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Influence of Urban Form on Car Ownership, Mode Choice, and Travel Distance in European Cities

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Motivation & Overarching questions

- Transport is only sector in Europe where emissions continue to grow.
  96% from road transport

- Emissions from urban mobility (c. 40% of transport emissions) arguably easiest to mitigate, but cars still dominate urban travel

- Which urban form features contribute to sustainable mobility outcomes?

- How do urban form influences vary across cities, countries?

Resolution & scope

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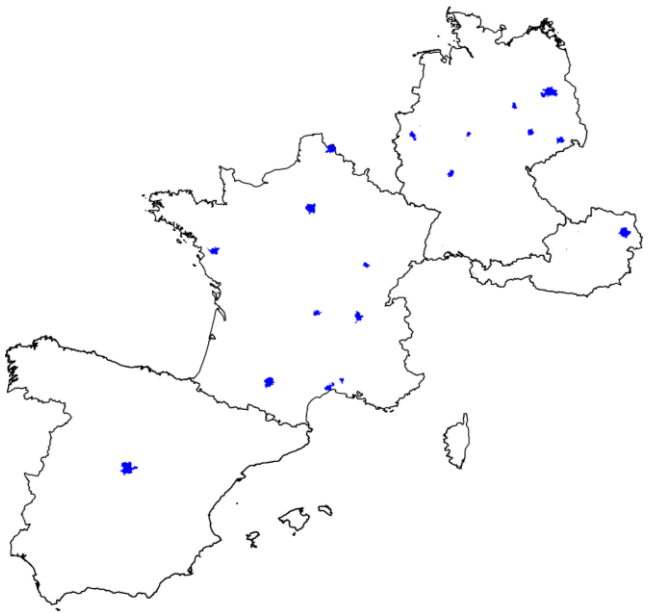
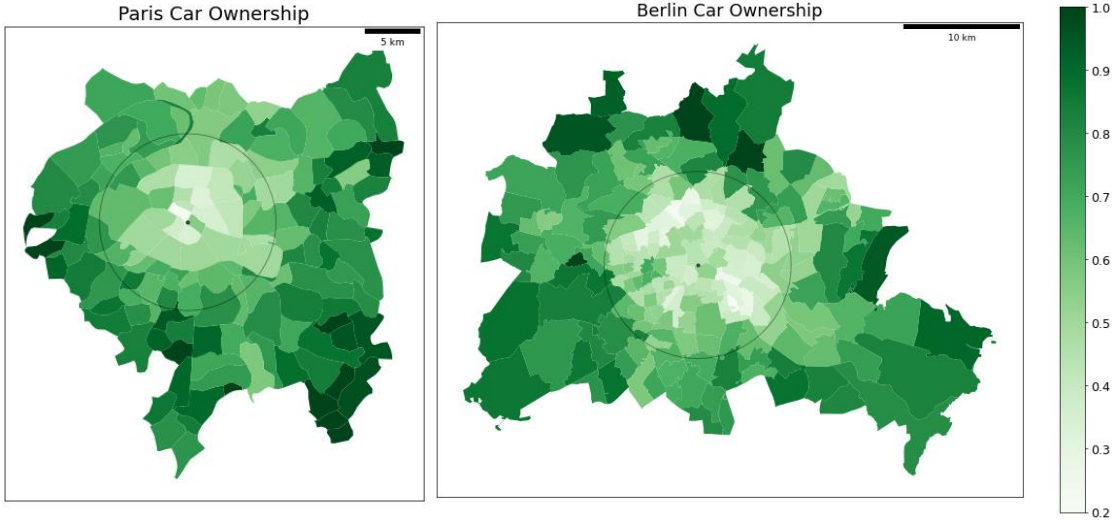
Scope – 19 cities in FR, DE, AT, ES



Resolution – Postcode or similar. ~5km^2 mean area



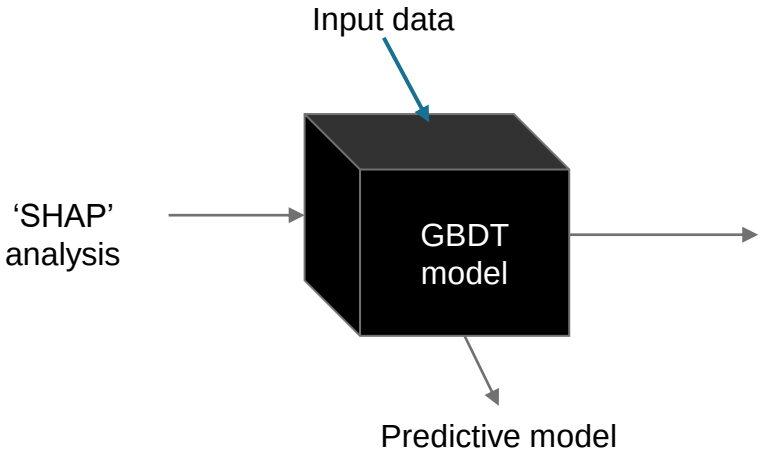
Data

- Urban form features
  - **D**ensity (population, building, street intersection)
  - Accessibility (**D**istance to city center & local subcenters)
  - **D**iversity (land use mix)
  - **D**istance to Transit
  - **D**esign of street networks (street length, streets per node)

- Urban mobility surveys, dependent variables:
  - Car ownership (household)
  - Trip distance (average by postcode)
  - Mode choice (individual trip)

Methods

- Gradient Boosting Decision Tree classification/regression models
- SHAP values for explainable machine learning; interpret the black box

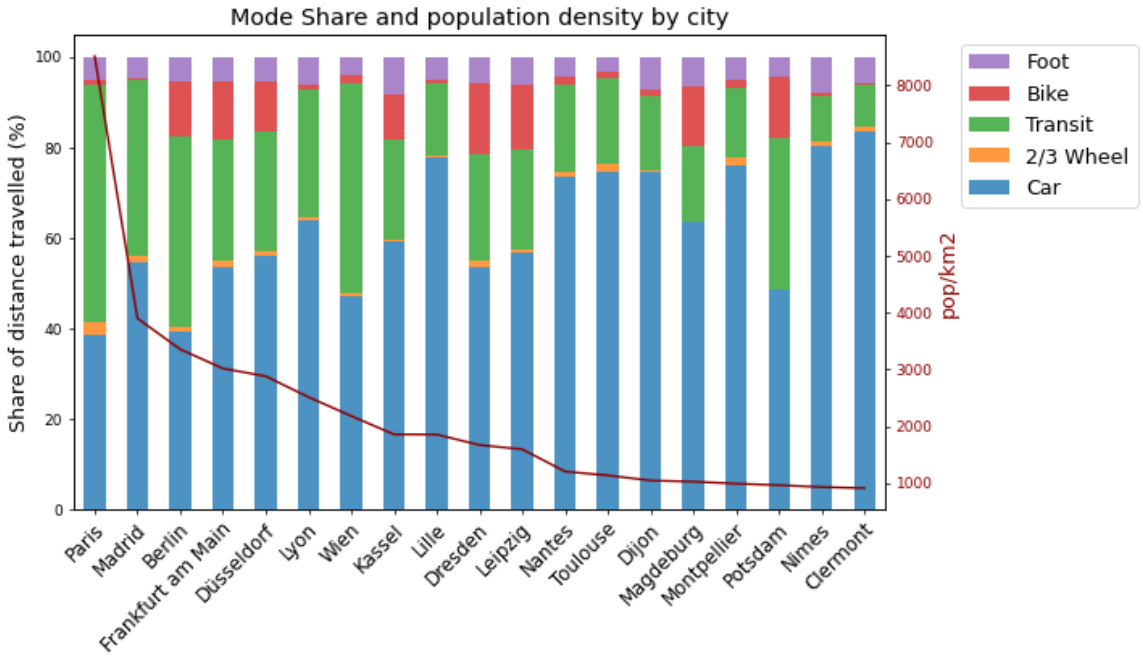


'Explainable AI'
Feature importance (FI) calculated for every obs.
Allows for non-linear relationships,
Local estimates of FI

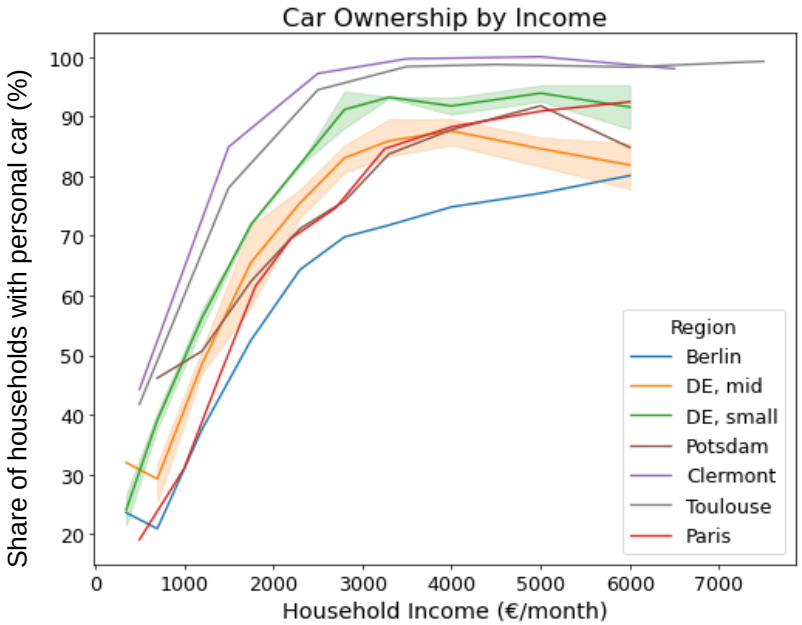
https://shap.readthedocs.io/en/latest/example_notebooks/overviews/An%20introduction%20to%20explainable%20AI%20with%20Shapley%20values.html#

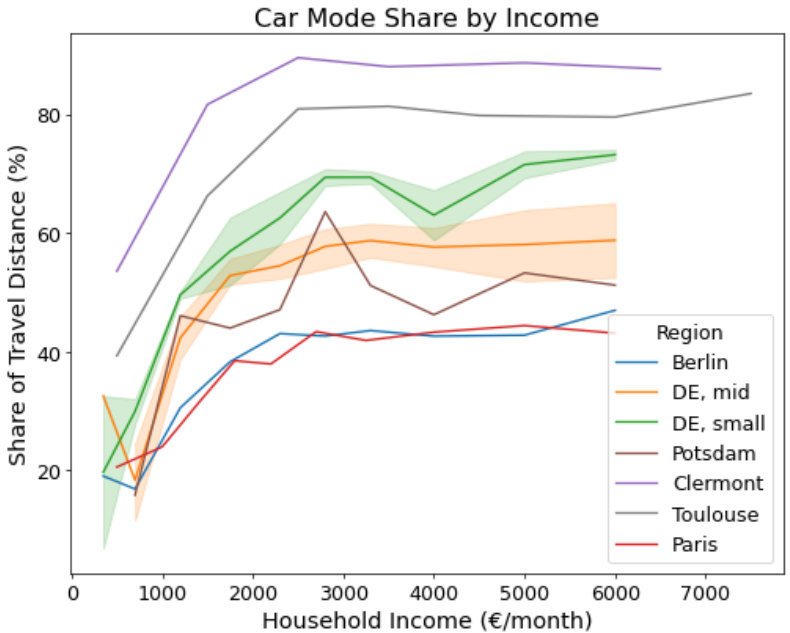
Mode share vs city density

- Car mode share generally lower in denser cities
- Country effects also apparent

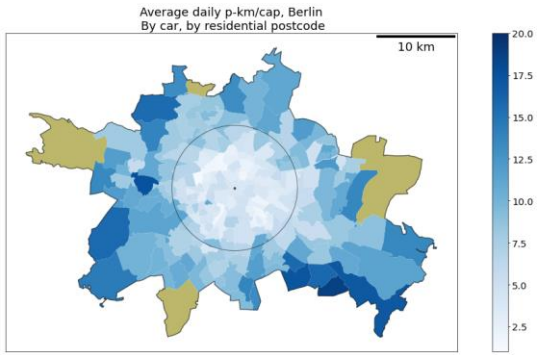


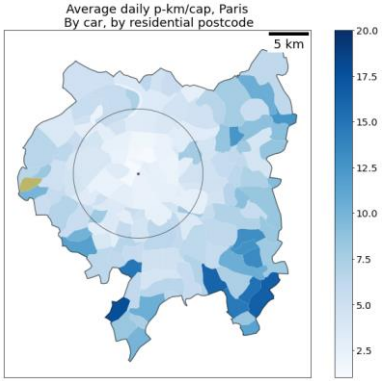
Car ownership and mode share vs income

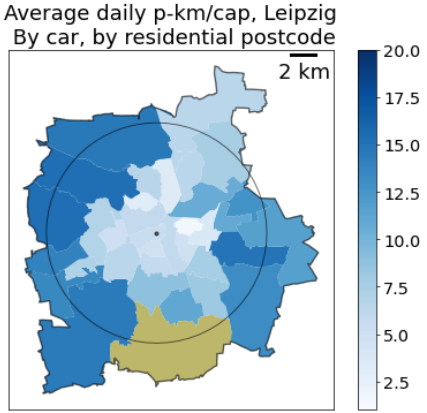


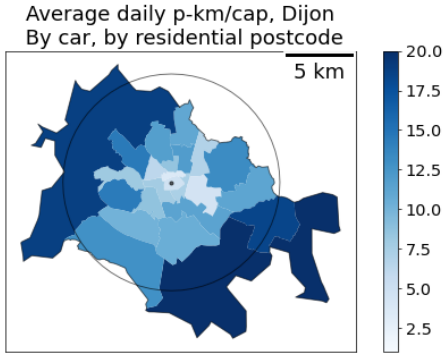


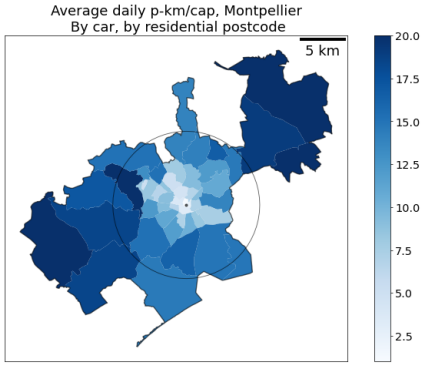
Daily car travel in large vs small- and mid-size cities

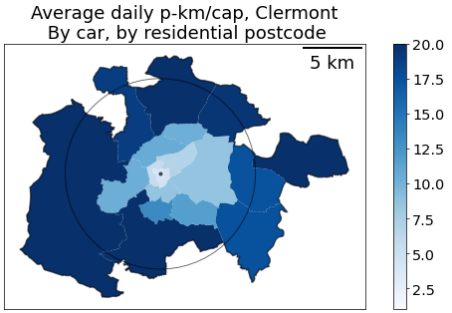




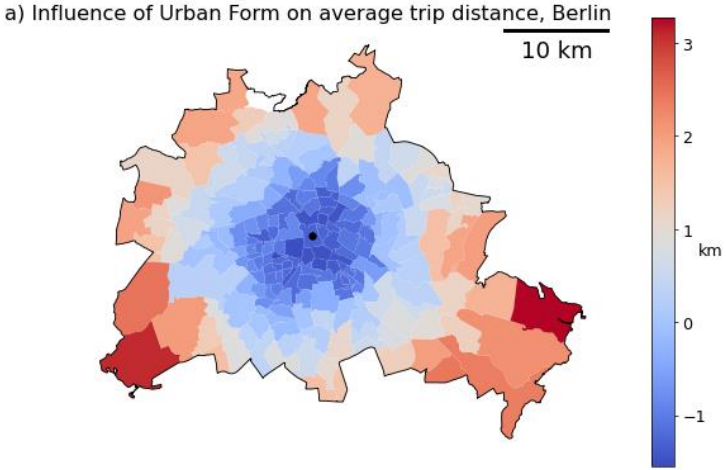


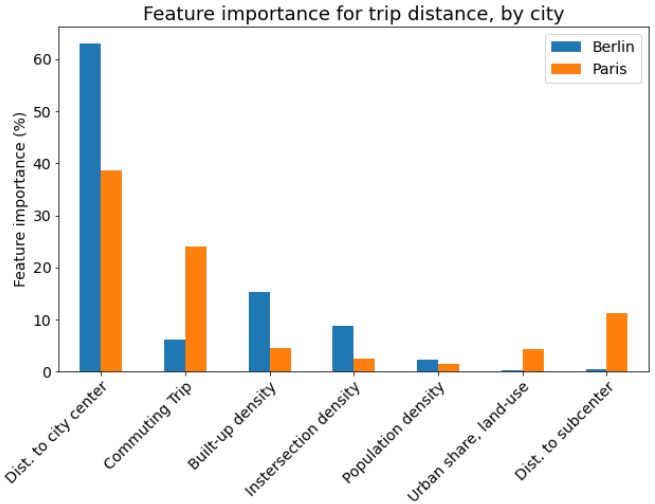


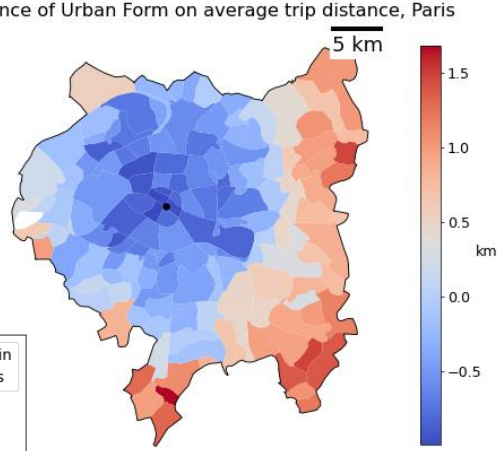




Model results: Urban form and trip distance







Model results: Urban form and car ownership

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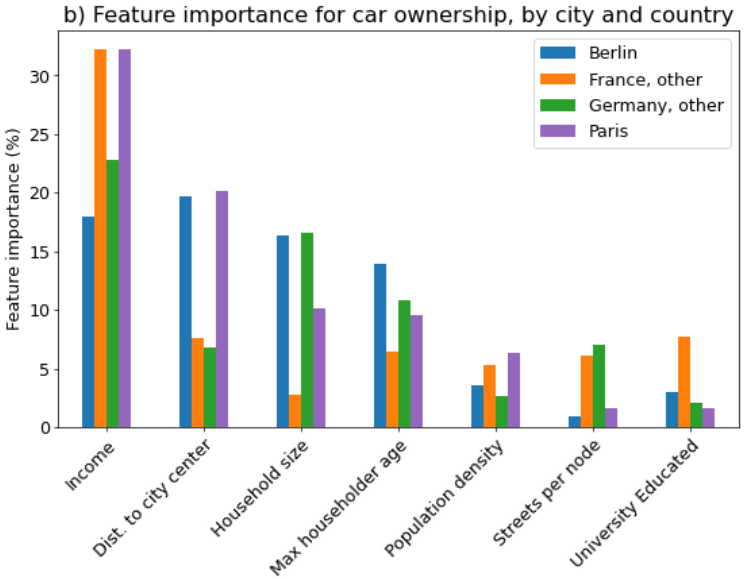
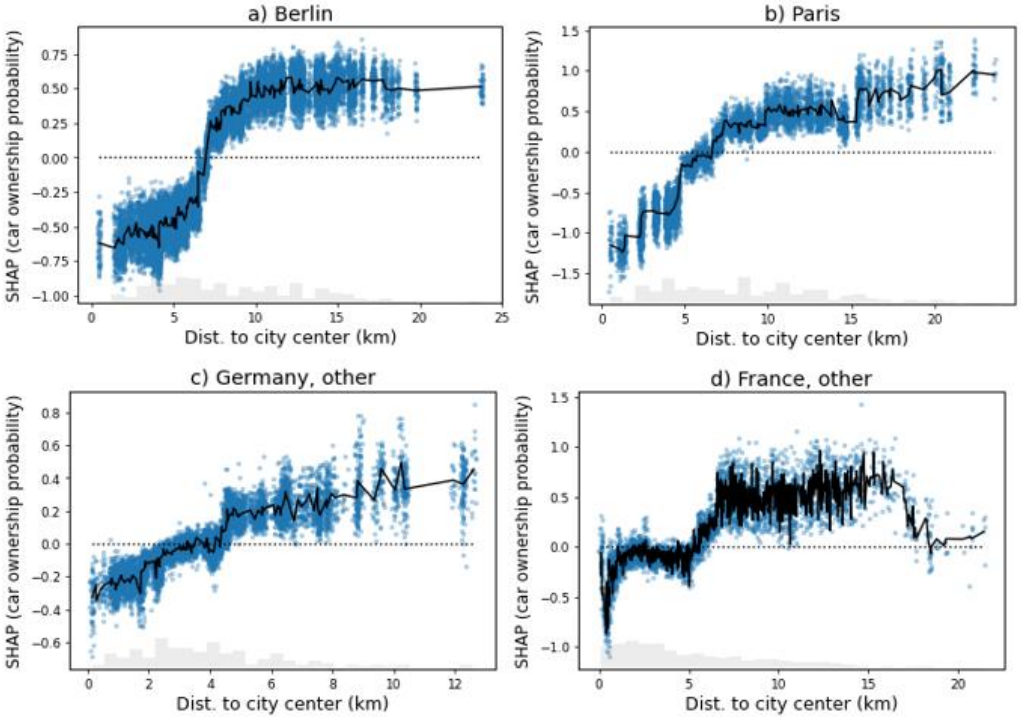
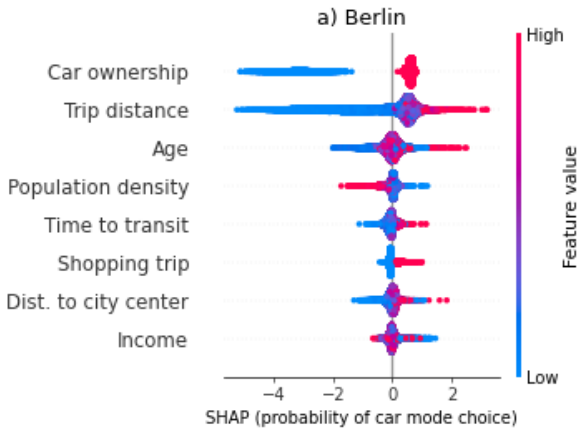
Threshold effect with distance to center, especially in Berlin

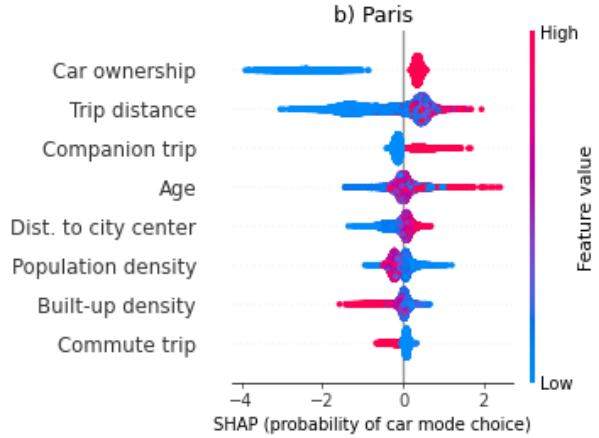


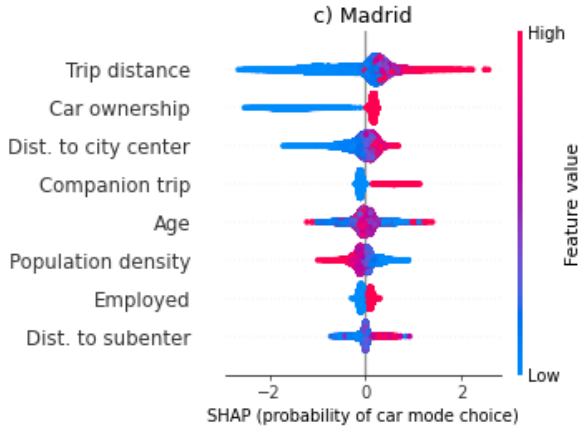


Model results: Urban form and mode choice

- Car ownership and trip distance are most important for mode choice = car
- NB companion trips, age, and distance to center







Recommendations

1. Concentrate residential development and population growth close to existing centers
2. Reduce car mode share for longer trips (increased transit, more costly car use)
3. Focus on subgroups for reducing car dependency, e.g. companion trips,
4. Focus on (tech and policy) solutions for small and mid-size cities

Thank you

Contact:
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Project website:
https://peterberr.github.io/sufficcs/

Preprint:
https://www.researchsquare.com/article/rs-2924076/v1

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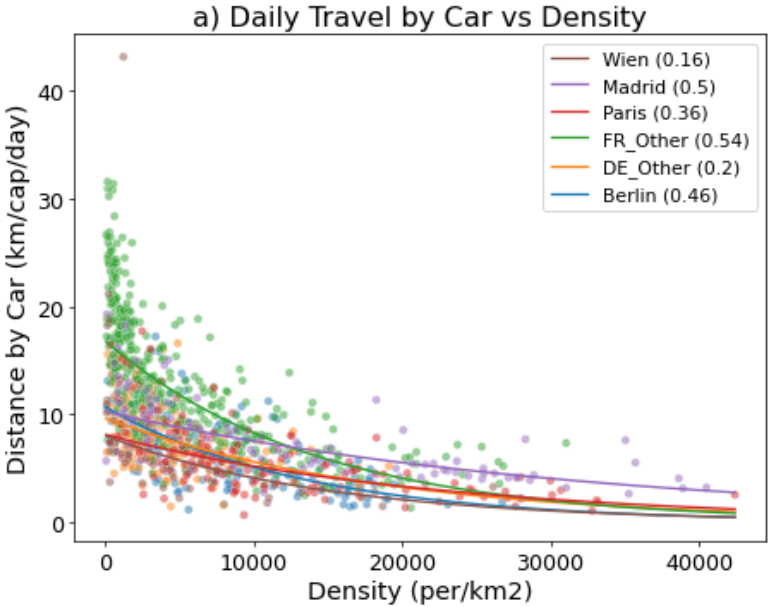
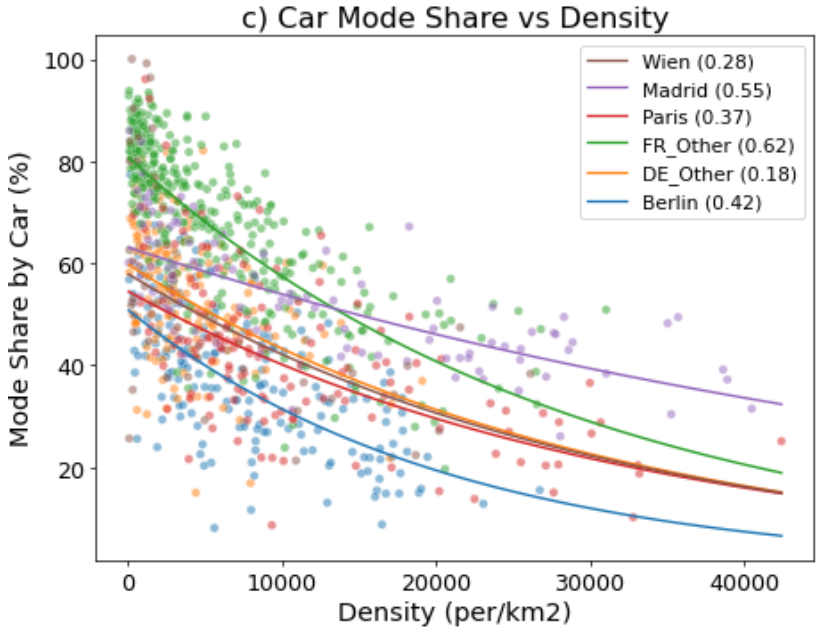
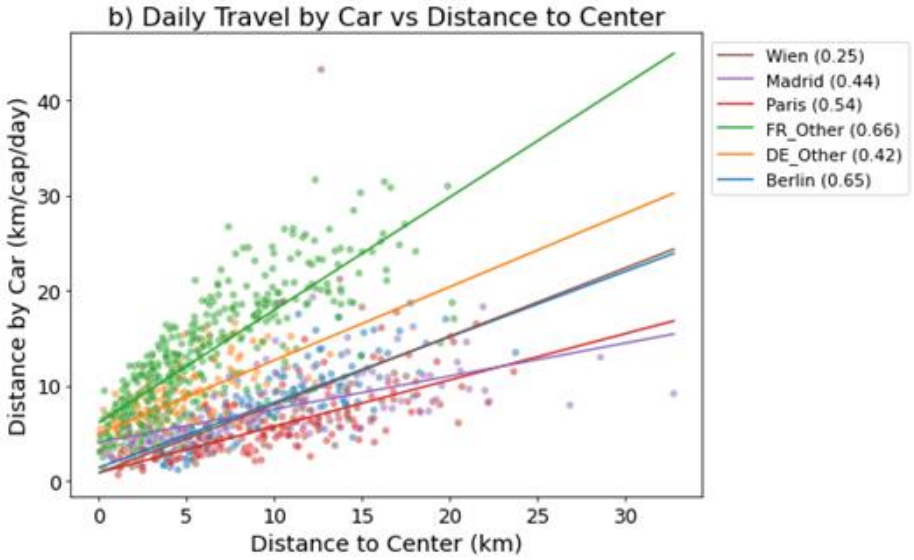
Extra slides

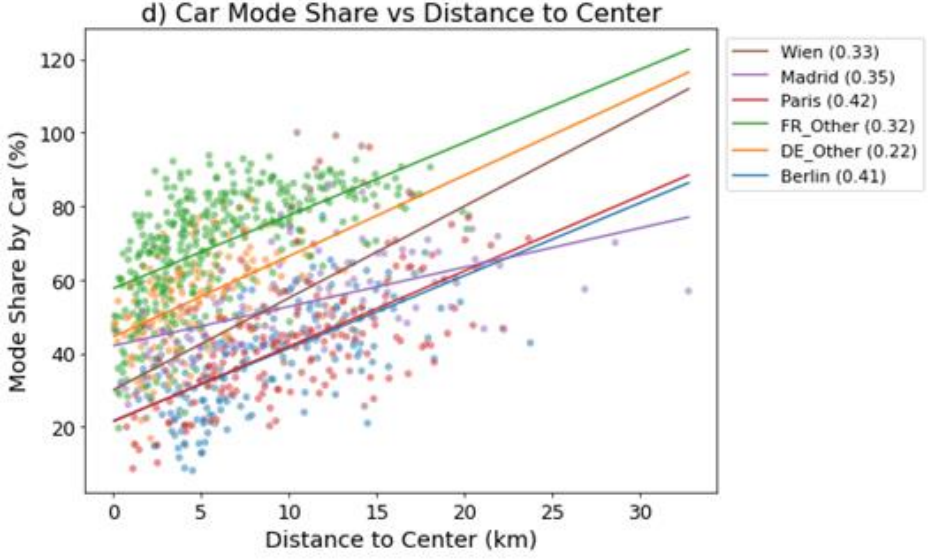
Car travel and mode share vs Density



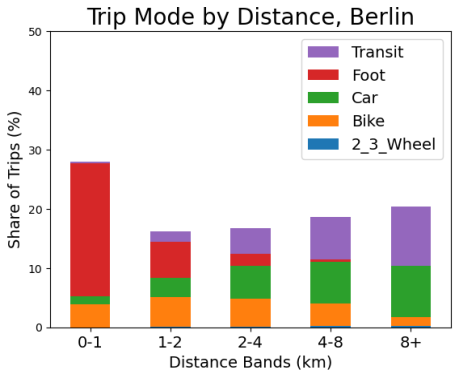


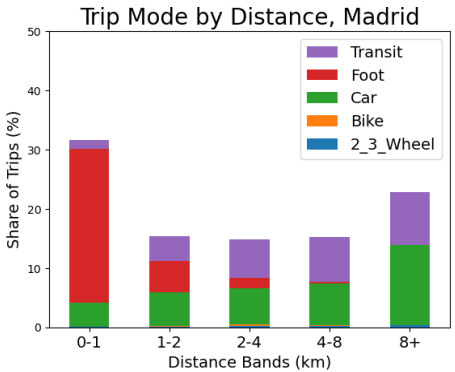
Car travel and mode share vs Distance to Center

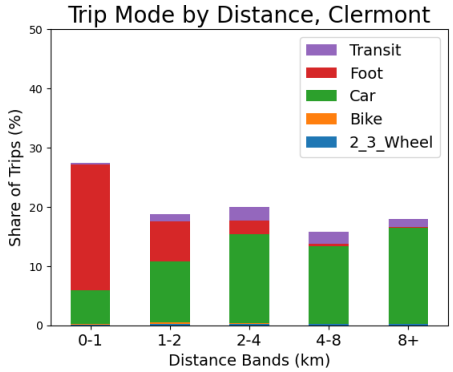


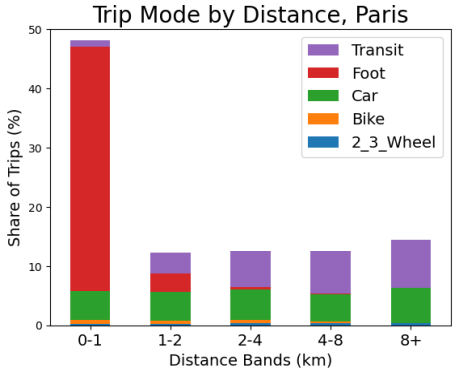


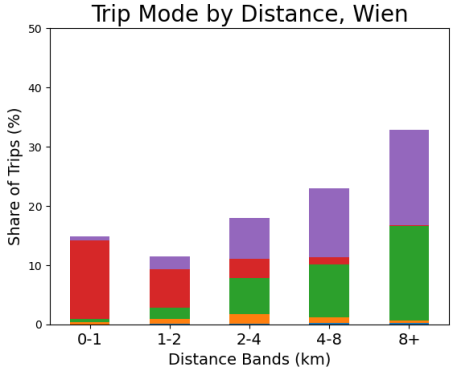
Trip Mode by Distance – selected cities

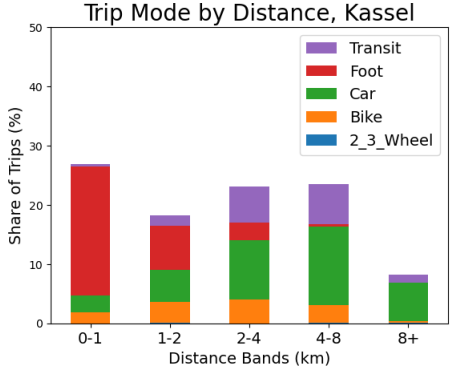




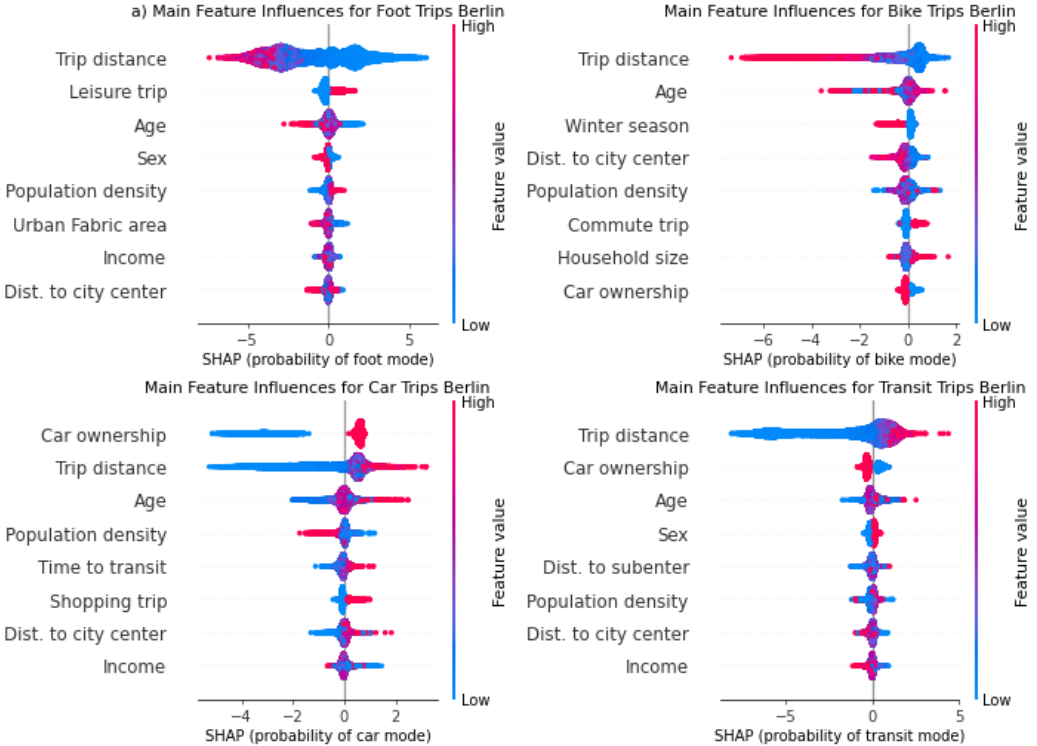




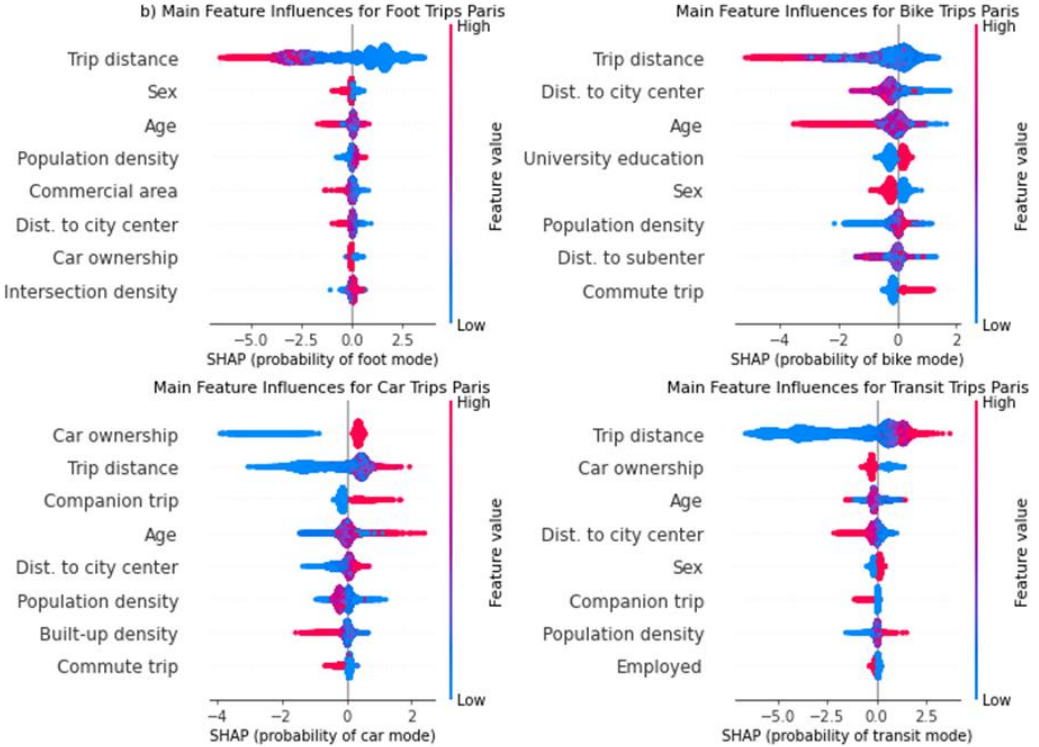




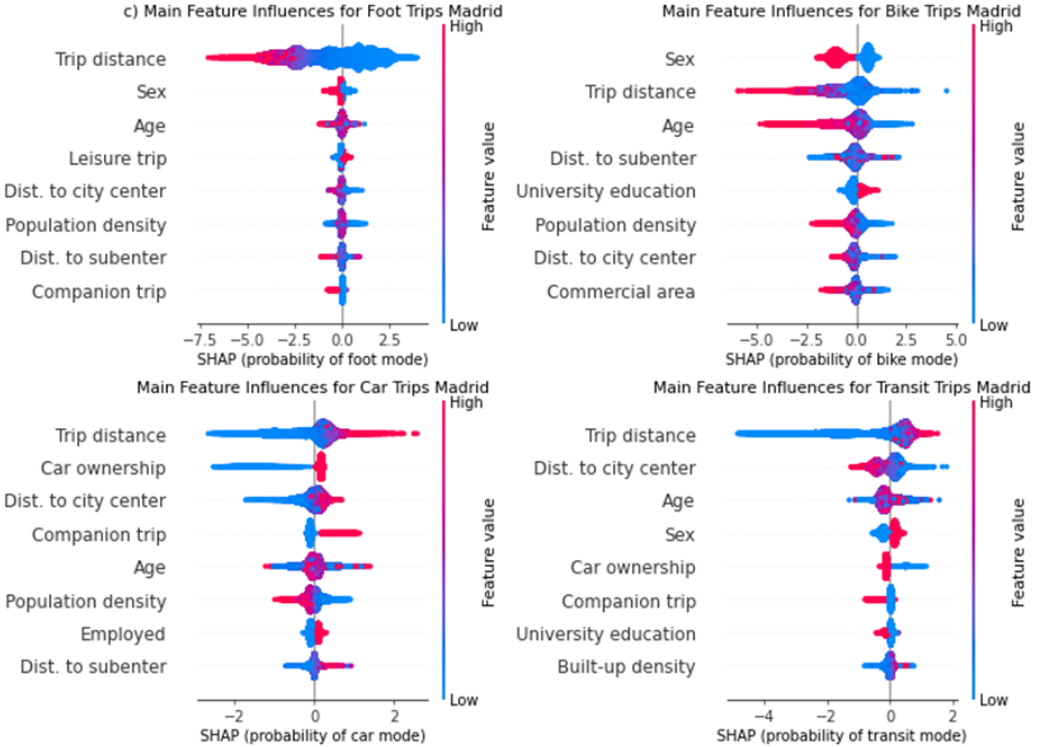
Feature influences for mode choice, Berlin



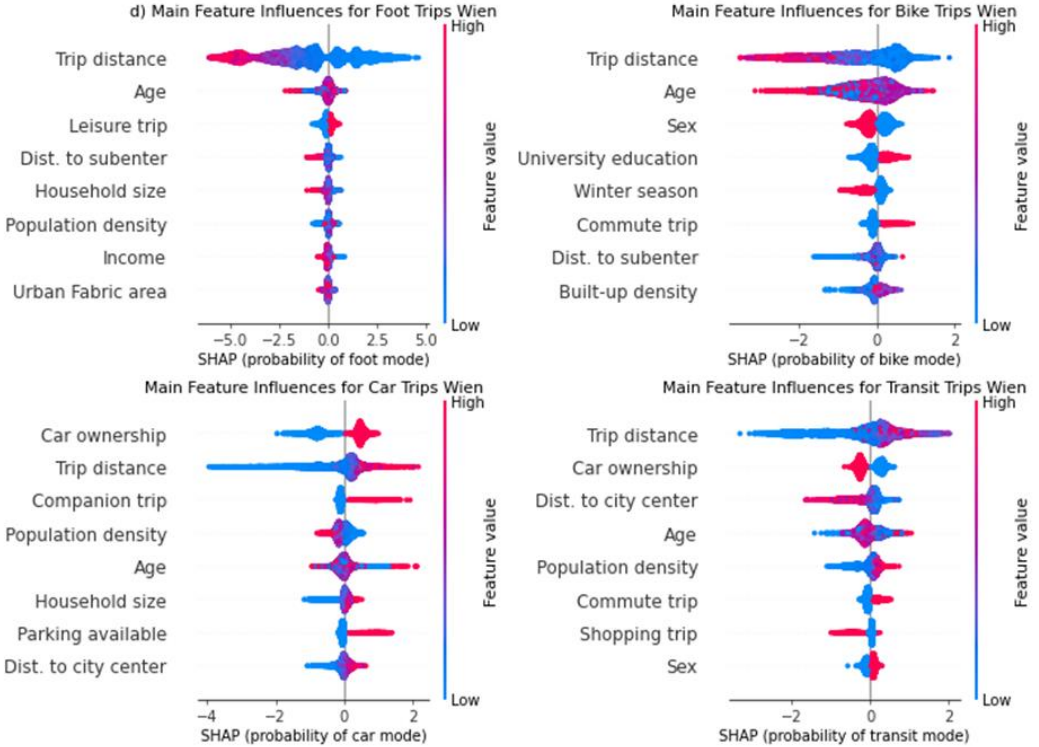
Feature influences for mode choice, Paris



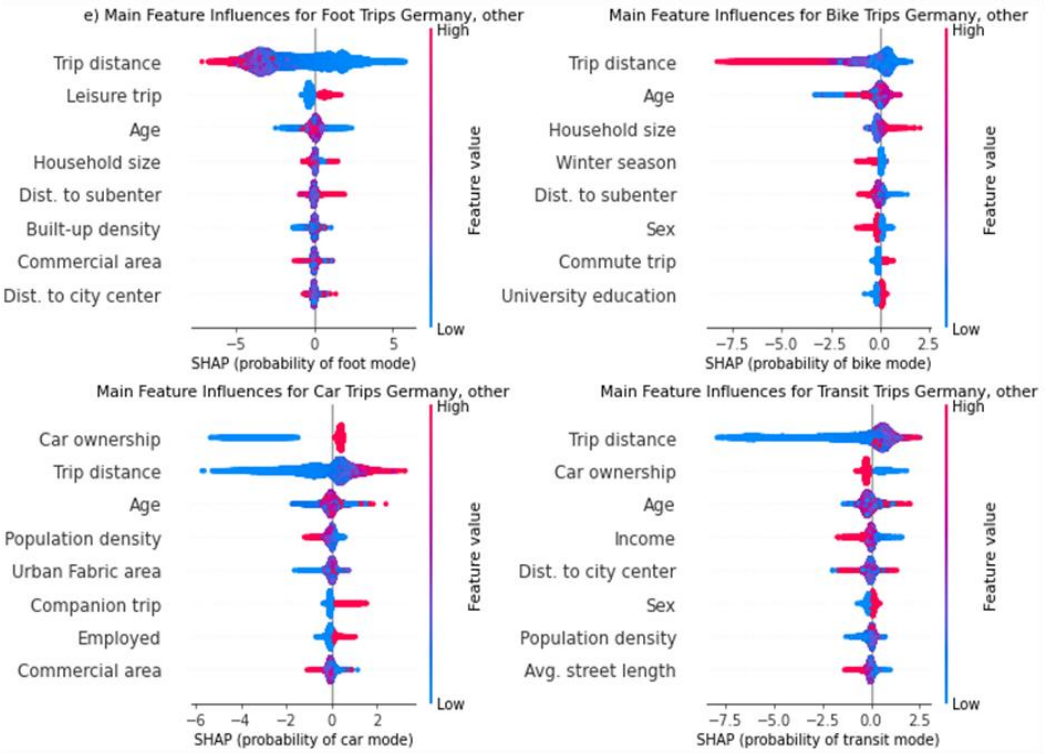
Feature influences for mode choice, Madrid



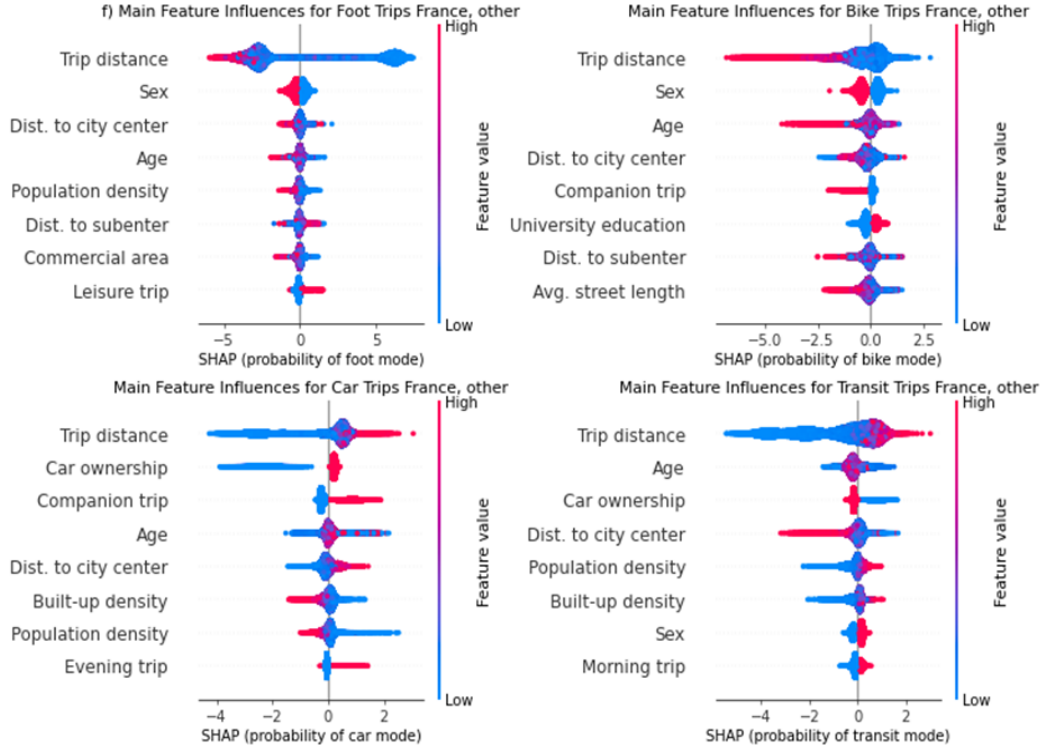
Feature influences for mode choice, Wien



Feature influences for mode choice, other Germany



Feature influences for mode choice, other France



Network diagram of variable groups