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Classical and Bayesian Inference of the Generalized Log-Logistic Distribution with Applications to Survival Data

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Abstract : A generalized log-logistic distribution with variable shapes of the hazard rate was introduced and studied, extending the log-logistic distribution by adding an extra parameter to the classical distribution, leading to greater flexibility in analysing and modeling various data types. The proposed distribution has a large number of well-known lifetime special sub-models such as; Weibull, log-logistic, exponential, and Burr XII distributions. Its basic mathematical and statistical properties were derived. The method of maximum likelihood was adopted for estimating the unknown parameters of the proposed distribution, and a Monte Carlo simulation study is carried out to assess the behavior of the estimators. The importance of this distribution is that its tendency to model both monotone (increasing and decreasing) and non-monotone (unimodal and bathtub shape) or reversed “bathtub” shape hazard rate functions which are quite common in survival and reliability data analysis. Furthermore, the flexibility and usefulness of the proposed distribution are illustrated in a real-life data set and compared to its sub-models; Weibull, log-logistic, and BurrXII distributions and other parametric survival distributions with 3-parmaeters; like the exponentiated Weibull distribution, the 3-parameter lognormal distribution, the 3- parameter gamma distribution, the 3-parameter Weibull distribution, and the 3-parameter log-logistic (also known as shifted log-logistic) distribution. The proposed distribution provided a better fit than all of the competitive distributions based on the goodness-of-fit tests, the log-likelihood, and information criterion values. Finally, Bayesian analysis and performance of Gibbs sampling for the data set are also carried out.

Keywords : hazard rate function, log-logistic distribution, maximum likelihood estimation, generalized log-logistic distribution, survival data, Monte Carlo simulation
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