Application of Intuitionistic Fuzzy Set 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 has been 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 diagnose the disease accurately, but this is not studied in other existing methods.

Keywords- Intuitionistic fuzzy sets (IFS), fuzzy logic (FL), n-parameters medical diagnosis

I. 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 hesitancy 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, these 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 diagnosis the disease accurately.

II. PRELIMINARIES

A. Definition

Let a set E be fixed. An Intuitionistic fuzzy set or IFS A in E is an object having the form A = [\{< x, \mu_A(x), \nu_A(x) > | x \in E \}] where the functions

\[ \mu_A: E \rightarrow [0, 1] \] and \[ \nu_A: E \rightarrow [0, 1] \] define the degree of membership and degree of non-membership 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) + \nu_A(x) \leq 1. The amount \Pi A (x) = 1 - (\mu_A(x) + \nu_A(x)) is called the hesitation part, which may cater to either membership value or non-membership value or both.

B. Definition

If A is an IFS of X, then the max-min composition of the IFR R (X \rightarrow Y) with A is an IFS B of Y denoted by B = R \circ A, and is defined by the membership function. 
\[ \mu_{R \circ A}(y) = \bigvee \{ \mu_A(x) \land \mu_R(x, y) \} \] and the non-membership function given by
\[ \nu_{R \circ A}(y) = \bigwedge \{ \nu_A(x) \lor \nu_R(x, y) \} \] \((\forall y \in Y)\) (Here \( \mu = \text{max}, \nu = \text{min} \)

C. Definition

Let X be a non-empty set, A set of \( n \frac{\mu_i q_{i}}{i=1} \). Level generated by an IFS A, where \( n \frac{\mu_i q_{i}}{i=1} \in [0,1] \) are membership values, such that \( 0 \leq \frac{n}{i=1} \mu_i q_{i} + \frac{n}{i=1} q_{i} \leq 1 \) is defined as:

\[ J(x) = \bigvee_{i=1}^{n} \mu_i q_i < \bigwedge_{i=1}^{n} q_i \iff \{ < x, \mu_A(x) + \nu_A(x) > \} \]

\[ \bigvee_{i=1}^{n} \mu_i q_i - \bigwedge_{i=1}^{n} q_i \times \nu_A(x) > / x \in A \}

D. Definition

Let R be an IFR(C \rightarrow F) and construct an IFR Q from the set of stakeholders S to the set of criteria C. Clearly, the composition T of IFRS R and Q(T = R \circ Q) describes the state of the stakeholder in terms of the factors as an IFR from S to F given by the membership function 
\[ \mu_T(s_i, f_j) = \bigvee_{c \in C} \{ \mu_R(s_i, c) \land \mu_Q(c, f_j) \} \] And the non-membership function given by \( \nu_T(s_i, f_j) = \bigwedge_{c \in C} \{ \nu_R(s_i, c) \lor \nu_Q(c, f_j) \} \) \( s_i \in S \) and \( f_j \in F \). For a given R and Q, the relation T = R \circ Q can be computed.

III. MEDICAL DIAGNOSIS

Suppose that 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, \( M_1(p \rightarrow S) \) and \( M_2 \) from the set of patients to the set of symptoms s, i.e., \( M_2(S \rightarrow D) \) then

\[ K_1 = \text{max} \{ \min \{ \mu_A(x), \nu_A(x) \} | x \in E \} \]

\[ K_2 = q_1 = \frac{\mu_A(x) \times \nu_A(x)}{2(\mu_A(x) + \nu_A(x))} \]

\[ K_3 = q_i = \frac{\mu_A(x) \times \nu_A(x)}{2(q_{i-1} + \mu_A(x))} \]
\[ K_q = \sum_{i=1}^{n} q_i \cdot \nu_q(x) \]
\[ K_p = J(x) < \sum_{i=1}^{n} q_i \cdot x_i \cdot \nu_q(x) \cdot \nu_q(x+1) > \]
\[ K_e = \sum_{i=1}^{n} q_i \cdot \nu_q(x) \cdot \nu_q(x+1) > \]
\[ H(x) = \sum_{i=1}^{n} q_i \cdot \nu_q(x) \cdot \nu_q(x+1) > \]
\[ G(x) = \sum_{i=1}^{n} q_i \cdot \nu_q(x) \cdot \nu_q(x+1) > \]
\[ \min \{ \mu_A(x), q_1, q_2, \ldots, q_n \cdot \nu_q(x) \cdot \nu_q(x+1) > \} \]

**IV. ALGORITHM**

Compute \( K_i = \text{PoD} \) in Table 1 and Table 2 and the resultant in Table 3.

Table 3 values are applied in \( K_2 \), \( K_3 \) and \( K_4 \) and the results are given in Table 4.

Table 4 values are applied in \( K_5, K_6 \) and \( K_7 \) and the results are named as Table 5.

Table 5 values are applied in \( K_8 \) and the result is given in Table 6.

Finally, select the minimum values from each row of Table 6, and then conclude that the patient \( p_i \) is suffering from the disease \( d_j \).

**V. CASE STUDY**

Let there be four patients \( P = \{ \text{Ram, Sri, Wilson, Marina} \} \) and the set of symptoms \( S = \{ \text{temperature, headache, stomach-pain, cough, chest-pain} \} \). The set of Diagnosis

<table>
<thead>
<tr>
<th>( \text{Ram} )</th>
<th>( \text{Sri} )</th>
<th>( \text{Wilson} )</th>
<th>( \text{Marina} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{Viral fever}</td>
<td>(5.017,017,025,2)</td>
<td>(7.034,077,027,2)</td>
<td>(5.034,077,027,2)</td>
</tr>
<tr>
<td>\text{Malaria}</td>
<td>(5.017,017,025,2)</td>
<td>(8.02,044,015,1)</td>
<td>(5.07,071,025,2)</td>
</tr>
<tr>
<td>\text{Typhoid}</td>
<td>(8.02,044,015,1)</td>
<td>(6.033,075,027,2)</td>
<td>(8.02,044,015,1)</td>
</tr>
<tr>
<td>\text{Stomach Problem}</td>
<td>(4.02,086,024,2)</td>
<td>(4.02,086,024,2)</td>
<td>(3.025,069,023,2)</td>
</tr>
<tr>
<td>\text{Chest Problem}</td>
<td>(4.02,086,024,2)</td>
<td>(3.025,069,023,2)</td>
<td>(7.034,077,027,2)</td>
</tr>
</tbody>
</table>

**If \( S \rightarrow D \)**

<table>
<thead>
<tr>
<th>( \text{Temperature} )</th>
<th>( \text{Headache} )</th>
<th>( \text{Stomach pain} )</th>
<th>( \text{Cough} )</th>
<th>( \text{Chest pain} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{Ram}</td>
<td>(0.4,0.2)</td>
<td>(0.5,0.2)</td>
<td>(0.8,0.1)</td>
<td>(0.2,0.6)</td>
</tr>
<tr>
<td>\text{Sri}</td>
<td>(0.8,0.1)</td>
<td>(0.8,0.2)</td>
<td>(0.8,0.1)</td>
<td>(0.4,0.3)</td>
</tr>
<tr>
<td>\text{Wilson}</td>
<td>(0.2,0.2)</td>
<td>(0.5,0.3)</td>
<td>(0.9,0.0)</td>
<td>(0.2,0.7)</td>
</tr>
<tr>
<td>\text{Marina}</td>
<td>(0.4,0.4)</td>
<td>(0.7,0.1)</td>
<td>(0.9,0.1)</td>
<td>(0.8,0.1)</td>
</tr>
</tbody>
</table>

**If \( P \rightarrow S \)**

Table 4: Using step 1, we get

<table>
<thead>
<tr>
<th>( \text{Viral fever} )</th>
<th>( \text{Malaria} )</th>
<th>( \text{Typhoid} )</th>
<th>( \text{Stomach Problem} )</th>
<th>( \text{Chest Problem} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{Ram}</td>
<td>(0.5012,0.05)</td>
<td>(0.5012,0.05)</td>
<td>(0.016,0.10)</td>
<td>(0.0112,0.05)</td>
</tr>
<tr>
<td>\text{Sri}</td>
<td>(0.0238,0.20)</td>
<td>(0.018,0.20)</td>
<td>(0.018,0.20)</td>
<td>(0.0112,0.20)</td>
</tr>
<tr>
<td>\text{Wilson}</td>
<td>(0.0198,0.20)</td>
<td>(0.012,0.05)</td>
<td>(0.012,0.05)</td>
<td>(0.014,0.30)</td>
</tr>
<tr>
<td>\text{Marina}</td>
<td>(0.050,0.05)</td>
<td>(0.050,0.05)</td>
<td>(0.050,0.05)</td>
<td>(0.050,0.05)</td>
</tr>
</tbody>
</table>

**If \( D \)**

<table>
<thead>
<tr>
<th>( \text{Viral Fever} )</th>
<th>( \text{Malaria} )</th>
<th>( \text{Typhoid} )</th>
<th>( \text{Stomach Problem} )</th>
<th>( \text{Chest Problem} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\text{Ram}</td>
<td>(0.014)</td>
<td>(0.0075)</td>
<td>(0.012)</td>
<td>(0.0238)</td>
</tr>
<tr>
<td>\text{Sri}</td>
<td>(0.016)</td>
<td>(0.005)</td>
<td>(0.012)</td>
<td>(0.0238)</td>
</tr>
<tr>
<td>\text{Wilson}</td>
<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.012)</td>
<td>(0.0238)</td>
</tr>
<tr>
<td>\text{Marina}</td>
<td>(0.012)</td>
<td>(0.005)</td>
<td>(0.012)</td>
<td>(0.0238)</td>
</tr>
</tbody>
</table>
VI. CONCLUSION

An intuitionistic fuzzy set [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.

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