Fabrication-Adaptive Optimization, with an Application to Photonic Crystal Design

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Abstract

It is often the case that the computed optimal solution of an optimization problem cannot be implemented directly, irrespective of data accuracy, due to either (*i*) technological limitations (such as physical tolerances of machines or processes), (*ii*) the deliberate simplification of a model to keep it tractable (by ignoring certain types of constraints that pose computational difficulties), and/or (*iii*) human factors (getting people to "do" the optimal solution). Motivated by this observation, we present a modeling paradigm called "fabrication-adaptive optimization" for treating issues of implementation/fabrication. We develop computationally-focused theory and algorithms, and we present computational results for incorporating considerations of implementation/fabrication into constrained optimization problems that arise in photonic crystal design. The fabrication-adaptive optimization framework stems from the robust regularization of a function. When the feasible region is not a normed space (as typically encountered in application settings), the fabrication-adaptive optimization framework typically yields a non-convex optimization problem. (In the special case where the feasible region is a finite-dimensional normed space, we show that fabrication-adaptive optimization can be re-cast as an instance of modern robust optimization.) We study a variety of problems with special structures on functions, feasible regions, and norms, for which computation is tractable, and develop an algorithmic scheme for solving these problems in spite of the challenges of non-convexity. We apply our methodology to compute fabrication-adaptive designs of two-dimensional photonic crystals with a variety of prescribed features.

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