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IFS WITH n-PARAMETERS IN MEDICAL DIAGNOSIS

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Abstract: In this paper, we first introduce intuitionistic fuzzy sets [IFS] with n-parameters. This method of approach is different and singular in certain aspects. In this n-parameters method the relationship between membership values and hesitancy values and hesitancy values and non-membership values are studied to diagnosis the cause of diseases. The symptoms are checked once and even if there is slight variations in the symptoms the doctor can diagnoses the disease accurately, but this is not studied in other existing methods.

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Key Words: intuitionistic fuzzy sets (IFS), fuzzy logic (FL), n-parameters medical diagnosis

1. Introduction

An intuitionistic fuzzy set (Atanassov IFS presented in 1986) has been used. There are three functions in this fuzzy sets namely, membership, non membership and hesitancy. Here hesitancy plays a vital role in determining the diseases. The distance between membership values and hesitancy values has n-parameters similarly, the distance between non membership values and hesi-

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tancy is also has n-parameters. There are reasons for considering the distance between these values as n parameters. One or two causes alone cannot help to identify the diseases because there could be so many reasons that would have caused the diseases. To diagnose the disease to the patients, this n-parameters will be valuable to the doctors.

By studying the metabolism of a patient it cannot be clearly confirmed about the cause of a disease sometimes, all treatment will end up in failure. In some cases, after studying the symptoms completely if the treatment is given the patient is cured successfully. Many research scholars have studied role of membership, non-membership and hesitancy values. But the significant role of hesitancy values ignored in those approaches. Here the n-parameters method is used to diagnoses the disease accurately.

"There are countless rational numbers between any two given rational numbers". This new approach, the relationship of hesitancy values with membership values or the relationship of hesitancy values with non-membership values will decide the type of disease. Here hesitancy values play a vital role. It is explained using Sanchez's approach for medical diagnosis using IFS with n-parameters method.

2. Preliminaries

We give some basic definitions, which are used in our next section.

Definition 2.1. Let a set E be fixed. An Intuitionistic fuzzy set or IFS A in E is an object having the form $A = \{\langle\, x\ ,\ \mu_A(x)\ ,\ \gamma_A(x)\,\rangle\ /x \in E\ \}$ where the functions $\mu_A : E \to [0,1]$ and$\gamma_A : E \to [0,1]$ define the degree of membership and degree of non-membership respectively of the element $x \in E$ to the set A, which is a subset of E, and for every $x \in E$,$0 \leq \mu_A(x)+\gamma_A(x) \leq 1$. The amount $\Pi_A(x) = 1 - (\mu_A(x) + \gamma_A(x))$is called the hesitation part, which may cater to either membership value or non-membership value or both.

Definition 2.2. Let X be a non empty set, A set of $\left(\overset{n}{\underset{i=2}{\pi}} q_i\ ,\ \overset{n}{\underset{i=2}{\pi}}\ q_i'\right)$-level generated by an IFS A, where $\overset{n}{\underset{i=2}{\pi}} q_i\ ,\ \overset{n}{\underset{i=2}{\pi}}\ q_i' \in [0,1]$ are membership values, such that $0 \leq \overset{n}{\underset{i=2}{\pi}} q_i\ +\ \overset{n}{\underset{i=2}{\pi}}\ q_i' \leq 1$, is defined as:

$$J^{(A)}_{\overset{n}{\underset{i=2}{\pi}} q_i < \overset{n}{\underset{i=2}{\pi}}\ q_i'} = \left\{ \left\langle x, \mu_A(x) + \overset{n}{\underset{i=2}{\pi}}\ q_i \times q_1, \overset{n}{\underset{i=2}{\pi}}\ q_i' \times \gamma_A(x) \right\rangle /x \in A \right\};$$

$$H^{(A)}_{\overset{n}{\underset{i=2}{\pi}} q_i > \overset{n}{\underset{i=2}{\pi}} q_i'} = \left\{ \left\langle x, \mu_A(x) \times \overset{n}{\underset{i=2}{\pi}} q_i, \gamma_A(x) + \overset{n}{\underset{i=2}{\pi}} q_i' \times q_1 \right\rangle / x \in A \right\};$$

$$G^{(A)}_{\overset{n}{\underset{i=2}{\pi}} q_i = \overset{n}{\underset{i=2}{\pi}} q_i'} = \left\{ \left\langle x, \mu_A(x) + \overset{n}{\underset{i=2}{\pi}} q_i, \overset{n}{\underset{i=2}{\pi}} q_i' \times \gamma_A(x) \right\rangle / x \in A \right\}.$$

In general $\{\langle \mu_A(x), q_n, q_{n-1}, ..., q_2, q_1, q_2', q_3', ..., q_n', \gamma_A(x)\rangle\}$ this q_1 is hesitancy, distance from membership and non-membership values. $q_n, q_{n-1}, ..., q_2$ are distance from membership and hesitancy $q_2', q_3', ..., q_n'$ are distance from non-membership and hesitancy.

Definition 2.3. If A and B are two IFS of the set E then $A \subset B \Leftrightarrow$ for every $x \in E$,

$$[\mu_A(x) \leq \mu_B(x) \; and \; \gamma_A(x) \geq \gamma_B(x)], \quad A \supset B, \; A = B \Leftrightarrow \text{ for every } x \in E,$$

$$[\mu_A(x) \leq \mu_B(x) \; and \; \gamma_A(x) \geq \gamma_B(x)],$$

then

$$A \cap B = \{\langle x, \min(\mu_A(x), \mu_B(x)), \max(\gamma_A(x), \gamma_B(x))/x \in E\rangle\},$$

$$A \cup B = \{\langle x, \max(\mu_A(x), \mu_B(x)), \min(\gamma_A(x), \gamma_B(x))/x \in E\rangle\}.$$

3. Medical Diagnosis

Suppose S is a set of symptoms, D is a set of diagnosis and P is a set of patients. Let M_1 be an IFR,$M_1\,(P \to S)$ and M_2 from the set of patients to the set of symptoms s, i.e., $M_2\,(S \to D)$ then

$$K_1 = A \cap B = \{\langle \min(\mu_A(x), \mu_B(x)), \max(\gamma_A(x), \gamma_B(x))\rangle\},$$

$$K_2 = A \cup B = \{\langle \max(\mu_A(x), \mu_B(x)), \min(\gamma_A(x), \gamma_B(x))\rangle\},$$

$$K_3 = q_1 = \frac{\mu_A(x) \times \gamma_B(x)}{2\,(\mu_A(x) + \gamma_B(x))},$$

$$K_4 = \overset{n}{\underset{i=2}{\pi}} q_i = \frac{q_{n-1} \times \mu_A(x)}{2\,(q_{n-1} + \mu_A(x))},$$

$$K_5 = \overset{n}{\underset{i=2}{\pi}} q_i' = \frac{q_{n-1}' \times \gamma_A(x)}{2\,(q_{n-1}' + \gamma_A(x))},$$

$$K_6 = J^{(A)}_{\underset{i=2}{\overset{n}{\pi}} q_i < \underset{i=2}{\overset{n}{\pi}} q_i'} = \left\{ \left\langle \mu_A(x) + \underset{i=2}{\overset{n}{\pi}} q_i \times q_1, \underset{i=2}{\overset{n}{\pi}} q_i' \times \gamma_A(x) \right\rangle \right\},$$

$$K_7 = H^{(A)}_{\underset{i=2}{\overset{n}{\pi}} q_i > \underset{i=2}{\overset{n}{\pi}} q_i'} = \left\{ \left\langle \mu_A(x) \times \underset{i=2}{\overset{n}{\pi}} q_i, \gamma_A(x) + \underset{i=2}{\overset{n}{\pi}} q_i' \times q_1 \right\rangle \right\},$$

$$K_8 = G^{(A)}_{\underset{i=2}{\overset{n}{\pi}} q_i = \underset{i=2}{\overset{n}{\pi}} q_i'} = \left\{ \left\langle \mu_A(x) \times \underset{i=2}{\overset{n}{\pi}} q_i, \underset{i=2}{\overset{n}{\pi}} q_i' \times \gamma_A(x) \right\rangle \right\}$$

then

$$K_9 = \min \left\{ \left\langle \mu_A(x), q_n, ..., q_2, q_1, q_2', q_3', ..., q_n', \gamma_A(x) \right\rangle \right\}.$$

4. Algorithm

Step 1: K_1 and K_2 formulas are applied in Table 1 and in Table 2 and the resul tant is in Table 3.

Step 2: Table 3 values are applied in K_3, K_4 and K_5 and the results are given in Table 4.

Step 3: Table 4 values are applied in K_6,K_7 and K_8 and the results are named as Table 5.

Step 4: Table 5 values are applied in K_9, and the result is given in Table 6.

Step 5: Finally, select the minimum values from each row of Table 6, and then conclude that the patientp_i is suffering from the disease d_r.

5. Case Study

Let there be four patients P = {Wilson, Janie, Sofia, Marina} and the set of symptoms S = {temperature, headache, stomach-pain, cough, chest-pain}. The set of Diagnosis D = {Viral Fever, Malaria, Typhoid, Stomach Problem, Chest-Problem}.

Now, select the minimum values from each row of Table6, it is obvious that, if the doctor agrees then Wilson, Sofia and Marina suffer from Malaria whereas Janie faces stomach problem.

	Temperature	Head ache	Stomach pain	Cough	Chest-pain
Wilson	(0.8, 0.1)	(0.6, 0.1)	(0.2, 0.8)	(0.6, 0.1)	(0.1, 0.6)
Janie	(0.0, 0.8)	(0.4, 0.4)	(0.6, 0.1)	(0.1, 0.7)	(0.1, 0.8)
Sofia	(0.8, 0.1)	(0.8, 0.1)	(0.0, 0.6)	(0.2, 0.7)	(0.0, 0.5)
Marina	(0.6, 0.1)	(0.5, 0.4)	(0.3, 0.4)	(0.7, 0.2)	(0.3, 0.4)

Table 1: IFR $M_1\,(P \rightarrow S)$

	Viral Fever	Malaria	Typhoid	Stomach Problem	Chest Problem
Temperature	(0.4, 0.0)	(0.7, 0.0)	(0.3, 0.3)	(0.1, 0.7)	(0.1, 0.8)
Head ache	(0.3, 0.5)	(0.2, 0.6)	(0.6, 0.1)	(0.2, 0.4)	(0.0, 0.8)
Stomach pain	(0.1, 0.7)	(0.0, 0.9)	(0.2, 0.7)	(0.8, 0.0)	(0.2, 0.8)
Cough	(0.4, 0.3)	(0.7, 0.0)	(0.2, 0.6)	(0.2, 0.7)	(0.2, 0.8)
Chest-pain	(0.1, 0.7)	(0.1, 0.8)	(0.1, 0.9)	(0.2, 0.7)	(0.8, 0.1)

Table 2: IFR $M_2\,(S \rightarrow D)$

	Viral Fever	Malaria	Typhoid	Stomach Problem	Chest Problem
Wilson	(0.4, 0.1)	(0.7, 0.1)	(0.6, 0.1)	(0.2, 0.4)	(0.2, 0.6)
Janie	(0.3, 0.5)	(0.2, 0.6)	(0.4, 0.4)	(0.6, 0.1)	(0.1, 0.7)
Sofia	(0.4, 0.1)	(0.7, 0.1)	(0.6, 0.1)	(0.2, 0.4)	(0.2, 0.5)
Marina	(0.4, 0.1)	(0.7, 0.1)	(0.5, 0.3)	(0.3, 0.4)	(0.3, 0.4)

Table 3: Using step1, we get

6. Conclusion

Intuitionistic fuzzy sets[IFS] with n-parameters approach is different and singular in certain aspects. In n-parameters approach the relationship between membership values and hesitancy values, hesitancy values and non-membership values are studied, to diagnosis the cause of the disease. The symptoms are checked once and even if there is slight variations in the symptoms the doctor can diagnoses the disease accurately, but this is not studied in other existing methods.

	Wilson	Janie	Sofia	Marina
Viral Fever	(.4, .018, .04, .014, .1)	(.3, .035, .093, .039, .5)	(.4, .018, .04, .014, .1)	(.4, .018, .04, .014, .1)
Malaria	(.7, .018, .04, .028, .1)	(.2, .05, .075, .066, .6)	(.7, .018, .04, .028, .1)	(.7, .018, .04, .028, .1)
Typhoid	(.6, .018, .04, .014, .1)	(.4, .04, .1, .04, .4)	(.6, .018, .04, .014,.1)	(.5, .03, .09, .03, .3)
Stomach Prob-lem	(.2, .04, .06, .05, .4)	(.1, .014, .04, .018, .7)	(.2, .02, .07, .03, .5)	(.3, .03, .08, .03, .4)
Chest Prob-lem	(.2, .05, .075, .066, .6)	(.1, .014, .04, .018, .7)	(.2, .02, .07, .03, .5)	(.3, .03, .08, .03, .4)

Table 4: Using step2, we get

	Viral Fever	Malaria	Typhoid	Stomach Problem	Chest Problem
Wilson	(0.0072, 0.1005)	(0.7007, 0.0028)	(0.0108, 0.1005)	(0.2024, 0.0200)	(0.2037, 0.0396)
Janie	(0.3032, 0.0190)	(0.2037, 0.0396)	(0.4040, 0.4040)	(0.0100, 0.1008)	(0.1005, 0.0126)
Sofia	(0.0072, 0.1005)	(0.7007, 0.0028)	(0.0108, 0.1008)	(0.2024, 0.0200)	(0.2014, 0.0150)
Marina	(0.0072, 0.1005)	(0.7007, 0.0028)	(0.5027, 0.0090)	(0.3024, 0.0120)	(0.3024, 0.0120)

Table 5: Using step3, we get

	Viral Fever	Malaria	Typhoid	Stomach Problem	Chest Problem
Wilson	0.0072	0.0028	0.0108	0.0200	0.0396
Janie	0.0190	0.0396	0.0160	0.0108	0.0126
Sofia	0.0072	0.0028	0.0108	0.0200	0.0150
Marina	0.0072	0.0028	0.0090	0.0090	0.0090

Table 6: Using step4, we get

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