Approximation of continuous random variables for the evaluation of the reliability parameter of complex stress-strength models

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A stress-strength model consists of an item, a component, or a system with an intrinsic random strength that is subject to a random stress during its functioning, so that it works until the strength is greater than the stress. The probability of this event occurring is called the reliability parameter. Since stress and strength are often functions of elementary stochastic factors and the form of these functions is usually very complex, it descends that finding their exact statistical distribution, and then the value of the reliability parameter, is at least cumbersome if not actually impossible. It is standard practice to carry out Monte Carlo simulations in order to find this value numerically. A convenient alternative solution to this impasse comprises discretization, i.e., substituting the probability density functions of the continuous random variables with the probability mass functions of properly chosen approximating discrete random variables. Thus, an approximate value of the reliability parameter can be recovered by enumeration. Many discretization methods have been proposed in the literature so far, which may differ from one another in their ultimate scope and range of applicability [1, 2, 3]. In this work, we will revise and further refine these techniques and apply them to the context of complex stress-strength models. A comparative study will empirically investigate the performance of these methods by considering several well-known engineering problems and give some practical advice on their mindful use.

Keywords: approximation; discretization; Monte Carlo simulation; reliability parameter; stress-strength model

References

[1] Roy D., Dasgupta T. (2001). A discretizing approach for evaluating reliability of complex systems under stress-strength model. *IEEE Transactions on Reliability*, 50(2), 145-150.

[2] Barbiero A. (2012). A general discretization procedure for reliability computation in stress-strength models. *Mathematics and Computers in Simulation*, 82, 1667-1676.

[3] Drezner Z., Zerom D. (2016). A simple and effective discretization of a continuous random variable. *Communications in Statistics-Simulation and Computation*, 45(10), 3798-3810.

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