UCLA Samueli Electrical & Computer Engineering

Visitor Seminar

Co-Design of Complex Systems: From Autonomy to Future Mobility Systems

Dr. Gioele Zardini

Massachusetts Institute of Technology

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Engineering Bldg. IV – Shannon Room #54-134

Abstract When designing complex systems, we need to consider multiple trade-offs at various abstraction levels and scales, and choices of single components need to be studied jointly. For instance, the design of future mobility solutions (e.g., autonomous vehicles, micromobility) and the design of the mobility systems they enable are closely coupled. Indeed, knowledge about the intended service of novel mobility solutions would impact their design and deployment process, whilst insights about their technological development could significantly affect transportation management policies. Optimally co-designing sociotechnical systems is a complex task for at least two reasons. On one hand, the co-design of interconnected systems (e.g., large networks of cyber-physical systems) involves the simultaneous choice of components arising from heterogeneous natures (e.g., hardware vs. software parts) and fields, while satisfying systemic constraints and accounting for multiple objectives. On the other hand, components are connected via collaborative and conflicting interactions between different stakeholders (e.g., within an intermodal mobility system). In this talk, I will present a framework to co-design complex systems, leveraging a monotone theory of co-design and tools from game theory. The framework will be instantiated in the task of designing future mobility systems, all the way from the policies that a city can design, to the autonomy of vehicles part of an autonomous mobility-on-demand service. Through various case studies, I will show how the proposed approaches allow one to efficiently answer heterogeneous questions, unifying different modeling techniques and promoting interdisciplinarity, modularity, and compositionality. I will then discuss open challenges for compositional systems design optimization, and present my agenda to tackle them.

Biography Gioele Zardini is a Ph.D. Candidate at the Institute for Dynamic Systems and Control, ETH Zurich, working with Emilio Frazzoli. He received his BSc. and MSc. in Mechanical Engineering with focus in Robotics, Systems and Control from ETH Zurich in 2017 and 2019, respectively. He spent time in Singapore as a researcher at nuTonomy (then Aptiv, now Motional), at Stanford University (working with Marco Pavone) and at MIT (in 2020 working with David Spivak, and currently with Munther Dahleh). Driven by societal challenges, the goal of his research is to develop efficient computational tools and algorithmic approaches to formulate and solve complex, interconnected system design and autonomous decision-making problems. His research interests include the co-design of sociotechnical systems, compositionality in engineering, applied category theory, decision and control, optimization, and game theory, with applications to intelligent transportation systems, autonomy, and complex networks and infrastructures. He will join MIT as an assistant professor in Fall 2024.

For more information, contact Prof. Paulo Tabuada at tabuada@ee.ucla.edu