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Big data-driven large-scale group decision-making under uncertainty (BiGDM-U)

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Cutting-edge technologies, including big data, have a potential role in adopting in society, healthcare organizations, and our daily lives (Abdulwahab et al., 2022; Huang et al., 2021; Sarkar et al., 2022). Big data would play an important role in terms of acting as a facilitator to achieve the desired information in the decision-making process. The concept of big data brings a complex and large volume of data generated from many resources and clinical datasets, and it delivers crucial insights into the patient's care. In addition, big data has the vast potential to enhance healthcare operations through data-driven decision-making in the fuzzy environment.

Group decision-making under the fuzzy environment is measured as a decision situation in which a group of experts is requested to present their preference information to gain a common solution to a problem consisting of more than two alternatives or objects (Liu et al., 2022; Paul et al., 2022). Recently, group decision-making has been extensively studied in different application areas, such as healthcare and supply chain organizations (Laganà and Colapinto, 2022; Pamucar et al., 2022). However, with the rapid development of society and the increasingly complex management, economic situation, and decision-making responsibilities are becoming increasingly difficult. Therefore, large-scale group decision-making has become the focus of decision-making problems. Large-scale group decision-making or complex group decision-making problems under fuzzy environments are very generally come upon in real life, particularly in the era of big data (Choi and Chen, 2021; Modgil et al., 2021; Tang and Liao, 2021; Tang et al., 2019). Because of the growth of large-scale interaction among employers, users, and experts, the current literature emphasizes the role of large-scale group decision-making problems.

With a fast pace of growth, big data analytics has caused an evolutionary paradigm in healthcare research and practices. It has made available different tools applicable to the accumulation, analysis, management, and adaptation of massive, disparate, structured, and unstructured data that are generated increasingly by the existing healthcare systems. Moreover, recent years have witnessed the wide application of this new technology to processes such as disease diagnosis and care delivery. However, although the current literature indicated the large-scale group decision-making problems under different fuzzy sets play a critical role in the adaption of big data-driven, a few of the literature has been focused on using the large-scale group decision-making in the areas of big data-driven. Therefore, in this special issue, we focused on this topic to gain a deeper insight into the current situation of the research being conducted across the world and also to depict an overall picture of the use of big data by means of large-scale group decision-making methods to analyze, manage, and adapt the large volumes of data in this domain.

However, for this special issue, we have received 31 manuscripts on the different topics of big data, decision making, fuzzy sets, large-scale group decision making, and other related fields. The received papers have been extensively reviewed by the journal to select the best articles regarding their novelty, quality, and technical contribution to big data, decision making, fuzzy sets, and large-scale group decision

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making. The present special issue has incubated 22 articles collected in the BiGDM-U special issue in the domain of Applied Intelligence. Each article has been reviewed by at least four expert reviewers and then chosen depending on the way it contributes to the subject (Babaeinesami et al., 2022; Li et al., 2022; Swathi et al., 2022; Zhang et al., 2022). Due to the number of published papers in this special, we present a summary of some published papers in the following paragraphs.

Alattas and Wu (2022) proposed a new framework for the evaluation of the obstacles to the adoption of the Internet of Medical Things (IoMT) by means of the extended generalized TODIM (Portuguese abbreviation for interactive multi-criteria decision-making) method under the hesitant fuzzy environment. Their paper proposed a hesitant, generalized TODIM method to identify the best solution to the typically-arising multi-criteria group decision-making (MCGDM) problems. Moreover, they used a number of new operational laws and distance measures in dealing with hesitant fuzzy sets. Their developed framework consisted of quantitative and qualitative criteria, including costs and benefits. Their findings confirmed the regulatory affairs, liability, vendor lock-in, installation difficulties, trust management system, etc., as the main obstacles to the adoption of IoMT.

Jiang et al. (2022) proposed an innovative decision-making method to describe the group users' cognitive preferences. They integrated a fuzzy measure (as the underlying technical support) with Choquet integral and Višekriterijumsko Kompromisno Rangiranje (VIKOR) method. They also made use of the expressive advantages of interval-valued dual hesitant fuzzy linguistic information to propose a new group recommendation method. Their findings proved the efficacy of the proposed method, which was termed Choquet integral-VIKOR.

In another article, Lu and Liao (2022) conducted an overview to comprehensively understand group decision making (GDM) in Healthcare Industry 4.0 and determine the directions for future development. Additionally, bibliometric research was carried out on already-published studies to explore the development trends. Moreover, they discussed how to implement GDM methods in Healthcare Industry 4.0 under the paradigm of the general GDM process. Their article discussed the current research challenges and attempted to find some directions for medical GDM research in the future. They also provided a detailed description of various types of information representation, expert and decision information clustering methods, consensus measurements, and result elicitation techniques. Furthermore, the authors introduced LSGDM methods as well as different medical applications used in the studies they reviewed. Finally, several applications of Healthcare Industry 4.0 with digitalization and intelligence were proposed (e.g., the customization of patients' medical devices), which are the most recent directions of research into decision-making problems in the medical context.

Under a fuzzy environment, Vesković et al. (2022) proposed an integrated large-scale group MCDM model to be applicable to selecting a reach stacker in a container terminal. Their primary objective was the creation of a perfect fuzzy group multi-criteria decision-making (MCDM) model. To this end, they combined Fuzzy MARCOS (Measurement of alternatives and ranking according to COmpromise solution), Fuzzy FUCOM (Full Consistency Method), and Fuzzy Bonferroni Mean (BM) operator. Their model takes into consideration 15 criteria that are separated into three categories: technical, technological, and economic categories, which were assessed by 18 experts. For the determination of the weight values of the criteria, Fuzzy FUCOM was employed through 72 models averaged by means of the Fuzzy BM operator. They used Fuzzy MARCOS and the Fuzzy BM operator in order to evaluate and select a reach stacker (RS). Their findings demonstrated that, in group decision-making and processing of a larger set of data, the technological group is the key group of criteria. In addition, the optimum option is the seventh variant; as a result, the requirement to choose RS for the container terminal is satisfied. The following steps were taken into action to verify the obtained results: determining the impact of the reverse rank fuzzy matrix, simulating the weight values of the criteria through 50 formed scenarios, and finally comparing the proposed method performance with two other MCDM methods in a fuzzy context.

A new decision-making method was proposed in the study of Krishankumar et al. (2022) for the evaluation of the Cloud vendor selection for the healthcare industry with the use of a big data-driven decision model with probabilistic linguistic information. First, they gathered data in the form of complex expressions from several cloud users; then, the data were transformed into a holistic decision matrix using adopting probabilistic linguistic information (PLI). PLI represents complex linguistic expressions together with the associated confidence levels. Then, the authors created a holistic decision matrix with the missing values imputed using an imputation algorithm proposed in their study. In addition, a newly proposed mathematical model and partial information were used to determine the weight of each criterion. In the final step, an approach called the evaluation based on the distance from average solution (EDAS) was extended to PLI in order to rank CVs rationally. They provided a real-time example of a CV selection for a healthcare center in India in order to evaluate their proposed model performance; the results of the case study and comparative research showed both the advantages and limitations of their model.

A DES-based group decision model was introduced by Xu et al. (2021), applicable to group decision-making in cases where there are large-scale alternatives. To solve the problem, that study designed a dynamic ensemble selection (DES)-based group decision model employing historical decision data. Such data of a group of experts were gathered from the same multi-criteria decision framework. Then, the data were mixed so that a set of base classifiers (BCs) could be trained to learn group preferences. An iterative comparison of the precision of an ensemble of randomly chosen BCs and that of the optimal BC was made regarding the prediction of the similar historical alternatives of the new alternative. Based on the results of this comparison, they proposed a new DES method that could be applied to selecting a competent subset of BCs for the new alternative. To a certain degree, DES could effectively avoid the error-independence assumption. On the basis of the similar historical alternatives specified by the ensemble of the selected BCs, the authors succeeded in developing a group decision optimization model to learn the criteria weights through assessing the criteria and also the use of ensemble predictions derived from the selected BCs. With the learned criterion weights, the understandable group decision result was produced for the new alternative. In addition, they carried out a case study whose results confirmed that the proposed model outperformed the other existing models in terms of the diagnosis of thyroid nodules by means of group capabilities. Its performance on 30 real datasets was compared with the performance of five representative DES methods.

In another paper, Raeisi and Jafarzadeh Ghoushchi (2022) developed a robust fuzzy multi-objective location-routing problem regarding managing hazardous waste under uncertain conditions. They used several algorithms to solve the above-mentioned problem: Non dominated Sorting Genetic Algorithm-II, Multi-Objective Invasive Weed Optimization, Multi-Objective Particle Swarm Optimization, Pareto Envelope-based Selection Algorithm, Multi-Objective Grey Wolf Optimizer algorithms, and Multi-Objective Evolutionary Algorithm Based on Decomposition. Based on the findings, the Multi-Objective Invasive Weed Optimization algorithm showed the highest efficiency. As indicated by the authors, the first innovation of their research was the obtainment of income from waste incineration and also the reduction of the risk of COVID-19 infection. Both of them were taken into account when developing their proposed model. Their next innovation was considering uncertainty for some of the most important parameters of the model when applying the robust fuzzy optimization model. In addition, they applied a number of meta-heuristic algorithms to the solution of the problem, e.g., Multi-Objective Grey Wolf Optimizer, Multi-Objective Evolutionary Algorithm Based on Decomposition, and Multi-Objective Invasive Weed Optimization, which have been rarely employed in the relevant literature.

A cluster-based stratified hybrid decision support model was proposed by Tirkolaee and Torkayesh (2022) under uncertainty in a way to be applicable to the selection of the most sustainable healthcare landfill site. They employed a new decision support system to address the problem of selecting landfill locations for the disposal of healthcare waste. The model was built by integrating the K-means algorithms with Stratified Best-Worst Method (SBWM) and a new hybrid MARCOS-CoCoSo under grey interval numbers. Their hybrid model takes into consideration the waste generation rates in medical centers, potential events in the unforeseen future, and the uncertain opinions of experts. A case study was conducted in the context of Mazandaran province, Iran, in order to examine the practicality of the proposed model. It could effectively deal with a total of 79 medical centers in 4 clusters addressing 9 criteria for the prioritization of the candidate sites. Additionally, the weight coefficients were exposed to sensitivity analysis with the aim of evaluating the obtained results. In the final step, they compared the performance of the proposed model with that of some well-known methods, which confirmed the high effectiveness of the model. The findings suggested the adherence to local regulations and future expansion potentials as the two best criteria with importance values of 0.173 and 0.164, respectively. Then, they also specified the optimum site alternatives for each cluster of medical centers.

An online education satisfaction evaluation was proposed in the study of Xu et al. (2022). It essentially worked based on the cloud model and fuzzy TOPSIS. With the aim of the better use of online education during the post-COVID-19 era, they carried out an online education satisfaction survey in four different types of colleges with the participation of a total of 129,325 students. A fuzzy TOPSIS (technique for order preference by similarity to ideal solution) method was designed based on the cloud model for the purpose of ranking the colleges' satisfaction levels. Initially, in accordance with the features of online education during COVID-19, they constructed an evaluation indicator system considering four different dimensions: technology, learner, instructor, and environment, which included 10 indicators and 94 sub-indicators. After that, the cloud model was employed to describe the natural language and the uncertainty in a large volume of assessment information in a quantitative way. The authors applied a cloud model generator to the sub-indicators and achieved a conversion of high effectiveness and flexibility between quantitative values and linguistic information. They provided the cloud model of indicators through the integration of the corresponding sub-indicators. The indicators' weights were defined using the entropy method based

on the cloud model and possibility degree matrix. This was said to eliminate the judgment of the decision-maker and also to provide considerable power for dealing with practical problems with unknown weight information. To end, they also proposed a fuzzy TOPSIS method based on the cloud model with the aim of ranking the satisfaction level of online education at the colleges investigated. The method was compared with other methods for validation purposes. The results of their experiments were inconsistent with the proportion of students accepting online education in the post-epidemic era. The findings from the second questionnaire showed that as the qualitative evaluation of the cloud model of indicators enhanced, the qualitative evaluation of satisfaction of different types of colleges also enhanced. The results confirmed the practicality of the proposed method.

In another study, Gomasta et al. (2022) introduced a temporal activity-biased weight model, which assigned a higher weight to the recent activities of users. They also designed an algorithm that could list the most effective influential users. Furthermore, the model took into consideration the effects of topical similarities from both direct and indirect neighbors of the users. Experiments were carried out on two real datasets; the results showed that the proposed framework outperformed the other frameworks suggested in similar studies with similar objectives.

Ghasemi et al. (2022) developed an innovative humanitarian relief logistic network to apply to multi-objective optimization under stochastic programming. They designed a scenario-based stochastic multi-objective location-allocation-routing model applicable to a real humanitarian relief logistics problem. The model was focused on both pre-and post-disaster conditions in the presence of uncertainty. They adopted a simulation approach to address the demand uncertainty problem effectively. Their model combined the two phases at the same time. The authors also took into account all the following issues: strategic and operational decisions (pre-disaster and post-disaster), fairness in the evacuation, relief item distribution (which may include commodities and relief workers), and victim evacuation (which may include homeless people, injured people, and corpses). Three metaheuristic algorithms for the large-scale problem (case study) and the Epsilon-constraint method for small- and medium-scale problems were used to solve the problem at hand. According to the empirical findings, the proposed model was successful in locating the shelters and relief distribution centers, determining the proper routes, and allocating the available resources in real-life, uncertain disaster situations.

Liu et al. (2022) introduced an ensemble learning model for preference-geographical aware point-of-interest recommendation. This study designed a novel ensemble learning framework for POI recommendation, named PreferenceGeographical Point-of-interest Recommendation Ensemble (PG-PRE). For a target user, we first construct multiple similar user groups and use a roulette selection-based sampling method to improve the variousness of such groups. Each group will give a POI recommendation suggestion. Then a Gaussian mixture-based approach is proposed to calculate the voting weight of each group. Finally, a recommendation list of the target user is achieved by comprehensively considering each group's suggestions according to the corresponding voting weight. The experimental results confirmed that the proposed method outperformed the latest POI recommendation methods in terms of the tasks defined.

Mahmoudi et al. (2022) proposed a novel framework to solve Large-Scale Group Decision-Making (LSGDM) problems for measuring the performance of healthcare construction projects. In this regard, they have extended the Ordinal Priority Approach (OPA) of Multiple Criteria Decision Analysis (MCDA) to achieve a new model called Group Weighted Ordinal Priority Approach (GWOPA). Since the input data of the model were preference relations, they utilized the ordinal K-means to cluster the experts' opinions. In order to check the consensus among the experts, they have proposed Weighted Kendall's W and confidence level index using Fisher distribution. To consider the sensitivity level of the problem, several objective thresholds and feedback mechanisms were provided which could promote the quality of the final results. To check the application of the proposed framework, they have addressed a case study from the healthcare industry in China. In the case study, number five hospital projects were selected from various cities, and their performance was calculated by employing their proposed framework. Also, a comprehensive sensitivity analysis was performed on the performance of the projects, which showed the solutions of the proposed framework were reliable. Finally, the results revealed that their proposed approach could save resources (time, cost, etc.) during performance measurement of the healthcare construction projects based on a large number of experts.

The guest editors of this special issue would like to thank all reviewers who have done great work evaluating these submission numbers. In addition, we appreciate all authors who have greatly contributed to the fulfillment of the strict requirements of this special issue in terms of framing the quality and novelty of the papers presented in this issue. The present special issue aims to provide a scientific avenue directing the researchers towards the discovery of more knowledge of the topics discussed above.