

Parametric Valid Inequalities in Discrete Optimization



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Parametric Valid Inequalities

- Developed parametric valid inequalities (PVI_s) based on duality and the value functions of multilevel/multistage mixed integer linear optimization problems
- Employed these inequalities in two research works

Solving Multilevel/Multistage Mixed Integer Linear Optimization

Warm-starting Mixed Integer Linear Optimization

Motivation

Many real-world applications have:

- Discrete/indivisible decisions
- Multiple objectives
- Multiple decision-makers
- Multiple time periods

But hardly any research work addresses this generic class of problems

Motivation

Many applications require re-solving an optimization problem:

- Thousands of times per minute
- Closely-related problems with minor variation in the input data

But usually, these re-solves are done independently by discarding most of the useful historical information

Application Areas

- Airline pricing and capacity allocation
- Natural gas shipping
- Road network construction
- Toll revenue maximization
- Electricity demand management
- Chemical process optimization
- Gene-deletion strategy development
- Attacker-defender type problems
- Many more...

Application Areas

- | | | |
|-----------------------|-------------------------------|-------------------------|
| Online optimization | Optimization problem classes | Algorithms |
| • Routing | • Bilevel optimization | • Decomposition |
| • Stochastic matching | • Multi-criteria optimization | • Lagrangian relaxation |
| • Resource allocation | • Stochastic optimization | |

Methodology

- Developed an abstract framework for generalizing Benders' technique for reformulation that encompasses non-traditional problem classes
- Specified an algorithmic procedure employing PVI_s
- Applied this procedure to solve mixed integer bilevel linear optimization problems
- Developed an open-source solver in C++ for this algorithm

Methodology

- Solving an optimization problem
- Gathering certain information primarily based on the theory of duality for mixed integer linear optimization
- Reusing the information via PVI_s while solving a related problem
- Implementation in SYMPHONY, an open-source solver written in C/C++