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Preface to the special issue on numerical simulations and optimization under uncertainty

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Introduction

Numerical simulations and optimization activities are fundamental for daily engineering tasks. Therefore, these tools have become the core area of many fields related to intelligent activities such as structural and mechanical systems, artificial intelligence, smart manufacturing, and computational engineering problems. However, real-life problems usually involve different types of uncertainties implying complexity in the solving process. To overcome this issue, probabilistic models have been used but sometimes are not enough. Recently, research on uncertainty modeling is progressing rapidly and many essential and breakthrough studies have already been done. Fuzzy sets are the main tools to handle these uncertainties. Although this concept can handle incomplete information in various real-world issues, it cannot address all types of uncertainty such as indeterminate and inconsistent information. So, some extensions of fuzzy sets such as intuitionistic fuzzy set, picture fuzzy set, Pythagorean fuzzy set, spherical fuzzy set, neutrosophic set, plithogenic set, and their generalizations have been proposed. The objective of this special collection is to compile recent developments in methodologies, techniques, and applications of numerical simulations and optimization under uncertainty for various practical problems.

Published research

The special issue entitled "Numerical Simulations and Optimization Under Uncertainty: Recent Trends, Challenges, and Applications in Mechanical Systems" includes seven publications that were accepted for publication out of a significant number of submissions after rigorous peer review.

Three articles in the discipline of modeling under uncertainty and indeterminacy have been chosen: Tian and Shen[1] initially presented a hybrid optimization method based on the flight characteristics of air-breathing hypersonic vehicle (ABHV). The numerical demonstrations demonstrate that this strategy can successfully handle the ABHV trajectory optimization problem. Then they discussed the uncertain no-fly zone situation (NFZ). Consequently, possible uncertain NFZs are treated as chance restrictions. On the basis of this, a convexification method is proposed that may transform the concave chance constraint into a deterministic constraint that can be solved by convex optimization.

In a multi-attribute decision-making (MADM) system, decision-makers must deal with two types of situations: (i) the selected parameters are likely to be

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classified into their respective parametric-valued subcollections, and (ii) the acceptance level for decision-makers' approximate opinions must be assessed by possibility setting. Consequently, Rahman et al.[2] solved this deficiency by developing a unique structure, namely the possibility fuzzy hypersoft set (pfhs-set). The algebraic properties and set-theoretic operations of pfhs-set are initially illustrated mathematically. Secondly, two algorithms based on AND and OR-operations of pfhs-set are presented and validated through application in MADM real-world scenarios for the evaluation of agri-automobile; their applicability is then determined through a vivid comparison. Thirdly, similarity metrics between pfhs-sets are constructed and validated with the aid of an application in recruitment-based pattern recognition, and their significance is evaluated by comparing them to the most applicable models.

Parameters play an important part in every decision-making scenario; however, their evaluation by experts becomes especially important in cases where parameters are ambiguous. In these cases, the experts evaluate the level of uncertainty associated with each parameter by assigning a fuzzy membership-grade to it. Ihsan et al.[3] defined the fuzzy parameterized intuitionistic fuzzy hypersoft expert set (FPIFHsES), which is capable of addressing the shortcomings of existing models such as the fuzzy parameterized intuitionistic fuzzy soft expert set (FPIFSES) for the consideration of multi-argument approximate function. The FPIFHsES is more adaptable and reliable due to the decision support system's in-depth study of attributes. Utilizing theoretical, axiomatic, and computational methods, the FPIFHsES is characterized.

In the field of numerical linear algebra and matrix analysis, two papers have been selected. Wei and Zhang[4] generalized the modified generalized shift-splitting preconditioned (MGSSP) algorithms and presented the new generalized shift-splitting preconditioned (NGSSP) approach for nonsymmetric saddle point problems. In addition, they investigated the convergence conditions of the respective matrix splitting iteration methods of the NGSSP preconditioned saddle point matrices. Based on the efficient variant of the Hermitian and skew-Hermitian splitting (EVHSS) preconditioner, the authors of reference[5] relaxed the strong condition on the iterative parameter α, generalized the algorithms, and introduced the modified variant of the Hermitian and skew-Hermitian splitting (MVHSS) preconditioner for solving the generalized saddle point problem. In addition, they proved that the MVHSS iterative approach converges under weaker conditions.

Due to a bounded domain, Boutiara et al.[6] present initial-boundary value problems for time-fractional analogs of the Kuramoto-Sivashinsky, Korpusov-Pletnikov-Sveshnikov, Cahn-Allen, and Hoff equations. The conditions necessary for the explosive expansion of solutions in a limited amount of time are displayed. Pohozhaev's nonlinear capacity plan is also considered as well.

Finally, one paper on the topic of lifetime models has been chosen. Due to its adaptability in modeling life datasets, the Weibull Distribution (WD) is often employed in reliability engineering. The function of the risk is either increasing, decreasing, or stable. In reliability engineering, these models are used to simulate the entirety of a system. The Modified Weibull Extension Distribution (MWEM) is a very new variant of WD. In comparison to WD, the MWEM has been found to be more accurate when predicting lifetime data. While its use to predicting product lives and reliability is well-documented, a comparison to other variants of WD is lacking. Alshenawy et al.[7] have made an effort to address this gap. They proposed Bayesian methods for analysis in the presence of non-informative (uniform) and informative (gamma) priors. On the basis of a comprehensive simulation research and real-world analysis, it has been determined that Bayesian approaches outperformed maximum likelihood estimates (MLE) in estimating model parameters. Estimation of reliability and entropy for these data sets have also been covered. Results demonstrated that estimations for MWEM parameters were generally stable over time.

Concluding remarks

In this special issue, seven articles demonstrate various numerical modeling and optimization approaches applied to real-world challenges. This collection of scientific works affords us a unique opportunity to gain a clearer understanding of the inter-disciplinary approach and the connections between various research topics.

As Guest Editors, we extend our sincere gratitude to the reviewers who gave us with invaluable feedback during the procedures of revising the articles and evaluating them. Last but not least, we would like to extend our greatest appreciation to the respected individuals who made it possible for us to realize our ideas and who offered an exceptional and welcoming environment for this special edition. Lastly, we would also want to thank all of the authors for their contributions. This project only materialized due to their diligence, dedication, and foresight.

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