

Transit Equity in Pittsburgh: A data-driven approach

Heinz College Capstone, Spring 2023

Mahnoor Ayub, Cailin De Zeeuw, Yuxuan He,
Matt Lampl, Sara Maillacheruvu,
& Sai Tej Reddy Vulupala

**Midterm
Report**

Agenda

1. Project Summary & Context
2. Current State of Transit in Pittsburgh
3. Exploratory Data Analysis
4. Our Approach
5. Current Results & Challenges
6. Future Work
7. Case Studies

Our Team



**Mahnoor
Ayub**



**Cailin
De Zeeuw**



**Yuxuan
He**



**Matt
Lampl**



**Sara
Maillacheruvu**



**Sai Tej
Reddy Vulupala**

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Our client is Bike Share Pittsburgh



The non-profit organization behind Pittsburgh's only bikeshare program, **POGOH** (formerly Healthy Ride)

Mission

provide Pittsburgh with a joyful, sustainable, and affordable mobility service for all residents and visitors



POGOH is Pittsburgh's bike share network

- Launched in May, 2022 (replacing the HealthyRide network)
- 37 stations, 360 bikes
- 20 charging stations through partnership with Duquesne Light
- Actively expanding the network

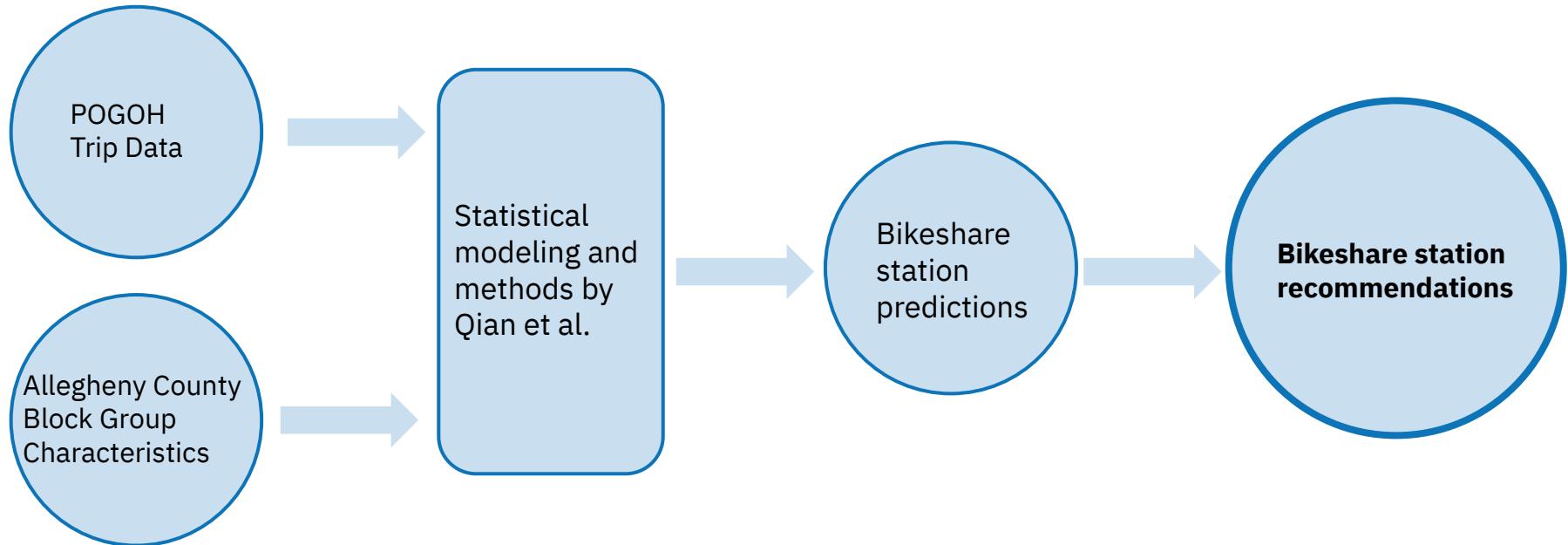
Project Motivation

- Transport equity, accessibility, physical health improvements
- Bikeshare ridership concentrated among white, wealthier communities



Bike Share Pittsburgh can improve transportation equity by intentionally siting bikeshare stations to maximize measures of accessibility

Our project uses data to make recommendations



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Pittsburghers travel by...



CAR



BUS



BIKE



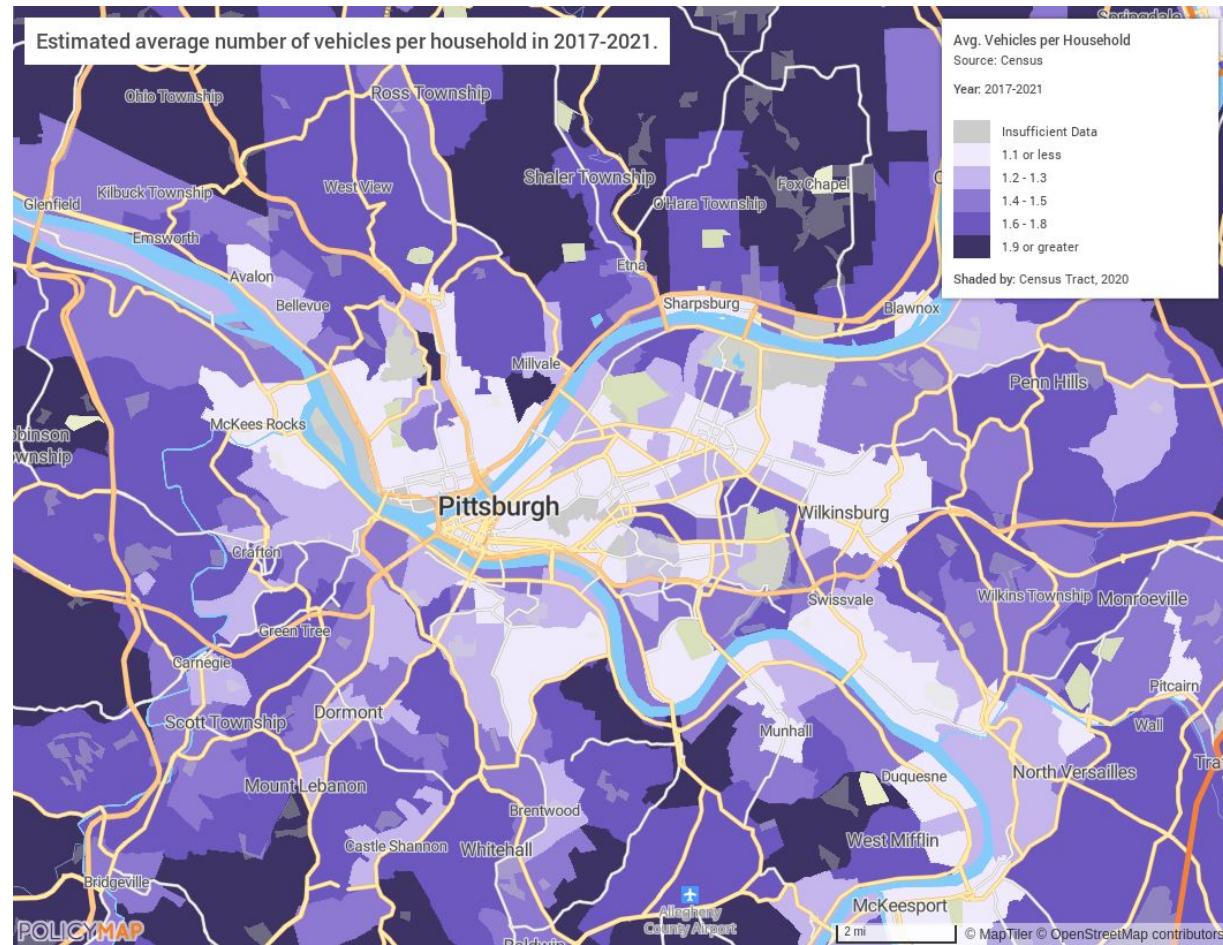
SCOOTER



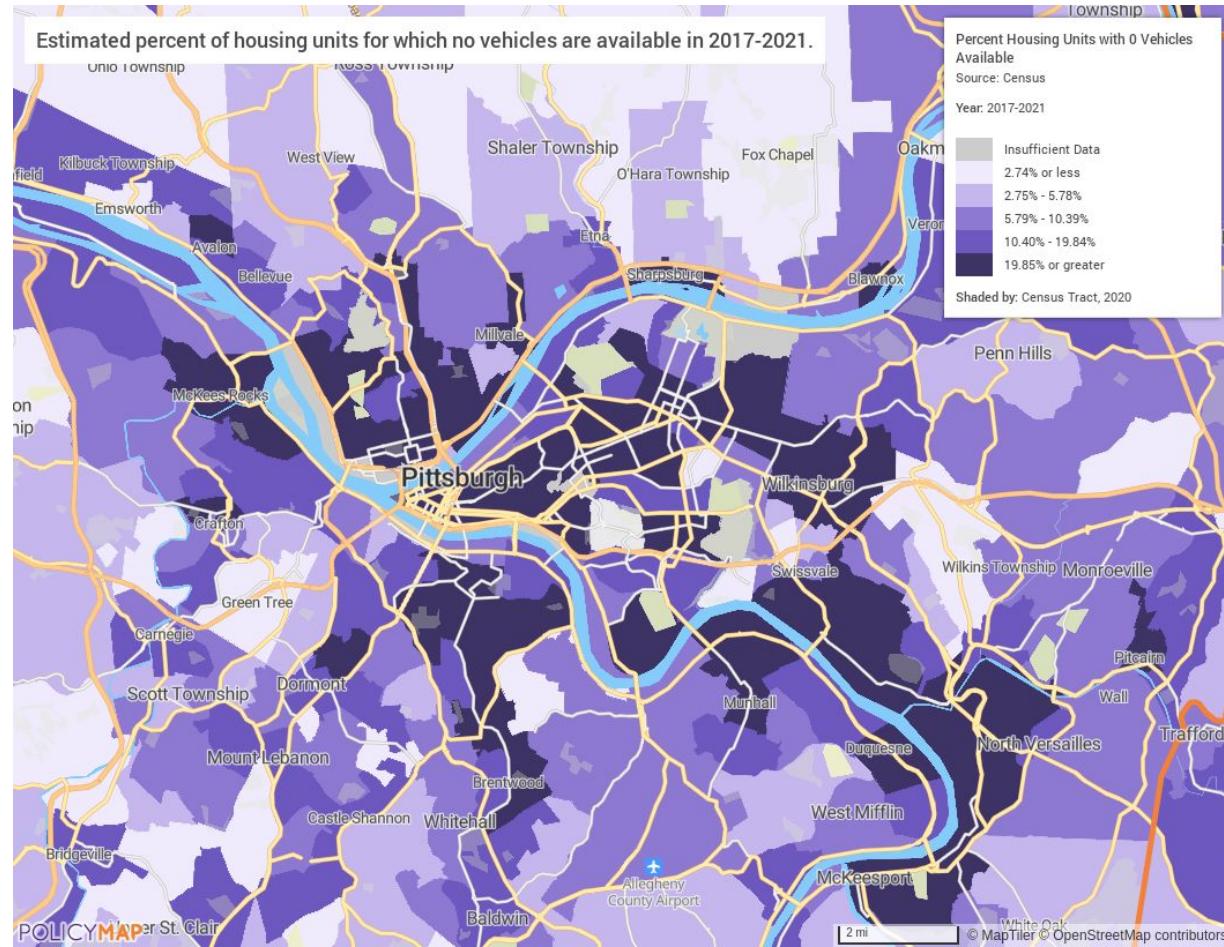
FOOT



TRAIN



Allegheny County's average number of vehicles per household is slightly **less** than the national average

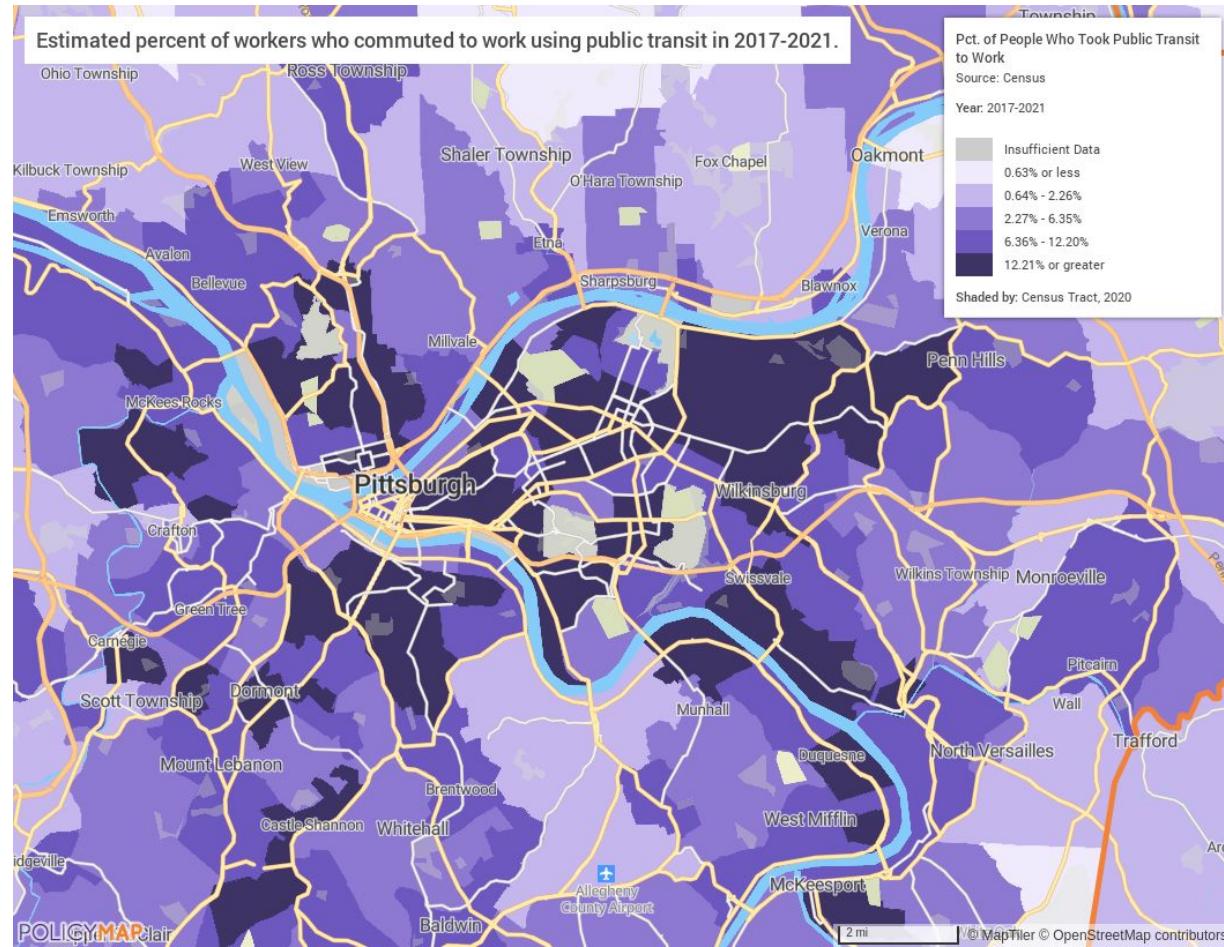


23% of
Pittsburgh
households have
no car access

Bus System

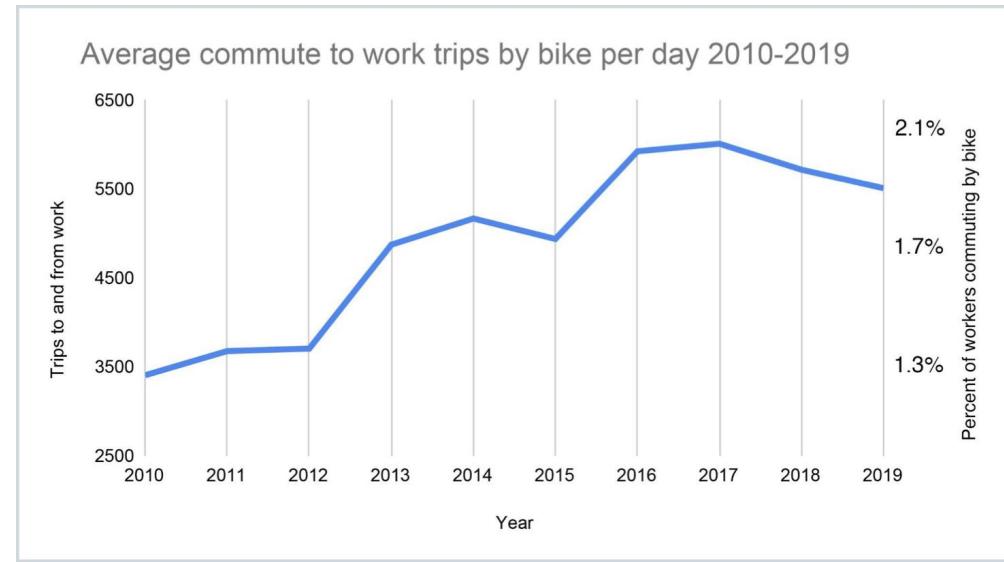


- Operated by Port Authority of Allegheny County
- 700 buses run out of the PRT station to 7,000 stops
- System operates over 100 routes, including local and express routes, specialty services - Free Fare Zone downtown and the Airport Flyer
- Almost 84% of all bus routes travel to Downtown Pittsburgh.
- YPRT fare is \$2.75 for unlimited rides within a three hour period.



Commuting by **public transit** is concentrated across the county

Bike usage in Pittsburgh is low, but increasing



- Pittsburgh has seen the second fastest 20-year growth in bike commuters in the United States
- Of the 60 largest US cities, 13th highest number of bike commuters

“Make My Trip Count” Survey

- 15% of respondents in Pittsburgh (and 9.9% when including surrounding boroughs) choose to bike for transportation
- 40% of those who don't cycle indicate that more bike lanes would encourage them to try

Spin Scooters



- Launched on 9th July 2021 by Move PGH
- Anyone 18 years and older can use Spin Scooters in by downloading the Transit App for free
- Starting fee of \$1 plus 39 cents per minute.
- Cheaper rates for low income riders - Spin Access program.
- “Make Pittsburgh an inclusive 15-min city”
- Residents have concerns regarding ride safety, obstruction of sidewalks and parking of scooters.

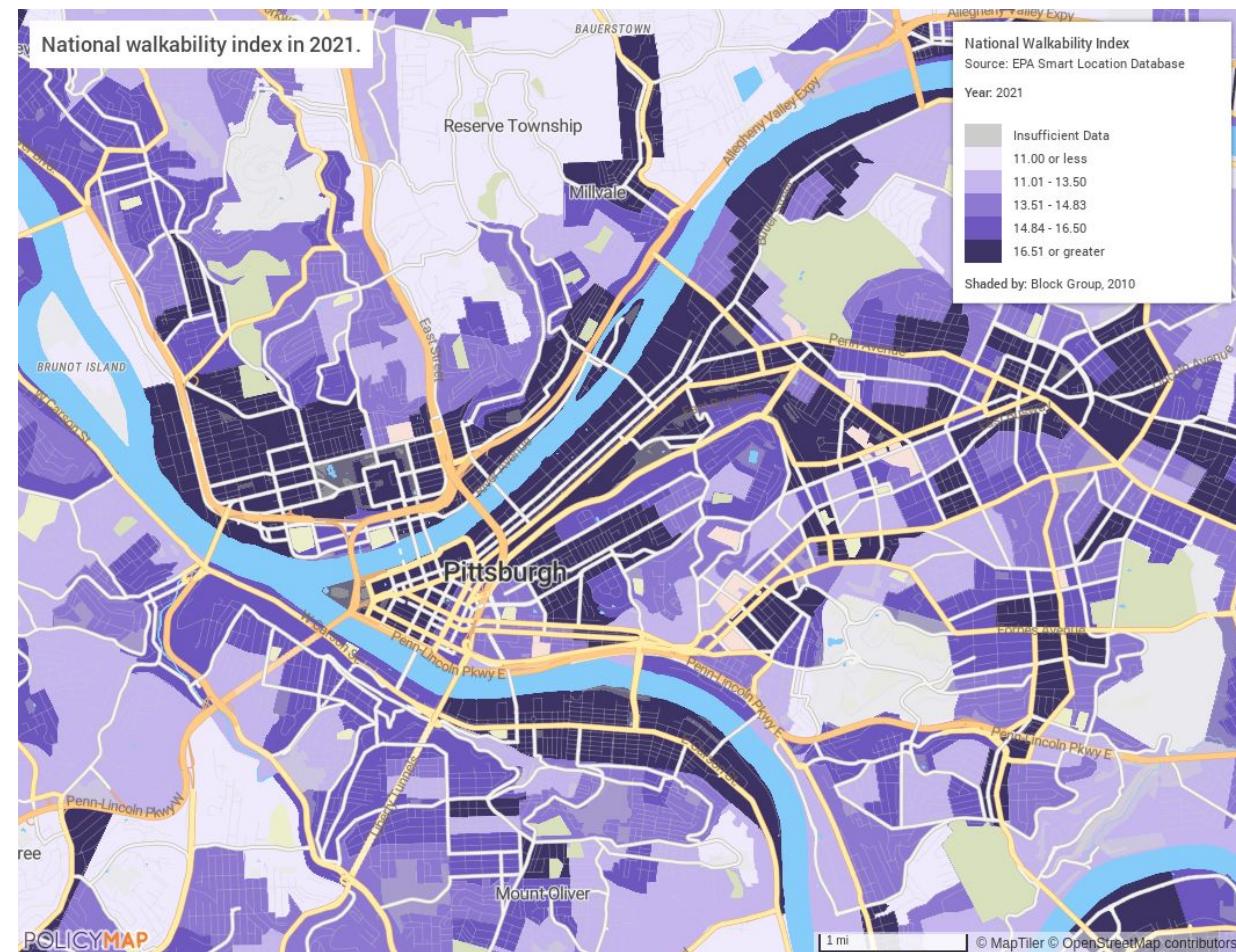
Walkability



- Pittsburgh among some of the most walkable cities in the United States, particularly the neighborhoods Downtown, Oakland, and Shadyside
- Earning a 63 Average on Walkscore
- Over 16,000 Pittsburghers walk to and from their job each day!
- 28% of Pittsburgh residents include walking among their top three commute modes (Make my trip count survey).



Pittsburgh is relatively walkable, according to the National Walkability Index



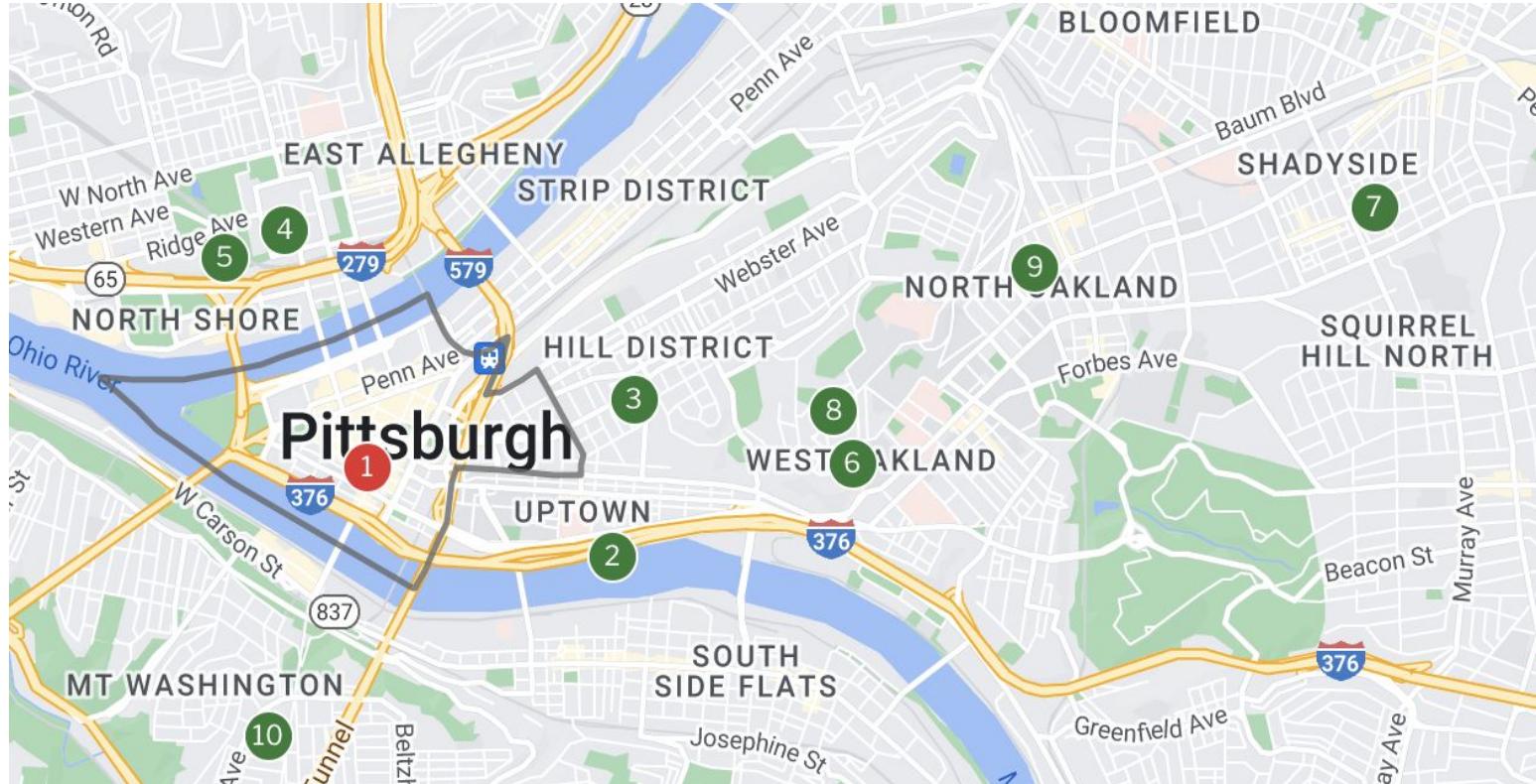
Light Rail System



Photo by [Jimmy Woo](#) on [Unsplash](#)

- Light rail system, known as the T
- Operates two main lines: the Red Line and the Blue Line.
- Serves downtown Pittsburgh, the South Hills, and the North Shore.
- System features 27 total stations that span 26.2 miles.

Downtown Pittsburgh has the highest transit score



Transit Score is a measure of how well a location is served by public transit on a scale from 0 to 100,
developed by the organization *Walk Score*

Strengths of Transit in Pittsburgh

- Low cost for bus/train rides
- Real-time bus tracking
- Implementation of transit signal priority to improve bus travel times.
- 138,000 Pittsburghers live within a half mile of public transit
- 45.7% transit users commute under 30 minutes (Moovit Public Transit)

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Data Sources

POGOH Trip Data

- Number of Docks
- Start Station
- End Station
- Trip Start time
- Trip End time
- RiderID
- BikeModel (Electric or Non-electric)
- Membership status

Census Data

- Total Population
- Number of Households
- Percentage of White Population
- Average Age of Population
- Percentage of Young Population (20 - 34)
- Median Income
- Low Vehicle Households
- Labor Force (total population able to work)
- Employment rate
- Bike Path Density
- Park Density
- Number of Transit Stops

Data Cleaning Methodology

Raw data

Remove grace period trips

Remove trips over 5 hours

Remove trips less than 2 minutes

Row represents **one trip**, made by **one rider**. One rider may take many trips (i.e., appear many times in dataset).

Row count: 76,161

Assumption: Rider did not actually take trip.
Row count: 68,829

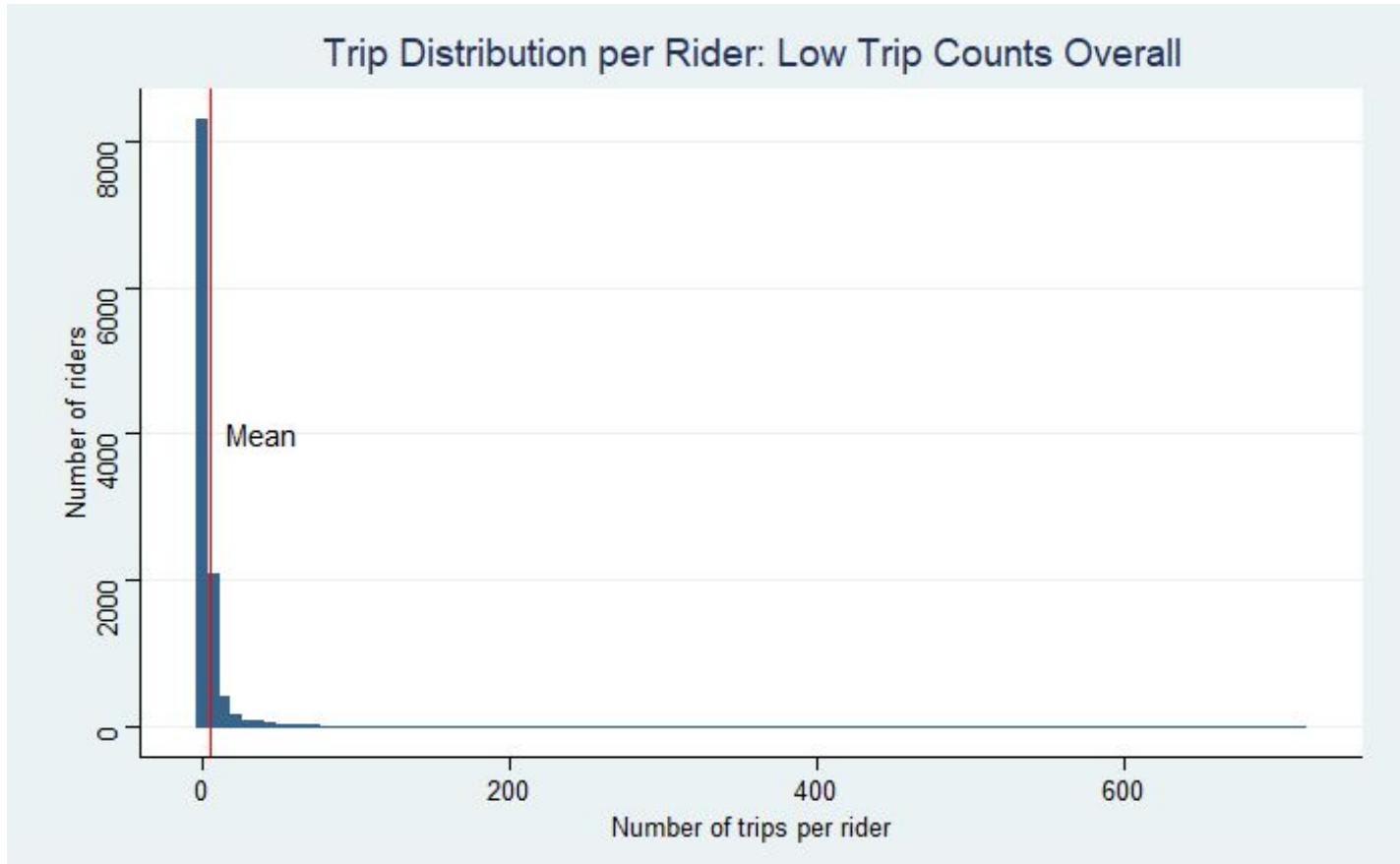
Assumption: Rider took the trip for leisure or failed to re-dock.
Row count: 68,371

Assumption: Functionally “failed” trips that didn’t go anywhere.
Final row count: 67,780

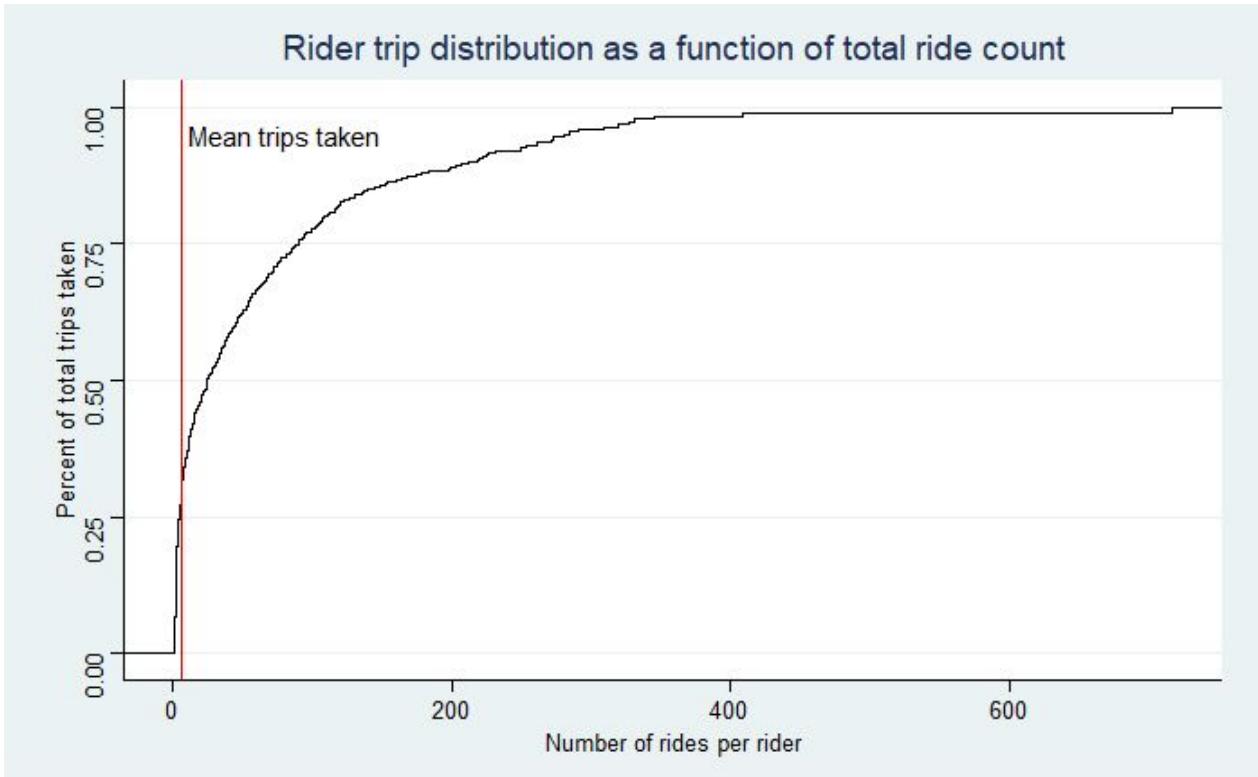
Total rows lost: 8,381

Percent rows lost: 11%

Most riders take few trips

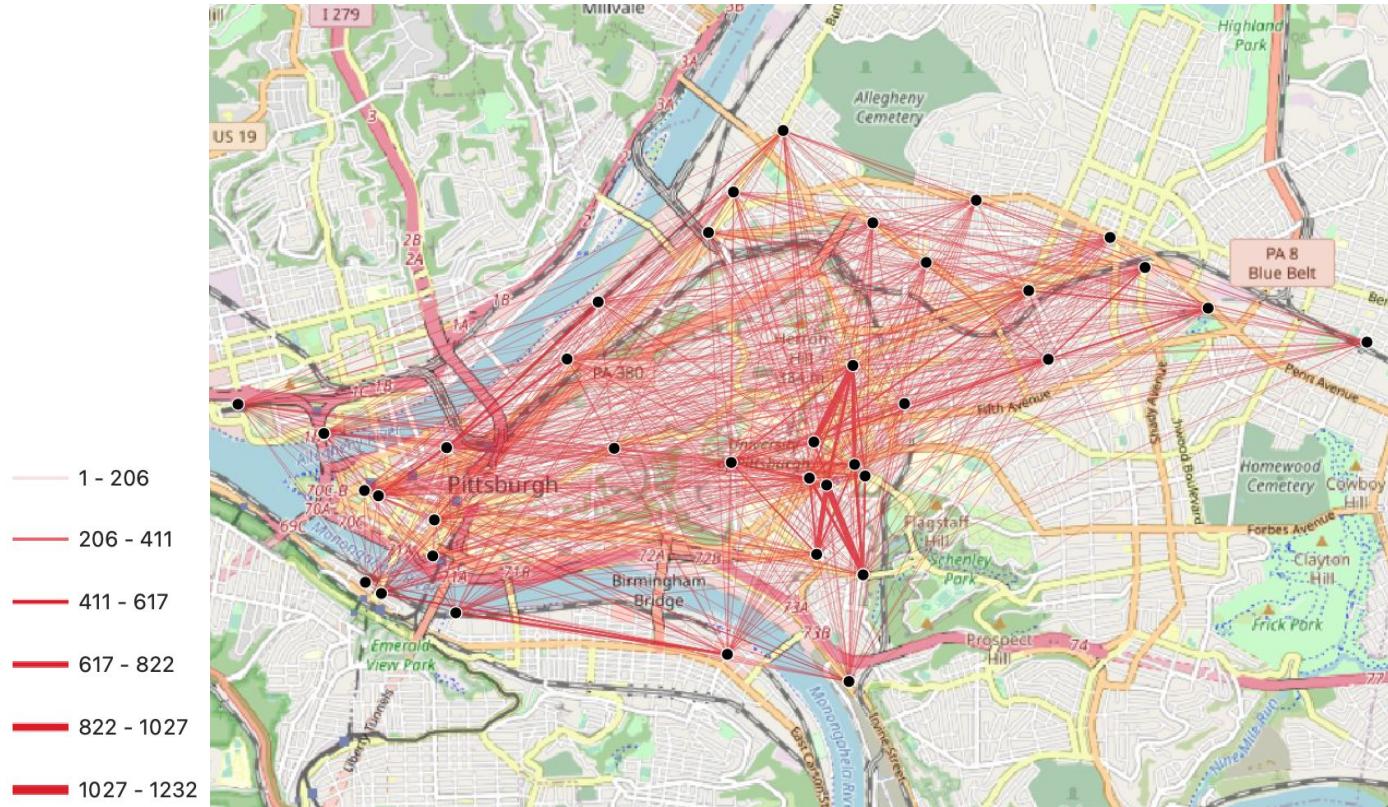


Total trips driven by casual users



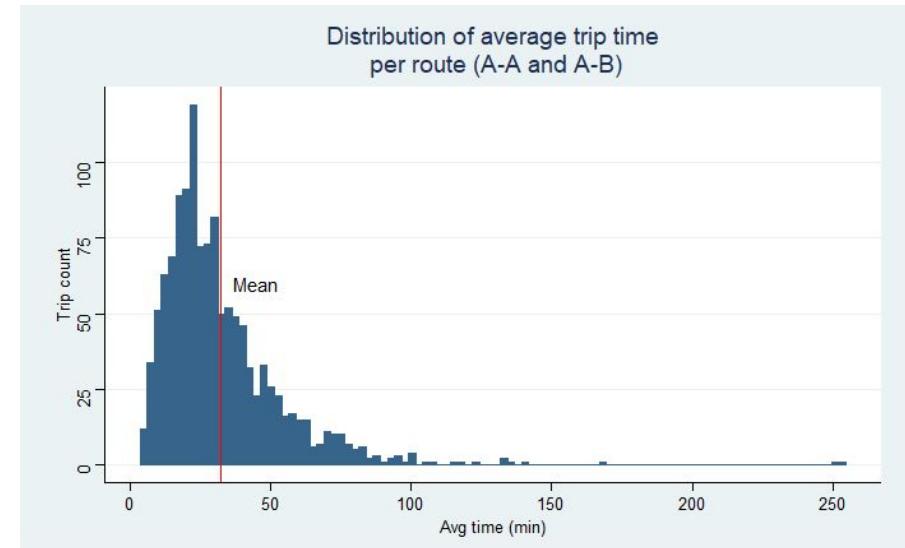
Number of rides	Number of riders
500+	1
250+	16
150+	40
100+	88
75+	138
50+	236
40+	300
30+	411
20+	588
10+	1125
5+	2295
1 time only	4428

Most Popular Routes



Superstar routes inflate mean trips per route

Start.Station.Id	End.Station.Id	route_cts	avg_time
26	26	1538	70.53
20	13	1232	6.45
13	20	1219	5.76
34	12	1171	4.09
23	23	1154	57.22
12	34	1142	4.71
21	21	1068	60.09
9	9	982	58.71
22	22	879	58.97
13	10	824	5.44
10	13	670	7.09
34	29	663	7.75
29	20	590	7.96
34	13	588	8.88
20	29	585	6.79



	Mean	Median
Trip Counts	54.54 trips	14 trips
Trip Time	32.42 mins	27.04 mins

Statistics on Routes in Disadvantaged Areas

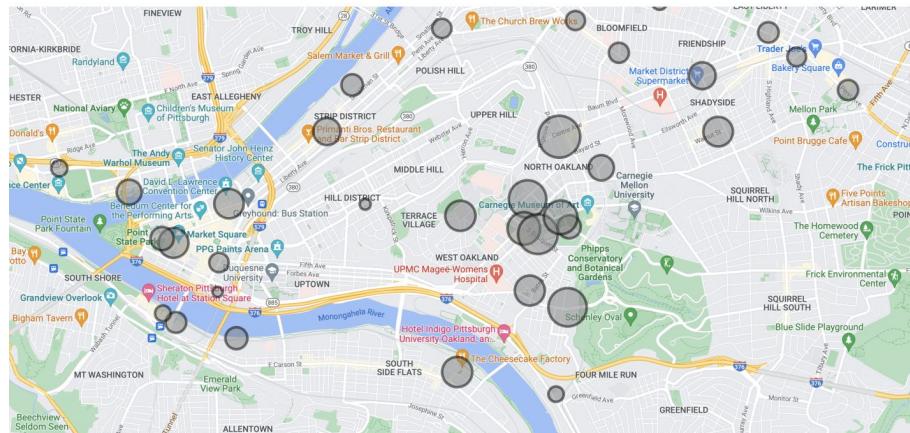
TRIP COUNT

Origin\Destination	Others	Disadvantaged
Others	47,985 trips	2,805 trips
Disadvantaged	4,340 trips	263 trips

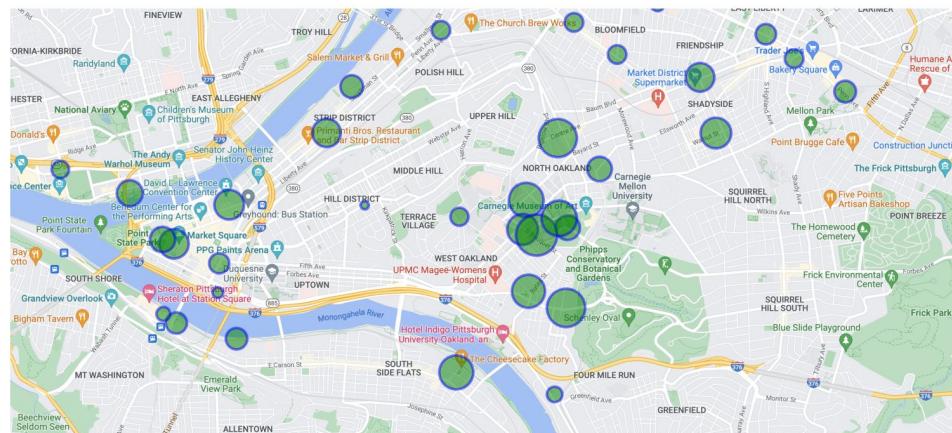
AVERAGE TIME

Origin\Destination	Others	Disadvantaged
Others	23 min	33 min
Disadvantaged	22 min	28 min

Distributions of Trip Origins and Destinations

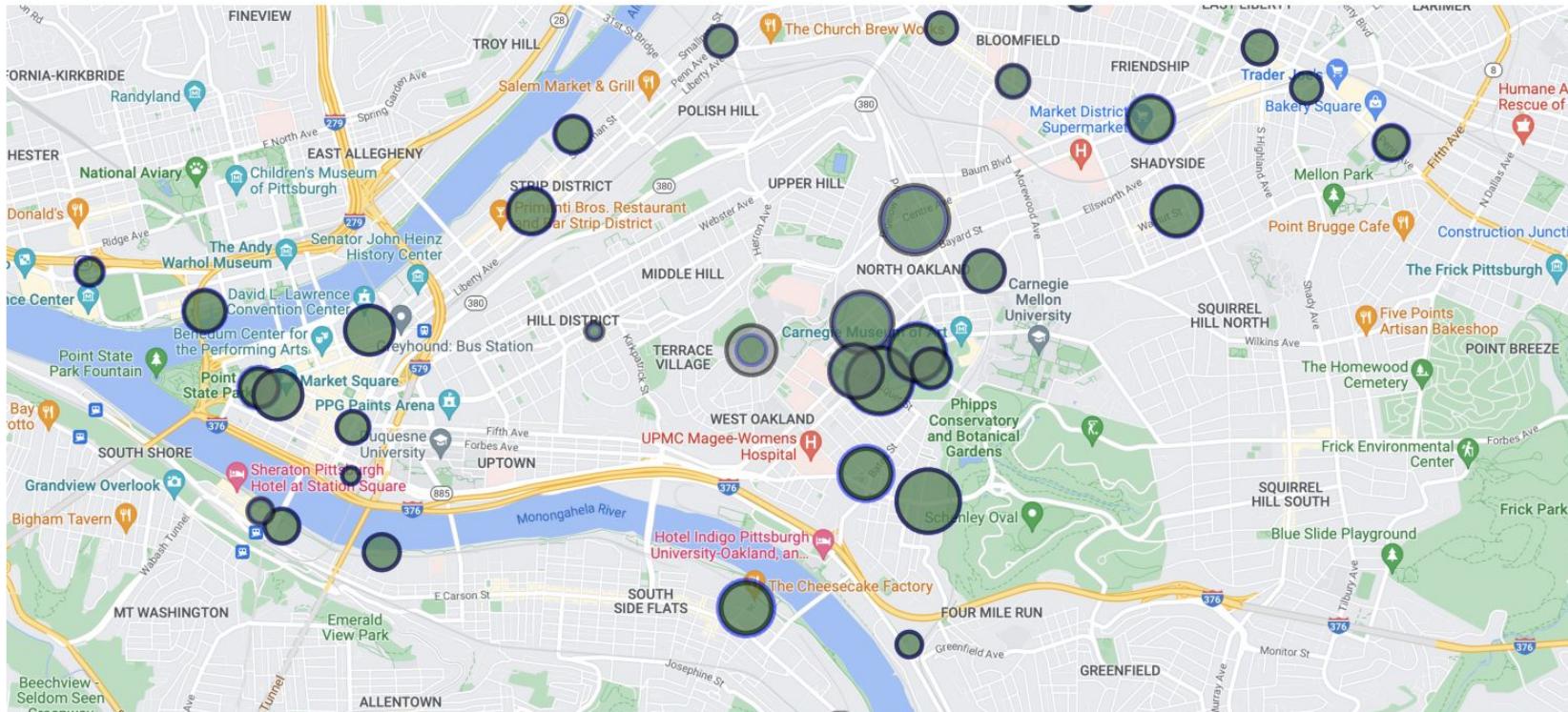


Start Stations

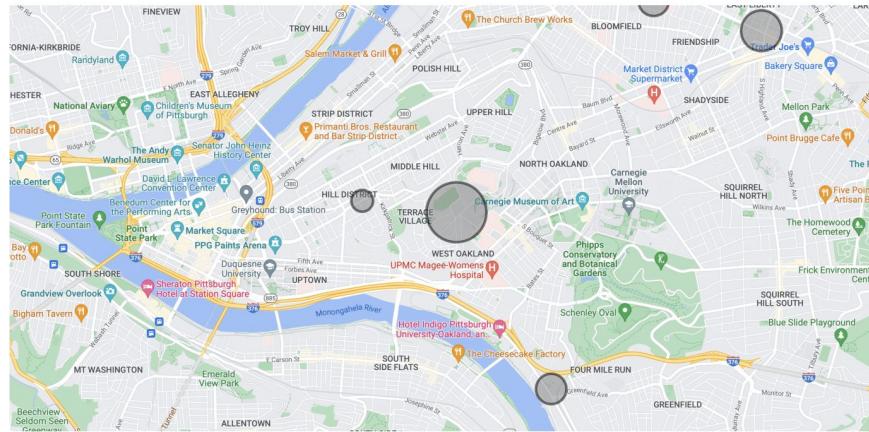


End Stations

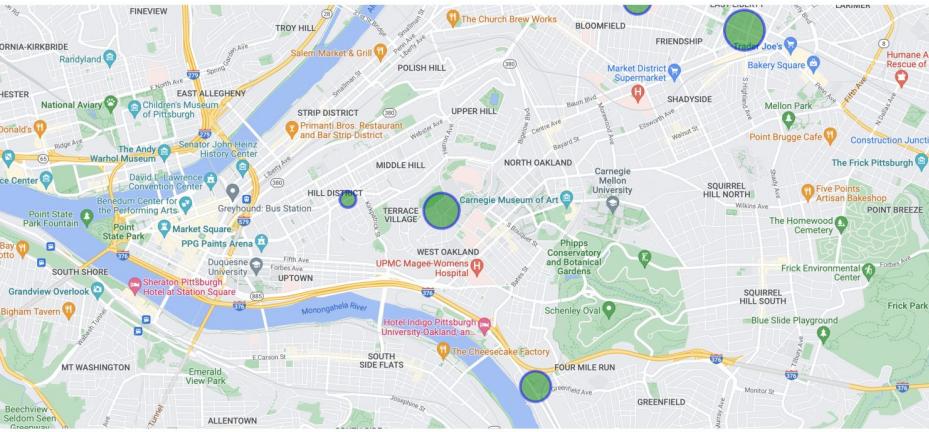
The distributions of trip origins and destinations are almost identical



Distributions of origins and destinations in disadvantaged areas



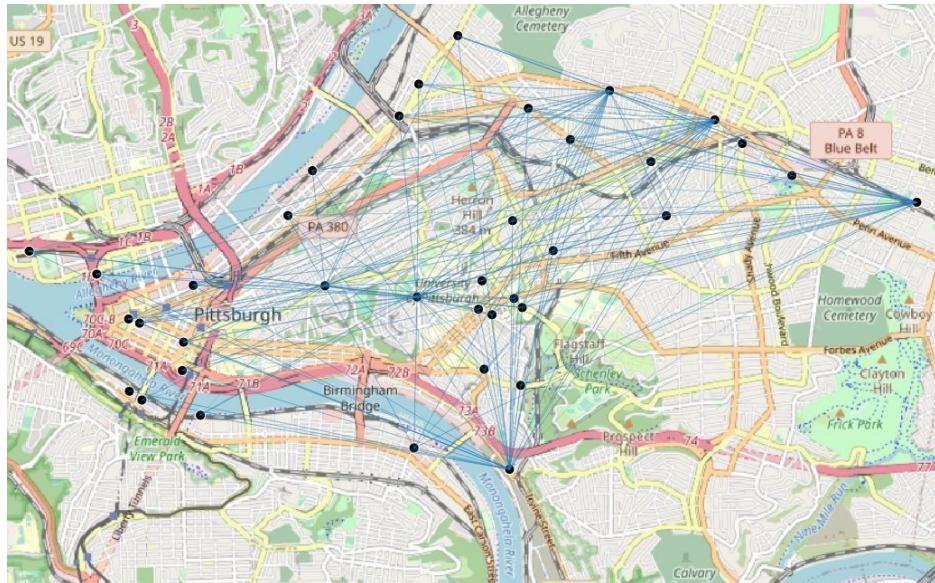
Distribution of **Start** Stations
in Disadvantaged Areas



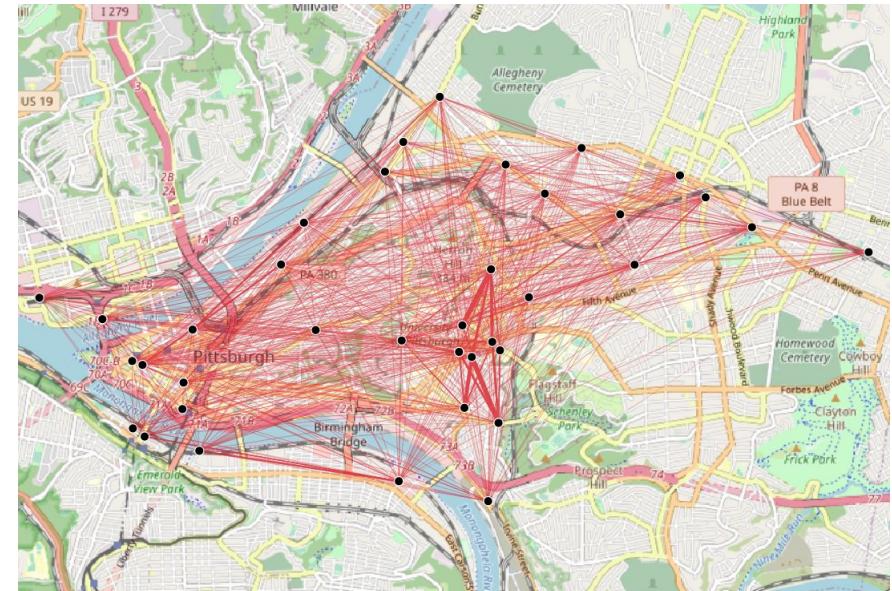
Distribution of **End** Stations
in Disadvantaged Areas

Distributions of Origins and Destinations

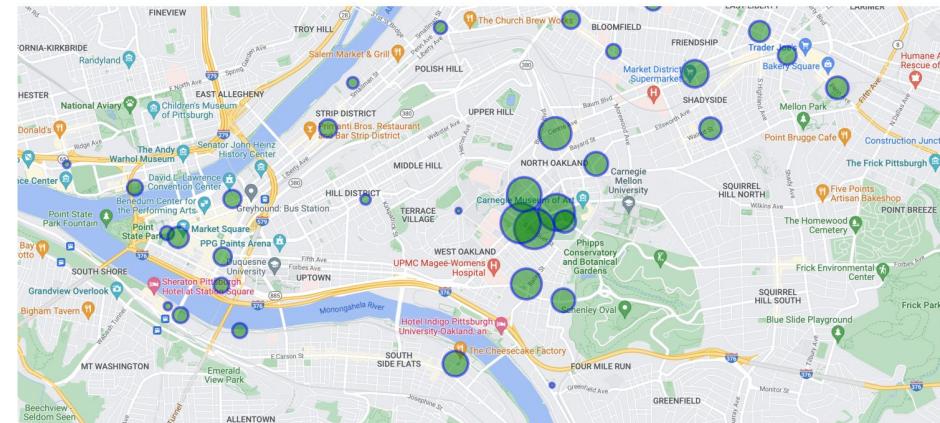
Disadvantaged start or stop only



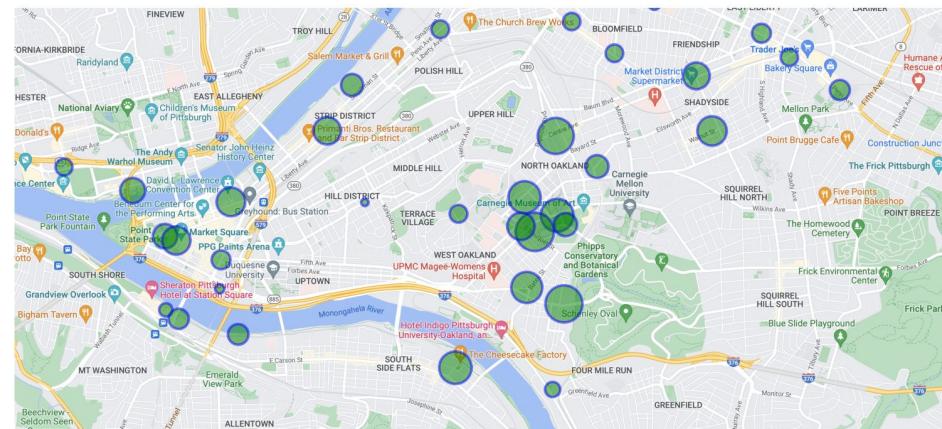
All routes



Distributions of Destinations



Distribution of **End** Stations Originating from **Disadvantaged** Areas



Distribution of **End** Stations Originating from **Other** Areas

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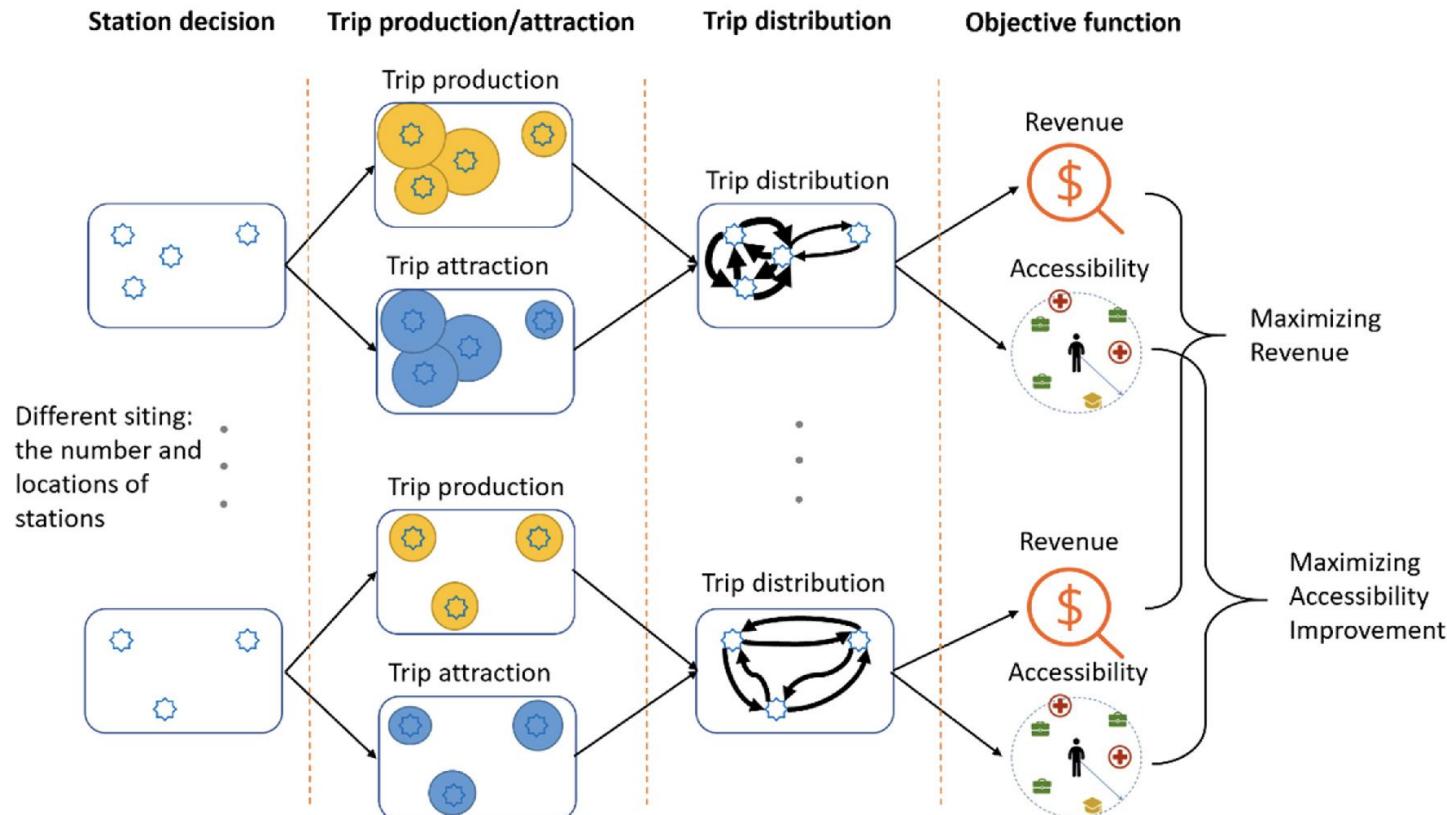
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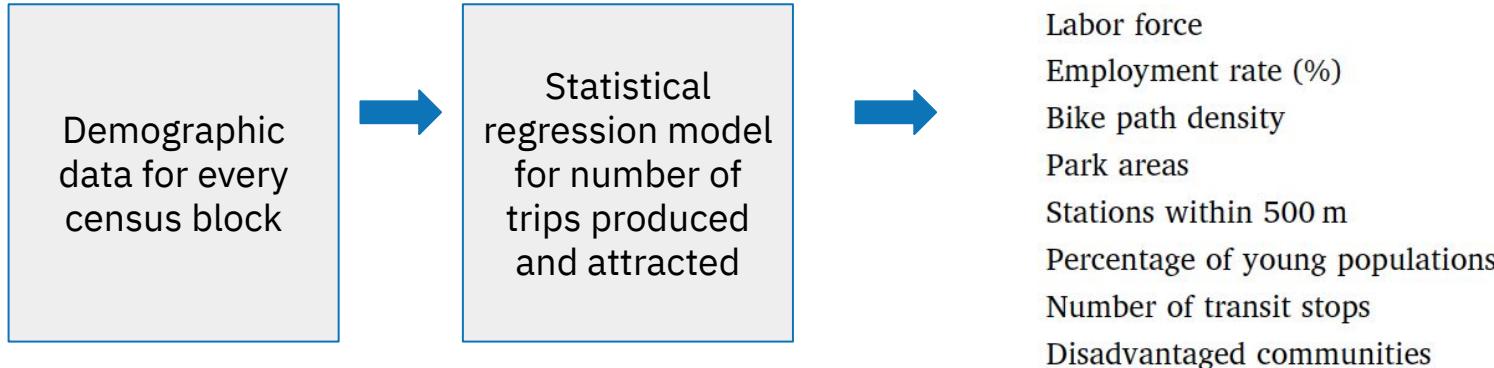
**Case
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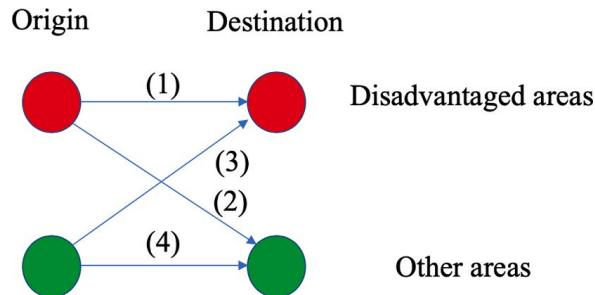
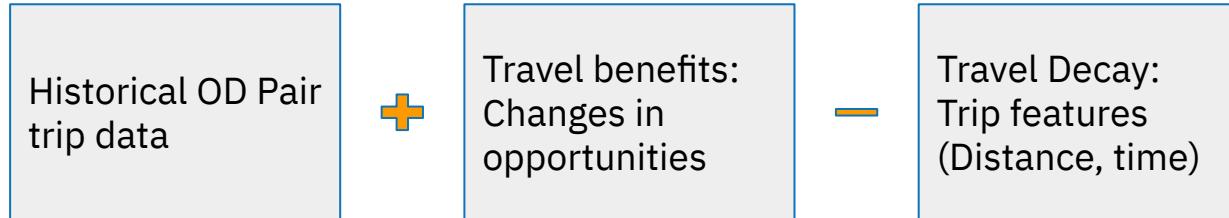
Research summary



Step 1: Estimating Ridership using Demographic data

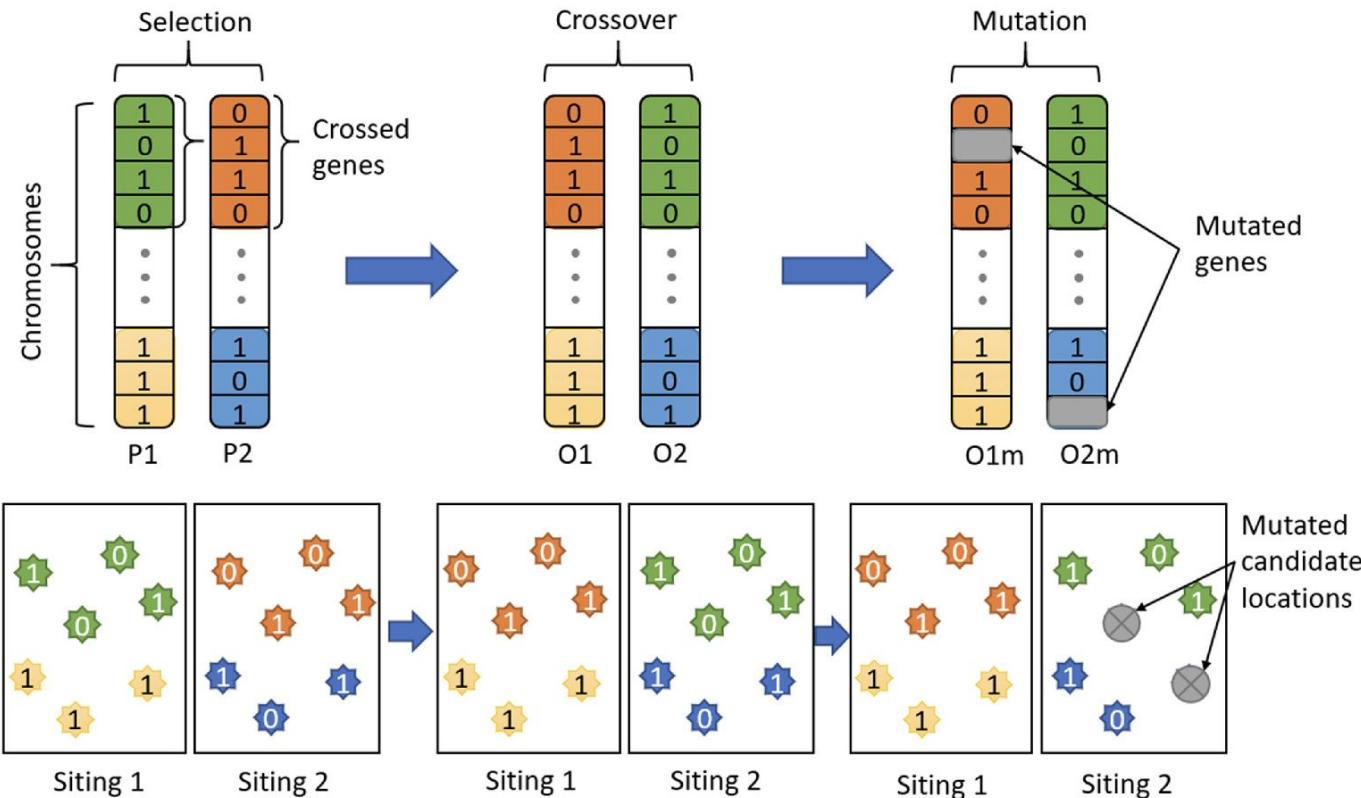


Step 2: Understand Bikeshare Destination Choices



$$T_{ij} = A_i O_i B_j D_j (S_{ij})^\rho * e^{(-\beta C_{ij})}$$

Step 3: Optimizing equitable distribution of stations



Our Approach

STEP 1

Prediction models for trip production and trip attraction

- Coefficients estimated from Chicago bike share
- Negative binomial regression model
- Qian and Jaller (2020)

STEP 2

Prediction model for trip distribution

- Competing destination model to understand the purpose of bikeshare usage
- Qian and Jaller (2021)

STEP 3

Station siting options

- Census blocks where potential bike share stations could be placed

STEP 4

Calculate objective function

- Maximize accessibility improvement
- Simulate various options
- Genetic algorithm optimization method
- Qian, Jaller and Circella (2022)

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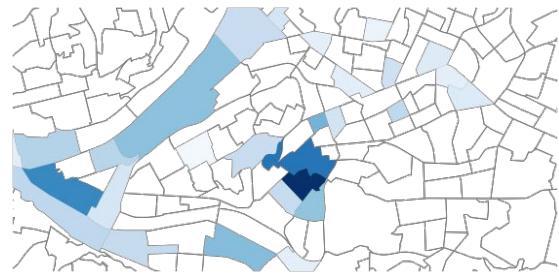
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Negative Binomial Regression Model

- Good for count data (i.e., number of starts and ends of trips in a block group)
- Response Variables: Start Counts (Production) and End Counts (Attraction)

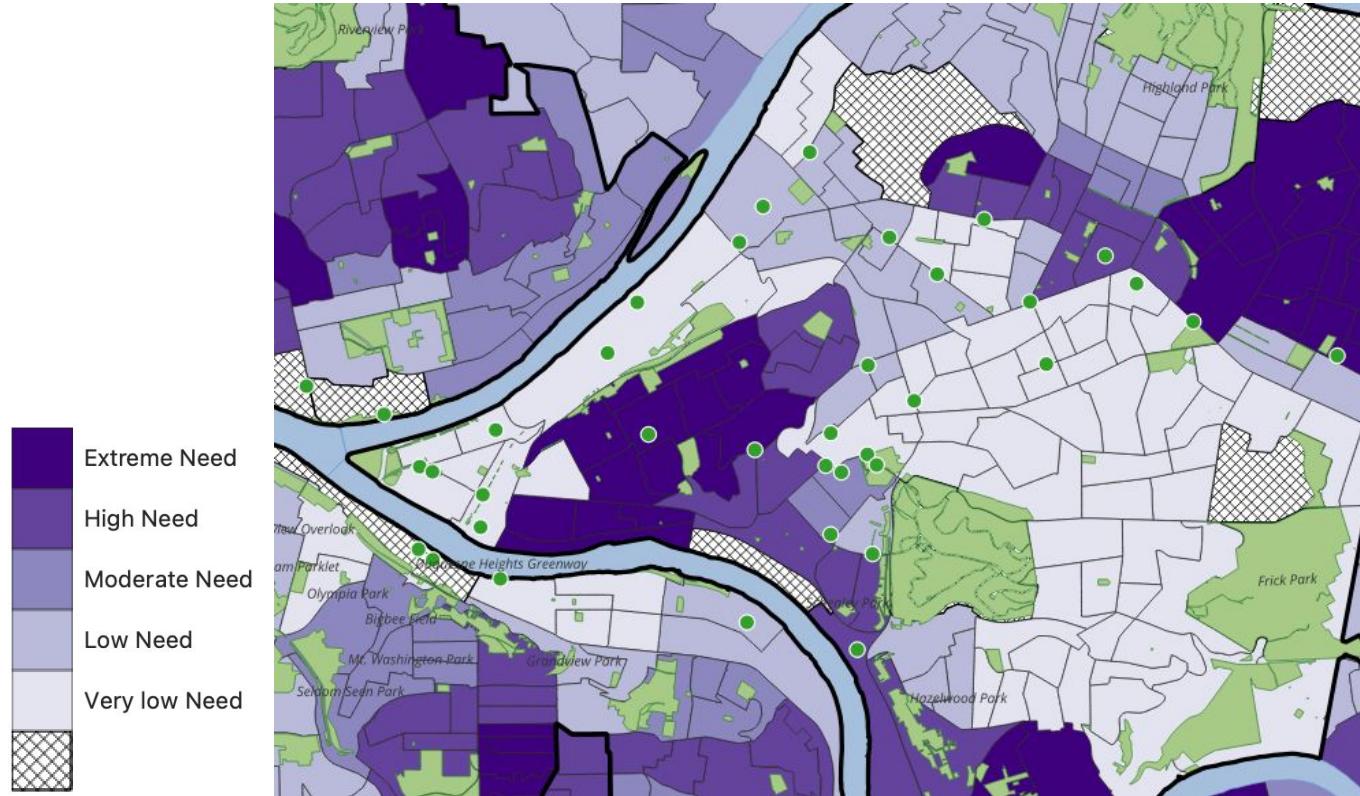
Start Counts (Production)



End Counts (Attraction)

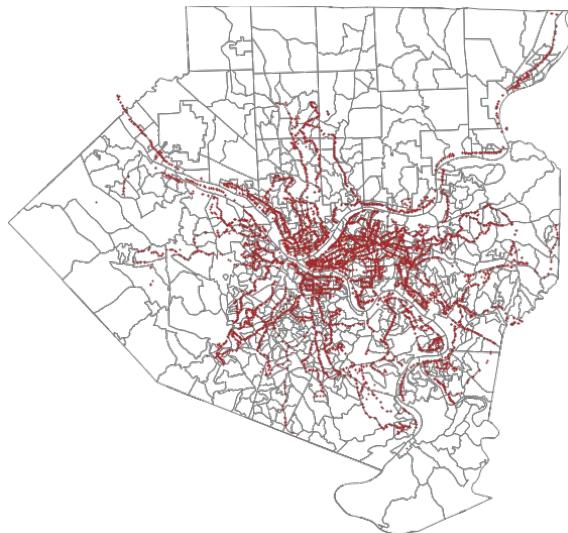


POGOH Stations and the Pittsburgh Community Need Index

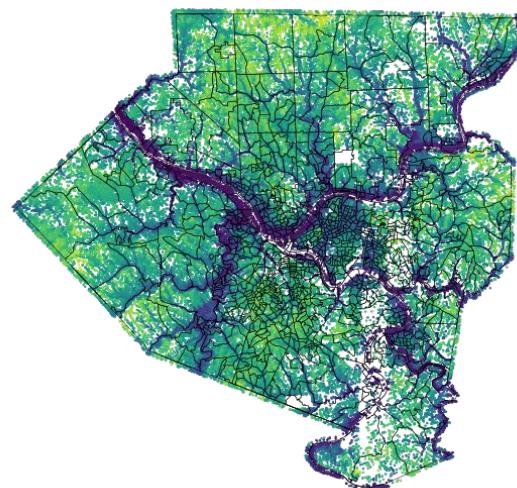


Negative Binomial Regression Inputs

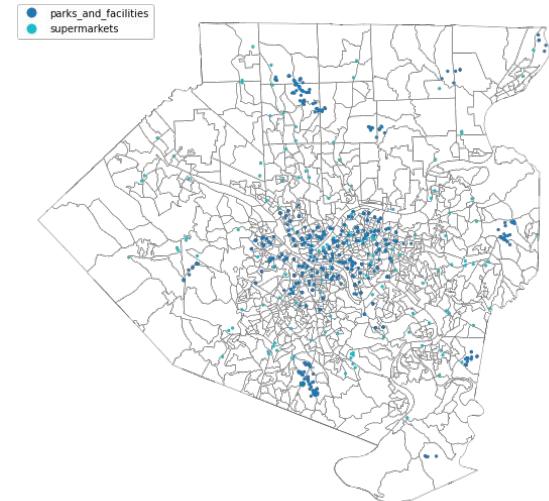
Bus Stops



Elevation



Assets

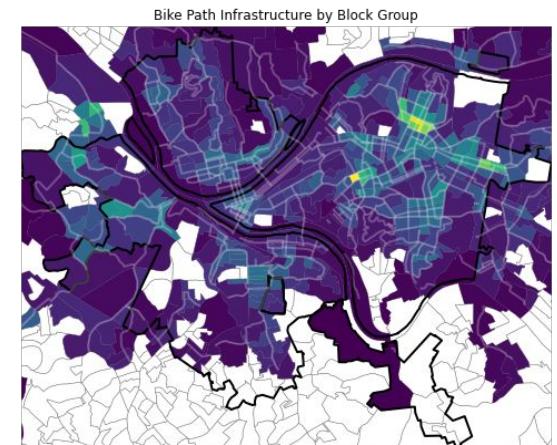
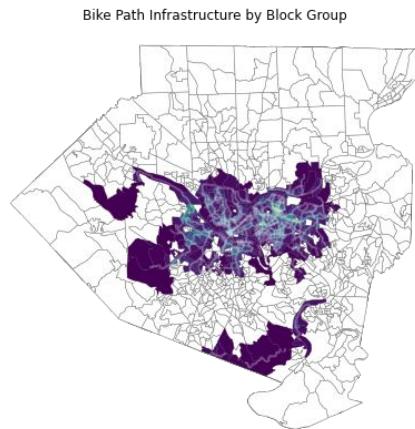
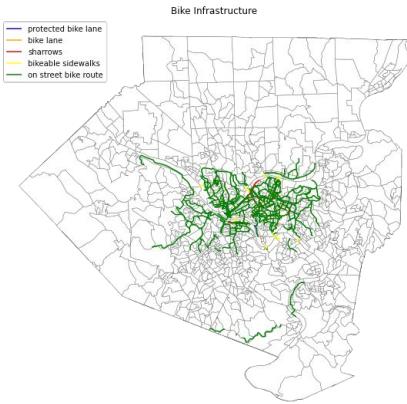


Inputs to the Model

- Number of Docks
- Total Population
- Number of Households
- Percentage of White Population
- Average Age of Population
- Percentage of Young Population (20 - 34)
- Median Income
- Low Vehicle Households
- Labor Force (total population able to work)
- Employment rate
- Bike Path Density
- Park Density
- Number of Transit Stops
- Number of Grocery Stores
- Number of Schools
- Number of Hospitals
- Number of Parks

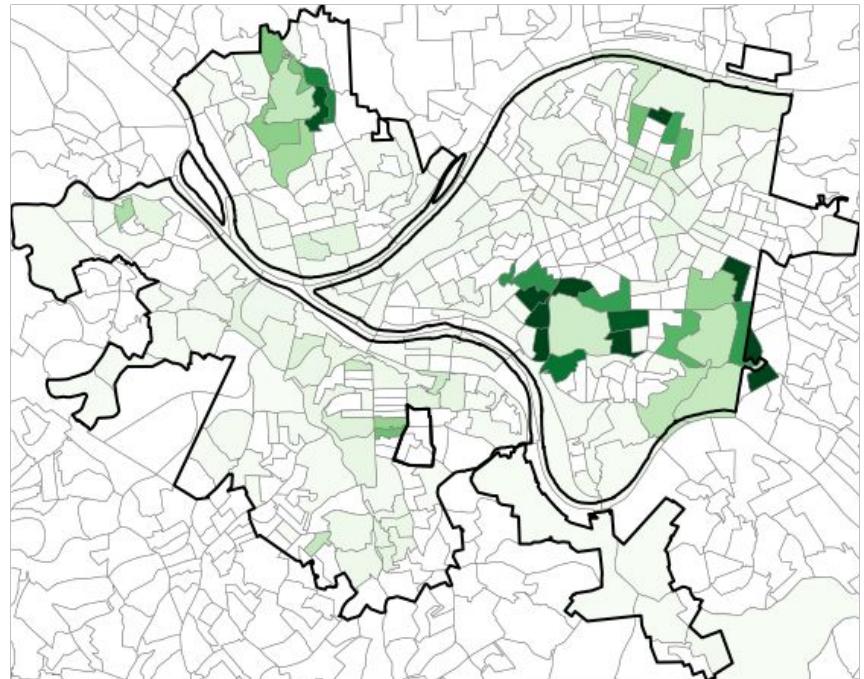
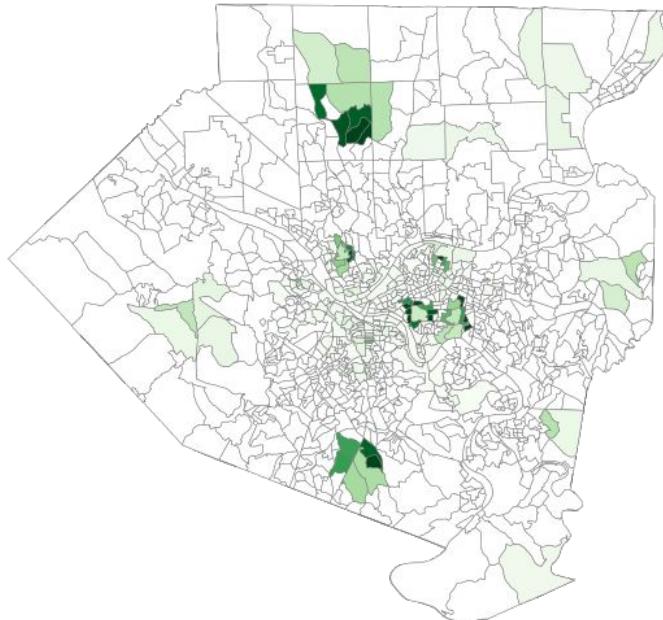
Bike Path Density

Bike Path Density = Total Length of Bike Infrastructure / Total Area



Park Density

Park Density = Park Area / Total Area

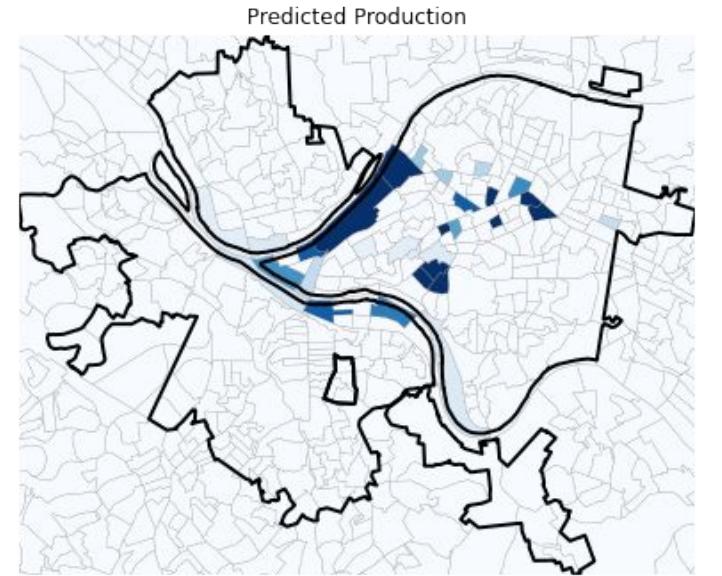
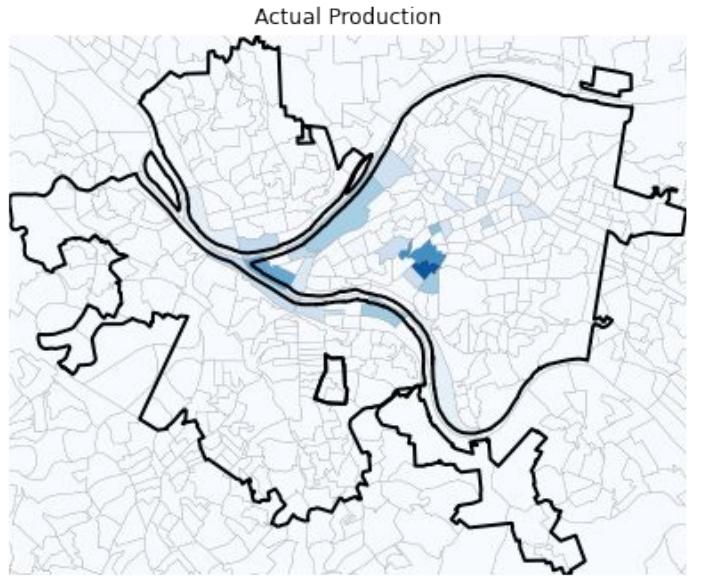


The Chicago Model Applied

Variable	production_coefs	attraction_coefs
Constant	-0.08315	-0.3528
Labor_Force	0.000055	0.000051
Employment_Rate	0.07107	0.07471
bike_path_density	0.005212	0.005122
Park_Areas	0.000004	0.000004
Stations_Within_500m	0.0875	0.07594
PCT_Young_Pop	0.03298	0.032
Num_Transit_Stops	0.02045	0.02217
Disadvantaged	-0.3082	-0.2948

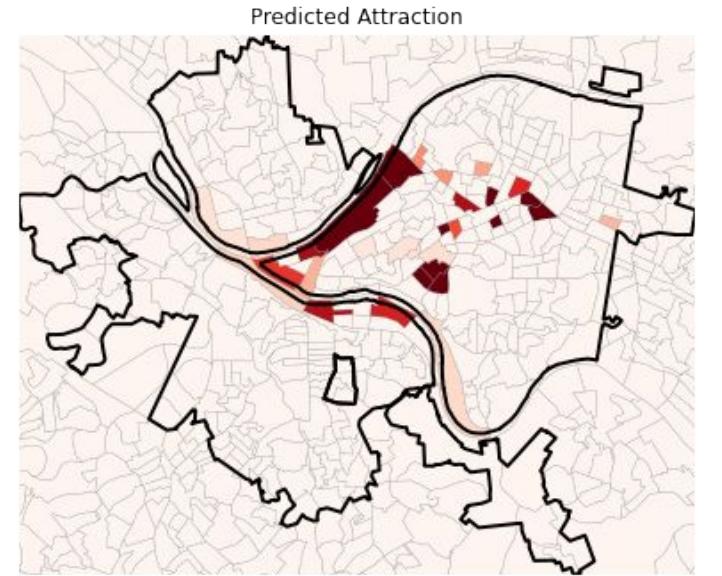
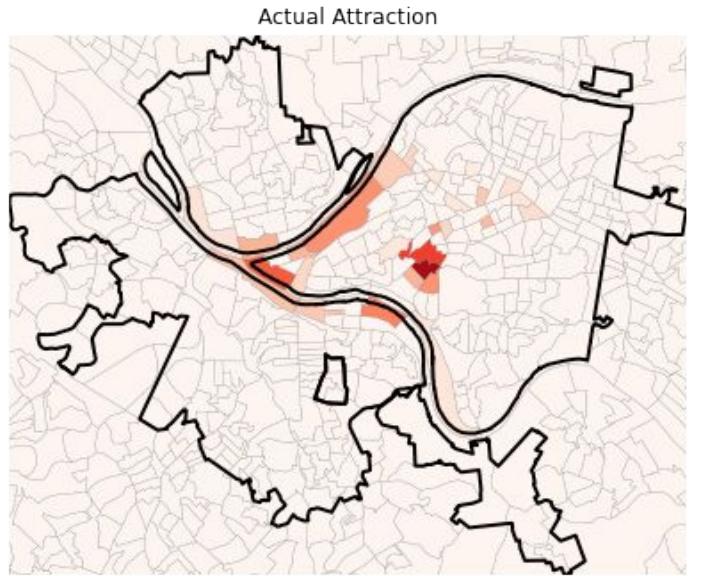
The Chicago Model Applied

Comparing Actual and Predicted Production

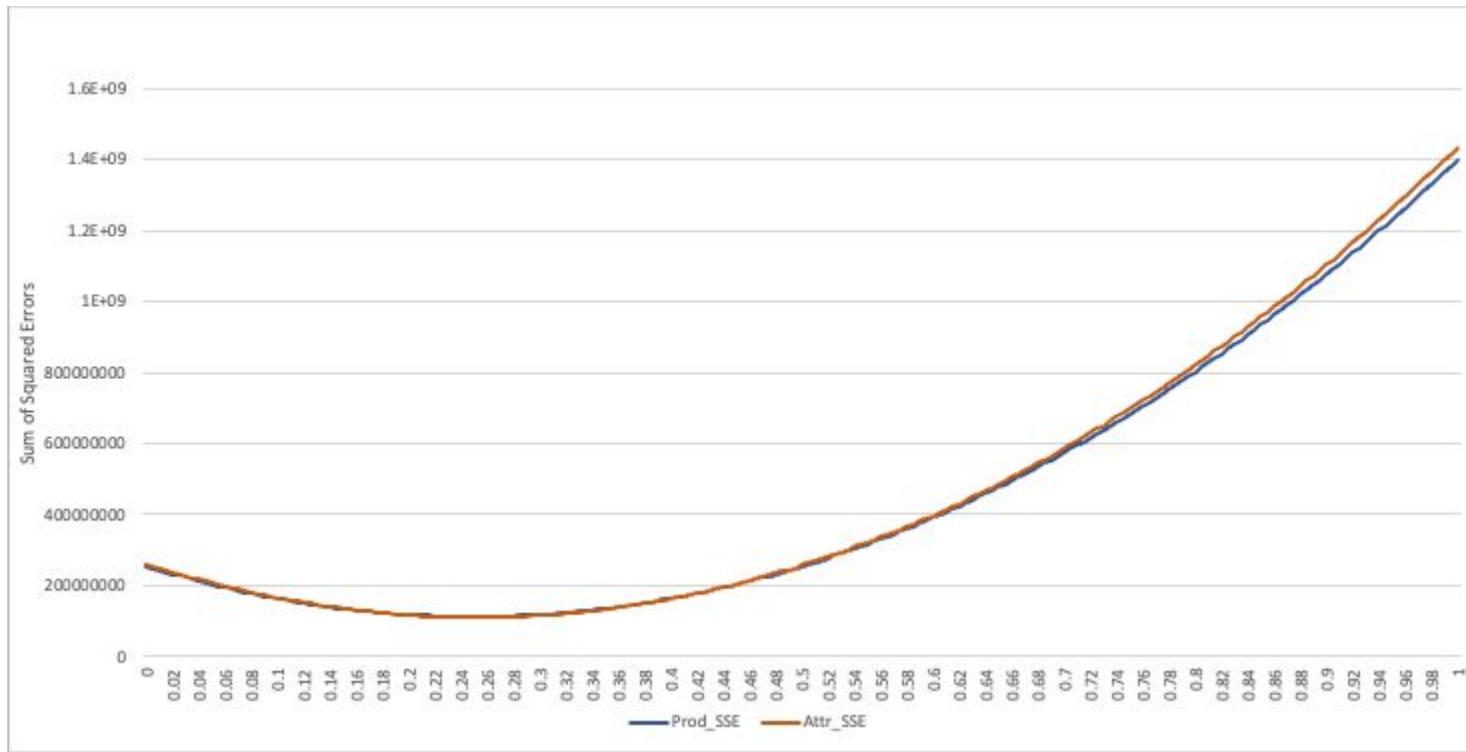


The Chicago Model Applied

Comparing Actual and Predicted Attraction

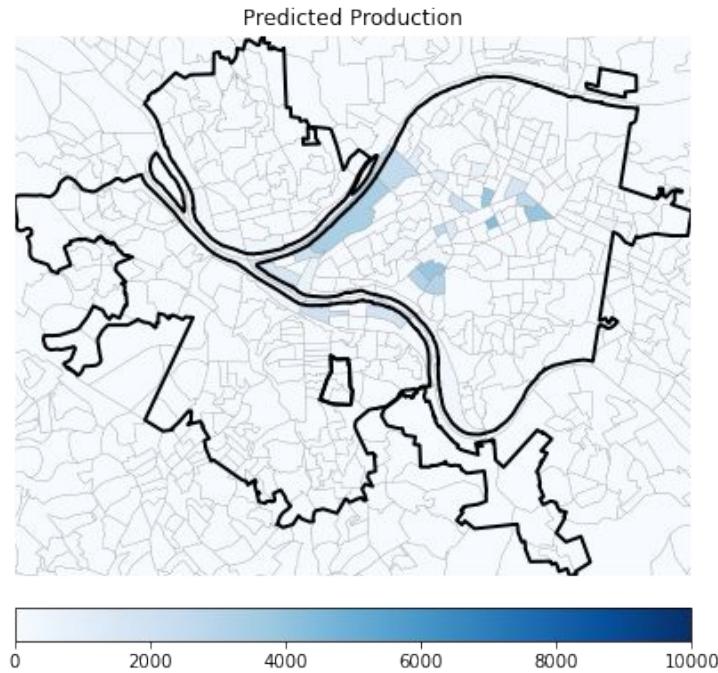
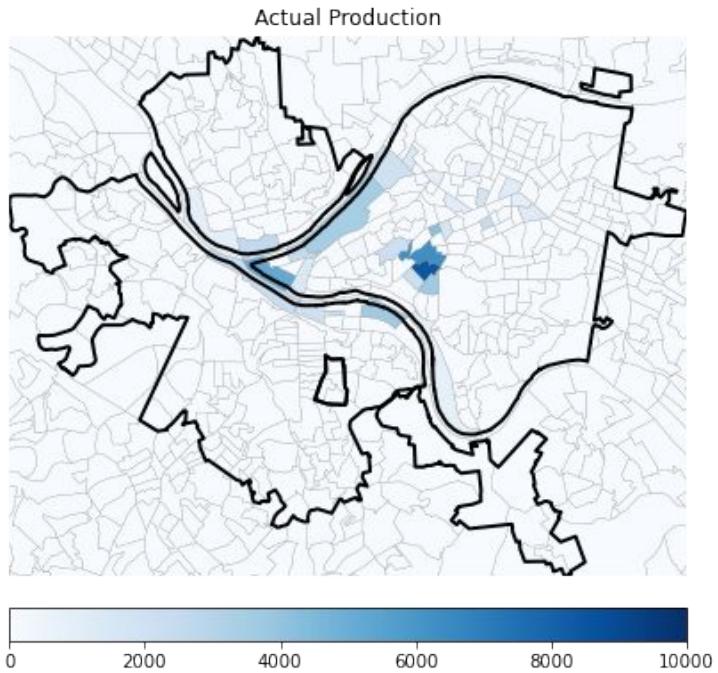


The Chicago Model Scaled



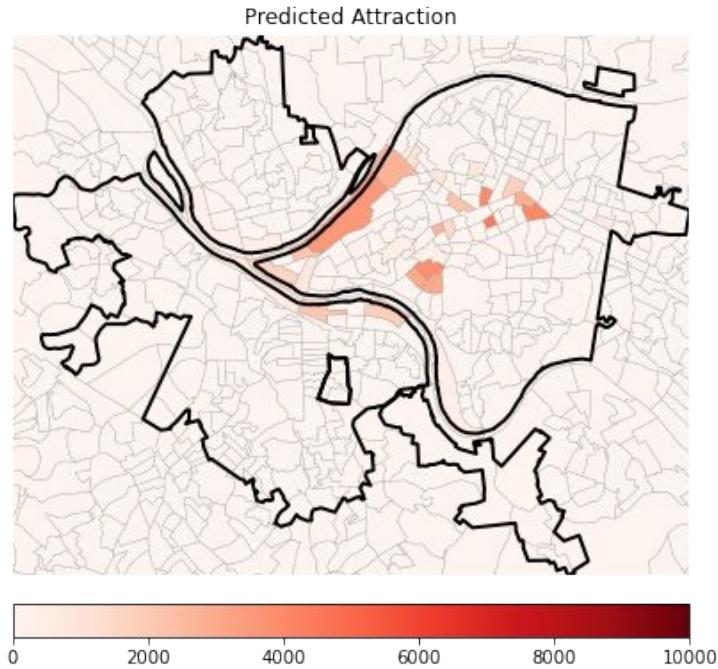
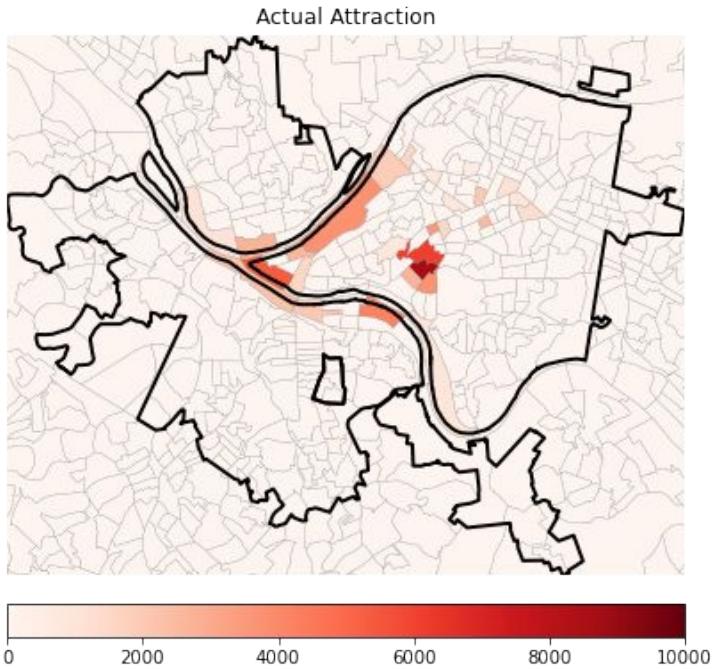
The Chicago Model Scaled (0.25)

Comparing Actual and Predicted Production

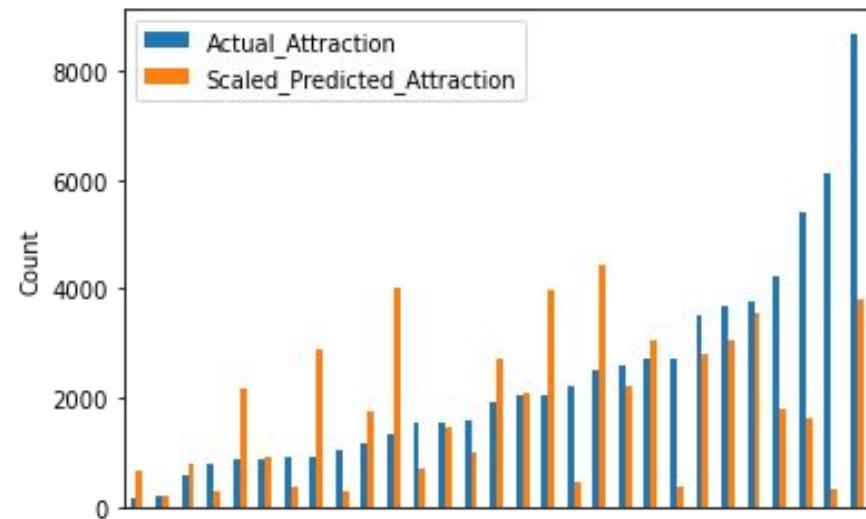
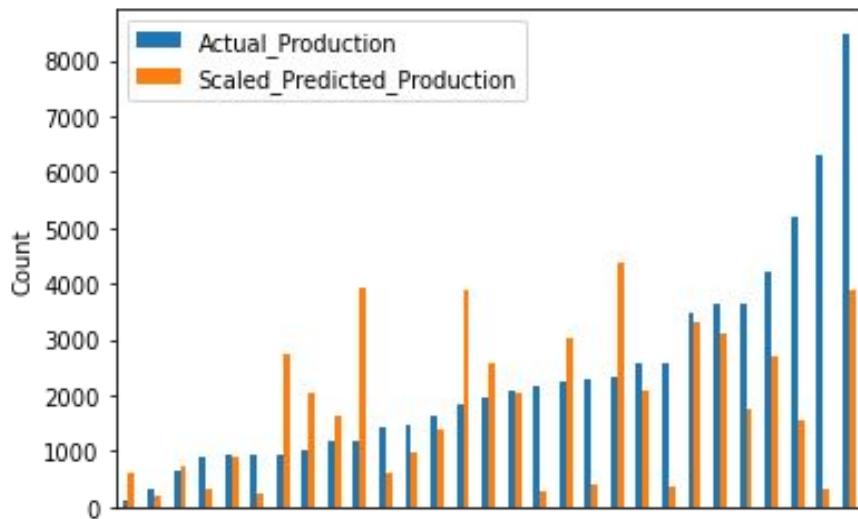


The Chicago Model Scaled (0.25)

Comparing Actual and Predicted Attraction



Results

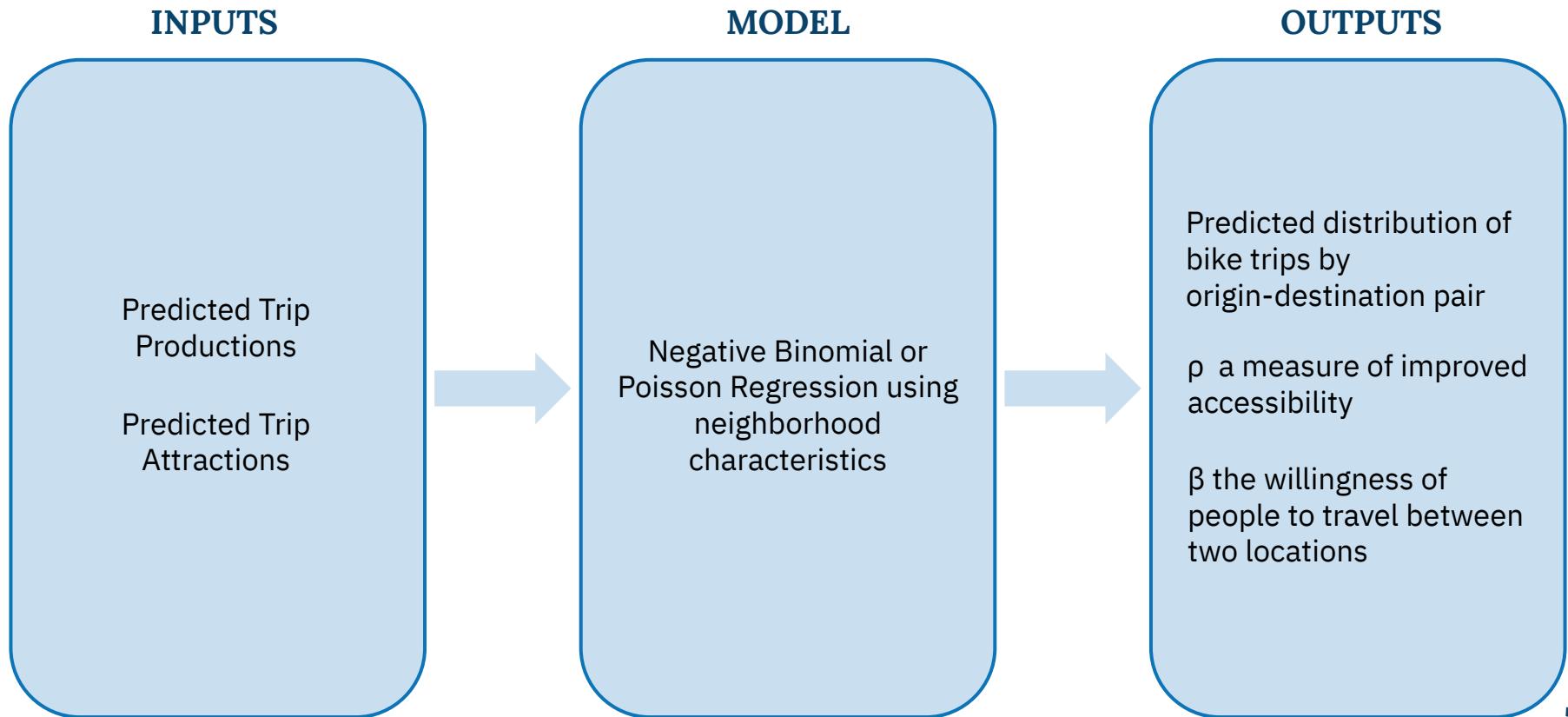


Future Work

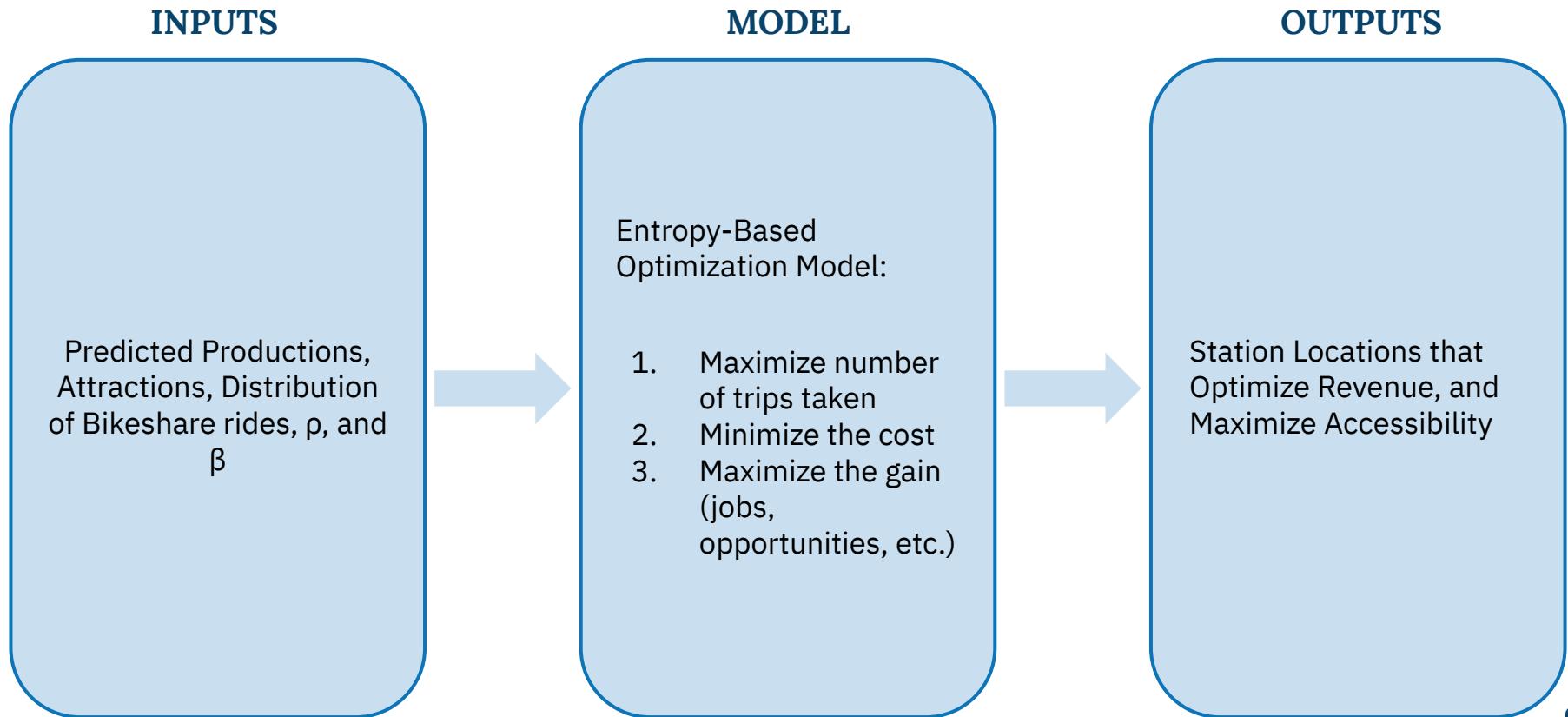
COMPETING DESTINATION MODEL

GENETIC ALGORITHM OPTIMIZATION

COMPETING DESTINATION MODEL



GENETIC ALGORITHM OPTIMIZATION



Additional Data Sources

- Mobility Justice Membership Data
 - Descriptive analysis:
 - Most popular routes
 - Average number of trips per rider
 - Average trip time per rider
 - Proportion of overall riders
- Potential data merge with Allegheny County DHS
 - Person-level information
 - Participation in SNAP, TANF, etc.

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Case studies: Chicago



L: [Brandi Alexandra](#) on [Unsplash](#)
R: Photo by [Jake Leonard](#) on [Unsplash](#)



- 16,500 bikes and 600+ stations
- Population: 2.7 million

Key Findings

- Fully electrifying fleet
- “Divvy for Everyone”
- Interactive data dashboard, in partnership with City of Chicago

Case studies: San Francisco



Photo by [Madhukar Kumar](#) on [Unsplash](#)

- Dock-based (Bay Wheels) and dockless (JUMPBike) bikeshare systems operating concurrently
- 7,000 bikes and 550 stations for Bay Wheels

Key Findings

- SFMTA requirement to place 20% of the stations in low income communities.
- “Bikeshare for All” program
- Jump Bikes scaled back in 2019 due to issues of safety, theft and vandalism

Case studies: Philadelphia



- 1,000+ bikes and 130+ stations
- Planned and managed by the City of Philadelphia
- Member of the Better Bike Share Partnership

Key Findings

- Installed 20 stations in underserved communities
- Education and outreach programming

Thank you!

SPECIAL THANKS TO

*Bike Share
Pittsburgh*

Dr. Xiaodong Qian



WAYNE STATE
UNIVERSITY

POGOH

Dr. Lee Branstetter

Cameron Drayton

Carnegie Mellon University
HeinzCollege

INFORMATION SYSTEMS • PUBLIC POLICY • MANAGEMENT

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Questions & Discussion

