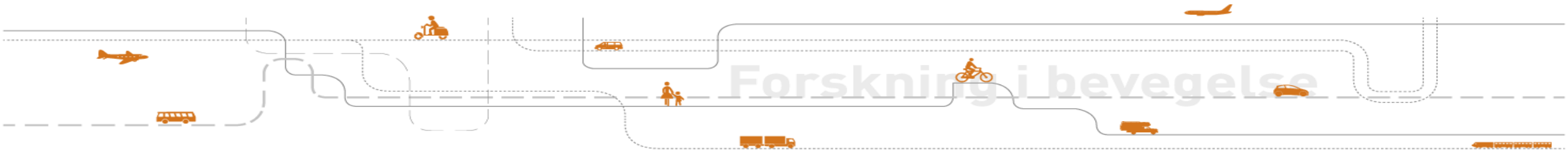
Combining AI with transport models: Experiences from Norway

ECTRI TG TMM Webinar

Stefan Flügel, Institute of Transport Economics (Oslo)

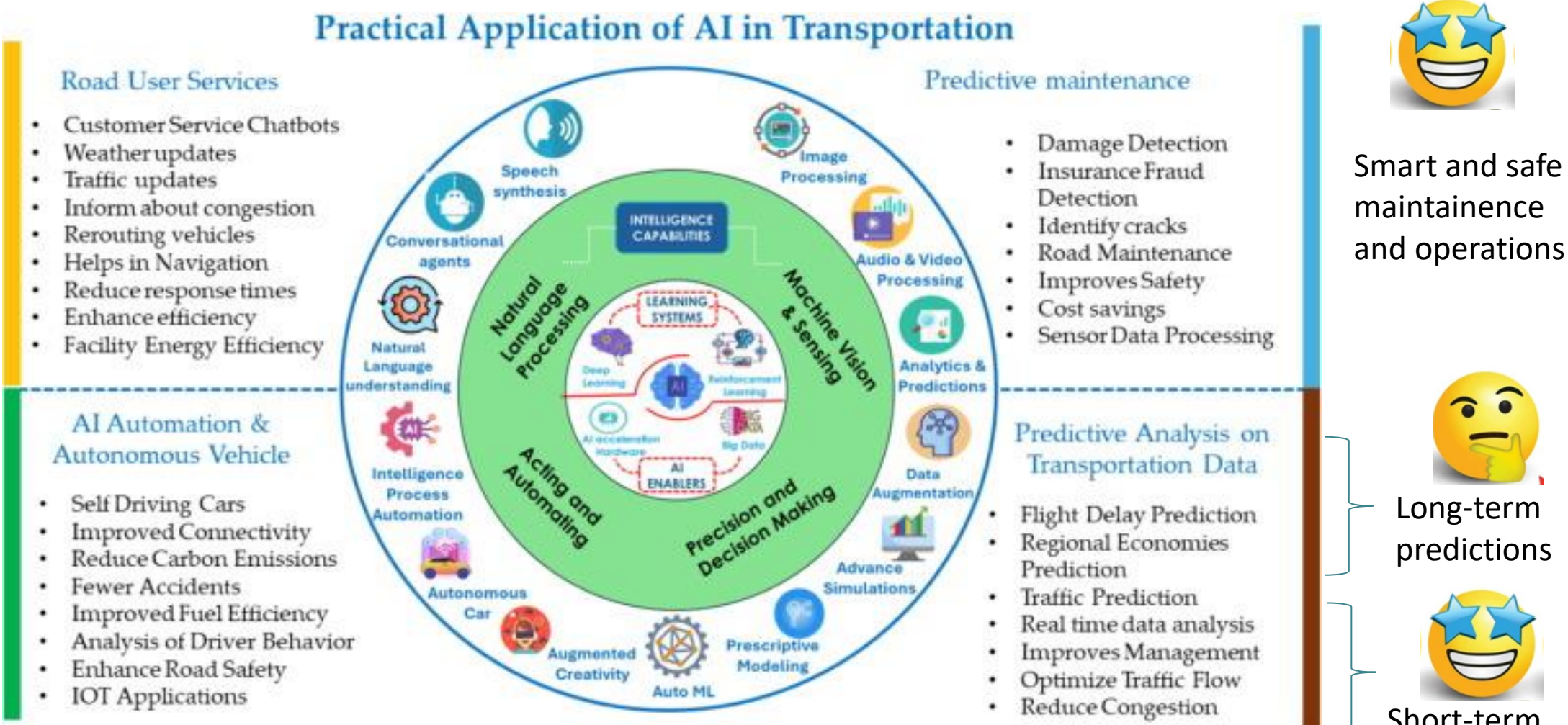
21.05.2025



The use of AI in the transport sector

User support and information systems

Automation



Smart and safe maintainence and operations

Long-term predictions

Short-term predictions

Soure: Wang et al. 2024 with edits

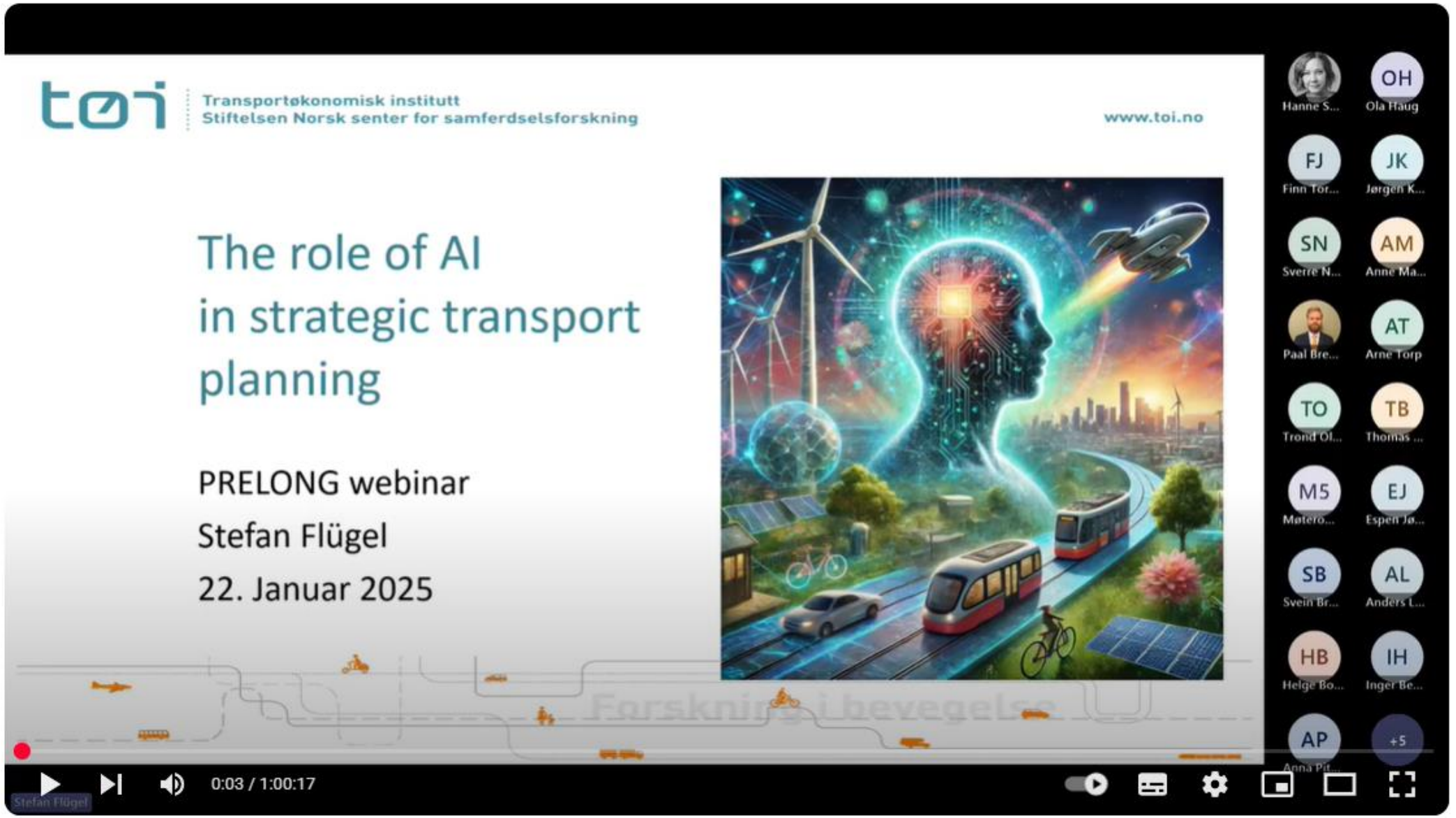
Wang, X., Zhu, X., Anwar, M. K., Meng, Q., & Zhong, N. (2024). Evaluating the role of AI and empirical models for predicting regional economic growth and transportation dynamics: An application of advanced AI approaches. *International Journal of Transportation Science and Technology*. https://doi.org/https://doi.org/10.1016/j.ijtst.2024.08.007

Related documents

English summary

https://www.toi.no/publikasjoner/mot-aktivitetsbasert-ettersporsels-modellering-bruk-av-maskinlaering-for-prediksjon-av-transport-middel-valg-og-aktivitetsplaner

https://www.toi.no/publications/artifical-intelligence-for-strategic-transport-planning-opportunities-and-limitations-article39132-29.html



The role of AI in strategic transport planning – with contributions from the PRELONG-project 1/22/25

https://www.youtube.com/watch?v=xH8Gk9BUjx4

My working definitions for this presentation

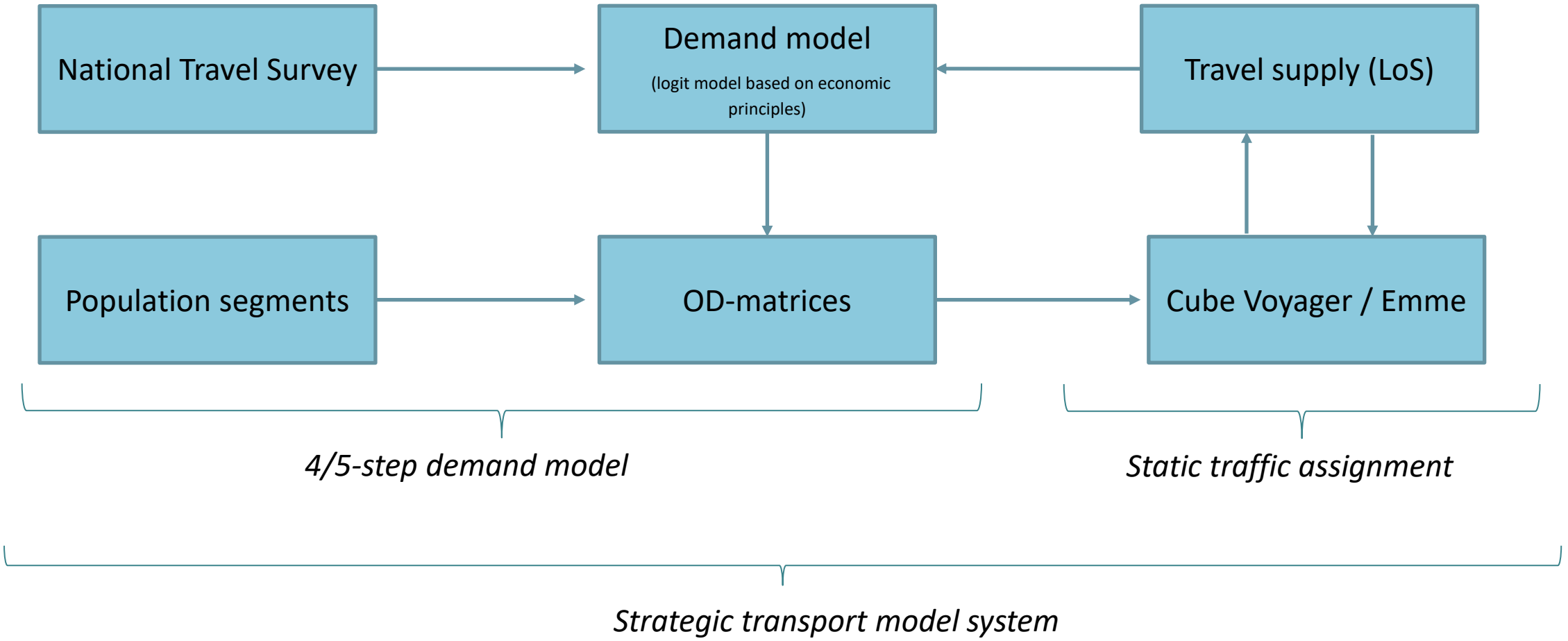
Strategic transport planning is a field of transport planning that deals with situations where real-world training data is scarce or unavailable

- *Predictions under scenario*
  - Eg. new travel models
- *Long-term predictions*
- *Counterfactual policies*

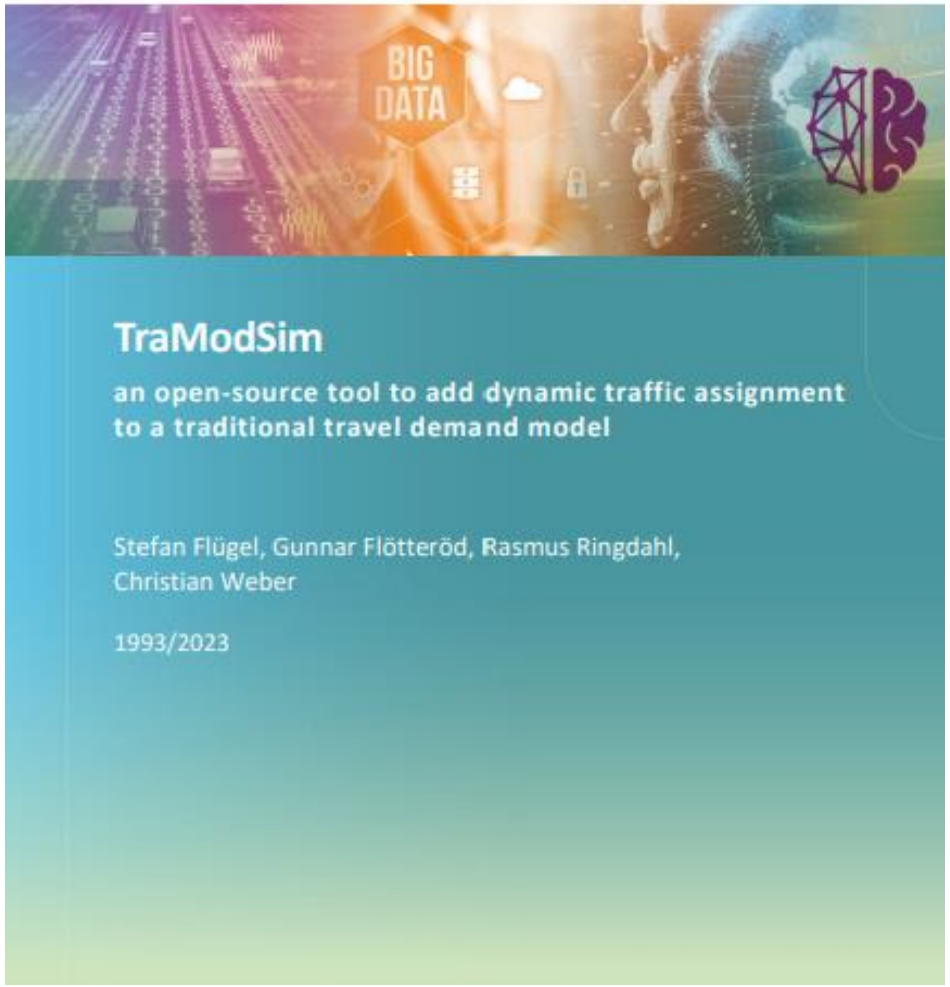
(Modern) AI includes method based on neural networks (“deep learning”)

- *Predictive models (GNN, RNN, …)*
- *Generative AI (Transformer, Diffusion models,…)*
  - Large Language models
  - AI-superforecaster
  - AI-agent systems

High-level data flow in «official» transport models in Norway



Coupling of models



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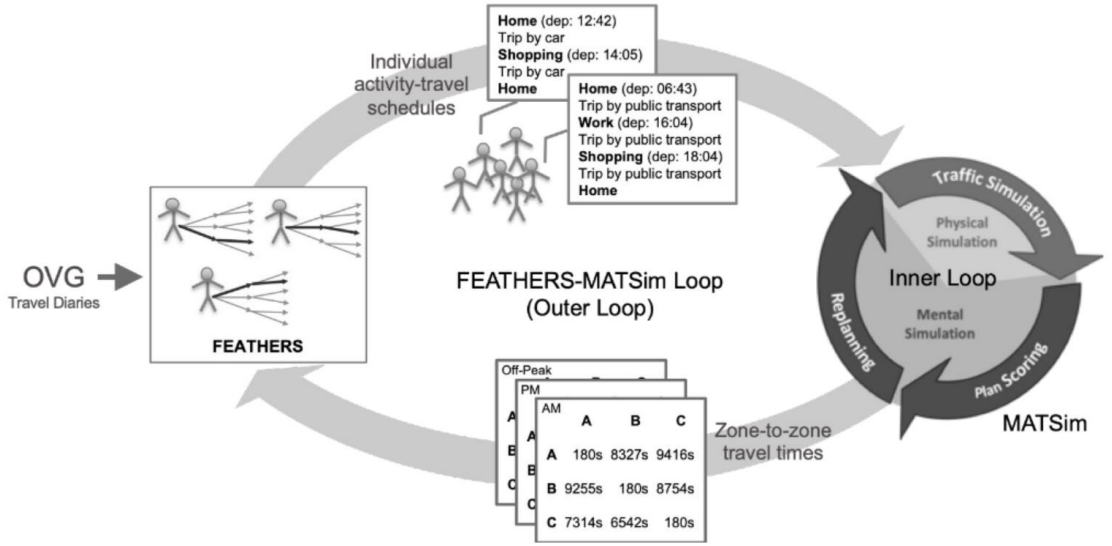
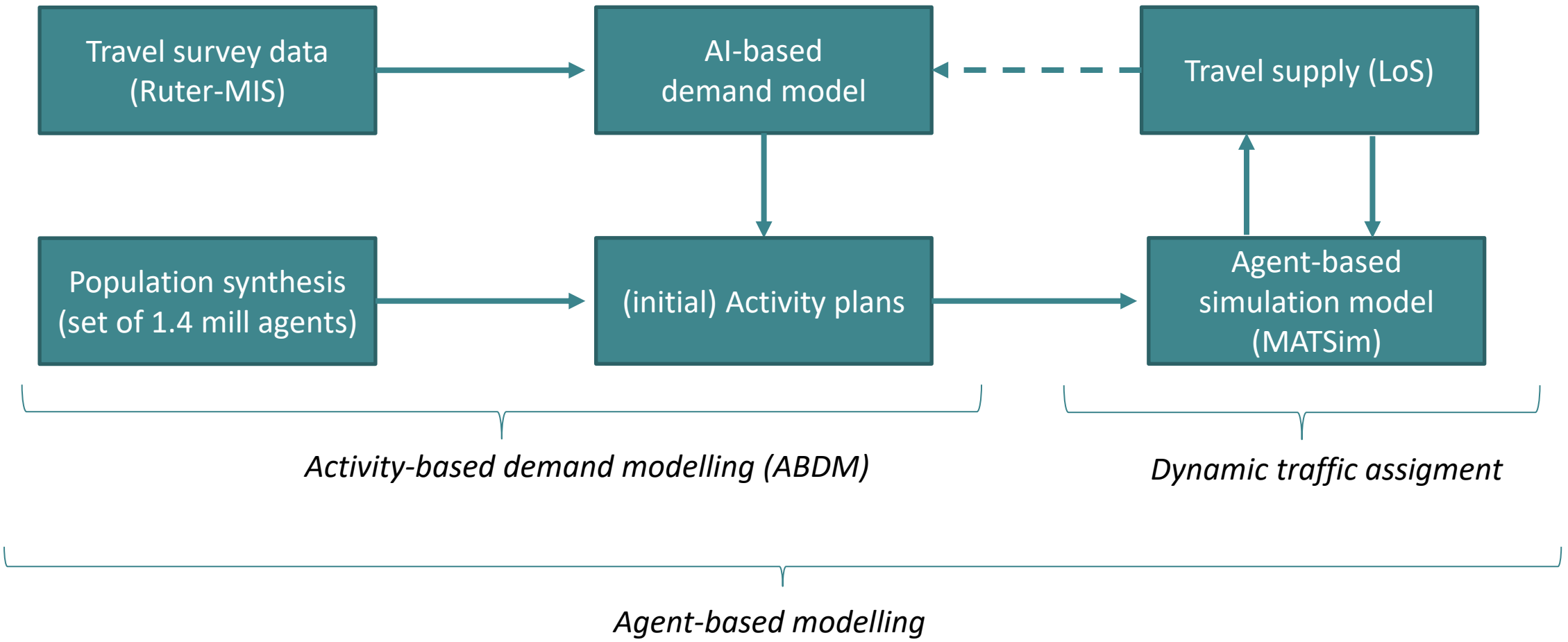
The 10th International Workshop on Agent-based Mobility, Traffic and Transportation Models, Methodologies and Applications (ABMTRANS 2021)
March 23 - 26, 2021, Warsaw, Poland

Expanding the analysis scope of a MATSim transport simulation by integrating the FEATHERS activity-based demand model

Dominik Ziemke[a,b,*], Luk Knapen[b], Kai Nagel[a]



Our approach (for Oslo Area)



Can machine learning models replace transport models? Most likely not!

Category	**Models from "first principles"** (transport models / simulation models)	**Data-driven models** (machine learning)
Prediction	Via mathematical equation system or computation/simulation	Interpolation (and extrapolation) from (typically observed) data
Underlying functions	Based on behavioral theory (e.g., utility maximization) and (simplified) representations of physical laws	Trained from data
Equilibrium calculation	Yes, possible and often explicit through iterative calculation/simulation	At best implicit
Quantitative scenario analysis / long – term predictions / counterfactual predictions	Possible by changing input data and assuming that mathematical functions and internal mechanisms hold	Typically, not possible because of insufficient variation in training data
Computational needs / speed	Very high / slow	Relatively low / fast

«good at interpolation, bad at extrapolation»

--> training based on simulated data (meta-model)

TrAffic Planner project

toi

UNIVERSITETET I BERGEN

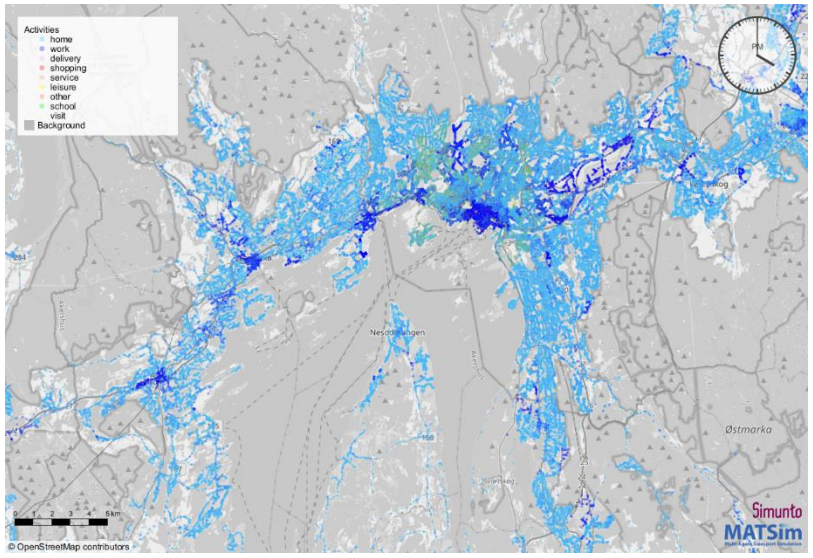
Statens vegvesen

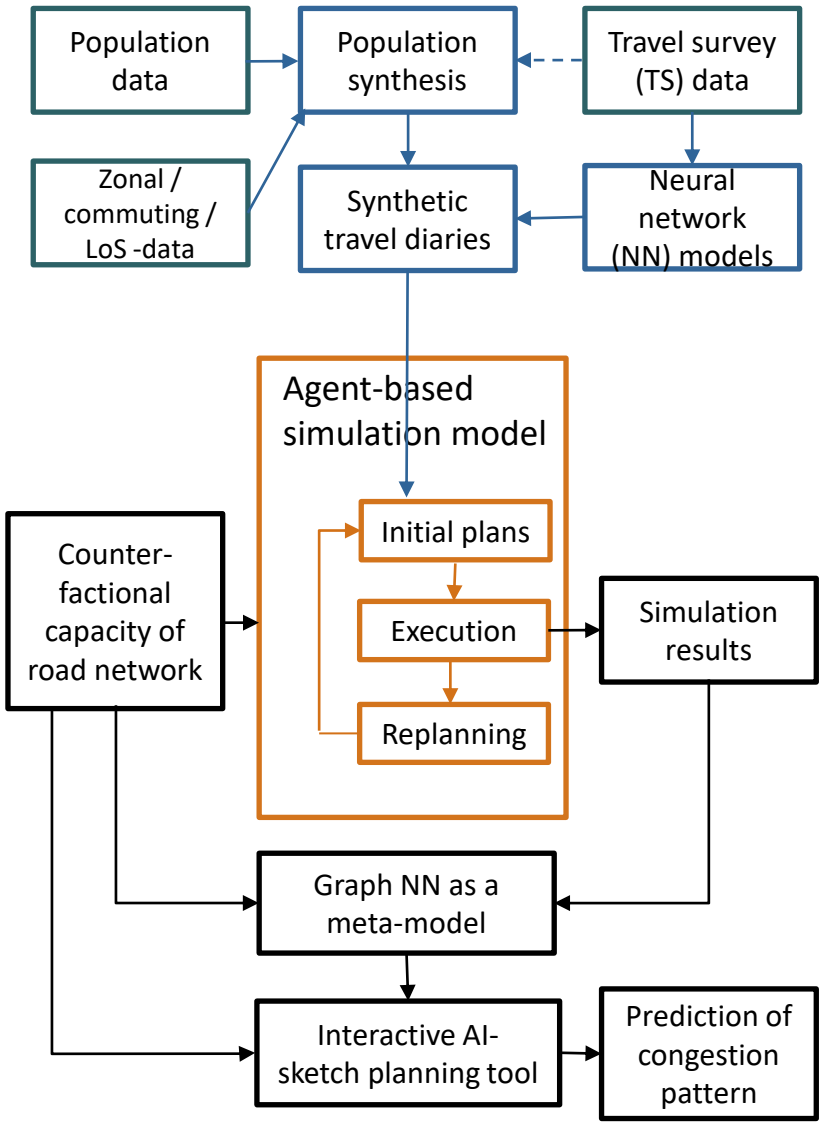
Epigram Image analysis

Ruter Kollektivtrafikk for Oslo og Akershus

vti

Snapshot of synthetic travel population

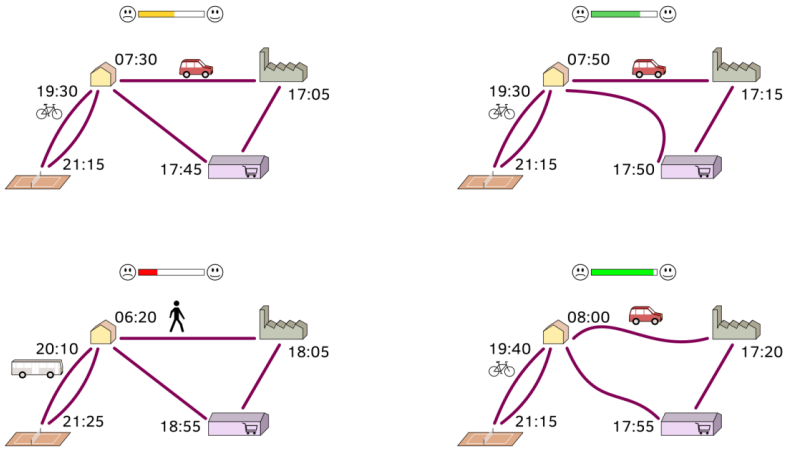




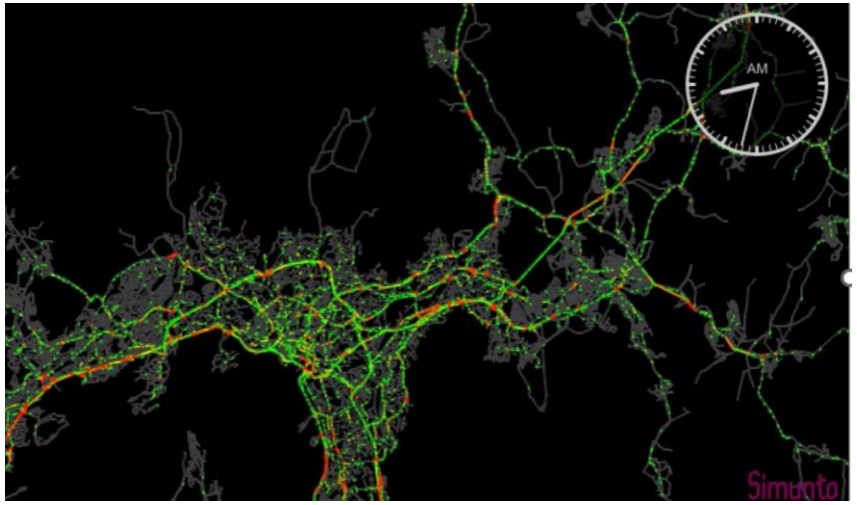
Scientific objective (PhD project)
"Traffic Prediction with Graph Neural Networks"

Applied objective: **Fast and user-friendly sketch-planning tools**
* Tool to generate synthetic travel data (Greater Oslo area)
* Tool to predict congestion given changes in road capacity

Illustration of replanning in simulation model

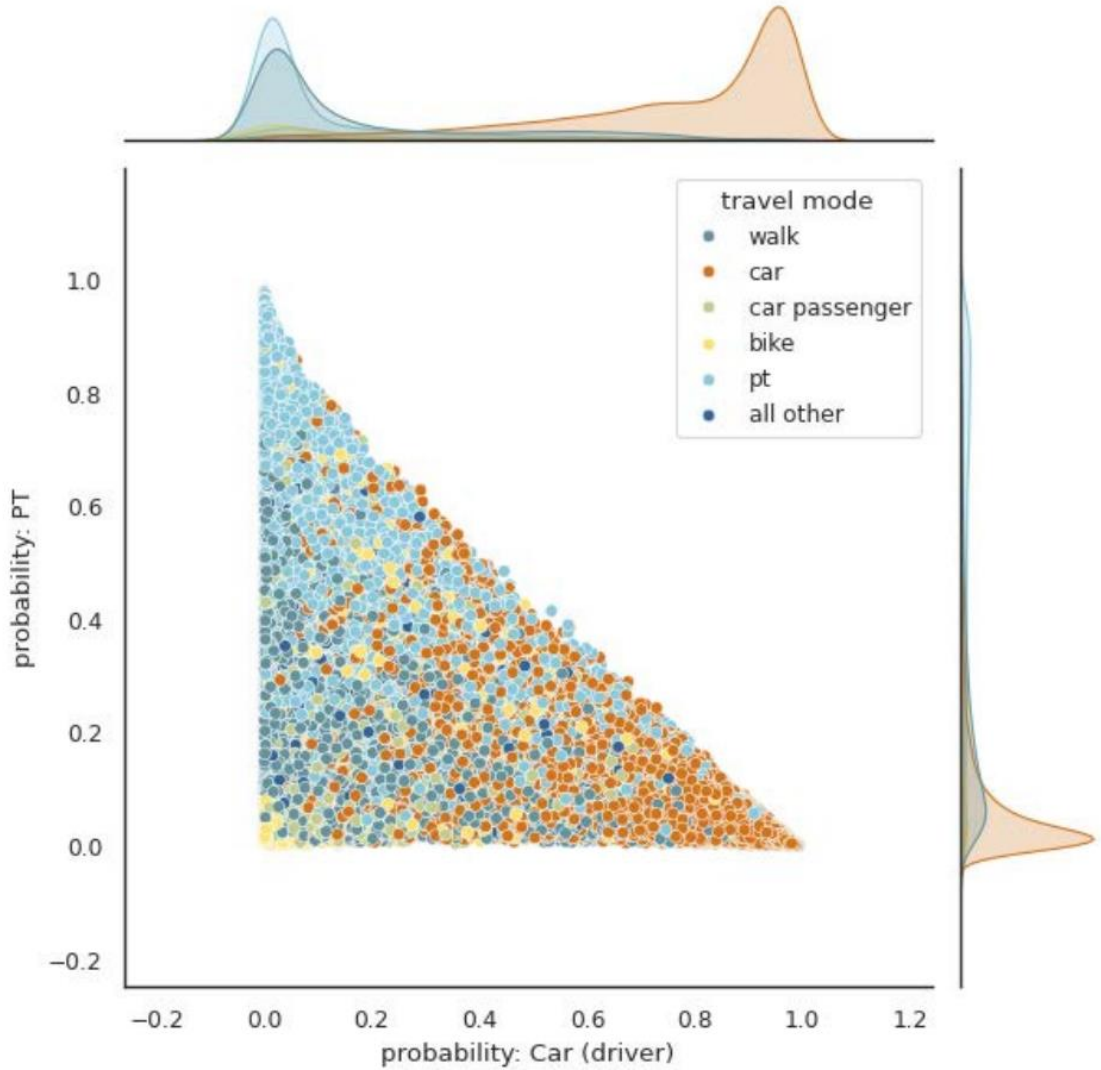


Snapshot of simulation results



Some results on the validation data

(Figures from Flügel et al 2024)



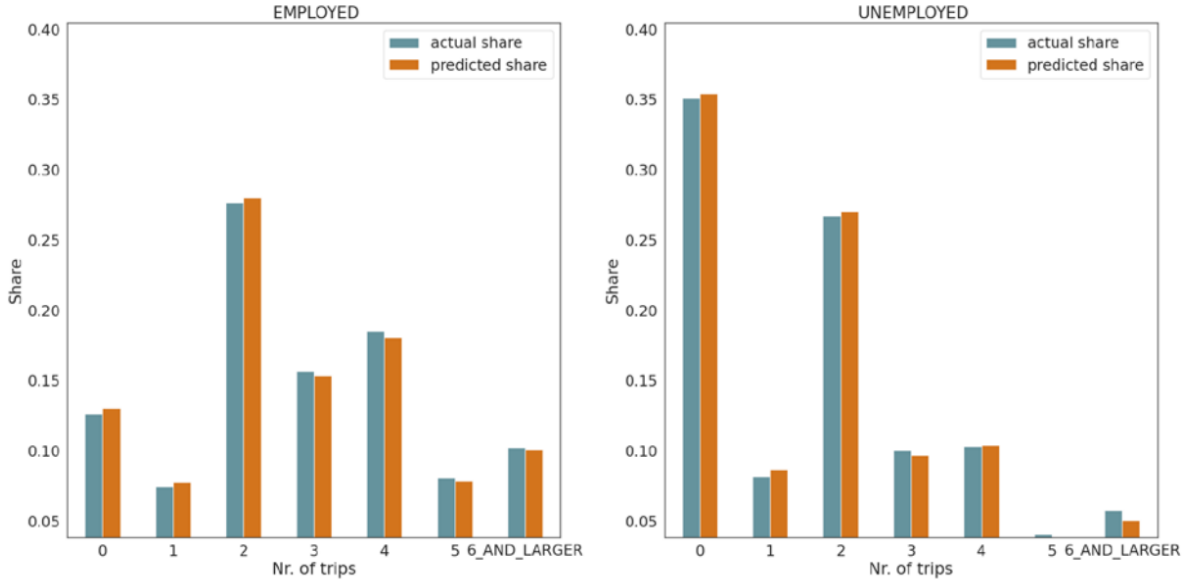
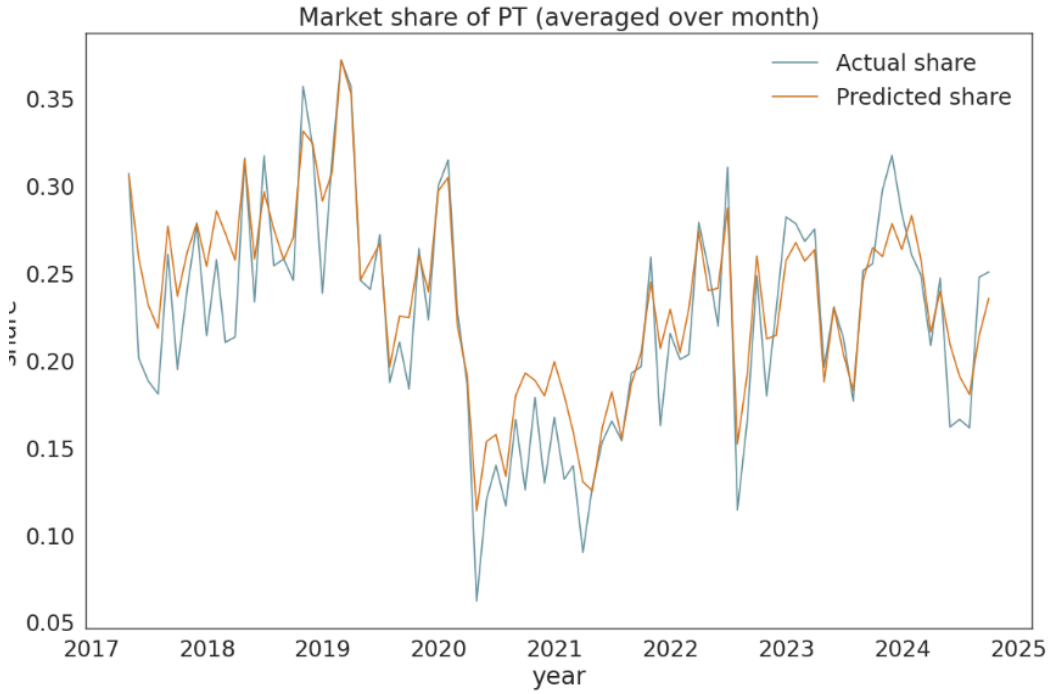
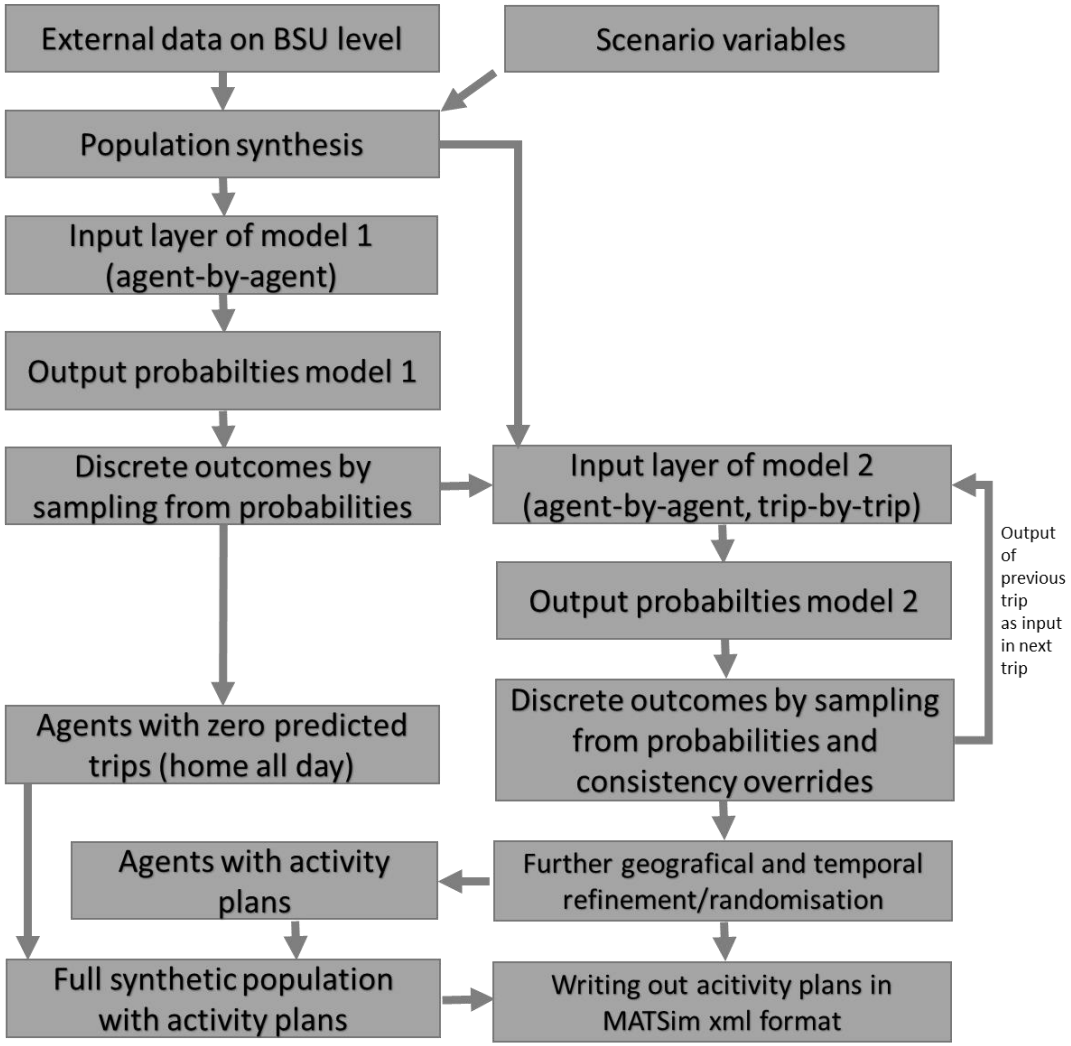


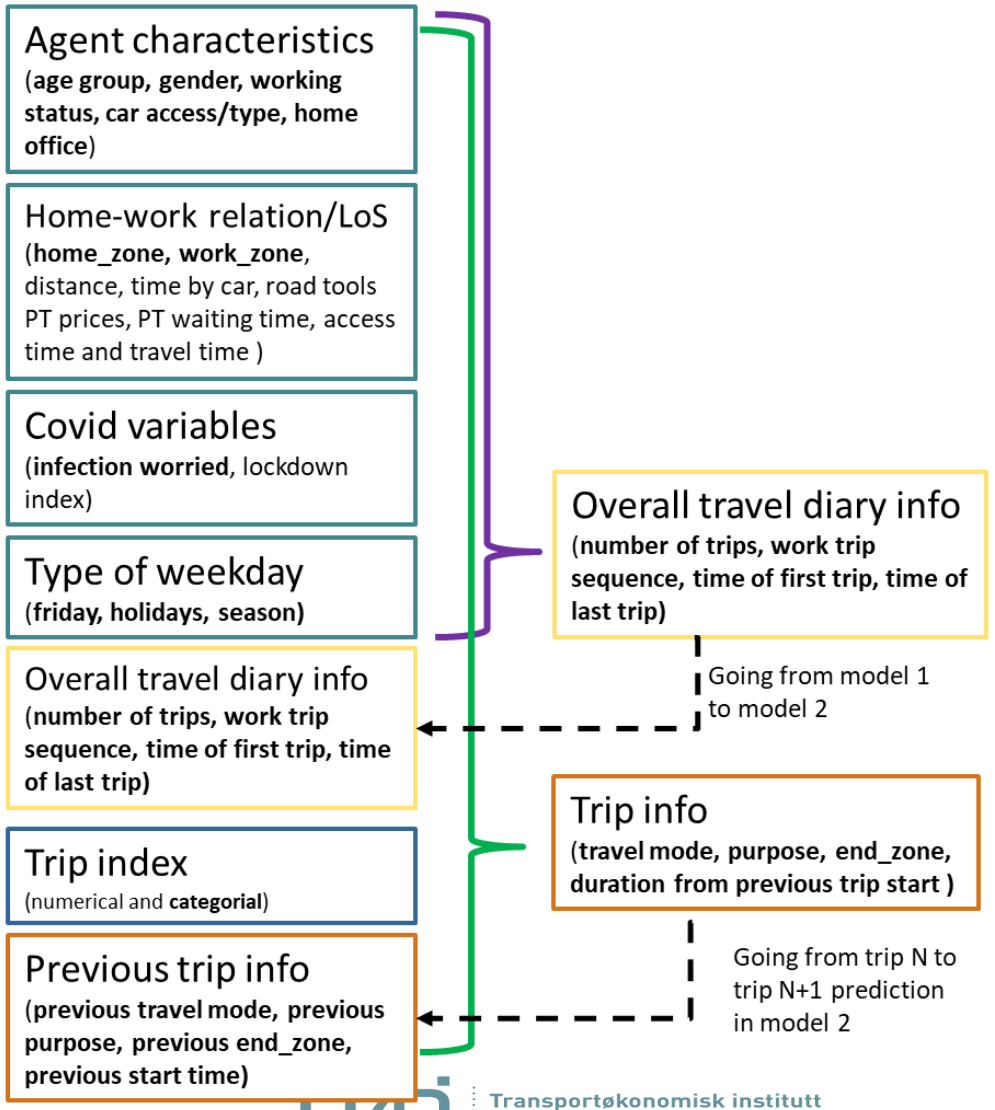
Figure 4.2: Actual share (in Ruter-MIS) and predicted share (from model 1) on the validation data for the Number of trips by occupation status.



Predictive machine learning models for synthetic travel population generation for the Oslo metropolitan area

(Figures from Flügel et al 2024)





Specification and calibration of (classical) transport model

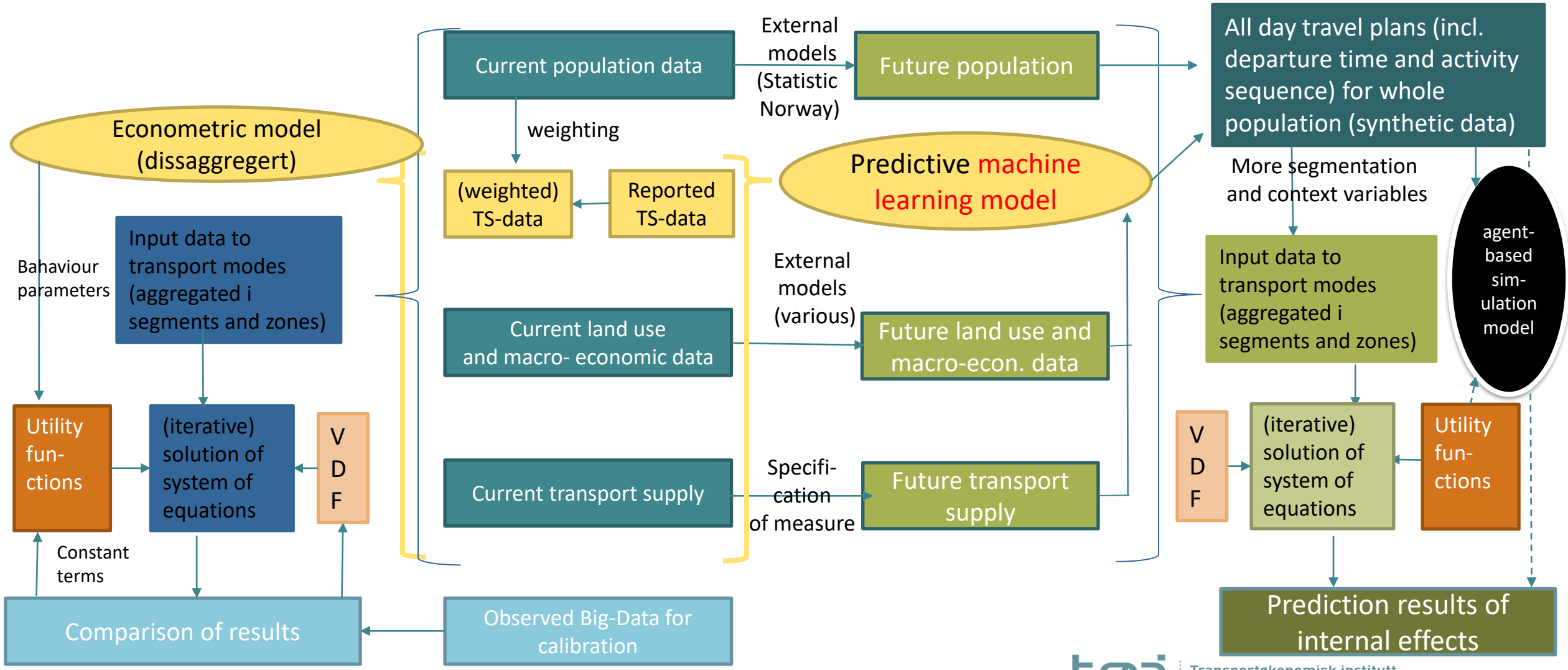
Empirical data basis

(various possibility for improvements with AI)

Prediction and specification of external data (future year)

Prediction of internal effects with (classical) transport models

(Possible enhancements with AI)



Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

Summing up, concluding remarks

- Strategic transport planning in Norway relies mainly on (static) transport models
  - *However, increasing need for SOTA methods*
    - Modelling long-term congestion patterns in cities (→ dynamic traffic assignment)
    - Mobility-as-a-Service (→ agent-based modelling for dynamic supply-demand interactions)
    - Disruptive changes to daily life (→ activity-based demand modelling)
- We can use ML-models to generate (initial) travel plans for activity-based demand models
  - *Can – to some degree – be used for predictive purposes*
- To study congestion given long-term- or counterfactual policies, we still need transport (simulation) models
  - *AI for complementary analysis*
  - *AI-meta-models (trained on simulation results) remain a research frontier*