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Fuzzy Shortest Path Problem by Using Ranking Function

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Abstract: ***In this paper algorithm is presented to find shortest path in fuzzy environment. The Trapezoidal fuzzy numbers is given to assess the shortest path from initial node to terminal node by using Ranking Functions.***

Keywords: Fuzzy set theory, Trapezoidal fuzzy numbers, Ranking functions

1. Introduction

The shortest path problems deals on finding the path with minimum distance. It is one of the most fundamentals and well known optimization problems that appear in many application as a sub-problem..In shortest path problems it is assumed that decision maker is certain about the parameters such as distance, days, time etc., between different nodes.

Many researchers have developed much concentration to the fuzzy shortest path, since I is essential to many of applications [1],[2] [6-9]. In some applications the numbers associated with nodes (edges) may represent characteristics (parameters).

The shortest path (length) was first developed by Dubois and Prade [3] Takahashi Yamakami [4] discussed the shortest path with fuzzy parameters.In real life situations there always exist uncertainty about the parameters between different nodes. In such cases the parameters are represented byfuzzyNumbers(Liu.ST & Kao). (10).

2. Preliminaries

Some basic definitions are reviewed

2.1 Definition

The characteristic functionμ_A of a set A is subset of X assigns a value 0 or 1 to each element of X. this functions can be generalized to a function such that the value assigned to the element of the Universal set X, fall within a specified range [0,1]. The assigned value indicate membership function of the element in the set A.

2.2 The functions μ_A is called the membership function and the set A={(x: μ_A(x)} defined byμ_A, (x x) is called a fuzzy set.

2.3 A fuzzy numberA = (a,b,c,d), is a trapezoidal fuzzy numbers if membership funciton is given by

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a} & a \le x \le b \\ 1 & b \le x \le c \\ \frac{x-d}{c-d} & c \le x \le d \end{cases}$$

2.4 Ranking function: [defuzzified values]

A convenient method for using fuzzy numbers is by Ranking [5],[6] (centre of Area) It is defined by **R(Ă)** = $\int_x x\mu_{\check{A}}(x)\, d\,x$

$$\frac{\int_x x\mu_{\check{A}}(x)\, d\,x}{\int_x \mu_{\check{A}}(x)\, d\,x}$$

where μ_A (x) is membership function (aggregated) and x is the output variable.

3. Method of Ranking (Centroid of Area)

The following is the procedure for finding Ranking function for the given Trapezoidal fuzzy numbers (a,b,c,d).

$$\int \mu_A(x)\, d\,x = \int_a^b \frac{x-a}{b-a}\, dx + \int_b^c dx + \int_c^d \frac{x-d}{c-d}\, dx$$

$$\int \mu_A(x)\, d\,x = \frac{1}{b-a}\left[\frac{(x-a)^2}{2}\right] + [c-b] + b\frac{1}{c-d}\left[\frac{(x-d)2}{2}\right]$$

$$= \frac{1}{2}[d+c-b-a]$$

$$\int x\,\mu_A(x)\, d\,x = \int_a^b x\frac{x-a}{b-a}\, dx + \int_b^c x\, dx + \int_c^d x\frac{x-d}{c-d}\, dx$$

$$= \frac{1}{b-a}\left[\frac{(x-a)^3}{3} + a\frac{(x-a)^2}{2}\right]_a^b + \left[\frac{(c^2-b^2)}{2}\right] + \frac{1}{c-d}\left[\frac{(x-d)^3}{3} + d\frac{(x-d)^2}{2}\right]_c^d$$

$$= \frac{1}{6}[d^2+c^2-b^2-a^2-ab+cd]$$

Therefore **R(Ă)** = $\int_x x\mu_{\check{A}}(x)\, d\,x$

$$\frac{\int_x x\mu_{\check{A}}(x)\, d\,x}{\int_x \mu_{\check{A}}(x)\, d\,x}$$

= (1/3{[(a+b+c+d) – (cd-ab) /[(c+d) – (a+b)]}

Special Case:

When b = a **R(Ă) = (a+b+d) / 3**

4. Description of the Model

Trapezoidal fuzzy numbers are converted into expected time (Normal time) by using method of Ranking.. These values treated as a normal time between the nodes and Shortest Path is calculated by using the given algorithm.

4.1 Algorithm

Step 1: Construct the network according to Fulkerson's Rule.

Step 2: From given the Trapezoidal fuzzy numbers using the method of Ranking function find the normal time.

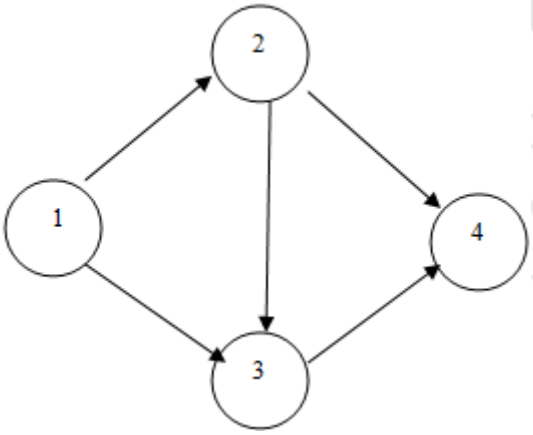
Step 3: Find the number of possible ways (path from initial node to end)

Step 4: From the all possible ways find the summation of normal time, from that find the minimum distance from initial node to terminal node .[ie] Shortest path to complete the project

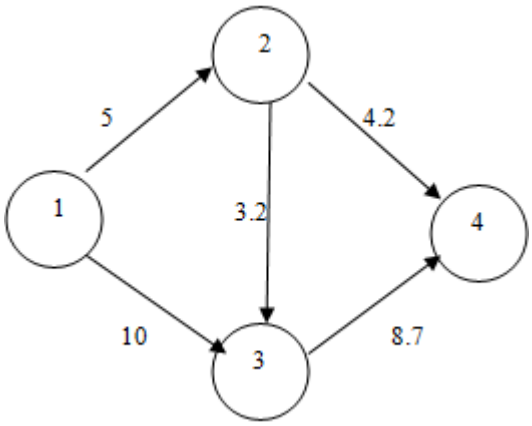
5. Numerical Example

Consider a small network with 4 notes and 5 activities. The distance between them is represented by Trapezoidal fuzzy Nos.

Activity (Aij)	Trapezoidal fuzzy Nos. (a b c d)
A_{12}	- (3 5 5 7)
A_{13}	- (5 10 10 15)
A_{23}	- (1 3 4 5)
A_{24}	- (2 4 5 6)
A_{34}	- (6 8 10 11)



Stage 1: After evaluating the normal time by the method of Ranking function we obtain.



Stage 2: The possible ways are

1 – 2 – 4 = 9.2 ,
1 – 2 – 3 – 4 = 16.9 ,
1 – 3 – 4 = 18.7.

6. Conclusion

In this paper Ranking Function formula applied for trapezoidal fuzzy numbers to convert into normal time and applied given algorithm to find the shortest path from the initial vertex to end vertex.. The decision maker to decide the best possible shortest path in fuzzy environments.

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