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Experience with Several Multi-fidelity Surrogate Frameworks

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Abstract

In this paper, multi-fidelity surrogate (MFS) frameworks are investigated with the aid of an algebraic example for 100 different designs of experiments (DOEs). These include three Bayesian frameworks using 1) a model discrepancy function, 2) low fidelity model calibration and 3) a comprehensive approach. Two simple frameworks using 1) a discrepancy function and 2) low fidelity model calibration which are counterparts of the Bayesian frameworks 1) and 2) are also investigated. Their computational cost saving and accuracy improvement over a single fidelity surrogate model are investigated as a function of the ratio of the sampling costs of low and high fidelity simulations. The maximum cost saving was 85% and the maximum accuracy improvement was 40% when the number of low fidelity samples is about ten times larger than that of high fidelity samples for various computational costs. We found that the DOE can substantially change the relative standing of the different frameworks. Therefore, an important question is how to determine which model works best for a specific problem and DOE. The cross validation error appears to be a reasonable candidate for estimating which MFS models would perform poorly for a specific problem.

Keywords: Multi-fidelity surrogate framework, Comparison study, Discrepancy function, Calibration, Bayesian.