Engineering Risk Analysis Group
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MSc thesis

Traditional and approximate Bayesian computations with applications to random fields

Junyi Jiang, March 2018

Background

Bayesian inference has been popular due to its effectiveness for the estimation of posterior distribution which represents the updated belief of a given set of parameters after taking measured data into consideration. In this thesis, the traditional and approximate Bayesian computations (ABC) with applications to random fields have been implemented and compared. The primary purpose is to check the feasibility and efficiency of random field inference via ABC.

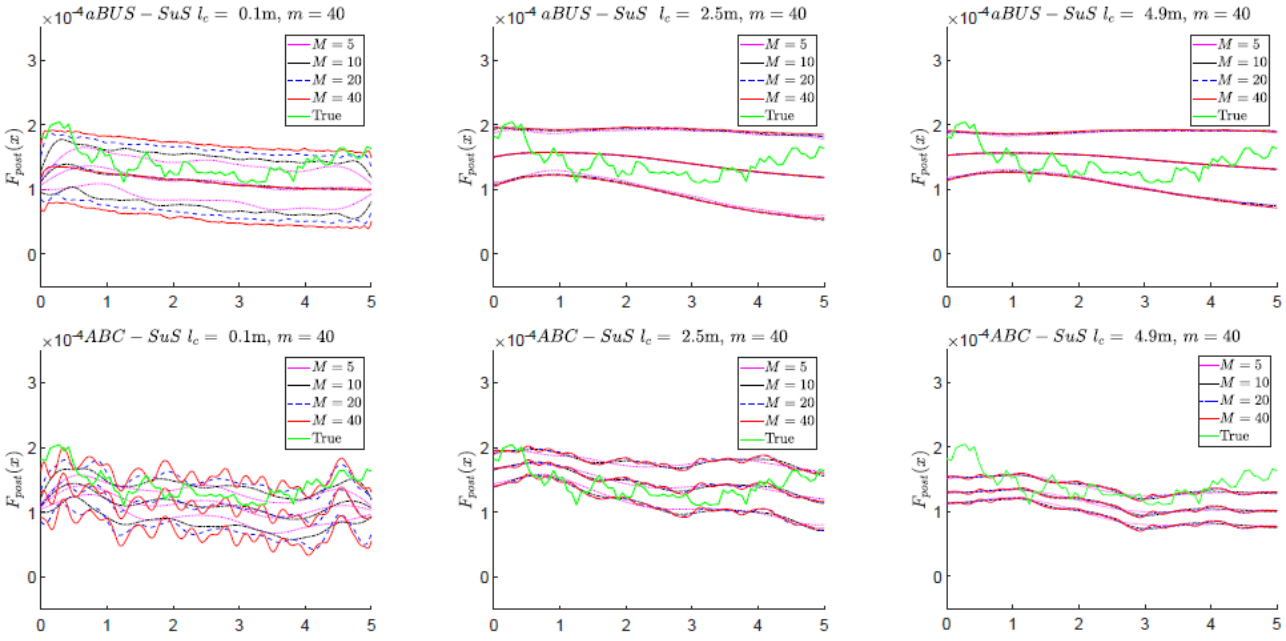

Figure 1. Posterior realizations of flexibility with different updating approach (1st row: aBUS-SuS, 2nd row: ABC-SuS) and correlation length (1st column: l_c = 0.1m, 2nd column: l_c = 2.5m, 3rd column: l_c = 4.9m). Estimated ± 95% confidence interval for 5×10^4 simulations are marked.

Methodology

For traditional updating, the Markov chain Monte Carlo (MCMC) and the adaptive Bayesian Updating with structural reliability methods (aBUS) are used. As for the ABC scheme, MCMC and subset simulation (SuS) are adopted. Figure 1 indicates the posterior realizations of flexibility in beam benchmark with aBUS-SuS and ABC-SuS updating method, respectively.

Conclusion

The ABC-SuS has good performance when the correlation length and summary statistics are appropriately specified. Although the random field realization and model evaluation are still required, the ABC scheme could deal with cases where likelihood function is expensive to compute. Further studies on auxiliary models in ABC are recommended, which could reduce the computation burden associated to the random field realization.

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