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Research Article

Shortest Path On Intuitionistic Trapezoidal Neutrosophic Fuzzy Graphs With Application

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Abstract

In this article, stretch esteemed intuitionistic trapezoidal neutrosophic fuzzy graph (ITrNFG) of SPP, which is drew on trapezoidal numbers and ITrNFG. Hear a genuine application is given an illustrative model for ITrNFG. Additionally Shortest way is determined for this model. This present Chola period buildted temple SPP checked with Dijkstra's Algorithm.

Keywords : Intuitionistic fuzzy number (IFN), Trapezoidal fuzzy number (TrFN), shortest path (SP), Intuitionistic Trapezoidal Neutrosophic Fuzzy Graph (ITrNFG)

I. INTRODUCTION

J.Ye introduced decision making Neural Computing and Applications. [10] and ye[12] 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. P.Jayagowri [19] Using Trapizoidal Intuitionistic Fuzzy Number to Find Optimized Path in a Network. [21] G Kumar, discussed Algorithm for shortest path problem in a network with interval valued intuitionistic trapezoidal fuzzy number

Section II, introduced some basic concepts related to definitions. Section III, introduced ITrNFG proposed algorithm and find SPP using that proposed algorithm. Section IV, we apply real life application. The application has Chola period buildted temple and find its SPP using ITrNFG proposed algorithm. Section V verified shortest path on Chola period buildted temple with Dijkstra's algorithm. Conclusion is given in section VI.

II. METHODOLOGY

In this section we explain some important definition.

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Definition 2.1 [10]

Let $\bar{n}_1 = \langle\, [(t_a^L, t_b^L, t_c^L, t_d^L), (t_a^U, t_b^U, t_c^U, t_d^U)], [(i_a^L, i_b^L, i_c^L, i_d^L), (i_a^U, i_b^U, i_c^U, i_d^U)], [(f_a^L, f_b^L, f_c^L, f_d^L), (f_a^U, f_b^U, f_c^U, f_d^U)] \,\rangle$ and $\bar{n}_2 = \langle\, [(T_a^L, T_b^L, T_c^L, T_d^L), (T_a^U, T_b^U, T_c^U, T_d^U)], [(I_a^L, I_b^L, I_c^L, I_d^L), (I_a^U, I_b^U, I_c^U, I_d^U)], [(F_a^L, F_b^L, F_c^L, F_d^L), (F_a^U, F_b^U, F_c^U, F_d^U)] \,\rangle$ both intuitionistic trapezoidal neutrosophic numbers. Therefore following procedure is hold:

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

We propose definition of score and accuracy functions for an intuitionistic trapezoidal neutrosophic number.

Definition 2.2 [10]

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

$$S(\bar{n}) = \frac{1}{3}\left\{ 2 + \left(\frac{t_a^L + t_b^L + t_c^L + t_d^L}{4} - \frac{t_a^U + t_b^U + t_c^U + t_d^U}{4} \right) - \left(\frac{i_a^L + i_b^L + i_c^L + i_d^L}{4} - \frac{i_a^U + i_b^U + i_c^U + i_d^U}{4} \right) - \left(\frac{f_a^L + f_b^L + f_c^L + f_d^L}{4} - \frac{f_a^U + f_b^U + f_c^U + f_d^U}{4} \right) \right\} \quad \text{-----------------} \quad (1)$$

Where the higher value of $S(\bar{n})$, larger the intuitionistic trapezoidal number $\bar{n}$.

III. INTUITIONISTIC TRAPEZOIDAL NEUTROSOPHIC FUZZY GRAPH ALGORITHM

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

Step :1

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

Step: 2

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

Step : 3

If 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.

IV. DATA ANALYSIS

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

1. Amarasundreashwarar Temple

2. Gangai konda cholapuram

3. Thiruvanai Kovil

4. Moovar Kovil

5. Shri Suryanar Temple

6. Brihadeeswarar Temple

7. Airavatesvara Temple

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

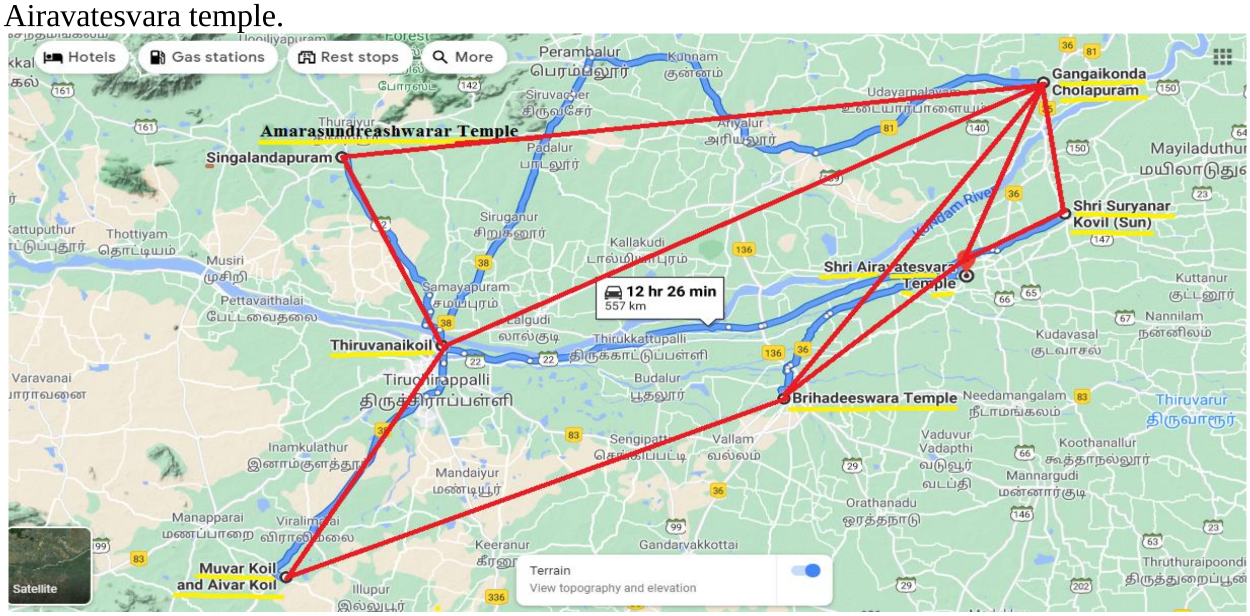


Fig 3: A graph of Chola period buildted temples

Here distance between one temple to another temple is calculated in kilometers. The numerical value of the distance is converted to ITrNFG with the help of through trapezoidal signed distance.

The given distance (kilometer) converted to neutrosophic number. We converted neutrosophic number as (a_1, a_2, a_3, a_4) are membership function & $(a_1^*, a_2^{*'}, a_3^{*'}, a_4^*)$ are nonmembership function. These functions converted to fuzzy trapezoidal numbers using trapezoidal signed distance $\frac{a_1 + a_2 + a_3 + a_4}{4}$. Finally converted interval-valued intuitionistic trapezoidal neutrosophic fuzzy number.

Here, Apply the ITrNFN in our algorithm to find shortest path to India famous seven tourist place

Edges	**Intuitionistic trapezoidal fuzzy neutrosophic numbers**
$1-2$	$<[(0.52, 0.82, 0.95, 0.99), (0.11, 0.14, 0.18, 0.29)], [(0.28, 0.29, 0.34, 0.45), (0.21, 0.66, 0.85, 0.92)], [(0.009, 0.131, 0.159, 0.225), (0.727, 0.869, 0.924, 0.956)]), >$
$1-3$	$<[(0.06, 0.35, 0.47, 0.52), (0.46, 0.57, 0.65, 0.92)], [(0.021, 0.079, 0.142, 0.326), (0.772, 0.803, 0.858, 0.999)], [(0.048, 0.070, 0.105, 0.197), (0.729, 0.895, 0.957, 0.999)]>$
$2-3$	$<[(0.922, 0.955, 0.966, 0.977), (0.027, 0.045, 0.051, 0.057)], [(0.344, 0.392, 0.425, 0.539), (0.237, 0.575, 0.623, 0.865)], [(0.104, 0.124, 0.157, 0.243), (0.727, 0.843, 0.879, 0.923)]>$
$2-5$	$<[(0.125, 0.316, 0.396, 0.427), (0.475, 0.684, 0.725, 0.852)], [(0.057, 0.172, 0.215, 0.244), (0.679, 0.828, 0.88, 0.925)], [(0.042, 0.074, 0.085, 0.095), (0.883, 0.896, 0.926, 0.999)]) >$
$2-6$	$<[(0.41, 0.65, 0.72, 0.82), (0.06, 0.35, 0.42, 0.57)], [(0.19, 0.28, 0.33, 0.52), (0.51, 0.66, 0.69, 0.82)], [(0.043, 0.109, 0.112, 0.172), (0.751, 0.891, 0.956, 0.966)]>$
$3-4$	$<[(0.213, 0.465, 0.525, 0.657), (0.275, 0.535, 0.719, 0.611)], [(0.07, 0.14, 0.22, 0.45), (0.55, 0.78, 0.84, 0.95)], [(0.039, 0.085, 0.105, 0.185), (0.752, 0.897, 0.957, 0.982)]>$
$4-6$	$<[(0.89, 0.95, 0.97, 0.99), (0.01, 0.02, 0.05, 0.12)], [(0.113, 0.435, 0.573, 0.619), (0.293, 0.565, 0.627, 0.775)], [(0.112, 0.128, 0.232, 0.456), (0.537, 0.768, 0.842, 0.925)]>$
$5-6$	$<[(0.37, 0.65, 0.71, 0.87), (0.06, 0.35, 0.47, 0.52)], [(0.14, 0.25, 0.32, 0.57), (0.22, 0.68, 0.87, 0.95)], [(0.05, 0.09, 0.22, 0.32), (0.67, 0.83, 0.85, 0.97)]>$
$5-7$	$<[(0.06, 0.18, 0.21, 0.27), (0.71, 0.82, 0.84, 0.91)], [(0.025, 0.072, 0.089, 0.102), (0.879, 0.928, 0.93, 0.975)], [(0.01, 0.04, 0.06, 0.09), (0.89, 0.95, 0.97, 0.99)]>$
$6-7$	$<[(0.52, 0.61, 0.64, 0.79), (0.25, 0.31, 0.36, 0.52)], [(0.22, 0.3, 0.36, 0.44), (0.59, 0.64, 0.67, 0.78)], [(0.137, 0.155, 0.201, 0.311), (0.619, 0.799, 0.812, 0.966)]>$

Table 1: Intuitionistic trapezoidal fuzzy neutrosophic edge weight.

Iteration: 0

Assume the initial value

$$d_1 = \left\langle \begin{matrix} [(0,0,0,0),\ (0,0,0,0)], [(0,0,0,0),\ (0,0,0,0)],\ [(1,1,1,1), (1,1,1,1)], [(1,1,1,1),\ (1,1,1,1)], \\ [(1,1,1,1), (1,1,1,1)], [(1,1,1,1),\ (1,1,1,1)] \end{matrix} \right\rangle .$$

Here we assume d_1 is the Amarasundreashwarar Temple.

Iteration: 1

In this iteration was calculated through proposed algorithm from Chola period buildted temples, Amarasundreashwarar Temple to Airavatesvara temple.

ITrNSP is calculated to Amarasundreashwarar Temple from Gangai konda cholapuram .

The labeled node is Gangai konda cholapuram and minimum provided corresponding node is Amarasundreashwarar Temple.

Minimum Node	**Labeled Node**	**Path Node**
Amarasundreashwarar Temple	Gangai konda cholapuram	<[(0.52, 0.82, 0.95, 0.99), (0.11, 0.14, 0.18, 0.29)], [(0.28, 0.29, 0.34, 0.45), (0.21, 0.66, 0.85, 0.92)], [(0.009, 0.131, 0.159, 0.225), (0.727, 0.869, 0.924, 0.956)] >

Iteration: 2

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

ITrNSP is calculated to Thiruvanai Kovil from Amarasundreashwarar Temple and Gangai konda cholapuram .

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

Minimum Node	**Labeled Node**	**Path Node**
Gangai konda cholapuram	Thiruvanai Kovil	<[(0.963, 0.992, 0.998, 0.999), (0.134, 0.179, 0.222, 0.33)], [(0.096, 0.114, 0.145, 0.242), (0.049, 0.379, 0.529, 0.796)], [(0.0009, 0.016, 0.025, 0.055), (0.529, 0.732, 0.812, 0.882)] >

Iteration: 3

The node Moovar Kovil was forerunner node of Thiruvanai Kovil.

ITrNSP is calculated to Moovar Kovil from Thiruvanai Kovil.

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

Minimum Node	**Labeled Node**	**Path Node**
Thiruvanai Kovil	Moovar Kovil	<[(0.97, 0.995, 0.999, 0.9996), (0.372, 0.618, 0.78, 0.739)], [(0.007, 0.016, 0.03, 0.1), (0.03, 0.29, 0.44, 0.76)], [(0.0003, 0.001, 0.002, 0.01), (0.398, 0.657, 0.777, 0.866)] >

Iteration: 4

The node Shri Suryanar Temple was forerunner node of Gangai konda cholapuram .

ITrNSP is calculated to Shri Suryanar Temple from Gangai konda cholapuram.

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

Minimum Node	**Labeled Node**	**Path Node**

Gangai konda cholapuram	Shri Suryanar Temple	$<[(0.58, 0.877, 0.969, 0.994), (0.533, 0.728, 0.774, 0.895)], [(0.016, 0.049, 0.0731, 0.109), (0.142, 0.546, 0.748, 0.851)], [(0.0004, 0.009, 0.0135, 0.021), (0.642, 0.779, 0.856, 0.955)]>$

Iteration: 5

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

ITrNSP is calculated to Brihadeeswarar Temple from Gangai konda cholapuram , Moovar Kovil and Shri Suryanar Temple .

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

Minimum Node	**Labeled Node**	**Path Node**
Gangai konda cholapuram	Brihadeeswarar Temple	$<[(0.717, 0.937, 0.986, 0.998), (0.163, 0.441, 0.524, 0.694)], [(0.053, 0.081, 0.112, 0.234), (0.107, 0.436, 0.357, 0.754)], [(0.0004, 0.014, 0.018, 0.039), (0.546, 0.774, 0.883, 0.923)]>$

Iteration: 6

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

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

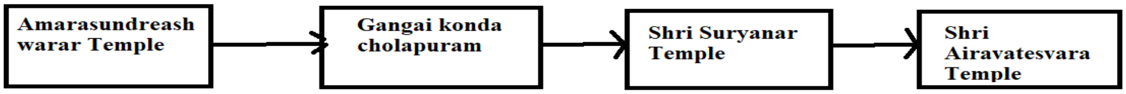
Minimum Node	**Labeled Node**	**Path Node**
Shri Suryanar Temple	Shri Airavatesvara Temple	$<[(0.605, 0.899, 0.9755, 0.996), (0.864, 0.951, 0.964, 0.99)], [(0.0004, 0.0035, 0.006, 0.011), (0.125, 0.507, 0.696, 0.829)], [(0.000004, 0.0004, 0.0008, 0.002), (0.057, 0.74, 0.83, 0.945)]>$

Since Shri 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 trapezoidal neutrosophic fuzzy graph shortest path is



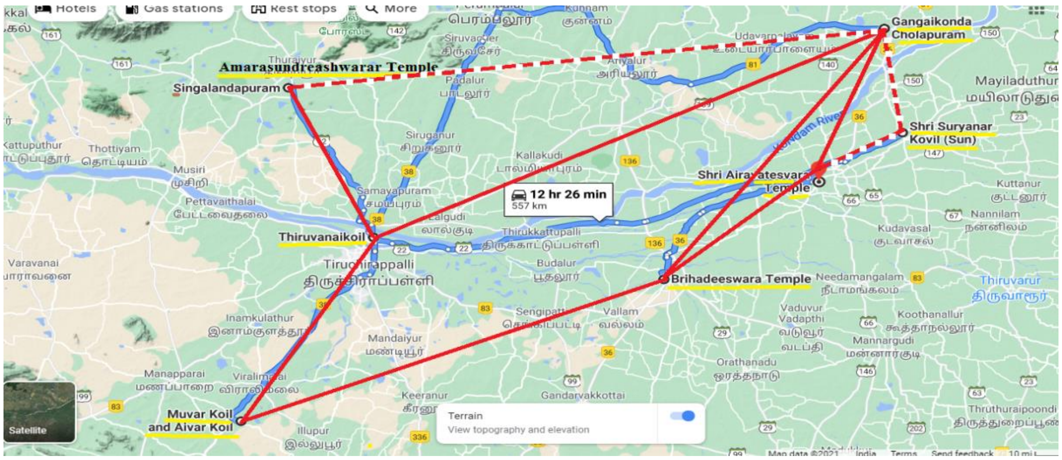


Fig 4: SP from Amarasundreashwarar Temple to Shri Airavatesvara temple.[

V. 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 Chola period buildted temples km.

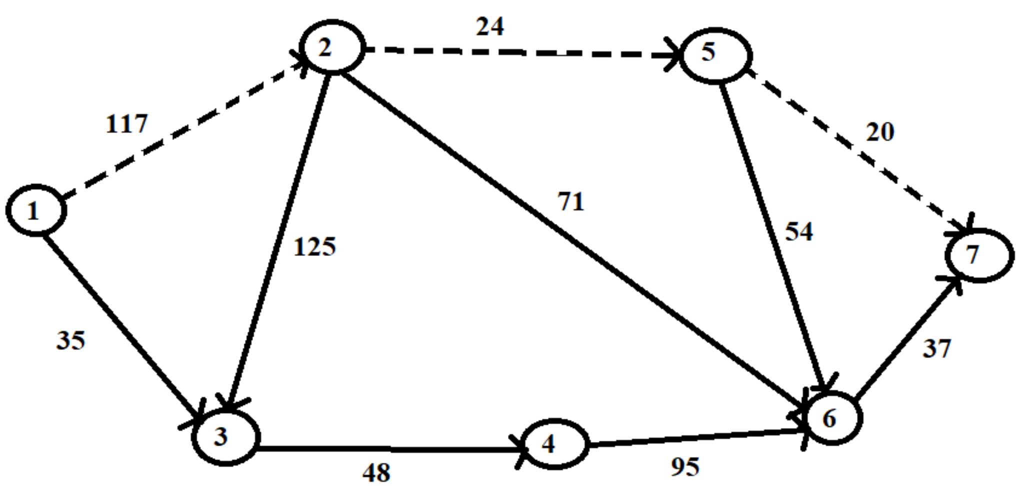


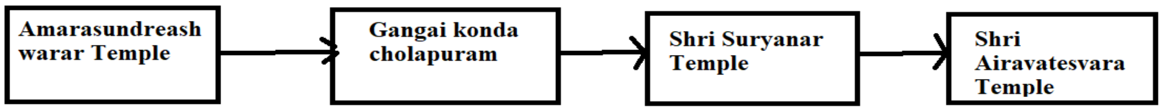
Fig 5 : SP for Dijkstra's Algorithm.

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

$1 \to 2 \to 5 \to 7$

Here these two paths intuitionistic trapezoidal neutrosophic fuzzy graphs and Dijkstra's Algorithm are same. The shortest path is

$1 \to 2 \to 5 \to 7$



VI CONCLUSION

In this article, discovering SP on Chola period buildted temples using intuitionistic trapezoidal neutrosophic fuzzy graph. A genuine application is given to act as an ITrNFG. Finally checked most brief way SP on Chola period buildted temples with Dijkstra'algorithm.

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