2456-8686, vii(ii), 2023: 031-036
https://doi.org/10.26524/cm173

ORIGINAL RESEARCH **Open Access**

The Study of Plithogenic Intuitionistic fuzzy sets and its implementation in Insurance Sector

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Received: 29 August 2023/ Accepted: 01 September 2023/ Published online: 16 December 2023

Abstract

The core objective of the course is to gain knowledge of the basic concepts of Plithogenic intuitionistic fuzzy sets(PIFS) for single valued which deals with the components characterized by the features with many trait values. The accumulation operatives such as intersection, union, complement, inclusion of PIFS were introduced. Moreover, an application of PIFS in the field of Insurance is provided to validate the benefit of the optimization technique.

Key Words: Plithogenic Set, Intuitionistic fuzzy set, Plithogenic intuitionistic fuzzy set(PIFS), PIFS Operators, Insurance.

AMS Classification: 54A40, 03E72.

1 Introduction

In 1965, Zadeh [13] proposed the theory of fuzzy set (FS), which laid the groundwork for the development of fuzzy arithmetic. Many fields of mathematics use this notion, including inference, decision theory, computational mathematics, theory of fuzzy sets, real computation, measuring theories, and topologies.

In fuzzy set theory, a parameter belonging in a fuzzy set is associated with a single value lies between zero and one. Even so, as there may be some linguistic grade, it is not always true that the grade of non-belonging of a parameter in a fuzzy set is equal to one minus the belonging grade. As a result, Atanassov [1] postulated a generalisation of fuzzy sets as intuitionistic fuzzy sets (IFS), which integrate the grade of uncertainty known as the uncertainty boundary (which is

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defined as 1 minus the sum of belonging and non- belonging grades, correspondingly). The idea of establishing IFS as generalised FS is intriguing and beneficial in a wide range of application sectors.

Plithogeny is the edifice, formation, extension and establishment of innovative literatures from the conjunction of sustained or unsustainable numerous distinct articles. In 2017, Smarandache [8, 9, 10] envisioned the plithogenic set (PS) as a generality of neutrosophy.

The constituents of PS are represented by single or multiple characteristics, that each have numerous parameters. Each trait value will have its own (fuzzy, intuitionistic fuzzy or neutrosophic) appurtenance grade for the component x (say) to the plithogenic set P (say) with reference to certain restriction. Smarandache[8,9] introduced the inconsistency grade between each value of traits and the paradox value of traits for the first time, resulting in improved exactness for the Plithogenic accumulation operatives (fuzzy, intuitionistic fuzzy or neutrosophic).

An individual's life and asset are confronted by the risk of mortality, physical illness, or ruination. These perils can result in financial losses. Insurance is a proactive way of transferring such uncertainties to an Insurance company.In this article we study how the introduced PIFS operators helps in the Insurance sector to analyze the categories of insurance prevalently opted by the society.

2 Preliminary Concepts

The preliminary ideas and explanations of Plithogenic sets and their operatives have been made referred in [8,9,10] which aids in the successful completion of our research work.

3 Accumulation Operatives of PIFS single valued Numbers

The trait is $\Im$ = “appurtenance”

The collection of trait values I= {belonging, non-belonging}, whose cardinality is |I| = 2;

The paradox grade = belonging;

The trait values appurtenance grade function:

$$d : P * I \to [0,1], \quad \begin{array}{l} d(a, belonging) \in [0,1], d(a, non\ belonging) \in [0,1], \\ with\ d(a, belonging) + d(a, non\ belonging) \leq 1, \end{array}$$

and the values of inconsistent grade function:

$C : I * I \rightarrow [0,1],$

$C(belonging\ , belonging\ ) = C(non\,belonging\ \ , non belonging\ ) = 0,$

$C(belonging\ , non\,belonging) = 1$

This implies that if one imposes the τ_{norm} on belonging function on the PIFS single valued accumulation operatives (Intersection, Union, Complement, etc.), one has to utilise the τ_{conorm} on non-belonging function (and mutually).

PIFS Single valued operators 3.1

Consider the Plithogenic Intuitionistic single valued grade of appurtenance of values of trait u to the set P using the following criteria: $d^n{}_\alpha(u) = (\alpha_1, \alpha_2) \in [0,1]^2$ *and* $d^n{}_\beta(u) = (\beta_1, \beta_2) \in [0,1]^2$

PIFS Intersection 3.1.1

$$(\alpha_1, \alpha_2) \wedge_P (\beta_1, \beta_2) = (\alpha_1 \wedge_P \beta_1, \alpha_2 \vee_P \beta_2)$$

PIFS Union 3.1.2

$$(\alpha_1, \alpha_2) \vee_P (\beta_1, \beta_2) = (\alpha_1 \vee_P \beta_1, \alpha_2 \wedge_P \beta_2)$$

PIFS Complement 3.1.3

$$\neg_P(\alpha_1, \alpha_2) = (\alpha_2, \alpha_1)$$

PIFS Inclusions (Partial orders) 3.1.4

(i) Simple Intuitionistic Fuzzy Inclusion

$$(\alpha_1, \alpha_2) \leq_{IF} (\beta_1, \beta_2)\ iff\ \alpha_1 \leq \beta_1\ \ and\ \alpha_2 \geq \beta_2.$$

(ii) Complete Intuitionistic Fuzzy Inclusion

$$(\alpha_1, \alpha_2) \leq_P (\beta_1, \beta_2)\ if\ \alpha_1 \leq (1-C)\beta_{1,}, \alpha_2 \geq (1-C)\beta_2$$

Where $C \in [0, 0.5)$ which is the inconsistent grade function between the paradox trait grade and the trait value. If C does not prevail we will take it as zero by default.

4 Using PIFS Operators, a Method for Finding the Optimal Solution is Proposed

Stage 1: Categorize the scenario with the traits and itsrespective trait values.

Stage 2: Find the inconsistent grade according to the Researcher A and B PIFS grades.

Stage 3: Compute the PIFS optimum solution using Intersection operator.

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Note: The intersection operator was used. However, the reader is free to work with other operators as well.

5 Application

Consider the primary trait "types of insurance opted by the society" which has the trait values

Life Insurance- whose refined values are-term life and whole life which is represented by $\{g_1, g_2\}$

Health Insurance - whose refined values are-Indemnity Plan and Definite benefit plan which is symbolized by $\{t_1, t_2\}$

Disability Insurance- whose refined values are- Long term disability and Short term disability which is denoted by $\{h_1, h_2\}$

Home owners Insurance- whose refined values are- Dwelling, Contents and Personal liability which is signified by $\{r_1, r_2, r_3\}$

The multi trait of dimension 4 is,

$$R_4 = \{(g_i, t_j, h_k, r_l), \; for\, all \; 1 \le i \le 2, 1 \le j \le 2, 1 \le k \le 2, 1 \le l \le 3\}$$

The Paradox trait values are g_2, t_2, h_1, r_3 correspondingly for each single dimensional trait.

The uni- dimensional trait inconsistent grades are:

$$C(g_1, g_2) = \frac{1}{2}, \;\; C(t_1, t_2) = \frac{1}{2}, C(t_1, t_3) = 1$$

$$C(h_1, h_2) = \frac{1}{2} \, and \, C(l_1, l_2) = \frac{1}{2}, C(l_1, l_3) = 1.$$

Let's make utilise $fuzzy \tau_{norm} = a \wedge_F b = ab$ & $fuzzy \, \tau_{conorm} = a \vee_F b = a + b - ab$.

Four-dimensional PIFS Intersection

Let $x_A = \{d_A(x, g_i, t_j, h_k, r_l) \; for\, all \; 1 \le i \le 2, 1 \le j \le 2, 1 \le k \le 2, 1 \le l \le 3\}$

and $x_B = \{d_B(x, g_i, t_j, h_k, r_l) \; for\, all \; 1 \le i \le 2, 1 \le j \le 2, 1 \le k \le 2, 1 \le l \le 3\}$

Then

$x_A(g_i,t_j,h_k,r_l)\wedge_p x_B(g_i,t_j,h_k,r_l)=$
$\{C(g_D,g_i)*[d_A(x,g_D)\vee_f d_B(x,g_i)+(1-C(g_D,g_i))*[d_A(x,g_D)\wedge_f d_B(x,g_i)]1\le i\le 2;$
$C(t_D,t_j)*[d_A(x,t_D)\vee_f d_B(x,t_j)+(1-C(t_D,t_j))*[d_A(x,t_D)\wedge_f d_B(x,t_j)]1\le j\le 2;$
$C(h_D,h_k)*[d_A(x,h_D)\vee_f d_B(x,h_k)+(1-C(h_D,h_k))*[d_A(x,h_D)\wedge_f d_B(x,h_k)]1\le k\le 2;$
$C(r_D,r_l)*[d_A(x,r_D)\vee_f d_B(x,r_l)+(1-C(r_D,r_l))*[d_A(x,r_D)\wedge_f d_B(x,r_l)]1\le l\le 3\}.$

Trait	Life Insurance		Health Insurance		Disability Insurance		Home owners Insurance		
values of Trait	Term life	Whole life	Indemnity Plans	Definite Benefit plan	Short term disability	Long term disability	Dwelling	Contents	Personal liability
Inconsistent grade	0.5	1	0	1	0.5	1	0	0.5	1
Agent A PIFS grade	(0.1, 0.5)	(0.8,0 .2)	(0.3, 0.4)	(0.7,0.2)	(0.1, 0.5)	(0.8, 0.3)	(0.5, 0.5)	(0.6,0.5)	(0.9, 0.1)
Agent B PIFS grade	(0.2, 0.4)	(0.7, 0.4)	(0.4, 0.7)	(0.2,0.8)	(0.3, 0.5)	(0.6, 0.1)	(0.8, 0.2)	(0.1, 0.7)	(0.5, 0.5)
$x_A \wedge_p x_B$	(0.5,0.4)	(0.8,0.2)	(0.4,0.6)	(0.7,0.1)	(0.4,0.2)	(0.5,0.4)	(0.8,0.2)	(0.3,0.1)	(0.7,0.3)

Table 1: According to Insurance agent (A & B) PIFS grades the above table represents the Optimum solution

6 Conclusion & Future work

According to the Insurance agent's (A& B) Intuitionistic fuzzy grades most of the people opted for Whole life, Definite, Long term, Dwelling insurances. We can apply this concept to major areas that deals with many trait values. In the near future we can broaden the idea further to interval valued in order to evaluate the better accurateness.

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