INTUITIONISTIC FUZZY SET WITH $H_{\alpha\beta}^*$ AND $J_{\alpha\beta}^*$ OPERATOR TECHNIQUES IN MEDICAL DIAGNOSIS

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Abstract: In this paper we propose a new approach for medical diagnosis the symptoms of disease using Intuitionistic fuzzy set with different operators. The membership and non-membership values are not always possible up to our satisfaction, but in deterministic (hesitation) part has more important role here, the fact that in decision making, particularly in case of medical diagnosis, there is a fair chance of the existence of a non-zero hesitation part at each moment of evaluation.

Key Words: Intuitionistic Fuzzy set (IFS), Intuitionistic Fuzzy Relation (IFR), Intuitionistic Medical Diagnosis (IMD).

1. INTRODUCTION

The field of medicine is one of the fruitful areas of applications for fuzzy set theory. In the discrimination analysis, the symptoms are ranked according to the grade of discrimination of each disease by a particular symptom. Nowadays in our day to day life Indian information technology sector is growing rapidly. This has generated a new genre of occupational health problems such as musculo-skeletal disorders, computer vision syndrome, psycho-social and sleep problems. Since researches addressing these issues are scarce, we planned to determine the health hazards faced by software engineers so as to crystallise the research question for larger survey, to the most rampant and crucial issues. Since most IT professionals have access to internet, electronic mail (e-mail) survey was also done.

Over time, long periods of time on the computer can take a toll on their health. Recently, British scientists discovered a link between computer use and depression. IT professionals are handling the crisis and disaster recovery, which can be very stressful. Hunched in an office chair for hours at a time can cause severe pain and discomfort, especially in the lower back. Over time, poor posture can permanently damage the structure of the spine resulting in acute, chronic. This survey is done from friends and relatives working as software engineers in Chennai, India. Some of the common problems are as follows: Musculo-skeletal discomfort, computer vision syndrome, most of them were staying away from their family and their regular source of meal was hotel, overweight were not satisfied with the time they spent with their family. As noted in the present study, that musculo-skeletal discomfort and computer workers. Some of the most commonly computer related health problems reported are Stress, Ulcer, Vision, Spinal Problems, Blood Pressure etc.,

In real world, we frequently deal with vague or imprecise information. Information available is sometimes vague, sometimes inexact or sometimes insufficient. Out of several higher order fuzzy sets, intuitionistic fuzzy sets (IFS)[2,3] have been found to be highly useful to deal with vagueness. There are situations where due to insufficiency in the information available, the evaluation of membership values is not possible up to our satisfaction. Due to the same reason, evaluation of non-membership values is also not always possible and consequently there remains a part in deterministic on which hesitation survives. Certainly Fuzzy sets theory is not appropriate to deal with such problem, rather IFS theory is more suitable. Out of several generalizations of fuzzy set theory for various objectives, the notion introduced by Atanassov[2] in defining intuitionistic fuzzy sets is interesting and useful. Fuzzy sets are intuitionistic fuzzy sets but the converse is not necessarily true[2]. In fact there are situations where IFS theory is more appropriate to deal with[5]. Besides, it has been cultured in [6] that vague sets[7] are nothing but IFS.
In the present paper we study Sanchez’s method [8] for medical diagnosis using Intuitionistic fuzzy set with different operators [1]. The method of intuitionistic medical diagnosis [IMD] involves intuitionistic fuzzy relations [IFR] as defined in [4].

2. PRELIMINARIES

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

Definition 2.1

Let a set $E$ be fixed. An intuitionistic fuzzy set (IFS) $A$ in $E$ is an object having the form $\tilde{A} = \{ (x, \mu_A(x), \gamma_A(x)) / x \in E \}$ where the function $\mu_A : E \rightarrow [0,1]$ and $\gamma_A : E \rightarrow [0,1]$ 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.

3. METHODOLOGY - I

Definition 3.1

If $A$ and $B$ are two IFS of the set $E$, then

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

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

Definition 3.2

We define an operator over an intuitionistic fuzzy set $A$ (IFS $A$), given the fixed numbers $\alpha, \beta \in [0,1], \alpha, \beta \in [0,1]$, as

$H^\alpha,\beta_A(x) = \{ (x, \alpha \mu_A(x), \gamma_A(x) + \beta \cdot (1 - \alpha \mu_A(x) - \gamma_A(x))) / x \in E \}$

4. MEDICAL DIAGNOSIS

Suppose $S$ is a set of symptoms, $H$ is a set of Health problems, and $W$ is a set of workers. Let $M_1$ be an intuitionistic fuzzy relations [IFR] $M_1(W \rightarrow S)$ and Let $M_2$ be an intuitionistic fuzzy relations [IFR] $M_2(S \rightarrow H)$ from the set of workers to the set of symptoms.

Then

$M_1 = A \cap B = \{ (x, \min(\mu_A(x), \mu_B(x)), \max(\gamma_A(x), \gamma_B(x))) / x \in E \}$

$M_2 = A \cup B = \{ (x, \max(\mu_A(x), \mu_B(x)), \min(\gamma_A(x), \gamma_B(x))) / x \in E \}$

$M_3 = (M_1 \circ M_2)$

$M_4 = H^\alpha,\beta_A(x) = \{ (x, \alpha \mu_A(x), \gamma_A(x) + \beta \cdot (1 - \alpha \mu_A(x) - \gamma_A(x))) / x \in E \}$

Here $\alpha, \beta = 0.5$

$M_5 = \mu_A(x) \land \gamma_A(x) = \min(\mu_A(x), \gamma_A(x))$

Algorithm 4.1

Step 1:

$M_1(W \rightarrow S)$ and $M_2(S \rightarrow H)$ are applied in Table 1 and Table 2 , we get the results is named Table 3 (ie, compute $M_3 = M_1 \circ M_2$)

Step 2:

The Table 3 values are applied in the formula $M_4$ and get the results is named Table 4.

Step 3:

The Table 4 values are applied in $M_5$ and get the result is named Table 5.

Step 4:

Finally, we select the maximum value from(Table 5)each row, and then we conclude that the workers $W_i (i = 1,2,3,4)$ is suffering from the Health problems $H_j (j = 1,2,3,4,5)$

Case Study 4.2

Let there be four workers $W = \{ Vicky, John, Doss, Peter \}$ and the set of symptoms
S = \{Headache, Acidity, Burning Eyes, Back pain, Depression\}. Let the set of Health problems be H = \{Stress, Ulcer, Vision problem, Spinal problems, Blood pressure\}

Table 1: IFR $M_1(W \rightarrow S)$

<table>
<thead>
<tr>
<th></th>
<th>Headache</th>
<th>Acidity</th>
<th>Burning Eyes</th>
<th>Back Pain</th>
<th>Depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicky</td>
<td>(0.9, 0.1)</td>
<td>(0.7, 0.2)</td>
<td>(0.2, 0.8)</td>
<td>(0.7, 0.2)</td>
<td>(0.2, 0.7)</td>
</tr>
<tr>
<td>John</td>
<td>(0.0, 0.7)</td>
<td>(0.4, 0.5)</td>
<td>(0.6, 0.2)</td>
<td>(0.2, 0.7)</td>
<td>(0.1, 0.2)</td>
</tr>
<tr>
<td>Doss</td>
<td>(0.7, 0.1)</td>
<td>(0.7, 0.1)</td>
<td>(0.0, 0.5)</td>
<td>(0.1, 0.7)</td>
<td>(0.0, 0.6)</td>
</tr>
<tr>
<td>Peter</td>
<td>(0.5, 0.1)</td>
<td>(0.4, 0.3)</td>
<td>(0.4, 0.5)</td>
<td>(0.8, 0.2)</td>
<td>(0.3, 0.4)</td>
</tr>
</tbody>
</table>

Table 2: IFR $M_2(S \rightarrow H)$

<table>
<thead>
<tr>
<th></th>
<th>Stress</th>
<th>Ulcer</th>
<th>Vision Problem</th>
<th>Spinal Problems</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>(0.3, 0.0)</td>
<td>(0.0, 0.6)</td>
<td>(0.2, 0.2)</td>
<td>(0.2, 0.8)</td>
<td>(0.2, 0.8)</td>
</tr>
<tr>
<td>Acidity</td>
<td>(0.3, 0.5)</td>
<td>(0.2, 0.6)</td>
<td>(0.5, 0.2)</td>
<td>(0.1, 0.5)</td>
<td>(0.0, 0.7)</td>
</tr>
<tr>
<td>Burning Eyes</td>
<td>(0.2, 0.8)</td>
<td>(0.0, 0.8)</td>
<td>(0.1, 0.7)</td>
<td>(0.7, 0.0)</td>
<td>(0.2, 0.8)</td>
</tr>
<tr>
<td>Back Pain</td>
<td>(0.7, 0.3)</td>
<td>(0.5, 0.0)</td>
<td>(0.2, 0.6)</td>
<td>(0.1, 0.7)</td>
<td>(0.1, 0.8)</td>
</tr>
<tr>
<td>Depression</td>
<td>(0.2, 0.6)</td>
<td>(0.1, 0.8)</td>
<td>(0.2, 0.8)</td>
<td>(0.2, 0.7)</td>
<td>(0.8, 0.1)</td>
</tr>
</tbody>
</table>

Table 3: Using Step 1 (ie, compute $M_3 = (M_1 \circ M_2)$)

<table>
<thead>
<tr>
<th></th>
<th>Stress</th>
<th>Ulcer</th>
<th>Vision Problem</th>
<th>Spinal Problems</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicky</td>
<td>(0.7, 0.1)</td>
<td>(0.5, 0.2)</td>
<td>(0.5, 0.2)</td>
<td>(0.2, 0.5)</td>
<td>(0.2, 0.7)</td>
</tr>
<tr>
<td>John</td>
<td>(0.3, 0.5)</td>
<td>(0.2, 0.6)</td>
<td>(0.4, 0.5)</td>
<td>(0.6, 0.2)</td>
<td>(0.2, 0.2)</td>
</tr>
<tr>
<td>Doss</td>
<td>(0.3, 0.1)</td>
<td>(0.2, 0.6)</td>
<td>(0.5, 0.2)</td>
<td>(0.2, 0.5)</td>
<td>(0.2, 0.6)</td>
</tr>
<tr>
<td>Peter</td>
<td>(0.7, 0.1)</td>
<td>(0.5, 0.2)</td>
<td>(0.4, 0.2)</td>
<td>(0.4, 0.5)</td>
<td>(0.3, 0.4)</td>
</tr>
</tbody>
</table>

Table 4: Using Step 2
The result of the IT workers health problems from Table 5, we see that the max value of Vicky and Peter is 0.35 and therefore both of them suffer from Stress. The max value of John is 0.30. This concludes that John faces Spinal Problem. Whereas the max value of Doss is 0.25 and therefore Doss faces Vision Problem.

5.METHODOLOGY II

Definition 5.1

If A and B are two IFS of the set E, then
\[ A \cap B = \{x, \min(\mu_A(x), \mu_B(x)), \max(\gamma_A(x), \gamma_B(x))\}/x \in E \}\]
\[ A \cup B = \{x, \max(\mu_A(x), \mu_B(x)), \min(\gamma_A(x), \gamma_B(x))\}/x \in E \}\]

Definition 5.2

We define an operator over an intuitionistic fuzzy set A (IFS A), given the fixed numbers \( \alpha, \beta \in [0, 1] \), as
\[ J^*_{\alpha, \beta}(A) = \{x, \mu_A(x) + \alpha \cdot (1 - \mu_A(x) - \beta \cdot \gamma_A(x)), \beta \cdot \gamma_A(x)\}/x \in E \}

MEDICAL DIAGNOSIS 6

Suppose S is a set of symptoms, H is a set of Health problems, and W is a set of workers. Let \( N_1 \) be an intuitionistic fuzzy relations [IFR] \( N_1 (W \rightarrow S) \) and Let \( N_2 \) be an intuitionistic fuzzy relations [IFR] \( N_2 (S \rightarrow H) \) from the set of workers to the set of symptoms. Then
\[ N_1 = A \cap B = \{x, \min(\mu_A(x), \mu_B(x)), \max(\gamma_A(x), \gamma_B(x))\}/x \in E \}\]
\[ N_2 = A \cup B = \{x, \max(\mu_A(x), \mu_B(x)), \min(\gamma_A(x), \gamma_B(x))\}/x \in E \}\]
\[ N_3 = (N_1 \circ N_2) \]
\[ N_4 = J^*_{\alpha, \beta}(A) = \{x, \mu_A(x) + \alpha \cdot (1 - \mu_A(x) - \beta \cdot \gamma_A(x)), \beta \cdot \gamma_A(x)\}/x \in E \} \]
Here $\alpha, \beta = 0.5$

\[ N_5 = \mu_A(x) \lor \gamma_A(x) = \max\{\mu_A(x), \gamma_A(x)\} \]

**Algorithm 6.1**

**Step 1:**

\(N_1 (W \rightarrow S)\) and \(N_2 (S \rightarrow H)\) are applied in Table 1 and Table 2, we get the results is named Table 3 (ie, compute \(N_3 = (N_1 \circ N_2)\)).

**Step 2:**

The Table 3 values are applied in the formula \(N_4\) and get the results is named Table 4.

**Step 3:**

The Table 4 values applied in \(N_5\) and get the result is named Table 5.

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Finally, we select the maximum value from (Table 5) each row, and then we conclude that the workers \(W_i (i = 1, 2, 3, 4)\) is suffering from the Health problems \(H_j (j = 1, 2, 3, 4, 5)\).

**Case Study 6.2**

Let there be four workers \(W = \{ Vicky, John, Doss, Peter \}\) and the set of symptoms \(S = \{ \text{Headache, Acidity, Burning Eyes, Back pain, Depression} \}\). Let the set of Health problems be \(H = \{ \text{Stress, Ulcer, Vision problem, Spinal problems, Blood pressure} \}\).

**Table 1: IFR \(N_1 (W \rightarrow S)\)**

<table>
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<th>Back Pain</th>
<th>Depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicky</td>
<td>(0.9, 0.1)</td>
<td>(0.7, 0.2)</td>
<td>(0.2, 0.8)</td>
<td>(0.7, 0.2)</td>
<td>(0.2, 0.7)</td>
</tr>
<tr>
<td>John</td>
<td>(0.0, 0.7)</td>
<td>(0.4, 0.5)</td>
<td>(0.6, 0.2)</td>
<td>(0.2, 0.7)</td>
<td>(0.1, 0.2)</td>
</tr>
<tr>
<td>Doss</td>
<td>(0.7, 0.1)</td>
<td>(0.7, 0.1)</td>
<td>(0.0, 0.5)</td>
<td>(0.1, 0.7)</td>
<td>(0.0, 0.6)</td>
</tr>
<tr>
<td>Peter</td>
<td>(0.5, 0.1)</td>
<td>(0.4, 0.3)</td>
<td>(0.4, 0.5)</td>
<td>(0.8, 0.2)</td>
<td>(0.3, 0.4)</td>
</tr>
</tbody>
</table>

**Table 2: IFR \(N_2 (S \rightarrow H)\)**

<table>
<thead>
<tr>
<th></th>
<th>Stress</th>
<th>Ulcer</th>
<th>Vision Problem</th>
<th>Spinal problems</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>(0.3, 0.0)</td>
<td>(0.0, 0.6)</td>
<td>(0.2, 0.2)</td>
<td>(0.2, 0.8)</td>
<td>(0.2, 0.8)</td>
</tr>
<tr>
<td>Acidity</td>
<td>(0.3, 0.5)</td>
<td>(0.2, 0.6)</td>
<td>(0.5, 0.2)</td>
<td>(0.1, 0.5)</td>
<td>(0.0, 0.7)</td>
</tr>
<tr>
<td>Burning Eyes</td>
<td>(0.2, 0.8)</td>
<td>(0.0, 0.8)</td>
<td>(0.1, 0.7)</td>
<td>(0.7, 0.0)</td>
<td>(0.2, 0.8)</td>
</tr>
<tr>
<td>Back Pain</td>
<td>(0.7, 0.3)</td>
<td>(0.5, 0.0)</td>
<td>(0.2, 0.6)</td>
<td>(0.1, 0.7)</td>
<td>(0.1, 0.8)</td>
</tr>
<tr>
<td>Depression</td>
<td>(0.2, 0.6)</td>
<td>(0.1, 0.8)</td>
<td>(0.2, 0.8)</td>
<td>(0.2, 0.7)</td>
<td>(0.8, 0.1)</td>
</tr>
</tbody>
</table>

**Table 3: Using Step 1 (ie, compute \(N_3 = (N_1 \circ N_2)\))**
The final result of the IT workers health problems from Table 5, we see that the max value of Vicky and Peter is 0.82 and therefore both of them suffer from Stress. The max value of John is 0.75. This concludes that John faces Spinal Problem. Whereas the max value of Doss is 0.70 and therefore Doss faces Vision Problem.

**6. CONCLUSION**

Overall the final results from the methodology I and II are applied in the different operators, but the result will be same. ie, Vicky and Peter suffers from Stress, John faces Spinal problem, Doss faces Vision problem.

**7. ACKNOWLEDGEMENT**

The authors thank to the Managing Editor and the anonymous reviewer for his suggestion which have led to an improvement in both quality and clarity of the paper.
8. REFERENCES


