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PREFACE
Decision Making Using Extensions of Ordinary Fuzzy Sets

Decision-making is the cognitive process of selecting a course of action from multiple alternatives. Fuzziness is the uncertainty resulting from vagueness. Most natural language descriptors are vague and somewhat uncertain, rather than precise. Fuzzy set approaches to decision-making are usually most appropriate when human evaluations and the modeling of human knowledge are needed. This special issue covers several theoretical and practical representations of decision-making on the usage of extensions of ordinary fuzzy sets. The issue covers eleven original research and application-oriented papers covering different areas of decision-making on the usage of extensions of ordinary fuzzy sets. These papers are the substantially extended versions of the papers selected from 180 contributions presented at the 13^{th} International FLINS Conference on Data Science and Knowledge Engineering for Sensing Decision Support (FLINS 2018), organized by Ulster University held at Belfast, Northern Ireland, in August 21-24, 2018.

In the first paper of this issue, a hardware architecture design for real- time edge detection based on Interval Type-2 fuzzy systems is presented. The proposed architecture is designed in order to be implemented on FPGAs, taking advantage of the parallelism, pipelining and fixed-point notation strategies.

The second paper proposes a performance measurement model for software testing teams. The model employs interval-valued intuitionistic preference relations to weigh the performance indicators and to determine the performance score of the team members.

The next paper discusses the 6-element linguistic truth-valued intuitionistic fuzzy lattice triangular algebra structure, transforming it into the linguistic truth-valued intuitionistic fuzzy interval value by using two unary operations

μ and v of triangular algebra, defining the transformation function $[\mu \odot v]$ and comparing the interval values by using scoring functions.

The fourth paper initially proposes a new hybrid approach that combines Rough Set Theory with Machine Learning algorithms. Furthermore, a novel algorithm based on rough set theory is proposed by the idea of combining probability based Naive Bayes and nearest neighbor based K-Nearest Neighbors to efficiently improve the classification performance.

The fifth paper presents an investment analysis for hospitals with interval-valued neutrosophic CODAS method. The same problem is also solved by interval-neutrosophic TOPSIS. The results of interval-valued neutrosophic CODAS and interval-valued neutrosophic TOPSIS are compared.

In the next paper, expanded categorical propositions (ECPs) are designed to be expressions in formal structure of categorical propositions, and to overcome the limitations. So, ECPs are firstly systemized by the systemized quantifiers, the existential, the universal and the partial, which cover all the first-step partition of certitude and exactitude. Thus the quantifiers in ECPs are put in a logic calculi. Secondly, ECPs are quantification-improved by having dyadic places covered by all the systemized quantifiers.

The seventh paper modifies the CODAS method by making a new distance measurement definition. The aim of this paper is to apply the modified Pythagorean fuzzy extension of CODAS method for the selection of the best AS/RS technology.

The eight paper presents a new fuzzy edge detection method applied on fuzzy images. The aim of this paper is that each pixel value in a digital image can be extended to be a fuzzy number; therefore, the images are fuzzified using interval type-2, general type-2 and type-1 fuzzy sets.

The ninth paper uses Pythagorean fuzzy sets for the extension of WASPAS method, which is a multicriteria method integrating simple additive weighting and weighted product methods. Single valued PFS are used in the proposed WASPAS method and an application of the proposed Pythagorean fuzzy WASPAS through a selection problem among communication firms.

The tenth paper attempts to estimate reliability of hazardous event via Top Event Probability (FTEP) in fuzzy fault tree analysis. The case study relates to flash vessel in an ammonia tank in a large Fertilizer complex in Mumbai, India.

The last paper of this issue introduces generalized three-dimensional spherical fuzzy sets with their arithmetic, aggregation, and defuzzification operations. Its objective is to extend classical CODAS method to spherical fuzzy CODAS method. The paper also defines spherical fuzzy distances based on the membership, nonmembership and hesitancy parameters.

I hope that this special issue will serve as a useful source of ideas, techniques, and methods for further research in the applications of fuzzy sets

to extensions of fuzzy sets. I am grateful to the referees whose valuable and highly appreciated works contributed to the selection of the high quality papers published in this special issue. My sincere thanks go to Prof. Dan Simovici, the editor-in-chief, who was highly instrumental in bringing this project to its fruitful completion.

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