The Train Driver Recovery Problem - Solution Method and Decision Support System Framework - DTU Orbit (28/06/2019)

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In this thesis we consider the train driver recovery problem (TDRP). The problem occurs when the daily train driver schedule becomes infeasible due to irregular operations on the railway network. Unforeseen disruptions such as signalling problems or rolling stock failures prevent the train drivers from following the originally scheduled sequence of activities in their duties. The real-time re-scheduling of the disrupted train driver duties is currently performed manually by the train driver dispatchers. If the disruption is severe and many train driver duties are disturbed, this is a very complicated task to carry out. The interest of the passenger railway operator DSB S-tog A/S in introducing automated decision support for the train driver dispatchers is a key motivation for this project. We propose an optimization-based solution method for solving the TDRP and develop a prototype for the decision support system. The framework is based on solving restricted TDRP instances with a rolling time horizon, aiming at modifying the original duty schedule as little as possible. We formulate TDRP as a set partitioning model, where variables represent train driver recovery duties, and describe why the proposed model and solution method is suitable for solving in real-time. Recovery duties are generated as resource constrained paths in duty networks, and the set partitioning problem is solved with a linear programming based branch-and-price algorithm. Dynamic column generation and problem space expansion at each node of the branch-and-price tree together with a constraint branching strategy coniv tribute to the solution method. Real-life operational data is provided by DSB S-tog A/S in order to test the implemented solution method. Based on the computational experiments presented in this thesis, we conclude that the proposed approach is indeed applicable for implementation in a decision support system for train driver dispatchers in practice. DSB S-tog A/S is working on using the research results obtained during this thesis and the programming code of the prototype to develop and implement the train driver decision support system in their operational environment. Besides solving a particular optimization problem, this thesis contributes with a description of the railway planning process, tactical crew scheduling and the real-time dispatching solutions, taking a starting point in DSB S-tog's operations. Furthermore, we present comprehensive reviews of operations research applications within railway crew scheduling, rolling stock re-scheduling, railway crew re-scheduling, and airline crew recovery. In addition, the project has resulted in the three scientific publications listed below. 1. Rezanova NJ, Ryan DM. The train driver recovery problem–A set partitioning based model and solution method. Computers and Operations Research, in press, 2009. doi: 10.1016/j.cor.2009.03.023. 2. Clausen J, Larsen A, Larson J, Rezanova NJ. Disruption management in the airline industry–Concepts, models and methods. Computers and Operations Research, in press, 2009. doi: 10.1016/j.cor.2009.03.027. 3. Rezanova NJ, Ryan DM. The train driver recovery problem–A set partitioning based model and solution method. IMM-Technical Report-2006-24. Informatics and Mathematical Modelling, Technical University of Denmark, 2006. Available at http://www2.imm.dtu.dk/pubdb/p.php?5157.

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