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THE CHINESE UNIVERSITY OF HONG KONG
Institute of Network Coding
and
Department of Information Engineering
Seminar

Distributed Inference under Gossip and Intermittency

by

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The Chinese University of Hong Kong

Abstract

The year 2010 marks fifty years since the seminal March 1960 paper of Rudy Kalman. It is then fitting that we revisit Kalman filter in the setting of loosely coupled distributed agents (systems or sensors) that exchange data *locally* according to a random protocol (e.g., gossip,) and when the underlying sparse communications network is subject to intermittent random failures. We describe the Gossip Interactive Kalman Filter (GIKF) that successfully addresses three main issues: i) the *distributed* nature of the problem – measurement collection, inference algorithm, and underlying networked system; ii) the *intermittency* of the observations, e.g., packet loss resulting from communication infrastructure failures; and iii) random asynchronous communications protocol, e.g., *gossip*. We characterize the asymptotic path properties of the GIKF and its performance by modeling the associated Riccati equation as a *random dynamical system* (RDS). We establish a *distributed detectability condition* under which the distributed GIKF is asymptotically equivalent to the optimal centralized filter. We show that the sample paths of the Riccati RDS converge in distribution to an *invariant measure* on the cone of positive definite matrices – this is the random equivalent of Kalman's asymptotic result that, under appropriate controllability and observability conditions, the Riccati equation converges to a fixed point. Finally, we obtain a *large deviation* result that characterizes the optimal decay rate of the probability of rare events, i.e., events where the paths of the random Riccati equation are bounded away from the fixed point of the non random Riccati equation.

This is joint work with Soummya Kar and based on his recent PhD thesis, June 2010, CMU.

1. Soummya Kar and José M. F. Moura, "*Gossip and Distributed Kalman Filtering: Weak Consensus under Weak Detectability*," http://arxiv.org/abs/1004.0381.
2. Soummya Kar and José M. F. Moura "*Kalman Filtering with Intermittent Observations: Weak Convergence and Moderate Deviations*," http://arxiv.org/abs/0910.4686.
3. Soummya Kar, José M. F. Moura, Kavita Ramanan "*Distributed Parameter Estimation in Senhsor Networks: Nonlinear Observation Models and Imperfect Communication*," arxiv.org/abs/0809.0009.

Biography

José M. F. Moura is a University Professor at Carnegie Mellon University (CMU) where he founded the Center for Sensed Critical Infrastructure Research and the Information and Communication Technologies Institute. He holds a D.Sc. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology (MIT). His interests are in algebraic and statistical signal/ image processing, with projects on distributed algorithms, large scale critical physical infrastructures, bioimaging, intelligent compilers for signal processing algorithms.

He was President of the IEEE Signal Processing Society, was the Editor in Chief for the IEEE Transactions on Signal Processing, and was on the Boards of the IEEE Proceedings and the ACM Sensors Journal. He has received several awards, including Fellow of the IEEE, Fellow of the AAAS, corresponding member of the Academia das Ciências of Portugal, IEEE 3rd Millennium Medal, IEEE SPS Meritorious Service Award, IBM Faculty Award, CMU's College of Engineering Outstanding Research Award, CMU's Phillip Dowd Fellowship Award for Excellence in Engineering Education. In 2010, he was elected University Professor at CMU.

****ALL ARE WELCOME ****

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