Neutrosophic Co-degree and Neutrosophic Degree alongside Chromatic Numbers in the Setting of Some Classes Related to Neutrosophic Hypergraphs

Research Article
Journal of Current Trends in Computer Science Research

Neutrosophic Co-degree and Neutrosophic Degree alongside Chromatic Numbers in the Setting of Some Classes Related to Neutrosophic Hypergraphs

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Submitted: 10 Nov 2022; **Accepted**: 15 Nov 2022; **Published**: 20 Nov 2022

Citation: *Henry Garrett, (2022). 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) 06-14.*

Abstract

New setting is introduced to study types of coloring numbers, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs. Different types of procedures including neutrosophic (r; n)-regular hypergraphs and neutrosophic complete r-partite hypergraphs are proposed in this way, some results are obtained. General classes of neutrosophic hypergraphs are used to obtain chromatic number, the representatives of the colors, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs.

Using colors to assign to the vertices of neutrosophic hypergraphs and characterizing representatives of the colors are applied in neutrosophic (r; n)-regular hypergraphs and neutrosophic complete r-partite hypergraphs. Some questions and problems are posed concerning ways to do further studies on this topic. Using different ways of study on neutrosophic hypergraphs to get new results about number, degree and co-degree in the way that some number, degree and co-degree get understandable perspective.

Neutrosophic (r; n)-regular hypergraphs and neutrosophic complete r-partite hypergraphs are studied to investigate about the notions, coloring, the representatives of the colors, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic (r; n)-regular hypergraphs and neutrosophic complete r-partite hypergraphs. In this way, sets of representatives of colors, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges have key points to get new results but in some cases, there are usages of sets and numbers instead of optimal ones. Simultaneously, notions chromatic number, the representatives of the colors, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges are applied into neutrosophic hypergraphs, especially, neutrosophic (r; n)-regular hypergraphs and neutrosophic complete r-partite hypergraphs to get sensible results about their structures. Basic familiarities with neutrosophic hypergraphs theory and hypergraph theory are proposed for this article.

Keywords: Degree, Coloring, Co-degree
AMS Subject Classification: 05C17, 05C22, 05E45

Background

Fuzzy set in Ref. [22] by Zadeh (1965), intuitionistic fuzzy sets in Ref. [3] by Atanassov (1986), a first step to a theory of the intuitionistic fuzzy graphs in Ref. [18] by Shannon and Atanassov (1994), a unifying field in logics neutrosophy: neutrosophic probability, set and logic, rehoboth in Ref. [19] by Smarandache (1998), single-valued neutrosophic sets in Ref. [20] by Wang et al. (2010), single-valued neutrosophic graphs in Ref. [5] by Broumi et al. (2016), operations on single-valued neutrosophic graphs in Ref. [1] by Akram and Shahzadi (2017), neutrosophic soft graphs in Ref. [17] by Shah and Hussain (2016), bounds on the average and minimum attendance in preference-based activity scheduling in Ref. [2] by Aronshtam and Ilani (2022), 1 investigating the recoverable robust single machine scheduling problem under interval uncertainty in Ref. [4] by Bold and Goerigk (2022), new bounds for the b-chromatic number of vertex deleted graphs in Ref. [6] by Del-Vecchio and Kouider (2022), bipartite completion of colored graphs avoiding chordless cycles of given lengths in Ref. [7] by Elaine et al., infinite chromatic games in Ref. [12] by Janczewski et al. (2022), edge-disjoint rainbow triangles in edge-colored graphs in Ref. [13] by Li and Li (2022), rainbow triangles in arc-colored digraphs in Ref. [14] by Li et al. (2022), a sufficient condition for edge 6-colorable planar graphs with maximum degree 6 in Ref. [15] by Lu and Shi (2022), some comparative results concerning the Grundy and b-chromatic number of graphs in Ref. [16] by Masih and Zaker (2022), color neighborhood union conditions for proper edge-pancyclicity of edge-colored complete graphs in Ref. [21] by Wu et al. (2022), dimension and coloring alongside domination in neutrosophic hypergraphs in Ref. [9] by Henry Garrett (2022), three types of neutrosophic alliances based on connectedness and (strong) edges in Ref. [11] by Henry Garrett (2022), properties of SuperHyperGraph and neutrosophic SuperHyperGraph in Ref. [10] by Henry Garrett (2022), are studied. Also, some studies and researches about neutrosophic graphs, are proposed as a book in Ref. [8] by Henry Garrett (2022). In this section, I use two subsections to illustrate a perspective about the background of this study

Motivation and Contributions

In this study, there's an idea which could be considered as a motivation.

Question 1.1: *Is it possible to use mixed versions of ideas concerning \neutrosophic degree", \neutrosophic co-degree" and \neutrosophic coloring" to define some notions which are applied to neutrosophic hypergraphs?*

It's motivation to find notions to use in any classes of neutrosophic hypergraphs. Real-world applications about time table and scheduling are another thoughts which lead to be considered as motivation. Connections amid two items have key roles to assign colors and introducing different types of degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs. Thus they're used to define new ideas which conclude to the structure of coloring, degree and co-degree. The concept of having general neutrosophic hyperedge inspires me to study the behavior of general neutrosophic hyperedge in the way that, types of coloring numbers, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs are introduced.

The framework of this study is as follows. In the beginning, I introduced basic definitions to clarify about preliminaries. In section \New Ideas For Neutrosophic Hypergraphs", new notions of coloring, degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs are introduced. In section \Applications in Time Table and Scheduling", one application is posed for neutrosophic hypergraphs concerning time table and scheduling when the suspicions are about choosing some subjects. In section \Open Problems", some problems and questions for further studies are proposed. In section \Conclusion and Closing Remarks", gentle discussion about results and applications are featured. In section \Conclusion and Closing Remarks", a brief overview concerning advantages and limitations of this study alongside conclusions are formed.

1.2 Preliminaries

Definition 1.2. (Graph).

$G = (V;E)$ is called a graph if V is a set of objects and E is a subset of $V \times V$ (E is a set of 2-subsets of V) where V is called vertex set and E is called edge set.

Every two vertices have been corresponded to at most one edge.

Definition 1.3. (Hypergraph).

$H = (V;E)$ is called a hypergraph if V is a set of objects and for every

nonnegative integer $t \leq n$; E is a set of t-subsets of V where V is called vertex set 71and E is called hyperedge set.

Definition 1.4. (Neutrosophic Hypergraph).

$NHG = (V;E; = (\sigma_1; \sigma_2; \sigma_3); \mu = (\mu_1; \mu_2; \mu_3))$ is called a neutrosophic hypergraph if it's hypergraph, σ_i : V ! [0; 1]; μ_i : E ! [0; 1]; and for every $v_1 v_2 \;\; v_t \in E$;

$$\mu(v_1 v_2 \bullet\bullet\bullet v_t) \leq \sigma(v_1) \wedge \sigma(v_2) \wedge \bullet\bullet\bullet \sigma(v_t).$$

(i) : σ is called neutrosophic vertex set.
(ii) : μ is called neutrosophic hyperedge set.
(iii) : $|V|$ is called order of NHG and it's denoted by O(NHG).
(iv) : $\Sigma_{v\in V}\,\sigma(v)$ is called neutrosophic order of NHG and it's denoted by $O_n(NHG)$.
(vi) : $|E|$ is called size of NHG and it's denoted by S(NHG).
(vii) : $\Sigma_{e\in E}\mu(e)$ is called neutrosophic size of NHG and it's denoted by $S_n(NHG)$.

Example 1.5. Assume Figure (1).
(i) : Neutrosophic hyperedge $n_1n_2n_3$ has three neutrosophic vertices.
(ii) : Neutrosophic hyperedge $n_3n_4n_5n_6$ has four neutrosophic vertices.
(iii) : Neutrosophic hyperedge $n_1n_7n_8n_9n_5n_6$ has six neutrosophic vertices.
(iv) : σ = {(n_1; (0:99; 0:98; 0:55)); (n_2; (0:74; 0:64; 0:46)); (n_3; (0:99; 0:98; 0:55));
(n_4; (0:54; 0:24; 0:16)); (n_5; (0:99; 0:98; 0:55)); (n_6; (0:99; 0:98; 0:55));
(n_7; (0:99; 0:98; 0:55)); (n_8; (0:99; 0:98; 0:55)); (n_9; (0:99; 0:98; 0:55))} is
neutrosophic vertex set.
(v) :μ = {(e_1; (0:01; 0:01; 0:01)); (e_2; (0:01; 0:01; 0:01)); (e_3; (0:01; 0:01; 0:01))g) is
neutrosophic hyperedge set.
(vi) : *O(NHG)* = 9:
(vii) : $O_n(NHG)$ = (8:21; 7:74; 4:47):
(viii) : *S(NHG)* = 3:
(ix) : $S_n(NHG)$ = (0:03; 0:03; 0:03)

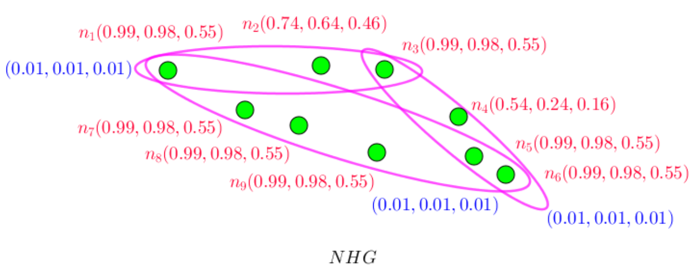


Figure 1: There are three neutrosophic hyperedges and two neutrosophic vertices.

Definition 1.6. (Neutrosophic Edge *t*-Regular Hypergraph).
A neutrosophic hypergraph *NHG* = (*V*;*E*; σ, μ) is called a neutrosophic edge *t*-regular hypergraph if every neutrosophic hyperedge has only t neutrosophic
vertices.

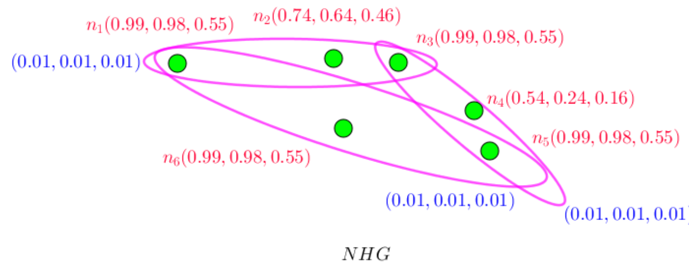


Figure 2: *NHG* = (*V*;*E*; σ, μ) is neutrosophic edge 3-regular hypergraph

Question 1.7. What-if all neutrosophic hypergraphs are either edge t-regular or not?
In the following, there are some directions which clarify the existence of some
neutrosophic hypergraphs which are either edge t-regular or not.

Example 1.8. Two neutrosophic hypergraphs are presented such that one of them is edge t-regular and another isn't.

(i) : Assume Figure (1). It isn't neutrosophic edge *t*-regular hypergraph.
(ii) : Suppose Figure (2). It's neutrosophic edge 3-regular hypergraph.

Definition 1.9. (Neutrosophic vertex *t*-Regular Hypergraph).
A neutrosophic hypergraph *NHG* = (*V*;*E*; σ, μ) is called a neutrosophic vertex *t*-regular hypergraph if every neutrosophic vertex is incident to only t neutrosophic
hyperedges.

Example 1.10. Three neutrosophic hypergraphs are presented such that one of them is vertex *t*- regular and anothers aren't.

(i) : Consider Figure (1). It isn't neutrosophic edge *t*-regular hypergraph.
(ii) : Suppose Figure (2). It's neutrosophic edge 3-regular hypergraph but It isn't neutrosophic vertex 3-regular hypergraph.
(iii) : Assume Figure (3). It's neutrosophic vertex 2-regular hypergraph but It isn't neutrosophic edge *t*-regular hypergraph.

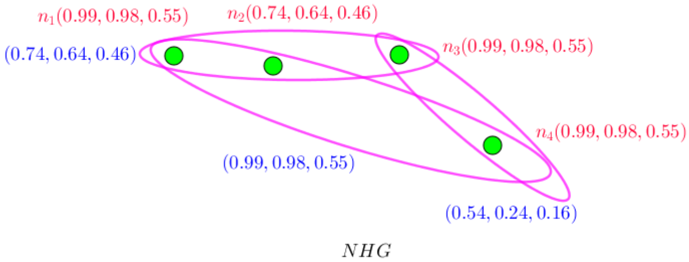


Figure 3: $NHG = (V, E, \sigma, \mu)$ is neutrosophic strong hypergraph.

Definition 1.11. (Neutrosophic Strong Hypergraph).
A neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ is called a neutrosophic strong hypergraph if it's hypergraph and for every $v_1v_2 \bullet\bullet\bullet v_t \in E$,
$\mu(v_1v_2 \bullet\bullet\bullet v_t) = \sigma(v_1) \wedge \sigma(v_2) \wedge \bullet\bullet\bullet \sigma(v_t)$.

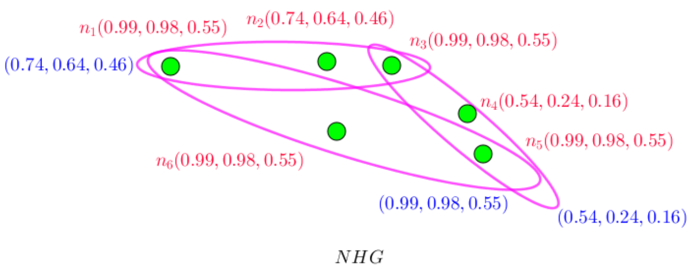


Figure 4: $NHG = (V, E, \sigma, \mu)$ is neutrosophic strong hypergraph.

Example 1.12. Three neutrosophic hypergraphs are presented such that one of them 117 is neutrosophic strong hypergraph and others aren't.

(i) : Consider Figure (1). It isn't neutrosophic strong hypergraph.
(ii) : Assume Figure (2). It isn't neutrosophic strong hypergraph.
(iii) : Suppose Figure (3). It isn't neutrosophic strong hypergraph.
(iv) : Assume Figure (4). It's neutrosophic strong hypergraph. It's also neutrosophic edge 3-regular hypergraph but it isn't neutrosophic vertex t-regular hypergraph.

Definition 1.13. (Neutrosophic Strong Hypergraph).
Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ A neutrosophic hyperedge $v_1v_2 \bullet\bullet\bullet v_t \in E$ is called a neutrosophic strong hyperedge if
$\mu(v_1v_2 \bullet\bullet\bullet v_t) = \sigma(v_1) \wedge \sigma(v_2) \wedge \bullet\bullet\bullet \ \sigma(v_t)$.

Proposition 1.14. *Assume neutrosophic strong hypergraph NHG = (V, E, σ, μ.) Then all neutrosophic hyperedges are neutrosophic strong.*

Definition 1.15. (Neutrosophic Hyperpath).
A path $v_0, E_0, v_1, v_1, E_1, v_2, \bullet\bullet\bullet, v_{t-1}, E_{t-1}, v_t$, is called neutrosophic hyperpath such that v_{i-1} and v_i have incident to E_{i-1} for all nonnegative integers $0 \leq i \leq t$. In this case, t-1 is called length of neutrosophic hyperpath. Also, if x and y are two neutrosophic vertices, then maximum length of neutrosophic hyperpaths from x to y, is called neutrosophic hyperdistance and it's denoted by $d(x, y)$. If $v_0 = v_t$, then it's called neutrosophic hypercycle.

Example 1.16. Assume Figure (1).
(i) : $n_1;E_1;\ n_3;E_2;\ n_6;E_3;\ n^1$ is a neutrosophic hypercycle.
(ii) : $n_1;E_1;\ n_n;E_2;\ n_6;E_3;\ n_1$ isn't neither neutrosophic hypercycle nor neutrosophic
hyperpath.
(iii) : $n_1E_1n_3E_2n_6E_3n_1$ isn't neither neutrosophic hypercycle nor neutrosophic hyperpath.
(iv) : $n_1;\ n_3;\ n_6;\ n_1$ isn't neither neutrosophic hypercycle nor neutrosophic hyperpath.
(v) : $n_1E_1;\ n_3;E_2;\ n_6;E_3$; n1 isn't neither neutrosophic hypercycle nor neutrosophic hyperpath.
(vi) : $n_1;E_1;\ n_3;E_2;\ n_6;E_3;\ n_7$ is a neutrosophic hyperpath.
(vii) : Neutrosophic hyperdistance amid n_1 and n_4 is two.
(viii) : Neutrosophic hyperdistance amid n_1 and n_7 is one.
(ix) : Neutrosophic hyperdistance amid n_1 and n_2 is one.
(x) : Neutrosophic hyperdistance amid two given neutrosophic vertices is either one or Two

New Ideas For Neutrosophic Hypergraphs

Question 2.1. *What-if the notion of complete proposes some classes of neutrosophic hypergraphs?*
In the setting of neutrosophic hypergraphs, the notion of complete have introduced some classes. Since the vertex could have any number of arbitrary hyperedges. This notion is too close to the notion of regularity. Thus the idea of complete has an obvious structure in that, every hyperedge has n vertices so there's only one hyperedge.

Definition 2.2. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$. It's denoted by 156 NHG^r_n and it's $(r; n)$ - regular if every hyperedge has exactly r vertices in the way that, all r-subsets of the vertices have an unique hyperedge where $r \leq n$ and $|V| = n$

Example 2.3. In Figure (5), NHG^3_4 is shown.

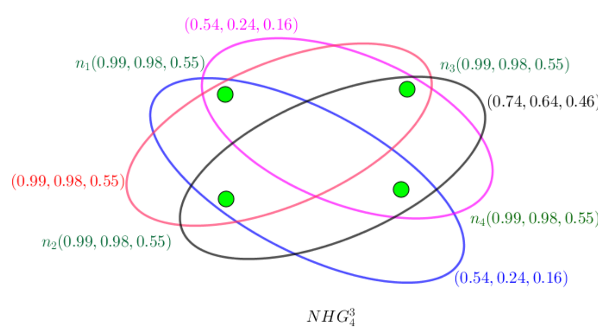


Figure 5: $NHG^3 = (V, E, \sigma, \mu)$ is neutrosophic (3; 4)- regular hypergraph

Definition 2.4. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$
(i): Maximum number is maximum number of hyperedges which are incident to a vertex and it's denoted by $\Delta(NHG)$;
(ii): Minimum number is minimum number of hyperedges which are incident to a vertex and it's denoted by $\delta(NHG)$
(iii): Maximum value is maximum value of vertices and it's denoted by $\Delta_n(NHG)$;;
(iv): Minimum value is minimum value of vertices and it's denoted by $\delta_n(NHG)$.

Example 2.5. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ as Figure (5).
(i) : $\Delta(NHG) = 3$;
(ii) : $\delta(NHG) = 3$;
(iii) : $\Delta_n(NHG) = (0.99, 0.98, 0.55)$;
(iv) : $\delta_n(NHG) = (0.99, 0.98, 0.55)$.

Proposition 2.6. *Assume neutrosophic hypergraph* $NHG^r = (V, E, \sigma, \mu)$ which is $(r, n)-$ regular. Then $\Delta(NHG) = \delta(NHG)$.
Proof. Consider neutrosophic hypergraph $NHG^r = (V, E, \sigma, \mu)$ which is (r, n) regular. Every hyperedge has same number of vertices. Hyperedges are distinct. It implies the number of hyperedges which are incident to every vertex is the same.

Proposition 2.7. Assume neutrosophic hypergraph $NHG^r = (V, E, \sigma, \mu)$ which is $(r, n)-$ regular. Then the number of hyperedges equals to n choose r.

Proof. Suppose neutrosophic hypergraph $NHG^r = (V, E, \sigma, \mu)$ which is (r, n) regular. Every hyperedge has r vertices. Thus r subsets of n form hyperedges. It induces n choose r.

Proposition 2.8. Assume neutrosophic hypergraph $NHG^r = (V, E, \sigma, \mu)$ which is $(r, n)-$ regular. Then
(i) : Chromatic number is at least r;
(ii) : Chromatic number is at most Δr;
(iii) : Neutrosophic chromatic number is at most $\Delta_n r$.
Proof. (i). Suppose $NHG^r = (V, E, \sigma, \mu)$. Every hyperedge has r vertices. It implies the set of representatives has at least r members. Hence chromatic number is at least r.
(ii). Suppose $NHG^r = (V, E, \sigma, \mu)$. Every hyperedge has r vertices. It implies the set of representatives has at least r members. If all vertices have at least one common hyperedge, then chromatic number is at most Δ_r. Thus chromatic number is at most Δ_r.
(iii). Consider $NHG_r = (V, E, \sigma, \mu)$. Every hyperedge has r vertices. It implies the set of representatives has at least r members. If all vertices have at least one common hyperedge, then neutrosophic chromatic number is at most $\Delta_n r$. Thus neutrosophic chromatic number is at most $\Delta_n r$.

Question 2.9. *What-if the notion of complete proposes some classes of neutrosophic hypergraphs with some parts?*

In the setting of neutrosophic hypergraphs, when every part has specific attribute inside and outside, the notion of complete is applied to parts to form the idea of completeness.

Definition 2.10. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$. It's denoted by $NHG_{r\ n1, n2, \cdots, nr}$ and it's complete $r-$partite if V can be partitioned into r non-empty parts, V_i, and every hyperedge has only one vertex from each part where ni is the number of vertices in part V_i.

Example 2.11. In Figure (6), $NHG^3_{333} = (V, E, \sigma, \mu)$ is shown.

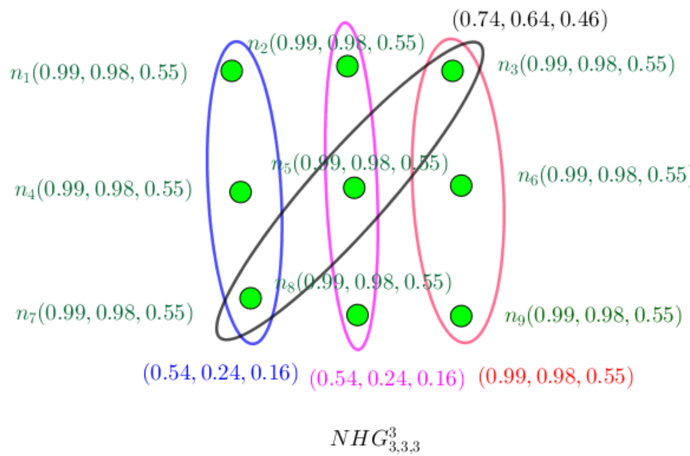


Figure 6: $NHG^3_{333} = (V, E, \sigma, \mu)$ is neutrosophic complete 3−partite hypergraph.

Proposition 2.12. For any given r, the number of neutrosophic complete $r-$partite hypergraph $NHG_{r\ p1, p2, \cdots, pr} = (V, E, \sigma, \mu)$ is at most $p_1 \times p_2, \times \bullet \bullet \bullet \times p_r$.

Proof. Assume r is given. Consider $NHG^r_{p1, p2, \cdots, pr} = (V, E, \sigma, \mu)$ is neutrosophic complete r−partite hypergraph. Any possible hyperedge has to choose exactly one vertex from every part. First part has p_1 vertices. Thus there are p_1 choices. Second part has p_2 vertices and et cetera. Thus for any given r, the number of neutrosophic complete $r-$partite hypergraph $NHG_r = (V, E, \sigma, \mu)$ is at most $p_1 \times p_2 \times \bullet \bullet \bullet \times p_r$.

Proposition 2.13. *Assume neutrosophic complete r−partite hypergraph* $NHG^r_{\ n1, n2, \cdots, nr} = (V, E, \sigma, \mu)$. *Then*
(i) : *Chromatic number is at least* r;
(ii) : *Neutrosophic chromatic number is at least*

min $X \subseteq V$ and X is *r-subset* $\Sigma_{x \in X} \sigma(x)$.

Proof. (i). Suppose neutrosophic complete $r-$partite hypergraph $NHG^r_{n,n,\ldots n2}$ Every hyperedge has r vertices. It implies the set of representatives has r members. Hence chromatic number is least r.
(ii). Consider neutrosophic complete $r-$partite hypergraph

$NHG^r_{n,n,...n2}$ Every hyperedge has r vertices. It implies the set of representatives has r members. If all vertices have at least one common hyperedge, then neutrosophic chromatic number is at least min$X \subseteq V$ and X is r-subset $\Sigma_{x\in X}\sigma(x)$.

Definition 2.14. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$.
(i) : A neutrosophic number of vertices $x_1, x_2, \cdots, x_n$ i

$$\Sigma_{i=1}^{n}\sigma(x_i).$$

(ii) : A neutrosophic number of hyperedges $e_1, e_2, \cdots, e_n$ is

$$\Sigma_{i=1}^{n}\mu(e_i).$$

Example 2.15. I get some clarifications about new definitions.
(i): In Figure (5), NHG^3_4 is shown.
(a) : A neutrosophic number of vertices n_1, n_2, n_3 is

$$\Sigma_{i=1}^{3}\sigma(n_i) = (2.97, 2.94, 1.65).$$

(b) : A neutrosophic number of hyperedges e_1, e_2, e_3 is

$$\Sigma_{i=1}^{3}\sigma(e_i) = (1.82, 1.12, 0.78).$$

where e_1 = (0.54, 0.24, 0.16), e_2 = (0.74, 0.64, 0.46), e3 = (0.54, 0.24, 0.16).
(ii) : In Figure (6), $NHG^3_{333} = (V, E, \sigma, \mu)$ is shown.
(a) : A neutrosophic number of vertices n_1, n_2, n_3 is

$$\Sigma_{i=1}^{3}\sigma(n_i) = (2.97, 2.94, 1.65).$$

(b) : A neutrosophic number of hyperedges e_1, e_2, e_3 is

$$\Sigma_{i=1}^{3}\sigma(e_i) = (1.82, 1.12, 0.78).$$

where e_1 = (0.54, 0.24, 0.16), e_2 = (0.74, 0.64, 0.46), e_3 = (0.54, 0.24, 0.16).

Proposition 2.16. *Assume neutrosophic hypergraph NHG = (V, E, σ, μ). A neutrosophic number of vertices is at least* δ_n *and at most* O_n.

Proof. Suppose neutrosophic hypergraph NH$G = (V, E, \sigma, \mu)$. Let v be a given vertex. Then $\sigma(v) \geq min_{v\in V}\ \sigma(v)$. Thus $\sigma(v) \geq \delta_n$. So a neutrosophic number of vertices is at least δ_n. $\sigma(v) \leq \Sigma_{v\in V}\ \sigma(v)$. Thus $\sigma(v) \leq$ On. So a neutrosophic number of vertices is at most O_n. Hence a neutrosophic number of vertices is at least δ_n and at most O_n.

Proposition 2.17. *Assume neutrosophic hypergraph NHG = (V, E, σ, μ). A neutrosophic number of hyperedges is at least* δ^e *and at most* S_n *where* $\delta e = min_{e\in E}\ \mu(e)$.

Proof. Suppose neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$. Let e be a given hyperedge. Then $\mu(e) \geq min_{e\in E}\ \mu(e)$. Thus $\mu(v) \geq \delta^e$. So a neutrosophic number of hyperedges is at least δ_e . $\mu(e) \leq \Sigma_{e\in E}\mu(e)$. Thus $\mu(e) \leq S_n$. So a neutrosophic number of hyperedges is at most S_n. Hence a neutrosophic number of hyperedges is at least δ^e and at most S_n.

Definition 2.18. Assume neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$.
(i) : A degree of vertex x is the number of hyperedges which are incident to x.
(ii) : A neutrosophic degree of vertex x is the neutrosophic number of hyperedges which are incident to x.
(iii) : A degree of hyperedge e is the number of vertices which e is incident to them.
(iv) :A neutrosophic degree of hyperedge e is the neutrosophic number of vertices which e is incident to them.
(v) : A co-degree of vertices $x_1, x_2, \cdots, x_n$ is the number of hyperedges which are incident to $x_1, x_2, \cdots, x_n$.
(vi) : A neutrosophic co-degree of vertices $x_1, x_2, \cdots, x_n$ is the neutrosophic number of hyperedges which are incident to $x_1, x_2, \cdots, x_n$.
(vii) : A co-degree of hyperedges $e_1, e_2, \cdots, e_n$ is the number of vertices which $e_1, e_2, \cdots$, en are incident to them.
(viii) : A neutrosophic co-degree of hyperedges $e_1, e_2, \cdots, e_n$ is the neutrosophic number of vertices which $e_1, e_2, \cdots, e_n$ are incident to them.

Example 2.19. I get some clarifications about new definitions.
(i) : In Figure (5), NHG^3_4 is shown.
(a) : A degree of any vertex is 3.
(b) : A neutrosophic degree of vertex n_1 is (2.07, 1.46, 0.87).
(c) : A degree of hyperedge e where $\mu(e)$ = (0.99, 0.98, 0.55) is 3.
(d) : A neutrosophic degree of hyperedge e where $\mu(e)$ = (0.99, 0.98, 0.55) is (2.97, 2.94, 1.65).
(e) : A co-degree of vertices n_1, n_3 is 2.
(f) : A neutrosophic co-degree of vertices n_1, n_3 is (1.53, 1.22, 0.71).
(g) : A co-degree of hyperedges e_1, e_2 where $\mu(e_1)$ = (0.99, 0.98, 0.55) and $\mu(e_2)$ = (0.54, 0.24, 0.16) is 2.
(h) : A neutrosophic co-degree of hyperedges e_1, e_2 where $\mu(e_1)$ = (0.99, 0.98, 0.55) and $\mu(e_2)$ = (0.54, 0.24, 0.16) is (1.98, 1.96, 1.1).
(ii) : In Figure (6), $NHG^3_{333} = (V, E, \sigma, \mu)$ is shown.
(a) : A degree of any vertex $n_1, n_2, n_4, n_6, n_8, n_9$ is 1 and degree of any vertex n_3, n_5, n_7 is 2.
(b) : A neutrosophic degree of vertex $n_1, n_2, n_4, n_6, n_8, n_9$ is (0.99, 0.98, 0.55) and degree of any vertex n_3, n_5, n_7 is (1.98, 1.96, 1.1).
(c) : A degree of any hyperedge is 3.
(d) : A neutrosophic degree of hyperedge is (2.97, 2.94, 1.65).
(e) : A co-degree of vertices n_1, n_4 is 1.
(f): A neutrosophic co-degree of vertices n_1, n_4 is (0.54, 0.24, 0.16)
(g) : A co-degree of hyperedges e_1, e_2 where $\mu(e_1)$ = (0.99, 0.98, 0.55) and $\mu(e_2)$ = (0.54, 0.24, 0.16) is 1.
(h) : A neutrosophic co-degree of hyperedges e_1, e_2 where $\mu(e_1)$ = (0.99, 0.98, 0.55) and $\mu(e_2)$ = (0.54, 0.24, 0.16) is (0.99, 0.98, 0.55).

Proposition 2.20. *Assume neutrosophic complete r−partite hypergraph* $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$.

(i) : A degree of vertex x is at most

$p_2 \times \bullet\bullet\bullet \times p_r$.

(ii) : A degree of hyperedge e is r.

(iii) : A co-degree of vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ is at most

$p_{t+1} \times \bullet\bullet\bullet \times p_r$.

(iv) : A co-degree of hyperedges $e_1, e_2, \bullet\bullet\bullet, e_t$ is $r - t$.

Proof. (i). Suppose neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$. Vertex x belongs to part first part. x is chosen so for second part, there are p_2 choices and et cetera. By it's neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$, possible choice from every part is exactly one vertex. It induces for second part, one vertex has to be chosen and et cetera. Therefore the number of neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$, when x is chosen, introduces biggest possible number of degree of x which is $p_2 \times \bullet\bullet\bullet \times p_r$. Hence a degree of vertex x is at most $p_2 \times \bullet\bullet\bullet \times p_r$.

(ii). Consider neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$. Vertex x belongs to part first part. x is chosen so for second part, there is one choice and et cetera. By it's neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$, possible choice from every part is exactly one vertex. It induces for second part, one vertex has to be chosen and et cetera. Therefore neutrosophic complete r−partite hypergraph $NHG^r_{p,p,\ldots p2} = (V, E, \sigma, \mu)$ introduces exact number of degree of e which is r. Hence a degree of hyperedge e is r

(iii). Suppose neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$. Vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ belong to part first part, second part,...., and part t. $x_1, x_2, \bullet\bullet\bullet, x_t$ are chosen so for part $t+1$, there are pt+1 choices and et cetera. By it's neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\ldots,pr} = (V, E, \sigma, \mu)$, possible choice from every part is exactly one vertex. It induces for part $t+1$, one vertex has to be chosen and et cetera. Therefore the number of neutrosophic complete r−partite hypergraph $NHG^r_{p,p,\ldots,p2} = (V, E, \sigma, \mu)$, when $x_1, x_2, \bullet\bullet\bullet, x_t$ are chosen, introduces biggest possible number of co-degree of $x_1, x_2, \bullet\bullet\bullet, x_t$ which is $p_{t+1} \times \bullet\bullet\bullet \times p_r$. Hence a co-degree of vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ is at most $p_{t+1} \times \bullet\bullet\bullet \times p_r$

(iv). Consider neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$. Vertex x belongs to part first part. x is chosen so for second part, there is one choice and et cetera. By it's neutrosophic complete r−partite hypergraph $NHG^r_{p1,p2,\cdots,pr} = (V, E, \sigma, \mu)$, possible choice from every part is exactly one vertex. It induces for second part, one vertex has to be chosen and et cetera. Therefore neutrosophic complete r−partite hypergraph $NHG^r_{p,p,\ldots,p2} = (V, E, \sigma, \mu)$ introduces exact number of co-degree of $e_1, e_2, \bullet\bullet\bullet, e_t$ which is $r - t$. Hence a co-degree of hyperedges $e_1, e_2, \bullet\bullet\bullet$, et is $r - t$

Proposition 2.21. *Assume neutrosophic hypergraph NHG = (V, E, σ, μ) where E is power set of V. Then the number of hyperedges is 2^n*

Proof. Consider neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. The cardinality of E is 2^n. The number of hyperedges is 2^n.

Proposition 2.22. *Assume neutrosophic hypergraph NHG = (V, E, σ, μ) where E is power set of V. Then*

(i) *: A degree of vertex x is 2^{n-1}.*

(ii) : A degree of hyperedge e is at most O and at least 0.

(iii) : A co-degree of vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ is at most 2^{n-t}.

(iv) : A co-degree of hyperedges $e_1, e_2, \bullet\bullet\bullet$, et is at most $O - t$ and at least 0.

Proof. (i). Suppose neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. Vertex x is chosen. Thus all hyperedges have to have x. It induces E' is power set of $V \setminus \{x\}$. The cardinality of E' is 2^{n-1}. So the number of hyperedges which are incident to x, is 2^{n-1}. It implies a degree of vertex x is 2^{n-1}.

(ii). Consider neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. Hyperedge e is chosen. Thus a hyperedge has either all vertices or no vertex. It induces for hyperedge e, the number of vertices is either O or 0. Then a degree of hyperedge e is at most O and at least 0.

(iii). Suppose neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. Vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ are chosen. Thus all hyperedges have to have $x_1, x_2, \bullet\bullet\bullet, x_t$. It induces E' is power set of $V \setminus \{x_1, x_2, \bullet\bullet\bullet, x_t\}$. The cardinality of E' is 2^{n-t}. So the number of hyperedges which are incident to $x_1, x_2, \bullet\bullet\bullet, x_t$, is 2^{n-t}. It implies a co-degree of vertices $x_1, x_2, \bullet\bullet\bullet, x_t$ is 2^{n-t}.

(iv). Consider neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. Hyperedges e1, e2, , et are chosen. Thus hyperedges $e_1, e_2, \ldots\ldots., e_t$ don't have all vertices. Since one edge is incident to all vertices and there's no second edge to be incident to all vertices. It implies hyperedges $e_1, e_2, \bullet\bullet\bullet, e_t$ have all vertices excluding only t vertices or no vertex. It induces for hyperedges $e_1, e_2, \bullet\bullet\bullet, e_t$, the number of vertices is either $O - t$ or 0. Hence a co-degree of hyperedges $e_1, e_2, \bullet\bullet\bullet, e_t$ is at most $O - t$ and at least 0.

Proposition 2.23. *Assume neutrosophic hypergraph NHG = (V, E, σ, μ) where E is power set of V. Then*

(i) : Chromatic number is O;

(ii) : Neutrosophic chromatic number is O_n.

Proof. (i). Suppose neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of V. Every hyperedge has either of 0, 1, 2,. . . . . .,0 vertices but for any of two vertices, there's at least one hyperedge which is incident to them. Furthermore, all vertices have at least one common hyperedge which is V.. Since $V \in E$ and V is also a hyperedge. It implies the set of representatives has O members. Hence chromatic number is O.

(ii). Consider neutrosophic hypergraph $NHG = (V, E, \sigma, \mu)$ where E is power set of. Every hyperedge has either of 0, 1, 2, ... ,0 vertices but for any of two vertices, there's at least one hyperedge which is incident to them. Furthermore, all vertices have at least one common hyperedge which is V.. Since $V \in E$ and V is also a hyperedge. It implies the set of representatives has members. Hence neutrosophic chromatic number is O_n.

Applications in Time Table and Scheduling

Designing the programs to achieve some goals is general approach to apply on some issues to function properly. Separation has key role in the context of this style. Separating the duration of work which are consecutive, is the matter and it has important to avoid mixing up.

Step 1. (Definition) Time table is an approach to get some attributes to do the work fast and proper. The style of scheduling implies special attention to the tasks which are consecutive.

Step 2. (Issue) Scheduling of program has faced with difficulties to differ amid consecutive section. Beyond that, sometimes sections are not the same.

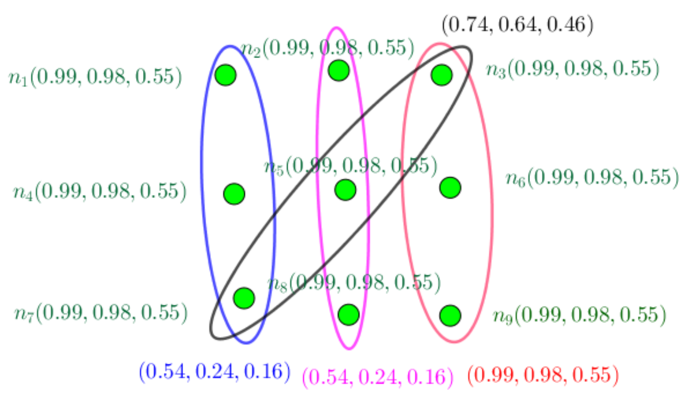
Step 3. (Model) As Figure (7), the situation is designed as a model. The model uses data to assign every section and to assign to relation amid section, three numbers belong unit interval to state indeterminacy, possibilities and determinacy. There's one restriction in that, the numbers amid two sections are at least the number of the relation amid them. Table (1), clarifies about the assigned numbers to these situation.

Table 1: Scheduling concerns its Subjects and its Connections as a Neutrosophic Hypergraph in a Model.

Sections of NHG	n_1	n_2 • • •	n_9
Values	(0.99, 0.98, 0.55)	(0.74, 0.64, 0.46)• • •	(0.99, 0.98, 0.55)
Connections of NHG	E_1, E_2	E_3	E_4
Values	(0.54, 0.24, 0.16)	(0.99, 0.98, 0.55)	(0.74, 0.64, 0.46)

Step 4. (Solution) As Figure (7) shows, $NHG^3_{333} = (V, E, \sigma, \mu)$ is neutrosophic complete 3 partite hypergraph as model, proposes to use different types of degree 308 of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, 309 neutrosophic number of vertices, neutrosophic number of hyperedges and et cetera.

(i) : The notions of neutrosophic number are applied on vertices and hyperedges.



$NHG^3_{3,3,3}$

Figure 7: Vertices are suspicions about choosing them.

(a) : A neutrosophic number of vertices n_1, n_2, n_3 is

$$\Sigma_{i=1}^{3}\sigma(n_i) = (2.97, 2.94, 1.65).$$

(b) : A neutrosophic number of hyperedges e_1, e_2, e_3 is

$$\Sigma_{i=1}^{3}\sigma(e_i) = (1.82, 1.12, 0.78).$$

where $e_1 = (0.54, 0.24, 0.16)$, $e_2 = (0.74, 0.64, 0.46)$, $e_3 = (0.54, 0.24, 0.16)$.

(ii) : The notions of degree, co-degree, neutrosophic degree and neutrosophic co-degree are applied on vertices and hyperedges.

(a) : A degree of any vertex n_1, n_2, n_4, n_6, n_8, n_9 is 1 and degree of any vertex n_3, n_5, n_7 is 2.

(b) : A neutrosophic degree of vertex n_1, n_2, n_4, n_6, n_8, n_9 is (0.99, 0.98, 0.55) and degree of any vertex n_3, n_5, n_7 is (1.98, 1.96, 1.1).

(c) : A degree of any hyperedge is 3.

(d) : A neutrosophic degree of hyperedge is (2.97, 2.94, 1.65).

(e) : A co-degree of vertices n_1, n_4 is 1.

(d) : A neutrosophic co-degree of vertices n_1, n_4 is (0.54, 0.24, 0.16).

(g) : A co-degree of hyperedges e_1, e_2 where $\mu(e_1) = (0.99, 0.98, 0.55)$ and $\mu(e_2) = (0.54, 0.24, 0.16)$ is 1.

(h) : A neutrosophic co-degree of hyperedges e_1, e_2 where $\mu(e_1) = (0.99, 0.98, 0.55)$ and $\mu(e_2) = (0.54, 0.24, 0.16)$ is (0.99, 0.98, 0.55).

Open Problems

The different types of degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges are introduced on neutrosophic hypergraphs. Thus,

Question 4.1. *Is it possible to use other types neutrosophic hyperedges to define different types of degree and co-degree in neutrosophic hypergraphs?*

Question 4.2. *Are existed some connections amid degree and co-degree inside this concept and external connections with* *other types of neutrosophic degree and neutrosophic co-degree in neutrosophic hypergraphs?*

Question 4.3. *Is it possible to construct some classes on neutrosophic hypergraphs which have "nice" behavior?*

Question 4.4. *Which applications do make an independent study to apply these types degree, co-degree, neutrosophic degree and neutrosophic co-degree in neutrosophic hypergraphs?*

Problem 4.5. *Which parameters are related to this parameter?*

Problem 4.6. *Which approaches do work to construct applications to create independent study?*

Problem 4.7. *Which approaches do work to construct definitions which use all definitions and the relations amid them instead of separate definitions to create independent study?*

Conclusion and Closing Remarks

This study introduces different types of degree of vertices, degree of hyperedges, co-degree of vertices, co-degree of hyperedges, neutrosophic degree of vertices, neutrosophic degree of hyperedges, neutrosophic co-degree of vertices, neutrosophic co-degree of hyperedges, neutrosophic number of vertices, neutrosophic number of hyperedges in neutrosophic hypergraphs. The connections of neutrosophic vertices which are clarified by general hyperedges differ them from each other and and put them in different categories to represent one representative for each color. Further studies could be about changes in the settings to compare this notion amid different settings of neutrosophic hypergraphs theory. One way is finding some relations amid these definitions of notions to make sensible definitions. In Table (2), some limitations and some advantages of this study are pointed out.

Table 2: A Brief Overview about Advantages and Limitations of this study

Advantages	Limitations
1.Defining degree 2. Defining co-degree	1. General Results
3. Defining neutrosophic degree 4. Applying colortring	2. Connections With Parameters
5. Defining neutrosophic co-degree	3. Connections of Results

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