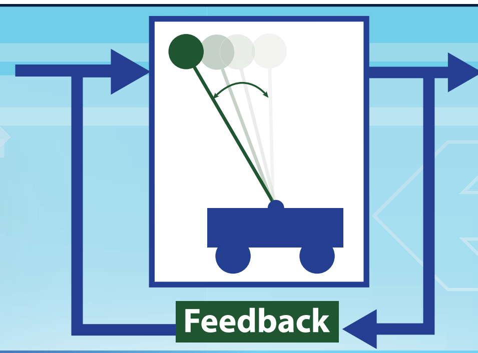
COLLEGE OF ENGINEERING

# Control Seminar




Sponsored by: Bosch, Ford, and Toyota

# The Role of Network Structure in Controlling Complex Networks


## JORGE CORTES

Professor
Dept. of Mechanical and Aerospace Engineering
University of California


## Friday, December 7, 2018

## 3:30 – 4:30 pm     1500 EECS


**ABSTRACT:** Controllability of complex network systems is an active areaof research at the intersection of network science, control theory, and multi-agent coordination, with multiple applications ranging from brain dynamics to the smart grid and cyber-physical systems. The basic question is to understand to what extent the dynamic behavior of the entire network can be shaped by changing the states of some of its subsystems, and decipher the role that network structure plays in achieving this. This talk examines this question in two specific instances: characterizing network controllability when control nodes can be scheduled over a time horizon and hierarchical selective recruitment in brain networks. Regarding controllability, we show how time-varying control schedules can significantly enhance network controllability over fixed ones, especially when applied to large networks. Through the analysis of a novel scale-dependent notion of nodal centrality, we show that optimal time-varying scheduling involves the actuation of the most central nodes at appropriate spatial scales. Regarding hierarchical selective recruitment, we examine network mechanisms for selective inhibition and top-down recruitment of subnetworks under linear-threshold dynamics. Motivated by the study of goal-driven selective attention in neuroscience, we build on the characterization of key network dynamical properties to enable, through either feedforward or feedback control, the targeted inhibition of task-irrelevant subnetworks and the top-down recruitment of task-relevant ones. Our results allow us to draw interesting interpretations on the role played by timescale separation, the structure of intra- and inter-connections among network layers, and the selective activity of task-irrelevant and task-relevant subnetworks in the brain.


**BIO:** Jorge Cortes is a Professor with the Department of Mechanical and Aerospace Engineering at the University of California, San Diego. He received the Licenciatura degree in mathematics from the Universidad de Zaragoza, Spain, in 1997, and the Ph.D. degree in engineering mathematics from the Universidad Carlos III de Madrid, Spain, in 2001. He held postdoctoral positions at the University of Twente, The Netherlands, and at the University of Illinois at Urbana-Champaign, USA. He was an Assistant Professor with the Department of Applied Mathematics and Statistics at the University of California, Santa Cruz from 2004 to 2007. He is the author of "Geometric, Control and Numerical Aspects of Nonholonomic Systems" (New York: Springer-Verlag, 2002) and co-author of "Distributed Control of Robotic Networks" (Princeton: Princeton University Press, 2009). He received a NSF CAREER award in 2006 and was the recipient of the 2006 Spanish Society of Applied Mathematics Young Researcher Prize. He has co-authored papers that have won the 2008 IEEE Control Systems Outstanding Paper Award, the 2009 SIAM Review SIGEST selection from the SIAM Journal on Control and Optimization, and the 2012 O. Hugo Schuck Best Paper Award in the Theory category. He has been an IEEE Control Systems Society Distinguished Lecturer (2010-2014) and is an IEEE Fellow. His current research interests include distributed control and optimization, network science, opportunistic state-triggered control, reasoning and decision making under uncertainty, and distributed coordination in power networks, robotics, and transportation.

ECE ELECTRICAL & COMPUTER ENGINEERING UNIVERSITY OF MICHIGAN    BOSCH    Ford    TOYOTA

*Questions? Contact: Judi Jones asap@umich.edu*