

DATA-DRIVEN DYNAMICAL SYSTEMS: LEARNING, SIMULATION, AND CONTROL

600 DATA SCIENCE, MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

MATTEO TOMASETTO[†], ANDREA MANZONI^{*} AND J. NATHAN KUTZ[#]

[†] Department of Mechanical Engineering, Politecnico di Milano, via La Masa 1, 20156 Milano, Italy
matteo.tomasetto@polimi.it, <https://github.com/MatteoTomasetto>

^{*} MOX - Department of Mathematics, Politecnico di Milano,
Piazza Leonardo da Vinci 32, 20133 Milano, Italy
andrea.l.manzoni@polimi.it, <https://orcid.org/0000-0001-8277-2802>

[#] Department of Applied Mathematics, University of Washington, Seattle, WA 98195, USA
kutz@uw.edu, <https://dynamicsai.org>

Keywords: Reduced order modeling, latent dynamics, sparsity-preserving techniques, dimensionality reduction, dynamical systems.

ABSTRACT

The need for describing, predicting, and controlling the dynamics of complex systems has led to a multitude of numerical methods across several disciplines over the last decade, blending physics-based and data-driven techniques to different extents. Reduced order modeling and dimensionality reduction paradigms through, e.g., proper orthogonal decomposition, dynamic mode decomposition, as well as autoencoders and transformers, provide well-established techniques to discover low-rank spatio-temporal patterns, embed the dynamics in a reduced subspace, ultimately requiring latent dynamics modeling for reliable forecasting. Since the introduction of the sparse identification of nonlinear dynamics (SINDy) technique ten years ago, several extensions provide nowadays a wide set of sparsity-preserving techniques, and have ultimately made data-driven modeling and discovery an extremely active research area, nowadays integrating deep learning for uncovering effective coordinates, Bayesian and kernel methods for uncertainty quantification, multi-fidelity methods for data fusion, neural networks for time series description, deep reinforcement learning for controls, to name a few.

Key to all these strategies is the suitable modeling of the latent dynamics - the aspect this minisymposium will focus on, covering the theoretical analysis, computational techniques, and practical use of data-driven methods for the model reduction and discovery of dynamical systems, all towards efficient and accurate predictions in applied sciences and engineering.

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