

2024-01-19

# **Simple Open Data Measures of Public Transit Service Availability**

**Usecases for Closeness Centrality and Isochrones**

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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 [1], it has become part of a widespread political discourse around the so called *Verkehrswende* [2]. With increased awareness and concrete experiences of climate change this discourse has reached states of heated debate. Benefits of

## 1.1 Transit Accessibility 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 [3].
  - statistical routing data based on conveyal engine [4]

### 1.1.3 Research Question

- How can an easy closenes centrality measure help asses transit service availability and equality

## 1.2 Related Work

- Network Centrality Measures
  - road networks
  - public transit networks
  - bipartite networks
- Transit Equity Studies
  - US
  - Network Planning [3]

## 1.3 Methodological Approach

### 1.3.1 Data Acquisition

- explorative data analysis

#### 1.3.1.1 Transport Data

- osm files from geofabrik [5]
- gtfs files from various transit companies [6]–[8] vrs

#### 1.3.1.2 Destinations

- Usage of openly available data, preferably from osm ..
- specific data if necessary, eg [9]

### 1.3.2 Data Processing

- Isochrones
  - available from openrouteservice [10], as used in [11], not used because:
- travel time matrices

- enough for basic reach analyses, isochrone itself not important
- calculated with r5py [12] as used in [13], based on the conveyal engine [4], [14]

## **1.4 Geographic Case Studies**

- Selected based on data availability, personal familiarity.

## **2 Closeness or Reachability**

### **2.1 Closeness Centrality**

### **2.2 Reach**

#### **2.2.1 Isochrones as a Measure of Reach**

### **2.3 Comparison Use Cases**

### **2.4 Methods**

#### **2.4.1 Available Data**

- school data from [9]
- sports data from osm

#### **2.4.2 Processing**

### **2.5 Results**

## **3 Comparisons with Non-Schedule-Based Modes**

### **3.1 Cycling**

#### **3.1.1 Methods**

#### **3.1.2 Results**

### **3.2 Cars**

#### **3.2.1 Methods**

- added parking times

#### **3.2.2 Results**

## **3.3 Temporal Discrepancies with Scheduled Transit**

### **3.4 Limitations**

- limitations to car traffic estimations
- limitations to parking times

## **4 Distinguishing Transit Footprints**

### **4.1 Historical Urban Blueprints**

### **4.2 Radial and Tangential Services**

### **4.3 Methods**

#### **4.3.1 Visual Differences**

#### **4.3.2 Inequality Measures**

- Lorenz Curves and Gini Coefficients being silly sometimes [15]

### **4.4 Results**

### **4.5 Hub and Spoke Transit Planning**

## **5 Recap of Results**



## 6 Discussion

### 6.1 General Limitations

- Lack of real world measures as Comparisons
- Focuses solely on door to door travel times and neglects
  - reliability Data
  - delay data both for cars and public transit
  - public transit fare structures [16]
- *inequality* being silly at times [15].

## Bibliography

- [1] H. Holzapfel, “Hat das Auto in der Stadt noch etwas zu suchen?”, *Strategien gegen den Verkehrsinfarkt*. in Deutsche-Bank-Research. Schäffer-Poeschel, Stuttgart, pp. 63–80, 1993.
- [2] H. Holzapfel, *Urbanismus und Verkehr: Beitrag zu einem Paradigmenwechsel in der Mobilitätsorganisation*. Wiesbaden: Springer Fachmedien Wiesbaden, 2020. doi: 10.1007/978-3-658-29587-5.
- [3] F. Pieper, “Der Kreislauf der Aufgaben – Leistungsplanung und Leistungserstellung im Betrieb”, *Grundwissen Personenverkehr und Mobilität*. GRT Global Rail Academy and Media GmbH, Leverkusen, pp. 234–283, 2021.
- [4] M. W. Conway, A. Byrd, and M. van der Linden, “Evidence-Based Transit and Land Use Sketch Planning Using Interactive Accessibility Methods on Combined Schedule and Headway-Based Networks”, *Transportation Research Record*, vol. 2653, no. 1, pp. 45–53, 2017, doi: 10.3141/2653-06.
- [5] Geofabrik GmbH, “Geofabrik Download Server”. Accessed: Dec. 17, 2023. [Online]. Available: <http://download.geofabrik.de/>
- [6] VVS, “Soll-Fahrplandaten VVS 2024 Jahresfahrplan”. Accessed: Dec. 17, 2023. [Online]. Available: [https://www.opendata-oepnv.de/ht/de/organisation/verkehrsverbuende/vvs/startseite?tx\\_vrrkit\\_view%5Baction%5D=details&tx\\_vrrkit\\_view%5Bcontroller%5D=View&tx\\_vrrkit\\_view%5Bdataset\\_formats%5D%5B0%5D=ZIP&tx\\_vrrkit\\_view%5Bdataset\\_name%5D=soll-fahrplandaten-vvs&cHash=77fbc8e1cfc3643518ca99625acb8ff1](https://www.opendata-oepnv.de/ht/de/organisation/verkehrsverbuende/vvs/startseite?tx_vrrkit_view%5Baction%5D=details&tx_vrrkit_view%5Bcontroller%5D=View&tx_vrrkit_view%5Bdataset_formats%5D%5B0%5D=ZIP&tx_vrrkit_view%5Bdataset_name%5D=soll-fahrplandaten-vvs&cHash=77fbc8e1cfc3643518ca99625acb8ff1)
- [7] Rhein-Neckar-Verkehr GmbH, “Aktueller GTFS”. Accessed: Nov. 27, 2023. [Online]. Available: [https://www.opendata-oepnv.de/ht/de/organisation/verkehrsunternehmen/rnv/openrnv/datensaetze?id=1405&tx\\_vrrkit\\_view\[dataset\\_name\]=soll-fahrplandaten-rnv&tx\\_vrrkit\\_view\[action\]=details&tx\\_vrrkit\\_view\[controller\]=View](https://www.opendata-oepnv.de/ht/de/organisation/verkehrsunternehmen/rnv/openrnv/datensaetze?id=1405&tx_vrrkit_view[dataset_name]=soll-fahrplandaten-rnv&tx_vrrkit_view[action]=details&tx_vrrkit_view[controller]=View)
- [8] DELFI, “Deutschlandweite Sollfahrplandaten (GTFS)”. Accessed: Dec. 20, 2023. [Online]. Available: [https://www.opendata-oepnv.de/ht/de/organisation/delfi/startseite?tx\\_vrrkit\\_view%5Baction%5D=details&tx\\_vrrkit\\_view%5Bcontroller%5D=View&tx\\_vrrkit\\_view%5Bdataset\\_formats%5D%5B0%5D=ZIP&tx\\_vrrkit\\_view%5Bdataset\\_name%5D=deutschlandweite-sollfahrplandaten-gtfs&cHash=01414d5793fcd0abb0f3a2e35176752c](https://www.opendata-oepnv.de/ht/de/organisation/delfi/startseite?tx_vrrkit_view%5Baction%5D=details&tx_vrrkit_view%5Bcontroller%5D=View&tx_vrrkit_view%5Bdataset_formats%5D%5B0%5D=ZIP&tx_vrrkit_view%5Bdataset_name%5D=deutschlandweite-sollfahrplandaten-gtfs&cHash=01414d5793fcd0abb0f3a2e35176752c)
- [9] Ministerium für Schule und Bildung NRW, “Grunddaten der Schulen und Schulaufsicht in NRW”. Accessed: Jan. 04, 2024. [Online]. Available: <https://www.schulministerium.nrw.de/BiPo/OpenData/Schuldaten/schuldaten.csv>
- [10] HeiGIT, “Openrouteservice API”. Accessed: Jul. 01, 2023. [Online]. Available: <https://openrouteservice.org/>
- [11] L. Prayogi, A. W. Purwantiasning, D. Hantono, and Y. Sari, “Openrouteservice Pedestrian Reach Analysis on Road Networks Around Metro Stations”, *International Conference on Engineering, Construction, Renewable Energy, and Advanced Materials*, no. 0, Nov. 2022, Accessed: Jun. 25, 2023. [Online]. Available: <https://jurnal.umj.ac.id/index.php/icecream/article/view/14720>

- [12] C. Fink, W. Klumpenhouwer, M. Saraiva, R. Pereira, and H. Tenkanen, “r5py: Rapid Realistic Routing with R5 in Python”. Accessed: Jan. 18, 2024. [Online]. Available: <https://zenodo.org/records/7060438>
- [13] H. Tenkanen and T. Toivonen, “Longitudinal spatial dataset on travel times and distances by different travel modes in Helsinki Region”, *Scientific Data*, vol. 7, no. 1, p. 77, Mar. 2020, doi: 10.1038/s41597-020-0413-y.
- [14] M. W. Conway, A. Byrd, and M. van Eggermond, “Accounting for uncertainty and variation in accessibility metrics for public transport sketch planning”, *Journal of Transport and Land Use*, vol. 11, no. 1, Jul. 2018, doi: 10.5198/jtlu.2018.1074.
- [15] D. Graeber and D. Wengrow, *The Dawn of Everything. A New History of Humanity*. Dublin: Penguin Books, 2022.
- [16] M. W. Conway and A. F. Stewart, “Getting Charlie off the MTA: a multiobjective optimization method to account for cost constraints in public transit accessibility metrics”, *International Journal of Geographical Information Science*, vol. 33, no. 9, pp. 1759–1787, 2019, doi: 10.1080/13658816.2019.1605075.