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Knapsack Problems with Conflict and Forcing Constraints on Special Graphs

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We consider the classical 0-1 knapsack problem and add binary constraints for pairs of items. These can be either conflict constraints stating that certain pairs of items cannot be simultaneously contained in a feasible solution, or forcing constraints requiring that at least one of the two items of each given pair must be included in the knapsack. These constraints can be represented by a conflict resp. forcing graph $G = (V, E)$, where each item j corresponds to a vertex $v_j \in V$ and an edge $e = (v_i, v_j) \in E$ indicates a binary constraint between items i and j. Note that our model can be seen as a weighted independent set resp. vertex cover problem with an additional budget constraint.

In this talk we will concentrate on the identification of special graph classes as conflict resp. forcing graphs which permit (Fully) Polynomial Approximations Schemes ((F)PTASs). In particular, we will show that chordal graphs and graphs of bounded treewidth allow an FPTAS for both problem versions. Then we present a PTAS for planar conflict graphs based on the method by Baker. In contrast to this positive approximability result, the knapsack problem with a planar forcing graph is inapproximable.

Finally, we also develop dynamic programming schemes allowing an FPTAS for a number of other graph classes defined by the exclusion of certain induced subgraphs.

(Joint work with Joachim Schauer)

Miyhun Kang und Bettina Klinz