Information on the IEEE 14-bus Databases

Prepared by Andreas Venzke, Lejla Halilbasic,
Florian Thams, and Spyros Chatzivasileiadis

June 20, 2019

1 Database

You will receive two datasets that were prepared for the IEEE 14-bus system. You are welcome to use these datasets for your future studies, your work or your research. If you use them please cite the following paper:

> F. Thams, A. Venzke, R. Eriksson, S. Chatzivasileiadis. Efficient Database Generation for Data-Driven Security Assessment of Power Systems. *Accepted in IEEE Transactions on Power Systems*, 2019.
>
> and/or
>
> L. Halilbasic, F. Thams, A. Venzke, S. Chatzivasileiadis, P. Pinson. Data-driven Security-Constrained AC-OPF for Operations and Markets. In 20th Power Systems Computation Conference, Dublin, Ireland, pages 1-7, June 2018.

1.1 Difference between the two datasets

Database OPF with VG: Q-limits are not enforced. For this dataset, we run the standard power flow algorithm (provided by `Matpower`), which does not check if the PV buses violate their reactive power limits.

Database OPF without VG: Q-limits are enforced. For this dataset, we run a power flow algorithm (again provided by `Matpower`), which checks

if the PV buses violate their reactive power limits. If a PV bus (which is usually a generator bus) injects reactive power that exceeds the Q-limits of the generator, the PV-bus is transformed to a PQ-bus, with $Q = Q_{\text{limit}}$, and the voltage is allowed to vary. This is a more realistic implementation of the power flow, as in reality, if the determined reactive power cannot be provided, then the voltage will necessarily change.

1.2 Contents of each database

Database OPF with VG: 49'615 points, Q-limits not enforced

Database OPF without VG: 675'367 points, Q-limits enforced

For every database, we assessed each operating point for both N-1 security and small signal stability. For more information on the method, please see [1], and [2]

N-1 security: We run a power flow considering the base case and the single outage of each component. If any of the power flow cases violate component limits (line flow limits or voltage limits) the setpoint is classified as N-1 insecure. Considered contingencies include all line outages (except for lines 7-8 and 6-13 that make the problem infeasible, i.e. 14-bus system is not N-1 secure for these outages).

Small-signal stability: We consider a full dynamic model for each generator (6th-order), including governor, Automatic Voltage Regulator (AVR type I, 3-states), and Power System Stabilizer (PSS). We set the stability limit at 3% damping ratio. All operating points with a damping ratio below 3% are considered insecure. For more info and the data assumed, please see: [1].

References

[1] F. Thams, A. Venzke, R. Eriksson, and S. Chatzivasileiadis, "Efficient database generation for data-driven security assessment of power systems," *IEEE Transactions on Power Systems*, 2018, online avaiable: https://arxiv.org/abs/1806.01074.

[2] A. Venzke, D. K. Molzahn, and S. Chatzivasileiadis, "Efficient creation of datasets for data-driven power system applications," 2019, accepted at the 21st Power Systems Computation Conference (PSCC) 2020, Porto, Portugal.