Resilient Control for Critical Infrastructure Networks

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Abstract: Resilience is becoming a key consideration in the design and operation of critical infrastructure systems such as transportation, production and data networks. Due to their increasing scale and interconnectedness, these systems pose several new challenges. For example, small local disruptions can cascade through the network to cause massive failures, or local actions to mitigate disruptions can increase vulnerability of the other parts of the network. In spite of sustained research efforts, the available approaches either take a static perspective, and hence are inadequate to address these challenges, or they do not provide formal guarantees.

In this talk, I present provably-resilient distributed control policies for dynamic flows over networks, and illustrate the results in the context of urban transportation networks. Specifically, I present a novel class of locally cooperative routing policies. These policies, when used as local adjustments to standard global route choice models, lead to stability of classical transportation equilibria in the dynamical setting. The same policies also render maximum resilience to the network against malicious disruptions. These results rely on a combination of tools from network flows, evolutionary game theory and monotone dynamical systems, and particularly highlight the effect of cascade phenomena on resilience.

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Host: Dr. Arye Nehorai

Short Bio: Ketan Savla is a research scientist in the Laboratory for Information and Decision Systems at MIT. He obtained his Ph.D. in Electrical Engineering and M.A. in Applied Mathematics, both in 2007, from University of California at Santa Barbara, as well as M.S. in Mechanical and Industrial Engineering from University of Illinois, Urbana-Champaign in 2004. His current research interest is in control and optimization techniques for mobile robotic networks, humans-in-loop systems, complex service networks and computational neuroscience. His awards include best student paper finalist at Control and Decision Conference 2005 and a best thesis award from UCSB.