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Probabilistically constrained linear programming

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Abstract

We consider linear programs with constraints, involving random right-hand-sides, that are required to be satisfied with certain prespecified probability. Such probabilistically constrained linear programs (PCLP) arise in applications in reliability and risk management.

There are two key challenges in solving PCLPs. First, given a candidate solution, checking feasibility is difficult as it involves evaluating the cumulative distribution function (cdf) of a random vector. Second, even if the cdf can be computed/approximated, the feasible region is non-convex leading to a strongly NP-hard problem.

We address the first challenge via sampling. We show that the problem can be approximated satisfactorily by using an empirical distribution(involving a small number of sample points) for the random parameters. The second challenge is handled by adopting a mixed-integer programming approach. We study the relaxation corresponding to a single row of the probabilistic constraint and obtain strengthened formulations. As a byproduct of this analysis, we obtain new results for the previously studied mixing set, subject to an additional knapsack inequality.

Join work with J. Luedtke and G.L. Nemhauser.