Formulating Branch-and-Bound as a Reinforcement Learning Problem NY, USA
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PROBLEM B&B is the state-of-the-art algorithm for solving NP-hard combinatorial optimization problems. Finding a feasible solution with a certificate of optimality requires two kinds of decisions: how to *branch* on the current problem and how to *select* the next problem. Currently, decision rules in B&B rely on suboptimal heuristics that are prohibitively time-consuming and explore excessively large search trees.

ANALYSIS I show the expert decision rule, known as fullstrong branching, performs well because it benefits from the side effects of solving auxiliary linear programs. With side-effects such as pruning and improvements in primal bound disabled, the decision rule is no longer so great. Nevertheless, seeking improvement in dual bound remains a compelling strategy. Furthermore, I conclude global branching decisions reduce to those based on local heuristics when they have no control over the selection rule.

ALGORITHM I provide the first RL formulation of B&B that can jointly learn a branching and selecting policy. I introduce a Q-network architecture to parametrize a changing action space with graph neural networks and attention mechanisms. I combat the growing action space faced in B&B by factorizing the policy into a brancher that is conditioned on the decisions of an independently-trained selector.

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