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A Retrospective Study on Applications of the Lindley Distribution

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Abstract The need for efficient statistical models has increased with the flow of new data, which makes distribution theory a particularly interesting and attractive field. Here, we provide a thorough study of the applications of the Lindley distribution and its diverse generalizations. More precisely, we review some special applications in various areas, such as time series analysis, stress strength analysis, acceptance sampling plans and data analysis. We also conduct a comparative study between the Lindley distribution and some of its generalizations by using four real-life data sets.

Keywords Lindley distribution, Stress-strength, Time series modeling, Quality control, Astrophysics.

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1. Introduction

In recent years, there has been a growing interest in introducing new distributions and their generalizations because of the diversity of the data encountered in practice. Therefore, the statisticians aim to develop different distributions presenting flexible and original properties.

In this spirit, Lindley [46] coined the term "Lindley distribution" to refer to a one-parameter distribution used in fiducial and Bayesian inferences. Its properties and applications in reliability analysis were studied by Ghitany et al., [38], showing that it may provide a better fit than the exponential distribution. The Lindley distribution's simplicity and moderate flexibility paved the way for generalized versions, with the goal of building models and with better goodness of fit to data sets than the well-known basic distributions. Some of these generalizations are the size-biased Poisson-Lindley distribution by Ghitany and Al-Mutairi [34], discrete Poisson-Lindley distribution by Sankaran [57] and zero-truncated Poisson-Lindley distribution by Ghitany et al., [36], two-parameter Lindley distribution by Shanker and Mishra [62], power Lindley distribution by Ghitany et al., [35], inverse Lindley distribution by Sharma et al., [65], exponentiated power Lindley distribution by Ashour and Eltehiwy [13], generalized power Lindley distribution by Liyanage

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and Parai [47], extended Lindley distribution by Bakouch et al., [14], Akash distribution by Shanker [59], quasi Akash distribution by Shanker [60], weighted Akash distribution Shanker and Shukla [64], quasi Lindley distribution by Shanker and Mishra [63], extended power Lindley distribution by Alkarni [4], discrete Lindley distribution by Deniz and Ojeda [30], weighted Lindley distribution by Ghitany et al., [37], discrete Poisson-Akash distribution by Shanker [61], new weighted Lindley distribution by Asgharzadeh [12], transmuted Lindley distribution by Merovci [50], new extended generalized Lindley distribution by Maya and Irshad [48], and transmuted two-parameter Lindley distribution by Kemaloglu and Yilmaz [41].

Some recent works based on the Lindley distribution are the Topp-Leone odd Lindley family of distributions by Reyad et al., [55], wrapped Lindley distribution by Joshi and Jose [40], Marshall-Olkin extended quasi Lindley distribution by Udoudo and Etuk [68], three-parameter generalized Lindley by Ekhosuehi and Opone [33], Lindley Weibull distribution by Cordeiro et al., [29], alpha power transformed power Lindley distribution by Hassan et al., [39], alpha power transformed Lindley distribution by Dey et al., [31], Weibull Marshall-Olkin Lindley distribution by Afify et al., [2], inverted modified Lindley distribution by Chesneau et al., [26], sum and difference of two Lindley distributions by Chesneau et al., [24], modified Lindley distribution by Chesneau et al., [25], wrapped modified Lindley distribution by Chesneau et al., [27], and Lindley-Lindley distribution by Chesneau et al., [28]. Tomy [66] contains a previous review of the Lindley distribution and its generalizations. Trigonometric extensions of the Lindley distribution derived from trigonometric families of distributions (see Chesneau and Artault [23]) are under development. As a first proposal, we may cite the sine-modified Lindley distribution introduced by Tomy et al., [67].

The main motivation behind this study is to expose the diverse applications of the Lindley distribution and its generalizations in various fields, like reliability, time series, quality control, astrophysics and the analysis of various kinds of data as well.

The paper unfolds as follows: In Section 2, we consider some applications of the Lindley distribution and some of its generalizations in time series modeling. Section 3 presents applications of stress-strength analysis. Section 4 contains applications for various acceptance sampling plans. Section 5 discusses applications in real data analysis. Finally, in Section 6, we conclude the paper.

2. Applications in time series modeling

Over the last decades, there has been increasing interest in developing time series models for real-valued observations by using Gaussian or non-Gaussian distributions. Among the existing time series models, let us evoke the autoregressive models, integer valued models for discrete distributions, stochastic volatility and autoregressive conditional duration models. In this section, we consider autoregressive minification processes, geometric processes and the first order non-negative integer valued autoregressive processes.

2.1. Autoregressive minification process

Udoudo and Etuk [68] proposed different minification processes with a generalized quasi Lindley distribution as a marginal distribution.