CIVIL AND ENVIRONMENTAL ENGINEERING

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School of Civil and Environmental Engineering

Present

Compositional Design of Complex Systems: From Autonomy to Future Mobility

Speaker:

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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, while 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 as 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.

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12:20 – 1:10 PM
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Bio: Gioele is the Rudge (1948) and Nancy Allen Assistant Professor at Massachusetts Institute of Technology. He is a PI in the Laboratory for Information and Decision Systems (LIDS), the Department of Civil and Environmental Engineering (CEE), and an affiliate faculty with the Institute for Data, Systems and Society (IDSS). He received his doctoral degree in 2024 from ETH Zurich, and holds both a BSc. and a MSc. in Mechanical Engineering and Robotics, Systems and control from ETH Zurich. Before joining MIT as a faculty, he was a Postdoctoral Scholar at Stanford University (January to June 2024), and held various visiting positions at nuTonomy Singapore (then Aptiv, now Motional), Stanford, and MIT. 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 interests include the co-design complex systems, all the way from future mobility systems to autonomous systems, compositionality in engineering, planning and control, and game theory.