Exact and heuristic approaches for the Railway crew scheduling

Akshat Bansal[*], **K. P. Anoop and Narayan Rangaraj**

Department of Industrial Engineering and Operations Research, Indian Institute of Technology Bombay,
Mumbai - 400076, India
akshat.bansal@iitb.ac.in, kpanoop@iitb.ac.in, narayan.rangaraj@iitb.ac.in
[*] Corresponding author

Abstract. This research considers crew scheduling for long-distance passenger trains taking Indian Railways as a test case. Railway crew scheduling refers to assigning tasks (or trips) to crew members covering all trains for a defined period, satisfying the operational constraints and labour union rules. Exact and heuristic-based approaches have been implemented, and their performance is compared through computational experiments over real data sets. The exact method comprises two steps: In the first step, a constraint programming model is formulated, which generates all the feasible duties, and in the second step, a set covering problem formulation is used that finds the optimal set of duties to minimize the crew requirement. The problem is NP-hard, and it turns out to be challenging to compute exact solutions for real-life practical decisions that are handled. Therefore, we propose a heuristic algorithm that uses bin-packing features to solve the problem in polynomial time and is capable of providing good quality solutions. Additionally, the heuristic can incorporate soft constraints that improve workload balance and is easily extendable to freight trains that are generally operated in an ad-hoc manner. Ultimately, this work aims to present a better alternative to the existing manual crew allocation procedure.

Keywords: Railway crew scheduling; Indian railways; Constraint programming; Set covering problem; Heuristic algorithm

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