ETH zürich SDSC HASLERSTIFTUNG

Center for Sustainable Future Mobility (CSFM)

Evaluating the Robustness of Deep Learning Models for Mobility Prediction Through Causal Interventions

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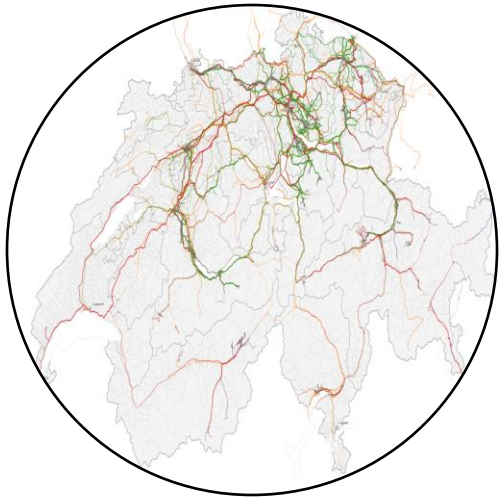
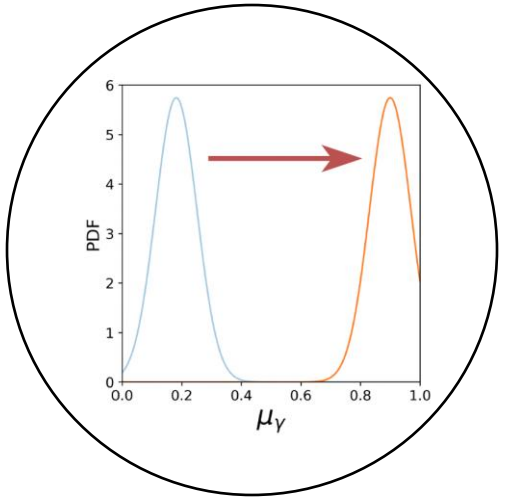
Mobility Prediction Beyond Accuracy - Robustness

Observational Data



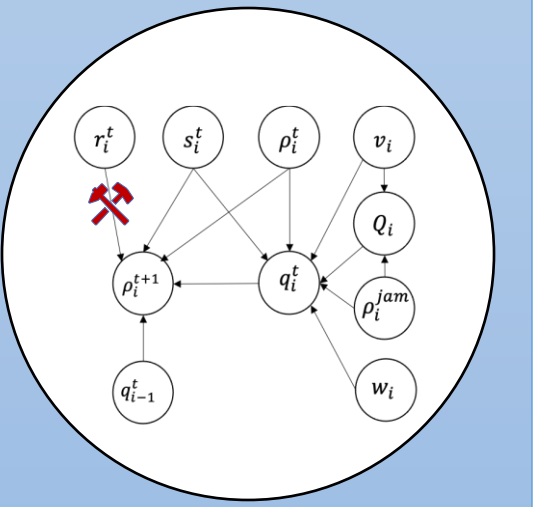
	Accuracy
Model 1	✓
Model 2	✓

Mobility Pattern Change



	Accuracy
Model 1	✓
Model 2	✗

Interventional Data



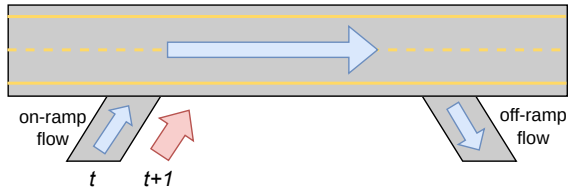
Mechanistic Mobility Simulator

Causal Intervention

Uncertainty Estimation

Results on Case Studies

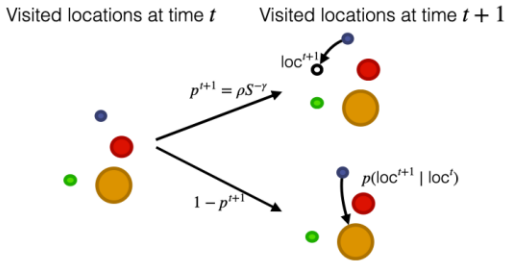
Traffic Forecasting (aggregated mobility):



Synthetic data are generated using the CTM macroscopic traffic simulator.

1) The intervention on speed has minor or no impacts on the prediction accuracy.
2) Prediction accuracy drops when intervening the flow arrival rate and off-flow, and the extent aligns with the strength of the intervention.

Next Location Prediction (individual mobility):



Synthetic data are generated using the density-EPR and individual preferential transition mechanistic simulators.

1) Prediction performance variations align with the strength of the intervention.
2) Interventions on individual location preferences have more significant impacts than the overall population-level location attractiveness.

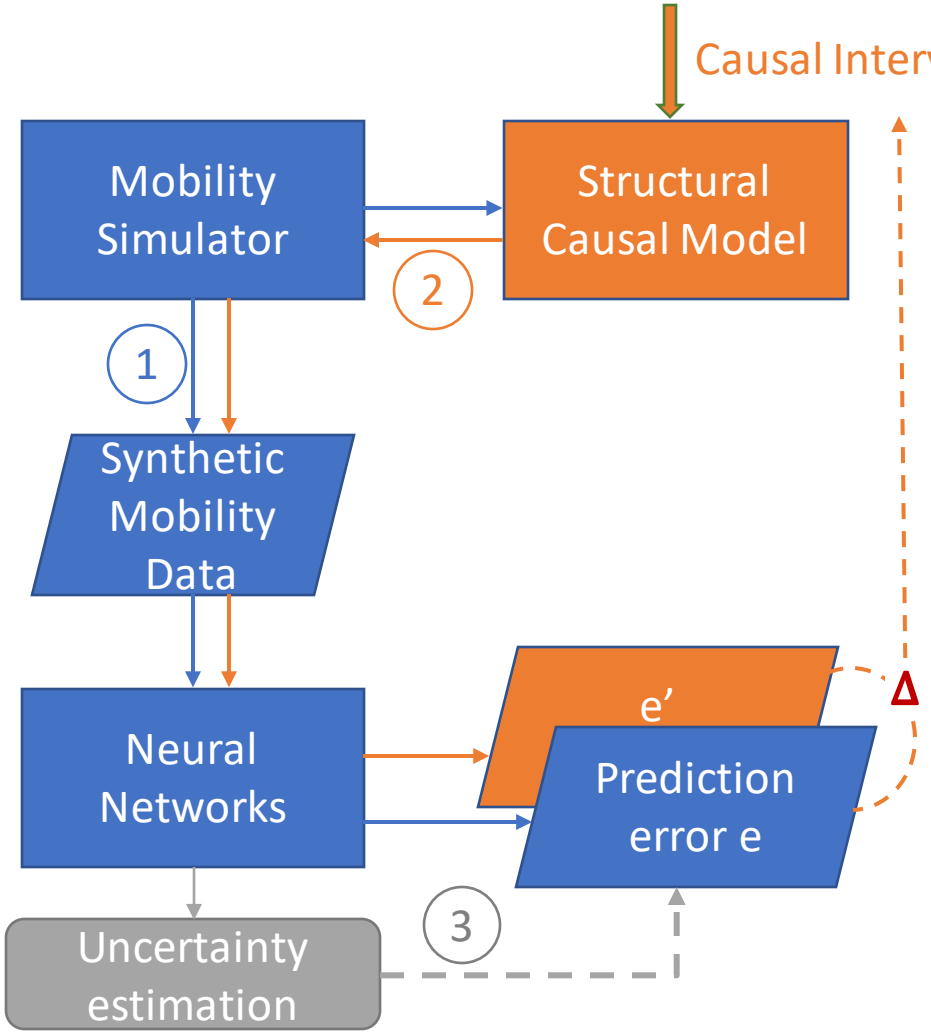
Conclusions

- Propose a new **method to evaluate the robustness** of deep learning models towards different distribution shifts of mobility data

- Provide **benchmark datasets and specifications** for evaluating the robustness of deep learning models for mobility prediction

Causal Intervention-Based Method

1. Construct **Structural Causal Model (SCM)** based on mobility simulators



2. Conduct causal interventions and test the difference in prediction errors

3. Quantify the degree of domain shifts using **uncertainty estimation**