Basic Neutrosophic Notions Concerning Neutrosophic SuperHyperDominating and Neutrosophic SuperHyperResolving in Neutrosophic SuperHyperGraph

Preprint · August 2022

DOI: 10.13140/RG.2.2.29173.86244

1 author:

Henry Garrett

Basic Neutrosophic Notions Concerning Neutrosophic SuperHyperDominating and Neutrosophic SuperHyperResolving in Neutrosophic SuperHyperGraph

Henry Garrett

Independent Researcher

DrHenryGarrett@gmail.com

Twitter's ID: @DrHenryGarrett | ©DrHenryGarrett.wordpress.com

Abstract

Basic neutrosophic notions concerning hugely diverse types of neutrosophic SuperHyperDominating and hugely diverse types of neutrosophic SuperHyperResolving in neutrosophic SuperHyperGraph are introduced. Hugely diverse types of general forms of neutrosophic SuperHyperGraph are discussed. Hugely diverse types of neutrosophic SuperHyperEdges are defined. Different neutrosophic notions are assigned to neutrosophic SuperHyperPaths. Restricted status of neutrosophic classes of neutrosophic SuperHyperGraphs are presented. Different types of neutrosophic strengths and cardinalities are used. Further directions about some types of neutrosophic SuperHyperGraphs are summerized.

Keywords: Neutrosophic SuperHyperDominating, Neutrosophic SuperHyperResolving, Neutrosophic SuperHyperGraph.

AMS Subject Classification: 05C17, 05C22, 05E45

1 Background

Dimension and coloring alongside domination in neutrosophic hypergraphs in **Ref.** [4] by Henry Garrett (2022), three types of neutrosophic alliances based on connectedness and (strong) edges in **Ref.** [6] by Henry Garrett (2022), properties of SuperHyperGraph and neutrosophic SuperHyperGraph in **Ref.** [5] by Henry Garrett (2022), are studied. Also, some studies and researches about neutrosophic graphs, are proposed as a book in **Ref.** [3] by Henry Garrett (2022).

2 Preliminaries

Definition 2.1 (Neutrosophic Set)**.** (**Ref.** [2],Definition 2.1,p.87).

Let X be a space of points (objects) with generic elements in X denoted by x; then the **neutrosophic set** A (NS A) is an object having the form

$$A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$$

where the functions $T, I, F : X \to]^{-}0, 1^{+}[$ define respectively the a **truth-membership function**, an **indeterminacy-membership function**, and a **falsity-membership function** of the element $x \in X$ to the set A with the condition

$$^{-}0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3^{+}.$$

The functions $T_A(x), I_A(x)$ and $F_A(x)$ are real standard or nonstandard subsets of $]^{-}0, 1^{+}[$.

Definition 2.2 (Single Valued Neutrosophic Set)**.** (**Ref.** [9],Definition 6,p.2).

Let X be a space of points (objects) with generic elements in X denoted by x. A **single valued neutrosophic set** A (SVNS A) is characterized by truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. For each point x in X, $T_A(x), I_A(x), F_A(x) \in [0, 1]$. A SVNS A can be written as

$$A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}.$$

Definition 2.3. The crisp subset of X in which all its elements have nonzero membership degree is defined as the degree of truth-membership, indeterminacy-membership and falsity-membership of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$T(A) = \min[T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$I(A) = \min[I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } F(A) = \min[F_A(v_i), F_A(v_j)]_{v_i, v_j \in A}.$$

Definition 2.4. The crisp subset of X in which all its elements have nonzero membership degree is defined as the **support** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$supp(A) = \{x : \ T_A(x), I_A(x), F_A(x) > 0\}.$$

Definition 2.5 (Neutrosophic SuperHyperGraph)**.** (**Ref.** [8],Definition 3,p.291).

A **neutrosophic SuperHyperGraph** (NSHG) S is an ordered pair $S = (V, E)$, where

- (i) $V = \{V_1, V_2, \ldots, V_m\}$ a finite set of finite single valued neutrosophic subsets of V';
- (ii) $V_i = \{(v_i, \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) : \ \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) \geq 0\}$ and $0 \leq \mu_j(v_i) + \lambda_j(v_i) + \tau_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;
- (iii) $E = \{E_1, E_2, \ldots, E_m\}$ a finite set of finite single valued neutrosophic subsets of V;
- (iv) $E_i = \{(V_i, \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) : \ \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) \geq 0\}$ and $0 \leq \mu'_j(V_i) + \lambda'_j(V_i) + \tau'_j(V_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;
- (v) $V_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;
- (vi) $E_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;
- (vii) $\sum_j supp(V_i) = V, \ (j = 1, 2, \ldots, m)$;
- $(viii)$ $\sum_j supp(E_i) = V, \ (j = 1, 2, \ldots, m)$;
- (ix) and the following conditions hold:

$$T(E_j) \leq \min[T(V_i), T(V_j)]_{V_i, V_j \in E_j},$$

$$I(E_j) \leq \min[I(V_i), I(V_j)]_{V_i, V_j \in E_j},$$

$$\text{and } F(E_j) \leq \min[F(V_i), F(V_j)]_{V_i, V_j \in E_j}.$$

Here the edges E_j and the vertices V_j are single valued neutrosophic sets. $\mu_j(v_i), \lambda_j(v_i)$, and $\tau_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the vertex v_i to the vertex V_j. $\mu'_j(v_i), \lambda'_j(v_i)$, and $\tau'_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the vertex v_i to the edge E_j. Thus, the elements of the **incidence matrix** of neutrosophic SuperHyperGraph are of the form $(v_{ij}, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i))$, the sets V and E are crisp sets.

Definition 2.6 (Characterization of the Neutrosophic SuperHyperGraph)**.** (**Ref.** [8],Section 4,pp.291-292).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. The edges E_i and the vertices V_i of SuperHyperGraph (NSHG) $S = (V, E)$ could be characterized as follow-up items.

(i) If $|V_i| = 1$, then V_i is called **vertex**;

(ii) if $|V_i| \geq 1$, then V_i is called **SuperVertex**;

(iii) if for all V_is are incident in E_i, $|V_i| = 1$, and $|E_i| = 2$, then E_i is called **edge**;

(iv) if for all V_is are incident in E_i, $|V_i| = 1$, and $|E_i| \geq 2$, then E_i is called **HyperEdge**;

(v) if there's a V_i is incident in E_i such that $|V_i| \geq 1$, and $|E_i| = 2$, then E_i is called **SuperEdge**;

(vi) if there's a V_i is incident in E_i such that $|V_i| \geq 1$, and $|E_i| \geq 2$, then E_i is called **SuperHyperEdge**.

3 General Forms of Neutrosophic SuperHyperGraph

If we choose different types of binary operations, then we could get hugely diverse types of general forms of neutrosophic SuperHyperGraphs.

Definition 3.1 (t-norm)**.** (**Ref.** [7], Definition 5.1.1, pp.82-83).

A binary operation $\otimes : [0,1] \times [0,1] \to [0,1]$ is a ***t*-norm** if it satisfies the following for $x, y, z, w \in [0,1]$:

(i) $1 \otimes x = x$;

(ii) $x \otimes y = y \otimes x$;

(iii) $x \otimes (y \otimes z) = (x \otimes y) \otimes z$;

(iv) If $w \leq x$ and $y \leq z$ then $w \otimes y \leq x \otimes z$.

Definition 3.2. The crisp subset of X in which all its elements have nonzero membership degree is defined as the degree of truth-membership, indeterminacy-membership and falsity-membership of the single valued neutrosophic set (with respect to t-norm T_{norm}): $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$T(A) = T_{norm}[T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$I(A) = T_{norm}[I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } F(A) = T_{norm}[F_A(v_i), F_A(v_j)]_{v_i, v_j \in A}.$$

Definition 3.3. The crisp subset of X in which all its elements have nonzero membership degree is defined as the **support** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$supp(A) = \{x : \ T_A(x), I_A(x), F_A(x) > 0\}.$$

Definition 3.4. (General Forms of Neutrosophic SuperHyperGraph).
A **neutrosophic SuperHyperGraph** (NSHG) S is an ordered pair $S = (V, E)$, where

(i) $V = \{V_1, V_2, \ldots, V_m\}$ a finite single valued neutrosophic subset of V';

(ii) $V_i = \{(v_i, \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) : \ \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) \geq 0\}$ and $0 \leq \mu_j(v_i) + \lambda_j(v_i) + \tau_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(iii) $E = \{E_1, E_2, \ldots, E_m\}$ a finite single valued neutrosophic subset of V';

(iv) $E_i = \{(v_i, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i)) : \ \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i)) \geq 0\}$ and $0 \leq \mu'_j(v_i) + \lambda'_j(v_i) + \tau'_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(v) $V_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vi) $E_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vii) $\sum_j supp(V_i) = V, \ (j = 1, 2, \ldots, m)$;

$(viii)$ $\sum_j supp(E_i) = V, \ (j = 1, 2, \ldots, m)$.

Here the edges E_j and the vertices V_j are single valued neutrosophic sets. $\mu_j(v_i), \lambda_j(v_i)$, and $\tau_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the vertex v_i to the vertex V_j. $\mu'_j(v_i), \lambda'_j(v_i)$, and $\tau'_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the vertex v_i to the edge E_j. Thus, the elements of the **incidence matrix** of t-norm neutrosophic SuperHyperGraph are of the form $(v_{ij}, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i))$, the sets V and E are crisp sets.

Definition 3.5 (Characterization of the Neutrosophic SuperHyperGraph)**.**
(**Ref.** [8],Section 4,pp.291-292).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. The edges E_i and the vertices V_i of SuperHyperGraph (NSHG) $S = (V, E)$ could be characterized as follow-up items.

(i) If $|V_i| = 1$, then V_i is called **vertex**;

(ii) if $|V_i| \geq 1$, then V_i is called **SuperVertex**;

(iii) if for all V_is are incident in E_i, $|V_i| = 1$, and $|E_i| = 2$, then E_i is called **edge**;

(iv) if for all V_is are incident in E_i, $|V_i| = 1$, and $|E_i| \geq 2$, then E_i is called **HyperEdge**;

(v) if there's a V_i is incident in E_i such that $|V_i| \geq 1$, and $|E_i| = 2$, then E_i is called **SuperEdge**;

(vi) if there's a V_i is incident in E_i such that $|V_i| \geq 1$, and $|E_i| \geq 2$, then E_i is called **SuperHyperEdge**.

4 Relations of Single Valued Neutrosophic Graph and Single Valued Neutrosophic HyperGraph With Neutrosophic SuperHyperGraph

Definition 4.1 (Single Valued Neutrosophic Graph)**.** (**Ref.** [2],Definition 3.1,p.89).

A **single valued neutrosophic graph** (SVN-graph) with underlying set V is defined to be a pair $G = (A, B)$ where

(i) The functions $T_A : V \to [0,1], I_A : V \to [0,1]$, and $F_A : V \to [0,1]$ denote the degree of truth-membership, degree of indeterminacy-membership and falsity-membership of the element $v_i \in V$, respectively, and

$$0 \le T_A(v_i) + I_A(v_i) + F_A(v_i) \le 3 \text{ for all } v_i \in V \ (i = 1, 2, \ldots, n).$$

(ii) The functions $T_B : V \times V \to [0,1], I_B : V \times V \to [0,1]$, and $F_B : V \times V \to [0,1]$ are defined by

$$T_B(\{v_i, v_j\}) \le \min[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \le \min[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \le \min[F_A(v_i), F_A(v_j)]$$

denote the degree of truth-membership, indeterminacy-membership and falsity-membership of the edge $(v_i, v_j) \in E$ respectively, where

$$0 \le T_B(\{v_i, v_j\}) + I_B(\{v_i, v_j\}) + F_B(\{v_i, v_j\}) \le 3 \text{ for all } \{v_i, v_i\} \in E \ (i = 1, 2, \ldots, n).$$

We call A the **single valued neutrosophic vertex set** of V, B the **single valued neutrosophic edge set** of E, respectively. Note that B is a symmetric single valued neutrosophic relation on A. We use the notation (v_i, v_j) for an element of E. Thus, $G = (A, B)$ is a single valued neutrosophic graph of $G^* = (A, B)$ if

$$T_B(\{v_i, v_j\}) \le \min[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \le \min[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \le \min[F_A(v_i), F_A(v_j)] \text{ for all } (v_i, v_j) \in E.$$

Proposition 4.2. *Let an ordered pair $S = (V, E)$ be a single valued neutrosophic graph. Then $S = (V, E)$ is a neutrosophic SuperHyperGraph (NSHG) S.*

Definition 4.3 (Single Valued Neutrosophic HyperGraph)**.** (**Ref.** [1],Definition 2.5,p.123).

Let $V = \{v_1, v_2, \ldots, v_n\}$ be a finite set and $E = \{E_1, E_2, \ldots, E_m\}$ be a finite family of non-trivial single valued neutrosophic subsets of V such that $V = \sum_i supp(E_i),\ i = 1, 2, 3, \ldots, m$, where the edges E_i are single valued neutrosophic subsets of V, $E_i = \{(v_j, T_{E_i}(v_j), I_{E_i}(v_j), F_{E_i}(v_j))\},\ E_i \ne \emptyset$, for $i = 1, 2, 3, \ldots, m$. Then the pair $H = (V, E)$ is a **single valued neutrosophic HyperGraph** on V, E is the family of single-valued neutrosophic HyperEdges of H and V is the crisp vertex set of H.

Proposition 4.4. *Let an ordered pair $S = (V, E)$ be single valued neutrosophic HyperGraph. Then $S = (V, E)$ is a type of general forms of neutrosophic SuperHyperGraph (NSHG) S.*

5 Types of SuperHyperEdges

Definition 5.1. Let an ordered pair $S = (V, E)$ be a neutrosophic SuperHyperGraph (NSHG) S. Then a sequence of SuperHyperVertices and SuperHyperEdges

$$V_1, E_1, V_2, E_2, V_3, \ldots, V_{s-1}, E_{s-1}, V_s$$

is called a **neutrosophic SuperHyperPath** (NSHP) from SuperHyperVertex V_1 to SuperHyperVertex V_s if either of following conditions hold:

(i) $V_i, V_{i+1} \in E_i$;

(ii) there's a vertex $v_i \in V_i$ such that $v_i, V_{i+1} \in E_i$;

(iii) there's a SuperVertex $V_i' \in V_i$ such that $V_i', V_{i+1} \in E_i$;

(iv) there's a vertex $v_{i+1} \in V_{i+1}$ such that $V_i, v_{i+1} \in E_i$;

(v) there's a SuperVertex $V_{i+1}' \in V_{i+1}$ such that $V_i, V_{i+1}' \in E_i$;

(vi) there are a vertex $v_i \in V_i$ and a vertex $v_{i+1} \in V_{i+1}$ such that $v_i, v_{i+1} \in E_i$;

(vii) there are a vertex $v_i \in V_i$ and a SuperVertex $V_{i+1}' \in V_{i+1}$ such that $v_i, V_{i+1}' \in E_i$;

$(viii)$ there are a SuperVertex $V_i' \in V_i$ and a vertex $v_{i+1} \in V_{i+1}$ such that $V_i', v_{i+1} \in E_i$;

(ix) there are a SuperVertex $V_i' \in V_i$ and a SuperVertex $V_{i+1}' \in V_{i+1}$ such that $V_i', V_{i+1}' \in E_i$.

Definition 5.2. (Characterization of the Neutrosophic SuperHyperPaths).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. A neutrosophic SuperHyperPath (NSHP) from SuperHyperVertex V_1 to SuperHyperVertex V_s is sequence of SuperHyperVertices and SuperHyperEdges

$$V_1, E_1, V_2, E_2, V_3, \ldots, V_{s-1}, E_{s-1}, V_s,$$

could be characterized as follow-up items.

(i) If for all V_i, E_j, $|V_i| = 1,\ |E_j| = 2$, then NSHP is called **path**;

(ii) if for all E_j, $|E_j| = 2$, and there's V_i, $|V_i| \geq 1$, then NSHP is called **SuperPath**;

(iii) if for all V_i, E_j, $|V_i| = 1,\ |E_j| \geq 2$, then NSHP is called **HyperPath**;

(iv) if there are V_i, E_j, $|V_i| \geq 1, |E_j| \geq 2$, then NSHP is called **SuperHyperPath**.

Definition 5.3. (Neutrosophic Strength of the Neutrosophic SuperHyperPaths).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. A neutrosophic SuperHyperPath (NSHP) from SuperHyperVertex V_1 to SuperHyperVertex V_s is sequence of SuperHyperVertices and SuperHyperEdges

$$V_1, E_1, V_2, E_2, V_3, \ldots, V_{s-1}, E_{s-1}, V_s,$$

have

(i) **neutrosophic t-strength** $(\min\{T(V_i)\}, m, n)_{i=1}^{s}$;

(ii) **neutrosophic i-strength** $(m, \min\{I(V_i)\}, n)_{i=1}^{s}$;

(iii) **neutrosophic f-strength** $(m, n, \min\{F(V_i)\})_{i=1}^{s}$;

(*iv*) **neutrosophic strength** $(\min\{T(V_i)\}, \min\{I(V_i)\}, \min\{F(V_i)\})_{i=1}^{s}$.

Definition 5.4. (Different Types of SuperHyperEdges).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Consider a SuperHyperEdge $E = \{V_1, V_2, \ldots, V_s\}$. Then E is called

(*i*) **neutrosophic** $\mathbf{a_T}$ if $T(E) = \min\{T(V_i)\}_{i=1}^{s}$;

(*ii*) **neutrosophic** $\mathbf{a_I}$ if $I(E) = \min\{I(V_i)\}_{i=1}^{s}$;

(*iii*) **neutrosophic** $\mathbf{a_F}$ if $F(E) = \min\{F(V_i)\}_{i=1}^{s}$;

(*iv*) **neutrosophic** $\mathbf{a_{TIF}}$ if $(T(E), I(E), F(E)) = (\min\{T(V_i)\}, \min\{I(V_i)\}, \min\{F(V_i)\})_{i=1}^{s}$;

(*v*) **neutrosophic** $\mathbf{b_T}$ if $T(E) = \prod\{T(V_i)\}_{i=1}^{s}$;

(*vi*) **neutrosophic** $\mathbf{b_I}$ if $I(E) = \prod\{I(V_i)\}_{i=1}^{s}$;

(*vii*) **neutrosophic** $\mathbf{b_F}$ if $F(E) = \prod\{F(V_i)\}_{i=1}^{s}$;

(*viii*) **neutrosophic** $\mathbf{b_{TIF}}$ if $(T(E), I(E), F(E)) = (\prod\{T(V_i)\}, \prod\{I(V_i)\}, \prod\{F(V_i)\})_{i=1}^{s}$;

(*ix*) **neutrosophic** $\mathbf{c_T}(/-\mathbf{d_T}/-\mathbf{e_T}/-\mathbf{f_T}/-\mathbf{g_T})$ if $T(E) > (/-\geq/-=/-</-\leq)$ maximum number of neutrosophic t-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j where $1 \leq i, j \leq s$;

(*x*) **neutrosophic** $\mathbf{c_I}(/-\mathbf{d_I}/-\mathbf{e_I}/-\mathbf{f_I}/-\mathbf{g_I})$ if $I(E) > (/-\geq/-=/-</-\leq)$ maximum number of neutrosophic i-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j where $1 \leq i, j \leq s$;

(*xi*) **neutrosophic** $\mathbf{c_F}(/-\mathbf{d_F}/-\mathbf{e_F}/-\mathbf{f_F}/-\mathbf{g_F})$ if $F(E) > (/-\geq/-=/-</-\leq)$ maximum number of neutrosophic f-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j where $1 \leq i, j \leq s$;

(*xii*) **neutrosophic** $\mathbf{c_{TIF}}(/-\mathbf{d_{TIF}}/-\mathbf{e_{TIF}}/-\mathbf{f_{TIF}}/-\mathbf{g_{TIF}})$ if $(T(E), I(E), F(E)) > (/-\geq/-=/-</-\leq)$ maximum number of neutrosophic strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j where $1 \leq i, j \leq s$.

6 Types of Notions Based on Different SuperHyperEdges

6.1 Symmetric Notions

For instance, both SuperHyperDominate, instantly.

Definition 6.1. (Neutrosophic SuperHyperDominating).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let D be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertex N in $V \setminus D$, there's at least a neutrosophic SuperHyperVertex D_i in D such that N, D_i is in a SuperHyperEdge is neutrosophic

$a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **SuperHyperDominating set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ SuperHyperDominating sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **SuperHyperDominating number** and it's denoted by $\mathcal{D}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A=\{<x:T_A(x),I_A(x),F_A(x)>,x\in X\}$:

$$|A|_T=\sum[T_A(v_i),T_A(v_j)]_{v_i,v_j\in A},$$

$$|A|_I=\sum[I_A(v_i),I_A(v_j)]_{v_i,v_j\in A},$$

$$|A|_F=\sum[F_A(v_i),F_A(v_j)]_{v_i,v_j\in A},$$

$$\text{and } |A|=\sum[|A|_T,|A|_I,|A|_F].$$

Definition 6.2. (Neutrosophic k-number SuperHyperDominating).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S=(V,E)$. Let D be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertex N in $V\setminus D$, there are at least neutrosophic SuperHyperVertices $D_1,D_2,\ldots,D_k$ in D such that $N,D_i(i=1,2,\ldots,k)$ is in a SuperHyperEdge is neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **k-number SuperHyperDominating set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ SuperHyperDominating sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **k-number SuperHyperDominating number** and it's denoted by $\mathcal{D}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A=\{<x:T_A(x),I_A(x),F_A(x)>,x\in X\}$:

$$|A|_T=\sum[T_A(v_i),T_A(v_j)]_{v_i,v_j\in A},$$

$$|A|_I=\sum[I_A(v_i),I_A(v_j)]_{v_i,v_j\in A},$$

$$|A|_F=\sum[F_A(v_i),F_A(v_j)]_{v_i,v_j\in A},$$

$$\text{and } |A|=\sum[|A|_T,|A|_I,|A|_F].$$

Definition 6.3. (Neutrosophic Dual SuperHyperDominating).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S=(V,E)$. Let D be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertex D_i in D, there's at least a neutrosophic SuperHyperVertex N in $V \setminus D$, such that N, D_i is in a SuperHyperEdge is neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **dual SuperHyperDominating set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ SuperHyperDominating sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **dual SuperHyperDominating number** and it's denoted by $\mathcal{D}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.4. (Neutrosophic Perfect SuperHyperDominating).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let D be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertex N in $V \setminus D$, there's only one neutrosophic SuperHyperVertex D_i in D such that N, D_i is in a SuperHyperEdge is neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **perfect SuperHyperDominating set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ SuperHyperDominating sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **perfect SuperHyperDominating number** and it's denoted by $\mathcal{D}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.5. (Neutrosophic Total SuperHyperDominating).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let D be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertex N in V, there's at least a neutrosophic SuperHyperVertex D_i in D such that N, D_i is in a SuperHyperEdge is neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **total SuperHyperDominating set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})$ SuperHyperDominating sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}$ **total SuperHyperDominating number** and it's denoted by $\mathcal{D}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-g_T/-g_I/-g_F/-g_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.6. (Different Types of SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. If $d(R_i, N) \neq d(R_i, N')$, then two SuperHyperVertices N and N' are

(i) **neutrosophic $\mathbf{a_T}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \min\{T(V_i), T(V_j)\}$;

(ii) **neutrosophic $\mathbf{a_I}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \min\{I(V_i), I(V_j)\}$;

(iii) **neutrosophic $\mathbf{a_F}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \min\{F(V_i), F(V_j)\}$;

(iv) **neutrosophic $\mathbf{a_{TIF}}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = (\min\{T(V_i), T(V_j)\}, \min\{I(V_i), I(V_j)\}, \min\{F(V_i), F(V_j)\})$;

(v) **neutrosophic $\mathbf{b_T}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \prod\{T(V_i), T(V_j)\}$;

(vi) **neutrosophic $\mathbf{b_I}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \prod\{I(V_i), I(V_j)\}$;

(vii) **neutrosophic $\mathbf{b_F}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = \prod\{F(V_i), F(V_j)\}$;

(viii) **neutrosophic $\mathbf{a_{TIF}}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j) = (\prod\{T(V_i), T(V_j)\}, \prod\{I(V_i), I(V_j)\}, \prod\{F(V_i), F(V_j)\})$;

(ix) **neutrosophic $\mathbf{c_T}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of neutrosophic t-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j;

(x) **neutrosophic $\mathbf{c_I}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of neutrosophic i-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xi) **neutrosophic $\mathbf{c_F}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of neutrosophic f-strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xii) **neutrosophic $\mathbf{c_{TIF}}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of neutrosophic strength of SuperHyperPath (NSHP) from SuperHyperVertex V_i to SuperHyperVertex V_j;

$(xiii)$ **neutrosophic $\mathbf{d_T}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of degree of truth-membership of all SuperHyperVertices in SuperHyperPath (NSHP) with maximum number of neutrosophic t-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xiv) **neutrosophic $\mathbf{d_I}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of degree of indeterminacy-membership of all SuperHyperVertices in SuperHyperPath (NSHP) with maximum number of neutrosophic i-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xv) **neutrosophic $\mathbf{d_F}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of degree of falsity-membership of all SuperHyperVertices in SuperHyperPath (NSHP) with maximum number of neutrosophic f-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xvi) **neutrosophic $\mathbf{d_{TIF}}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of the triple (degree of truth-membership, degree of indeterminacy-membership, degree of falsity-membership) of all SuperHyperVertices in SuperHyperPath (NSHP) with maximum number of neutrosophic f-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

$(xvii)$ **neutrosophic $\mathbf{e_T}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of SuperHyperEdges in SuperHyperPath (NSHP) with maximum number of neutrosophic t-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

$(xviii)$ **neutrosophic $\mathbf{e_I}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of SuperHyperEdges in SuperHyperPath (NSHP) with maximum number of neutrosophic i-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xix) **neutrosophic $\mathbf{e_F}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of SuperHyperEdges in SuperHyperPath (NSHP) with maximum number of neutrosophic f-strength from SuperHyperVertex V_i to SuperHyperVertex V_j;

(xx) **neutrosophic $\mathbf{e_{TIF}}$ resolved** by SuperHyperVertex R_i where $d(V_i, V_j)$ is the maximum number of SuperHyperEdges in SuperHyperPath (NSHP) with maximum number of neutrosophic t-strength, neutrosophic i-strength and neutrosophic f-strength from SuperHyperVertex V_i to SuperHyperVertex V_j.

Definition 6.7. (Neutrosophic SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let R be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertices N and N' in $V \setminus R$, there's at least a neutrosophic SuperHyperVertex R_i in R such that N and N' are neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ resolved by R_i, then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **SuperHyperResolving set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ SuperHyperResolving sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **SuperHyperResolving number** and it's denoted by $\mathcal{R}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.8. (Neutrosophic k-number SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let R be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertices N and N' in $V \setminus R$, there are at least neutrosophic SuperHyperVertices $R_1, R_2, \ldots, R_k$ in R such that N and N' are neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ resolved by $R_i (i = 1, 2, \ldots, k)$, then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **k-number SuperHyperResolving set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ SuperHyperResolving sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **k-number SuperHyperResolving number** and it's denoted by $\mathcal{R}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.9. (Neutrosophic Dual SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let R be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertices R_i and R_j in R, there's at least a neutrosophic SuperHyperVertex N in $V \setminus R$ such that R_i and R_j are neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ resolved by R_i, then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **dual SuperHyperResolving set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ SuperHyperResolving sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **dual SuperHyperResolving number** and it's denoted by $\mathcal{R}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.10. (Neutrosophic Perfect SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let R be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertices N and N' in $V \setminus R$, there's only one neutrosophic SuperHyperVertex R_i in R such that N and N' are neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ resolved by R_i, then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **perfect SuperHyperResolving set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ SuperHyperResolving sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **perfect SuperHyperResolving number** and it's denoted by $\mathcal{R}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.11. (Neutrosophic Total SuperHyperResolving).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let R be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. If for every neutrosophic SuperHyperVertices N and N' in V, there's at least a neutrosophic SuperHyperVertex R_i in R such that N and N' are neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ resolved by R_i, then the set of neutrosophic SuperHyperVertices S is called **neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **total SuperHyperResolving set**. The minimum (I-/F-/- -)T-neutrosophic cardinality between all neutrosophic $a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})$ SuperHyperResolving sets is called **(I-/F-/- -)T-neutrosophic** $\mathbf{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}$ **total SuperHyperResolving number** and it's denoted by $\mathcal{R}_{a_T(-a_I/-a_F/-a_{TIF}/-b_T/-b_I/-b_F/-b_{TIF}/-\ldots/-e_T/-e_I/-e_F/-e_{TIF})}(NSHG)$ where **(I-/F-/- -)T-neutrosophic cardinality** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$|A|_T = \sum [T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_I = \sum [I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$|A|_F = \sum [F_A(v_i), F_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } |A| = \sum [|A|_T, |A|_I, |A|_F].$$

Definition 6.12. (Neutrosophic Stable and Neutrosophic Connected).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. Let Z be a set of neutrosophic SuperHyperVertices [a SuperHyperVertex alongside triple pair of its values is called neutrosophic SuperHyperVertex.]. Then Z is called

(i) **stable** if for every two SuperHyperVertices in Z, there's no SuperHyperPaths amid them;

(ii) **connected** if for every two SuperHyperVertices in Z, there's at least one SuperHyperPath amid them.

Thus Z is called

(i) **stable (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set** if Z is (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set and stable;

(ii) **connected (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set** if Z is (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set and connected.

A number N is called

(i) **stable (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) number** if its corresponded set Z is (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set and stable;

(*ii*) **connected (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) number** if its corresponded set Z is (k-number/dual/perfect/total) (SuperHyperResolving/SuperHyperDominating) set and connected.

Thus Z is called

(*i*) **(-/stable/connected) (-/dual/total) perfect (SuperHyperResolving/SuperHyperDominating) set** if Z is (-/stable/connected) (-/dual/total) perfect (SuperHyperResolving/SuperHyperDominating) set.

A number N is called

(*i*) **-/stable/connected) (-/dual/total) perfect (SuperHyperResolving/SuperHyperDominating) number** if its corresponded set Z is -/stable/connected) (-/dual/total) perfect (SuperHyperResolving/SuperHyperDominating) set.

6.2 Antisymmetric Notions

For instance, SuperHyperVertex with bigger values SuperHyperDominates, instantly.

7 Classes of Neutrosophic SuperHyperGraphs

7.1 Restricted Status of Classes of Neutrosophic SuperHyperGraphs

Assume neutrosophic SuperHyperEdges (NSHE) E_i such that there's a V_i is incident in E_i such that $|V_i| \geq 1$, and $|E_i| = 2$. Consider $\mu = (\mu_1, \mu_2, \mu_3), \mu' = (\mu'_1, \mu'_2, \mu'_3)$.

Definition 7.1. Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$ and $\mathcal{O}(NSHG) = |V|$. Then

(*i*) : a sequence of consecutive neutrosophic SuperHyperVertices (NSHV) $(NSHP) : \{x_0\}, \{x_1\}, \cdots, \{x_{\mathcal{O}(NSHG)}\}$ is called **neutrosophic SuperHyperPath** (NSHP) where

$$\{\{x_i, \}\{x_{i+1}\}\} \in E, \ i = 0, 1, \cdots, \mathcal{O}(NSHG) - 1;$$

(*ii*) : **neutrosophic SuperHyperStrength** (NSHH) of neutrosophic SuperHyperPath (NSHP) $NSHP : \{x_0\}, \{x_1\}, \cdots, \{x_{\mathcal{O}(NSHG)}\}$ is $\bigwedge_{i=0,\cdots,\mathcal{O}(NSHG)-1} \mu'(\{\{x_i\}, \{x_{i+1}\}\})$;

(*iii*) : **neutrosophic SuperHyperConnectedness** (NSHN) amid neutrosophic SuperHyperVertices (NSHV) x_0 and x_t is

$$NSHN = \mu^{\infty}(x_0, x_t) = \bigvee_{P:\{x_0\},\{x_1\},\cdots,\{x_{\mathcal{O}(NSHG)}\}} \bigwedge_{i=0,\cdots,t-1} \mu'(\{\{x_i\}, \{x_{i+1}\}\});$$

(*iv*) : a sequence of consecutive neutrosophic SuperHyperVertices (NSHV) $NSHP : \{x_0\}, \{x_1\}, \cdots, \{x_{\mathcal{O}(NSHG)}\}, \{x_0\}$ is called **neutrosophic SuperHyperCycle** (NSHC) where

$$\{\{x_i\}, \{x_{i+1}\}\} \in E, \ i = 0, 1, \cdots, \mathcal{O}(NTG) - 1, \ \{\{x_{\mathcal{O}(NTG)}\}, \{x_0\}\} \in E$$

and there are two neutrosophic SuperHyperEdges (NSHE) $\{\{x\},\{y\}\}$ and $\{\{u\},\{v\}\}$ such that

$$\mu'(\{\{x\},\{y\}\}) = \mu'(\{\{u\},\{v\}\}) = \bigwedge_{i=0,1,\cdots,n-1} \mu'(\{\{v_i\},\{v_{i+1}\}\});$$

(v) : it's **neutrosophic SuperHyper-t-partite** (NSHT) where V is partitioned to t parts, $V_1^{s_1}, V_2^{s_2}, \cdots, V_t^{s_t}$ and the neutrosophic SuperHyperEdge (NSHE) $\{\{x\},\{y\}\}$ implies $\{x\} \in V_i^{s_i}$ and $\{y\} \in V_j^{s_j}$ where $i \neq j$. If it's neutrosophic SuperHyperComplete (NSHM), then it's denoted by $K_{\sigma_1,\sigma_2,\cdots,\sigma_t}$ where σ_i is σ on $V_i^{s_i}$ instead V which mean $\{x\} \notin V_i$ induces $\mu_i(\{x\}) = 0$. Also, $|V_j^{s_i}| = s_i$;

(vi) : neutrosophic SuperHyper-t-partite is **neutrosophic SuperHyperBipartite** (NSHB) if $t = 2$, and it's denoted by K_{σ_1,σ_2} if it's neutrosophic SuperHyperComplete (NSHM);

(vii) : neutrosophic SuperHyperBipartite is **neutrosophic SuperHyperStar** (NSHS) if $|V_1| = 1$, and it's denoted by S_{1,σ_2};

$(viii)$: a neutrosophic SuperHyperVertex (NSHV) in V is **neutrosophic SuperHyperCenter** (NSHR) if the neutrosophic SuperHyperVertex (NSHV) joins to all neutrosophic SuperHyperVertices (NSHV) of a neutrosophic SuperHyperCycle (NSHC). Then it's **neutrosophic SuperHyperWheel** (NSHW) and it's denoted by W_{1,σ_2};

(ix) : it's **neutrosophic SuperHyperComplete** (NSHM) where

$$\forall \{u\},\{v\} \in V,\ \mu'(\{\{u\},\{v\}\}) = \mu(\{u\}) \wedge \mu(\{v\});$$

(x) : it's **neutrosophic SuperHyperStrong** (NSHO) where

$$\forall \{\{u\},\{v\}\} \in E,\ \mu'(\{\{u\},\{v\}\}) = \mu(\{u\}) \wedge \mu(\{v\}).$$

8 Further Directions

8.1 First Direction

Definition 8.1 (t-norm)**.** (**Ref.** [7], Definition 5.1.1, pp.82-83).

A binary operation $\otimes : [0,1] \times [0,1] \to [0,1]$ is a ***t*-norm** if it satisfies the following for $x, y, z, w \in [0,1]$:

(i) $1 \otimes x = x$;

(ii) $x \otimes y = y \otimes x$;

(iii) $x \otimes (y \otimes z) = (x \otimes y) \otimes z$;

(iv) If $w \leq x$ and $y \leq z$ then $w \otimes y \leq x \otimes z$.

Definition 8.2. (t-norm Single Valued Neutrosophic Graph).

A **t-norm single valued neutrosophic graph** (tSVN-graph) with underlying set V is defined to be a pair $G = (A, B)$ where

(i) The functions $T_A : V \to [0,1], I_A : V \to [0,1]$, and $F_A : V \to [0,1]$ denote the degree of truth-membership, degree of indeterminacy-membership and falsity-membership of the element $v_i \in V$, respectively, and

$$0 \leq T_A(v_i) + I_A(v_i) + F_A(v_i) \leq 3 \text{ for all } v_i \in V \ (i = 1, 2, \ldots, n).$$

(ii) The functions $T_B : V \times V \to [0,1], I_B : V \times V \to [0,1]$, and $F_B : V \times V \to [0,1]$ are defined by

$$T_B(\{v_i, v_j\}) \leq T_{norm}[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \leq T_{norm}[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \leq T_{norm}[F_A(v_i), F_A(v_j)]$$

denote the degree of truth-membership, indeterminacy-membership and falsity-membership of the edge $(v_i, v_j) \in E$ respectively, where

$$0 \leq T_B(\{v_i, v_j\}) + I_B(\{v_i, v_j\}) + F_B(\{v_i, v_j\}) \leq 3 \text{ for all } \{v_i, v_i\} \in E \ (i = 1, 2, \ldots, n).$$

We call A the **single valued neutrosophic vertex set** of V, B the **single valued neutrosophic edge set** of E, respectively. Note that B is a symmetric single valued neutrosophic relation on A. We use the notation (v_i, v_j) for an element of E. Thus, $G = (A, B)$ is a t-norm single valued neutrosophic graph of $G^* = (A, B)$ if

$$T_B(\{v_i, v_j\}) \leq T_{norm}[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \leq T_{norm}[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \leq T_{norm}[F_A(v_i), F_A(v_j)] \text{ for all } (v_i, v_j) \in E.$$

Definition 8.3. The crisp subset of X in which all its elements have nonzero membership degree is defined as the degree of truth-membership, indeterminacy-membership and falsity-membership of the single valued neutrosophic set (with respect to t-norm T_{norm}): $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$T(A) = T_{norm}[T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$I(A) = T_{norm}[I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } F(A) = T_{norm}[F_A(v_i), F_A(v_j)]_{v_i, v_j \in A}.$$

Definition 8.4. The crisp subset of X in which all its elements have nonzero membership degree is defined as the **support** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$supp(A) = \{x : \ T_A(x), I_A(x), F_A(x) > 0\}.$$

Definition 8.5. (t-norm Neutrosophic SuperHyperGraph).

A **t-norm neutrosophic SuperHyperGraph** (tNSHG) S is an ordered pair $S = (V, E)$, where

(i) $V = \{V_1, V_2, \ldots, V_m\}$ a finite single valued neutrosophic subset of V';

(ii) $V_i = \{(v_i, \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) : \ \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) \geq 0\}$ and $0 \leq \mu_j(v_i) + \lambda_j(v_i) + \tau_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(iii) $E = \{E_1, E_2, \ldots, E_m\}$ a finite single valued neutrosophic subset of V';

(iv) $E_i = \{(v_i, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i)) : \ \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i)) \geq 0\}$ and $0 \leq \mu'_j(v_i) + \lambda'_j(v_i) + \tau'_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(v) $V_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vi) $E_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vii) $\sum_j supp(V_i) = V, \ (j = 1, 2, \ldots, m)$;

(viii) $\sum_j supp(E_i) = V,\ (j = 1, 2, \ldots, m)$;

(ix) and the following conditions hold:

$$T(E_j) \leq T_{norm}[T(V_i), T(V_j)]_{V_i, V_j \in E_j},$$

$$I(E_j) \leq T_{norm}[I(V_i), I(V_j)]_{V_i, V_j \in E_j},$$

$$\text{and } F(E_j) \leq T_{norm}[F(V_i), F(V_j)]_{V_i, V_j \in E_j}.$$

Here the edges E_j and the vertices V_j are single valued neutrosophic sets. $\mu_j(v_i), \lambda_j(v_i)$, and $\tau_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the vertex v_i to the vertex V_j. $\mu'_j(v_i), \lambda'_j(v_i)$, and $\tau'_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the vertex v_i to the edge E_j. Thus, the elements of the **incidence matrix** of t-norm neutrosophic SuperHyperGraph are of the form $(v_{ij}, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i))$, the sets V and E are crisp sets.

8.2 Second Direction

Definition 8.6. (x Single Valued Neutrosophic Graph).

A **x single valued neutrosophic graph** (xSVN-graph) with underlying set V is defined to be a pair $G = (A, B)$ where

(i) The functions $T_A : V \to [0, 1], I_A : V \to [0, 1]$, and $F_A : V \to [0, 1]$ denote the degree of truth-membership, degree of indeterminacy-membership and falsity-membership of the element $v_i \in V$, respectively, and

$$0 \leq T_A(v_i) + I_A(v_i) + F_A(v_i) \leq 3 \text{ for all } v_i \in V\ (i = 1, 2, \ldots, n).$$

(ii) The functions $T_B : V \times V \to [0, 1], I_B : V \times V \to [0, 1]$, and $F_B : V \times V \to [0, 1]$ are defined by

$$T_B(\{v_i, v_j\}) \leq \max[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \leq \max[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \leq \max[F_A(v_i), F_A(v_j)]$$

denote the degree of truth-membership, indeterminacy-membership and falsity-membership of the edge $(v_i, v_j) \in E$ respectively, where

$$0 \leq T_B(\{v_i, v_j\}) + I_B(\{v_i, v_j\}) + F_B(\{v_i, v_j\}) \leq 3 \text{ for all } \{v_i, v_i\} \in E\ (i = 1, 2, \ldots, n).$$

We call A the **single valued neutrosophic vertex set** of V, B the **single valued neutrosophic edge set** of E, respectively. Note that B is a symmetric single valued neutrosophic relation on A. We use the notation (v_i, v_j) for an element of E. Thus, $G = (A, B)$ is a x single valued neutrosophic graph of $G^* = (A, B)$ if

$$T_B(\{v_i, v_j\}) \leq \max[T_A(v_i), T_A(v_j)],$$

$$I_B(\{v_i, v_j\}) \leq \max[I_A(v_i), I_A(v_j)],$$

$$\text{and } F_B(\{v_i, v_j\}) \leq \max[F_A(v_i), F_A(v_j)] \text{ for all } (v_i, v_j) \in E.$$

Definition 8.7. The crisp subset of X in which all its elements have nonzero membership degree is defined as the degree of truth-membership, indeterminacy-membership and falsity-membership of the single valued neutrosophic set: $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$T(A) = \max[T_A(v_i), T_A(v_j)]_{v_i, v_j \in A},$$

$$I(A) = \max[I_A(v_i), I_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } F(A) = \max[F_A(v_i), F_A(v_j)]_{v_i, v_j \in A}.$$

Definition 8.8. The crisp subset of X in which all its elements have nonzero membership degree is defined as the **support** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$supp(A) = \{x : \ T_A(x), I_A(x), F_A(x) > 0\}.$$

Definition 8.9. (x Neutrosophic SuperHyperGraph).

A **x neutrosophic SuperHyperGraph** (xNSHG) S is an ordered pair $S = (V, E)$, where

(i) $V = \{V_1, V_2, \ldots, V_m\}$ a finite set of finite single valued neutrosophic subsets of V';

(ii) $V_i = \{(v_i, \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) : \ \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) \geq 0\}$ and $0 \leq \mu_j(v_i) + \lambda_j(v_i) + \tau_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(iii) $E = \{E_1, E_2, \ldots, E_m\}$ a finite set of finite single valued neutrosophic subsets of V;

(iv) $E_i = \{(V_i, \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) : \ \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) \geq 0\}$ and $0 \leq \mu'_j(V_i) + \lambda'_j(V_i) + \tau'_j(V_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(v) $V_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vi) $E_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vii) $\sum_j supp(V_i) = V, \ (j = 1, 2, \ldots, m)$;

$(viii)$ $\sum_j supp(E_i) = V, \ (j = 1, 2, \ldots, m)$;

(ix) and the following conditions hold:

$$T(E_j) \leq \max[T(V_i), T(V_j)]_{V_i, V_j \in E_j},$$

$$I(E_j) \leq \max[I(V_i), I(V_j)]_{V_i, V_j \in E_j},$$

$$\text{and } F(E_j) \leq \max[F(V_i), F(V_j)]_{V_i, V_j \in E_j}.$$

Here the edges E_j and the vertices V_j are single valued neutrosophic sets. $\mu_j(v_i), \lambda_j(v_i)$, and $\tau_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the vertex v_i to the vertex V_j. $\mu'_j(v_i), \lambda'_j(v_i)$, and $\tau'_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the vertex v_i to the edge E_j. Thus, the elements of the **incidence matrix** of x neutrosophic SuperHyperGraph are of the form $(v_{ij}, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i))$, the sets V and E are crisp sets.

8.3 Third Direction

Definition 8.10. (p Single Valued Neutrosophic Graph).

A **p single valued neutrosophic graph** (pSVN-graph) with underlying set V is defined to be a pair $G = (A, B)$ where

(i) The functions $T_A : V \to [0, 1], I_A : V \to [0, 1]$, and $F_A : V \to [0, 1]$ denote the degree of truth-membership, degree of indeterminacy-membership and falsity-membership of the element $v_i \in V$, respectively, and

$$0 \leq T_A(v_i) + I_A(v_i) + F_A(v_i) \leq 3 \text{ for all } v_i \in V \ (i = 1, 2, \ldots, n).$$

(ii) The functions $T_B : V \times V \to [0, 1], I_B : V \times V \to [0, 1]$, and $F_B : V \times V \to [0, 1]$ are defined by

$$T_B(\{v_i, v_j\}) \leq T_A(v_i) \times T_A(v_j),$$

$$I_B(\{v_i, v_j\}) \leq I_A(v_i) \times I_A(v_j),$$

$$\text{and } F_B(\{v_i, v_j\}) \leq F_A(v_i) \times F_A(v_j)$$

denote the degree of truth-membership, indeterminacy-membership and falsity-membership of the edge $(v_i, v_j) \in E$ respectively, where

$$0 \leq T_B(\{v_i, v_j\}) + I_B(\{v_i, v_j\}) + F_B(\{v_i, v_j\}) \leq 3 \text{ for all } \{v_i, v_i\} \in E \ (i = 1, 2, \ldots, n).$$

We call A the **single valued neutrosophic vertex set** of V, B the **single valued neutrosophic edge set** of E, respectively. Note that B is a symmetric single valued neutrosophic relation on A. We use the notation (v_i, v_j) for an element of E. Thus, $G = (A, B)$ is a p single valued neutrosophic graph of $G^* = (A, B)$ if

$$T_B(\{v_i, v_j\}) \leq T_A(v_i) \times T_A(v_j),$$

$$I_B(\{v_i, v_j\}) \leq I_A(v_i) \times I_A(v_j),$$

$$\text{and } F_B(\{v_i, v_j\}) \leq F_A(v_i) \times F_A(v_j) \text{ for all } (v_i, v_j) \in E.$$

Definition 8.11. The crisp subset of X in which all its elements have nonzero membership degree is defined as the degree of truth-membership, indeterminacy-membership and falsity-membership of the single valued neutrosophic set: $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$T(A) = [T_A(v_i) \times T_A(v_j)]_{v_i, v_j \in A},$$

$$I(A) = [I_A(v_i) \times I_A(v_j)]_{v_i, v_j \in A},$$

$$\text{and } F(A) = [F_A(v_i) \times F_A(v_j)]_{v_i, v_j \in A}.$$

Definition 8.12. The crisp subset of X in which all its elements have nonzero membership degree is defined as the **support** of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

$$supp(A) = \{x : \ T_A(x), I_A(x), F_A(x) > 0\}.$$

Definition 8.13. (p Neutrosophic SuperHyperGraph).

A **p neutrosophic SuperHyperGraph** (pNSHG) S is an ordered pair $S = (V, E)$, where

(i) $V = \{V_1, V_2, \ldots, V_m\}$ a finite set of finite single valued neutrosophic subsets of V';

(ii) $V_i = \{(v_i, \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) : \ \mu_j(v_i), \lambda_j(v_i), \tau_j(v_i)) \geq 0\}$ and $0 \leq \mu_j(v_i) + \lambda_j(v_i) + \tau_j(v_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(iii) $E = \{E_1, E_2, \ldots, E_m\}$ a finite set of finite single valued neutrosophic subsets of V;

(iv) $E_i = \{(V_i, \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) : \ \mu'_j(V_i), \lambda'_j(V_i), \tau'_j(V_i)) \geq 0\}$ and $0 \leq \mu'_j(V_i) + \lambda'_j(V_i) + \tau'_j(V_i)) \leq 3, \ (j = 1, 2, \ldots, m)$;

(v) $V_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vi) $E_i \neq \emptyset, \ (j = 1, 2, \ldots, m)$;

(vii) $\sum_j supp(V_i) = V, \ (j = 1, 2, \ldots, m)$;

$(viii)$ $\sum_j supp(E_i) = V, \ (j = 1, 2, \ldots, m)$;

(ix) and the following conditions hold:

$$T(E_j) \leq [T(V_i) \times T(V_j)]_{V_i, V_j \in E_j},$$

$$I(E_j) \leq [I(V_i) \times I(V_j)]_{V_i, V_j \in E_j},$$

$$\text{and } F(E_j) \leq [F(V_i) \times F(V_j)]_{V_i, V_j \in E_j}.$$

Here the edges E_j and the vertices V_j are single valued neutrosophic sets. $\mu_j(v_i), \lambda_j(v_i)$, and $\tau_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the vertex v_i to the vertex V_j. $\mu'_j(v_i), \lambda'_j(v_i)$, and $\tau'_j(v_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the vertex v_i to the edge E_j. Thus, the elements of the **incidence matrix** of p neutrosophic SuperHyperGraph are of the form $(v_{ij}, \mu'_j(v_i), \lambda'_j(v_i), \tau'_j(v_i))$, the sets V and E are crisp sets.

References

1. M. Akram et al., "*Single-valued neutrosophic Hypergraphs*", TWMS J. App. Eng. Math. 8 (1) (2018) 122-135.

2. S. Broumi et al., "*Single-valued neutrosophic graphs*", Journal of New Theory 10 (2016) 86-101.

3. Henry Garrett, (2022). "*Beyond Neutrosophic Graphs*", Ohio: E-publishing: Educational Publisher 1091 West 1st Ave Grandview Heights, Ohio 43212 United States. ISBN: 979-1-59973-725-6 (http://fs.unm.edu/BeyondNeutrosophicGraphs.pdf).

4. Henry Garrett, "*Dimension and Coloring alongside Domination in Neutrosophic Hypergraphs*", Preprints 2021, 2021120448 (doi: 10.20944/preprints202112.0448.v1).

5. Henry Garrett, "*Properties of SuperHyperGraph and Neutrosophic SuperHyperGraph*", Neutrosophic Sets and Systems 49 (2022) 531-561 (doi: 10.5281/zenodo.6456413). (http://fs.unm.edu/NSS/NeutrosophicSuperHyperGraph34.pdf). (https://digitalrepository.unm.edu/nss_journal/vol49/iss1/34).

6. Henry Garrett, "*Three Types of Neutrosophic Alliances based on Connectedness and (Strong) Edges*", Preprints 2022, 2022010239 (doi: 10.20944/preprints202201.0239.v1).

7. H.T. Nguyen and E.A. Walker, "*A First course in fuzzy logic*", CRC Press, 2006.

8. F. Smarandache, "*Extension of HyperGraph to n-SuperHyperGraph and to Plithogenic n-SuperHyperGraph, and Extension of HyperAlgebra to n-ary (Classical-/Neutro-/Anti-) HyperAlgebra*", Neutrosophic Sets and Systems 33 (2020) 290-296. (doi: 10.5281/zenodo.3783103).

9. H. Wang et al., "*Single-valued neutrosophic sets*", Multispace and Multistructure 4 (2010) 410-413.