A System Reliability Method with Dependent Kriging Predictions

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ABSTRACT
When limit-state functions are highly nonlinear, traditional reliability methods, such as the first order and second order reliability methods, are not accurate. Monte Carlo simulation (MCS), on the other hand, is accurate if a sufficient sample size is used, but is computationally intensive. This research proposes a new system reliability method that combines MCS and the Kriging method with improved accuracy and efficiency. Cheaper surrogate models are created for limit-state functions with the minimal variance in the estimate of the system reliability, thereby producing high accuracy for the system reliability prediction. Instead of employing global optimization, this method uses MCS samples from which training points for the surrogate models are selected. By considering the dependence between responses from a surrogate model, this method captures the true contribution of each MCS sample to the uncertainty in the estimate of the system reliability and therefore chooses training points efficiently. Good accuracy and efficiency are demonstrated by three examples.

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