

Exercise - L-shaped method

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Decomposition for the wind power producer problem

Take the wind power producer example from Lecture 03 (Multi-stage stochastic programming). Assume we only trade in the day-ahead market and balancing market, i.e., we result in a two-stage stochastic program (page 9, lecture 03).

Sets	
\mathcal{S}	Set of scenarios $s \in \mathcal{S}$
Parameters	
λ^D	Electricity price on the day-ahead market
λ^+	Selling electricity price on the balancing market
λ^-	Purchasing electricity price on the day-ahead market
\bar{P}	Capacity of the wind farm
W_s	Wind power production in scenario $s \in \mathcal{S}$
π_s	Probability scenario $s \in \mathcal{S}$
Variables	
p^D	Power sold on the day-ahead market [MWh]
p^+	Excess production sold on the balancing market [MWh]
p^-	Missing production bought on the balancing market [MWh]

$$\text{Max } \lambda^D p^D + \sum_{s \in \mathcal{S}} \pi_s (\lambda^+ p_s^+ - \lambda^- p_s^-) \quad (1a)$$

$$\text{s.t. } p^D \leq \bar{P} \quad (1b)$$

$$W_s - p^D = p_s^+ - p_s^- \quad \forall s \in \mathcal{S} \quad (1c)$$

$$p^D \in \mathbb{R}^+ \quad (1d)$$

$$p_s^+, p_s^- \in \mathbb{R}^+ \quad \forall s \in \mathcal{S} \quad (1e)$$

The objective function (1a) maximizes the profit based on the transactions on the day-ahead and balancing market. Constraint (1b) restricts the amount offered in the day-ahead market to the capacity of the wind farm. Constraint (1c) determines the imbalances compared to the day-ahead market offer based on the realization of the scenario. In constraints (1d) and (1e) the non-negativity of the variables is ensured.

Tasks

1. Decompose the problem in master problem and subproblems.
2. Based on the general formulation of the model, derive the formula for the optimality cut for the L-shaped method (single-cut version). This means: define how the coefficients E_i and e_i ($i \in \mathcal{I}$ being the set of cuts) are calculated based on the parameters and variables in the master and subproblems and write down the inequality for the cut based on E_i and e_i .
3. Do we need infeasibility cuts for this model? Justify your answer.