

Noisy sensor network localization: robust facial reduction and the Pareto frontier

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We consider the localization problem in sensor networks where the inter-sensor distance measurements are inaccurate and incomplete. In this paper, we present two novel algorithms for large-scale sensor localization based on semidefinite programming relaxations. Emerging exoscale networks lead to semidefinite relaxations that are prohibitively large for interior-point methods to handle. Both of our methods are able to efficiently solve the semidefinite programming relaxations without the use of interior-point methods. Our first method works by relating cliques in the graph of the problem to faces of the positive semidefinite cone, allowing us to devise a combinatorial algorithm for the localization problem that is provably robust and parallelizable. Our second algorithm is a first order method for maximizing the trace—a popular low-rank inducing regularizer—in a robust formulation of the localization problem. Namely, we consider the related much easier problem where the trace objective and the robust constraint are interchanged. By solving a sequence of these easier problems, we are able to obtain a solution to the original max-trace problem. Both of our algorithms output a configuration of sensors that can serve as a high-quality initialization for local optimization techniques. We provide numerical experiments on large-scale sensor network localization problems illustrating the development.