Locomotive Assignment in Railway Freight Transport

The problem

MÁV-Trakció Zrt. is an independent railway company that performs various traction and shunting activities in Hungary. Due to the expanding market, fulfilling all incoming orders with the available resources became progressively harder.

There are many rules related to the placement of incoming orders. Some of these rules allow that an order even few hours before the ordered train need to be pulled, can be withdrawn or modified. Therefore, comparing the railway freight transportation to railway passenger transportation some main differences are visible, like the non existence of a fixed timetable. The orders shows some uncertainty that makes the problem harder than the similar locomotive assignment problem of the railway passenger transportation.

Our task can be formulated as follow: solve the locomotive assignment planning problem at least 15 days before the ordered trains are planned to be pulled for 4 weeks of period, and due to the changes that might occur in orders during the days before realizations of those we need to introduce replanning models for dispatchers.

Results and achievements

The locomotive assignment planning problem was modeled as a multicommodity network flow, corresponding to the different types of engines available. The resulting mathematical program was implemented in the Mosel modeling language, and solved with XPRESS-MP. An alternative heuristic of dividing the problem into single commodity network flow problems was also proposed, which was implemented as a C++ code together with a network flow solver.

The results of locomotive assignment planning problem served well the planning phase, however, the large number of changes in the incoming orders redefined the timetable of locomotive assignment problem for a shorter period. Due to the fact that task list of engines and the corresponding personnel duties has been defined on the basis of the planning model, every deviation from that makes additional cost for the company. Therefore, to handle this situation we developed a rolling horizon rescheduling scheme that not only tries to minimize the costs, knowing the changes in the orders, but also strives for keeping the changes compared to the original schedule to a minimum.

Such models have two linear objective functions (cost of flow; changes compering the original plan). The constraints are multicommodity network flow type, but here the commodities are no longer engine types but task list of engines. Number of commodities, in this new model, are much larger than for the original locomotive assignment planning problem.

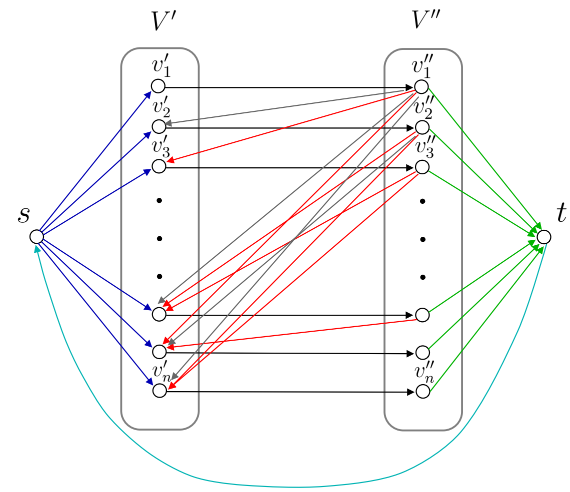

Figure 1: MCNF model of locomotive allocation

We have succeeded in making a framework for allocating the locomotives which automates the tedious parts of the work, and serves as a decision support tool for other parts where human experience is irreplaceable, especially regarding changes in orders that are foreseeable from customer behavior patterns.

Challenge overview

At the time, dispatchers were assigned to the 3 major regions of the country, and managed the resources separately, relying only on their experience. The sheer volume of orders made creating a schedule a daunting task, but the frequent changes in the incoming orders turned this into a precarious juggling act. This situation being insupportable, the company was looking for a more sophisticated, more unified framework.

Executive summary

The optimal allocation of available resources is a key prerequisite of a profitable company. Using appropriate mathematical models, an efficient schedule can be computed and maintained in a timely manner, achieving a considerable reduction in costs, delays, and emissions.

Implementation of the initiative

The researchers of Optimization Research Group at Budapest University of Technology and Economics (BUTE) and experts of MÁV-Trakció Zrt. worked together in the form of an R&D project from 2011 until the end of 2012. During that time the researchers of BUTE gradually refined their model using the reality checks provided by the company's experts.

Lessons learned and replicability

The basic models employed in this project can be applied to similar problems in transportation and logistics, with respect to the special details that every unique problem has.

Participants of the project

All participants belong to the Optimization Research Group of Budapest University of Technology and Economics: Zs. Barta, A. Egri, T. Illés and R. Molnár-Szipai.

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http://www.mav-trakcio.hu

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