Urban Transportation: Key Concepts and Data Sources

Uijeong “UJ” Hwang

2025-10-08

Components of Urban Transportation Systems

- **Mode**

Type of transport used for moving people or goods

- **Infrastructure**

Physical facilities and structures that enable movement

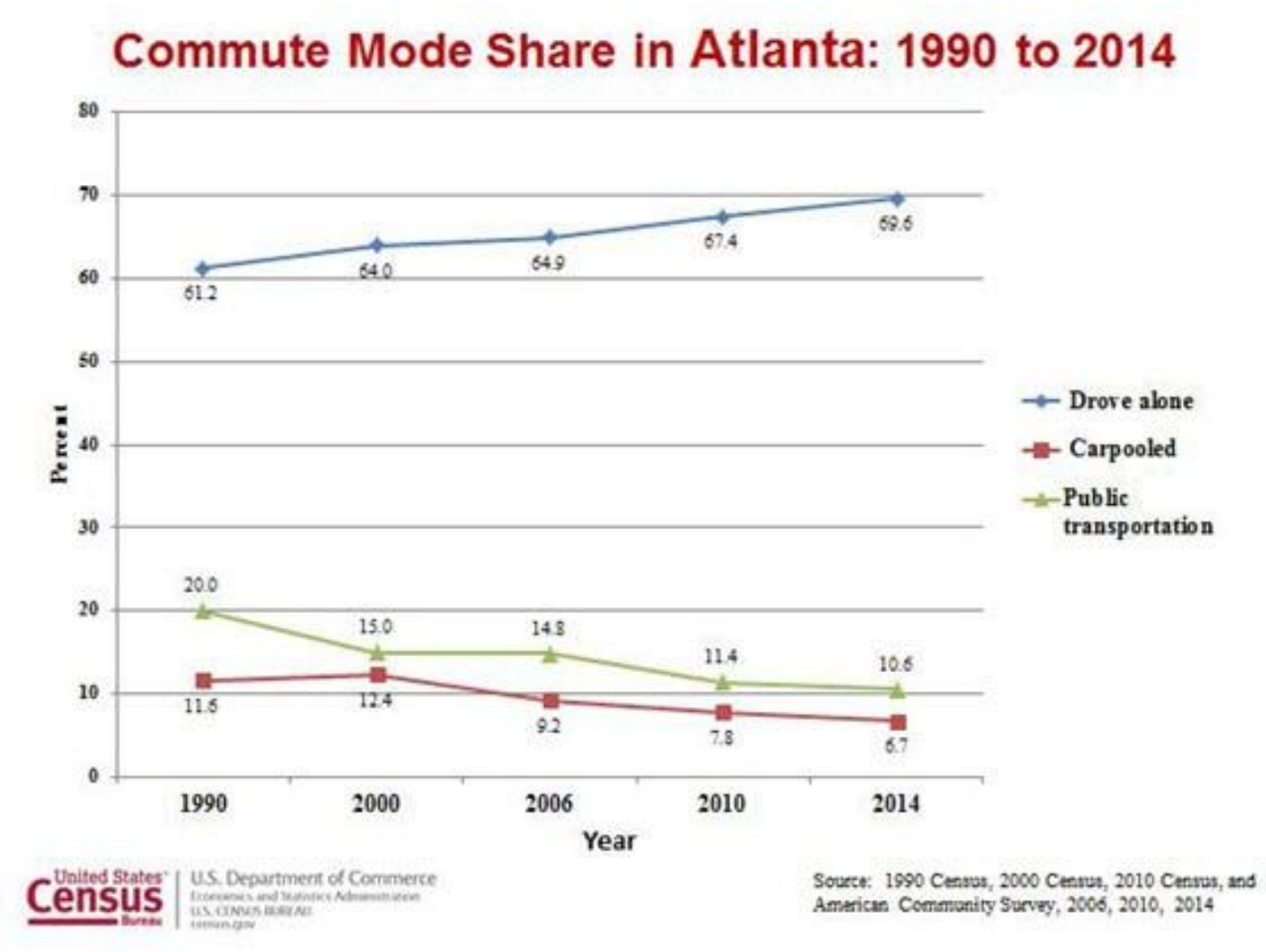
- **Network**

A system of linked locations that represent the functional and spatial organization of transportation

- **Flow**

Movements of people, vehicles, or goods along their respective networks over time

Mode Share



"2022 census estimates show that, of workers commuting within the city, about 68% drove alone, 8% carpooled, and 5% used public transportation. Atlanta has a reputation for bad traffic and has been ranked among the worst cities for commuters."

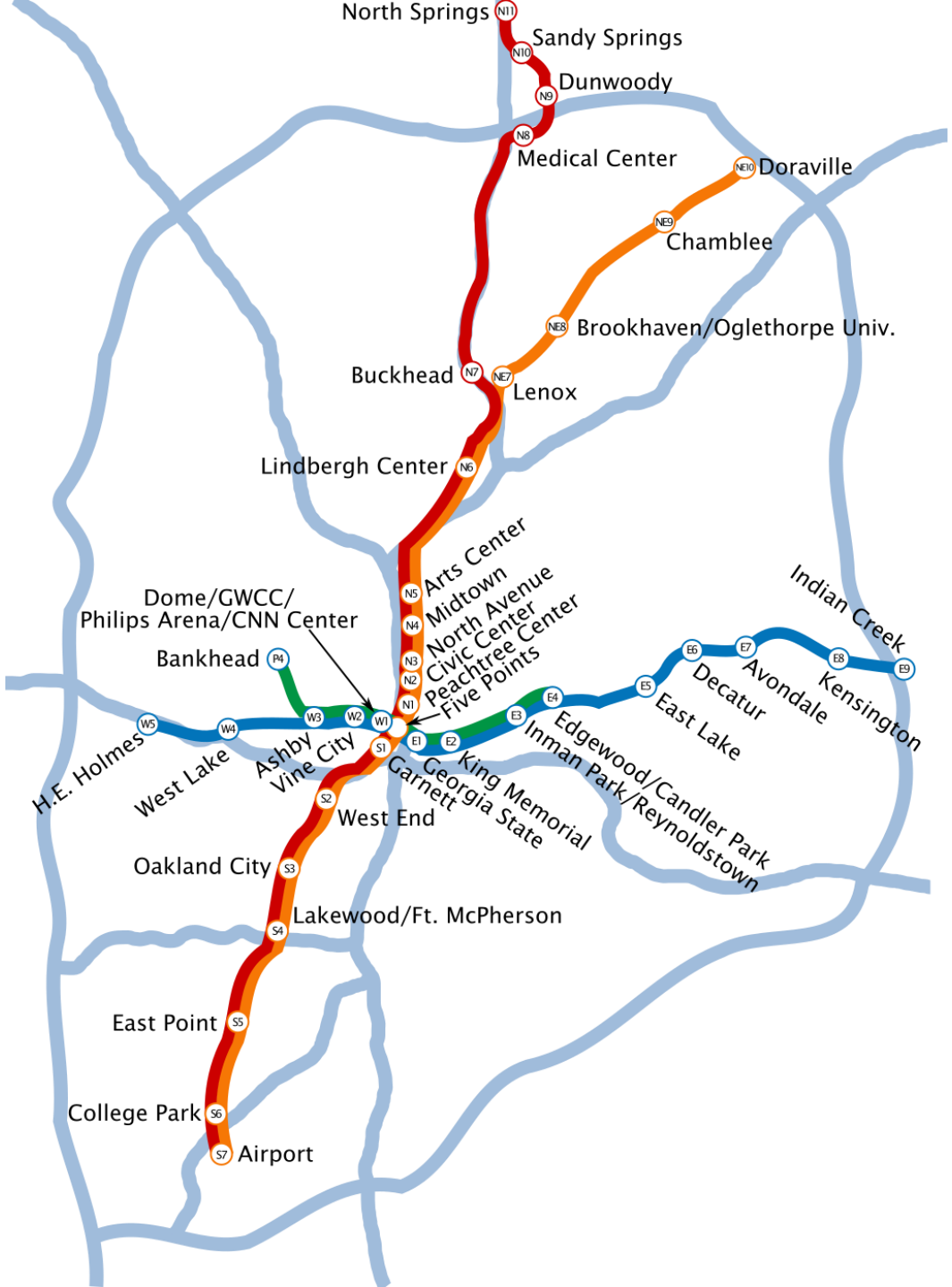
- Wikipedia

Mode Share

Metropolitan areas with over 1,000,000 inhabitants [edit]

Metro area	walking	cycling	public transport	private motor vehicle	year	Survey Area	Country
Detroit	1%	0%	2%	92%	2016[22]		USA
Indianapolis	1%	0%	1%	91%	2016[33]	UA	USA
Houston	1%	0%	2%	91%	2016[32]	UA	USA
Dallas	1%	0%	2%	90%	2016[20]	UA	USA
San Antonio	2%	0%	3%	90%	2016[55]	UA	USA
Las Vegas	1%	0%	4%	90%	2016[36]	UA	USA
Phoenix	2%	1%	2%	87%	2016[50]	UA	USA
Miami	2%	1%	4%	87%	2016[40]	UA	USA
Edmonton	3%	1%	6%	87%	2021 [26]	CMA	Canada
Atlanta	1%	0%	3%	86%	2016[5]	UA	USA
San Diego	3%	1%	3%	85%	2016[56]	UA	USA
Los Angeles	3%	1%	5%	85%	2016[38]	UA	USA
Adelaide	3%	1%	11%	85%	2016[4]	GCCSA	Australia
San Jose	2%	2%	5%	84%	2016[58]	UA	USA
Baltimore	3%	0%	7%	84%	2016[10]	UA	USA
Calgary	4%	1%	8%	84%	2021 [17]	CMA	Canada
Perth	3%	1%	12%	84%	2016[13]	GCCSA	Australia
Austin	2%	1%	3%	83%	2019[9]		USA
Denver	2%	1%	4%	81%	2020[23]	UA	USA
Auckland	5%	1%	12%	81%	2018[8]	MUA	New Zealand
Brisbane	4%	1%	14%	81%	2016[13]	GCCSA	Australia
Philadelphia	4%	1%	10%	80%	2016[49]	UA	USA
Portland	3%	3%	7%	78%	2016[51]	UA	USA
Jakarta	1%	0.2%	20%	78%*	2019[34]	UA *67% motorbike	Indonesia
Seattle	4%	1%	10%	77%	2016[61]	UA	USA
Chicago	3%	1%	13%	77%	2016[18]	UA	USA
Toronto	5%	1%	16%	76%	2021[66]	CMA	Canada

MARTA rail system



Transit usage and population density

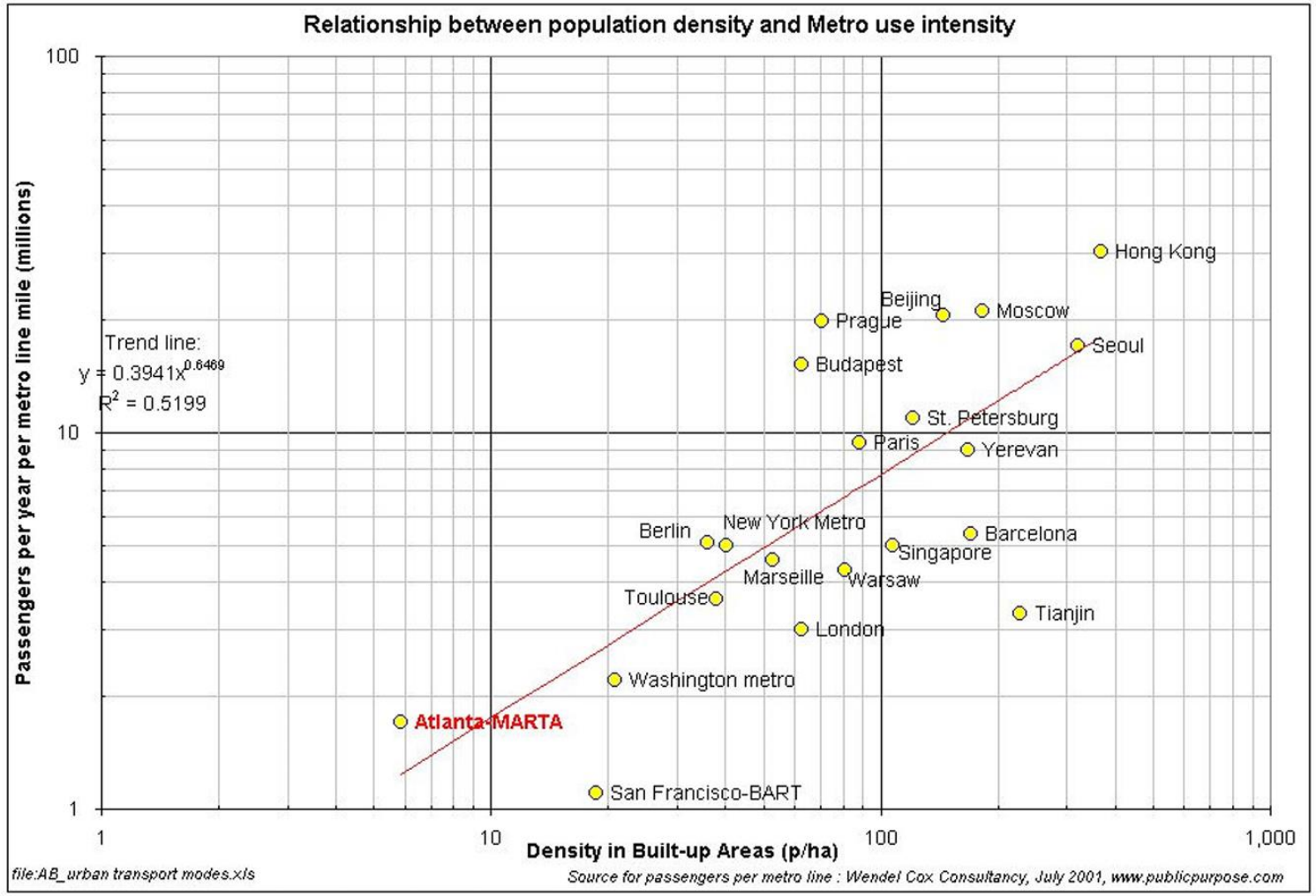
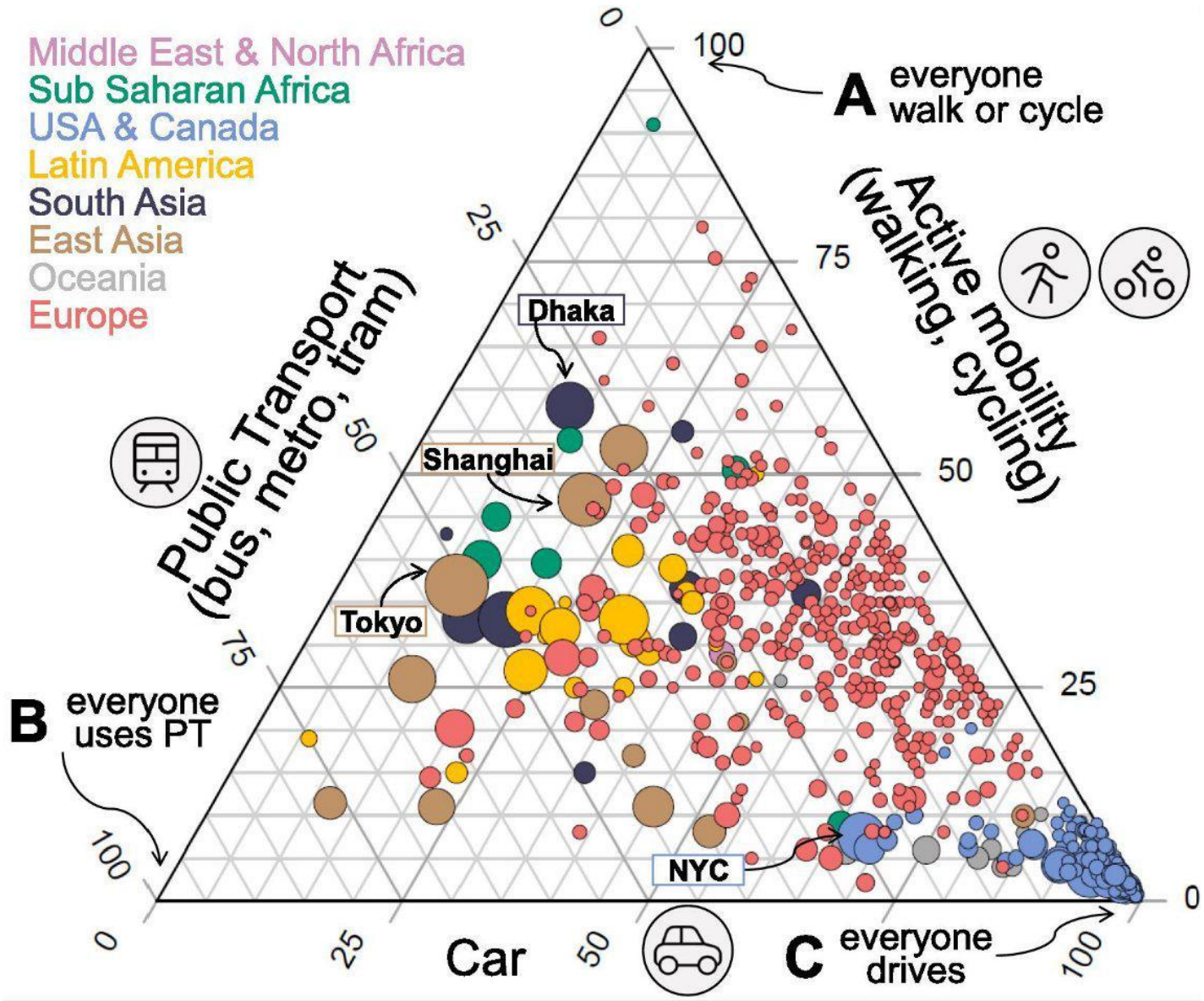


Figure 17.1 Relationship between population density and metro use intensity

Bertaud, A., & Richardson, H. W. (2004). Transit and density: Atlanta, the United States and western Europe. *Urban Sprawl in Western Europe and the United States. London: Ashgate*, 293-310.

Car-dependency around the world

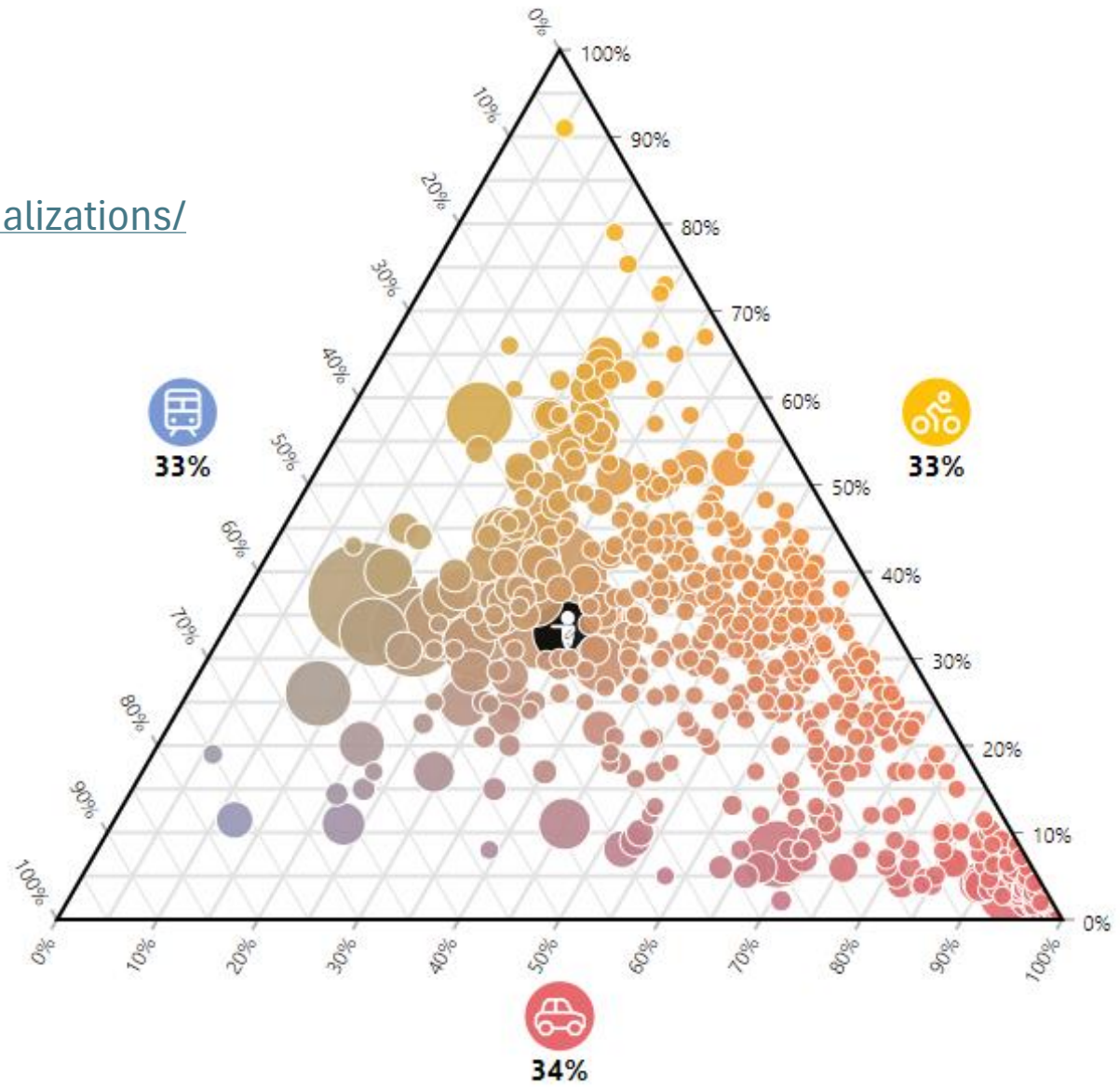


https://www.reddit.com/r/dataisbeautiful/comments/1birq3a/modal_share_distribution_in_nearly_800_cities_in/

Car-dependency around the world

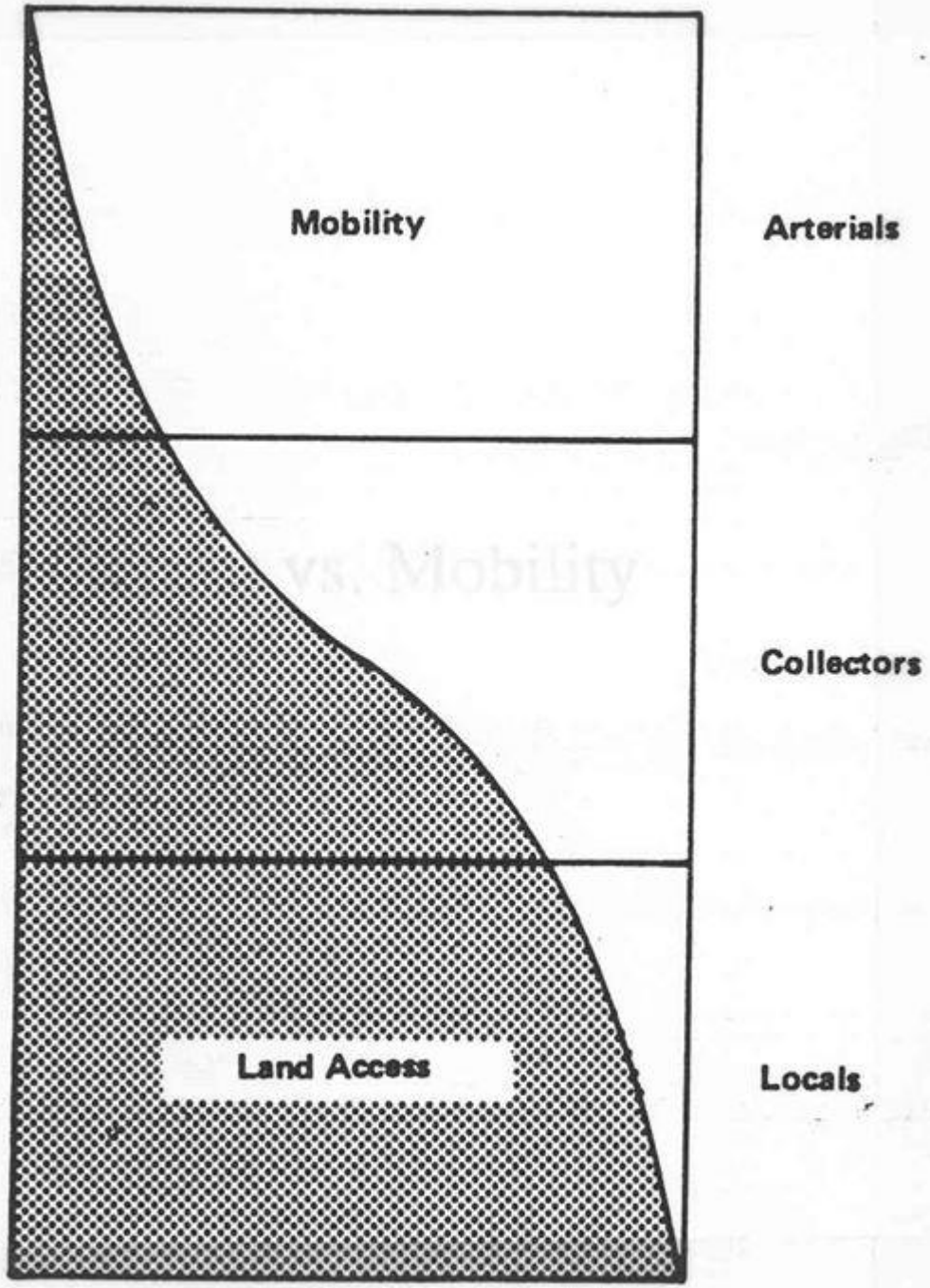
Interactive version

https://citiesmoving.com/visualizations/



Prieto-Curiel, R., & Ospina, J. P. (2024). The ABC of mobility. *Environment International*, *185*, 108541.

Mobility vs. Accessibility



Mobility vs. Accessibility

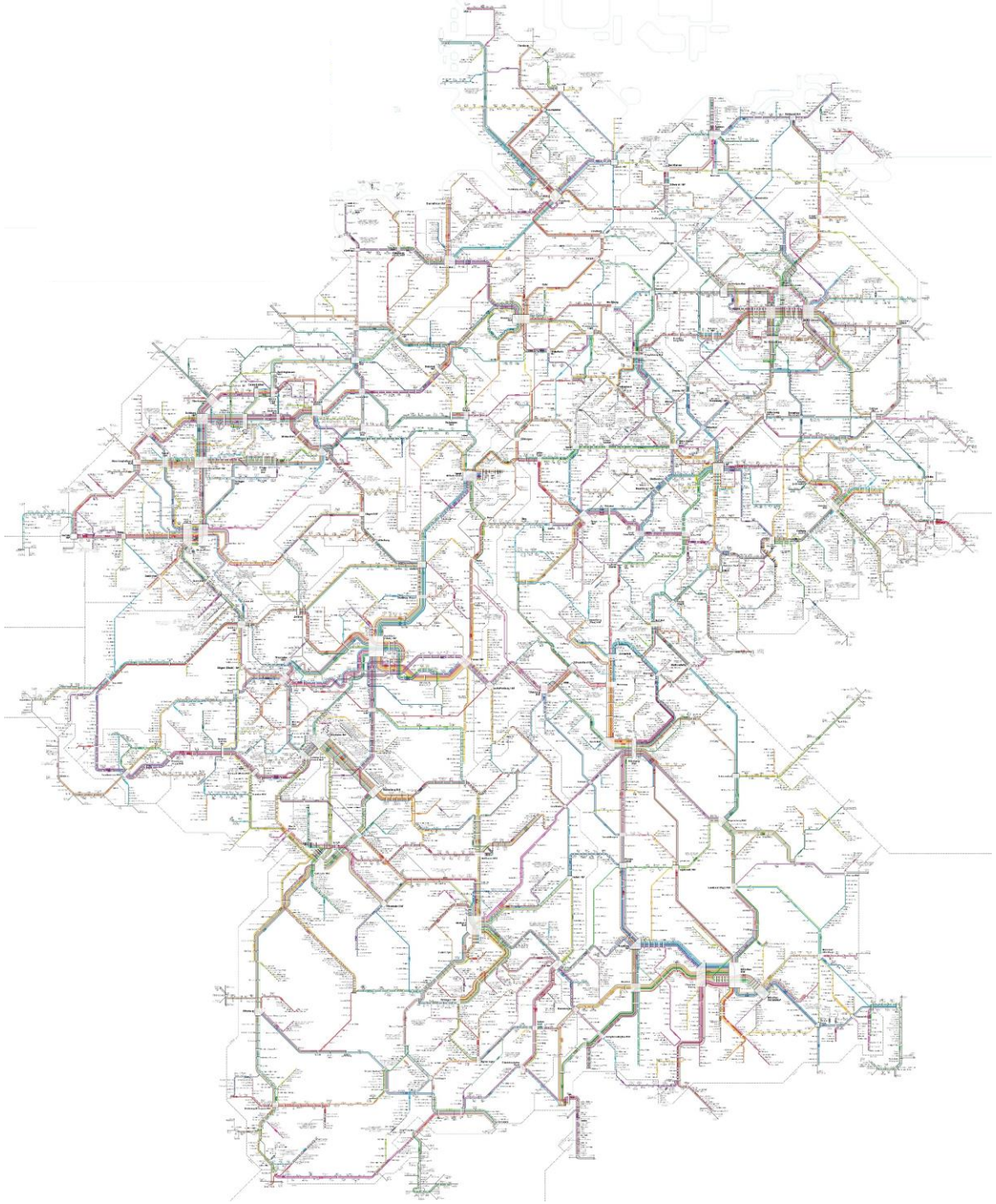
Mobility

The ease or ability to move — how fast, efficiently, and freely people or goods can travel through a system.

Accessibility

The ease of reaching desired destinations — how well people can connect to opportunities like jobs, schools, shops, and services.

Mobility vs. Accessibility



Mobility vs. Accessibility

https://www.reddit.com/r/transit/comments/19fg3id/germanys_entire_regional_rail_network_notoc/
http://www.wiki-info.de/bahn-verbindungen-ice/ice-hochgeschwindigkeitsstrecken.htm

Mobility vs. Accessibility

Mobility

The ease or ability to move — how fast, efficiently, and freely people or goods can travel through a system.

- Focus: Movement itself (speed, flow, travel time)

Accessibility

The ease of reaching desired destinations — how well people can connect to opportunities like jobs, schools, shops, and services.

- Focus: Opportunities that can be reached within a given time or cost

Accessibility Matters

*"**Accessibility** is a function of **land use** and **transportation**"*

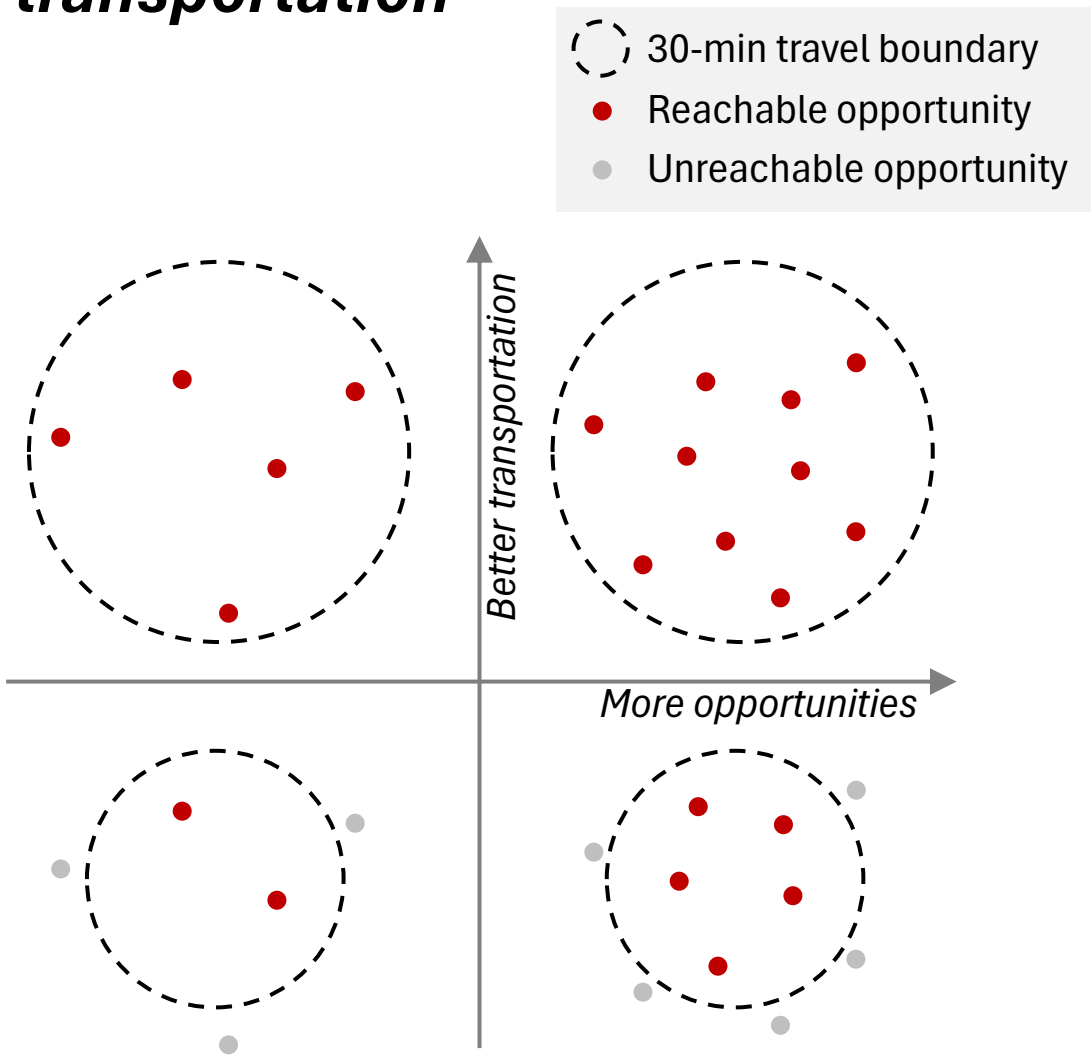
- Land use: *where things are*
  - Land use determines the **location**, **density**, and **type** of opportunities

- Transportation: *how we connect them*
  - The transportation system defines the **ease of travel** between those origins and destinations.

Accessibility Matters

*"**Accessibility** is a function of **land use** and **transportation**"*

- Land use: *where things are*
  - Land use determines the **location**, **density**, and **type** of opportunities
- Transportation: *how we connect them*
  - The transportation system defines the **ease of travel** between those origins and destinations.



The “5Ds” of the Built Environment

The “5D” factors are a foundational framework for explaining how land-use and urban form influence travel behavior (e.g., trip generation, mode choice, and VMT)

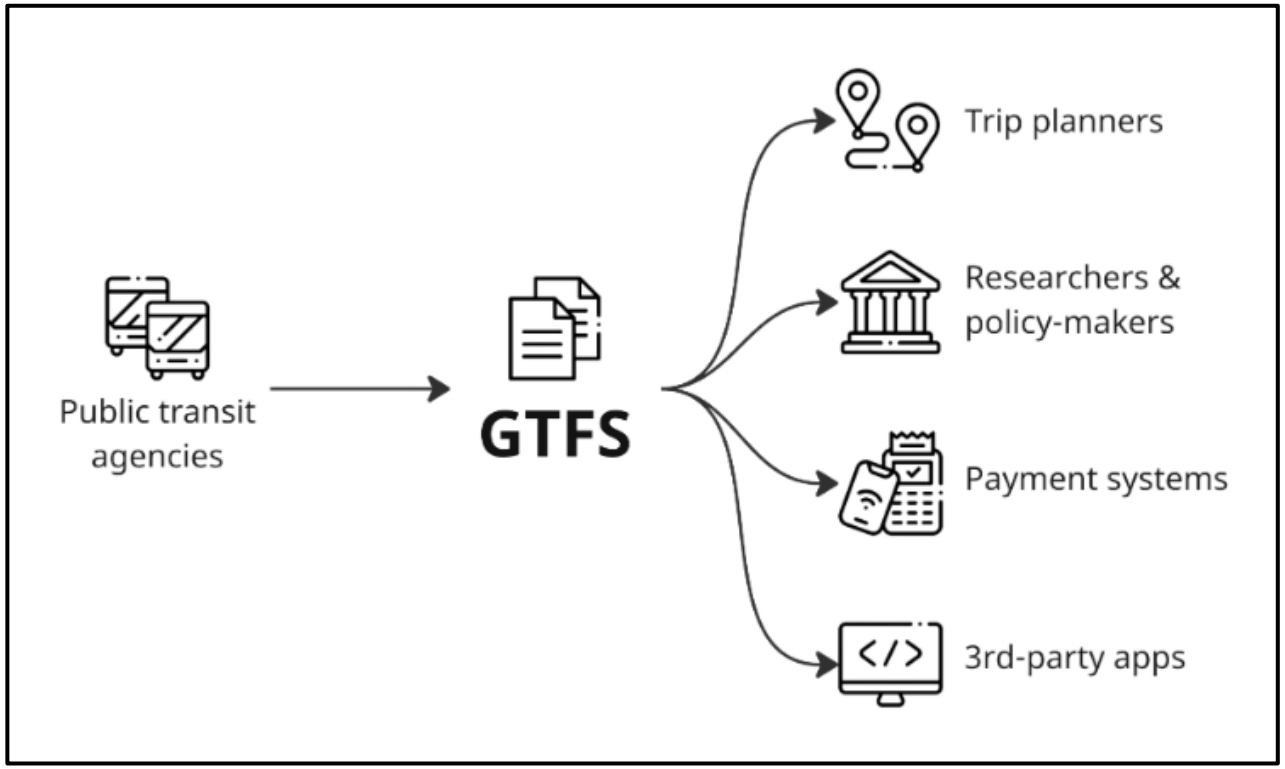
- ***Density***: concentration of people or jobs within an area.
- ***Diversity***: mix of land uses (residential, commercial, office, recreational)
- ***Design***: Street network characteristics and urban design quality
- ***Destination Accessibility***: Ease of reaching key opportunities
- ***Distance to Transit***: Proximity to public transportation stops

Ewing, R., & Cervero, R. (2010). Travel and the built environment: A meta-analysis. *Journal of the American planning association*, *76*(3), 265-294.

Transportation Data Sources

- **Infrastructure & Network**
  - General Transit Feed Specification (GTFS)
  - OpenStreetMap (OSM)
- **Travel Behavior**
  - Household Travel Surveys: NHTS; region-wide surveys
  - Sensor & GPS data

GTFS



General Transit Feed Specification

Format

GTFS or the General Transit Feed Specification defines a common data format for public transportation schedules and associated geographic information. Wikipedia

Developed by: Google

Filename extension: zip

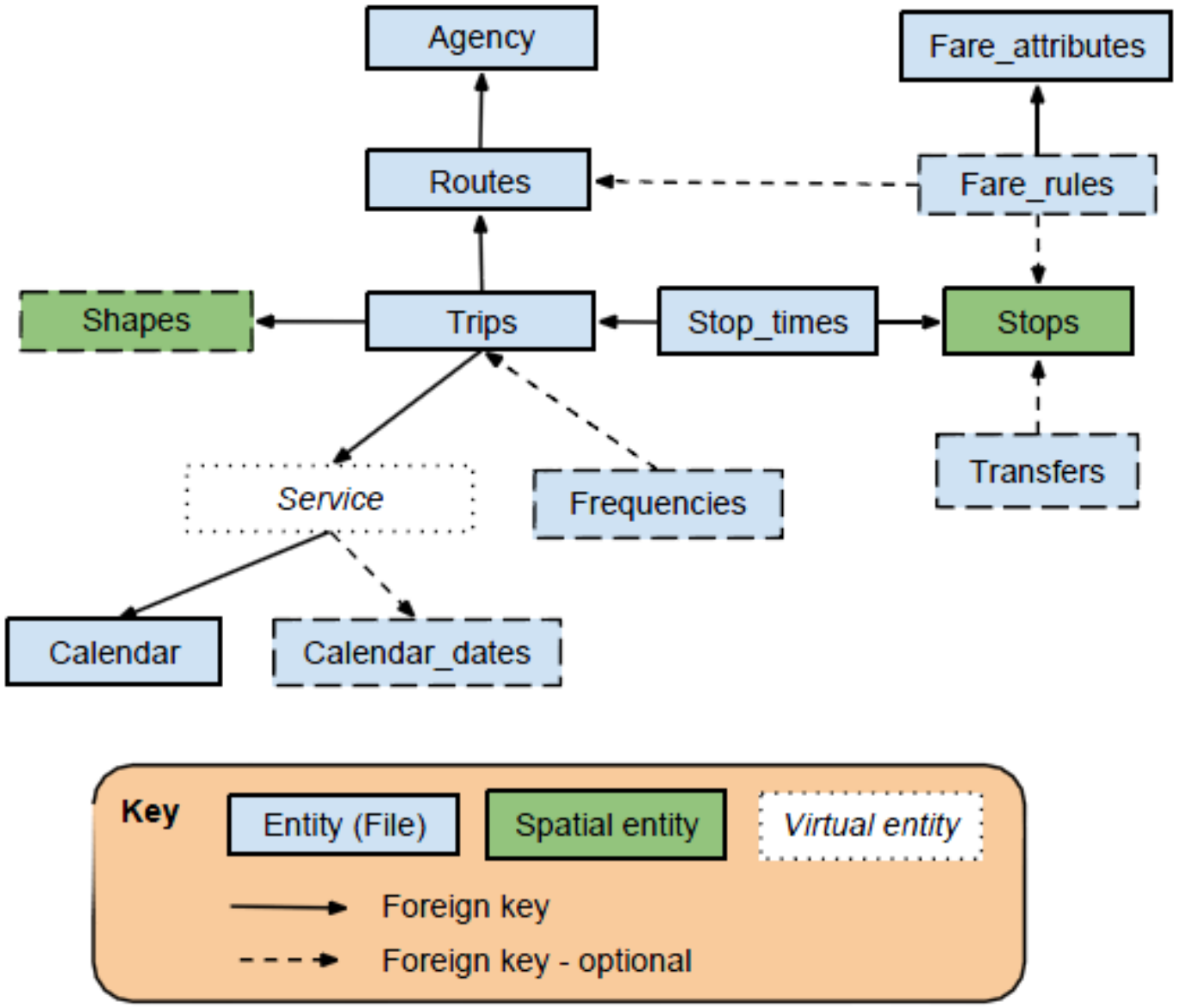
Initial release: 27 September 2006; 18 years ago

Open format?: Yes, CC BY 3.0

Standard: De facto standard

https://gtfs.org/getting_started/what_is_GTFS/

GTFS



https://trilliumtransit.com/2016/07/05/gtfs-examples/

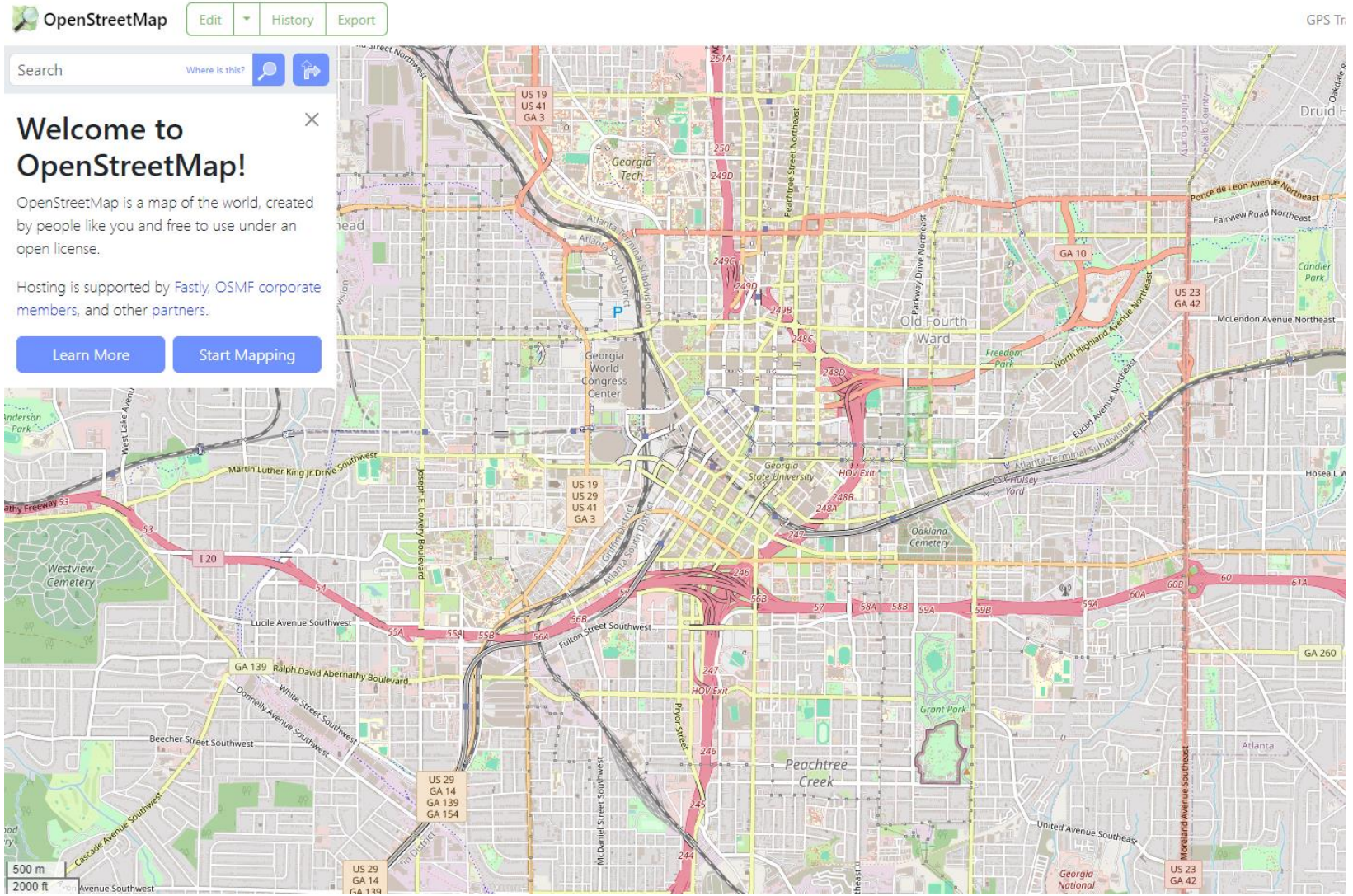
OSM

“OpenStreetMap (abbreviated OSM) is a website that uses an open geographic database which is updated and maintained by a community of volunteers via open collaboration.”

- Wikipedia

“The project that creates and distributes free geographic data for the world. We started it because most maps you think of as free actually have legal or technical restrictions on their use, holding back people from using them in creative, productive, or unexpected ways.”

- OSMwiki



https://www.openstreetmap.org/

OSM

Maps/Routing

General Purpose Maps

- OpenStreetMap.org (Mapnik, Osmarender, Cyclemap)
- OpenStreetMap.org with marker
- The Information Freeway
- OpenStreetBrowser World
- Mobile Map World
- OSM WMS Europe Europe

Specialized Maps

- OpenCycleMap World
- Reit- und Wanderkarte Europe
- Hiking Map World
- OpenPisteMap
- ÖPNV-Karte Europe (Public transport map)
- FreieTonne (See- und Gewässerkarte, siehe Startseite)
- OpenSeaMap (Start)
- OpenLinkMap
- Parking Map
- Wheelmap World

Routing

- Mapquest (Open) World
- OpenRouteService Europa
- yournavigation.org World
- CloudMade Maps World

Specialized Maps Germany

- Mauerkarte

Tools

- Geofabrik Map
- bigmap
- Place marker on map

Debug data

- Geofabrik OSM Inspector World
- keep right World
- NoName Layer
- Relation Analzyer
- Restriction Analyser World

Analyse data

- Tagwatch
- Taginfo

Edit map/report errors

- Edit map in Potlatch
- OpenStreetBugs (appspot.com)
- OpenStreetBugs (schokokeks.org)

Compare maps

- Geofabrik Map Compare
- Transparent Map Compare (sautter.com)

Community

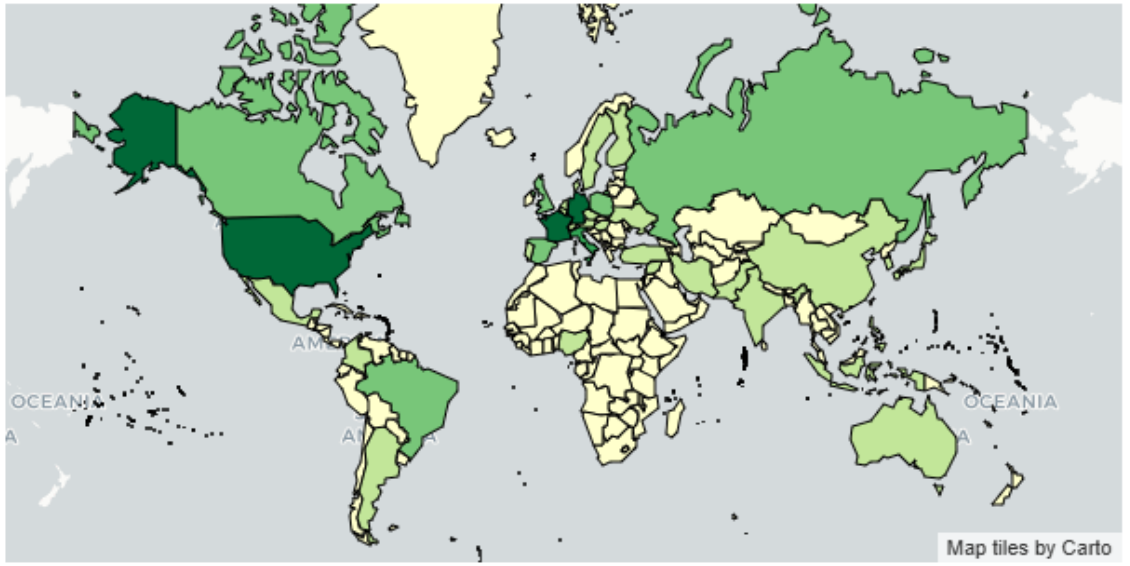
- Forum (Subforum: Germany)
- OSM in Twitter

OSM

OSMstats About: Trends Members Elements Countries Changesets Boards Date: 8 10 2025

Edits per country for Oct, 07th 2025

Classification by amount of contributors contributors per population contributors per area mapping activity

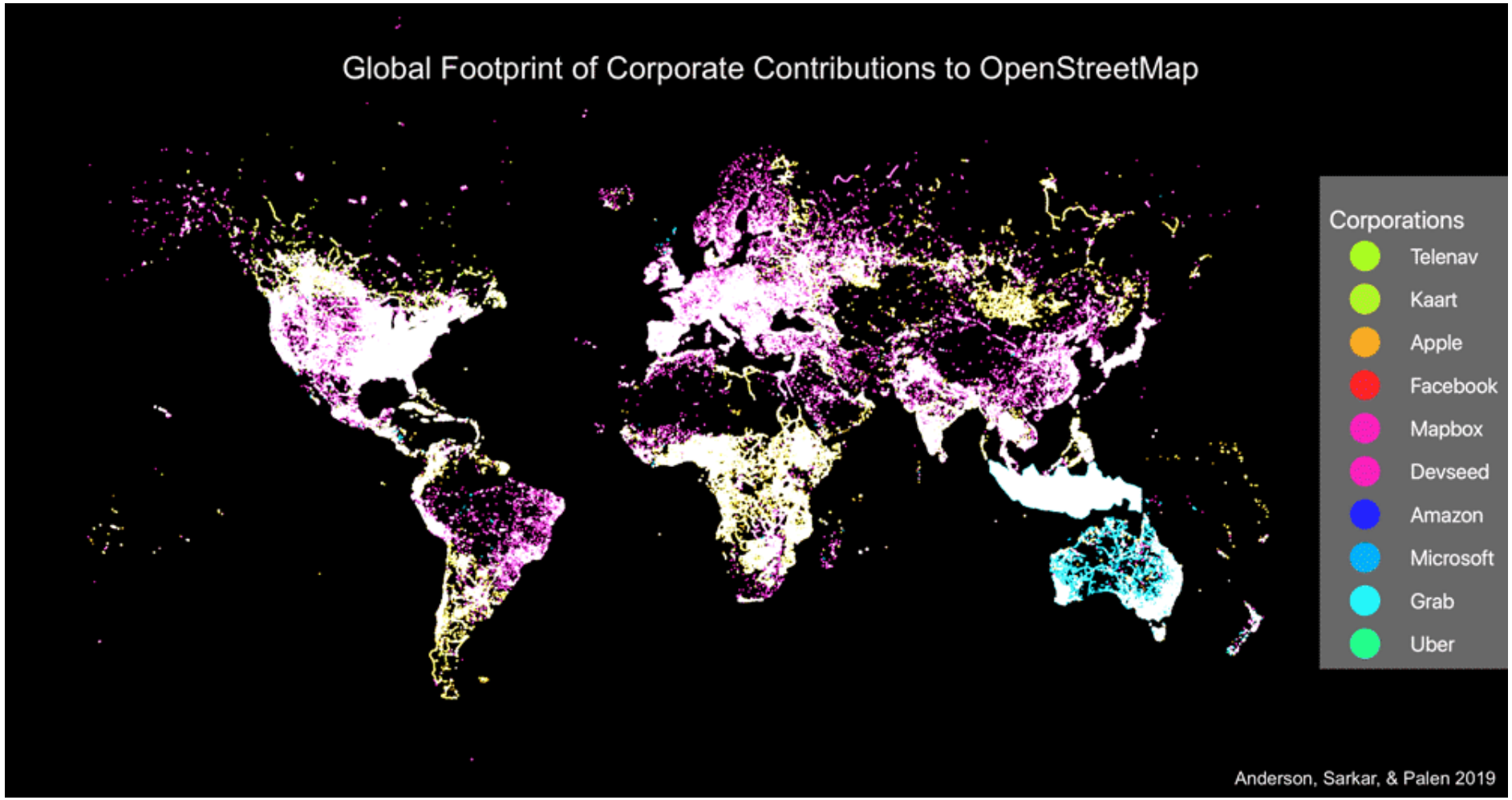


Notice: The changeset's bbox center is utilized for counting. This can cause inaccuracies between ~2% and ~10%.

No.	Country	Contributors (organised)	Map changes (organised)	Created	Modified	Deleted
1.	Germany	874 (0%)	145670 (0%)	73544	65030	7096
2.	United States	868 (4%)	553734 (0%)	423160	87436	43138
3.	France	479 (1%)	133789 (0%)	77234	44626	11929
4.	Italy	304 (3%)	77228 (0%)	54083	18116	5029
5.	United Kingdom	301 (3%)	106712 (0%)	64243	34715	7754
6.	Poland	255 (2%)	74601 (0%)	43890	23457	7254
7.	Russia	225 (0%)	95604 (0%)	72646	16825	6133
8.	Spain	208 (1%)	56315 (0%)	40650	12717	2948
9.	Canada	202 (4%)	1016325 (0%)	970010	20095	26220
10.	Brazil	161 (16%)	106581 (0%)	65384	7055	34142

https://osmstats.neis-one.org/?item=countries

Corporate Participation in OSM



"While we tend to think the community involved in OSM is made up of mainly individuals, there is an increasing participation by large firms in the development of OSM. Companies such as Uber, Facebook, Microsoft, and Apple are just some of the companies that have hired people to review and edit data on OSM. This often includes reviewing data captured through the use of artificial intelligence from satellite data and confirming specific observations such as roads."

https://www.geographyrealm.com/community-involvement-in-openstreetmap/

Travel Survey

- A data collection method to gather information about travel patterns and behaviors.
- Key components include:
  - Trip details
  - Household characteristics
  - Individual demographics
- Methods:
  - Questionnaires
  - Travel diaries
  - GPS tracking

Diary Instructions

Use this diary to record information about **ALL** the **PLACES** you visit on your assigned travel days. Record one **PLACE** per page.

Answer all of the questions on each page for each place.

What is a **PLACE?**

A **PLACE** is any location where you do something. You may stay there for a long time (like at work or school) or just a few minutes (like at a drive-thru window).

- ✓ **IF YOU DRIVE**, include places where you drop off or pick up passengers or buy fuel.
- ✓ **IF YOU ARE A PASSENGER**, only include places where you got in or out of a vehicle, but do not include stops to let other people on or off.

Keep your completed Travel Diary by the phone. We'll call you to collect the information, or you can call us toll-free at 1-877-261-4621. If you are unable to complete the diary, please have a caregiver or other adult complete the diary for you. **Thank you!**

Confidentiality:
This survey is conducted in accordance with strict privacy provisions. All information, whether related to personal identity or travel and activities, will remain completely confidential. The information will not be published, sold, distributed, or otherwise made available to any third party.

Questions? Call the toll-free Survey Hotline:
1-877-261-4621

1

EXAMPLE PLACE

A **What is this PLACE?** ☐ My home ☒ Another place *(provide address below)*

What is the NAME and ADDRESS of this PLACE?

Sunny Farms Supermarket
Name of place (if any)

901 Main St.
Street address OR nearest cross-streets

Anytown *City* | TX *State* | 99999 *Zip*

B **What TIME did you ARRIVE?** *(Please record exact time)*
11 : 35 ☒ am ☐ pm

C **HOW did you travel there?** *(Check one* **MODE***)*

- ☐ Walk
- ☐ Wheelchair/Electric Scooter (not on a vehicle)
- ☐ Auto/Van/Truck - Driver
- ☒ Auto/Van/Truck - Passenger
- ☐ Transit (DART or The T)
- ☐ DART Paratransit
- ☐ MITS Paratransit
- ☐ Other Specialized Transit or Shuttle Service
- ☐ Taxi
- ☐ School Bus
- ☐ Other: _____

D1 **How many people traveled with you?** *(DON'T include yourself)* 1

D2 **Of those, how many were household members?** 1

E **What ACTIVITIES did you do there?** *(Write code from* **LIST 1** *on flap)*
Main activity (code): 11
Other activity (code): 14

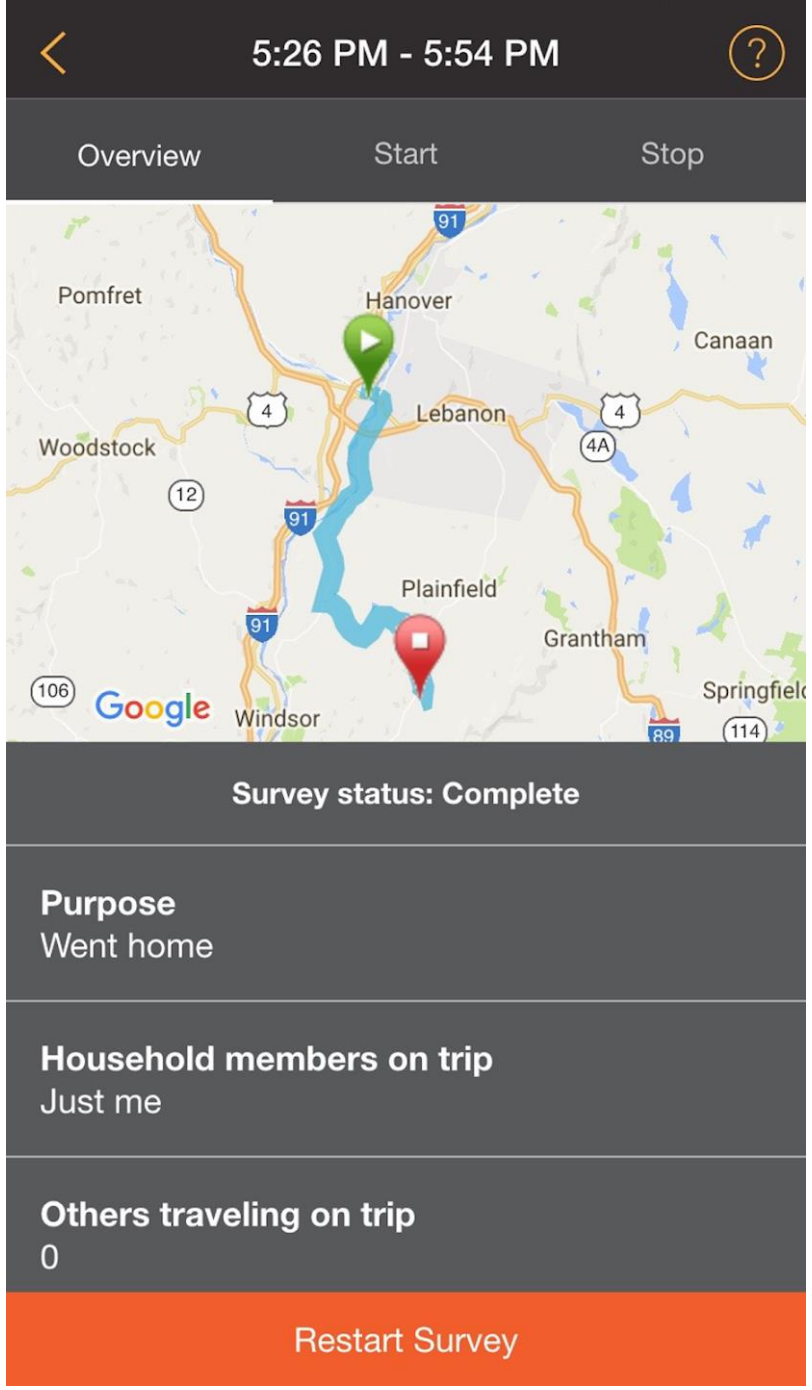
F **What TIME did you LEAVE?** *(Please record exact time)*
12 : 52 ☐ am ☒ pm → Next PLACE
☐ Did not leave → Go to DAY 2 - PAGE 10

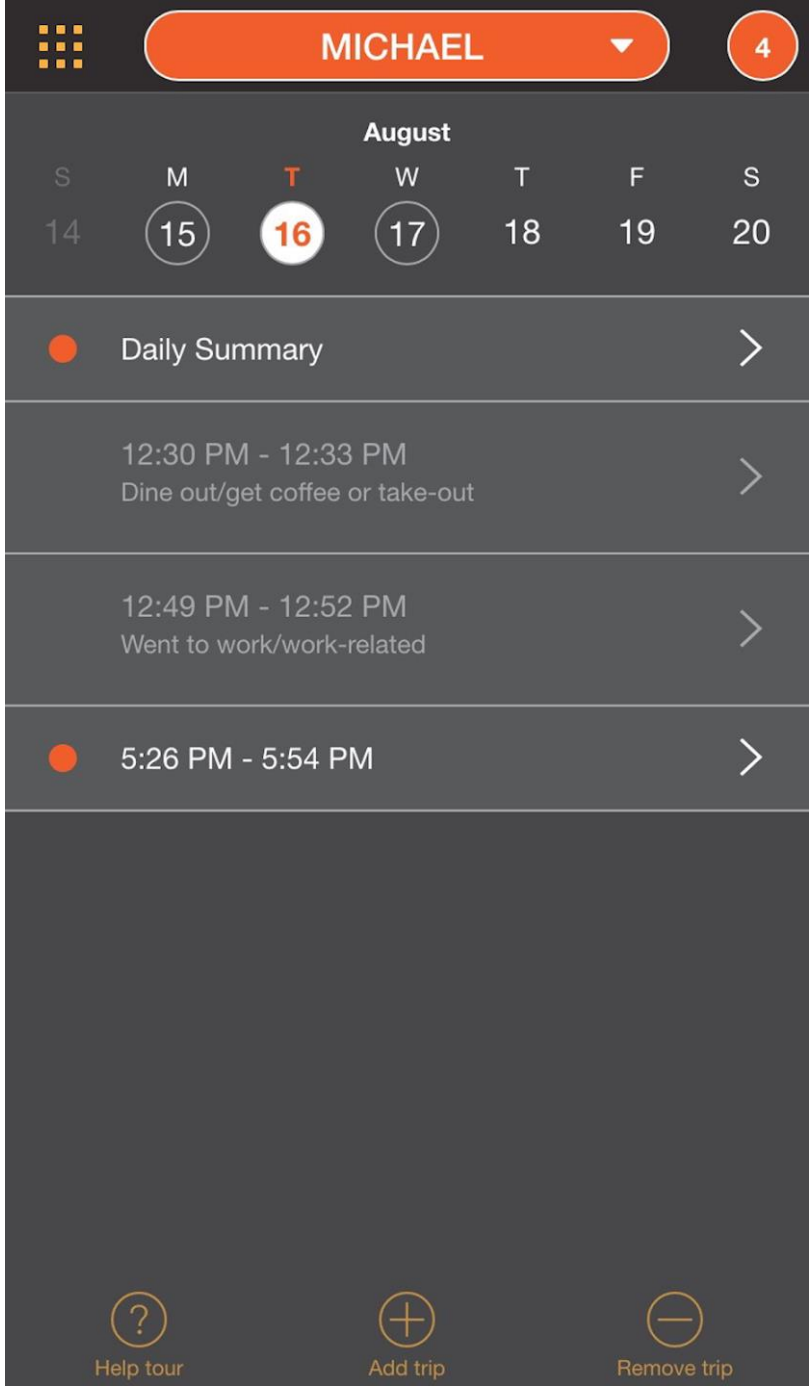
2

https://www.researchgate.net/figure/2-Travel-diary-pages_fig1_254609779

Travel Survey

- A data collection method to gather information about travel patterns and behaviors.
- Key components include:
  - Trip details
  - Household characteristics
  - Individual demographics
- Methods:
  - Questionnaires
  - Travel diaries
  - GPS tracking

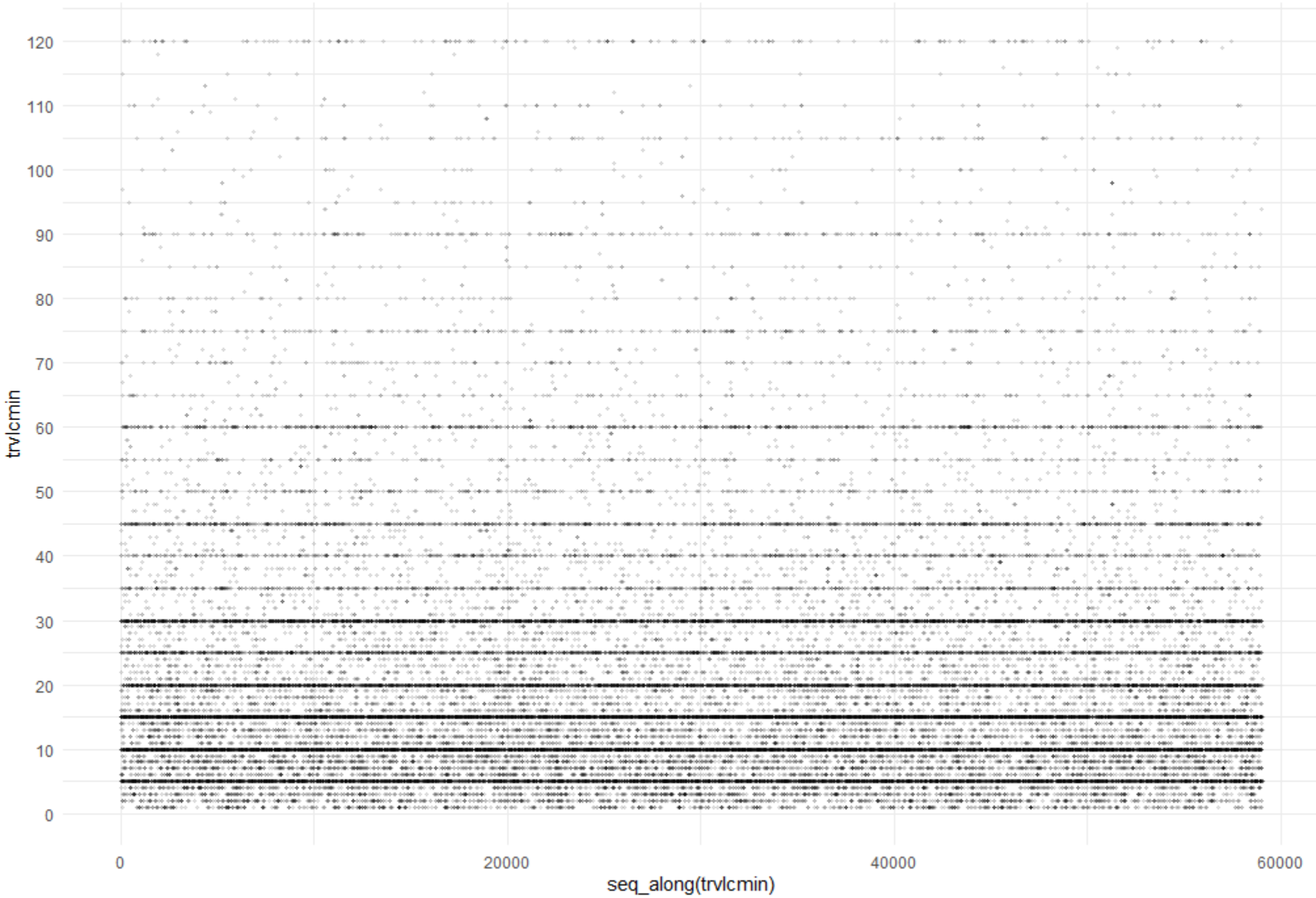




https://play.google.com/store/apps/details?id=com.rsginc.rmove&hl=en_US&pli=1

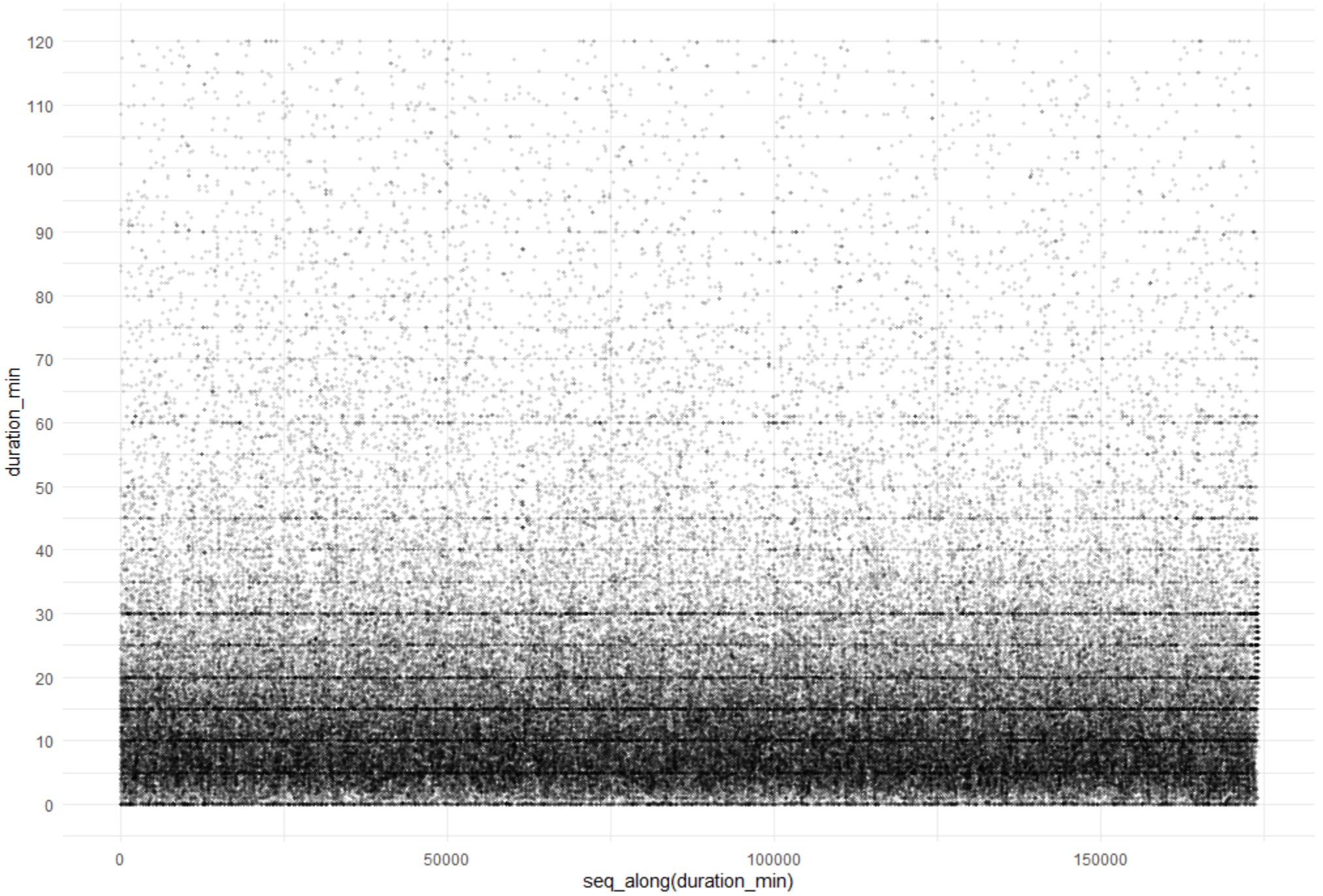
Travel Time Distribution in Surveys

- 2017 National Household Travel Survey (NHTS) – Georgia Add-On



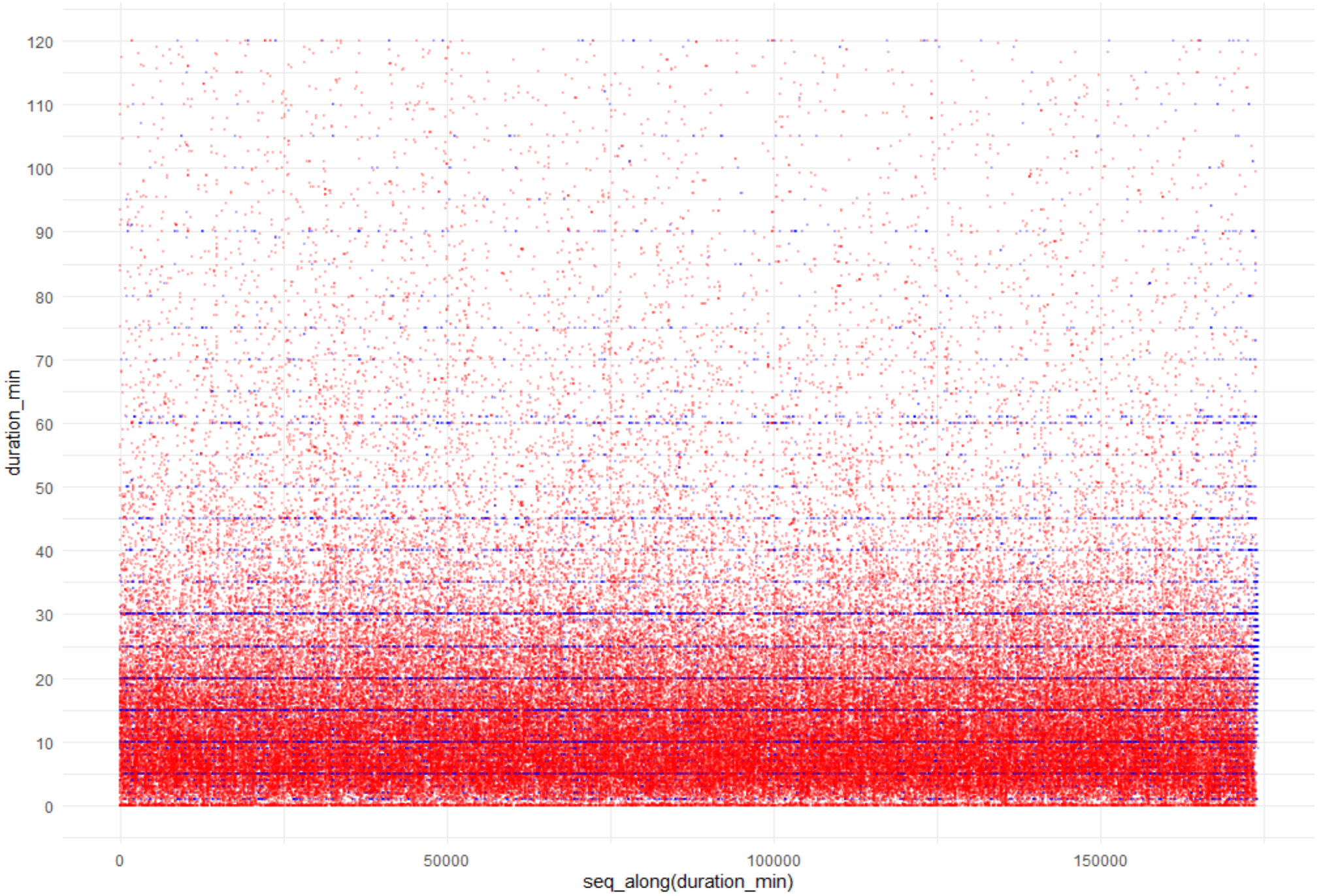
Travel Time Distribution in Surveys

- 2021 Twin Cities Travel Behavior Inventory Survey



Travel Time Distribution in Surveys

- 2021 Twin Cities Travel Behavior Inventory Survey
- **41%** of households (3.2k of 7.9k) participated the survey using the “rMove” app.
- Trips recorded through the app accounted for **85%** (154k of 180k) of all trips collected.



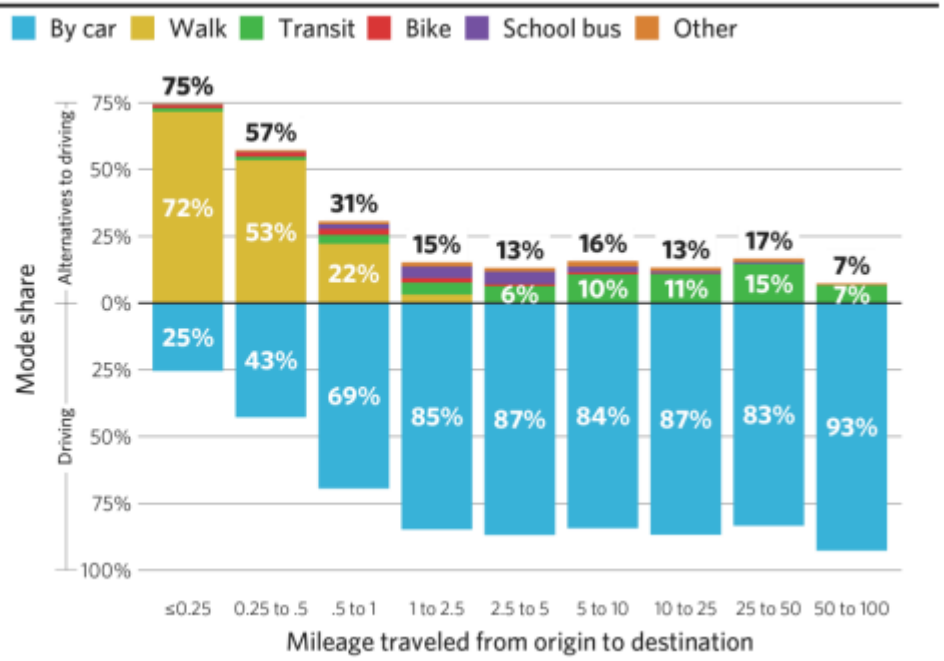
Travel Survey

Travelers relied most on non-car modes for the shortest trips.

Note: Includes trips by residents age 5 and older of the CMAP seven-county region, Grundy, and DeKalb. Includes only trips that were within, to, and/or from one of those counties. Distances capture the total distance traveled along the route, not just the distance from origin to destination. Unlabeled bars have less than 5 percent mode share. "By car" includes trips as either a driver or a passenger of a personal vehicle (not including services like taxis or TNCs).

Sample size: Figures are based on a total of 97,230 recorded trips. Trips of 50 to 100 miles have the lowest sample size, with 496 records.

Source: Chicago Metropolitan Agency for Planning analysis of My Daily Travel data.

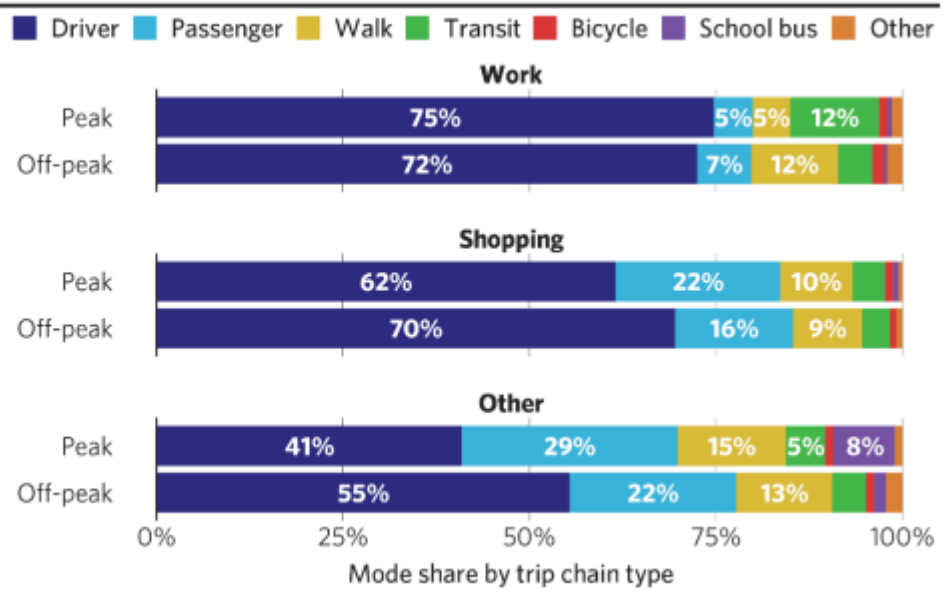


Travel choices differ significantly between peak and off-peak trips.

Note: Includes trips by residents age 5 and older of the CMAP seven-county region, Grundy, and DeKalb. Includes only trips that were within, to, and/or from one of those counties. Peak trips include all trips that were in motion between 6:00 a.m. and 9:00 a.m. or between 3:00 p.m. and 7:00 p.m. Unlabeled bars have less than 5 percent mode share.

Sample size (Work/Shopping/Other):
- Peak (28,768/6,229/24,556);
- Off-peak (13,800/8,818/15,016).

Source: Chicago Metropolitan Agency for Planning analysis of My Daily Travel data.

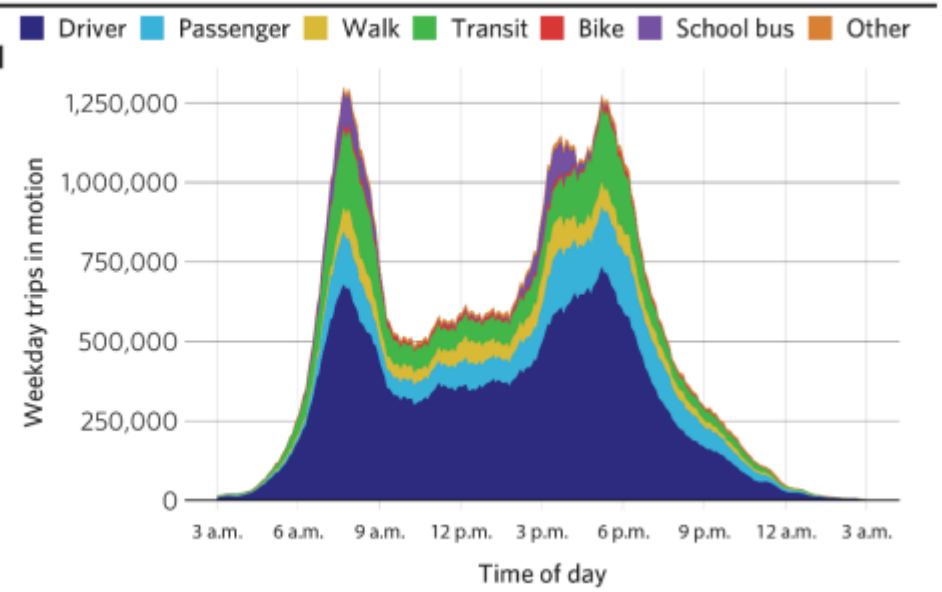


The morning and evening peaks in travel demand were very pronounced, although the COVID-19 pandemic's impact on these travel patterns remains uncertain.

Note: Trips in motion are 25-minute rolling averages. Includes trips by residents age 5 and older of the CMAP seven-county region, Grundy, and DeKalb. Includes only trips that were within, to, and/or from one of those counties.

Sample size: Figures are based on a total of 97,224 records.

Source: Chicago Metropolitan Agency for Planning analysis of My Daily Travel data.

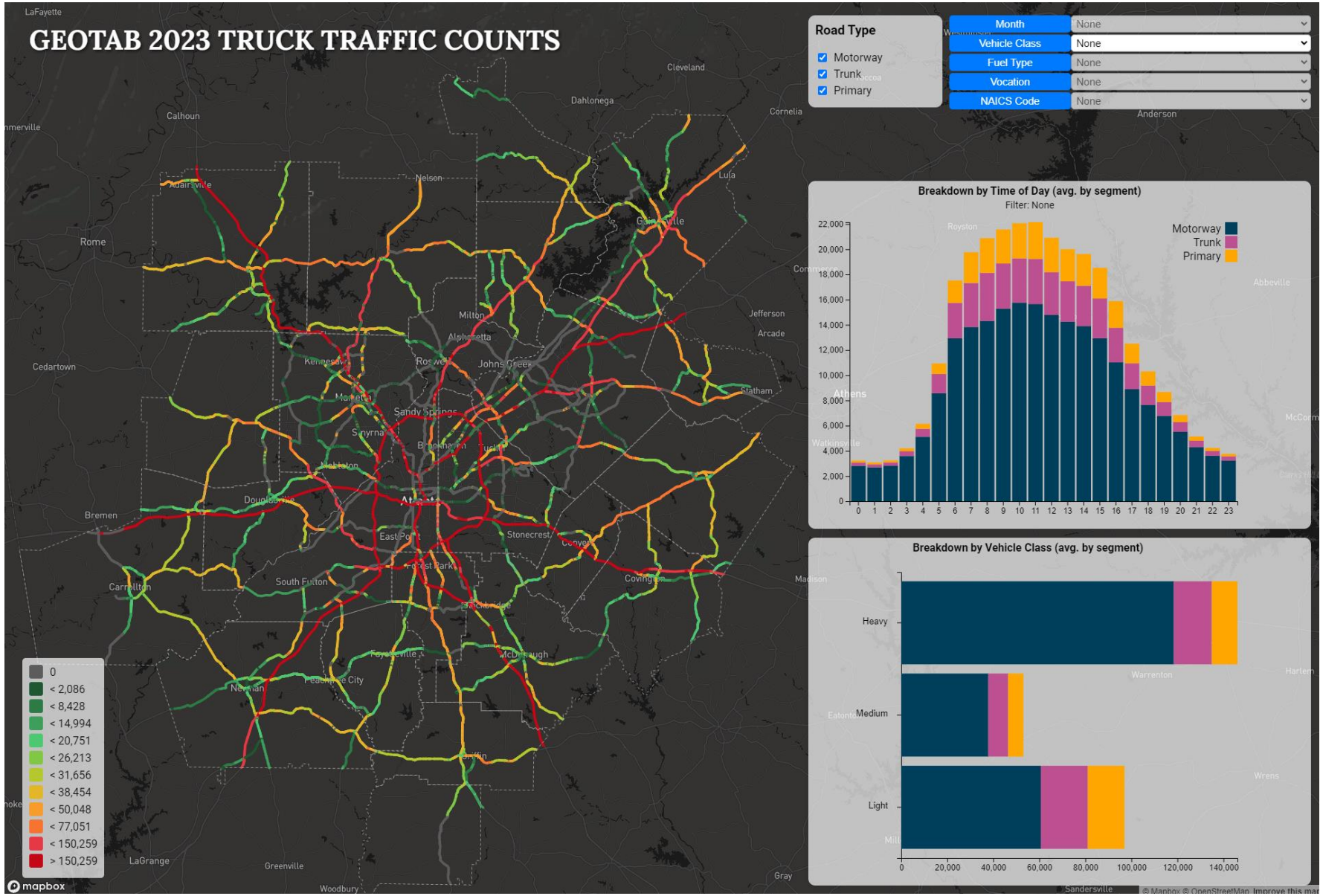


https://cmap.illinois.gov/wp-content/uploads/My-Daily-Travel-pre-pandemic-travel-1.pdf

Sensor & GPS data

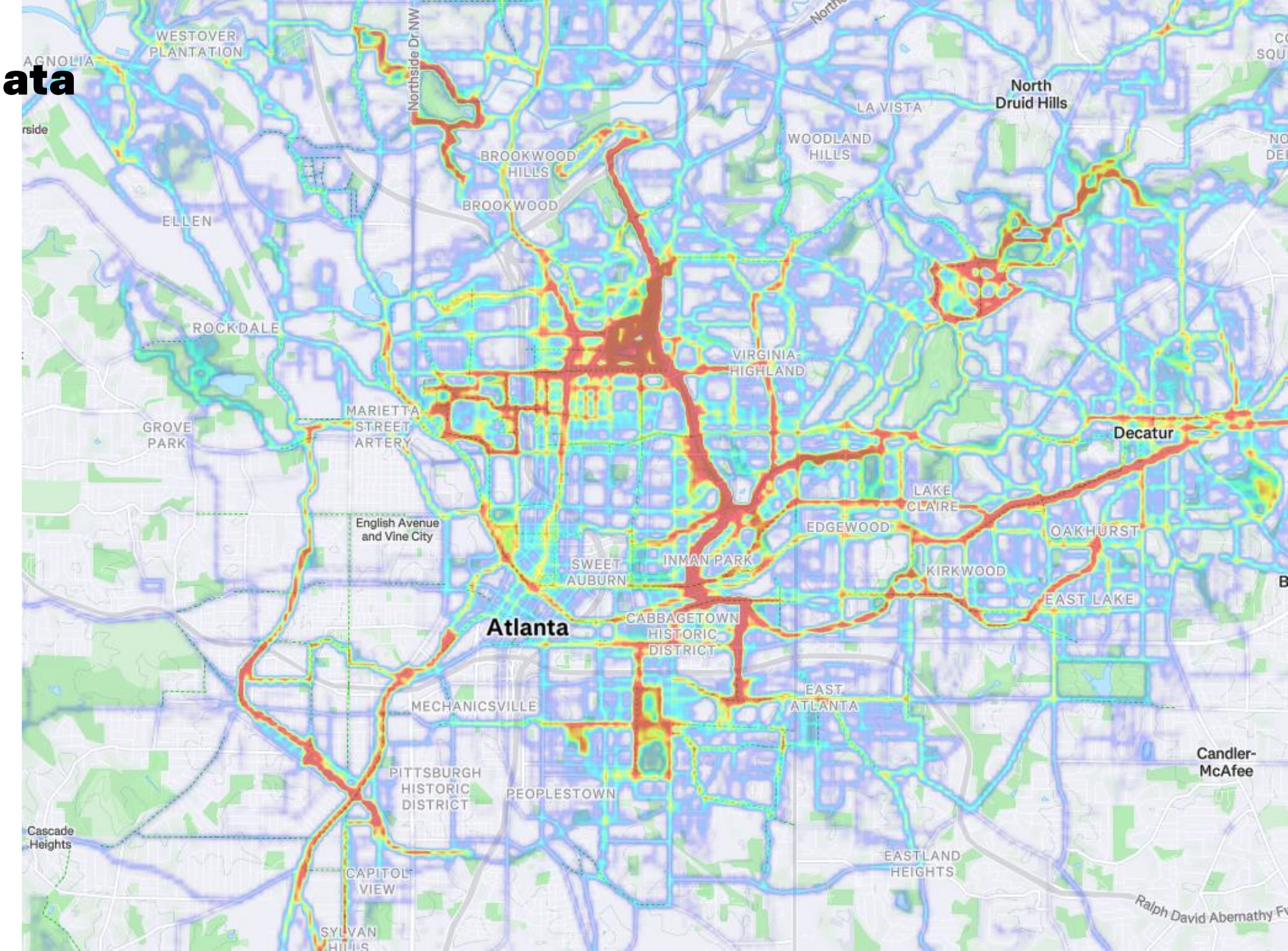
https://ujhwang.github.io/geotab-viz

- Freight volume data from Geotab



Sensor & GPS data

- Active mobility data from Strava



Sensor & GPS data

- Road roughness data from NIRA Dynamics