

A Multi-Attribute Decision-Making Model Using Interval-Valued Intuitionistic Fuzzy Numbers and Attribute Correlation

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ABSTRACT

This article describes a decision analysis method with attribute correlation and attribute values of interval-valued intuitionistic fuzzy numbers (IVIFN). This considers the correlation between attributes and undetermined attribute weight information was put forward against the case where solution attribute values are interval-valued intuitionistic fuzzy numbers. To achieve a comprehensive consideration of the undetermined evaluation attribute weight information, experts' positive and negative ideal solutions against each attribute are taken as reference points, attribute weight is obtained via decision making trial and evaluation laboratory (DEMATEL) method according to the direct relation matrix provided by experts against attribute sets. On this basis, evaluation information is aggregated by using weighted arithmetic average operators. Then, the closeness degree formula of interval-valued intuitionistic fuzzy numbers relative to the maximum IVIFN is provided by combining the Euclidean distance of IVIFN, thus determining closeness degree and making an ordering of all solutions. Finally, the feasibility and validity of the method proposed in this study are verified via a case analysis of the best information system decision-making.

KEYWORDS

Attribute Correlation, DEMATEL, Interval-Valued Intuitionistic Fuzzy Number, Multi-Attribute Decision-Making, Relative Closeness Degree

1. INTRODUCTION

The essence of multi-attribute decision-making is to order and pick over a group of (limited) alternatives via a certain way by using the existing decision-making information. In social, economic, technological, military, and other decision-making problems, decision makers often need to provide their preference information of decision-making solutions. However, due to the complexity of actual decision-making environment, as well as the knowledge structure and professional level of decision makers, time and other factors, decision makers usually fail to provide accurate preference information regarding decision-making schemes, there is still a certain degree of hesitation, in this case it would

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be more suitable to adopt intuitionistic fuzzy numbers or interval-valued intuitionistic fuzzy numbers (IVIFN) to express the decision makers' preference information.

In recent years, interval-valued intuitionistic fuzzy set-related research has attracted attention of experts and scholars, and has been widely applied in the study of multi-attribute decision-making issues. For instance: Nayagam *et al.* (2011) introduced and studied a new method for ranking interval-valued intuitionistic fuzzy sets. This method is illustrated by numerical examples and compared with other methods. Park *et al.* (2011) extend the technique for order preference by similarity to ideal solution (TOPSIS) method to solve multiple attribute group decision making (MAGDM) problems in interval-valued intuitionistic fuzzy environment in which all the preference information provided by the decision-makers is presented as interval-valued intuitionistic fuzzy decision matrices. Ye (2010) proposed a multi-criteria decision-making method based on the weighted correlation coefficients of entropy under an intuitionistic fuzzy environment, as well as providing the evaluation formula of weighted correlation coefficients of the ideal solution, but there will be some difficulties in applying the method to an interval-valued intuitionistic fuzzy environment. Zhang *et al.* (2012) proposed a decision-making method that is based on interval-valued intuitionistic fuzzy entropy against decision-making problems with completely unknown attribute weight. Gao *et al.* (2014) proposed an interval-valued intuitionistic fuzzy multi-criteria decision-making method that is based on prospect theory against multi-criteria decision-making problems with completely unknown or partly known criteria weight. Park *et al.* (2009) and Xu (2010) proposed several decision-making methods based on the correlation coefficient and distance measure of interval-valued intuitionistic fuzzy sets (IVIFSs).

Tomas and Zeng (2013) proposed an extension of the multiplication multi-objective optimization ratio analysis (MULTIMOORA) method based upon interval-valued fuzzy numbers, provided the means for multi-criteria decision making related to uncertain assessments. Chen *et al.* (2011) developed an approach to tackle multiple criteria group decision-making problems in the context of interval-valued intuitionistic fuzzy sets. Li (2010) developed a nonlinear programming methodology that is based on the technique for order preference by similarity to ideal solution to solve multi-attribute decision-making problems with both ratings of alternatives on attributes and weights of attributes expressed with IVIFSs. Liu and Ren (2015) proposed a new type of multi-attribute decision-making method for intuitionistic fuzzy entropy against the existing intuitionistic fuzzy entropy, which only considers the deviation between membership degree and non-membership degree without considering intuitionistic fuzzy set's lack of hesitancy degree information. Wang (2006) and Wei (2008) set up an objective programming model based on distance measure and deviation maximization, respectively, and proposed a multi-attribute decision-making method with incomplete attribute weight information and attribute values of interval-valued intuitionistic fuzzy numbers. In the frame of intuitionistic fuzzy set and interval-valued intuitionistic fuzzy sets, Xu (2008), Wang *et al.* (2009), Nayagam *et al.* (2011), Li *et al.* (2014) and Liu *et al.* (2015) discussed the ordering of intuitionistic fuzzy sets and IVIFSs, and provided the application of these ordering methods in multi-attribute decision-making.

Yuan *et al.* (2014) proposed a new decision-making method based on correlation coefficients of interval-valued intuitionistic fuzzy numbers, which makes up the drawback of information confusion caused by decision-making methods that are based on distance measure while considering the impact of hesitancy degree, thereby reducing the loss of evaluation information. Shao and Zhao (2016) studies multi-criteria decision-making problems with completely unknown weight and evaluation information of interval-valued intuitionistic fuzzy numbers, he takes into account the impact of hesitancy degree, provides the vector expression of alternatives, positive and negative ideal solutions and proposes a vector projection measurement method in allusion to interval-valued intuitionistic fuzzy information. Qi *et al.* (2011) proposed an interval-valued intuitionistic fuzzy multi-attribute group decision-making method based on maximum entropy against decision-making problems with interval-valued intuitionistic fuzzy numbers and completely unknown attribute weight. Wang and Liu (2013) proposed an approach to multi-attribute decision making (MADM) where individual assessments are provided as interval-valued intuitionistic fuzzy numbers (IVIFNs). Liu (2015) drew

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