

中央研究院數學研究所

Institute of Mathematics, Academia Sinica

Taipei Postdoc Seminar

Speaker : Chun-Wei Chang (NCTS)

Title : Anticipating the Occurrence and Type of Critical Transitions

Time : 14:00 – 15:00, Wednesday, October 28, 2020

Venue : Lecture Hall 5F, Cosmology Building, NTU
(臺灣大學次震宇宙館 五樓演講廳)

Abstract : Critical transition can occur in many real-world systems. The ability to forecast the occurrence of transitions can be of major interest in a range of different contexts. Various early warning signals (EWS) have been developed to anticipate the coming critical transitions and successfully applied in models and natural systems. However, the efficacy of existing EWS remains elusive. Moreover, existing EWS cannot distinguish between different types of transition (e.g., distinguish the transition induced by fold from period-doubling bifurcation) and do not establish a practical threshold indicating the condition that the critical transition is deemed to occur. Here, we introduce a powerful EWS, named Dynamical Eigen-Value (DEV), that is rooted in the bifurcation theory of dynamical systems to estimate the local Lyapunov stability of the system (the dominant eigenvalue). Mathematically, $|\text{DEV}|$ approaches one when the system approaches bifurcation, and the DEV in the complex plane indicates the type of transition. We evaluate the efficacy of the DEV approach in model systems with known transition timing and bifurcation types. We then demonstrate this approach in real-world systems, including phytoplankton under perturbation in a microcosm, a voice production experiment analyzing physiological properties of vocal fold vibration, ATP dynamics in the cytosol under hypoxia, CaCO_3 abundance of sediments from the end of the last greenhouse earth, and electrical properties of the “1996 Western North America blackouts”. Throughout these examples, DEV provides a powerful approach to anticipate transitions in complementary to the existing EWS.

Organizer : Wei-Bo Su (AS), Peng-Jie Wong (NCTS)

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