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Application of neutrosophic resolving sets in earthquake disaster management using neutrosophic graph models

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Abstract:

Neutrosophic graphs are more suitable for modelling real-life situations because real world data is often uncertain, incomplete, inconsistent, or indeterminate and neutrosophic graphs are specifically designed to handle all of neutrosophic graphs, these aspects simultaneously. In this article we introduced neutorosophic resolving set, neutorosophic resolving number, neutorosophic super resolving set, neutorosophic super resolving number, inter-valued neutorosophic resolving set, inter-valued neutorosophic resolving number, also derived some theorems, properties, corollaries and also discussed real life application based on neutrosophic resolving sets.

Keywords: Neutrosophic graphs, strength of connectedness, neutorosophic resolving number, inter-valued neutorosophic resolving number.

1. Introduction

Neutrosophic graphs are more acceptable for real-life situations because they allow accurate, flexible, and realistic modeling of uncertainty, ignorance, and conflict factors that are inherent in nearly every real-world system. Neutrosophic graphs separate the true, the false, and the indeterminate. In graph theory, a resolving set is a subset of vertices that uniquely identifies all other vertices in the graph based on their distances to the vertices in the set. When extended into the neutrosophic domain, this concept becomes more powerful by incorporating truth, indeterminacy, and falsity—key elements of neutrosophic logic—to model uncertain, incomplete, or inconsistent information. A neutrosophic resolving set is a group of vertices in a neutrosophic graph that allows us to tell apart every other vertex based on the neutrosophic distance vector (which includes truth, indeterminacy, and falsity) from it to the vertices in the group.

Since its introduction by Zadeh in 1965 [1], a novel fuzzy notion has been successfully used to model the different uncertain real-world applications in decision-making problems. The fuzzy idea is a more sophisticated version of the classical set, with distinct membership value grades. The fundamental classical set's two truth values are either 0 or 1. Crisp sets are inappropriate when dealing with the uncertainties of real-life problems. All items in the type

1 fuzzy set can have the proper membership between 0 and 1 in the case of 1 or 0. The anticipated result will result from this. In this instance, the determination of an object's degree of course within the fuzzy set is characterized by its membership score, which is a unique number that falls between 0 and 1 and is different from the probability value within the fuzzy set.

The individual making the choice might not be capable of managing the uncertainties of any complicated real-life situation if they are only using one membership grade value. To tackle this problem, Atanassov [2] presented the intuitionistic fuzzy set (IFS) and its characteristics. Each fuzzy set element is also assigned a hesitation rating and a non-membership grade. The fuzzy set's properties can be easily described by using the three different attributes and taking into account the parameters, which are regulated by IFS numbers and include inferiority, superiority, and hesitations. Smarandache [3,4] introduced the innovative idea of neutrophilic sets using the IFS ideology and more relevant data that addressed the real-world issues related to imprecise, hazy, and uncertainty movement. The neutrosophic set is capable of capturing the ambiguities produced by irregular, unclear, and unpredictable data in any situation. It is essentially a more complete form of fuzzy sets, uncertain fuzzy sets, and simple traditional sets alike. Each element of the neutrosophic set has been assigned one of three membership grades: ambiguous, false, or true. The three membership classes of the neutrosophic set are independent of each other and are always contained within [0, 1]. A useful tool for simulating real-world issues is a graph. Typically, nodes and loops model the graph to represent the items and their relationships. A wide variety of graph types, such as FGs, IFS, and N_G theories, are required to represent the wide variety of information types observed in practical applications [5–11]. IFS relationships were first proposed by Shannon and Atanassov [12]. They went on to publish a number of theorems and introduce the concept of intuitionistic fuzzy graphs. Parvathi et al. [13–15] suggested a number of different methods to connect two intuitionistic fuzzy graphs. Rashmanlou and colleagues [16–18] established several product operations on IFGs, such as lexicographic, direct, strong, and semi-strong products. They describe the union on intuitionistic fuzzy networks, the unrestricted join, and the connected components. Actually, the n-Super hyper graph, which was introduced alongside super-vertices by Smarandache [19], is the most complete kind of graph currently accessible. Akram and colleagues first proposed the concept of a fuzzy Pythagorean graph [20–25]. According to Khizar Hayat et al. [26], the permanent function is used as a basis to determine the determinant and adjoint of neutrosophic matrices with interval values. Type 2 soft graphs were defined by Khizar Hayat et al. [27] on underlying subgraphs of a simple graph. For neutrosophic sets, Faruk Karaaslan and Khizar Hayat [28] provided verires matrices. They provided an application for multi-criteria group decision-making based on verires matrices. A study by Majeed et al. [29] examined several index kinds in neutrosophic graphic representations. Both degree-based and completely degree-based indices fall within this category. The neutrosophic graph's vertex absolute degree, r-edge regular, and strongly edge regular were introduced by Kaviyarasu, M. [30]. Additionally, he discussed other aspects of these graphs. The max product of complement notation in NG was suggested by Wadei Faris AL-Omeri et al. [31] in order to determine the most efficient web streaming platforms.

Many others have explored the neutrosophic graph in different dimensions (Table 1). However, not yet taken into consideration is the idea of the score function's absolute value. We may concentrate on the issues that arise in real time during earthquakes in Japan because the score function is crucial in many decision-making situations. One eventual goal is to set up an earthquake response center that aids in the recovery from such catastrophes.

Techniques	**Solved Problem**	**Reference**
Complex intuitionistic FG	Cellular network provider businesses using fuzzy graphs to test our method	[32]
NG	RSM index modification	[33]
NG	Find weak edge weights	[34]
Colouring of NG	To determine which website is phishing	[35]
Pentapartitioned NG	Finding the safest routes	[36]
Complex NG	Architecture of hospital infrastructure	[37]
NG	Making decisions and proposing a Japanese earthquake reaction centre	[38]

Table 1

Inspiration and extent

• The purpose of creating a new mathematical technique for data integration is to provide a more flexible approach to real-time problem solutions.

• By developing NG, knowledge is advanced through the use of theoretical graphs and neutrosophic collections, opening up new avenues for the use of mathematical techniques.

• Complex circumstances can be addressed more readily by exploring concepts like union, join, composition of NG, and complicated homeomorphisms, providing valuable information for problem solving in the real world.

• Turkey-Syria's proximity to the Pacific Circle of Fire makes it vulnerable to earthquakes. Effective seismic response centres must be set up in order to mitigate the effects of a disaster. By accounting for the unpredictability of interaction, decision-making, and resource allocation, neutrophilic graph theory makes it easier to describe and analyse large networks across a range of areas.

Important of this study

- Neutrophic collections and visualisations are particularly well-suited to address the problems of ambiguity, indeterminacy, and uncertainty in particular contexts, such as response to earthquakes organising, despite the fact that rough sets, fuzzy sets, and other generalisations of fuzzy sets are important and commonly used in many applications.

- Disaster response centres in Syria and Turkey use MADM models, particularly those that apply neutrosophic reason. These models are important because they provide a systematic framework for evaluating complex choices in the face of uncertainty, taking stakeholder preferences into consideration, balancing trade-offs, and encouraging adaptability in decision-making. Reaction centres can improve their management and mitigate the impact of earthquakes on affected areas by putting these strategies into practice.

Benefits and drawbacks

- Compared to traditional crisp or fuzzy graphs, neutrophilic graphs can be more nuanced in their representation of uncertainty. Decision-makers can more accurately model and reason about uncertain relationships when they are able to convey information that is correct, erroneous, or unclear. Neutosophic graphs use truth, indeterminacy, and falsity grading to provide a comprehensive representation of uncertainty. Its granularity allows decision-makers to capture even the smallest variations in the level of uncertainty, which can improve analysis and decision-making. Analysing neutrophilic graphs in large-scale systems with numerous interrelated components can be challenging and computationally expensive. Since neutrophilic network topologies necessitate certain expertise and experience, they may be challenging for non-experts to comprehend or assess.

- The reliability and correctness of neutronosophic graph models may be difficult to evaluate and confirm when there are few ground truths or benchmark datasets. Assessing the viability and effectiveness of neutrosophic graph-based methods requires sensitivity tests and strong validation procedures.

The study's contributions

Through the application of neutrosophic graph theory to seismic response study can help develop disaster response plans that are more flexible and resilient. Neutrophilic graphs are used to illustrate the complex network of connections, lines of communication, and decision-making processes inside the, enabling more comprehensive planning and preparation methods. This paper's themes are as follows: N_G, union graphs, sums, complements, and graph compositions are defined in Section 2. We also discuss several associated properties of weak and strong complex N_G and describe their isomorphism. In the third section, we describe the neutrosophic resolving sets on N_G and go over some of the related characteristics. To support the suggested concepts, we provide some specific examples. The definition and discussion of the interval-valued neutrosophic resolving set on interval-valued N_G are covered in Section 4. Section 5 presents a modified resolving set that is neutrosophic, specifically applied to modified neutrosophic graphs. Conclusions, recommendations, and applications are included in Section 6.

2. Preliminaries

Definition 2.1

Let us assume that G = (α, β) and G′ = (α′, β′) are neutrosophic graphs. An isomorphism $\mathfrak{R}$: G → G′ is a map $\mathfrak{R}$: V → V′ that is bijective and fulfils $\alpha(v_i) = \alpha'(\mathfrak{R}(v_i))$ ∀ $v_i \in V$. i.e., $T_\alpha(v_i) = T_{\alpha'}(\mathfrak{R}(v_i))$, $I_\alpha(v_i) = I_{\alpha'}(\mathfrak{R}(v_i))$, $F_\alpha(v_i) = F_{\alpha'}(\mathfrak{R}(v_i))$, ∀ $v_i \in V$ and $\beta(v_i, v_j) = \beta'(\mathfrak{R}(v_i), \mathfrak{R}(v_j))$ ∀ $(v_i, v_j) \in V$ i.e., $T_\beta(v_i, v_j) = T_{\beta'}(\mathfrak{R}(v_i), \mathfrak{R}(v_j))$, $I_\beta(v_i, v_j) = I_{\beta'}(\mathfrak{R}(v_i), \mathfrak{R}(v_j))$, $F_\beta(v_i, v_j) = F_{\beta'}(\mathfrak{R}(v_i), \mathfrak{R}(v_j))$, ∀ $(v_i, v_j) \in V$. We represented it as G ≅ G′.

Definition 2.2

Let G = (α, β) and G′ = (α′, β′) be neutrosophic graphs. There is a map $\mathfrak{R}$: V →V′ that satisfies $\beta(v_i, v_j) = \beta'(\mathfrak{R}(v_i), \mathfrak{R}(v_j))$ ∀ $(v_i, v_j) \in V$ i.e., $T_\beta(v_i, v_j) = T_{\beta'}(\mathfrak{R}(v_i)\, \mathfrak{R}(v_j))$, $I_\beta(v_i, v_j) = I_{\beta'}(\mathfrak{R}(v_i)\, \mathfrak{R}(v_j))$, $F_\beta(v_i, v_j) = F_{\beta'}(\mathfrak{R}(v_i)\, \mathfrak{R}(v_j))$, ∀ $(v_i, v_j) \in V$. Then $\mathfrak{R}$: G → G′ is a co-weak isomorphism.

Definition 2.3

Let G = (α, β) be an SVN_G. If G has a path P of path length K. The strength of neutrosophic path connecting two nodes p and q such as P = p = {p_1, (p_1, p_2), p_2, ..., p_{k-1}(p_{k-1}, p_k)}, p_k = q , then $T^k_\beta(p, q)$, $I^k_\beta(p, q)$ and $F^k_\beta(p, q)$ is called the strength of the neutrosophic path. This path describes as follows.

$T^k_\beta(p, q) = \sup (T_\beta(p, p_1)\, T_\beta(p_1, p_2) \ldots T_\beta(p_{k-1}, p_k))$,

$I^k_\beta(p, q) = \sup (I_\beta(p, p_1)\, I_\beta(p_1, p_2) \ldots I_\beta(p_{k-1}, p_k))$,

$F^k_\beta(p, q) = \inf (F_\beta(p, p_1)\, F_\beta(p_1, p_2) \ldots F_\beta(p_{k-1}, p_k))$.

Definition 2.4

Let G = (α, β) be an 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: $T^{sc}_\beta(p, q) = \sup \{T^k_\beta(p, q) / k = 1, 2, 3, \ldots\}$

$I^{sc}_\beta(p, q) = \sup \{I^k_\beta(p, q) / k = 1, 2, 3, \ldots\}$

$F^{sc}_\beta(p, q) = \inf \{F^k_\beta(p, q) / k = 1, 2, 3, \ldots\}$.

Definition 2.5

Let G [R, S] be an IVF_G on a crisp graph G*(V, E), where R = $[\alpha^l{}_R(v_i), \alpha^u{}_R(v_j)]$ and S = $[\alpha^l{}_s(v_i, v_j), \alpha^u{}_S(v_i, v_j)]$. If R is an IVFS on vertex set V and S is an IVFS on edge set E, satisfy the following condition:

1) $V = \{ v_1, v_2, ..., v_n \}$, such that $\alpha^l{}_R : V \to [0, 1]$, $\alpha^u{}_R : V \to [0, 1]$,

2) $\alpha^l{}_s : V \times V \to [0, 1]$, $\alpha^u{}_S : V \times V \to [0, 1]$ are the functions that satisfy following conditions.

(i) $\alpha^l{}_s(v_i, v_j) \le \min \{\alpha^u{}_R(v_i), \alpha^u{}_R(v_j)\}$ for all $(v_i, v_j) \in E$ and

(ii) $\alpha^u{}_s(v_i, v_j) \le \min \{\alpha^u{}_R(v_i), \alpha^u{}_R(v_j)\}$ for all $(v_i, v_j) \in E$.

Definition 2.6

Let G (α, β) be IVFG with |v| = n; a subset of IVFG is

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

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

The way φ is represented in relation to (α- φ) is distinct, then the subset φ is said to be an interval-valued fuzzy resolving set of G.

Definition 2.7

An SVNG 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 $T_\alpha : V_G \to [0, 1]$, $I_\alpha : V_G \to [0, 1]$, $F_\alpha : V_G \to [0, 1]$,
$0 \le T_\alpha(v_i) + I_\alpha(v_i) + F_\alpha(v_i) \le 3$, for all $v_i \in V_G$.

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

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

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

iii) $F_\beta(x, y) \ge \max \{F_\alpha(x), F_\alpha(y)\}$, $(x, y) \in (V_G \times V_G)$ and

$0 \le T_\beta(x, y) + I_\beta(x, y) + F_\beta(x, y) \le 3 \; \forall \; (x, y) \in E$.

3 Neutrosophic resolving sets on neutrosophic graphs

3.1 Definition

Let G (α, β) be NG with |v|= n, a subset of NG is

$$\varphi = \left\{\begin{matrix} \frac{v_1}{T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1)}, \\ \frac{v_2}{T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2)}, \\ \frac{v_3}{T_\alpha(v_3), I_\alpha(v_3), F_\alpha(v_3)}, \\ \cdots\cdots\cdots.., \\ \frac{v_k}{T_\alpha(v_k), I_\alpha(v_k), F_\alpha(v_k)} \end{matrix}\right\}, \; (\alpha - \varphi) = \left\{\begin{matrix} \frac{v_{k+1}}{T_\alpha(v_{k+1}), I_\alpha(v_{k+1}), F_\alpha(v_{k+1})}, \\ \frac{v_{k+2}}{T_\alpha(v_{k+2}), I_\alpha(v_{k+2}), F_\alpha(v_{k+2})}, \\ \frac{v_{k+3}}{T_\alpha(v_{k+3}), I_\alpha(v_{k+3}), F_\alpha(v_{k+3})}, \\ \cdots\cdots\cdots.., \\ \frac{v_n}{T_\alpha(v_n), I_\alpha(v_n), F_\alpha(v_n)} \end{matrix}\right\}.$$

The subset φ is referred to as a neutrosophic resolving set of G if its representation φ in reference to (α- φ) is distinct. The minimum size of the neutrosophic resolving set is called the neutrosophic resolving number (G).

3.2 Illustration

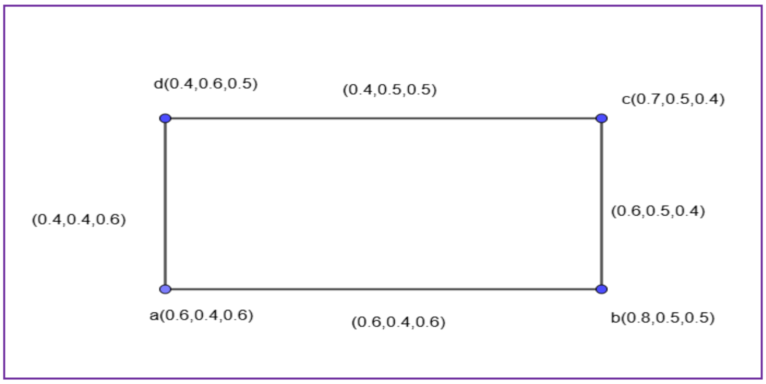

Figure.1: Neutrosophic graph

Here V = {a, b, c, d} be the vertex set of G* and E = {ab, bc, cd, da} be the edge set of G*

$\alpha = \left\{\alpha_1 = \frac{a}{(0.6,0.4,0.60}, \alpha_2 = \frac{b}{(0.8,0.5,0.5)}, \alpha_3 = \frac{c}{(0.7,0.5,0.4)}, \alpha_4 = \frac{d}{(0.4,0.6,0.5)}\right\}$,

$\beta = \left\{\beta_1 = \frac{ab}{(0.6,0.4,0.6)}, \beta_2 = \frac{bc}{(0.6,0.5,0.4}, \beta_3 = \frac{cd}{(0.4,0.5,0.5)}, \beta_4 = \frac{da}{(0.4,0.4,0.6)}\right\}$.

Strength of connectedness matrix of N$_G$

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

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

$(S_1/\alpha_3) = \{\beta^{sc}(a,c), \beta^{sc}(b,c)\} = \{(0.6, 0.4, 0.6), (0.6, 0.5, 0.4)\}$

$(S_1/\alpha_4) = \{\beta^{sc}(a,d), \beta^{sc}(b,d)\} = \{(0.4, 0.4, 0.6), (04, 0.5, 0.5)\}$

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 $S_2 = \{\alpha_1, \alpha_3\}$ $S_3 = \{\alpha_1, \alpha_4\}$, $S_4 = \{\alpha_2, \alpha_3\}$, $S_5 = \{\alpha_2, \alpha_4\}$,$S_6 = \{\alpha_3, \alpha_4\}$ are all resolving set of G.

3.3 Definition

Let G (α, β) be N_G with ∣v∣= n. A subset φ of N_G is said to be super-resolving neutrosophic set of G if the representation φ with respect to α it is distinct. The minimum size of super resolving neutrosophic set is called super-resolving neutrosophic numbe,r denoted by (G).

3.4 Illustration

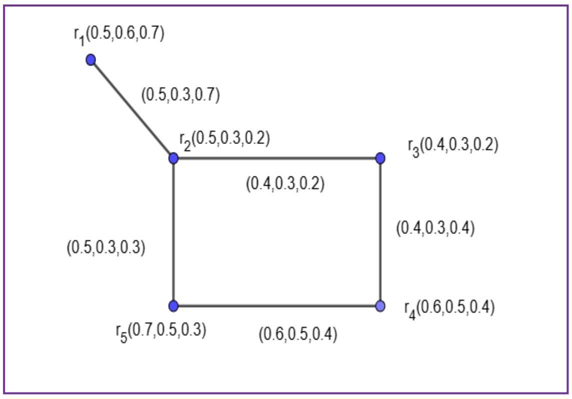

Figure 3: Neutrosophic graph

Here vertex set V = {r_1, r_2, r_3, r_4, r_5}, α ={$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$} where $\alpha(r_i) = \alpha_i = \left(\frac{r_i}{T_\alpha (v_i), I_\alpha (v_i), F_\alpha (v_i)}\right)$

Strength of connectedness matrix for T

$$\begin{pmatrix} 0 & .5 & .5 & .5 & .4 \\ .5 & 0 & .4 & .4 & .5 \\ .5 & .4 & 0 & .4 & .4 \\ .5 & .4 & .4 & 0 & .6 \\ .4 & .5 & .4 & .6 & 0 \end{pmatrix}$$

Strength of connectedness matrix for I

$$\begin{pmatrix} 0 & .3 & .3 & .3 & .3 \\ .3 & 0 & .3 & .3 & .3 \\ .3 & .3 & 0 & .4 & .4 \\ .3 & .3 & .4 & 0 & .6 \\ .3 & .3 & .4 & .6 & 0 \end{pmatrix}$$

Strength of connectedness matrix for F

$$\begin{pmatrix} 0 & .2 & .3 & .4 & .2 \\ .2 & 0 & .2 & .4 & .3 \\ .3 & .2 & 0 & .4 & .3 \\ .4 & .4 & .4 & 0 & .4 \\ .2 & .3 & .3 & .4 & 0 \end{pmatrix}$$

Let S = {r_1, r_2} be a super neutrosophic resolving set of G because the representation of s with respect to α is distinct. So that (G) = 2.

3.5 Theorem

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

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

be a neutrosophic resolving set of G. So the representation of φ with respect to (α − φ) should be distinct but the set φ ned 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 (α - φ) also hence be neutrosophic super resolving set is always be neutrosophic resolving set.

3.6 Theorem

Two neutrosophoic graphs G (V, α, β) and $G'(V', \alpha', \beta')$ are isomorphic then $nr(G) = nr(G')$.

Proof:

If G and G' are isomorphic then there exists a one to one onto mapping R: V →V' such that

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

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

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

$$\varphi = \left\{ \begin{array}{l} \frac{v_1}{T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1)}, \\ \frac{v_2}{T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2)}, \\ \dots\dots\dots, \\ \frac{v_p}{T_\alpha(v_p), I_\alpha(v_p), F_\alpha(v_p)} \end{array} \right\}$$ be a minimal neutrosophic resolving set of G therefore (G) = p and

$\varphi' = \left\{ \begin{array}{c} \frac{R(v_1)}{R(T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1))}, \\ \frac{R(v_2)}{R(T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2))}, \\ \dots\dots\dots, \\ \frac{R(v_p)}{R(T_\alpha(v_p), I_\alpha(v_p), F_\alpha(v_p))} \end{array} \right\}$ be the subset of G'. Here φ be the neutrosophic resolving set of G, so that the representation of

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

Where i =1,2,…….,(n-p). Which are all distinct.

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

Where i = 1, 2, 3, …, (n-p)

$$= \left\{ \begin{array}{c} [\beta^{sc}(T_\alpha(v_{p+i}), T_\alpha(v_1)), \beta^{sc}(I_\alpha(v_{p+i}), I_\alpha(v_1)), \beta^{sc}(F_\alpha(v_{p+i}), F_\alpha(v_1))], \\ [\beta^{sc}(T_\alpha(v_{p+i}), T_\alpha(v_2)), \beta^{sc}(I_\alpha(v_{p+i}), I_\alpha(v_2)), \beta^{sc}(F_\alpha(v_{p+i}), F_\alpha(v_2))], \\ \dots\dots\dots, \\ [\beta^{sc}(T_\alpha(v_{p+i}), T_\alpha(v_p)), \beta^{sc}(I_\alpha(v_{p+i}), I_\alpha(v_p)), \beta^{sc}(F_\alpha(v_{p+i}), F_\alpha(v_p))] \end{array} \right\}.$$

Where i=1, 2, 3, ..., (n-p). Which are all distinct. (Because G 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 neutrosophic resolving set δ' of

$$(G', \delta') = \left\{ \begin{array}{c} \frac{R(v_1)}{R(T_\alpha(v_1), I_\alpha(v_1), F_\alpha(v_1))}, \\ \frac{R(v_2)}{R(T_\alpha(v_2), I_\alpha(v_2), F_\alpha(v_2))}, \\ \dots\dots\dots, \\ \frac{R(v_t)}{R(T_\alpha(v_t), I_\alpha(v_t), F_\alpha(v_t))} \end{array} \right\}$$

$|\varphi'| = p > |\delta'| = t$, $R(\delta) = \delta'$.

$(\alpha' - \delta' \setminus \delta') =$

$$\left\{\begin{array}{c}[\beta'^{sc}(T_{\alpha'}R(v_{t+i}), T_{\alpha'}R(v_1)])], \beta'^{sc}(I_{\alpha'}R(v_{t+i}), I_{\alpha'}R(v_1)]), \beta'^{sc}(F_{\alpha'}R(v_{t+i}), F_{\alpha'}R(v_1)])], \\ [\beta'^{sc}(T_{\alpha'}R(v_{t+i})], T_{\alpha'}R(v_2)]), \beta'^{sc}(I_{\alpha'}R(v_{t+i})], I_{\alpha'}R(v_2)]), \beta'^{sc}(F_{\alpha'}R(v_{t+i})], F_{\alpha'}R(v_2)])], \\ \dots\dots\dots, \\ [\beta'^{sc}(T_{\alpha'}R(v_{t+i})], T_{\alpha'}R(v_t)]), \beta'^{sc}(I_{\alpha'}R(v_{t+i})], I_{\alpha'}R(v_t)]), \beta'^{sc}(F_{\alpha'}R(v_{t+i})], F_{\alpha'}R(v_t)])]\end{array}\right\}.$$

Where i=1, 2, 3, …, (n-t)

$$= \left\{\begin{array}{c}[\beta^{sc}(T_\alpha(v_{t+i}), T_\alpha(v_1)), \beta^{sc}(I_\alpha(v_{t+i}), I_\alpha(v_1)), \beta^{sc}(F_\alpha(v_{t+i}), F_\alpha(v_1))], \\ [\beta^{sc}(T_\alpha(v_{t+i}), T_\alpha(v_2)), \beta^{sc}(I_\alpha(v_{t+i}), I_\alpha(v_2)), \beta^{sc}(F_\alpha(v_{t+i}), F_\alpha(v_2))], \\ \dots\dots\dots, \\ [\beta^{sc}(T_\alpha(v_{t+i}), T_\alpha(v_t)), \beta^{sc}(I_\alpha(v_{t+i}), I_\alpha(v_t)), \beta^{sc}(F_\alpha(v_{t+i}), F_\alpha(v_t))]\end{array}\right\}.$$

Where i=1, 2, 3, …, (n-t).

Which are all distinct. This implies $|\delta| = t$ be a minimal neutrosophic resolving set of G. This is contradiction to $|\varphi| = p$ is minimal neutrosophic resolving set of G. Hence (G) = nr (G').

3.7 Corollary

Two neutrosophoic graphs G (V, α, β) and G' (V', α', β') are co-weak isomorphic then
nr (G) = nr (G').

3.8 Corollary

Two inter valued neutrosophoic graphs G (V, α,β) and G' (V', α', β') are isomorphic then
inr (G) = ***inr*** (G').

3.9 Corollary

Two inter valued neutrosophoic graphs G (V, α, β) and G'(V', α', β') are co-weak isomorphic then ***inr*** (G) = ***inr*** (G').

3.10 Corollary

Let G (V, α, β) be a neutrosophoic graph with |V| = 4 and G* is a cycle. If β is not a constant function then n (G) = 2.

3.11 Corollary

If φ is a Neutrosophoic resolving set of a neutrosophoic graph G (V, σ, μ), then (σ – φ) does not necessarily have to be a neutrosophoic 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

4.1 Definition

An IVN$_G$ with vertex set V is defined by $\widetilde{IN}_G = (\alpha, \beta)$.

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 $\beta = \{[T^l{}_\beta, T^U{}_\beta], [I^l{}_\beta, I^U{}_\beta], [F^l{}_\beta, F^U{}_\beta]\}$ is an interval-valued neutrosophic relation on E_G is defined as follows

1) $V = \{v_1, v_2, v_3, \ldots, v_n\}$, such that $T^l{}_\alpha : V_G \to [0, 1]$, $T^U{}_\alpha : V_G \to [0, 1]$, $I^l{}_\alpha : V_G \to [0,1]$, $I^u{}_\alpha : V_G \to [0, 1]$ and $F^l{}_\alpha : V_G \to [0, 1]$, $F^u{}_\alpha : V_G \to [0, 1]$ denote the degree of truth membership, the degree of indeterminacy membership and falsity membership values of the vertices respectively and $0 \le T_\alpha(x, y) + I_\alpha(x, y) + F_\alpha(x, y) \le 3$.

2) $T^l{}_\beta : V_G \to [0, 1]$, $T^U{}_\beta : V_G \to [0, 1]$, $I^l{}_\beta : V_G \to [0, 1]$, $I^u{}_\beta : V_G \to [0, 1]$ and $F^l{}_\beta : V_G \to [0, 1]$, $F^u{}_\beta : V_G \to [0, 1]$ 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 $0 \le T_\beta(x, y) + I_\beta(x, y) + F_\beta(x, y) \le 3$ for all $(x,y) \in E$.

4.2 Definition

Let $G(\alpha, \beta)$ be N_G, with $|v| = n$ the subset φ of G is said to be inter-valued neutrosophic resolving set of G if

$$\varphi = \left\{ \begin{array}{c} \frac{v_1}{\{[(T\alpha^{l}(v_1), T\alpha^{u}(v_1)], \{[(I\alpha^{l}(v_1), I\alpha^{u}(v_1)], \{[(F\alpha^{l}(v_1), F\alpha^{u}(v_1)]\}}, \\ \frac{v_2}{\{[(T\alpha^{l}(v_2), T\alpha^{u}(v_2)], \{[(I\alpha^{l}(v_2), I\alpha^{u}(v_2)], \{[(F\alpha^{l}(v_2), F\alpha^{u}(v_2)]\}}, \\ \frac{v_3}{\{[(T\alpha^{l}(v_3), T\alpha^{u}(v_3)], \{[(I\alpha^{l}(v_3), I\alpha^{u}(v_3)], \{[(F\alpha^{l}(v_3), F\alpha^{u}(v_3)]\}}, \\ \ldots\ldots\ldots, \\ \frac{v_k}{\{[(T\alpha^{l}(v_k), T\alpha^{u}(v_k)], \{[(I\alpha^{l}(v_k), I\alpha^{u}(v_k)], \{[(F\alpha^{l}(v_k), F\alpha^{u}(v_k)]\}} \end{array} \right\},$$

$$(\alpha - \varphi) = \left\{ \begin{array}{c} \frac{v_{k+1}}{\{[(T\alpha^{l}(v_{k+1}), T\alpha^{u}(v_{k1})]\}, \{[(I\alpha^{l}(v_1), I\alpha^{u}(v_1)], \{[(F\alpha^{l}(v_1), F\alpha^{u}(v_1)]\}}, \\ \frac{v_{k+2}}{\{[(T\alpha^{l}(v_2), T\alpha^{u}(v_2)], \{[(I\alpha^{l}(v_2), I\alpha^{u}(v_2)], \{[(F\alpha^{l}(v_2), F\alpha^{u}(v_2)]\}}, \\ \frac{v_{k+3}}{\{[(T\alpha^{l}(v_3), T\alpha^{u}(v_3)], \{[(I\alpha^{l}(v_3), I\alpha^{u}(v_3)]\}, \{[(F\alpha^{l}(v_3), F\alpha^{u}(v_3)]\}}, \\ \ldots\ldots\ldots, \\ \frac{v_n}{\{[(T\alpha^{l}(v_k), T\alpha^{u}(v_k)], \{[(I\alpha^{l}(v_k), I\alpha^{u}(v_k)]\}, \{[(F\alpha^{l}(v_k), F\alpha^{u}(v_k)]\}} \end{array} \right\},$$

the representation of φ with respect to $(\alpha - \varphi)$ are distinct. The minimum cardinality of this concerned set is called as interval valued neutrosophic resolving number, denoted by $\boldsymbol{inr}(G)$.

4.3 Definition

The representation of $(\alpha - H)$ with respect to H is written as $[P^l_{(i,j)}, P^u_{(i,j)}]$ where

$$P^{l}_{(i,j)} = \begin{Bmatrix} [\beta^{SC}T^{l}_{\beta}(v_{j,}v_1), \beta^{SC}I^{l}_{\beta}(v_j, v_1), \beta^{SC}F^{l}_{\beta}(v_{j,}v_1)], \\ [\beta^{SC}T^{l}_{\beta}(v_{j,}v_2), \beta^{SC}I^{l}_{\beta}(v_j, v_2), \beta^{SC}F^{l}_{\beta}(v_{j,}v_2)], \\ [\beta^{SC}T^{l}_{\beta}(v_{j,}v_3), \beta^{SC}I^{l}_{\beta}(v_j, v_3), \beta^{SC}F^{l}_{\beta}(v_{j,}v_3)], \\ \dots, \\ [\beta^{SC}T^{l}_{\beta}(v_{j,}v_k), \beta^{SC}I^{l}_{\beta}(v_j, v_k), \beta^{SC}F^{l}_{\beta}(v_{j,}v_k)] \end{Bmatrix}$$

$$P^{u}_{(i,j)} = \begin{Bmatrix} [\beta^{SC}T^{u}_{\beta}(v_{j,}v_1), \beta^{SC}I^{u}_{\beta}(v_{j,}v_1), \beta^{SC}F^{u}_{\beta}(v_{j,}v_1)], \\ [\beta^{SC}T^{u}_{\beta}(v_{j,}v_2), \beta^{SC}I^{u}_{\beta}(v_{j,}v_2), \beta^{SC}F^{u}_{\beta}(v_{j,}v_2)], \\ [\beta^{SC}T^{u}_{\beta}(v_{j,}v_3), \beta^{SC}I^{u}_{\beta}(v_{j,}v_3), \beta^{SC}F^{u}_{\beta}(v_{j,}v_3)], \\ \dots, \\ [\beta^{SC}T^{u}_{\beta}(v_{j,}v_k), \beta^{SC}I^{u}_{\beta}(v_{j,}v_k), \beta^{SC}F^{u}_{\beta}(v_{j,}v_k)] \end{Bmatrix},$$

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

4.4 Illustration

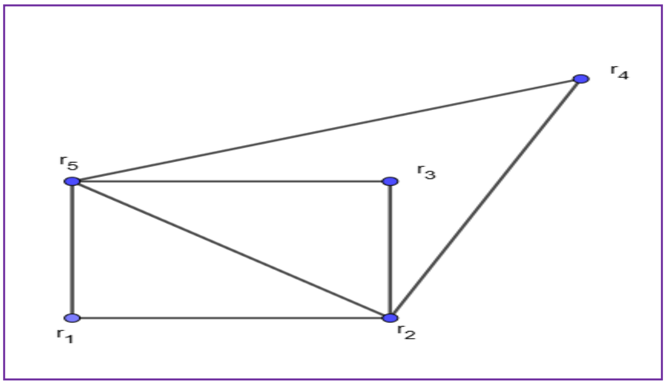

Figure.3: Inter valued neutrosophic graphs

Consider an IVN$_G$ G (α, β) as shown in figure, where the vector set of a graph G^* is {r_1, r_2, r_3, r_4, r_5} and {$r_1r_2, r_1r_5, r_2r_3, r_2r_4, r_2r_5, r_3r_5, r_4r_5$} is the edge set of G^*.

vertices	(T^l_α, T^l_α)	(I^l_α, I^l_α)	(F^l_α, F^l_α)
r1	(0.4, 0.5)	(0.1, 0.2)	(0.2, 0.3)
r2	(0.1, 0.2)	(0.2, 0.6)	(0.3, 0.6)
r3	(0.3, 0.4)	(0.1, 0.5)	(0.1, 0.5)
r4	(0.3, 0.2)	(0.5, 0.6)	(0.1, 0.2)
r5	(0.2, 0.7)	(0.3, 0.4)	(0.1, 0.5)

Table.2: Vertices

Edges	($T\beta^l$, $T\beta^u$)	($I\beta^l$, $I\beta^u$)	($F\beta^l$, $F\beta^u$)
r1r2	(0.1, 0.2)	(0.1, 0.2)	(0.3, 0.6)
r1r5	(0.2, 0.5)	(0.1, 0.2)	(0.2, 0.5)
r2r3	(0.1, 0.2)	(0.1, 0.5)	(0.3, 0.6)
r2r4	(0.1, 0.2)	(0.2, 0.6)	(0.3, 0.6)

r_2r_5	(0.1, 0.2)	(0.2, 0.4)	(0.3, 0.6)
r_3r_5	(0.2, 0.4)	(0.1, 0.4)	(0.1, 0.5)
r_4r_5	(0.2, 0.2)	(0.3, 0.4)	(0.1, 0.5)

Table.3: Edges

Strength of connectedness matrix for lower limits

$$\begin{pmatrix} 0 & 0.1,0.1,0.3 & 0.2,0.1,0.2 & 0.2,0.1,0.2 & 0.2,0.1,0.2 \\ 0.1,0.1,0.3 & 0 & 0.1,0.1,0.3 & 0.1,0.2,0.3 & 0.1,0.2,0.3 \\ 0.2,0.1,0.2 & 0.1,0.1,0.3 & 0 & 0.2,0.1,0.1 & 0.2,0.1,0.1 \\ 0.2,0.1,0.2 & 0.1,0.2,0.3 & 0.2,0.1,0.1 & 0 & 0.2,0.3,0.1 \\ 0.2,0.1,0.2 & 0.1,0.2,0.3 & 0.2,0.1,0.1 & 0.2,0.3,0.1 & 0 \end{pmatrix}$$

Strength of connectedness matrix for upper limits

$$\begin{pmatrix} 0 & 0.2,0.2,0.6 & 0.4,0.2,0.5 & 0.2,0.2,0.5 & 0.5,0.2,0.5 \\ 0.2,0.2,0.6 & 0 & 0.2,0.5,0.6 & 0.2,0.6,0.6 & 0.2,0.4,0.6 \\ 0.4,0.2,0.5 & 0.2,0.5,0.6 & 0 & 0.2,0.5,0.5 & 0.4,0.4,0.5 \\ 0.2,0.2,0.5 & 0.2,0.6,0.6 & 0.2,0.5,0.5 & 0 & 0.2,0.4,0.5 \\ 0.5,0.2,0.5 & 0.2,0.4,0.6 & 0.4,0.4,0.5 & 0.2,0.4,0.5 & 0 \end{pmatrix}$$

Let $\varphi = \{r_1, r_2\}$, $(\alpha - \varphi) = \{r_3, r_4, r_5\}$, where $T\alpha^{l}(r_i) = T\alpha_i^{l}$, $T\alpha^{u}(r_i) = T\alpha_i^{u}$, $I\alpha^{l}(r_i) = I\alpha_i^{l}$, $I\alpha^{U}(r_i) = I\alpha_i^{u}$, $F\alpha^{l}(r_i) = I\alpha_i^{l}$, $F\alpha^{u}(r_i) = F\alpha_i^{u}$.

Where r_1 = {(0.4, 0.5), (0.1, 0.2), (0.2, 0.3)},

r_2 = {(0.1, 0.2), (0.2, 0.6), (0.3, 0.6)} ,

r_3 = {(0.3, 0.4), (0.1, 0.5), (0.1, 0.5)},

r_4 = {(0.3, 0.2), (0.5, 0.6), (0.1, 0.2)},

r_5 = {(0.2, 0.7), (0.3, 0.4), 0.1, 0.5)}

$$(r_3/\varphi) = \begin{Bmatrix} \left[(\beta^{\infty'} T^l{}_\beta(r_1,r_3), (\beta^{\infty'} T^u{}_\beta(r_1,r_3)\right], \\ \left[(\beta^{\infty'} I^l{}_\beta(r_1,r_3), (\beta^{\infty'} I^u{}_\beta(r_1,r_3)\right], \\ \left[(\beta^{\infty'} F^l{}_\beta(r_1,r_3), (\beta^{\infty'} F^u{}_\beta(r_1,r_3)\right] \end{Bmatrix} = \{[0.2, 0.4], [0.1, 0.2], [0.2, 0.5]\}$$

$$(r_4/\varphi) = \begin{Bmatrix} \left[(\beta^{\infty'} T^l{}_\beta(r_1,r_4), (\beta^{\infty'} T^u{}_\beta(r_1,r_4)\right], \\ \left[(\beta^{\infty'} I^l{}_\beta(r_1,r_4), (\beta^{\infty'} I^u{}_\beta(r_1,r_4))\right], \\ \left[(\beta^{\infty'} F^l{}_\beta(r_1,r_4), (\beta^{\infty'} F^u{}_\beta(r_1,r_4)\right] \end{Bmatrix} = \{[0.2, 0.2], [0.1, 0.2], [0.2, 0.5]\}$$

$$(r_4/\varphi) = \begin{Bmatrix} \left[(\beta^{\infty'} T^l{}_\beta(r_1,r_5), (\beta^{\infty'} T^u{}_\beta(r_1,r_5)\right], \\ \left[(\beta^{\infty'} I^l{}_\beta(r_1,r_5), (\beta^{\infty'} I^u{}_\beta(r_1,r_5)\right], \\ \left[(\beta^{\infty'} F^l{}_\beta(r_1,r_5), (\beta^{\infty'} F^u{}_\beta(r_1,r_5)\right] \end{Bmatrix} = \{[0.2, 0.5], [0.1, 0.2], [0.2, 0.5]\}$$

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

5. Neutrosophic modified resolving set on modified Neutrosophic graphs.

Let G = (α, β) be an SVNG. If G has path P of path length k. The weakness of connectedness of a neutrosophic path connecting two nodes p and q, such as P: p = p_1, (p_1, p_2), p_2, ..., $p_{(k-1)}$ ($p_{(k-1)}$, p_k), p_k = q), then $T^k{}_\beta$ (p, q), $I^k{}_\beta$(p, q) and $F^k{}_\beta$(p, q) , is called the weakness of the neutrosophic path. This path is described as follows.

$T^k{}_\beta$ (p, q) = inf (T_β (p, p_1) T_β (p_1, p_2) ... T_β (p_{k-1}, p_k)),
$I^k{}_\beta$ (p, q) = inf (I_β (p, p_1) I_β (p_1, p_2) ... I_β (p_{k-1}, p_k))
$F^k{}_\beta$ (a, b) = sup (F_β (p, p_1) F_β (p_1, p_2) ... F_β (p_{k-1}, p_k)).

5.1 Definition

Let G = (α, β) be an SVNG. 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 {$T^k{}_\beta$ (p, q)/ k =1, 2, 3,...}
$I^{wc}{}_\beta$ (p, q) = inf {$I^k{}_\beta$ (p, q)/ k = 1, 2, 3,...}
$F^{wc}{}_\beta$ (p, q) =sup { $F^k{}_\beta$ (p, q)/ k=1, 2, 3,...}.

5.2 Definition

An SVMNG with vertex set V is defined by $\overline{MN}_G$ = (α, β) (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 neutrosophic relation on satisfying the following condition:

1) V = {v_1, v_2 ,..., v_n }, such that T_α :$V_G \to$ [0, 1], I_α :$V_G \to$ [0, 1], F_α : $V_G \to$ [0, 1], For all vertices v_i, the sum of the values T_α (v_i), I_α (v_i), and F_α (v_i) must be between 0 and 3 inclusive.

2) T_β: $E_G \rightarrow$ [0, 1], I_β:$E_G \rightarrow$ [0, 1], F_β:$E_G \rightarrow$ [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

$0 \le T_\beta(x,y) + I_\beta(x,y) + F_\beta(x,y) \le 3$ for all $(x,y) \in E$.

5.3 Definition

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

5.4 Illustration

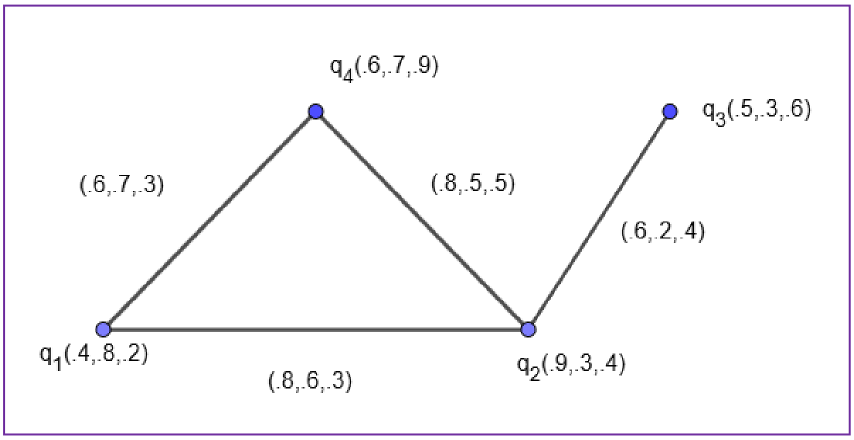

Figure.4: Modified Neutrosophic graphs

Weak of connectedness of the above neutrosophic graphs is

	q_1	q_2	q_3	q_4
q_1	0	(.8, .6, .3)	(.8, .6, .3)	(.6, .6, .3)
q_2	..8, .6, .3)	0	(.6, .2, .4)	(.8, .5, .3)
q_3	(.8, .6, .3))	(.6, .2, .4)	0	(.8, .5, .4)
q_4	(.6, .6, .3))	(.8, .5, .3)	(.8, .5, .4)	0

Let $\alpha = \{q_1, q_2, q_3, q_4\}$, $\varphi_1 = \{q_1, q_2\}$ so $(\alpha - \varphi_1) = \{q_3, q_4\}$

$$(\varphi_1/q_3) = \begin{Bmatrix} [(T^{wc}{}_\beta(q_1,q_3), I^{wc}{}_\beta(q_1,q_3), F^{wc}{}_\beta(q_1,q_3)], \\ [(T^{wc}{}_\beta(q_2,q_3), I^{wc}{}_\beta(q_2,q_3), F^{wc}{}_\beta(q_2,q_3)] \end{Bmatrix} = \{(.8, .6, .3), (.6, .2, .4)\}$$

$$(\varphi_1/q_4) = \begin{Bmatrix} [T^{wc}{}_{\beta}(q_{1,}q_4), I^{wc}{}_{\beta}(q_{1,}q_4), F^{wc}{}_{\beta}(q_{1,}q_4)] \\ [T^{wc}{}_{\beta}(q_{2,}q_4), I^{wc}{}_{\beta}(q_{2,}q_4), F^{wc}{}_{\beta}(q_{2,}q_4)] \end{Bmatrix} = \{(.6, .6, .3), (.8, .5, .3)\}$$

The representation of φ_1 with respect to $(\alpha - \varphi_1)$ are distinct so that φ_1 is modified resolving set in MN_G. So that ***MNR*** (G) = 2. In this same manner $\varphi_2 = \{q_1, q_3\}$ $\varphi_3 S_3 = \{q_1, q_4\}$, $\varphi_4 S_4 = \{q_2, q_3\}$, $S_5 = \{q_2, q_4\}$, $S_6 = \{q_3, q_4\}$ all are resolving set of G.

6. Applications

The neutrosophic graph is the perfect model for real-world situations for disaster management like earthquakes, floods, and tsunamis, where information is incomplete, delayed, confusing, uncertain, indeterminate, or partially true. In emergency management, after an earthquake, emergency teams need to:

- Please identify the impacted areas at your earliest convenience.
- Sort the places with the greatest degree of uncertainty first.
- Despatch rescue teams optimally.

However:

- Some sensors may be offline.
- Data from affected areas may be incomplete (roads destroyed, communication failure).
- Some damage reports may be conflicting or delayed.

Thus, uncertainty (indeterminacy) exists.

Using a neutrosophic resolution set, we can select key locations (hospitals, emergency hubs, and monitoring centres) that best resolve the uncertainty across all impacted areas. For the Turkey – Syria Earthquake 2023 scenario, let us consider a mathematical modelling approach to represent expert opinions on the necessity and characteristics of an intermediary measure for earthquake-resistant facilities in various regions. The information about the 2023 Turkey-Syria Earthquake is displayed in the table 4 below.

Area	**Deaths**	**Injuries**
Adana	454.00	7,450.0
Adiyaman	8,387.0	17,499
Batman	00000	20.000
Diyarbakir	414.00	902.00
Elazığ	5.0000	379.00
Gaziantep	3,904.0	13,325
Hatay	24,147	30,762
Kahramanmaraş	1,393.0	6,444.0
Kilis	74.000	754.00

Malatya	1,393.0	6,444.0
Mardin	1.0000	00000
Osmaniye	1,010.0	2,606.0
Şanlıurfa	340	8,919.0
Total	53,537	107,703
Unspecified	695.00	8,045.0

Table 4

Let's pick 6 real locations affected by the 2023 Turkey–Syria earthquake:

Location	**Damage Level (approx.)**	**Data Certainty**
Gaziantep	Heavy	Certain
Kahramanmaraş	Severe	Certain
Hatay	Very Heavy	Uncertain (delayed reports)
Adana	Moderate	Certain
Aleppo	Severe	Uncertain
Malatya	Heavy	Indeterminate (conflicting reports)

Table 5

Convert this problem in Neutrosophic Graph Model

Each city is considered a vertex. Link cities according to their infrastructure and geographic proximity. The degree of certainty in connections is represented by edge weights.

For example:

- **Certain connections**: strong roads, functioning communication.
- **Uncertain connections:** broken roads, poor data flow.

Give edges and vertices neutrosophic elements (falsity (F), indeterminacy (I), and truth (T). Reliable statistics and preliminary reports suggest that T (certainty) is 90%, I (indeterminacy) is 5%, and F (falsity) is 5% in the city of Gaziantep. There is strong earthquake readiness in Tokyo, according to neutrophilic values, with 80% agreeing, 20% having a moderate attitude, and 10% disagreeing. One possible representation of the Tokyo model is

(T: 0.8, 0.2, and 0.1). The team evaluates expert viewpoints regarding the need to establish an earthquake response centre in each area. With trustworthy data and preliminary reports, the city of Gaziantep shows that T (certainty) is 90%, I (indeterminacy) is 5%, and F (falsity) is 5%. A representation of Gaziantep would be (0.9, 0.05, 0.05).

Kahramanmaraş is the epicentre region, mostly verified so that T (certainty) is 85%, I (indeterminacy) is 10%, and F (falsity) is 5%. Kahramanmaraş may be represented as (0.85, 0.10, 0.05). The city of Hatay has delayed/conflicting reports so that T (5%), I (35%), and F (15%), so Hatay may be represented as (0.5, 0.35, 0.15). Adana has minimal disruption and reliable sensors, so T (95%), I (3%), and F (2%). Therefore, Adana may be represented as (0.95, 0.03, 0.02), and Aleppo has political conflict and uncertain data, so T (60%), I (25%), and F (15%) for Aleppo may be represented as (0.6, 0.25, 0.15).

Similarly Neutrosophic Edge Values (connections)

Vertex (City)	**T (Certainty)**	**I (Indeterminacy)**	**F (Falsity)**	**Reason**
City Gaziantep	0.9	0.05	0.05	Reliable data, early reports
Kahramanmaraş	0.85	0.10	0.05	Epicenter region, mostly verified
Hatay	0.5	0.35	0.15	Delayed/conflicting reports
Adana	0.95	0.03	0.02	Minimal disruption, reliable sensors
Aleppo	0.6	0.25	0.15	Political conflict, uncertain data
Malatya	0.65	0.25	0.10	Reports contradicting severity

Table 6

Edges represent road access, communication, or data flow. The cities of Gaziantep and Kahramanmaraş have strong links and main roads, so T (90%), I (5%), and F (5%). Therfore the neutrosophic values of the edge between Gaziantep and Kahramanmaraş is (0, 9, 0.05, 0.05) the city Gaziantep and Hatay has Partial road damage, and has delayed data so T (60%), I (25%), F (15%) so that the neutrosophic values of the edge between Gaziantep and Hatay is (0.6, 0.25, 0.15), the city between hatay and Aleppo has Border conflict, high uncertainty so T(40%), I (40%), F (15%) therefore the edge neutrosophic value between hatay and Aleppo is (0.4, 0.4, 0.2), the road between Kahramanmaraş and Malatya has blockages so T (70%), I (20%), F (10%) therefore the edge neutrosophic value between Kahramanmaraş and Malatya is (0.7, 0.2, 0.1) the cities Malatya and Aleppo are remote and unclear routes so T(30%), I (50%), F (20%) so that the edge neutrosophic value between Malatya and Aleppo is (0.3, 0.5, 0.2) the city Hatay and Adana has highway intact so T (85%), I (1%), F (5%) so the edge neutrosophic value between Hatay and Adana is (0.85, 0.1, 0.15) finally the city Aleppo and Adana has Secondary roads and data flow unstable so T(60%), I(25%), F(15%) so the edge neutrosophic value between Aleppo and Adana is (0.6, 0.25, 0.15). The following table 7 and figure 5 show the neutrosophic edge values.

Edge (City1)	**(City2)**	**T**	**I**	**F**	**Notes**
Gaziantep	Kahramanmaraş	0.9	0.05	0.05	Strong link, main road
Gaziantep	Hatay	0.6	0.25	0.15	Partial road damage, delayed data
Hatay	Aleppo	0.4	0.4	0.2	Border conflict, high uncertainty
Kahramanmaraş	Malatya	0.7	0.2	0.1	Reports of road blockages
Malatya	Aleppo	0.3	0.5	0.2	Remote, unclear routes
Hatay	Aleppo	0.85	0.1	0.05	Highway intact
Aleppo	Adana	0.6	0.25	0.15	Secondary roads, data flow unstable

Table 7

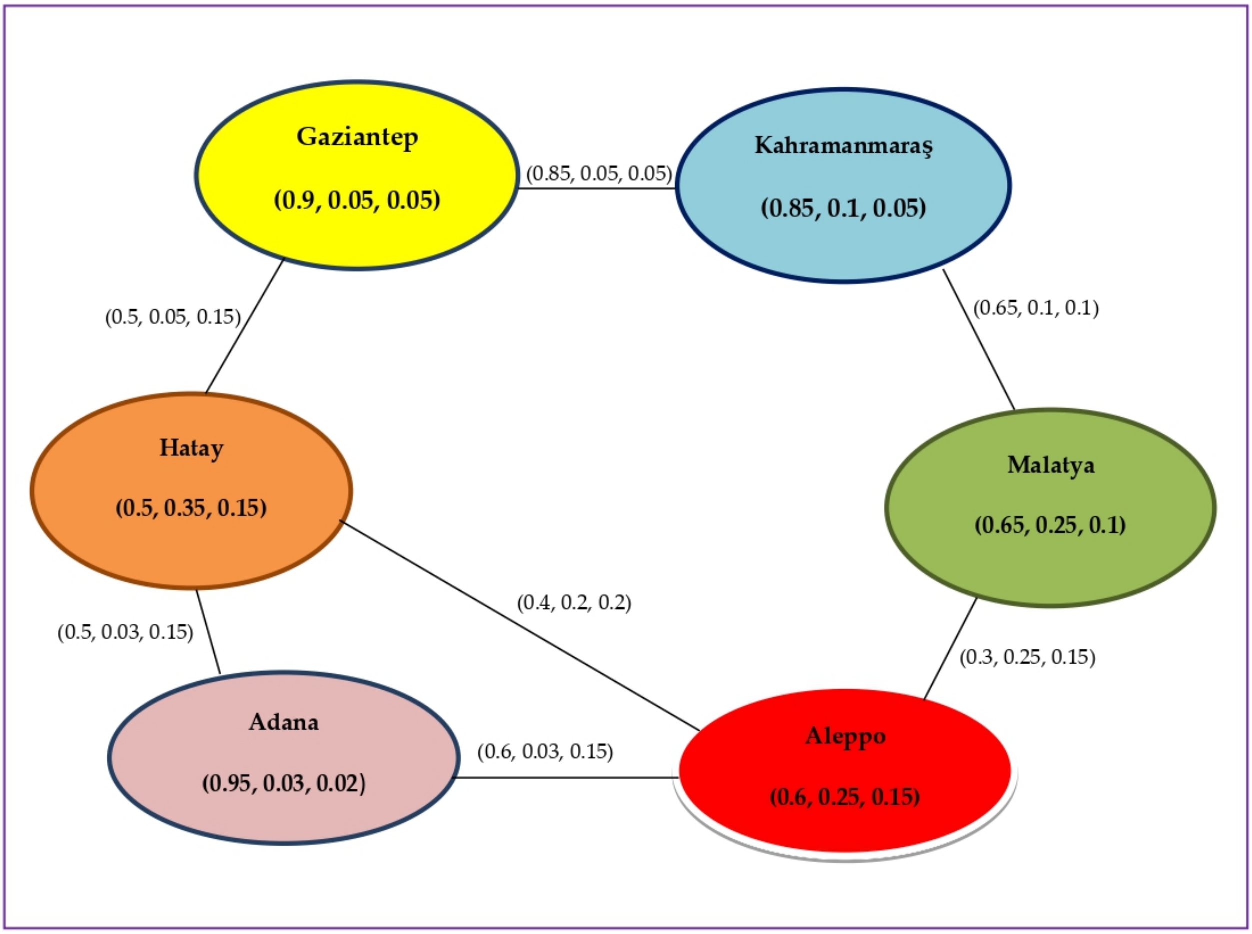

Figure. 5

Strength of connectedness matrix for T (Certainty)

	Gaziantep	**Kahramanmaraş**	**Malatya**	**Hatay**	**Aleppo**	**Adana**
Gaziantep	0	0.85	0.65	0.5	0.5	0.5
Kahramanmaraş	0.85	0	0.65	0.5	0.6	0.5
Malatya	0.65	0.65	0	0.5	0.5	0.5
Hatay	0.5	0.5	0.5	0	0.5	0.5
Aleppo	0.5	0.6	0.5	0.5	0	0.6
Adana	0.5	0.5	0.5	0.5	0.6	0

Strength of connectedness matrix for I (Indeterminacy)

	Gaziantep	Kahramanmaraş	Malatya	Hatay	Aleppo	Adana
Gaziantep	0	0.05	0.05	0.05	0.05	0.03
Kahramanmaraş	0.05	0	0.1	0.1	0.1	0.03
Malatya	0.05	0.1	0	0.2	0.25	0.03
Hatay	0.05	0.1	0.2	0	0.2	0.03
Aleppo	0.05	0.1	0.25	0.2	0	0.03
Adana	0.03	0.03	0.03	0.03	0.03	0

Strength of connectedness matrix for F (Falsity)

	Gaziantep	Kahramanmaraş	Malatya	Hatay	Aleppo	Adana
Gaziantep	0	0.2	0.15	0.15	0.15	0.15
Kahramanmaraş	0.2	0	0.1	0.15	0.15	0.15
Malatya	0.15	0.1	0	0.15	0.15	0.15
Hatay	0.15	0.15	0.15	0	0.15	0.15
Aleppo	0.15	0.15	0.15	0.15	0	0.15
Adana	0.15	0.15	0.15	0.15	0.15	0

Let us denote Gaziantep (G), Kahramanmaraş (K), Malatya (M), Hatay (H), Aleppo (AL), Adana (A). Let us take R = {G, K}, (V-R) = {M, H, Al, A}. Here the subset R = {G, K} is a resolving set of G.

β^{SC} (M, G), β^{SC} (M, K) = (0.65, 0.05, 0.15), (0.65, 0.1, 0.1)

β^{SC} (H, G), β^{SC} (H, K) = (0.5, 0.05, 0.15), (0.5, 0.1, 0.15)

β^{SC} (AL, G), β^{SC} (AL, K) = (0.5, 0.05, 0.15), (0.6, 0.1, 0.15)

β^{SC} (A, G), β^{SC} (A, K) = (0.5, 0.03, 0.15), (0.5, 0.03, 0.15)

The representation of (α - R) with respect to R are all distinct, therefore R is the neutrosophic reasolving set of G. Effective localization of high-priority zones is made possible in seismic disaster management by the use of neutrosophic resolving sets, even in cases where data is ambiguous, lacking, or contradictory. More lives are eventually saved as a result of quicker rescue efforts and more effective resource allocation.

Neutrosophic resolving sets benefits for earthquake scenarios

Modelling uncertainty portrays ambiguous or contradictory damage reports accurately. Improved localization aids in the specific identification of impacted areas for focused rescue decision support helps rescue crews prioritize tasks when data is lacking. Adaptable data management performs well with ambiguous or hazy sensor data (such as that from drones or the internet of things). Management of redundancy resolves ambiguities that are not captured by traditional graphs.

6. Conclusions

Neutrosophic graphs are effective tools for modelling systems with inconsistent, ambiguous, and incomplete information, which is prevalent in many real-world domains such as risk assessment and disaster management, social network analysis, cybersecurity and intrusion detection, medical diagnosis systems, and decision-making in uncertain environments. This manuscript's primary contribution is the introduction of the concepts of neutrosophic resolving sets in neutrosophic graphs, neutrosophic super resolving sets in neutrosophic graphs, and inter-valued neutrosophic resolving sets in inter-valued neutrosophic graphs. Additionally, we have defined an application based on neutrosophic resolving sets and discussed various theorems, corollaries, and properties. We might investigate further neutrosophic resolving set problems in the future. The earthquake prediction centre has been established at several places in Syria and Turkey using the neutrosophic graph. In order to make better decisions, vertices in a neutrosophic graph are more beneficial. In order to avoid catastrophes during earthquakes, the mathematical underpinnings of neutrosophic graph theory tend to suggest appropriate places from Turkey to Syria.

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