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A New Approach of Multi-Dimensional Single Valued Plithogenic Neutrosophic Set in Multi Criteria Decision Making

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Abstract: In the wider problem-solving process, decision-making requires knowledge to choose the possible and optimum solution in the real time. Decision making become further complicated if the available criteria are more. In this research work our intend is to study the behaviour of Multi-Dimensional Single valued Plithogenic Neutrosophic Sets(MSVPNS) used in multi criteria decision making with multi values of attributes. We also introduce a novel method to find the optimum solution of Single valued Plithogenic Neutrosophic Sets(SVPNS) with its operators. We apply this concept in the field of agriculture which deals with multi values of attribute and obtain a fruitful result for practising agriculture in a successful way.

Keywords: Decision making, Multi criteria decision making, Neutrosophic set, Plithogenic set, Plithogenic Neutrosophic set.

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1. Introduction

Decision-making process may be termed as the investigation, identification and choice of alternatives, the most appropriate option for the perseverance. It is generally called a cognitive analysis, since it involves conceptual and logical reasoning. There are some strategies in decision-making that are worth exploring, but there is little interest in the number of different alternatives, rather than in describing all possible solutions and select the one with the greatest likelihood of success, or the one that best matches the specific target or purpose.

Decision-making is a process that eliminates uncertainty to a significant degree. In most decisions, uncertainty is minimized rather than removed. Just in a few cases decisions are taken with absolute certainty. This means that most decisions require a certain amount of risk.

If there is no uncertainty, so there is no decision; only since you have to act and assume a determined conclusion. Decisions decide the progress of the project, and often there are tough times when they seem not to be as straightforward as we assume they are tougher.

Zadeh [14] brought a successful revolution by introducing a new theory of sets (i.e.) Fuzzy sets (FS) in the area of problem solving world and mathematics. Fuzzy sets accept the view that the knowledge available in the real world is not always definite or crisp, but keeps the hand of uncertainty and the analysis of this uncertainty will aid a great deal in the decision making process.

Atanassov [2] coined Intuitionistic fuzzy set (IFS) to manage vagueness which is an extension of the FS. IFS allocates both membership and non-membership degree for each component with the constraint that the addition of these two evaluations is less than or equal to unity. IFS plays a major role in resolving vagueness or uncertainty in decision making.

Smarandache [7] proposed Neutrosophic sets (NSs), a generalization of FS and IFS.NSs is highly supportive for dealing with insufficient, indefinite, and varying data that occurs in the the real world. NSs are characterized by functions of truth (T), indeterminacy (I) and falsity (F) membership functions. This concept is very essential in decision making process since indeterminacy is clearly enumerated and the truth, indeterminacy, and falsity membership functions are independent.

Smarandache [6] introduced the Plithogenic set (PS) as a generalization of neutrosophy in 2017. The components of PS are represented by one or many number of attributes and each of it have numerous values. Each values of attribute have its appurtenance degree for the component x (say) to the PS (say P) with reference to certain constraints. For the first time, Smarandache introduced the dissimilarity degree between each value of attribute and the predominant value of attribute which results in getting the enhanced accurateness for the plithogenic aggregation operators.

In this research work, we study how the single valued plithogenic neutrosophic set used in multi criteria decision making with multi values of attributes.

Section 1 gives the brief introduction with the organisation of the paper. Section 2 deals with the preliminary concepts. In this section we give the basic definitions, important results that is needed for our research work. Section 3 explains uni attribute value SVPNS with their operators. Section 4 is an extension of section 3 which is our proposed concept dealing with MSVPNS with their aggregation operators. Section 5 gives an algorithm for computing the optimum solution for numerical data. Section 6 explains the application of the constructed algorithm in the field of agriculture. Section 7 gives the results and discussions of the numerical problem and Section 8 concludes the present research work with the future work.

2. Preliminaries

Definition 2.1 [14] Let J be a universal set and the fuzzy set $F = \{\langle j, \gamma_f(j)\rangle \mid j \in J\}$ is termed by a belonging degree γ_f as $\gamma_f : J \to [0,1]$.

Definition 2.2 [2] Let H be a non-void set. The set $B = \{\langle h, \mu_B, \varphi_B \rangle h \in H\}$ is called an intuitionistic fuzzy set (in short, IFS) of H where the function $\mu_B : H \to [0,1]$, $\varphi_B : H \to [0,1]$ represents the belonging degree (say $\mu_B(h)$) and non- belonging degree (say $\varphi_B(h)$) of each component $h \in H$ to the set B and satisfies the constraint that $0 \le \mu_B(h) + \varphi_B(h) \le 1$.

Definition 2.3 [9] Let H be a non-void set. The set $B = \{\langle n, \lambda_B, \phi_B, \gamma_B \rangle h \in H\}$ is called a neutrosophic set (say NS) of H where the function $\lambda_B : H \to [0,1]$, $\phi_B : H \to [0,1]$ and $\gamma_B : H \to [0,1]$

represents the belonging degree (say $\lambda_B(h)$), neutral degree (say $\phi_B(h)$), and non- belonging degree (say $\gamma_B(h)$)of each component $h \in H$ to the set B and satisfies the limitation that $0 \le \lambda_B(h) + \phi_B(h) + \gamma_B(h) \le 3$.

Definition 2.4 [6] Plithogenic set (PS) is a generalization of a crisp set, a fuzzy set (FS), an intuitionistic fuzzy set (IFS) and a neutrosophic set (NS), while these four categories are represented by a particular values of attribute (appurtenance): single value (belonging)-for a crisp set and a FS, two values (belonging, non-belonging)-for an IFS, or triple values (belonging, non-belonging and indeterminacy) for NS.

In general, PS is a set whose members are determined by a set of elements with four or more values of attributes.

Definition 2.5 [6] Let Z be the universal set. A non-void set $B = \{\beta_1, \beta_2, ... \beta_s\}, s \ge 1$ of uni-dimensional parameters and $\beta \in B$ attributes is known as the values of attribute continuum of the PS. A given value whose range of all probable values is the non-void set U, is any finite discrete set $U = \{u_1, u_2, ..., u_s\}, 1 \le s < \infty$, or infinitely countable set $U = \{u_1, u_2, ..., u_\infty\}$, or infinitely uncountable set $U =]x, y[, x < y, where]...[$ where U can be any open, quasi-open or closed interval from the set of real numbers of another universal set.

Definition 2.6 [10] Let R be a non-void subset of U, where R is the collection of the values of all attributes that the researchers need for their application. Every component $y \in$ P is described by the values of all attributes in $R = \{r_1, r_2, ... r_m\}, m \ge 1$.

Definition 2.7 [11] Generally there is a predominant values of attribute (DAV) within the value set R of the attribute, which is defined by the researchers upon their application. Predominant value is the most significant value of the attribute in which the researchers are involved. There are situations where such DAV may not be taken into consideration or does not exist, or several predominant (essential) values of attributes may exist when various methods would be applied.

Definition 2.8 [10] Each values of attribute $r \in R$ has its respective appurtenance degree $d(y, r)$ of the element y to the set P, with reference to some given criteria. The appurtenance degree can be: a fuzzy or intuitionistic fuzzy or neutrosophic to the plithogenic set. Therefore the values of attribute appurtenance degree function is $\forall x \in X, d : X \times W \to X([0,1]^T)$, so $d(y, r)$ is a subset of $[0,1]^T$, where $X([0,1]^T)$ is the power set of the $[0,1]^T$, where T=1 for FS, T=2 for IFS or T = 3 for NS.

Definition 2.9 [6] Let the cardinal $|R| \ge 1$. Let $C : R * R \to [0,1]$ be the values of attribute dissimilarity degree function between any two values of attributes r_1 and r_2 represented by $C(r_1, r_2)$ which satisfies the following conditions

(i) $C(r_1, r_2) = 0$, the dissimilarity degree among the same values of attribute is zero;

(ii) $C(r_1, r_2) = C(r_2, r_1)$ commutativity.

Remarks

1. The degree of dissimilarity is often determined between uni-dimensional values of attributes. We divide multi-dimensional value of attribute into its equivalent uni-dimensional values of attribute.

2. The dissimilarity function of the values of attribute allows the plithogenic operators and the relationship of plithogenic partial order to achieve a precise result.

3. In every domain where the PS is used in connection with the application, the values of attribute dissimilarity degree function is designed to solve. If the aggregation is overlooked, it still works, but the result will lose exactness.

Definition 2.10 [6] Plithogenic aggregation operators

The degree of dissimilarity for the values of attribute is calculated between each values of attribute with reference to the DAV represented by r_d. Most of the plithogenic aggregation operators (Intersection, Union, Partial orders) are linear combination of the fuzzy ℓ_{norm} (symbolized by $\wedge_f$) and fuzzy ℓ_{conorm} (symbolized by $\vee_f$).

If one imposes the ℓ_{norm} on DAV represented by r_d, and the dissimilarity between r_d and r_2 is $C(r_d, r_2)$, then onto values of attribute r_2 one imposes

$$[1 - C(r_d, r_2)] * \ell_{norm}(r_d, r_2) + C(r_d, r_2) * \ell_{conorm}(r_d, r_2)$$

or by using notations

$$[1 - C(r_d, r_2)] * \wedge_f(r_d, r_2) + C(r_d, r_2) * \vee_f(r_d, r_2).$$

Likewise if one imposes the ℓ_{conorm} on DAV represented by r_d, and the dissimilarity between r_d and r_2 is $C(r_d, r_2)$, then onto values of attribute r_2 one imposes

$$[1 - C(r_d, r_2)] * \ell_{conorm}(r_d, r_2) + C(r_d, r_2) * \ell_{norm}(r_d, r_2)$$

or by using notations

$$[1 - C(r_d, r_2)] * \vee_f(r_d, r_2) + C(r_d, r_2) * \wedge_f(r_d, r_2).$$

3. One Attribute Single valued Plithogenic Neutrosophic set (OASVPNS)

The attribute is Φ = "appurtenance"

The set of values of attributes R= {belonging, indeterminacy, non-belonging}, whose cardinal |R| = 3;

The DAV = belonging;

The values of attribute appurtenance degree function:

$d : P * R \to [0,1]$, $d(y, belonging) \in [0,1], d(y, indeterminacy) \in [0,1], d(y, non\ belonging) \in [0,1]$

with $0 \le d(y, belonging) + d(y, indeterminacy) + d(y, non\,belonging) \le 3;$

and the values of attribute dissimilarity degree function:

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

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

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

$C(belonging\ , \ indeterminacy) = c(non\,belonging\ , \ indeterminacy) = \frac{1}{2},$

which means that for the SVPNS aggregation operators (Intersection, Union, Complement etc.), if one imposes the ℓ_{norm} on belonging function, then one has to impose the ℓ_{conorm} on non-belonging (and mutually), while on indeterminacy one imposes the average of ℓ_{norm} and ℓ_{conorm}.

3.1 OASVPNS operators

Let us consider the single valued plithogenic neutrosophic degree of appurtenance of values of attribute r of x to the set P with reference to some given criteria:

$$d^N\kappa(r) = (\kappa_1, \kappa_2, \kappa_3) \in [0,1]^3 \ and \ d^N{}_{\varepsilon}(r) = (\varepsilon_1, \varepsilon_2, \varepsilon_3) \in [0,1]^3$$

3.1.1 OASVPNS Intersection

$$(\kappa_1, \kappa_2, \kappa_3) \wedge_P (\varepsilon_1, \varepsilon_2, \varepsilon_3) = (\kappa_1 \wedge_P \varepsilon_1, \frac{1}{2}(\kappa_2 \wedge_f \varepsilon_2 + \kappa_2 \vee_f \varepsilon_2), \kappa_3 \vee_P \varepsilon_3)$$

3.1.2 OASVPNS Union

$$(\kappa_1, \kappa_2, \kappa_3) \vee_P (\varepsilon_1, \varepsilon_2, \varepsilon_3) = (\kappa_1 \vee_P \varepsilon_1, \frac{1}{2}(\kappa_2 \wedge_f \varepsilon_2 + \kappa_2 \vee_f \varepsilon_2), \kappa_3 \wedge_P \varepsilon_3)$$

3.1.3 OASVPNS Negation

$$\neg_P(\kappa_1, \kappa_2, \kappa_3) = (\kappa_3, \kappa_2, \kappa_1)$$
$$\neg_P(\kappa_1, \kappa_2, \kappa_3) = (\kappa_3, 1 - \kappa_2, \kappa_1)$$
$$\neg_P(\kappa_1, \kappa_2, \kappa_3) = (1 - \kappa_1, \kappa_2, 1 - \kappa_3) \quad etc.,$$

3.1.4 OASVPNS Inclusions (Partial orders)

(i) Simple Neutrosophic Inclusion

$$(\kappa_1, \kappa_2, \kappa_3) \leq_N (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ if \ \kappa_1 \leq \varepsilon_1, \kappa_2 \geq \varepsilon_2, \kappa_3 \geq \varepsilon_3$$

(ii) Complete Neutrosophic Inclusion

$$(\kappa_1, \kappa_2, \kappa_3) \leq_P (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ if \ \kappa_1 \leq \varepsilon_1, \kappa_2 \geq 0.5 * \varepsilon_2, \kappa_3 \geq \varepsilon_3$$

3.1.5 OASVPNS Equality

(i) Simple Neutrosophic equality

$$(\kappa_1, \kappa_2, \kappa_3) =_N (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ if \ (\kappa_1, \kappa_2, \kappa_3) \leq_N (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ and (\varepsilon_1, \varepsilon_2, \varepsilon_3) \leq_N (\kappa_1, \kappa_2, \kappa_3)$$

(ii) Complete Neutrosophic equality

$$(\kappa_1, \kappa_2, \kappa_3) =_P (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ if \ (\kappa_1, \kappa_2, \kappa_3) \leq_P (\varepsilon_1, \varepsilon_2, \varepsilon_3) \ and (\varepsilon_1, \varepsilon_2, \varepsilon_3) \leq_P (\kappa_1, \kappa_2, \kappa_3)$$

4. Proposed Multi-Dimensional Single valued Plithogenic Neutrosophic set (MSVPNS)

Consider a universal set E and $A, B \subset E$ be two single valued plithogenic neutrosophic sets.

Let $\beta_{[n]} = \beta_1 * \beta_2 * \ldots \beta_n$ be an n-dimensional attribute for $n \geq 1$, and every attribute β_i, $1 \leq i \leq n$, has $v_i \geq 1$ values:

$$R_i = \{r_{i1}, r_{i2}, \ldots r_{iv_i}\}$$

An element $x \in P$ is characterized by $v_1 * v_2 * \ldots v_n = v\, values$:

$$R = \sum_{i=1}^{m} \{r_{i1}, r_{i2}, \ldots r_{iv_i}\} = \{r_{11}, r_{12}, \ldots r_{1v_1}\} * \{r_{21}, r_{22}, \ldots r_{2r_{v2}}\} * \ldots \{r_{m1}, r_{m2}, \ldots r_{mr_m}\}$$
$$= \{r_{1j_1}, r_{2j_2}, \ldots r_{nj_n}\}, 1 \leq j_1 \leq v_1, 1 \leq j_2 \leq v_2, \ldots 1 \leq j_n \leq v_n\}.$$

Let $C(r_{iD}, r_{ik}) = C_{ik} \subseteq [0,1]^3$ be the neutrosophic degree of dissimilarity between the attribute β_i predominant value (represented by r_{iD}) and other attribute ψ_i value (represented by r_{ik}) for $1 \leq i \leq n$, and $1 \leq k \leq v_i$. And C_{ik} as a part of the unit interval [0, 1], may be a subset, or an interval, or a hesitant set, or a single number etc.

We break up the n dimensional attribute into n uni dimensional attribute. And when applying the plithogenic aggregation operators onto an n-uple $(r_{1j_1}, r_{2j_2}, \ldots r_{nj_n})$, we independently apply the ℓ_{norm}, ℓ_{conorm} or a linear combination of its n- components: $r_{1j_1}, r_{2j_2}, \ldots r_{nj_n}$

Let $d_A : P * R_i \to \mathrm{P}([0,1])^3$ for each $1 \leq i \leq n$, be the appurtenance neutrosophic degree function, whereas $\mathrm{P}([0,1])$ is the power set of the unit interval [0, 1], i.e. all subsets of [0, 1].

Upon the values of attribute degree function, the ℓ_{norm}, ℓ_{conorm} and their linear combinations are adjusted to the neutrosophic sets.

Consequently $d_B : P * R_i \to \mathrm{P}([0,1])^3$

4.1 Multi-Dimensional Single valued Plithogenic Neutrosophic set operators (MSVPNS)

Let us consider the notations for two n-uple PSVNS denoted by

$$x_A = \{d_A(x, w_1), \ldots d_A(x, w_i), \ldots d_A(x, w_n)\} \text{ and}$$
$$x_B = \{d_B(x, w_1), \ldots d_B(x, w_i), \ldots d_B(x, w_n)\}$$

4.1.1 MSVPNS Intersection and Union

Let w_{id} be the attribute β_i predominant value and w_i be any of the attribute β_i value, $i \in \{1, 2, \ldots, n\}$

$$x_A \wedge_p x_B = \{(1 - C(w_{id}, w_i)) * [d_A(x, w_{id}) \wedge_f d_B(x, w_i)] + C(w_{id}, w_i) * [d_A(x, w_{id}) \vee_f d_B(x, w_i)] 1 \leq i \leq n$$

$$x_A \vee_p x_B = \{(1 - C(w_{id}, w_i)) * [d_A(x, w_{id}) \vee_f d_B(x, w_i)] + C(w_{id}, w_i) * [d_A(x, w_{id}) \wedge_f d_B(x, w_i)] 1 \leq i \leq n$$

4.1.2 MSVPNS Negation

Without loss of generality, we assume the values of attribute dissimilarity degrees are

$$C(w_{1d}, w_1),...C(w_{id}, w_i),..., C(w_{nd}, w_n).$$

The plithogenic neutrosophic element values of attributes are $\{w_1,..., w_i,..., w_n\}$.The values of attributes appurtenance degree: $\{d_A(x, w_1),...d_A(x, w_i),...d_A(x, w_n)\}$. Then the plithogenic neutrosophic complement (negation) is

$$1 - C(w_{1d}, w_1),...1 - C(w_{id}, w_i),...,1 - C(w_{nd}, w_n), anti(w_1),..., anti(w_i),..., anti(w_n)$$

Or

$$\neg_p x_A = \{\ d_A(x, anti(w_1) = d_A(x, w_1),..., d_A(x, anti(w_i) = d_A(x, w_i),..., d_A(x, anti(w_n) = d_A(x, w_n)$$

where $anti(w_i), 1 \le i \le n,$ is the attribute β_i contradictory value of w_i or $C(w_{id}, anti(w_i)) = [1 - C(w_{id}, w_i)]$

4.1.3 MSVPNS Partial order

Consider a partial order relation $x_A \le_p x_B$ on $P([0,1])^3$

if and only if

$$d_A(x, w_i) \le (1 - C(w_{id}, w_i)) * d_B(x, w_i),\ for\ 0 \le C(w_{id}, w_i) < 0.5 \text{ and}$$
$$d_A(x, w_i) \ge (1 - C(w_{id}, w_i)) * d_B(x, w_i),\ for\ C(w_{id}, w_i) \in [0.5,1]\ for\ all\ 1 \le i \le n$$

4.1.4 MSVPNS Equality

Consider a relation of total order has been represented on $P([0,1])^3$ then

$$x_A =_p x_B\ iff\ x_A \le_p x_B\ and\ x_B \le_p x_A.$$

5. Proposed Method to find the optimal solutions of MSVPNS

Step 1: Classify the problem with the attributes and its corresponding values of attribute.

Step 2: The cardinal number can be found as per the multi attribute dimension (say 'm') and denote it by R_m and find $|r_m|$

Step 3: Split the multi-dimensional attribute into its equivalent uni-dimensional attribute and compute the dissimilarity degree. Also Dissimilarity degree between two different attributes are zero.

Step 4: Choose the predominant values of attribute for each corresponding uni-dimensional attribute.

Step 5: Calculate the SVPNS intersection for n attribute which is given by

(i) for interior degrees of dissimilarity

$$((\lambda_{i1}, \lambda_{i2}, \lambda_{i3}), 1 \le i \le m) \wedge_p (\mu_{i1}, \mu_{i2}, \mu_{i3}, 1 \le i \le m) = [\lambda_{i1} \wedge_p \mu_{i1}, \frac{1}{2}(\lambda_{i2} \wedge_f \mu_{i2} + \lambda_{i2} \vee_f \mu_{i2}),\ \lambda_{i3} \vee_p \mu_{i3}], 1 \le i \le m)$$

(ii)

$$x_A \wedge_p x_B = \{(1-C(w_{id}, w_i)) * [d_A(x, w_{id}) \wedge_f d_B(x, w_i)] + C(w_{id}, w_i) * [d_A(x, w_{id}) \vee_f d_B(x, w_i)] 1 \le i \le m$$

Select the optimal representation of x from the intersection of x_A *and* x_B

Note. Here we have used the intersection operator. But the option is free for the reader to collaborate with other operators (union, complement, partial order and equality) of their choice.

6. Application

In this section, we give a numerical example to find the optimum solution of Multi Single valued Plithogenic Neutrosophic Set which has 40 values of attribute.

Let P be a plithogenic neutrosophic set representing the factors needed for agriculture.

According to the experts A and B, $x \in P$ be the type of agriculture characterized by 3 attributes (Soil, Water, Crops) that has to be evaluated

Soil - whose values of attributes are {sandy, clay, loamy, Red, Black} = $\{s_1, s_2, s_3, s_4, s_5\}$

Water- whose values of attributes are {Rain-fed farming, Irrigation} = $\{w_1, w_2\}$

Crops- whose values of attributes are {Food, cash, plantation, Horticulture} = $\{t_1, t_2, t_3, t_4\}$.

The multi attribute of dimension 3 is,

$$R_3 = \{(s_i, w_j, t_k), \text{ for all } 1 \le i \le 5, 1 \le j \le 2, 1 \le k \le 4\}$$

The cardinal of R_3 *is* $|R_3| = 5 * 2 * 4 = 40$.

The predominant values of attributes are s_1, w_1, t_1 respectively for every uni-dimensional attribute correspondingly.

The uni- dimensional attribute dissimilarity degrees are:

$$c(s_1, s_2) = \frac{1}{4}, c(s_1, s_3) = \frac{2}{4}, c(s_1, s_4) = \frac{3}{4}, c(s_1, s_5) = 1$$

$$c(w_1, w_2) = 1$$

$$c(t_1, t_2) = \frac{1}{3}, c(t_1, t_3) = \frac{2}{3}, c(t_1, t_4) = 1.$$

Let us use $fuzzy\ \ell_{norm} = a \wedge_f b = ab$ and $fuzzy\ \ell_{conorm} = a \vee_f b = a + b - ab$

Dissimilarity Degree	**0**	**1/4**	**2/4**	**3/4**	**1**	**0**	**1**	**0**	**1/3**	**2/3**	**1**
Values of Attribute	Sandy	clay	loamy	Red	Black	Rain-fed farming	Irrigation	Food	cash	Plantation	Horticulture

Expert A Plithogenic Neutrosophic Degree	(0.1,0.5,0.3)	(0.2,0.3,0.1)	(0.6,0.1,0.2)	(0.2,0.6,0.5)	(0.4,0.2,0.1)	(0.8,0.2,0.3)	(0.5,0.2,0.3)	(0.1,0.6,0.3)	(0.4,0.6,0.5)	(0.2,0.5,0.7)	(0.3,0.2,0.9)
Expert B Plithogenic Neutrosophic Degree	(0.2,0.3,0.4)	(0.7,0.1,0.4)	(0.5,0.7,0.3)	(0.9,0.1,0.4)	(0.1,0.6,0.3)	(0.5,0.2,0.7)	(0.6,0.1,0.5)	(0.3,0.8,0.1)	(0.4,0.3,0.1)	(0.8,0.1,0.2)	(0.1,0.3,0.2)

Tri-dimensional SVPNS Intersection

Let $x_A = \{d_A(x, s_i, w_j, t_k)\ for all\ 1 \le i \le 5, 1 \le j \le 2, 1 \le k \le 4\}$

and $x_B = \{d_B(x, s_i, w_j, t_k)\ for all\ 1 \le i \le 5, 1 \le j \le 2, 1 \le k \le 4\}$

Then

$$x_A(s_i, w_j, t_k) \wedge_p x_B(s_i, w_j, t_k) =$$
$$\{(1 - c(s_{iD}, s_i)) * [d_A(x, s_{iD}) \wedge_f d_B(x, s_i)] + c(s_{iD}, s_i) * [d_A(x, s_{iD}) \vee_f d_B(x, s_i)] 1 \le i \le 5;$$
$$(1 - c(w_{jD}, w_j)) * [d_A(x, w_{jD}) \wedge_f d_B(x, w_j)] + c(w_{jD}, w_j) * [d_A(x, w_{jD}) \vee_f d_B(x, w_j)] 1 \le j \le 2;$$
$$(1 - c(t_{kD}, t_k)) * [d_A(x, t_{kD}) \wedge_f d_B(x, t_k)] + c(t_{kD}, t_k) * [d_A(x, t_{kD}) \vee_f d_B(x, t_k)] 1 \le k \le 4\}$$

Let us have

$$x_A[d_A(s_1) = (0.1, 0.5, 0.3), d_A(w_2) = (0.5, 0.2, 0.3), d_A(t_3) = (0.2, 0.5, 0.7)]\ and$$
$$x_B[d_B(s_1) = (0.2, 0.3, 0.4), d_B(w_2) = (0.6, 0.1, 0.5), d_B(t_3) = (0.8, 0.1, 0.2)]$$

We take only 3-values of attribute: (s_1, w_2, t_3) for the other 39 3-values of attributes follow the same procedure.

$$x_A \wedge_P x_B = (0.1, 0.5, 0.3) \wedge_p (0.2, 0.3, 0.4); (0.5, 0.2, 0.3) \wedge_p (0.6, 0.1, 0.5); (0.2, 0.5, 0.7) \wedge_p (0.8, 0.1, 0.2)$$
where
$$d^N A(x, s_1) \wedge_p d^N B(x, s_1) = (0.1, 0.5, 0.3) \wedge_p (0.2, 0.3, 0.4)$$

First use the interior 'n' degree of dissimilarity among the 'n' components T, I and F (i.e.) 0, ½, 1.

$$(0.1, 0.5, 0.3) \wedge_p (0.2, 0.3, 0.4) = (0.1 \wedge_p 0.2, \frac{1}{2}[(0.5 \wedge_f 0.3) + (0.5 \vee_f 0.3)], 0.3 \vee_p 0.4)$$
$$= [(1-0)(0.1 \wedge_f 0.2) + 0.(0.1 \vee_f 0.2), \frac{1}{2}(0.5 \wedge_p 0.3 + 0.5 \vee_p 0.3), (1-0)(0.3 \vee_f 0.4) + 0 * (0.3 \wedge_f 0.4)]$$
$$= (0.2, 0.4, 0.12)$$

Similarly $d^N{}_A(x, w_2) \wedge_p d^N{}_B(x, w_2) = (0.5, 0.2, 0.3) \wedge_p (0.6, 0.1, 0.5) = (0.8, 0.15, 0.15)$ and also

$$d^N{}_A(x,t_3)\wedge_p d^N{}_B(x,t_3)=\left(0.2,0.5,0.7\right)\wedge_p (0.8,0.1,0.2)=(0.61,0.03,0.34)$$

Hence $x_A \wedge_p x_B(s_1,w_2,t_3)\approx((0.2,0.4,0.12);(0.8,0.15,0.15);(0.61,0.03,0.34))$.

We need to intersect the MSVPNS of the experts A and B to obtain the optimal representation of x.

7. Results and Discussions

Based on the Expert's (A and B) data the optimal condition for the given scenario is obtained at $s_5, w_2\ and\ t_4$ with the values

$$x_A \wedge_p x_B(s_4,w_2,t_4)\approx((0.8,0.2,0.5);(0.8,0.4,0.5);(0.8,0.5,0.7))$$

Therefore, black soil with irrigation water to cultivate horticulture is the best method for the factors needed for agriculture.

The above procedure is more generalized as it uses MSVPNS which deals with more attributes simultaneously. The beauty of this method is its ease as the researcher need not to manage with complex lengthy computation based operators. Also this method has a practical approach of using broad spectrum that can engage modifications according to the necessity of the provided environment. We can generalize the model of this method in plithogenic neutrosophic environments that can manage difficulties of the physical world.

8. Conclusion and Future Work

In this research work, we studied the application of multi-dimensional single valued plithogenic neutrosophic set in MCDM problems specifically in the field of agriculture. We apply the concept in the research areas which dealing with multi values of attributes. Thus the plithogenic aggregation operators gives the optimal solutions for the plithogenic neutrosophic environment. In future we can extend the concept to interval valued plithogenic neutrosophic sets which may help abundantly in the areas related with decision making.

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