A bi-objective approach for robust train platforming

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With intensification of rail traffic and maintenance, railway network in urban areas is considerably solicited. Thus major stations, as main nodes of the network, are paramount in capacity management. Indeed, intelligent planning methods allow the safe reception of greater number of train. Routing trains through these stations forms the train platforming problem (**TPP**). This planning takes the form of a track occupancy diagram which serves as the basis for multiple operations (traffic management, train display, etc.). Moreover, train platforming takes account of many requirement, such as safety or connections.

Many works have established techniques for solving the TPP using combinatorial optimization [2]. DPF Solution, department of the main French infrastructure manager SNCF Réseau, understood the value of deploying these methods through the OpenGOV software. OpenGOV was developed in-house with the help of experts in railway operation. Now, the software is already adopted by a twenty of stations in France.

Otherwise, routing has to cope with usual disturbances such as delays [1] or track closures. Yet, various forms of residual capacity ensure easy recovering. The residual capacity defines two main recovery robustness [3] indicators :

- the respect of buffer times in order to deal with frequent delays
- the assignment of back-up routes in order to deal with track closure

As those two aspects are generally contradictory, this paper proposes a bi-objective approach. It allows exploring compromise solutions.

We introduce an integer linear programming formulation based on a conflict graph in which we look for a stable set. The formulation is enriched with back-up routing variables, buffer variables and feasibility constraints. The algorithm aims at minimizing penalties due to buffer-times violations and the number of trains assigned without backup route. The resolution is based on the epsilon-constraint method.

This algorithm leads to experimentation with OpenGOV framework. We tackle real instances of traffic at main French stations : Paris Gare de Lyon, Paris Est and Lyon Part-Dieu. We obtain Pareto fronts in a reasonable time. The algorithm gives many relevant solutions that could not be obtained with a simple stable set formulation.

References

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