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Department of Medicine
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Channing Network Science Seminar

February 05, 2016, 11am @ 5th floor conference room



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Universal Resilience Patterns in Complex Networks

Abstract: Resilience, a system's ability to adjust its activity to retain its basic functionality under errors, failures and environmental changes, is a defining property of many complex systems. Despite widespread consequences on human health, economy and the environment, events leading to loss of resilience, from cascading failures in technological systems to mass extinctions in ecological networks, are rarely predictable and are often irreversible. These limitations are rooted in a theoretical gap: the current analytical framework of resilience is designed to treat low-dimensional models of a few interacting components, being unsuitable for characterizing multi-dimensional systems consisting of a large number of components that interact through a complex network. Here we bridge this theoretical gap by developing a set of analytical tools to identify the natural control and state parameters of a multi-dimensional complex system, helping us derive an effective one-dimensional dynamics that accurately predicts the system's resilience. The proposed analytical framework allows us to systematically separate the role of the system's dynamics and topology, collapsing the behavior of different networks onto a single universal resilience function. The analytical results unveil the network characteristics that can enhance or diminish resilience, offering avenues to prevent the collapse of ecological, biological or economic systems, and guiding the design of technological systems that are resilient to external perturbations and environmental changes alike.

Bio: Dr. Jianxi Gao is a postdoctoral research associate in Northeastern University from 2012. Dr. Gao got his Ph. D. degree in Shanghai Jiao Tong University from 2008 to 2012. During his Ph.D. from 2009 to 2012 he visited prof. H. Eugene Stanley in Physics department in Boston University. and prof. Shlomo Havlin in Physics department Bar-Ilan University. He has focused primarily on the percolation of networks of interdependent networks and the optimum synchronization on self-propelled agent systems. He develops a general analytical framework for studying percolation of n interdependent networks and illustrate the analytical solutions for many distinct examples. Jianxi Gao proposes a system of iterative equations somewhat analogous to Kirchhoff equations for the resistor network in the field of percolation on interdependent networks, which shows his intelligent in finding the new percolation law in complex networks. Very recently, Dr. Gao develop a set of analytical tools to identify the natural control and state parameters of a multi-dimensional complex system, helping us derive an effective one-dimensional dynamics that accurately predicts the system's resilience. The proposed analytical framework allows us to systematically separate the role of the system's dynamics and topology, collapsing the behavior of different networks onto a single universal resilience function. His publications were reported by influential professional and public media, such as sciencenews.org, Science China Press, Phys.org, and Eurekalert.

Hosted by Yang-Yu Liu