

Community Clustering Preventing Failure Cascades

A Model and Algorithms to Design Resilient Smart Grid Coalitions

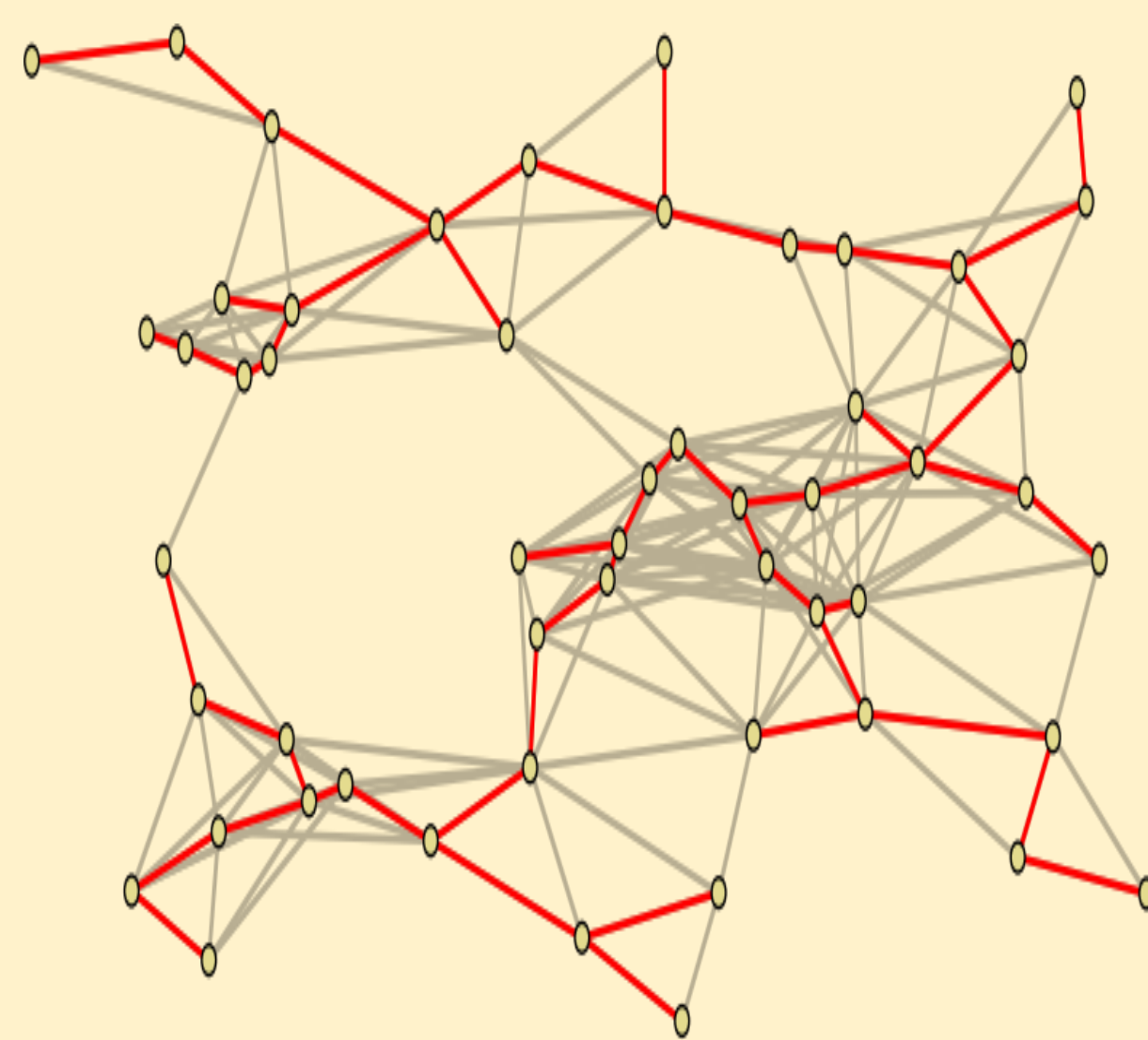
Cascading errors and blackouts can rapidly propagate through the power grid. The capability to instantly turn parts of the grid into stable, self-sufficient islands can **stop error cascades by cutting propagation paths**.

We propose a model for clustering the distribution grid into coalitions with respect to topological features of the power grid and expected load profiles and generation schedules of the participating nodes, thus introducing a **dedicated topology and routing layer**, to increase overall system resilience.

Basic Design Parameters

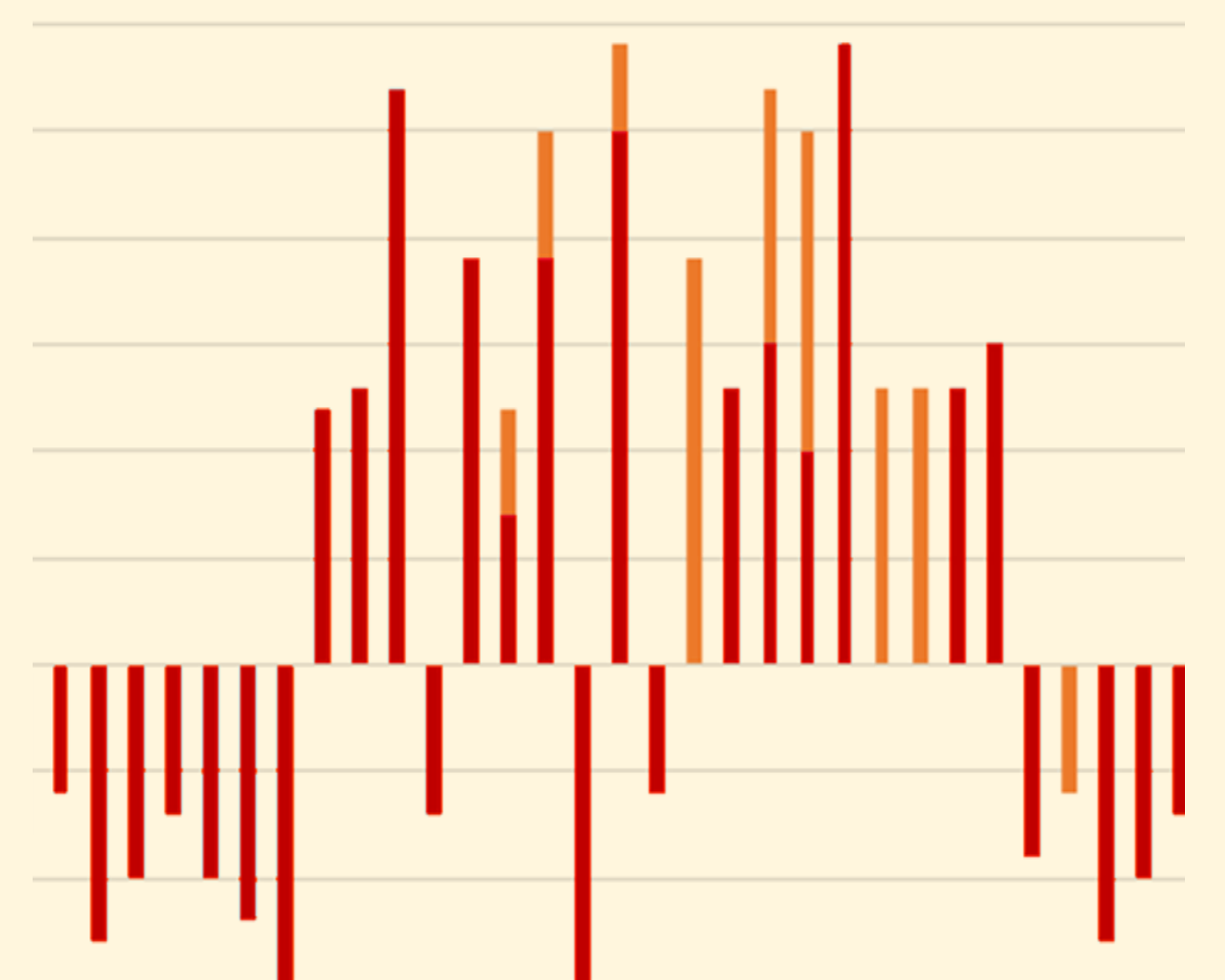
Proximity

The investigated distribution grid is clustered according to node proximity and the position of breakers and transformers to enable islanding.



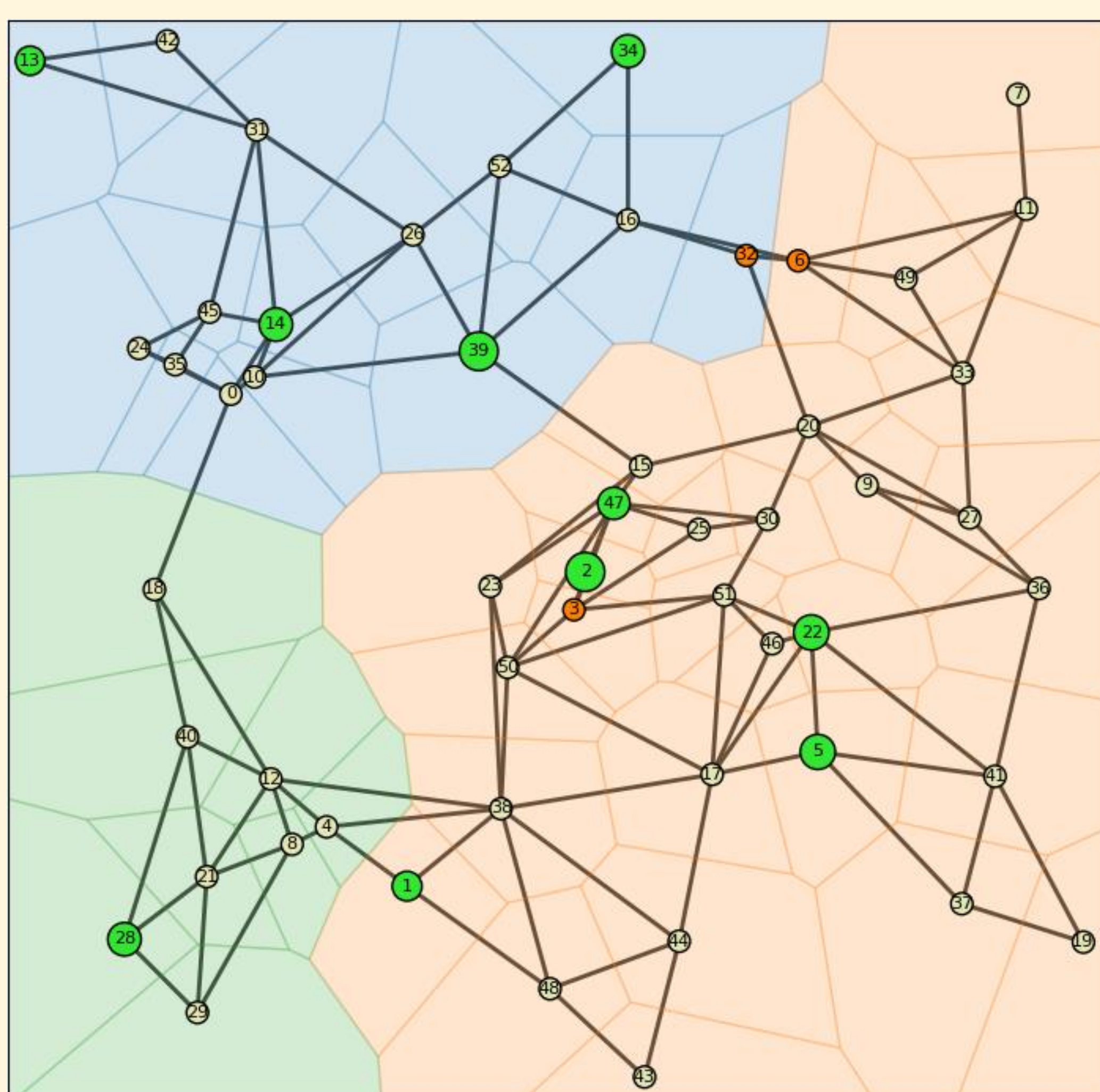
Balance

Each cluster is as balanced as possible regarding power generation and consumption and expected load and generation profiles.



Research Questions

1. Which actors and structural components are most relevant? What is the recommended abstraction level to model islanding capability and coalitions?
2. Which clustering strategy is most suitable? Can decentralized algorithms increase scalability?
3. What parameters and objective functions result in coalitions that are optimal for which scenarios?



Model: Weightable Node Properties

- Node Type
- Flexibility Profile
- Optimal Load
- Price Vector
- Priority
- Topological Position
- Reliability
- Blackstart Capability
- Voltage Level
- Controllability

Algorithm Outline

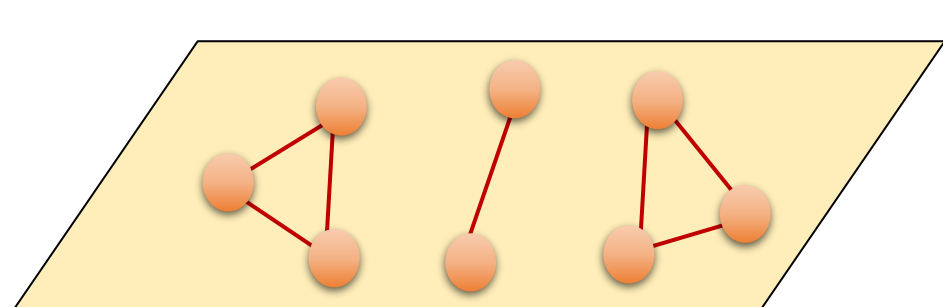
Part 1 – How to create clustering: Minimize weight of coalitions

- Balance load profiles
- Identify islandable grid sections

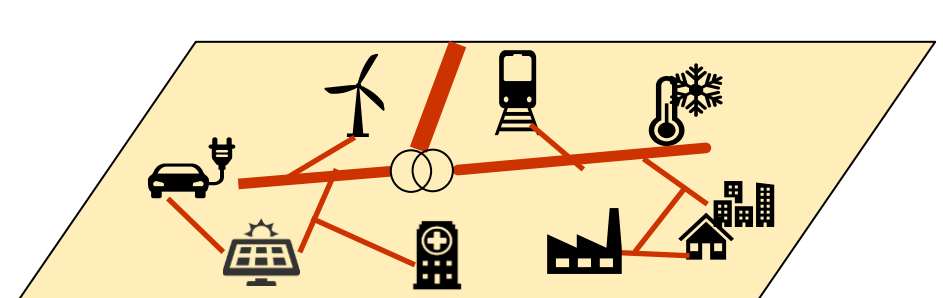
Part 2 – How to stop propagation of cascading failures

- Open breakers at coalition boundary
- Re-negotiate consumption schedules and generation schedules

Future Research



Hierarchical Encapsulation: High-level coalitions contain underlying clusters, allowing to separate unaffected coalitions more efficiently.



Real-World Grids: Current distribution grids are not as connected yet. To apply the proposed scheme, existing datasets have to be extended by e.g. medium voltage DC lines.