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Adversarially Robust Bayesian Optimization for Efficient Auto-Tuning of Generic Control Structures under Uncertainty

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Abstract

The performance of advanced controllers depends on the selection of several tuning parameters that can affect the closed-loop control performance and constraint satisfaction in highly nonlinear and nonconvex ways. There has been a significant interest in auto-tuning of complex control structures using Bayesian optimization (BO). However, an open challenge is how to deal with uncertainties in the closed-loop system that cannot be attributed to a lumped, small-scale noise term. This paper develops an adversarially robust BO (ARBO) method that is suited to auto-tuning problems with significant time-invariant uncertainties in a plant simulator. ARBO uses a Gaussian process model that jointly describes the effect of the tuning parameters and uncertainties on the closed-loop performance. ARBO uses an alternating confidence-bound procedure to simultaneously select the next candidate tuning and uncertainty realizations, implying only one expensive closed-loop simulation is needed at each iteration. The advantages of ARBO are demonstrated on two case studies.

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