Accepted Manuscript

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PII: S0045-7825(16)31191-4
DOI: http://dx.doi.org/10.1016/j.cma.2017.02.025
Reference: CMA 11352

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date : 23 September 2016
Revised date : 16 February 2017
Accepted date : 17 February 2017

Please cite this article as: D.G. Giovanis, et al., Bayesian updating with subset simulation using artificial neural networks, *Comput. Methods Appl. Mech. Engrg.* (2017), http://dx.doi.org/10.1016/j.cma.2017.02.025

Bayesian updating with subset simulation using artificial neural networks

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Abstract

We propose a hybrid methodology that implements artificial neural networks (ANN) in the framework of Bayesian updating with structural reliability methods (BUS) in order to increase the computational efficiency of BUS in sampling-based Bayesian inference of numerical models. In particular, ANNs are incorporated in BUS with subset simulation (SuS). The basic concept is to train an ANN in each subset of SuS with a fraction of the required number of samples per subset and employ the trained ANN to generate the remaining samples. This is achieved by replacing the full model evaluation at a candidate sample point of the Markov Chain Monte Carlo (MCMC) simulation within SuS by an ANN estimate. To ensure the accuracy of the surrogate, each ANN estimate is tested against a set of conditions. The ANN training is specifically tailored to the adaptive variant of BUS enhanced with MCMC with optimal scaling. The applicability as well as the efficiency of the proposed method are examined by means of numerical results in three test cases.

Keywords: Bayesian updating, subset simulation, artificial neural networks, MCMC

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