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THE SETUP, CALIBRATION AND VALIDATION OF STRATEGIC TRANSPORT MODELS

THE TRANSPORT DEMAND MODEL OF THE STATE OF BAVARIA

Udo Heidl

Transport Authorities in Bavaria and their functions

Bavarian Motorway Authority

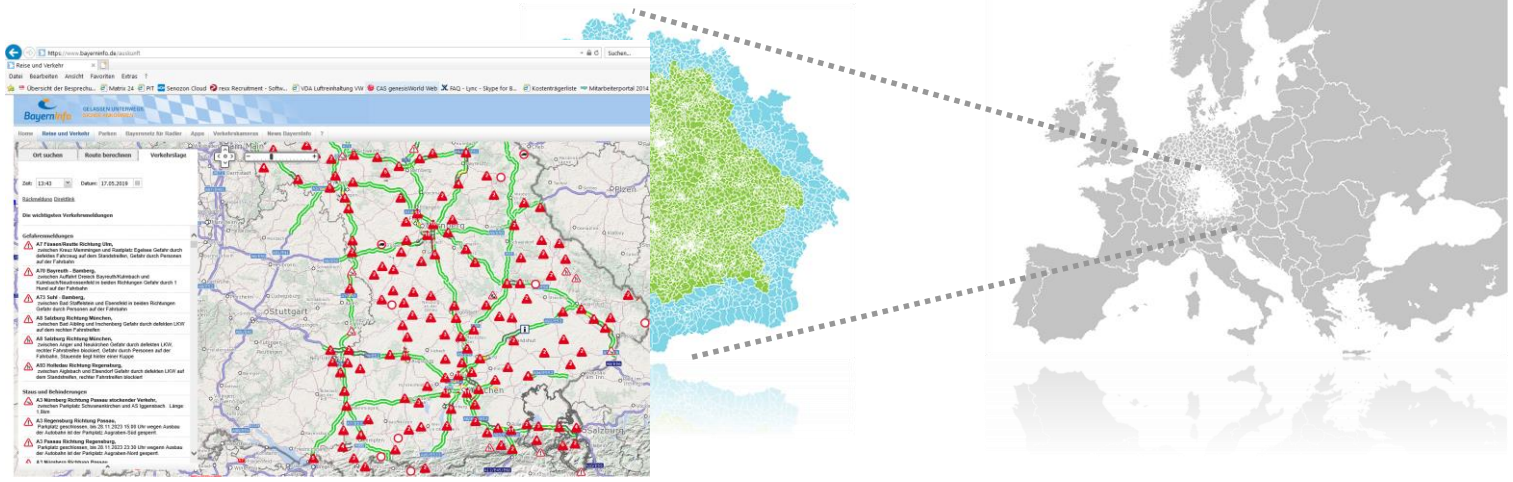
- Responsible for **planning** and maintenance of the bavarian highway network
- Planning includes assesment of variants (cost/benefit)
- Operator of Bayern-Info – Information system for Travellers

Need for a Central Planning Tool for operative and strategic planning for private and public transport

Transparency | Credibility | Acceptance

Bavarian Railways Company (BEG)

- Since 1995 State of Bavaria is responsible for local passenger transport (*Act on the Regionalisation of Public Local Passenger Transport*)
- BEG is a state owned company
- BEG is responsible for **planning** (lines, time table, capacity)
- BEG defines requirements for the extension of the rail infrastructure (links, stations and stops)



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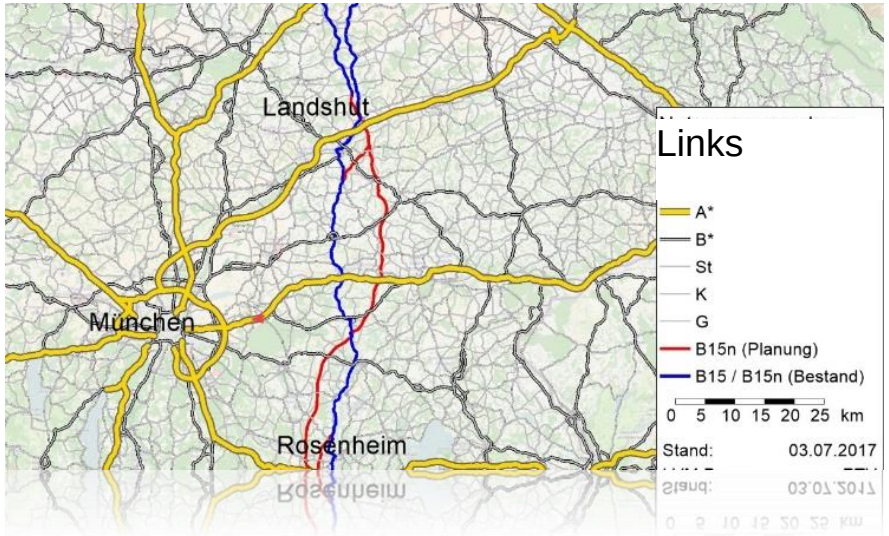
Agenda

The Transport demand model for Bavaria

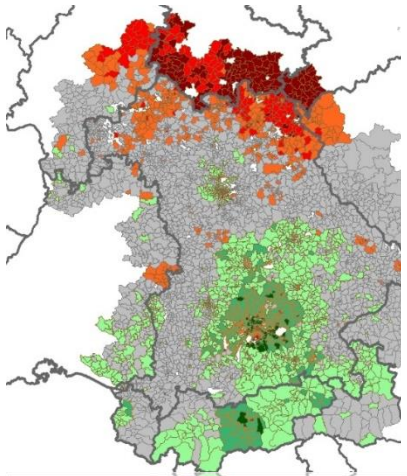
- Use Cases
- Key facts, setup and performance
- Calibration and Validation
- Conclusion

Bavarian Transport Demand Model - Use Cases

Comprehensive transport data base for the country



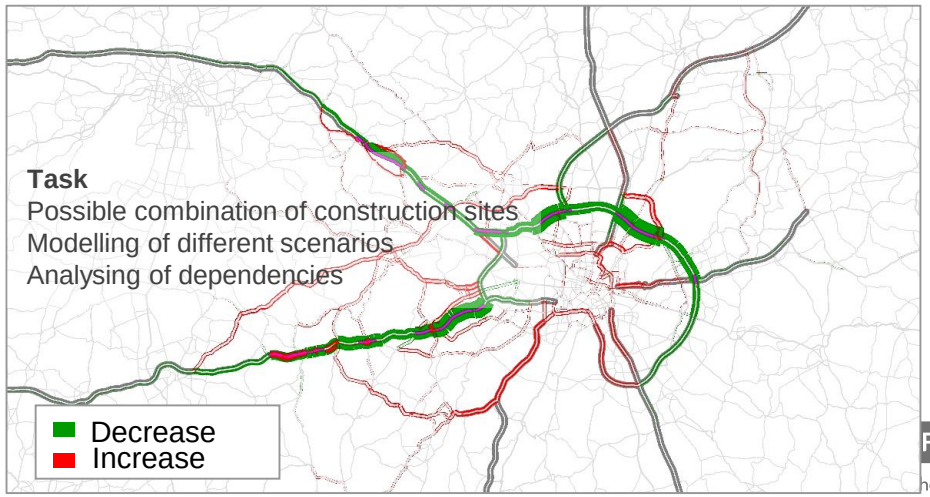
Long term Transport Forecast 2030



Development trip generation
Private Transport
FY 2030

Traffic studies regaring rail and road schemes

Operative Construction Planning



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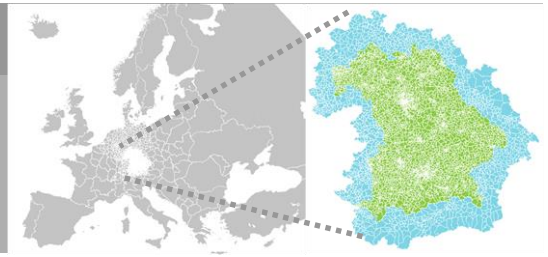
Bavarian Transport Demand Model– Key facts

NETWORKMODEL

Multimodal bavaria


Car driver, Car passenger,
PuT, Bike, Walking

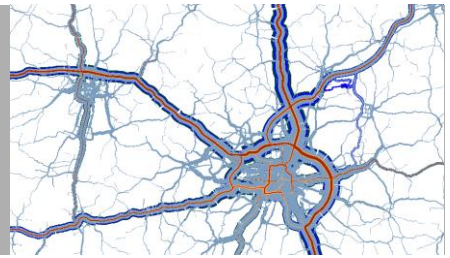
6,600 Zones



6,100 in
planning area

500 in
rest of Europe

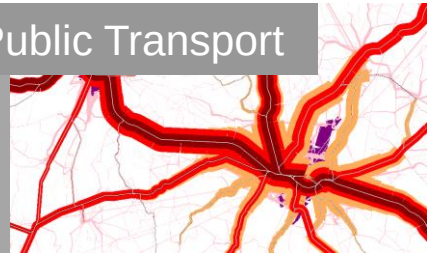
300,000 km road



350,000 links
150,000 nodes

4 transport systems
7 assigned segments

3,8 mio service-km Public Transport



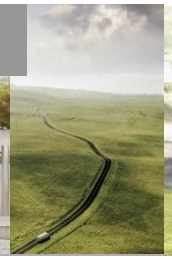
45,000 stops

28,000 line routes

9 transport Systems
2 assigned segments

DEMAND MODEL

3 demand models


All day person traffic

Long distance traffic

Commercial traffic car

44 person groups

23 private traffic

21 commercial traffic

32 activities

11 private traffic
with 58 activity chains

21 commercial traffic
with 25 activity chains

different time intervals

Workday (Monday to Friday)

Average day

Peak hour

Holiday

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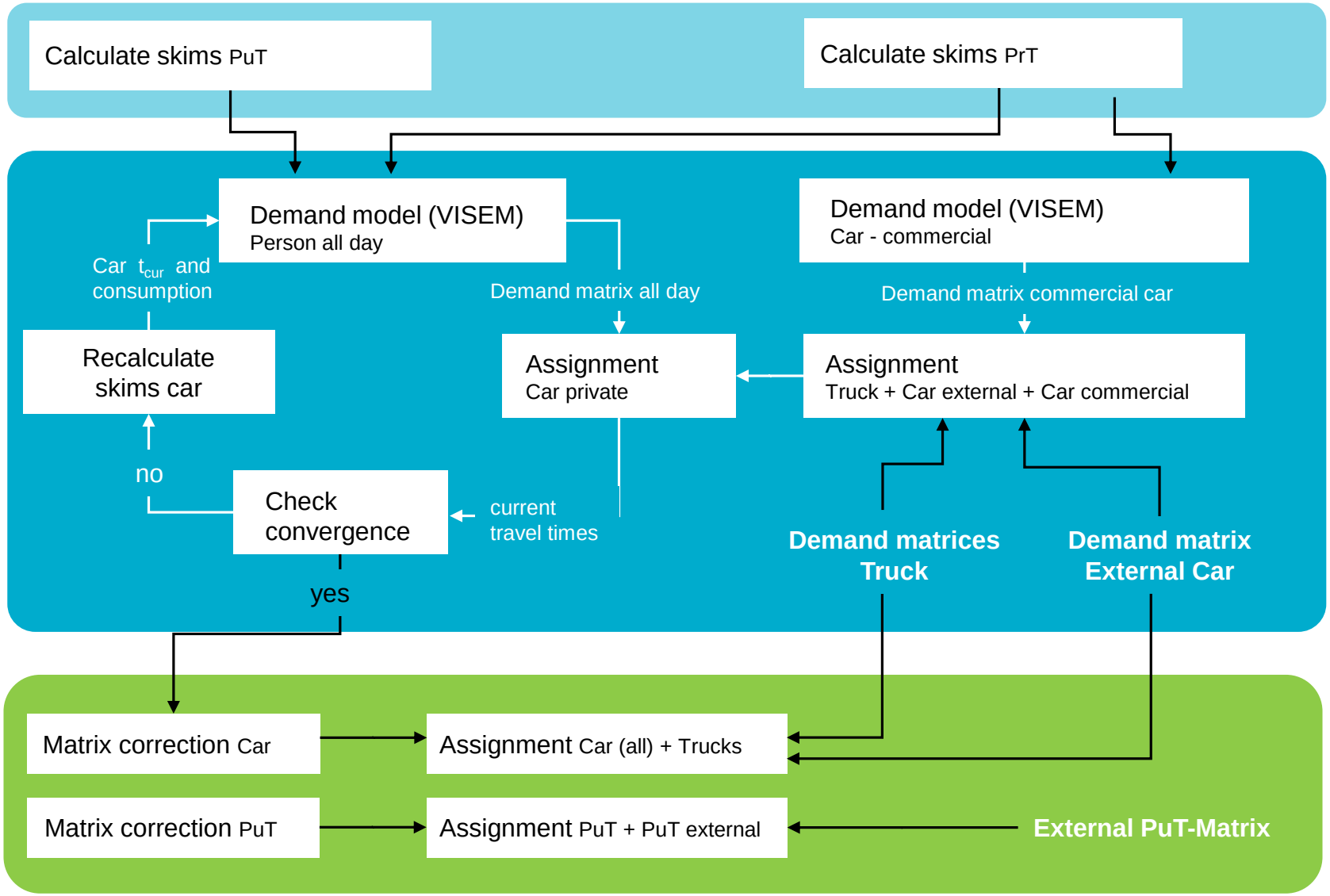
Bavarian Transport Demand Model – Setup



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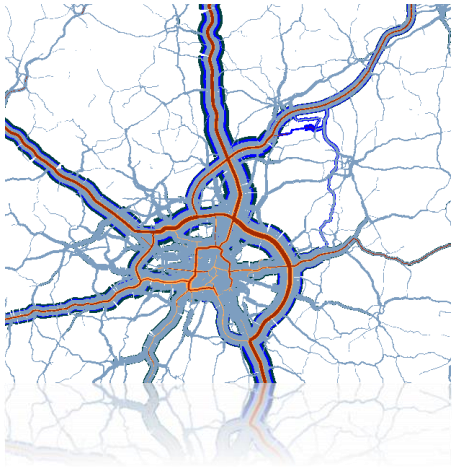
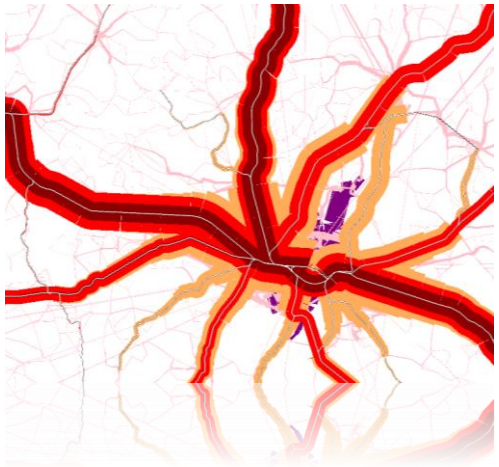
Bavarian Transport Demand Model – Performance



- **Assignment PrT**

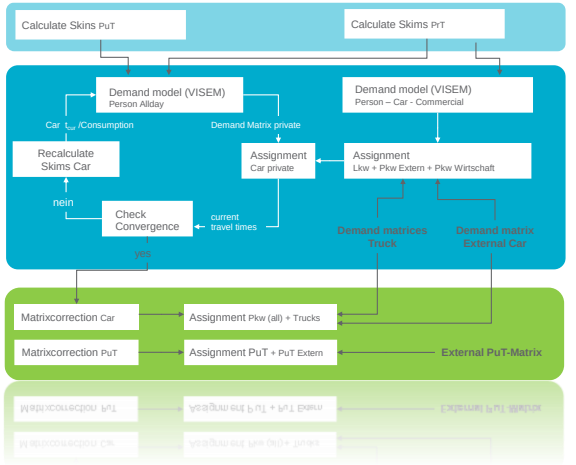
  all segments: 5h
  Gap = 10^{-5}

  Car warm start: 15 min
  Gap = 10^{-5}



- **Assignment Put**

  90 Minutes



- **Running Demand Loop with 6 Iterations**

  50 hours

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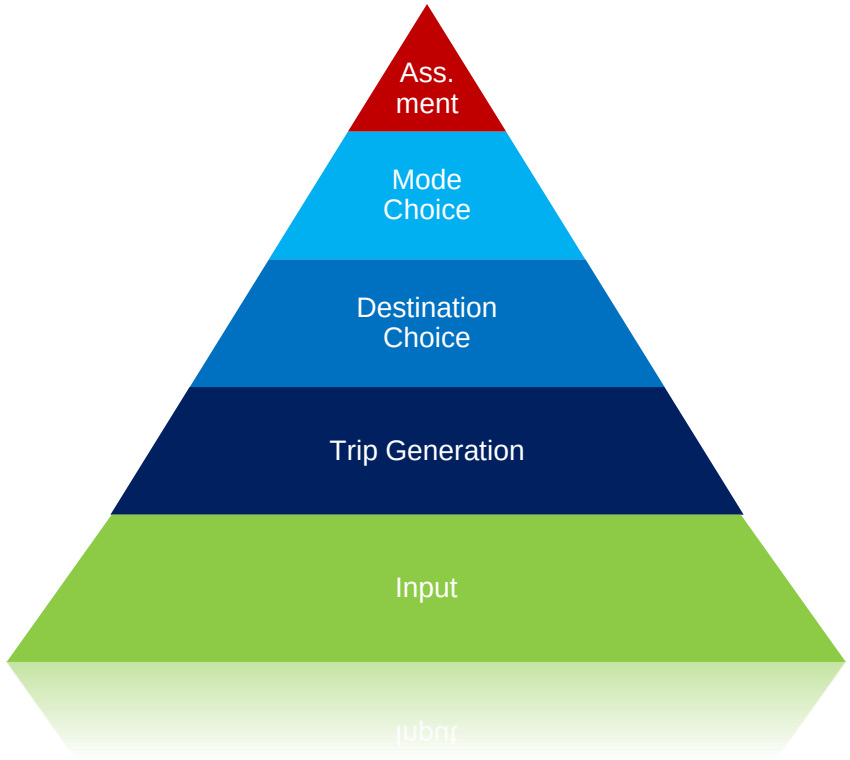
Bavarian Transport Demand Model Calibration/Validation Process



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Bavarian Transport Demand Model - Input data

Example:
Municipality Dingolfing

- BMW Factory

Work places:
- Source: Nexiga GmbH
- manual validation

Original data

Data after validation

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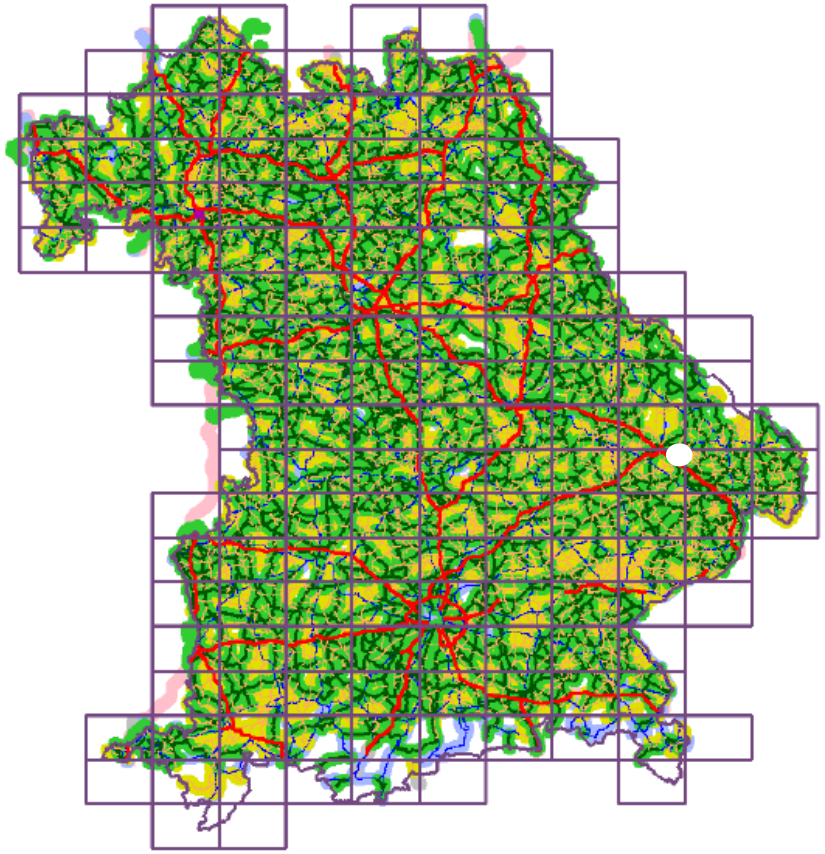
Bavarian Transport Demand Model - network model validation

Checking completness
of network base



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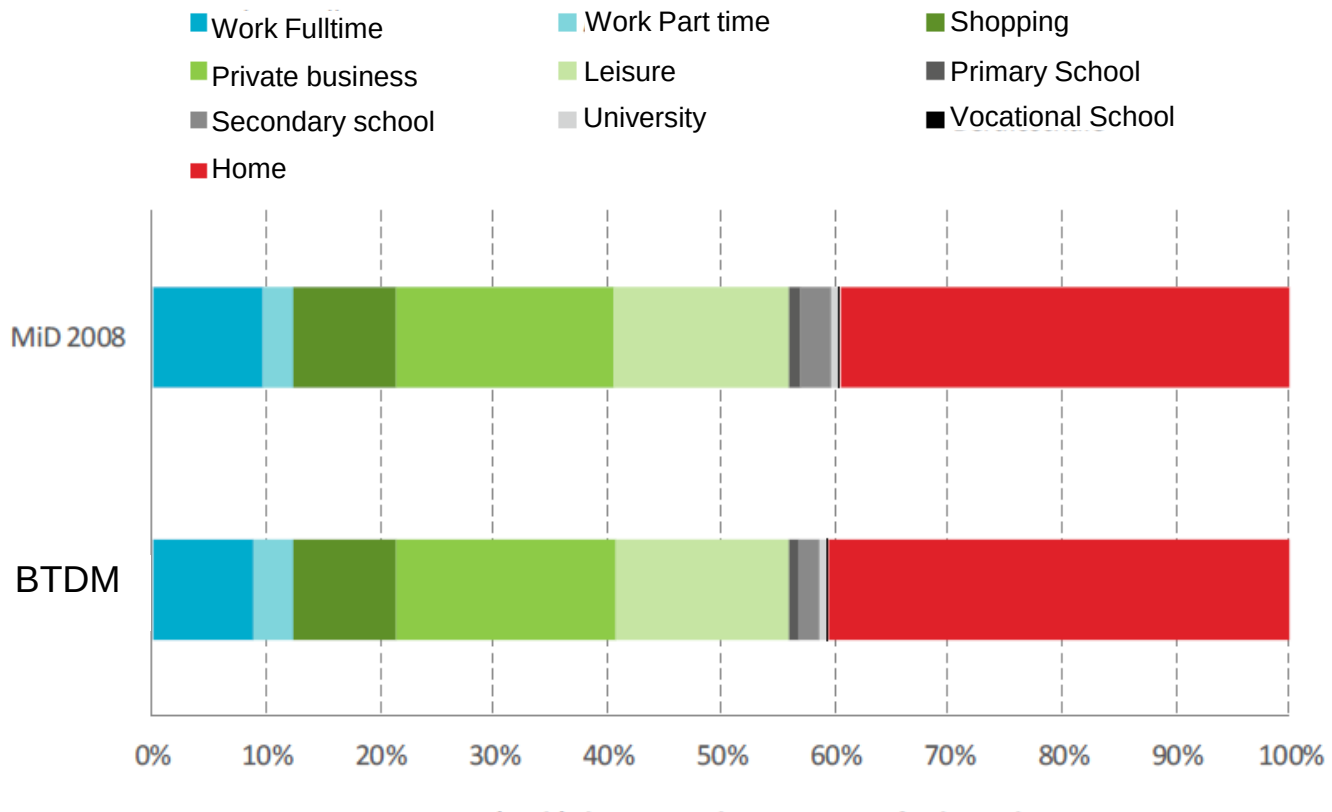
Bavarian Transport Demand Model - Validation of trip generation

Validation of the number of trips for every person group

Empirical base:

- German national household survey MiD 2008
- 16.000 trips in Bavaria



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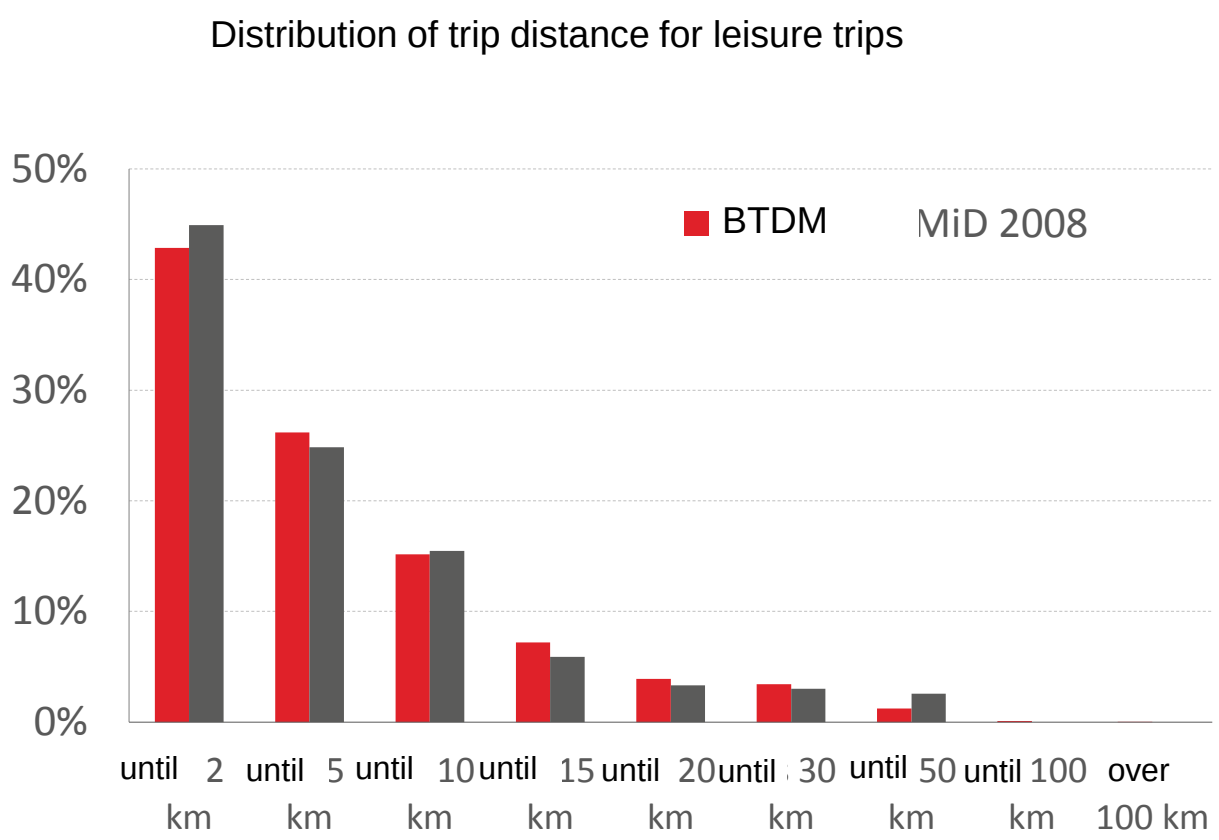
Bavarian Transport Demand Model - Validation of Destination Choice

Validation of trip length for every trip purpose and mode

Empirical base:

- German national household survey MiD 2008
- 16.000 trips in Bavaria



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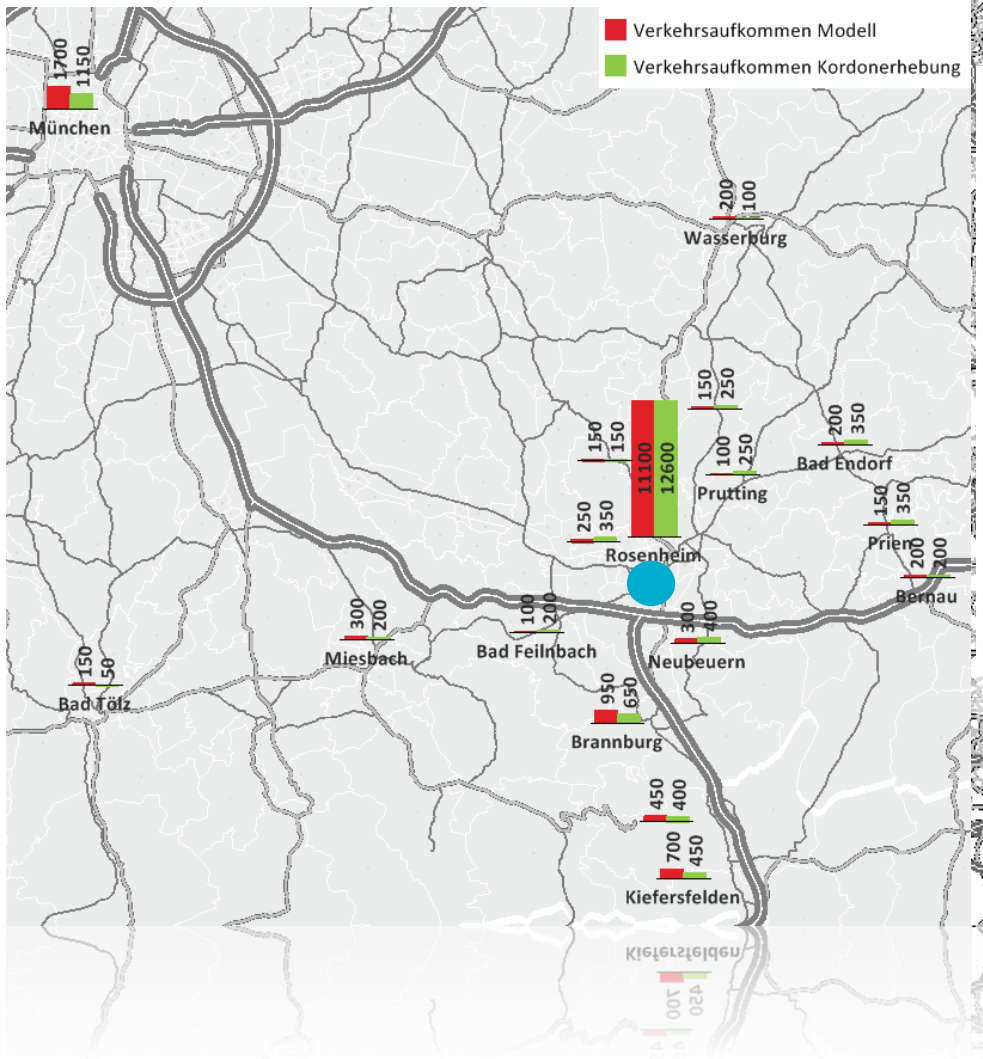
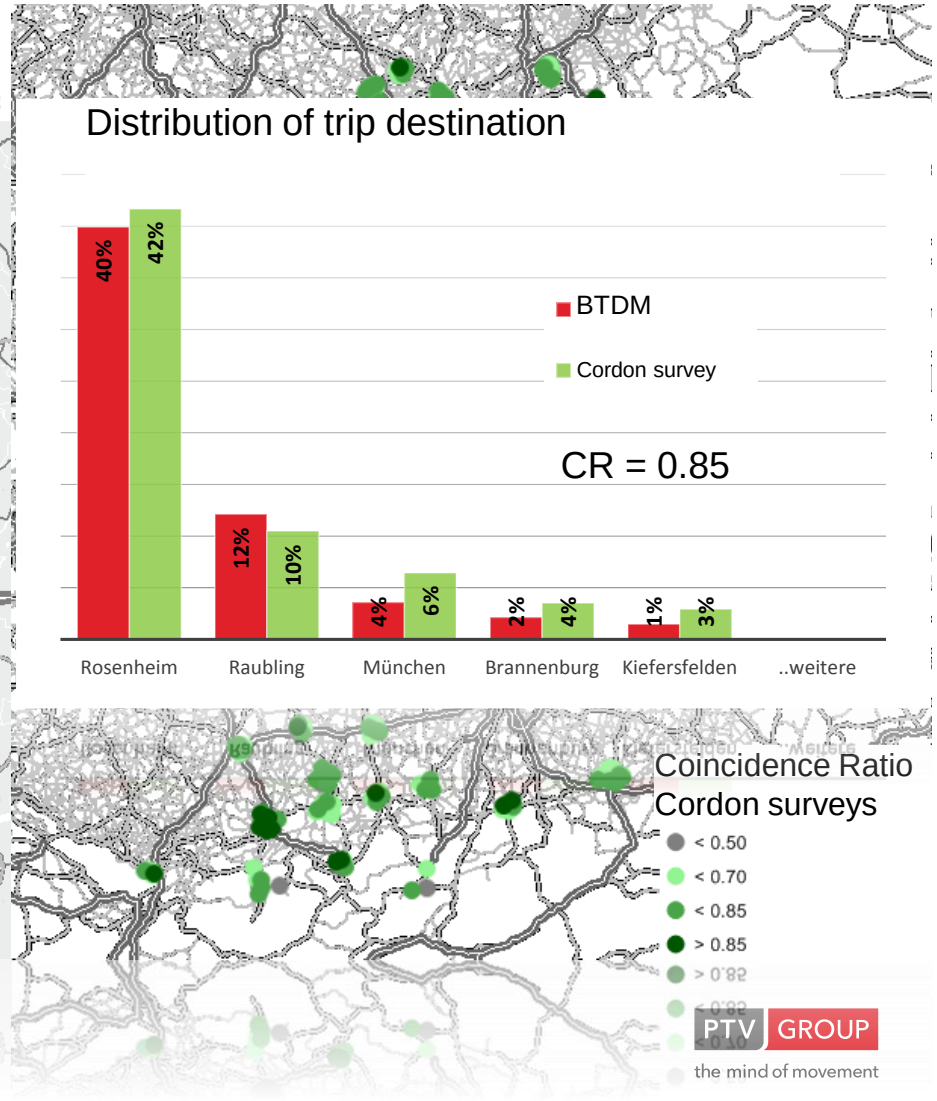
Bavarian Transport Demand Model - Validation of Destination Choice

Validation of Destination choice on base of cordon surveys for many Bavarian municipalities

Coincidence Ratio CR

$$CR = \left\{ \frac{\sum_T [min(PM_T, PO_T)]}{\sum_T [max(PM_T, PO_T)]} \right\}$$





Bavarian Transport Demand Model - Validation of Mode choice

Validation of Modal Split je person group Based on MiD 2008

Person Group	CAR			Car Passenger			PuT			Bike			Walk		
	BTDM	MiD 2008	Diff	BTDM	MiD 2008	Diff	BTDM	MiD 2008	Diff	BTDM	MiD 2008	Diff	BTDM	MiD 2008	Diff
1	0.0%	0.0%	0.0%	56.7%	56.5%	0.2%	1.5%	1.3%	0.1%	7.2%	6.8%	0.3%	34.7%	35.3%	-0.6%
2	0.0%	0.0%	0.0%	44.6%	44.6%	0.0%	5.8%	5.8%	0.0%	8.3%	8.3%	0.0%	41.4%	41.3%	0.0%
3	4.8%	4.8%	0.0%	25.2%	25.2%	0.0%	27.2%	27.2%	0.0%	22.8%	22.8%	-0.1%	20.0%	20.0%	0.0%
4	47.0%	47.0%	-0.1%	10.7%	10.7%	0.0%	14.0%	14.0%	0.1%	6.9%	7.0%	0.0%	21.4%	21.4%	0.0%
5	16.6%	16.7%	-0.1%	11.7%	11.8%	-0.1%	27.3%	27.4%	-0.1%	22.4%	22.1%	0.3%	21.9%	21.9%	0.0%
6	42.3%	42.5%	-0.2%	19.5%	19.7%	-0.1%	20.3%	20.2%	0.1%	3.8%	3.7%	0.1%	14.1%	13.9%	0.2%
7	52.1%	52.6%	-0.6%	2.3%	2.4%	0.0%	9.0%	9.3%	-0.2%	16.0%	15.7%	0.2%	20.6%	20.0%	0.6%
8	66.4%	66.7%	-0.3%	3.3%	3.6%	-0.3%	5.5%	5.6%	-0.1%	6.2%	6.2%	0.0%	18.5%	17.9%	0.7%
9	66.6%	66.8%	-0.2%	5.1%	5.2%	-0.1%	2.8%	2.9%	0.0%	10.3%	10.2%	0.1%	15.2%	15.0%	0.1%
10	36.9%	37.3%	-0.4%	11.2%	11.3%	-0.1%	17.9%	18.4%	-0.5%	14.0%	13.6%	0.4%	19.9%	19.5%	0.5%
11	48.6%	49.7%	-1.1%	9.9%	10.0%	-0.2%	10.9%	10.8%	0.1%	9.3%	8.8%	0.5%	21.3%	20.6%	0.6%
12	73.6%	73.9%	-0.2%	8.8%	8.9%	0.0%	3.5%	3.6%	0.0%	7.3%	7.2%	0.1%	6.7%	6.5%	0.2%
13	57.2%	57.0%	0.2%	4.8%	4.8%	0.0%	5.7%	5.7%	0.0%	13.1%	13.3%	-0.2%	19.2%	19.1%	0.1%
14	72.8%	72.5%	0.2%	5.7%	5.7%	0.1%	3.5%	3.3%	0.2%	5.7%	5.9%	-0.2%	12.3%	12.6%	-0.3%
15	74.2%	74.1%	0.1%	8.6%	8.7%	-0.1%	0.5%	0.3%	0.2%	8.1%	8.2%	-0.1%	8.6%	8.7%	-0.1%
16	7.8%	7.8%	0.0%	11.6%	11.5%	0.1%	33.0%	32.6%	0.4%	30.1%	30.1%	0.1%	17.5%	18.0%	-0.6%
17	43.9%	43.5%	0.5%	9.2%	9.1%	0.1%	8.2%	8.1%	0.1%	17.8%	18.2%	-0.4%	20.8%	21.1%	-0.3%
18	54.0%	54.1%	-0.1%	12.9%	12.6%	0.3%	0.0%	0.0%	0.0%	13.5%	13.6%	-0.1%	19.7%	19.8%	-0.1%
19	58.1%	57.8%	0.3%	10.6%	8.9%	1.7%	0.7%	0.4%	0.3%	13.8%	13.3%	0.5%	16.7%	19.6%	-2.9%
20	36.9%	36.8%	0.2%	15.2%	15.2%	0.1%	9.0%	9.1%	-0.1%	9.8%	9.9%	0.0%	29.0%	29.1%	-0.1%
21	56.9%	56.7%	0.2%	5.6%	5.6%	0.0%	2.5%	2.5%	0.0%	12.1%	12.0%	0.1%	22.9%	23.2%	-0.2%
22	17.1%	17.1%	0.0%	11.2%	11.4%	-0.2%	11.8%	11.5%	0.3%	21.0%	21.0%	0.0%	38.9%	39.0%	-0.1%
23	34.0%	33.9%	0.0%	7.1%	7.1%	0.0%	11.9%	11.8%	0.1%	7.7%	7.8%	-0.1%	39.3%	39.3%	0.0%
24															
25															

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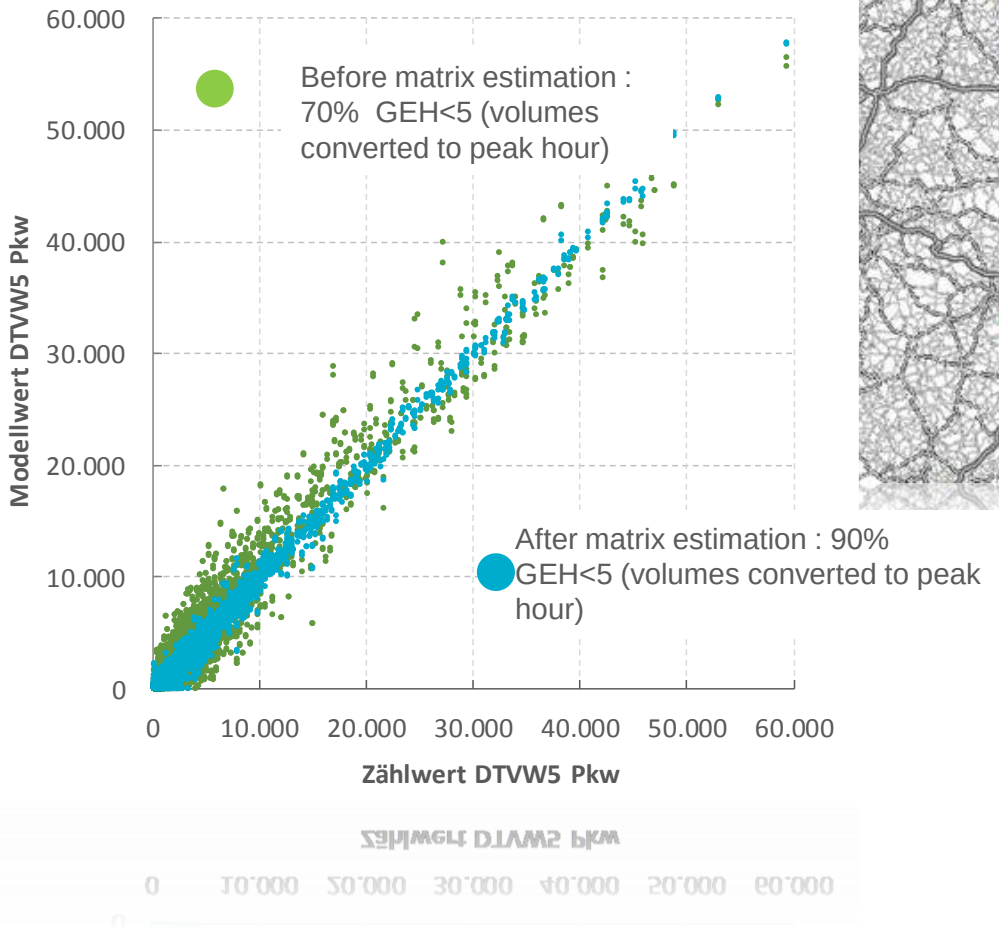
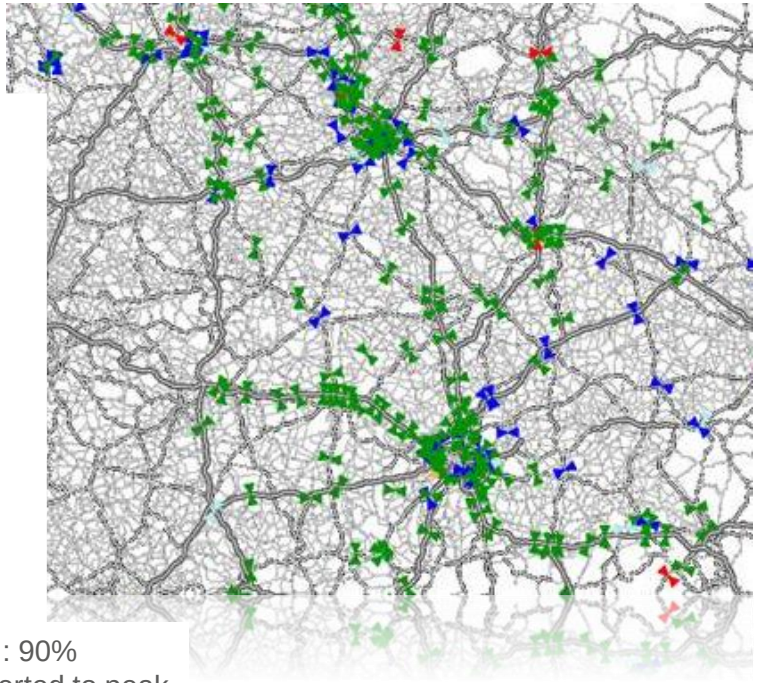
Bavarian Transport Demand Model– Assignment

- **Model reaches a GEH< 5 for 70% of 7,500 count locations (GEH is defined for peak hour volumes)**

$$GEH = \sqrt{\frac{2 \cdot (M - C)^2}{M + C}}$$

M: Model
C: Count





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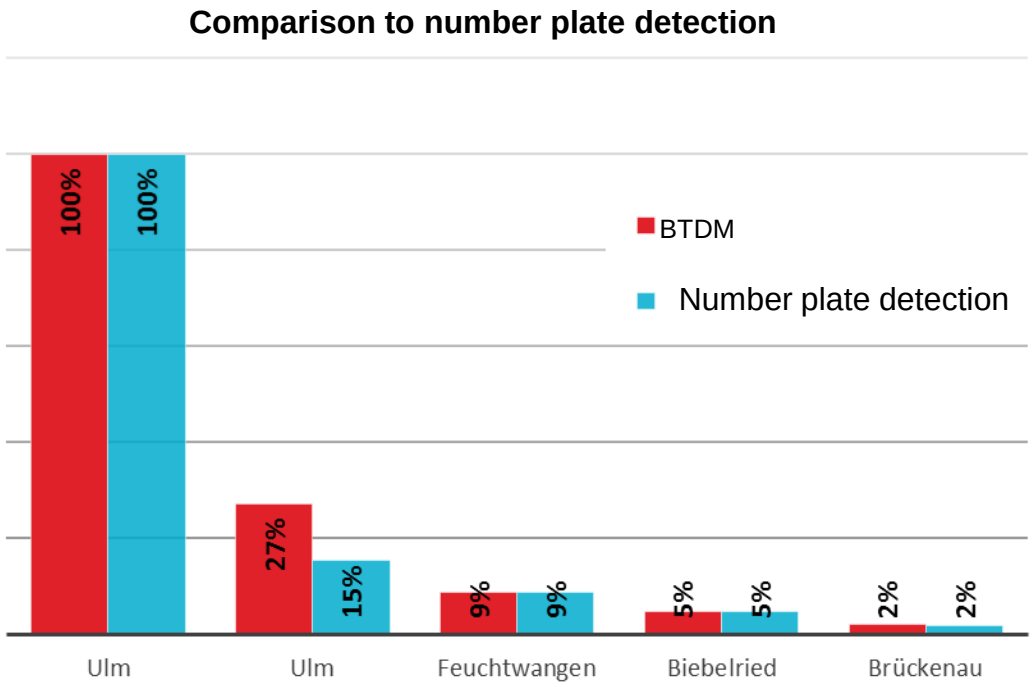
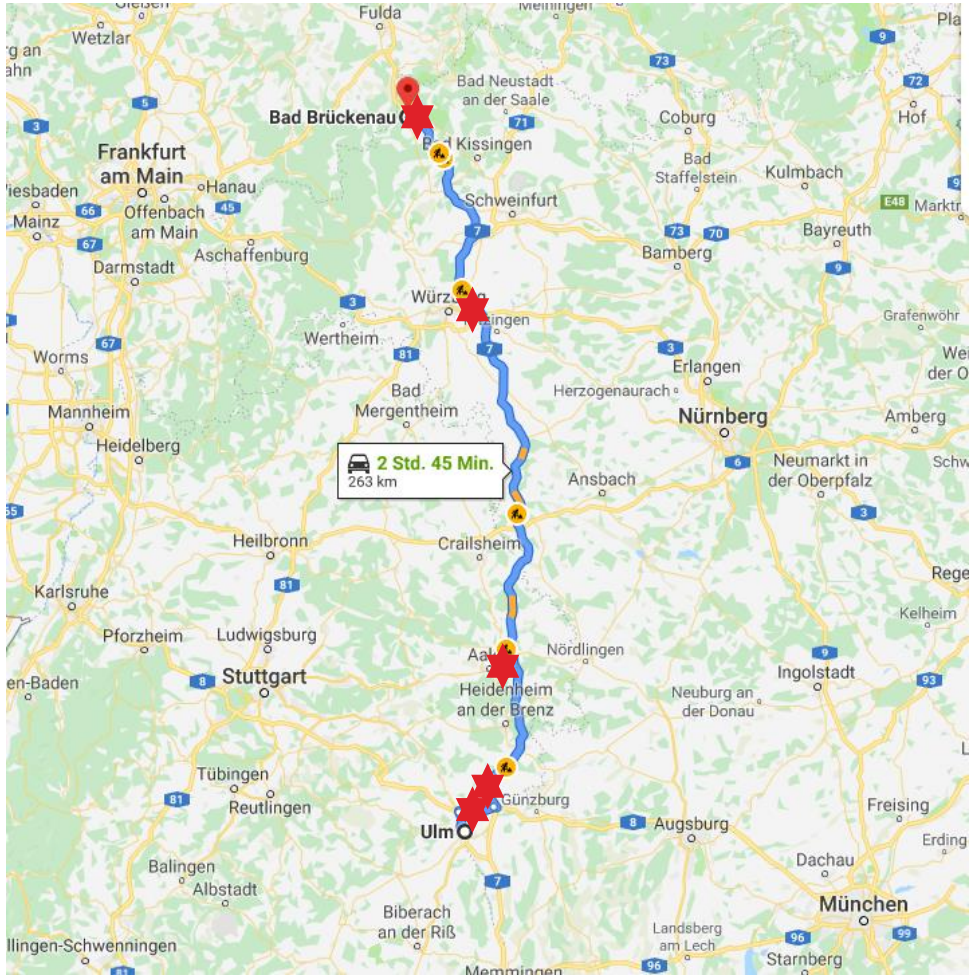
Bavarian Transport Demand Model - Route choice, Assignment

For 40 road corridors a number plate detection survey has been conducted





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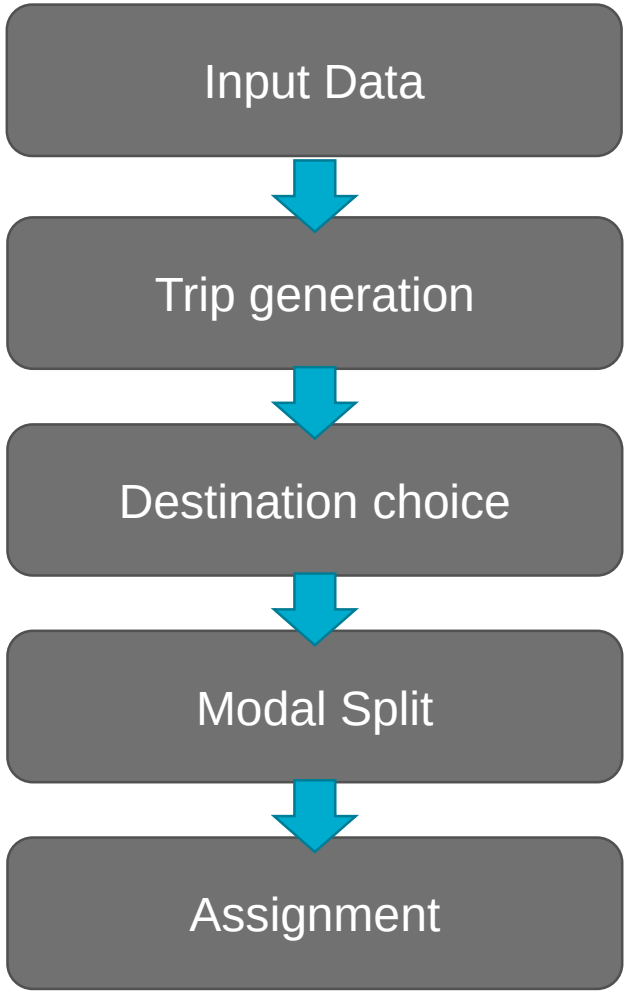
Bavarian Transport Demand Model - Other Checks and Tests of Model Quality



- Validation of route choice using apps for road navigation and journey planer (PuT)
- Comparison against commuter statistics of the German agency for work
- Validation of model results against train capacity
- Realism tests for road and rail schemes
- Sensitivity tests for road capacities and PuT travel times
- Visualising of effects of the matrix correction
- + External quality assurance by Prof. Markus Friedrich, University of Stuttgart:

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Conclusion

The Transport demand model for Bavaria

- Is innovative but nothing completely new
- Offers many applications and secures consistency
- Can handle future tasks in in traffic and transport (like MaaS, environmental analysis)
- Can be used by public authority and every consultant
- Can be refined and recalibrated for a local application

The set-up of a model like this

- Needs intensive (automatically) calibration and validation
- Awareness of modal abstraction
- ... and courage to scan the model manually

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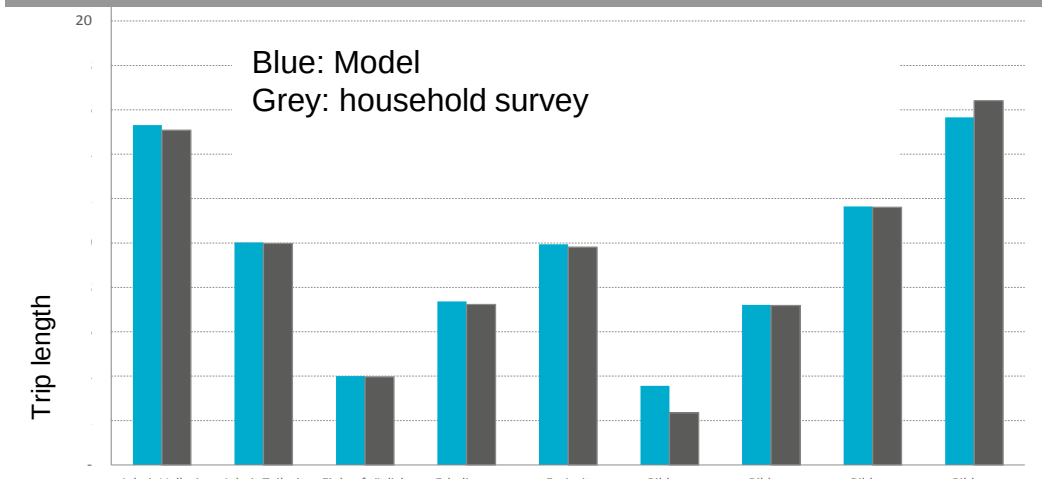
Bavarian Transport Demand Model– Calibration

- **Automated Calibration of**
  - Mean trip length for 11 activities
  - Modal Split for 23 person groups
  - Trip distribution of commuters
  - Using household survey and public statistics

Calibrating trip length for activities



Activities: work, education, shopping, leisure. home

Calibrating Modal Split for person groups

Car | Car Pass | PuT | Bike | Walk

Pkw			Pkw-Mitfahrer			ÖV			Rad			Fuß		
LVMBy	MiD 2008	Diff	LVMBy	MiD 2008	Diff	LVMBy	MiD 2008	Diff	LVMBy	MiD 2008	Diff	LVMBy	MiD 2008	Diff
0.0%	0.0%	0.0%	56.7%	56.5%	0.2%	1.5%	1.3%	0.1%	7.2%	6.8%	0.3%	34.7%	35.3%	-0.6%
0.0%	0.0%	0.0%	44.6%	44.6%	0.0%	5.8%	5.8%	0.0%	8.3%	8.3%	0.0%	41.4%	41.3%	0.0%
4.8%	4.8%	0.0%	25.2%	25.2%	0.0%	27.2%	27.2%	0.0%	22.8%	22.8%	-0.1%	20.0%	20.0%	0.0%
47.0%	47.0%	-0.1%	10.7%	10.7%	0.0%	14.0%	14.0%	0.1%	6.9%	7.0%	0.0%	21.4%	21.4%	0.0%
16.6%	16.7%	-0.1%	11.7%	11.8%	-0.1%	27.3%	27.4%	-0.1%	22.4%	22.1%	0.3%	21.9%	21.9%	0.0%
42.3%	42.5%	-0.2%	19.5%	19.7%	-0.1%	20.3%	20.2%	0.1%	3.8%	3.7%	0.1%	14.1%	13.9%	0.2%
52.1%	52.6%	-0.6%	2.3%	2.4%	0.0%	9.0%	9.3%	-0.2%	16.0%	15.7%	0.2%	20.6%	20.0%	0.6%
66.4%	66.7%	-0.3%	3.3%	3.6%	-0.3%	5.5%	5.6%	-0.1%	6.2%	6.2%	0.0%	18.5%	17.9%	0.7%
66.6%	66.8%	-0.2%	5.1%	5.2%	-0.1%	2.8%	2.9%	0.0%	10.3%	10.2%	0.1%	15.2%	15.0%	0.1%
36.9%	37.3%	-0.4%	11.2%	11.3%	-0.1%	17.9%	18.4%	-0.5%	14.0%	13.6%	0.4%	19.9%	19.5%	0.5%
48.6%	49.7%	-1.1%	9.9%	10.0%	-0.2%	10.9%	10.8%	0.1%	9.3%	8.8%	0.5%	21.3%	20.6%	0.6%
73.6%	73.9%	-0.2%	8.8%	8.9%	0.0%	3.5%	3.6%	0.0%	7.3%	7.2%	0.1%	6.7%	6.5%	0.2%
57.2%	57.0%	0.2%	4.8%	4.8%	0.0%	5.7%	5.7%	0.0%	13.1%	13.3%	-0.2%	19.2%	19.1%	0.1%
72.8%	72.5%	0.2%	5.7%	5.7%	0.1%	3.5%	3.3%	0.2%	5.7%	5.9%	-0.2%	12.3%	12.6%	-0.3%
74.2%	74.1%	0.1%	8.6%	8.7%	-0.1%	0.5%	0.3%	0.2%	8.1%	8.2%	-0.1%	8.6%	8.7%	-0.1%
7.8%	7.8%	0.0%	11.6%	11.5%	0.1%	33.0%	32.6%	0.4%	30.1%	30.1%	0.1%	17.5%	18.0%	-0.6%
43.9%	43.5%	0.5%	9.2%	9.1%	0.1%	8.2%	8.1%	0.1%	17.8%	18.2%	-0.4%	20.8%	21.1%	-0.3%
54.0%	54.1%	-0.1%	12.9%	12.6%	0.3%	0.0%	0.0%	0.0%	13.5%	13.6%	-0.1%	19.7%	19.8%	-0.1%
58.1%	57.8%	0.3%	10.6%	8.9%	1.7%	0.7%	0.4%	0.3%	13.8%	13.3%	0.5%	16.7%	19.6%	-2.9%
36.9%	36.8%	0.2%	15.2%	15.2%	0.1%	9.0%	9.1%	-0.1%	9.8%	9.9%	0.0%	29.0%	29.1%	-0.1%
56.9%	56.7%	0.2%	5.6%	5.6%	0.0%	2.5%	2.5%	0.0%	12.1%	12.0%	0.1%	22.9%	23.2%	-0.2%
17.1%	17.1%	0.0%	11.2%	11.4%	-0.2%	11.8%	11.5%	0.3%	21.0%	21.0%	0.0%	38.9%	39.0%	-0.1%
34.0%	33.9%	0.0%	7.1%	7.1%	0.0%	11.9%	11.8%	0.1%	7.7%	7.8%	-0.1%	39.3%	39.3%	0.0%

Bavarian Transport Demand Model

Client:

Bavarian
Ministry of Interior,
Construction and
Transport

Model Builders

prognos

SSP Consult
Beratende Ingenieure GmbH

PTV Transport Consult GmbH

PTV GROUP
the mind of movement

PTV AG

Universität Stuttgart

Data Provision, Freight Modelling

Solution Set Up

Model application: Forecast Bavaria 2030

Model Review

Model Users

SSP Consult
Beratende Ingenieure GmbH

PTV Transport Consult GmbH

prognos

Bavarian planning organisations

Local consultants

Traffic studies (regional, local)

Assement for investement in Rail infrastructure

Noise and Air pollution reduction concepts

Base for update of VIB (Traffic information center – BayernInfo)

etc.

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