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Identifying coarse-grained PDE models from data with the sparse identification of nonlinear dynamics KADIERDAN KAHEMAN, EURIKA KAISER, ADITYA NAIR, NATHAN KUTZ, STEVEN BRUNTON, University of Washington — Identifying reduced order models of complex systems, such as are found in fluid mechanics, is a challenging, yet vital topic. In addition to Galerkin projection, which has been a mainstay of the fluid mechanics' community for decades, techniques from machine learning are emerging to identify accurate and efficient models from data. The sparse identification of nonlinear dynamics (SINDy) algorithm has recently been shown to provide data-driven reduced-order models for fluids that are both interpretable and generalizable. However, it is difficult to identify models with rational function nonlinearities using the SINDy approach, although these dynamics appear in many systems of interest, especially those systems with a separation of timescales. A recent extension to SINDy has enabled the identification of rational function nonlinearities, but this approach is numerically fragile and highly sensitive to noise. In this work, we develop a robust extension of SINDy to identify rational function nonlinearities, using an iterative approach to improve the conditioning of the algorithm. We demonstrate this implicit SINDy approach on several ODE and PDE systems, including the unsteady BZ chemical flow reaction.

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