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Editorial: Advanced data-driven methods and applications for smart grid

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Editorial on the Research Topic
Advanced data-driven methods and applications for smart grid

Introduction

During the operation of smart grid, the data of power production, transmission and consumption will be recorded (Liu et al., 2023). With the rapid development of information technology, the data volume shows an explosive growth trend (Zhou et al., 2016; Tan et al., 2017; Ahmad et al., 2020). The explosive growth of data has brought challenges to power monitoring and data transmission to a certain extent, and also restricted the development of smart grid to a certain extent. The development of smart grid requires scientific methods to optimize the configuration of data, deeply analyze the massive data stored in it, and use big data technology to effectively mine, analyze, transform and store unstructured data, so as to make the smart grid develop more directionally and achieve the goal of scientific and sustainable development (Srikantha and Kundur, 2019; Rituraj et al., 2022).

Many AI technologies have important reference value in the smart grid planning, prediction, intelligent monitoring, intelligent control, auxiliary decision-making, equipment inspection, fault diagnosis and other application scenarios of the modern energy systems. Neural network, expert system, data mining and other technologies have their advantages and disadvantages and application scope. In the application, attention should be paid to the scientific selection of various technologies, and the correction and maintenance of reliability, interpretability, data sample accumulation, infrastructure preparation, and knowledge base, so as to be well prepared for potential challenges in the 21st century.

This Research Topic aims to provide a platform to promote state-of-the-art research methods and results in data-driven methods and applications for smart grid, such as: Energy Prediction, Fault Diagnosis, Equipment Inspection, Intelligent Dispatch, and Stability Assessment, etc. It is hoped that this series of articles can provide valuable references for academic researchers and power industry engineers in related fields.

Main contributed papers

Yin et al. developed a modeling method for NOx concentration prediction in coal-fired power plant, based on data-driven feature fusion and LSTM neural network. The collected data is innovatively converted into a sequence similar to images, and a CNN is then used to fuse the high-dimensional features of image-like sequences and mine the spatial-coupling features between multiple variables. Moreover, the fused features are transferred to the LSTM neural network to find the time-coupling characteristics between variables. It has been well shown show that the prediction error of NOx concentration based on the proposed data-driven hybrid CNN-LSTM model is much lower than that of traditional models.

Liao et al. proposed a new data-driven graph signal model of power system fault diagnosis based on the conflict graph theory. In which, a fault branch diagnosis method based on graphical Fourier transform (GFT) is also constructed. The correctness and effectiveness of the model and the method are verified by simulated samples. It has been proven that, considering the measurement data from the fault recorder and relay protection devices, the identification accuracy is relatively high, and the method is also very robust to bad data interference.

Tang et al. proposed a data-driven early fault identification method for the incipient faults of distribution networks. In which, a waveform segmentation recognition framework is developed to divide the waveform into multiple segments and identify the initial fault through the similarity of the decomposed segments. Then, a similarity comparison network is constructed to learn the waveform by sharing the weights of two CNNs. Both real-world data and simulation data are used to demonstrate the effectiveness and accuracy of the proposed fault identification method.

Guan et al. presented a data-driven unmanned aerial vehicle (UAV) inspection method for transmission lines in smart grids. How to effectively traverse UAVs through numerous, dispersed target nodes in a vast area with the least cost, is a very challenging issue. The authors reformulate the problem to a series of vehicle routing problems (VRPs) with different constraints, and a diversified trajectory-driven DRL method with coder-decoder scheme is proposed to solve the problems. Comparison results on five types of routing problems have shown that the proposed method is superior to traditional DRL and heuristic methods.

Zhou et al. provided an intelligent dispatching knowledge learning model of power system based on reinforcement learning. The authors are ambitious to obtain interpretable scheduling decision knowledge rather than simply adopting many AI-related models. In this paper, a knowledge efficiency evaluation index is developed to guide the extraction of original domain knowledge. The simulation results show that the proposed method is able to provide optimal generation scheduling strategy according to the time series load curves, and effectively reduce the generation cost of the smart grid.

Liu et al. provided a data-driven power system transient stability assessment framework based on GNN. The framework consists of a feature preprocessing module, multiple physical information neural networks and an online update scheme with transfer learning and center moment difference. The *t*-distribution random neighbor embedding is used to virtualize the effectiveness of the proposed framework. Case study results have shown that the proposed method can achieve accurate transient stability assessment under the condition of changing power system operating conditions, and thus feasible for online use in future smart grids.

Perspectives

In conclusion, this Research Topic provides multidisciplinary data-driven studies in the field of smart grid. Data-driven and AI technology have become a hotspot to supplement the disadvantages of traditional model-based approaches in smart grid area. Nevertheless, there are still great challenges in data fusion, and data mining using domain knowledge. Hopefully, the data-driven techniques will assistant us run towards a clean and efficient energy future.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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