UC RIVERSIDE | UNIVERSITY OF CALIFORNIA | Mechanical Engineering

The Department of Mechanical Engineering Presents

Saber Jafarpour, Ph.D.

Postdoctoral Research Fellow
Department of Electrical and Computer Engineering
Georgia Institute of Technology

Title: Safety and resilience of large-scale networks via contraction theory

Abstract: Recent decades have witnessed the rise of network systems that operate with unprecedented scale and efficiency. Examples include smart infrastructures, robotic networks, and artificial neural networks. However, providing safety and reliability guarantees for these networks is usually challenging due to their large size and their inherent nonlinearity. In this talk, we present elements of a non-Euclidean contraction theory to establish stability and robustness certificates for neural networks and dynamic flow networks. In the first part of the talk, we study the input-output robustness of implicit neural networks with respect to adversarial perturbations. Implicit neural networks are a recently-developed class of learning models that replace the layers in traditional neural networks with a fixed-point equation. Inspired by a dynamical system perspective to implicit networks, we study the solvability of their fixed-point equations via contraction theory and provide (i) tight conditions for their well-posedness, (ii) explicit bounds on their input-output Lipschitz constants, and (iii) optimization problems for their robust training. Numerical simulations show the improved robustness of our implicit neural networks compared to state-of-the-art architectures. In the second part of the talk, we study the resilience of dynamic flow networks with respect to transient uncertainties. By extending the classical contraction theory, we establish a dichotomy in the asymptotic behavior of dynamic flow networks. Using this dichotomy, we investigate the resilience of the input metering in transportation networks.

About the Speaker: Saber Jafarpour is a postdoctoral research fellow in the Department of Electrical and Computer Engineering at the Georgia Institute of Technology. Prior to that, he was a postdoctoral researcher in the Center for Control, Dynamical Systems, and Computation at UC Santa Barbara. He received his Ph.D. in Mathematics and Statistics from Queen's University in 2016. His research interests are centered around control theory and autonomy with applications to energy and transportation systems and neural networks.

ZOOM
98733315827

THURSDAY, MARCH, 3, 2022
11:00AM-11:50AM