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Bilevel Knapsack Problems in a Stackelberg Model

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We consider a bilevel knapsack problem, in which one player, the follower, decides on the optimal utilization of a bounded resource. The second player, the leader, can offer incentives so that the follower chooses options attractive also for the leader. Formally, each of the two players is associated with a subset of the knapsack items. The follower selects a subset of all items in order to maximize its overall profit. The leader receives as pay-off only the values from those of its items that are included by the follower in the overall knapsack solution. We consider the case where the leader can offer part of the profit of every item to the follower, and the case where the leader can set the weights of items for the leader, aiming at a maximum weight of the selected leader's item.

In both cases the resulting setting is a Stackelberg strategic game. The leader has to resolve the trade-off between offering highly attractive incentives to the follower and thereby lowering its own pay-offs. We analyze the problem for the case in which the follower solves the resulting knapsack problem to optimality and obtain a number of negative complexity results. Then we invoke a common assumption of the literature, namely that the follower's computing power is bounded. Under this condition, we study several natural Greedy-type heuristics applied by the follower.

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