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Graph based approaches for scheduling trains in railway networks

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Railway infrastructure managers face highly complex train scheduling problems during real-time traffic control, since the operations are usually perturbed. It is the managers duty to provide an immediate alternative schedules for minimizing the negative effects of these perturbations.

In the literature, several graph based techniques were developed to formulate and solve this type of optimization problems. D'Ariano *et. al.* (2007, 2008) have presented a directed graph based representation of train scheduling problems with an appropriate branch-and-bound algorithm. Based on their model, Corman *et. al.* (2010) have developed a tabu search based approach to reschedule trains in case of perturbations. In a more recent article, a bilevel approach were presented (Corman *et. al.*, 2012) where the train network is decomposed into smaller regions and a global coordinator ensures the feasibility of inter-area decisions. A branch-and-bound algorithm was published to solve the coordinator problem.

Adonyi *et. al.* (2010) have adopted and applied the formerly developed S-graph framework for the scheduling of a railway system. The S-graph framework was initially developed to solve makespan minimization problems of chemical batch plants (Sanmartí *et. al.*, 2002), and later extended to a wide range of scheduling problems (Hegyháti and Friedler, 2011). Compared to other (mostly MILP formulation based) approaches in the area, the S-graph framework provided better performance and proved to avoid modeling mistakes resulting in practically infeasible solutions. Since the underlying structure of both scheduling problems are similar, the same S-graph approach with appropriate modifications was applied to solve the train scheduling problems.

The aim of this presentation is to review the available approaches and their applicability for train scheduling problems, analyzing their advantages and shortcomings.

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