

Guest Editorial: Uncertain Multicriteria Decision Making Using Evolutionary Algorithms

UNCERTAIN multicriteria decision making is to select or rank objects based on the evaluation done by the decision-maker on several criteria under uncertainty. Uncertain multicriteria decision making has been proved as a useful means in diverse fields such as management, finance, economics, education, environmental protection, medicine, engineering, and so on. Due to numerous successful applications, it becomes more and more prevailing.

It becomes quite a challenging task, as far as the solution methodologies of uncertain multicriteria decision making is concerned. The complexity becomes more and more significant in terms of problem size (e.g., number of criteria, size of the search space). Moreover, the solution time has to be reasonable for most of the problems encountered in practice. Hence, the development of advanced multicriteria evolutionary algorithms has been widely investigated.

The purpose of this special issue is to gather together high-quality papers which significantly contribute to new theories, applications, and algorithms about uncertain multicriteria decision making. It not only reports recent significant developments but also highlights potential, growing research directions, and future trends, which will benefit researchers in studying theories, applications, and algorithms about uncertain multicriteria/multiobjective/multiattribute decision making.

A total of 23 creative, innovative, and profound papers were finally accepted for this special issue. Various real-world applications of uncertain multicriteria decision making include portfolio optimization, classification, job-shop scheduling, supply chain planning, condition-based maintenance optimization, task resource assignment, and so on. Novel and creative algorithms are presented, including NSGA-II genetic algorithm, improved memetic algorithm, hybrid algorithm of imperialist competitive algorithm (ICA) and firefly algorithm (FA), archive-guided multiobjective particle swarm algorithm, cooperative artificial bee colony algorithm, etc. The 23 accepted papers can be broadly classified into the following three groups.

The first group of papers focuses on the theoretical achievements about uncertain multicriteria/multiobjective/multiattribute decision making. The paper entitled “Multiple-Attribute Decision Making Based on Archimedean Bonferroni Operators of q -Rung Orthopair Fuzzy Numbers” extends the Bonferroni mean (BM) operator to the q -rung orthopair fuzzy numbers, and proposes the q -Rung Orthopair fuzzy weighted Archimedean BM (q -ROFWABM) operator. Then, a new

multiple-attribute decision-making method is developed based on the q -ROFWABM operator. In the paper entitled “Interactive Decomposition Multiobjective Optimization via Progressively Learned Value Functions,” an interactive framework for the decomposition-based evolutionary multiobjective optimization algorithm is developed to lead a decision maker to the preferred solutions of her/his choice, which consists of three modules, i.e., consultation, preference elicitation, and optimization. In the paper entitled “A Compromise-Typed Variable Weight Decision Method for Hybrid Multiattribute Decision Making,” a new compromise-typed variable weight decision method is developed for solving hybrid multiattribute decision-making problems with multiple types of attribute values. The paper entitled “An Additive Consistency and Consensus-Based Approach for Uncertain Group Decision-Making with Linguistic Preference Relations” discusses the formulation of several goal programming models for managing the additive consistency and consensus of linguistic preference relations. It then develops an additive consistency and consensus-based method for group decision making with linguistic preference relations. The paper entitled “Integer Programming Models to Manage Consensus for Uncertain MCGDM Based on PSO Algorithms” emphasizes optimization consensus models for multiple criteria group decision-making problems under interval information. An antithetic method-based particle swarm optimization algorithm is designed to solve the nonlinear integer programming models. The paper entitled “A New Belief Rule Base Model With Attribute Reliability” proposes a new belief rule base model with attribute reliability to address an engineering system under the disturbance from the noise and sensors’ tracing ability. The disturbance factors denote the attribute ability to provide correct information and are considered by attribute reliability, in order to better model complex system behavior and further improve modeling accuracy.

The second group of papers focuses on real-world applications and solution algorithms of uncertain decision making or multicriteria/multiobjective/multiattribute decision making. The paper entitled “Condition-Based Maintenance Optimization for Multicomponent Systems Under Imperfect Repair—Based on RFADT Model” proposes a new condition-based maintenance optimization model for multicomponent systems with the imperfect repair, in order to minimize the maintenance cost and the system downtime cost simultaneously. A genetic algorithm with self-crossover operation and shift mutation operation is designed for the proposed multivariable and nonlinear programming model. In the paper entitled “Promotion Decisions Under

Asymmetric Demand-Generation Information: Self-Operated, Online-Platform, and Offline-Outlet Strategies,” the authors have developed a specific multistage decision-making mathematical model with uncertain demand information and effort for the third party, where a firm considers adopting a promotion strategy after the end of a conventional selling season. In the paper entitled “Maintenance Spare Parts Demand Forecasting for an Automobile 4S Shop Considering Weather Data,” a novel method is proposed for the paper “Multimodal Gait Recognition with Inertial Sensor Data and Video Using Evolutionary Algorithm” proposes a new decision fusion-based approach to recognize multimodal human gait with internal sensor data and video using the evolutionary algorithm, grey wolf optimizer. The paper entitled “Novel Mechanism Based Artificial Bee Colony Algorithm for Fuzzy Portfolio Selection” presents a novel mechanism based on artificial bee colony algorithm for the fuzzy portfolio selection problem, which consists of two new proposed learning strategies—direction learning and elite learning. The paper entitled “Coopetition Strategy and Pricing Timing in an Outsourcing Supply Chain With Uncertain Operation Risks” deals with the coopetition strategies between the original equipment manufacturers and the competitive original design manufacturers, and focuses on the impact of the uncertain market demand by considering the external demand and the degree of product substitution as uncertain variables. In the paper entitled “Passenger Flow Prediction for New Line Using Region Dividing and Fuzzy Boundary Processing,” the author proposes a new prediction model by exploring the relationship between the passenger flow of a station and its surrounding area’s factors, which provides a scientific determination for designing a precise and efficient public transport network. The paper entitled “A Hybrid Cooperative Coevolution Algorithm for Fuzzy Flexible Job Shop Scheduling” proposes an effective hybrid cooperative coevolution algorithm for fuzzy flexible job-shop scheduling problem, in which genetic algorithms and particle swarm optimization are combined to improve the convergence ability, and a parameter self-adaptive strategy is applied to the problems of different scale effectively.

The third group of papers focuses on the real-world applications and solution algorithms of uncertain multicriteria/multiobjective/multiattribute decision making. The paper entitled “A Novel Hybrid ICA-FA Algorithm for Multiperiod Uncertain Portfolio Optimization Model based on Multiple Criteria” has proposed a novel multiobjective mean–variance–skewness model for multiperiod portfolio selection problem in uncertain investment environment, and designed a hybrid of ICA and FA, termed ICA-FA, to solve it. The paper “Developing Multiobjective Equilibrium Optimization Method for Sustainable Uncertain Supply Chain Planning Problems” develops a new multiobjective two-stage equilibrium optimization method for a supply chain planning problem with uncertain demands. A new archive-guided multiobjective particle swarm optimization based on decomposition is finally designed to solve the approximate optimization model. The paper entitled “Cooperative Artificial Bee Colony Algorithm With Multiple Populations for Interval Multiobjective Optimization Problems” investigates a novel interval multiobjective optimization method, called the Interval Cooperative Multiobjective Artificial Bee Colony Algorithm. The paper entitled “Analyzing a Closed-Loop Supply

Chain Considering Environmental Pollution Using the NSGA-II Genetic Algorithm” proposes a biobjective mathematical model for a closed-loop supply chain network that considers forward–reverse logistics and the uncertainty of demands, to maximize total profit and minimize environmental pollution. Then, the Nondominated Sorting Genetic Algorithm (NSGA)-II is used to analyze the Pareto solutions of the proposed model. The paper entitled “A NSGA-II Algorithm Hybridizing Local Simulated-Annealing Operators for a Bicriteria Robust Job-Shop Scheduling Problem Under Scenarios” discusses a bicriteria robust job-shop scheduling problem, in order to minimize the mean makespan and minimize the worst-case makespan among all scenarios. Here, the authors have considered that the NSGA-II algorithm framework is incorporate with local SA operators to solve the proposed problem. The paper entitled “Multiobjective Evolutionary Feature Selection for Fuzzy Classification” discusses a novel multivariate feature selection method in which both search strategy and classifier are based on multiobjective evolutionary computation. In the paper entitled “Improving Image Matting by Multiobjective Evolutionary Optimization Based on Fuzzy Multicriteria Evaluation and Decomposition,” a fuzzy multicriteria evaluation and a multiobjective evolutionary algorithm based on multicriteria decomposition are proposed to optimize the large-scale uncertain multicriteria optimization problem, sampling-based image matting. In the paper entitled “Fuzzy Optimal Allocation Model for Task Resource Assignment Problem in Collaborative Logistics Network,” the cost, time, and quality are selected as decision goals to establish fuzzy resources allocation model for multistage random tasks. The improved memetic algorithm is applied to solve the problem. In the paper entitled “A Knowledge-Based Risk Measure From a Fuzzy Multicriteria Decision-Making Perspective,” a new risk measure incorporating the dimension of knowledge is proposed, and a fuzzy multicriteria decision-making method is employed to assess the strength of knowledge.

We would like to take this opportunity to express our sincere thanks to the authors who have shared their recent research ideas, results, and achievements in this issue. Our thanks also extend to the reviewers, whose expert and constructive comments are crucial in achieving the high standards of these papers. Finally, we would like to express our many thanks to the Editor-in-Chief, Prof. J. Garibaldi and Prof. B. John, Editor for Special Issues, for all their support and assistance.

We hope that the readers will enjoy this special issue and find it stimulating and thought-provoking.

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