Robustness and stability of integrated stochastic optimization approaches for scheduling trains and railway infrastructure maintenance

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This work addresses a tactical railway traffic management problem focused on the optimization of train dispatching decisions and timing decisions related to short-term maintenance works in a railway network subject to disturbed process times. This is modeled as a mixed-integer programming formulation in which the traffic flow and track maintenance variables, constraints and objectives are integrated under a stochastic environment. The resulting bi-objective optimization problem is to minimize the deviation from a scheduled plan and to maximize the number of aggregated maintenance works. The two objectives require to schedule competitive train operations versus maintenance works on the same infrastructure elements. Numerical experiments are performed on a realistic railway network. We measure the quality of the integrated solutions in terms of their robustness to random perturbations of the train travel times and of the maintenance works. Pareto optimal methods are compared for the bi-objective problem. We also evaluate the impact of introducing routing stability constraints in order to force the trains to keep the same route among the different stochastic disturbed scenarios. The experiments show that forcing the routing stability reduces the routing flexibility and the ability to optimize the two performance indicators when dealing with stochastic disturbances of process times.

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