Chapter 8
Some Generalized Intuitionistic Fuzzy Geometric Aggregation Operators with Applications in Multi-Criteria Decision Making Process

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ABSTRACT

The aggregation operators play an important role in the fusion of multidimensional information in decision making process. In this study, a series of generalized aggregation operators such as: the generalized intuitionistic fuzzy weighted geometric (GIFWG) operator, the generalized intuitionistic fuzzy ordered weighted geometric (GIFOWG) operator and the generalized intuitionistic fuzzy hybrid geometric (GIHG) operator are proposed under intuitionistic fuzzy environment by controlling the power of the argument values with an additional parameter p. Some of the important properties and some special cases of these operators are also included in this study. Further, the developed approach is utilized to deal with multi-criteria decision making (MCDM) problems. Numerical examples are constructed to illustrate the developed approach effectively.

1. INTRODUCTION

Zadeh (1965) introduced the concept of fuzzy sets (FSs) as the generalization of classical sets. Atanassov (1986) presented the concept of intuitionistic fuzzy sets (IFSs) as a generalization of FSs, characterized by a membership degree, a non-membership degree and a hesitancy degree. After that IFSs had received more and more attention due to the capability of dealing with vague or imprecise information. Gau and Buehrer (1993) introduced the concept of vague set but Bustine and Burillo (1996) proved

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that the notion of vague set is the same as that of IFSs. This theory is applied in almost every branch of science and engineering such as: decision making (Xu and Yager, 2006; Boran et al., 2009; Xu, 2007b; Xu, 2005; Xu, 2007c; Chan and Kumar, 2007; Xu and Chen, 2007a; Wang, 2008; Zhao, 2009; Xu and Xia, 2011; Zhao et al., 2010; Tan and Chen, 2010; Wang and Liu, 2012; Zhang, 2013; Xia and Xu, 2013; etc), cluster analysis (Iakovidis et al., 2008; Pelekis et al., 2008; Xu, 2009b; Cai et al., 2009; Xu and Wu, 2010; etc), medical diagnosis (Szmidt and Kacprzyk, 2004; Szmidt and Kacprzyk, 2005; Wu et al., 2007; Khatibi and Montazer, 2009; etc) and many more.

Almost in all the applications of IFSs, the aggregation of multi information into a collective one is an important part and received much more attention to practitioners. Yager (1988) introduced the ordered weighted averaging (OWA) operator by providing a parameterized family of aggregation operators. Based on the geometric mean and the OWA operator, the ordered weighted geometric (OWG) operator is developed by Chiclana et. al. (2002). Yager (2004) extended the OWA operator by providing a new class of operators called the generalized ordered weighted averaging (GOWA) operators. These operators have been used in a wide range of applications such as engineering (Cleland and Kocaoglu; 1981), neural networks (Yager, 1995; Yager, 1992), database systems (Bordogna and Pasi, 1995), fuzzy logic controllers (Yager et. al., 1994), decision making (Yager, 1993; Cutello and Montero, 1994), etc. Atanassov (1986, 1989, 1994), De et. al. (2000), Xu (2005, 2007a), Xu & Da (2002) and Xu & Yager (2006) did pioneering standard research on the intuitionistic fuzzy operational laws and the development of aggregation operators. Atanassov (1994) proposed addition and multiplication operation, and De, et. al. (2000) defined scalar multiplication operation and power operation over intuitionistic fuzzy numbers (IFNs). Based on these laws and the OWA operator, Xu (2007a) introduced some intuitionistic fuzzy aggregation operators such as: intuitionistic fuzzy weighted averaging (IFWA) operator, intuitionistic fuzzy ordered weighted averaging (IFOWA) operator and intuitionistic fuzzy hybrid averaging (IFHA) operator. Xu & Yager (2006) developed some intuitionistic fuzzy geometric aggregation operators such as: intuitionistic fuzzy weighted geometric averaging (IFWGA) operator, intuitionistic fuzzy ordered weighted geometric averaging (IFOWGA) operator and intuitionistic fuzzy hybrid geometric averaging (IFHGA) operator based on the OWG operator.

Zhao et. al. (2010) pointed out that the GOWA operators had not been extended to accommodate intuitionistic fuzzy environment. Thus, Zhao et. al. (2010) introduced a class of new aggregation operators such as: generalized intuitionistic fuzzy weighted averaging (GIFWA) operator, generalized intuitionistic fuzzy ordered weighted average (GIFOWA) operator and generalized intuitionistic fuzzy hybrid average (GIFHA) operator. Yet the generalized geometric aggregation operators are not introduced to accommodate intuitionistic fuzzy information. So, effort is made in this direction to propose a series of generalized aggregation operators such as: the generalized intuitionistic fuzzy weighted geometric (GIFWG) operator, the generalized intuitionistic fuzzy ordered weighted geometric (GIFOWG) operator and the generalized intuitionistic fuzzy hybrid geometric (GIHG) operator are proposed under intuitionistic fuzzy environment by controlling the power of the argument values with an additional parameter p. Some of the important properties and some special cases of these operators are also included in this study. Further, the developed approach is utilized to deal with multi-criteria decision making (MCDM) problems. Numerical examples are constructed to illustrate the developed approach effectively.