Nonlinear manifold approximations for reduced-order modeling of nonlinear systems

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The majority of existing reduced-order modeling methods use a linear subspace for dimensionality reduction. This has the significant mathematical advantage of leading to a reduced model with known and analyzable structure; however, for complex systems and transport-dominated dynamics, linear compression often does not yield a sufficiently rich approximation. This talk presents our recent work in using nonlinear dimensionality reduction via quadratic manifolds combined with our non-intrusive Operator Inference approach. The approach can be viewed as a form of data-driven closure modeling, since the quadratic component introduces directions into the approximation that lie in the orthogonal complement of the linear subspace, but without introducing any additional degrees of freedom to the low-dimensional representation. The result is reduced-order models that benefit from the increased richness of the representation in a quadratic manifold, while retaining an analyzable structure.

Joint work with Rudy Geelen (The University of Texas at Austin), Steve Wright (University of Wisconsin) and Laura Balzano (University of Michigan).