



复旦大学数学科学学院 数学综合报告会

报告题目: From Traditional Assimilation to Bridging Model Hierarchies, Causal Inference, and Digital Twins

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时间: 2026-06-24 星期三 13:30-14:30

地点: 光华楼东主楼1601

报告摘要:

In this talk, I will present data assimilation as a crucial bridge between models and data across diverse scientific fields. I will begin with a brief review of traditional data assimilation before demonstrating its broad utility for facilitating and interacting with other areas of study and innovation. First, I will demonstrate how models of varying complexity from different communities can be integrated through a reconfigured latent data assimilation approach. In particular, I will illustrate how to leverage the strengths of idealized models and complex operational models to create a more accurate and cohesive system, with an application to the El Niño-Southern Oscillation. Second, I will introduce assimilative causal inference (ACI), a new framework that uses Bayesian data assimilation to trace causes backward from observed effects, providing a unique way to study predictability and attribution with applications to climate tipping points, model reduction, and extreme events. ACI uniquely identifies dynamic causal interactions without requiring observations of candidate causes, accommodates short datasets, and scales efficiently to high dimensions. It provides online tracking of causal roles that may reverse intermittently and establishes a mathematically rigorous criterion for the causal influence range, revealing how far effects propagate. Finally, I will present a nonlinear neural differential equation modeling framework that leverages generalized Koopman theory to learn a latent representation of the state variables. This enables closed-form solutions for nonlinear data assimilation and advances computationally efficient digital twins.

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