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Bayesian inference with reliability methods without knowing the maximum of the likelihood function

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Abstract

In the BUS (Bayesian Updating with Structural reliability methods) approach, the uncertain parameter space is augmented by a uniform random variable and the Bayesian inference problem is interpreted as a structural reliability problem. A posterior sample is given by an augmented vector sample within the failure domain of the structural reliability problem where the realization of the uniform random variable is smaller than the likelihood function scaled by a constant c. The constant c must be selected such that $1/c$ is larger or equal than the maximum of the likelihood function, which, however, is typically unknown a-priori. For BUS combined with sampling based reliability methods, choosing c too small has a negative impact on the computational efficiency. To overcome the problem of selecting c, we propose a post-processing step for BUS that returns an unbiased estimate for the evidence and samples from the posterior distribution, even if $1/c$ is selected smaller than the maximum of the likelihood function. The applicability of the proposed post-processing step is demonstrated by means of rejection sampling. However, it can be combined with any structural reliability method applied within the BUS framework.

Keywords: Bayesian updating, Bayesian model class selection, rejection sampling, structural reliability

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