

Preface

Decision making is the study of identifying and choosing alternatives based on the values and preferences of a decision maker. Making a decision implies that there are alternative choices to be considered, and in such a case we want not only to identify as many of these alternatives as possible but to choose the one that best fits with our goals, objectives, desires, values, and so on.

The history of fuzzy sets began with the introduction of their ordinary type by Zadeh in 1965 and evolved by the extensions of ordinary fuzzy sets: interval-valued fuzzy sets (Zadeh, 1975; Grattan-Guinness, 1975; Jahn, 1975; Sambuc, 1975), type-2 fuzzy sets (Zadeh, 1975), intuitionistic fuzzy sets (Atanassov, 1986), fuzzy multisets (Yager, 1996), neutrosophic sets (Smarandache, 1999), nonstationary fuzzy sets (Garibaldi and Ozen, 2007), Hesitant fuzzy sets (Torra, 2010), and Pythagorean fuzzy sets.

Each of these extensions has been used in the solutions of single criterion and multiple criteria decision making problems. Intuitionistic fuzzy sets and hesitant fuzzy sets are the most used extensions in the fuzzy sets history. Neutrosophic sets and Pythagorean fuzzy sets are the generalization of intuitionistic fuzzy sets and they are expected to be competitive with the other extensions in the future.

This special issue includes nine papers on decision-making theory and applications using the extensions of ordinary fuzzy sets. Most of these papers have been presented at FLINS 2016 conference organized on *uncertainty modeling in knowledge engineering and decision making* in Roubaix, France between the dates August 24-26, 2016. They have been selected after a peer review process with at least three reviewers per paper.

The first paper aims at establishing a clear taxonomy regarding the types of consistency of preference relations with hesitant information such as, hesitant fuzzy preference relation, hesitant multiplicative preference relation, and the extended hesitant fuzzy linguistic preference relation.

The second paper tries to select the best photovoltaic alternative based on some predetermined criteria using a projection model-based intuitionistic fuzzy multicriteria decision making method. The data in the decision matrix are composed of linguistic evaluations.

The third paper develops a data presentation model that ensures higher reliability of decision-making on the basis of experience. The difference of the proposed model is the representation of experience by a set of transformations of situations and solutions permissible transformations formulated by the expert and considered as a description of the meaning of situations.

The fourth paper is on a special version of parking lots, Park&Ride (P&R) facilities, considering the need to support public transport usage. Randomly chosen P&R lots in Istanbul are compared according to the predetermined criteria by using interval-valued intuitionistic fuzzy PROMETHEE method. However, the number of evaluation criteria for P&R lots are large and firstly some of them are eliminated by using Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique.

The fifth paper extends the robustness analysis of the fuzzy connectives based on the pointwise sensitivity of such operators. Starting with an evaluation of the δ sensitivity in representable fuzzy negations, triangular norms and conorms, the authors apply the results in the class of fuzzy difference operators and their dual construction. The paper formally states that the robustness preserves the projection functions related to intuitionistic fuzzy (co)difference operators.

The sixth paper presents an evaluation methodology to measure the performance of healthcare facility websites. It includes an explanation for healthcare facility websites' quality performance under distinctive evaluation criteria by rating and accordingly ranking them. The most significant feature of this study is how it deals with the interaction characteristics among the selected decision criteria for the website evaluation process. The method uses intuitionistic fuzzy Choquet integral approach under group decision making settings

The seventh paper focuses on the representation of opposite concepts as paired fuzzy concepts, under a restricted setting for general paired structures. It examines the notion of bipolarity and the semantics of bivariate scales, the proposed setting allows accomplishing a faithful knowledge representation by means of appropriate aggregation functions, based on the separate evaluation of paired opposite concepts.

The eighth paper models the cloud service provider selection problem as a multi criteria decision-making problem involving 7 criteria, 21 sub-criteria and 4 alternatives. The evaluations regarding the cloud alternatives are expressed as Pythagorean fuzzy sets. Pythagorean fuzzy TOPSIS method

is used to rank the alternatives. The robustness of the decision model is checked using one-at-a-time sensitivity analysis.

The ninth paper proposes a method of credibility factors reasoning based on linguistic truth-valued intuitionistic fuzzy hesitancy degree in order to process fuzziness and incomparability associated with human's intelligent activities in the real world. Based on linguistic truth-valued intuitionistic fuzzy algebra, the concepts and properties of the linguistic-valued truth credibility degree and its inverse operator are discussed.

I hope this issue will provide a useful resource of ideas, techniques, and methods for the research on the theory and applications of decision-making by using extensions of ordinary fuzzy sets. I thank all the authors whose contributions and efforts made the publication of this issue possible. I am also grateful to the referees for their valuable and highly appreciated works contributed to select the high quality of papers published in this issue. Finally, my sincere thanks go to Prof. Dan Simovici, Editor-in-Chief, for his supports throughout the process of editing this issue.

Prof. Cengiz Kahraman
Istanbul Technical University
Department of Industrial Engineering
34367 Macka/Istanbul/Turkey
Tel: +90-212-2931300 (Ext. 2035)
Fax: +90-212-2407260
E-mail: kahramanc@itu.edu.tr