Tuning of RAPTOR journey planning algorithm to improve the end-user satisfaction

Pastirčáková, K.[1], **Šulc, J.**[1]

e-mail: jsulc83@gmail.com, tel.: +420 608 566 153

[1]**Jan Perner Transport Faculty, University of Pardubice,Pardubice, Czech republic**

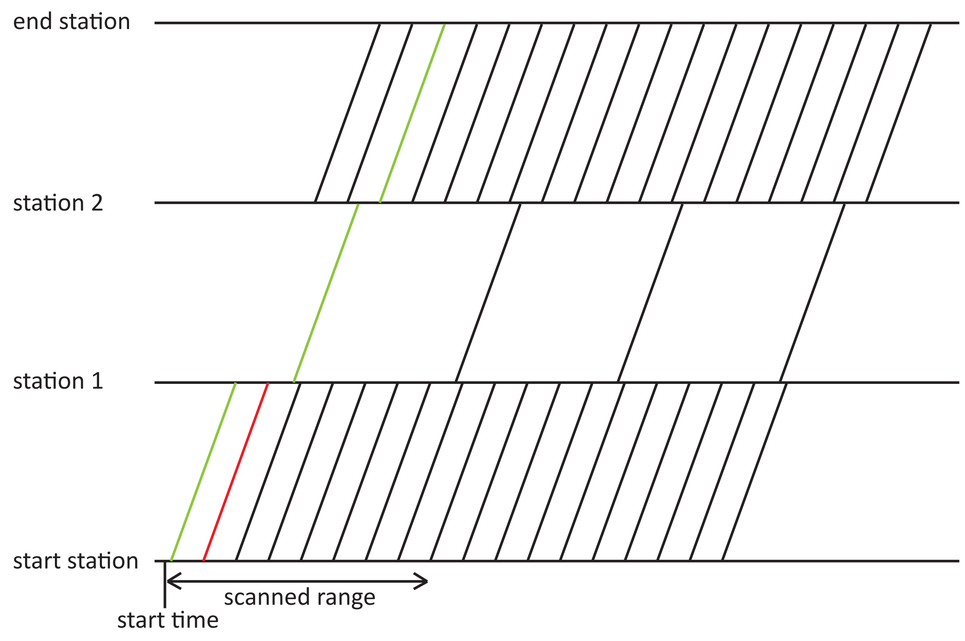
Introduction

The RAPTOR journey planning algorithm optimizes for two criteria: arrival time and number of transfers. However, when optimizing for the minimal arrival time, RAPTOR doesn't maximize the departure time, neither it finds any later alternatives. Both properties are important for the end user satisfaction with a journey planner especially in multi-modal journey planner. Skipping in time to obtain the next alternative journey can degrade or significantly slow down the algorithm. In this paper we are analyzing model situations and impact of two approaches. Cycle management of general RAPTOR and specific setting of RAPTOR extension - rRAPTOR - which leads to provisioning set of journeys within a time range having minimal travel time for given number of transfers.

As for the RAPTOR cycle management, we describe how to minimize the travel time by running the RAPTOR algorithm consecutively 3 times. In the first run we determine the earliest arrival time, in the second run we identify the latest departure time. The third run serves for the selection of the final journey in the way which shifts the waiting times towards the end of the journey, therefore the final journey is more resilient to delays.
We then discuss the possibilities of provisioning the time alternatives for the journeys found. For comparism we made tests described in this paper.

Conditions of test

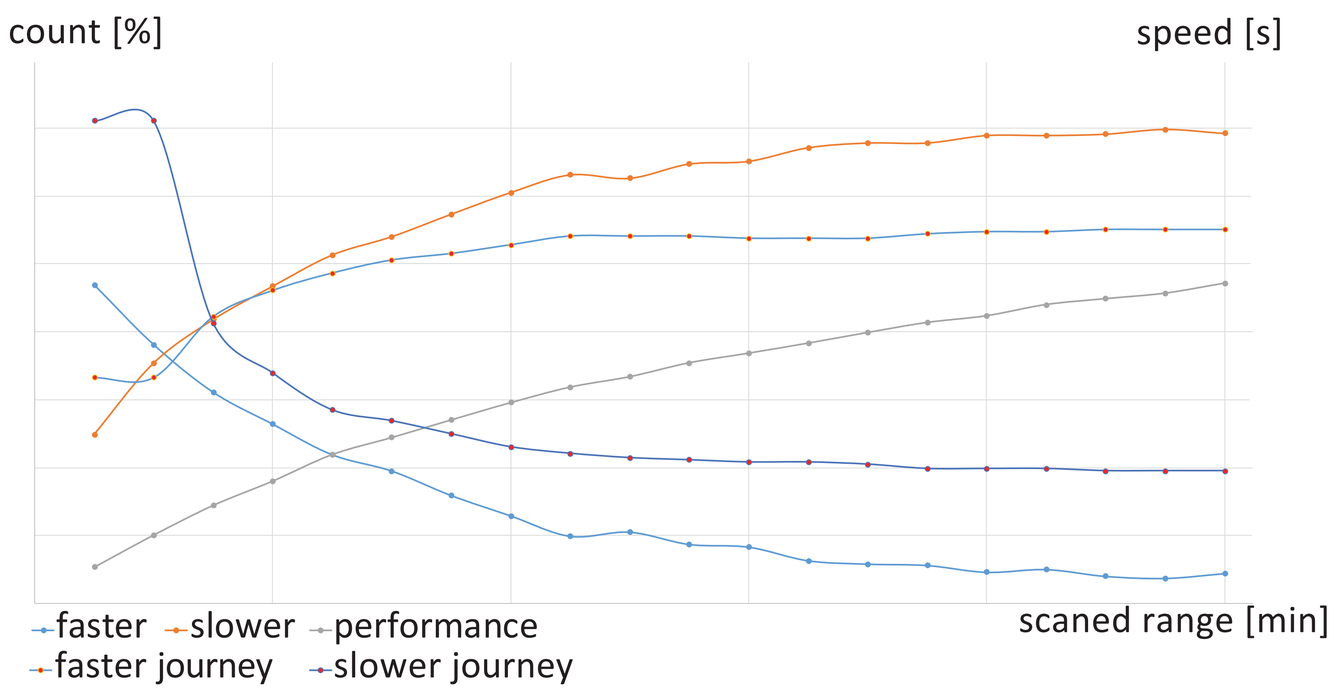
- 1.000 searches with random source and destination stop, random maximal number of transfers, random selection of providing either random departure time or random arrival time.
- Simplified RAPTOR cycle management is used for provisioning three time-alternatives, with time shift after the latest departure time within the existing Pareto-set (or before earliest arrival time). As discussed previously, such search is more efficient, but it can omit some Pareto-optimal journeys.
- rRAPTOR is tested for 5-100 minutes long time ranges.
- Timetables are combined of city, suburban and train transportation in Czech region of Liberec. The overall network has 350 stops, 122 routes served by 4.433 trips, and a total of 142.229 distinct departures (a trip departing from a stop). The shortest interval between consecutive trips is 4 minutes (city transport) and the longest is 1440 minutes (train transport).
- 1 core, no parallelization.

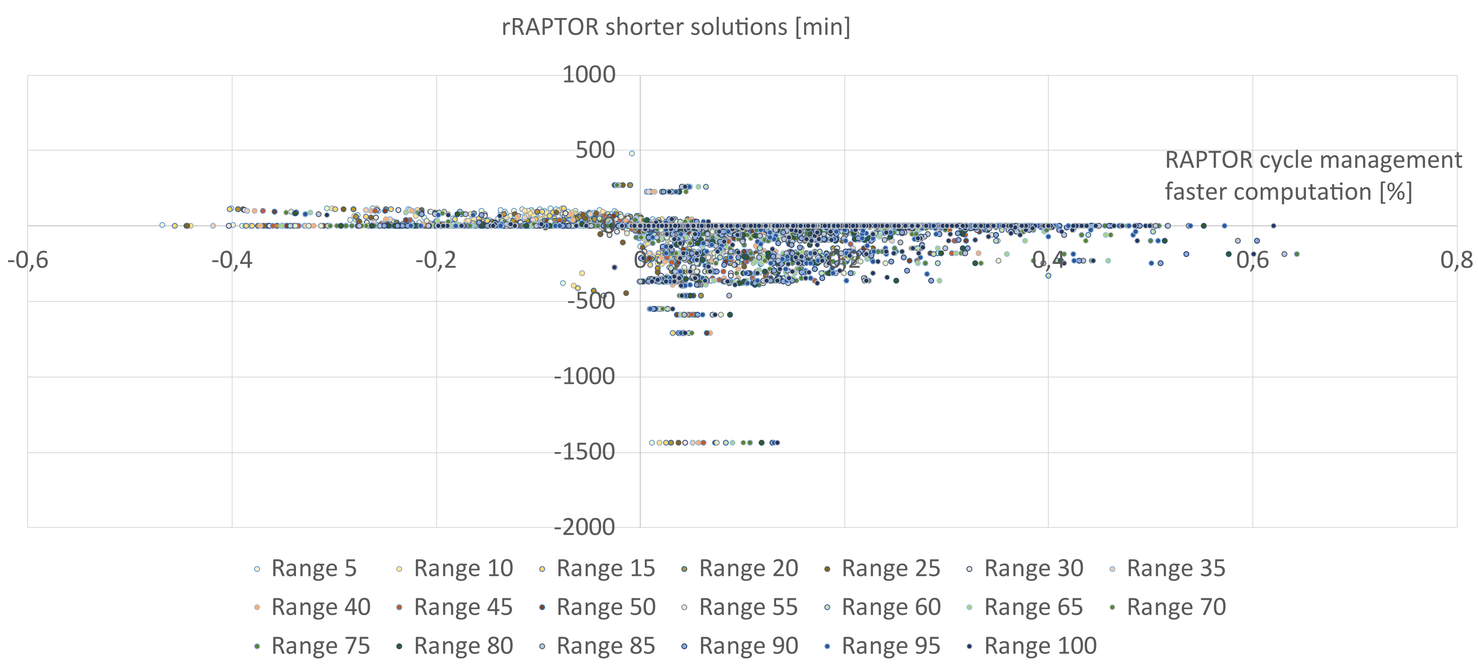


Algorithm speed and speed of journeys

1st graph shows the results of test searches. Light blue curve shows the number of cases in which rRAPTOR is faster than RAPTOR. Curve of faster journeys (blue curve with orange dots) shows cases where simplified RAPTOR cycle management found connections with higher differences between start and end time of the journey. Grey curve represents speed of rRAPTOR and is on the minor axis. The Grey curve shows that the increase in the calculation time is sublinear.

2nd graph shows the comparison the timeliness of rRAPTOR against the simplified RAPTOR cycle management, while also comparing the lengths of the journeys found. If we further segment the results based on transportation type, then the second quadrant of the graph is dominated by city transportation, whereas the fourth quadrant is dominated by journeys which include also the suburban or train trips.





Conclusion

Both suboptimal approaches - rRAPTOR and simplified RAPTOR cycle management - are utilizable for journey planner, yet none of them can be marked as optimal solution. The tests revealed that rRAPTOR is suitable for city transport and generally systems with low differences in trip frequencies. If the differences between trip frequencies are high, for example when combining high frequency city transportation with low frequency suburban and train transportation, then the use of simplified RAPTOR cycle management is preferable.

The resulting journey planner is already used in public transit routing systems in the Czech Republic. We still receive customer complaints on the amount and variability of alternative journeys provided, however the complaint rate is steadily very low, around 1 complaint raised per quarter.