Metamodels in structural reliability and sensitivity analysis

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An interesting idea in probabilistic analyses consists in using metamodels as surrogates to computationally demanding numerical models, in order to circumvent the computational burden involved in such probabilistic analyses. The main objective is therefore to build the most accurate metamodel that mimics the given numerical model, from a set of calls to this model as small as possible. Several approaches have been proposed in the past, ranging from Response Surface Methods, Artificial Neural Networks to more recent Support Vector Machines (SVMs). A key issue in the so-called machine learning community is to select an adequate candidate function and an optimal set of points to train this function.
The presentation will aim at showing the ability of SVMs to tackle probabilistic problems, ranging from sensitivity analysis to reliability assessment. It will address some important and complex problems, such as system reliability, multiple design points, discontinuous limit-state functions, high-dimensional problems involving large numbers of input random variables, … It will also give details about how the metamodel is built from wisely selected points, composed of either an initial set of points or sequential sets of points, with updates of the learning algorithm (active learning). Various strategies will be presented and examples of applications will be given, in order to illustrate the potential gains of SVM-based surrogate models compared to existing and usual methods.