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Double Hierarchy Linguistic Term Set and Its Extensions

Theory and Applications

Springer

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Preface

The essence of decision-making is to evaluate alternatives and choose the best alternative(s) based on the established goal in the complex decision-making environment. In the actual decision-making problem, due to the limitations of people's cognitive structure, the variability of decision-making environment, and the complexity and fuzziness of objective things, people usually use relative quantifiers like natural languages or extended linguistic terms to describe or evaluate the uncertainty of objective things. To solve this kind of decision-making problem with linguistic evaluation information, the scholars have put forward lots of linguistic expression models, which can be used to transform the linguistic evaluation information into the corresponding linguistic variables, and rank the alternatives using the traditional linguistic decision-making methods. However, with the rapid development of science and technology and the acceleration of information updating, the complexity of decision-making problems becomes increasingly obvious, so the traditional way of single linguistic evaluation or the way of adding linguistic modifier, or the way of only using numbers or the combination of numbers and linguistic variables can no longer be applied to the dynamic and complex decision-making problems that need multiple linguistic terms to describe. Based on this, taking the complex decision-making problems as the research objects, Gou et al. (2017) firstly put forward the concept of double hierarchy linguistic term set (DHLTS). Soon afterwards, some extensions of DHLTS have been developed such as hesitant fuzzy environment named double hierarchy hesitant fuzzy linguistic term set (DHHFLTS), unbalanced DHLTS (UDHLTS), linguistic preference ordering (LPO), double hierarchy hesitant fuzzy linguistic preference relation (DHLPR), double hierarchy hesitant fuzzy linguistic preference relation (DHHFLPR), etc.

Based on the DHLTS and its extensions, this book gives a thorough and systematic introduction to the latest research results on double hierarchy linguistic term set theory and applications, which includes the measure methodologies of double hierarchy hesitant fuzzy linguistic information, the consistency methodologies, the

group consensus decision-making methodologies of DHHFLPRs, LPOs and self-confident DHLPR and the large-scale group consensus decision-making methodologies of DHHFLPRs in depth and systematically. We apply these methodologies to some practical decision-making problems under different double hierarchy linguistic environments. The book is constructed into five chapters that deal with different but related issues, which are listed as follows:

Chapter 1 mainly introduces the state of the art of DHLTSs to fully reflect people's true evaluation of objective things in complex decision-making environments from the perspectives of fully analyzing human cognition and parsing complex linguistic information structure. Additionally, this chapter develops some extensions of DHLTS under different decision-making environments including DHHFLTS, UDHLTS, LPO, DHLPR, DHHFLPR, etc. Furthermore, some operational laws of DHLTSs and DHHFLTSs are introduced. Finally, several comparative methods of DHLTSs and DHHFLTSs are proposed based on the expected and variance values, the hesitance degrees, and the envelopes of DHHFLTSs.

Chapter 2 studies some measure methodologies of double hierarchy hesitant fuzzy linguistic information to optimize the deviation between different parameters such as linguistic terms and preference information, etc., Firstly, this chapter studies some traditional distance measures of double hierarchy hesitant fuzzy linguistic information such as Hamming distance, Euclidean measure and Hausdorff distance, introduces the concept of the hesitance degree of DHHFLTS, and discusses some distance and similarity measures of double hierarchy hesitant fuzzy linguistic information with hesitance degrees. Additionally, this chapter investigates the ordered weighted distance and similarity measures and the hybrid ordered weighted distance and similarity measures of double hierarchy hesitant fuzzy linguistic information. Finally, this chapter develops decision-making methods based on the proposed distance measures and applies them to solve the practical problems of Sichuan liquor brands evaluation.

Chapter 3 establishes the consistency theory framework of double hierarchy hesitant fuzzy linguistic preference information, including additive consistency and multiplicative consistency. Firstly, this chapter introduces some consistency checking methods and inconsistency repairing methods from the perspectives of additive consistency and multiplicative consistency, respectively. Then, this chapter proposes group decision-making methods based on the discussed additive consistency and multiplicative consistency and applies them to solve the actual problems of Sichuan province water resources situation assessment and venture capital assessment of real estate market, respectively. These two consistency methods can comprehensively evaluate the consistencies of DHHFLPRs from different angles.

Chapter 4 firstly studies the group consensus decision-making method based on DHHFLPRs. In group decision-making processes, based on the additive consistencies or multiplicative consistencies of DHHFLPRs, this chapter studies the correlation coefficient and correlation measures of DHHFLPRs and constructs the group consensus decision-making method and applies this method to the venture

capital assessment of real estate market. Then, this chapter studies the consensus decision-making methods with LPOs. This chapter develops models to equivalently transform each LPO into the corresponding DHLPR with complete consistency and proposes some consensus models with DHLPRs to obtain the final decision-making result which is equal to the decision-making result with LPO information. Additionally, this chapter defines the concept of self-confident DHLPR, in which the basic element consists of the DHLT and the self-confident degree simultaneously. Finally, this chapter develops a double hierarchy linguistic preference values and self-confident degrees modifying-based consensus model to manage the group decision-making (GDM) problems with self-confident DHLPRs based on the priority ordering theory.

Chapter 5 studies the large-scale group consensus decision-making methods based on DHHFLPRs and applies them to deal with practical large-scale group decision-making (LSGDM) problems. Specially, the concept of a large-scale group consensus decision-making-related problem is not meant here in the sense of computational social choice and related areas (Brandt et al. 2016; Chevalayre et al. 2007). On the one hand, this chapter mainly discusses the large-scale group clustering method and the weight-determining method, proposes the large-scale group consensus decision-making method and applies this method to the assessments of water resources in some cities of Sichuan province. On the other hand, by constructing new clustering method and consensus model, and from the perspective of in-depth analyzing minority opinions and non-cooperative behaviors in LSGDM, this chapter puts forward a novel large-scale group consensus decision-making method based on DHHFLPRs, which is more in line with human cognition, and applies this method to the comprehensive assessments of the reasons of haze formation.

This book is suitable for the engineers, technicians, and researchers in the fields of fuzzy mathematics, operations research, information science, 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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