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Some SuperHyperDegrees and Co-SuperHyperDegrees on Neutrosophic SuperHyperGraphs And SuperHyperGraphs Alongside Applications in Cancer's Treatments

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Abstract

In this research, new setting is introduced for new notions, namely, SuperHyperDegree and Co-SuperHyperDegree. Two different types of definitions are debut for them but the research goes further and the SuperHyperNotion, SuperHyperUniform, and SuperHyperClass based on that are well-defined and well-reviewed. The literature review is implemented in the whole of this research. For shining the elegancy and the significancy of this research, the comparison between this SuperHyperNotion with other SuperHyperNotions and fundamental SuperHyperNumbers are featured. The definitions are followed by the examples and the instances thus the clarifications are driven with different tools. The applications are figured out to make sense about the theoretical aspect of this ongoing research. The cancer's treatments are the under research to figure out the challenges make sense about ongoing and upcoming research. The special case is up. The cells are viewed in the deemed ways. There are different types of them. Some of them are individuals and some of them are well-modeled by the group of cells. These types are all officially called "SuperHyperVertex" but the relations amid them all officially called "SuperHyperEdge". The frameworks "SuperHyperGraph" and "neutrosophic SuperHyperGraph" are chosen and elected to research about "cancer's treatments". Thus these complex and dense SuperHyperModels open up some avenues to research on theoretical segments and "cancer's treatments". Some avenues are posed to pursue this research. It's also officially collected in the form of some questions and some problems. If there's a SuperHyperEdge between two SuperHyperVertices, then these two SuperHyperVertices are called SuperHyperNeighbors. The number of SuperHyperNeighbors for a given SuperHyperVertex is called SuperHyperDegree. The number of common SuperHyperNeighbors for some SuperHyperVertices is called Co-SuperHyperDegree for them and used SuperHyperVertices are called Co-SuperHyperNeighbors. A graph is SuperHyperUniform if it's SuperHyperGraph and the number of elements of SuperHyperEdges are the same. Assume a neutrosophic SuperHyperGraph. There are some SuperHyperClasses as follows. It's SuperHyperPath if it's only one SuperVertex as intersection amid two given SuperHyperEdges with two exceptions; it's SuperHyperCycle if it's only one SuperVertex as intersection amid two given SuperHyperEdges; it's SuperHyperStar it's only one SuperVertex as intersection amid all SuperHyperEdges; it's SuperHyperBipartite it's only one SuperVertex as intersection amid two given SuperHyperEdges and these SuperVertices, forming two separate sets, has no SuperHyperEdge in common; it's SuperHyperMultiPartite it's only

one SuperVertex as intersection amid two given SuperHyperEdges and these SuperVertices, forming multi separate sets, has no SuperHyperEdge in common; it's SuperHyperWheel if it's only one SuperVertex as intersection amid two given SuperHyperEdges and one SuperVertex has one SuperHyperEdge with any common SuperVertex. The number of SuperHyperEdges for a given SuperHyperVertex is called SuperHyperDegree. The number of common SuperHyperEdges for some SuperHyperVertices is called Co-SuperHyperDegree for them. The number of SuperHyperVertices for a given SuperHyperEdge is called SuperHyperDegree. The number of common SuperHyperVertices for some SuperHyperEdges is called Co-SuperHyperDegree for them. The model proposes the specific designs. The model is officially called "SuperHyperGraph" and "Neutrosophic SuperHyperGraph". In this model, The "specific" cells and "specific group" of cells are modeled as "SuperHyperVertices" and the common and intended properties between "specific" cells and "specific group" of cells are modeled as "SuperHyperEdges". Sometimes, it's useful to have some degrees of determinacy, indeterminacy, and neutrality to have more precise model which in this case the model is called "neutrosophic". In the future research, the foundation will be based on the caner's treatment and the results and the definitions will be introduced in redeemed ways. A basic familiarity with SuperHyperGraph theory and neutrosophic SuperHyperGraph theory are proposed.

Keywords: (Neutrosophic) SuperHyperGraph, (Neutrosophic) SuperHyperDegrees, Cancer's Treatments

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

1 Background

There are some studies covering the topic of this research. In what follows, there are some discussion and literature reviews about them.

First article is titled "properties of SuperHyperGraph and neutrosophic SuperHyperGraph" in **Ref.** [8] by Henry Garrett (2022). It's first step toward the study on neutrosophic SuperHyperGraphs. This research article is published on the journal "Neutrosophic Sets and Systems" in issue 49 and the pages 531-561. In this research article, different types of notions like dominating, resolving, coloring, Eulerian(Hamiltonian) neutrosophic path, n-Eulerian(Hamiltonian) neutrosophic path, zero forcing number, zero forcing neutrosophic- number, independent number, independent neutrosophic-number, clique number, clique neutrosophic-number, matching number, matching neutrosophic-number, girth, neutrosophic girth, 1-zero-forcing number, 1-zero- forcing neutrosophic-number, failed 1-zero-forcing number, failed 1-zero-forcing neutrosophic-number, global- offensive alliance, t-offensive alliance, t-defensive alliance, t-powerful alliance, and global-powerful alliance are defined in SuperHyperGraph and neutrosophic SuperHyperGraph. Some Classes of SuperHyperGraph and Neutrosophic SuperHyperGraph are cases of study. Some results are applied in family of SuperHyperGraph and neutrosophic SuperHyperGraph. Thus this research article has concentrated on the vast notions and introducing the majority of notions.

The seminal paper and groundbreaking article is titled "neutrosophic co-degree and neutrosophic degree alongside chromatic numbers in the setting of some classes related to neutrosophic hypergraphs" in **Ref.** [6] by Henry Garrett (2022). In this research article, a novel approach is implemented on SuperHyperGraph and neutrosophic SuperHyperGraph based on general forms without using neutrosophic classes of neutrosophic SuperHyperGraph. It's published in prestigious and fancy journal is entitled "Journal of Current Trends in Computer Science Research (JCTCSR)" with

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abbreviation "J Curr Trends Comp Sci Res" in volume 1 and issue 1 with pages 06-14. The research article studies deeply with choosing neutrosophic hypergraphs instead of neutrosophic SuperHyperGraph. It's the breakthrough toward independent results based on initial background.

In two articles are titled "Initial Material of Neutrosophic Preliminaries to Study Some Neutrosophic Notions Based on Neutrosophic SuperHyperEdge (NSHE) in Neutrosophic SuperHyperGraph (NSHG)" in **Ref.** [5] by Henry Garrett (2022) and "Basic Neutrosophic Notions Concerning SuperHyperDominating and Neutrosophic SuperHyperResolving in SuperHyperGraph" in **Ref.** [3] by Henry Garrett (2022) , there are some efforts to formalize the basic notions about neutrosophic SuperHyperGraph and SuperHyperGraph.

Some studies and researches about neutrosophic graphs, are proposed as book in **Ref.** [4] by Henry Garrett (2022) which is indexed by Google Scholar and has more than 2225 readers in Scribd. It's titled "Beyond Neutrosophic Graphs" and published by Ohio: E-publishing: Educational Publisher 1091 West 1st Ave Grandview Heights, Ohio 43212 United State. This research book covers different types of notions and settings in neutrosophic graph theory and neutrosophic SuperHyperGraph theory.

Also, some studies and researches about neutrosophic graphs, are proposed as book in **Ref.** [7] by Henry Garrett (2022) which is indexed by Google Scholar and has more than 2921 readers in Scribd. It's titled "Neutrosophic Duality" and published by Florida: GLOBAL KNOWLEDGE - Publishing House 848 Brickell Ave Ste 950 Miami, Florida 33131 United States. This research book presents different types of notions SuperHyperResolving and SuperHyperDominating in the setting of duality in neutrosophic graph theory and neutrosophic SuperHyperGraph theory. This research book has scrutiny on the complement of the intended set and the intended set, simultaneously. It's smart to consider a set but acting on its complement that what's done in this research book which is popular in the terms of high readers in Scribd.

1.1 Motivation and Contributions

In this research, there's an idea which could be considered as a motivation. I try to bring the motivation in the narrative ways. Some cells have been faced with some attacks from the situation which is caused by the cancer's attacks. In this case, there are some embedded analysis on the ongoing situations which in that, the cells could be labelled as some groups and some groups or individuals have excessive labels which all are raised from the behaviors to overcome the cancer's attacks. In the embedded situations, the individuals of cells and the groups of cells could be considered as "new groups". Thus it motivates us to find the proper model for getting more proper analysis on this messy story. I've found the SuperHyperModels which are officially called "SuperHyperGraphs" and "Neutrosophic SuperHyperGraphs". In this SuperHyperModel, the cells and the groups of cells are defined as "SuperHyperVertices" and the relations between the individuals of cells and the groups of cells are defined as "SuperHyperEdges". Thus it's another motivation for us to do research on this SuperHyperModel based on the "cancer's treatments". Sometimes, the situations get worst. The situation is passed from the certainty and precise style. Thus it's the beyond them. There are three descriptions, namely, the degrees of determinacy, indeterminacy and neutrality, for any object based on vague forms, namely, incomplete data, imprecise data, and uncertain analysis. The latter model could be considered on the previous SuperHyperModel. It's SuperHyperModel. It's SuperHyperGraph but it's officially called "Neutrosophic SuperHyperGraphs".

Question 1.1. *How to define the notions and to do research on them to find the "amount" of either individual of cells or the groups of cells based on the fixed cell or the* *fixed group of cells, extensively, the "common amount" of based on the fixed groups of cells or the fixed groups of group of cells?*

Question 1.2. *What are the best descriptions for the cancer's treatments in terms of these messy and dense SuperHyperModels where embedded notions are illustrated?*

It's motivation to find notions to use in this dense model is titled "SuperHyperGraphs". Thus it motivates us to define different types of "SuperHyperDegree" and "Co-SuperHyperDegree" on "SuperHyperGraph" and "Neutrosophic SuperHyperGraph". Then the research has taken more motivations to define SuperHyperClasses and to find some connections amid this SuperHyperNotion with other SuperHyperNotions. It motivates us to get some instances and examples to make clarifications about the framework of this research. The general results and some results about some connections are some avenues to make key point of this research, "cancer's treatments", more understandable and more clear.

The framework of this study is as follows. In the beginning, I introduce basic definitions to clarify about preliminaries. In the subsection "Preliminaries", initial definitions about SuperHyperGraphs and neutrosophic SuperHyperGraph are deeply-introduced and in-depth-discussed. The elementary concepts are clarified and illustrated completely and sometimes review literature are applied to make sense about what's going to figure out about the upcoming sections. The main definitions and their clarifications alongside some results about new notions, SuperHyperDegree and Co-SuperHyperDegree are figured out in section "New Ideas on SuperHyperGraphs". In the sense of tackling on getting results and in order to make sense about continuing the research, the ideas of SuperHyperUniform and Neutrosophic SuperHyperUniform are introduced and as their consequences, corresponded SuperHyperClasses are figured out to debut what's done in this section, titled "SuperHyperUniform and Neutrosophic SuperHyperUniform". As going back to origin of the notions, there are some smart steps toward the common notions to extend the new notions in new frameworks, SuperHyperGraph and Neutrosophic SuperHyperGraph, in the section "SuperHyperDegree and Co-SuperHyperDegree: Common and Extended Definition In SuperHyperGraphs". The starter research about the relation with SuperHyperParameters and as concluding and closing section of theoretical research are contained in section "The Relations With SuperHyperParameters". Some SuperHyperParameters are fundamental and they are well-known as fundamental numbers as elicited and discussed in the sections, "The Relations With SuperHyperDominating" and "The Relations With SuperHyperResolving". There are curious questions about what's done about the relations with SuperHyperParameters to make sense about excellency of this research and going to figure out the word "best" as the description and adjective for this research as presented in sections, "The Relations With SuperHyperOrder","The Relations With SuperHyperRegularity","The Minimum SuperHyperDegree","The Maximum SuperHyperDegree". The keyword of this research debut in the section "Applications in Cancer's Treatments" with two cases and subsections "Case 1: SuperHyperDegree and Co-SuperHyperDegree in the Simple SuperHyperModel" and "Case 2: SuperHyperDegree and Co-SuperHyperDegree in the More Complicated SuperHyperModel". In the section, "Open Problems", there are some scrutiny and discernment on what's done and what's happened in this research in the terms of "questions" and "problems" to make sense to figure out this research in featured style. The advantages and the limitations of this research alongside about what's done in this research to make sense and to get sense about what's figured out are included in the section, "Conclusion and Closing Remarks".

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1.2 Preliminaries

In this subsection, basic material which is used in this article, is presented. Also, new ideas and their clarifications are elicited.

Definition 1.3 (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 1.4 (Single Valued Neutrosophic Set)**.** (**Ref.** [11],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 1.5. The **degree of truth-membership**, **indeterminacy-membership** and **falsity-membership of the subset** $X \subset A$ of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

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

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

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

Definition 1.6. The **support** of $X \subset A$ of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

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

Definition 1.7 (Neutrosophic SuperHyperGraph (NSHG))**.** (**Ref.** [10],Definition 3,p.291).

Assume V' is a given set. A **neutrosophic SuperHyperGraph** (NSHG) S is an ordered pair $S = (V, E)$, where

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

(ii) $V = \{(V_i, T_{V'}(V_i), I_{V'}(V_i), F_{V'}(V_i)) : \ T_{V'}(V_i), I_{V'}(V_i), F_{V'}(V_i) \geq 0\}$, $(i = 1, 2, \ldots, n)$;

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

(iv) $E = \{(E_{i'}, T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'})) : \ T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'}) \geq 0\}$, $(i' = 1, 2, \ldots, n')$;

(v) $V_i \neq \emptyset$, $(i = 1, 2, \ldots, n)$;

(vi) $E_{i'} \neq \emptyset$, $(i' = 1, 2, \ldots, n')$;

(vii) $\sum_i supp(V_i) = V$, $(i = 1, 2, \ldots, n)$;

(viii) $\sum_{i'} supp(E_{i'}) = V$, $(i' = 1, 2, \ldots, n')$;

(ix) and the following conditions hold:

$$T'_V(E_{i'}) \leq \min[T_{V'}(V_i), T_{V'}(V_j)]_{V_i, V_j \in E_{i'}},$$

$$I'_V(E_{i'}) \leq \min[I_{V'}(V_i), I_{V'}(V_j)]_{V_i, V_j \in E_{i'}},$$

$$\text{and } F'_V(E_{i'}) \leq \min[F_{V'}(V_i), F_{V'}(V_j)]_{V_i, V_j \in E_{i'}}$$

where $i' = 1, 2, \ldots, n'$.

Here the neutrosophic SuperHyperEdges (NSHE) $E_{j'}$ and the neutrosophic SuperHyperVertices (NSHV) V_j are single valued neutrosophic sets. $T_{V'}(V_i), I_{V'}(V_i)$, and $F_{V'}(V_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the neutrosophic SuperHyperVertex (NSHV) V_i to the neutrosophic SuperHyperVertex (NSHV) V. $T'_V(E_{i'}), T'_V(E_{i'})$, and $T'_V(E_{i'})$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the neutrosophic SuperHyperEdge (NSHE) $E_{i'}$ to the neutrosophic SuperHyperEdge (NSHE) E. Thus, the ii'th element of the **incidence matrix** of neutrosophic SuperHyperGraph (NSHG) are of the form $(V_i, T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'}))$, the sets V and E are crisp sets.

Definition 1.8 (Characterization of the Neutrosophic SuperHyperGraph (NSHG))**.** (**Ref.** [10],Section 4,pp.291-292).

Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. The neutrosophic SuperHyperEdges (NSHE) $E_{i'}$ and the neutrosophic SuperHyperVertices (NSHV) V_i of neutrosophic 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**.

If we choose different types of binary operations, then we could get hugely diverse types of general forms of neutrosophic SuperHyperGraph (NSHG).

Definition 1.9 (t-norm)**.** (**Ref.** [9], 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 1.10. The **degree of truth-membership**, **indeterminacy-membership** and **falsity-membership of the subset** $X \subset A$ of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$ (with respect to t-norm T_{norm}):

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

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

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

Definition 1.11. The **support** of $X \subset A$ of the single valued neutrosophic set $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in X\}$:

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

Definition 1.12. (General Forms of Neutrosophic SuperHyperGraph (NSHG)).
Assume V' is a given set. A **neutrosophic SuperHyperGraph** (NSHG) S is an ordered pair $S = (V, E)$, where

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

(ii) $V = \{(V_i, T_{V'}(V_i), I_{V'}(V_i), F_{V'}(V_i)) : \; T_{V'}(V_i), I_{V'}(V_i), F_{V'}(V_i) \geq 0\}$, $(i = 1, 2, \ldots, n)$;

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

(iv) $E = \{(E_{i'}, T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'})) : \; T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'}) \geq 0\}$, $(i' = 1, 2, \ldots, n')$;

(v) $V_i \neq \emptyset$, $(i = 1, 2, \ldots, n)$;

(vi) $E_{i'} \neq \emptyset$, $(i' = 1, 2, \ldots, n')$;

(vii) $\sum_i supp(V_i) = V$, $(i = 1, 2, \ldots, n)$;

(viii) $\sum_{i'} supp(E_{i'}) = V$, $(i' = 1, 2, \ldots, n')$.

Here the neutrosophic SuperHyperEdges (NSHE) $E_{j'}$ and the neutrosophic SuperHyperVertices (NSHV) V_j are single valued neutrosophic sets. $T_{V'}(V_i), I_{V'}(V_i)$, and $F_{V'}(V_i)$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership the neutrosophic SuperHyperVertex (NSHV) V_i to the neutrosophic SuperHyperVertex (NSHV) V. $T'_V(E_{i'}), T'_V(E_{i'})$, and $T'_V(E_{i'})$ denote the degree of truth-membership, the degree of indeterminacy-membership and the degree of falsity-membership of the neutrosophic SuperHyperEdge (NSHE) $E_{i'}$ to the neutrosophic SuperHyperEdge (NSHE) E. Thus, the ii'th element of the **incidence matrix** of neutrosophic SuperHyperGraph (NSHG) are of the form $(V_i, T'_V(E_{i'}), I'_V(E_{i'}), F'_V(E_{i'}))$, the sets V and E are crisp sets.

Definition 1.13 (Characterization of the Neutrosophic SuperHyperGraph (NSHG))**.** (**Ref.** [10],Section 4,pp.291-292).
Assume a neutrosophic SuperHyperGraph (NSHG) S is an ordered pair $S = (V, E)$. The neutrosophic SuperHyperEdges (NSHE) $E_{i'}$ and the neutrosophic SuperHyperVertices (NSHV) V_i of neutrosophic SuperHyperGraph (NSHG) $S = (V, E)$ could be characterized as follow-up items.

Table 1. The Values of Vertices, SuperVertices, Edges, HyperEdges, and SuperHyperEdges Belong to The Neutrosophic SuperHyperGraph Mentioned in the Example (2.2)

The Values of The Vertices	The Number of Position in Alphabet
The Values of The SuperVertices	The Minimum Values of Its Vertices
The Values of The Edges	The Minimum Values of Its Vertices
The Values of The HyperEdges	The Minimum Values of Its Vertices
The Values of The SuperHyperEdges	The Minimum Values of Its Endpoints

(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**.

2 New Ideas on SuperHyperGraphs

Definition 2.1. If there's a SuperHyperEdge between two SuperHyperVertices, then these two SuperHyperVertices are called **SuperHyperNeighbors**. The number of SuperHyperNeighbors for a given SuperHyperVertex is called **SuperHyperDegree**. The number of common SuperHyperNeighbors for some SuperHyperVertices is called **Co-SuperHyperDegree** for them and used SuperHyperVertices are called **Co-SuperHyperNeighbors**.

Example 2.2. A SuperHyperGraph is depicted in the Figure (1). The characterization of SuperHyperDegree is as follows. The SuperHyperDegree of SuperHyperVertices, $M, J, P, F, L_6, M_6, R, V_1, V_2$ and V_3, are the same and equals to the SuperHyperOrder, ten. By using the Figure (1), and the Table (1), the neutrosophic SuperHyperGraph is obtained and the computations are straightforward to make sense about what's figured out on determinacy, indeterminacy and neutrality.

Example 2.3. A SuperHyperGraph is depicted in the Figure (2). The characterization of SuperHyperDegree for interior SuperHyperVertices is as follows.

(i) The SuperHyperDegree of SuperHyperVertices, T_3, S_3, U_3, V_4 and V_5 are the same and equals to six.

(ii) The SuperHyperDegree of SuperHyperVertices, S_6, R_6, T_6, V_7, V_8 and V_9 are the same and equals to ten.

(iii) SuperHyperDegree of SuperHyperVertices, H_6, C_6, O_6, and E_6 are the same and equals to twelve.

(iv) The SuperHyperDegree of SuperHyperVertices, R, P, J, and M are the same and equals to ten.

The characterization of SuperHyperDegree for exterior SuperHyperVertices is as follows.

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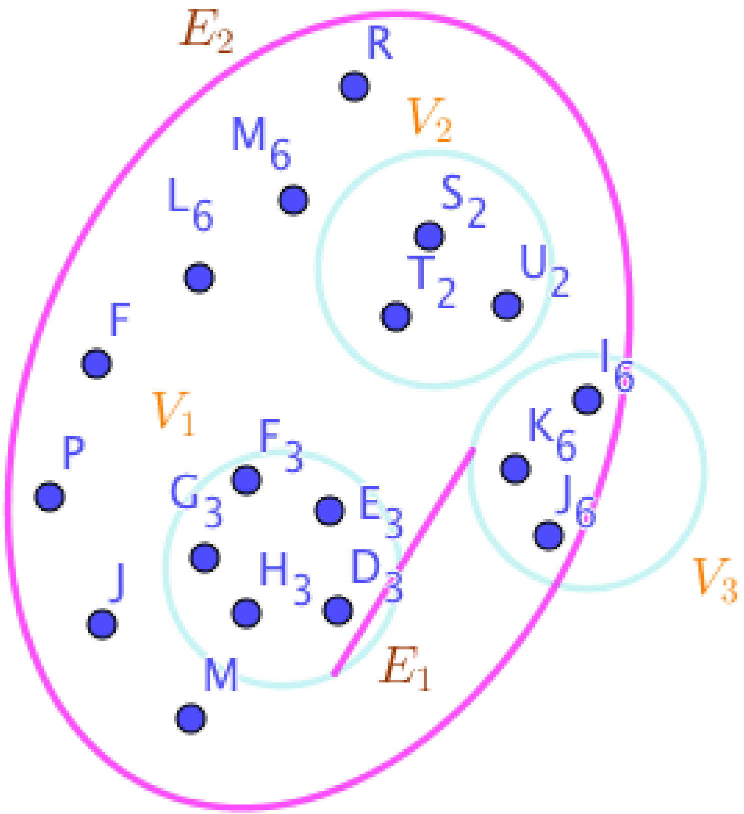

Figure 1. A SuperHyperGraph Associated to the Notions of SuperHyperDegree in the Example (2.2)

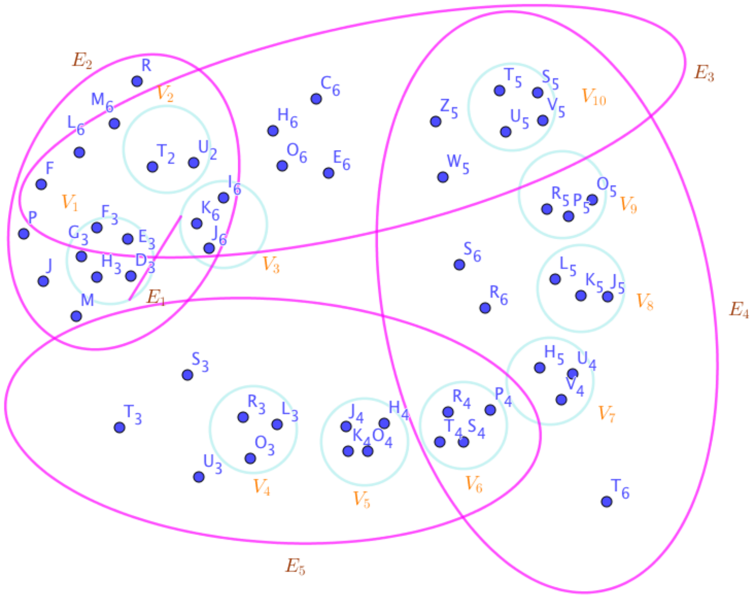

Figure 2. A SuperHyperGraph Associated to the Notions of SuperHyperDegree in the Example (2.3)

Table 2. The Values of Vertices, SuperVertices, Edges, HyperEdges, and SuperHyperEdges Belong to The Neutrosophic SuperHyperGraph Mentioned in the Example (2.3)

The Values of The Vertices	The Number of Position in Alphabet
The Values of The SuperVertices	The Minimum Values of Its Vertices
The Values of The Edges	The Minimum Values of Its Vertices
The Values of The HyperEdges	The Minimum Values of Its Vertices
The Values of The SuperHyperEdges	The Minimum Values of Its Endpoints

(i) The SuperHyperDegree of SuperHyperVertex, V_4 equals to fourteen.

(ii) The SuperHyperDegree of SuperHyperVertices, Z_5, W_5 and V_{10} are the same and equals to eighteen.

(iii) SuperHyperDegree of SuperHyperVertices, F, L_6, M_6, V_2, and V_3 are the same and equals to sixteen.

By using the Figure (2), and the Table (2), the neutrosophic SuperHyperGraph is obtained and the computations are straightforward to make sense about what's figured out on determinacy, indeterminacy and neutrality.

Proposition 2.4. *The SuperHyperDegree of interior SuperHyperVertices are the same.*

Proof. Interior SuperHyperVertices belong to one SuperHyperEdges, according to the definition of being interior SuperHyperVertices. Thus They've common SuperHyperEdge. And there's no more SuperHyperEdge in common version. It implies the SuperHyperDegree of every interior SuperHyperVertex is the fixed amount and same number. It induces that the SuperHyperDegree of interior SuperHyperVertices are the same. □

The operation on the SuperHyperDegree is the matter. One case is about the situation in that, the changes or, prominently, "adding" is acted as an operation. In

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what follows, the operation, adding has the key role to play with the flexibilities of notions. But it's important to mention that theses operations, adding and changes, couldn't be applied to the framework and the setting of SuperHyperDegree since there's only one SuperHyperDegree in this setting. Another idea is about the "corresponded set" which is excerpt SuperHyperDegree as initial notion. The number is titled SuperHyperDegree is obtained from "corresponded set".

Proposition 2.5. *The changes or adding any number of exterior SuperHyperVertices has no change in Co-SuperHyperDegree.*

Proof. The changes has no effect on the corresponded set related Co-SuperHyperDegree since the obtained number isn't changed. Adding any number of exterior SuperHyperVertices hasn't formed any new corresponded set related to that Co-SuperHyperDegree. Since they're exterior SuperHyperVertices thus they belongs to same SuperHyperEdges and they've same situations in the terms of SuperHyperNeighbors. Thus adding any amount of exterior SuperHyperVertices doesn't make new SuperHyperNeighbor and the number of SuperHyperNeighbors hasn't changed when adding exterior SuperHyperVertices has happened. Since all exterior SuperHyperVertices have same amount of SuperHyperNeighbors and it's predicted to have smaller "corresponded set" but the cardinality of new "corresponded set" hasn't changed and it's the same. Generally, the operation, adding, makes the "corresponded set" to be the same or smaller. That, the first case is happened and the new "corresponded set" and the old "corresponded set" are the same. To sum them up, the changes or adding any number of exterior SuperHyperVertices has no change in Co-SuperHyperDegree. □

In the upcoming result, the comparison is featured between the SuperHyperDegree and the Co-SuperHyperDegree where one SuperHyperVertex could be the intersection of these new notions.

Proposition 2.6. *The SuperHyperDegree based on a SuperHyperVertex is greater than the Co-SuperHyperDegree based on that SuperHyperVertex.*

Proof. The Co-SuperHyperDegree of a SuperHyperVertex and other SuperHyperVertices induces the number of common SuperHyperNeighbors is the matter. Thus the number of SuperHyperNeighbors of intended SuperHyperVertex which is interpreted as SuperHyperDegree, has exceed when the number of common SuperHyperNeighbors is on demand and requested in some cases but the number of common SuperHyperNeighbors is at most equal to the number of SuperHyperNeighbors of intended SuperHyperVertex. Thus the SuperHyperDegree based on a SuperHyperVertex is greater than the Co-SuperHyperDegree based on that SuperHyperVertex.

□

Example 2.7. A SuperHyperGraph is mentioned in the Example (2.2). The characterization of Co-SuperHyperDegree for all SuperHyperVertices is as follows. The Co-SuperHyperDegree for any amount of the SuperHyperVertices are the same and equals to ten.

Example 2.8. A SuperHyperGraph is mentioned in the Example (2.3). The characterization of Co-SuperHyperDegree for all SuperHyperVertices is as follows.

(i) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{M, J, P, F, L_6, M_6, R, V_1, V_2, V_3\}$ are the same and equals to ten.

(ii) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{F, L_6, M_6, V_2, V_3\}$ and any amount of the SuperHyperVertices $\{C_6, H_6, O_6, E_6, Z_5, W_5, V_{10}\}$ are the same and equals to twelve.

(iii) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{M, J, P, R, V_1\}$ and any amount of the SuperHyperVertices $\{C_6, H_6, O_6, E_6, Z_5, W_5, V_{10}\}$ are the same and equals to zero.

(iv) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{F, L_6, M_6, V_2, V_3\}$ with any amount of the SuperHyperVertices $\{Z_5, W_5, V_{10}\}$ are the same and equals to three.

(v) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{M, J, P, R, V_1\}$ with any amount of the SuperHyperVertices $\{Z_5, W_5, V_{10}, S_6, R_6, V_6, V_7, V_8, V_9\}$ are the same and equals to zero.

(vi) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{H_6, O_6, C_6, E_6\}$ with any amount of the SuperHyperVertices $\{S_6, R_6, V_6, V_7, V_8, V_9\}$ are the same and equals to zero.

(vii) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{H_6, O_6, C_6, E_6\}$ with any amount of the SuperHyperVertices $\{Z_5, W_5, V_{10}\}$ are the same and equals to three.

(viii) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{M, J, P, F, L_6, M_6, R, V_1, V_2, V_3, H_6, O_6, C_6, E_6, Z_5, W_5, V_{10}, S_6, R_6, V_7, V_8, V_9\}$ with any amount of the SuperHyperVertices $\{S_3, T_3, U_3, V_4, V_5, V_6\}$ are the same and equals to zero.

(ix) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{V_6\}$ with any amount of the SuperHyperVertices $\{S_3, T_3, U_3, V_4, V_5, V_6\}$ are the same and equals to one.

(x) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{F, L_6, M_6, V_2, V_3, H_6, O_6, C_6, E_6, \}$ are the same and equals to ten.

(xi) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{Z_5, W_5, V_{10}, S_6, R_6, V_6, V_7, V_8, V_9\}$ are the same and equals to nine.

(xii) The Co-SuperHyperDegree for any amount of the SuperHyperVertices $\{Z_3, T_3, U_3, V_4, V_5, V_6\}$ are the same and equals to six.

3 SuperHyperUniform and Neutrosophic SuperHyperUniform

Definition 3.1. A graph is **SuperHyperUniform** if it's SuperHyperGraph and the number of elements of SuperHyperEdges are the same.

The characterizations of all SuperHyperVertices are concluded in the terms of SuperHyperDegree in the following result.

Proposition 3.2. *In a SuperHyperUniform, the interior SuperHyperDegree of every SuperHyperVertex is the same with each other.*

Proof. Every SuperHyperEdge has same amount of SuperHyperVertices but interior SuperHyperVertices are incident to only and only one SuperHyperEdge and by the elements of all SuperHyperEdges are the same, thus every interior SuperHyperVertex has same amount of SuperHyperNeighbors implying the SuperHyperDegree has to be a fixed number. Thus in a SuperHyperUniform, the interior SuperHyperDegree of every SuperHyperVertex is the same with each other. □

Definition 3.3. Assume a neutrosophic SuperHyperGraph. There are some SuperHyperClasses as follows.

(i). It's **SuperHyperPath** if it's only one SuperVertex as intersection amid two given SuperHyperEdges with two exceptions;

(ii). it's **SuperHyperCycle** if it's only one SuperVertex as intersection amid two given SuperHyperEdges;

(iii). it's **SuperHyperStar** it's only one SuperVertex as intersection amid all SuperHyperEdges;

(iv). it's **SuperHyperBipartite** it's only one SuperVertex as intersection amid two given SuperHyperEdges and these SuperVertices, forming two separate sets, has no SuperHyperEdge in common;

(v). it's **SuperHyperMultiPartite** it's only one SuperVertex as intersection amid two given SuperHyperEdges and these SuperVertices, forming multi separate sets, has no SuperHyperEdge in common;

(vi). it's **SuperHyperWheel** if it's only one SuperVertex as intersection amid two given SuperHyperEdges and one SuperVertex has one SuperHyperEdge with any common SuperVertex.

The same amount is considered on specific parameters and it's considered as the notation, r, in the used notion, uniform.

Proposition 3.4. *In the SuperHyperStar, there's a SuperHyperVertex such that its SuperHyperDegree equals to SuperHyperOrder.*

Proof. One SuperHyperVertex is incident to all possible SuperHyperEdges. Thus this SuperHyperVertex is SuperHyperNeighbor to all possible SuperHyperVertices. It implies the SuperHyperVertex has SuperHyperDegree number of SuperHyperNeighbors. Thus in the SuperHyperStar, there's a SuperHyperVertex such that its SuperHyperDegree equals to SuperHyperOrder. □

Proposition 3.5. *In the SuperHyperPath, the SuperHyperDegree is $2r$ for exterior SuperHyperVertices and the SuperHyperDegree is r for interior SuperHyperVertices.*

Proof. The interior SuperHyperVertices are incident to one SuperHyperEdge but it's SuperHyperUniform, thus the elements of every SuperHyperEdge is the same is denoted by r. Thus the SuperHyperDegree is r for interior SuperHyperVertices. The exterior SuperHyperVertices are incident to only and only two SuperHyperEdges. There are two different SuperHyperNeighbors for exterior SuperHyperVertices. One kind is labeled as interior SuperHyperVertices with the number r via using SuperHyperUniform style and another sort is titled as exterior SuperHyperVertices are counted to be s since the number hasn't to be fixed implying it's different for every exterior SuperHyperVertex. Thus the SuperHyperDegree is $2r$ for exterior SuperHyperVertices. To sum them up, in the SuperHyperPath, the SuperHyperDegree is $2r$ for exterior SuperHyperVertices and the SuperHyperDegree is r for interior SuperHyperVertices. □

Proposition 3.6. *In the SuperHyperCycle, the SuperHyperDegree is $2r - s$ for exterior SuperHyperVertices and the SuperHyperDegree is r for interior SuperHyperVertices.*

Proof. The interior SuperHyperVertices are uniquely characterized by one SuperHyperEdge having r exterior SuperHyperVertices and interior SuperHyperVertices. Thus the SuperHyperDegree is r for interior SuperHyperVertices. The exterior SuperHyperVertices are uniquely characterized by two SuperHyperEdges having $2r - s$ exterior SuperHyperVertices and interior SuperHyperVertices where s is the number of common exterior SuperHyperVertices between two used SuperHyperEdges. To sum them up, in the SuperHyperCycle, the SuperHyperDegree is $2r - s$ for exterior SuperHyperVertices and the SuperHyperDegree is r for interior SuperHyperVertices. □

Proposition 3.7. *In the SuperHyperStar, the SuperHyperDegree is either $(r - 1)s$ or r.*

Proof. One SuperHyperVertex is incident to all possible SuperHyperEdges. Thus this SuperHyperVertex has the number of other SuperHyperVertices multiplying the SuperHyperUniform constant minus one. In other words, it's $(r - 1)s$. There are two categories of SuperHyperVertices. Other SuperHyperVertices have no SuperHyperEdges with each other. Thus the amount of SuperHyperDegree is the same with SuperHyperUniform constant which is r. Thus in the SuperHyperStar, the SuperHyperDegree is either $(r - 1)s$ or r. □

Proposition 3.8. *In the SuperHyperBipartite, the SuperHyperDegree is either nr or mr.*

Proof. Every SuperHyperBipartite has two the SuperHyperParts. Any SuperHyperVertex has only SuperHyperEdges with another SuperHyperPart. There are some SuperHyperVertices don't belong to any SuperHyperPart. Every SuperHyperEdge has r SuperHyperVertices by applying SuperHyperUniform properties. Thus the maximum number of cardinality for SuperHyperParts, is determiner to decide about the multiplier for SuperHyperUniform constant r. Thus in the SuperHyperBipartite, the SuperHyperDegree is either nr or mr. □

Proposition 3.9. *In the SuperHyperMultiPartite, the SuperHyperDegree is either of $(\sum_{i=1}^{s} n_i - n_{j_{j=1,2,\ldots,s}})r$.*

Proof. In the SuperHyperMultiPartite, there's only one SuperHyperVertex from a SuperHyperPart incident to a SuperHyperEdge. The SuperHyperUniform implies having r as multiplier for every SuperHyperVertex from a SuperHyperPart. For a fixed SuperHyperVertex from a SuperHyperPart, there are some SuperHyperParts and r SuperHyperNeighbors from every of them. Thus In the SuperHyperMultiPartite, the SuperHyperDegree is either of $(\sum_{i=1}^{s} n_i - n_{j_{j=1,2,\ldots,s}})r$. □

Proposition 3.10. *In the SuperHyperWheel, the SuperHyperDegree is $3r - 2s - 1$ for exterior SuperHyperVertices and the SuperHyperDegree is $r - 1$ for interior SuperHyperVertices. For the SuperHyperCenter, SuperHyperDegree is $r(n - 1)$.*

Proof. The exterior SuperHyperVertices are incident to only and only three SuperHyperEdges. It implies at most $3r$ SuperHyperVertices by applying SuperHyperUniform property. But the exterior SuperHyperVertices are incident three times. It induces they've $3r - 2s - 1$ SuperHyperNeighbors. The interior SuperHyperVertices are incident to one SuperHyperEdge. Thus They've $r - 1$ SuperHyperNeighbors by using the SuperHyperUniform property. The third category has only one SuperHyperVertex, namely, the SuperHyperCenter has n the SuperHyperEdges inducing rn SuperHyperNeighbors via applying the SuperHyperUniform property. To sum them up, in the SuperHyperWheel, the

SuperHyperDegree is $3r - 2s - 1$ for exterior SuperHyperVertices and the SuperHyperDegree is r for interior SuperHyperVertices. For the SuperHyperCenter, SuperHyperDegree is $r(n-1)$. □

4 SuperHyperDegree and Co-SuperHyperDegree: Common and Extended Definition In SuperHyperGraphs

Definition 4.1. The number of SuperHyperEdges for a given SuperHyperVertex is called **SuperHyperDegree**. The number of common SuperHyperEdges for some SuperHyperVertices is called **Co-SuperHyperDegree** for them. The number of SuperHyperVertices for a given SuperHyperEdge is called **SuperHyperDegree**. The number of common SuperHyperVertices for some SuperHyperEdges is called **Co-SuperHyperDegree** for them.

Example 4.2. Assume the Example (2.2). The whole possible cases are investigated as follows. The SuperHyperDegree for any given SuperHyperVertex is one. The Co-SuperHyperDegree for some SuperHyperVertices is one. The SuperHyperDegree for any given SuperHyperEdge is ten. The Co-SuperHyperDegree for some SuperHyperEdges is ten.

Example 4.3. Assume the Example (2.3). The following cases characterize all possible situations.

(i) : The SuperHyperDegree for any given SuperHyperVertex from $\{M, J, P, R, V_1, H_6, O_6, C_6, E_6, S_6, R_6, V_7, V_8, V_9, V_4, V_5, T_3, S_3, U_3\}$ is one.

(ii) : The Co-SuperHyperDegree for some SuperHyperVertices from $\{M, J, P, F, R, V_1, H_6, O_6, C_6, E_6, S_6, R_6, V_7, V_8, V_9, V_4, V_5, T_3, S_3, U_3\}$ is one.

(iii) : The SuperHyperDegree for any given SuperHyperVertex from $\{F, L_6, M_6, V_2, V_3, Z_5, W_5, V_{10}, V_6\}$ is two.

(iv) : The Co-SuperHyperDegree for some SuperHyperVertices from either of $\{F, L_6, M_6, V_2, V_3, \}, \{Z_5, W_5, V_{10}\}, \{V_6\}$ is two.

(v) : The SuperHyperDegree for SuperHyperEdge, E_1 is two.

(vi) : The SuperHyperDegree for SuperHyperEdge, E_2 is ten.

(vii) : The SuperHyperDegree for SuperHyperEdge, E_3 is twelve.

$(viii)$: The SuperHyperDegree for SuperHyperEdge, E_4 is nine.

(ix) : The SuperHyperDegree for SuperHyperEdge, E_5 is six.

(x) : The Co-SuperHyperDegree for SuperHyperEdges, E_1, E_2 is two.

(xi) : The Co-SuperHyperDegree for SuperHyperEdges, E_1, E_2, E_3 is one.

(xii) : The Co-SuperHyperDegree for SuperHyperEdges, E_1, E_3 is one.

$(xiii)$: The Co-SuperHyperDegree for SuperHyperEdges, E_2, E_3 is five.

(xiv) : The Co-SuperHyperDegree for SuperHyperEdges, E_3, E_4 is three.

(xv) : The Co-SuperHyperDegree for SuperHyperEdges, E_4, E_5 is one.

$(xvi):$ The Co-SuperHyperDegree for SuperHyperEdges rather than above cases is zero.

Proposition 4.4. *In the SuperHyperPath, the SuperHyperDegree is either one or two.*

Proof. Every SuperHyperVertex is incident to one or two SuperHyperEdges. Thus the SuperHyperDegree for any given SuperHyperVertex is one or two. Thus in the SuperHyperPath, the SuperHyperDegree is either one or two. □

Proposition 4.5. *In the SuperHyperCycle, the SuperHyperDegree is two.*

Proof. Every SuperHyperEdge contains too many SuperHyperVertices and there's obvious number. It's r. Since it's SuperHyperUniform. But, reversely, any SuperHyperVertices contains only two SuperHyperEdges. The latter is called to be the SuperHyperDegree for those SuperHyperVertices. Thus the notion is faraway from SuperHyperNeighbors and there's no connection amid them to said the SuperHyperDegree. Thus in the SuperHyperCycle, the SuperHyperDegree is two. □

Proposition 4.6. *In the SuperHyperStar, the SuperHyperDegree is either s or one.*

Proof. All SuperHyperEdges cross from the SuperHyperCenter. Thus the SuperHyperCenter is the SuperHyperNeighbor to all SuperHyperVertices. To get more, there's no SuperHyperEdge beyond that. It implies Other SuperHyperVertices has only one SuperHyperEdge with the SuperHyperCenter. It induces they've only one SuperHyperNeighbor, namely, the SuperHyperCenter. Thus in the SuperHyperStar, the SuperHyperDegree is either s or one. □

Proposition 4.7. *In the SuperHyperBipartite, the SuperHyperDegree is either n or m.*

Proposition 4.8. *In the SuperHyperMultiPartite, the SuperHyperDegree is either of $\sum_{i=1}^{s} n_i - n_{j\,j=1,2,\ldots,s}$.*

Proposition 4.9. *In the SuperHyperWheel, the SuperHyperDegree is either s or three.*

5 The Relations With SuperHyperParameters

6 The Relations With SuperHyperDominating

Proposition 6.1. *A SuperHyperVertex SuperHyperDominates at least SuperHyperDegree SuperHyperVertices.*

Proposition 6.2. *If the SuperHyperDegree is m, then there are at least m SuperHyperDominated SuperHyperVertices.*

Proposition 6.3. *If the SuperHyperDegree is m, then the SuperHyperVertex has m, the SuperHyperNeighbors.*

Proposition 6.4. *The notions the SuperHyperDegree and the SuperHyperDominating coincide.*

Proposition 6.5. *A SuperHyperVertex SuperHyperDominates is equivalent to its SuperHyperDegree.*

Proposition 6.6. *A SuperHyperVertex SuperHyperDominates only and only SuperHyperDegree SuperHyperVertices.*

Proposition 6.7. *If the SuperHyperDegree of SuperHyperVertex is m, then that SuperHyperVertex SuperHyperDominates only and only m SuperHyperVertices.*

7 The Relations With SuperHyperResolving

Proposition 7.1. *A SuperHyperVertex doesn't SuperHyperResolve at least SuperHyperDegree SuperHyperVertices.*

8 The Relations With SuperHyperOrder

Proposition 8.1. *In the SuperHyperStar, the SuperHyperDegree of the SuperHyperCenter is SuperHyperOrder with its consideration.*

9 The Relations With SuperHyperRegularity

Proposition 9.1. *In the SuperHyperCycle, the all SuperHyperDegrees are SuperHyperRegular.*

Proposition 9.2. *In the SuperHyperBipartite, the all SuperHyperDegrees in every SuperHyperPart are SuperHyperRegular.*

Proposition 9.3. *In the SuperHyperMultiPartite, the all SuperHyperDegrees in every SuperHyperPart are SuperHyperRegular.*

10 The Minimum SuperHyperDegree

Proposition 10.1. *In the SuperHyperStar, the all SuperHyperDegrees are the minimum with the exception of SuperHyperCenter.*

11 The Maximum SuperHyperDegree

Proposition 11.1. *In the SuperHyperCycle, the all SuperHyperDegrees are the maximum.*

Proposition 11.2. *In the SuperHyperPath, the all SuperHyperDegrees are the maximum with the exceptions of two SuperHyperVertices.*

12 Applications in Cancer's Treatments

The treatments for cancer are spotlight. The cells and vessels have vital roles in the body. In the cancer as disease, the attacks on cells could act differently. In some cases, there are some situations which are messy and they've needed to have complicated detailed-oriented models. The situations are embedded to each other and there are too many information.

In this study, there are some directions about the roles of cells and the properties are raised from them. In this complicated situation, the objects are embedded to each other and it's hard to characterize the useful data and proper direction to make the situations more understandable for getting more directions to treat the cancer.

Step 1. (Definition) The situations are complicated. Some cells are the same in the terms of the situation in front of the cancer's attacks. But the situation goes to be more complex where the cells and the groups of cells have some common properties with each others.

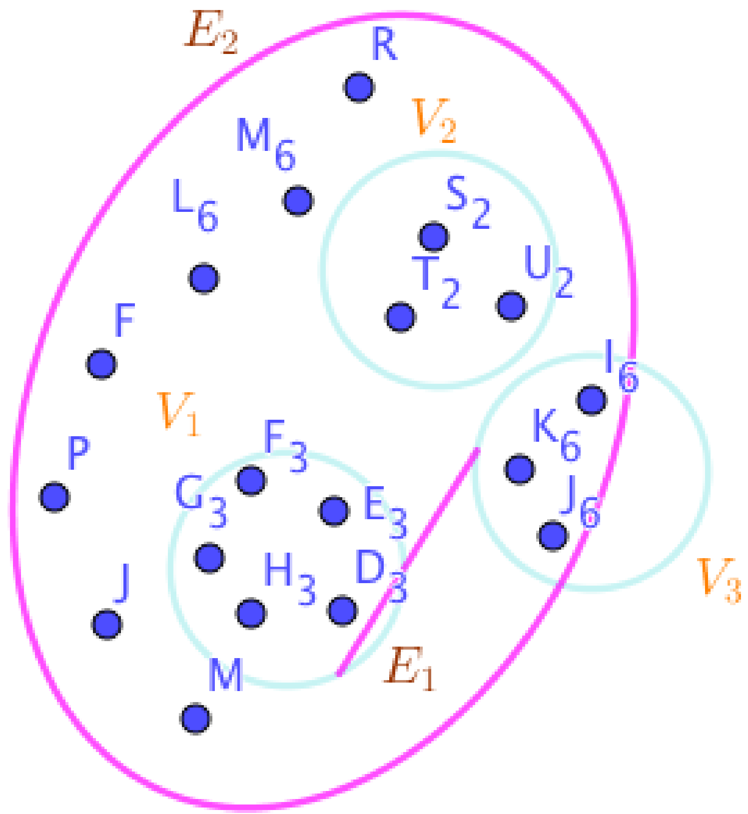

Figure 3. A SuperHyperGraph Associated to the Notions of SuperHyperDegree in the Section (12)

Step 2. (Issue) The cancer attacks to some cells and some cells have same situations but sometimes the cells and groups of cells have elected some directions to protect themselves and sometimes they've some special attributes.

Step 3. (Model) The model proposes the specific designs. The model is officially called "SuperHyperGraph" and "Neutrosophic SuperHyperGraph". In this model, The "specific" cells and "specific group" of cells are modeled as "SuperHyperVertices" and the common and intended properties between "specific" cells and "specific group" of cells are modeled as "SuperHyperEdges". Sometimes, it's useful to have some degrees of determinacy, indeterminacy, and neutrality to have more precise model which in this case the model is called "neutrosophic".

12.1 Case 1: SuperHyperDegree and Co-SuperHyperDegree in the Simple SuperHyperModel

Step 4. (Solution) The model is illustrated in the Figure (3). A SuperHyperGraph is depicted in the Figure (3). The characterization of SuperHyperDegree is as follows. The SuperHyperDegree of SuperHyperVertices, $M, J, P, F, L_6, M_6, R, V_1, V_2$ and V_3, are the same and equals to the SuperHyperOrder, ten.

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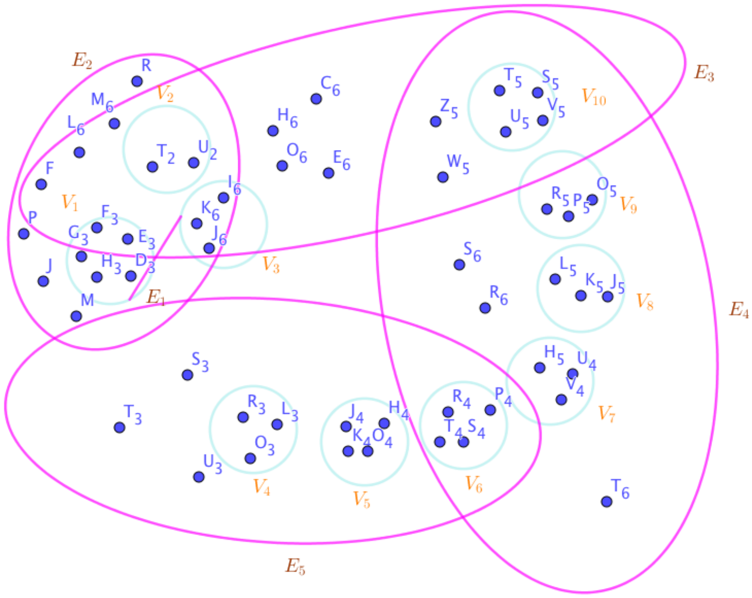

Figure 4. A SuperHyperGraph Associated to the Notions of SuperHyperDegree in the Section (12)

12.2 Case 2: SuperHyperDegree and Co-SuperHyperDegree in the More Complicated SuperHyperModel

Step 4. (Solution) A SuperHyperGraph is depicted in the Figure (4). The characterization of SuperHyperDegree for interior SuperHyperVertices is as follows.

- (*i*) The SuperHyperDegree of SuperHyperVertices, T_3, S_3, U_3, V_4 and V_5 are the same and equals to six.
- (*ii*) The SuperHyperDegree of SuperHyperVertices, S_6, R_6, T_6, V_7, V_8 and V_9 are the same and equals to ten.
- (*iii*) SuperHyperDegree of SuperHyperVertices, H_6, C_6, O_6, and E_6 are the same and equals to twelve.
- (*iv*) The SuperHyperDegree of SuperHyperVertices, R, P, J, and M are the same and equals to ten.

The characterization of SuperHyperDegree for exterior SuperHyperVertices is as follows.

- (*i*) The SuperHyperDegree of SuperHyperVertex, V_4 equals to fourteen.
- (*ii*) The SuperHyperDegree of SuperHyperVertices, Z_5, W_5 and V_{10} are the same and equals to eighteen.
- (*iii*) SuperHyperDegree of SuperHyperVertices, F, L_6, M_6, V_2, and V_3 are the same and equals to sixteen.

By using the Figures (3), (4) and the Table (3), the neutrosophic SuperHyperGraph is obtained.

Table 3. The Values of Vertices, SuperVertices, Edges, HyperEdges, and SuperHyperEdges Belong to The Neutrosophic SuperHyperGraph Mentioned in the Section (12)

The Values of The Vertices	The Number of Position in Alphabet
The Values of The SuperVertices	The Minimum Values of Its Vertices
The Values of The Edges	The Minimum Values of Its Vertices
The Values of The HyperEdges	The Minimum Values of Its Vertices
The Values of The SuperHyperEdges	The Minimum Values of Its Endpoints

13 Open Problems

This research proposes some tools to provide the backgrounds for SuperHyperDegree and Co-SuperHyperDegree with applications in cancer's treatments. The results are the starters to tackle the complexities in the theoretical issues and applications.

There are some avenues to pursue this research. This issues are addressed as "questions" and "problems". The notions of SuperHyperDegree and Co-SuperHyperDegree have the eligibilities to make continuous research to make the concept more understandable.

Question 13.1. *Are there other types of notions to define in this model to do research about this special case in cancer's treatment?*

Question 13.2. *How to define notions in this embedded model?*

Question 13.3. *What's the specific research based on cancer's treatment but in these models, namely, SuperHyperGraphs and neutrosophic SuperHyperGraphs?*

Question 13.4. *In this research, the concentrations are on the cells and embedded relations amid them, are there other types of foundations?*

Problem 13.5. *What are the special cases in real challenges of cancer's treatment related to these models, namely, SuperHyperGraphs and neutrosophic SuperHyperGraphs, and their procedures of modeling on cells and embedded cells based on "specific" properties?*

Problem 13.6. *How to characterize the borders of this case in cancer's treatment, completely?*

Problem 13.7. *How to advance the theoretical backgrounds of this research to overcome the challenges in cancer's treatment?*

14 Conclusion and Closing Remarks

In this section, concluding remarks and closing remarks are represented. The drawbacks of this article are illustrated. Some benefits and advantages of this study are highlighted.

This research uses some approaches to make neutrosophic SuperHyperGraphs more understandable. In this way, the cancer's treatments, are the cases to make the theoretical concept. The caner's treatment involves the cells and their roles in relations with each other. In this way, I propose, the specific models, namely, SuperHyperGraphs and neutrosophic SuperHyperGraphs, in redeemed ways in that, the cells are only considered in the caner's attacks. In the viewpoint of mathematical perspective, I define some SuperHyperClasses and there are some categories about the theoretical results. In the future research, the foundation will be based on the caner's treatment and the results and the definitions will be introduced in redeemed ways. In the Table (4), some limitations and advantages of this study are pointed out.

Table 4. A Brief Overview about Advantages and Limitations of this Research

Advantages	Limitations
1. Defining SuperHyperDegree	1. Detail-Oriented Applications
2. Defining Co-SuperHyperDegree	
3. Extended and Common Definition	2. General Results
4. Connection With Other SuperHyperNotions	
5. Used SuperHyperClasses	3. Connections Amid Results

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, *"Basic Neutrosophic Notions Concerning SuperHyperDominating and Neutrosophic SuperHyperResolving in SuperHyperGraph"*, ResearchGate 2022 (doi: 10.13140/RG.2.2.29173.86244).
4. 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).
5. Henry Garrett, "*Initial Material of Neutrosophic Preliminaries to Study Some Neutrosophic Notions Based on Neutrosophic SuperHyperEdge (NSHE) in Neutrosophic SuperHyperGraph (NSHG)*", ResearchGate 2022 (doi: 10.13140/RG.2.2.25385.88160).
6. Henry Garrett, "*Neutrosophic Co-degree and Neutrosophic Degree alongside Chromatic Numbers in the Setting of Some Classes Related to Neutrosophic Hypergraphs*", J Curr Trends Comp Sci Res 1(1) (2022) 06-14.
7. Henry Garrett, (2022). "*Neutrosophic Duality*", Florida: GLOBAL KNOWLEDGE - Publishing House 848 Brickell Ave Ste 950 Miami, Florida 33131 United States. ISBN: 978-1-59973-743-0 (http://fs.unm.edu/NeutrosophicDuality.pdf).
8. 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).
9. H.T. Nguyen and E.A. Walker, "*A First course in fuzzy logic*", CRC Press, 2006.
10. 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).

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