The Boat and Barge Routing Problem

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Abstract

Coal must be delivered regularly to the thermal power plants in Denmark to ensure stable and reliable production of electricity and heat. Coal delivered from overseas is distributed from central depots to the power plants by an internal fleet of tug boats and barges. Coal is loaded onto a barge, which is then pulled by a tug boat to a power plant, where the barge is unloaded. While the barge is unloaded, the tug boat is not needed and can sail on, possibly with another barge. If a delivery cannot be made by the internal fleet, then an external delivery can be made at a significantly higher cost. The $\mathcal{NP}$-hard Boat and Barge Routing Problem (BBRP) consists in finding paths for barges and tug boats such that all deliveries are made and such that the total cost of tug boat sailing and external deliveries is minimized.

We present a mathematical formulation for the problem and two branch-and-price algorithms. The first algorithm has two pricing problems for generating barge paths resp. tug boat paths. The second algorithm has only one pricing problem: barges are handled in the master problem and only tug boat paths are generated in the pricing problem.

The solution approaches are computationally evaluated on a set of real-life test instances provided by DONG Energy, a Danish utility company.

Computational results show that the algorithm with one pricing problem has superior performance, which indicates that movement synchronization between two types of vehicles is better handled by modeling barges as resources in the master problem than as independent vehicles. This observation can be applied to other vehicle routing problems.