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# A column generation approach for the driver scheduling problem with staff cars

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## Abstract

Given a set of timetabled bus trips, transport companies are faced with the challenge of finding a feasible driver schedule that covers all trips and abides by various labor union regulations. The regulations are primarily concerned with providing sufficient breaks for the drivers during the day. Practical limitations in the city network enforce drivers to travel by cars between bus stops to have breaks. Transport companies have a limited number of cars, known as staff cars, which have to be returned to their respective depots at the end of the day. The simultaneous scheduling of drivers and staff cars for the drivers is known as the driver scheduling problem with staff cars (DSPSC). It is estimated that the DSPSC accounts for 60% of a bus company's operational expense, and this paper proposes a column generation approach that attempts to minimize operational expense. The column generation framework iterates between a master problem, a subproblem for generating driver variables and a subproblem for generating staff car variables. The subproblem related to the drivers is formulated as a resource constrained shortest path problem, which is solved by a dynamic programming approach. Several heuristic branching strategies are explored to find integer solutions. The proposed methodology is tested on eight real-life instances from seven Northern European bus companies. A comparison with a state-of-the-art mixed integer programming (MIP) solver and an adaptive large neighborhood search (ALNS) heuristic indicate that the column generation approach provides improved solutions for six instances and the average improvement is 1.45%.