Algorithmic methods

Funding period: 01.09.2010–

Robust Combinatorial Optimization

DFG Research Training Group
Methods for Discrete Structures
www.math.tu-berlin.de/MDS

Technische Universität Berlin

Kai-Simon Goetzmann

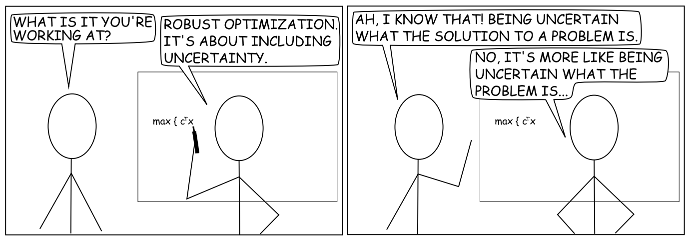
Supervisor: Rolf H. Möhring

Robust Models

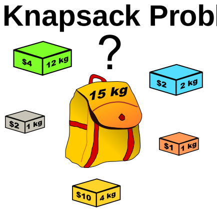
Motivation: The usual assumption in combinatorial optimization is that all data is exactly known in advance. In practice this is rarely the case. This is the reason why uncertainty in the data is included in the models, leading to *Robust Optimization*.

Our Model:

- Γ-scenarios: Given is a nominal instance of the problem, but up to Γ changes in data can occur.
- Minmax-objective: Minimize the worst-case cost, i.e. the cost in the worst possible scenario.



The Knapsack Problem



Uncertain Profits | **Uncertain Weights**

Binary Knapsack

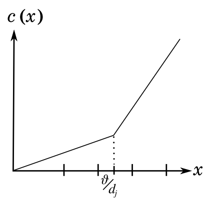
Bertsimas/Sim 2003:
Binary problems with Γ-scenarios for uncertain costs can be solved by solving $n+1$ instances of the deterministic problem.
$\Rightarrow$ **FPTAS** for Profit Robust Binary Knapsack.

Extension of the standard DP:
An additional component in the states allows to decide whether an item increases its size.
The DP is then turned into an FPTAS.
$\Rightarrow$ **FPTAS** for Weight Robust Binary Knapsack.

FPTAS for the General Robust Knapsack with uncertain weights and profits.

Unbounded Knapsack

Extension of Bertsimas/Sim 2003:
Cost robust *non-binary* problems with Γ-scenarios can be solved if the original problem with piecewise linear cost functions with a single bend can be solved.



This could be shown for the Unbounded Knapsack.
$\Rightarrow$ $(2+\epsilon)$**-approximation** for Profit Robust UKP.

Same ideas as for the binary case lead to similar results.
$\Rightarrow$ **FPTAS** for Weight Robust UKP.

$(2+\epsilon)$**-approximation** for the General Robust UKP.