Optimization of a Real-World Auto-Carrier Transportation Problem

Mauro Dell'Amico Simone Falavigna
Manuel Iori

DISMI, University of Modena and Reggio Emilia,
Via Amendola 2, Padiglione Buccola, 42122, Reggio Emilia, Italy.

{mauro.dellamico, simone.falavigna, manuel.iori}@unimore.it

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Abstract

One of the main logistic issues in the automotive industry concerns the delivery of vehicles (e.g., cars, vans or trucks) to dealers. Usually vehicle manufacturers do not deliver their products directly, but rely on special logistic companies. These companies receive the vehicles from the manufacturers, stock them in storage areas and deliver them to the dealers when ordered (see, e.g., Agbegha et al. (1998) and Tadei et al. (2002)).

The deliveries are provided by special trucks, called auto-carriers, composed by a tractor and perhaps a trailer, both usually equipped with upper and lower loading planes. The loading capacity of an auto-carrier strongly depends on the vehicles dimensions and shapes. To increase such capacity auto-carriers are usually equipped with particular loading equipments. For example, vehicles may be partially rotated and the upper loading planes may be translated vertically, extended and/or rotated. The problem of loading vehicles into auto-carrier is thus not trivial to solve.

This work is devoted to the study of a real-world case derived from the everyday activity of one of these logistic companies. In particular we are given a fleet of heterogeneous auto-carriers based at a central depot, and a set of dealers, each requiring a certain number of vehicles. We need to load vehicles into auto-carriers and route auto-carriers along the road network to serve all dealers with minimum routing cost. Split deliveries (see, e.g., Archetti and Speranza (2008)) are allowed.

The problem belongs to the class of loading and routing problems (see, e.g., Iori and Martello (2010)) and is very complex, because it requires not only the solution of the loading problem for each auto-carrier, but also the routing of the auto-carriers. Both these two sub-problems are NP-hard. Moreover, the size of the problems we address is very large: on average about 800 vehicles are delivered everyday to 200 dealers using 100 auto-carriers in the instances that were provided to us. It is thus natural to focus on heuristic techniques.

We developed an Iterated Local Search algorithm that uses nine inner local search techniques, all based on classical ideas from the vehicle routing literature. Any time one of these techniques has to determine the feasibility of the loading associated to a route, it invokes a loading algorithm. Such algorithm is based on an approximation of the original loading problem, which is solved by means of a combinatorial branch-and-bound.

We prove the effectiveness of the proposed heuristic by means of extensive tests on real-world instances. We gain some insight in the performance of the algorithms by testing different configurations, for both the loading and the routing part. We also study the relative impacts of the real-world constraints and discuss they way in which they affect the results.

References

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