Preface

Extensions of Fuzzy Sets and Fuzzy Decision Making

In ordinary fuzzy sets introduced by Zadeh (1965), the non-membership of an element is the complement of the membership degree to 1. This feature was criticized by various researchers who suggest that the membership degree of an element should be also fuzzy and there should be no necessity for the complementary feature in ordinary fuzzy sets. By incorporating fuzziness of membership degrees and/or by removing the complementary feature, ordinary fuzzy sets have been extended to new extensions: Type-2 fuzzy sets and interval-valued fuzzy sets (Zadeh, 1975); introduced intuitionistic fuzzy sets (Atanassov, 1986); hesitant fuzzy sets (Torra, 2010); intuitionistic type-2 fuzzy sets (Atanassov, 1999); Pythagorean fuzzy sets (Yager (2013); q-rung orthopair fuzzy sets (Yager, 2017); neutrosophic sets (Smarandache, 1998); picture fuzzy sets (Coung, 2017); spherical fuzzy sets (Kahraman and Kutlu Gündoğdu, 2018); circular intuitionistic fuzzy sets (Atanassov, 2020); and decomposed fuzzy sets (Cebi et al., 2022).

This issue includes eleven original papers on the theoretical and practical usage of these extensions in decision making area, each written by their experts. The first paper describes four intuitionistic fuzzy modal topological structures and some of their properties are discussed. The particular cases of three of the extended modal operators over intuitionistic fuzzy sets are used and some properties of the new operators are discussed. The second paper presents a novel MCDM methodology including an interval valued picture fuzzy (IVPF) SWARA & CODAS methodology and applies it to the renewable energy source selection problem in Turkey. The IVPF SWARA method is used for determination of criteria weights and the IVPF CODAS method is used for the selection of the best alternative. The third paper extends the concept of a chromatic number search of fuzzy graph to intuitionistic case. The chromatic number as an intuitionistic fuzzy set determines the greatest degree of separability of the vertices of the graph when it is colored with a given

number of colors. An algorithm for determining the chromatic number is proposed. The fourth paper proposes a fuzzy multi-criteria decision-making method based on decomposed fuzzy Additive Ratio Assessment (ARAS) method. The proposed method aims at enhancing the accuracy of decision-making by enabling decision-makers to express their evaluations more accurately. An application of post-disaster temporary shelter selection is demonstrated to illustrate the effectiveness of the proposed approach. The fifth paper proposes a fuzzy model to optimize the evaluation of room maintenance factor. The model incorporates a set of linguistic variables and fuzzy rules to represent the imprecise and uncertain nature of the evaluation process. It demonstrates the effectiveness of the proposed model through a case study involving the evaluation of room maintenance factor in a healthcare facility. The sixth paper uses interval type-3 fuzzy to automate quality control in material production. Surface roughness and porosity of the materials are utilized to estimate the quality of the material with a type-3 fuzzy approach. Surface roughness is estimated with the fractal dimension as is mainly a geometrical feature of the material in a finished product. The seventh paper uses picture fuzzy (PF) CRITIC method to calculate the weights of the criteria and picture fuzzy TOPSIS method to rank the alternatives. The proposed multi-experts interval-valued PF CRITIC&TOPSIS methodology is applied to the post-disaster location selection of debris waste sites in Istanbul. The eight paper proposes a new risk assessment method to consider both uncertainty and inconsistency in the risk assessment process by using truth, indeterminacy and falsity parameters to assess the probability of risk occurrence and severity of risk consequence. Then, a fuzzy inference based if-then rules structure is used to obtain the risk magnitude. The ninth paper proposes an extension of replicated ANOVA, based on the theories of IFSs and index matrices, which is referred to as RIFANOVA. A unique set of data for 107 patients at a hospital in Bulgaria is also analyzed, tested for prostate cancer to determine the influence of "prostate-specific antigen (PSA)" and "digital rectal examination (DRE)" factors on the aggressiveness of cancer according to the Gleason scale applying the ANOVA and the RIFANOVA. The tenth paper solves the problem how to reform Aristotelian syllogisms (ASs), making them compatible with classic logic, and further deducts the reformed syllogisms in terms of formal languages. It asserts that there exist two challenging defaults in Aristotelian categorical propositions (ACPs) made up of ASs. To overcome these two defaults, new forms of categorical propositions called expanded categorical propositions, ECPs, term-bound by dyadic fuzzy quantifiers with membership invariants) are introduced. The eleventh and the last paper models the capital budgeting problem as a 0-1 non-linear programming problem using intuitionistic fuzzy set theory. The validation of the model is demonstrated with a Wallbox Fast Charging OEM application problem. The sensitivities of the model parameters on the decision are also examined.

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