Estimating electricity network reliability using a splitting method

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Scientific Meeting

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Grid = electrical power network
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\[ V_{\text{min}} < |V(t)| < V_{\text{max}}, \quad \text{at all } N \text{ nodes for all } t \]
\[ |I(t)| < I_{\text{max}}, \quad \text{at all connections for all } t \]
Grid reliability indices

- Probability
- Expected duration
- Expected number
- Expected severity

of constraint violations during a week/month/...
Grid reliability indices

- **Probability**
- Expected duration
- Expected number
- Expected severity

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

**Aim** Find these indices!
Motivation

Crude Monte Carlo

Splitting technique

Estimate $P(\text{violation})$

1. Simulate stochastic process
2. Derive all voltages/currents
3. Check constraints
Estimate $\mathbb{P}(\text{violation})$

for all MC samples

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

end

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

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\[ l_1, l_2, l_3 \]

\[ T_1, T_2, T_3 \]

\[ t \]

\[ h(X(t)) \]

Estimate \( P(violation) \) by

\[ \prod_{k} R_{k} / N_{k - 1} = 1 \]

Workload experiment

Crude MC \( \sim 79 \times \) Splitting

W. Wadman

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Splitting technique

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

$$\prod_{k} \frac{R_k}{N_{k-1}} = \frac{111}{122} = \frac{1}{4}.$$
Splitting technique

Motivation

Crude Monte Carlo Splitting technique

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

$$\prod_{k} R_k/N_{k-1} = \frac{111}{122} = \frac{1}{4}.$$ 

Workload experiment

Crude MC $\sim 79 \times$ Splitting