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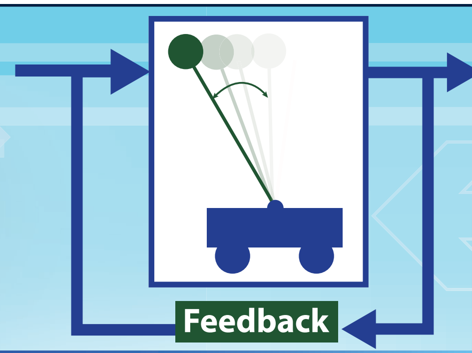
Control Seminar



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Efficient Reachability for Safe Autonomous Systems: A Mixed Monotone Approach

SAMUEL COOGAN

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Georgia Tech

September 18, 2020 3:30 - 4:30 pm

Event will take place via Zoom

ABSTRACT: Reachability analysis of a dynamical system consists of identifying the set of possible future states given a set of initial states. Most reachability methods are known to suffer from the curse of dimensionality, yet there is a growing need for fast reachability methods in modern applications of control and autonomy. In this talk, we show that mixed monotone systems theory, which decomposes a dynamical system's vector field into increasing and decreasing components, provides an efficient method for overapproximating reachable sets of nonlinear systems as hyperrectangles. This is achieved by embedding the dynamics in a higher dimensional system that exhibits a monotonicy property, and we show that this theory is applicable to a large class of nonlinear systems. Moreover, there often exists multiple decompositions for a given system, and we demonstrate how the quality of the reachable set approximations depends on the choice of decomposition. We further show that mixed monotone systems theory applies to systems subject to unknown disturbances and allows for identifying robustly invariant sets via equilibria in the embedding space. We propose a method for including mixed monotone reachability in a feedback loop to guarantee safe control and demonstrate our results through several examples.

BIO: Sam Coogan is an assistant professor at Georgia Tech with a joint appointment in the School of Electrical and Computer Engineering and the School of Civil and Environmental Engineering. Prior to joining Georgia Tech in 2017, he was an assistant professor in the Electrical Engineering Department at UCLA from 2015-2017. He received the B.S. degree in Electrical Engineering from Georgia Tech and the MS and PhD degrees in Electrical Engineering from the University of California, Berkeley. His research is in the area of dynamical systems and autonomy and focuses on developing scalable tools for verification and control of networked, cyber-physical systems with an emphasis on transportation systems. He received the Outstanding Paper Award for the IEEE Transactions on Control of Network Systems in 2017, a CAREER award from the National Science Foundation in 2018, a Young Investigator Award from the Air Force Office of Scientific Research in 2018, and the Donald P. Eckman Award from the American Automatic Control Council in 2020.

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