# Short term predictions in public transport

## Applying Dutch smartcard data

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1st Smart card data workshop
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# Introduction

- Assistant professor at TU Delft
- Consultant Public Transport at Goudappel Coffeng

- 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**
*Van Oort, N. et al. (2012). The impact of scheduling on service reliability: trip time determination and holding points in long-headway services. Public Transport, 4(1), 39-56.*

# 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)

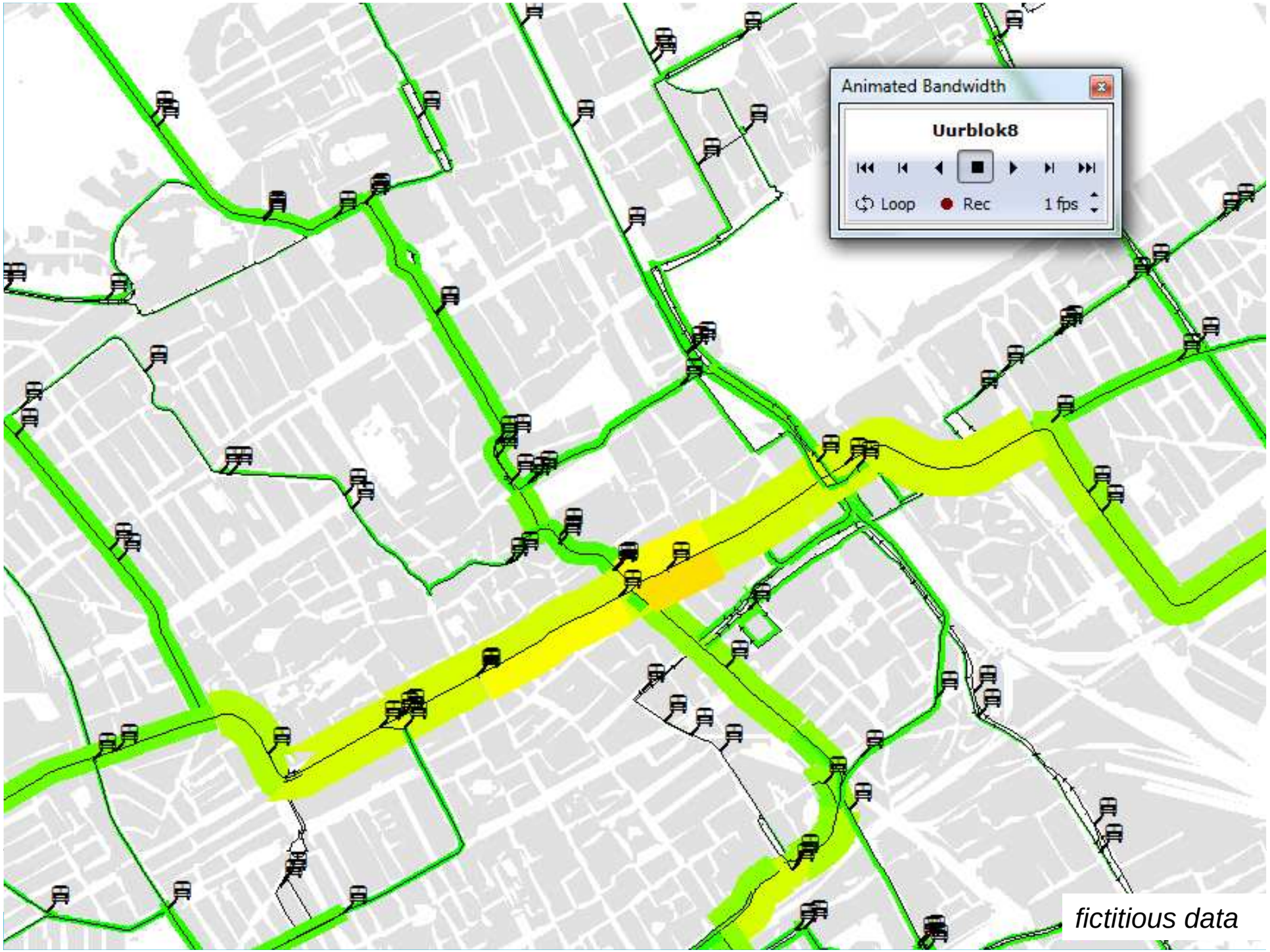
- Whatif scenario's
  - Stops: removing or adding
  - Faster and higher frequencies
  - Route changes

- Quick insights into
  - Expected cost coverage
  - Expected ridership

OmniTRANS
Transport Planning Software

# Connecting data to transport model

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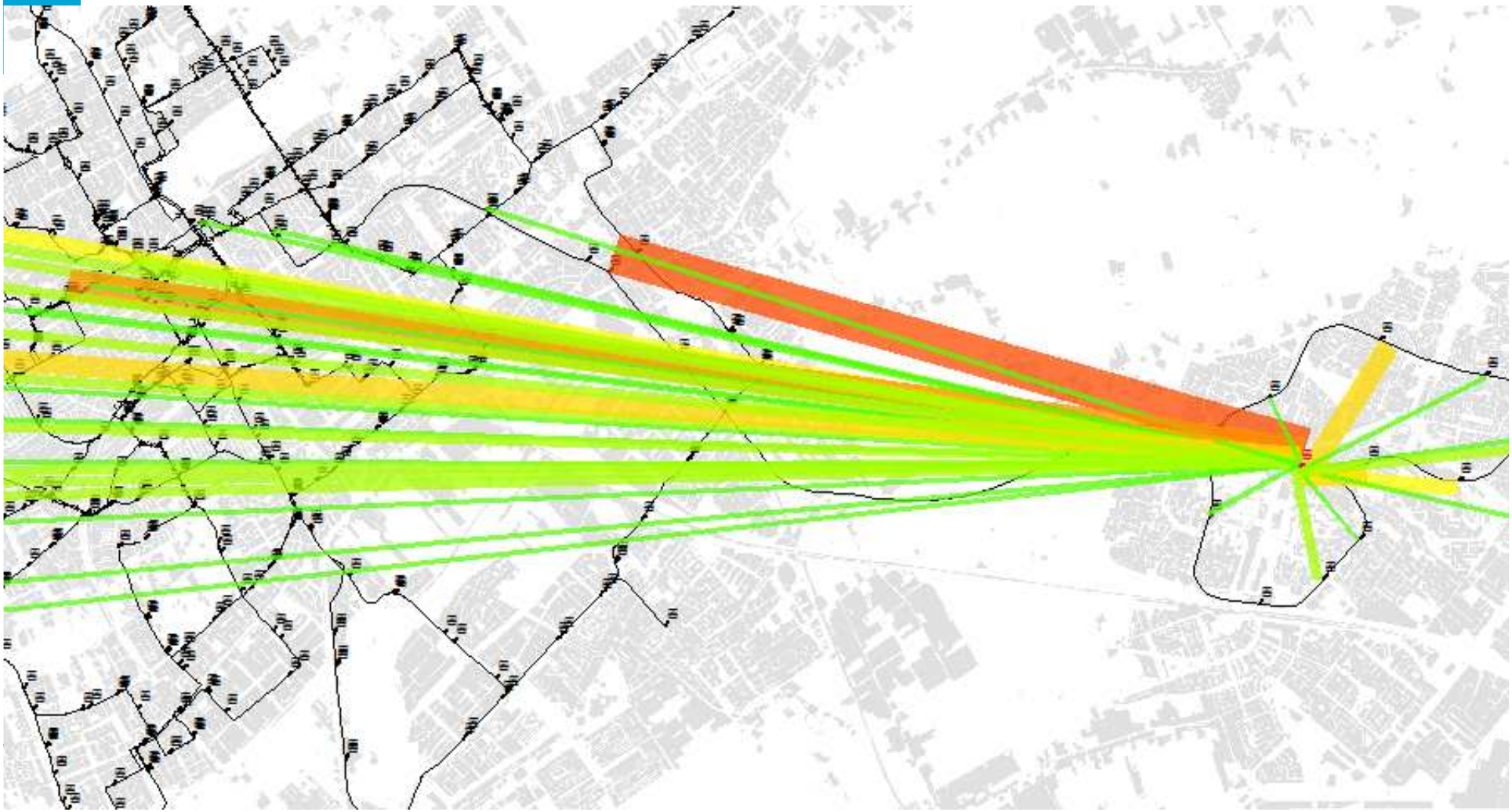
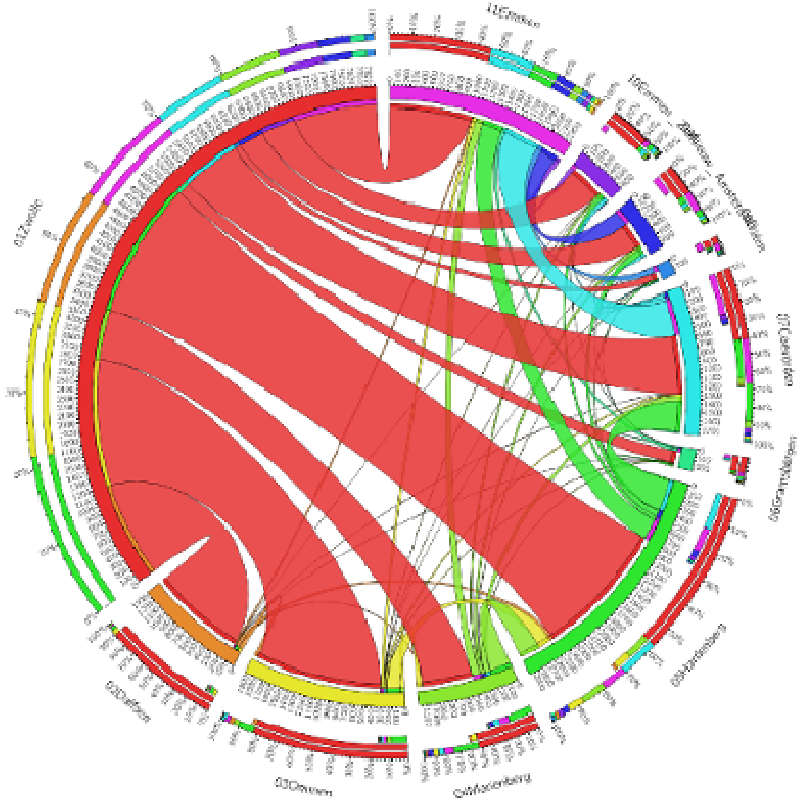
Fictieve data

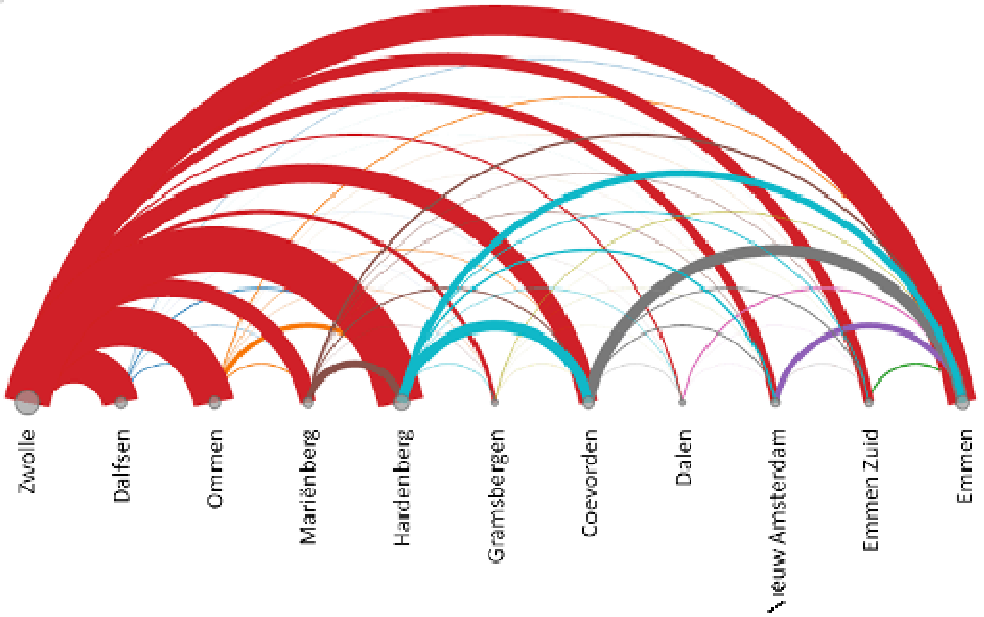
# OD-patterns



*Fictieve data*

# OD-patterns




Zwolle
Dalfsen
Ommen
Mariënberg
Hardenberg
Gramsbergen
Coevorden
Dalen
Nieuw Amsterdam
Emmen Zuid
Emmen

# 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

$$C_{ij} = \alpha_1 T_{ij} + \alpha_2 WT_{ij} + \alpha_3 NT_{ij} + \alpha_4 F_{ij} \quad (1)$$

*With:*

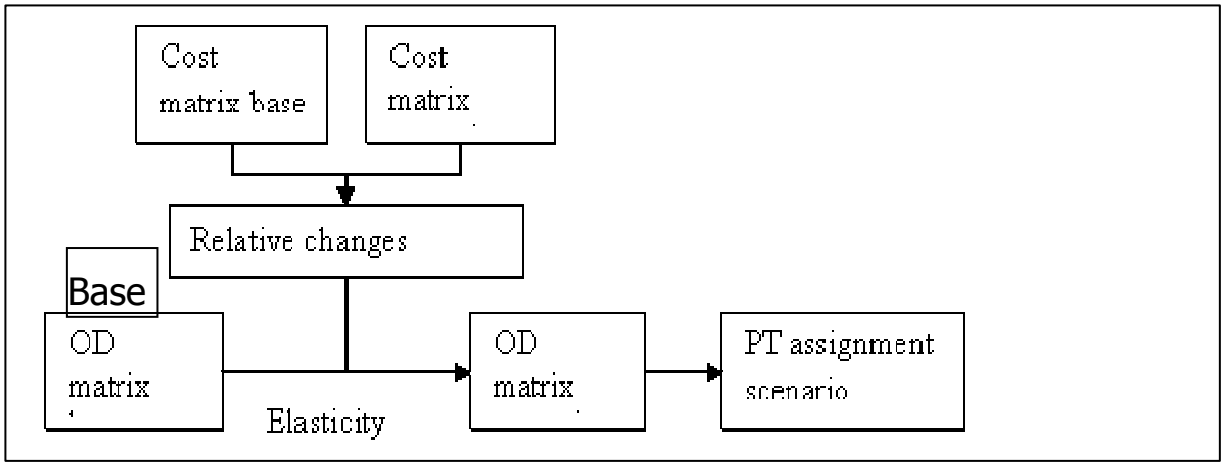
| | |
|---|---|
| $C_{ij}$ | Generalized costs on OD pair *i,j* |
| $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ | Weight coefficients in generalized costs calculation |
| $T_{ij}$ | In-vehicle travel time on OD pair *i,j* |
| $WT_{ij}$ | Waiting time on OD pair *i,j* |
| $NT_{ij}$ | Number of transfers on OD pair *i,j* |
| $F_{ij}$ | Fare to be paid by the traveler on OD pair *i,j* |

NOTE:

- Simple changes
- Short term
- Only LOS changes
- Accuracy

Elasticities

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



# Whatif scenarios

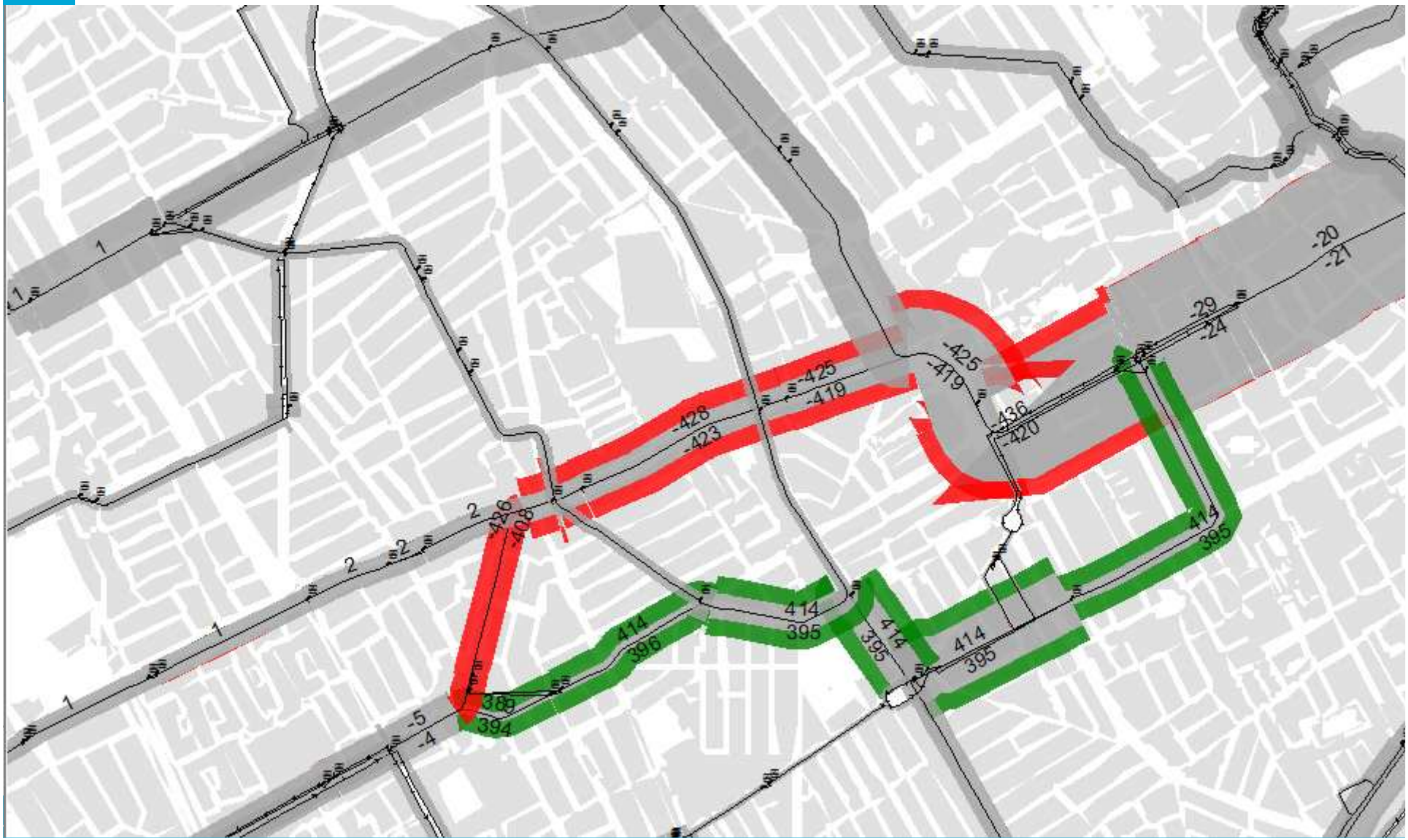
**Adjusting**

- Speed
- Fares
- Routes
- Frequency

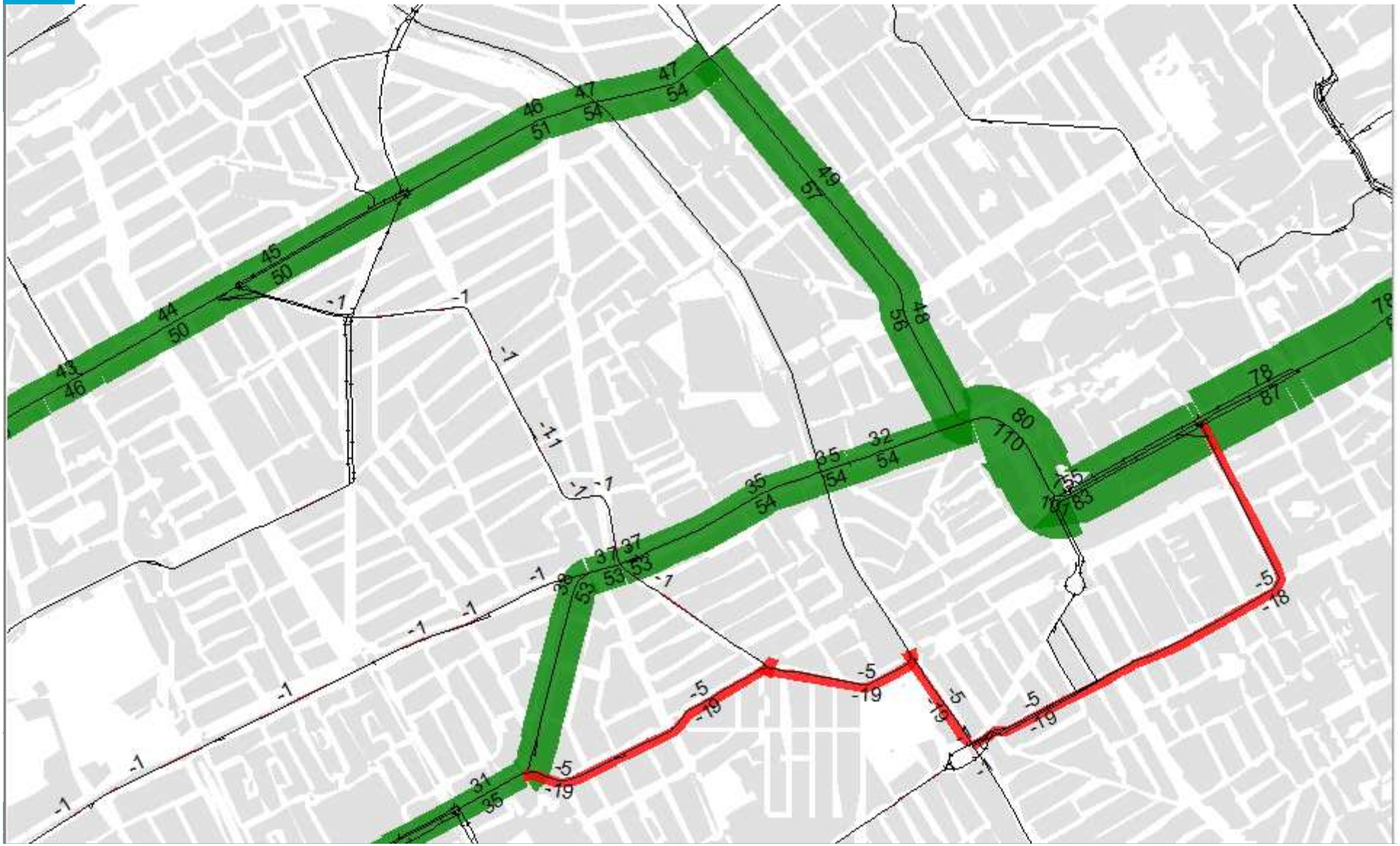
**Illustrating impacts on (indicators):**

- 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 strenths 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**

https://nielsvanoort.weblog.tudelft.nl/