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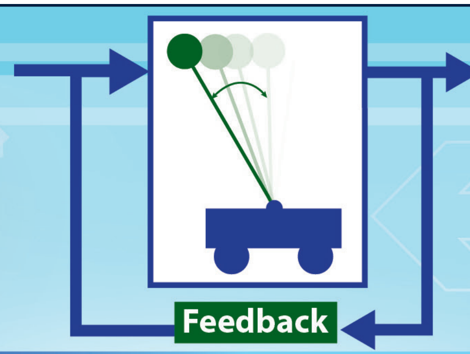

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Optimal Time Trajectory with Provable Safety for Connected and Automated Vehicles

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February 5, 2021 @ 3:30 pm - 4:30 pm
Event will take place via Zoom

ABSTRACT: Connected and automated vehicles (CAVs) provide the most intriguing opportunity for enabling users to better monitor transportation network conditions and make better operating decisions to improve safety and reduce pollution, energy consumption, and travel delays. CAVs are typical cyber-physical systems where the cyber component (e.g., data and shared information through vehicle-to-vehicle and vehicle-to-infrastructure communication) can aim at optimally controlling the physical entities (e.g., CAVs, non-CAVs). The cyber-physical nature of such systems is associated with significant control challenges and gives rise to a new level of complexity in modeling and control. As we move to increasingly complex emerging mobility systems, new control approaches are needed to optimize the impact on system behavior of the interplay between vehicles at different traffic scenarios. In this talk, I will present a decentralized control framework for coordination of CAVs at different traffic scenarios, e.g., merging at roadways and roundabouts, crossing unsignalized intersections, cruising in congested traffic, passing through speed reduction zones, and lane-merging or passing maneuvers. The framework includes: (1) an upper-level optimization that yields for each CAV its optimal path, including the time trajectory and lane, to pass through a given traffic scenario by alleviating congestion; and (2) a low-level optimization that yields for each CAV its optimal control input (acceleration/deceleration) to achieve the optimal path and time derived in the upper-level. I will present a geometric duality framework using hyperplanes to prove strong duality of the upper-level optimization problem and the condition under which the optimal solution always exists. Strong duality implies that the optimal path for each CAV does not activate any of the state, control, and safety constraints of the low-level optimization, thus allowing for online implementation.

BIO: Dr. Andreas Malikopoulos is the Terri Connor Kelly and John Kelly Career Development Associate Professor in the Department of Mechanical Engineering and the Director of the Sociotechnical Systems Center at the University of Delaware (UD). Prior to these appointments, he was the Deputy Director and the Lead of the Sustainable Mobility Theme of the Urban Dynamics Institute at Oak Ridge National Laboratory, and a Senior Researcher with General Motors Global Research & Development. He received a Diploma from the National Technical University of Athens, Greece, and his M.S. and Ph.D. degrees from the University of Michigan, Ann Arbor, in 2004 and 2008, respectively, all in Mechanical Engineering. His research interests span several fields, including analysis, optimization, and control of cyber-physical systems; decentralized stochastic systems; stochastic scheduling and resource allocation; and learning in complex systems. Dr. Malikopoulos is the recipient of several prizes and awards, including the 2007 Dare to Dream Opportunity Grant from the University of Michigan Ross School of Business, the 2007 University of Michigan Teaching Fellow, the 2010 Alvin M. Weinberg Fellowship, the 2019 IEEE Intelligent Transportation Systems Young Researcher Award, and the 2020 UD's College of Engineering Outstanding Junior Faculty Award. He has been selected by the National Academy of Engineering to participate at the 2010 German-American Frontiers of Engineering (FOE) Symposium and organize a session in transportation at the 2016 European-American FOE Symposium. He has also been selected as a 2012 Kavli Frontiers of Science Scholar by the National Academy of Sciences. Dr. Malikopoulos has been an Associate Editor of the IEEE Transactions on Intelligent Vehicles and IEEE Transactions on Intelligent Transportation Systems from 2017 through 2020. He is currently an Associate Editor of Automatica and IEEE Transactions on Automatic Control. He is a Senior Member of the IEEE and a Fellow of the ASME.

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