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ORIGINAL ARTICLE

Dynamic Aggregation Operators Based on Intuitionistic Fuzzy Tools and Einstein Operations



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Abstract The idea of combine aggregation and intuitionistic fuzzy information plays essential role in multi criteria decision making (MCDM) process. However, this new branch has attracted researchers that study in different fields recently. In this paper, we study MCDM problems with intuitionistic fuzzy environment. Firstly, we introduce some operations related with Einstein t-norm and t-conorm such as, Einstein sum, product and exponentiation. After that, we define dynamic intuitionistic fuzzy Einstein averaging (DIFWA^ε) operator and dynamic intuitionistic fuzzy Einstein geometric averaging (DIFWG^ε) operator. Their notable property is that collect and aggregate values in different period based on Einstein operations in intuitionistic fuzzy set (IFS)s. In addition, we compare the defined operators with the existing intuitionistic fuzzy dynamic operators and get the corresponding relations. We establish two methods using with DIFWA^ε and DIFWG^ε to solve MCDM problems with intuitionistic fuzzy tools. Finally, an illustrated example is presented to show the applicability of the introduced methods.

Keywords Dynamic operator · Weighted averaging operator · Intuitionistic fuzzy set · Einstein operations

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1. Introduction

Zadeh introduced fuzzy set theory (FST) in 1965 [1], then it has been applied in many areas and MCDM problems. Atanassov extended Zadeh's FST in 1986, and presented intuitionistic fuzzy set (IFS) theory [2]. Atanassov's IFS theory is more powerful technique to deal with vagueness and uncertainty according to FST. IFS consists of a membership degree, a non-membership degree and a hesitation degree. For this reason, it may be claimed that IFS is more appropriate to represent the opinions of decision makers in decision making problems. Therefore, IFS has been exploited in many MCDM problems such as supplier selection [3, 4], medical diagnosis [5, 6], decision making methods [7, 8, 9], pattern recognition [10, 11].

One of the most important issues in decision making problems is to aggregate intuitionistic fuzzy information and intuitionistic fuzzy numbers. The aggregation of these information is required for different decision makers, time periods, evaluations of alternatives. Many aggregation operators have been developed to do this. Xu [12] defined the intuitionistic fuzzy weighted averaging (IFWA) operator, the intuitionistic fuzzy ordered weighted averaging (IFOWA) operator, and the intuitionistic fuzzy hybrid aggregation (IFHA) operator. Xu and Yager [13] proposed some geometric aggregation operators, such as the intuitionistic fuzzy weighted geometric (IFWG) operator, the intuitionistic fuzzy ordered weighted geometric (IFOWG) operator, and the intuitionistic fuzzy hybrid geometric (IFHG) operator. They also applied the IFHG operator for multiple criteria group decision making (MCGDM) problem. Xu and Yager [14] defined intuitionistic fuzzy variable and uncertain intuitionistic fuzzy variable; also dynamic intuitionistic fuzzy weighted averaging (DIFWA) operator when all the decision information about attributes are shown IFSs for different periods and uncertain dynamic intuitionistic fuzzy weighted averaging (UDIFWA) operator when all the decision information about attributes are shown interval-valued IFSs for different periods. They developed two procedures to solve the DIF-MADM problems by using DIFWA operator and UDIFWA operator. Chen [15] analyzed the influences of optimism and pessimism on MCDM problems and introduced optimistic and pessimistic point operators. The author also proposed the optimistic and pessimistic score functions based on point operators to evaluate the alternatives for each criterion. Li [16] improved the generalized ordered weighted averaging (GOWA) operators introduced by Yager [17] using with IFSs. Wei [18] presented induced intuitionistic fuzzy ordered weighted geometric (I-IFOWG) operator and induced interval-valued intuitionistic fuzzy ordered weighted geometric (I-IIFOWG) operator for solving MCGDM problems. During improvement process, the author took into account both the attribute weights and the expert weights which weren't considered previous version of those aggregation operators. Zeng and Su [19] defined an intuitionistic fuzzy ordered weighted distance (IFOWD) operator, which combined both distance measures and aggregation operators. Xu and Xia [20] proposed aggregation operators based on Choquet integrals and Dempster-Shafer operations and extended them to adapt interval-valued intuitionistic fuzzy situations. Tan and Chen [21] proposed an

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