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Scalable Modeling and Solution of Stochastic Multiobjective Optimization Problems

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Abstract

We present a scalable computing framework for the solution stochastic multiobjective optimization problems. The proposed framework uses a nested conditional value-at-risk (nCVaR) objective to find compromise solutions among conflicting random objectives. We prove that the associated nCVaR minimization problem can be cast as a standard stochastic programming problem with expected value (linking) constraints. We also show that these problems can be implemented in a modular and compact manner using PLASMO (a Julia-based structured modeling framework) and can be solved efficiently using PIPS-NLP (a parallel nonlinear solver). We apply the framework to a CHP design study in which we seek to find compromise solutions that trade-off cost, water, and emissions in the face of uncertainty in electricity and water demands.

Keywords: large scale; optimization; stochastic; multiobjective; CVaR

1 Motivation

Stochastic multiobjective optimization (SMOO) problems trade-off multiple random objectives, multiple statistics (metrics) of a single random objective, or combinations of both (e.g., expected cost vs. expected environmental impact, expected cost vs. worst-case cost, expected cost vs. worst-case environmental impact) [1, 19]. These types of problems also arise in multi-stakeholder decision-making in which a population of stakeholders seek to balance their conflicting objectives and priorities (e.g., attitudes and perceptions towards risk). One special case of SMOO is deterministic multiobjective optimization (MOO), for which general formulations and computational frameworks are well-established [35, 41, 22]. SMOO formulations have a wide range of applications that include finance [2], energy systems [9], chemical processes [43, 37, 31], transportation logistics [21], facility location [16, 14], manufacturing and production planning [42], supply chain management [40], telecommunication, health care management [3, 5], budget allocation [23], and project management [20].

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