Targeted Random Sampling for Reliability Assessment: A Demonstration of Concept

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Abstract

Monte Carlo simulation provides the benchmark for computational methods in reliability assessment in terms of both accuracy and robustness. However, Monte Carlo methods are well-known to be computationally expensive and, in many cases, intractable. Several improvements have been proposed to increase their computational efficiency for reliability analysis including Latin hypercube sampling; see Olsson et al. (2003), importance sampling; see Scheuller and Stix (1987), subset sampling; see Au and Beck (2001), and line sampling; see Koutsourelakis et al. (2004), among others. The primary drawback of Monte Carlo methods is that, even using the most advanced methods, a large proportion of the samples are of little, if any, use to the reliability assessment.

This work demonstrates a new Monte Carlo concept, referred to as Targeted Random Sampling (TRS), that is rooted in the recently developed Refined Stratified Sampling method; see Shields et al. (2004). TRS enables the selection of random samples from specific strata of the space (with known probability of occurrence) that are identified, based on statistical information available form existing samples, as being particularly important to estimation of the statistical quantity of interest (here probability of failure). In this work, the concept is developed and it is demonstrated how the method can be used to concentrate random samples in the vicinity of the failure surface to facilitate very rapid convergence of the probability of failure estimate.

References

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