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Wenjing Liao
Yingjie Liu</td></tr>
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<tr><th>abstract</th><td>Identifying unknown differential equations from a given set of discrete time dependent data is a challenging problem. A small amount of noise can make the recovery unstable, and nonlinearity and differential equations with varying coefficients add complexity to the problem. We assume that the governing partial differential equation (PDE) is a linear combination of a subset of a prescribed dictionary containing different differential terms, and the objective of this paper is to find the correct coefficients. We propose a new direction based on the fundamental idea of convergence analysis of numerical PDE schemes. We utilize Lasso for efficiency, and a performance guarantee is established based on an incoherence property. The main contribution is to validate and correct the results by Time Evolution Error (TEE). The new algorithm, called Identifying Differential Equations with Numerical Time evolution (IDENT), is explored for data with non-periodic boundary conditions, noisy data and PDEs with varying coefficients. From the recovery analysis of Lasso, we propose a new definition of Noise-to-Signal ratio, which better represents the level of noise in the case of PDE identification. We systematically analyze the effects of data generations and downsampling, and propose an order preserving denoising method called Least-Squares Moving Average (LSMA), to preprocess the given data. For the identification of PDEs with varying coefficients, we propose to add Base Element Expansion (BEE) to aide the computation. Various numerical experiments from basic tests to noisy data, downsampling effects and varying coefficients are presented.</td></tr>
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