

Optimizing Parameters of the LinDistFlow Power Flow Approximation for Distribution Systems

Babak Taheri^{1,2}, Rahul Gupta³, Daniel Molzahn¹

¹Georgia Institute of Technology, ²Hitachi Energy Research, ³Washington State University

The DistFlow model accurately represents power flows in distribution systems, but the model's nonlinearities result in computational challenges for many applications. Accordingly, a linear approximation known as LinDistFlow (and its three-phase extension LinDist3Flow) is commonly employed. This paper introduces a parameter optimization algorithm for enhancing the accuracy of this approximation for both balanced single-phase equivalent and unbalanced three-phase distribution network models, with the goal of aligning the outputs more closely with those from the nonlinear DistFlow model. Using sensitivity information, our algorithm optimizes the LinDistFlow approximation's coefficient and bias parameters to minimize discrepancies in predictions of voltage magnitudes relative to the nonlinear DistFlow model. The parameter optimization algorithm employs the Truncated Newton Conjugate-Gradient (TNC) method to fine-tune coefficients and bias parameters during an offline training phase to improve the LinDistFlow approximation's accuracy. Numerical results underscore the algorithm's efficacy, showcasing accuracy improvements in L1-norm and L ∞ -norm losses of up to 92% and 88%, respectively, relative to the traditional LinDistFlow model. We also assess how the optimized parameters perform under changes in the network topology and demonstrate the optimized LinDistFlow approximation's efficacy in a hosting capacity optimization problem.