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Stress-strength reliability analysis of system with multiple types of components using survival signature

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Abstract

In this paper, we study the estimation for stress-strength reliability of the system with multiple types of components based on survival signature. In the situation that different types of components are subjected to different types of random stresses, the maximum likelihood estimator, maximum spacing estimator, bootstrap-p confidence interval, two point estimators and generalized confidence interval using generalized pivotal quantity for system stress-strength reliability are derived under the assumption that the stresses and strengths variables follow the Gompertz distributions with common or unequal scale parameters. Additionally, when the stresses and strengths variables follow the Gompertz distributions with unequal scale parameters, a modified generalized confidence interval for the system stress-strength reliability based on the Fisher Z transformation is also proposed. In the situation that the system is subjected to the common stress, the above point estimators and confidence intervals for the system stress-strength reliability are also developed. Monte Carlo simulations are performed to compare the performance of these point estimators and confidence intervals. A real data analysis is presented for an illustration of the findings.

Keywords: Gompertz distribution; Generalized pivotal quantity; Maximum spacing estimator; Stress-strength reliability; multiple types of components; Survival signature.

1. Introduction

Stress-strength models are of special importance in engineering applications. A technical system or unit may be subjected to randomly occurring environmental stresses such as pressure, temperature, and humidity. The survival of the system heavily depends on its resistance. In the simplest form of the stress-strength model, a failure occurs when the strength (or resistance) of the component drops below the stress. In this case the stress-strength reliability (SSR) R is defined as the probability that the component's strength is greater than the stress, that is, $R = P(X_1 > X_2)$, where X_1 is the random strength of the component and X_2 is the random stress placed on it. The stress-strength model has been applied in various fields such as engineering, seismology, oceanography, hydrology, economics and medicine; see for example Johnson [1] and Kotz et al. [2]. Eryılmaz [3] studied Multivariate stress-strength model for coherent structures. The SSR for consecutive k-out-of-n: G system was considered by Eryılmaz [4]. Additionally, Eryılmaz [5] developed the SSR for a coherent system. For more extensive and lucid researches on the stress-strength model by Eryılmaz, see [6, 7, 8]. Recently, Liu et al. [9] studied the estimation for SSR of a N-M-cold-standby redundancy system based on progressive Type-II censoring sample. The SSR of a standby redundancy system with independent stress and strength based on different probability distributions, viz. Exponential, Gamma and Lindley distributions was studied by Khan and Jan [10]. Estimations of the reliability in multicomponent stress-strength systems were obtained by Kızılaslan and Nadar [11, 12] when the underlying distributions were Weibull distribution and Marshall-Olkin bivariate weibull distribution. Wang et al. [13] developed inferential procedures for the generalized exponential stress-strength model based on generalized pivotal quantity (GPQ). For more details on the stress-strength model in recent years, see [14, 15, 16, 17, 18, 19].

The system signature has been found to be useful for comparisons performance and the quantification of the reliability of coherent system. A lucid review of the theory about signature and its application were presented by Samaniego [20]. The main advantage of system signature is that it separates the structure of the system from the failure time distribution of the components. However, when it comes to real world systems with more than one component type, a reliability analysis

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