Chapter 4
Intuitionistic Fuzzy Distance-Based Intuitionistic Fuzzy TOPSIS Method and Application to MADM

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ABSTRACT

In this paper, an intuitionistic fuzzy (IF) distance measure between two triangular intuitionistic fuzzy numbers (TIFNs) is developed. The metric properties of the proposed IF distance measures are also studied. Then, based on the IF distance, an extended TOPSIS is developed to solve multi-attribute decision making (MADM) problems with the ratings of alternatives on attributes of TIFNs. In this methodology, the IF distances between each alternative and the TIFN positive ideal-solution are calculated as well as the TIFN negative ideal-solution. Then the relative closeness degrees obtained of each alternative to the TIFN positive ideal solution are TIFNs. Based on the ranking methods of TIFNs the alternatives are ranked. A numerical example is examined to the validity and practicability of the method proposed in this paper.

INTRODUCTION

In the application of fuzzy numbers, distance measures between fuzzy numbers play a very important role. Thus some researchers of Cheng (1998), Chakraborty (2006), Guha and Chakraborty (2010), Tran and Duckstein (2002), Voxman (1998), Xu and Li (2001) have focused their attention to compute the distances between fuzzy numbers (Cheng, 1998; Chakraborty, 2006; Guha & Chakraborty, 2010; Tran

& Duckstein, 2002; Voxman, 1998; Xu & Li, 2001). Atanassov (1999) proposed the intuitionistic fuzzy (IF) sets, which is an extension of the fuzzy set and it is better than fuzzy set in dealing with vagueness and uncertainty of more flexible and practical. Based on the study of distance measures between fuzzy numbers, some researchers studied the distance between IF sets (Grzegorzewski, 2004; Szmidt & Kacprzyk, 2000; Wang & Xin, 2005). As a specialization of IF-set, the concept of intuitionistic fuzzy numbers (IFNs) can express information more abundant and flexible than the fuzzy number. However, there is very little investigation on distance measure between IFNs. Grzegorzewski (2003) studied the distance of IFNs, which is expressed as crisp values. It is unreasonable, the reason is that from a viewpoint of logic, a distance measure between IFNs should be an IFN. In other word, the uncertainty or hesitation or lack of knowledge presented in defining IFN should inherently be involved in their corresponding distance measures. Guha and Chakraborty (2010) studied the distance measure between two IFNs, which is IFN. In this paper, extending the fuzzy distance given by Tran and Duckstein (2002), a new IF distance measure between two triangular intuitionistic fuzzy numbers (TIFNs) defined by Li (2010) is proposed based on interval difference. Here the distance between two TIFNs is also TIFN.

The TOPSIS method is an important method for MADM problems. Some researchers studied classical TOPSIS method (Hwang, 1981; Lai, 1994), and some researchers studied TOPSIS with IF information (Zhang & Xu, 2015; Chen, 2015; Li & Nan, 2011; Li, 2010, 2012). The basic premise of the TOPSIS is that the chosen alternative should be the shortest distance to the positive ideal solution, and the longest distance from the negative ideal solution simultaneously. Thus, the distance measure plays an important role in TOPSIS method. Yu (2014) studied the Hamming distance of TrIFN, and give the TOPSIS method based on TrIFN. However, these distance measures existed TOPSIS were expressed as crisp values, which is unreasonable. So far as we know, there is no investigation on using the IF distance measure in TOPSIS to solve MADM with TIFNs. Thus, based on the new IF distance measure defined in this paper, the TOPSIS is extended to solve MADM problems in which the ratings of alternatives on attributes of TIFNs. The distances of each alternative from the TIFNs positive ideal solution, the TIFNs negative ideal solution and the relative closeness degrees of each alternative to the TIFNs positive ideal solution are calculated and they are still TIFNs. Then according to the ranking method of the weighted value-indexes and weighted ambiguity-indexes of TIFNs given by Li (2015), the alternatives are ranked.

The rest of the paper is organized as follows. Section 2 describes the basic definition and the operations of TrIFNs and TIFNs. The ranking order relation of TIFNs based on weighted value-indexes and weighted ambiguity-indexes is introduced in this section. In section 3, Some exist distances of IFNs are introduced. A new intuitionistic fuzzy distance between TIFNs is defined, respectively. The metric properties are studied. Section 4 introduce the principle of TOPSIS method for MADM with TIFNs and TrIFNs. An improved TOPSIS method be proposed. In section 5, a numerical example of personnel recruitment is used to illustrate the feasibility and practicability of the proposed extended TOPSIS. A short conclusion is given in section 6.

PRELIMINARIES

The Definition of IFNs

How to express an ill-known quantity using the intuitionistic fuzzy set is very important in game modeling. Inspired by the concept of the fuzzy number (Dubois, 1980), an IFN $\tilde{a}$ which is a special intuitionistic fuzzy set on the real number set R is defined as follow.

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