



# **KIOS Distinguished Lecture Series**



**Prof. Christos G. Cassandras** Boston University, USA

## Thursday, 13 February 2025, at 12:00 Amphitheatre B108

## Optimizing Autonomous Multi-Agent Systems With Safety Guarantees: Making Autonomous Vehicles a Reality

#### **LECTURE ABSTRACT**

Optimal control methods provide solutions to safety-critical problems but easily become intractable. Control Barrier Functions (CBFs) have emerged as a popular technique that facilitates their solution by provably guaranteeing safety, through their forward invariance property, trading off conservativeness with performance. This approach involves defining a performance objective alongside CBF-based safety constraints that are always enforced and it depends on the selection of tunable parameters. Rather than heuristically tuning these critical parameters, a systematic Reinforcement Learning (RL) approach can be used to learn the optimal parameters in a bi-level optimization setting where safety is always guaranteed even during on-line training.

This framework is applied to Connected Automated Vehicle (CAVs) in transportation systems where the objective is to jointly minimize the travel time and energy consumption for each vehicle subject to speed, acceleration, and speed-dependent safety constraints. The situation is more challenging in mixed traffic where both CAVs and Human Driven Vehicles (HDVs) must interact. We show that this approach can often be robust to the behavior of HDVs despite their uncontrollable and unpredictable behaviors. In a more general non-cooperative game setting, we will present a Cooperative Compliance Control (CCC) approach using a "refundable toll" scheme to achieve a desired compliance probability through a feedback control mechanism combining global (social) with local (individual) components.



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#### **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 cofounder of Boston University's Center for Information and Systems Engineering (CISE). He received a B.S. degree from Yale University, M.S.E.E from Stanford University, and S.M. and Ph.D. degrees from 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 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 500 refereed papers in these areas, and 8 books.

He has guest-edited several technical journal issues and serves on several journal Editorial Boards. In addition to his academic activities, 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 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* from 1998 through 2009 and has also served as Editor for Technical Notes and Correspondence and Associate Editor. He is currently an Editor of *Automatica*. 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, including the *American Control Conference* in 2001, the *IEEE Conference on Decision and Control* in 2002 and 2016, and the *20th IFAC World Congress* in 2017 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*, a 2011 prize and a 2014 prize for the IBM/IEEE Smarter Planet Challenge competition (for a "Smart Parking" system and for the analytical engine of the Street Bump system respectively), the 2014 Engineering Distinguished Scholar Award at Boston University, several honorary professorships, a 1991 Lilly Fellowship and a 2012 Kern Fellowship. He is a member of Phi Beta Kappa and Tau Beta Pi. He is also a Fellow of the IEEE and a Fellow of the IFAC and holds a Chair Professorship at the Department of Automation, Tsinghua University.



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