SEMINAR ANNOUNCEMENT

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
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Area: Control, Intelligent Systems and Robotics

Host: Professor Sam, Ge Shuzhi

Co-Sponsored by:
IEEE Singapore Control Systems Chapter

TOPIC	:	**Policy Optimization for Optimal Control with Guarantees of Robustness**
SPEAKER	:	**Professor Tamer Başar** **Swanlund Endowed Chair Emeritus, and** **CAS Professor Emeritus of Electrical and Computer Engineering** **University of Illinois Urbana-Champaign**
DATE	:	**Friday, 11 November 2022**
TIME	:	**4.00PM to 5.00PM**
VENUE	:	**E1-06-03 Seminar Room** **NUS College of Design and Engineering, NUS**

ABSTRACT

Policy optimization (PO) is a key ingredient of modern reinforcement learning (RL), and can be used for efficient design of optimal controllers. For control design, certain constraints are generally enforced on the policies to be implemented, such as stability, robustness, and/or safety concerns on the closed-loop system. Hence, PO entails, by its nature, a constrained optimization in most cases, which is also nonconvex, and analysis of its global convergence is generally very challenging. Further, another element that compounds the challenge is that some of the constraints that are safety-critical, such as closed-loop stability or the H-infinity (H∞) norm constraint that guarantees system robustness, can be difficult to enforce on the controller while being learned as the PO methods proceed. We have recently overcome this difficulty for a special class of such problems, which I will discuss in this talk, while also placing this in a broader context.

Specifically, I will introduce the problem of PO for H2 optimal control with a guarantee of robustness according to the H∞ criterion, for both continuous- and discrete-time linear systems. I will argue, with justification, that despite the nonconvexity of the problem, PO methods can enjoy the global convergence property. More importantly, I will show that the iterates of two specific PO methods (namely, natural policy gradient and Gauss-Newton) automatically preserve the H∞ norm (i.e., the robustness) during iterations, thus enjoying what we refer to as “implicit regularization” property. Furthermore, under certain conditions, convergence to the globally optimal policies features globally sub-linear and locally super-linear rates. Due to the inherent connection of this optimal robust control model to risk-sensitive optimal control and linear quadratic (LQ) dynamic games, these results also apply as a byproduct to these settings as well, with however some adjustments. The latter, in particular, entails PO with two agents, and the order in which the updates are carried out becomes a challenging issue, which I will also discuss. The talk will conclude with some informative simulations, and a brief discussion of extensions to the model-free framework and associated sample complexity analyses.

BIOGRAPHY

Tamer Başar has been with University of Illinois Urbana-Champaign since 1981, where he is currently Swanlund Endowed Chair Emeritus; CAS Professor Emeritus of ECE; and Research Professor, CSL and ITI. Currently, he is also the Executive Director of Illinois@Singapore, an entity in CREATE. At Illinois, he has served as Director of the Center for Advanced Study (2014-2020), Interim Dean of Engineering (2018), and Interim Director of the Beckman Institute (2008-2010). He is a member of the US National Academy of Engineering; Fellow of IEEE, IFAC, and SIAM; and has served as presidents of the IEEE Control Systems Society (CSS), the International Society of Dynamic Games (ISDG), and the American Automatic Control Council (AACC). He has received several awards and recognitions over the years, including the highest awards of IEEE CSS, IFAC, AACC, and ISDG, the IEEE Control Systems Technical Field Award, Wilbur Cross Medal from his alma mater Yale, and a number of international honorary doctorates and professorships. He was Editor-in-Chief of the IFAC Journal Automatica between 2004 and 2014, and is currently editor of several book series. He has contributed profusely to fields of systems, control, communications, optimization, networks, and dynamic games, and has current research interests in stochastic teams, games, and networks; multi-agent systems and learning; data-driven distributed optimization; epidemics modeling and control over networks; strategic information transmission, spread of disinformation, and deception; security and trust; energy systems; and cyber-physical systems.