Machine Learning for Optimal Inverter Operation in Distribution Grids

Smart inverters have been advocated as a fast-responding voltage control solution in distribution grids with renewables. Nevertheless, finding the optimal inverter setpoints for reactive power in near real time can be computationally and communication-wise taxing. We put forth two deep neural network (DNN)-based approaches to facilitate inverter control. The first approach is a learning-to-optimize scheme, where a DNN is used by the utility to predict the optimal power flow (OPF) minimizers once presented with the new grid loading conditions. The novel feature here is that this DNN is trained to match not only the minimizers but also their sensitivities with respect to the OPF problem parameters. This is a unique feature for the learning-to-optimize setup yielding a dramatic improvement in data efficiency. The second approach targets a decentralized control scheme, where inverter control curves are modeled as DNNs that are jointly trained through an OPF formulation via stochastic primal-dual updates. Thanks to a flexible DNN architecture, the inverters can be partially driven by a utility control signal depending on the available communication specifications.