

Learning to Solve the AC-OPF using Sensitivity-Informed Deep Neural Networks

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To shift the computational burden from real-time to offline in delay-critical power systems applications, recent works entertain the idea of using a deep neural network (DNN) to predict the solutions of the AC optimal power flow (AC-OPF) once presented load demands. As network topologies may change, training this DNN in a sample-efficient manner becomes a necessity. To improve data efficiency, this work utilizes the fact OPF data are not simple training labels, but constitute the solutions of a parametric optimization problem. We thus advocate training a sensitivity-informed DNN (SI-DNN) to match not only the OPF optimizers, but also their partial derivatives with respect to the OPF parameters (loads). It is shown that the required Jacobian matrices do exist under mild conditions, and can be readily computed from the related primal/dual solutions. The proposed SI-DNN is compatible with a broad range of OPF solvers, including a non-convex quadratically constrained quadratic program (QCQP), its semidefinite program (SDP) relaxation, and MATPOWER; while SI-DNN can be seamlessly integrated in other learning-to-OPF schemes. Numerical tests on three benchmark power systems corroborate the advanced generalization and constraint satisfaction capabilities for the OPF solutions predicted by an SI-DNN over a conventionally trained DNN, especially in low-data setups.