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Sparse Optimization in Learning Governing Equations for Time Varying Measurements

Learning the governing equations for time-varying measurement data is of great interest across different scientific fields. Recovering the governing equations becomes quite challenging, when such data is moreover highly corrupted or does not hold certain properties. In this work, we show that if the data or one data set exhibits chaotic behavior, it is possible to recover the underlying governing nonlinear differential equations by solving an l1 minimization problem which assumes a parsimonious representation of the system and exploit the joint sparsity in different context. Theoretical reconstruction guarantees are obtained by combining recent results on statistical properties of chaotic data with results from compressed sensing theory. Numerical methods are based on iterative thresholding operators and various numerical examples including the Lorenz equations and high dimensional ODEs will be presented to illustrate the power, generality, and efficiency of our model.