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# OPTIMISATION OF MULTI-YEAR PLANNING STRATEGIES TO BETTER INTEGRATE RENEWABLE ENERGIES AND NEW ELECTRICITY USAGES ON THE DISTRIBUTION GRID

## 1. CONTEXT

- Future of electricity distribution: new usages in the distribution grid, e.g., electric vehicles, distributed energy generation, local storage units...
- How to adapt the grid to these new usages at lowest cost?

## 2. DECISION TOOL

- PARADIS (EDF R&D and CentraleSupélec/L2S, [DUT15]) is a tool to simulate planning strategies for different scenarios

- **Scenario generator**: creates realistic random scenarios of RE’s arrivals and the consumption and production profiles
- **Strategy planning**: defines the decision tree used by the Distribution System Operator (DSO)
- **Simulator**: simulates the evolution of the grid
- **Balance**: computes the final costs of the planning strategy

For a prescribed planning strategy:

- In PARADIS, planning strategies are defined using parameters (up to about 10 parameters)

## 3. PLANNING STRATEGIES

### Main characteristics of the problem

- Expensive simulations (e.g., 5 minutes for one simulation)
- Continuous parameters
- Stochastic simulator (scenario-based)
- Conflicting objectives
- Impact of extreme values

### Different formulations of the problem

- Mono-objective optimisation: \( \min q_\alpha(x) \), with \( q_\alpha(x) \) an \( \alpha \)-quantile (or superquantile) of the cost \( Z(x) \)
- Multi-objective and/or constrained optimisation with more than one cost function \( Z_i(x), Z_j(x), \ldots \)
- Robust optimisation: e.g., \( \min_{x, \varepsilon} q_\alpha(x + \varepsilon) \), with \( \varepsilon \) a random perturbation of the parameters
- Quasi-optimal regions:
  \[ \Gamma = \{ x \in \mathbb{X} : q_\alpha(x) \leq q^* + \Delta ; q^* = \min_{\varepsilon} q_\alpha(x + \varepsilon) \} \]
  with \( \Delta \) a constant that defines the accepted level of quasi-optimality, or
  \[ \Gamma = \{ x \in \mathbb{X} : q_\alpha(x) \leq q^* ; q^* = \inf_{x \in \mathbb{R}, \varepsilon} \{ x \in \mathbb{X} : q_\alpha(x + \varepsilon) \leq x \geq \varepsilon / \} \}

## 4. RESEARCH IDEAS

### Bayesian Optimization

- And other ideas:
  - Scenario min-max optimisation [CAR15]
  - Quantile estimation [LAB16]
  - Reliability-based design optimisation [DUB11]
  - Bayesian algorithms for best arm identification [RUS16]
  - Informational approach to global optimisation [VILO9]

### SOME REFERENCES


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*Images and diagrams are not included in the text representation.*