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SHORTEST PATH ON INTUITIONISTIC TRIANGULAR NEUTROSOPHIC FUZZY GRAPHS WITH APPLICATION

R.Divya

Assistant Professor, PG and Research Department of Mathematics,
Cauvery College for Women (Autonomous),
Affiliated to Bharathidasan University,
Trichy-18, Tamil Nadu, India.

Abstract

In this article, Intuitionistic Triangular Neutrosophic Fuzzy Graph of Shortest Path Problem was Inaugurated, which is drew on triangular numbers and Intuitionistic Neutrosophic Fuzzy Graph. Real-world application is given as an illustrative model for Intuitionistic Triangular Neutrosophic Fuzzy Graph. Here we introduced famous chola period temples. These types of temples builted in various king of cholas. Here we assume only seven types of temples as vertices of Intuitionistic Triangular Neutrosophic Fuzzy Graph. Use of fuzzification method, edge weights of this Graph was calculated. Score function of Intuitionistic Triangular Neutrosophic Fuzzy Graph is inaugurated, with the help of this score function in the proposed algorithm, shortest way is determined.. This present Chola period temples Shortest Path Problem. Obtained shortest path is verified through Dijkstra's Algorithm with the help of Python Jupyter Notebook (adaptation) programming.

Keywords

Intuitionistic fuzzy number (IFN), Triangular fuzzy number (TFN), Shortest path (SP), Intuitionistic Triangular Neutrosophic Fuzzy Graph(ITNFG).

1. INTRODUCTION

The creators of, Ahuja [1] examined systematic execution of Dijkstra's calculation. Arsham [2] introduced another crucial arrangement calculation which permits affectability examination without utilizing any counterfeit, slack or surplus factors. Anusuya [3] apply positioning capacity for briefest way issue. Broumi [4] proposed for extend esteemed neutrosophic number. Broumi [5] presented neutrosophic charts with most limited way issues. Broumi [6] proposed calculation gives Shortest way issue on single esteemed neutrosophic charts. Broumi [7] proposed the Shortest way under Bipolar Neutrosophic setting. Broumi [8] gave the Shortest way issue under span esteemed neutrosophic setting. Chiranjibe Jana [9] Presented Trapezoidal neutrosophic aggregation operators and its application in multiple attribute decision making process. De [10] Computation of Shortest Path in a fuzzy organization. De [11] study on ranking of trapezoidal intuitionistic fuzzy numbers. Enayattabar [12] introduced Dijkstra calculation for briefest way issue under Pythagorean fuzzy climate. Jana

[13] presented stretch esteemed trapezoidal neutrosophic set. Jayagowri [14] discover Optimized Path in a Network utilizing trapezoidal intuitionistic fuzzy numbers. Kalaiarasi [15] determine Shortest Path On Intuitionistic Trapezoidal Neutrosophic Fuzzy Graphs With Application Kalaiarasi [16] determine The Shortest Path Problem On India Famous Seven Tourist Place with Dijkstra's Algorithm in Interval-Valued Intuitionistic Triangular Neutrosophic Fuzzy Graphs. Kumar [17] proposed to tackling briefest way issue with edge weight. Kumar [18] introduced Algorithm for most limited way issue in an organization with span esteemed intuitionistic trapezoidal fuzzy number. Kumar [19] presented the SPP from an underlying hub to an objective hub on neutrosophic chart . Majumdar [20] introduced an intuitionistic fuzzy most brief way organization. Nagoor Gani [21] looking intuitionistic fuzzy most brief organization. Ojekudo Nathaniel akpofure [22] tended to the most brief way utilizing Dijkstra's calculation. Said broumi [23] processing the most brief way Neutrosophic Information. Smarandache [24] summed up the fuzzy rationale and presented two neutrosophic ideas. Victor christianto [25] gave a neutrosophic approach to futurology. Wang [26] contributed neutrosophic sets with their properties. Xu [27] introduced a strategies for amassing span esteemed intuitionistic fuzzy data, Yang [28] introduced rectangular hindrance subject to various improvement capacities regarding the quantity of curves. Ye [29] proposed a Trapezoidal fuzzy Neural Computing and Applications. Ye [30] developed of the Multi models dynamic strategy utilizing shape liking measure, Ye [31] presented a Prioritized aggregation operators of trapezoidal intuitionistic fuzzy sets and their application {32] Kalaiarasi and Divya explained The shortest path on minimal spanning tree with triangular single-valued neutrosophic intuitionistic fuzzy graph. [33] Kalaiarasi and Divya explained Fuzzy coloring circular interval graphs of integer decomposition with constant variables.

Here, in this paper disclosed the briefest way to Chola period temples utilized the proposed calculation.

Intuitionistic fuzzy number gives more accuracy than fuzzy numbers. So that intuitionistic fuzzy numbers are used for finding shortest path of a graph. .

In this paper Dijkstra's algorithm is the only algorithm suitable for verifying our real world problem , because of the edge weight of fuzzy graph, rather than other algorithms.

Section 2, introduced some basic concepts related to definitions. Section 3, introduced Intuitionistic Triangular Neutrosophic Fuzzy Graph operations and proposed algorithm and find SPP using that proposed algorithm. Section 4, we apply real life application. The application has Chola period buildted temple and find its SPP using Intuitionistic Triangular Neutrosophic Fuzzy Graph proposed algorithm . Section 5, used Python Jupyter Notebook (version) programming, verified shortest path on Chola period temples with Dijkstra's algorithm. Conclusion are given in section 6.

2. METHODOLOGY

In this section, we explain important notions of Intuitionistic Fuzzy Sets.

Definition 2.1

Let $\bar{n}_1 = \langle\ [(t_1, t_2, t_3), (t_4, t_5, t_6)],\ [(i_1, i_2, i_3), (i_4, i_5, i_6)], [(f_1, f_2, f_3), (f_4, f_5, f_6)]\ \rangle$ and

$\bar{n}_2 = \langle\ [(T_1, T_2, T_3), (T_4, T_5, T_6)],\ [(I_1, I_2, I_3), (I_4, I_5, I_6)], [(f_1, f_2, f_3), (f_4, f_5, f_6)]\ \rangle$ both intuitionistic triangular neutrosophic fuzzy numbers. Therefore following procedure are hold :

(1) $\bar{n}_1 \oplus \bar{n}_2 = \langle\ [(t_1 + T_1 - t_1T_1, t_2 + T_2 - t_2T_2, t_3 + T_3 - t_3T_3), (t_4 + T_4 - t_4T_4, t_5 + T_5 - t_5T_5, t_6 + T_6 - t_6T_6)],$
$[(i_1I_1, i_2I_2, i_3I_3), (i_4I_4, i_5I_5, i_6I_6)], [(f_1F_1, f_2F_2, f_3F_3), (f_4F_4, f_5F_5, f_6F_6)],\ \rangle$

(2) $\bar{n}_1 \otimes \bar{n}_2 = \langle\ [(t_1T_1, t_2T_2, t_3T_3), (t_4T_4, t_5T_5, t_6T_6)],$
$[(i_1 + I_1 - i_1I_1, i_2 + I_2 - i_2I_2, i_3 + I_3 - i_3I_3),$
$(i_4 + I_4 - i_4I_4, i_5 + I_5 - i_5I_5, i_6 + I_6 - i_6I_6)],$
$[(f_1 + F_1 - f_1F_1, f_2 + F_2 - f_2F_2, f_3 + F_3 - f_3F_3),$
$(f_4 + F_4 - f_4F_4, f_5 + F_5 - f_5F_5, f_6 + F_6 - f_6F_6)],$

(3)
$$\begin{aligned}\lambda \bar{n}_1 = \langle\ & [(1-(1-t_1)^{\lambda}, 1-(1-t_2)^{\lambda}, 1-(1-t_3)^{\lambda}),\\ & (1-(1-t_4)^{\lambda}, 1-(1-t_5)^{\lambda}, 1-(1-t_6)^{\lambda})], [((i_1)^{\lambda}, (i_2)^{\lambda}, (i_3)^{\lambda}),\\ & ((i_4)^{\lambda}, (i_5)^{\lambda}, (i_6)^{\lambda})],\ [((f_1)^{\lambda}, (f_2)^{\lambda}, (f_3)^{\lambda}),\\ & ((f_4)^{\lambda}, (f_5)^{\lambda}, (f_6)^{\lambda})]\ \rangle\ for\ \ \lambda > 0.\end{aligned}$$

(4)
$$\begin{aligned}\bar{n}_1^{\lambda} = \langle\ & [((t_1)^{\lambda}, (t_2)^{\lambda}, (t_3)^{\lambda}), ((t_4)^{\lambda}, (t_5)^{\lambda}, (t_6)^{\lambda})],\\ & [(1-(1-i_1)^{\lambda}, 1-(1-i_2)^{\lambda}, 1-(1-i_3)^{\lambda}),\\ & (1-(1-i_4)^{\lambda}, 1-(1-i_5)^{\lambda}, 1-(1-i_6)^{\lambda})],\\ & [(1-(1-f_1)^{\lambda}, 1-(1-f_2)^{\lambda}, 1-(1-f_3)^{\lambda}),\\ & (1-(1-f_4)^{\lambda}, 1-(1-f_5)^{\lambda}, 1-(1-f_6)^{\lambda})]\ \rangle\ for\ \ \lambda > 0.\end{aligned}$$

We propose definition of score and accuracy functions for an intuitionistic triangular neutrosophic fuzzy number

Definition 2.2

Let $\bar{n}_1 = \langle [(t_1,t_2,t_3), (t_4,t_5,t_6)], [(i_1,i_2,i_3),(i_4,i_5,i_6)], [(f_1,f_2,f_3),(f_4,f_5,f_6)] \rangle$ be an intuitionistic triangular neutrosophic number, then defined as their score functions

$$S(\bar{n}) = \frac{1}{3}\left\{2+\left(\frac{t_1+2t_2+t_3}{4}-\frac{t_4+2t_5+t_6}{4}\right)-\left(\frac{i_1+2i_2+i_3}{4}-\frac{i_4+2i_5+i_6}{4}\right)\right.$$
$$\left.-\left(\frac{f_1+2f_2+f_3}{4}-\frac{f_4+2f_5+f_6}{4}\right)\right\}, \ S(\bar{n}) \in [0,\ 1] \text{------------} \quad (2.1)$$

where the higher value of $S(\bar{n})$, larger the intuitionistic triangular neutrosophic fuzzy number $\bar{n}$.

Definition 2.3

Let $\bar{n}_1 = \langle [(t_1,t_2,t_3), (t_4,t_5,t_6)], [(i_1,i_2,i_3),(i_4,i_5,i_6)], [(f_1,f_2,f_3),(f_4,f_5,f_6)] \rangle$ be an intuitionistic triangular neutrosophic fuzzy number, then defined as their accuracy functions

$$H(\bar{n}) = \frac{1}{3}\left\{2+\left(\frac{t_1+2t_2+t_3}{4}-\frac{t_4+2t_5+t_6}{4}\right)-\left(\frac{f_1+2f_2+f_3}{4}-\frac{f_4+2f_5+f_6}{4}\right)\right\}, \ H(\bar{n}) \in [0,1] \text{-----------} \quad (2.2)$$

where the higher value of $H(\bar{n})$, larger the intuitionistic triangular neutrosophic fuzzy number $\bar{n}$.

3. INTUITIONISTIC TRIANGULAR NEUTROSOPHIC FUZZY GRAPH

Advantages of the proposed Algorithm

It is easy to understand a step wise representation and not dependent on any programming language. So we introduce Intuitionistic Triangular Neutrosophic Fuzzy Graph algorithm.

Algorithm:

In this research, we using proposed algorithm for finding shortest path.

Step :1

Let $d_1 = \langle [(0,0,0), (0,0,0)], [(1,1,1),(1,1,1)], [(1,1,1), (1,1,1)] \rangle$ and the source node as $[d_1 = \langle [(0,0,0), (0,0,0)], [(1,1,1),(1,1,1)], [(1,1,1),(1,1,1)] \rangle]$.

Step: 2

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

Step : 3

If the minimum value of i. $ie.,\ i = r$ then the lable node j as $[\ d_j, r\ ]$. If minimum arise related to more than one values of i. Their position we choose minimum value of i.

Step: 4

Let the destination node be $[\ d_n, l\ ]$. Here source node is d_n. We conclude a score function and we finds minimum value of intuitionistic trapezoidal neutrosophic number.

Step: 5

We calculate shortest path problem between source and destination node. Review the label of node 1. Let it be as $[d_n, A]$. Now review the label of node A and so on. Replicate the same procedure until node 1 is procured.

Step: 6

The shortest path can be procured by combined all the nodes by the step 5.

4. DATA ANALYSIS

To find shortest path on Chola period temples using intuitionistic triangular neutrosophic fuzzy graph.

In this chapter, AST denotes AmarasundreashwararTemple, GKCT denotes Gangai konda cholapuram Temple, TKT denotes Thiruvanai Kovil Temple, MKT denotes Moovar Kovil Temple, SST denotes Shri Suryanar Temple, BT denotes Brihadeeswarar Temple, and SAT denotes Shri Airavatesvara Temple.

Here, each node is converts as ITNFN.

Here we consider source node is Amarasundreashwarar Temple and destination node is Airavatesvara temple . To find shortest path on Amarasundreashwarar Temple to Airavatesvara temple.

Node 1 = AmarasundreashwararTemple

Node 2 = Gangai konda cholapuram Temple

Node 3 = Thiruvanai Kovil Temple

Node 4 = Moovar Kovil Temple

Node 5 = Shri Suryanar Temple

Node 6 = Brihadeeswarar Temple

Node 7 = Shri Airavatesvara Temple

The distance (km) between temples are considered as the edges of the graph. Considered distance are converted as Intuitionistic Triangular Neutrosophic Fuzzy Graph using the score function(fuzzification) of Intuitionistic Triangular Neutrosophic Fuzzy Graph.

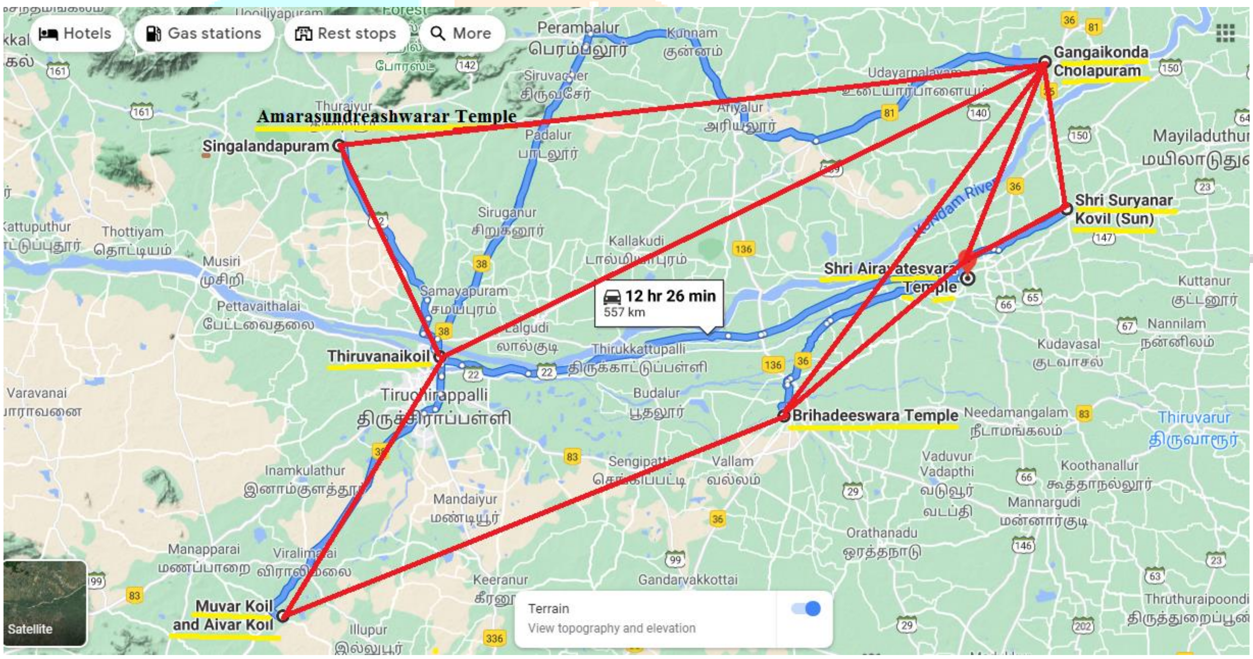


Fig 2.1 : A graph of Chola period temples

Here distance between one temple to another temple is calculated in kilometers. The numerical value of the distance is converted to Intuitionistic Triangular Neutrosophic Fuzzy Graphs with the help of through Neutrosopic Score function and trapezoidal signed distance.

The given distance (kilometer) converted to neutrosophic number $\frac{2+T-I-F}{3}$ (using score function). We converted neutrosophic number as (a_1, a_2, a_3) are membership function & $(a_1^*, a_2^{*'}, a_3^{*'})$ are non-membership function. These functions converted to fuzzy triangular numbers using triangular signed distance

$\frac{a_1 + 2a_2 + a_3}{4}$. Finally converted Intuitionistic Triangular Neutrosophic Fuzzy Number.

Here, Apply the Intuitionistic Triangular Neutrosophic Fuzzy Number in our algorithm to find shortest path to Chola period temples.

In this application, many paths have chola period temples. To calculate Shortest Path using score function(Definition 2.1 and 2.2).

An algorithm is used to apply a definite procedure and the process has been expensive and time consuming

Here node 1-2 = 117 km

This km changed to neutrosophic number use neutrosophic score function, and each neutrosophic number converted to fuzzification method, so we get fuzzy number. Finally we convert membership and non-membership from fuzzy number because of Intuitionistic fuzzy number, and use triangular signed distance to membership and non-membership functions. At last we get Intuitionistic Triangular Neutrosophic Fuzzy Number.

820	340	131
0.82	0.34	0.131
(0.82, 0.18)	(0.34, 0.66)	(0.131, 0.869)

$$<[(0.65, 0.82, 0.99), (0.11, 0.18, 0.25)], [(0.16, 0.34, 0.52), (0.57, 0.66, 0.75)], [(0.07, 0.131, 0.192), (0.813, 0.869, 0.925)]>$$

1-3= 35 km

350	142	105
0.35	0.142	0.105
(0.35, 0.65)	(0.142, 0.858)	(0.105, 0.895)

$$<[(0.21, 0.35, 0.49), (0.49, 0.65, 0.81)], [(0.088, 0.142, 0.196), (0.744, 0.858, 0.972)], [(0.018, 0.105, 0.192), (0.835, 0.895, 0.955)]>$$

2-3= 125 km

955	425	157
0.955	0.425	0.157
(0.955, 0.045)	(0.425, 0.575)	(0.157, 0.843)

<[(0.911,0.955,0.999), (0.029, 0.045,0.061)], [(0.229, 0.425,0.621), (0.425,0.575,0.725)],[(0.013,0.157,0.301),(0.722,0.843,0.964)]>

2-5= 24 km

316	172	74
0.316	0.172	0.074
(0.316, 0.684)	(0.172, 0.828)	(0.074, 0.926)

<[(0.128,0.316,0.504), (0.556, 0.684,0.812)], [(0.011, 0.172,0.333), (0.721,0.828,0.935)],[(0.049,0.074,0.099),(0.873,0.926,0.979)]>

2-6= 71 km

650	330	109
0.65	0.33	0.109
(0.65, 0.35)	(0.33, 0.67)	(0.109, 0.891)

<[(0.59,0.65,0.71), (0.17, 0.35,0.53)], [(0.17, 0.33,0.49), (0.51,0.67,0.83)],[(0.035,0.109,0.183),(0.826,0.891,0.956)]>

3-4= 48 km

465	220	103
0.465	0.22	0.103
(0.465, 0.535)	(0.22, 0.78)	(0.103, 0.897)

<[(0.395,0.465,0.535), (0.455, 0.535,0.615)], [(0.11, 0.22,0.33), (0.71,0.78,0.85)],[(0.011,0.103,0.195),(0.821,0.897,0.973)]>

4-6= 95 km

950	435	232
0.95	0.435	0.232
(0.95, 0.05)	(0.435, 0.565)	(0.232, 0.768)

$$<[(0.91, 0.95, 0.99), (0.02, 0.05, 0.08)], [(0.333, 0.435, 0.537), (0.505, 0.565, 0.625)], [(0.149, 0.232, 0.315), (0.733, 0.768, 0.803)]>$$

5-6= 54 km

650	320	170
0.65	0.32	0.17
(0.65, 0.35)	(0.32, 0.68)	(0.17, 0.83)

$$<[(0.51, 0.65, 0.79), (0.24, 0.35, 0.46)], [(0.17, 0.32, 0.47), (0.6, 0.68, 0.76)], [(0.09, 0.17, 0.25), (0.69, 0.83, 0.97)]>$$

5-7= 20 km

180	72	50
0.18	0.072	0.05
(0.18, 0.82)	(0.072, 0.928)	(0.05, 0.95)

$$<[(0.09, 0.18, 0.27), (0.71, 0.82, 0.93)], [(0.045, 0.072, 0.099), (0.869, 0.928, 0.987)], [(0.03, 0.05, 0.07), (0.93, 0.95, 0.97)]>$$

6-7= 20 km

640	330	201
0.64	0.33	0.201
(0.64, 0.36)	(0.33, 0.67)	(0.201, 0.799)

$$<[(0.56, 0.64, 0.72), (0.28, 0.36, 0.44)], [(0.2, 0.33, 0.46), (0.59, 0.67, 0.75)], [(0.069, 0.201, 0.333), (0.737, 0.799, 0.861)]>$$

In this iteration SPP was calculated through the proposed algorithm, the concept of the Chola period temples shortest path calculated from Amarasundreashwarar Temple to Shri Airavatesvara Temple.

Let n = 7 is the destination node, since there are totally 7 nodes.

Iteration: 1

Assume the source node is Amarasundreashwarar Temple. Here we assume

$d_1 = \langle [(0,0,0), (0,0,0)], [(1,1,1),(1,1,1)],[(1,1,1), (1,1,1)] \rangle$ and label of source node is

$\{ <[(0,0,0),(0,0,0)],[(1,1,1),(1,1,1)],[(1,1,1),(1,1,1)]>,-- \}$ the value of d_j, $j = 2,3,4,5,6$ is succeeding:

Here we assume d_1 is the Amarasundreashwarar Temple.

Iteration: 2

The node Gangai konda cholapuram Temple has only node Amarasundreashwarar Temple as the predecessor.

Intuitionistic Triangular Fuzzy Neutrosophic Shortest Path is calculated from Gangai konda cholapuram Temple to Amarasundreashwarar Temple.

Since node 2 has only node 1 as the predecessor. So fix $i = 1$ and $j = 2$ we apply step 2 at proposed algorithm.

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

$$= \text{minimum} \left\{ \begin{array}{l} <[(0,0,0),(0,0,0)],[(1,1,1),(1,1,1)],[(1,1,1),(1,1,1)]>\oplus \\ <[(0.65,0.82,0.99), (0.11, 0.18,0.25)], [(0.16, 0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]> \end{array} \right\}$$

$$= \left\{ \begin{array}{l} <[(0.65,0.82,0.99), (0.11, 0.18,0.25)], [(0.16, 0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]> \end{array} \right\}$$

Therefore minimum value $i = 1$, corresponding to label node 2 as

$$= \left\{ \begin{array}{l} [(0.65,0.82,0.99), (0.11, 0.18,0.25)], [(0.16, 0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]>, 1 \end{array} \right\}$$

$$d_2 = \left\{ \begin{array}{l} <[(0.65,0.82,0.99), (0.11, 0.18,0.25)], [(0.16, 0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]> \end{array} \right\}$$

The labeled node is Gangai Konda Cholapuram and minimum provided corresponding node is Amarasundreashwarar Temple.

Minimum Node	Labeled Node	Path Node
AST	GKCT	$<[(0.65,0.82,0.99),(0.11,0.18,0.25)],[(0.16,0.34,0.52),(0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]>$

Iteration: 3

The node Thiruvanai Kovil Temple has two predecessors node, they are node Amarasundreashwarar Temple and node Gangai konda cholapuram Temple.

Intuitionistic Triangular Fuzzy Neutrosophic Shortest Path is calculated to Thiruvanai Kovil from Amarasundreashwarar Temple and Gangai konda cholapuram.

Since node 3 has two predecessors node 1 and node 2. So fix $i=1,2$ and $j=3$ we apply step 2 at proposed algorithm.

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

$$= \text{minimum}\left\{\begin{array}{l} <[(0,0,0),(0,0,0)],[(1,1,1),(1,1,1)],[(1,1,1),(1,1,1)]> \oplus <[(0.21,0.35,0.49),\\ (0.49,0.65,0.81)],[(0.088,0.142,0.196),(0.744,0.858,0.972)],[(0.018,0.105,0.192),\\ (0.835,0.895,0.955)]>,<[(0.65,0.82,0.99),(0.11,0.18,0.25)],[(0.16,0.34,0.52),\\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]> \oplus \\ <[(0.911,0.955,0.999),(0.029,0.045,0.061)],[(0.229,0.425,0.621),\\ (0.425,0.575,0.725)],[(0.013,0.157,0.301),(0.722,0.843,0.964)]> \end{array}\right\}$$

$$= \text{minimum}\left\{\begin{array}{l} <[(0.21,0.35,0.49),(0.49,0.65,0.81)],[(0.088,0.142,0.196),\\ (0.744,0.858,0.972)],[(0.018,0.105,0.192),(0.835,0.895,0.955)]>,\\ <[(0.9688,0.9919,0.999),(0.1358,0.217,0.2957)],[(0.0366,0.1445,0.323),\\ (0.2422,0.3795,0.5437)],[(0.0009,0.0205,0.0577),(0.5869,0.7325,0.8917)]> \end{array}\right\}$$

Using equation (2.1),we have

$$S\left\{\begin{array}{l} <[(0.21,0.35,0.49),(0.49,0.65,0.81)],[(0.088,0.142,0.196),\\ (0.744,0.858,0.972)],[(0.018,0.105,0.192),(0.835,0.895,0.955)]> \end{array}\right\}$$

$S(\bar{n}_1) = 0.2647$

$$S\left\{\begin{array}{l} <[(0.9688,0.9919,0.999),(0.1358,0.217,0.2957)],[(0.0366,0.1445,0.323),\\ (0.2422,0.3795,0.5437)],[(0.0009,0.0205,0.0577),(0.5869,0.7325,0.8917)]> \end{array}\right\}$$

$S(\bar{n_2}) = 0.0978$

Therefore minimum value $i = 2$, corresponding to label node 3 as

$$\left\{\begin{matrix} <[(0.9688, 0.9919, 0.999), (0.1358, 0.217, 0.2957)], [(0.0366, 0.1445, 0.323), \\ (0.2422, 0.3795, 0.5437)], [(0.0009, 0.0205, 0.0577), (0.5869, 0.7325, 0.8917)]>, 2 \end{matrix}\right\}$$

$$d_3 = \left\{\begin{matrix} <[(0.9688, 0.9919, 0.999), (0.1358, 0.217, 0.2957)], [(0.0366, 0.1445, 0.323), \\ (0.2422, 0.3795, 0.5437)], [(0.0009, 0.0205, 0.0577), (0.5869, 0.7325, 0.8917)]> \end{matrix}\right\}$$

Here, the labeled node is Thiruvanai Kovil and the minimum provided corresponding node is Gangai konda cholapuram .

Minimum Node	**Labeled Node**	**Path Node**
GKCT	TKT	$<[(0.9688, 0.9919, 0.999), (0.1358, 0.217, 0.2957)], [(0.0366, 0.1445, 0.323), (0.2422, 0.3795, 0.5437)], [(0.0009, 0.0205, 0.0577), (0.5869, 0.7325, 0.8917)]>$

Iteration: 4

The node Moovar Kovil has only node Thiruvanai Kovil as the predecessor.

Intuitionistic Triangular Fuzzy Neutrosophic Shortest Path is calculated to Moovar Kovil from Thiruvanai Kovil.

Since node 4 has only node 3 as the predecessor. So fix $i = 3$ and $j = 4$ we apply step 2 at proposed algorithm.

$d_4 =$ minimum $\{d_3 \oplus d_{34}\}$

$$= \text{minimum} \left\{\begin{matrix} <[(0.9688, 0.9919, 0.999), (0.1358, 0.217, 0.2957)], [(0.0366, 0.1445, 0.323), \\ (0.2422, 0.3795, 0.5437)], [(0.0009, 0.0205, 0.0577), (0.5869, 0.7325, 0.8917)]> \oplus \\ <[(0.395, 0.465, 0.535), (0.455, 0.535, 0.615)], [(0.11, 0.22, 0.33), \\ (0.71, 0.78, 0.85)], [(0.011, 0.103, 0.195), (0.821, 0.897, 0.973)]> \end{matrix}\right\}$$

$$= \left\{\begin{matrix} <[(0.98, 0.995, 0.999), (0.529, 0.636, 0.728)], [(0.004, 0.032, 0.107), \\ (0.172, 0.296, 0.462)], [(0.000009, 0.002, 0.011), (0.482, 0.657, 0.868)]> \end{matrix}\right\}$$

Therefore minimum value $i=3$, corresponding to label node 4 as

$$=\begin{Bmatrix} <[(0.98,0.995,0.999),(0.529,0.636,0.728)],[(0.004,0.032,0.107), \\ (0.172,0.296,0.462)],[(0.000009,0.002,0.011),(0.482,0.657,0.868)]>,3 \end{Bmatrix}$$

$$d_4=\begin{Bmatrix} <[(0.98,0.995,0.999),(0.529,0.636,0.728)],[(0.004,0.032,0.107), \\ (0.172,0.296,0.462)],[(0.000009,0.002,0.011),(0.482,0.657,0.868)]> \end{Bmatrix}$$

Here, the labeled node is Moovar Kovil and the minimum provided corresponding node is Thiruvanai Kovil.

Minimum Node	Labeled Node	Path Node
TKT	MKT	$<[(0.98,0.995,0.999),(0.529,0.636,0.728)],[(0.004,0.032,0.107),(0.172,0.296,0.462)],[(0.000009,0.002,0.011),(0.482,0.657,0.868)]>$

Iteration: 5

The node Shri Suryanar Temple has only node Gangai konda cholapuram as the predecessor.

Intuitionistic Triangular Fuzzy Neutrosophic Shortest Path is calculated to Shri Suryanar Temple from Gangai konda cholapuram.

Since node 5 has only node 2 as the predecessor. So fix $i=2$ and $j=5$ we apply step 2 at proposed algorithm.

$d_5=$ minimum $\{d_2 \oplus d_{25}\}$

$$=\text{minimum}\begin{Bmatrix} <[(0.65,0.82,0.99),(0.11,0.18,0.25)],[(0.16,0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)]>\oplus \\ <[(0.128,0.316,0.504),(0.556,0.684,0.812)],[(0.011,0.172,0.333), \\ (0.721,0.828,0.935)],[(0.049,0.074,0.099),(0.873,0.926,0.979)]> \end{Bmatrix}$$

$$=\begin{Bmatrix} <[(0.695,0.877,0.995),(0.605,0.741,0.859)],[(0.002,0.058,0.173), \\ (0.411,0.546,0.701)],[(0.003,0.0096,0.019),(0.709,0.805,0.906)]> \end{Bmatrix}$$

Therefore minimum value $i=2$, corresponding to label node 5 as

$$= \left\{ \begin{array}{l} <[(0.695, 0.877, 0.995), (0.605, 0.741, 0.859)], [(0.002, 0.058, 0.173), \\ (0.411, 0.546, 0.701)], [(0.003, 0.0096, 0.019), (0.709, 0.805, 0.906)]>, 2 \end{array} \right\}$$

$$d_5 = \left\{ \begin{array}{l} <[(0.695, 0.877, 0.995), (0.605, 0.741, 0.859)], [(0.002, 0.058, 0.173), \\ (0.411, 0.546, 0.701)], [(0.003, 0.0096, 0.019), (0.709, 0.805, 0.906)]> \end{array} \right\}$$

Here the labeled node is Shri Suryanar Temple and the minimum provided corresponding node is Gangai konda cholapuram . .

Minimum Node	Labeled Node	Path Node
GKCT	SST	$<[(0.695, 0.877, 0.995), (0.605, 0.741, 0.859)], [(0.002, 0.058, 0.173), (0.411, 0.546, 0.701)], [(0.003, 0.0096, 0.019), (0.709, 0.805, 0.906)]>$

Iteration: 6

The node Brihadeeswarar Temple has three predecessors node, they are node Gangai konda cholapuram , node Moovar Kovil and node Shri Suryanar Temple.

Intuitionistic Triangular Fuzzy Neutrosophic Shortest Path is calculated to Brihadeeswarar Temple from Gangai konda cholapuram , Moovar Kovil and Shri Suryanar Temple .

Since node 6 has three predecessors . The predecessors are node 2, node 4 and node 5. So fix $i = 2, 4, 5$ and $j = 6$ we apply step 2 at proposed algorithm.

d_6 = minimum $\{d_2 \oplus d_{26}, d_4 \oplus d_{46}, d_5 \oplus d_{56}\}$

$$= \text{minimum} \left\{ \begin{array}{l} <[(0.65,0.82,0.99),\ (0.11,\ 0.18,0.25)],\ [(0.16,\ 0.34,0.52), \\ (0.57,0.66,0.75)],[(0.07,0.131,0.192),(0.813,0.869,0.925)] > \oplus \\ <[(0.59,0.65,0.71),\ (0.17,\ 0.35,0.53)],\ [(0.17,\ 0.33,0.49), \\ (0.51,0.67,0.83)],[(0.035,0.109,0.183),(0.826,0.891,0.956)] >, \\ <[(0.98,0.995,0.999),\ (0.529,\ 0.636,0.728)],\ [(0.004,\ 0.032,0.107), \\ (0.172,0.296,0.462)],[(0.000009,0.002,0.011),(0.482,0.657,0.868)] > \oplus \\ <[(0.91,0.95,0.99),\ (0.02,\ 0.05,0.08)],\ [(0.333,\ 0.435,0.537), \\ (0.505,0.565,0.625)],[(0.149,0.232,0.315),(0.733,0.768,0.803)] >, \\ <[(0.695,0.877,0.995),\ (0.605,\ 0.741,0.859)],\ [(0.002,\ 0.058,0.173), \\ (0.411,0.546,0.701)],[(0.003,0.0096,\ 0.019),(0.709,0.805,0.906)] > \oplus \\ <[(0.51,0.65,0.79),\ (0.24,\ 0.35,0.46)],\ [(0.17,\ 0.32,0.47), \\ (0.6,0.68,0.76)],[(0.09,0.17,0.25),(0.69,0.83,0.97)] > \end{array} \right\}$$

$$= \text{minimum} \left\{ \begin{array}{l} <[(0.856,0.937,0.997),(0.2613,0.467,\ 0.647)],[(0.0272,\ \ 0.1122,0.2548), \\ (0.291,0.442,\ 0.6225)],[(0.0024,0.014,\ 0.035),(0.671,0.774,0.884)]>, \\ <[(0.998,0.9997,0.99999),(0.538,0.654,0.749)],[(0.001,0.014,0.057), \\ (0.087,0.167,0.289)],[(0.000001,0.0005,0.003),(0.353,0.504,0.697)] >, \\ <[(0.85,0.956,0.999),(0.699,0.832,0.9238)],[(0.0003,0.0185,0.0813), \\ (0.247,0.371,0.322)],[(0.0003,0.002,0.005),(0.489,0.668,0.879)] > \end{array} \right\}$$

Using equation (2.1), we have

$$S \left\{ \begin{array}{l} <[(0.856,0.937,0.997),(0.2613,0.467,\ 0.647)],[(0.0272,\ \ 0.1122,0.2548), \\ (0.291,0.442,\ 0.6225)],[(0.0024,0.014,\ 0.035),(0.671,0.774,0.884)]> \end{array} \right\}$$

$$S(\bar{n}_1) = 0.149$$

$$S \left\{ \begin{array}{l} <[(0.998,0.9997,0.99999),(0.538,0.654,0.749)],[(0.001,0.014,0.057), \\ (0.087,0.167,0.289)],[(0.000001,0.0005,0.003),(0.353,0.504,0.697)] > \end{array} \right\}$$

$$S(\bar{n}_2) = 0.32662$$

$$S \left\{ \begin{array}{l} <[(0.85,0.956,0.999),(0.699,0.832,0.9238)],[(0.0003,0.0185,0.0813), \\ (0.247,0.371,0.322)],[(0.0003,0.002,0.005),(0.489,0.668,0.879)] > \end{array} \right\}$$

$$S(\bar{n}_3) = 0.3032$$

Therefore minimum value $i = 2$, corresponding to lable node 6 as

$$\left\{\begin{array}{l}<[(0.856,0.937,0.997),(0.2613,0.467,0.647)],[(0.0272,0.1122,0.2548),\\(0.291,0.442,0.6225)],[(0.0024,0.014,0.035),(0.671,0.774,0.884)]>,2\end{array}\right\}$$

$$d_6=\left\{\begin{array}{l}<[(0.856,0.937,0.997),(0.2613,0.467,0.647)],[(0.0272,0.1122,0.2548),\\(0.291,0.442,0.6225)],[(0.0024,0.014,0.035),(0.671,0.774,0.884)]>\end{array}\right\}$$

Here, the labeled node is Brihadeeswarar Temple and the minimum provided corresponding node is Gangai konda cholapuram

.

Minimum Node	Labeled Node	Path Node
GKCT	BT	$<[(0.856,0.937,0.997),(0.2613,0.467,0.647)],[(0.0272,0.1122,0.2548),(0.291,0.442,0.6225)],[(0.0024,0.014,0.035),(0.671,0.774,0.884)]>$

Iteration: 7

The node Shri Airavatesvara Temple has two predecessors node, they are node Shri Suryanar Temple and node Brihadeeswarar Temple. ITNSP is calculated to Shri Airavatesvara Temple from Shri Suryanar Temple and Brihadeeswarar Temple

Since node 7 has two predecessors node 5 and node 6. So fix $i=5,6$ and $j=7$ we apply step 2 at proposed algorithm.

$d_7=$ minimum $\{d_5\oplus d_{57},\ d_6\oplus d_{67}\}$

$$=\text{minimum}\left\{\begin{array}{l}<[(0.695,0.877,0.995),(0.605,0.741,0.859)],[(0.002,0.058,0.173),\\(0.411,0.546,0.701)],[(0.003,0.0096,0.019),(0.709,0.805,0.906)]>\oplus\\<[(0.09,0.18,0.27),(0.71,0.82,0.93)],[(0.045,0.072,0.099),\\(0.869,0.928,0.987)],[(0.03,0.05,0.07),(0.93,0.95,0.97)]>,\\<[(0.856,0.937,0.997),(0.2613,0.467,0.647)],[(0.0272,0.1122,0.2548),\\(0.291,0.442,0.6225)],[(0.0024,0.014,0.035),(0.671,0.774,0.884)]>\oplus\\<[(0.56,0.64,0.72),(0.28,0.36,0.44)],[(0.2,0.33,0.46),\\(0.59,0.67,0.75)],[(0.069,0.201,0.333),(0.737,0.799,0.861)]>\end{array}\right\}$$

$$= \text{minimum} \begin{Bmatrix} <[(0.722,0.899,0.996),(0.885,0.953,0.99)],[(0.00009,0.004,0.017), \\ (0.357,0.507,0.692)],[(0.00009,0.0005,0.0013),(0.659,0.765,0.8788)]>, \\ <[(0.93,0.977,0.999),(0.468,0.659,0.802)],[(0.005,0.037,0.1172), \\ (0.172,0.296,0.467)],[(0.0002,0.003,0.012),(0.494,0.618,0.761)]> \end{Bmatrix}$$

Using equation (2.1),we have

$$S\begin{Bmatrix} <[(0.722,0.899,0.996),(0.885,0.953,0.99)],[(0.00009,0.004,0.017), \\ (0.357,0.507,0.692)],[(0.00009,0.0005,0.0013),(0.659,0.765,0.8788)]> \end{Bmatrix}$$

$$S(\bar{n}_1) = 0.26339$$

$$S\begin{Bmatrix} <[(0.93,0.977,0.999),(0.468,0.659,0.802)],[(0.005,0.037,0.1172), \\ (0.172,0.296,0.467)],[(0.0002,0.003,0.012),(0.494,0.618,0.761)]> \end{Bmatrix}$$

$$S(\bar{n}_2) = 0.2665$$

Therefore minimum value $i = 5$, corresponding to lable node 7 as

$$\begin{Bmatrix} <[(0.722,0.899,0.996),(0.885,0.953,0.99)],[(0.00009,0.004,0.017), \\ (0.357,0.507,0.692)],[(0.00009,0.0005,0.0013),(0.659,0.765,0.8788)]>,5 \end{Bmatrix}$$

$$d_6 = \begin{Bmatrix} <[(0.722,0.899,0.996),(0.885,0.953,0.99)],[(0.00009,0.004,0.017), \\ (0.357,0.507,0.692)],[(0.00009,0.0005,0.0013),(0.659,0.765,0.8788)]> \end{Bmatrix}$$

The labeled node is Airavatesvara Temple and the minimum provided corresponding node is Shri Suryanar Temple .

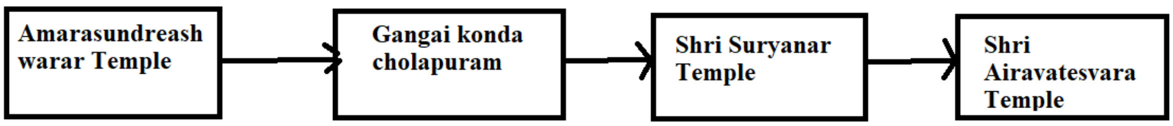
Minimum Node	**Labeled Node**	**Path Node**
SST	SAT	$<[(0.722,0.899,0.996),(0.885,0.953,0.99)],$ $[(0.00009,0.004,0.017),(0.357,0.507,0.692)],$ $[(0.00009,0.0005,0.0013),(0.659,0.765,0.8788)]>$

Since Airavatesvara Temple is the destination node .

We calculate SP to destination node to source node. Since

Labeled Node	Minimum Node
Shri Airavatesvara Temple	Shri Suryanar Temple
Shri Suryanar Temple.	Gangai konda cholapuram
Gangai konda cholapuram	Amarasundreashwarar Temple

Therefore the Chola period buildted temples intuitionistic nether triangular neutrosophic fuzzy graph shortest path is



Here double red nodes are shortest path of the Chola period temples .

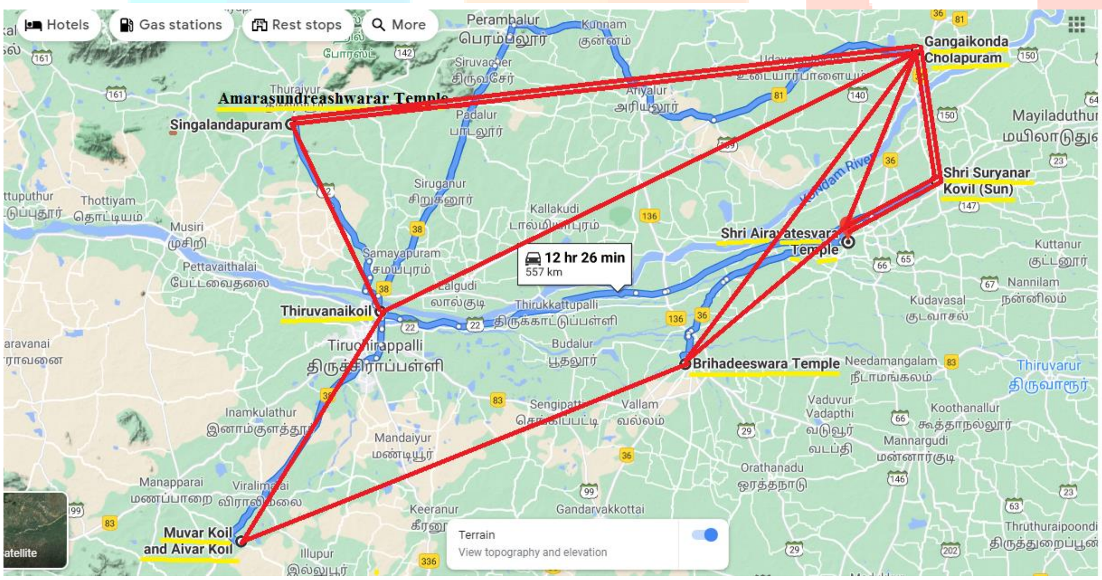


Fig 2.2 : SP from Amarasundreashwarar Temple to Airavatesvara temple.

5. SHORTEST PATH ON DIJKSTRA'S ALGORITHM

Edge weight suitable algorithm is Dijkstra's algorithm. So here we conclude same type of Shortest Path through Dijkstra's Algorithm.

In the above real life application, we clarify another method of Shortest Path Problem using Dijkstra's algorithm. In this Shortest Path Problem, we use direct method of Dijkstra's algorithm and we assume edge weight is Chola period temples km.

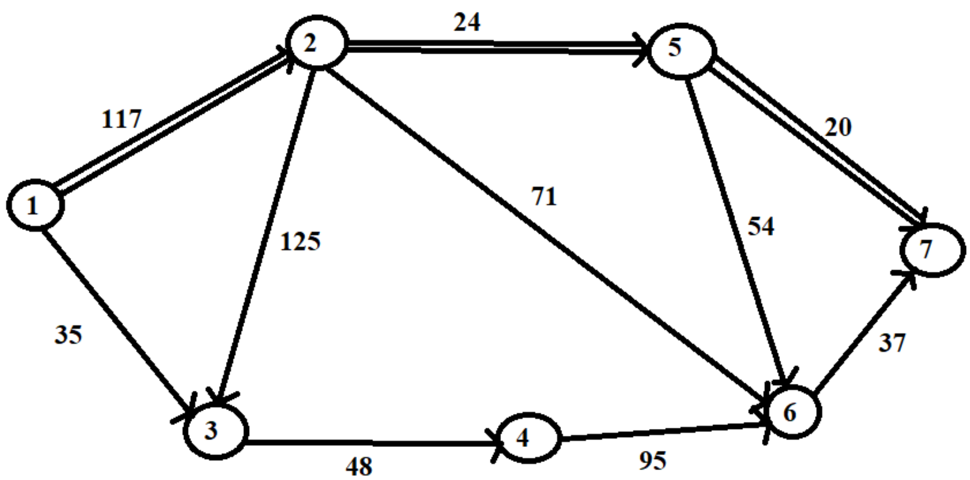


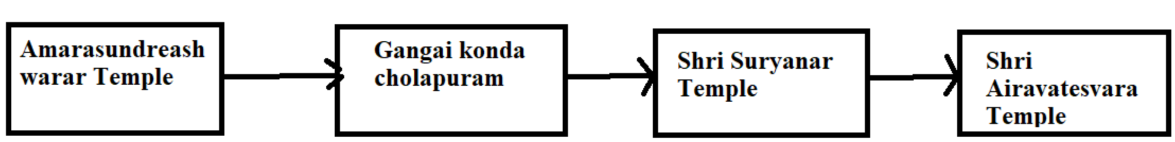
Fig 3.1 : SP for Dijkstra's Algorithm.

Here, we verify Chola period buildted temples shortest path through Dijkstra's Algorithm. We have the paths are

$$1 \rightarrow 2 \rightarrow 5 \rightarrow 7$$

Here, the intuitionistic triangular Neutrosophic fuzzy graphs and Dijkstra's Algorithm are same. The shortest path is

$$1 \rightarrow 2 \rightarrow 5 \rightarrow 7$$



DIJKSTRA'S ALGORITHM PYTHON PROGRAM

Python program has been used to verify the result of Dijktra's Algorithm. It can be accessed earily and checked properly.

```
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 = [[0,1,1,0,0,0,0],
         [0,0,1,0,1,1,0],
         [0,0,0,1,0,0,0],
         [0,0,0,0,0,1,0],
         [0,0,0,0,0,1,1],
         [0,0,0,0,0,0,1],
         [0,0,0,0,0,0,0]]
edges =  [[0,117,35,0,0,0,0],
         [0,0,125,0,24,71,0],
         [0,0,0,48,0,0,0],
         [0,0,0,0,0,95,0],
         [0,0,0,0,0,54,20],
         [0,0,0,0,0,0,37],
         [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: 117
The shortest distance of  c  from the source vertex a is: 35
The shortest distance of  d  from the source vertex a is: 83
The shortest distance of  e  from the source vertex a is: 141
The shortest distance of  f  from the source vertex a is: 178
The shortest distance of  g  from the source vertex a is: 161
```

6. CONCLUSION

In this article, discovering Shortest Path on Chola period temples using Intuitionistic Triangular Neutrosophic Fuzzy Graph. We use Neutrosophic score function and Triangular signed distance for fuzzification of membership and non-membership function. Intuitionistic Triangular Neutrosophic Fuzzy Number Score function is used to calculate Shortest Path of Intuitionistic Triangular Neutrosophic Fuzzy Graph. A genuine application is given to act as an Intuitionistic Triangular Neutrosophic Fuzzy Graph. Finally most brief way Shortest Path on Chola period buildted temples verified with Dijkstra's algorithm through the long last Python Jupyter Notebook (form) programming.

Futuristic work:

In future shortest path problem can be applied by using Kruskal's Algorithm. We can verified by applying transportation Problem and Decision making problem. All weightage fuzzy number will be incorporated to find the shortest route of traffic or human intervention practical problem.

REFERENCES

[1] R K Ahuja, K Mehlhrn, J B Orlin, R E Tarjan, Faster algorithms for the shortest path problem, J ACM, 37(2) (1990) 213-223.

[2] H Arsham, Stability analysis for the shortest path problem, Congressus Numerantium, 133 (1998) 171-210.

[3] V Anusuya, R Sathya, Shortest path with complement of type-2 fuzzy number, malya journal of mathematik, S(1), (2013) 71-76.

[4] S Broumi, A Bakali, T Mohamed, F Smarandache, L Vladareanu, Shortest path problem under triangular fuzzy neutrosophic information, In 10th International conference on software, knowledge, information management and applications (SKIMA), (2016) 169-174.

[5] S Broumi, T Mohamed, A Bakali, F Smarandache, Single valued neutrosophic graphs, J New Theory, 10 (2016) 86-101.

[6] S Broumi, T Mohamed, A Bakali, F Smarandache, K K Krishnan, Shortest path problem on single valued neutrosophic graphs, International symposium on networks, computers and communications, (2017).

[7] S Broumi, A Bakali, M Talea, F Smarandache, M Ali, Shortest path under Bipolar Neutrosophic setting. Appl.Mech.Mater, 859 (2017), 59-66.

[8] S Broumi, A Bakali, M Talea, F Smarandache, P K Kishore, R Sachin, Shortest path problem under interval-valued neutrosophic setting, Int. J. Adv. Trends Compt. Sci. Eng, 8 (2019) 216-222.

[9] Chiranjibe Jana, Madhumangal Pal, Faruk Karaaslan, Jian-qiang Wang, Trapezoidal neutrosophic aggregation operators and its application in multiple attribute decision making process, Scientia Iranica E, 27(3) (2020) 1655-1673.

[10] P K De, Amita Bhinchar, Computation of Shortest Path in a fuzzy network, International journal computer applications. 11(2) (2010) 0975-8887.

[11] P K De, Debaroti Das, A study on ranking of trapezoidal intuitionistic fuzzy numbers, International Journal of Computer information systems and industrial management applications, 6 (2014) 437-444.

[12] M Enayattabar, A Ebrahimnejad, H Motameni, Dijkstra algorithm for shortest path problem under interval-valued Pythagorean fuzzy environment, Complex Intell Syst, (2018) 1-8.

[13] C Jana, M Pal, F Karaaslan and J-Q wang, Trapezoidal neutrosophic aggregation operators and their application to the multi-attribute decision – making process, Scientia iranica, Transactions E : Industrial Engineering, 27(3) (2020) 1655-1673.

[14] P Jayagowri, G G Ramani, Using Trapizoidal Intuitionistic Fuzzy Number to Find Optimized Path in a Network, Advances in Fuzzy Systems, (2014).

[15] K.Kalaiarasi, R.Divya, Shortest Path On Intuitionistic Trapezoidal Neutrosophic Fuzzy Graphs With Application", Turkish Online Journal of Qualitative Inquiry (TOJQI), Volume 12, Issue 3, June 2021, Impact Factor : - , Pg.no: 714-723, ISSN 1309-6591.

[16] K.Kalaiarasi, R.Divya, The Shortest Path Problem On India Famous Seven Tourist Place with Dijkstra's Algorithm in Interval-Valued Intuitionistic Triangular Neutrosophic Fuzzy Graphs, International Journal of Advanced Research in Engineering and Technology(IJARET), Volume 11, Issue 7, July 2020, Pg.no: 881-891, Impact Factor: - , ISSN 0976-6499.

[17] A Kumar, K Kaur, A New Algorithm for Solving Shortest Path Problem on a Network with Imprecise Edge Weight, Applications and Applied Mathematics, 6(2) (2011) 602-619.

[18] G Kumar, R K Bajaj, and N Gandotra, Algorithm for shortest path problem in a network with interval valued intuitionistic trapezoidal fuzzy number, Procedia Computer Science, 70 (2015) 123-129.

[19] R Kumar, S A Edaltpanah, S Jha, S Broumi, A Dey, Neutrosophic shortest path problem, Neutrosophic Sets Syst, 23, (2018) 5-15.

[20] S Majumdar, A Pal, Shortest path problem on Intuitionistic Fuzzy Network, Annals of Pure and Applied Mathematics, 5(1) (2013) 26-36.

[21] A Nagoor Gani, M Mohamed Jabarulla, On searching intuitionistic fuzzy shortest network , Applied mathematical Science, 69 (2010) 3447-3454.

[22] Ojekudo, Nathaniel akpofure, Akpan, Nsikan Paul , An application of Dijkstra's algorithm to shortest path problem, IOSR journal of Mathematics, 13(3) (2017) 20-32.

[23] Said Broumi, Assia Bakali, Mohamed Talea, Florentin Smarandache, Shortest path problem under Trapezoidal Neutrosophic Information, Computing Conference, (2017) 142-148.

[24] F Smarandache, A unifying field in logic. Neutrosophy: neutrosophic probability, set, logic, 4th edn. American Research Press, Rehoboth (2005).

[25] Victor christianto, Florentin Smarandache, Remark on artificial intelligence, humanoid and terminator scenario : A neutrosophic way to futurology , International journal of neutrosophic science,1(1) (2020) 08-13.

[26] H Wang, F Smarandache, Y Zhang, R Sunderraman, Single value neutrosophic sets, Multisp Multistruct, 4 (2010) 410-413.

[27] Z S Xu, Methods for aggregating interval-valued intuitionistic fuzzy information and their application to decision making, Control and decision, 22(2) (2007) 215-219.

[28] C D Yang, D T Lee, C K Wong, On bends and lengths of rectilinear paths : a graph theoretic approach, Int J Comput Geom Appl, 2(1) (1992) 61-74.

[29] J Ye, Trapezoidal neutrosophic set and its application to multiple attribute decision making, Neural Computing and Applications, 26(5), (2014), 1157-1166.

[30] J Ye, Multi criteria decision-making method using the Dice similarity measure between expected intervals of trapezoidal fuzzy numbers, Journal of Decision Systems, 21(4), (2012), 307-317.

[31] J Ye, Prioritized aggregation operators of trapezoidal intuitionistic fuzzy sets and their application to multi-criteria decision making, Neural comput Appl, (2014), 1447-1454.

[32] K.Kalaiarasi, R.Divya, The shortest path on minimal spanning tree with triangular single-valued neutrosophic intuitionistic fuzzy graph, Parishodh journal, 2020, IX, 3899-3903.

[33] K.Kalaiarasi, R.Divya, Fuzzy coloring circular interval graphs of integer decomposition with constant variables, Global journal of mathematical sciences: Theory and practical, Vol 13, Issue 6, June 2017 ,Pg: 2235 -2254, , Impact Factor: 0.19, ISSN :2320-3242.