Estimating electricity network reliability using a splitting method

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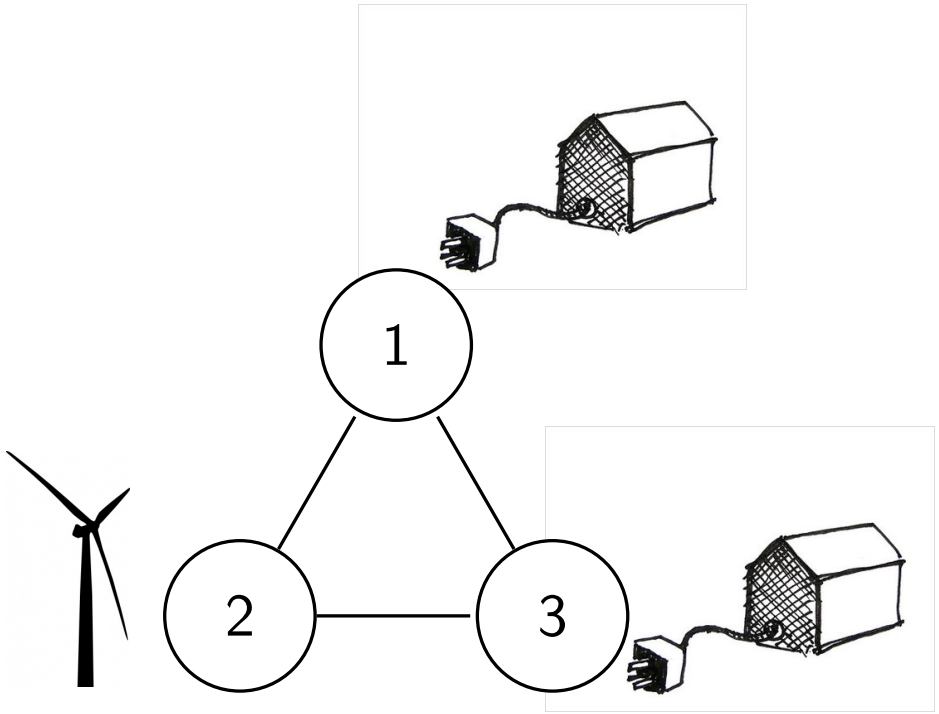
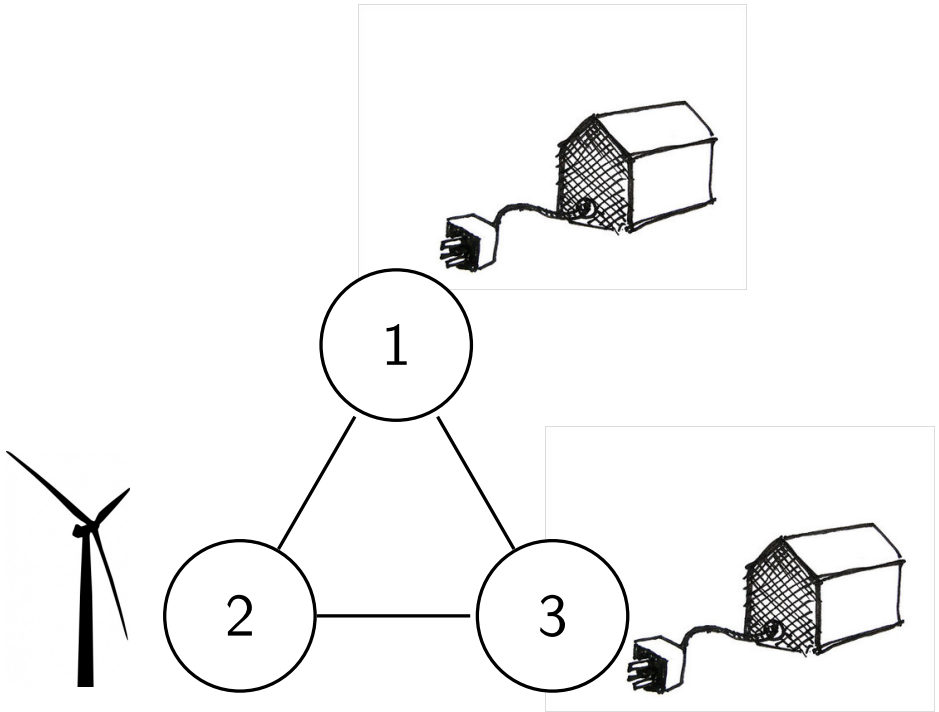
Grid = electrical power network



Grid = electrical power network



$$V_{\min} < |V(t)| < V_{\max}, \qquad \text{at all } N \text{ nodes for all } t$$
$$|I(t)| < I_{\max}, \qquad \text{at all connections for all } t$$

Grid reliability indices

- Probability
- Expected duration
- Expected number
- Expected severity

of constraint violations during a week/month/...

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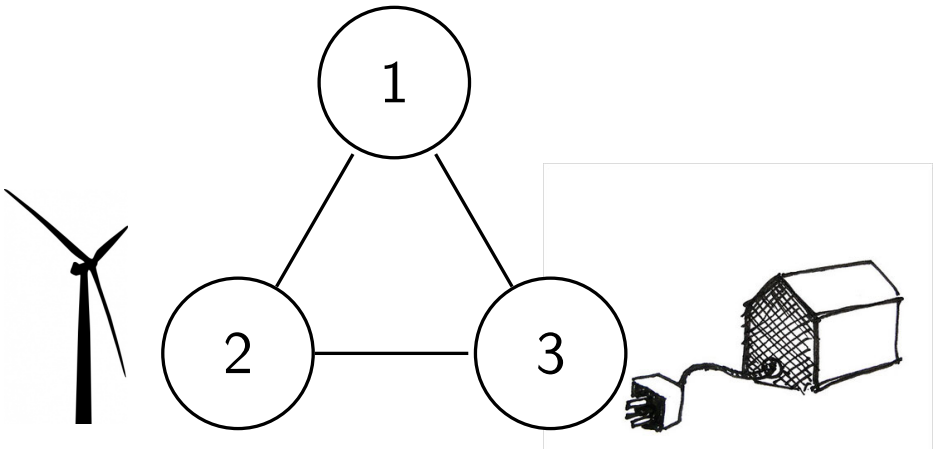
Aim Find these indices!

Estimate $\mathbb{P}$(violation)

1. Simulate stochastic process
2. Derive all voltages/currents
3. Check constraints



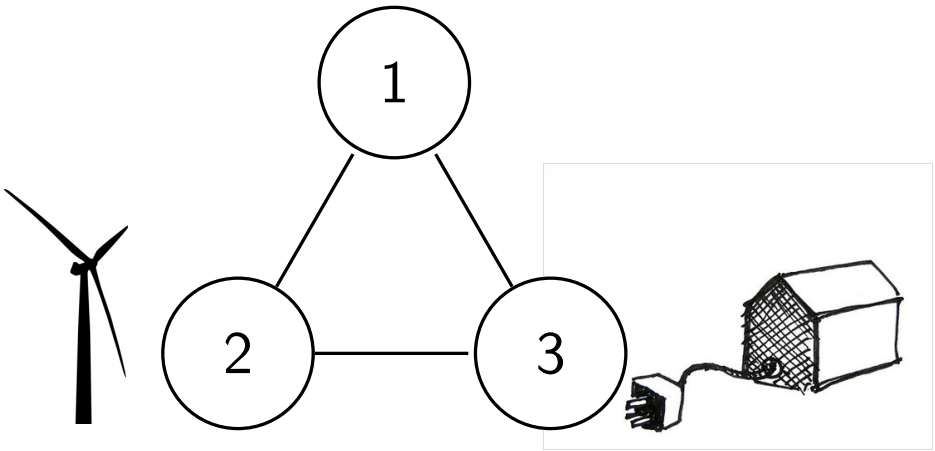
Estimate $\mathbb{P}$(violation)

for all MC samples

1. Simulate stochastic process
2. Derive all voltages/currents
3. Check constraints

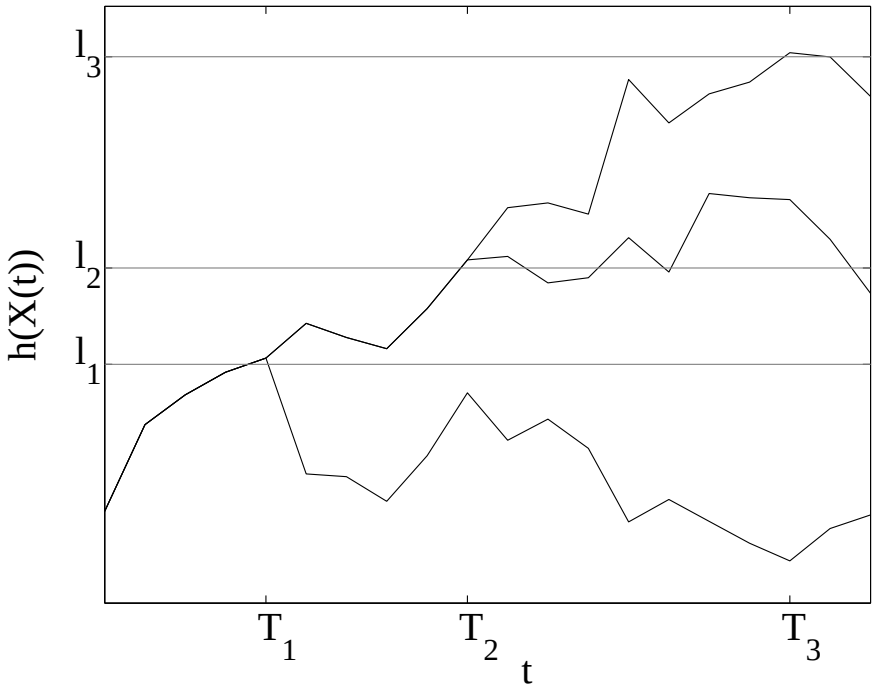
end

$$\text{Estimate} = \frac{\#\text{violations}}{\#\text{MC samples}}$$

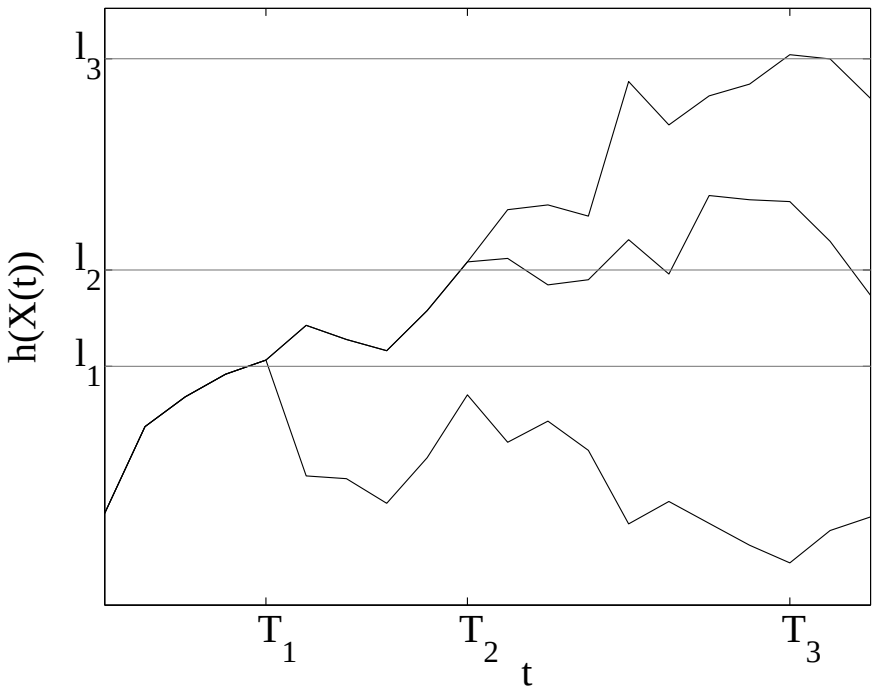


Splitting technique

Splitting technique



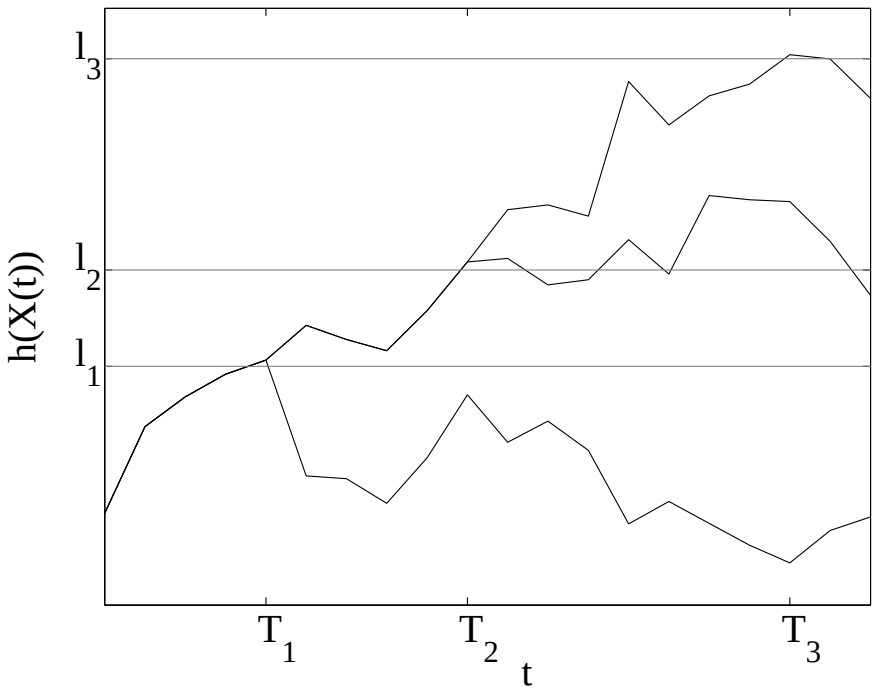
Splitting technique



Estimate $\mathbb{P}(\text{violation})$ by

$$\prod_k R_k/N_{k-1} \quad = \quad \frac{1}{1}\frac{1}{2}\frac{1}{2} = \frac{1}{4}.$$

Splitting technique



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Workload experiment

Crude MC $\sim 79 \times$ Splitting