Shortest Path On Interval- Valued Triangular Neutrosophic Fuzzy Graphs With Application

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Abstract

In this article, inaugurate interval-valued triangular neutrosophic fuzzy graph (IVTNFG) of SPP, which is drew on three-sided numbers and IVTNFG. Hear a genuine application is given an illustrative model for IVTNFG. Additionally Shortest way is determined for this model. This present Dijkstra's Algorithm briefest way was checked through Python Jupiter Notebook (adaptation) programming.

Keywords: Interval-valued fuzzy number (IVFN), Triangular fuzzy number (TFN), shortest path (SP).

I. INTRODUCTION

J.Ye introduced decision making Neural Computing and Applications. [10] and ye[34] trapezoidal fuzzy numbers are applied rather than triangular fuzzy numbers Chiranjbe jana [11] extended interval trapezoidal neutrosophic set and define trapezoidal, triangular neutrosophic score and accuracy function. Lakshmana gomathi nayagam velu [36] extended ranking function of fuzzy numbers and discussed principles of ranking functions. . C.Jana [37] applied for trapezoidal interval-valued trapezoidal neutrosophic sets and discussed weighted arithmetic operator.

Section III, introduced some basic concepts related to definitions. Section IV, introduced IVTNFG proposed algorithm and find SPP using that proposed algorithm. Section V, we apply real life application. The application has world seven wonders and find its SPP using IVTNFG proposed algorithm. Section VI, used Python Jupyter Notebook (version) programming, verified shortest path on seven wonders with Dijkstra’s algorithm. Conclusion is given in section VII.

II. LITERATURE REVIEW

The creators of, Ahuja R K [1] examined systematic execution of Dijkstra's calculation. Yang C D [2] introduced rectangular hindrance subject to various improvement capacities regarding the quantity of curves. Arsham H [3] introduced another crucial arrangement calculation which permits affectability examination without utilizing any counterfeit, slack or surplus factors. Broumi S [4] tackled the most limited way issue utilizing Dijksta's calculation. Ye. J [5] presented neutrosophic hesistant fluffy sets. Broumi [6] proposed for extend esteemed neutrosophic number. Broumi S [7] presented neutrosophic charts with most limited way issues. Smarandache F [8] summed up the fluffy rationale and presented two neutrosophic ideas Wang H [9] contributed neutrosophic sets with their properties. J.Ye [10] proposed a Trapezoidal fluffy Neural Computing and Applications C.Jana [12] presented stretch esteemed trapezoidal neutrosophic set. Ojekudo Nathaniel akpofure [13] tended to the most brief way utilizing Dijkstra's calculation. Ye.J [14] developed of the Multi models dynamic strategy utilizing shape liking measure. Said broumi [15] processing the most brief way Neutrosophic Information . V. Anusuya [16] apply positioning capacity for briefest way issue. Victor christianto [17] gave a neutrosophic approach to futurology. P. K. De [18] Computation of Shortest Path in a fuzzy organization. A Nagoor Gani [19] looking intuitionistic fluffy most brief organization. P.Jayagowri [20] discover Optimized Path in a Network utilizing trapezoidal intuitionistic fluffy numbers. A.Kumar [21] proposed to tackling briefest way issue with edge weight. G.Kumar [22] introduced Algorithm for most limited way issue in an organization with span esteemed intuitionistic trapezoidal fluffy number. S Majumdar [23] introduced an intuitionistic fluffy most brief way organization. Xu, Z.S [24] introduced a strategies for amassing span esteemed intuitionistic fluffy data. Broumi S [25] proposed calculation gives Shortest way issue on single esteemed neutrosophic charts. Shop I [26]) apply positioning technique for single esteemed neutrosophic numbers and its applications. Enayattabar.M [27] introduced Dijkstra calculation for briefest way issue under Pythagorean fluffy climate Broumi [28] proposed the Shortest way under Bipolar Neutrosophic setting . Store I [29] presented single esteemed trapezoidal neutrosophic numbers with their properties. Kumar R [30] presented the SPP from an underlying hub to an objective hub on neutrosophic chart

.Broumi [31] gave the Shortest way issue under span esteemed neutrosophic setting. K.Kalaiarasi [32] introduced three-sided intuitionistic fluffy single esteemed neutrosophic edge weight. Said Broumi [33] built up another methodology an arrangement with neutrosophic SPP.Ye.J [34] presented a Prioritized aggregation operators of trapezoidal intuitionistic fuzzy sets and their application. P.K. De [35] study on ranking of trapezoidal intuitionistic fuzzy numbers.

Here, in this paperdisclosedthe briefest way to seven marvels utilized the proposed calculation.

III. PRELIMINARIES

Definition 2.1 [34]

Let $\bar{n}_1 = \langle [(t_a^L, t_b^L, t_c^L), (t_a^U, t_b^U, t_c^U)], [(i_a^L, i_b^L, i_c^L), (i_a^U, i_b^U, i_c^U)], [(f_a^L, f_b^L, f_c^L), (f_a^U, f_b^U, f_c^U)] \rangle$ and

$\bar{n}_2 = \langle [(T_a^L, T_b^L, T_c^L), (T_a^U, T_b^U, T_c^U)], [(I_a^L, I_b^L, I_c^L), (I_a^U, I_b^U, I_c^U)], [(F_a^L, F_b^L, F_c^L), (F_a^U, F_b^U, F_c^U)] \rangle$

Therefore the conditionsare ,

(1) $$\bar{n}_1 \oplus \bar{n}_2 = \langle [(t_a^L + T_a^L - t_a^L T_a^L, t_b^L + T_b^L - t_b^L T_b^L, t_c^L + T_c^L - t_c^L T_c^L), (t_a^U + T_a^U - t_a^U T_a^U, t_b^U + T_b^U - t_b^U T_b^U, t_c^U + T_c^U - t_c^U T_c^U)], [(i_a^L I_a^L, i_b^L I_b^L, i_c^L I_c^L), (i_a^U I_a^U, i_b^U I_b^U, i_c^U I_c^U)], [(f_a^L F_a^L, f_b^L F_b^L, f_c^L F_c^L), (f_a^U F_a^U, f_b^U F_b^U, f_c^U F_c^U)] \rangle$$

(2) $$\bar{n}_1 \otimes \bar{n}_2 = < [(t_a^L T_a^L, t_b^L T_b^L, t_c^L T_c^L), (t_a^U T_a^U, t_b^U T_b^U, t_c^U T_c^U)], [(i_a^L + I_a^L - i_a^L I_a^L, i_b^L + I_b^L - i_b^L I_b^L, i_c^L + I_c^L - i_c^L I_c^L) (i_a^U + I_a^U - i_a^U I_a^U, i_b^U + I_b^U - i_b^U I_b^U, i_c^U + I_c^U - i_c^U I_c^U)], [(f_a^L + F_a^L - f_a^L F_a^L, f_b^L + F_b^L - f_b^L F_b^L, f_c^L + F_c^L - f_c^L F_c^L), (f_a^U + F_a^U - f_a^U F_a^U, f_b^U + F_b^U - f_b^U F_b^U, f_c^U + F_c^U - f_c^U F_c^U)] >$$

(3) $$\lambda \bar{n}_1 = < [((1-(1-t_a^L)^\lambda, (1-(1-t_b^L)^\lambda, (1-(1-t_c^L)^\lambda), ((1-(1-t_a^U)^\lambda, (1-(1-t_b^U)^\lambda, (1-(1-t_c^U)^\lambda)], [((i_a^L)^\lambda, (i_b^L)^\lambda, (i_c^L)^\lambda), ((i_a^U)^\lambda, (i_b^U)^\lambda, (i_c^U)^\lambda)], [((f_a^L)^\lambda, (f_b^L)^\lambda, (f_c^L)^\lambda), ((f_a^U)^\lambda, (f_b^U)^\lambda, (f_c^U)^\lambda)] >$$

(4) for $\lambda > 0$.

$$\bar{n}_1^\lambda = < [(((t_a^L)^\lambda, (t_b^L)^\lambda, (t_c^L)^\lambda), ((t_a^U)^\lambda, (t_b^U)^\lambda, (t_c^U)^\lambda)], [((1-(1-i_a^L)^\lambda, (1-(1-i_b^L)^\lambda, (1-(1-i_c^L)^\lambda), ((1-(1-i_a^U)^\lambda, (1-(1-i_b^U)^\lambda, (1-(1-i_c^U)^\lambda)], [((1-(1-f_a^L)^\lambda, (1-(1-f_b^L)^\lambda, (1-(1-f_c^L)^\lambda), ((1-(1-f_a^U)^\lambda, (1-(1-f_b^U)^\lambda, (1-(1-f_c^U)^\lambda)] >$$

(5) for $\lambda \geq 0$.

Definition 2.2[34]

Assume $\bar{n}_1 = \langle [(t_a^L, t_b^L, t_c^L, t_d^L), (t_a^U, t_b^U, t_c^U, t_d^U)], [(i_a^L, i_b^L, i_c^L, i_d^L), (i_a^U, i_b^U, i_c^U, i_d^U)], [(f_a^L, f_b^L, f_c^L, f_d^L), (f_a^U, f_b^U, f_c^U, f_d^U)] \rangle$ score functions of trapezoidal neutrosophic number defined as

$$S(\bar{n}) = \left(\frac{t_a^U + t_b^U + t_c^U + t_d^U}{4} + \frac{t_a^L + t_b^L + t_c^L + t_d^L}{4} \right) + \left(\frac{i_a^U + i_b^U + i_c^U + i_d^U}{4} - \frac{i_a^L + i_b^L + i_c^L + i_d^L}{4} \right) + \left(\frac{f_a^U + f_b^U + f_c^U + f_d^U}{4} - \frac{f_a^L + f_b^L + f_c^L + f_d^L}{4} \right), \quad S(\bar{n}) \in [-1, 1], \text{ ----------------- } (1)$$

Here $t_b^L = t_c^L$, $t_b^U = t_c^U$, $i_b^L = i_c^L$, $i_b^U = i_c^U$, $f_b^L = f_c^L$ and $f_b^U = f_c^U$ hold in an IVTrNN $\bar{n}$ in Equation (1), then Equation (1) reduce to interval triangular neutrosophic number

$$S(\bar{n}) = \left(\frac{t_a^U + 2t_b^U + t_c^U}{4} + \frac{t_a^L + 2t_b^L + t_c^L}{4}\right) + \left(\frac{i_a^U + 2i_b^U + i_c^U}{4} - \frac{i_a^L + 2i_b^L + i_c^L}{4}\right) + \left(\frac{f_a^U + 2f_b^U + f_c^U}{4} - \frac{f_a^L + 2f_b^L + f_c^L}{4}\right),\ S(\bar{n}) \in [-1,\ 1], \quad (2)$$

Definition 2.3[34]

Assume $\bar{n}_1 = \left\langle [(t_a^L, t_b^L, t_c^L), (t_a^U, t_b^U, t_c^U)], [(i_a^L, i_b^L, i_c^L), (i_a^U, i_b^U, i_c^U)], [(f_a^L, f_b^L, f_c^L), (f_a^U, f_b^U, f_c^U)] \right\rangle$ an accuracy functions of an IVTrNN defined as

$$H(\bar{n}) = \left(\frac{t_a^U + t_b^U + t_c^U}{3} + \frac{t_a^L + t_b^L + t_c^L}{3}\right) + \left(\frac{f_a^U + f_b^U + f_c^U}{3} - \frac{f_a^L + f_b^L + f_c^L}{3}\right),\ H(\bar{n}) \in [0,\ 1], \quad (3)$$

When $t_b^L = t_c^L$, $t_b^U = t_c^U$, $i_b^L = i_c^L$, $i_b^U = i_c^U$, $f_b^L = f_c^L$ and $f_b^U = f_c^U$, Equation (3) reduce to accuracy function of an interval triangular neutrosophic number as

$$H(\bar{n}) = \left(\frac{t_a^U + 2t_b^U + t_c^U}{4} + \frac{t_a^L + 2t_b^L + t_c^L}{4}\right) + \left(\frac{f_a^U + 2f_b^U + f_c^U}{4} - \frac{f_a^L + 2f_b^L + f_c^L}{4}\right),$$

$$H(\bar{n}) \in [0,\ 1], \quad (4)$$

IV. ALGORITHM AND ILLUSTRATIVE EXAMPLE

Step 1 Assume $d_1 = \langle [(0,0,0),\ (0,0,0)],\ [(1,1,1),(1,1,1)], [(1,1,1),\ (1,1,1)] \rangle$ and the source node as $\lfloor d_1 = \langle [\ (0,0,0),\ (0,0,0)\ ], [\ (1,1,1),(1,1,1)], [\ (1,1,1),(1,1,1)\ ] \rangle \rfloor$.

Step: 2 Find $d_j =$ minimum $\{d_i \oplus d_{ij}\};\ j = 2,3,.......n.$

Step : 3 If more than one value of source node and the node j, we find d_j through minimum value of i.

Step: 4 If we finds score function through we calculate source node d_n.

Step: 5 Replicate step 2 and step 3 until the node is acquire.

Step: 6 joined all the nodes by the above steps, we have finally get Shortest path.

ILLUSTRATIVE EXAMPLE

We find shortest path of IVTNFG through above procedure

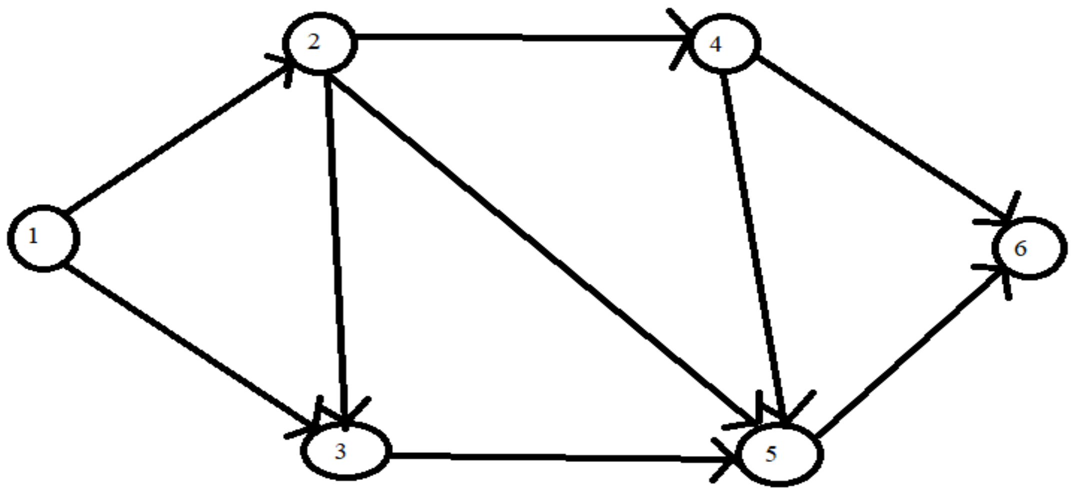


Fig 1: IVTNFG

Edges	**Interval-valued triangular neutrosophic fuzzy numbers**
$1-2$	< [(0.05, 0.06, 0.09), (0.17, 0.25, 0.38)], [(0.05, 0.15, 0.2), (0.12, 0.18, 0.38)], [(0.12, 0.26, 0.32), (0.04, 0.11, 0.15)] >
$1-3$	< [(0.02, 0.03, 0.05), (0.2, 0.3, 0.4)], [(0.05, 0.06, 0.09), (0.16, 0.26, 0.38)] [(0.07, 0.13, 0.2), (0.14, 0.19, 0.27)] >
$2-3$	<[(0.07, 0.11, 0.12), (0.12, 0.23, 0.35)], [(0.05, 0.13, 0.22), (0.14, 0.21, 0.25)], [(0.07, 0.16, 0.27), (0.02, 0.19, 0.29)] >
$2-4$	<[(0.03, 0.06, 0.11), (0.13, 0.26, 0.41)], [(0.04, 0.12, 0.14), (0.15, 0.23, 0.32)], [(0.07, 0.18, 0.35), (0.02, 0.13, 0.25)] >
$2-5$	<[(0.09, 0.17, 0.34), (0.03, 0.11, 0.26)], [(0.12, 0.23, 0.35), (0.06, 0.09, 0.15)], [(0.14, 0.28, 0.38), (0.02, 0.06, 0.12)] >
$3-5$	<[(0.01, 0.07, 0.32), (0.12, 0.17, 0.31)], [(0.09, 0.21, 0.4), (0.07, 0.1, 0.13)], [(0.17, 0.25, 0.48), (0.01, 0.03, 0.06)] >
$4-5$	<[(0.01, 0.03, 0.06), (0.12, 0.29, 0.49)], [(0.07, 0.13, 0.2), (0.12, 0.22, 0.26)], [(0.09, 0.16, 0.35), (0.05, 0.12, 0.23)] >
$4-6$	<[(0.04, 0.09, 0.17), (0.16, 0.23, 0.31)], [(0.08, 0.14, 0.28), (0.07, 0.16, 0.27)], [(0.15, 0.21, 0.34), (0.06, 0.09, 0.15)] >
$5-6$	<[(0.07, 0.12, 0.21), (0.12, 0.17, 0.31)], [(0.14, 0.27, 0.39), (0.05, 0.06, 0.09)], [(0.17, 0.29, 0.44), (0.02, 0.03, 0.05)] >

Table 1:IVTNF edge weight.

$d_1 = \langle [(0,0,0),\ (0,0,0)],\ [(1,1,1),(1,1,1)], [(1,1,1),\ (1,1,1)] \rangle$, label of source node is $\{\langle [(0,0,0),\ (0,0,0)],\ [(1,1,1),(1,1,1)], [(1,1,1),\ (1,1,1)] \rangle, --\}$ the value of $d_j,\ \ j = 2,3,4,5,6$ is consecutive.

Iteration 1:

Assume $i = 1$ and $j = 2$ we proceed step 2

$d_2 = \min\{d_1 \oplus d_{12}\}$

Smallest value $i = 1$, parallel to label node 2

$$= \left\{ \begin{array}{l} <[(0.05, 0.06, 0.09), (0.17, 0.25, 0.38)], [(0.05, 0.15, 0.2), (0.12, 0.18, 0.3)], \\ [(0.12, 0.26, 0.32), (0.04, 0.11, 0.15)] >, 1 \end{array} \right\}$$

$$d_2 = \left\{ \begin{array}{l} <[(0.05, 0.06, 0.09), (0.17, 0.25, 0.38)], [(0.05, 0.15, 0.2), (0.12, 0.18, 0.3)], \\ [(0.12, 0.26, 0.32), (0.04, 0.11, 0.15)] > \end{array} \right\}$$

Iteration 2:

Assume $i = 1, 2$ and $j = 3$ we proceed step 2.

$d_3 = \min\{d_1 \oplus d_{13},\ d_2 \oplus d_{23}\}$

$$= \text{minimum} \left\{ \begin{array}{l} <[(0.02, 0.03, 0.05), (0.2, 0.3, 0.4)], [(0.05, 0.06, 0.09), (0.16, 0.26, 0.38)], \\ [(0.07, 0.13, 0.2), (0.14, 0.19, 0.27)] >, <[(0.12, 0.16, 0.2), (0.27, 0.42, 0.59)], \\ [(0.002, 0.02, 0.04), (0.02, 0.04, 0.08)], [(0.01, 0.04, 0.09), (0.001, 0.02, 0.04)] > \end{array} \right\}$$

$$S\left\{ \begin{array}{l} <[(0.02, 0.03, 0.05), (0.2, 0.3, 0.4)], [(0.05, 0.06, 0.09), (0.16, 0.26, 0.38)], \\ [(0.07, 0.13, 0.2), (0.14, 0.19, 0.27)] > \end{array} \right\}$$

Using equation(1),we have

$S(\bar{n}_1) = 0.6$

$$S\left\{ \begin{array}{l} <[(0.12, 0.16, 0.2), (0.27, 0.42, 0.59)], [(0.002, 0.02, 0.04), (0.02, 0.04, 0.08)], \\ [(0.01, 0.04, 0.09), (0.001, 0.02, 0.04)] > \end{array} \right\}$$

$S(\bar{n}_2) = 0.59$

Here, minimum value $i = 2$, parallel to label node 3 as

$$\left\{ \begin{array}{l} <[(0.12, 0.16, 0.2), (0.27, 0.42, 0.59)], [(0.002, 0.02, 0.04), (0.02, 0.04, 0.08)], \\ [(0.01, 0.04, 0.09), (0.001, 0.02, 0.04)] >, 2 \end{array} \right\}$$

$$d_3 = \left\{ \begin{array}{l} <[(0.12, 0.16, 0.2), (0.27, 0.42, 0.59)], [(0.002, 0.02, 0.04), (0.02, 0.04, 0.08)], \\ [(0.01, 0.04, 0.09), (0.001, 0.02, 0.04)] > \end{array} \right\}$$

Iteration 3:

Assume $i = 2$ and $j = 4$ we proceedstep 2 .

$d_4 = \min\{d_2 \oplus d_{24}\}$

Smallest value $i = 2$, parallel to label node 4 as

$$= \left\{ \begin{array}{l} <[(0.08, 0.12, 0.19), (0.28, 0.45, 0.63)], [(0.002, 0.018, 0.028), (0.018, 0.04, 0.096)], \\ [(0.008, 0.05, 0.112), (0.0008, 0.0143, 0.0375)] >, 2 \end{array} \right\}$$

$$d_4 = \left\{ \begin{array}{l} <[(0.08, 0.12, 0.19), (0.28, 0.45, 0.63)], [(0.002, 0.018, 0.028), (0.018, 0.04, 0.096)], \\ [(0.008, 0.05, 0.112), (0.0008, 0.0143, 0.0375)] > \end{array} \right\}$$

Iteration 4:

Assume $i = 2, 3, 4$ and $j = 5$ we proceed step 2 .

$d_5 = \min\{d_2 \oplus d_{25},\ d_3 \oplus d_{35}, d_4 \oplus d_{45}\}$

Here,

$S(\bar{n}_1) = 0.213$

$S(\bar{n}_2) = 0.782$

$S(\bar{n}_3) = 0.7511$

Here, smallest value $i = 2$, parallel to lable node 5 as

$$\left\{\begin{array}{l} <[(0.13, 0.22, 0.39), (0.19, 0.33, 0.54)], [(0.006, 0.03, 0.07), (0.007, 0.016, 0.045)], \\ [(0.016, 0.07, 0.12), (0.0008, 0.007, 0.018)]>, 2 \end{array}\right\}$$

$$d_5 = \left\{\begin{array}{l} <[(0.13, 0.22, 0.39), (0.19, 0.33, 0.54)], [(0.006, 0.03, 0.07), (0.007, 0.016, 0.045)], \\ [(0.016, 0.07, 0.12), (0.0008, 0.007, 0.018)]> \end{array}\right\}$$

Iteration 5:

Assume $i = 4, 5$ and $j = 6$ we proceed step 2.

$d_6 = \min\{ d_4 \oplus d_{46}, d_5 \oplus d_{56}\}$

$S(\bar{n}_1) = 0.773$

$S(\bar{n}_2) = 0.775$

Here, smallest value $i = 4$, parallel to label node 6 as

$$\left\{\begin{array}{l} <[(0.12, 0.19, 0.33), (0.39, 0.58, 0.74)], [(0.0002, 0.003, 0.008), (0.001, 0.006, 0.03)], \\ [(0.001, 0.01, 0.04), (0.00005, 0.001, 0.006)]>, 4 \end{array}\right\}$$

$$d_6 = \left\{\begin{array}{l} <[(0.12, 0.19, 0.33), (0.39, 0.58, 0.74)], [(0.0002, 0.003, 0.008), (0.001, 0.006, 0.03)], \\ [(0.001, 0.01, 0.04), (0.00005, 0.001, 0.006)]> \end{array}\right\}$$

$$\left\{\begin{array}{l} <[(0.12, 0.19, 0.33), (0.39, 0.58, 0.74)], [(0.0002, 0.003, 0.008), (0.001, 0.006, 0.03)], \\ [(0.001, 0.01, 0.04), (0.00005, 0.001, 0.006)]> \end{array}\right\}$$

To calculate shortest path started by labeled node 6 :

$$\left\{\begin{array}{l} <[(0.12, 0.19, 0.33), (0.39, 0.58, 0.74)], [(0.0002, 0.003, 0.008), (0.001, 0.006, 0.03)], \\ [(0.001, 0.01, 0.04), (0.00005, 0.001, 0.006)]>, 4 \end{array}\right\}$$

And , node 4 is labeled by

$$\left\{\begin{array}{l} <[(0.08, 0.12, 0.19), (0.28, 0.45, 0.63)], [(0.002, 0.018, 0.028), (0.018, 0.04, 0.096)], \\ [(0.008, 0.05, 0.112), (0.0008, 0.0143, 0.0375)]>, 2 \end{array}\right\}$$

Node 2 is labeled by

$$\left\{\begin{array}{l} <[(0.05, 0.06, 0.09), (0.17, 0.25, 0.38)], [(0.05, 0.15, 0.2), (0.12, 0.18, 0.3)], \\ [(0.12, 0.26, 0.32), (0.04, 0.11, 0.15)]>, 1 \end{array}\right\}$$

Joined all the labeled nodes , we have $1 \rightarrow 2 \rightarrow 4 \rightarrow 6.$

Node	d_i	**Interval-valued triangular fuzzy neutrosophic shortest path between j^{th} and 1^{st} node**
2	$[(0.05, 0.06, 0.09), (0.17, 0.25, 0.38)]$, $[(0.05, 0.15, 0.2), (0.12, 0.18, 0.3)]$, $[(0.12, 0.26, 0.32), (0.04, 0.11, 0.15)]$	$1 \rightarrow 2$
3	$[(0.12, 0.16, 0.2), (0.27, 0.42, 0.59)]$, $[(0.002, 0.02, 0.04), (0.02, 0.04, 0.08)]$, $[(0.01, 0.04, 0.09), (0.001, 0.02, 0.04)]$	$1 \rightarrow 2 \rightarrow 3$
4	$[(0.08, 0.12, 0.19), (0.28, 0.45, 0.63)]$, $[(0.002, 0.018, 0.028), (0.018, 0.04, 0.096)]$, $[(0.008, 0.05, 0.112), (0.0008, 0.0143, 0.0375)]$	$1 \rightarrow 2 \rightarrow 4$

5	[(0.13, 0.22, 0.39), (0.19, 0.33, 0.54)], [(0.006, 0.03, 0.07), (0.007, 0.016, 0.045)], [(0.016, 0.07, 0.12), (0.0008, 0.007, 0.018)]	1 → 2 → 5
6	[(0.12, 0.19, 0.33), (0.39, 0.58, 0.74)], [(0.0002, 0.003, 0.008), (0.001, 0.006, 0.03)], [(0.001, 0.01, 0.04), (0.00005, 0.001, 0.006)]	1 → 2 → 4 → 6

Table 2:IVTNF distance and shortest path

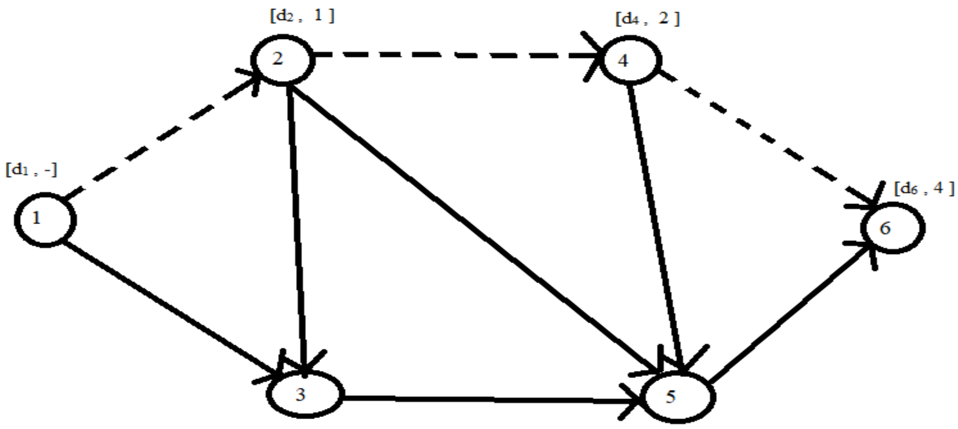


Fig 2: SPIVTNFG

V. ANALYSIS OF DATA: To find shortest path on seven wonders using interval-valued triangular neutrosophic fuzzy graph.

1.Machu picchu

2.Itza chichen

3. Christ the redeemer

4. Colosseum

5. Petra

6. Taj mahal

7. Great wall

Here we consider source node is machu picchu and destination node is great wall. To find shortest path on machu picchu to great wall.

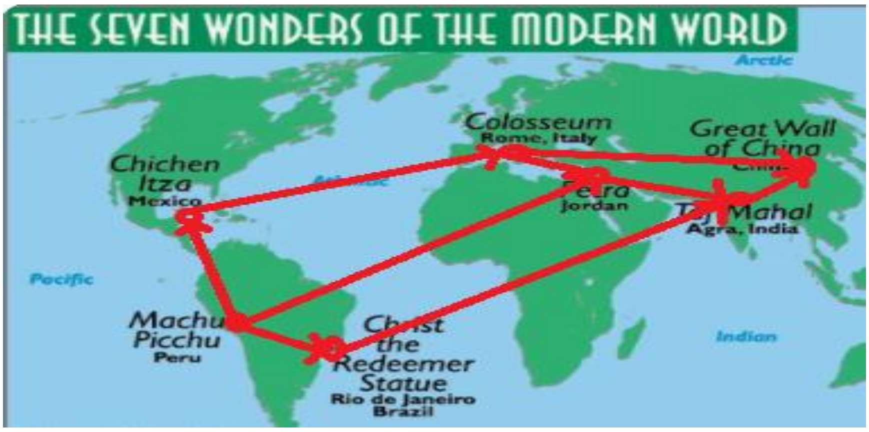


Fig 3 : A graph of seven wonders

Here distance between one wonder to another wonder is calculated in kilometers. The numerical value of the distance is converted to IVTNFG with the help of through triangular signed distance.

The given distance (kilometer) converted to triangular number. These triangular numbers are verified through signed distance $\frac{a_1 + 2a_2 + a_3}{4}$. Then these numbers (a_1, a_2, a_3) are converted to fuzzy number as $(a_1^{'}, a_2^{'}, a_3^{'})$. Here after the TFN converted to IVFN. Where $(a_1^{'}, a_2^{'}, a_3^{'})$ are membership function & $(a_1^{*}, a_2^{*'}, a_3^{*'})$ are non-membership function. Finally convert interval-valued triangular fuzzy number to interval-valued triangular neutrosophic fuzzy number (IVTNFN). The interval-valued triangular neutrosophic fuzzy number are

$$< [(a_{11}^{'}, a_{12}^{'}, a_{13}^{'}), (a_{11}^{*}, a_{12}^{*}, a_{13}^{*})], [(a_{21}^{'}, a_{22}^{'}, a_{23}^{'}), (a_{21}^{*}, a_{22}^{*}, a_{23}^{*})], [(a_{31}^{'}, a_{32}^{'}, a_{33}^{'}), (a_{31}^{*}, a_{32}^{*}, a_{33}^{*})] >$$

Here, Apply the IVTNFN in our algorithm to find shortest path to seven wonders.

Edges	Intuitionistic trapezoidal fuzzy neutrosophic numbers
$1-2$	$<[(0.32, 0.54, 0.76), (0.39, 0.46, 0.53)], [(0.18, 0.27, 0.36), (0.67, 0.73, 0.79)], [(0.07, 0.15, 0.23), (0.72, 0.85, 0.98)] >$

1 − 3	<[(0.65, 0.72, 0.79), (0.15, 0.28, 0.41)], [(0.22, 0.37, 0.52), (0.49, 0.63, 0.77)], [(0.12, 0.25, 0.38), (0.62, 0.75, 0.88)], >
1 − 5	<[(0.95, 0.97, 0.99), (0.01, 0.03, 0.05)], [(0.21, 0.33, 0.45), (0.48, 0.67, 0.86)], [(0.14, 0.26, 0.38), (0.59, 0.74, 0.89)], >
2 − 4	<[(0.65, 0.77, 0.89), (0.13, 0.23, 0.33)], [(0.29, 0.36, 0.43), (0.52, 0.64, 0.76)], [(0.07, 0.13, 0.19), (0.79, 0.87, 0.95)], >
3 − 6	<[(0.79, 0.88, 0.97), (0.05, 0.12, 0.19)], [(0.25, 0.32, 0.39), (0.52, 0.68, 0.84)], [(0.04, 0.14, 0.24), (0.78, 0.86, 0.94)], >
4 − 5	<[(0.63, 0.74, 0.85), (0.17, 0.26, 0.35)], [(0.39, 0.47, 0.55), (0.35, 0.53, 0.71)], [(0.06, 0.15, 0.24), (0.74, 0.85, 0.96)], >
4 − 7	<[(0.81, 0.85, 0.89), (0.02, 0.15, 0.28)], [(0.29, 0.37, 0.45), (0.52, 0.63, 0.74)], [(0.19, 0.24, 0.29), (0.59, 0.76, 0.93)], >
5 − 6	<[(0.65, 0.79, 0.93), (0.14, 0.21, 0.28)], [(0.25, 0.42, 0.59), (0.31, 0.58, 0.85)], [(0.09, 0.25, 0.41), (0.63, 0.75, 0.87)], >
6 − 7	<[(0.63, 0.77, 0.91), (0.14, 0.23, 0.32)], [(0.31, 0.44, 0.57), (0.37, 0.56, 0.75)], [(0.05, 0.21, 0.37), (0.64, 0.79, 0.94)], >

Table 1: Interval-valued triangular fuzzy neutrosophic edge weight.

Iteration: 0

Assume the initial value

$d_1 = \langle [(0,0,0),\ (0,0,0)],\ [(1,1,1), (1,1,1)], [(1,1,1),\ (1,1,1)] \rangle$. Here we assume d_1 is a wonder machu picchu.

Iteration: 1

In this iteration was calculated through proposed algorithm from the wonders machu picchu to itza chichen. The labeled node is itza chichen and minimum provided corresponding node is machu picchu.

Minimum Node	Labeled Node	Path Node
Machu pichu	Itza chichen	<[(0.32, 0.54, 0.76), (0.39, 0.46, 0.53)], [(0.18, 0.27, 0.36), (0.67, 0.73, 0.79)], [(0.07, 0.15, 0.23), (0.72, 0.85, 0.98)] >

Iteration: 2

The node Christ the redeemer was forerunner node of machu picchu. Here the labeled node is Christ the redeemer and the minimum provided corresponding node is machu picchu.

Minimum Node	Labeled Node	Path Node
Machu pichu	Christ the Redeemer	<[(0.65, 0.72, 0.79), (0.15, 0.28, 0.41)], [(0.22, 0.37, 0.52), (0.49, 0.63, 0.77)], [(0.12, 0.25, 0.38), (0.62, 0.75, 0.88)], >

Iteration: 3

The node Colosseum was one forerunner node of itza chichen. Here the labeled node is Colosseum and the minimum provided corresponding node is itza chichen.

Minimum Node	Labeled Node	Path Node
Itza chichen	Colosseum	<[(0.762, 0.894, 0.974), (0.469, 0.584, 0.685)], [(0.052, 0.097, 0.32), (0.348, 0.467, 0.6)], [(0.0049, 0.0195, 0.0437), (0.5688, 0.7395, 0.931)], >

Iteration: 4

The node Petra has two forerunner node, they are machu picchu and Colosseum.
IVTNSP is calculated to Petra from Machu picchu and Colosseum. Here, the labeled node is Petra and the minimum provided corresponding node is Machu picchu.

Minimum Node	Labeled Node	Path Node
Machu pichu	Petra	$<[(0.95, 0.97, 0.99), (0.01, 0.03, 0.05)], [(0.21, 0.33, 0.45), (0.48, 0.67, 0.86)], [(0.14, 0.26, 0.38), (0.59, 0.74, 0.89)], >$

Iteration: 5

The node Taj mahal has two forerunner node, they are Christ the Redeemer and Petra. IVTNSPis to Taj mahal from Christ the Redeemer and Petra. Here, the labeled node is Taj mahal and the minimum provided corresponding node is Petra.

Minimum Node	Labeled Node	Path Node
Petra	Taj mahal	$<[(0.9825, 0.9937, 0.9993), (0.1486, 0.2337, 0.316)], [(0.0525, 0.1386, 0.2655), (0.1488, 0.3886, 0.731)], [(0.0126, 0.065, 0.1558), (0.3717, 0.555, 0.7743)] >$

Iteration: 6

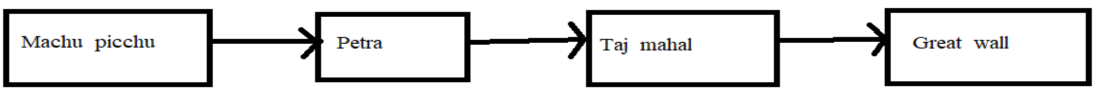
The node Great wall has two forerunner node , they are Colosseum and Taj mahal. IVTNSP is calculated to Great wall from Taj mahal and Colosseum. The labeled node is Great wall and the minimum provided corresponding node is Taj mahal.

Minimum Node	Labeled Node	Path Node
Taj mahal	Great wall	$<[(0.9935, 0.9985, 0.9999), (0.2678, 0.4099, 0.5349)], [(0.01627, 0.0609, 0.15133), (0.055, 0.2176, 0.54825)], [(0.00063, 0.0136, 0.0576), (0.2379, 0.43845, 0.7278)] >$

Since Great wall is the destination node. We calculate SP to destination node to source node. Since

Labeled Node	Minimum Node
Great wall	Taj mahal
Taj mahal	Petra
Petra	Machu picchu

Therefore the seven wonders interval-valued nether triangular neutrosophic fuzzy graph shortest path is



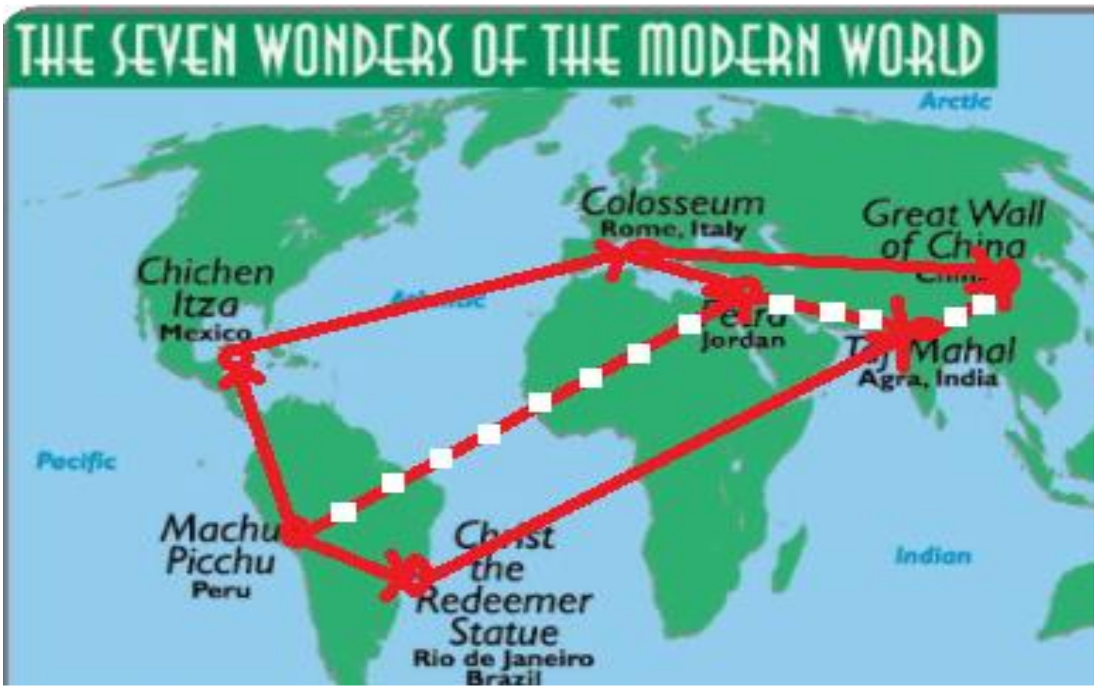


Fig 4 : SP from machu picchu to Great wall.

VI.SHORTEST PATH ON DIJKSTRA'S ALGORITHM

In the above real life application, we clarify another method of SPP using Dijkstra's algorithm. In this SPP, we use direct method of Dijkstra's algorithm and we assume edge weight is seven wonders km.

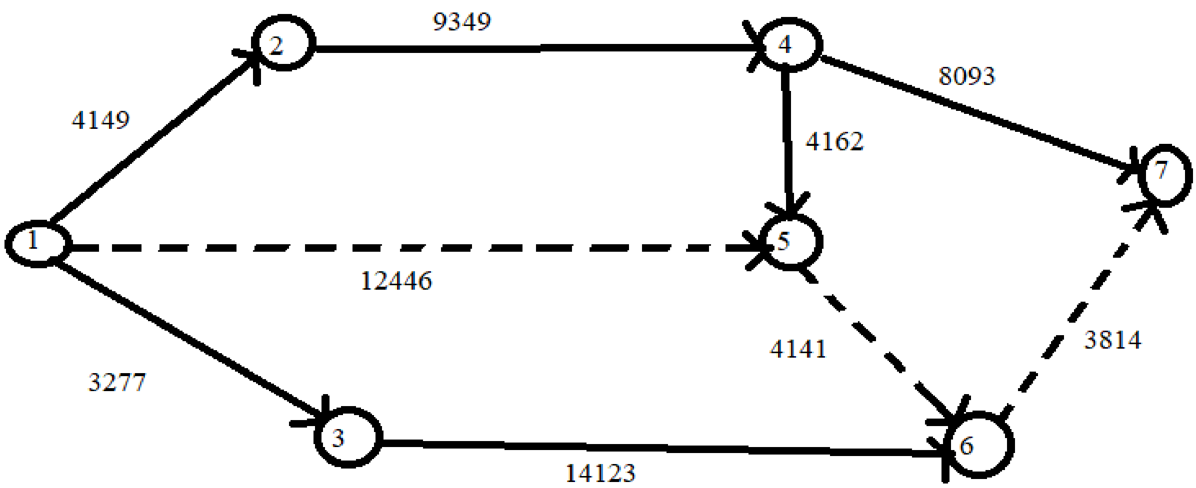


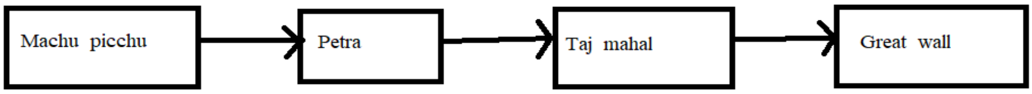
Fig 5 : SP for Dijkstra's Algorithm.

Here, we verify seven wonders shortest path through Dijkstra's Algorithm. We have the paths are

$$1 \rightarrow 5 \rightarrow 6 \rightarrow 7$$

Here these two paths interval-valued triangular neutrosophic fuzzy graphs and Dijkstra's Algorithm are same. The shortest path is

$$1 \rightarrow 5 \rightarrow 6 \rightarrow 7$$



DIJKSTRA'S ALGORITHM PYTHON PROGRAM

```
import sys

def to_be_visited():
   global visited_and_distance
   v = -10

   for index in range(number_of_vertices):
      if visited_and_distance[index][0] == 0 and (v < 0 or visited_and_distance[index][1] <=
visited_and_distance[v][1]):
         v = index
   return v

vertices = [[0,1,1,0,1,0,0],
         [0,0,0,1,0,0,0],
         [0,0,0,0,0,1,0],
         [0,0,0,0,1,0,1],
         [0,0,0,0,0,1,0],
         [0,0,0,0,0,0,1],
         [0,0,0,0,0,0,0]]
edges =  [[0,4149,3277,0,12446,0,0],
         [0,0,0,9349,0,0,0],
         [0,0,0,0,0,14123,0],
         [0,0,0,0,4162,0,8093],
         [0,0,0,0,0,4141,0],
         [0,0,0,0,0,0,3814],
         [0,0,0,0,0,0,0]]

number_of_vertices = len(vertices[0])

visited_and_distance = [[0, 0]]
for i in range(number_of_vertices-1):
   visited_and_distance.append([0, sys.maxsize])
for vertex in range(number_of_vertices):

      to_visit = to_be_visited()
   for neighbor_index in range(number_of_vertices):
    if vertices[to_visit][neighbor_index] == 1 and visited_and_distance[neighbor_index][0] == 0:
         new_distance = visited_and_distance[to_visit][1] + edges[to_visit][neighbor_index]

         if visited_and_distance[neighbor_index][1] > new_distance:
            visited_and_distance[neighbor_index][1] = new_distance
   visited_and_distance[to_visit][0] = 1

i = 0

for distance in visited_and_distance:
     print("The shortest distance of ",chr(ord('a') + i), " from the source vertex a is:",distance[1])
     i = i + 1
```

Output for the above program

The shortest distance of a from the source vertex a is: 0
The shortest distance of b from the source vertex a is: 4149
The shortest distance of c from the source vertex a is: 3277
The shortest distance of d from the source vertex a is: 13498
The shortest distance of e from the source vertex a is: 12446
The shortest distance of f from the source vertex a is: 16587
The shortest distance of g from the source vertex a is: 20401

VII CONCLUSION

In this article, discovering SP on span esteemed three-sided neutrosophic fluffy chart. A genuine application is given to act as an illustration of IVTNFG. The most brief way was determined for this IVTNFG utilizing IVTNFGSPP calculation. At long last Python Jupyter Notebook (form) programming checked most brief way on seven marvels with Dijkstra'algorithm.

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