Seminar on Control Theory at Fukuoka

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13:30-14:30

Data-Driven Analysis and Synthesis of Positive Systems

Takumi Iwata (Hiroshima University, Japan)

Abstract: In the analysis and synthesis of dynamical systems, model-based approaches that rely on mathematical models have long been the standard. In contrast, data-driven approaches, which utilize measurement data obtained from the system, have recently gained attention as they enable analysis and synthesis directly from data, even when accurate modeling is challenging. In this talk, I present our recent work on data-driven analysis and synthesis, with a focus on positive systems. In particular, I discuss data informativity—a property of a dataset that indicates whether it contains sufficient information to solve a specific analysis or synthesis problem—and show how a linear programming (LP) framework can be employed in this context. Finally, I illustrate its application to the positive stabilization of networked systems.

Bio: Takumi Iwata received the Ph.D. degree in engineering from Nagoya University, Nagoya, Japan, in 2024. Since 2024, he has been an Assistant Professor (Special Appointment) at the School of Informatics and Data Science, Hiroshima University, Higashi-Hiroshima, Japan. His research interests include data-driven analysis and control of dynamical systems.

15:00-16:00

Generalized Lyapunov Inequalities for *k*-contraction: from Analysis to Feedback Design

Samuele Zoboli (LAAS-CNRS, France)

Abstract: Contraction analysis has emerged as a useful tool in nonlinear control, providing attractor-independent guarantees on asymptotic behaviors through differential conditions that are well suited for computational verification and controller synthesis. However, many systems cannot be made contractive, which has motivated the search for generalized notions capturing weaker convergence properties. One such extension is k-contraction, which can guarantee interesting convergence properties without requiring an exponential decrease of the distance between any two system trajectories. In this talk, I will introduce the concept of k-contraction and discuss the types of guarantees it can provide on a system's asymptotic behavior. I will then present a set of generalized Lyapunov inequalities that extend classical contraction conditions to the k-contraction setting and enable the transition from analysis to control design. Finally, I will show how quasi-LMI and BMI formulations can be used to synthesize linear feedback laws ensuring k-contractivity of the closed-loop dynamics, and show their potential application in the context of multi-stability.

Bio: Samuele Zoboli received his B.Sc. degree in Electronics Engineering from the University of Modena and Reggio Emilia, Italy, in 2016, and his M.Sc. degree in Automation Engineering from the University of Bologna, Italy, in 2019. He obtained his Ph.D. in

Automatic Control from the University of Lyon 1, France, in 2023, where his research focused on deriving robustness and stability guarantees for systems controlled by deep neural network feedback laws using nonlinear control theory. From 2023 to 2025, he was a postdoctoral researcher in the MAC team at LAAS-CNRS, France, working on partial stability for nonlinear systems and event-triggering strategies in deep neural network controllers. Since October 2025, he has been a permanent researcher at CNRS, based at LAAS-CNRS. His research interests include nonlinear systems control, multi-agent synchronization, and control-oriented artificial intelligence.