Smart Energy Systems
Winter 2020-2021

Optimization Project Group
Milestone 3

supervised by Ogün Yurdakul

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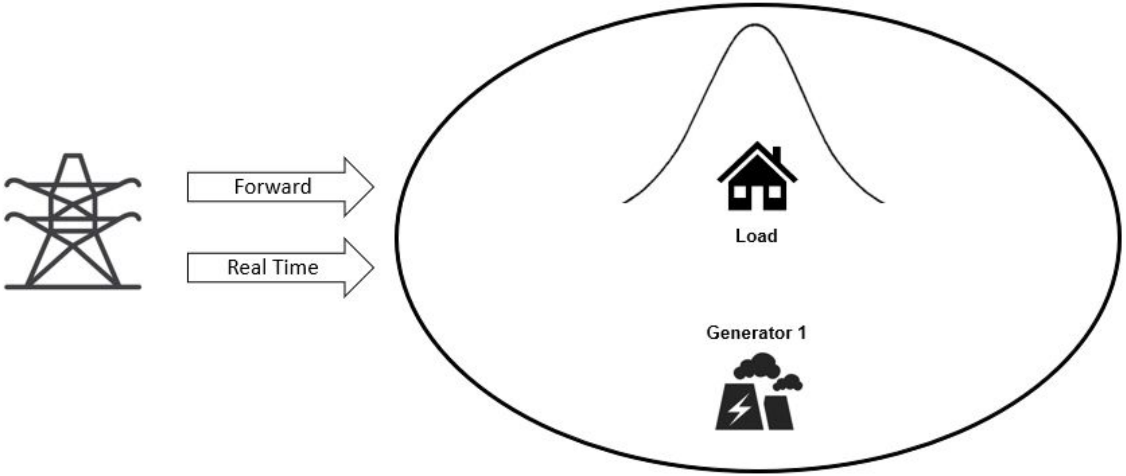
Structure

1. Recap: Stochastic Unit Commitment
2. Implementation
3. New Constraints
4. Results & Interpretation

Recap: Stochastic Unit Commitment

- Optimization of dispatch schedule of all power generation units to match the electricity demand and to minimize total cost

New:
- Minimum up- and downtime constraints
- Ramping constraints
- Energy storage resource



Recap: Stochastic Unit Commitment

Problem

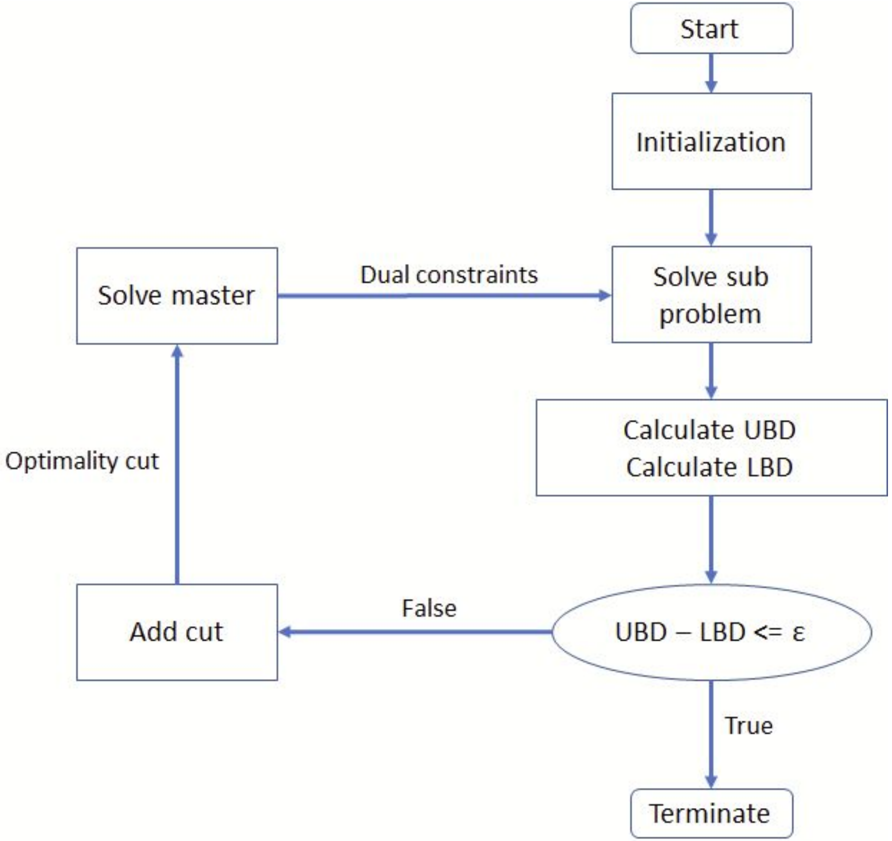
- Two staged problem:
- First-stage decision:
  - commitment status of generator
  - electricity through forward contract
- Second-stage decision:
  - power dispatch of generator
  - electricity through real time contract
- Uncertainty of load values

Solution approach

- L-shaped method decomposes the two stages into a master and sub problem
- Master and sub problem are solved iteratively and feed back into each other
  → restricts the solution space until optimal solution is found
- Monte Carlo simulation to account for the uncertainty of loads

New: differing Monte Carlo sample sizes

Implementation



Constraints | Case 2

Minimum Up- and Downtime

$$u^{i}_{\gamma_g}[h] - u^{i}_{\gamma_g}[h-1] \leq u^{i}_{\gamma_g}[\nu],\ \forall \nu \in \mathbb{N} \text{ such that}$$
$$h \leq \nu \leq \min\{h-1+T^{\uparrow}_{\gamma_g}, H\},$$

$$u^{i}_{\gamma_g}[h-1] - u^{i}_{\gamma_g}[h] \leq 1 - u^{i}_{\gamma_g}[\nu],\ \forall \nu \in \mathbb{N} \text{ such that}$$
$$h \leq \nu \leq \min\{h-1+T^{\downarrow}_{\gamma_g}, H\},$$

Assumptions:

$$T^{\uparrow}_{\gamma g} = 3$$
$$T^{\downarrow}_{\gamma g} = 4$$
$$u^{i}_{\gamma g}[0] = 0$$

Ramping

$$-5 \leq p^{i}_{\gamma g}[h] - p^{i}_{\gamma g}[h-1] \leq 5$$

Assumption: $p^{i}_{\gamma g}[0] = 0$

Constraints | Case 3

Energy storage

$$E_{\sigma s}[h] = E_{\sigma s}[h-1] - net_i[h]$$

$$0 \leq E_{\sigma s} \leq 5$$

$$-10 \leq net_i[h] \leq 10$$

Assumptions:

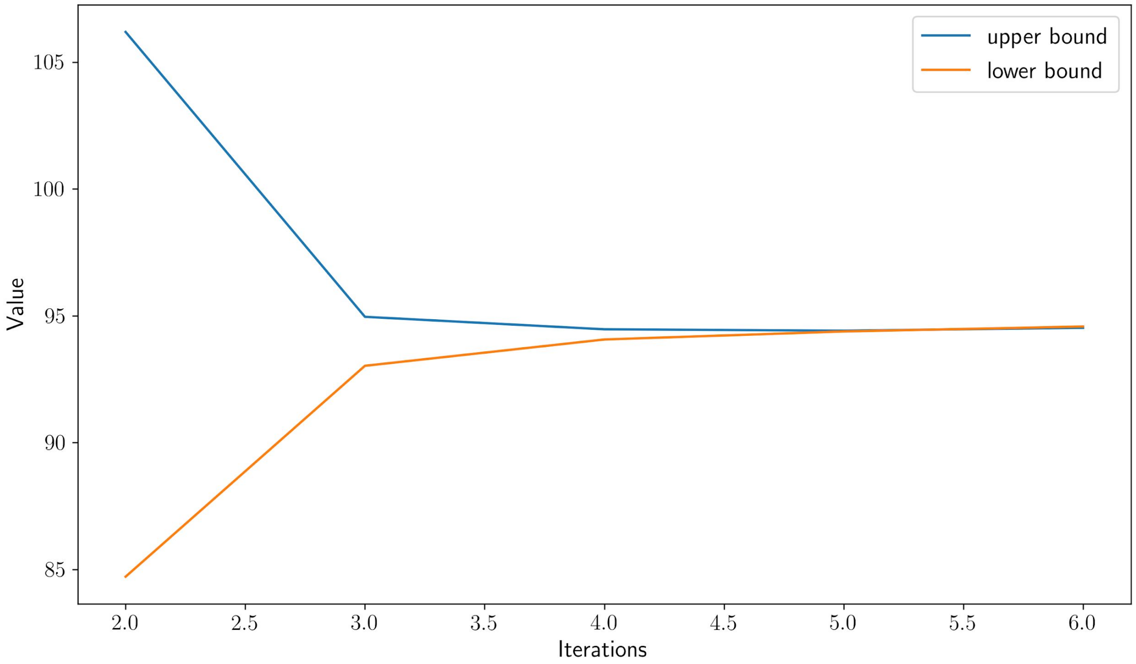
$$E_{\sigma s}[0] = 0$$

$net_i[h] < 0:$ Charge storage

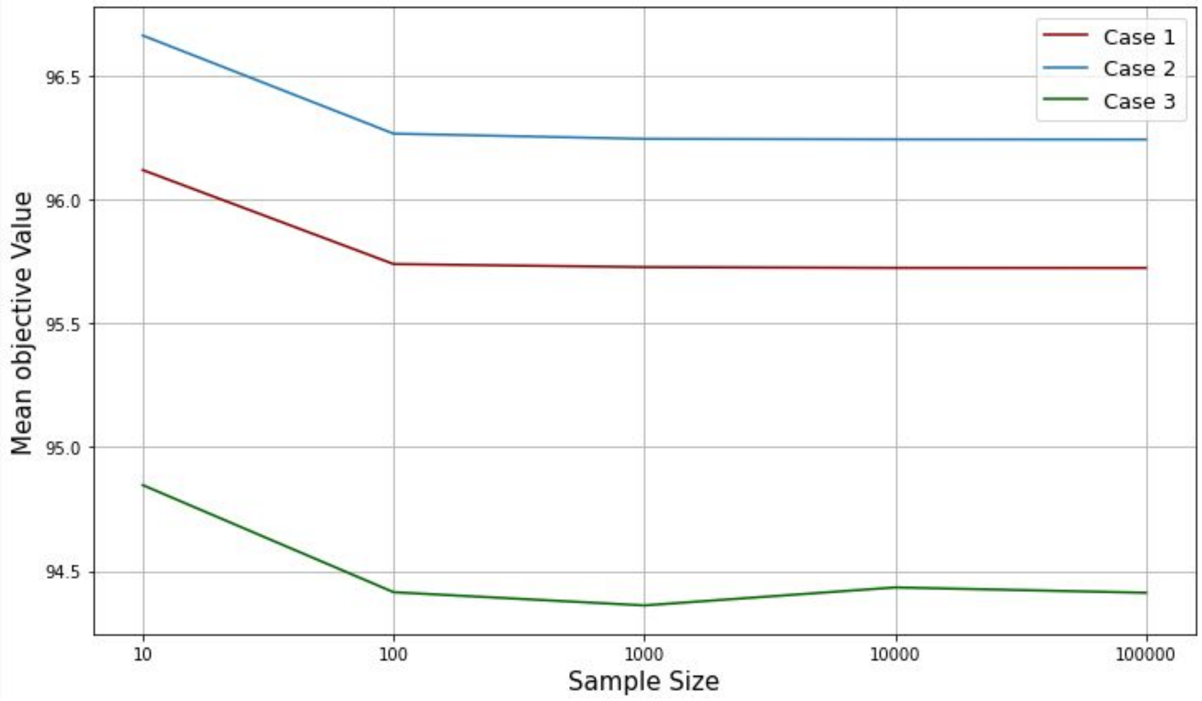
$net_i[h] > 0:$ Discharge storage

Results | Bound evolution

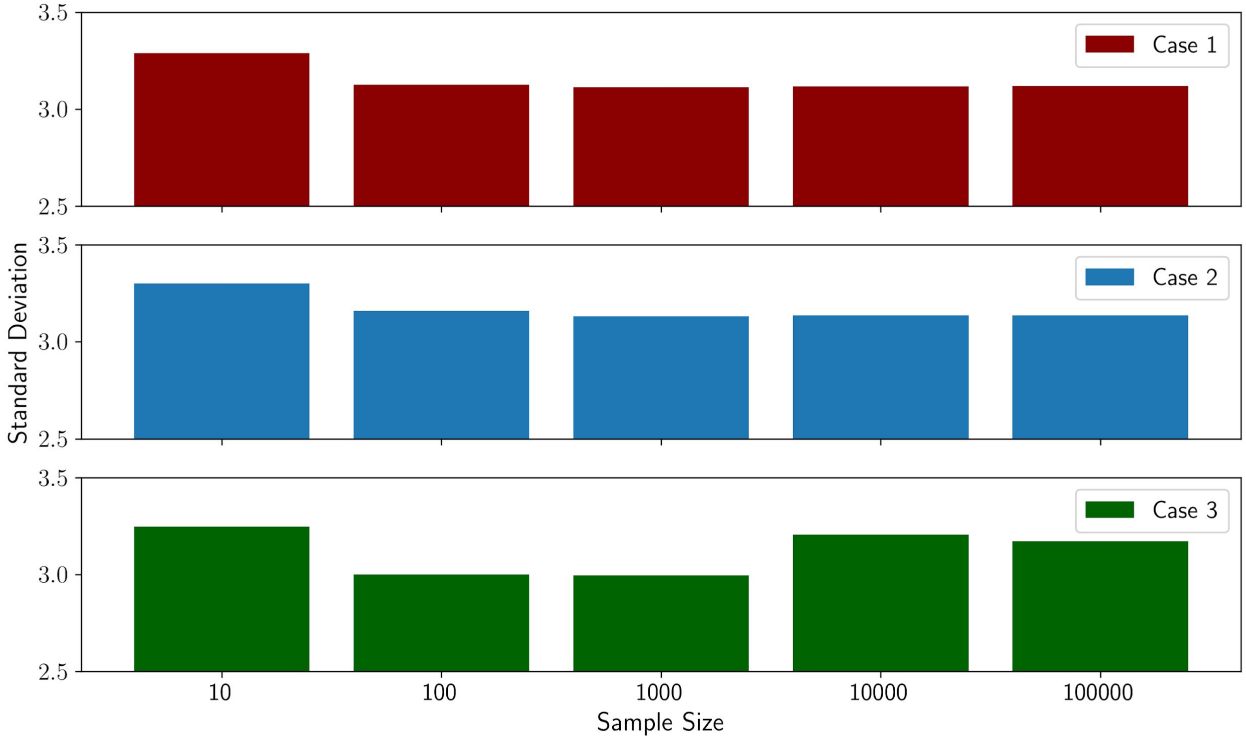
Sample size: 10.000 | Case 1



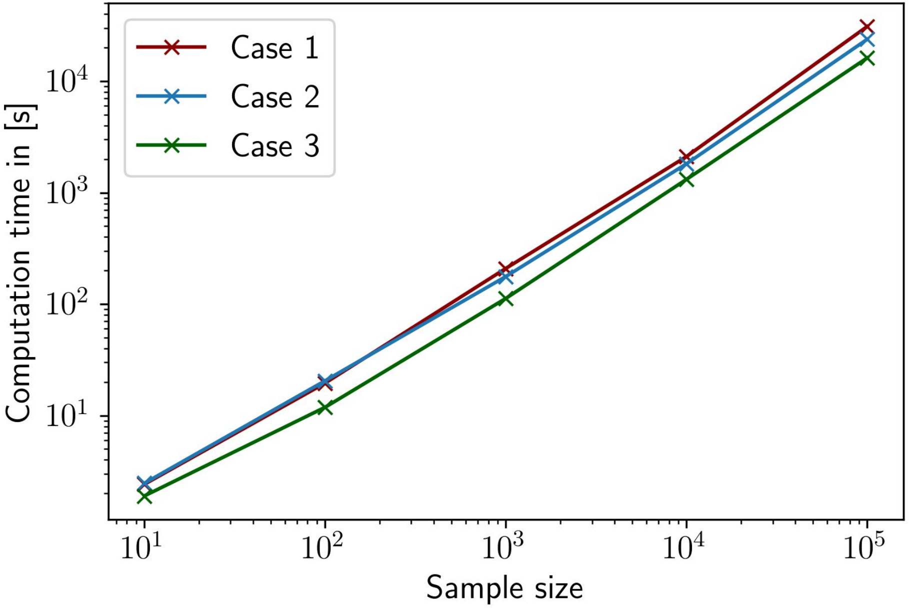
Results | Objective values



Results | Standard Deviation



Results | Computation Times

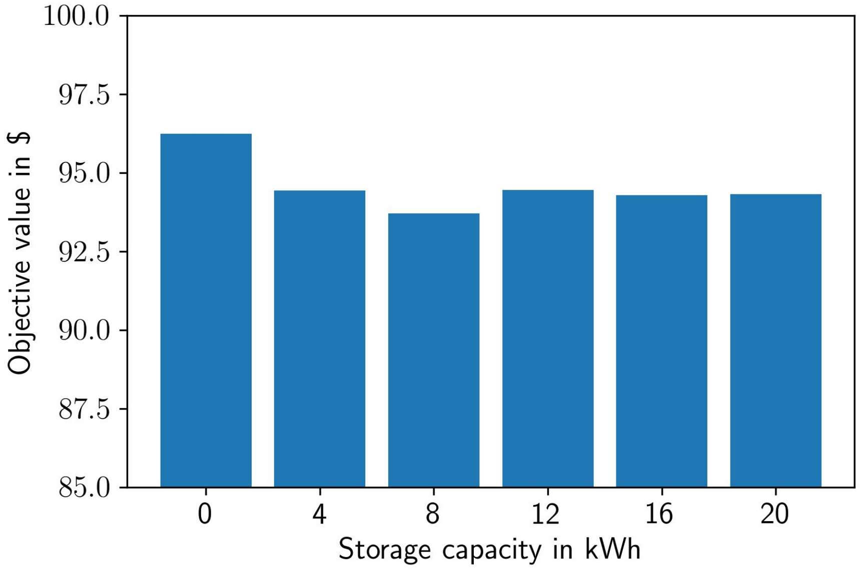


Measures to improve runtime

- Remove unnecessary constraints
  - ↓ 5 %
- Execution via terminal
  - ↓ 20 %
- Enable multiprocessing
  - ↓ 75 %

Results | Sensitivity Analysis

Sample size: 10.000



Key Facts

- Best storage capacity: 8 kWh
- Decreasing until 8 kWh
- Nearly static from 12 kWh
- Explanation outlier:
    - No costs for battery

Thanks for your attention

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