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Nonlinear reduced order model for parametric partial differential equations

Reduced order modeling is a powerful tool for approximating the solution to parametric partial differential equations (PDEs). Classical approaches are formulated for PDEs on Hilbert spaces and involve one single linear space to approximate the set of PDE solutions, the so-called solution manifold. The effectiveness of this method relies on the decay of the Kolmogorov n-width which quantifies how well the solution manifold can be approximated by a linear space of dimension n. The slower the decay the larger n has to be to meet a target accuracy resulting in large computational cost as well as numerical difficulties to build the linear space.

In this presentation, we introduce reduced models relying on a collection of linear or nonlinear approximation spaces called a library, and which can also be formulated on general metric spaces. To build the spaces of the library, we rely on greedy algorithms involving different splitting strategies which lead to a hierarchical tree-based representation. We illustrate through numerical examples that the proposed strategies have a wider range of applicability in terms of the parametric PDEs that can successfully be addressed.