A New Fuzzy Joint Choquet Integral Method Under Interval-Valued Function

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ABSTRACT

A new fuzzy group decision-making method considering multi-attributes correlation under interval-valued function is presented, which mainly includes (1) acquiring the group fuzzy preference matrix and (2) handling the interactions between multiple evaluation attributes. To do that, firstly, the fuzzy joint Choquet integral based on an interval-valued function is proposed, which not only reflects the interaction between multiple attributes in a complex and uncertain environment, but also retains the initial preference of the decision maker. Secondly, a Shapley value with fuzzy measure is applied to assign each decision maker's weight, and the fuzzy group preference matrix is acquired by fusing the fuzzy preference matrices of all decision makers. Finally, a nursing home selection case is depicted to explain the effectiveness of the proposed technique. The corresponding sensitivity analysis is operated, which clarifies the reliability and flexibility of the proposed technique.

KEYWORDS

1. INTRODUCTION

The multi-attribute group decision making (MAGDM) is to fuse preferences depicted through some decision makers about evaluation attributes for alternatives (Li, 2007; Fu et al. 2020). The problem of MAGDM can be seen everywhere in daily life (Tong et al.,2022; Zheng er al.,2023; Chao et al.,2021). For example, people are concerned about the choice of nursing homes, the choice of cruise ships (Cao et al.,2022) or the choice of sustainable suppliers (Xu et al.,2019). In the traditional MAGDM, the evaluation attributes belong to a mutually independent state. Due to the advent of social media, the environment of MAGDM becomes complicated, which makes the evaluation attributes have a certain degree of uncertainty, resulting in a certain relationship between evaluation attributes. Therefore, how to build a new MAGDM method with multi-evaluation attributes correlation is the key problem addressed in this paper.

One of the key issues is to deal with the correlation between multiple evaluation attributes (Ju et al.,2020; Chen et al. 2020; Li et al., 2020). In the traditional process of MAGDM, the weights of evaluation attributes are subjectively given or objectively obtained. This indicates that these evaluation attributes are independent of each other. However, Due to the advent of social media, the environment

of MAGDM becomes more and more complex and uncertain, which makes the evaluation attributes have some correlation with each other (Marichal & Roubens, 2000; She et al.,2021; Teng& Liu, 2021). For example, the evaluation attributes in nursing homes include living environment, hardware facilities and the literacy of accompanying personnel. The living environment can reflect the good attitude of the caregivers to work, and the high-quality caregivers also show that their serious attitude in work makes the living environment of the elderly comfortable. This indicates that there is a positive relationship between the evaluation attributes of nursing homes.

Choquet integral is an effective way to solve the interaction between multiple evaluation attributes (Teng& Liu, 2021; Wang et al.,2018; Byüközkan et al.,2021]. For example, Teng et al. (2021) designed a generalized Choquet integral to explore the correlation between evaluation attributes in MAGDM. At the same time, the Pythagorean fuzzy number based Choquet integral is proposed to discuss the interaction between multiple evaluation attributes (Byüközkan et al.,2021). These Choquet integral methods can not preserve the initial preferences of each decision maker in the merging of all preference fusion, while fuzzy numbers with interval valued functions can deal with this problem well (Dubois & Prade, 1980; Qiu,2021; Qiu &Yu, 2023; Li et al.,2018; 2020; Fei et al.,2018; Nan,2014). In the traditional Choquet integral, the multiple evaluation attributes are local interaction, only some attributes coalitions are considered. In order to consider all attribute coalitions, hence, the fuzzy joint Choquet integral based on an interval-valued function is put forward to deal with the correlation between multiple evaluation attributes in this paper.

Another key issue is how to reflect the global interaction relationship between decision makers. In traditional MAGDM stage, decision makers' weights are also subjectively given or objectively calculated (Hendiani et al.,2020; Liu et al.2019; Xu et al.2019). This also shows that the decision makers belong to an independent state. With the emergence of Internet media, there is a certain trust relationship between decision makers, and some scholars regard this trust relationship as a reliability resource to dominate the weight of decision makers (Lu et al., 2021; Zhang et al., 2020, Teng et al., 2022; Xu et al.,2020; Liu et al.,2019). For instance, the trust relationship is used to induce the weight of decision makers (Liu et al.,2019). Ma et al. (2021) formalized the trust relationship as an interaction weight between two decision makers. Although this reflects the interaction relationship of all decision makers in the merging of MAGDM. However, this kind of interaction is a local relationship, which does not make decision makers interact globally to ensure the fairness of weight allocation. Therefore, the Shapley value is applied in this paper to fairly dominate decision makers' weights.

Based on the above literature analysis and inspiration, a new fuzzy group decision making method considering multi-evaluation attributes correlation under interval-valued function is put forward, which it mainly includes two innovations:

(1) The fuzzy joint Choquet integral based on an interval-valued function is put forward. First, fuzzy Choquet integral ($F - CI_{\mu}$) and the fuzzy inverse Choquet integral ($FR - CI_{\mu}$) under an interval-valued function are put forward, respectively. And then the fuzzy joint Choquet integral ($FJ - CI_{\mu}$) under an interval-valued function is proposed, which is composed of the linear convex combination of $F - CI_{\mu}$ and $FR - CI_{\mu}$. This $FJ - CI_{\mu}$ not only reflects the global interaction between multiple attributes, but also retains the initial preference of the decision maker.

(2) The new fuzzy group decision making method is presented. First, the Shapley value with fuzzy measure is applied to assign the weight of each decision maker, which illustrates the global interaction among decision makers to ensure the fairness of each decision maker. And then, the fuzzy group preference matrix is acquired by fusing the fuzzy preference matrices of all decision makers.

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