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KIOS Distinguished Lecture Series

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Decentralized Control and Optimization of Cooperative Multi-Agent Systems

Thursday 19 Apr 2018, 11:00 - 12:00
Room B108, "Anastasios G. Leventis", UCY

Friday 20 Apr 2018, 16:30 - 17:30
Room 010, Social Facilities Building 7, UCY

ABSTRACTS

In the first lecture, a unifying optimization-based framework will be presented which encompasses most commonly encountered cooperative multi-agent system problems, including coverage control, consensus, formation control, and persistent monitoring. We will then address the issue of identifying conditions under which a centralized solution to such problems can be recovered in a decentralized manner. For parametric optimization problems, conditions and explicit distributed algorithms can be derived. For dynamic optimization problems, however, decentralization can be challenging due to the time-varying nature of the agent network and the fact that agents take actions depending on interactions with the environment (targets, data sources). For the class of persistent monitoring problems studied in a one-dimensional setting, we have shown that a complete optimal solution can be obtained through an event-driven centralized gradient-based algorithm using Infinitesimal Perturbation Analysis (IPA). We will show that the IPA gradient can be recovered in an "almost distributed" manner in which each agent optimizes its trajectory based on local information, except for one event requiring communication from a non-neighbor agent.

In the second lecture, we will focus on the emerging multi-agent system known as the "Internet of Cars". Currently, transportation systems are not cooperative, thus giving rise to a Price of Anarchy: the gap between current "selfish" user-centric and optimal "social" system-centric traffic equilibria which are achievable with automated mobility. The advent of Connected Automated Vehicles (CAVs) can transform this into a cooperative system where a social optimum can be achieved through decentralized control and optimization methods applied to each CAV. We will present a decentralized framework for optimally controlling CAVs on line in order to cross intersections under hard safety constraints without any explicit traffic signaling and with the goal of minimizing fuel consumption while achieving maximal throughput. A complete analytical solution of these decentralized problems can be obtained and conditions have been derived under which feasible solutions satisfying all safety constraints always exist. Simulation examples will be included to demonstrate substantial dual benefits of the proposed decentralized framework by allowing CAVs to conserve momentum and fuel while also improving travel time.

BRIEF BIO

Christos G. Cassandras is Distinguished Professor of Engineering at Boston University. He is Head of the Division of Systems Engineering, Professor of Electrical and Computer Engineering, and co-founder of Boston University's Center for Information and Systems Engineering (CISE). He received degrees from Yale University (B.S., 1977), Stanford University (M.S.E.E., 1978), and Harvard University (S.M., 1979; Ph.D., 1982). In 1982-84 he was with ITP Boston, Inc. where he worked on the design of automated manufacturing systems. In 1984-96 he was a faculty member at the Department of ECE, University of Massachusetts/Amherst. He specializes in the areas of discrete event and hybrid systems, cooperative control, stochastic optimization, and computer simulation, with applications to computer and sensor networks, manufacturing systems, and transportation systems. He has published over 400 refereed papers in these areas, and six books. He has guest-edited several technical journal issues and serves on several journal Editorial Boards. He has worked extensively with industrial organizations on various systems integration projects and the development of decision-support software. He has most recently collaborated with The MathWorks, Inc. in the development of the discrete event and hybrid system simulator SimEvents. Dr. Cassandras was Editor-in-Chief of the IEEE Transactions on Automatic Control (1998-2009). He was the 2012 President of the IEEE Control Systems Society (CSS). He has also served as Vice President for Publications and on the Board of Governors of the CSS, as well as on several IEEE committees, and has chaired several conferences. He has been a plenary/keynote speaker at numerous international conferences and has also been an IEEE Distinguished Lecturer. He is the recipient of several awards, including the 2011 IEEE Control Systems Technology Award, the Distinguished Member Award of the IEEE Control Systems Society (2006), the 1999 Harold Chestnut Prize (IFAC Best Control Engineering Textbook) for Discrete Event Systems: Modeling and Performance Analysis. He is a Fellow of the IEEE and a Fellow of the IFAC.

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