New heuristic for searching BPP and DBPP instances with large proper gap

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Abstract. We consider the bin packing problem and the dual bin packing problem, with the aim of maximizing the best known (proper) gaps. Using new heuristics, we improved the best known proper gap from 1.0625 to 1.0925. The best known dual gap is raised from 1.0476 to 1.1775. The proper dual gap is improved to 1.1282.

Keywords: bin packing problem; dual bin packing problem; proper relaxation; gap; proper gap; dual gap; proper dual gap

We consider the bin packing problem, the dual bin packing problem and its proper and continous relaxations based on the formulation by Gilmore and Gomory [GG1]. The following inequality shows relations between objective values of the considered problems:

$$\overline{z}(E) \leq \overline{z}_P(E) \leq \overline{z}_C(E) \leq z_C(E) \leq z_P(E) \leq z(E).$$

Also there is a series of gaps: the gap $\Delta(E) = z(E) - z_C(E)$, the proper gap $\Delta_p(E) = z(E) - z_P(E)$, the dual gap $\overline{\Delta}(E) = \overline{z}_C(E) - \overline{z}(E)$ and the proper dual gap $\overline{\Delta}_p(E) = \overline{z}_P(E) - \overline{z}(E)$. The main open problem here is whether there is an instance with the gap or the dual gap greater than 2.

The search is based on the method described by Kartak, Ripatti, Scheithauer and Kurz [KRSK1] for the bin packing problem. This method is a branch and bound search with special cuts. We adapt it for the dual bin packing problem.

The heuristic is based on the following observation. The set of patterns for n items under the domination relation (introduced in [KRSK1]) is isomorphic to the well-known poset $M(n)$ introduced by Stanley [St1]. We experimented with the rank function of poset $M(n)$ and developed a new cut that allowed us to get the results presented in the abstract.

References

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