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Distributed Design: a New Direction in Distributed Control

Cedric Langbort
University of Illinois

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Abstract:

Since the field started investigating the influence of specific information patterns in optimal control in the sixties, "distributed control" has almost become synonymous with the problem of designing controllers with externally-imposed observation and communication structures. While the difficulty of this question certainly justifies the extensive attention it has received until now, we believe that it also has overshadowed other important issues that appear naturally in the design of controllers for distributed systems. For example, one significant difficulty in controlling such systems lies in the fact that the control law (regardless of whether it is "distributed" in the traditional sense or not) may have to be constructed by several different decision makers (e.g., co-located with the distributed units), with access to different segmented, incomplete, and/or possibly inconsistent models of the full plant to be controlled. This talk will explore such distributed design issues in two ways: first, we focus on a theoretical distributed design framework in which a controller must be constructed by different designers, with access to only partial model information. Using tools and ideas from the theory of communication complexity in Computer Science, we characterize the class of controllers that can be obtained in this way, and give tight bounds on the best worst-case achievable closed-loop performance over families of plants. Then, we present an online multiplayer game currently under development at the University of Illinois, which we use as a testbed to learn how groups of human subjects take decision in the presence of segmentation of information, and handle distributed control design in practice. Of particular interest in these experiments are the unprompted development and use of cooperation languages between decision makers. Some of the work presented here is joint with Jean-Charles Delvenne (UCL), Jerome Barral, Takashi Tanaka, and Robert Wilson (UIUC).

About the Speaker:

Cedric Langbort is currently an assistant professor of Aerospace Engineering at the University of Illinois at Urbana-Champaign (UIUC). He was born in Paris, France in 1977. He studied at the Ecole Nationale Superieure de l'Aeronautique et de l'Espace - Supaero in Toulouse (Aerospace Engineering degree; M.S. control theory) and the Institut Non-Lineaire in Nice (M.S. dynamical systems) before receiving the Ph.D. degree in Theoretical & Applied Mechanics from Cornell University in January 2005. He then spent a year and a half as a postdoctoral scholar in the Center for the Mathematics of Information at Caltech before joining UIUC. His work is in the field of Aerospace Information Technology with applications to large-scale distributed systems such as multi-vehicle missions, air traffic management systems, or smart materials. Of particular interest are fundamental questions regarding the role of communication constraints between subsystems, system's architecture, tolerance to individual failure, and intrinsic limitations of distributed control algorithms due to segmentation of information.