Detection and Estimation Using Regularized Least Squares:
Performance Analysis and Optimal Tuning Under Uncertainty

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This talk considers the problem of signal estimation and detection in linear systems under additive and multiplicative uncertainty.

The estimation problem is considered in the first part of the talk. We utilize regularized least squares for signal estimation and show how the regularization parameter can be optimally tuned to take care of 1) the additive noise 2) the ill-posed-ness of the channel matrix and 3) channel (multiplicative) uncertainty. The performance of the proposed approach is demonstrated by applying it to a large set of real world discrete ill-posed problems showing that it outperforms popular benchmark regularization methods in many cases while maintaining lower computational complexity

In the second part of the talk we utilize regularized least squared and its boxed relaxed version for BPSK detection. We derive precise error analysis at high dimensions using the Convex Gaussian Min-max theorem, a recently developed tool that emerged from the theory of compressed sensing. We take advantage of these accurate performance prediction results to optimally tune the parameters involved in the detection. We further extend our analysis to the case where channel uncertainty is also present and use that to optimally divide the power between the two phases of channel estimation and data transmission.

Biography

Tareq Y. Al-Naffouri received the B.S. degrees in mathematics and electrical engineering (with first honors) from King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, the M.S. degree in electrical engineering from Georgia Institute of Technology, Atlanta, and the Ph.D. degree in electrical engineering from Stanford University, CA, in 2004. He was a visiting scholar at the California Institute of Technology, Pasadena, from January to August 2005 and during the summer of 2006. He was a Fulbright Scholar at the University of Southern California from February to September 2008. He is currently an Associate Professor at the Electrical Engineering Department at King Abdullah University of Science & Technology (KAUST) Saudi Arabia. His research interests lie in the areas of adaptive, statistical, and sparse signal processing and their applications, and in localization, and machine learning.