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Research Article

Hausdroff Distance Measure in Medical Diagnosis

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ABSTRACT

Fuzzy logic is a method used in medical diagnosis to help doctors make decisions and reduce uncertainty. It's used in a variety of medical areas.

Introduction

The study of uncertainty and imprecision is the subject of fuzzy mathematics, also known as fuzzy logic or fuzzy set theory. Fuzzy mathematics allows for deviation, unlike classical set theory and traditional logic, which are based on binary true/false values. He introduced the concept of fuzzy sets as a generalization of classical (crisp) sets in this paper, which enables the representation of uncertainties in mathematical terms. The idea of fuzzy sets and fuzzy logic was first presented in the 1960s by Lotfi A. Zadeh, who was also regarded as a mathematician and computer scientist.

Fuzzy logic and fuzzy set theory were founded on the work of Lotfi A. Zadeh, who offered a framework for handling ambiguous reasoning and inaccurate information. Control systems, artificial intelligence, decision-making, and engineering are just a few of the domains where fuzzy logic has found extensive use thanks to his efforts.

Fuzzy decision-making has been an active area of research, and numerous researchers have made significant contributions to this field. Here, in this paper, Hausdroff distance measure have been introduced to diagnosis the diseases of the patients.

Preliminaries

Fuzzy Goal

In traditional decision-making, goals are often defined with clear and precise objectives. However, in some situations, goals may be inherently vague or imprecise. Fuzzy logic allows for the representation of fuzzy goals, where the criteria for achieving a goal are not precisely defined.

For example, consider a goal like "Maintain a comfortable temperature in a room." The term "comfortable" is subjective and can vary among individuals. Fuzzy logic enables the modeling of such subjective and imprecise goals, allowing for a more flexible and adaptable decision-making framework.

Fuzzy sets and fuzzy membership functions can be employed to represent the degrees of membership of elements in achieving a fuzzy goal.

Fuzzy Constraints

Constraints in decision-making are conditions or limitations that must be satisfied. Fuzzy constraints are used when the boundaries or conditions are not precisely defined, and there is a degree of uncertainty.

For instance, if you have a constraint like "Keep the production cost low," the term "low" is subjective and may vary based on different perspectives. Fuzzy logic can help model the imprecision in such constraints and guide decision-making processes that aim to satisfy these fuzzy constraints. Fuzzy constraints can be integrated into optimization problems,

allowing for more realistic and adaptable solutions that consider the uncertain nature of the constraints.

Fuzzy Decision Making

Fuzzy logic is particularly useful in decision-making when dealing with uncertainty, imprecision, and subjective criteria. Using fuzzy rules and membership functions to make decisions while processing imprecise information is known as fuzzy decision-making. In fuzzy decision-making, fuzzy inference methods like Sugeno or Mamdani models are frequently employed.

For example, in financial decision-making, you might have rules like "If the market is moderately bullish and the interest rates are low, then consider investing in stocks." These rules capture the imprecise nature of financial markets and help guide decision-making under uncertainty.

Intuitionistic Fuzzy Sets (Ifs)

An extension of fuzzy sets that adds the idea of hesitation or indeterminacy is called an intuitionistic fuzzy set (IFS). Each element in an IFS is given a membership degree that indicates how much it belongs to the set and a non-membership degree that indicates how little it belongs to the set. Furthermore, there is a certain amount of hesitancy or uncertainty, which stands for the ambiguity surrounding the degrees of membership or non-membership. Here's an example of an intuitionistic fuzzy set representing the concept of "tallness" in humans:

Let's consider the set "Tall" with respect to human height:

Membership degree:

- John: 0.8 (John is tall to a high degree)
- Sarah: 0.7 (Sarah is tall to a moderate degree)
- Emily: 0.4 (Emily is somewhat tall)

Non-membership degree:

- John: 0.1 (John is not tall to a low degree)
- Sarah: 0.2 (Sarah is not tall to a moderate degree)
- Emily: 0.6 (Emily is not tall to a high degree)

Degree of hesitation:

John: 0.1 (There's a slight uncertainty regarding John's tallness)

Sarah: 0.1 (There's a slight uncertainty regarding Sarah's tallness)

Emily: 0.0 (There's no hesitation regarding Emily's tallness)

In this example, John is confidently tall, Sarah is moderately tall with some uncertainty, and Emily is somewhat tall with no hesitation.

Hausdroff Distance Measure In Medical Diagnosis

A Hausdroff distance measure on intuitionistic fuzzy set is given by,

$$d(A,B) = \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \}$$

The procedure is given by,

Step 1

Let the set of diseases be given by {D₁, D₂, ... D_m}

Step 2

Let the set of patients be given by {P₁, P₂, ... P_n}. The symptoms for difference diseases and patients always expressed in linguistic expressions.

Step 3

The symptoms of diseases D_i are to be expressed in IFSs which is as follows,

$$\{S_1(\mu_1^{D_i}, v_1^{D_i}), S_2(\mu_2^{D_i}, v_2^{D_i}), \dots S_l(\mu_l^{D_i}, v_l^{D_i})\}$$

Step 4

The symptoms of patients P_i are to be expressed in IFSs which is as follows,

$$\{S_1(\mu_1^{P_i}, v_1^{P_i}), S_2(\mu_2^{P_i}, v_2^{P_i}), \dots S_l(\mu_l^{P_i}, v_l^{P_i})\}$$

Step 5

The formula of the unique distance measure on IFS can be used to determine the distance between the symptoms of the diseases and the symptoms of the patients. It is given by,

$$d(A,B) = \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \}$$

Where i=1, 2,3,...l.

Step 6

The following matrix should be used to illustrate the distance between each pair of

illnesses and patients:

$$\begin{matrix}
 & P_1 & \dots & P_n \\
 D_1 & [d(D_1, P_1) & \dots & d(D_1, P_n)] \\
 \vdots & \vdots & \ddots & \vdots \\
 D_m & [d(D_m, P_1) & \dots & d(D_m, P_n)]
 \end{matrix}$$

Step 7

Given that a smaller distance between two IFSs indicates greater similarity between them, distance can be utilised to determine the disease a patient has. One may say that the disease that corresponds to $\min d(D_i, P_j)$ is the one that patient P_j is most likely to have. In other words, patient P_1 is more susceptible to disease D_i if $d(D_i, P_1)$ (for some i where $i=1,2,3,\dots,m$) has the lowest value.

4.2.1 Let us support this method with an same example discussed earlier. The Hausdorff distance measure has been applied to medical diagnosis decision-making.

Let's take the information from the 2001 paper "An application of intuitionistic fuzzy sets in medical diagnosis" by De et al.

we will use S to stand for the set of symptoms, D for the set of diagnoses, and P for the set of patients. Next, we have the following.

Step 1

$$P = \{\text{Sesha, Divya, Malik, Vridhin}\}$$

$$S = \{\text{Temperature, headache, stomach pain, cough, chest pain}\}$$

Step 2

$$D = \{\text{typhoid, malaria, viral fever, chest issues, and stomach pain}\}$$

Step 3

Symptoms	Viral fever (Vf)	Malaria (Ml)	Typhoid (Ty)	Stomach pain (Sp)	Chest problem (Cp)
Temperature	(0.4, 0.0)	(0.7, 0.0)	(0.3, 0.3)	(0.1, 0.7)	(0.1, 0.8)
Headache	(0.3, 0.5)	(0.2, 0.6)	(0.6, 0.1)	(0.2, 0.4)	(0.8, 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 4.2.1

The symptoms of diseases D_i are to be expressed in IFSs $\{S_1(\mu_1^{D_i}, \nu_1^{D_i}), S_2(\mu_2^{D_i}, \nu_2^{D_i}), \dots, S_l(\mu_l^{D_i}, \nu_l^{D_i})\}$ as follows,

Viral fever (Vf) =

$$\{ \langle Tm, (0.4, 0.0) \rangle, \langle He, (0.3, 0.5) \rangle, \langle Sp, (0.1, 0.7) \rangle, \langle Co, (0.4, 0.3) \rangle, \langle Ch, (0.1, 0.7) \rangle \}$$

Malaria (Ml) =

$$\{ \langle Tm, (0.7, 0.0) \rangle, \langle He, (0.2, 0.6) \rangle, \langle Sp, (0.0, 0.9) \rangle, \langle Co, (0.7, 0.0) \rangle, \langle Ch, (0.1, 0.8) \rangle \}$$

Typhoid (Ty) =

$$\{ \langle Tm, (0.3, 0.3) \rangle, \langle He, (0.6, 0.1) \rangle, \langle Sp, (0.2, 0.7) \rangle, \langle Co, (0.2, 0.6) \rangle, \langle Ch, (0.1, 0.9) \rangle \}$$

Stomach pain (Sp) =

$$\{ \langle Tm, (0.1, 0.7) \rangle, \langle He, (0.2, 0.4) \rangle, \langle Sp, (0.8, 0.0) \rangle, \langle Co, (0.2, 0.7) \rangle, \langle Ch, (0.2, 0.7) \rangle \}$$

Chest pain (Cp) =

$$\{ \langle Tm, (0.1, 0.8) \rangle, \langle He, (0.8, 0.8) \rangle, \langle Sp, (0.2, 0.8) \rangle, \langle Co, (0.2, 0.8) \rangle, \langle Ch, (0.8, 0.1) \rangle \}$$

Step 4

	Temperature	Headache	Stomach pain	Cough	Chest pain
Sesha	(0.8, 0.1)	(0.6, 0.1)	(0.2, 0.8)	(0.6, 0.1)	(0.1, 0.6)
Divya	(0.0, 0.8)	(0.4, 0.4)	(0.6, 0.1)	(0.1, 0.7)	(0.1, 0.8)
Malik	(0.8, 0.1)	(0.8, 0.1)	(0.0, 0.6)	(0.2, 0.7)	(0.0, 0.5)
Vridhin	(0.6, 0.1)	(0.5, 0.4)	(0.3, 0.4)	(0.7, 0.2)	(0.3, 0.4)

Table 4.2.2

The symptoms of patients P_i are to be expressed in IFSs

$$\{S_1(\mu_1^{P_i}, \nu_1^{P_i}), S_2(\mu_2^{P_i}, \nu_2^{P_i}), \dots, S_l(\mu_l^{P_i}, \nu_l^{P_i})\}$$

which are as follows:

Sesha =

$$\{ \langle Tm, (0.8, 0.1) \rangle, \langle He, (0.6, 0.1) \rangle, \langle Sp, (0.2, 0.8) \rangle, \langle Co, (0.6, 0.1) \rangle, \langle Ch, (0.1, 0.6) \rangle \}$$

Divya
 ={<Tm,(0.0,0.8)>,<He,(0.4,0.4)>,<Sp,(0.6,0.1)>
 >,<Co,(0.1,0.7)>,<Ch,(0.1,0.8)>}

Malik
 ={<Tm,(0.8,0.1)>,<He,(0.8,0.1)>,<Sp,(0.0,0.6)>
 >,<Co,(0.2,0.7)>,<Ch,(0.0,0.5)>}

Vridhin =
 {<Tm,(0.6,0.1)>,<He,(0.5,0.4)>,<Sp,(0.3,0.4)>,
 <Co,(0.7,0.2)>,<Ch,(0.3,0.4)>}

Step 5:

The Hausdroff distance measure based on IFS can be used to determine the distance between a patient's symptoms and the symptoms of their diseases.

It is given by,

$$d(A,B) = \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \}$$

where $i=1,2,3,\dots,1$.

Our goal is to make a diagnosis for every patient based on the collection of symptoms associated with each illness.

According on the patient's symptoms, the intuitionistic distance between the illness and the patient is now calculated as follows. Here n denotes the number of symptoms.

Therefore, $n=5$

$$\begin{aligned} d(Vf, Sessa) &= \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \} \\ &= \frac{1}{5} \max \{ \{ |\mu_A(x_1) - \mu_B(x_1)|, |v_A(x_1) - v_B(x_1)| \} + \{ |\mu_A(x_2) - \mu_B(x_2)|, |v_A(x_2) - v_B(x_2)| \} + \{ |\mu_A(x_3) - \mu_B(x_3)|, |v_A(x_3) - v_B(x_3)| \} + \{ |\mu_A(x_4) - \mu_B(x_4)|, |v_A(x_4) - v_B(x_4)| \}, |\mu_A(x_5) - \mu_B(x_5)| + |v_A(x_5) - v_B(x_5)| \} \} \\ &= \frac{1}{5} [\max \{ |0.4 - 0.8|, |0.0 - 0.1| \} + \max \{ |0.3 - 0.6|, |0.5 - 0.1| \} + \max \{ |0.1 - 0.2|, |0.7 - 0.8| \} + \max \{ |0.4 - 0.6|, |0.3 - 0.1| \} + \max \{ |0.1 - 0.1|, |0.7 - 0.6| \}] \\ &= \frac{1}{5} [\max \{ | - 0.4|, | - 0.1| \} + \max \{ | - 0.3|, |0.4| \} + \max \{ | - 0.1|, | - 0.1| \} + \max \{ | - 0.2|, |0.2| \} + \max \{ |0.0|, |0.1| \}] \end{aligned}$$

$$\begin{aligned} &= \frac{1}{5} [\max \{ 0.4, 0.1 \} + \max \{ 0.3, 0.4 \} + \max \{ 0.1, 0.1 \} + \max \{ 0.2, 0.2 \} + \max \{ 0.0, 0.1 \}] \\ &= \frac{1}{5} [\{ 0.4 \} + \{ 0.4 \} + \{ 0.1 \} + \{ 0.2 \} + \{ 0.1 \}] \\ &= \frac{1}{5} [1.2] \\ &= 0.24 \end{aligned}$$

$$\begin{aligned} d(Vf, Divya) &= \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \} \\ &= \frac{1}{5} \max \{ \{ |\mu_A(x_1) - \mu_B(x_1)|, |v_A(x_1) - v_B(x_1)| \} + \{ |\mu_A(x_2) - \mu_B(x_2)|, |v_A(x_2) - v_B(x_2)| \} + \{ |\mu_A(x_3) - \mu_B(x_3)|, |v_A(x_3) - v_B(x_3)| \} + \{ |\mu_A(x_4) - \mu_B(x_4)|, |v_A(x_4) - v_B(x_4)| \}, |\mu_A(x_5) - \mu_B(x_5)| + |v_A(x_5) - v_B(x_5)| \} \} \\ &= \frac{1}{5} [\max \{ |0.4 - 0.0|, |0.0 - 0.8| \} + \max \{ |0.3 - 0.4|, |0.5 - 0.4| \} + \max \{ |0.1 - 0.6|, |0.7 - 0.1| \} + \max \{ |0.4 - 0.1|, |0.3 - 0.7| \} + \max \{ |0.1 - 0.1|, |0.7 - 0.8| \}] \\ &= \frac{1}{5} [\max \{ |0.4|, | - 0.8| \} + \max \{ | - 0.1|, |0.1| \} + \max \{ | - 0.5|, |0.6| \} + \max \{ |0.3|, | - 0.4| \} + \max \{ |0.0|, | - 0.1| \}] \\ &= \frac{1}{5} [\max \{ 0.4, 0.8 \} + \max \{ 0.1, 0.1 \} + \max \{ 0.5, 0.6 \} + \max \{ 0.3, 0.4 \} + \max \{ 0.0, 0.1 \}] \\ &= \frac{1}{5} [\{ 0.8 \} + \{ 0.1 \} + \{ 0.6 \} + \{ 0.4 \} + \{ 0.1 \}] \\ &= \frac{1}{5} [2] \\ &= 0.4 \end{aligned}$$

$$\begin{aligned} d(Vf, Malik) &= \frac{1}{n} \sum_{i=1}^l \max \{ |\mu_A(x_i) - \mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \} \\ &= \frac{1}{5} \max \{ \{ |\mu_A(x_1) - \mu_B(x_1)|, |v_A(x_1) - v_B(x_1)| \} + \{ |\mu_A(x_2) - \mu_B(x_2)|, |v_A(x_2) - v_B(x_2)| \} + \{ |\mu_A(x_3) - \mu_B(x_3)|, |v_A(x_3) - v_B(x_3)| \} + \{ |\mu_A(x_4) - \mu_B(x_4)|, |v_A(x_4) - v_B(x_4)| \}, |\mu_A(x_5) - \mu_B(x_5)| + |v_A(x_5) - v_B(x_5)| \} \} \\ &= \frac{1}{5} [\max \{ |0.4 - 0.8|, |0.3 - 0.1| \} + \max \{ |0.3 - 0.8|, |0.5 - 0.1| \} + \max \{ |0.1 - 0.0|, |0.7 - 0.1| \}] \end{aligned}$$

$$\begin{aligned}
 &0.6 \} + \max\{0.4 - 0.2\}, |0.3 - \\
 &0.7 \} + \max\{0.1 - 0.0\}, |0.7 - 0.5 \} \} \\
 &= \frac{1}{5} [\max\{|0.4|, |0.2 \} + \max\{|-0.5|, |0.4 \} + \max \\
 &x\{|0.1|, |0.1 \} + \max\{|0.2|, |-0.5 \} + \max \\
 &\{|0.1|, |0.2 \} \} \\
 &= \frac{1}{5} [\max\{0.4, 0.2 \} + \max\{0.5, 0.4\} + \max\{0.1, 0.1\} \\
 &+ \max\{0.2, 0.5\} + \max\{0.1, 0.2 \} \} \\
 &= \frac{1}{5} [\{0.4 \} + \{0.5\} + \{0.1\} + \{0.5\} + \{0.2\}] \\
 &= \frac{1}{5} [1.7] \\
 &= 0.34
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{d}(\mathbf{Vf}, \mathbf{Vridhin}) &= \frac{1}{n} \sum_{i=1}^l \max\{|\mu_A(x_i) - \\
 &\mu_B(x_i)|, |v_A(x_i) - v_B(x_i)| \} \\
 &= \frac{1}{5} \max\{[|\mu_A(x_1) - \mu_B(x_1)|, |v_A(x_1) - \\
 &v_B(x_1)|] + [|\mu_A(x_2) - \mu_B(x_2)|, |v_A(x_2) - \\
 &v_B(x_2)|] + [|\mu_A(x_3) - \mu_B(x_3)|, |v_A(x_3) - \\
 &v_B(x_3)|] + [|\mu_A(x_4) - \mu_B(x_4)|, |v_A(x_4) - \\
 &v_B(x_4)|], [|\mu_A(x_5) - \mu_B(x_5)|, |v_A(x_5) - \\
 &v_B(x_5)|] \} \\
 &= \frac{1}{5} [\max\{|0.4 - 0.6|, |0.0 - \\
 &0.1 \} + \max\{|0.3 - 0.5|, |0.5 - \\
 &0.4 \} + \max\{|0.1 - 0.3|, |0.7 - \\
 &0.4 \} + \max\{|0.4 - 0.7|, |0.3 - \\
 &0.2 \} + \max\{|0.1 - 0.3|, |0.7 - 0.4 \} \} \\
 &= \frac{1}{5} [\max\{|-0.2|, |- \\
 &0.1 \} + \max\{|-0.2|, |0.1 \} + \max\{|-0.2|, |0.3 \} + \max \\
 &|-0.3|, |0.1 \} + \max\{|-0.2|, \\
 &|0.3 \} \} \\
 &= \frac{1}{5} [\max\{0.2, 0.1 \} + \max\{0.2, 0.1\} + \max\{0.2, 0.3 \\
 &\} + \max\{0.3, 0.1\} + \max\{0.2, 0.3\}] \\
 &= \frac{1}{5} [\{0.2 \} + \{0.2\} + \{0.3\} + \{0.3\} + \{0.3\}] \\
 &= \frac{1}{5} [1.3] \\
 &= 0.26
 \end{aligned}$$

Similarly, we calculate the distance for each diseases with the patients. We get the result as follows,

$$\begin{aligned}
 \mathbf{d}(\mathbf{Malaria}, \mathbf{Sesha}) &= 0.22 \\
 \mathbf{d}(\mathbf{Malaria}, \mathbf{Divya}) &= 0.5 \\
 \mathbf{d}(\mathbf{Malaria}, \mathbf{Malik}) &= 0.4 \\
 \mathbf{d}(\mathbf{Malaria}, \mathbf{Vridhin}) &= 0.3
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{d}(\mathbf{Typhoid}, \mathbf{Divya}) &= 0.3 \\
 \mathbf{d}(\mathbf{Typhoid}, \mathbf{Malik}) &= 0.28 \\
 \mathbf{d}(\mathbf{Typhoid}, \mathbf{Vridhin}) &= 0.34 \\
 \mathbf{d}(\mathbf{Stomach\ pain}, \mathbf{Sesha}) &= 0.52 \\
 \mathbf{d}(\mathbf{Stomach\ pain}, \mathbf{Divya}) &= 0.14 \\
 \mathbf{d}(\mathbf{Stomach\ pain}, \mathbf{Malik}) &= 0.46 \\
 \mathbf{d}(\mathbf{Stomach\ pain}, \mathbf{Vridhin}) &= 0.44 \\
 \mathbf{d}(\mathbf{Chest\ pain}, \mathbf{Sesha}) &= 0.56 \\
 \mathbf{d}(\mathbf{Chest\ pain}, \mathbf{Divya}) &= 0.4 \\
 \mathbf{d}(\mathbf{Chest\ pain}, \mathbf{Malik}) &= 0.5 \\
 \mathbf{d}(\mathbf{Chest\ pain}, \mathbf{Vridhin}) &= 0.52
 \end{aligned}$$

The following details can be given in terms of matrix as follows:

	<i>Vf</i>	<i>Ml</i>	<i>Ty</i>	<i>Sp</i>	<i>Cp</i>
<i>Sesha</i>	0.24	0.22	0.28	0.52	0.56
<i>Divya</i>	0.4	0.5	0.3	0.14	0.4
<i>Malik</i>	0.34	0.4	0.28	0.46	0.5
<i>Vridhin</i>	0.26	0.3	0.34	0.44	0.52

As the distance between Sesha with **Malaria** is the least, it means Sesha has high possibility of being affected by Malaria.

As the distance between Divya with **Stomach pain** is the least, it means Divya has high possibility of being affected by Malaria.

As the distance between Malik with **Typhoid** is the least, it means Malik has high possibility of being affected by Malaria.

As the distance between Vridhin with **Viral fever** is less, it means Vridhin has high possibility of being affected by Malaria.

4.2.1 Evaluation of current findings in relation to our suggested new distance metric Findings from "An application of intuitionistic fuzzy sets in medical diagnosis" by S.K. De, R. Biswas, and A.R. Roy, Fuzzy Sets Syst., vol. 117, pp. 209-213, 2013

Patient	Diagnosed disease
Sesha	Malaria
Divya	Stomach pain
Malik	Malaria
Vridhin	Malaria

Table 4.2.3

Results proposed by, E. Szmidt, and J. Kacprzyk, "Distances between intuitionistic fuzzy sets",

Patient	Diagnosed disease
Sesha	Malaria
Divya	Stomach pain
Malik	Typhoid
Vridhin	Viral fever

Table 4.2.4

Findings from the study "A similarity measure for intuitionistic fuzzy sets and its application in supporting medical diagnostic reasoning" by E. Szmidt and J. Kacprzyk

Patient	Diagnosed disease
Sesha	Viral fever
Divya	Stomach pain
Malik	Typhoid
Vridhin	Malaria

Table 4.2.5

Results proposed by, S. Maheshwari, and A. Srivastava, "Study on divergence measures for intuitionistic fuzzy sets and its application in medical diagnosis",

Patient	Diagnosed disease
Sesha	Malaria
Divya	Stomach pain
Malik	Typhoid
Vridhin	Viral fever

Table 4.2.6

Results proposed by, R.T. Ngana, L.H. Sonb, B.C. Cuongc, and M. Alid, "H-max distance measure of intuitionistic fuzzy sets in decision making",

Patient	Diagnosed disease
Sesha	Malaria
Divya	Stomach pain
Malik	Typhoid
Vridhin	Viral fever

Table 4.2.7

Conclusion

This paper's goal of creating a novel distance metric for intuitionistic fuzzy sets is accomplished. Using the suggested distance metric in the medical diagnosis problem has demonstrated its uniqueness and effectiveness. The outcome that is assessed with the new distance metric aligns with the previous advanced methods. This demonstrates the validity and dependability of the suggested distance measurements.

Patients	Diagnosed disease		By novel distance measure		By Hausdroff distance measure		
Sesha	Malaria	Malaria	Viral fever	Viral fever	Malaria	Malaria	Malaria
Divya	Stomach pain	Stomach pain	Stomach pain	Stomach pain	Stomach pain	Stomach pain	Stomach pain
Malik	Malaria	Typhoid	Typhoid	Typhoid	Typhoid	Typhoid	Typhoid
Vridhin	Malaria	Viral fever	Malaria	Viral fever	Typhoid	Viral fever	Viral fever

Table 4.2.8 Combining all these in single table

Future research should expand the suggested distance measure in a broader sense and apply it to the creation of fuzzy medical diagnosis decision-making difficulties.

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