The equivalent transformation of the d-dimensional Orthogonal Packing Problem

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Abstract. We consider the d-dimensional Orthogonal Packing Problem and present an effective algorithm for building equivalent OPP-d instances with certain properties. We apply the developed toolset for building equivalent instances with the reduced number of the raster points.

Keywords: orthogonal packing problem; bin packing problem; knapsack problem; conservative scale; equivalence of instances; raster points; raster model

We consider the well-known d-dimensional Orthogonal Packing Problem (OPP-d), which can be formulated as follows. A set of d-dimensional items (rectangular boxes) needs to be packed into a fixed container. The input data describe the dimensions of the container $W_k \in \mathbb{R}_+$, $1 \le k \le d$, and the dimensions of the n items $w_i^k \in \mathbb{R}_+$, $1 \le k \le d$ for each item $1 \le i \le n$. We ask whether all boxes can be orthogonally packed into the container without rotations.

Using the toolset of conservative scales introduced by Feteke and Schepers [FS1] we are able to change the items' sizes in the initial instance to obtain an equivalent instance with the same solution. We present an effective algorithm for building equivalent instances with certain properties.

We also consider the so-called raster model for OPP-d introduced by Belov, Kartak, Rohling and Scheithauer [BKRS1]. It is a 0/1 ILP model in which number of variables and constraints linearly depends on the total number of raster points over all dimensions. Using our algorithm we construct equivalent instances with reduced number of raster points. We also present an algorithm to find a lower bound on the minimum possible number of raster points over all equivalent instances. For some instances, it proves that it is impossible to reduce the number of raster points. Numerical results are presented.

References

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