Stochastic Comparisons Between the Component and System Redundancy for Series Assembly Systems

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Received: 2019/02/11 Accepted: 2019/11/23

Extended Abstract

Paper pages (249-262)

Introduction

Optimum lifetime of a series system with active spares always depends on the allocation of spares at component /system level. In order to optimize the lifetime of a system, an important problem in reliability theory is-where to allocate a redundant component. In general, there are two types of redundancy- active redundancy or parallel redundancy where system life is the maximum of the lives of the original component and the redundant component, and the standby redundancy where system life is the sum of the lives of the original component and the redundant component. It is a well-known principle to the design engineers that active redundancy at the component level is better than that at the system level in usual stochastic ordering. In the literature, this result has been generalized to different other stochastic orders, namely hazard rate order, reversed hazard rate order, likelihood ratio order.

In order to optimize the lifetime of a coherent system, one efficient method is to add redundancy components to the system. In general, there are two types of redundancies called active redundancy and standby redundancy commonly used in reliability engineering and system security. The former [active redundancy] is used when replacement of components during the operation of the system is impossible; in this case the redundancies are put in parallel to components of the system which leads to taking the maximum of random lifetimes. The latter [standby redundancy] is used when replacement of components during the operation of the system is possible; in this case the redundancy starts functioning immediately after the corresponding original component in the system fails which leads to taking the convolution of random variables. k-out-of- n assembly systems have important applications in various areas such as software reliability, decision theory, and more. For example, Hwang and Rothblum (1995) mentioned a

software system redundancy in which a 2-out-of-3 redundancy is introduced to increase the reliability of a series software system, which can be regarded as an assembly system of 2-out-of-2 and 2-out-of-3 systems.

In this paper, we discuss stochastic comparisons of active redundancy at component level versus system level. We also consider series systems in order to compare their lifetimes using the usual stochastic, the hazard rate and the reversed hazard rate orders, for two cases: (i) the spare and parent components are independent and have the same distribution, and then (ii) the spare and parent components are dependent and have not the same distribution.

Results and discussion

Comparisons of different characteristics associated with lifetimes of reliability systems is quite important and useful in reliability theory, as it would enable us to approximate complex systems by simpler systems and subsequently be able to obtaining some bounds for important ageing characteristics of the considered complex system. One way to achieve this in through the theory of stochastic orderings. In this paper, we discuss stochastic comparisons of active redundancy at component level versus system level. We also consider series systems in order to compare their lifetimes using the usual stochastic, the hazard rate and the reversed hazard rate orders, for two cases: (i) the spare and parent components are independent and have the same distribution, and then (ii) the spare and parent components are dependent and have not the same distribution.

Conclusion

Comparisons of various characteristics of lifetimes of different systems have been discussed rather extensively in the literature, and many stochastic orderings have been used for this purpose. We consider series systems in order to compare their lifetimes using the usual stochastic, hazard rate and reversed hazard rate orders, for two following cases when:

- the spare and parent components are independent and have the same distribution;
- the spare and parent components are dependent and have not the same distribution.

Keywords: Stochastic orders, Component redundancy, System redundancy, Coherent system.
Mathematics Subject Classification (2010): 90B25, 60E15, 60K10.

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