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A new approach for ranking fuzzy numbers based on fuzzy simulation analysis method

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Abstract

A new approach for ranking fuzzy numbers based on a fuzzy simulation analysis (FSA) method is proposed. A combination method including computer and math application is developed first. The method is intuitive and can be used to order fuzzy numbers easily. The approach is illustrated by numerical examples, showing that it overcomes the shortcoming existing fuzzy ranking approaches, especially when it is difficult to use other methods to solve ranking fuzzy problems.

Keywords: Fuzzy numbers; Fuzzy ranking; Fuzzy simulation analysis method

1. Introduction

In decision theory, each alternative is measured by its ''objective'' or ''utility'' value. Alternatives are ranked on the basis of their objective values, as long as they are crisp numbers. However, if the utility numbers assigned to alternatives

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are fuzzy, the ranking process is no longer straightforward. In practice, many real-world problems require handling and evaluation of fuzzy data for making decision. To evaluate and compare different alternatives among them, it is necessary to rank fuzzy numbers. In addition, the concept of optimum or best choice is completely based on ranking or comparison. With the development of fuzzy set theory, fuzzy ranking has become a topic that has been studied by many researchers since presented by Jain [6] and Dubois and Prade [4]. These methods range from the trivial to the complex, including one fuzzy number attribute to many fuzzy number attributes. A review and comparison of these existing methods can be found in many places [1,2,15]. According to Lee and Li [7], there are two approaches to the ranking methods, namely defining a ranking function or obtaining a fuzzy set of optimal alternatives. Fortemps and Roubens [5] merged the comparison of two fuzzy numbers by two methods. In a more recent review, Wang and Kerre [12,13] proposed several axioms as reasonable properties to determine the rationality of a fuzzy ordering or ranking method and systematically compared a wide array of fuzzy ranking methods. Saade and Schwarzlander [10], used intervals to consider ordering. Their definition was more complicated and did not use the concept of "signed". They only used non-negative values to compare the ordering of fuzzy numbers. In a recent paper, Yoon [14] proposed a probabilistic approach to rank complex fuzzy numbers, but this method raised one caveat. The resulting transformation may not be analytic for all shapes of fuzzy functions, especially when quotients are involved. Liu [9] proposed four methods for fuzzy ranking based on possibility. Tran and Duckstein [11] developed a new method based on fuzzy distance. Of course, this approach can overcome many of the problems inherent to existing methods, but they are difficult and complex to grasp or to apply in solving practical problems. Almost every method, however, has pitfalls in some respect, such as inconsistency with human intuition, indiscrimination and difficulty of interpretation.

In spite of the existence of a variety of methods, no one can rank fuzzy numbers satisfactorily in all cases and situations. Our motivation is to present a new combinative method based on fuzzy simulation analysis which is able to rank the fuzzy numbers effectively.

This paper is organized as follows: the next section introduces the basic concept of fuzzy math and fuzzy simulation. In Section 3, a new approach based on a fuzzy simulation analysis method and its algorithm are proposed for ranking fuzzy numbers. Three simple numerical examples are presented and compared with traditional methods in Section 4, and Section 5 contains conclusion.

2. Basic knowledge of fuzzy math and fuzzy simulation

Fuzzy numbers are a special kind of fuzzy set, which are normal and convex. Although these numbers can be described by using many special methods and