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Recent advances on Non-Guillotine Orthogonal Multi-Dimensional Packing Problems: the UniPack framework

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Abstract:
Given a set of items and a set of containers, packing problems are concerned with the loading of the items into the containers, according to some packing rules, in order to optimize performance measure. Under this broad definition, we find a wide set of academic and real-life problems from the knapsack problem to the cargo loading and multi-dimensional bin packing problems with special balancing constraints. In this talk we present UniPack, a general framework to build heuristics for various packing problems. Given a constructive heuristic, the UniPack heuristic iterates the ordering of the items given to the heuristic as an input, in order to guide it to the optimal solution. To achieve this goal, a scoring function is associated to each item and the item list is sorted by items' scoring values. UniPack is efficient and easy to adapt to different packing problems. In fact, when the packing problem is changed, the user has to design back only the function updating the scoring values. Moreover, changing the rules for the scoring updating, one can completely change the UniPack behavior, letting UniPack to act as Iterated Local Search, Grasp or GLS heuristics.
The UniPack algorithm is tested on several two and three dimensional packing problems, including Three-Dimensional Bin Packing, Two-Dimensional Bin Packing, Two-Dimensional Knapsack, Two-Dimensional Strip Packing and Three-Dimensional Container Loading problems. Extensive computational results show that the new heuristics are able to obtain state-of-the-art results, but with a negligible computational effort. Moreover, UniPack is the only general framework applicable to a large number of multi-dimensional packing problems.