Computational aspects in second order methods for large scale optimization

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In the recent years interest kept on steadily increasing around second order methods for the resolution of continuous large scale problems traditionally handled by first order methods. This has been the case for example for machine learning and compressed sensing problems.

In this tutorial, we will analyze key computational aspects related to an efficient implementation of second order methods for large scale problems. In particular we will focus on Newton-like methods for different classes of problems (nonlinear least-squares, linear programming, semidefinite programming) and we will discuss how the arising large scale Newton equations can be efficiently handled by iterative linear solvers. We will analyze the level of error acceptable in the Newton equations so to keep the favorable convergence properties of Newton-like methods and how to speed up the adopted iterative linear solver. We will show that careful use of second-order information and proper use of the problem's structure can lead to very efficient optimization methods, which significantly overpass their potential cost limitations.