B,A\,)$ as
$C_{IFMS}\,(A,B) =\ \frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_A^j(x_i)\,\mu_B^j(x_i) +$ $\vartheta Ajxi\,\vartheta Bjxi$
= $\frac{1}{\eta}\sum_{j=1}^{\eta}\{\ \sum_{i=1}^{n}\big(\ \mu_B^j(x_i)\,\mu_A^j(x_i) +\ \vartheta_B^j(x_i)\,\vartheta_A^j(x_i)\ \big)\}$ = $C_{IFMS}\,(B,A)$

3.5 Numerical Evaluation

3.5.1 Example:

Let X = {A_1, A_2, A_3, A_4........ A_n } with A = { A_1, A_2, A_3, A_4, A_5} and B ={ A_6, A_7, A_8, A_9, A_{10}} are the *IFMS* defined as

A={
$\langle\ A_1$: (0.6,0.4), (0.5, 0.5) $\rangle$, $\langle A_2$: (0.5,0.3), (0.4, 0.5)$\rangle$,
$\langle\ A_3$, (0.5, 0.2), (0.4, 0.4)$\rangle$, $\langle\ A_4$: (0.3,0.2), (0.3, 0.2)$\rangle$,
$\langle\ A_5$: (0.2,0.1), (0.2, 0.2)$\rangle$ }

B={
$\langle\ A_6$: (0.8,0.1), (0.4, 0.6) $\rangle$,
$\langle A_7$: (0.7,0.3), (0.4, 0.2)$\rangle$, $\langle\ A_8$, (0.4, 0.5), (0.3, 0.3)$\rangle$
$\langle\ A_9$: (0.2,0.7), (0.1, 0.8)$\rangle$, $\langle\ A_{10}$: (0.2,0.6), (0, 0.6)$\rangle$ }

Here, the cardinality η = 5 as | Mc(A)| = |NMc(A)| = 5 and | Mc(B)| = |NMc(B)| = 5 and the Correlation *IFMS* similarity measure is = **0.8147**

3.5.2 Example:

Let $X = \{A_1, A_2, A_3, A_4 \ldots\ldots A_n\}$ with $A = \{A_1, A_2\}$ and $B = \{A_9, A_{10}\}$ are the *IFMS* defined as

$A = \{ \langle A_1 : (0.1,0.2) \rangle, \langle A_2 : (0.3,0.3) \rangle \}$, $B = \{ \langle A_9 :$ *:0.1,0.2,A10 :0.2,0.3 }*

Here, the cardinality $\eta = 2$ as $|\mathrm{Mc}(A)| = |\mathrm{NMc}(A)| = 2$ and $|\mathrm{Mc}(B)| = |\mathrm{NMc}(B)| = 2$ and the Correlation *IFMS* similarity measure is **0.9827**

3.5.3 Example:

Let $X = \{A_1, A_2, A_3, A_4 \ldots\ldots A_n\}$ with $A = \{A_1, A_2\}$ and $B = \{A_3, A_4\}$ are the *IFMS* defined as

$A = \{ \langle A_1\ (0.4,0.2,0.1), (0.3, 0.1, 0.2), (0.2, 0.1, 0.2), (0.1, 0.4, 0.3) \rangle,$
$\langle A_2\ (0.6,0.3,0), (0.4, 0.5, 0.1), (0.4, 0.3, 0.2), (0.2, 0.6, 0.2) \rangle \}$

$B = \{ \langle A_3 : (0.5,0.2,0.3), (0.4, 0.2, 0.3), (0.4, 0.1, 0.2), (0.1, 0.1, 0.6) \rangle$
$\langle A_4 : (0.4,0.6,0.2), (0.4, 0.5, 0), (0.3, 0.4, 0.2), (0.2, 0.4, 0.1) \rangle \}$

The cardinality $\eta = 2$ as $|\mathrm{Mc}(A)| = |\mathrm{NMc}(A)| = |\mathrm{Hc}(A)| = 2$ and $|\mathrm{Mc}(B)| = |\mathrm{NMc}(B)| = |\mathrm{Hc}(B)| = 2$. Here, the Correlation *IFMS* similarity is **0.8939**

3.5.4 Example:

Let $X = \{A_1, A_2, A_3, A_4 \ldots A_n\}$ with $A = \{A_1, A_2\}$ and $B = \{A_6\}$ such that the IFMS A and B are

$A = \{ \langle A_1 : (0.6,0.2,0.2), (0.4, 0.3, 0.3), (0.1, 0.7, 0.2) \rangle,$
$\langle A_2 : (0.7,0.1,0.2), (0.3, 0.6, 0.1), (0.2, 0.7, 0.1) \rangle \}$

$B = \{ \langle A_6 : (0.8,0.1,0.1), (0.2, 0.7, 0.1), (0.3, 0.5, 0.2) \rangle \}$

As $|\mathrm{Mc}(A)| = |\mathrm{NMc}(A)| = |\mathrm{Hc}(A)| = 2$ and $|\mathrm{Mc}(B)| = |\mathrm{NMc}(B)| = |\mathrm{Hc}(B)| = 1$,
their cardinality $\eta = \mathrm{Max}\ \{\eta(A), \eta(B)\} = \max\ \{2,1\} = 2$. The Correlation *IFMS* measure is **0.9214**

4. MEDICAL DIAGNOSIS USING IFMS – CORRELATION MEASURE

As Medical diagnosis contains lots of uncertainties, they are the most interesting and fruitful areas of application for fuzzy set theory. A symptom is an uncertain indication of a disease and hence the uncertainty characterizes a relation between symptoms and diseases. Thus working with the uncertainties leads us to accurate decision making in medicine. In most of the medical diagnosis problems, there exist some patterns, and the experts make decision based on the similarity between unknown sample and the base patterns.

In some situations, terms of membership function (fuzzy set theory) alone is not adequate. Hence, the terms like membership and non membership function (Intuitionistic fuzzy set theory) is considered to be the better one. Due to the increased volume of information available to physicians from new medical technologies, the process of classifying different set of symptoms under a single name of disease becomes difficult. Recently, there are various models of medical diagnosis under the general framework of fuzzy sets are proposed. In some practical situations, there is the possibility of each element having different membership and non membership functions. The distance and similarity measure among the Patients Vs Symptoms and Symptoms Vs diseases gives the proper medical diagnosis. Here, the proposed correlation measure point out the proper diagnosis by the highest similarity measure.

The unique feature of this proposed method is that it considers multi membership and non membership. By taking one time inspection, there may be error in diagnosis. Hence, this multi time inspection, by taking the samples of the same patient at different times gives best diagnosis.

Let $P = \{P_1, P_2, P_3, P_4\}$ be a set of Patients.

D = { Fever, Tuberculosis, Typhoid, Throat disease } be the set of diseases

and S = { Temperature, Cough, Throat pain, Headache, Body pain } be the set of symptoms.

Our solution is to examine the patient at different time intervals (three times a day), which in turn give arise to different membership and non membership function for each patient.

Table: 1 – IFMs Q : The Relation between Patient and Symptoms

Q	Temperature	Cough	Throat Pain	Head Ache	Body Pain
P_1	(0.6, 0.2) (0.7, 0.1) (0.5, 0.4)	(0.4, 0.3) (0.3, 0.6) (0.4, 0.4)	(0.1, 0.7) (0.2, 0.7) (0, 0.8)	(0.5, 0.4) (0.6, 0.3) (0.7, 0.2)	(0.2, 0.6) (0.3, 0.4) (0.4, 0.4)
P_2	(0.4, 0.5) (0.3, 0.4) (0.5, 0.4)	(0.7, 0.2) (0.6, 0.2) (0.8, 0.1)	(0.6, 0.3) (0.5, 0.3) (0.4, 0.4)	(0.3, 0.7) (0.6, 0.3) (0.2, 0.7)	(0.8, 0.1) (0.7, 0.2) (0.5, 0.3)
P_3	(0.1, 0.7) (0.2, 0.6) (0.1, 0.9)	(0.3, 0.6) (0.2, 0) (0.1, 0.7)	(0.8, 0) (0.7, 0.1) (0.8, 0.1)	(0.3, 0.6) (0.2, 0.7) (0.2, 0.6)	(0.4, 0.4) (0.3, 0.7) (0.2, 0.7)
P_4	(0.5, 0.4) (0.4, 0.4) (0.5, 0.3)	(0.4, 0.5) (0.3, 0.3) (0.1, 0.7)	(0.2, 0.7) (0.1, 0.6) (0, 0.7)	(0.5, 0.4) (0.6, 0.3) (0.3, 0.6)	(0.4, 0.6) (0.5, 0.4) (0.4, 0.3)

Let the samples be taken at three different timings in a day (morning, noon and night)

Table: 2 – IFMs R: The Relation among Symptoms and Diseases

R	Viral Fever	Tuberculosis	Typhoid	Throat disease
Temperature	(0.8, 0.1)	(0.2, 0.7)	(0.5, 0.3)	(0.1, 0.7)
Cough	(0.2, 0,7)	(0.9, 0)	(0.3, 0,5)	(0.3, 0,6)
Throat Pain	(0.3, 0.5)	(0.7, 0.2)	(0.2, 0.7)	(0.8, 0.1)
Head ache	(0.5, 0.3)	(0.6, 0.3)	(0.2, 0.6)	(0.1, 0.8)
Body ache	(0.5, 0.4)	(0.7, 0.2)	(0.4, 0.4)	(0.1, 0.8)

Table: 3 – The Correlation Measure between IFMs Q and R :

Correlation Measure	Viral Fever	Tuberculosis	Typhoid	Throat disease
P_1	**0.9117**	0.6835	0.9096	0.5767
P_2	0.7824	**0.9140**	0.8199	0.7000
P_3	0.6289	0.7319	0.7143	**0.9349**
P_4	0.8795	0.6638	**0.9437**	0.6663

The ***highest similarity measure*** from the table 4.3 gives the proper medical diagnosis.
Patient **P1** suffers from **Viral Fever,** Patient **P2** suffers from **Tuberculosis,** Patient **P3** suffers from **Throat disease** and the Patient **P4** suffers from **Typhoid.**

5. PATTERN RECOGNISION OF IFMS CORRELATION SIMILARITY MEASURE

5.1 Example

Let X = {A_1, A_2, A_3, A_4........ A_n } with A = { A_1, A_2, A_3, A_4, A_5} and B ={ A_2, A_5, A_7, A_8, A_9} are the *IFMS* defined as

Pattern I = { $\langle A_1 : (0.6,0.4), (0.5, 0.5) \rangle$, $\langle A_2 :$:0.5,0.3 , 0.4, 0.5 , A3 , 0.5, 0.2 , 0.4, 0.4 , $\langle A_4 : (0.3,0.2), (0.3, 0.2) \rangle$, $\langle A_5 : (0.2,0.1), (0.2, 0.2) \rangle$ }

Pattern II = { $\langle A_2 : (0.5,0.3), (0.4, 0.5) \rangle$, $\langle A_5 : (0.2,0.1), (0.2, 0.2) \rangle$ $\langle A_7 : (0.7,0.3), (0.4, 0.2) \rangle$, $\langle A_8 , (0.4, 0.5), (0.3, 0.3) \rangle$, $\langle A_9 : (0.2,0.7), (0.1, 0.8) \rangle$ }

Then the testing *IFMS* Pattern III be { A_6, A_7, A_8, A_9, A_{10}} such that {$\langle A_6 : (0.8, 0.1), (0.4, 0.6) \rangle$, $\langle A_7 : (0.7,0.3), (0.4, 0.2) \rangle$, $\langle A_8 , (0.4, 0.5), (0.3, 0.3) \rangle$,$\langle A_9 :$:0.2,0.7, 0.1, 0.8 ,A10 :0.2,0.6, 0, 0.6 }

Here, the cardinality η = 5 as | Mc(A)| = |NMc(A)| = 5 and | Mc(B)| = |NMc(B)| = 5

then the Correlation Similarity measure between Pattern (I, III) is 0.8147, Pattern (II, III) is **0.8852**

The testing Pattern III belongs to Pattern II type

5.2 Example:

Let X = {A_1, A_2, A_3, A_4........ A_n } with A = { A_1, A_2 }; B ={ A_4, A_6}; C = { A_1, A_{10}} ; D = { A_4, A_6} ; E = { A_4, A_6}are the *IFMS* defined as
A = { $\langle A_1 : (0.1,0.2)\rangle, \langle A_2 : (0.3, 0.3)\rangle$ } ; B = { $\langle A_4$: *:0.2,0.2 , A6 :0.3, 0.2 } ;*
C = { $\langle A_1 : (0.1,0.2)\rangle, \langle A_{10} : (0.2, 0.3)\rangle$ } ; D = { $\langle A_3$: *:0.2,0.1 , A4 :0.3, 0.2 } ;*
E = { $\langle A_1 : (0.5,0.4)\rangle, \langle A_4 : (0.8, 0.1)\rangle$ }

The *IFMS* Pattern Y = { $\langle A_1 : (0.1, 0.2)\rangle, \langle A_{10}$: *:0.2, 0.3 }*
Here, the cardinality η = 2 as | Mc(A)| = |NMc(A)| = 2 and | Mc(B)| = |NMc(B)| = 2,

then the Correlation measure between the Patten (A, Y) = 0.9829, Patten (B, Y) = 0.9258, Patten (C, Y) = **1,** Patten (D, Y) = 0.8889, Patten (E, Y) = 0.7325 and the **testing Pattern Y belongs to Pattern C type**

5.3 Example:

Let X = {A_1, A_2, A_3, A_4........ A_n } with X1 = { A_1, A_2 }; X2 ={ A_3, A_4 }; X3 = { A_1, A_4 } are the *IFMS* defined as

A = { $\langle A_1 : (0.4,0.2,0.1), (0.3, 0.1, 0.2), (0.2, 0.1, 0.2), (0.1, 0.4, 0.3)\rangle$, $\langle A_2 : (0.6,0.3,0), (0.4, 0.5, 0.1), (0.4, 0.3, 0.2), (0.2, 0.6, 0.2)\rangle$ }

B = { $\langle A_3 : (0.5,0.2,0.3), (0.4, 0.2, 0.3), (0.4, 0.1, 0.2), (0.1, 0.1, 0.6)\rangle$ $\langle A_4 : (0.4,0.6,0.2), (0.4, 0.5, 0), (0.3, 0.4, 0.2), (0.2, 0.4, 0.1)\rangle$ }

C = { $\langle A_1 : (0.4,0.2,0.1), (0.3, 0.1, 0.2), (0.2, 0.1, 0.2), (0.1, 0.4, 0.3)\rangle$, $\langle A_4 : (0.4,0.6,0.2), (0.4, 0.5, 0), (0.3, 0.4, 0.2), (0.2, 0.4, 0.1)\rangle$ }

then the Pattern D of *IFMS* referred as { $\langle A_5 : (0.4,0.6,0.2), (0.4, 0.5, 0), (0.3, 0.4, 0.2), (0.2, 0.4, 0.1)\rangle$, $\langle A_6 : (0.4,0.2,0.2), (0.5, 0.5, 0), (0.2, 0.4, 0.2), (0.2, 0.5, 0.1)\rangle$ }

The cardinality η = 2 as | Mc(A)| = |NMc(A)| = | Hc(A)| = 2 and | Mc(B)| = |NMc(B)| = | Hc(B)| = 2, then the Proposed Correlation Similarity measure between the Pattern (A, D) is **0.8628** ; the Pattern (B, D) is 0.8175 and the Pattern (C, D) is 0.8597**.**

Hence, the testing Pattern D belongs to Pattern A type

6. CONCLUSIONS

The Correlation similarity measure of IFMS from IFS theory is derived in this paper. The prominent characteristic of this method is that the Correlation measure of any two IFMSs equals to one if and only if the two IFMSs are the same, referred in the example 5:2 of pattern recognition. From the numerical evaluation, it is clear that this proposed method can be applied to decision making problems. The example 3.5.1, 3.5.2 of numerical evaluation shows that the new measure perform well in the case of membership and non membership function and example 3.5.3, 3.5.4 of numerical evaluation depicts that the proposed measure is effective with three representatives of IFMS – membership, non membership and hesitation functions. Finally, the medical diagnosis has been given to show the efficiency of the developed Correlation similarity measure of IFMS.

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