NAME : Mert Karacelebi, Alexandre Oudalov
COUNTRY : Netherlands, Switzerland
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***Question 2.6: Artificial intelligence is currently providing insights to assist operations staff in their decision making. How can artificial intelligence be harnessed to provide further support such as recommending courses of action for operational decision-makers?***

Conventional power systems can be modeled in detail and operated robustly due to the high flexibility in the generation which comes from dispatchable synchronous machines and static (predictable) characteristics of the demand. However, over the last decade power systems are evolving with active distribution grids and power electronics based generation. Well studied power dynamics are getting more complex and faster which forces system operators to develop new tools in the system operation. Data-driven artificial intelligence (AI) solutions can be used in this new environment to approximate certain tasks in the power system domain.

System operators could utilize AI in both system analysis like congestion identification or risk estimation and system control. AI models are (usually) black box models and their interpretability is low. That’s why currently using AI as a part of a larger framework is more suitable for operational decision makers. Providing the model performance with a different set of examples generates certain confidence in the AI model which builds up a certain trust with the user. However, AI models that rely entirely on data without using domain expertise cannot guarantee success, unlike their analytical counterparts. Instead of focusing on the individual cases, we are able to analyze a large number of scenarios.

AI tools can provide fast execution times that enable system operators to screen multiple scenarios with associated costs. Based on comparing many conditions at the same time, system operators can obtain a certain course of action set. The computational demand of obtaining such a control action set is limited by other processes than AI such as obtaining model inputs, communication, or system analysis (power flow, EMS, OMS, etc.). Our contribution takes advantage of this characteristic of AI for the dynamic security risk assessment problem.

Our paper provides an estimation of the blackout risk of the operation in the planning stage. Market-based dispatch is available for operators 24 hours ahead of the operation and the aspect of dynamic security is usually omitted because of heavy dynamic simulations. Moreover, the intraday market changes the actual dispatch 15 minutes before the operation which creates a challenging environment for operators. Our AI solution is trained with an extensive knowledge base that covers different operating conditions, topologies, and possible large disturbances. The knowledge base contains power flow solutions and the risk factor of the operation which is calculated by the ratio of blackout conditions to the total number of simulations per case.  This tool can be used in real-time to evaluate the certain risk of the operation. Although the proposed model does not provide any control action, system operators can check the outcome of their actions instantly to gain support from AI. Possible further support can be achieved with the following applications: Evaluation of day-ahead risk and possible schedules; identification of critical “n-1” cases to include in security-constrained OPF;  investigation of grid weakness by screening risk under topological changes.

As an extension of this work, AI and standard power system analysis tools can be combined inside a single workflow that can provide a set of actions with their possible outcomes without any need for human interaction. This hybrid workflow will combine both the high prediction capability of AI and power system knowledge. As writers of the paper, we believe AI has a huge potential in power system operation and control if it is combined with the technical knowledge at hand.