



## Plithogenic set for multi-variable data analysis

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### Abstract

The m-polar and multi-dimensional data sets given a platform to deal with multi-valued attributes. In this case, a problem addressed that sometimes the attributes may contain many types of opposites, non-opposites and neutrals values as for example Rainbow. One of the best examples is sports data sets where each time the value of an attribute changes several times towards the given team, the opposition of the given team as well as draw conditions. The precise representation of these types of data sets and their mathematical analysis are crucial tasks for the research communities. The current paper tried to develop new mathematical set theories for precise representation and analysis of sports data via plithogenic set and its mathematical algebra.

**Keywords:** Plithogenic data, multi-valued, data, Neutrosophic set, Knowledge representation

### 1. Introduction

The theory of neutrosophic set is introduced by Smarandache [1] considering the concept of fuzzy sets [2] for handling acceptance, rejection and uncertain part. This theory is recently utilized for data analysis and processing tasks [3]. This given a well established platform to analyze the n-valued data sets [4-5] based on their acceptance, rejection and uncertain part. In this process, the researchers addressed that there are several data sets that contains many types of dynamics, opposites, neutrals as well as non-opposites sides. One of the best suitable example is

sports data sets which contain many types of opposite, non--opposite, neutral side for the given match. Same time the behavior of the crowd, address of any person contains many types of dynamics. This type of data set and its representation is called as "Plithogenic set" by Smarandache in 2017 [6-7]. One of the suitable examples is student CGPA is based on more than several papers performance. For example, a faculty says "The student (x1) is intelligent". This proposition is statement can be based on more than three or four subject performance according to the experts as: Science (whose attribute values are: mathematics, physics, anatomy), Literature (whose attribute values are: poetry, novel), and Arts (whose only attribute value is: sculpture). Nowadays online TV channel pack is based on multi-valued different types of attributes and customers select the particular group which fulfills the requirement. In these cases, difficult for the users to select the subscribe the particular pack for the given channel. To resolve this issue current paper focuses on plithogenic set, its uses and applications is discussed for better understanding.

The Plitho--geny word coined from: crowd, a large number of events, to be blended or mixed together. It means the plithogeny may utilize as genesis or formation, development of many static or dynamic attributes at the same time. In this way plithogeny set contains contradictory, neutrals, non-contradictory multi-valued attributes to represent the particular event or knowledge. Hence it is hybrid of many opposites, neutrals and non-opposites attributes connected or non--connected to represent the particular concept. A continuum process of merging, and splitting, or integration and disintegration as happened in chemistry, opinion mining, social synchrony. Same time the psychological view that conscious, unconscious, Aconscious, Optimism, Pesimism is plithogenic view that used to change several times based on our degree of perception. One of the suitable examples is win, loss and draw of any matches fluctuate several times for the same match. The precise representation of this data set is one of the crucial tasks for the researchers when this large number of dynamic data generated at each moment which can be done using plithogeny set. To achieve this goal, the current paper focuses on dealing with these types of multi--attributes and its algebra for further applications in knowledge processing tasks. One of the suitable examples is the performance of a cricket player is based on plithogenic set which increases several times, decrease several time and may consistent. It is difficult to measure the performance of a player for the selectors at a given phase

of time. To deal with these types of issues current paper works on plithogenic set and its properties.

Other parts are composed as follows: Section 2 contains preliminaries about neutrosophic set to measure the linguistics. Section 3 contains introduction of plithogenic set and its graphical applications. Section 4 contains conclusions and references.

**2. Background**

**2.1 Neutrosophic Set:**

The neutrosophic set consisting reptile functions namely truth, indeterminacy and false, (T, I, F), independently. Each of these values lies between 0 and 1 and does not depend on them. The boundary conditions of sum of these membership degrees  $0 \leq T + I + F \leq 3$ . In this 0 is hold for the universal false cases and 3 are the universal truth cases three memberships.

i.e.  $\lambda = \{ \langle x : T, I, F \rangle : x \in \xi \}$  .....

This set contains triplet having true, a false and indeterminacy membership values which can be charaterized independently,  $T_N, F_N, I_N$ , independently in  $[0,1]$ . It can be abbreviate as follows:

$$N = \{ \langle k; T_N(k), I_N(k), F_N(k) \rangle : k \in \xi; T_N(k), I_N(k), F_N(k) \in [0, 1]^+ \} \dots\dots(1)$$

There is no restriction on the sum of  $T_N(k), I_N(k)$  and  $F_N(k)$ .

$$\text{So } 0 \leq T_N(k) + I_N(k) + F_N(k) \leq 3^+ \dots\dots\dots(2)$$

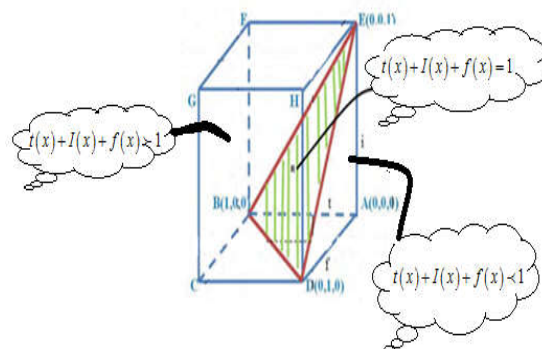


Figure 1. The graphical visualization of neutrosophic environment

## 2.2. Linguistic neutrosophic set.

A single valued neutrosophic linguistic set A (abbr. SVNLS) in  $\xi$  can be defined as

$$N_{SVNLS} = \left\{ \left\langle x, \left[ s_{\theta(x)}, s_{\rho(x)} \right], (T_N(x), I_N(x), F_N(x)) \right\rangle \mid x \in \xi \right\} \quad (37)$$

where  $s_{\theta(x)}, s_{\rho(x)} \in \widehat{S}$ ,  $T_N(x) \subseteq [0,1]$ ,  $I_N(x) \subseteq [0,1]$ ,  $F_N(x) \subseteq [0,1]$  with the condition  $0 \leq T_N(x) + I_N(x) + F_N(x) \leq 3$ , for any  $x \in \xi$ .  $[s_{\theta(x)}, s_{\rho(x)}]$  is an uncertain linguistic term, The function  $T_N(x)$ ,  $I_N(x)$ ,  $F_N(x)$  express, respectively, the degree of truth - membership, the degree of indeterminacy - membership and the degree of falsehood - membership. Of the element  $x$  in  $\xi$  belonging to the linguistic term  $[s_{\theta(x)}, s_{\rho(x)}]$ .

In this process the author address that there are several attributes which changes several times in opposites, neutral and non-opposites side. One of the best suitable example is a cricket match which changes several times. The precise analysis of these types of uncertainty in multi-valued attributes. The current paper focused on utilizing the properties of plithogenic set in the next section.

## 2.3. Plithogenic Set

Let  $\xi$  be a universe of discourse,  $P$  be a subset of this universe of discourse, “ $a$ ” be a multi-valued attribute,  $V$  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  $c$  the (fuzzy, intuitionistic fuzzy, neutrosophic) degree of contradiction (dissimilarity) between attribute values as  $(\langle A, \text{Neutral } A, \text{Anti } A \rangle; \langle B, \text{Neutral } B, \text{Anti } B \rangle; \langle C, \text{Neutral } C, \text{Anti } C \rangle)$

Then  $(P, a, V, d, c)$  is named a Plithogenic Set.

A plithogenic set is a set  $P$  whose each element  $x$  is characterized by many attribute values.

A generic element  $x \in P$  is therefore characterized by all attribute's values in  $V = \{v_1, v_2, \dots, v_n\}$ , for  $n \geq 1$ .

The precise representation of plithogenic operators, a contradiction (dissimilarity) degree function  $c(\cdot, \cdot)$  between the attribute values is implemented. Each plithogenic operator is a linear combinations of the fuzzy t-norm and fuzzy t-conorm:

$c: V \times V \rightarrow [0, 1]$  is the contradiction degree function between the values  $v_1$  and  $v_2$ , noted as  $c(v_1, v_2)$ , and satisfying the following axioms:

$$c(v_1, v_1) = 0,$$

$$c(v_1, v_2) = c(v_2, v_1), \text{ commutativity.}$$

Into the set  $V$ , in general, one has a dominant attribute value (the most important attribute value in  $V$ ) that is established by each expert upon the application needed to solve.

It means the plithogenic set may contains four or more then four-valued attribute. In this case, the plithogenic aggregation operators (intersection, union, complement, inclusion, equality) are based on contradiction degrees between attributes' values. Same time the union and intersections can be used as fuzzy operators' *t-norm* and *t-conorm*. The current paper tried to illustrate these two operators using an illustrative example.

#### 4. Illustration

Plithogenic set is an extension of the classical set, fuzzy set, intuitionistic fuzzy set, and neutrosophic set, since in all these four types of sets a generic element  $x$  is characterized by one attribute only (appurtenance), which has one single attribute value (membership – in classical and fuzzy sets), two attribute values (membership and nonmembership – in intuitionistic fuzzy set), and three attribute values (membership, indeterminacy, and nonmembership – in neutrosophic set).

Example: Let us suppose want to represent the performance of a cricketer like Virat Kohli and Rohit sharma which is collected on 30 Jan 2020 [8]. It is difficult to measure them just by

one parameter. In this case the expert require more than one attributes and its changes as shown below:

Table 1. The Batting performance of Virat Kohli in various format

	Mat	Inns	NO	Runs	HS	Ave	BF	SR	100	50	4s	6s	Ct	St
<b>Tests</b>	84	141	10	7202	254*	54.97	12457	57.81	27	22	805	22	80	0
<b>ODIs</b>	245	236	39	11792	183	59.85	12626	93.39	43	57	1109	120	126	0
<b>T20Is</b>	81	75	21	2783	94*	51.53	2012	138.32	0	24	256	76	41	0
<b>First-class</b>	116	189	17	9451	254*	54.94	16360	57.76	34	30	1118	37	111	0
<b>List A</b>	279	269	42	13234	183	58.29	14162	93.44	47	65	1273	144	144	0
<b>T20s</b>	280	265	50	8889	113	41.34	6605	134.57	5	64	806	286	128	0

It can be observed that from Table 1 the Virat Kohli selected after measurement of more than 116 matches in First Class with 9451runs, 54 average, 57 SR and 34 hundreds. This performance can be founded same in ODI and Test after selection. He has faced almost similar balls in Tests and one day with same Average and Double strike rate. It shows Virat Kohli plays based on situation of the game in consistent or mesokurtic behavior as per his performance data.

Table 2. The Batting performance of Rohit Sharma various format

	Mat	Inns	NO	Runs	HS	Ave	BF	SR	100	50	4s	6s	Ct	St
<b>Tests</b>	32	53	7	2141	212	46.54	3613	59.25	6	10	216	52	31	0
<b>ODIs</b>	224	217	32	9115	264	49.27	10250	88.92	29	43	817	244	77	0
<b>T20Is</b>	107	99	14	2713	118	31.91	1957	138.63	4	20	242	124	40	0
<b>First-class</b>	92	143	16	7118	309*	56.04	NA	NA	23	30	NA	NA	73	0
<b>List A</b>	295	284	40	11357	264	46.54	NA	NA	32	56	NA	NA	101	0
<b>T20s</b>	327	314	46	8582	118	32.02	6422	133.63	6	59	760	358	131	0

It can be observed that from Table 2 that, Rohit Sharma selected after measurement of more than 92 matches in First Class with 7118 runs, 56 average, and 23 hundreds. His performance is below in Test and ODI as per First Claas. However his performance is better in ODI and T20 game when compared to Test as per current data. It shows his performance is leptokurtic behavior as per data.

The problem arises with selectors to choose a particular player which can perform as per Virat Kohli and Rohit Sharma. In this case finding the minimum level and maximum level data is one of the major issues for the selection committee. To resolve this issue the current paper utilizes min and max of t-norms and t conforms operators in plithogenic set.

Case (i) The selection committee first try to get one of the suitable batsman who have perform maximum level in each format as per record of Virat Kohli or Rohit Sharma in this case intersection operator i.e. t-co-norms will provide as shown in Table 3.

Table 3. The Maximum level of Batting performance either Virat Kohli or Rohit Sharma in various format

	Mat	Inns	NO	Runs	HS	Ave	BF	SR	100	50	4s	6s	Ct	St
<b>Tests</b>	84	141	10	7202	254*	54.97	12457	59.25	27	22	805	52	80	0
<b>ODIs</b>	245	236	39	11792	264	59.85	12626	93.39	43	57	1109	244	126	0
<b>T20Is</b>	107	99	14	2783	118	51.53	2012	138.63	4	24	256	124	41	0
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<b>List A</b>	295	284	42	13234	264	58.29	14162	93.44	47	65	1273	144	144	0
<b>T20s</b>	327	314	50	8889	118	41.34	6605	134.57	6	64	806	358	131	0

The Table 3 represents that, a batsman has faced more than 9000 balls with 50 average in each format having strike rate more than 60 can be selected.

In case this data is more higher level and none of candidate can be selected. In this case the selection committee need a minimum level data which predict the common performance of Virat Kohli and Rohit Sharma. It will be minimum to select a batsman and later groomed. To achieve this goal, the t-norm can be utilized in plithogenic set shown in Table 4.

Table 4. The Maximum Common Batting performance of Virat Kohli and Rohit Sharma in various format

	Mat	Inns	NO	Runs	HS	Ave	BF	SR	100	50	4s	6s	Ct	St
<b>Tests</b>	32	53	7	2141	212	46.54	3613	57.81	6	10	216	52	31	0
<b>ODIs</b>	224	217	32	9115	183	49.27	10250	88.92	29	43	817	244	77	0
<b>T20Is</b>	81	75	14	2713	94*	31.91	1957	138.63	0	24	242	124	40	0
<b>First-class</b>	92	143	16	7118	254*	54.94	NA	NA	23	30	NA	NA	73	0

<b>List A</b>	279	284	40	11357	183	56.54	NA	NA	32	56	NA	NA	101	0
<b>T20s</b>	327	265	56	8582	113	32.02	6422	133.63	5	59	760	286	128	0

The Table 4 represents that, a batsman played more than 90 match in First Class with 7000 Runs and 50 average can be selected who can later perform in Test and One day as per Virat and Rohit Sharma.

It can be observed that, the current paper provides a solution to deal with multi-valued attributes. However the current paper does not focus on dominant attributes in the plithogenic set which affect the decision.

The current paper shows that set of multi-valued and different types of data set can be done using plithogenic set and its operator. It can be observed that in above-given data sets Virat Kohli performance oversees the Rohit sharma on some entries, on some entries they are equal whereas some entries it is less. These data can fluctuate or change in opposite, neutral and non-opposite direction. These types of data sets can be handled by plithogenic set and its operations. Same time plithogenic set provides different levels to set the parameters for selection based on expert requirements rather than single-valued. In future, author work will focus on introducing a new graphical structure for the visualization of plithogeny set.

#### 4. Conclusions:

In this paper, the author provides an initial way to establish plithogenic set with an example. It will helpful for the researchers of data analysis and neutrosophic researchers to deal with uncertainty in multi-valued attributes.

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