The Center for Control, Dynamical Systems, and Computation
University of California at Santa Barbara
Spring 2009 Seminar Series
Presents

Information Theoretic Bounds for Distributed Computation

Ola Ayaso
Electrical & Computer Engineering
Georgia Institute of Technology

Friday, April 03, 2009 3:00 - 4:00pm Webb 1101

Abstract:

We seek to understand the fundamental limitations, of distributed computation over networks, imposed by limited communication capabilities and network topology. Computation in networks arises in various contexts, such as wireless and sensor networks, consensus, and belief propagation. In each of these situations, individual nodes have access to only part of the information they need and must communicate via the network in order to execute required computations. In our formulation, each node has an initial measurement and would like to estimate a given function that depends on the initial measurements of multiple nodes. An underlying topology determines which nodes can communicate directly with each other over noisy channels. A distributed computation algorithm specifies both the communications and computations that nodes will execute to derive the desired function estimate. Using information theoretic inequalities, we obtain a lower bound on the computation time that must be satisfied by *any* distributed computation algorithm so that the mean square error in the nodes' estimates is within a specified accuracy. To establish tightness of the bound, we consider a specific scenario where nodes seek to estimate a linear combination of the distributed initial measurements (e.g., the well known distributed averaging setup) while communicating over erasure channels. We develop a distributed quantized algorithm whose computation time depends reciprocally on "conductance", which is a property of the network that captures the information flow bottleneck. This reciprocal relationship is consistent with our lower bound, and hence establishes both that the bound is tight and that the proposed algorithm run time is optimal.

About the Speaker:

Ola Ayaso is a postdoctoral fellow in the Electrical and Computer Engineering department at the Georgia Institute of Technology. She received a PhD from MIT in 2008, the M.S. from MIT, and B.S. with high distinction from the American University of Beirut, all in electrical engineering. Her research interests include algorithms and limits of computation and coordination in distributed systems and dynamic networks.