International Journal of Mathematics Trends and Technology
ISSN: 2231 – 5373/doi:10.14445/22315373/IJMTT-V67I11P504
Volume 67 Issue 11, 31-37, November, 2021

Calculation of Shortest Path in a Closed Network in Fuzzy Environment

P.K Raut[1], Dr S.P Behera[2], Dr. J.K.Pati[3]

[1]Research Scholar, [2]Assistant Professor, [3]Associate Professor

C.V. Raman Global University, Bhubaneswar, Odisha

Abstract - *In this paper, we have to calculate the shortest path in a directory graph in which vertices (nodes) and edges remain crisp and the edge weight will be a Trapezoidal fuzzy numbers using this concepts we suggest an algorithm that deals with fuzzy shortest path problem, and tried to accumulate most of the exciting ideas on the comparison of trapezoidal fuzzy numbers. Our new algorithm work to find first the shortest path in the associated network and then second we suggest a way to measure the degree between fuzzy shortest path length (FSPL) and each fuzzy path length and the path having the highest similarity degree is the shortest path.*

Keywords - *fuzzy weighted graph, shortest length (path), fuzzy number*

I. INTRODUCTION

This research paper mainly aim to determine the optimal or finest path in a complex network previously various approaches have been used like Breadth first search (BFS), partial derivatives, Dijkstra's algorithm, etc. But by using this fuzzy number, we observed that it provides the best time complexity among all the previously used methods. Hence, we consider the arc length of the network represents travelling time, cost, distance, and other variables. Here we consider a road network over an entire city as closed graph then the shortest path can be found by using the fuzzy logic process. Here we basically deal with Triangular fuzzy number and Trapezoidal fuzzy number.

II. PRELIMINARIES

A. Intuitionistic fuzzy sets (ifs)

Let X be a general set, then an intuitionistic fuzzy set A in X is given by A= {(x, μA(x), υA (x))/x X}. Here the function μA (x): X → [0, 1] and υA(x): X→ [0, 1] this determine the membership and Non membership degree of the element and $0 \leq \mu A(x) + \upsilon A(x) \leq 1$

B. Intuitionistic Fuzzy number

Let A = {(x, μA(x), υA (x))/x X} be an intuitionistic fuzzy set, then we can say (μA(x), υA(x)) an intuitionistic fuzzy number. We represent A= (a, b, c, l, m, n) is an intuitionistic fuzzy number. Where a, b, c ∈ F (I) l, m, n∈ F(I) where I= [0,1] and $0 \leq c+n \leq 1$.

C. Triangular Intuitionistic fuzzy Number

The Triangular intuitionistic fuzzy number A is denoted by {(μ, υ)/x∈ R} where A μA and υA are triangular fuzzy number with $\upsilon A \leq \mu^c A$

1.

Let X is the general set then the fuzzy set is defined as

A = {[x, μA(x)] x∈ X}

And the membership function

μA: X→ [0, 1], where μA(x) denotes the degree of membership of the element x to the set A

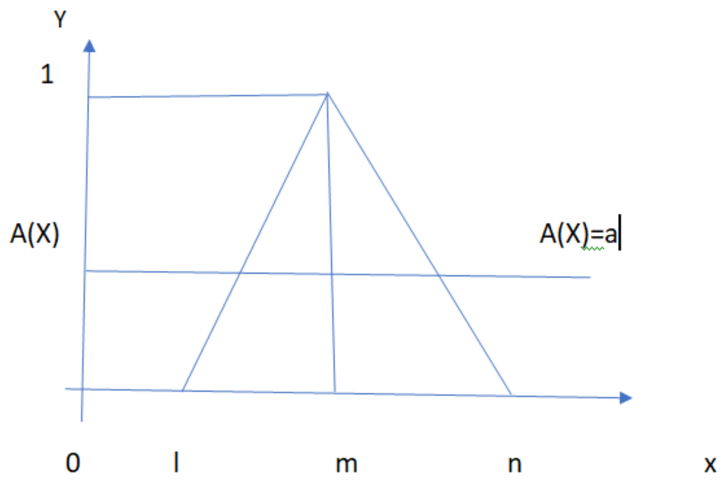
2.

Let A= (m_1, m_2, m_3) and B= (n_1, n_2, n_3) be the two triangular fuzzy number and its sum will be

$A+B = (m_1+n_1, m_2+n_2, m_3+n_3)$

And the membership Functions

$$A(x) = \begin{cases} 0 & \text{If } X \leq m-l \\ \frac{x-(m-l)}{l} & \text{If } m-l<x<m \\ 1 & \text{If } x= m \\ \frac{(m+n)-x}{n} & \text{If } m<x<m+n \\ 0 & \text{If } x \geq m+n \end{cases}$$



IV. FUZZY SHORTEST PATH LENGTH PROCEDURE

In this paper, Triangular fuzzy number is considered as arc length in a network. The shortest path length strategy is based on the Chuang and Kung [4] method

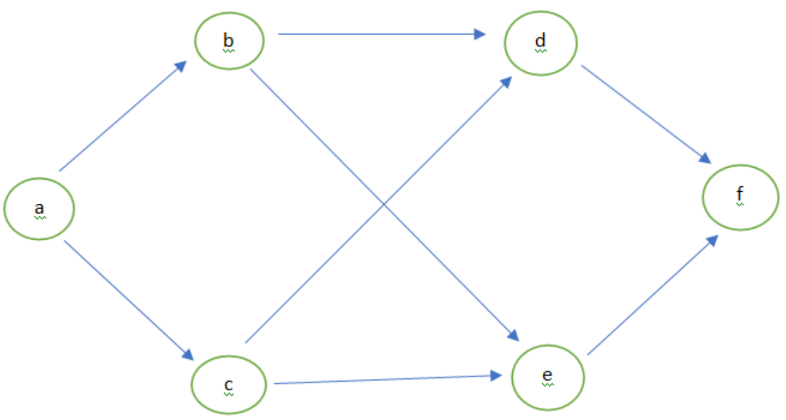
Table A

Fuzzy shortest path length procedure

1. Compute all the possible path length L_I from i=1, 2, n where L_i= (l_1', m_1', n_1').
2.Initialize L_{imn}= (l, m, n) =L_1= (l_1', m_1', n_1')
3.Initialize i=2

4.Compute m: if $m \leq a_i'$ $l=\frac{(m-mi)-(l-li)}{(m+mi)-(l+li)}$ if $m> li$ $m= \min(l, l_i)$ $n=\min(n, n_i)$
5.Set $L_{min} = (l, m, n)$ as calculated in step4
6.I=i+1 If i<n+1, go to step 4

To illustrate the above let us take a example where arc length is take a triangular number shown in fig. B



[Fig B: Network Example]

In figure B. there are four possible paths and the corresponding path length are as follows.

TABLE 2 :(Arc length)

Arc (I, j)	Length L_{ij}
(a, b)	(1,4,5)
(a, c)	(2,3,4)
(b,d)	(1,3,4)
(b,e)	(2,4,6)
(c, d)	(2,5,6)
(c, e)	(2,4,8)
(d, f)	(2,3,8)
(e, f)	(3,6,8)

Step1

S1: a-b-d-f =length L1= (4, 10, 17)

S2: a-b-e-f = length L2 = (6, 14, 18)

S3: a-c-d-f = lengthL3 = (6, 11, 18)

S4: a-c-e-f =length L4 = (7, 13, 20)

Step2

L (min) = (l,m,n)= L1 = (4,10,17)

Step3

Initialize i=2

Step4

Compute (l, m, n):

m=$\frac{(14*10)-(6*4)}{(14*10)-(6+4)}$ =8.2

l=min (6, 4) = 4

n=min (17, 14) = 14

Step5

L (min) = (4, 8.2, 14)

Step-6

I=3 (i=i+1)

Since i$< n + 1$

So then again go to step 4

(4, 8.2, 14)

(6, 11, 18)

m=$\frac{(8.2*11)-(4*6)}{(8.2+11)-(4+6)}$ =7.19

l=min (4, 6) =4

n=min (14, 11) =11

And similarly

i=4, i= (i+1) and i<n+1

So again go to step 4

(4, 7.9, 11)

(7, 13, 20)

m=$\frac{(7.19*13)-(4*7)}{(7.19+13)-(4+7)}$ =7.12

l=min (4, 7) = 4

n=min (11, 13) =11

(4, 7.2, 11)

Step-7

At i=5 the process stops and finally we get fuzzy shortest path (4, 7.12, 11)

IV. ALGORITHM FOR SEARCHING SHORTEST PATH

Here we use new algorithm that used to determine the fuzzy shortest path (length). That follows below

ALGORITHM

1. To find all the path from source vertex S to Destination vertex D .and to calculate the corresponding path length L_i, i =1, 2, 3…n

2. Calculate L_{min} by using fuzzy shortest path length process

3. Find Euclidean distance d for I = 1, 2….n between path and L_{min}

4. Determine the shortest path having the lowest Euclidian distance

From the above algorithm the first two steps have been already calculated

And the second step, we calculate the similar degree between L_{min} and L_i

S (A, B) =$\sum_{K-1}^{M} \frac{[1-|A(x_k - B(x_k))|]}{m}$

Previously we find there are three possible path (length) in fig.(B)

S1= (a-b-d-f)

S2= (a-b-e-f)

S3= (a-c-d-f)

S4= (a-c-e-f)

Hence the minimum path length is L_{min} = a-b-d-f

Now we come to the step-3 and to find the Euclidian distance (d) between all path lengths and L_{min}

For first path=a-b-d-f

Path length is (4, 10, 17) and L_{min} is (4, 7.2, 11)

Hence the Euclidian distance is d (path1,l_{min})=$\sqrt{(4-4)^2 + (10-7.2)^2 + (17-11)^2}$=6.62

For second path=a-b-e-f

Path length is (6, 14, 18) and L_{min} is (4, 7.2, 11)

Hence the Euclidian distance is

d (path2,L_{min})=$\sqrt{(6-4)^2 + (14-7.2)^2 + (18-11)^2}$=9.96

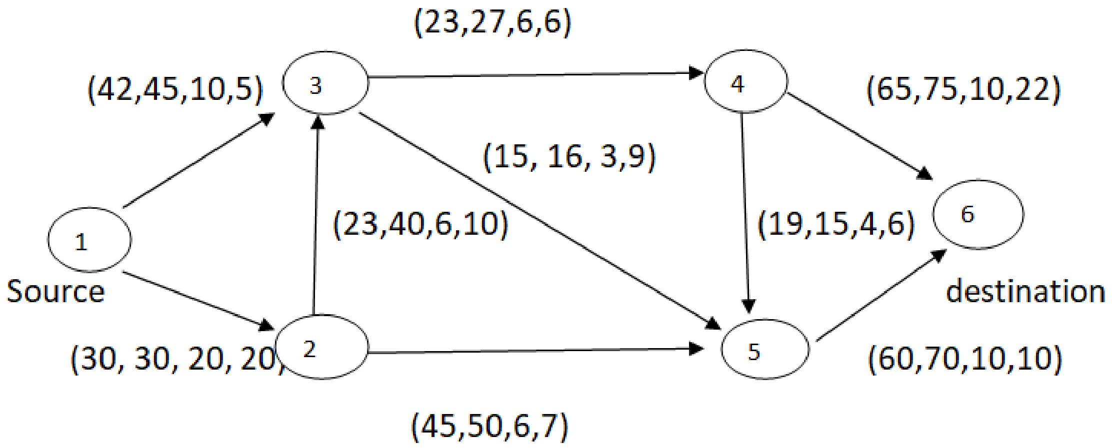
Similarly from path3 is d (path3, L_{min}) = 8.21

And path4 is d (path4, L_{min}) = 11.11

From the above we see that path 1 has the lowest Euclidean distance so we choose the path1 (a-b-d-f) is the shortest path

V. IMPLEMENTATION

A weighted graph with trapezoidal fuzzy lengths shown in fig c, we will propose an algorithm on a fig C. Here we have to determine fuzzy shortest path from source to destination



(Fig.C)

Here the paths are

S1: 1-3-4-6= L1= (130, 147, 26, 33)

S2: 1-3-4-5-6=L2= (144, 157, 30, 27)

S3:1-2-5-6=L3= (135, 150, 36, 37)

S4:1-2-3-5-6=L4= (128, 156, 39, 49)

S5:1-3-5-6=L5= (117, 131, 23, 24)

By using this algorithm we get L_{min}= (113, 117, 26, 23) .Now we get the length between L_{min} and L_i in a table, finally we get S2 is a shortest path where L4 has the highest degree=50.92 to (L_{min})

Paths	$L(l_i, l_{min})$
S1:1-3-4-6	32.38
S2:1-3-4-5-6	50.92
S3:1-2-5-6	43.23
S4:1-2-3-5-6	46.59
S5:1-3-5-6	24.89

VI. CONCLUSION

In this paper, we have developed an algorithm to find the optimal path in a fuzzy weighted graph with edge length is trapezoidal fuzzy number and also this developed algorithm helps to find the shortest path for decision-makers. We have tried to make most of the exciting ideas on the Comparisons of Trapezoidal fuzzy numbers.

VII. REFERENCE

[1] Application of Shortest Path Algorithm to GIS using Fuzzy Logic by Petrík, S. Madarász, L. Ádám,N. Vokorokos.
[2] Chuang T.N, Kung J.Y, The fuzzy shortest path length and the corresponding shortest path in a network, Computers and Operations Research 32 (2005) 1409–1428.
[3] C. M. Klein. Fuzzy shortest paths. Fuzzy Sets and Systems, 39 (1991) 27–41.
[4] T. N. Chuang and J. Y. Kung. The fuzzy shortest path length and the corresponding shortest path in a network. Computers
[5] Dubois, D. and H. Prade, Theory and Applications: Fuzzy Sets and Systems, Academic Press, New York, (1980).
[6] Odada S., Gen M., Fuzzy Shortest Path Problems, Computer and Industrial Engineering, 27 (1994) 465-468.
[7] Milos Seda: Fuzzy Shortest Paths approximation for solving the Fuzzy Steiner Tree Problem in Graphs.
[8] Chris Cornelis, Peter De Kesel, Etienne E. Kerre: Shortest Paths in Fuzzy Weighted Graphs
[9] Okada, S. and T. Soper, A shortest path problem on a network with fuzzy arc lengths, Fuzzy Sets and Systems, 109 (2000) 129-140.