The Department of Civil and Environmental Engineering at the University of Houston presents...

The CIVE 6111 Graduate Seminar Series

Model-Free Network Control

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Friday, August 31, 2018
2:45PM-3:45PM
Classroom Business Building (CBB) Room 108

Abstract

Coupled networks can be used to represent complex processes such as those in cells, food webs, and ecological systems, as well as interactions within social groups, and communications in wireless networks. One major goal of network analyses is to design methods to control these processes to pre-specified target states. For example, in cellular processes, we may inquire if damaging consequences of genetic mutations or chromosomal rearrangement can be circumvented through external intervention. In ecological systems, we may wish to determine how a new (or an extinct) species may be established in an ecosystem with minimal perturbation. The evident approach is to start from a realistic model of the underlying network; unfortunately, this is often an extremely difficult task; for one, precise interactions between participants is generally not available. In this talk, I will introduce a model-free approach for network control. The “state” of the network is assumed to be the experimentally accessible profile consisting of the “count” or “density” of the relevant species. Interestingly, controlling the system to a pre-specified target state only requires knowledge of “response surfaces,” which consists of the system responses to a specific set of external perturbations. Analyses of model systems and nonlinear electrical circuits show that a target state can be approached by external control of the levels of a few nodes. This approach can prove useful in many contexts including in reprogramming cellular states or introduction of an extinct species into an environment.

Bio

Gemunu Gunaratne is a Professor and the Chairman of the Department of Physics at the University of Houston. He received his Ph.D. from Cornell University and conducted post-doctoral research at the University of Chicago before assuming the position at the University of Houston. He proposed the use of periodic orbits and their eigenvalues to characterize strange attractors and showed how dynamical invariants such as fractal dimensions and expansion rates can be derived from these eigenvalues. In spatio-temporal patterns, he invented a class of measures, referred to as the “disorder function,” to quantify the level of pattern irregularity, and used them to describe the dynamics of pattern relaxation. He was a member of the “Chicago” group that first established anomalous scaling properties of hard-turbulence. Gunaratne’s group analyzed “stylized facts” in financial markets, and showed that they follow from a stochastic process with variable diffusion. He has addressed several biologically related problems including establishing linear response as a possible means to establish the strength of osteoporotic bone and developing models to study animal locomotion. More recently, he has focused on model-free control algorithms for coupled networks and turbulent flows.