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Nonlinear approximation of high-dimensional anisotropic analytic functions

The usual approach to model reduction for parametric/random partial differential equations is to construct a linear space of (hopefully small) dimension n which accurately approximates the parameter-to-solution map. This linear reduced model can then be used for various tasks such as building a forward solver or estimating the state or the parameters from data observations. It is well-understood in other problems of numerical computation that nonlinear methods may provide improved numerical efficiency, suggesting the use of nonlinear methods for model reduction as well. In a so-called library approximation, the single linear space is replaced by a collection of affine spaces and the best space may be chosen for each parameter query.

In this talk, we present a specific example of library approximation where the parameter domain is split into a finite number of cells and where different reduced affine spaces of dimension m are assigned to each cell. Given m, we derive an upper bound on the dimension of the library needed to achieve a target accuracy and illustrate the performance of the method through several numerical examples. Finally, we extend this strategy to approximate a general class of anisotropic analytic functions.