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Solving large-scale railway scheduling problems with automated and assisted driving systems

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The railway scheduling problem concerns the determination of trains' scheduled departure and arrival times at stops, and the allocation of capacity in the network. The timetable must be both conflict-free given infrastructure constraints, and stable enough for trains to recover from delays that could occur in normal operations. Existing methods for tactical scheduling contain a trade-off between having an accurate (microscopic) representation of signalling constraints, and having a simple-enough (macroscopic) infrastructure representation to scale to real-world problem instances. This creates issues for infrastructure managers looking to run more trains on their infrastructure by migrating to Distance-To-Go (DTG) signalling systems (e.g. ETCS Level 2), and to exploit the capabilities of Connected Driver Advisory Systems (C-DAS) and Automatic Train Operation (ATO) to control trains more precisely. In this paper, we present a methodology for incorporating the capabilities of DTG signalling in conjunction with C-DAS and ATO systems into a disjunctive scheduling model for both periodic and nonperiodic instances. We show that the resulting model has both a microscopic infrastructure representation, and a macroscopic computational complexity, allowing railways to quickly compute conflict-free and stable timetables for large problem instances. The resulting model also accurately represents the computation of the brake indication point for both conventional and DTG signalling as a function of the trains' current speed. Tests on a large-scale periodic scheduling instance in the UK show that the model produces timetables with reasonable computation time.