Learning Nonlinear Dynamical Structures Using Compressive Sensing and Sparse Optimization

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Abstract: Extracting governing equations from dynamic data is an essential task in model selection and parameter estimation. The form of the governing equation is rarely known a priori; however, based on the sparsity-of-effect principle one may assume that the number of candidate functions needed to represent the dynamics is very small. In this work, we leverage the sparse structure of the governing equations along with recent results from random sampling theory to develop methods for selecting dynamical systems from under-sampled data. Using results from compressive sensing, we show that the strategies lead to exact recovery, which is stable to the sparse structure of the governing equations and robust to noise in the estimation of the velocity. Computational results validate each of the sampling strategies and highlight potential applications.

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