

Polynomial least squares and their ridges for uncertainty quantification

Polynomial approximations are now used routinely in industry for propagating aleatory uncertainties in computational fluid dynamics simulations. Over the past two decades there has been much research into (i) the rationale for polynomial basis selection; (ii) the techniques to compute coefficients, and (iii) the strategies for sampling. In the first part of this talk, I will review some of the key concepts that underpin polynomial approximations in uncertainty quantification, with a focus on sampling techniques for least squares methods. In particular, I will present some parallels between polynomial least squares and sparse grid integration techniques.

Following this, I will discuss a relatively new idea: polynomial ridge approximations. For problems where the number of dimensions are very large, polynomial ridge approximations facilitate dimension reduction by constructing a polynomial over a dimension reducing subspace. This can be done for both scalar- and vector-valued quantities of interest.

I will close this talk by focusing on applications to computational fluid dynamics simulations and demonstrate how one can use polynomial approximations not just on key output quantities of interest, but also for recovering the entire flow-field---rivaling some recent machine learning techniques.