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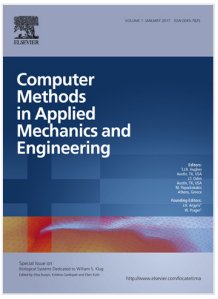

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Bayesian updating and model class selection with Subset Simulation

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Abstract

Identifying the parameters of a model and rating competitive models based on measured data has been among the most important and challenging topics in modern science and engineering, with great potential of application in structural system identification, updating and development of high fidelity models. These problems in principle can be tackled using a Bayesian probabilistic approach, where the parameters to be identified are treated as uncertain and their inference information are given in terms of their posterior probability distribution. For complex models encountered in applications, efficient computational tools robust to the number of uncertain parameters in the problem are required for computing the posterior statistics, which can generally be formulated as a multi-dimensional integral over the space of the uncertain parameters. Subset Simulation has been developed for solving reliability problems involving complex systems and it is found to be robust to the number of uncertain parameters. An analogy has been recently established between a Bayesian updating problem and a reliability problem, which opens up the possibility of efficient solution by Subset Simulation. The formulation, called BUS (Bayesian Updating with Structural reliability methods), is based the standard rejection principle. Its theoretical correctness and efficiency requires the prudent choice of a multiplier, which has remained an open question. This paper presents a fundamental study of the multiplier and investigates its bias effect when it is not properly chosen. A revised formulation of BUS is proposed, which fundamentally resolves the problem such that Subset Simulation can be implemented without knowing the multiplier a priori. An automatic stopping condition is also provided. Examples are presented to illustrate the theory and applications.

Keywords: Bayesian inference, BUS, Subset Simulation, Markov Chain Monte Carlo, model