Deriving all Passenger Flows in a Railway Network from Ticket Sales Data

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Abstract

In optimizing the Belgian national passenger train schedule, we use the quality criterium of total expected passenger travel time and try to minimize this. Using routing algorithms on the train service network, from ticket sales data, we determine the number of passengers on each local station to station ride action, on each in-station dwell action and also, on each potential transfer action. Once these are known, they can be used as constants in the subsequent timing optimization stage. We applied the first phase to the whole current Belgian passenger train service network and now continue on the timing optimization stage.

Keywords: Railway timetabling, Passenger service, Passenger flows, Shortest Path Routing

1 Reflowing: Deriving Local Passenger Flows

In optimizing the national railway timetable for the Belgian infrastructure company Infrabel, we use the quality criterium of expected total passenger travel time and try to minimize this. Optimizing the timing of all trains fairly over all passengers requires passenger flow information. Focus is usually on determining the train service offer side, being the train timing, without considering the demand side data, being the passenger flow information. In our research [2], we focus on passenger flow derivation. We start from train ticket sales data and use Dijkstras modified shortest path algorithm and some other techniques on the Belgian passenger train service graph to determine a route per passenger origin destination station pair. We sum route passenger flows over all these routes. Infrabel did not have this passenger flow information available, but they need it to optimize many decisions. We determined these passenger flows for the current timetable.

2 Ticket Sales Data Gathering Recommendations

Our research also resulted in some recommendations for passenger flow related data recording procedures, which would improve the input data.

- First, since train tickets and subscriptions are defined in terms of zones instead of stations, for an origin or destination zone with more than one station, the exact origin station or destination station is currently unknown. This information could be easily gathered at ticket purchase time by asking the passenger. Another option is to redefine tickets and subscriptions in term of stations instead of zones. Currently, using the complementary data of the number of departing passengers per station, we constructed best estimates for the station based ticket usage.
- Currently, the origin destination matrix we use to derive passenger flows, gives no information about the travel direction in the morning or the evening. When designing an optimal timetable, it would be very useful to know the difference between passenger flows in the morning and the evening.
- Third, we could ask the passenger a preferred route, defined as the sequence of trains he/she would normally take, as well as the preferred departure or arrival time.

3 Retiming and Reflow-Retime-Iterations

We call the subsequent stage of optimizing the timing part of a schedule, *retiming*. We use stochastic expected passenger time, based on historical, measured delay distributions. Inserting supplements on actions, weighted with these delay distributions, we obtain a robust [1, 3, 4] schedule. We also show how, in optimization of a timetable, timing and passenger flows should be treated as interdependent. This means that reflowing and retiming can be applied iteratively. This is part of our future research.

References

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