Finite element-fidelity parametrization of kriging metamodels for structutal reliability assessement

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It is critical to obtain a precise estimation of the probability of failure when doing the reliability analysis of a given structure. The Monte-carlo estimator is a non-intrusive and unbiased estimator than can be easily implemented to compute this probability. However, the Monte Carlo estimator requires to simulate the structure for a large number of realizations of input random variables due to its low convergence rate. For complex mechanical problems solved by the finite element method (FEM), the computational cost of this estimator may thus be important. Therefore, some reliability analysis are based on a metamodel built from a few calls to the finite element solver that allows to quickly approximate the structural response. To accurately estimate the probability of failure, the metamodel has to be precise close to the limit state delimitating the safe and failure zones. One of the common methods to construct a metamodel is kriging [2]. This estimation of uncertainty allows to couple the metamodel with the Monte-Carlo estimator, which enables to define an adaptative strategy to improve the quality of the metamodel near the limit state [1]. The discretization of the mechanical problem leads to an error in the structural response and thus in the estimation of the probability of failure. To control that error, multifidelity kriging was introduced in 2020 [3]. However, it requires the use of an expensive *a posteriori* discretization error estimate that is not available for every mechanical problem. This work exploits *a priori* knowledge of the FEM convergence rate to build a mesh size parameterized kriging metamodel. This metamodel allows to compute the probability of failure for any mesh size through Monte-Carlo sampling and thus check for mesh convergence.

Keywords: Multi-fidelity, Kriging, Probability of failure, Mesh convergence.

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