Adaptive sparse polynomial chaos expansions

by **Bruno Sudret**, Phimeca Engineering, Paris & Cournon

Numerical methods for uncertainty propagation in physical systems and reliability analysis have gained much attention in the last ten years. Among others, the so-called spectral methods based on the polynomial chaos representation of the random model response are developing fast.

Based on the pioneering work by Ghanem, these methods differ from classical Monte Carlo simulation in the sense that they represent the system random response in a functional way instead of “sample-by-sample”.

From the probabilistic model of the input parameters (i.e. their probability density functions), the generalized polynomial chaos basis is build: it is made of tensor products of orthogonal polynomials in the input random variables. The coefficients of the random response in this basis may be computed by non intrusive methods such as projection and regression, i.e. using a suitable series of runs of the deterministic physical model. Statistical moments or probabilities of failure are post-processed from these coefficients at almost zero cost.

The presentation will recall the basics of polynomial chaos expansion and emphasize recent research topics: how to master the accuracy of the (truncated) series expansions, how to deal with a large number of input random variables, how to build sparse chaos representation that encompass only the significant terms. Application examples in structural reliability will be given.