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Information and Control in Networks

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Preface

In the control of complex networked systems, a central role is played by information. System dynamics and information flows evolve in an intertwined way. While Control Theory and Information Theory have traditionally developed independently from each other, the need for a convergence of the two has strongly emerged in the last 15 years, and is now a very active research field. In addition to efforts in Control and Information Theory, strong research is witnessed in such diverse fields as Computer Science, Mathematics, and Statistics. Potential applications of the theory include remote robot control, automated highway navigation using wireless sensor systems, automatic control for unmanned aerial vehicles, and design of critical energy, transportation, and health care systems, and more.

This book collects contributions from some of the world-leading researchers in the area who have gathered in Lund on October 17–19, 2012 for the LCCC Workshop in Information and Control in Networks. The workshop was held in the middle of a five-weeks-long focus period on the same theme which has created exciting cross-fertilization and new ideas. (Please, refer to the webpage http://www.lccc.lth.se/index.php?page=workshop2012-10 for more detailed information.)

The book is organized in three parts, consisting of three chapters each. The first part collects contributions dealing with the problem of stabilizability of dynamical systems with communication constraints in the feedback loop. In particular, Franceschetti and Minero provide a survey of several results that have appeared in the last 15 years on this topic; Zaidi et al. study the stabilization problem of a linear system driven by Gaussian noise with a Gaussian relay channel in the feedback loop; Cardoso de Castro et al. design energy-efficient radio-mode switching controllers for stabilization over noisy channels.

The second part includes chapters exploring the fundamental relationships between Control and Information from three different angles: Nayyar et al. discuss a novel 'common information approach' solving decentralized stochastic control problems; Asnani et al. present a unified framework for deriving the relations between information and estimation in the presence of feedback; Yüksel studies the design problem of information channels for stabilization and optimization in networked control.

The third and final part of the book includes contributions dealing with different information dynamics over networks: Nair investigates the problem of characterizing those noiseless network topologies for which the information transmission problem is equivalent to the existence of an admissible multi-commodity flow; Elia et al. adopt a dynamical system viewpoint in order to tackle the problem of distributed computation over unreliable networks whereby transmission links are subject to both additive noise and packet drops; Sedghi and Jonckheere apply techniques from Markov Random Fields to deal with the problem of detection of faults or malicious attacks in the smart power grid.

Any attempt to sketch a brief summary of the historical development of the subject here would necessary fail to do justice to its breadth and complexity. We rather address the reader to the reference lists of the different chapters, and in particular in the ones by Franceschetti and Minero, Nayyar et al., for an overview of the relevant literature. A complete list of the titles of the LCCC workshop's seminars is also included in the next two pages, with the aim of giving the reader an idea of the full range of themes discussed there, including those who have not resulted in a contribution to this book.

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