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Backdoors to combinatorial optimization: feasibility and optimality.

Summary: There has been considerable interest in the identification of structural properties of combinatorial problems that lead, directly or indirectly, to the development of efficient algorithms for solving them. One such concept is that of a backdoor set—a set of variables such that once they are instantiated, the remaining problem simplifies to a tractable form. While backdoor sets were originally defined to capture structure in decision problems with discrete variables, here we introduce a notion of backdoors that captures structure in optimization problems, which often have both discrete and continuous variables. We show that finding a feasible solution and proving optimality are characterized by backdoors of different kinds and size. Surprisingly, in certain mixed integer programming problems, proving optimality involves a smaller backdoor set than finding the optimal solution. We also show extensive results on the number of backdoors of various sizes in optimization problems. Overall, this work demonstrates that backdoors, appropriately generalized, are also effective in capturing problem structure in optimization problems.

Keywords: search; variable selection; backdoor sets

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