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International Journal of Current Research
Vol. 5, Issue, 07, pp.1794-1796, July, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

OPTIMAL SOLUTION FOR FUZZY NETWORKING PROBLEM USING RANKING METHOD

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ARTICLE INFO

Article History:
Received 14th April, 2013
Received in revised form
11th May, 2013
Accepted 20th June, 2013
Published online 18th July, 2013

Key words:
Fuzzy Networking problem,
Fuzzy numbers,
Travelling distance,
Fuzzy ranking method.

ABSTRACT

In this paper, a new method is proposed to find the optimum solution of fuzzy networking problem. The fuzzy networking problem has been transformed into crisp network problem and it is solved by using forward and backward calculation. In this problem, D_{ij} denotes the duration from activity *i* to activity *j*. The distance $\tilde{D}_{ij}$ is taken as trapezoidal fuzzy numbers, which are ranked by using ranking method. The proposed method is easy to understand and to apply for finding the fuzzy critical path of fuzzy networking problem. Numerical example shows that the fuzzy ranking method gives an effective result of fuzzy networking problem.

INTRODUCTION

Network scheduling is the technique used for planning and scheduling large project in which the objective is to minimize the duration. Planning and scheduling are valuable communication and management tools for projects. Critical path method (CPM) and Program evaluation review technique (PERT) are two basic planning and control techniques. CPM is the project modeling technique, which was developed in the 1950's by Morgan. The aim of Critical Path Method is to find the shortest time in which the project can be completed. In this paper, we investigate a more realistic problem, namely, project scheduling problem with fuzzy cost (time) $\tilde{D}_{ij}$. Since the objective is to determine the optimum project duration with minimum cost (time), the objective function is considered also as a fuzzy number. The proposed method is used to rank the fuzzy objective function for finding the best solution. The fuzzy project scheduling problem with ranking method can be applied in linear programming problem, transportation problem, assignment problem, etc. The Yager's 10] ranking method has been adopted to transform the fuzzy network scheduling problem to a crisp one so that the conventional solution method may be applied to solve network scheduling problem. Buckly [1] has applied the triapezoidal fuzzy numbers in linear programming. The basic concepts of fuzzy sets and its applications are discussed by Dubois and Prade [6]. The fuzzy numbers can be explained by many ranking methods [2,4,5,8]. Kikuchi [7] deals the method of defuzzification of fuzzy numbers. Chen [3], Stefan Chanas [9] solved the networking problem with fuzzy duration.

Preliminaries

Definition 1

The membership grade corresponds to the degree to which an element is compatible with the concept represented by fuzzy set.

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Definition2

Let *X* denotes universal set. Then the characteristic function, which assigns certain values or a membership grade to the elements of this universal set within a specified range [0, 1], is known as membership function and the set, thus defined is called a fuzzy set.

Definition3

Let *X* denote a universal set. Then the membership function μ_A by using a fuzzy set *A* is usually denoted as $\mu_A : X \to I$, where I = [0, 1]

Definition4

An α-cut of a fuzzy set *A* is a crisp set A^α that contains all the elements of the universal set *X* that have a membership grade in *A* greater or equal to specified value of α. Thus

$$A^\alpha = \{x \in X, \mu_A(x) \geq \alpha\}, 0 \leq \alpha \leq 1$$

Definition5

A trapezoidal membership function is specified by four parameters (a, b, c, d) and it is defined as follows

$$\mu_A(x) = \begin{cases} f_A(x), a \leq x \leq b \\ 1 \qquad , b \leq x \leq c \\ g_A(x), c \leq x \leq d \\ 0 \qquad , \text{otherwise} \end{cases}$$

where $f_A(x)$ is continuous and increasing function (from 0 to 1), $g_A(x)$ is continuous and decreasing function (from1to 0). This function is determined by the choice of the parameter (a, b, c, d).

Formulation of Fuzzy Net working problem

The Net working problem can be thought of as the opposite of the shortest route problem, i.e., to find the longest route of unit flow entering at the start node and terminating at the finish node. It is defined as follows:

x_{ij} = Amount of flow in activity (*i, j*) for all defined *i* and *j*

D_{ij} = Duration of activity (*i, j*) for all defined i and *j*

Thus the objective function of the linear programming problem as follows:

$$\text{Minimize } z = \sum_{\substack{\text{All defined} \\ \text{activity}(i,j)}} D_{ij} x_{ij}$$

where D_{ij} is the distance from activity *i* to activity *j*, and the variables x_{ij} are all nonnegative. For each node, there is one constraint that represents the conservation of flow,

i.e., Total input flow = Total output flow

The network problem can be formulated with the help of membership function. In the first step, the fuzzy network problem can be converted into equivalent crisp network problem. Here $\tilde{D}_{ij}$ is taken as trapezoidal fuzzy number. When the distance $\tilde{D}_{ij}$ are fuzzy numbers, then the total distance become a fuzzy number.

$$\tilde{z}^* = \min \tilde{z} = \sum \tilde{D}_{ij} x_{ij}$$

It cannot be minimized directly, for solving the fuzzy network problem, it is necessary to defuzzify the fuzzy distance coefficients into crisp ones by a fuzzy number ranking method. By applying ranking method to networking problem, the objective function is defuzzified as

$$r(\tilde{z}^*) = \min \tilde{z} = \sum r(\tilde{D}_{ij}) x_{ij}$$

The ranking of fuzzy number can be calculated as

$$r(\tilde{D}) = \int_0^1 0.5\left(D_\alpha^{\ L} + D_\alpha^{\ U}\right) d\alpha$$

where $\left(D_\alpha^{\ L}, D_\alpha^{\ U}\right)$ is the α - cut of the fuzzy number *D*.

Numerical Example

The proposed method called fuzzy ranking method is illustrated by the following example. Consider the fuzzy networking problem with fuzzy time duration. The problem is to find the critical path and total fuzzy project completion time of the project in Fig.1, which are trapezoidal fuzzy number.

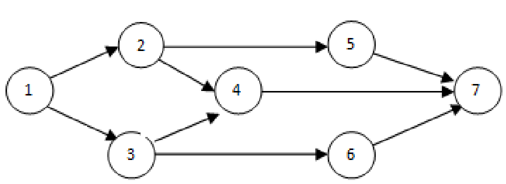

Fig.1

Table 1. The fuzzy duration for the above network activities is given in

Activity	Fuzzy duration
(1,2)	(25,28,32,35)
(1,3)	(40,55,65,70)
(2,4)	(32,37,43,48)
(2,5)	(35,38,42,45)
(3,4)	(20,25,35,40)
(3,6)	(42,45,49,60)
(4,7)	(60,65,75,85)
(5,7)	(65,75,85,90)
(6,7)	(15,18,22,26)

Now, $r(25,28,32,35)$ is calculated by using Yager's ranking method. The membership function of trapezoidal fuzzy number (25, 28, 32, 35) is expressed as follows:

$$\mu(x) = \begin{cases} \dfrac{x-25}{3} & , 25 \le x \le 28 \\ 1 & , 28 \le x \le 32 \\ \dfrac{35-x}{3} & , 32 \le x \le 35 \\ 0 & , \text{otherwise} \end{cases}$$

The α-cut of fuzzy number (25, 28, 32, 35) is (3α+25,35-3α) .The rank of a_{12} is

$$r(a_{12}) = r(25,28,32,35) = \int_0^1 (0.5)(60)d\alpha = 30$$

In similar manner, the remaining duration are calculated using the ranking method

$r(a_{13}) = 57.5$, $r(a_{24}) = 40$,
$r(a_{34}) = 30$, $r(a_{25}) = 40$,
$r(a_{36}) = 49$, $r(a_{47}) = 71.25$,
$r(a_{57}) = 78.75$, $r(a_{67}) = 20.25$

Now, the fuzzy network problem becomes

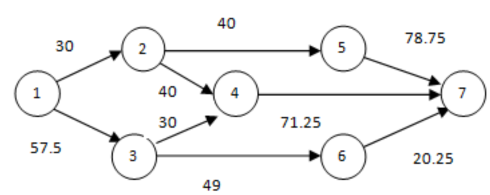

Fig.2

The critical path calculations are calculated in Fig. 2 by using Forward and backward calculations that are as follows:

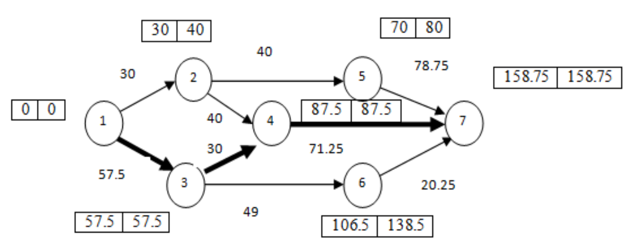

Fig.3

From the above Fig. 3 the critical path is $1 \rightarrow 3 \rightarrow 4 \rightarrow 7$ and the project completion time is 158.75

Conclusion

In this paper, a new method is proposed to solve fuzzy networking problem, which occurs in real life situations. The ranking method is simple and suitable for all type of optimization problem like Linear programming problem, Transportation problem, Assignment problem. The different types of membership function can also be used instead of Trapezoidal membership function.

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