Modelling and Solving Large Scale
Sensor Network Localization Problems

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The sensor network localization, SNL, problem consists of locating the positions of ad hoc wireless sensors, given only the distances between sensors that are within radio range and the positions of a subset of the sensors (called anchors). Wireless sensor networks have many applications, e.g. in monitoring physical or environmental conditions (temperature, sound, vibration, pressure, battlefield surveillance, home automation, hospital patients, traffic control, etc.). The SNL problem can be relaxed to a weighted, nearest, (positive) semidefinite programming, SDP, completion problem. This relaxation is ill-conditioned because the feasible set is restricted to a low dimensional face of the SDP cone. This means that the Slater constraint qualification fails. Also, nonuniqueness of the optimal solution results in large sensitivity to small perturbations in the data.

We turn what is ordinarily regarded as a difficulty to our advantage with a preprocessing technique that solves the SNL problem. Our algorithm is based on repeatedly identifying faces of the semidefinite cone corresponding to intersections of cliques (i.e., the source of the degeneracy) in the SNL problem to reduce its size. In most cases, the SDP relaxation as well as the original SNL problem is completely solved without ever requiring an SDP solver.