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Fuzzy Decision-Making Methods Based on Prospect Theory and Its Application in Venture Capital

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Preface

As the development of computer techniques, information updating has sped up and the decision-making environments have been more and more complex. It brings huge challenges for Decision-Makers (DMs) to make a complete rational choice under such complex decision-making circumstance. Hence, the researches about behavioral decision-making with bounded rationality have become more and more popular among researchers around the world. Prospect Theory (PT) is an important theory to explain the bounded rational decision-making under uncertainty, and it has been widely used in behavioral decision making. In addition, fuzzy information has been constantly developed and extended since it was proposed due to its advantage in describing the real perceptions of DMs for decision-making objects. Thus, the Multi-Attribute Decision-Making (MADM) with fuzzy information has been rapidly constructed and widely applied to various fields. Based on the analysis above, in this book, we focus on introducing the MADM methods under different fuzzy circumstances with prospect framework, in which the PT is used to portray the bounded rational characteristics of DMs and the fuzzy information is adopted to depict the real perceptions of them for alternatives in the decision-making process. Also, these methods will be used to solve the decision-making problems in investment field. The detailed contexts of this book are summarized as follows:

(1) Considering the net certain level represented by the shortfall between the membership and non-membership of intuitionistic fuzzy information, the score function of intuitionistic fuzzy information takes the place of the variable of weighting function in PT. Furthermore, the average of evaluation information under each attribute is adopted as the decision-making reference point. According to this, the prospect value of each alternative is calculated. In this book, the detailed steps of the decision-making method with PT under intuitionistic fuzzy circumstance [1] are given in Chap. 2. Then, an illustrative example for investors to select an optimal alternative is conducted to show the feasibility and effectiveness of the given method. Also, a comparative analysis is carried out between this method and the TOPSIS with intuitionistic fuzzy information to show its advantages.

(2) The QUALIFLEX is a pairwise comparison method for alternatives with respect to each attribute under all possible permutations. Moreover, the linguistic term is a very general way used by DMs to express their real perceptions. In particular, the probabilistic linguistic information, including the probability of each linguistic term, can simulate the vague perceptions of the DMs well. It is common for the DMs to have different risk attitudes for gain and loss when making their decisions under uncertainty, which is well explained by PT. Hence, PT has been integrated into the QUALIFLEX. Then, in this book, a QUALIFLEX based on PT (named as prospect QUALIFLEX) with probabilistic linguistic information [2] is introduced in Chap. 3. In order to show the advantages of this prospect QUALIFLEX, an extended QUALIFLEX with probabilistic linguistic information [2] is given in this chapter as well. The feasibility and validity of those methods have been verified by a numerical example in venture capital. The comparative and simulated analyses show that the former method with prospect framework is more appropriate than the latter one because of the inherent psychological behaviors of the DMs and its excellent ability in identifying the similar alternatives.

(3) In this book, the idea of PT has been integrated into the ranking method-PROMETHEE [3] in Chap. 4 as well. Additionally, considering the universality and flexibility of the linguistic information in daily life, the hesitant fuzzy linguistic information is adopted as the basic line of evaluation information of the method. Also, the advantages of group decision-making have been considered in this book. Therefore, a group PROMETHEE based on PT under hesitant fuzzy linguistic circumstance[3] is given. Moreover, in order to show its feasibility and availability, other related methods [3] have been introduced in this book as well, such as the extended PROMETHEE and TODIM with hesitant fuzzy linguistic information. The advantages and disadvantages of those methods have been verified by the comparative analysis from an illustrative example, by the sensitive analysis and by the simulation analysis, respectively.

(4) Consensus is an important and essential issue, which is deserved to be studied in group decision making. In this book, the PT has been introduced to explore the psychological characteristics of DMs in consensus problem, and the probabilistic hesitant fuzzy preference information is used as the basic line of the evaluation information. Therefore, a consensus model based on the PT under probabilistic hesitant fuzzy preference circumstance [4] is introduced in Chap. 5. To explain the advantages of this model, other consensus models [4] are also given, such as the consensus process based on PT with hesitant fuzzy preference information, the consensus process based on expected theory with probabilistic hesitant fuzzy preference information and hesitant fuzzy preference information correspondingly. Moreover, the idea of variance to measure the fluctuation of data [4] has been introduced in the consensus model to measure the consensus degree of DMs. Then, the measurement and adjustment of consensus based on priority vector [4] is given. Furthermore, these methods are applied to solve a decision-making problem so as to demonstrate

their feasibility. Also, the comparative analysis [4] is used to explore the advantages and disadvantages of those methods. Obviously, the method based on PT with probabilistic hesitant fuzzy preference information is better due to the fact that PT reflects the behaviors of DMs in the decision-making process and that the probabilistic hesitant fuzzy preference information includes more original information. Finally, 1000 sets of random decision-making information [4] are produced to demonstrate the difficult degree of reaching consensus among the four methods, and it demonstrates that the consensus with PT is more difficult to achieve than with expected theory, which means that the former one is more precise in reaching consensus and making decisions.

(5) According to PT, the improvement of the conventional TODIM [5] is shown in Chap. 6. Because the classical TODIM could not fully reflect the different risk attitudes of DMs and ignores the transformed weighting function in the decision-making process explained by PT. Hence, an improved TODIM which comprehensively considers those behaviors is introduced.

Due to the advantage of probabilistic hesitant fuzzy information in describing the different hesitancy degrees of DMs among several possible hesitancy values, the improved TODIM with probabilistic hesitant fuzzy information [6] is introduced in Chap. 7. The improved TODIM with hesitant fuzzy information [6] is introduced, too. In order to show the advantages of this improved TODIM, the classical TODIM has been given under both probabilistic hesitant fuzzy circumstance and hesitant fuzzy circumstance [6]. Those four methods are used to analyze the investment decision-making problem. Then, the comparative analysis about the difference of the results is presented [6]. Also, the sensitive analysis about the parameters in those methods and the simulation analysis with 1000 decision-making information are used to show the advantages of the improved TODIM with probabilistic hesitant fuzzy information [6]. When the improved TODIM is compared with the classical TODIM, the former one includes the transformed weighting function to reflect the real perceptions of DMs is more appropriate. When the TODIM under probabilistic hesitant fuzzy circumstance is compared with TODIM under hesitant fuzzy circumstance, the former one can reflect more evaluation information and it is more flexible.

From the perspective of theory, they are presented above. There are also applications for those MADM methods. From the perspective of practical application, they are used to solve the decision-making problems of investors. It not only considers the bounded rational characteristics of investors in the decision-making process, but also reflects the vague perceptions of investors for the objects caused by the limited ability of them, the asymmetric information, etc. It provides an effective way for investors to solve the decision-making problems. Moreover, in this book, the decision-making indices for both the initial selection of project and the sequential decision-making of funding the project or not have been given.

In general, PT is adopted as the basic theory to describe the decision-making behaviors of DMs under uncertain decision-making circumstance, and the different types of fuzzy information are used to describe the decision-making information, a set of MADM methods have been introduced based on PT with different fuzzy

information. Those methods in this book can be helpful for not only perfecting the decision-making framework in the MADM field but also expanding the research strategy of behavioral science. Moreover, it can promote the integration of cross-curricular interests between fuzzy decision-making and behavioral decision making and play a fundamental role to build the more scientific and effective decision-making theories. This book is suitable for the engineers, technicians and researchers in the fields of fuzzy mathematics, operations research, behavioral sciences, management science and engineering, etc. It can also be used as a textbook for postgraduate and senior-year undergraduate students of the relevant professional institutions of higher learning.

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