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Similarity Measure between Picture Fuzzy Sets and its applications in Medical Diagnosis

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Abstract - Fuzzy sets with intuitionistic properties are more advanced record of the traditional fuzzy sets, which is frequently used in a variety of applications to deal with uncertainty and fuzzy situations. The degree of neutrality, which is typically taken into account in medical diagnosis, is one of the crucial and essential components that is not taken into account in IFS. We proposed new similarity measure in this research that may contrast picture Fuzzy Sets(PFSs).The proposed similarity measure on PFSs have been used to attempt medical diagnosis in this research. It has been discovered that similarity measures enable the introduction of weights for all symptoms, allowing the patient to be diagnosed directly.

Keywords - Fuzzy sets, Intuitionistic fuzzy sets, Picture Fuzzy Sets, Medical diagnosis, Similarity Measures.

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INTRODUCTION

Zadeh (1965) was the first to establish the idea of a fuzzy set. The fuzzy set can express the state between "belong to" and "not belong to" by assigning a membership degree between 0 and 1 to items with respect to a set. As a result, fuzzy sets can be used to explain a large number of uncertainties that aren't adequately represented by classical sets. Since its inception, fuzzy set hypothesis has been employed in various applications, counting automatic control, pattern recognition, and decision-making. The hypothesis of fuzzy sets has been found to be unsatisfactory in many actual circumstances. As a result, numerous higher theories have arisen over time, such as intuitionistic fuzzy sets (IFS), Pythagorean fuzzy sets, q-rung fuzzy sets given by Lin (2020) and so on. Intuitionistic fuzzy sets Atanassov(1986) is a higher hypothesis that is a notion of fuzzy sets that ask specialists to provide non-membership opinions on set elements. As a result, IFSs are frequently employed in pattern recognition applications suggested by Du and Hu (2015). The tools that are frequently employed in those application challenges are similarity and distance measures. These two ideas are complimentary in the sense that by subtracting one from a unit, one can be derived from the other. Similarity measure can be used to solve issues in a range of contexts, like decision making, machine learning, and pattern detection suggested by Wei (2017, 2018). Despite the fact that IFSs are superior to FSs at conveying cloudy and unclear data, they shortage a crucial notion, namely degree of neutrality, which is relevant in a variety of circumstances such includes human voting, medical diagnosis, and personal selection, to name a few examples. When it comes to general election, a person has four choices: poll in favor, poll against, abstain from polling, or refuse to poll. In medical diagnostics, symptoms such as fever and headache may have little influence on disorders such as chest pain and stomach pain.

Cuong and Kreinovich(2013) created PFS, a novel generalization of FSs and IFSs, to cope with such circumstances. The degree of membership, non-membership, and neutrality for every individual member in a PFS is defined, as well as the requirement that a total of these grades that is less than or equal to one. We'll also show some examples of how our measure compares to Wei (2017b, 2018)'s similarity measures.

The concept of IFS was added to Sanchez's method of medical diagnosis after De et al. (2001) investigated it. Using the distance measures, they suggested, Szmidt and Kacprzyk (2001) investigated medical diagnosis. Own (2009) investigated the benefits of type-2 fuzzy and the relationship within type-2 fuzzy sets and axiomatically defined IFSs. The application of changing outcomes in medical diagnosis is the last.

This paper's key contribution is:

1. New similarity measures have been proposed that can be used to compare

PFSs.

2. We've also shown its properties in order to confirm that the recommended measures are present.

3. To show medical diagnosis, some numerical examples are provided.

PRELIMINARIES

Definition 1:

Let $M = (c_y: y = 1,2,\dots,n)$ be the Universal set.

For $c_y \in M$, Zadeh (1965) introduced fuzzy set as:

$$L = \{(c_y, \delta_L(c_y)) : c_y \in M, y = 1,2,\dots,n\}$$

Where $\delta_L(c_y)$ stands for membership degree of $c_y \in M$ in the set L such that

$0 \le \delta_L(c_y) \le 1$

Definition 2:

For $c_y \in M$, Atanassov (1986) introduced intuitionistic fuzzy set as:

$$L = \{(c_y, \delta_L(c_y), \vartheta_L(c_y)) : c_y \in M, y = 1,2,\dots,n\}$$

Where $\delta_L(c_y)$ stands for membership degree and $\vartheta_L(c_y)$ stands for non-membership degree of $c_y \in M$ in the set L such that $0 \le \delta_L(c_y)+\vartheta_L(c_y) \le 1$

Definition 3:

For $c_y \in M$, Cuong (2013) introduced picture fuzzy set as:

$$L = \{(c_y, \delta_L(c_y), \theta_L(c_y), \vartheta_L(c_y)) : c_y \in M\},$$
$$y = 1,2,..,n$$

where $\delta_L(c_y)$ stands for membership degree, $\vartheta_L(c_y)$ stands for non-membership degree and $\theta_L(c_y)$ stands for neutral degree of $c_y \in M$ in the set L such that

$$0 \le \delta_L(c_y)+\vartheta_L(c_y)+\theta_L(c_y) \le 1$$

Theorem: Atanassov (1986) If a function $S: PFS(M) \times PFS(M) \to R$ satisfies the following properties, then it is a similarity measure on PFS(M):

(1) $0 \le S(L, D) \le 1$

(2) $S(L, D) = S(D, L)$

(3) $S(L, D) = 1$; if A=B

(4) if $L \subseteq D \subseteq V$,then $S(L, D) \ge S(L, V)$ and $S(D, V) \ge S(L, V)$

PROPOSED MEASURE

$$S_Z(L,D) = 1 - \frac{1}{n}\sum_{y=1}^{n}\left(|\,\delta_L(c_y) - \delta_D(c_y)\,| + |\,\vartheta_L(c_y) - \vartheta_D(c_y)\,| + |\,\theta_L(c_y) - \theta_D(c_y)\,|\right)$$

MEDICAL DIAGNOSIS

Let M = {Raju, Rajni, Rani, Roy} represent the set of four patients, K show their symptoms, where K = {temperature, fever, foot Pain, headache, hand pain}, and Q represent the diagnosis, where Q = {Diabetes, Anxiety, Lupus, Depression, Yeast infection} PFNs M → K → Q are represented in table by the relation K. Calculate the distance between patient and diseases using proposed similarity measure. The patient is likely to have the disease if there is a close proximity between the patient and the disease.

	Temperature	Fever	Foot pain	Headache	Hand pain
Raju	(0.1,0.2,0.3)	(0.4,0.1,0.2)	(0.0,0.2,0.3)	(0.3,0.1,0.2)	(0.1,0.2,0.2)
Rajni	(0.1,0.2,0.7)	(0.2,0.1,0.6)	(0.6,0.1,0.1)	(0.3,0.2,0.1)	(0.2,0.3,0.4)
Rani	(0.9,0.1,0.0)	(0.2,0.3,0.4)	(0.8,0.2,0.0)	(0.1,0.2,0.2)	(0.2,0.1,0.6)
Roy	(0.5,0.3,0.1)	(0.1,0.3,0.2)	(0.2,0.8,0.1)	(0.4,0.2,0.1)	(0.1,0.2,0.7)

	Diabetes	Anxiety	Lupus	Depression	Yeast infection
temperature	(0.0,0.3,0.3)	(0.3,0.1,0.0)	(0.1,0.2,0.3)	(0.2,0.1,0.2)	(0.4,0.2,0.2)
Fever	(0.1,0.2,0.7)	(0.3,0.1,0.5)	(0.5,0.1,0.1)	(0.3,0.0,0.1)	(0.2,0.3,0.1)
Foot pain	(0.8,0.1,0.0)	(0.2,0.3,0.4)	(0.8,0.2,0.0)	(0.1,0.2,0.2)	(0.2,0.1,0.6)
Headache	(0.4,0.3,0.1)	(0.1,0.2,0.3)	(0.2,0.7,0.1)	(0.3,0.2,0.1)	(0.1,0.2,0.6)
Hand pain	(0.5,0.2,0.1)	(0.1,0.3,0.0)	(0.2,0.7,0.1)	(0.2,0.2,0.1)	(0.1,0.2,0.6)
Raju	0.3600	0.5800	0.4400	0.7600	0.4800
Rajni	0.5800	0.4000	0.4200	0.5000	0.3000
Rani	0.3200	0.5200	0.2400	0.3200	0.4000
Roy	0.2400	0.3400	0.0800	0.4400	0.4800

From the last table we have concluded that raju is afflicted with diabetes, rajni is afflicted with yeast infection, rani is afflicted with lupus and roy is afflicted with lupus.

CONCLUSION

Using the suggested similarity measures on PFSs, this piece of work illustrates how to go about medical decision-making. First noted in medical diagnostics is the idea of distance measures on PFSs to resolve uncertainty. In order to properly complete medical decision-making, this article offers a critical

algorithm. This paper's main contribution is the creation of a distance-based medical decision-making system for PFSs. The ability of PFS to adequately deal with inaccuracy, ambiguity and ambiguity while incorporating the idea of neutrality to some extent is the main justification for the choice. It helps medical professionals diagnose patients more effectively by giving them assistance.

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