Locomotive Assignment in Railway Freight Transport

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.

Challenge overview

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, and the frequent changes in those orders posed an additional challenge. Therefore, the company was seeking a more sophisticated scheduling system.

The problem

Railway freight transportation is fundamentally different from passenger transportation in that it lacks a timetable that is fixed long before realization. Scheduling locomotives becomes more reactionary, especially with the current rules that allow for orders to be placed even a few hours before the requested departure time.

Our task was twofold: due to labour agreements, the personnel has to receive a preliminary schedule 15 days before a month starts, and secondly, we were to develop a rescheduling framework for handling incoming changes.

Results and achievements

The locomotive assignment 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.

Both approaches proved efficient for the planning phase, however, rerunning the model each time a change happens was deemed impractical, as this shuffles around the existing engine task lists and corresponding personnel duties too much. To handle this situation, we developed a rolling horizon scheme that not only tries to minimize the costs, but also strives for keeping the changes compared to the original schedule to a minimum.

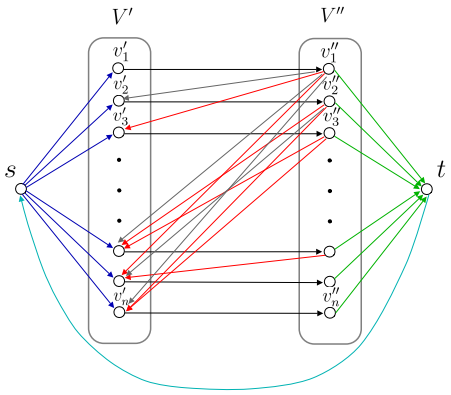

Figure 1: MCNF model of locomotive allocation

Such models have two linear objective functions (cost of flow; changes compared to the original plan). The constraints are of a multicommodity network flow type, but here the commodities are no longer the engine types, but the task lists of individual engines. Hence the number of commodities in this model is much larger than in the original locomotive assignment problem.

The company's experts shared our opinion, that the resulting framework automates the tedious parts of the dispatchers' 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.

Contacts, references

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http://www.mav-trakcio.hu

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