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Mathematical Programming Methods for Large-scale Structural Topology Optimization

Structural topology optimization is a relatively new but rapidly expanding field because of its interesting theoretical implications in mathematics, mechanics, and computer science, and its important practical applications in the manufacturing and aerospace industries.

Topology optimization determines the optimal distribution of material in a prescribed design domain. The domain is often discretized by finite elements, with the variables representing the density of each element. A common example is maximizing the stiffness of the structure while satisfying a volume constraint and equilibrium equations [2].

While a variety of large-scale nonlinear solvers could be applied, structural topology optimization problems are usually solved by sequential convex approximation methods such as the Method of Moving Asymptotes (MMA) [1]. This method was specially designed for use within optimal design and is now extensively used in commercial optimal design software as well as academic research codes. However, it is a first-order method with slow convergence rates.

A large set of test problems has now been gathered, along with extensive results for different solvers. Performance profiles compare the special-purpose first-order methods with some general-purpose solvers such as FMINCON, IPOPT, and SNOPT, confirming that the use of second-order information leads to better designs more efficiently than the classical structural optimization solvers.

Given the performance profiles, a sequential quadratic programming method SQP+ has been developed based on the algorithm explained in [3].Two phases, an inequality and an equality phase, are combined to produce faster convergence. Both phases use second-order information and problem-specific characteristics to improve the efficiency of the solver.

[1] K. Svanberg. *The method of moving asymptotes: A new method for structural optimization.* International J. for Numerical Methods in Engineering, 24:2, 359-373, 1987.

[2] M.P. Bendsoe and O. Sigmund. *Topology Optimization: Theory, Methods and Applications*, Springer, 2003.

[3] J.L. Morales, J. Nocedal, and Y. Wu. *A sequential quadratic programming algorithm with an additional equality constrained phase*, J. of Numerical Analysis, 32:2, 553-579, 2010.