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Neutrosophic resolving set : A novel tool for managing uncertainity in disaster resource optimization

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ABSTRACT: Since real-world data is frequently ambiguous, inconsistent, partial, or indeterminate, and because neutrosophic graphs are particularly made to manage all of these qualities concurrently, they are more suited for modeling real-life scenarios. The following terms were introduced in this article: neutrosophic resolving set, neutrosophic resolving number, neutrosophic super resolving set, neutrosophic modify resolving number, inter-valued neutorosophic resolving set, and inter-valued neutorosophic resolving number. Additionally, some theorems, properties, and corollaries were derived and real-world applications based on neutrosophic resolving sets were discussed.

Key Words: Neutrosophic graphs, strength of connectedness, neutorosophic resolving number, neutrosophic modify resolving number, inter-valued modify neutorosophic resolving number.

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1. Introduction

Neutrosophic graphs are more appropriate for real-world scenarios because they enable precise, adaptable, and realistic modeling of the components of ignorance, conflict, and uncertainty that are present in almost all real-world systems. Neutrosophic graphs distinguish between the real, false, and unknown. According to graph theory, a resolving set is a subset of vertices that, by virtue of their distances from the vertices in the set, uniquely identifies every other vertex in the graph. In order to describe uncertain, partial, or inconsistent information, this idea is strengthened when it is extended into the neutrosophic realm by including truth, indeterminacy, and falsity essential components of neutrosophic logic. In a neutrosophic graph, a neutrosophic resolving set is a collection of vertices that make it possible to distinguish each other from one another using the neutrosophic distance vector (which comprises truth, indeterminacy, and falsehood) between the group's vertices.

A revolutionary fuzzy idea has been effectively used to describe the many uncertain real-world applications in decision-making issues since Zadeh first proposed it in 1965 [1]. With several membership value grades, the fuzzy concept is an advanced form of the classical set. The two truth values of the basic classical set are either 0 or 1. When addressing the uncertainties of real-life issues, crisp sets are not suitable. In the case of 1 or 0, every item in the type 1 fuzzy set may have the appropriate membership between 0 and 1. This will lead to the expected outcome. In this case, the membership score a distinct number between 0 and 1 that differs from the probability value inside the fuzzy set is used to determine an object's degree of course within the fuzzy set.

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Using just one membership grade value may leave the person making the decision unable to handle the uncertainties of any complex real-life scenario. In order to address this issue, Atanassov [2] introduced the intuitionistic fuzzy set (IFS) and its properties. Additionally, a reluctance rating and a non-membership grade are given to every fuzzy set element. Using the three qualities and considering the parameters, which are controlled by IFS numbers and include inferiority, superiority, and hesitations, it is simple to characterize the features of the fuzzy set. With the use of more pertinent data and the IFS worldview, Smarandache [3,4] presented the novel concept of neutrophilic sets, which solved practical problems with imprecise, foggy, and uncertain movement. In any case, the neutrosophic set may capture the ambiguities created by irregular, ambiguous, and unexpected data. In essence, it is an expanded version of fuzzy sets, uncertain fuzzy sets, and basic conventional sets. Three membership grades have been given to each element of the neutrosophic set: true, false, or ambiguous. The three membership classes of the neutrosophic set are always included inside [0, 1] and are independent of one another. A graph may be used to simulate real-world problems. To represent the elements and their connections, the graph is usually modeled using nodes and loops. For practical applications, a broad range of information types must be represented by a wide range of graph types, including FGs, IFS, and $N_G$theories [5,6,7,8,9,10,11]. The first proposal for IFS linkages came from Shannon and Atanassov [12]. After that, they published many theorems and presented the idea of intuitionistic fuzzy graphs. Parvathi et al. [13,14,15] proposed many approaches to link two intuitionistic fuzzy networks. On IFGs, Rashmanlou and associates [16,17,18] developed a number of product operations, including lexicographic, direct, strong, and semi-strong products. They characterize the unconstrained join, the linked components, and the union on intuitionistic fuzzy networks. It turns out that the most comprehensive kind of graph available today is the n-Super hyper graph, which Smarandache [19] presented together with super-vertices. A fuzzy Pythagorean graph was initially introduced by Akram and associates [20,21,22,23,24,25]. The determinant and adjoint of neutrosophic matrices with interval values are found using the permanent function as a foundation, as stated by Khizar Hayat et al. [26]. On underlying subgraphs of a simple graph, Khizar Hayat et al. [27] established type 2 soft graphs. Khizar Hayat and Faruk Karaaslan [28] presented verires matrices for neutrosophic sets. Based on verires matrices, they offered a multi-criteria group decision-making solution. Several index types in neutrosophic visual representations were studied by Majeed et al. [29]. This group includes indexes that are entirely degree-based as well as degree-based. The r-edge regular, strongly edge regular, and vertex absolute degree of the neutrosophic graph were presented by Kaviyarasu, M. [30]. He also covered other facets of these graphs. To identify the most effective online streaming platforms, Wadei Faris AL-Omeri et al. [31] proposed using the max product of complement notation in N˙G. In fuzzy situations, Vijayabalan D et al. [32] explore a new approach to comparing the expectancies of stochastic models. Economic theory and actuarial science both rely on stochastic models. The key benefit of this research is that it helps to understand the new concepts of stochastic comparison among stochastic models based on the exponential order. Using the fuzzy mean inactive time order concept, we developed a new definition, solved the preservation properties and theorem, and implemented it. There are numerous uses for stochastic models. Vijayabalan D. et al. [33] developed a new technique for comparing stochastic model predictions in fuzzy environments, enhancing understanding of actuarial science and economical modeling. They solved preservation properties, used a definition for fuzzy mean inactivity time order, and presented applications.

The neutrosophic graph has been investigated in many dimensions by several authors (Table 1). The concept of the score function's absolute value hasn't been considered yet, however. Since the score function is essential in many decision-making scenarios, we may focus on the problems that emerge in real time during earthquakes in Japan. Establishing an earthquake response center to facilitate the recovery from similar disasters is one long-term objective.

Table 1: .

Techniques	**Solved Problem**	**Reference**
Complex intuitionistic F_G	Cellular network provider businesses using fuzzy graphs to test our method	[34]

Techniques	Solved Problem	Reference
N_G	RSM index modification	[35]
N_G	Find weak edge weights	[36]
Colouring of N_G	To determine which website is phishing	[37]
Pentapartitioned N_G	Finding the safest routes	[38]
Complex N_G	Architecture of hospital infrastructure	[39]
N_G	Making decisions and proposing a Japanese earthquake reaction centre	[40]

Motivation

- Developing a new mathematical method for data integration aims to provide real-time issue solving more flexibility.
- By creating N_G, theoretical graphs and neutrosophic collections are used to expand knowledge and provide new opportunities for applying mathematical methods.
- By investigating ideas like union, join, composition of N_G, and complex homeomorphisms, complex situations may be handled more easily and provide useful insights for real-world issue solutions.
- Haiti is susceptible to earthquakes due to its closeness to the Pacific Circle of Fire. To lessen the impact of a catastrophe, efficient seismic response centers must be established. Neutrophilic graph theory facilitates the description and analysis of vast networks in a variety of domains by taking into consideration the unpredictable nature of interaction, decision-making, and resource allocation.

Important of this study

- Although rough sets, fuzzy sets, and other generalizations of fuzzy sets are significant and frequently used in many applications, neutrophilic collections and visualisations are especially well-suited to address the issues of ambiguity, indeterminacy, and uncertainty in specific contexts, such as response to earthquakes organising.
- Haiti disaster response centers use MADM models, especially those that employ neutrosophic reasoning. Because they provide a methodical framework for assessing difficult decisions in the face of uncertainty, these models are significant because they balance trade-offs, take stakeholder preferences into account, and promote flexibility in decision-making. Using these techniques may help reaction centers manage better and lessen the effects of earthquakes on impacted communities.

The study's outcomes

More adaptable and durable disaster response strategies may be created by using neutrosophic graph theory to earthquake response studies. More thorough planning and preparation techniques are made possible by the use of neutrophilic graphs, which show the intricate web of relationships, channels of communication, and decision-making processes within. The following are the topics of this paper: Section 2 defines N_G, union graphs, sums, complements, and graph compositions. Additionally, we explain the isomorphism between weak and strong complex N_G and analyze a number of related characteristics. We outline the neutrosophic resolving sets on N_G and discuss some of the associated properties in the third section. We provide some concrete instances to illustrate the proposed ideas. Section 4 describes and discusses the interval-valued neutrosophic resolving set on interval-valued N_G. A modified neutrosophic resolving set is introduced in Section 5 and used to modified neutrosophic graphs. Section 6 contains conclusions, suggestions, and applications.

2. Preliminaries

Definition 2.1 *Let us assume that $G = (\alpha, \beta)$ and $G' = (\alpha', \beta')$ are neutrosophic graphs. An isomorphism $\mathscr{R}: G \to G'$ is a map $\mathscr{R}: V \to V'$ that is bijective and fulfils*

$$\alpha(v_i) = \alpha'(\mathscr{R}(v_i)) \quad \forall\, v_i \in V.$$

i.e.,

$$T_\alpha(\mathscr{R}(v_i)) = T_{\alpha'}(\mathscr{R}(v_i)), \quad I_\alpha(v_i) = I_{\alpha'}(\mathscr{R}(v_i)), \quad F_\alpha(v_i) = F_{\alpha'}(\mathscr{R}(v_i)) \quad \forall\, v_i \in V,$$

and

$$\beta(v_i, v_j) = \beta'(\mathscr{R}(v_i), \mathscr{R}(v_j)) \quad \forall\, (v_i, v_j) \in V,$$

i.e.,

$$T_\beta(v_i, v_j) = T_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j)),$$
$$I_\beta(v_i, v_j) = I_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j)),$$
$$F_\beta(v_i, v_j) = F_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j))$$

We represent it as $G \cong G'$.

Definition 2.2 *Let $G = (\alpha, \beta)$ and $G' = (\alpha', \beta')$ be neutrosophic graphs. There is a map $\mathscr{R}: V \to V'$ that satisfies*

$$\beta(v_i, v_j) = \beta'(\mathscr{R}(v_i), \mathscr{R}(v_j)) \quad \forall\, (v_i, v_j) \in V,$$

i.e.,

$$T_\beta(v_i, v_j) = T_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j)),$$
$$I_\beta(v_i, v_j) = I_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j)),$$
$$F_\beta(v_i, v_j) = F_{\beta'}(\mathscr{R}(v_i), \mathscr{R}(v_j)) \quad \forall\, (v_i, v_j) \in V.$$

Then $\mathscr{R}: G \to G'$ is a co-weak isomorphism.

Definition 2.3 *Let $G = (\alpha, \beta)$ be a Single Valued Neutrosophic Graph (SVN˙G). If G has a path P of path length k, the strength of the neutrosophic path connecting two nodes p and q, such as*

$$P = p = \{p_1, (p_1, p_2), p_2, \ldots, p_{k-1}, (p_{k-1}, p_k)\}, \quad \text{where } p_k = q,$$

then $T^k_\beta(p, q)$, $I^k_\beta(p, q)$, and $F^k_\beta(p, q)$ are called the strengths of the neutrosophic path. This path is described as follows:

$T^k_\beta(p, q) = \sup\left(T_\beta(p, p_1),\ T_\beta(p_1, p_2),\ \ldots,\ T_\beta(p_{k-1}, p_k)\right),$
$I^k_\beta(p, q) = \sup\left(I_\beta(p, p_1),\ I_\beta(p_1, p_2),\ \ldots,\ I_\beta(p_{k-1}, p_k)\right),$
$F^k_\beta(p, q) = \inf\left(F_\beta(p, p_1),\ F_\beta(p_1, p_2),\ \ldots,\ F_\beta(p_{k-1}, p_k)\right).$

Definition 2.4 *Let $G = (\alpha, \beta)$ be a Single Valued Neutrosophic Graph SVN_G. The strength of connection of a path P between two nodes a and b is defined by $T^{sc}_\beta(p, q)$, $I^{sc}_\beta(p, q)$, and $F^{sc}_\beta(p, q)$, where:*

$$T^{sc}_\beta(p, q) = \sup\left\{T^k_\beta(p, q) \;\middle|\; k = 1, 2, 3, \ldots\right\},$$

$$I^{sc}_\beta(p, q) = \sup\left\{I^k_\beta(p, q) \;\middle|\; k = 1, 2, 3, \ldots\right\},$$

$$F^{sc}_\beta(p, q) = \inf\left\{F^k_\beta(p, q) \;\middle|\; k = 1, 2, 3, \ldots\right\}.$$

Definition 2.5 *Let $G = [R, S]$ be an Interval-Valued Fuzzy Graph IVF_G on a crisp graph $G^*(V, E)$, where*

$$R = \left[\alpha^l_R(v_i),\, \alpha^u_R(v_j)\right] \quad \text{and} \quad S = \left[\alpha^l_S(v_i, v_j),\, \alpha^u_S(v_i, v_j)\right].$$

If R is an interval-valued fuzzy set (IVFS) on the vertex set V and S is an IVFS on the edge set E, they satisfy the following conditions:

1. $V = \{v_1, v_2, \ldots, v_n\}$, *such that* $\alpha^l_R: V \to [0,1], \quad \alpha^u_R: V \to [0,1]$,

2. $\alpha^l_S: V \times V \to [0,1], \quad \alpha^u_S: V \times V \to [0,1]$ *are functions satisfying the following conditions:*

   (i) $\alpha^l_S(v_i, v_j) \le \min\{\alpha^u_R(v_i), \alpha^u_R(v_j)\} \quad \forall (v_i, v_j) \in E$ *and*

   (ii) $\alpha^u_S(v_i, v_j) \le \min\{\alpha^u_R(v_i), \alpha^u_R(v_j)\} \quad \forall (v_i, v_j) \in E$.

Definition 2.6 *Let* $G = (\alpha, \beta)$ *be an Interval-Valued Fuzzy Graph* IVF_G *with* $|V| = n$*; a subset of the* IVF_G *is defined as:*

$$\phi = \left\{ \frac{v_1}{\left(\alpha^{l(v_1)}, \alpha^{u(v_1)}\right)}, \frac{v_2}{\left(\alpha^{l(v_2)}, \alpha^{u(v_2)}\right)}, \frac{v_3}{\left(\alpha^{l(v_3)}, \alpha^{u(v_3)}\right)}, \ldots, \frac{v_k}{\left(\alpha^{l(v_k)}, \alpha^{u(v_k)}\right)} \right\},$$

and

$$(\alpha - \phi) = \left\{ \frac{v_{k+1}}{\left(\alpha^{l(v_{k+1})}, \alpha^{u(v_{k+1})}\right)}, \frac{v_{k+2}}{\left(\alpha^{l(v_{k+2})}, \alpha^{u(v_{k+2})}\right)}, \frac{v_{k+3}}{\left(\alpha^{l(v_{k+3})}, \alpha^{u(v_{k+3})}\right)}, \ldots, \frac{v_n}{\left(\alpha^{l(v_n)}, \alpha^{u(v_n)}\right)} \right\}.$$

If the way ϕ *is represented in relation to* $(\alpha - \phi)$ *is distinct, then the subset* ϕ *is said to be an interval-valued fuzzy resolving set of* G.

Definition 2.7 *An* SVN_G *with vertex set* V *is defined by* $\overline{N_G} = (\alpha, \beta)$*, where* $\alpha = (T_\alpha, I_\alpha, F_\alpha)$ *is a single-valued neutrosophic set on* V_G*, and* $\beta = (T_\beta, I_\beta, F_\beta)$ *is a single-valued neutrosophic relation on* E_G*, satisfying the following condition:*

1. $V = \{v_1, v_2, \ldots, v_n\}$, *such that* $T_\alpha: V_G \to [0,1], \quad I_\alpha: V_G \to [0,1], \quad F_\alpha: V_G \to [0,1]$, *and* $0 \le T_\alpha(v_i) + I_\alpha(v_i) + F_\alpha(v_i) \le 3, \quad forall\, v_i \in V_G$.

2. $T_\beta: E_G \to [0,1]$, $I_\beta: E_G \to [0,1]$, *and* $F_\beta: E_G \to [0,1]$ *are functions satisfying the following conditions:*

   (i) $T_\beta(x, y) \le \min\{T_\alpha(x), T_\alpha(y)\}, \quad \forall (x, y) \in V_G \times V_G$,

   (ii) $I_\beta(x, y) \le \min\{I_\alpha(x), I_\alpha(y)\}, \quad \forall (x, y) \in V_G \times V_G$,

   (iii) $F_\beta(x, y) \ge \max\{F_\alpha(x), F_\alpha(y)\}, \quad \forall (x, y) \in V_G \times V_G$*,and*
   $0 \le T_\beta(x, y) + I_\beta(x, y) + F_\beta(x, y) \le 3, \quad \forall (x, y) \in E$.

3. Neutrosophic resolving sets on neutrosophic graphs

Definition 3.1 *Let* $G = (\alpha, \beta)$ *be a neutrosophic graph* N_G *with* $|V| = n$*. A subset of* N_G *is*

$$\alpha = \left\{ \begin{array}{l} \alpha_1 = \dfrac{v_1}{T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1)}, \\ \alpha_2 = \dfrac{v_2}{T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2)}, \\ \alpha_3 = \dfrac{v_3}{T_\alpha(v_3), I_\alpha(v_3), F_\alpha(v_3)}, \\ \cdots \\ \alpha_k = \dfrac{v_k}{T_\alpha(v_k), I_\alpha(v_k), F_\alpha(v_k)}, \end{array} \right\}.$$

$$\alpha = \left\{ \begin{array}{l} \alpha_{k+1} = \dfrac{v_{k+1}}{T_\alpha(v_{k+1}), I_\alpha(v_{k+1}), F_\alpha(v_{k+1})}, \\ \alpha_{k+2} = \dfrac{v_{k+2}}{T_\alpha(v_{k+2}), I_\alpha(v_{k+2}), F_\alpha(v_{k+2})}, \\ \alpha_{k+3} = \dfrac{v_{k+3}}{T_\alpha(v_{k+3}), I_\alpha(v_{k+3}), F_\alpha(v_{k+3})}, \\ \quad \ldots \\ \quad \alpha_n = \dfrac{v_n}{T_\alpha(v_n), I_\alpha(v_n), F_\alpha(v_n)}, \end{array} \right\}.$$

The subset φ is referred to as a neutrosophic resolving set of G if its representation φ in reference to $(\alpha - \varphi)$ is distinct. The minimum size of the neutrosophic resolving set is called the neutrosophic resolving number and is denoted by $NR(G)$.

Illustration : 3.2

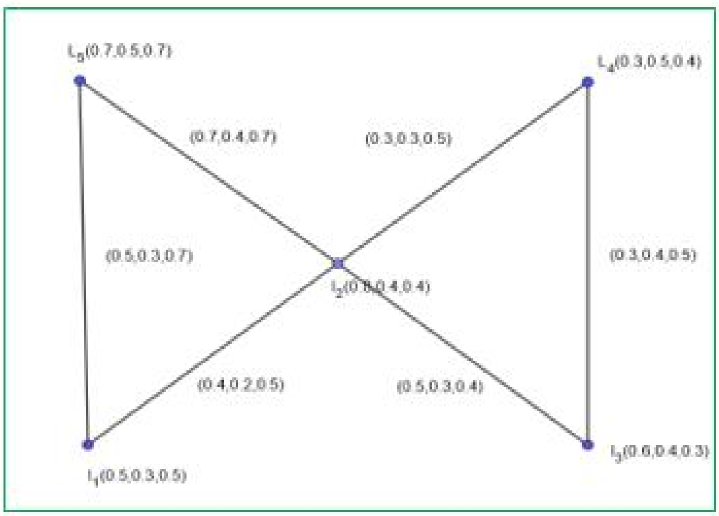

Figure 1: Neutrosophic graph

Let $V = \{l_1, l_2, l_3, l_4, l_5\}$ be the vertex set of G^*, and
$E = \{l_1l_2,\ l_2l_3,\ l_3l_4,\ l_4l_2,\ l_5l_2,\ l_1l_5\}$ be the edge set of G^*,
$\alpha = \{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\}$, where $\alpha_i = \left\{ \frac{l_i}{(T_\alpha(l_i),\ I_\alpha(l_i),\ F_\alpha(l_i))} \right\}$,

$$\alpha = \left\{ \alpha_1 = \frac{l_1}{(0.5,\ 0.3,\ 0.5)}, \alpha_2 = \frac{l_2}{(0.8,\ 0.4,\ 0.4)}, \alpha_3 = \frac{l_3}{(0.6,\ 0.4,\ 0.3)}, \right.$$
$$\left. \alpha_4 = \frac{l_4}{(0.3,\ 0.5,\ 0.4)}, \alpha_5 = \frac{l_5}{(0.7,\ 0.5,\ 0.7)}, \right\}$$

$\beta = \{\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6\}$

$$\beta = \left\{ \begin{array}{l} \beta_1 = \dfrac{l_1 l_2}{(0.4,\ 0.2,\ 0.5)}, \\ \beta_2 = \dfrac{l_1 l_5}{(0.5,\ 0.3,\ 0.7)}, \\ \beta_3 = \dfrac{l_2 l_3}{(0.5,\ 0.3,\ 0.4)}, \\ \beta_4 = \dfrac{l_3 l_4}{(0.3,\ 0.4,\ 0.5)}, \ \dfrac{l_2 l_4}{(0.3,\ 0.3,\ 0.5)}, \ \dfrac{l_2 l_5}{(0.7,\ 0.4,\ 0.7)} \end{array} \right\}.$$

Strength of connectedness matrix of the N_G

$$\begin{pmatrix} 0 & 0.5, 0.3, 0.5 & 0.5, 0.3, 0.5 & 0.3, 0.3, 0.5 & 0.5, 0.3, 0.7 \\ 0.5, 0.3, 0.5 & 0 & 0.5, 0.3, 0.4 & 0.3, 0.3, 0.5 & 0.7, 0.4, 0.7 \\ 0.5, 0.3, 0.5 & 0.5, 0.3, 0.4 & 0 & 0.3, 0.4, 0.5 & 0.5, 0.3, 0.7 \\ 0.3, 0.3, 0.5 & 0.3, 0.3, 0.5 & 0.3, 0.4, 0.5 & 0 & 0.3, 0.3, 0.7 \\ 0.5, 0.3, 0.7 & 0.7, 0.4, 0.7 & 0.5, 0.3, 0.7 & 0.3, 0.3, 0.7 & 0 \end{pmatrix}$$

Let $S_1 = \{\alpha_1, \alpha_2\}$, $(\alpha - S_1) = \{\alpha_3, \alpha_4, \alpha_5\}$

$$(S_1/\alpha_3) = \{\beta^{sc}(l_1, l_3),\ \beta^{sc}(l_2, l_3)\} = \{(0.5,\ 0.3,\ 0.5),\ (0.5,\ 0.3,\ 0.4)\}$$

$$(S_1/\alpha_4) = \{\beta^{sc}(l_1, l_4),\ \beta^{sc}(l_2, l_4)\} = \{(0.3,\ 0.3,\ 0.5),\ (0.5,\ 0.3,\ 0.7)\}$$

$$(S_1/\alpha_5) = \{\beta^{sc}(l_1, l_5),\ \beta^{sc}(l_2, l_5)\} = \{(0.5,\ 0.3,\ 0.7),\ (0.7,\ 0.4,\ 0.7)\}$$

The representation of S_1 with respect to $(\alpha - S_1)$ is distinct, so that S_1 is a resolving set in N_G.

In this same manner:

$$\begin{array}{lll} S_2 = \{\alpha_1, \alpha_3\}, & S_3 = \{\alpha_1, \alpha_4\}, & S_4 = \{\alpha_2, \alpha_3\}, \\ S_5 = \{\alpha_2, \alpha_4\}, & S_6 = \{\alpha_1, \alpha_5\}, & S_7 = \{\alpha_2, \alpha_5\}, \\ S_8 = \{\alpha_3, \alpha_4\}, & S_9 = \{\alpha_3, \alpha_5\}, & S_{10} = \{\alpha_4, \alpha_5\} \end{array}$$

are all resolving sets of G with minimum cardinality so that the neutrosophic resolving number is $\mathfrak{n}r(G) = 2$.

Definition 3.2 *Let $G = (\alpha, \beta)$ be a neutrosophic graph N_G with $|v| = n$. A subset φ of N_G is said to be a super-resolving neutrosophic set of G if the representation φ with respect to α is distinct. The minimum size of a super-resolving neutrosophic set is called the super-resolving neutrosophic number and is denoted by $\mathfrak{sn}\mathcal{R}(G)$.*

Illustration : 3.3

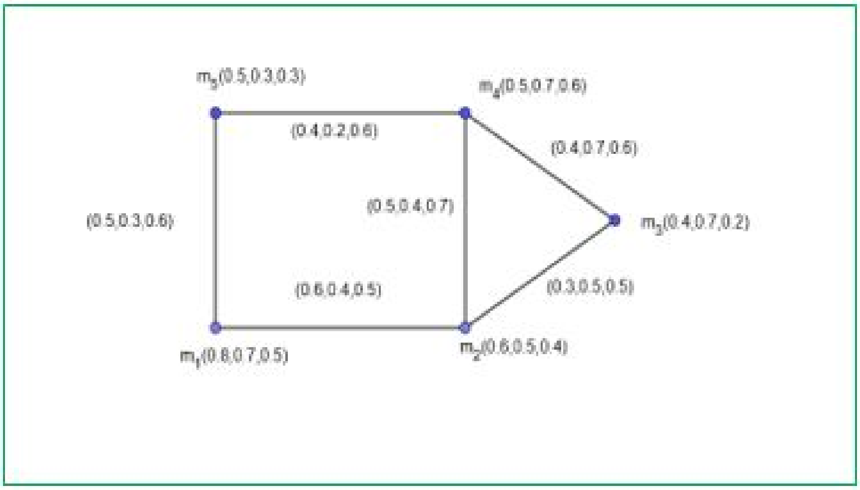

Figure 2: Neutrosophic graph

Here vertex set $V = \{m_1, m_2, m_3, m_4, m_5\}$, $\alpha = \{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\}$.
Where $\alpha(m_i) = \alpha_i = \left(\frac{m_i}{T_\alpha(m_i), I_\alpha(m_i), F_\alpha(m_i)}\right)$

Strength of connectedness matrix for T

$$\begin{pmatrix} 0.8 & 0.6 & 0.4 & 0.5 & 0.5 \\ 0.6 & 0.6 & 0.5 & 0.5 & 0.5 \\ 0.4 & 0.5 & 0.4 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.4 & 0.5 & 0.6 \\ 0.5 & 0.5 & 0.4 & 0.6 & 0.5 \end{pmatrix}$$

Strength of connectedness matrix for I

$$\begin{pmatrix} 0.7 & 0.4 & 0.4 & 0.4 & 0.3 \\ 0.4 & 0.5 & 0.5 & 0.5 & 0.3 \\ 0.4 & 0.5 & 0.7 & 0.7 & 0.3 \\ 0.4 & 0.5 & 0.7 & 0.7 & 0.3 \\ 0.3 & 0.3 & 0.3 & 0.3 & 0.3 \end{pmatrix}$$

Strength of connectedness matrix for F

$$\begin{pmatrix} 0.5 & 0.5 & 0.5 & 0.6 & 0.6 \\ 0.5 & 0.4 & 0.5 & 0.6 & 0.6 \\ 0.6 & 0.5 & 0.6 & 0.2 & 0.6 \\ 0.6 & 0.6 & 0.6 & 0.6 & 0.6 \\ 0.6 & 0.6 & 0.6 & 0.6 & 0.3 \end{pmatrix}$$

Let $S_1 = \{\alpha_1, \alpha_2\}$,

$$(S_1/\alpha_1) = \{\beta^{sc}(m_1,m_1), \beta^{sc}(m_2,m_1)\} = \{(0.8,0.7,0.5),\ (0.6,0.4,0.5)\}$$
$$(S_1/\alpha_2) = \{\beta^{sc}(m_1,m_2), \beta^{sc}(m_2,m_2)\} = \{(0.6,0.4,0.5),\ (0.6,0.5,0.4)\}$$
$$(S_1/\alpha_3) = \{\beta^{sc}(m_1,m_3), \beta^{sc}(m_2,m_3)\} = \{(0.4,0.4,0.5),\ (0.5,0.5,0.5)\}$$
$$(S_1/\alpha_4) = \{\beta^{sc}(m_1,m_4), \beta^{sc}(m_2,m_4)\} = \{(0.5,0.4,0.6),\ (0.5,0.5,0.6)\}$$
$$(S_1/\alpha_5) = \{\beta^{sc}(m_1,m_5), \beta^{sc}(m_2,m_5)\} = \{(0.5,0.3,0.6),\ (0.5,0.3,0.6)\}$$

Let $S_1 = \{\alpha_1, \alpha_2\}$ be a super neutrosophic resolving set of G because the representation of S with respect to α is distinct. So that $\mathfrak{sn}\mathcal{R}_G = 2$.

Theorem 3.1 *Neutrosophic super resolving set is always neutrosophic resolving set but converse need not be true.*

Proof: Let G be a neutrosophic graph with n vertices and let

$$\varphi = \left\{ \begin{array}{l} \frac{v_1}{T_\alpha(v_1),\ I_\alpha(v_1),\ F_\alpha(v_1)} \\ \frac{v_2}{T_\alpha(v_2),\ I_\alpha(v_2),\ F_\alpha(v_2)} \\ \frac{v_3}{T_\alpha(v_3),\ I_\alpha(v_3),\ F_\alpha(v_3)} \\ \vdots \\ \frac{v_k}{T_\alpha(v_k),\ I_\alpha(v_k),\ F_\alpha(v_k)} \end{array} \right\}.$$

be a neutrosophic resolving set of G. So the representation of φ with respect to $(\alpha-\varphi)$ should be distinct but the set φ need not be distinct with respect to α so that neutrosophic resolving set need not be neutrosophic super resolving set of G. Conversely, let φ be a neutrosophic super resolving set of G, then the representation of φ with respect to α is distinct from this representation of φ with respect to $(\alpha-\varphi)$ also. Hence, the neutrosophic super resolving set is always a neutrosophic resolving set. □

Theorem 3.2 *Two neutrosophic graphs $G(V,\alpha,\beta)$ and $G'(V',\alpha',\beta')$ are isomorphic, then*

$$\mathfrak{nr}(G) = \mathfrak{nr}(G').$$

Proof: If G and G' are isomorphic, then there exists a one-to-one and onto mapping $R: V \to V'$ such that

$$(T_\alpha(v_i), I_\alpha(v_i), F_\alpha(v_i)) = (T_{\alpha'}(R(v_i)), I_{\alpha'}(R(v_i)), F_{\alpha'}(R(v_i))) \quad \forall\, v_i \in V,$$

and

$$[T_\beta(v_iv_j), I_\beta(v_iv_j), F_\beta(v_iv_j)] = [T_{\beta'}(R(v_iv_j)), I_{\beta'}(R(v_iv_j)), F_{\beta'}(R(v_iv_j))] \quad \forall\, (v_iv_j) \in V.$$

Let $V = \{v_1, v_2, v_3, \ldots, v_n\}$ be the vertex set of G, and

$$\varphi = \left\{ \begin{array}{l} \frac{v_1}{(T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1))}, \\ \frac{v_2}{(T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2))}, \\ \vdots \\ \frac{v_p}{(T_\alpha(v_p), I_\alpha(v_p), F_\alpha(v_p))} \end{array} \right\}$$

be a minimal neutrosophic resolving set of G. Therefore, $(G) = p$.

Let

$$\varphi' = \left\{ \begin{array}{l} \frac{R(v_1)}{(R(T_\alpha(v_1)), R(I_\alpha(v_1)), R(F_\alpha(v_1)))}, \\ \frac{R(v_2)}{(R(T_\alpha(v_2)), R(I_\alpha(v_2)), R(F_\alpha(v_2)))}, \\ \vdots \\ \frac{R(v_p)}{(R(T_\alpha(v_p)), R(I_\alpha(v_p)), R(F_\alpha(v_p)))} \end{array} \right\}$$

be the corresponding subset of G'.

Here, φ is the neutrosophic resolving set of G, so the representation of Let

$$((\alpha-\varphi)\setminus\varphi)=\left\{\begin{array}{l}[\beta^{sc}(T_\alpha(v_{p+i}),T_\alpha(v_1)),\ \beta^{sc}(I_\alpha(v_{p+i}),I_\alpha(v_1)),\ \beta^{sc}(F_\alpha(v_{p+i}),F_\alpha(v_1))],\\ [\beta^{sc}(T_\alpha(v_{p+i}),T_\alpha(v_2)),\ \beta^{sc}(I_\alpha(v_{p+i}),I_\alpha(v_2)),\ \beta^{sc}(F_\alpha(v_{p+i}),F_\alpha(v_2))],\\ \vdots \\ [\beta^{sc}(T_\alpha(v_{p+i}),T_\alpha(v_p)),\ \beta^{sc}(I_\alpha(v_{p+i}),I_\alpha(v_p)),\ \beta^{sc}(F_\alpha(v_{p+i}),F_\alpha(v_p))]\end{array}\right\}$$

Where $i=1,2,\ldots,(n-p)$, which are all distinct.

$$((\alpha'-\varphi')\setminus\varphi')$$
$$=\left\{\begin{array}{l}\left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{p+i})),T_{\alpha'}(R(v_1))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{p+i})),I_{\alpha'}(R(v_1))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{p+i})),F_{\alpha'}(R(v_1)))\right],\\ \left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{p+i})),T_{\alpha'}(R(v_2))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{p+i})),I_{\alpha'}(R(v_2))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{p+i})),F_{\alpha'}(R(v_2)))\right],\\ \vdots \\ \left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{p+i})),T_{\alpha'}(R(v_p))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{p+i})),I_{\alpha'}(R(v_p))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{p+i})),F_{\alpha'}(R(v_p)))\right]\end{array}\right\}$$

Where $i=1,2,3,\ldots,(n-p)$. Which are all distinct.

$$((\alpha-\varphi)\setminus\varphi)=\left\{\begin{array}{l}[\beta^{\mathrm{sc}}(T_\alpha(v_{p+i}),T_\alpha(v_1)),\beta^{\mathrm{sc}}(I_\alpha(v_{p+i}),I_\alpha(v_1)),\beta^{\mathrm{sc}}(F_\alpha(v_{p+i}),F_\alpha(v_1))],\\ [\beta^{\mathrm{sc}}(T_\alpha(v_{p+i}),T_\alpha(v_2)),\beta^{\mathrm{sc}}(I_\alpha(v_{p+i}),I_\alpha(v_2)),\beta^{\mathrm{sc}}(F_\alpha(v_{p+i}),F_\alpha(v_2))],\\ \vdots \\ [\beta^{\mathrm{sc}}(T_\alpha(v_{p+i}),T_\alpha(v_p)),\beta^{\mathrm{sc}}(I_\alpha(v_{p+i}),I_\alpha(v_p)),\beta^{\mathrm{sc}}(F_\alpha(v_{p+i}),F_\alpha(v_p))]\end{array}\right\}$$

Where $i=1,2,3,\ldots,(n-p)$. Which are all distinct. (Because G is isomorphic to G'). so that φ' is a neutrosophic resolving set of G'.

Claim: Next, to prove φ' is a minimum neutrosophic resolving set of α'. Consider the neutrosophic resolving set δ' of

$$(G',\delta')=\left(\begin{array}{c}\frac{R(v_1)}{R(T_\alpha(v_1),I_\alpha(v_1),F_\alpha(v_1))},\\ \frac{R(v_2)}{R(T_\alpha(v_2),I_\alpha(v_2),F_\alpha(v_2))},\\ \vdots \\ \frac{R(v_t)}{R(T_\alpha(v_t),I_\alpha(v_t),F_\alpha(v_t))}\end{array}\right),|\varphi'|=p>|\delta'|=t,\quad R(\delta)=\delta'.$$

$$((\alpha'-\delta')\setminus\delta')$$
$$=\left\{\begin{array}{l}\left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{t+i})),T_{\alpha'}(R(v_1))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{t+i})),I_{\alpha'}(R(v_1))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{t+i})),F_{\alpha'}(R(v_1)))\right],\\ \left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{t+i})),T_{\alpha'}(R(v_2))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{t+i})),I_{\alpha'}(R(v_2))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{t+i})),F_{\alpha'}(R(v_2)))\right],\\ \vdots \\ \left[\beta^{\mathrm{sc}'}(T_{\alpha'}(R(v_{t+i})),T_{\alpha'}(R(v_t))),\beta^{\mathrm{sc}'}(I_{\alpha'}(R(v_{t+i})),I_{\alpha'}(R(v_t))),\beta^{\mathrm{sc}'}(F_{\alpha'}(R(v_{t+i})),F_{\alpha'}(R(v_t)))\right]\end{array}\right\}$$

Where $i=1,2,3,\ldots,(n-t)$.

This implies

$$((\alpha-\delta)\setminus\delta)=\left\{\begin{array}{l}[\beta^{\mathrm{sc}}(T_\alpha(v_{t+i}),T_\alpha(v_1)),\beta^{\mathrm{sc}}(I_\alpha(v_{t+i}),I_\alpha(v_1)),\beta^{\mathrm{sc}}(F_\alpha(v_{t+i}),F_\alpha(v_1))],\\ [\beta^{\mathrm{sc}}(T_\alpha(v_{t+i}),T_\alpha(v_2)),\beta^{\mathrm{sc}}(I_\alpha(v_{t+i}),I_\alpha(v_2)),\beta^{\mathrm{sc}}(F_\alpha(v_{t+i}),F_\alpha(v_2))],\\ \vdots \\ [\beta^{\mathrm{sc}}(T_\alpha(v_{t+i}),T_\alpha(v_t)),\beta^{\mathrm{sc}}(I_\alpha(v_{t+i}),I_\alpha(v_t)),\beta^{\mathrm{sc}}(F_\alpha(v_{t+i}),F_\alpha(v_t))]\end{array}\right\}$$

Where $i=1,2,3,\ldots,(n-t)$. Which are all distinct.

This implies $|\delta|=t$ is a minimal neutrosophic resolving set of G. This contradicts $|\varphi|=p$ being the minimal neutrosophic resolving set of G.

Hence, $(G)=\mathfrak{nr}(G')$. □

Corollary 3.1 *Two neutrosophic graphs $G = (V, \alpha, \beta)$ and $G' = (V', \alpha', \beta')$ are co-weak isomorphic, then*

$$\mathfrak{nr}(G) = \mathfrak{nr}(G').$$

Corollary 3.2 *Two inter valued neutrosophoic graphs $G = (V, \alpha, \beta)$ and $G' = (V', \alpha', \beta')$ are isomorphic then*

$$\mathfrak{inr}(G) = \mathfrak{inr}(G').$$

Corollary 3.3 *Two inter valued neutrosophoic graphs $G = (V, \alpha, \beta)$ and $G' = (V', \alpha', \beta')$are co-weak isomorphic then*

$$\mathfrak{inr}(G) = \mathfrak{inr}(G').$$

.

Corollary 3.4 *Let $G = (V, \alpha, \beta)$ be a neutrosophoic graph with $|V|$ and G^* is a cycle. If β is not a constant function then \(G) = 2*

Corollary 3.5 *If ϕ is a neutrosophic resolving set of a neutrosophic graph $G = (V, \sigma, \mu)$, then $(\sigma - \phi)$ does not necessarily have to be a neutrosophic resolving set of G.*

Note: In a neutrosophic graph if edge membership values are constant, then we do not have a neutrosophic resolving set.
Note: In a neutrosophic graph, the neutrosophic resolving set depends only on edge membership values

4. Inter valued neutosophic resolving set on inter valued neutrosophic graphs

Definition 4.1 *An Interval-Valued Neutrosophic Graph IVN_G with vertex set V is defined by $IN_G = (\alpha, \beta)$, where $\alpha = \{[T^l_\alpha, T^u_\alpha], [I^l_\alpha, I^u_\alpha], [F^l_\alpha, F^u_\alpha]\}$ is an interval-valued neutrosophic set on V_G, and $\beta = \Big\{[T^l_\beta, T^u_\beta], [I^l_\beta, I^u_\beta], [F^l_\beta, F^u_\beta]\Big\}$ is an interval-valued neutrosophic relation on E_G, defined as follows.*

1. *$V = \{v_1, v_2, v_3, \dots, v_n\}$, such that: $T^l_\alpha, T^u_\alpha : V_G \to [0, 1]$, $I^l_\alpha, I^u_\alpha : V_G \to [0, 1]$, $F^l_\alpha, F^u_\alpha : V_G \to [0, 1]$ denote the degree of truth membership, the degree of indeterminacy membership and falsity membership values of the vertices respectively and $0 \le T_\alpha(x) + I_\alpha(x) + F_\alpha(x) \le 3$.*
2. *$T^l_\beta, T^u_\beta : E_G \to [0, 1], I^l_\beta, I^u_\beta : E_G \to [0, 1], F^l_\beta, F^u_\beta : E_G \to [0, 1]$, denote the degree of truth membership, the degree of indeterminacy membership and falsity membership values of the edges respectively such that*
   - *(i)* $T^l_\beta(x, y) \le \min\{T^l_\alpha(x), T^l_\alpha(y)\}$, $T^u_\beta(x, y) \le \min\{T^u_\alpha(x), T^u_\alpha(y)\}$,
   - *(ii)* $I^l_\beta(x, y) \le \min\{I^l_\alpha(x), I^l_\alpha(y)\}$, $I^u_\beta(x, y) \le \min\{I^u_\alpha(x), I^u_\alpha(y)\}$,
   - *(iii)* $F^l_\beta(x, y) \ge \max\{F^l_\alpha(x), F^l_\alpha(y)\}$, $F^u_\beta(x, y) \ge \max\{F^u_\alpha(x), F^u_\alpha(y)\}$.
     Where $0 \le T_\beta(x, y) + I_\beta(x, y) + F_\beta(x, y) \le 3$.

Definition 4.2 *Let $G(\alpha, \beta)$ be a neutrosophic graph ($\dot{N}G$) with $|V| = n$. A subset $\varphi \subseteq G$ is said to be an interval-valued neutrosophic resolving set of G if:*

$$\varphi = \left\{ \begin{array}{l} \dfrac{v_1}{\Big\{[(T_\alpha^{l(v_1)},\ T_\alpha^{u(v_1)})],\ [(I_\alpha^{l(v_1)},\ I_\alpha^{u(v_1)})],\ [(F_\alpha^{l(v_1)},\ F_\alpha^{u(v_1)})]\Big\}}, \\ \dfrac{v_2}{\Big\{[(T_\alpha^{l(v_2)},\ T_\alpha^{u(v_2)})],\ [(I_\alpha^{l(v_2)},\ I_\alpha^{u(v_2)})],\ [(F_\alpha^{l(v_2)},\ F_\alpha^{u(v_2)})]\Big\}}, \\ \dfrac{v_3}{\Big\{[(T_\alpha^{l(v_3)},\ T_\alpha^{u(v_3)})],\ [(I_\alpha^{l(v_3)},\ I_\alpha^{u(v_3)})],\ [(F_\alpha^{l(v_3)},\ F_\alpha^{u(v_3)})]\Big\}}, \\ \cdots, \\ \dfrac{v_k}{\Big\{[(T_\alpha^{l(v_k)},\ T_\alpha^{u(v_k)})],\ [(I_\alpha^{l(v_k)},\ I_\alpha^{u(v_k)})],\ [(F_\alpha^{l(v_k)},\ F_\alpha^{u(v_k)})]\Big\}} \end{array} \right\}$$

$$(\alpha-\varphi)=\left\{\begin{array}{l}\dfrac{v_{k+1}}{\Big\{[(T_{\alpha}^{l(v_{k+1})},\ T_{\alpha}^{u(v_{k+1})})],\ [(I_{\alpha}^{l(v_{k+1})},\ I_{\alpha}^{u(v_{k+1})})],\ [(F_{\alpha}^{l(v_{k+1})},\ F_{\alpha}^{u(v_{k+1})})]\Big\}},\\ \dfrac{v_{k+2}}{\Big\{[(T_{\alpha}^{l(v_{k+2})},\ T_{\alpha}^{u(v_{k+2})})],\ [(I_{\alpha}^{l(v_{k+2})},\ I_{\alpha}^{u(v_{k+2})})],\ [(F_{\alpha}^{l(v_{k+2})},\ F_{\alpha}^{u(v_{k+2})})]\Big\}},\\ \dfrac{v_{k+3}}{\Big\{[(T_{\alpha}^{l(v_{k+3})},\ T_{\alpha}^{u(v_{k+3})})],\ [(I_{\alpha}^{l(v_{k+3})},\ I_{\alpha}^{u(v_{k+3})})],\ [(F_{\alpha}^{l(v_{k+3})},\ F_{\alpha}^{u(v_{k+3})})]\Big\}},\\ \cdots,\\ \dfrac{v_{n}}{\Big\{[(T_{\alpha}^{l(v_{n})},\ T_{\alpha}^{u(v_{n})})],\ [(I_{\alpha}^{l(v_{n})},\ I_{\alpha}^{u(v_{n})})],\ [(F_{\alpha}^{l(v_{n})},\ F_{\alpha}^{u(v_{n})})]\Big\}}\end{array}\right\}$$

The representations of φ with respect to $(\alpha-\varphi)$ are distinct. The minimum cardinality of such a set φ is called the interval-valued neutrosophic resolving number, denoted by

$$\mathfrak{inr}(G).$$

Definition 4.3 *The representation of $(\alpha-H)$ with respect to H is written as $[P^{l}_{(i,j)},\ P^{u}_{(i,j)}]$ where*

$$P^{l}_{(i,j)}=\left\{\begin{array}{l}[\beta^{SC}T^{l}_{\beta}(v_j,v_1),\ \beta^{SC}I^{l}_{\beta}(v_j,v_1),\ \beta^{SC}F^{l}_{\beta}(v_j,v_1)],\\ [\beta^{SC}T^{l}_{\beta}(v_j,v_2),\ \beta^{SC}I^{l}_{\beta}(v_j,v_2),\ \beta^{SC}F^{l}_{\beta}(v_j,v_2)],\\ [\beta^{SC}T^{l}_{\beta}(v_j,v_3),\ \beta^{SC}I^{l}_{\beta}(v_j,v_3),\ \beta^{SC}F^{l}_{\beta}(v_j,v_3)],\\ \quad\vdots\\ [\beta^{SC}T^{l}_{\beta}(v_j,v_k),\ \beta^{SC}I^{l}_{\beta}(v_j,v_k),\ \beta^{SC}F^{l}_{\beta}(v_j,v_k)]\end{array}\right\}$$

$$P^{u}_{(i,j)}=\left\{\begin{array}{l}[\beta^{SC}T^{u}_{\beta}(v_j,v_1),\ \beta^{SC}I^{u}_{\beta}(v_j,v_1),\ \beta^{SC}F^{u}_{\beta}(v_j,v_1)],\\ [\beta^{SC}T^{u}_{\beta}(v_j,v_2),\ \beta^{SC}I^{u}_{\beta}(v_j,v_2),\ \beta^{SC}F^{u}_{\beta}(v_j,v_2)],\\ [\beta^{SC}T^{u}_{\beta}(v_j,v_3),\ \beta^{SC}I^{u}_{\beta}(v_j,v_3),\ \beta^{SC}F^{u}_{\beta}(v_j,v_3)],\\ \quad\vdots\\ [\beta^{SC}T^{u}_{\beta}(v_j,v_k),\ \beta^{SC}I^{u}_{\beta}(v_j,v_k),\ \beta^{SC}F^{u}_{\beta}(v_j,v_k)]\end{array}\right\}$$

for $k\in\{j+1,j+2,\ldots,n\}$, are written in a form of $P(n-k)\times k$. This matrix is called interval-valued neutrosophic resolving matrix.

Illustration: 4.4

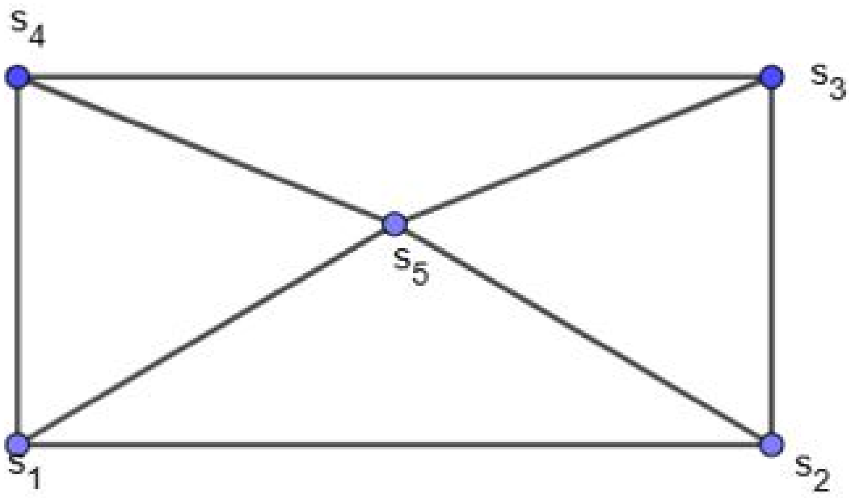

Figure 3: Inter valued neutrosophic graphs

Consider an Interval-Valued Neutrosophic Graph IVN_G $G(\alpha, \beta)$ as shown in the figure, where the vertex set of the graph G^* is $V(G^*) = \{s_1, s_2, s_3, s_4, s_5\}$ and
$E(G^*) = \{s_1s_2,\ s_1s_5,\ s_2s_3,\ s_2s_4,\ s_2s_5,\ s_3s_5,\ s_4s_5\}$ is the edge set of G^*

vertices	**s1**	**s2**	**s3**	**s4**	**s5**
T^l_α	0.5	0.2	0.4	0.4	0.3
T^u_α	0.6	0.3	0.5	0.3	0.8
I^l_α	0.2	0.3	0.2	0.6	0.4
I^u_α	0.3	0.7	0.6	0.7	0.5
F^l_α	0.3	0.4	0.2	0.2	0.2
F^u_α	0.4	0.7	0.6	0.3	0.6

Table 2: vertices

Edges	**S1S2**	**S2S3**	**S3S4**	**S4S1**	**S1S5**	**S2S5**	**S3S5**	**S4S5**
T^l_α	0.2	0.2	0.4	0.4	0.3	0.2	0.3	0.3
T^u_α	0.3	0.2	0.4	0.4	0.3	0.2	0.3	0.3
I^l_α	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.4
I^u_α	0.3	0.6	0.6	0.3	0.3	0.5	0.5	0.5
F^l_α	0.4	0.4	0.2	0.3	0.3	0.4	0.2	0.2
F^u_α	0.7	0.7	0.6	0.4	0.6	0.7	0.6	0.6

Table 3: Edges

Strength of connectedness matrix for lower limits

$$\begin{pmatrix} 0 & 0.2, 0.2, 0.4 & 0.4, 0.2, 0.4 & 0.4, 0.2, 0.3 & 0.3, 0.2, 0.3 \\ 0.2, 0.2, 0.4 & 0 & 0.2, 0.2, 0.4 & 0.2, 0.3, 0.4 & 0.2, 0.3, 0.4 \\ 0.4, 0.2, 0.4 & 0.2, 0.2, 0.4 & 0 & 0.4, 0.2, 0.2 & 0.3, 0.2, 0.2 \\ 0.4, 0.2, 0.3 & 0.2, 0.3, 0.4 & 0.4, 0.2, 0.2 & 0 & 0.3, 0.4, 0.2 \\ 0.3, 0.2, 0.3 & 0.2, 0.3, 0.4 & 0.3, 0.2, 0.2 & 0.3, 0.4, 0.2 & 0 \end{pmatrix}$$

Strength of connectedness matrix for upper limits

$$\begin{pmatrix} 0 & 0.3,0.3,0.7 & 0.4,0.3,0.7 & 0.4,0.3,0.4 & 0.3,0.3,0.6 \\ 0.3,0.3,0.7 & 0 & 0.3,0.6,0.7 & 0.3,0.6,0.7 & 0.3,0.5,0.7 \\ 0.4,0.3,0.7 & 0.3,0.6,0.7 & 0 & 0.4,0.6,0.6 & 0.3,0.5,0.6 \\ 0.4,0.3,0.4 & 0.3,0.6,0.7 & 0.4,0.6,0.6 & 0 & 0.3,0.5,0.6 \\ 0.3,0.3,0.6 & 0.3,0.5,0.7 & 0.3,0.5,0.6 & 0.3,0.5,0.6 & 0 \end{pmatrix}$$

Let $\varphi = \{s_1, s_2\}$, $(\alpha - \varphi) = \{s_3, s_4, s_5\}$, where $T^l_\alpha(\tilde{s}_i) = T^l_\alpha$, $T^u_\alpha(\tilde{s}_i) = T^u_\alpha$, $I^l_\alpha(\tilde{s}_i) = I^l_\alpha$, $I^u_\alpha(\tilde{s}_i) = I^u_\alpha$,$F^l_\alpha(\tilde{s}_i) = F^l_\alpha$, $F^u_\alpha(\tilde{s}_i) = F^u_\alpha$.

Where

$$\begin{aligned} s_1 &= \{(0.4,0.5),(0.1,0.2),(0.2,0.3)\}, \\ s_2 &= \{(0.1,0.2),(0.2,0.6),(0.3,0.6)\}, \\ s_3 &= \{(0.3,0.4),(0.1,0.5),(0.1,0.5)\}, \\ s_4 &= \{(0.3,0.2),(0.5,0.6),(0.1,0.2)\}, \\ s_5 &= \{(0.2,0.7),(0.3,0.4),(0.1,0.5)\}. \end{aligned}$$

$$(s_3/\varphi) = \left\{ \begin{matrix} \left[\beta^{\infty'} T^l_\beta(r_1,r_3),\ \beta^{\infty'} T^u_\beta(r_1,r_3)\right], \\ \left[\beta^{\infty'} I^l_\beta(r_1,r_3),\ \beta^{\infty'} I^u_\beta(r_1,r_3)\right], \\ \left[\beta^{\infty'} F^l_\beta(r_1,r_3),\ \beta^{\infty'} F^u_\beta(r_1,r_3)\right] \end{matrix} \right\} = \{[0.2,0.4],\ [0.1,0.2],\ [0.2,0.5]\}$$

$$(s_4/\varphi) = \left\{ \begin{matrix} \left(\beta^{\infty'} T^l_\beta(r_1,r_4),\ \beta^{\infty'} T^u_\beta(r_1,r_4)\right), \\ \left(\beta^{\infty'} I^l_\beta(r_1,r_4),\ \beta^{\infty'} I^u_\beta(r_1,r_4)\right), \\ \left(\beta^{\infty'} F^l_\beta(r_1,r_4),\ \beta^{\infty'} F^u_\beta(r_1,r_4)\right) \end{matrix} \right\} = \{[0.2,0.2],\ [0.1,0.2],\ [0.2,0.5]\}$$

$$(s_4/\varphi) = \left\{ \begin{matrix} \left(\beta^{\infty'} T^l_\beta(r_1,r_5),\ \beta^{\infty'} T^u_\beta(r_1,r_5)\right), \\ \left(\beta^{\infty'} I^l_\beta(r_1,r_5),\ \beta^{\infty'} I^u_\beta(r_1,r_5)\right), \\ \left(\beta^{\infty'} F^l_\beta(r_1,r_5),\ \beta^{\infty'} F^u_\beta(r_1,r_5)\right) \end{matrix} \right\} = \{[0.2,0.5],\ [0.1,0.2],\ [0.2,0.5]\}$$

Here the values are distinct so that the subset H is an inter-valued neutrosophic resolving set of G. Here, $\mathfrak{inr}(G) = 2$.

5. Neutrosophic modified resolving set on modified Neutrosophic graphs

Let $G = (\alpha, \beta)$ be an SVN_G. If G has a path P of path length k. The weakness of connectedness of a neutrosophic path connecting two nodes p and q, such as

$p = p_1,\ (p_1,p_2),\ p_2,\ \dots,\ p_{k-1},\ (p_{k-1},p_k),\ p_k = q$, then $T^k_\beta(p,q)$, $I^k_\beta(p,q)$, and $F^k_\beta(p,q)$ are called the weakness of the neutrosophic path. This path is described as follows:

$T^k_\beta(p,q) = \inf\left(T_\beta(p,p_1),\ T_\beta(p_1,p_2),\ \dots,\ T_\beta(p_{k-1},p_k)\right),$

$I^k_\beta(p,q) = \inf\left(I_\beta(p,p_1),\ I_\beta(p_1,p_2),\ \dots,\ I_\beta(p_{k-1},p_k)\right),$

$F^k_\beta(p,q) = \sup\left(F_\beta(p,p_1),\ F_\beta(p_1,p_2),\ \dots,\ F_\beta(p_{k-1},p_k)\right).$

Definition 5.1 *Let $G = (\alpha, \beta)$ be an SVN_G. The weak connectedness of a path P between two nodes a and b is defined by the pairs $T^{wc}_\beta(p,q)$, $I^{wc}_\beta(p,q)$, and $F^{wc}_\beta(p,q)$.*

where, $T^{wc}_\beta(p,q) = \inf\left\{T^k_\beta(p,q) \,\middle|\, k = 1,2,3,\dots\right\},$

$I^{wc}_\beta(p,q) = \inf\left\{I^k_\beta(p,q) \,\middle|\, k = 1,2,3,\dots\right\},$

$F^{wc}_\beta(p,q) = \sup\left\{F^k_\beta(p,q) \,\middle|\, k = 1,2,3,\dots\right\}.$

Definition 5.2 *An $SVMN_G$ with vertex set V is defined by $\overline{(MN)}_G = (\alpha, \beta)$ where $\alpha = (T_\alpha, I_\alpha, F_\alpha)$ is a single-valued modified neutrosophic set on V_G and $\beta = (T_\beta, I_\beta, F_\beta)$ is a single-valued modified relation satisfying the following condition:*

1. *$V = \{v_1, v_2, \ldots, v_n\}$ such that $T_\alpha : V_G \to [0,1]$, $I_\alpha : V_G \to [0,1]$, $F_\alpha : V_G \to [0,1]$ for all vertice v_i, the sum of the values $T_\alpha(v_i), I_\alpha(v_i), F_\alpha(v_i)$ must be between 0 and 3 inclusive.*
2. *$T_\beta : E_G \to [0,1]$, $I_\beta : E_G \to [0,1]$, $F_\beta : E_G \to [0,1]$ are the functions that satisfy the following conditions*
   - *(i)* $T_\beta(x,y) \le \max\{T_\alpha(x), T_\alpha(y)\}, (x,y) \in V_G \times V_G$
   - *(ii)* $I_\beta(x,y) \le \max\{I_\alpha(x), I_\alpha(y)\}, (x,y) \in V_G \times V_G$
   - *(iii)* $F_\beta(x,y) \ge \min\{F_\alpha(x), F_\alpha(y)\}, (x,y) \in V_G \times V_G$ *and* $0 \le T_\beta(x,y) + I_\beta(x,y) + F_\beta(x,y) \le 3$.

Definition 5.3 *Let G be a modified neutrosophic graph. A proper subset is called the modified neutrosophic resolving set of G if the modified representations of all elements in $(\alpha - \phi)$ with respect to ϕ are all distinct. The cardinality of the minimum modified neutrosophic resolving set is called the modified neutrosophic resolving number and is denoted as* (G)

Illustrartion: 5.4

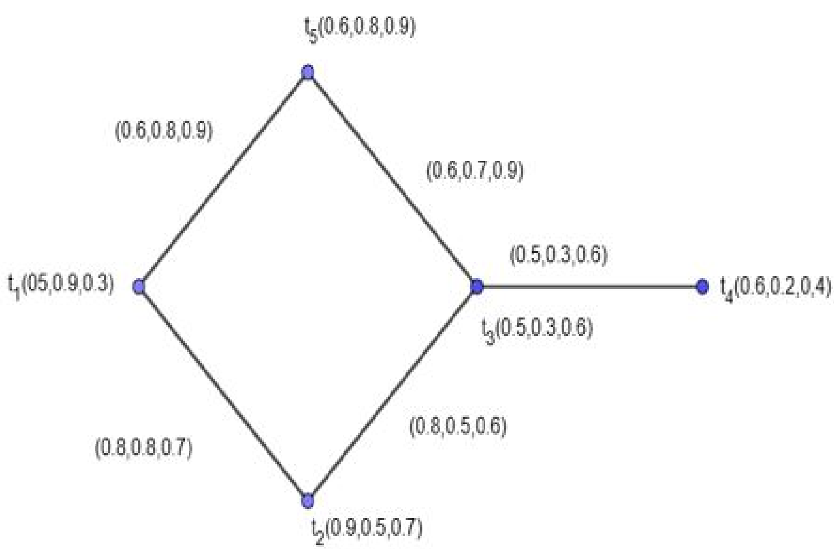

Figure 4: Modified Neutrosophic graphs

Weak of connectedness matrix of the above neutrosophic graphs is

$$\begin{bmatrix} 0 & 0.8,0.8,0.7 & 0.6,0.8,0.9 & 0.6,0.8,0.6 & 0.6,0.8,0.7 \\ 0.8,0.8,0.7 & 0 & 0.8,0.5,0.7 & 0.8,0.7,0.7 & 0.8,0.7,0.7 \\ 0.6,0.8,0.9 & 0.8,0.5,0.7 & 0 & 0.5,0.3,0.6 & 0.7,0.6,0.7 \\ 0.6,0.8,0.6 & 0.8,0.7,0.7 & 0.5,0.3,0.6 & 0 & 0.6,0.7,0.6 \\ 0.3,0.3,0.6 & 0.8,0.7,0.9 & 0.6,0.7,0.9 & 0.6,0.7,0.6 & 0 \end{bmatrix}$$

Let $\alpha = \{t_1, t_2, t_3, t_4, t_5\}, \varphi_1 = \{t_1, t_2\}$ so $(\alpha - \varphi_1) = \{t_3, t_4, t_5\}$

$$(\varphi_1/t_3) = \left\{ \begin{array}{c} \left[T_\beta^{wc}(t_1,t_3),\ I_\beta^{wc}(t_1,t_3),\ F_\beta^{wc}(t_1,t_3)\right], \\ \left[T_\beta^{wc}(t_2,t_3),\ I_\beta^{wc}(t_2,t_3),\ F_\beta^{wc}(t_2,t_3)\right] \end{array} \right\} = \{(0.6,0.8,0.9),(0.8,0.5,0.7)\}$$

$$(\varphi_1/t_4) = \left\{ \begin{array}{l} \left[T^{wc}_{\beta}(t_1,t_4),\ I^{wc}_{\beta}(t_1,t_4),\ F^{wc}_{\beta}(t_1,t_4)\right], \\ \left[T^{wc}_{\beta}(t_2,t_4),\ I^{wc}_{\beta}(t_2,t_4),\ F^{wc}_{\beta}(t_2,t_4)\right] \end{array} \right\} = \{(0.6, 0.8, 0.6), (0.8, 0.5, 0.7)\}$$

$$(\varphi_1/t_5) = \left\{ \begin{array}{l} \left[T^{wc}_{\beta}(t_1,t_5),\ I^{wc}_{\beta}(t_1,t_5),\ F^{wc}_{\beta}(t_1,t_5)\right], \\ \left[T^{wc}_{\beta}(t_2,t_5),\ I^{wc}_{\beta}(t_2,t_5),\ F^{wc}_{\beta}(t_2,t_5)\right] \end{array} \right\} = \{(0.6, 0.8, 0.7), (0.8, 0.7, 0.7)\}$$

The representation of φ_1 with respect to $(\alpha - \varphi_1)$ are distinct so that φ_1 is Modified resolving set in $\mathbf{MN}_G$. So that $mnr_(G) = 2$. In this same manner $\varphi_2 = \{t_1, t_3\}$, $\varphi_3 = \{t_1, t_4\}$, $\varphi_4 = \{t_2, t_3\}$, $\varphi_5 = \{t_2, t_4\}$, $\varphi_6 = \{t_3, t_4\}$ are all Modified resolving set of G.

6. Application

A neutrosophic resolving set is a part of neutrosophic graph theory, which is an extension of classical and fuzzy graph theory. In this theory, vertices are linked to truth (T), indeterminacy (I), and falsity (F) membership values. These sets are used to figure out or tell apart vertices in a neutrosophic network based on their representations, which include uncertainty and indeterminacy.

The information about 2010 Haiti earthquake

Here is a structured table that shows the statistics for the most impacted cities and estimations of the damage: An overview of how earthquakes affected each city

City	**Population Affected**	**% Buildings Damaged/Destroyed**	**Casualties (Est.)**	**Displacement**	**Key Infrastructure Damage**
Port-au-Prince	2.5–3 million	∼70%	70,000–200,000 deaths; 200,000+ injured	∼1 million homeless	Presidential Palace, National Assembly, Cathedral, main prison, hospitals, 5,000 schools
Léogâne	∼200,000	80–90%	Thousands (in national total)	Most displaced, tens of thousands in shelters	Water and sanitation systems, homes, schools, public buildings
Jacmel	∼40,000	30–50%	Hundreds to low thousands	Thousands displaced	Historic Cathedral, cultural sites, port, airport
Petit-Goâve	∼117,000	60–80%	Hundreds to low thousands	Tens of thousands displaced	Schools, churches, markets, roads, bridges
Carrefour	∼400,000	50–70%	Thousands likely; Injuries: tens of thousands	>100,000 displaced	Markets, public facilities, densely packed residential areas
Gressier	∼25,000	Up to 70%	Hundreds dead; thousands injured	Most displaced, many moved to capital	Poorly constructed homes, water infrastructure

Change this issue into a neutrosophic graph model. A vertex is each city. Connect cities based on how close they are to one other and how good their infrastructure is. Edge weights show how sure you are about connections. We need to discover a neutrosophic resolving set for this graph, and we'll do it step by step. Change this issue into a neutrosophic graph model. A vertex is a city.

Step 1: Define the neutrosophic graph.

Let the cities be vertices:

$\mathbf{v_1}$ = Port-au-Prince
$\mathbf{v_2}$ = Léogâne
$\mathbf{v_3}$ = Jacmel
$\mathbf{v_4}$ = Petit-Goâve
$\mathbf{v_5}$ = Carrefour
$\mathbf{v_6}$ = Gressier

Edges: Based on geographic and infrastructure proximity

We construct an **undirected neutrosophic graph** where:

- An edge exists if two cities are geographically close or share infrastructure dependencies.
- The edge weights are given as neutrosophic triples: (T, I, F)

Edge	T (Truth)	I (Indeterminacy)	F (Falsity)	Justification
$\mathbf{v_1}$–$\mathbf{v_2}$ (PAP – Léogâne)	0.9	0.05	0.05	Very close and dependent
$\mathbf{v_1}$–$\mathbf{v_5}$ (PAP – Carrefour)	0.95	0.03	0.02	Suburb of PAP
$\mathbf{v_1}$–$\mathbf{v_6}$ (PAP – Gressier)	0.85	0.10	0.05	Nearby region
$\mathbf{v_2}$–$\mathbf{v_4}$ (Léogâne – Petit-Goâve)	0.8	0.15	0.05	Adjacent towns
$\mathbf{v_3}$–$\mathbf{v_1}$ (Jacmel – PAP)	0.6	0.3	0.1	Moderately connected
$\mathbf{v_3}$–$\mathbf{v_6}$ (Jacmel – Gressier)	0.4	0.5	0.1	Uncertain terrain connectivity
$\mathbf{v_4}$–$\mathbf{v_6}$ (Petit-Goâve – Gressier)	0.6	0.25	0.15	Regional connection
$\mathbf{v_5}$–$\mathbf{v_6}$ (Carrefour – Gressier)	0.75	0.2	0.05	Both suburbs of PAP

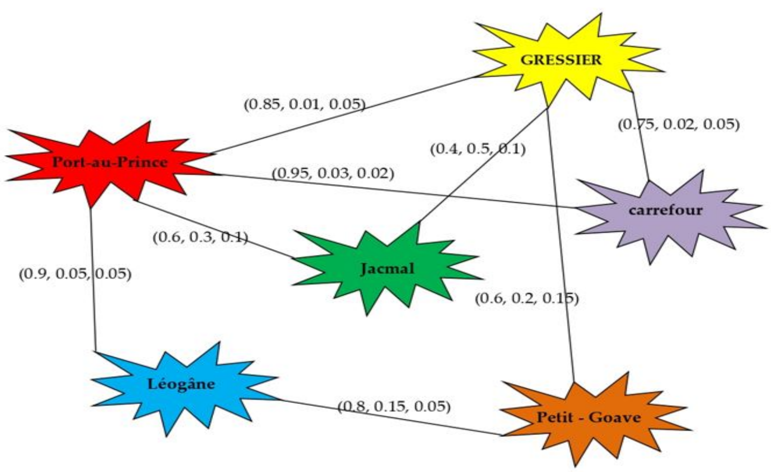

Figure 5: Neutrosophic resolving set

	$\mathbf{v}_1$	$\mathbf{v}_2$	$\mathbf{v}_3$	$\mathbf{v}_4$	$\mathbf{v}_5$	$\mathbf{v}_6$
$\mathbf{v}_1$	–	(0.9, 0.05, 0.05)	(0.6, 0.3, 0.1)	–	(0.95, 0.03, 0.02)	(0.85, 0.1, 0.05)
$\mathbf{v}_2$	(0.9, 0.05, 0.05)	–	–	(0.8, 0.15, 0.05)	–	–
$\mathbf{v}_3$	(0.6, 0.3, 0.1)	–	–	–	–	(0.4, 0.5, 0.1)
$\mathbf{v}_4$	–	(0.8, 0.15, 0.05)	–	–	(0.6, 0.25, 0.15)	–
$\mathbf{v}_5$	(0.95, 0.03, 0.02)	–	–	(0.6, 0.25, 0.15)	–	(0.75, 0.2, 0.05)
$\mathbf{v}_6$	(0.85, 0.1, 0.05)	–	(0.4, 0.5, 0.1)	–	(0.75, 0.2, 0.05)	–

Step 2: Finding neutrosophic resolving Set

Strength of connectedness matrix for T (Certainty)

	Port-au-Prince	**Léogâne**	**Jacmel**	**Petit-Goâve**	**Carrefour**	**Gressier**
Port-au-Prince	0	0.9	0.6	0.8	0.95	0.85
Léogâne	0.9	0	0.6	0.8	0.9	0.85
Jacmel	0.6	0.6	0	0.6	0.6	0.6
Petit-Goâve	0.8	0.8	0.6	0	0.8	0.9
Carrefour	0.95	0.9	0.6	0.8	0	0.85
Gressier	0.85	0.85	0.6	0.8	0.85	0

Strength of connectedness matrix for I (Indeterminacy)

	Port-au-Prince	**Léogâne**	**Jacmel**	**Petit-Goâve**	**Carrefour**	**Gressier**
Port-au-Prince	0	0.15	0.75	0.25	0.2	0.5
Léogâne	0.15	0	0.15	0.15	0.05	0.15
Jacmel	0.75	0.15	0	0.1	0.1	0.1
Petit-Goâve	0.25	0.15	0.1	0	0.2	0.25
Carrefour	0.2	0.05	0.1	0.2	0	0.2
Gressier	0.5	0.15	0.1	0.25	0.2	0

Strength of connectedness matrix for F (Falsity)

	Port-au-Prince	**Léogâne**	**Jacmel**	**Petit-Goâve**	**Carrefour**	**Gressier**
Port-au-Prince	0	0.1	0.1	0.1	0.05	0.1
Léogâne	0.1	0	0.1	0.05	0.05	0.15
Jacmel	0.1	0.1	0	0.05	0.05	0.05
Petit-Goâve	0.1	0.05	0.05	0	0.05	0.15
Carrefour	0.05	0.05	0.05	0.05	0	0.05
Gressier	0.1	0.15	0.05	0.15	0.05	0

Let us denote Port-au-Prince (PP), Léogâne (L), Jacmel (J), Petit-Goâve (PG), Carrefour (C), Gressier (G)

Let us take $R = \{L, J\}$, $V - R = \{\mathrm{PP}, \mathrm{PG}, \mathrm{C}, \mathrm{G}\}$

$$Y^{SC}(\mathrm{PP}/L),\ Y^{SC}(\mathrm{PP}/J) = (0.9,\ 0.15,\ 0.1),\ (0.6,\ 0.75,\ 0.1)$$
$$Y^{SC}(\mathrm{PG}/L),\ Y^{SC}(\mathrm{PG}/J) = (0.8,\ 0.15,\ 0.05),\ (0.6,\ 0.1,\ 0.05)$$
$$Y^{SC}(\mathrm{C}/L),\ Y^{SC}(\mathrm{C}/J) = (0.8,\ 0.15,\ 0.05),\ (0.6,\ 0.1,\ 0.05)$$
$$Y^{SC}(\mathrm{G}/L),\ Y^{SC}(\mathrm{G}/J) = (0.85,\ 0.15,\ 0.15),\ (0.6,\ 0.1,\ 0.05)$$

Since the representations of R with regard to $(\alpha - R)$ are all different, R is the neutrosophic resolving set of G. The neutrosophic resolving set is a small collection of cities (nodes) that can find and keep track of all the other cities, even when the information is unclear, missing, or contradictory.

Neutrosophic resolving set in the management of earthquakes

1. Smart use of resources

The resolution set helps keep track of or talk to all the other impacted regions in a unique way, which cuts down on duplication. Relief organizations may set up coordination centers in these important cities (like Léogâne (L) and Jacmel (J)) to keep track of and direct the distribution of supplies to all other places.

2. Keeping an eye on and watching disasters

The cities in the resolving set may be used as observation sites to get information about the network and the state of all the other cities (depending on how close they are and how well their infrastructure is connected). We can still figure out the situation of other cities even if we don't have direct data from them by looking at how far they are from the cities in the resolving set.

3. Putting networks back together after catastrophes

The resolving set offers a small but useful collection of reference points for rebuilding during the following tasks:

- Rebuilding transportation or supply networks,
- Planning where to put shelters, and
- Restoring communication infrastructure.

4. Medical care and emergency reaction Optimization

This model may assist design triage stations or mobile clinics in cities in the resolving sets, which are places where health teams can get to other towns when the terrain is unpredictable and the roads and services are compromised. The distance between each city and the resolving nodes may be used to uniquely identify the city's position and requirement, even if the mapping data is only partly distorted.

5. Making strategic decisions

In crisis situations, decision-makers face uncertain and partial information. A neutrosophic resolving set helps planners track progress, identify gaps, rebuild impact maps, and set priorities for recovery zones, allowing them to manage uncertain situations.

Neutrosophic resolving sets benefits for earthquake scenarios

Neutrosophic resolving sets are a new way to make decisions when things are hard, such when there is an earthquake. They define priorities for resources, take into account a wide range of social, economic, and environmental aspects, allow for flexible modeling, encourage community engagement, enhance risk assessment, manage uncertainty, and make sure that things may change. Neutrophilic reasoning helps individuals make better choices when they don't have all the facts or when the facts don't match up. Building integrity, geological studies, and historical data may be utilized to figure out what hazards are particular to a certain place. Decision-makers might analyze decisions like how to distribute resources or evacuation preparations by taking into account a number of opposing elements. They could also help you decide which resources are most important depending on how bad they are. Neosophic strategies can get people involved in the community by using their knowledge and preferences when making decisions. Finally, neutrosophic methods may change with new information or changing circumstances, making sure that plans are still useful after an earthquake. In conclusion, using neutrosophic resolution sets in earthquake scenarios makes decision-making more comprehensive, flexible, and informed, which improves disaster planning and response. Modeling uncertainty properly shows damage reports that are unclear or inconsistent. Better localization helps find the exact places that need assistance, and targeted rescue decision support helps rescue teams figure out what to do first when they don't have enough information. When sensor data is unclear or fuzzy, like data from drones or the Internet of Things, adaptable data management works effectively. Managing redundancy clears up things that typical graphs don't show clearly.

Key Features of neutrosophic resolving sets

- Handling Indeterminacy: Unlike fuzzy sets (which use membership grades) or intuitionistic fuzzy sets (which use membership and non-membership), neutrosophic resolving sets explicitly incorporate indeterminacy, making them suitable for complex, uncertain systems.
- Generalization: They generalize classical and fuzzy resolving sets, allowing broader applicability in real-world problems with incomplete or inconsistent data.
- Applications Across Domains: From decision-making to image processing, their versatility stems from the ability to model truth, indeterminacy, and falsity independently.

Limitations

- Complexity: The inclusion of three membership values (T, I, F) increases computational complexity compared to classical or fuzzy resolving sets.
- Data Requirements: Accurate assignment of truth, indeterminacy, and falsity values requires robust data or expert knowledge, which may not always be available.
- Integration with Other Models: While neutrosophic sets are powerful, integrating them with existing models (e.g., machine learning algorithms) requires further development.

Challenges

- Computational Complexity: Computing neutrosophic distances and finding the minimal resolving set can be computationally intensive for large images.
- Parameter Tuning: Assigning accurate T, I, F values require domain knowledge or pre-processing (e.g., machine learning models).

- Scalability: Extending to 3D images (e.g., volumetric MRI) increases complexity.

7. Conclusion

In many real-world domains, including risk assessment and disaster management, social network analysis, cybersecurity and intrusion detection, medical diagnosis systems, and decision-making in uncertain environments, neutrophilic graphs are useful tools for modeling systems with inconsistent, ambiguous, and incomplete information. The main contribution of this paper is the introduction of the notions of inter-valued neutrosophic resolving sets in inter-valued neutrosophic graphs, neutrosophic resolving sets in neutrosophic graphs, and neutrosophic super resolving sets in neutrosophic graphs. We have also explored some theorems, corollaries, and characteristics and proposed an application based on neutrosophic resolving sets. In the future, we may look at more neutrosophic resolving set difficulties. The neutrosophic graph has been used to build earthquake prediction centers in a number of locations around Syria and Turkey. Vertices in a neutrosophic graph are more useful for making better judgments. The mathematical foundations of neutrosophic graph theory tend to recommend suitable locations from Turkey to Syria in order to prevent disasters during earthquakes.

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