PURDUE UNIVERSITY | Elmore Family School of Electrical and Computer Engineering

Faculty Candidate Seminar – Autonomous and Connected Systems

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Monday, February 21, 2022
Presentation: 10:30 A.M. – 11:30 A.M.
Q & A: 11:30 A.M. – 12:00 P.M.
Purdue **G**raduate **S**tudent **C**enter
504 Northwestern Ave. ~ Room 105A & B
https://purdue-edu.zoom.us/j/98587059936

Safe AI-Enabled Autonomy

Abstract: AI-enabled autonomous systems show great promise to enable many future technologies such as autonomous driving, intelligent transportation, and robotics. Over the past years, there has been tremendous success in the development of autonomous systems, which was especially accelerated by the computational advances in machine learning and AI. At the same time, however, new fundamental questions were raised regarding the safety and reliability of these increasingly complex systems that often operate in uncertain and dynamic environments. In this seminar, I will provide new insights and exciting opportunities to address these challenges.

In the first part of the seminar, I will present a data-driven optimization framework to learn safe control laws for dynamical systems. For most safety-critical systems such as self-driving cars, safe expert demonstrations in the form of system trajectories that show safe system behavior are readily available or can easily be collected. At the same time, accurate models of these systems can be identified from data or obtained from first order modeling principles. To learn safe control laws, I present a constrained optimization problem with constraints on the expert demonstrations and the system model. Safety guarantees are provided in terms of the density of the data and the smoothness of the system model. Two case studies on a self-driving car and a bipedal walking robot illustrate the presented method. In the past years, it was shown that neural networks are fragile and that their use in AI-enabled systems has resulted in systems taking excessive risk. The second part of the seminar is motivated by this fact and presents a data-driven verification framework to quantify and assess the risk of AI-enabled systems. I particularly show how risk measures, classically used in finance, can be used to quantify the risk of not being robust to failure, and how we can estimate this risk from data. We will compare and verify four different neural network controllers in terms of their risk for a self-driving car. I will conclude by sharing exciting research directions in this area.

Bio: Lars Lindemann is currently a Postdoctoral Researcher in the Department of Electrical and Systems Engineering at the University of Pennsylvania. He received his B.Sc. degrees in Electrical and Information Engineering and his B.Sc. degree in Engineering Management in 2014 from the Christian-Albrechts-University (CAU), Kiel, Germany. He received his M.Sc. degree in Systems, Control and Robotics in 2016 and his Ph.D. degree in Electrical Engineering in 2020, both from KTH Royal Institute of Technology, Stockholm, Sweden. His current research interests include systems and control theory, formal methods, data-driven control, and autonomous systems. Lars received the Outstanding Student Paper Award at the 58th IEEE Conference on Decision and Control and was a Best Student Paper Award Finalist at the 2018 American Control Conference. He also received the Student Best Paper Award as a co-author at the 60th IEEE Conference on Decision and Control.

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