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The Intuitionistic Fuzzy FlowSort Method for Multicriteria Group Decision Making

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ABSTRACT

The real-life problems are multidimensional in nature and may involve some ambiguity when it comes to decision making. It is, therefore, difficult to design the evaluation criteria precisely and determine the exact value of the attributes in the multicriteria analysis. The intuitionistic fuzzy set (IFS) achieved great success in treating this kind of ambiguity in a great deal of research. The study of sorting problems is an active research issue in the multiple criteria decision aid (MCDA) area. This paper investigated one of the sorting methods, FLOWSORT, and extended it to the multicriteria group decision making based on the output aggregation of the individual sorting results. The rating of each alternative was described through linguistic terms that can be expressed in triangular intuitionistic fuzzy numbers. An illustrative example as well as an empirical comparison with other multi-criteria decision-making methods were carried out to validate the extension.

KEYWORDS

FlowSort Method, Intuitionistic Fuzzy Set, Multicriteria Group Decision Making, Sorting Problematic

1. INTRODUCTION

Multi-criteria decision making (MCDM) is considered as an essential part of modern decision science and operational research. It is the process of finding the best compromise among the feasible alternatives. It provides a wide variety of methodologies and techniques that enable the systematic treatment of decision problems under multiple criteria. The MCDA methods can be applied to four different kinds of analyses that can be performed in order to provide significant support to decision-makers (Remadi and Frikha, 2019). These are: (1) the choice of the best alternative, (2) the ranking of the set of the alternatives from the best to the worst, (3) the description of the features of the alternatives and (4) the classification of the alternatives into predefined homogenous groups.

In this paper, we studied the ordinal classification problem, also called sorting problem. It consists to orienting the decision problem to an assignment of alternatives to one of the predefined, ordered and homogenous categories or classes. The class is a set of alternatives with similar properties or even values for the same properties, when compared to the alternatives of the other classes. Multiple methods have been proposed during the previous decades. Among these, we can mention the well-known sorting methods, the ELECTRE-TRI (Shen et al. 2016), the THESEUS (Fernandez and Avarro, 2011), etc. Relying on the PROMETHEE (Brans et al. 1984) methodology, several authors proposed

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the PROMETHEE-TRI (Figueira et al. 2004), the PROMSORT (Araz and Ozkarahan, 2007) and the FlowSort (Nemery and Lamboray, 2007). In fact, the PROMETHEE is one of the most famous MCDM methods since it is easy to use, simple to process and uses less parameter than the other MCDM methods like ELECTRE (Govindan and Jepsen, 2016). Figueira et al. were pioneers in the PROMETHEE-TRI (Figueira et al. 2004) method, extending it to the sorting context, but it rather used incompletely ordered categories. In 2007, Araz & Ozkarahan proposed the PROMSORT (Araz and Ozkarahan, 2007) method which uses completely ordered categories but the assignment of the alternatives was not independent.

Developed by Nemery and Lamboray in 2007, FlowSort (Nemery and Lamboray, 2007) was proposed for assigning actions to completely ordered categories defined by limiting profiles or central profiles. It solves the drawbacks of PROMETHEE-TRI (Figueira et al. 2004) and PROMSORT (Araz and Ozkarahan 2007) and treats the problematic sorting issue for independent assignments and completely ordered categories. The alternatives and preference parameters evaluation of the FlowSort method are defined as crisp values. But, in a real-world situation, decisional problems are multidimensional and ambiguous in nature. So, it is difficult to express the evaluation criteria precisely. Multiple extensions of the FlowSort method have been developed to solve these problems. Indeed, Janssen and Nemery (2012) proposed an extension of the FlowSort sorting method to the case of input data imprecision. Moreover, Campos et al. (2015) extended FlowSort method to introduce a fuzzy sorting method called Fuzzy FlowSort (F-FlowSort). For a simplified FlowSort version, Assche and De Smet (2016) found the parameters of a sorting model using classification examples in the context of traditional sorting and interval sorting. Moreover, Pelissari et al. (2019) suggested a new multicriteria method SMAA-Fuzzy-FlowSort for sorting problems under uncertainty through applying the Stochastic Acceptability Analysis to the Fuzzy-FlowSort method.

As clearly stated above, the fuzzy set (FS) theory (Zadeh, 1965) has been successfully applied in a good number of studies. But, this theory is not flawless as it uses only the membership degree of an element to a fuzzy set which is belongs zero and one. Actually, it is necessary to define the non-membership degree of an element to a fuzzy set because it is not necessarily equal to 1 minus the degree of membership. To overcome this limitation, the intuitionistic fuzzy sets theory concept seems to be more suitable to deal with uncertainty than other generalized fuzzy sets forms (Zhang et al. 2013). Further, compared to the traditional fuzzy set, the IFS can describe the fuzzy nature of the real world more comprehensively (Wang et al. 2012). In fact, it provides more flexibility to treat real life problems under an uncertain environment because when the area changes, the intuitionistic fuzzy sets are easy to modify (Zhang et al. 2013). Remadi and Frikha, (2019) extended the FlowSort method for solving uncertainty using the IFS theory. This study presented the input data in the decision matrix as triangular intuitionistic fuzzy number and we considered parameter values such as indifference and preference thresholds, criteria weights and reference profiles as crisp numbers.

The complexity of the socio -economic environment causes single decision-makers to be unable to express their opinions or preferences on multiple criteria. In fact, the multiple criteria group decision making (MCGDM) problem is an important research topic that has drawn the attention of many researchers in the literature. In addition, the intuitionistic fuzzy set was applied to solve real complex Multicriteria Group Decision Making problems. Park et al. (2011) for instance, extended the group decision-making VIKOR method for an interval-valued intuitionistic fuzzy environment, in which the attribute weights information was partially known. In addition, Chen (2015) developed an extended TOPSIS (Chen and Hwang, 1992) method which included the comparison approach to address multiple criteria group decision-making medical problems in the interval-valued intuitionistic fuzzy set framework. In the context of sorting problem, Shen et al. (2016) provided a new outranking sorting method for solving Multi-Criteria Group Decision Making (MCGDM) problems using the Intuitionistic Fuzzy Set (IFS). Furthermore, Lolli et al. (2015) introduced a group decision support system, named FlowSort-GDSS, for sorting the failure modes into priority classes. Jiang and Ma (2018)