Mixed-integer simulation-based optimization for a superconductive magnet design

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Abstract

The optimization of continuous parameters in electrotechnical designs using electromagnetic field simulation is already standard. Typically, the simulation tools only carry out evaluations of the objective function and do not provide gradient information. If in addition to continuous design parameters also integer design parameters have to be optimized, only computational expensive random search methods like genetic algorithms are well known. In this paper, we present a new sequential modeling approach to solve mixed-integer simulation-based optimization problems for an electrotechnical design problem for superconductive magnets.

Each step of this approach uses stochastic modeling techniques to predict the simulation output by a surrogate function. The surrogate function treats the integer variables as real-valued ones. New promising parameter configurations are predicted by a “branch-and-bound” method, which solves the purely continuous subproblems by classical optimization methods for continuous and differentiable functions. The additional information of these simulation runs improves the quality of the surrogate function step by step.

The proposed approach is applied to optimize the distribution of coil blocks and coil windings of a superconductive magnet such that a maximal homogeneity of the magnetic field in the aperture is achieved.