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PERFECT AND STATUS IN SINGLE VALUED NEUTROSOPHIC GRAPHS

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ABSTRACT

In this paper, we introduce the concepts of perfect single valued neutrosophic, complete perfect single valued neutrosophic vertices, edges and graphs. We investigated some properties of status in complete perfect single valued neutrosophic graphs.

Key words: Perfect SVN vertex, perfect SVN edge, complete perfect SVN graphs, status in SVN graphs.

AMS Classification: 05C07, 68R10, 03E72

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1. INTRODUCTION

The fundamental concept of a fuzzy relation was defined by zadeh [14]. Atanassov K introduced the concepts of Intuitionistic fuzzy sets and systems [5]. Parvathi R, Karunambigai M.G. introduced the idea of a intuitionistic fuzzy relations and intuitionistic fuzzy graphs(IFGs) [12]. Smarandache introduced the concept of neutrosophic sets [13]. The concepts of certain types of neutrosophic graphs was introduced by R. Dhavaseelan, et al. [8]. A. Nagoor Gani and M. Basheer Ahmed [10] defined perfect fuzzy graph and complete perfect fuzzy graph and its properties. V.Krishnaraj, et al. [9] defined status, self-center and various properties in single valued neutrosophic graphs.

In this paper, we introduce the concepts of T_A, I_A and F_A-perfect single valued neutrosophic vertices, T_B, I_B and F_B-perfect single valued neutrosophic edges, (T_A, I_A, F_A)-

perfect single valued neutrosophic graphs, (T_B, I_B, F_B)-perfect single valued neutrosophic graphs, complete T_A, I_A and F_A-perfect single valued neutrosophic graphs, complete T_B, I_B and F_B-perfect single valued neutrosophic graphs, T, I and F-perfect single valued neutrosophic graphs, complete T, I and F-perfect single valued neutrosophic graphs, complete perfect single valued neutrosophic graphs and its properties.

2. PRELIMINARIES

Definition 2.1 [1] A Single Valued Neutrosophic (SVN) Graph with underlying set V is defined to be a pair G = (A, B) where

1. The function $T_A: V \to [0,1], I_A: V \to [0,1], F_A: V \to [0,1]$ denote the degree of truth-membership, degree of indeterminacy-membership and falsity-membership of the element$v_i \in V$, respectively, and $0 \leq T_A(v_i) + I_A(v_i) + F_A(v_i) \leq 3$ for all$v_i \in V$.

2. The functions $T_B: E \subseteq V \times V \to [0,1], I_B: E \subseteq V \times V \to [0,1], F_B: E \subseteq V \times V \to [0,1]$ are defined by $T_B(v_i, v_j) \leq min[T_A(v_i), T_A(v_j)]$, $I_B(v_i, v_j) \leq min[I_A(v_i), I_A(v_j)]$ and $F_B(v_i, v_j) \leq max[F_A(v_i), F_A(v_j)]$.

Definition 2.2 [3] A single valued neutrosophic graph G= (A, B) is called complete single valued neutrosophic graph if $T_B(v_i, v_j) = min[T_A(v_i), T_A(v_j)], I_B(v_i, v_j) = \min[I_A(v_i), I_A(v_j)]$ and $F_B(v_i, v_j) = max[F_A(v_i), F_A(\mathrm{v}_j)]$ for all $v_i, v_j \in V$.

Definition 2.3 [9] A connected SVN graph G is a T- self centered SVN graph, if every vertex of G is a T- central vertex. (i.e) $r_T(G) = e_T(v_i), \forall v_i \in V$. I- self centered SVN graph, if every vertex of G is a I- central vertex. (i.e) $r_I(G) = e_I(v_i), \forall v_i \in V$. F- self centered SVN graph, if every vertex of G is a F- central vertex. (i.e) $r_F(G) = e_F(v_i), \forall v_i \in V$. G is called self centered SVN graph, if every vertex of G is a central vertex. (i.e) $r(G) = e(v_i), \forall v_i \in V$.

Definition 2.4 [9] Let $G = (A, B)$ be a connected SVN graph.

The T-status of a vertex u of G is denoted by $s_T(u)$ and is defined as $s_T(u) = \sum_{v \in V} \delta_T(u, v)$,

The I-status of a vertex u of G is denoted by $s_I(u)$ and is defined as $\mathrm{s}_I(u) = \sum_{v \in V} \delta_I(u, v)$,

The F-status of a vertex u of G is denoted by $s_F(u)$ and is defined as $s_F(u) = \sum_{v \in V} \delta_F(u, v)$,

The status of a vertex u of G is defined as $s(u) = (s_T(u), s_I(u), s_F(u))$.

Definition 2.5 [9] Let $G = (A, B)$ be a connected SVN graph.

The minimum T-status of G is defined as $m[s_T(G)] = min\{s_T(u): u \in V\}$,

The minimum I-status of G is defined as $m[s_I(G)] = min\{s_I(u): u \in V\}$,

The minimum F-status of G is defined as $m[s_F(G)] = min\{s_F(u): u \in V\}$.

The minimum status of G is denoted by $m[s(G)]$ and is defined as $m[s(G)] = (m[s_T(G)], m[s_I(G)], m[s_F(G)])$.

Definition 2.6 [9] Let $G = (A, B)$ be a connected SVN graph.

The maximum T-status of G is defined as $M[s_T(G)] = max\{s_T(u): u \in V\}$,

The maximum I-status of G is defined as $M[s_I(G)] = max\{s_I(u): u \in V\}$,

The maximum F-status of G is defined as $M[s_F(G)] = max\{s_F(u): u \in V\}$.

The maximum status of G is denoted by $M[s(G)]$ and is defined as $M[s(G)] = (M[s_T(G)], M[s_I(G)], M[s_F(G)])$.

Definition 2.7 [9] Let $G = (A, B)$ be a connected SVN graph. The total T-status of a vertex u of G is denoted by $ts_T(u)$ and is defined as $ts_T(u) = \sum_{u \in V} s_T(u)$, The total I-status of a vertex u of G is denoted by $ts_I(u)$ and is defined as $ts_I(u) = \sum_{v \in V} s_I(u)$, The total F-status of a vertex u of G is denoted by $ts_F(u)$ and is defined as $ts_F(u) = \sum_{v \in V} s_F(u)$. The total status of G is denoted by $t[s(G)]$ and is defined as $t[s(G)] = (ts_T(u), ts_I(u), ts_F(u))$.

Definition 2.8 [9] Let $G = (A, B)$ be a connected SVN graph. The median is defined as $M(G) = (M_T(G), M_I(G), M_F(G))$, where $M_T(G) = \{v_i \in V: min\{s_T(v_i)\}\}$,

$M_I(G) = \{v_i \in V: min\{s_I(v_i)\}\}$,$M_F(G) = \{v_i \in V: min\{s_F(v_i)\}\}$.

Definition 2.9 [9] A connected SVN graph $G = (A, B)$ is a self-median if all the vertices have the same status. In other words, a connected SVN-graph $G = (A, B)$ is self-median if and only if $m[s(G)] = M[s(G)]$.

3. PERFECT AND COMPLETE PERFECT IN SINGLE VALUED NEUTROSOPHIC GRAPHS

Definition 3.1 Let $G = (A, B)$ be a connected SVN graph.

A vertex is called a

(1) T_A-perfect SVN vertex if $T_A(u) = 1$,

(2) I_A-perfect SVN vertex if $I_A(u) = 1$,

(3) F_A-perfect SVN vertex if $F_A(u) = 1$ for some $u \in V$.

An edge is called a

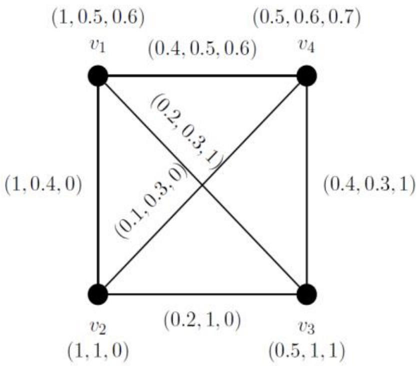
(1) T_B-perfect SVN edge if $T_B(u, v) = 1$,

(2) I_B-perfect SVN edge if $I_B(u, v) = 1$,

(3) F_B-perfect SVN edge if $F_B(u, v) = 1$ for some $(u, v) \in E$.

Example 3.1 Consider a SVN-graph, $G = (A, B)$ such that $V = \{v_1, v_2, v_3, v_4\}$. $E = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_4, v_1), (v_1, v_3), (v_2, v_4)\}$.

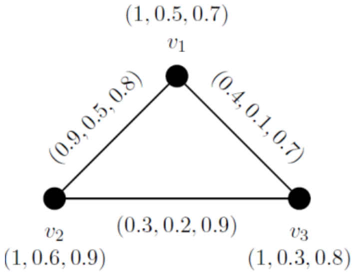
$v_1, v_2: T_A - perfect\ SVN\ vertex, v_2, v_3: I_A - perfect\ SVN\ vertex,$
$v_3: F_A - perfect\ SVN\ vertex, (v_1, v_2): T_B - perfect\ SVN\ edge,$
$(v_2, v_3): I_B - perfect\ SVN\ edge,\ (v_1, v_3), (v_3, v_4): F_B - perfect\ SVN\ edge.$



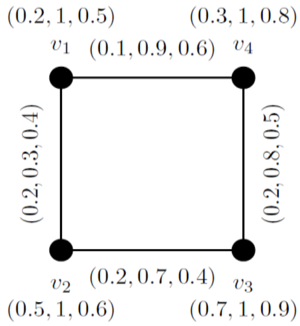
Definition 3.2 A connected SVN graph $G = (A, B)$ is called a T_A-perfect SVN graph if $T_A(u) = 1$ for all $u \in V$, I_A-perfect SVN graph if $I_A(u) = 1$ for all $u \in V$, F_A-perfect SVN graph if $F_A(u) = 1$ for all $u \in V$.

Example 3.2 Consider SVN-graphs, $G_1 = (A, B)$ such that $V_1 = \{v_1, v_2, v_3\}$, $E_1 = \{(v_1, v_2), (v_2, v_3), (v_3, v_1)\}$, $G_2 = (A, B)$ such that $V_2 = \{v_1, v_2, v_3, v_4\}$,

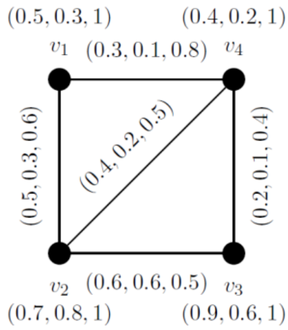
$E_2 = \{(v_1,v_2),(v_2,v_3),(v_3,v_4),(v_1,v_4)\}$, $G_3 = (A,B)$ such that $V_3 = \{v_1,v_2,v_3,v_4\}$, $E_3 = \{(v_1,v_2),(v_2,v_3),(v_3,v_4),(v_1,v_4),(v_2,v_4)\}$.



T_A – perfect SVN graph



I_A – perfect SVN graph

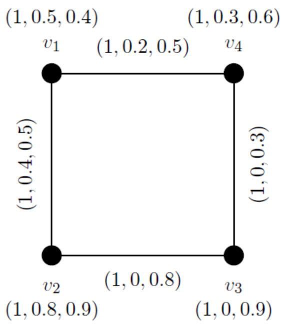


F_A – perfect SVN graph

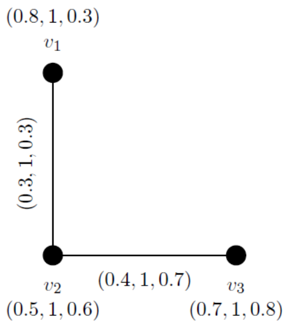
Definition 3.3 A connected SVN graph $G = (A,B)$ is called a
T_B-perfect SVN graph if $T_B(u,v) = 1$ for all $(u,v) \in E$,
I_B-perfect SVN graph if $I_B(u,v) = 1$ for all $(u,v) \in E$,
F_B-perfect SVN graph if $F_B(u,v) = 1$ for all $(u,v) \in E$.

Example 3.3 Consider SVN graphs, $G_1 = (A,B)$ such that$V_1 = \{v_1,v_2,v_3,v_4\}$, $E_1 = \{(v_1,v_2),(v_2,v_3),(v_3,v_4),(v_1,v_4)\}$,$G_2 = (A,B)$ such that $V_2 = \{v_1,v_2,v_3\}$, $E_2 = \{(v_1,v_2),(v_2,v_3)\}$, $G_3 = (A,B)$ such that $V_3 = \{v_1,v_2,v_3,v_4\}$, $E = \{(v_1,v_2),$

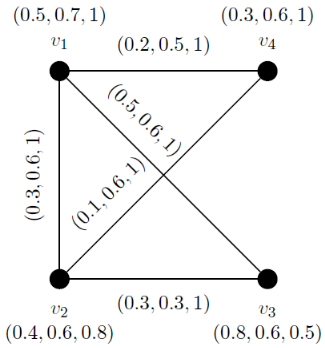
$(v_2,v_3),(v_1,v_4),(v_2,v_4),(v_1,v_3)\}$.



T_B-perfect SVN graph G_1



I_B-perfect SVN graph G_2



F_B-perfect SVN graph G_3

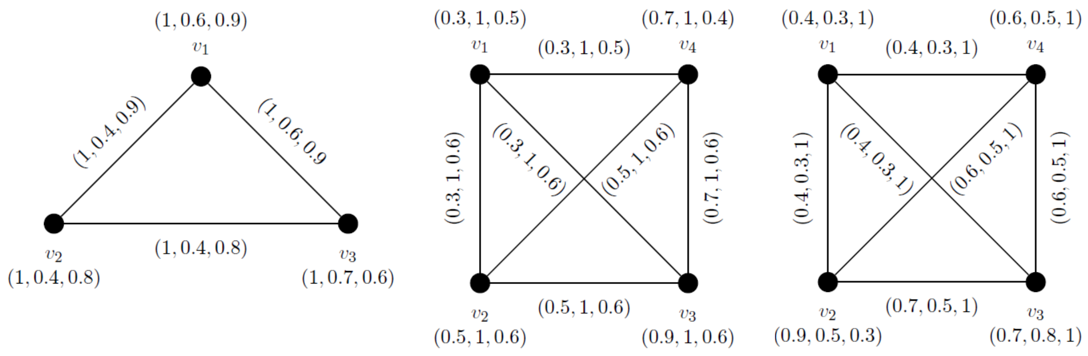
Remark 3.1

(i) Every T_B-perfect SVN graph is T_A-perfect SVN graph, Converse need not be true.
(ii) Every I_B-perfect SVN graph is I_A-perfect SVN graph, Converse need not be true.
(iii) Every F_A-perfect SVN graph is F_B-perfect SVN graph, Converse need not be true.

Definition 3.4 A connected SVN-graph $G = (A,B)$ is called a
(1) Complete T_B-perfect SVN graph if $T_B(u,v) = 1$ for all $u,v \in V$,
(2) Complete I_B-perfect SVN graph if $I_B(u,v) = 1$ for all $u,v \in V$,
(3) Complete F_B-perfect SVN graph if $F_B(u,v) = 1$ for all $u,v \in V$.

Example 3.4 Consider SVN-graphs, $G_1 = (A,B)$ such that $V_1 = \{v_1,v_2,v_3\}$, $E_1 = \{(v_1,v_2),(v_2,v_3),(v_3,v_1)\}$, $G_2 = (A,B)$ such that

$V_2 = \{v_1, v_2, v_3, v_4\}, E_2 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4), (v_2, v_4), (v_1, v_3)\}$, $G_3 = (A, B)$ such that$V_3 = \{v_1, v_2, v_3, v_4\}$, $E_3 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4), (v_2, v_4), (v_1, v_3)\}$.



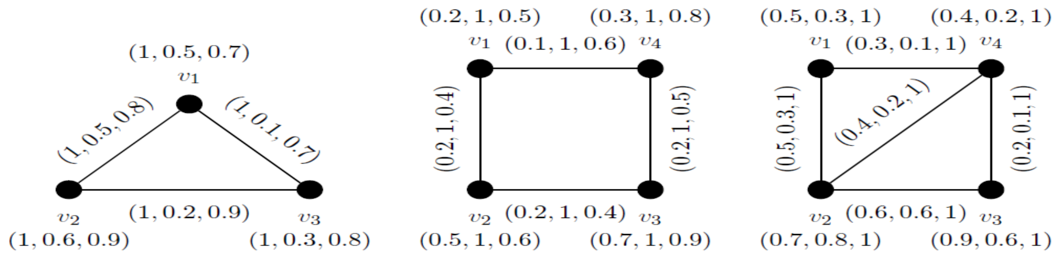
Complete T_B perfect SVNG Complete T_B perfect SVNG Complete T_B perfect

Definition 3.5 A connected SVN-graph $G = (A, B)$ is called a T-perfect single valued neutrosophic graph if it has T_A-perfect single valued neutrosophic graph and T_B-perfect single valued neutrosophic graph.

Definition 3.6 A connected SVN-graph $G = (A, B)$ is called a I-perfect single valued neutrosophic graph if it has I_A-perfect single valued neutrosophic graph and I_B-perfect single valued neutrosophic graph.

Definition 3.7 A connected SVN-graph $G = (A, B)$ is called a F-perfect single valued neutrosophic graph if it has F_A-perfect single valued neutrosophic graph and F_B-perfect single valued neutrosophic graph.

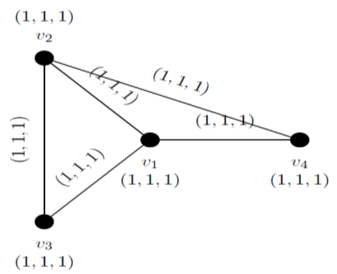
Example 3.5 Consider SVN-graphs, $G_1 = (A, B)$ such that $V_1 = \{v_1, v_2, v_3\}$, $E_1 = \{(v_1, v_2), (v_2, v_3), (v_3, v_1)\}$, $G_2 = (A, B)$ such that $V_2 = \{v_1, v_2, v_3, v_4\}$, $E_2 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4)\}$, $G_3 = (A, B)$ such that $V_3 = \{v_1, v_2, v_3, v_4\}$, $E_3 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4), (v_2, v_4)\}$.



T-perfect SVN graph G_1 I-perfect SVN graph G_2 F-perfect SVN graph G_3

Definition 3.8 A connected SVN-graph $G = (A, B)$ is called a perfect single valued neutrosophic graph if it has T,I and F-perfect single valued neutrosophic graph.

Example 3.6 Consider SVN-graphs,$G = (A, B)$ such that $V = \{v_1, v_2, v_3, v_4\}$,
$E = \{(v_1, v_2), (v_2, v_3), (v_3, v_1), (v_1, v_4), (v_2, v_4)\}$.



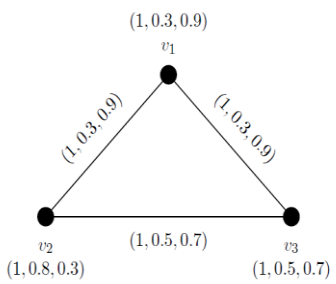
Perfect single valued neutrosophic graph G

Remark 3.2 A connected SVN-graph $G = (A, B)$ is called a complete T-perfect single valued neutrosophic graph if it has complete T_B-perfect single valued neutrosophic graph.

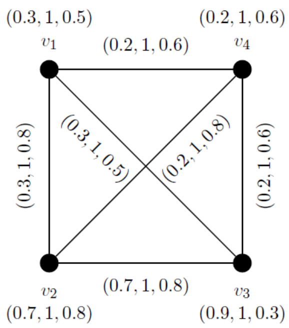
Remark 3.3 A connected SVN-graph $G = (A, B)$ is called a complete I-perfect single valued neutrosophic graph if it has complete I_B-perfect single valued neutrosophic graph.

Remark 3.4 A connected SVN-graph $G = (A, B)$ is called a complete F-perfect single valued neutrosophic graph if it has F_A-perfect single valued neutrosophic graph and complete F_B-perfect single valued neutrosophic graph.

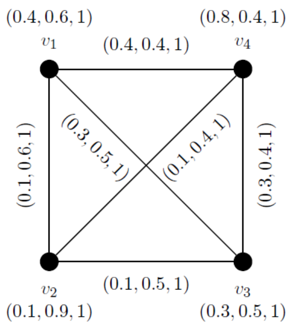
Example 3.7 Consider SVN-graphs, $G_1 = (A, B)$ such that $V_1 = \{v_1, v_2, v_3\}$, $E_1 = \{(v_1, v_2), (v_2, v_3), (v_3, v_1)\}$, $G_2 = (A, B)$ such that $V_2 = \{v_1, v_2, v_3, v_4\}$, $E_2 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4), (v_2, v_4), (v_1, v_3)\}$, $G_3 = (A, B)$ such that $V_3 = \{v_1, v_2, v_3, v_4\}$, $E_3 = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_1, v_4), (v_2, v_4), (v_1, v_3)\}$.



Complete T-perfect SVNG G_1



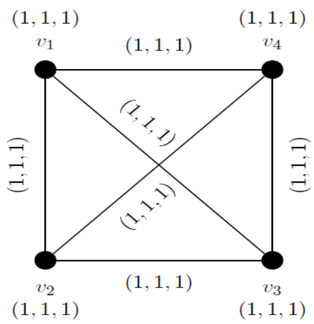
Complete I-perfect SVNG G_2



Complete F-perfect SVNG G_3

Definition 3.9 A connected SVN-graph $G = (A, B)$ is called a complete perfect single valued neutrosophic graph if it has complete T,I and F-perfect single valued neutrosophic graph.

Example 3.8 Consider a SVN-graph, $G = (A, B)$ such that $V = \{v_1, v_2, v_3, v_4\}$, $E = \{(v_1, v_2), (v_2, v_3), (v_3, v_1), (v_3, v_4), (v_1, v_4), (v_2, v_4)\}$.



Complete perfect single valued neutrosophic graph G

4. STATUS IN SINGLE VALUED NEUTROSOPHIC GRAPHS

Theorem 4.1 If $G = (A, B)$ is a complete single valued neutrosophic graph, then $(M[s_T(G)], M[s_I(G)], m[s_F(G)]) = (n-1)r(G)$, $|V| = n, n \geq 2$.

Proof. Let $G = (A, B)$ be a complete SVN graph, where $V = \{v_1, v_2, v_3, \ldots, v_n\}$.

Since G is complete SVN graph , $r(G) = (\frac{1}{T_A(v_i)}, \frac{1}{I_A(v_i)}, \frac{1}{F_A(v_i)})$ where $T_A(v_i)$ and $I_A(v_i)$ are the least value and $F_A(v_i)$ is greatest value.

$(M[s_T(G)], M[s_I(G)], m[s_F(G)]) \quad = (max\{s_T(v_i)\}, max\{s_I(v_i)\}, min\{s_F(v_i)\})$, $i = 1,2,3, \ldots, n$

$= (\text{Number of B distances})(\frac{1}{\wedge T_A(v_i)}, \frac{1}{\wedge I_A(v_i)}, \frac{1}{\vee F_A(v_i)}), \qquad i = 1,2,3,\ldots,n$

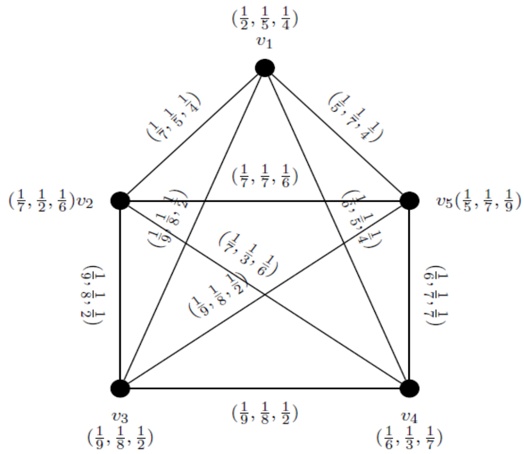
$= (n-1)(\frac{1}{\wedge T_A(v_i)}, \frac{1}{\wedge I_A(v_i)}, \frac{1}{\vee F_A(v_i)}), i = 1,2,3,\ldots,n$

$= (n-1)r(G)$

Hence $(M[s_T(G)], M[s_I(G)], m[s_F(G)]) = (n-1)r(G)$.

Example 4.1 Consider a SVN-graph, $G = (A, B)$ such that $V = \{v_1, v_2, v_3, v_4, v_5\}$, $E = \{(v_1, v_2), (v_2, v_3), (v_3, v_4), (v_4, v_5), (v_5, v_1), (v_1, v_3), (v_1, v_4), (v_2, v_5), (v_2, v_5),$

$(v_3, v_5)\}$.



Eccentricity of v_i are $e(v_1) = (9,8,2)$, $e(v_2) = (9,8,2)$,$e(v_3) = (9,8,2)$,$e(v_4) = (9,8,2)$, $e(v_5) = (9,8,2)$. Radius of G is $r(G) = (9,8,2)$, Status of G are $s(v_1) = (27,25,14)$, $s(v_2) = (30,23,14)$,$s(v_3) = (36,32,8)$,$s(v_4) = (28,23,14)$, $s(v_5) = (27,29,14)$.Maximum status of G is $M[s(G)] = (M_T(G), M_I(G), M_F(G)) = (36,32,14)$and Minimum status of G is $m[s(G)] = (m_T(G), m_I(G), m_F(G)) = (27,23,8)$. Therefore $(n-1)r(G) = 4(9,8,2) = (36,32,8) =$

$(M[s_T(G)], M[s_I(G)], m[s_F(\text{G})])$.

Theorem 4.2 Every complete perfect single valued neutrosophic graph is a self-centered single valued neutrosophic graph.

Proof. Since G be a complete perfect single valued neutrosophic graph, $\delta(v_i, v_j) = (1,1,1)$ for all $v_i, v_j \in V$. Therefore $e(v_i) = (1,1,1)$ for all $v_i \in V$ and $r(G) = (1,1,1) = e(v_i)$ for all $v_i, v_j \in V$. Hence G is self centered single valued neutrosophic graph.

Theorem 4.3 Every complete perfect single valued neutrosophic graph is a self median single valued neutrosophic graph.

Proof. Since G be a complete perfect single valued neutrosophic graph, $\delta(v_i, v_j) = (1,1,1)$ for all $v_i, v_j \in V$.

Therefore Status of $v_i \in V$ are

$$s(v_i) = (\sum_{v_j \in V} \delta_T(v_i, v_j), \sum_{v_j \in V} \delta_I(v_i, v_j), \sum_{v_j \in V} \delta_F(v_i, v_j))$$

$$= (\sum_{v_j \in V} 1, \sum_{v_j \in V} 1, \sum_{v_j \in V} 1)$$

$$s(v_i) = ((n-1), (n-1), (n-1))$$

Therefore $M[s(G)] = m[s(G)]$. Hence G is a self median single valued neutrosophic graph.

Theorem 4.4 The T-radius of a complete T-perfect SVNG $G = (V, E)$ with n vertices is always one.

Proof. Since $G = (V, E)$ is a complete T-perfect SVNG with n vertices, $\delta_T(v_i, v_j) = 1$ for all $v_i, v_j \in V$.

Therefore, $e_T(v_i) = max\{\delta_T(v_i, v_j): v_i, v_j \in V, v_i \neq v_j\}$,

$e_T(v_i) = 1$,

$r_T(G) = min\{e_T(v_i): v_i \in V\}$,

$r_T(G) = 1$.

Hence T-radius of a complete T-perfect SVNG with n vertices is always one.

Corollary 4.1 The I-radius of a complete I-perfect SVNG $G = (V, E)$ with n vertices is always one.

Corollary 4.2 The F-radius of a complete F-perfect SVNG $G = (V, E)$ with n vertices is always one.

Theorem 4.5 The T-diameter of a complete T-perfect SVNG $G = (V, E)$ with n vertices is always one.

Proof. Since $G = (V, E)$ is a complete T-perfect SVNG with n vertices, $\delta_T(v_i, v_j) = 1$ for all $v_i, v_j \in V$.

Therefore, $e_T(v_i) = max\{\delta_T(v_i, v_j): v_i, v_j \in V, v_i \neq v_j\}$,

$e_T(v_i) = 1$ for all $v_i, v_j \in V$,

$dia_T(G) = max\{e_T(v_i): v_i \in V\}$,

$dia_T(G) = 1$.

Hence T-diameter of a complete T-perfect SVNG with n vertices is always one.

Corollary 4.3 The I-diameter of a complete I-perfect SVNG $G = (V, E)$ with n vertices is always one.

Corollary 4.4 The F-diameter of a complete F-perfect SVNG $G = (V, E)$ with n vertices is always one.

Theorem 4.6 The T-status of any vertex in a complete T-perfect SVNG is $\mathrm{O(G)} - 1$.

Proof. Let $G = (V, E)$ be a complete T-perfect SVNG with n vertices.

Distance $\delta_T(v_i, v_j) = 1$ for all $v_i, v_j \in V$,

Therefore T-status of any vertex v_i of G is

$s_T(v_i) = \sum_{v_j \in V} \delta_T(v_i, v_j)$,

$$s_T(v_i) = \sum_{v_j \in V} 1,$$

$s_T(v_i) = n - 1$ for all $v_i \in V$.

Hence the T-status of any vertex in a complete T-perfect SVNG is $O(G) - 1$.

Corollary 4.5 The I-status of any vertex in a complete I-perfect SVNG is $O(G) - 1$.

Corollary 4.6 The F-status of any vertex in a complete F-perfect SVNG is $O(G) - 1$.

Theorem 4.7 The total T-status of any vertex in a complete T-perfect SVNG is $\mathrm{n(O(G) - 1)}$.

Proof. Let $G = (V, E)$ be a complete T-perfect SVNG with n vertices.

Therefore, $s_T(v_i) = n - 1$. for all $v_i \in V$,

$ts_T(v_i) = \sum_{v_i \in V} s_T(v_i)$,

$ts_T(v_i) = \sum_{v_i \in V} n - 1,$

$ts_T(v_i) = n(n-1)$ for all $v_i \in V$.

Hence the total T-status of any vertex in a complete T-perfect SVNG is $n(O(G) - 1)$.

Corollary 4.7 The total I-status of any vertex in a complete I-perfect SVNG is $\mathrm{n}(\mathrm{O}(\mathrm{G}) - 1)$.

Corollary 4.8 The total F-status of any vertex in a complete F-perfect SVNG is $\mathrm{n}(\mathrm{O}(\mathrm{G}) - 1)$.

5. CONCLUSIONS

In this paper, concepts of perfect single valued neutrosophic, complete perfect single valued neutrosophic vertices, edges and graphs have been introduced. Also investigated some properties of status in complete perfect single valued neutrosophic graphs followed by some examples.

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