Information Extraction and Decision Making in Dynamic Environments: A Hybrid Systems Approach

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Abstract: An outstanding challenge in the design of large scale, distributed sensing, actuation and control systems is the computational complexity arising from complex interactions between different system components as well as interactions with the dynamic environment the system operates in. How can we extract actionable information sparsely encoded in sensory data streams and detect interesting events? How can we build robust cyber-physical systems that can autonomously react to these events and perform complex tasks in dynamic environments? In the first part of the talk, I will introduce robust hybrid system identification schemes and illustrate how changes in the invariants of identified models can be used in event detection and information extraction from noisy sensory data. While in principle this approach leads to generically nonconvex, hard to solve problems, as we show, computationally tractable relaxations (and in some cases exact solutions) can be obtained. The second part of the talk focuses on design of correct-by-construction controllers for cyber-physical systems. I will present a general framework, which combines ideas from control theory and computer science, to synthesize hierarchical controllers from high level behavioral specifications. Then I will present a result on distributed synthesis that exploits the underlying network structure to reduce the computational complexity and to increase design modularity. I will describe applications of these ideas to a diverse set of problems ranging from video analytics and distributed surveillance to vehicle management systems.

Bio: Necmiye Ozay received the B.S. degree from Bogazici University, Istanbul in 2004, the M.S. degree from the Pennsylvania State University, University Park in 2006 and the Ph.D. degree from Northeastern University, Boston in 2010, all in electrical engineering. She was a Postdoctoral Scholar at the California Institute of Technology, Pasadena, between 2010 and 2013. She is currently an assistant professor of Electrical Engineering and Computer Science at the University of Michigan, Ann Arbor. Her research interests lie at the broad interface of dynamical systems, control, optimization and formal methods with applications in cyber-physical system design, system identification, verification & validation, autonomy and vision.