Colorado State University's
Information Science and Technology Center (ISTeC)
presents <u>two</u> lectures by

Dr. Christos Cassandras

Boston University
Head, Division of Systems Engineering
Center for Information and Systems Engineering

ISTeC Distinguished Lecture
in conjunction with the
Electrical and Computer Engineering Department and Computer Science Department Seminar Series

"Cooperative Control and Optimization in an Uncertain, Asynchronous, Wireless, Networked World"

Monday, October 25, 2010
Reception: 10:30 a.m.
Lecture: 11:00 – 12:00 noon
Location: Lory Student Center Room 205

Joint Electrical and Computer Engineering Department and Computer Science Department Special Seminar

sponsored by ISTeC

"Perturbation Analysis And Optimization Of Stochastic Hybrid Systems And Resource Contention Games"

Tuesday, October 26, 2010
Lecture: 9:30 – 10:30 a.m.
Location: Lory Student Center Room 214

ABSTRACTS

"Cooperative Control And Optimization In An Uncertain Asynchronous Wireless Networked World"

Cooperative control arises when a system consists of multiple distributed components (e.g., nodes in a sensor network) that jointly function to meet a system-wide objective, often in an uncertain environment. It involves communication among components which is typically carried out asynchronously, wirelessly, and subject to limitations such as energy or physical constraints in the environment. We will discuss cooperative control and optimization problems that arise when sensor networks are deployed to meet objectives such as maximizing the detection probability of random events in a given region and tracking data sources (possibly mobile) when they are detected. We also address the broader question: How much communication is needed to achieve optimal cooperation? We show that event-driven, rather than synchronous, communication can guarantee convergence in cooperative distributed schemes while maintaining optimal performance. In dealing with uncertain environments, we will contrast a new "hedge-and-react" approach to traditional "estimate-and-plan" techniques, and apply it to stochastic multi-traveling-salesmen types of problems. The presentation will include demonstrations of cooperative settings that involve teams of small wireless robots in a laboratory environment.

"Perturbation Analysis And Optimization Of Stochastic Hybrid Systems And Resource Contention Games"

Stochastic hybrid systems encompass all processes that combine time-driven and event-driven dynamics in uncertain environments. The control and optimization of such systems is challenging, especially in real-time applications, because of the complexity in their dynamics and the absence of information regarding the stochastic processes involved, which are often time-varying. Studying these systems as functions of a design or control parameter vector, we have recently shown that Infinitesimal Perturbation Analysis (IPA) boils down to a set of equations that provide (under very mild conditions) unbiased estimates of state and event time gradients dependent only on observable sample path data. These can then be used to solve performance optimization problems. These gradient estimates exhibit "robustness" in the sense that they are frequently independent of the time-driven dynamics and the noise processes involved. We will present some sufficient conditions under which this property holds. A class of such systems, termed Stochastic Flow Models (SFMs), can be used to capture the behavior of complex discrete event systems encountered, for instance, in manufacturing, communication and sensor networks, or multiagent distributed systems. We use SFMs to formulate ubiquitous resource contention problems with multiple users as stochastic non-cooperative games. Using IPA methods in conjunction with gradient-based algorithms we solve such problems from both a system-centric and a user-centric standpoint and explore the difference in the optimal solutions (sometimes referred to as the "price of anarchy.") We identify cases where the system-centric and user-centric optimal solutions can be made to coincide, a desirable property because of the equilibrium it implies, but also because it enables distributed and scalable solutions to resource contention games.

SPEAKER BIOGRAPHY

Christos G. Cassandras (cgc@bu.edu) is Head of the Division of Systems Engineering and Professor of Electrical and Computer Engineering at Boston University. He is also co-founder of Boston University's Center for Information and Systems Engineering (CISE). He received degrees from Yale University, Stanford University, and Harvard University. In 1982-84 he was with ITP Boston, Inc. where he worked on the design of automated manufacturing systems. In 1984-1996 he was a faculty member at the Department of Electrical and Computer Engineering, University of Massachusetts/Amherst. He specializes in discrete event and hybrid systems, stochastic optimization, and computer simulation, with applications to computer and sensor networks, manufacturing and transportation systems. He has published over 280 refereed papers in these areas, and five books. He has guest-edited several technical journal issues and serves on several journal Editorial Boards. He has 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) and has also served as Editor for Technical Notes and Correspondence and Associate Editor. He is currently the Vice President on Publications and serves on the Board of Governors of the IEEE Control Systems Society (CSS). He has chaired the CSS Technical Committee on Control Theory, and served as Chair of several conferences. He has been a plenary speaker at various international conferences, including the *American Control Conference* in 2001 and the *IEEE Conference on Decision and Control* in 2002. He is the recipient of several awards, including 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*, and a 1991 Lilly Fellowship. He is a Fellow of the IEEE and of the IFAC.

To arrange a meeting with the speaker, please contact Dr. Edwin Chong at (970) 491-7858
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