Numerical methods for solving mid-term hydropower optimization

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POLYTECHNIQUE MONTRÉAL

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Context

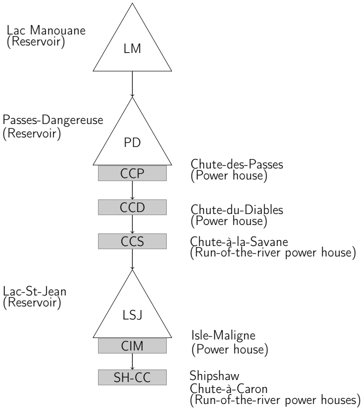

Figure – Hydroelectic system.

Caracteristics :

- 3 major reservoirs
- 6 power houses
- Capacity 3,125 MW

Objective : Maximize hydropower production subject to the system constraints.

⇒ Sampling stochastic dynamic programming (SSDP)

Formulation

$$\underset{u_t, s_{t+1}}{\text{maximize}} \quad \underset{q_t|v_t}{E}\left[\sum_{i=1}^{N} B(s_{i,t}, u_{i,t}, q_{i,t}) + f_{t+1}(s_{t+1}, h_{t+1})\right]$$

subject to

Mass balance in reservoir

$$s_{1,t+1} = s_{1,t} + q_{i,t} - u_{1,t} \qquad \forall t \in T$$

$$s_{i,t+1} = s_{i,t} + q_{i,t} - u_{i,t} + u_{i-1,t} \qquad \forall i \in N, \quad \forall t \in T$$

Hydroelectric production

$$p_{i,t} = Prod_i(s_{i,t}, u_{i,t}) \qquad \forall i \in N, \quad \forall t \in T$$

$$p_{\min} \leq \sum_{i=1}^{N} p_{i,t} \qquad \forall t \in T$$

Reservoir storage levels and water release

$$s_{i,t}^{\min} \leq s_{i,t} \leq s_{i,t}^{\max} \qquad \forall i \in N \quad \forall t \in T$$

$$0 \leq u_{i,t} \qquad \forall i \in N \quad \forall t \in T$$

How to determine the future value function $f_{t+1}()$?

$f_{t+1}()$ is an unknown continuous and nonlinear function that represents the expected future value.

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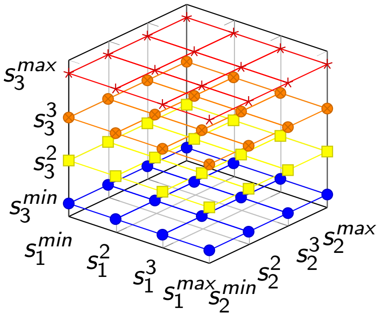
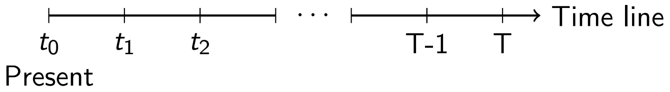
Discretization of the major reservoirs storages s_t.



Dynamic programming process



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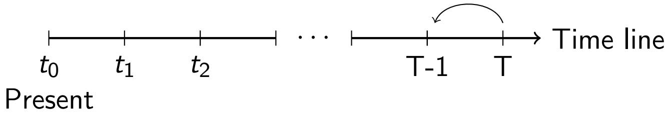
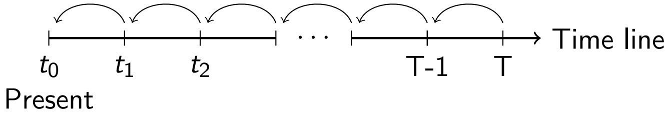


Dynamic programming process



Dynamic programming process