Chapter 69
Fuzzy Critical Path Method Based on a New Approach of Ranking Fuzzy Numbers Using Centroid of Centroids

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ABSTRACT

The Critical Path Method (CPM) is useful for planning and control of complex projects. The CPM identifies the critical activities in the critical path of an activity network. The successful implementation of CPM requires the availability of clear determined time duration for each activity. However, in practical situations this requirement is usually hard to fulfil since many of activities will be executed for the first time. Hence, there is always uncertainty about the time durations of activities in the network planning. This has led to the development of fuzzy CPM. In this paper, a new approach of ranking fuzzy numbers using centroid of centroids of fuzzy numbers to its distance from original point is proposed. The proposed method can rank all types of fuzzy numbers including crisp numbers with different membership functions. The authors apply the proposed ranking method to develop a new fuzzy CPM. The proposed method is illustrated with an example.

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INTRODUCTION

Fuzzy set theory introduced for the first time in 1965 by Zadeh. Since then a lot of problems in fuzzy mathematics has been created and developed. In this highly competitive world, the socio-economic, business and financial scenarios are changing at a faster rate. An investor wants to optimize his resources for high profits and less risk and on-time delivery to customers. To maximize resource utilization and minimize overall cost, project management has always been an important issue for several agencies and industrial organizations. The network techniques used to handle project analysis are Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM). A project, and more generally any activity network, is classically defined as a set of activities which must be performed according to some precedence constraints requiring that some activities cannot start before some others are completed. When resource constraints are not taken into account, a project can be represented by a directed acyclic graph where the nodes stand for activities and the arcs for precedence relations. In this context, the project manager generally aims at minimizing the completion time of the last task. When the activity times in a project are deterministic and known, CPM provides the minimal project duration and identifies the critical paths. Also, there are many cases where the activity times are not deterministic, but random assessments, and in this case PERT which is based on probability theory can be employed. However, in real world applications some activity times must be forecasted subjectively like using human judgement, decision-makers wisdom, professional knowledge, experience, instead of stochastic assumptions to determine activity times. An alternative way to deal with imprecise data is to employ the concept of fuzziness (Zadeh, 1965), whereby the vague activity times can be represented by fuzzy sets.

In this paper a new method is proposed to find a critical path of a project network under fuzzy environment. First, we define a new ranking function based on centroid of centroids of generalized fuzzy numbers to find the maximum and minimum of two trapezoidal fuzzy numbers, whereas other methods used the ranking index proposed by Liou and Wang (1992) or Kaufmann and Gupta (1988). The proposed method is illustrated by a numerical example taken from existing method (Liang and Han, 2004) and it is shown that the results of the proposed method and the existing method are identical.

The rest of the paper is organized as follows: some basic definitions, arithmetic operations of fuzzy sets available from existing literature are reviewed. Literature review of ranking fuzzy numbers is reviewed. Literature review of existing fuzzy critical path of a project network is reviewed. The proposed method of ranking fuzzy numbers using centroid of centroids is explained. New fuzzy critical path method is proposed by defining a fuzzy number using centroid of centroid. The proposed method is illustrated by a numerical example taken from existing method (Liang & Han, 2004) and it is shown that the results of the proposed method and the existing method are identical. Finally the conclusions are given.

FUZZY BASIC DEFINITIONS

In this section, some basic fuzzy basic definitions on fuzzy sets are presented (Kaufmann & Gupta, 1985):

Definition 1: Let U be a Universe set. A fuzzy set $\tilde{A}$ of U is defined by a membership function $f_{\tilde{A}} : U \to [0,1]$ where $f_{\tilde{A}}$ is the grade of x in $\tilde{A}$, $\forall x \in U$;