Master's Thesis

A globally convergent Levenberg-Marquardt method for degenerate optimization with equality and inequality constraints

Guidance

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Abstract

Degenerate optimization problems, which have attracted much attention recently, are problems where a certain regularity condition does not hold. In these cases, a point satisfying Karush-Kuhn-Tucker conditions is not locally unique. Promising algorithms for such problems are the stabilized sequential quadratic programming (sSQP) and the Levenberg-Marquardt (LM) methods. The LM method is one of Newton-type methods for nonlinear equations and has locally fast convergence. Its local behavior is better than that of sSQP for certain degenerate problems. However, since it is originally designed to solve nonlinear equations, a search direction generated by the LM method is not necessarily a descent one for the objective function. Thus, a sequence generated by the LM method may converge to a local maximum or a saddle point. To overcome this difficulty, Izmailov, Solodov, and Uskov proposed to use a merit function with the objective function for solving equality-constrained optimization problems.

In this paper, we extend the method by Ismailov et al. to optimization problems with both equality and inequality constraints. Our method is based on the constrained LM method, and thus it always generates nonnegative Lagrange multipliers for the inequality constraints. We show that the proposed method converges globally and superlinearly without the standard regularity conditions such as the linear independence constraint qualification and the second-order optimality conditions. Finally, we report some numerical experiments to see the validity of the proposed method.