Interpretable Augmented Ambiguity Set for Quantifying Regional Wind Power Uncertainty in Distributionally Robust Optimal Dispatch

Zhuo Li[1,2], Lin Ye[1], Ming Pei[1,3], Xuri Song[4], Yadi Luo[4], Yong Tang[4], Geert Deconinck[2]

[1]China agricultural university, [2]KU Leuven, [3]University College Dublin, [4]China Electric Power Research Institute

A large-scale grid penetration of wind power has posed severe uncertainty challenges for power system operation. This paper comes up with an interpretable augmented ambiguity set assisted by deep learning for two-stage economic dispatch formulated in a distributionally robust optimization, aiming at precisely representing regional wind power uncertainty. The specifically designed augmented ambiguity set is driven by both the fine-grained uncertainty model of each wind farm and interactive dependencies among different sites. In particular, a multi-teacher knowledge distillation-time generative adversarial network (MKD-time GAN) is presented for the first time to form a spherical ambiguity set gathering all possible distributions for power prediction error of single wind farm. This model leverages a cascaded learning framework by typical teacher-time GANs to jointly educate one general student-time GAN so as to induce a family of comprehensive reference distributions as an ambiguity set. Further, multiple ambiguity sets are mapped into augmented ambiguity set, an interdependent joint probability distribution space for regional prediction error by Nataf transformation. Based on that, a tractable solution algorithm of two-stage optimal dispatch is explicitly derived and saves computation scale. The benefits of both novel MKD-time GAN and decision-making dispatch schemes are demonstrated in IEEE 118-bus systems.

979-8-3315-8138-1