Dark data analysis using Intuitionistic Plithogenic graphs

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Dark data analysis using Intuitionistic Plithogenic graphs

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Abstract:

The precise analysis of uncertainty in given data sets and its mathematical representation is considered as one of the major issues at current time. The problem become more complex when the data sets contains several mutliattributes and its non-opposite sides. One of the suitable examples is cricket or sports data sets which create conflict among the experts in case of multi-decision process. The problem arises when the expert want to chategorize the performance of players based on its acceptation and rejection regions considering the contradiction. To deal with these types of data which contains human intuition in true and false regions intuitionistic Plithogenic set and its graphical visualization is introduced in this paper with an illustrative examples.

Keywords: Graph Analytics; Intuitionistic fuzzy set; Knowledge representation; Plithogenic set; Plithogenic graph; Turiyam Set.

1. INTRODUCTION

Recently, attention has been paid towards for characterization of dark data sets in positive and negative regions [1] to approximate the uncertainty [2]. In this case the problem arises while representation of dark data sets due to its multiattribute genericity [3]. Another reasons is these types of data contains several opposite, non-opposite or indeterminant sides which may contain contradiction among two experts in case of adequate representation. Hence

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the properties of Plithogenic set is introduced for precise representation of these types of multi-attributes with contradiction [3-4]. Recently, several applications of Plithogenic set is discussed in various fields as given below:

(i) Cricket data set [5],

(ii) Business analytics [6],

(iii) Construction field [7],

(iv) Pollution control[8],

(v) Doctor prescription [9] and other fields[10],

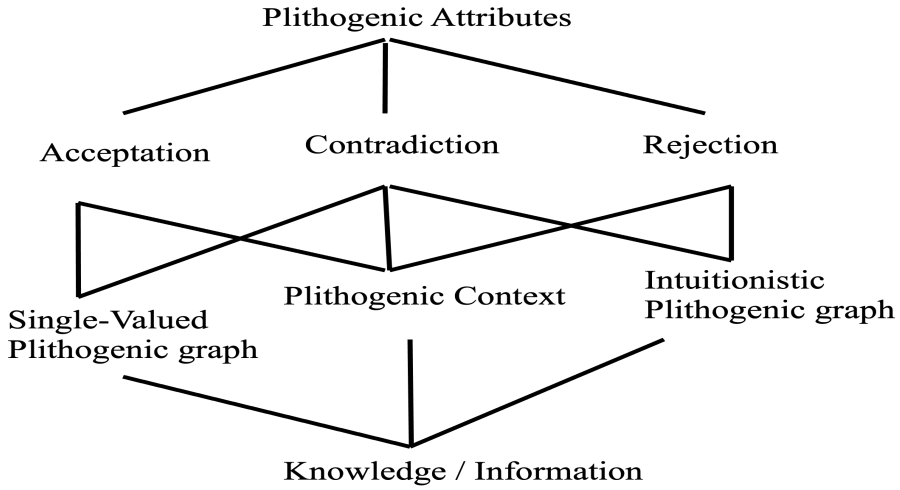

Figure 1: The motivation for Intuitionistic Plithogenic graph

It can be observed that Plithogenic set has received much attention by researchers of several fields [5-8] for various applications [9-10]. One of the problems is addressed while dealing with refusal degree in single-valued Plithogenic attribute [11]. To deal with it intuitionistic fuzzy set is considered as one of the potential method [12-13]. It is recently connected with Plithogenic set [14-15] and its graphical visualization [16] for approximating the uncertainty [17-18]. In this process following problems were addressed:

(i) How to represent data with Intuitionistic Plithogenic attributes in the given context,

(ii) How to compute union, intersection and complement among Intuitionistic Plithogenic attributes,

(iii) How to visualize the obtained computation in the Intuitionistic Plithogenic graph for multi-decision process.

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This paper focused on solving the above mentioned problems with an illustrative example. The motivation is to represent the acceptation, rejection as well as contradiction arises in Plithogenic attributes more precisely as demonstrated in Figure 1. The objective is to find some useful pattern from the data with intuitionistic Plithogenic attributes. To achieve this goal, the current paper put forward effort to explore the intuitionistic Plithogenic set and its graphical visualization.

Remaining part of the paper is organized as follows: Section 2 provides preliminaries about Plithogenic set. Section 3 includes the proposed method for dealing with data of Intuitionistic Plithogenic attribute with its illustration in Section 4. Section 5 includes conclusions followed by the references.

2. DATA WITH PLITHOGENIC ATTRIBUTE

This section provides preliminaries about Plithogenic set and its examples for understanding of intuitionistic Plithogenic set:

Definition 1. Plithogenic Set [3-4]: This set contains five parts to represents the multi-valued attributes of the given data sets. Let us suppose, ξ be a universe of discourse, P be a subset of this universe of discourse, "a" a multi-valued attribute, V is the range of the multi-valued attribute, "d" be the known (fuzzy, intuitionistic fuzzy, or neutrosophic) degree of appurtenance with regard to some generic of element x's attribute value to the set P, and c is the (fuzzy, intuitionistic fuzzy, neutrosophic) degree of contradiction (dissimilarity) among the attribute values as (<A, Neutral A, Anti A>; <B, Neutral B, Anti B>; <C, Neutral C, Anti C>). It can be represented as a set (P, a, V, d, c) which named as a Plithogenic Set (**P**). The Plithogenic set is a set **P** (P, a, V, d, c) in which each element $x \in P$ is characterized by all attribute's (a) values in $V = \{v_1, v_2, \ldots, v_n\}$, for $n \geq 1$ for the degree of appurtenance (d). The contradiction degree function (c) distinct the Plithogenic set which defined as follows:

(i) $c: V \times V \rightarrow [0, 1]$ represents the contradiction degree function among v_1 and v_2.

It used be noted as $c(v_1, v_2)$, and satisfies the following axioms:

(ii) $c(v_1, v_1) = 0$ *i.e.* the contradiction among v_1 and $v_2$is zero.

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(iii) $c(v_1, v_2) = c(v_2, v_1)$, the contradiction among v_1 and v_2 or v_2 and v_1 used to be considered as per the commutative property. In this paper, author focuses on single-valued fuzzy membership to handle the Plithogenic set.

Example 1: Let us suppose, an experts or commentator (y_1) given an opinion towards the player (x_1). The expert (y_1) agreed that player (x_1) is 60 percent suitable Test match, 20 percent suitable for one day match with $\frac{1}{3}$ contradiction, 70 percent suitable for T20 match with $\frac{2}{3}$ due to his/her ball faced at 80 percent matches and 50 percent strike rate with $\frac{1}{2}$ contradiction. It can be represented using Plithogenic context as shown in Table 1 [5].

Table 1: The expert (y_1) opinion towards a player (x_1)

Contradiction degree	0	$\frac{1}{3}$	$\frac{2}{3}$		0	$\frac{1}{2}$
Multi-attributes	Test Player	One day player	T20 Player		*Ball Faced*	*Strike Rate*
Fuzzy degree	0.6	0.2	0.7		0.8	0.5

Definition 2: Intuitionistic Fuzzy Set [12-13]: The intuitionistic fuzzy set is a generalization of fuzzy set. It represents the acceptation, rejection part of any attributes simultaneously. The intuitionistic fuzzy set A can be defined by $A = \{x, \mu_X(x), \nu_X(x)/x \in X\}$ where$\mu_A(x): E \to [0,1], \nu_A(x): E \to [0,1]$ for each $x \in E$ such that$0 \leq \mu_A(x) + \nu_A(x) \leq 1$. Here $\mu_A(x): E \to [0,1]$denote degrees of membership and$\nu_A(x): E \to [0,1]$denotes non-membership of $x \in A$, respectively.

It can be observed that, the numerical representation of Plithogenic data sets is complex tasks for knowledge processing. In case an expert wants to extract some useful information then difficult analysis it. To accomplish this

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task, recently single-valued Plithogenic graph with its applications is studied [17]. This paper tried to introduce Intuitionistic Plithogenic graph for multi-decision process motivated from [14-17]. To achieve this goal, Intuitionistic Plithogenic context and its graphical visualization is introduced in the next section.

3. PROPOSED METHOD

In this section, a method is proposed for dealing with data of Intuitionistic Plithogenic attributes and its graphical visualization for knowledge processing tasks as given below:

Step 1. Let us suppose any data set having Intuitionistic Plithogenic attributes as(P, a, V, d, c), where P is a Plithogenic set, a is the set of multi-valued attributes, V *is* the defined range of the multi-valued attributes, d is the intuitionistic degree of appurtenance and c is the single-valued degree of contradiction.

Step 2. Try to compute the union, intersection and complement among the Plithogenic attribute as follows:

(i) Union of single-valued Plithogenic set as

$$d_{p_1}(a_p, v_p) \vee d_{p_2}(a_p, v_p) = (1 - c_{\,p}) \times (d_{p_1}(a_p, v_p) \vee_f d_{p_2}(a_p, v_p)) + c_{\,p}(d_{p_1}(a_p, v_p) \wedge_f d_{p_2}(a_p, v_p))$$

(ii) Intersection of single-valued Plithogenic set as

$$d_{p_1}(a_p, v_p) \wedge d_{p_2}(a_p, v_p) = (1 - c_{\,p}) \times (d_{p_1}(a_p, v_p) \wedge_f d_{p_2}(a_p, v_p)) + c_{\,p}(d_{p_1}(a_p, v_p) \vee_f d_{p_2}(a_p, v_p))$$

(iii) Complement can be computed as follows:

$(d_p(a_p, v_p))' = (1 - c_{\,p}) \times d_p(a_p, v_p)$where dp represents degree of appurtenance, c_p represents contradiction degrees for the multi-valued attributes a_p.

Step 3. Compute the supremum and infimum among Intuitionistic Plithogenic sets based on its intuitionistic degree of appurtenance and help of Step 2 as: $V_1 = \left\{v_1, \mu_{v_1}(x), \nu_{\,v_1}(x)/x \in X\right\}$ and $V_2 = \left\{v_2, \mu_{v_2}(x), \nu_{\,v_2}(x)/x \in X\right\}$he union and intersection can be computed as follows:

$$(i).\ V_1 \vee_p V_2 = \left(\mu_{v_1} \vee_p \mu_{v_2}, \nu_{\,v_1} \wedge_p \nu_{\,v2}\right)$$
$$(ii).\ V_1 \wedge_p V_2 = \left(\mu_{v_1} \wedge_p \mu_{v_2}, \nu_{\,v_1} \vee_p \nu_{\,v2}\right)$$

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Otherwise the relation can be as follows: $d_{p_1}(a_p, v_p) \wedge d_{p_2}(a_p, v_p) \geq (1 - c_{\ p}) \times (d_{p_1}(a_p, v_p) \wedge_f d_{p_2}(a_p, v_p)) + c_{\ p}(d_{p_1}(a_p, v_p) \vee_f d_{p_2}(a_p, v_p))$

Step 4. Try to represent the computed degree of appurtenance in a defined Plithogenic graph $G=\{V_p, E_p, a_{\ p}, (\mu_{d_p}, \nu_{d_p}), c_p\}$ can be called as intuitionistic Plithogenic graph where (*Vp*)represents Intuitionistic Plithogenic attributes as vertex, (*Ep*) represents the intuitionistic Plithogenic set based edges, ($a_{p)}$ represents the multi-valued i.e. one or more attributes of distinct values. The intuitionistic degree of appurtenance (*dp*) says that at what level the given multi-valued attributes belongs to the set or does not belongs to the set. The (c_p) represents the contradiction degrees as single-valued fuzzy membership.

Step 5. The vertex can be represented as the Intuitionistic Plithogenic set as: $\frac{\{a_p,(\mu_{d_p},\nu_{d_p}),c_p\}}{V_p}$where ($a_p$)represents multi-valued attributes defines the Intuitionistic Plithogenic vertex(*Vp*). The degree of appurtenance (*dp*) represents the belongingness and non-belongingness of multi-valued attributes via intuitionistic Plithogenic set. The contradiction degree is represented using single-valued fuzzy membership as (c_p).

Step 6. The relationship among vertex can be represented as Intuitionistic Plithogenic set of edges as: $\frac{\{a_{pq},(\mu_{d_{pq}},\nu_{d_{pq}}),c_{pq}\}}{E_{pq}(V_pV_q)}$where $(a_{\ pq})$ represents one or more attributes which defines the Intuitionistic Plithogenic edges (E_{pq}). The degree of appurtenance $(d_{\ pq})$ represents the belongingness and non-belongingness of multi-valued edges with its single-valued contradiction degrees $(c_{\ pq})$ for the given edge.

Step 7. The contradiction among v_1 and v_2 (or v_2 and v_1) satisfies commutativity properties $c(v_1, v_2) = c(v_2, v_1)$. It means the Intuitionistic Plithogenic set based edges (E_{pq}) and (E_{qp}) represents same.

Step 8. The contradiction degrees $c(v_1, v_1) = 0$ due to which the edges can be edges can be represented as($E_{pq} \subseteq V_p \times V_q - V_p \times V_p - V_q \times V_q$).

Step 9. Now the data with Intuitionistic Plithogenic attributes considered at Step 1 can be visualized as shown in Figure 2.

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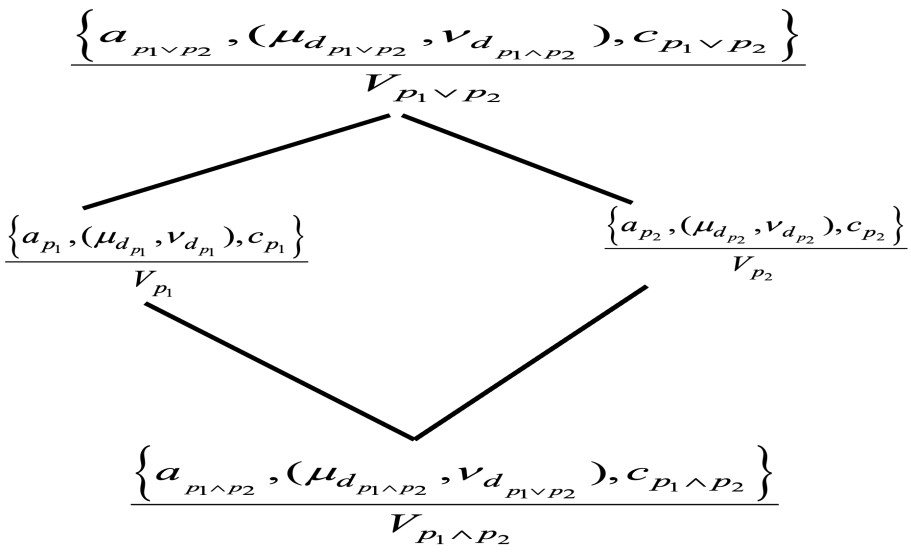

Figure 2: The Intuitionistic Plithogenic graph Visualization

Step 10: The Figure 2 can be analyzed based on supremum and infimum among the attributes for knowledge processing tasks.

Time complexity: Let us suppose, there are *n*-number of Intuitionistic Plithogenic attribute with *m*-number of multi-valued appurtenance degree of attributes then it may take O(*nm*) time. In addition to compute the rejection part with contradiction degree may take overall O($n.m^2$) time complexity.

4. ILLUSTRATIONS

Recently, uncertainty and vagueness exists in dark data set consider as one of the major issues by researchers [1-2]. In this process, a problem is addressed while precise representation of refusal degree and its representation [11]. To deal with it current paper tried to utilize Intuitionistic Plithogenic set [3-4] in this paper and its graphical visualization motivated from recent studies [14-1]. To achieve this goal, a method is proposed in Section 3 which is illustrated in this section using the extensive example shown in [5].

Example 2: Let us extend the Example 1 as the expert provides opinion about a player(x_1) in form of for

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Intuitionistic Plithogenic set as shown in Table 2. Same time another expert with whom the contradiction arises with expert 1 given his/her opinion about the player (x_1) in form of for Intuitionistic Plithogenic set as shown in

Table 3. The problem with selection committee is how to analyze the opinion of both experts for multi-decision process towards player(x_1) without any bias. To deal with it proposed method in this paper can be useful. First compute the union and intersection among the expert opinion as shown in Table 4. The obtained Intuitionistic Plithogenic context visualize based on its supremum and infimum as shown in Figure 2. Now try to extract information from the Figure 3 for knowledge processing tasks.

Table 2. An Expert (y_1) opinion about player(x_1)

Contradiction degree	0	0.33	0.66		0.0	0.5
Attribute values	Test	One day	T20		Ball faced	Strike rate
Player(x_1)	(0.4, 0.5)	(0.1, 0.2)	(0.0, 0.3)		(0.8, 0.2)	(0.4, 0.5)

Table 3. An Expert (y_2) opinion about player(x_1)

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Contradiction degree	0	0.33	0.66		0.0	0.5
Attribute values	Test	One Day	T20		Ball faced	Strike rate
Player(x_1)	(0.6, 0.3)	(0.4, 0.3)	(0.2, 0.5)		(0.6, 0.1)	(0.5, 0.3)

Table 4. The Intuitionistic Plithogenic context representation of Table 1 and 2

Contradiction degree	0	0.33	0.66		0.0	0.5
Attribute values	Test	One Day	T20		Ball faced	Strike rate
Expert $y_1$opinion about Pujara	(0.4, 0.5)	(0.1, 0.2)	(0.0, 0.3)		(0.8, 0.2)	(0.4, 0.5)
Expert $y_2$opinion about Pujara	(0.6, 0.3)	(0.4, 0.3)	(0.2, 0.5)		(0.6, 0.1)	(0.5, 0.3)
$y_1 \wedge_p y_2$ as per step 7 of Section 3.1	(0.24, 0.65)	(0.18, 0.31)	(0.13, 0.32)		(0.48, 28)	(0.45, 0.40)
$y_1 \vee_p y_2$ as per step 7 of Section 3.1	(0.76, 0.15)	(0.32, 0.19)	(0.07, 0.48)		(0.92, 0.02)	(0.45, 0.40)

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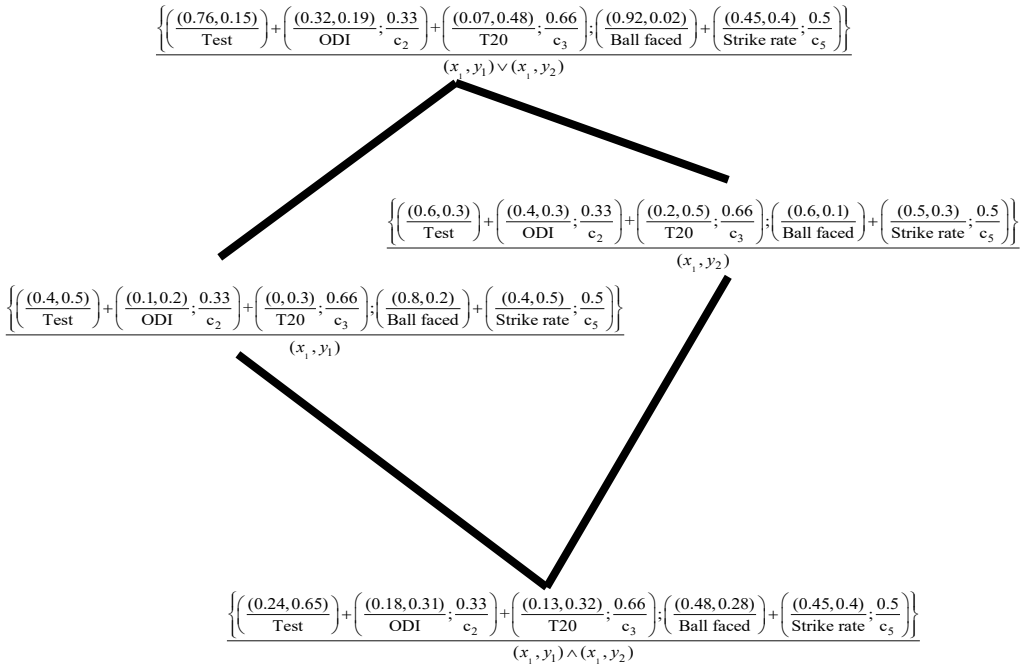

Figure 3. The Intuitionistic Plithogenic graph visualization of Table 4.

It can be observed that the Figure 3 represents that the expert (y_1) and (y_2) agreed that player (x_1) is 76 percent suitable for Test without any contradiction as per infimum node. The supremum node represents that the player (x_1) is 24 percent suitable for Test without any contradiction, 18 percent suitable for ODI with 30 percent contradiction, 13 percent for T20 with 66 percent contradiction due to his 48 percent ball faced and 45 percent strike rate with contradiction 0.5. It means that the player (x_1) is suitable for Test when compared to ODI and T20. In this way, the proposed method provides an alternative way to deal with data of Intuitionistic Plithogenic attributes when compared to any available approaches shown in Table 5. The proposed method does not provide any analysis when performance of a player changes based on given phase of time. To deal with this issue, the author will try to explore this area in depth with an illustrative examples.

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Table 5. The Comparion of the Porposed Method With Recent Approaches

	Plithogenic Set	Plithogenic graph	The Proposed method
Multi-attribute data set	Yes	Yes	Yes
Uncertainty	Yes	Yes	Yes
Acceptation	Yes	Yes	Yes
Rejection	No	No	Yes
Contradiction	Yes	Yes	Yes
Algebra	Union, Intersection, Complement	Union, Intersection, Complement	Union, Intersection, Complement
Graph	Yes	Yes	Yes
Multi-Decision Process	Yes	Yes	Yes
Cricket Data Analysis	Yes	Yes	Yes
Time Complexity	Not Discussed	$O(m.n^2)$ or $(n.m^2)$	$O(m.n^2)$ or $(n.m^2)$

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4. CONCLUSIONS

This paper introduced a method for dealing the data with Intuitionistic Plithogenic attributes and its graphical structure visualization based on infimum and supremum. One of the suitable examples is also given for understanding the proposed method and its applications for various research fields. In near future the author will focus on measuring the dynamic changes in Plithogenic attributes at given phase of time with its applications.

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Consent to participate: Author declares that there is no organs/tissues were obtained from prisoners.

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