Universality in Network Dynamics

Dr. Baruch Barzel
The Center for Complex Network Research
Northeastern University

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One of the major achievements of statistical mechanics is the development of theoretical tools to bridge between the microscopic description of a system and its observed macroscopic behavior. This allows us to track the way in which macroscopic phenomena emerge from the mechanistic description of the system's interacting components. A key factor in determining this emergent behavior is associated with the underlying geometry of the system's interactions; most importantly, the system's dimension. This approach has been very successful in treating systems that are characterized by localized interactions. Indeed, such systems, frequently observed in nature, feature a lattice (or lattice-like) structure with a finite dimension. However, in recent years we have seen a growing interest in complex systems, characterized by highly random and non-localized interaction patterns. Social networks, biological interactions and technological systems, such as the Internet or the power grid, are just a few examples. Featuring a profoundly different geometry than that of lattices, these complex systems confront us with a potentially new class of observed dynamical behaviors. By focusing on the system's response to local perturbations, we will uncover in this talk, these unique dynamical universality classes observed in complex networks.