Sparse Approximation Methods for the Control of Large Scale Inter-Networked Systems
Dr. Marco Levorato (Stanford)
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Abstract:

The explosion of the number of devices capable of transmitting and receiving information connected to wireless and wired communication infrastructures, both for human-to-human and machine-to-machine interaction, is forcing a technological transition to a different inter-networking model. Smart Energy grids and mobile health-care are important examples of complex heterogeneous systems merged with the global communication infrastructure. I will first present a framework for the optimization of energy consumption in smart buildings with real-time pricing. By observing a trajectory of the system, the scheduler learns the behavior of the consumer and of the energy pricing process, and controls the activation of devices to balance consumer dissatisfaction and financial cost of operations. I will then present a framework for the optimization of the sampling rate of heterogeneous on-body sensors for human activity monitoring. Our approach is shown to achieve high estimation accuracy with a dramatic reduction in the energy consumption of the communication network transferring data from the sensors to the mobile phone processing the samples. These two results highlight how the optimization of modern internet-worked systems needs to consider the interaction of a heterogeneous collection of sub-systems ranging from sensor networks, natural phenomena, communication protocols and control algorithms. However, the high complexity of these systems discourages the use of traditional optimization and learning tools in practice. I will discuss a novel framework for online learning and optimization in complex inter-networked systems based on sparse approximation theory. The main observation is that communication protocols, algorithms, as well as supposedly natural and human phenomena, induce a structured behavior of the stochastic process tracking the state of the system. This results in a regular structure at different time scales (hop number) of the graph modeling state transitions and enables dimensionality reduction. Sparse approximation algorithms can be then employed to dramatically reduce the number of observations required to estimate fundamental control functions mapped on the state space of these complex systems.

Biographical Information:

Marco Levorato obtained both the BE (Electronics and Telecommunications Engineering) and the ME (Telecommunications Engineering) summa cum laude from the University of Ferrara, Italy, in 2002 and 2005, respectively. In 2009, he received the Ph.D. in Information Engineering from the University of Padova. From 2010 to 2012 he was a post doctoral research fellow at Stanford and the University of Southern California (USC). Since January 2013, he is an ACCESS Post-Doctoral research associate in the Automatic Control Lab at the ACCESS Linnaeus Center, Royal Institute of Technology (KTH) in Stockholm. He co-authored 63 technical papers published in major IEEE journals and conferences. Marco Levorato is the recipient of the best paper award of IEEE Globecom 2012. His current research interests include modeling, analysis and control of internet-worked systems, Smart energy grids and On-body sensors for mobile health care.