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ScienceDirect
Mathematics and Computers in Simulation 81 (2011) 2062–2072
MATHEMATICS AND COMPUTERS IN SIMULATION
www.elsevier.com/locate/matcom

Tow stage design for estimating the reliability of series/parallel systems

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Received 20 October 2009; received in revised form 14 August 2010; accepted 7 December 2010
Available online 1 February 2011

Abstract

This work aims to determine in a practical and straightforward manner an efficient sampling scheme for estimating the reliability of series/parallel systems. One of the most crucial tasks is to determine the optimal number of units to sample. The sampling schemes given by the authors are complex and costly. We give a reliability sequential scheme which performs much better than the balanced allocation. For a large total number of units, the first order asymptotic optimality of such a scheme is validated by Monte Carlo simulations.

MSC: 62D05; 62L10; 62L12; 62N05

Keywords: Reliability; Sequential sampling; Two stage design

1. Introduction

Reliability modeling is a technique used to estimate efficiently the reliability of products and systems, including their components and sub-systems. From a reliability point of view, most products and/or systems can be modeled as a series, parallel, stand-by system, or combinations thereof. The most crucial task for designers, in reliability engineering and system safety, involves a multi-criteria optimization problem. Under a set of constraints such as risk, system weight, cost, performance and others, two main objectives are considered: (1) to maximize an estimate of system reliability and (2) to minimize the variance of the reliability estimate. Because system designers and users are risk-averse, they generally prefer the second objective which leads to a system design with a slightly lower reliability estimate but a lower variance of that estimate. In many situations a system is composed of a combination of series and parallel sub-systems. In the case of parallel–series and/or by duality series–parallel systems, the variance of the reliability estimate can be lowered by allocation of a fixed sample size, while reliability estimate is obtained by testing components. Sampling schemes for estimating the reliability of series/parallel systems with cost [11] need the optimization of the number of units to be tested in each component [6]. Classical procedures in the literature of reliability engineering are complex and costly in practice, cf. e.g. [2,5,9]. Actually, efficient designs are based on sequential procedures (two or three stage in a fixed or a Bayesian framework [1,3,7,8,10]). Reliability sequential schemes (R-SS) were applied successfully

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doi:10.1016/j.matcom.2010.12.033