FUDAN UNIVERSITY

Applied Math Ph.D. Seminar

Utilizing Causal Network Markers to Identify Tipping Points ahead of Critical Transition

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Time: 2025-10-09, 16:10 to 17:00

Location: Rm 1801, Guanghua East Tower

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Abstract: Early-warning signals of delicate design are always used to predict critical transitions in complex systems, which makes it possible to render the systems far away from the catastrophic state by introducing timely interventions. Traditional signals including the dynamical network biomarker (DNB), based on statistical properties such as variance and autocorrelation of nodal dynamics, overlook directional interactions and thus have limitations in capturing underlying mechanisms and simultaneously sustaining robustness against noise perturbations. This paper therefore introduces a framework of causal network markers (CNMs) by incorporating causality indicators, which reflect the directional influence between variables. Actually, to detect and identify the tipping points ahead of critical transition, two markers are designed: CNM-GC for linear causality and CNM-TE for non-linear causality, as well as a functional representation of different causality indicators and a clustering technique to verify the system's dominant group. Through demonstrations using benchmark models and real-world datasets of epileptic seizure, the framework of CNMs shows higher predictive power and accuracy than the traditional DNB indicator. It is believed that, due to the versatility and scalability, the CNMs are suitable for comprehensively evaluating the systems. The most possible direction for application includes the identification of tipping points in clinical disease.