Convex Relaxations of Chance Constrained AC Optimal Power Flow

High penetration of renewable energy sources and the increasing share of stochastic loads require the explicit representation of uncertainty in tools such as the optimal power flow (OPF). Current approaches follow either a linearized approach or an iterative approximation of non-linearities. This paper proposes a semidefinite relaxation of a chance constrained AC-OPF which is able to provide guarantees for global optimality. Using a piecewise affine policy, we can ensure tractability, accurately model large power deviations, and determine suitable corrective control policies for active power, reactive power, and voltage. We state a tractable formulation for two types of uncertainty sets. Using a scenario-based approach and making no prior assumptions about the probability distribution of the forecast errors, we obtain a robust formulation for a rectangular uncertainty set. Alternatively, assuming a Gaussian distribution of the forecast errors, we propose an analytical reformulation of the chance constraints suitable for semidefinite programming. We demonstrate the performance of our approach on the IEEE 24 and 118 bus system using realistic day-ahead forecast data and obtain tight near-global optimality guarantees.

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