

Metamodels for uncertainty quantification and reliability analysis

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Uncertainty quantification (UQ) in the context of engineering applications aims at quantifying the effects of uncertainty in the input parameters of complex models on their output responses. Due to the increased availability of computational power and advanced modelling techniques, current simulation tools can provide unprecedented insight in the behaviour of complex systems. However, the associated computational costs have also increased significantly, often hindering the applicability of standard UQ techniques based on Monte-Carlo sampling. To overcome this limitation, metamodels (also referred to as surrogate models) have become a staple tool in the Engineering UQ community. This lecture will introduce a general framework for dealing with uncertainty in the presence of expensive computational models, in particular for reliability analysis (also known as rare event estimation). Reliability analysis focuses on the tail behaviour of a stochastic model response, so as to compute the probability of exceedance of a given performance measure, that would result in a critical failure of the system under study. Classical approximation-based techniques, as well as their modern metamodel-based counterparts will be introduced.