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Project B15

Service Design in Public Transport

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Domain of Expertise: Traffic and Transport

Topic

The goal of this project is to support the design of a public transportation system by mathematical optimization. In this way, we want to improve the efficiency and the attractiveness of public transport. There are two major challenges:

1. the simultaneous optimization of two competing objectives, namely, cost minimization versus quality of service, and
2. the consideration of passenger behavior.

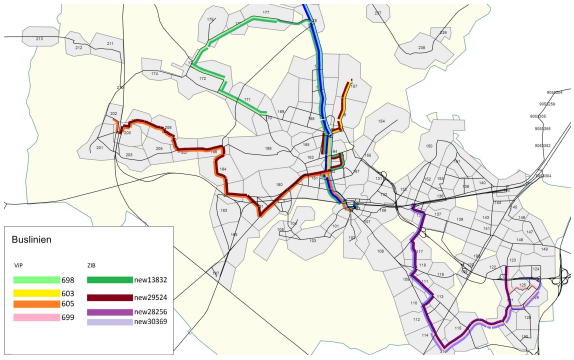
We focus on the *line planning problem*, i. e., the definition of line routes and their associated frequencies of operation.

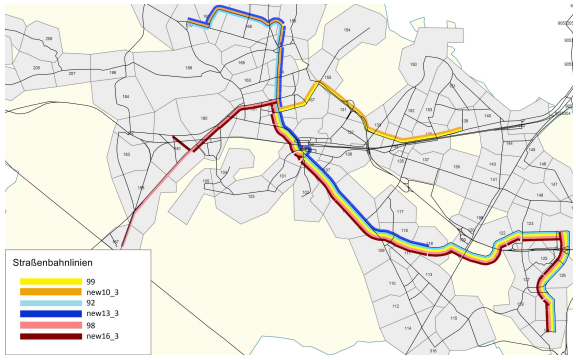
Line Optimization – Potsdam 2010

We optimized the 2010 line plan of Potsdam's public transport company ViP in the project Stadt+. The final optimized solution reduces the cost by around 4 % and the perceived travel time by around 6 %[a]. ViP implemented a slightly deviating plan: ViP did not want to reduce the tram network as much as the optimizer suggested for fear of demand reductions.

[a] evaluated with VISUM (ptv AG)

	optimized	implemented
average total travel time	36 min 3 s	36 min 39 s
average time in vehicle	13 min 8 s	14 min 36 s
average transfer waiting time	1 min 30 s	1 min 29 s
average walking time	1 min 38 s	1 min 37s
average perceived travel time	26 min	27 min 37 s
total number of transfers	10 595	11 141
passengers with 0 transfers	37 338	36 851
passengers with 1 transfer	10 088	10 503
passengers with 2 and more transfers	250	315





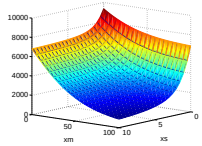
bus lines and tram lines that differ in the optimized line plan (lines with suffix "new") and in the implemented line plan; graphics with VISUM (ptv AG)

Transfers

- exact treatment of transfers ⇝ large scale models
- *direct connection approach* to maximize direct travelers
  - idea: penalize all paths that do not provide a direct connection
  - "first order" approximation on exact models
  - computationally tractable for medium-scale real-world instances
  - accurate estimates on the (real) number of direct travelers

Passenger Behavior and Variable Demand

- include passenger preferences in terms of the transportation mode, e. g., bus or tram
- bound passenger volume in terms of travel time (consider individual traffic as travel alternative)
- investigate the use of a demand function in line planning models



Matheon B3, B20, B22, F4; Verkehrsbetrieb Potsdam GmbH (ViP); IVU AG; M.E. Pfetsch (TU Darmstadt); R. Torres, L.M. Torres (EPN Quito)