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Editorial

Preface for "Applied Probability and Statistical Inference in Reliability Engineering"

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Reliability engineering constitutes a fundamental pillar of modern engineering science, addressing the modeling, analysis and prediction of system performance under uncertainty. Its theoretical backbone relies heavily on applied probability, stochastic processes and statistical inference, while its practical relevance spans structural engineering, materials science, environmental systems and complex engineered networks. The Special Issue "Applied Probability and Statistical Inference in Reliability Engineering" brings together eleven original research articles that collectively highlight recent methodological advances and emerging applications at the intersection of probabilistic modeling and reliability analysis.

A prominent theme in this Special Issue is the development and refinement of probabilistic models that accommodate nonstandard data features, including censoring, skewness, dependence, and imprecision. In this direction, Oz and Bayramoglu (Contribution 1) introduce fuzzy improved distributions for modeling exceedance counts within order statistic intervals, providing a flexible framework that incorporates epistemic uncertainty into exceedance-based reliability assessment. This contribution demonstrates how fuzzy probabilistic structures can enrich classical counting models, particularly in situations where data imprecision or vagueness is unavoidable.

Distributional modeling under non-Gaussian behavior is further explored in the context of reliability-based design. Kala (Contribution 2) proposes closed-form expressions for design quantiles that explicitly account for skewness and kurtosis through a Hermite expansion approach. By moving beyond the traditional normality assumption, this work offers a practical and analytically tractable tool for structural reliability applications where tail behavior plays a critical role in safety assessment. Complementing this perspective, Ianculescu and Anghel (Contribution 3) develop innovative explicit relations for estimating Weibull distribution parameters based on K-moments. Given the central role of the Weibull distribution in lifetime and reliability analysis, their contribution provides efficient parameter estimation techniques with potential advantages in robustness and interpretability.

Statistical inference under censoring schemes represents another core axis of the Special Issue. Bdair (Contribution 4) investigates inference for the two-parameter Birnbaum–Saunders distribution using Type-II censored samples, with an application to fatigue life data of aluminum coupon cuts. This study highlights both frequentist and practical aspects of inference in fatigue modeling, reinforcing the importance of censoring-aware methodologies in experimental reliability studies. In a related but distinct application domain, Ahmad, Ramadan and Aboshady (Contribution 5) analyze chemical decay processes in environmental nanomaterials using the Gamma distribution under a hybrid censoring scheme. Their work illustrates how common lifetime distributions can be adapted to environmental reliability problems, combining inferential rigor with real-world relevance.

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System-level reliability modeling is addressed through several contributions that emphasize structural configuration, dependence, and risk heterogeneity. Triantafyllou (Contribution 6) presents a probabilistic framework for threshold reliability structures consisting of three different component types, deriving explicit reliability measures and mean time to failure expressions. This work advances the analytical treatment of heterogeneous systems and provides useful insights for system designers and reliability analysts. Expanding on the role of heterogeneity, Ahmad, Aboshady, and Mansour (Contribution 7) conduct a comprehensive study of risk factors in system performance under adaptive progressive Type-II censoring. By integrating generalized failure rate models with advanced censoring mechanisms, this contribution sheds light on how risk factors influence reliability estimation and system behavior.

Stochastic process modeling forms another essential pillar of the Special Issue. Vanni and Lambert (Contribution 8) investigate aging renewal point processes and the exchangeability of event times, offering theoretical insights with implications for recurrent event modeling and repairable systems. Their results contribute to a deeper understanding of how aging mechanisms affect dependence structures in stochastic processes commonly used in reliability and survival analysis.

Beyond classical lifetime and system models, the Special Issue also broadens the conceptual scope of reliability. Marmor and Bashkansky (Contribution 9) address the reliability of partitioning metric space data, proposing methods to assess the stability and robustness of data partitioning procedures. This contribution reflects the growing interaction between reliability theory and data-driven methodologies, particularly relevant in modern applications involving complex and high-dimensional datasets. From a theoretical stochastic ordering perspective, Shrahili, Kayid, and Mesfioui (Contribution 10) examine the relative orderings of modified proportional hazard rate and modified proportional reversed hazard rate models. Their analysis strengthens the mathematical foundations of reliability comparison and stochastic dominance, offering tools for comparing lifetimes and system risks under different hazard structures.

Finally, the integration of reliability modeling with decision making and maintenance optimization is exemplified by Bian, Peng, and Ye (Contribution 11). They study systems subject to generalized Pólya censored δ shock models and derive optimal replacement policies based on the associated reliability characteristics. This work underscores the practical importance of linking stochastic failure modeling with economic considerations and operational strategies.

In summary, the contributions collected in this Special Issue reflect the richness and diversity of contemporary research in applied probability and statistical inference for reliability engineering. They demonstrate how advances in distribution theory, censoring methodologies, stochastic processes, and system modeling can be effectively combined to address complex reliability problems across a wide range of applications. By bridging theoretical developments with practical implementations, this Special Issue aims to stimulate further research and foster deeper integration between probabilistic modeling, statistical inference, and reliability engineering in increasingly complex and uncertain environments.

We wish to thank the authors for their contributions and their willingness to share innovative ideas and techniques to furnish this Special Issue. In addition, we would like to thank and express our appreciation to the reviewers since they spent a considerable amount of time providing accurate and fair manuscript evaluations. Last but not least, we would like to express our pleasure for working with Mrs. Ashley Chang of the Editorial Office of *Mathematics* for the fruitful and excellent cooperation.

Conflicts of Interest: The authors declare no conflict of interest.

List of Contributions

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