Planning energy investment under uncertainty

Primal and dual views

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Two-stage stochastic convex programming problem:

$$\begin{aligned} \min_{x,y} \quad & \mathbb{E}_\xi[f_\xi(x,y)] \\ \text{s.t.} \quad & (x(\xi), y(\xi)) \in C(\xi), \text{ a.e. } \xi \\ & (x,y) \in \mathcal{N} \rightarrow \text{ nonanticipative space} \end{aligned}$$

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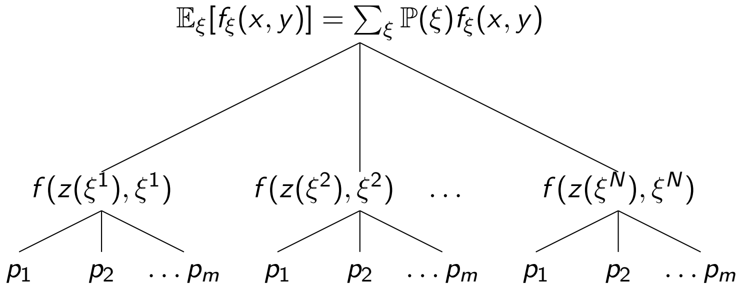
Objective: decompose the problem using its structure.

- Decomposition for different scenarios.
- Decomposition for different technologies.

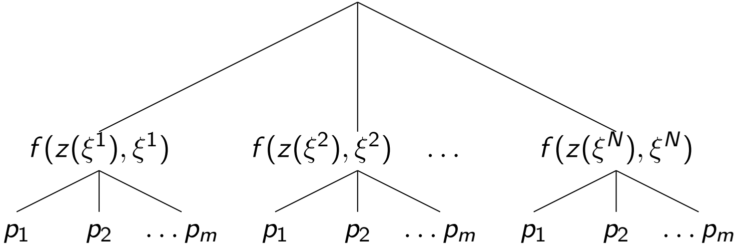
Dual-primal approach [ACS19]



- Progressive Hedging $\rightarrow$ separate the problem for different scenarios. ([Roc18]).
  - Scenario subproblems with coupling constraints.

Dual-primal approach [ACS19]

$$\mathbb{E}_\xi[f_\xi(x,y)] = \sum_\xi \mathbb{P}(\xi) f_\xi(x,y)$$



- Progressive Hedging $\rightarrow$ separate the problem for different scenarios. ([Roc18]).
  - Scenario subproblems with coupling constraints.
- Solve the dual scenario subproblems (separable for different plants) with a proximal bundle method ([Ber+17])

Inexact Proximal Bundle Progressive Hedging (work in progress)

Primal-dual approach: Inexact Progressive Hedging *à la bundle*.

- Relax the nonanticipativity constraints $\rightarrow$ Progressive Hedging approach.

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- Solving the dual problem with a proximal bundle method is equivalent to minimize an Augmented Lagrangian in primal variables:

$$w^+ \in \arg\min_{w \in \mathcal{N}^\perp} \left\{ \check{\phi}(w) - \frac{1}{2t}\|w - \hat{w}\|^2 \right\} \iff \begin{cases} \hat{\alpha} \in \arg\min_{\alpha} L_\xi(\alpha, \hat{w}(\xi)) \\ \hat{g}(\xi) = \hat{x}(\xi) - \mathbb{E}[\hat{x}] \\ w^+(\xi) = \hat{w}(\xi) - t\hat{g}(\xi) \end{cases}$$

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- We can introduce a stopping test measuring the estimates of primal feasibility and duality gap.
  - Price to pay: dual serious step sequence → subsequential convergence to solutions.

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- Call the (inexact) oracle at w^+, and check sufficient decrease of the dual function ([OSL14]).

References

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