Learning to Observe the Grid

Machine Learning for Distribution System State Estimation Under Limited and Uncertain Data

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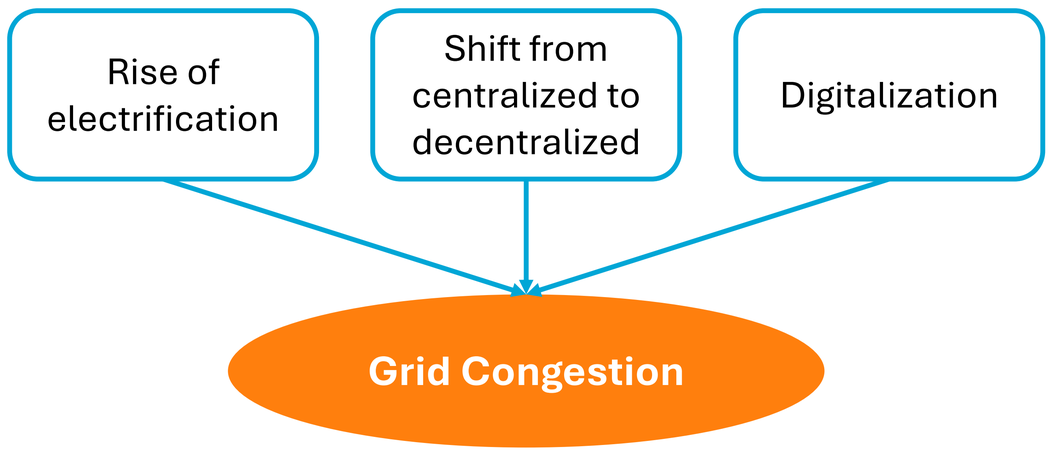
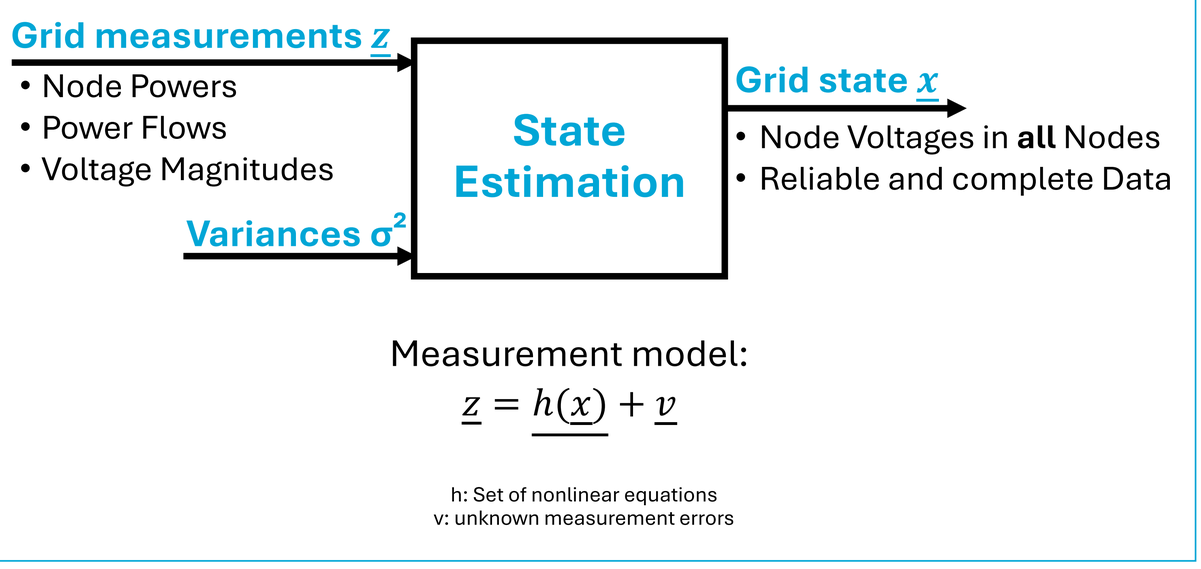
The Distribution System



Challenges

- Uncertain Measurements
- Limited Sensor Coverage
- High Variability

→ Traditional DSSE Methods fail



Measurement model:

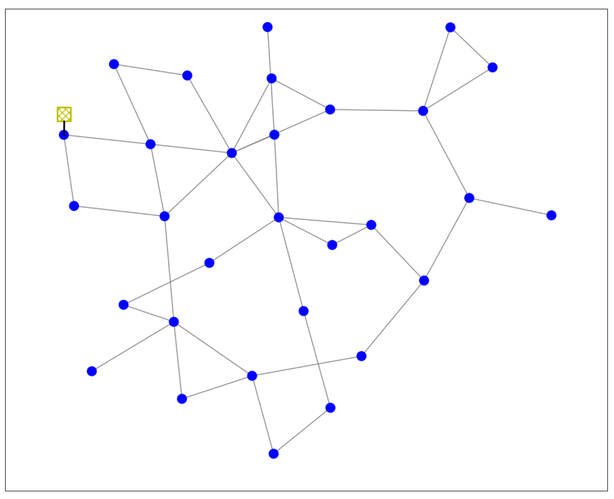
$$\underline{z} = \underline{h(x)} + \underline{v}$$

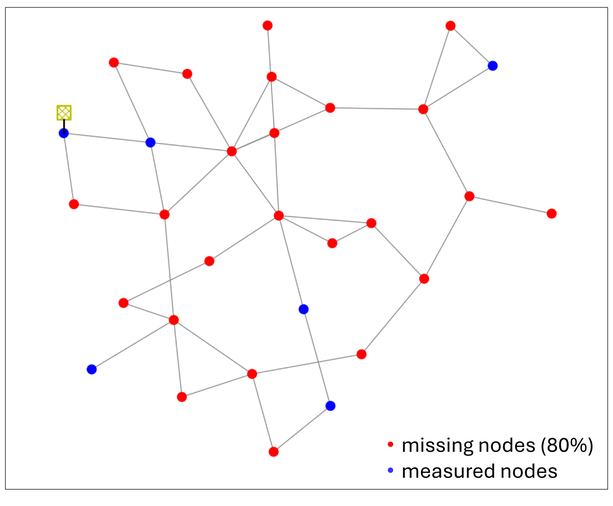
h: Set of nonlinear equations
v: unknown measurement errors

Open Questions

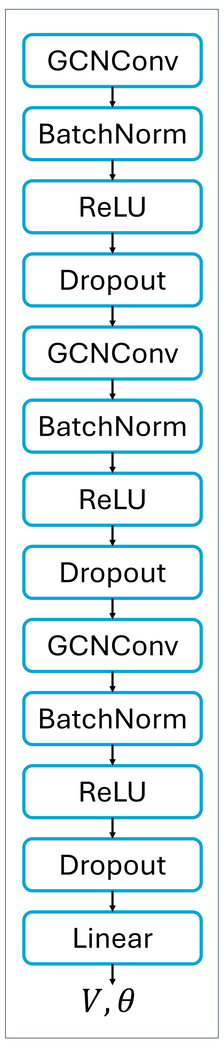
- How can **uncertainty** in state estimation be defined and quantified in operational terms?
- How should **synthetic data** (pseudo-measurements) be handled to avoid false confidence?
- What level of **accuracy** is acceptable for use **in real-time** grid planning and control?
- What is needed to support **long-term** resilience planning and investment decisions based on DSSE?

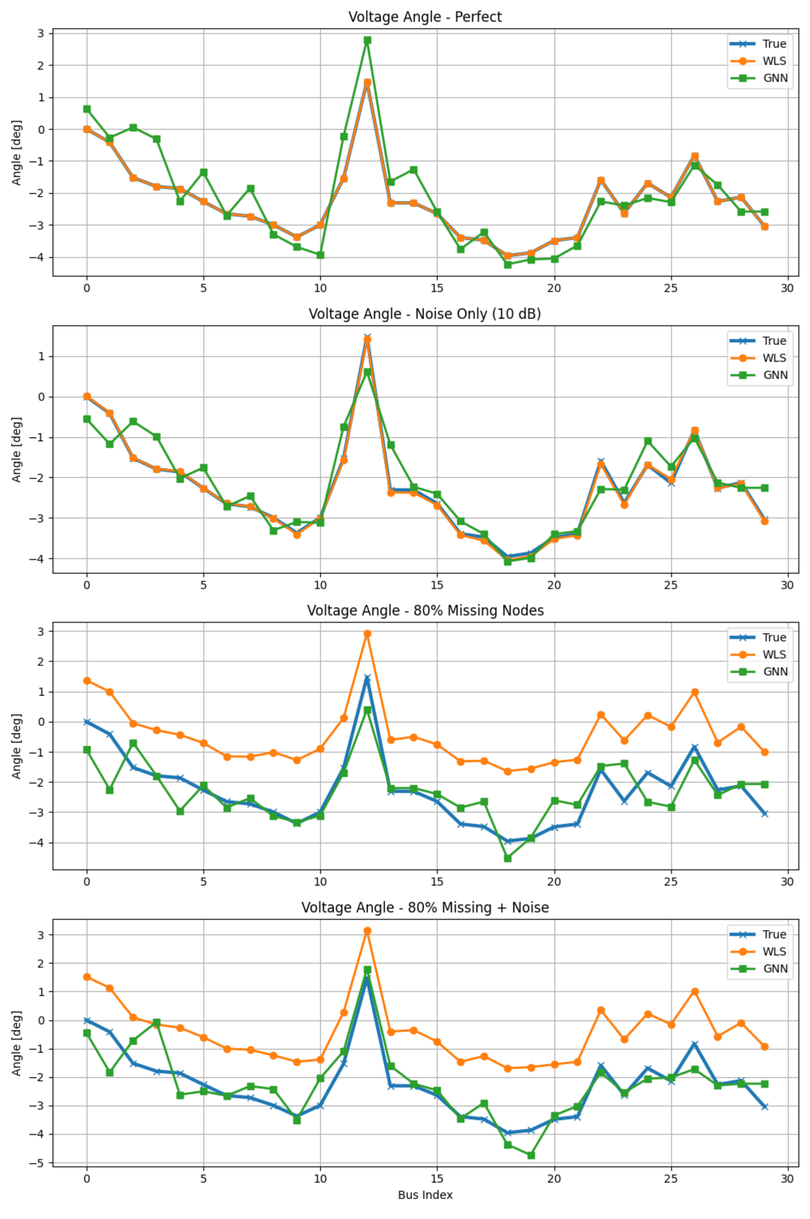
Preliminary Case Study on IEEE 30-bus system





GNN Architecture





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