TIMETABLE SYNCRONISATION FOR RAIL MASS TRANSIT

PRESENTATION ONLY

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ABSTRACT

Nothing to do but to look for the next transfer train is the passenger's plight when taking public transit in many places. To be able to design timetables with good co-ordination between train-lines so that passengers could enjoy "immediate" transfer is a service goal of the Mass Transit Railway Corporation (MTRC), which runs six railway lines with 13 interchange stations in Hong Kong. Whilst important, this problem has not received widespread research attention.

In this paper, we propose a mixed integer programming (MIP) optimization model for this timetable synchronization problem. The objective is to minimize the sum of all waiting times of all passengers at interchange stations in a railway system. By adjusting the trains' run-times and station dwell-times during their trips, and their dispatch times, turnaround times and headways at the terminals, we can construct high-quality timetables that optimize the objective of minimizing passenger waiting times. A novelty in our formulation is the use of binary variables to determine the relative sequencing of trains on different lines with passenger transfers, which enables the correct representation of the waiting times for transfers to the "next available" train at interchange stations. Furthermore, in our model, we not only adjust run times and dispatch times of trains but also dwell times, turnaround times and headway of trains, which are not studied in other papers. Numerical results will be reported, which indicate that our approach improves the synchronization of the current schedule significantly.

With trains departing every few minutes from each terminal, there are a large number of trips to consider, and hence the MIP formulation for the timetable synchronization contains thousands of binary variables and tens of thousands of continuous variables and constraints. We also investigated an optimization-based heuristic for this problem, where we heuristically "fix" the values of "most" of the binary values (based on the solution to the LP-relaxation), which determine the relative sequencing of the trains on different lines. We then solve the resulting MIP formulation, which is much smaller than the original MIP. By iteratively and heuristically searching for the subsets of integer variables to fix, we can get good-quality solutions within a reasonably short time.

In our preliminary study, we consider the train schedule in the MTR system in Hong Kong for both rush-hour and non-rush-hour periods. Using our model formulation, we constructed a schedule that reduces the waiting time for transferring passengers significantly compared to the current schedule. We also explore the trade-offs among different operational parameters and flexibility and their impact on overall passenger waiting-times.