Master's Thesis

A stabilized sequential quadratic programming method for degenerate nonlinear programming problems on Riemannian manifolds

Guidance

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Abstract

A constrained Riemannian nonlinear programming problem (RNLP) is an optimization problem on a Riemannian manifold with equality and inequality constraints, and it arises in various fields, such as machine learning and control theory. Many researchers have proposed optimality conditions and optimization methods for the constrained RNLP. Recently, Obara, Okuno, and Takeda proposed the Riemannian sequential quadratic programming (RSQP) method, which is an extension of the ordinary SQP method for the constrained nonlinear programming problem on the Euclidean space. They showed that the RSQP method converges globally to a Karush–Kuhn–Tucker (KKT) point when the constrained RNLP is non-degenerate, that is, certain regularity conditions and constraint qualifications (CQs) hold. However, it is not guaranteed for the method to find a solution when the problem is degenerate.

In this thesis, we propose a stabilized SQP method for a degenerate constrained RNLP. The proposed method is an extension of the stabilized SQP method in the Euclidean space. We show that the proposed method globally converges to a point that satisfies Approximate KKT (AKKT) conditions for the RNLP without assuming any CQs and regularity. Note that the AKKT conditions are necessary conditions for optimality and they become the usual KKT conditions under CQs. Finally, we conduct numerical experiments to confirm the effectiveness of the proposed method for degenerate problems.