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Editorial

Preface to Computational Mathematics and Applied Statistics

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The rapid advances in modeling research have created new challenges and opportunities for statisticians. These include statistical inferences in observational studies and many other emerging fields, which have motivated statisticians worldwide to develop cutting-edge methods and analytical strategies.

The main focus of this Special Issue is applications and methodological research in all fields of computational statistics. This Issue aims to provide a forum for computer scientists, mathematicians, and statisticians working in a variety of areas of statistics, including biometrics, econometrics, data analysis, graphics, and simulation. Computational Mathematics and Applied Statistics are two related fields that play a crucial and important role in the development and advancement of various scientific and technological domains.

Computational Mathematics involves developing and applying mathematical algorithms and models to solve complex problems using computers. This book integrates various mathematical disciplines, such as calculus, linear algebra, differential equations, optimization and numerical analysis, to develop efficient and accurate algorithms for scientific computation and data analysis. Computational Mathematics has numerous applications, including engineering, physics, biology, finance, and computer science.

Applied Statistics involves collecting, analyzing, and interpreting data to make informed decisions in various fields. It includes various statistical methods and tools, such as probability theory, hypothesis testing, regression analysis, and experimental design, to extract insights and patterns from data. Applied Statistics has applications in various fields, such as healthcare, finance, marketing, social sciences, and environmental studies.

In this book, the integration of these two fields has led to the development of data science, which has become a vital field for extracting insights from vast amounts of data. Furthermore, this book can be used as a textbook and/or reference book, which is especially suitable for undergraduates and graduates in computational mathematics, engineering, computer science, computational intelligence, and data science.

In [1], Tomy et al. explore the interdisciplinary partnership between Environmental Sciences and Statistics, highlighting the crucial role of statistical methods in solving environmental issues. By providing a clear roadmap, this paper facilitates collaborative learning between environmental scientists and quantitative researchers, enabling them to develop their analytical skills and knowledge base.

In [2], Irshad et al. present the discrete Pseudo Lindley (DPsL) distribution, which is a discrete version of the Pseudo Lindley (PsL) distribution. The authors conduct a systematic analysis of the mathematical properties of the DPsL distribution, including its probability-generating function, moments, skewness, kurtosis, and stress-strength reliability. The explicit forms of these properties make the distribution highly appealing. The practicality of the proposed distribution is demonstrated through its application to the first-order integer-valued autoregressive process, and its empirical relevance is validated through the analysis of three real-world datasets.

In [3], Tomy and Chesneau study a novel and flexible trigonometric extension of the modified Lindley distribution, known as the sine-modified Lindley distribution. This

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one-parameter survival distribution is created by incorporating features from the sine-generalized family of distributions, providing an attractive alternative to the Lindley and modified Lindley distributions, particularly for modeling lifetime phenomena with leptokurtic data. The results show that the sine-modified Lindley model outperforms important models such as the Lindley, modified Lindley, sine exponential, and sine Lindley models, based on various goodness-of-fit criteria.

In [4], Jamal et al. propose a new and improved functional form of the Burr III distribution, which enhances the classical distribution's flexibility and enables it to model the hazard rate functions of various shapes, including increasing, decreasing, bathtub, upside-down bathtub, and nearly constant. The article presents some of the distribution's fundamental properties, such as rth moments, sth incomplete moments, moment generating function, skewness, kurtosis, mode, ith order statistics, and stochastic ordering, in a clear and concise manner, and also demonstrates the effectiveness of the proposed model in three applications, consisting of both complete and censored samples.

In [5], Krishna et al. introduce the unit Teissier distribution, a bounded form of the Teissier distribution, and thoroughly examine its important properties. The analysis includes a shape analysis of the main functions, an analytical expression of moments based on the upper incomplete gamma function, incomplete moments, probability-weighted moments, and quantile function. The article also demonstrates the competency of the proposed model by analyzing two datasets from diverse fields.

In [6], Khan et al. utilize a new three-parameter continuous model, called the minimum Lindley Lomax distribution, by combining the Lindley and Lomax distributions. The article carefully examines various basic statistical aspects of the new distribution, including the quantile function, ordinary and incomplete moments, moment generating function, Lorenz and Bonferroni curves, order statistics, Rényi entropy, stress strength model, and stochastic sequencing. The article investigates the characterizations of the new model, estimates its parameters using maximum likelihood procedures and demonstrates the extensibility of the new model with two applications.

In [7], Nagarjuna et al. perform a hybrid distribution, the Nadarajah–Haghighi Lomax (NHLx) distribution, by combining the features of the Nadarajah–Haghighi and Lomax distributions. The NHLx distribution, with its four parameters, lower bounded support, and flexible distributional functions, including a unimodal probability density function and bathtub-shaped hazard rate function, provides an extension of the exponential Lomax distribution. Moreover, the distribution has the desirable statistical properties of moments and quantiles. The authors illustrate the statistical applicability of the NHLx distribution by conducting simulations and analyzing four real datasets.

In [8], Jasmine et al. conduct a study to manage hydrological resources such as reservoirs, rivers, and lakes. In recent years, data-driven techniques, such as the adaptive neuro-fuzzy inference system (ANFIS), have gained popularity in the hydrological field. This study explores the effective use of artificial intelligence for predicting evaporation in agricultural areas. Specifically, it examines ANFIS and hybridizes it with three optimizers: the genetic algorithm (GA), firefly algorithm (FFA), and particle swarm optimizer (PSO).

In [9], Dechpichai et al. aim to examine the spatial and temporal patterns of 124 meteorological stations in Thailand under ENSO. The research employs multivariate climate variables, including rainfall, relative humidity, temperature, max temperature, min temperature, solar downwelling and horizontal wind from the conformal cubic atmospheric model (CCAM), during the years of El Niño (1987, 2004, and 2015) and La Niña (1999, 2000, and 2011). This approach may be useful for planning and managing crop cultivation in different areas, using variables forecasted for the future and considering the effects of climate change.

In [10], Tomy and Chesneau examine the suitability of the sine-modified Lindley distribution, a relatively new statistical model, for analyzing biological data. The goodness-of-fit approach is employed to demonstrate the effectiveness of the model in estimating and modeling the lifespan of guinea pigs exposed to tubercle bacilli, the impact of growth hormone treatment on children, and the size of tumors in cancer patients. The researchers believe that this model has potential for the analysis of survival times related to cancer and other diseases. The paper also includes R codes for the figures and details on data processing.

In [11], Muchie et al. study small-area estimation methods to determine the prevalence of malnutrition among children under five in Ethiopia, specifically at the zonal level. To achieve this, the authors linked the most current survey data and census data available in Ethiopia. The findings revealed that stunting, wasting, and being underweight spatially varied across the zones, indicating that different regions face distinct challenges of varying degrees.

In [12], Pinault aims to advance the understanding of the mechanisms behind extreme climatic events, with the objective of improving forecasting methods and shedding light on the role of anthropogenic warming. The study utilizes wavelet analysis to identify the contribution of coherent Sea Surface Temperature (SST) anomalies produced from short-period oceanic Rossby waves to two case studies: a Marine Heatwave (MHW) in the northwestern Pacific with a significant impact in Japan, and a severe flood event in Germany. The study concludes by highlighting the need for further research to better understand how anthropogenic warming can modify key mechanisms in the evolution of dynamic systems that contribute to extreme events.

In [13], Essiomle and Adekambi focus their study on the Gerber–Shiu discounted penalty function with a constant interest rate, considering the delayed claim reporting times. The Poisson claim arrival scenario is used to derive the Laplace transform of the generalized Gerber-Shiu function, which leads to a second Volterra equation with a degenerated kernel. The study presents a closed-form expression for the Gerber–Shiu function in the case of an exponential claim distribution through sequence expansion. This expression enables the calculation of absolute and relative ruin probabilities.

In [14], Jamal et al. propose a generalized, odd, linear, exponential family of continuous distributions. The probability density and cumulative distribution function are represented as infinite linear combinations of the exponentiated-F distribution. Various statistical properties, including quantile function, moment-generating function, distribution of order statistics, moments, mean deviations, asymptotes, and the stress-strength model, are explored for the proposed family, and simulation studies are conducted for two sub-models to examine the asymptotic behavior of the maximum likelihood estimates.

In [15], Hussen and He discuss a generalized Prony method that can solve the sparse expansion problem for two generating functions, enabling the recovery of a wider range of function types using Prony-type methods. The two-generator sparse expansion problem has certain unique properties, such as the need to separate the two sets of frequencies from the zeros of the Prony polynomial. To address this issue, they propose a two-stage least-square detection method that effectively solves the problem.

In [16], Human et al. introduce a bivariate beta-type distribution that allows for users to detect a permanent upward or downward step shift in the process' variance without relying on parameter estimates. This approach offers an attractive and intuitive way to potentially identify the magnitude and time of shift occurrence. The paper derives certain statistical properties of this distribution, and simulations illustrate the theoretical results.

In [17], Shafiq et al. examine a novel discrete distribution, named the Binomial-Natural Discrete Lindley distribution, which is created by combining the binomial and natural discrete Lindley distributions. The distribution's properties, such as the moment-generating function, moments, hazard rate function, methods of moments, proportions, and maximum likelihood, are investigated.

Ultimately, this book is not intended to provide a comprehensive treatment of all the work in the field of Computational Mathematics and Applied Statistics development; rather, it is intended to help researchers focus on a few key strategies with the potential to have a high impact.

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