Robust optimization: A tractable approach to optimization under uncertainty

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Abstract

We propose an approach to address optimization under uncertainty that

(a) unlike dynamic and stochastic programming does not suffer from the curse of dimensionality,

(b) allows explicit control of the tradeoff of robustness and optimality, and

(c) inherits the computational complexity of the underlying deterministic problem.

Examples of concrete results include:

(a) the robust counterpart of a linear programming problem (LP) is still an LP and of a mixed integer programming problem (MIP) is still a MIP of comparable size.

(b) The robust counterpart of a polynomially solvable 0-1 discrete optimization problem remains polynomially solvable.

(c) Robust network flows can also be solved as a polynomial number of modified network flow problems.

(d) The robust counterpart of an NP-hard alpha-approximable 0-1 discrete optimization problem, remains alpha-approximable.

(e) Robust conic optimization problems retain their original structure. Specifically, robust second order cone problems (SOCPs) remain SCOPs and robust semidefinite optimization problems (SDPs) remain SDPs.

(f) When applied to classical supply chain optimization problems, the approach leads to tractable solutions that extend the applicability of known results and lead to deeper insights.

(g) When applied to linear quadratic control problems, the approach can handle constraints on controls and states that dynamic programming can not address.

Joint work with Melvyn Sim (a)–(e), Aurelie Thiele (f), and David Brown (g).