Failure Cascade Prediction in Large-Scale Power Systems

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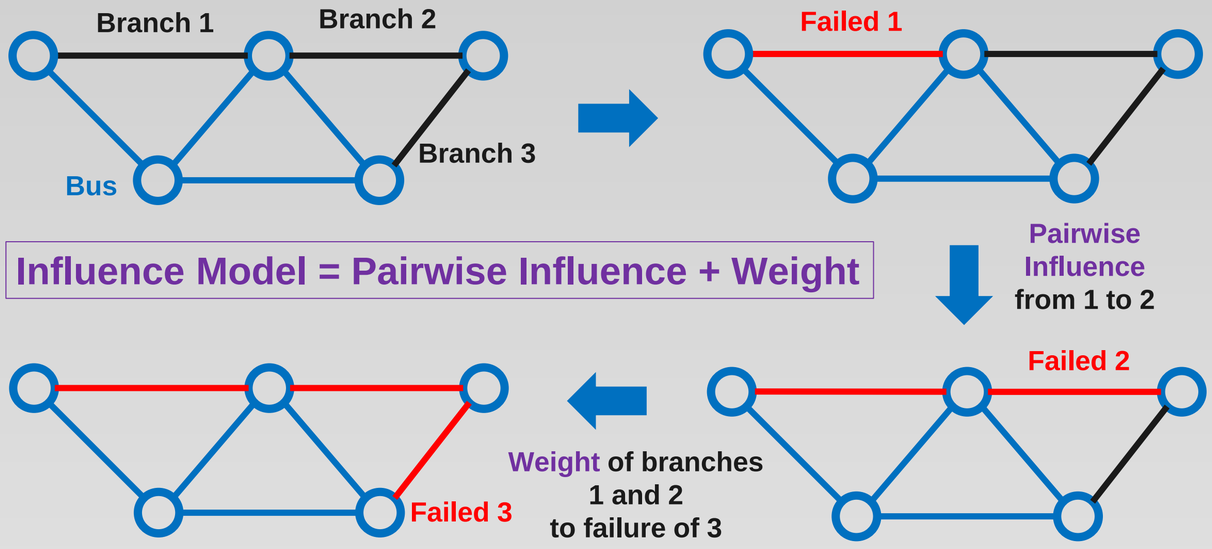
Power Blackout Stems from Failure Cascade

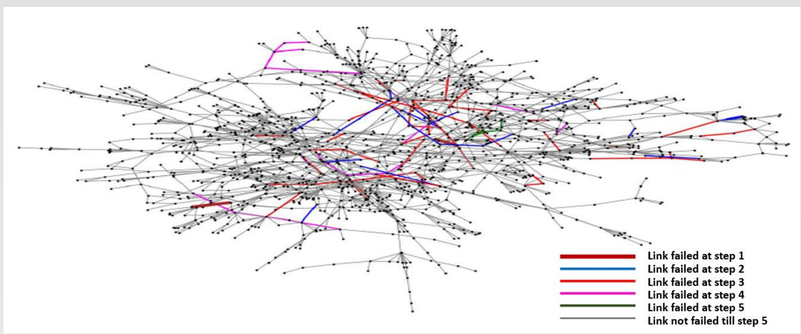
Influence Model Characterizes Failure Cascade



Demonstration of Influence Model on Real Power Grid

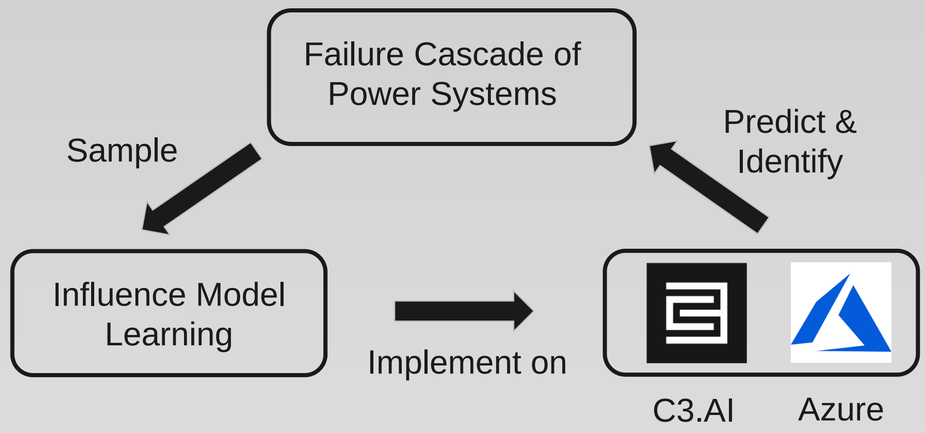
- data obtained

Example: IEEE1354



Goals:

- **Failure Cascade Predictor:** predicts failure cascade sequence accurately and efficiently given initial failure
- **Critical Component Identifier:** yields the top 10 to 20 components whose failure induces severe blackouts



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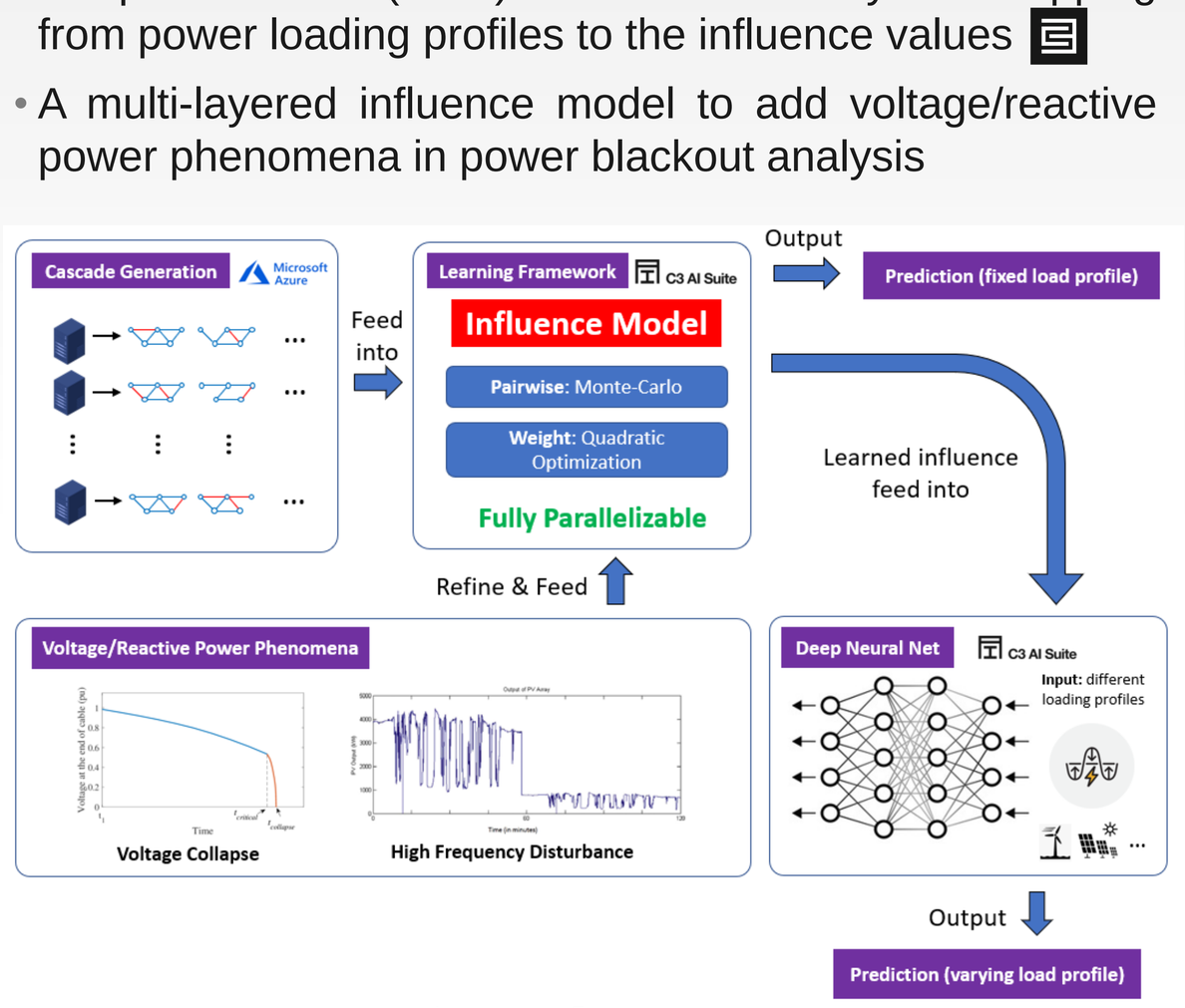
Technical Approach:

- Parallel cascade sample generation in the cloud
- Influence model learning framework for failure cascade prediction and critical component identification
- Deep neural net (DNN) module to identify the mapping from power loading profiles to the influence values
- A multi-layered influence model to add voltage/reactive power phenomena in power blackout analysis

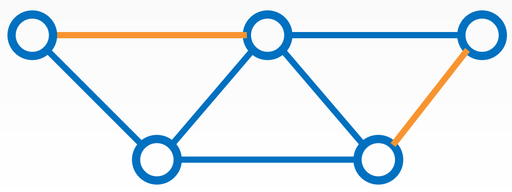


Expected Outcomes:

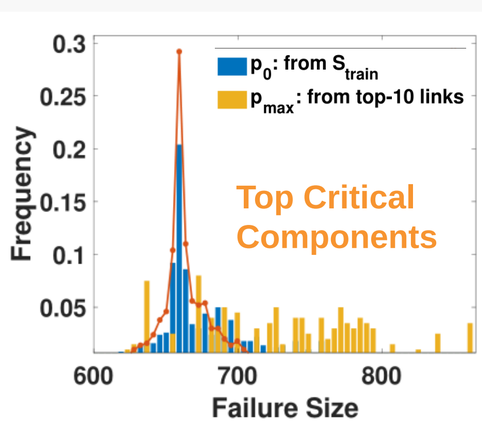
- **Failure Cascade Predictor**

Metric	Result
Failure Size	Error < 3% (100 failures, predicted size [97,103])
Final State	Error < 9% (100 components, >90 correct)
Failure Time	Error within 1 min for a 10-min failure cascade
Time Cost	1000 cascades for IEEE2383 AC in MATLAB. Simulation: 8 hours; Our method: 33s **(1/872)**

- **Critical Component Identifier**



Pick **Critical Components** by Influence Model



- **Ongoing Works**
  - DNN-based Influence Value Estimator Under Load Variation
  - Incorporation of Voltage/Reactive Power Phenomena in the Influence Model

X. Wu, D. Wu and E. Modiano, "Predicting Failure Cascades in Large Scale Power Systems via the Influence Model Framework," in *IEEE Transactions on Power Systems*, vol. 36, no. 5, pp. 4778-4790, Sept. 2021, doi: 10.1109/TPWRS.2021.3068409.

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