

Bounding Large Scale Optimization Problems under Uncertainty

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Many real world decision problems are dynamic and affected by uncertainty. Stochastic Programming provides a powerful approach to handle this uncertainty within a multi-period decision framework. However, as the number of stages increases, the computational complexity of these problems grows exponentially, posing significant challenges. To tackle this, approximation techniques are often used to simplify the original problem, providing useful upper and lower bounds for the objective function's optimal value.

This talk explores methods for generating bounds for a wide variety of problem structures affected by uncertainty. We begin by discussing bounds based on scenario grouping under the assumption that a sufficiently large scenario tree is given but is unsolvable, both in the context of stochastic programming and distributionally robust optimization. Next, we extend these techniques to address more complex problems, including multi-horizon stochastic optimization.

Finally, the talk introduces the integration of these bounding methods with Benders' decomposition. A Benders refinement-chain cuts method is proposed, where scenario subsets are used to generate group-wise optimality cuts. This aggregation significantly lowers the number of cuts required, while preserving valid lower bounds. Theoretical relationships between cuts generated at different refinement levels are established.

Numerical experiments on various energy and transportation optimization problems demonstrate the efficiency of the proposed approaches.

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