

Chapter

Perspective Chapter: A New Weighted Probability Model with Applications in Medical Sciences

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Abstract

Weighted probability distributions play a significant role in statistical modeling when observations are recorded according to a specific stochastic mechanism. In many practical situations, each observation does not have an equal probability of being selected or observed, resulting in data that no longer follow the original underlying distribution. Such distributions have received considerable attention due to their ability to model biased and weighted sampling schemes encountered in a wide range of disciplines, including reliability engineering, survival analysis, ecology, medicine, actuarial science, and industrial quality control. Motivated by the growing importance and applicability of weighted models, this study introduces a new four-parameter weighted lifetime distribution derived from a classical lifetime distribution through the incorporation of an appropriate weight function. The statistical properties of the proposed distribution are investigated in detail. Explicit expressions for the probability density function and cumulative distribution function are obtained, and several important distributional characteristics, including moments, moment generating function, quantile function, reliability function, hazard rate function, and entropy measures, are derived. In addition, the properties of order statistics are explored to facilitate applications involving ranked observations. Parameter estimation is carried out using the maximum likelihood method, and the asymptotic behavior of the estimators is discussed. A comprehensive Monte Carlo simulation study is conducted to evaluate the performance of the estimators in terms of bias and mean squared error under different sample sizes and parameter settings. Finally, the practical usefulness and flexibility of the proposed model are demonstrated through the analysis of two real-life data sets. The results indicate that the proposed distribution provides an effective and competitive model for fitting lifetime data exhibiting diverse hazard rate behaviors.

Keywords: life time distribution, entropy, maximum likelihood estimation, real life applications, R Software

1. Introduction

In recent years, weighted distributions have attracted considerable attention because of their ability to model data arising from non-random sampling schemes