Short term predictions in public transport
Applying Dutch smartcard data

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Introduction

• Assistant professor at TU Delft
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• Practice < - > Science

• Research agenda
  • Optimizing public transport level of service
  • Network, timetables and operations
  • Data driven research
  • Special interest in reliability and robustness

• Today: pragmatic approach to PT forecasts, usable for operators and authorities
• Modeling as a tool, not as an objective
Challenges in PT industry

Main challenges:
- Increasing cost efficiency
- Increasing customer experience
- Motivating new strategic investments

- Data and models enable achieving objectives
Applied examples

- **Monitoring and predicting passenger numbers: Whatif**

- **Quantifying benefits of enhanced service reliability in public transport**
  Van Oort, N. (2012)., Proceedings of the 12th International Conference on Advanced Systems for Public Transport (CASPT12), Santiago, Chile.

- **Optimizing planning and real time control**
  Van Oort, N. and R. van Nes (2009), Control of public transport operations to improve reliability: theory and practice, Transportation research record, No. 2112, pp. 70-76.

- **Optimizing synchronization multimodal transfers**
  Lee, A. N. van Oort, R. van Nes (2014), Service reliability in a network context: impacts of synchronizing schedules in long headway services, TRB

- **Improved scheduling**
Smartcard data (1/2)

The Netherlands
- OV Chipkaart
- Nationwide
- All modes: train, metro, tram, bus
- Tap in and tap out
- Bus and tram: devices are in the vehicle

Issues
- Privacy
- Data accessibility via operators

Data
- 19 million smartcards
- 42 million transactions every week
Smartcard data (2/2)

• Several applications of smartcard data (Pelletier et. al (2011). Transportation Research Part C)

Our research focus:

**Connecting to transport model**

• Evaluating history
• Predicting the future
• Elasticity approach (quick and low cost)

• Whatif scenario’s
  • Stops: removing or adding
  • Faster and higher frequencies
  • Route changes

• Quick insights into
  • Expected cost coverage
  • Expected ridership
Connecting data to transport model

- Importing PT networks (GTFS) (Open data)
- Importing smartcard data (Closed data)
- Matching
- Visualization options of transport model
Challenge the future

fictitious data
OD-patterns
Challenge the future

OD-patterns

Fictieve data
What if?
PT modelling

Traditional (4-step) model
- Multimodal (~PT)
- Network
- Complex
- Long calculation time
- Visualisation
- Much data
- Detailed results

Simple calculation
- PT only
- Line
- Transparent
- Short calculation time
- Only numbers
- Little data
- Assessments

Short term predictions
- Impact of construction works (rerouting, ridership decrease)
- Simple efficiency improvements (schedule, fares)
- Dealing with budget savings (least damage)

Elasticity method based on smartcard data
What if: elasticity approach

\[ C_{ij} = \alpha_1 T_{ij} + \alpha_2 WT_{ij} + \alpha_3 NT_{ij} + \alpha_4 F_{ij} \]  
\[ \text{With:} \]
\[ C_{ij} \] Generalized costs on OD pair \( i,j \)
\[ \alpha_1, \alpha_2, \alpha_3, \alpha_4 \] Weight coefficients in generalized costs calculation
\[ T_{ij} \] In-vehicle travel time on OD pair \( i,j \)
\[ WT_{ij} \] Waiting time on OD pair \( i,j \)
\[ NT_{ij} \] Number of transfers on OD pair \( i,j \)
\[ F_{ij} \] Fare to be paid by the traveler on OD pair \( i,j \)

Elasticities
- Literature (e.g. Balcombe)
- “Proven “ rules of thumb

NOTE:
- Simple changes
- Short term
- Only LOS changes
- Accuracy
Whatif scenarios

Adjusting
- Speed
- Fares
- Routes
- Frequency

Illustrating impacts on (indicators):
- Cost coverage
- Occupancy
- Ridership
- Revenues
Whatif results: Flows rerouting
Whatif results: Flows increased frequencies
Summary

- Major challenges in public transport
- Data supports optimization
- Evaluating and controlling -> predicting and optimizing

- Connecting data to transport models enables short term predictions
- Combining strengths of two approaches (complex <-> simple)

- First cases show promising results
- Valuable for quick scan or first selection of project alternatives

Next steps
- Updating elasticities (using smartcard data)
- Additional factors in cost function (reliability, crowding, etc)

Pitfall
Combining weaknesses of two approaches
Questions / Contact

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Publications

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