TRANSMISSION OUTAGE SCHEDULING OPTIMIZATION

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Problem Statement

Power grid operators and engineers must coordinate transmission, distribution, and generation system modifications amid growing challenges. The rise of intermittent energy sources, electric vehicle expansion, increasing demand, and extreme weather events strain traditional utility planning. Maintenance, upgrades, and new infrastructure must uphold bulk electric system safety and reliability (including N-1 contingency compliance) while navigating supply chain constraints, regulations, land use, system conditions, and competing priorities.

Objective

Develop a flexible tool for optimizing outage scheduling that allows adjustable priority weighting and dynamic updates based on project status while ensuring the reliability of the electric system.

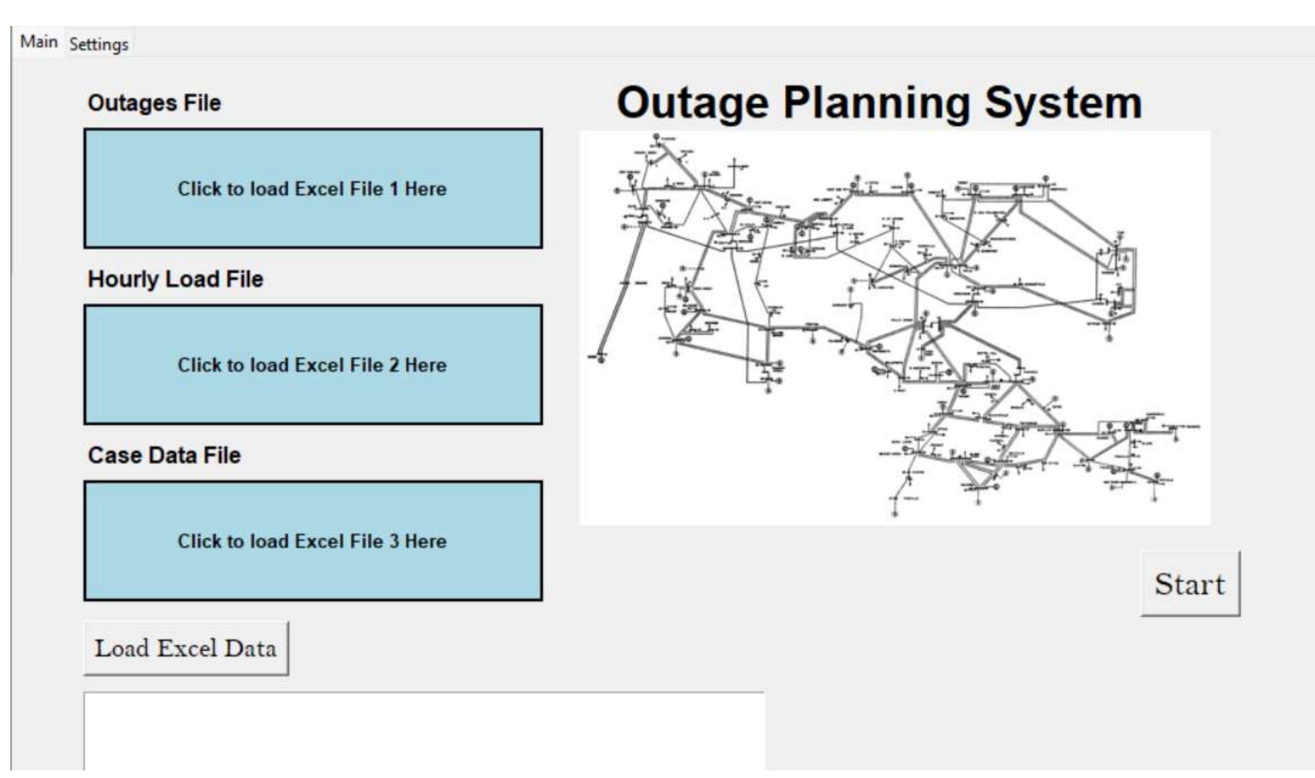

Figure 1: Graphic User Interface Main Window

Importance

The power grid faces increasingly complex regulatory requirements, unprecedented energy demand, and reduced online generation availability. Growing operational challenges and accelerated transmission expansion further strain the system. To address these issues, grid modernization is essential to enhance resiliency and support climate goals.

Methodology

The code will initially sequentially traverse all load cases in a year and determine passing/failing cases to meet the outage criteria. An optimization algorithm will later be implemented to reduce search time for the optimum schedule such as by starting in spring and fall time frames

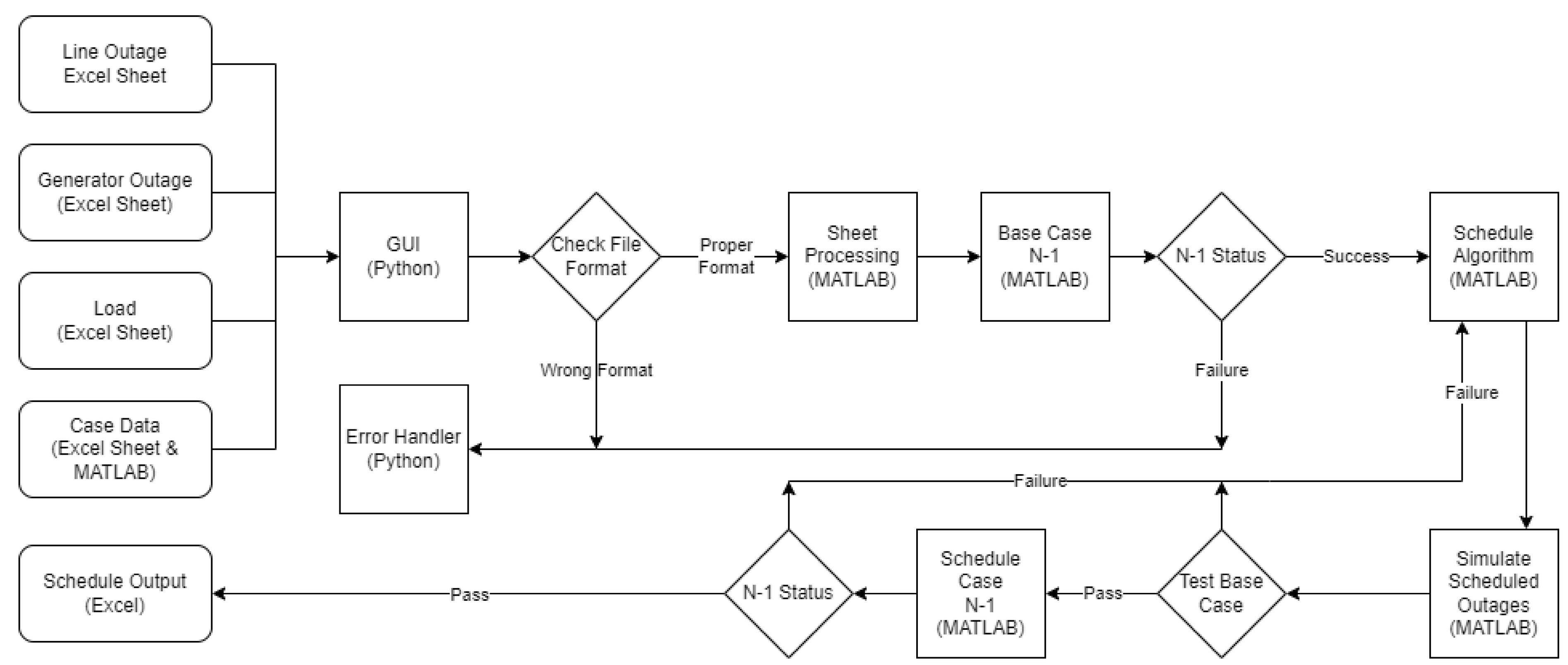

Figure 2: Transmission Outage Scheduling Flowchart

The tool provides an interactive interface for outage scheduling, supporting multiple Excel sheets with real-time validation. It prioritizes outages based on system impact, dependencies, duration, and constraints while incorporating hourly load data to assess stability. After forming an initial schedule, it performs N-1 to N-3 contingency analyses to evaluate concurrent outages and adjusts scheduling to minimize disruptions. Additionally, it identifies critical contingencies, ensures grid reliability, and integrates seamlessly with the simulation system.

Figure 3: Monthly Output Calendar

Optimization

Designed for optimal performance, the system enhances transmission outage scheduling with a base case contingency analysis (entire year of simulation takes 35 minutes), streamlined data ingestion, error handling, and parallel processing for resilient and efficient power system planning.

Limit Checking Results

- If any hour fails on MVA or VMAG, the scheduler will not schedule an outage there.
- Most of the violations in the base case were on a handful of busses and branches.

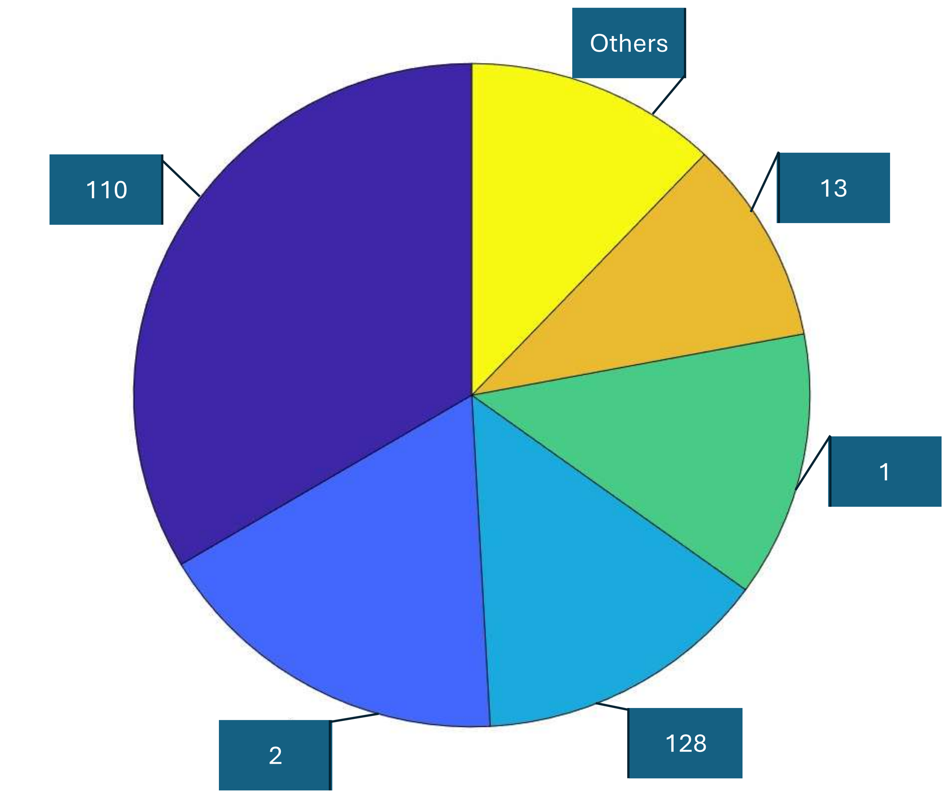

Figure 4: MVA limit failures by branch.

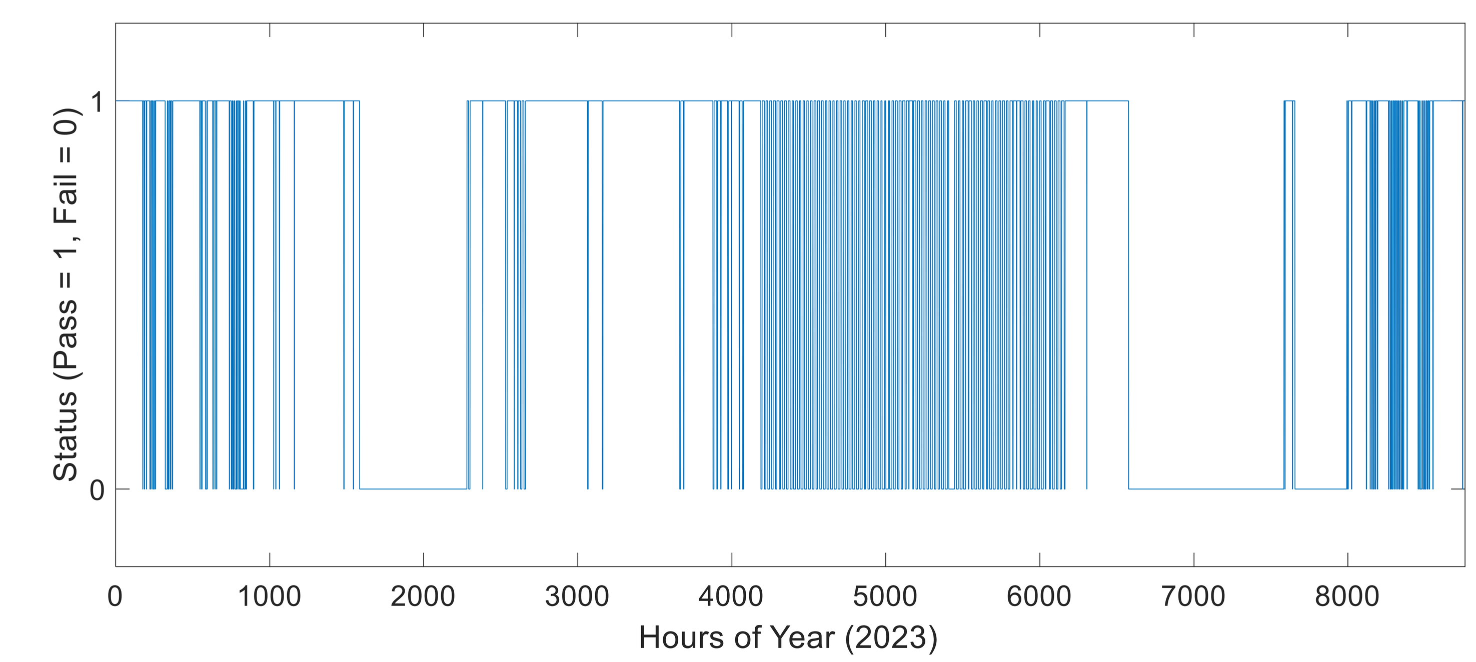

Figure 5: MVA & Voltage limit status

Conclusion

The problem statement was effectively addressed by the proposed method of outage scheduling. The approach effectively optimized the scheduling process, minimizing disruptions while ensuring system resiliency. The results from the proposed method meets all the objectives.

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