Special Single Valued Decagonal Neutrosophic Number and its Applications

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Abstract

The Neutrosophic number is defined to solve the vagueness of the real-life problem and to analysis the indeterminacy of the problem, the paper defines a special single valued Decagonal Neutrosophic number and De-Neutrosophication formula are formulated using the removal area method and a numerical practical example is illustrated of network path edges using Neutrosophic number.

Keywords: Neutrosophic number; removal area method; De-Neutrosophication

Introduction

World is everywhere uncertain and objects we encounter in the real physical life has vague situation. The degree of belongness helps to understand the vagueness of the situation fuzzy sets clears ambiguous case L.A Zadeh in the year 1965 introduced fuzzy set which became an eye opening in the field of fuzzy logic. This fuzzy logic is one of the tools to solve the imprecision problem in a computational way. To handle the vagueness and ambiguity traditional method of set theory and number are inadequate to solve it fuzzy is one of the concepts for this purpose.

Lotfi. A. Zadeh introduced the concept fuzzy set theory later Atanassov extended fuzzy set into Intuitionistic set which consists of membership function and non-membership functions. Later in 1995 Smarandache introduced a concept from Philosophy called Neutrosophy which consists of three components truthiness, falsehood and indeterminacy in which a large number of impacts in the indeterminate part of the component. Recently researchers around the globe making use of the Neutrosophic environment to solve various kinds of real-life problems. Several forms of Neutrosophic number like triangular, trapezoidal, pentagonal, hexagonal membership function which are both dependent or independent have been manifested and multi-criteria group decision-making problems are solved using novel Neutrosophic number.

1. Definitions

Definition 1: "***Single Valued linear Pentagonal Neutrosophic Number (SVPNN)[2]*:**
A single valued linear pentagonal Neutrosophic number $\underline{S}$ is defined and described as

$$\underline{S} = \langle[(g^1, h^1, i^1, j^1, k^1); \rho], [(g^2, h^2, i^2, j^2, k^2); \sigma], [(g^3, h^3, i^3, j^3, k^3); \omega]\rangle$$

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Where $\rho, \sigma, \omega \in [0,1]$. The Degree of truth membership function $(\theta_{\underline{S}}): \mathbb{R} \to [0, \rho]$,
Degree of Indeterminacy membership function $(\emptyset_{\underline{S}}): \mathbb{R} \to [\sigma, 1]$ and
Degree of falsity membership function $(\varphi_{\underline{S}}): \mathbb{R} \to [\omega, 1]$ are given as:

$$\theta_{\bar{S}}(d_T) = \begin{cases} \theta_{\overline{Sl1}}(d_T), & g^1 \le d_T \le h^1 \\ \theta_{\overline{sl2}}(d_T), & h^1 \le d_T \le i^1 \\ \rho, & x = i^1 \\ \theta_{\overline{sr1}}(d_T), & i^1 \le d_T \le j^1 \\ \theta_{\overline{sr2}}(d_T), & j^1 \le d_T \le k^1 \\ 0, & otherwise \end{cases} \qquad \emptyset_{\bar{S}}(d_I) = \begin{cases} \emptyset_{\overline{Sl1}}(d_I), & g^2 \le d_I \le h^2 \\ \emptyset_{\overline{sl2}}(d_I), & h^2 \le d_I \le i^2 \\ \sigma, & x = i^2 \\ \emptyset_{\overline{sr1}}(d_I), & i^2 \le d_I \le j^2 \\ \emptyset_{\overline{sr2}}(d_I), & j^2 \le d_I \le k^2 \\ 1, & otherwise \end{cases}$$

$$\varphi_{\bar{S}}(d_F) = \begin{cases} \varphi_{\overline{Sl1}}(d_F), & g^3 \le d_F \le h^3 \\ \varphi_{\overline{sl2}}(d_F), & h^3 \le d_F \le i^3 \\ \omega, & x = i^3 \\ \varphi_{\overline{sr1}}(d_F), & i^3 \le d_F \le j^3 \\ \varphi_{\overline{sr2}}(d_F), & j^3 \le d_F \le k^3 \\ 1, & otherwise \end{cases}$$

Special Single Valued Linear Decagonal Neutrosophic number:

Definition 2: S***pecial Single Valued Linear Decagonal Neutrosophic Number (SVLDNN)*:** A Special Single Valued Linear Decagonal Neutrosophic number $\underline{A}$ is defined and described as
$\underline{A}_{Decaneu} =< [(a_{11}, b_{11}, c_{11}, d_{11}, e_{11}, f_{11}, g_{11}, h_{11}, i_{11}, j_{11}); \Psi_T, \Omega_I, X_F] >$ Where $\Psi_T, \Omega_I, X_F \in [0,1]$
The Degree of truthiness $\theta_{\underline{A}_{Decaneu}} : \mathbb{R} \to [0, \Psi_T]$,
Degree of Indeterminate $\emptyset_{\underline{A}_{Decaneu}} : \mathbb{R} \to [\Omega_I, 1]$,
Degree of Falsity $\varphi_{\underline{A}_{Decaneu}} : \mathbb{R} \to [X_F, 1]$ are given as

$$\theta_{\bar{A}_{Decaneu}}(x) = \begin{cases} \frac{x-a_{11}}{b_{11}-a_{11}} \Psi_T & a_{11} \le x \le b_{11} \\ \frac{x-b_{11}}{c_{11}-b_{11}} \Psi_T & b_{11} \le x \le c_{11} \\ \frac{x-c_{11}}{d_{11}-c_{11}} \Psi_T & c_{11} \le x \le d_{11} \\ \frac{x-d_{11}}{e_{11}-d_{11}} \Psi_T & d_{11} \le x \le e_{11} \\ 0 & x = e_{11} \\ 0 & x = f_{11} \\ \frac{f_{11}-x}{f_{11}-g_{11}} \Psi_T & f_{11} \le x \le g_{11} \\ \frac{g_{11}-x}{g_{11}-h_{11}} \Psi_T & g_{11} \le x \le h_{11} \\ \frac{h_{11}-x}{h_{11}-i_{11}} \Psi_T & h_{11} \le x \le i_{11} \\ \frac{i_{11}-x}{i_{11}-j_{11}} \Psi_T & i_{11} \le x \le j_{11} \\ 1 & otherwise \end{cases} \qquad \emptyset_{\bar{A}_{Decaneu}}(x) = \begin{cases} \frac{x-a_{11}}{b_{11}-a_{11}} \Omega_I & a_{11} \le x \le b_{11} \\ \frac{x-b_{11}}{c_{11}-b_{11}} \Omega_I & b_{11} \le x \le c_{11} \\ \frac{x-c_{11}}{d_{11}-c_{11}} \Omega_I & c_{11} \le x \le d_{11} \\ \frac{x-d_{11}}{e_{11}-d_{11}} \Omega_I & d_{11} \le x \le e_{11} \\ 0 & x = e_{11} \\ 0 & x = f_{11} \\ \frac{f_{11}-x}{f_{11}-g_{11}} \Omega_I & f_{11} \le x \le g_{11} \\ \frac{g_{11}-x}{g_{11}-h_{11}} \Omega_I & g_{11} \le x \le h_{11} \\ \frac{h_{11}-x}{h_{11}-i_{11}} \Omega_I & h_{11} \le x \le i_{11} \\ \frac{i_{11}-x}{i_{11}-j_{11}} \Omega_I & i_{11} \le x \le j_{11} \\ 1 & otherwise \end{cases}$$

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$$\varphi_{\bar{A}_{Decaneu}}(x) = \begin{cases} \frac{x-a_{11}}{b_{11}-a_{11}}\,\mathrm{X_F} & a_{11} \le x \le b_{11} \\ \frac{x-b_{11}}{c_{11}-b_{11}}\,\mathrm{X_F} & b_{11} \le x \le c_{11} \\ \frac{x-c_{11}}{d_{11}-c_{11}}\,\mathrm{X_F} & c_{11} \le x \le d_{11} \\ \frac{x-d_{11}}{e_{11}-d_{11}}\,\mathrm{X_F} & d_{11} \le x \le e_{11} \\ 0 & x = e_{11} \\ 0 & x = f_{11} \\ \frac{f_{11}-x}{f_{11}-g_{11}}\,\mathrm{X_F} & f_{11} \le x \le g_{11} \\ \frac{g_{11}-x}{g_{11}-h_{11}}\,\mathrm{X_F} & g_{11} \le x \le h_{11} \\ \frac{h_{11}-x}{h_{11}-i_{11}}\,\mathrm{X_F} & h_{11} \le x \le i_{11} \\ \frac{i_{11}-x}{i_{11}-j_{11}}\,\mathrm{X_F} & i_{11} \le x \le j_{11} \\ 1 & otherwise \end{cases}$$

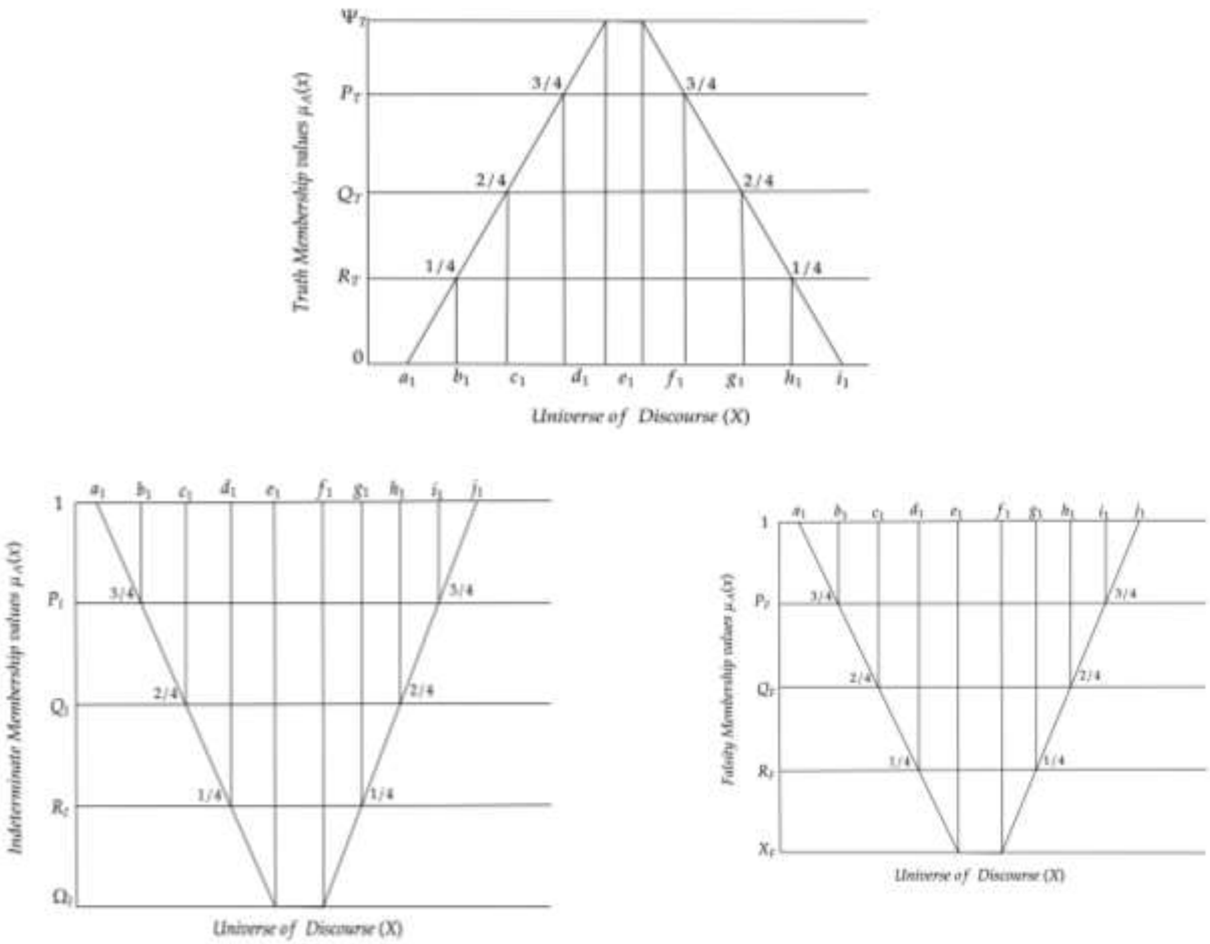

Figure 1 The Representation of special Decagonal Neutrosophic number Graphically

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The representation of Special Single Decagonal Neutrosophic(SSVLDN) number is given where purple represent membership function, green colour represents indeterminant membership, blue represent falsity membership function.

De-Neutrosophication of Single Valued Decagonal Neutrosophic number using removal area method:

Using area of Removal, the Decagonal Neutrosophic number is converted into the crisp value.

Consider the single valued nanogonal Neutrosophic number:

$$\underline{A}_{Decaneu} =< [(a_{10}, b_{10}, c_{10}, d_{10}, e_{10}, f_{10}, g_{10,} h_{10}, i_{10}, j_{10}); \Psi_{\tilde{T}}, \Omega_{\tilde{I}}, X_{\tilde{F}}] >$$

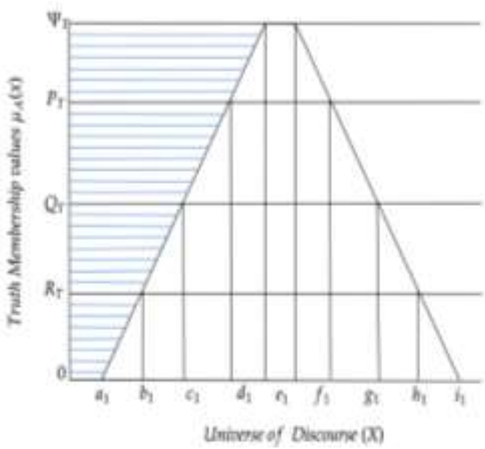

Figure 2: left side area removal of truth membership

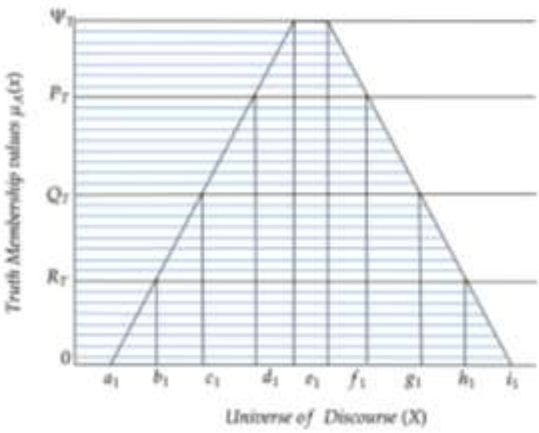

Figure 3: Right side area removal of

$$\underline{A}_{Decaneu}\left(\underline{O}_l, 0\right) = \frac{1}{2}\left\{\frac{(a_{10}+b_{10})}{2}\Psi_{\tilde{T}} + \frac{(b_{10}+c_{10})}{2}\Psi_{\tilde{T}} + \frac{(c_{10}+d_{10})}{2}\Psi_{\tilde{T}} + \frac{(d_{10}+e_{10})}{2}(1-\Psi_{\tilde{T}}) + \frac{(e_{10}+f_{10})}{2}(1)\right\}$$

$$\underline{A}_{Decaneu}\left(\underline{O}_r, 0\right) = \frac{1}{2}\left\{\frac{(e_{10}+f_{10})}{2}(1) + \frac{(f_{10}+g_{10})}{2}(1-\Psi_{\tilde{T}}) + \frac{(g_{10}+h_{10})}{2}\Psi_{\tilde{T}} + \frac{(h_{10}+i_{10})}{2}\Psi_{\tilde{T}} + \frac{(i_{10}+j_{10})}{2}\Psi_{\tilde{T}}\right\}$$

$$\underline{A}_{Decaneu}(\underline{O}, 0) = \frac{1}{4}[(a_{10} + 2b_{10} + 2c_{10} + d_{10} + g_{10} + 2h_{10} + 2i_{10} + j_{10})\Psi_{\tilde{T}} + (d_{10} + e_{10} + f_{10} + g_{10})(1-\Psi_{\tilde{T}})] + 2(e_{10} + f_{10})$$

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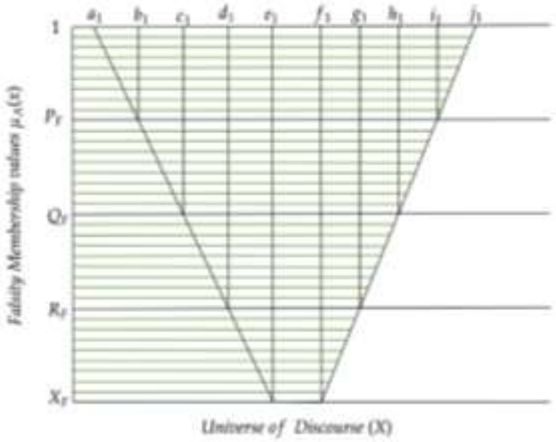

Figure 4: left side area removal of Indeterminacy membership

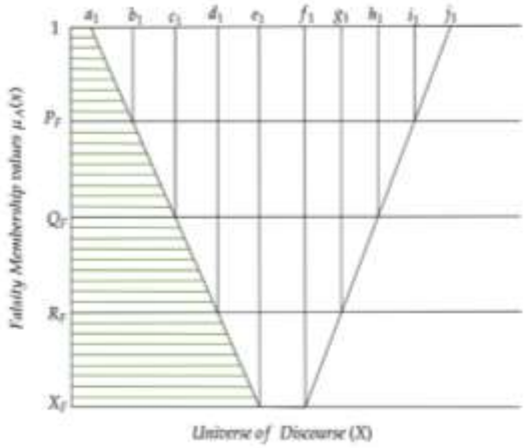

Figure 5: Right side area removal of Indeterminacy

$$\underline{A}_{Decaneu}\left(\underline{T_l},0\right)=\frac{1}{2}\left\{\frac{(a_{10}+b_{10})}{2}(1-\ \Omega_{\tilde{I}})+\frac{(b_{10}+c_{10})}{2}(1-\ \Omega_{\tilde{I}})+\frac{(c_{10}+d_{10})}{2}(1-\ \Omega_{\tilde{I}})+\frac{(d_{10}+e_{10})}{2}(\ \Omega_{\tilde{I}})+\frac{(e_{10}+f_{10})}{2}(1)\right\}$$

$$\underline{A}_{Decaneu}\left(\underline{T_r},0\right)=\frac{1}{2}\left\{\frac{(e_{10}+f_{10})}{2}(1)+\frac{(f_{10}+g_{10})}{2}(\ \Omega_{\tilde{I}})+\frac{(g_{10}+h_{10})}{2}(1-\ \Omega_{\tilde{I}})+\frac{(h_{10}+i_{10})}{2}(1-\ \Omega_{\tilde{I}})+\frac{(i_{10}+j_{10})}{2}(1-\ \Omega_{\tilde{I}})\right\}$$

$$\underline{A}_{Decaneu}(\underline{T},0)=\frac{1}{4}[(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})(1-\ \Omega_{\tilde{I}})+(d_{10}+e_{10}+f_{10}+g_{10})\ \Omega_{\tilde{I}}]+2(e_{10}+f_{10})$$

$$\underline{A}_{Decaneu}\left(\underline{P_l},0\right)=\frac{1}{2}\left\{\frac{(a_{10}+b_{10})}{2}(1-X_{\tilde{F}})+\frac{(b_{10}+c_{10})}{2}(1-X_{\tilde{F}})+\frac{(c_{10}+d_{10})}{2}(1-X_{\tilde{F}})+\frac{(d_{10}+e_{10})}{2}(X_{\tilde{F}})+\frac{(e_{10}+f_{10})}{2}(1)\right\}$$

$$\underline{A}_{Decaneu}\left(\underline{P_r},0\right)=\frac{1}{2}\left\{\frac{(e_{10}+f_{10})}{2}(1)+\frac{(f_{10}+g_{10})}{2}(X_{\tilde{F}})+\frac{(g_{10}+h_{10})}{2}(1-X_{\tilde{F}})+\frac{(h_{10}+i_{10})}{2}(1-X_{\tilde{F}})+\frac{(i_{10}+j_{10})}{2}(1-X_{\tilde{F}})\right\}$$

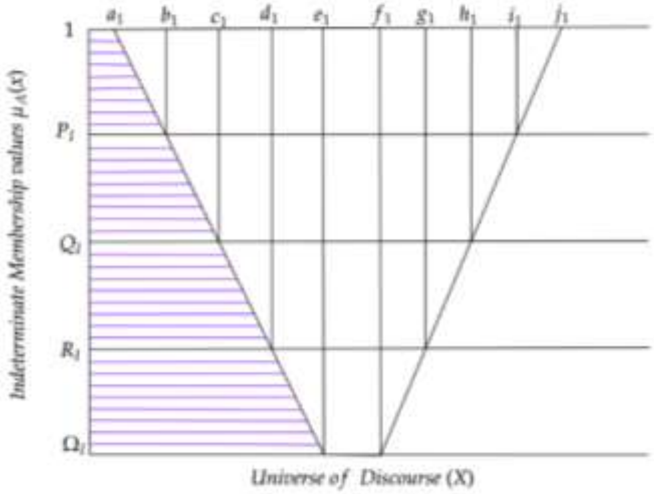

Figure 5: Right side area removal of Falsity

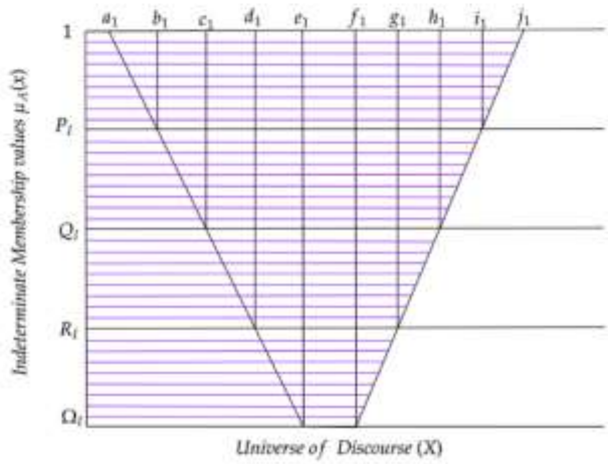

Figure 6: left side area removal of Falsity membership

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$$\underline{A}_{Decaneu}(\underline{P},0)=\frac{1}{4}[(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})(1-X_F)+(d_{10}+e_{10}+f_{10}+g_{10})X_F]+2(e_{10}+f_{10})$$

The score function of the Special Single Valued Linear Decagonal Neutrosophic Number

$$\underline{A}_{Decaneu}=<[(a_{10},b_{10},c_{10},d_{10},e_{10},f_{10},g_{10,}h_{10},i_{10},j_{10});\Psi_T,\Omega_I,X_F]>$$

$$\underline{A}_{neu}=\frac{(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})\Psi_{\tilde{T}}+(d_{10}+e_{10}+f_{10}+g_{10})(1-\Psi_{\tilde{T}})+(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})(1-\Omega_{\tilde{I}})+(d_{10}+e_{10}+f_{10}+g_{10})\Omega_{\tilde{I}}+(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})(1-X_{\tilde{F}})+(d_{10}+e_{10}+f_{10}+g_{10})X_{\tilde{F}}+6(d_{10}+e_{10})}{32}$$

Where $\Theta_{A_{Decneu}}:R\to[0,\Psi_{\tilde{T}}]$ where $\Psi_{\tilde{T}}$ is weighted average for the truth membership function. $\Phi_{A_{Decneu}}=R\to[\Omega_{\tilde{I}},1]$ where $\Omega_{\tilde{I}}$ is weighted average for the Indeterminate membership function $\psi_{A_{Decneu}}=R\to[\Xi_{\tilde{F}},1]$ where $\Xi_{\tilde{F}}$ is weighted average for the Falsehood membership function.

The score value of the special single valued linear decagonal Neutrosophic number

De-Neutrosophication Formula

Rewriting the formula as:

$$\alpha_{neu}=(a_{10}+2b_{10}+2c_{10}+d_{10}+g_{10}+2h_{10}+2i_{10}+j_{10})$$

$$\beta_{neu}=(d_{10}+e_{10}+f_{10}+g_{10})$$

$$\gamma_{neu}=6(d_{10}+e_{10})$$

$$\tilde{A}_{neu}=\frac{\alpha_{neu}(\Psi_{\tilde{T}})+\beta_{neu}(1-\Psi_{\tilde{T}})+\alpha_{neu}(1-\Omega_{\tilde{I}})+\beta_{neu}(\Omega_{\tilde{I}})+\alpha_{neu}(1-\Xi_{\tilde{F}})+\beta_{neu}(\Xi_{\tilde{F}})+\gamma_{neu}}{32}$$

4. Illustrative example

A. Neutrosophic edge weight of network problem

Problem to find the critical path of given Neutrosophic environment.

Table 1: Network path edges of Neutrosophic number

Activity	Duration (days)
0-1	$<(0.5,1,1.5,2,2.5,3,3.5,4,4.5,5)0.93,0.67,0.32>$
1-2	$<(5.5,6,6.5,7,7.5,8,8.5,9,9.5,10)0.85,0.62,0.43>$
1-3	$<(9.5,10,10.5,11,11.5,12,12.5,13,13.5,14)0.73,0.55,0.33>$
2-4	$<(3.5,4,4.5,5,5.5,6,6.5,7,7.5,8)0.75,0.63,0.27>$
2-5	$<(0.5,1,1.5,2,2.5,3,3.5,4,4.5,5);0.87,0.54,0.33>$
3-4	$<(0.5,1,1.5,2,2.5,3,3.5,4,4.5,5);0.86,0.52,0.21>$
3-6	$<(5.5,6,6.5,7,7.5,8,8.5,9,9.5,10);0.71,0.54,0.23>$
4-7	$<(3,3.5,4,4.5,5,5.5,6,6.5,7,7.5);0.67,0.47,0.28>$
5-7	$<(0.5,1,1.5,2,2.5,3,3.5,4,4.5,5);0.85,0.57,0.35>$
6-7	$<(5.5,6,6.5,7,7.5,8,8.5,9,9.5,10);0.75,0.53,0.25>$

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Using the formula of de-Neutrosophication the special single valued Decagonal Neutrosophic number is converted into a crisp value to calculate the critical path of the network diagram.

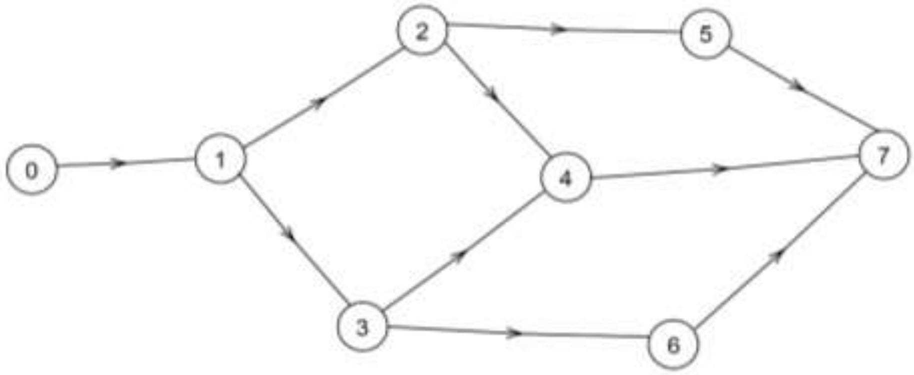

Figure 8: network diagram with special single valued Decagonal Neutrosophic number as edge weight

Calculations:

For the edge 0-1

$$< (0.5,1,1.5,2,2.5,3,3.5,4,4.5,5)0.93,0.67,0.32 >$$

Using the De-Neutrosophication formula

$$\alpha_{neu} = (0.5 + 2(1) + 2(1.5) + 2 + 3.5 + 2(4) + 2(4.5) + 5)$$

$$= 33$$

$$\beta_{neu} = (2 + 2.5 + 3 + 3.5)$$

$$= 10$$

$$\gamma_{neu} = 6(2 + 2.5)$$

$$= 27$$

$$\tilde{A}_{naneu} = \frac{33(0.93) + 10(1 - 0.93) + 33(1 - 0.67) + 10(0.67) + 33(1 - 0.32) + 10(0.32) + 27}{32}$$

$$= \frac{101.62}{32}$$

$$= 3.1756$$

Table 2: Crisp value of Neutrosophic number

Edges	**Crisp value**
0-1	3.1756
1-2	8.4806
1-3	12.787
2-4	6.784
3-4	3.333
2-5	3.25
3-6	9.558
4-7	5.865
5-7	3.246
6-7	9.4806

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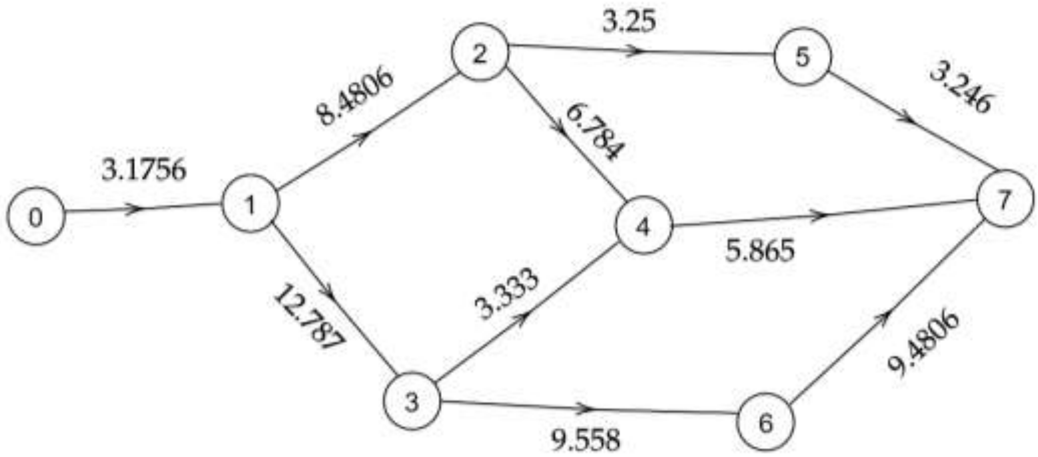

Figure 9: network diagram after the De-Neutrosophication of the Neutrosophic number

The possible path for this network
⓪①②⑤⑦ → 3.1756+8.4806+3.25+3.246 = 18.1522
⓪①②④⑦ → 3.1756+8.4806+6.784+5.865 = 24.3052
⓪①③④⑦ → 3.1756+12.787+3.333+5.865 = 25.1576
⓪①③⑥⑦ → 3.1756+12.787+9.558+9.4806 = 35.0012
The critical path for the given network is given by ⓪①③⑥⑦ with weight 18.1522

6. Conclusion

Neutrosophic environment determines the indeterminacy of the problem and the paper discusses about the Special Linear Decagonal Neutrosophic number and the crisp value is determined by applying the removal area method. A network path edges problem is solved using Neutrosophic number. In future this can be extended into hesitant Neutrosophic set, Bipolar Neutrosophic Environment.

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Conflicts of Interest: “The authors declare no conflict of interest.”

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