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SPEAKER TITLES/ABSTRACTS

J. Nathan Kutz
University of Washington

"Data-Driven Discovery of Governing Physical Laws and their Parametric Dependencies in Engineering, Physics and Biology"

A major challenge in the study of dynamical systems is that of model discovery: turning data into models that are not just predictive, but provide insight into the nature of the underlying dynamical system that generated the data. This problem is made more difficult by the fact that many systems of interest exhibit diverse behaviors across multiple time scales. We introduce a number of data-driven strategies for discovering nonlinear multiscale dynamical systems and their embeddings from data. We consider two canonical cases: (i) systems for which we have full measurements of the governing variables, and (ii) systems for which we have incomplete measurements. For systems with full state measurements, we show that the recent sparse identification of nonlinear dynamical systems (SINDy) method can discover governing equations with relatively little data and introduce a sampling method that allows SINDy to scale efficiently to problems with multiple time scales. Specifically, we can discover distinct governing equations at slow and fast scales. For systems with incomplete observations, we show that the Hankel alternative view of Koopman (HAVOK) method, based on time-delay embedding coordinates, can be used to obtain a linear model and Koopman invariant measurement system that nearly perfectly captures the dynamics of nonlinear quasiperiodic systems. We introduce two strategies for using HAVOK on systems with multiple time scales. Together, our approaches provide a suite of mathematical strategies for reducing the data required to discover and model nonlinear multiscale systems.