

Bi-Parameterized Two-Stage Stochastic Min-Max and Min-Min Mixed Integer Programs

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We introduce two-stage stochastic min-max and min-min integer programs with bi-parameterized recourse (BTSPs), where the first-stage decisions affect both the objective function and the feasible region of the second-stage problem. To solve these programs efficiently, we introduce Lagrangian-integrated L-shaped (L^2) methods, which guarantee exact solutions when the first-stage decisions are pure binary. For mixed-binary first-stage programs, we present a regularization-augmented variant of this method. We also introduce distributionally robust bi-parameterized two-stage stochastic integer programs and present an extension of the L^2 method and a reformulation-based method for programs with finite and continuous supports, respectively. Our computational results show that the L^2 method surpasses the benchmark method for bi-parameterized stochastic network interdiction problems, solving all instances in 23 seconds on average, whereas the benchmark method failed to solve any instance within 3600 seconds. Additionally, it achieves optimal solutions up to 18.4 and 1.7 times faster for instances of risk-neutral and distributionally robust bi-parameterized stochastic facility location problems, respectively. Furthermore, BTSPs have applications in solving stochastic problems with decision-dependent probability distributions or sets of distributions (ambiguity set). The L^2 method outperforms existing approaches, achieving optimal solutions 5.3 times faster for distributionally robust facility location problem with a decision-dependent and non-relatively complete ambiguity set.

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