Reliability estimation of multicomponent stress–strength model based on copula function under progressively hybrid censoring

Xuchao Bai, Yimin Shi, Yiming Liu, Bin Liu

PII: S0377-0427(18)30269-3
DOI: https://doi.org/10.1016/j.cam.2018.04.066
Reference: CAM 11663

To appear in: *Journal of Computational and Applied Mathematics*

Received date : 1 June 2017
Revised date : 26 March 2018

Reliability estimation of multicomponent stress-strength model based on copula function under progressively hybrid censoring

Xuchao Bai[a,*], Yimin Shi[a,*], Yiming Liu[a], Bin Liu[b]
[a] Department of Applied Mathematics, Northwestern Polytechnical University, Xi'an 710072, China
[b] School of Applied Science, Taiyuan University of Science and Technology, Taiyuan 030024, China

Abstract: In reliability analysis of the stress-strength models, the stress and strength variables are typically assumed as independent. However, such an assumption may be unrealistic in some applications. It is a meaningful issue to estimate the reliability of the stress-strength model for dependent stress and strength variables. In this paper, we estimate the reliability of multicomponent stress-strength model by assuming the dependent Weibull stress variables and exponential strength variables based on Gumbel copula under Type-I progressively hybrid censoring scheme. The estimators of the unknown parameters and reliability are obtained by using the maximum likelihood estimation method. Also, the asymptotic confidence intervals and Bootstrap percentile confidence intervals of the unknown parameters and reliability of stress-strength model are derived. Monte Carlo simulations are used to evaluate the performance of the maximum likelihood estimators, asymptotic confidence intervals and Bootstrap percentile confidence intervals. Finally, real data are analyzed to demonstrate the practicability of the stress-strength model in this article.
Key Words: multicomponent stress-strength model; Gumbel copula; Type-I progressively hybrid censoring scheme; Bootstrap percentile confidence interval; Monte Carlo simulation

1 Introduction

In reliability analysis, the stress-strength model describes the reliability of an individual which has a random strength X and is subject to a random stress Y. The individual fails if the strength cannot resist on the stress. Hence, $R = P(Y < X)$ represents the reliability of the individual. Birnbaum [1] connected the classical Mann-Whitney statistic with the stress-strength inference. Since then, the stress-strength models have been widely discussed in the statistical and reliability literature. There are many literatures have investigated the stress-strength models under different distributions. Guo and Krishnamoorthy [2] proposed some new approximate inferential methods for the reliability estimation in the stress-strength model when the stress and strength variables are independent normal random variables with unknown means and variances. Khan and Jan [3] studied the reliability estimation of the stress-strength model when strength variables followed finite mixture of two parameter Lindley distribution and stress variables followed exponential distribution, Lindley distribution and finite mixture of two parameter Lindley distribution, respectively. Kundu and Raqab [4] derived the estimation of $R = P(Y < X)$ when X and Y followed three-parameter generalized Rayleigh distributions with the same scale and location parameters but different shape parameters.

The above mentioned system is only a single-component system, but this assumption is not enough to cope with more cases. In fact, with the development of the science technology and manufactory technique, there are many multicomponent systems appearing in our daily life, such as the mouse, keyboards, IT hardware, aero-engines, and so on. It is significantly meaningful to study the reliability of multicomponent system in stress-strength models. Reliability analysis for a multicomponent survival stress-strength model based on exponential distributions was studied by Kunchur and Munoli [5]. Eryılmaz [6] got some conclusions about stress-strength reliability under multi-state systems modeling, and he also studied the multicomponent form. Rao et al. [7,8,9] discussed the reliability of multicomponent stress-strength model based on generalized exponential distribution, Burr-XII distribution and two parameter exponentiated Weibull distribution. An *n*-component-standby system stress-strength model was analyzed by Khan and Jan [10].

It is usually assumed that the stress and strength variables are independent, then based on this assumption to analysis the characteristics of the stress-strength models. However, in many cases, the stress and strength variables are dependent in some way. For example, a household income and

*Corresponding authors.
Email: baixuchao@126.com (X. Bai), ymshi@nwpu.edu.cn (Y. Shi).