1 Hardness of min-max robust optimization with discrete uncertainties

1.1 Uncertain constant

Reduce the min-max robust optimization problem with discrete uncertainties and uncertain constant to the min-max robust robust optimization problem without uncertain constant for $\mathcal{X} = \{0,1\}^n$.

1.2 NP-hardness of the robust shortest path problem

Proof that the min-max robust shortest path problem with discrete uncertainties $\mathcal{U}$ is NP-hard even if $|\mathcal{U}| = 2$.

2 Approximation for robust optimization with discrete uncertainties

Prove that for arbitrary $\mathcal{X} \subseteq \{0,1\}^n$ and discrete uncertainty set $\mathcal{U}$ the minimum cost solution x' with respect to $c'(i) = \max_{c \in \mathcal{U}} c(i)$ is a k-approximation for the optimum value of the min-max robust optimization problem.

3 Multi-objective optimization

Develop a DP algorithm to compute all efficient solutions of the knapsack problem with k profit functions that runs in pseudopolynomial time.

4 Min-Max Regret with discrete uncertainties

4.1 Hardness

Prove that the min-max regret shortest path problem is NP-hard with constant number of scenarios.

4.2 K-Approximation

Show that one of the two K-approximation algorithms for the min-max version is also a K-approximation for the min-max regret version and the other one does not work.

4.3 Min-Max Regret Global Min-Cut

Prove that the same algorithm as for the min-max global min-cut problem also works for the min-max regret global min-cut problem with constantly many scenarios.

5 Thinking Assignment

You now know two models for robust optimization: MIN-MAX and MIN-MAX-REGRET. Try to come up with alternative creative robust optimization models! Think about how to circumvent some of the known downsides of the two models we know. Again, this is no literature search exercise: Be creative!