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Inference for the Gompertz distribution under progressive type-I interval censoring

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Abstract: This paper investigates statistical inference for the unknown parameters γ and ω of the Gompertz distribution. Although extensive literature exists on parameter estimation under various censoring schemes, inference under progressive type-I interval censoring has received limited attention. Closed-form expressions for the maximum likelihood estimators and midpoint estimators are derived within this framework. The finite-sample performance of the proposed estimators is evaluated through extensive Monte Carlo simulation studies conducted using the R programming language. The estimators are compared using standard accuracy measures to assess their efficiency and robustness under different censoring configurations. Furthermore, a real data application is presented to demonstrate the practical applicability of the proposed methods. The results indicate that the proposed estimation procedures provide reliable and accurate inference for lifetime data analysis.

Keywords: Estimation, Gompertz distribution, progressive type-I interval censoring.

1. Introduction

For any random variable from Gompertz with parameters γ and ω, respectively, the probability density function (pdf), reliability and hazard function and cumulative distribution function (cdf) are

$$f(x) = \omega e^{\gamma x - \frac{\omega}{\gamma}(\exp(\gamma x)-1)} \quad \dots\dots\dots\dots\dots (1)$$

$$S(x) = e^{-\frac{\omega}{\gamma}(\exp(\gamma x)-1)} \quad \dots\dots\dots\dots\dots\dots (2)$$

$$H(x) = \omega e^{\gamma x} \quad \dots\dots\dots\dots\dots\dots (3)$$

$$F(x) = 1 - e^{-\frac{\omega}{\gamma}(\exp(\gamma x)-1)} \quad \dots\dots\dots\dots (4)$$

where the scale parameter is $\omega > 0$ and the shape parameter is $x > 0, \gamma > 0$. Gompertz distribution tends to an exponential distribution when $\gamma \to 0$. Gompertz distribution has a rate function and positive skewness. The Gompertz distribution can be demonstrated to be a condensed version of the type-I extreme value distribution. The Gompertz distribution has received considerable attention in reliability and survival analysis due to its flexibility in modeling monotone hazard rate functions [1,3,4,16,17,18]. .Statistical inference for the Gompertz distribution under censored data has been extensively studied in the literature. Several authors have investigated parameter estimation using maximum likelihood estimation (MLE) under different censoring schemes, including Type-I, Type-II, and progressive censoring. However, the presence of interval censoring combined with progressive removal complicates the likelihood function, often resulting in nonlinear score equations that do not admit

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