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Randomized Policy Optimization for Optimal Stopping

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Optimal stopping is the problem of determining when to stop a stochastic system in order to maximize reward, which is of practical importance in domains such as finance, operations management and healthcare. Existing methods for high-dimensional optimal stopping that are popular in practice produce deterministic linear policies – policies that deterministically stop based on the sign of a weighted sum of basis functions – but are not guaranteed to find the optimal policy within this policy class given a fixed basis function architecture. In this paper, we propose a new methodology for optimal stopping based on randomized linear policies, which choose to stop with a probability that is determined by a weighted sum of basis functions. We motivate these policies by establishing that under mild conditions, given a fixed basis function architecture, optimizing over randomized linear policies is equivalent to optimizing over deterministic linear policies. We formulate the problem of learning randomized linear policies from data as a smooth non-convex sample average approximation (SAA) problem. We theoretically prove the almost sure convergence of our randomized policy SAA problem and establish bounds on the out-of-sample performance of randomized policies obtained from our SAA problem based on Rademacher complexity. We also show that the SAA problem is in general NP-Hard, and consequently develop a practical heuristic for solving our randomized policy problem. Through numerical experiments on a benchmark family of option pricing problem instances, we show that our approach can substantially outperform state-of-the-art methods.

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