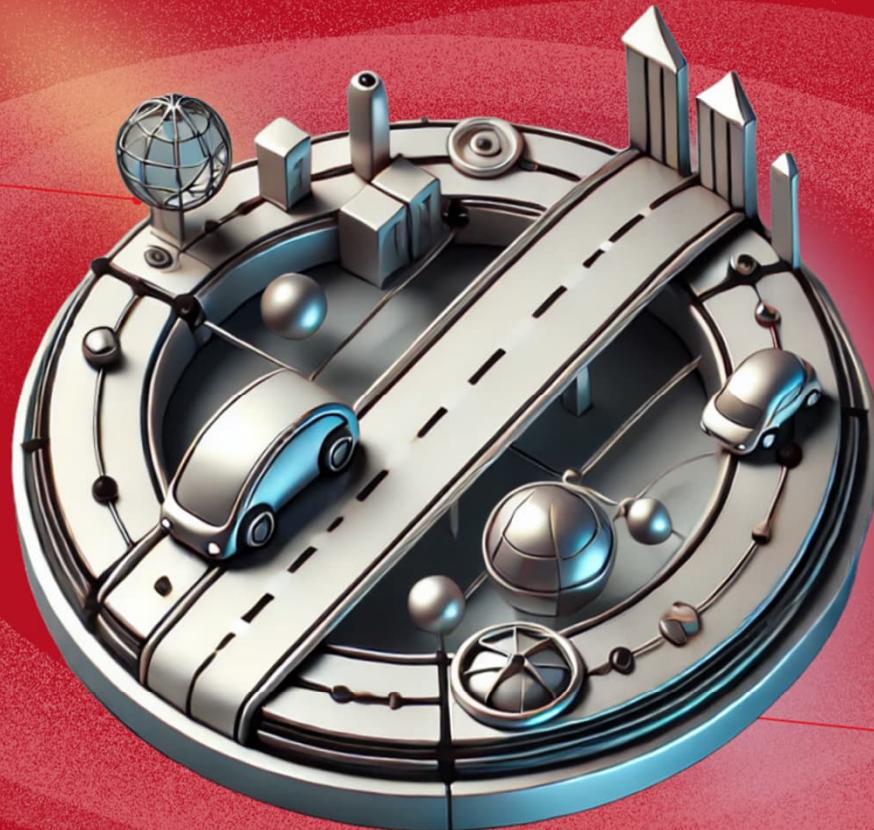


The Art and Science of Transportation Research in the AI Era

Transport modelling

Dr.-Ing. Wei Jiang



Dr.-Ing. Wei Jiang

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- Education:
 - M.Sc in the field of Infrastructure Planning
 - Doctoral study at the institute under the supervision of Prof. Boltze
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 - Traffic signal systems
 - Traffic simulation
 - Transport-related environmental impacts
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YUNEX TRAFFIC

Unternehmen Portfolio Weltweit Newsroom

Uniting what's next > in traffic.

Intelligente Verkehrsmanagementlösungen, die unsere Gesellschaft in Bewegung halten.

Yunex Traffic entwickelt innovative Lösungen und Services, die **Mobilität sicherer, effizienter und nachhaltiger** machen. Unsere Lösungen bewegen Menschen, verbinden Gemeinschaften und unterstützen eine nachhaltigere Welt.

Learning goals



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- #1 Understand the structure and components of macroscopic transport model
- #2 Understand the structure and components of microscopic traffic flow simulation
- #3 Understand the differences between them

- #4 Be able to create a small network using microscopic traffic flow simulation

Agenda



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- #1 Macroscopic transport model
- #2 Microscopic traffic flow simulation

Agenda



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- #1 Macroscopic transport model
- #2 Microscopic traffic flow simulation

#1.1 Features

- Analytical model
- Model current traffic volumes
- Forecast traffic volumes
- Used for private or freight transport



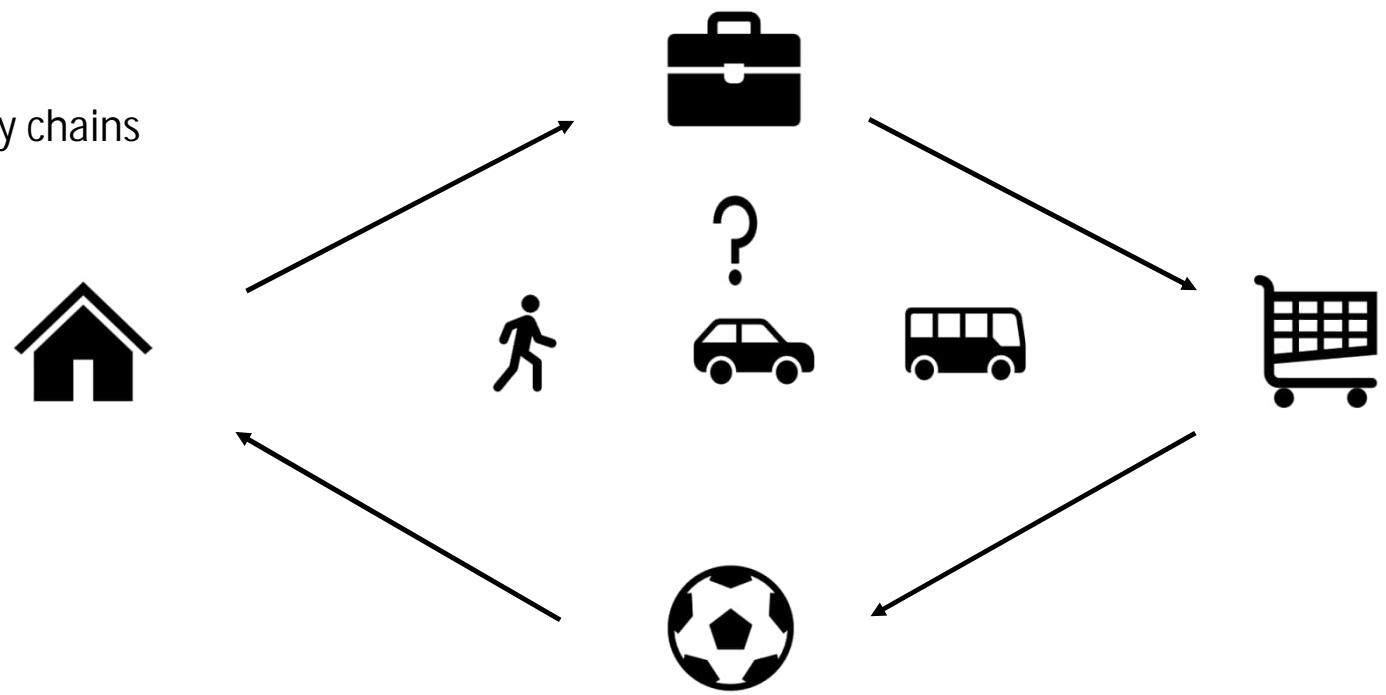
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#1.2 Causes of transport (1)

- Human needs
- Activities and activity chains



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#1.2 Causes of transport (2)



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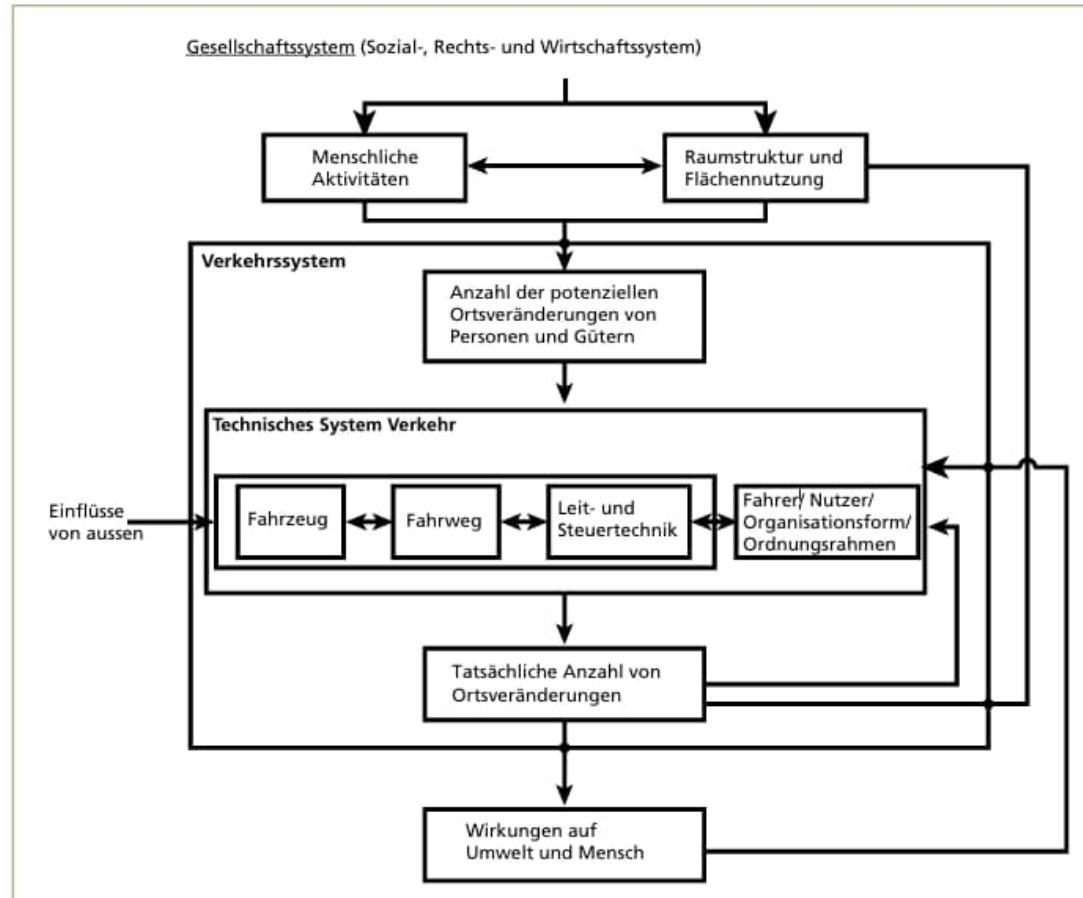


Image source:
Köhler, 2014

#1.3 Transport-related decisions



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- Where is the destination?
- Which travel mode is chosen?
- Which route to take?
- When does the trip start?
- How long does the trip take?

#1.4 Activity: inputs and results



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Brainstorming



#1.5 Structure of the transport model



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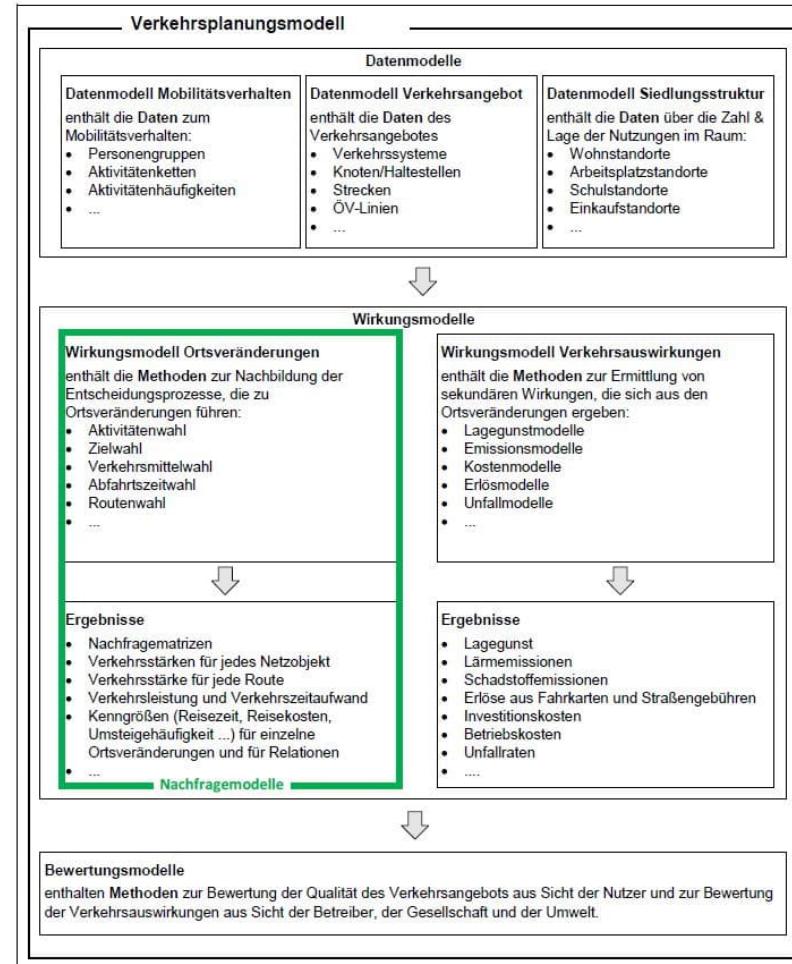


Image source:
Friedrich, 2011

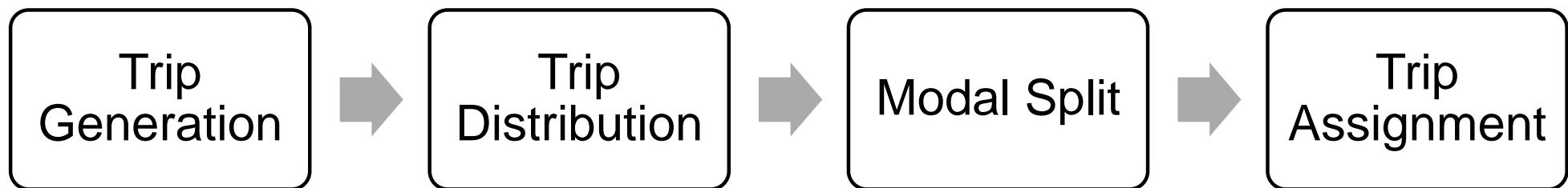
#1.6 Four steps model



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#1.7 Simulation steps of the transport model

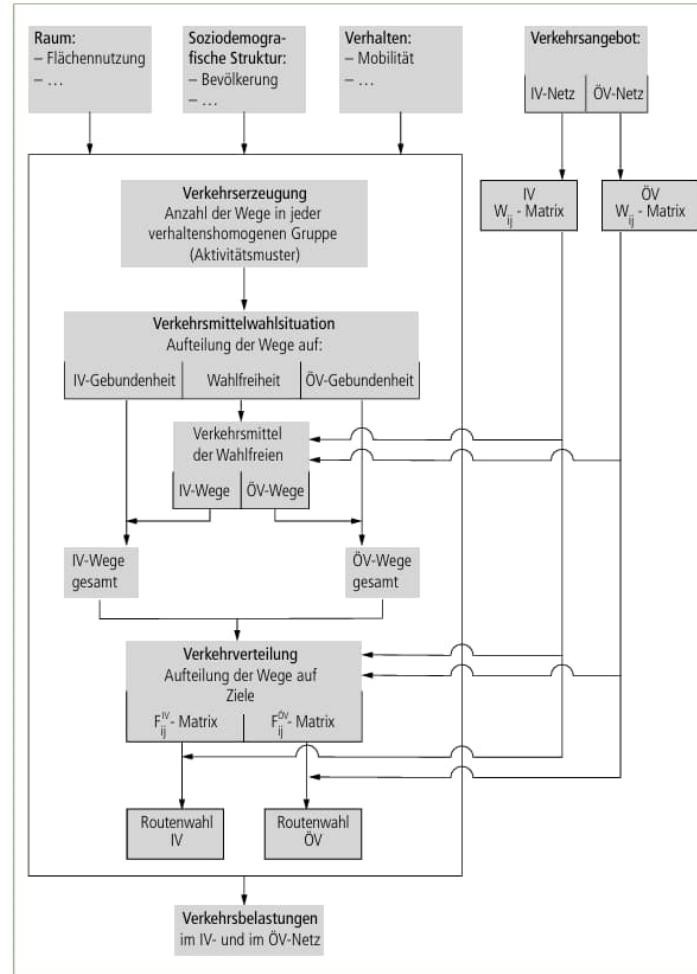


Image source:
Köhler, 2014

#1.8 Example PTV VISUM (1)



Transport demand model – travel behavior

- Total population size
- Categorised in 20 homogeneous groups
- 17 activity types
- Activity chains, eg. home – work – home, home – education – home, home – work – leisure - home

#1.8 Example PTV VISUM (2)

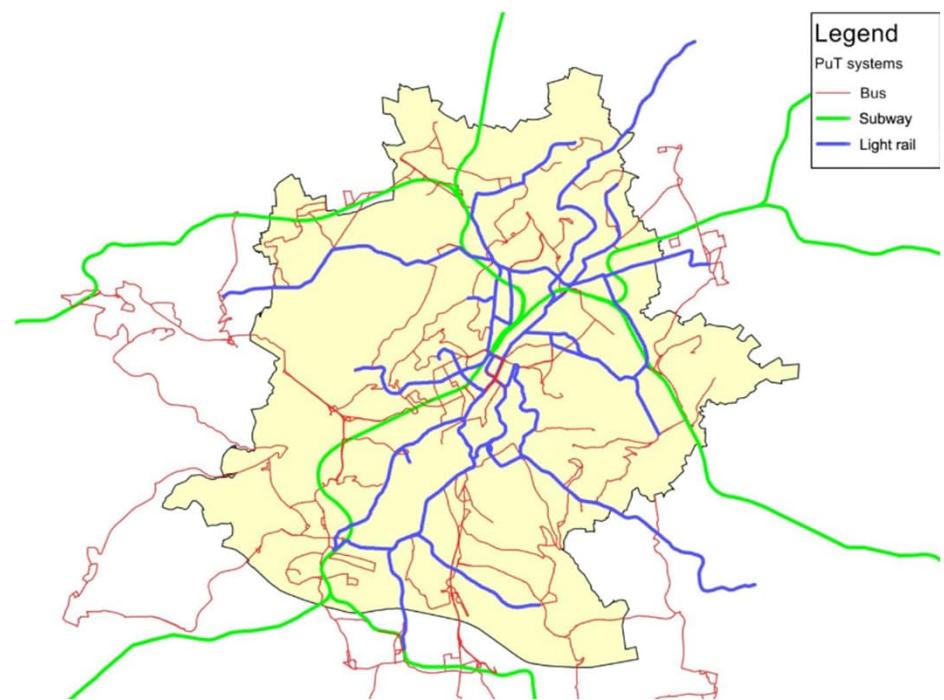
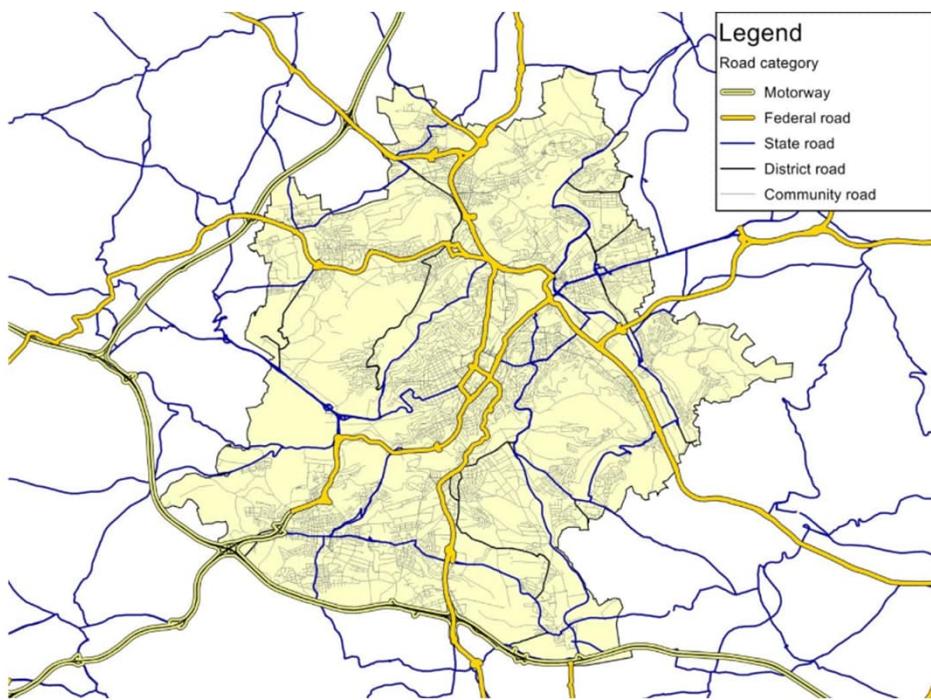


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Transport demand model – transport supply



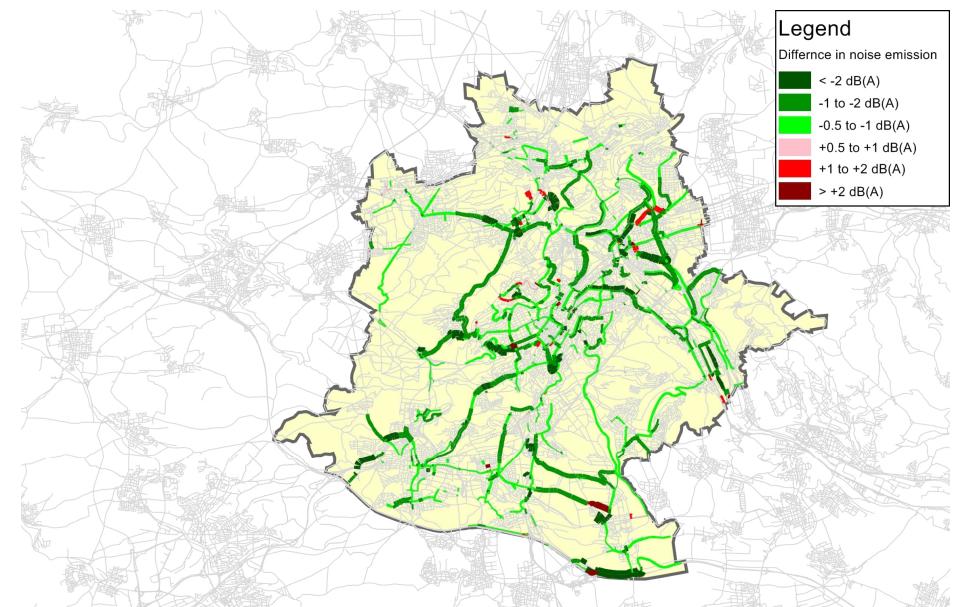
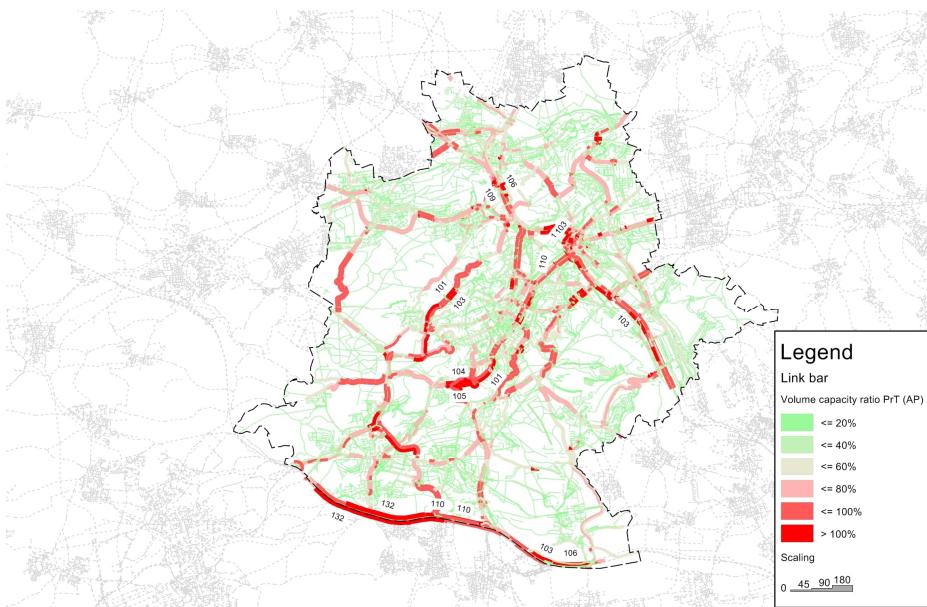
#1.8 Example PTV VISUM (2)



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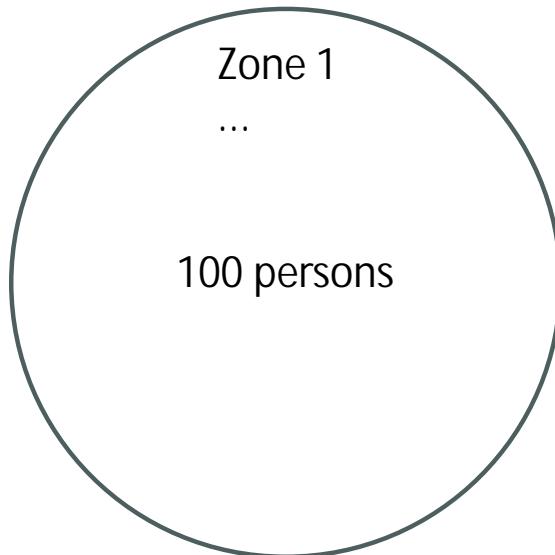
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Evaluation model – transport and emissions

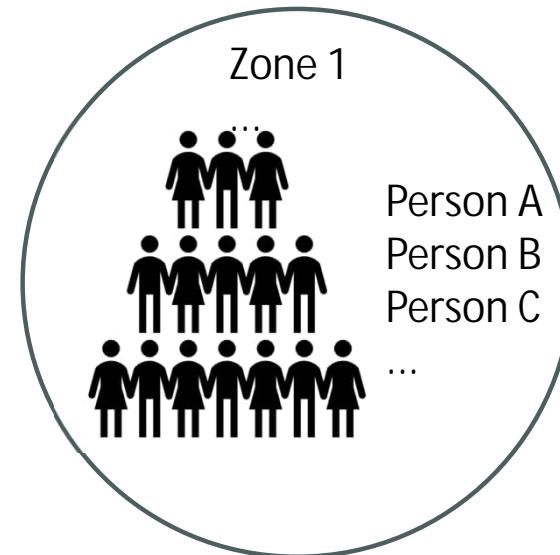


#1.9 Agent-based demand model

Macroscopic transport model



Agent-based demand model



#1.10 Summary of the macroscopic transport model



- Transport arises from human needs.
- Four step model to model transport demands.
- Input data are travel demands, transport supply and land use data.
- Results include traffic volumes in the transport network, transport-related emissions etc..
- Agent-based demand model can simulate each individual.

Agenda



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- #1 Macroscopic transport model
- #2 Microscopic traffic flow simulation

#2.1 Features

- Simulate traffic flow
- Simulate the movements of each road user
- Possible to simulate multiple traffic modes, eg. walking, cycling, motorised private transport, public transport and heavy transport
- Simulate complex interactions between different road users
- Use mathematical models
- With the help of GIS (geoinformation system)

#2.2 Use cases



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Traffic flow simulation is particularly useful for modelling urban traffic. Here are some examples in practice:

- Test and plan traffic signal control
- Evaluate and optimise the traffic flow quality in the current or planned scenarios
- Evaluate and optimise the pedestrian facility
- Use as the basis for further emission modelling

#2.3 Structure



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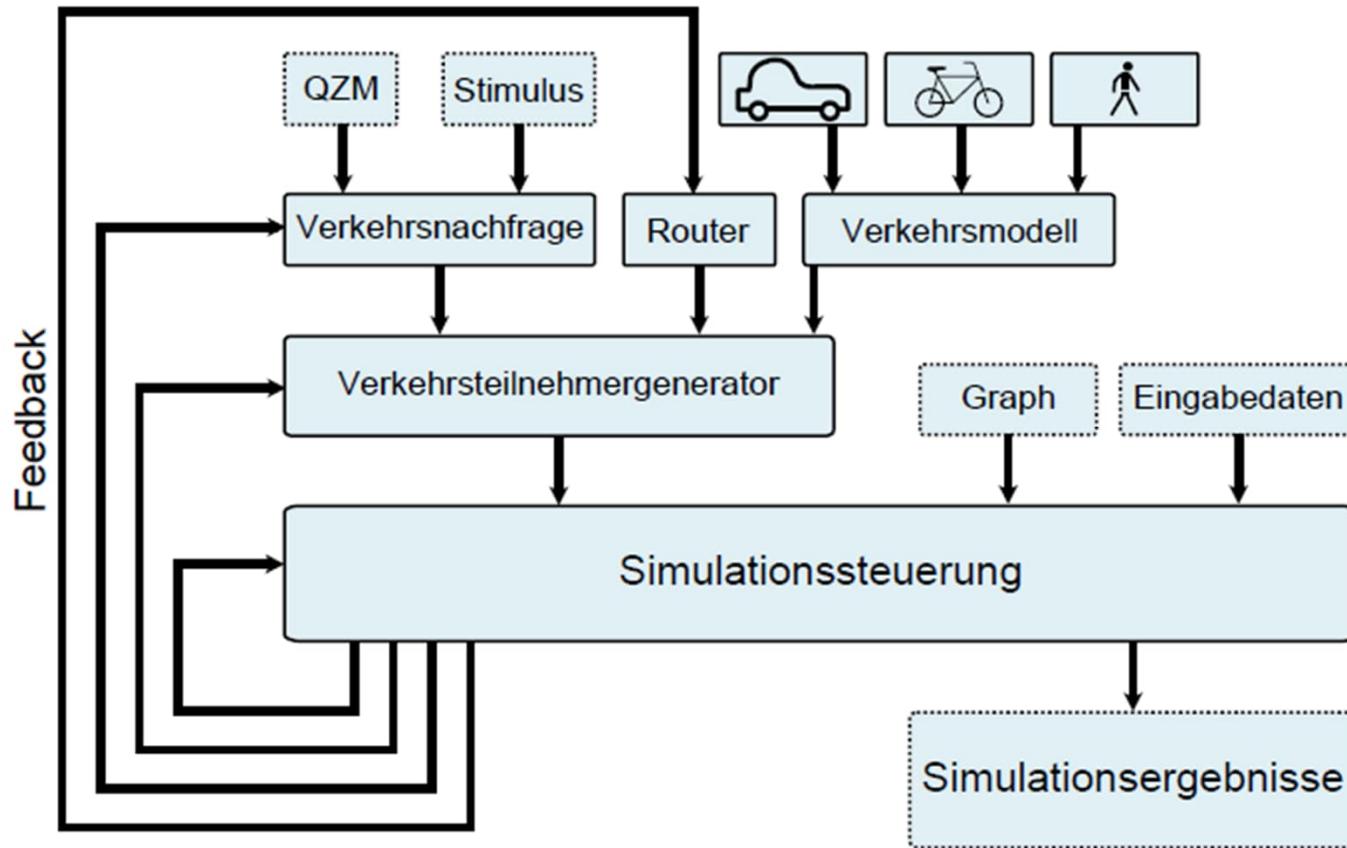
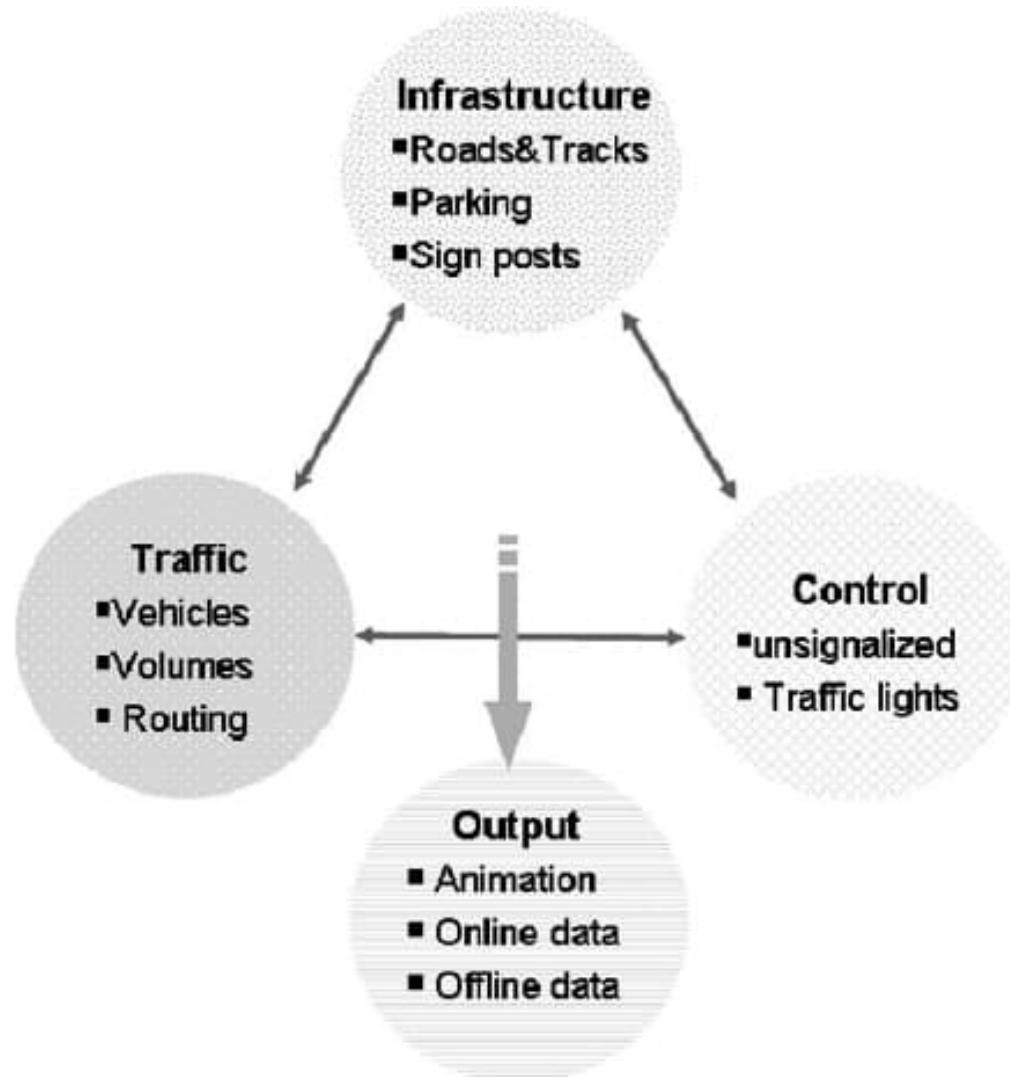


Image source:
Dallmeyer, 2014

#2.4 Inputs and results



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Image source:
Fellendorf, 2011

#2.4 Results

- Typical results include delay, travel time, stops, queues, speeds, and density.
- Vehicle projectory data can be exported.
- Aggregation levels are free to be chosen.
- Possible to create video clips with vehicles animated in 2D or 3D level.
- Exported data can be further used to estimate environmental-related parameters.

#2.5 Model calibration and validation



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Model calibration

Adjust model parameters so that the simulation model can better represent the field traffic condition

Model validation

Test the calibrated model on independent, unseen data to assess its generalisation ability and overall accuracy

#2.6 Examples for traffic simulation systems

- Aimsun
- PTV Vissim
- Corsim
- Transim
- Matsim



- Integration
- Hutsim
- Sumo



Image source: <https://www.aimsun.com/>;
<https://www.ptvgroup.com/de/produkte/ptv-vissim>
<https://en.wikipedia.org/wiki/CORSIM>
<https://www.ivt.ethz.ch/forschung/matsim.html>
<https://github.com/eclipse-sumo/sumo>



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#2.6 Example Aimsun



Image source:
<https://www.aimsun.com/>

#2.6 Example PTV Vissim (1)



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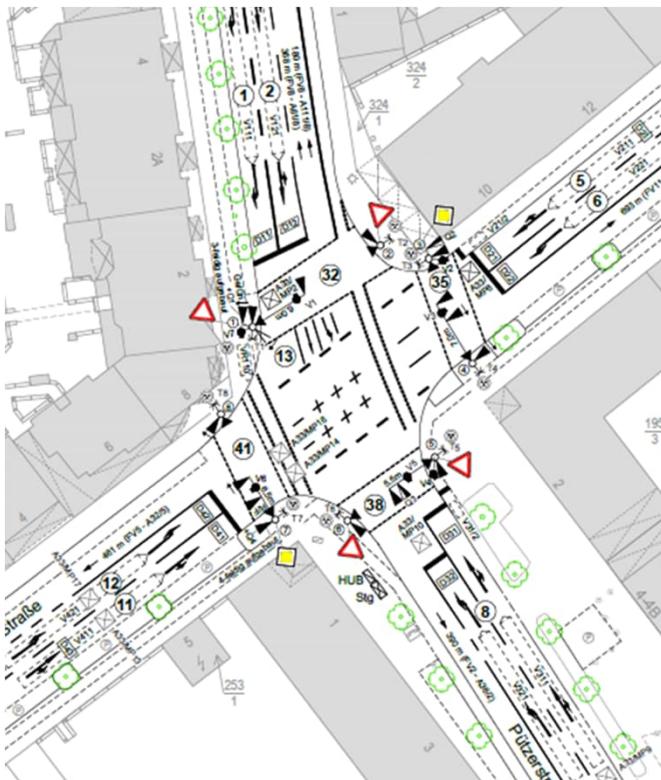
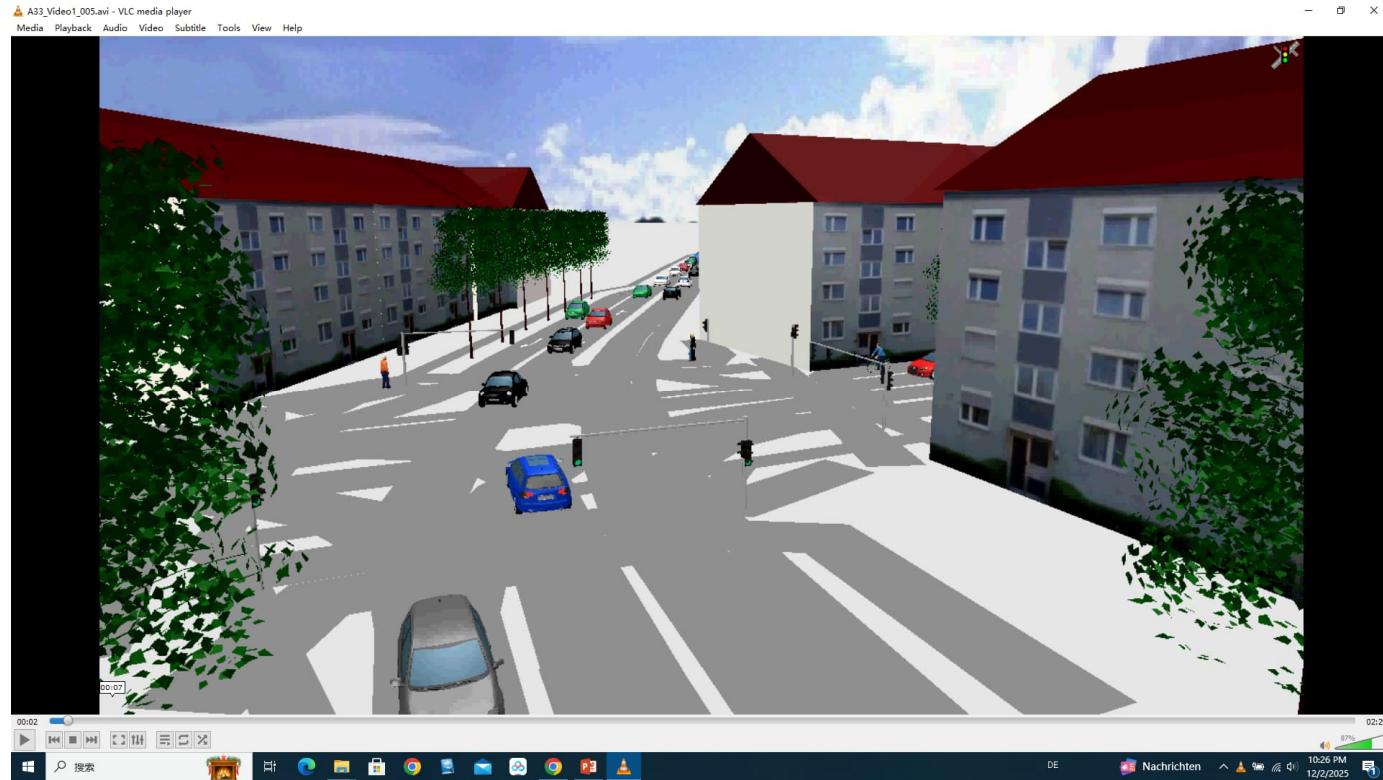
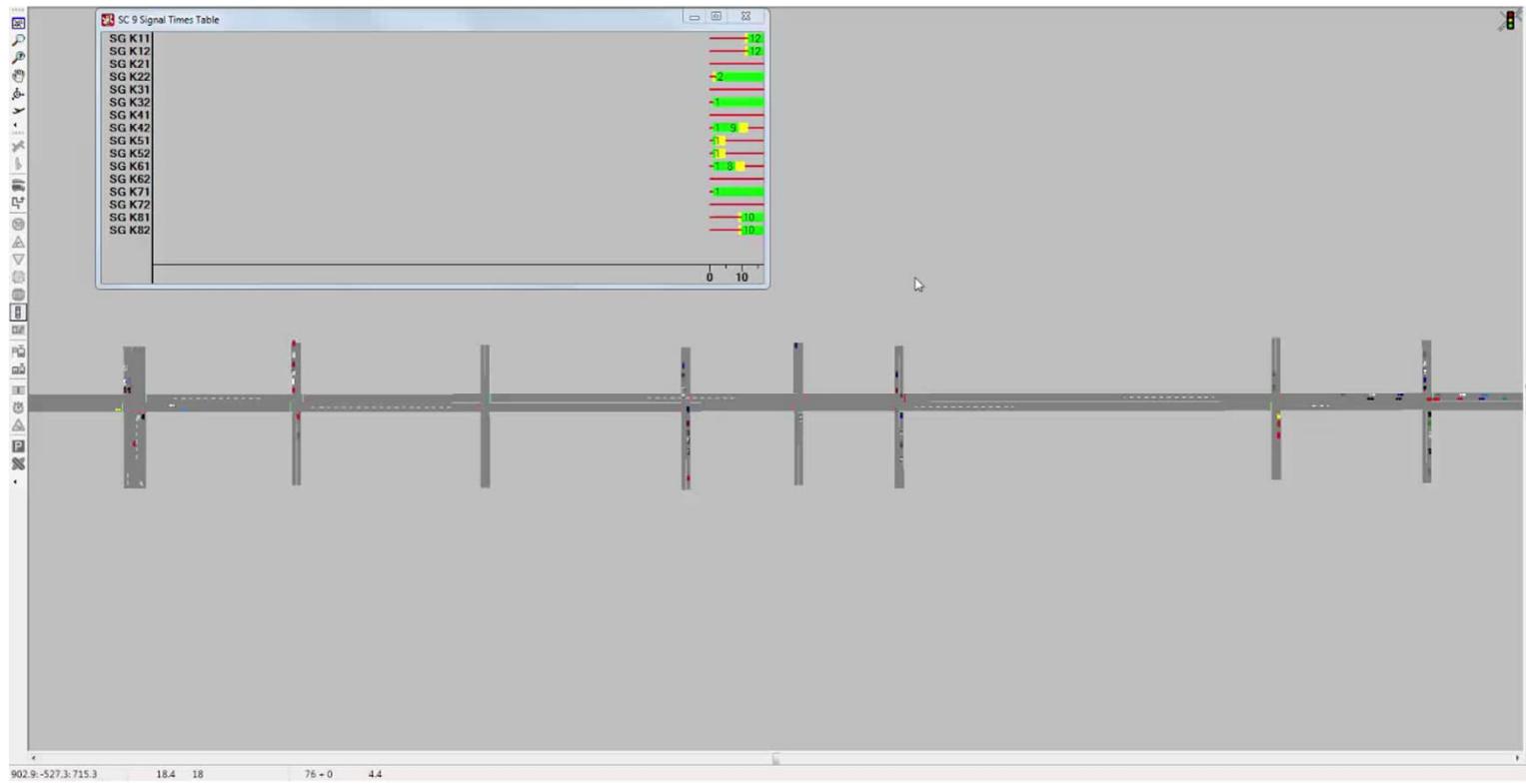


Image source: Straßenverkehrs- und Tiefbauamt Stadt Darmstadt

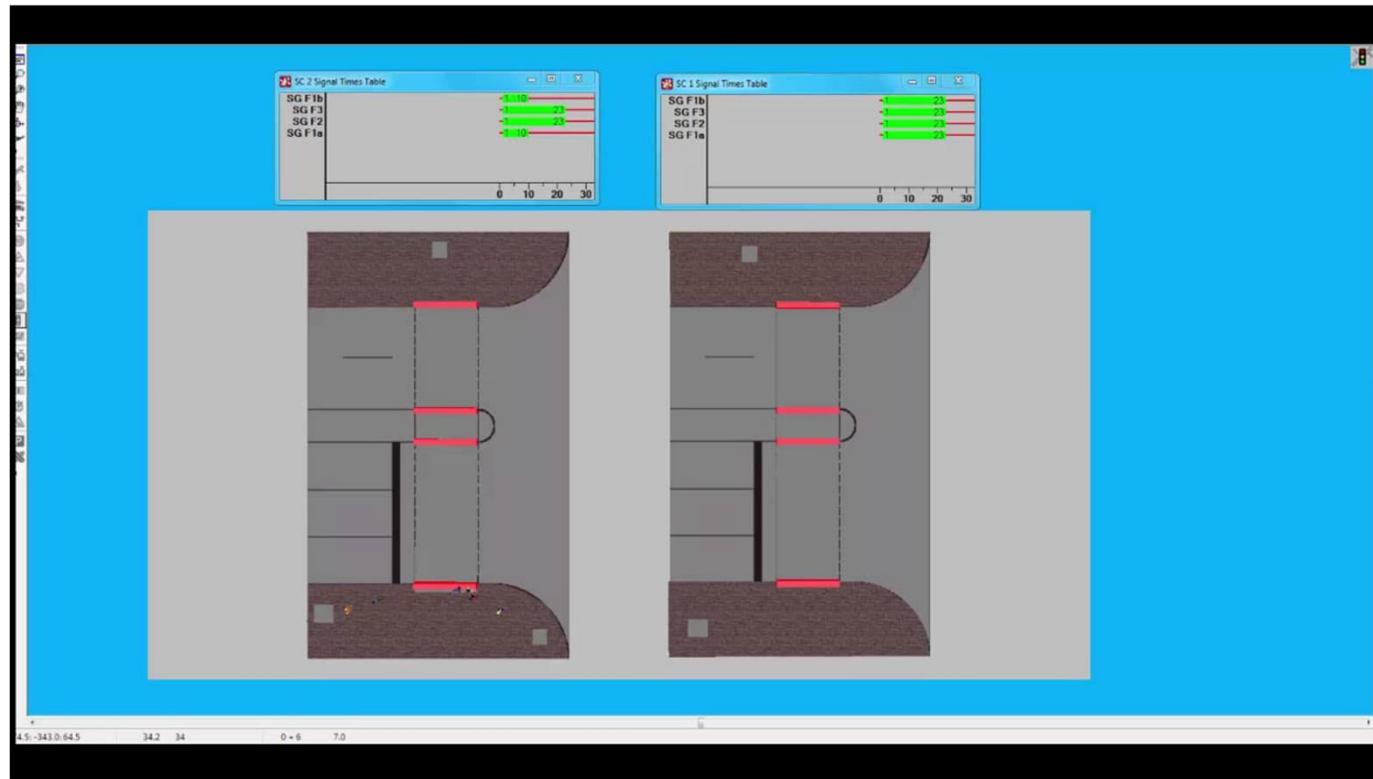
#2.6 Example PTV Vissim (2)



#2.6 PTV Vissim (3)



#2.6 Example PTV Vissim (4)



#2.7 Activity: let's create a network



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Please go to the notebook.

Please...



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- Apply for a trial license for the Aimsun Next Software under this link:

<https://www.aimsun.com/free-trial/>

- Download and install the software
- Open github and download the background image for the intersection



#2.8 Summary of the microscopic traffic flow simulation

- The microscopic traffic flow simulation aims to model the traffic flow using mathematical models.
- The model requires information about infrastructures, traffic demands and control rules.
- Results include delay, travel time, stops, queues, speeds, and density in different aggregated levels.
- Keep the model calibration and validation in mind.

Learning goals



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References

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- Friedrich, M. (2011). Wie viele? Wohin? Womit? Was können uns Verkehrsnachfragermodelle wirklich sagen? Tagungsbeitrag HEUREKA 11 - Optimierung in Verkehr und Transport.
- Köhler, Uwe. (2014). Einführung in die Verkehrsplanung.: Grundlagen, Modellbildung, Verkehrsprognose, Verkehrsnetze. Fraunhofer IRB Verlag, Stuttgart.