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Robust chance-constrained optimization with discrete distributions via a bundle approach

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Typically, probability distributions that generate uncertain parameters are uncertain themselves or even unknown. Distributional robustness determines optimized decisions that are protected in a robust fashion against all probability distributions in some appropriately chosen ambiguity set. We consider robust joint chance-constrained optimization problems with discrete probability distributions and introduce a practically efficient scenario-based bundle method without convexity assumptions on the constraint functions. We start by deriving an approximation problem to the original robust chance-constrained version by using smoothing and penalization techniques. The scenario-based bundle method first solves the approximation problem with a classical bundle method, and then uses the bundle solution to decide which scenarios to include in a scenario-expanded formulation. In our numerical experiments we demonstrate the efficiency of our approach on real-world gas transport problems with uncertain demands. Comparing our results to the classical robust reformulations for ambiguity sets consisting of confidence intervals and Wasserstein balls, we observe that the scenario-based bundle method often outperforms solving the classical reformulation directly and is guaranteed to find feasible solutions.

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