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Nonlinear dynamic estimation with sparse sensors STEVEN BRUNTON, University of Washington, JONATHAN TU, Princeton University, NATHAN KUTZ, University of Washington — We show that dimensionality reduction and compressive sensing strategies can be combined to estimate the state and/or parameters of a complex nonlinear system using only sparse measurements. L^2 based dimensionality reduction techniques, such as the proper orthogonal decomposition, are used to construct libraries spanning many dynamic phenomena, and sparse sensing is used to identify and reconstruct the dynamics from the library elements. This technique provides an objective and general framework for characterizing the underlying dynamics, stability, and bifurcations of the complex system. These methods are demonstrated on the complex Ginzburg-Landau equation using sparse, noisy measurements, as well as on the two-dimensional Navier-Stokes equation at low Reynolds number. Various spatiotemporal sampling strategies are investigated, with an emphasis on practical engineering considerations. We demonstrate that using a data-driven basis facilitates accurate nonlinear estimation from far fewer sensors than would typically be required of compressive sensing in a generic transform basis.

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