Some iterative algorithms for solving nonlinear optimization problems and their applications

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Abstract: This thesis develops and analyzes several iterative algorithms for solving nonlinear optimization problems, with a focus on both theoretical convergence properties and practical applications. We propose novel variants of gradient-based and Newton-type methods designed to address challenges such as non-convexity, ill-conditioning, and large-scale data. The convergence analysis establishes global convergence guarantees under standard assumptions, including Lipschitz continuity of the gradient and the Polyak-Łojasiewicz condition. Furthermore, we investigate the application of these algorithms to machine learning models, specifically in training deep neural networks and solving regularized regression problems. Extensive numerical experiments on benchmark datasets demonstrate that the proposed methods achieve faster convergence rates and superior solution quality compared to classical approaches. The results highlight the effectiveness of the iterative schemes in handling high-dimensional, nonlinear structures, offering robust tools for both theoretical optimization and real-world computational tasks.

Keywords: Iterative algorithm, nonlinear optimization, optimization problem, applications