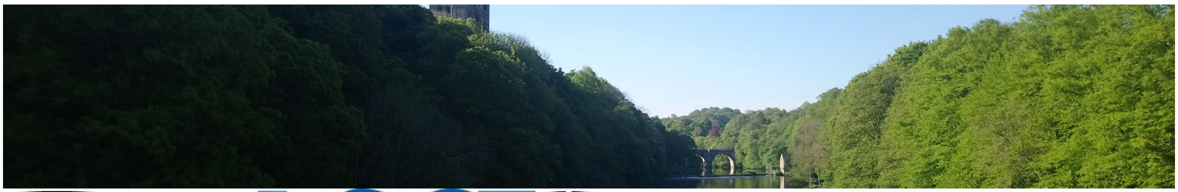

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Auto-adaptive Multi-Fidelity Kriging approach to estimate structural reliability

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Some parameters of a given mechanical problem may be subject to uncertainties. These parameters may be modeled as random variables. The uncertainty propagates toward the mechanical response and deterministic frameworks become unusable. The reliability analysis aims at studying the randomness of the structural response. This may be done by defining a scenario of failure and a limit state function separating realizations of the random variables between failed and safe. The probability of failure is defined as the probability that the structure is in the failed zone. Computing a precise estimation of the probability of failure for a given structure is critical when doing its reliability analysis. The Monte-Carlo estimator is easily implemented, non-intrusive to the simulations and un-biased. However, it requires to simulate the structure for a large number of realizations of input random variables. Each simulation usually consists in solving the finite element problem on a discretized structure. For complex mechanical problems, the computational cost may be important. Therefore, some reliability analysis are based on a metamodel built from a few calls to the solver and 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. It presents the advantage of providing an estimation of the uncertainty on the output for any input location. 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. The discretization of the structure leads to an error in the structural response and thus in the estimation of the probability of failure. This work presents an innovative method to guarantee the state of samples used to construct the metamodel in a multi-dimentional space of random variables utilizing bounds that may be computed by processing finite element results. The state of each sample is thus calculated on a coarse mesh far from the limit state and on a finer mesh close to it, reducing total CPU time. Finally, computing two kriging metamodels interpolating upper and lower bounds on the exact value of the limit state allows to compute discretization eroor bounds on the probability of failure in a multi-dimentional space of random variables. This may in the end guide remeshing.

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