

3D Packing Problems with an Uniform Weight Distribution

A Case Study

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Abstract:

This work addresses a real world problem proposed to us by a Portuguese automotive company. Every day this company needs to establish a plan to pack a set of boxes onto a truck. Since the transport is made directly from the suppliers to the factory, we don't need to consider the problem of establishing a route or to worry with multi-drop situations. So, we will only address the operations for packing the boxes.

The cargo consists of rectangular boxes with different sizes and weight, and the vehicle is a single truck. There are different types of boxes that are divided into two major groups: group A consists of small boxes with no lid that, before being placed inside the truck, need to be combined onto a pallet; group B consists of bigger, completely formed, boxes that are packed individually in the truck. We can divide our problem into two successive phases: the construction of pallets (a manufacturer's pallet loading problem) and the loading of the cargo into the truck (a single container loading problem). These two phases should not be solved independently, since the final dimensions of the pallets will have an impact on the final packing plan of the whole cargo.

According to Wäscher *et. al.* (2007) typology, this problem can be classified as a *Three-Dimensional Rectangular Single Large Object Placement Problem*.

Since this is a real application, some practical constraints cannot be overlooked, like load stability and box orientation constraints, weight limit of the truck and uniform distribution of weight inside the truck.

To solve this problem, we propose a constructive heuristic based on a layer arrangement approach, with a star strategy and with a weighted average measure for the boxes. For each layer, the main idea is to spread the heaviest boxes along the container in a star form, from the sides to the centre of the container. This heuristic is based on a corner selection that, instead of finding the appropriate corner for the current selected box, finds the appropriate box for the current corner. When we are left with a small number of boxes that weren't placed in the current layer, or when there isn't a sufficient number of boxes of the same height to build a complete layer, we will have to do some local changes in order to try to obtain a feasible solution. The application of this constructive heuristic to the company's data and the corresponding results will be presented and discussed.

Keywords: Container loading, Weight distribution, Heuristics.

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