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Simple Open Data Measures of Public Transit Service Availability

Temporal Variability

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Affidavits

Abstracts

English

German

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1 Introduction

In recent years, but for decades by now, the demand for a paradigm shift in transportation infrastructure and service has become louder and louder. While calls for a shift away from car centric mobility are nothing new and were a well established part of German Academic discourse in the 1990s already (Holzapfel, 1993), it has become part of a widespread political discourse around the so called *Verkehrswende* (Holzapfel, 2020). With increased awareness and concrete experiences of climate change this discourse has reached states of heated debate. Benefits of

1.1 Transit Accesibility Equity and Equality

1.1.1 Terminology

1.1.2 Motivation

- Traditional transport planning centering on men?
  - German Transport Planning post world war 2?
- Transit planning and identifying demand in public transit networks is a complicated process, that takes into account a plethora of data that's hard to access or acquire (Pieper, 2021).
  - statistical routing data based on conveyal engine (Conway et al., 2017)

1.1.3 Research Question

- How temporal variability in transit accessibility maps on to spatial usage patterns?

1.2 Related Work

- Network Centrality Measures
  - road networks
  - public transit networks
  - bipartite networks
- Transit Equity Studies
  - US
  - Network Planning (Pieper, 2021)
- Traveltime Datasets such as (Tenkanen & Toivonen, 2020) and (Verduzco Torres & McArthur, 2024)

1.3 Methodological Approach

1.3.1 Data Acquisition

- explorative data analysis

1.3.2 origins

- hexgrids from h3pandas (Dahn, 2023) based on uber's implementation of them

1.3.2.1 Transport Data

- osm files from geofabrik (Geofabrik GmbH, 2018)
- gtfs files from various transit companies (DELFI, 2023; Rhein-Neckar-Verkehr GmbH, 2023; VRS, 2023; VVS, 2023).

1.3.2.2 Population Data

1.3.3 Destinations

- Usage of openly available data, preferably from osm .. extracted with pyrosm (Tenkanen, 2023)
- specific data if necessary, eg secondary school data not mapped in osm (Ministerium für Schule und Bildung NRW, 2016)

1.3.4 Case Studies

- Selected based on data availability, personal familiarity.

1.3.4.1 secondary schools

- see (Verduzco Torres & McArthur, 2024)
- data from (Ministerium für Schule und Bildung NRW, 2016)

1.3.4.2 sports clubs

- osm data

1.3.4.3 hexgrid cells

- h3 pandas (Dahn, 2023)

2 Transit Reach

2.1 Measures of Reach

2.1.1 Isochrones as a Measure of Reach

- ors (HeiGIT, 2023)
- cummulative or individual accesibility measures from (Verduzco Torres & McArthur, 2024)

2.1.2 Mean Travel Time

2.2 Temporal Variability

- conveyal approach (Conway et al., 2018)
  - also used in (Verduzco Torres & McArthur, 2024) for metrics spanning the UK, but identified gap in temporal variability of transport choices
- automatic clustering using u-map, pca and k-means

2.3 Processing

2.3.1 Travel Matrices

- enough for basic reach analyses, isochrone itself not important
- calculated with r5py (Fink et al., 2022) as used in (Tenkanen & Toivonen, 2020), based on the conveyal engine (Conway et al., 2017; 2018)

2.3.2 clustering

- Dimensionality reduction PCA or UMAP (McInnes, 2018) based on the maths from (McInnes et al., 2020)
- Clustering K-Means or HDBSCAN (McInnes et al., 2016) based on an algorithm proposed by (Campello et al., 2013)

2.4 Results

3 Transit Access and Planning

3.1 Conveyal Percentiles

- see (Verduzco Torres & McArthur, 2024)

3.2 Processing

3.3 Results

4 Results

5 Discussion

5.1 General Limitations

- Lack of real world measures as Comparisons
- Focuses solely on door to door travel times and neglects
  - reliability and delay Data
  - public transit fare structures (Conway & Stewart, 2019)
- lacks data including
  - comparisons to cars
  - ride hailing services see (Barajas & Brown, 2021)
  - related on demand services (trial at rohrbach)
- *inequality* being silly at times (Graeber & Wengrow, 2022).

5.2 Methodological short commings

- UMAP clustering prone to confabulations (2018; Schubert, 2017).

6 Final Remarks

6.1 Conclusion

6.2 Outlook

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