TRANSPORTATION LEARNING NETWORK

A partnership with MDT•NDDOT•SDDOT•WYDOT and the Mountain-Plains Consortium Universities

Welcome!

Unravel the impact of COVID-19 on the Spatio-Temporal Mobility Patterns of Microtransit

Presented by:
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Our partners:

MOUNTAIN-PLAINS CONSORTIUM · MONTANA MDT DEPARTMENT OF TRANSPORTATION · NORTH DAKOTA Transportation · SD DEPARTMENT OF TRANSPORTATION · WYDOT · NDSU · UPPER GREAT PLAINS TRANSPORTATION INSTITUTE TRANSPORTATION LEARNING NETWORK

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PROJECT BRIEFING

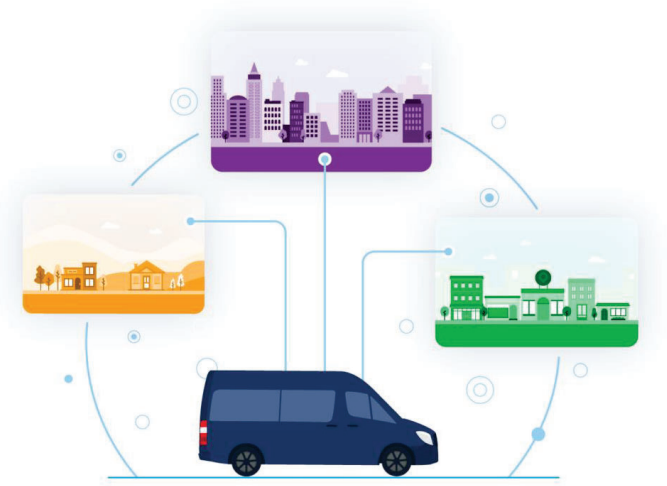
- **MPC-608: Impact of mobility as a service (MaaS) on transit access**
- **Jointly sponsored by Mountain-Plains Consortium and Utah Department of Transportation (UDOT)**
- **Represent the first of its kind to offer insights into how COVID-19 altered travel behavior**

Pre-COVID	Post-COVID
Inadequate Connectivity	Contagion risk
Decreasing Ridership	Financial Adversity
Increasing Operating Cost	Social Segregation

What is Microtransit?

- Demand-responsive service
- Serve customers to initiate any trip start and end within a designated area

Microtransit is simply tech-enabled **shared transportation** that lives in the space **between traditional fixed route transit and ride hailing technology**. Its routes are nimble; its "schedules" aren't really schedules at all, as they shift constantly based on rider demand; and its vehicles range in size from vans, shuttles, or buses.



What does Microtransit offer?

- Flexible route
- First-mile/Last-mile Connection
- Integration into public transit system

…

RESEARCH OBJECTIVES

1. Understood spatio-temporal patterns in microtransit activities
2. Uncover community structures of microtransit trips
3. Analyzed overall influence of COVID-19 on microtransit activities in Utah

Zhou, Y., Liu, X. C., & Grubesic, T. (2021). Unravel the impact of COVID-19 on the spatio-temporal mobility patterns of microtransit. *Journal of Transport Geography*, *97*, 103226.

RESEARCH AREA

Via on-demand pilot launched in November, 2019

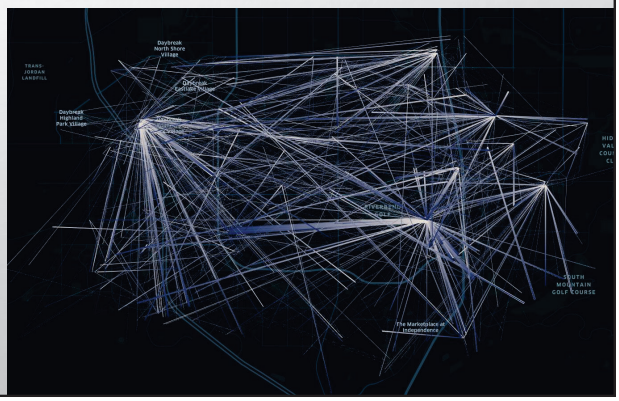
65 square miles, including seven TRAX and FrontRunner stations

DATA

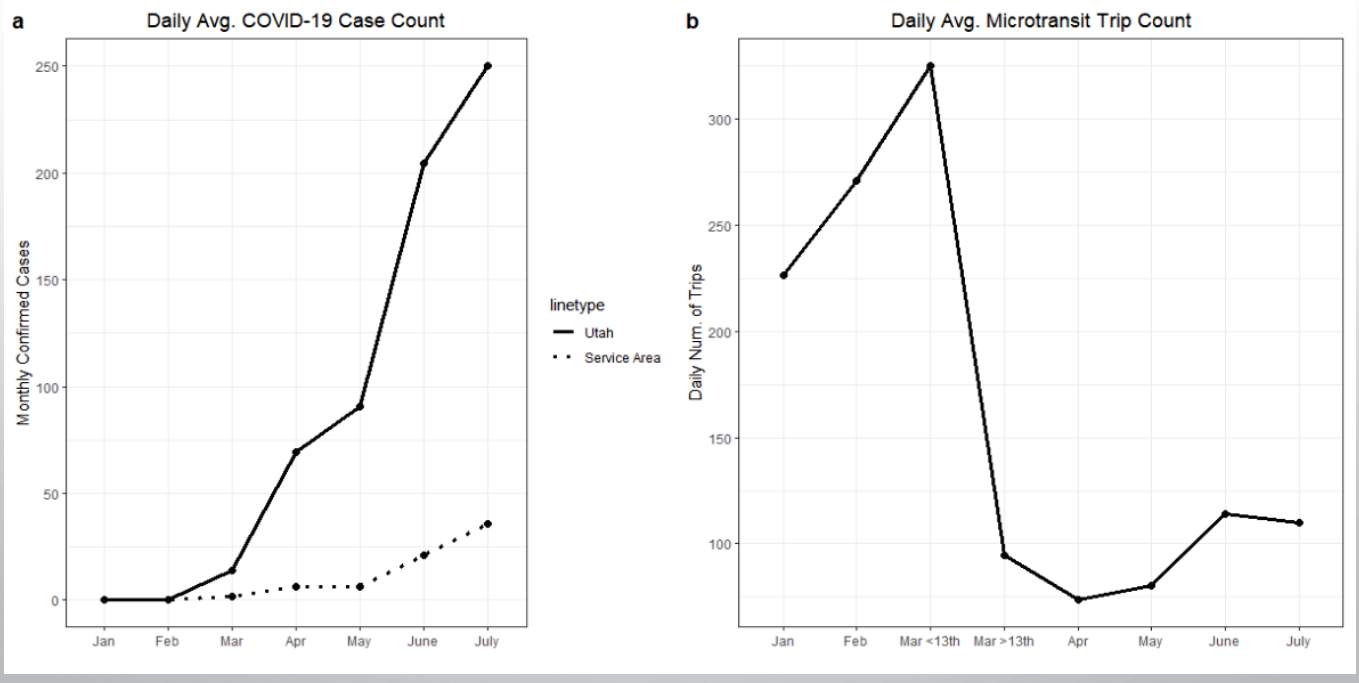
Features	Measurement	Units	Range
Rider ID	Nominal	NA	
Pick-up lat	Interval	Decimal degree	[40.464, 40.568]
Pick-up long	Interval	Decimal degree	[-112.071, -111.83]
Drop-off lat	Interval	Decimal degree	[40.463,40.568]
Drop-off long	Interval	Decimal degree	[-112.071, -111.83]
Pick-up time	Interval	NA	[01/01/2020 08:24:00, 07/31/2020 21:00:00]
Drop-off time	Interval	NA	[01/01/2020 08:48:00, 07/31/2020 21:06:00]
Trip duration	Ratio	Minute	[0, 437.817]
Trip distance	Ratio	Mile	[0.077, 11.104]
Num. of passengers	Ratio	NA	[1, 5]
Ride cost	Ratio	Cent	[0, 1250]
Payment type	Nominal	NA	UTA ticket, Apple Pay, Credit card, Free, Google pay, Ride credit, Waived
Request source	Nominal	NA	App, Call center
Customer rating	Ordinal	NA	1, 2, 3, 4, 5
Wheelchair Accessibility	Nominal	NA	0: wheelchair-accessible 1: non-wheelchair-accessible

DATA STATISTICS

- The study period spans January 1st, 2020 to July 31st, 2020
- 31,199 microtransit trips
- 1,569 unique users
- 2,472 unique pick-up points / 2,317 unique drop-off points



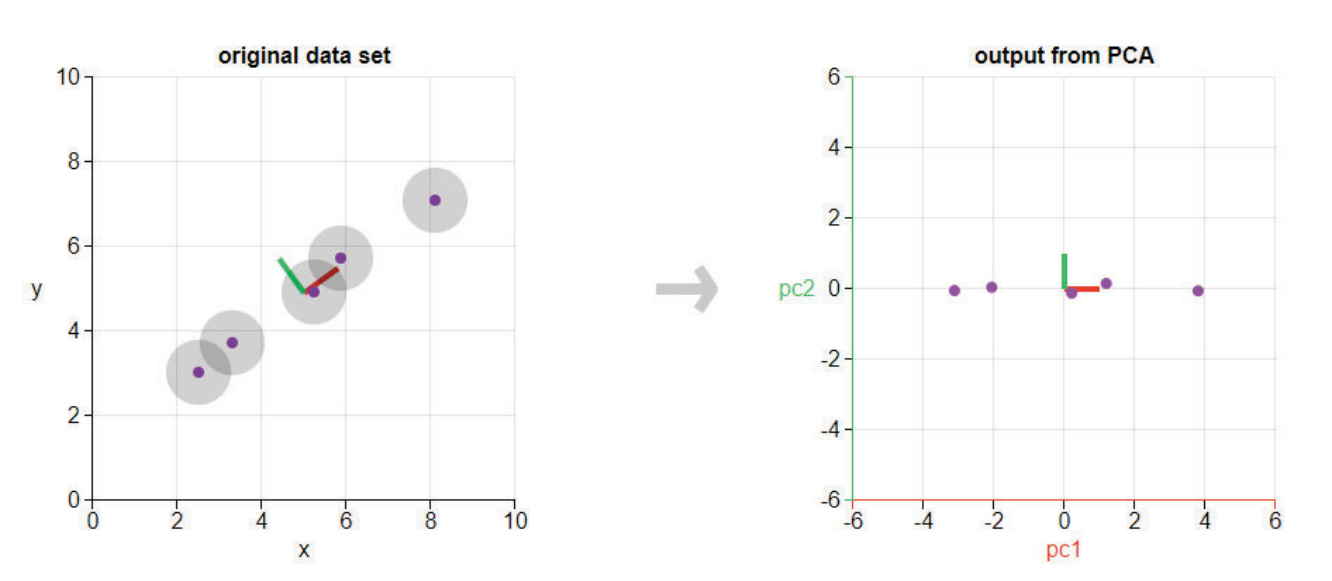
COVID-19 IN UTAH



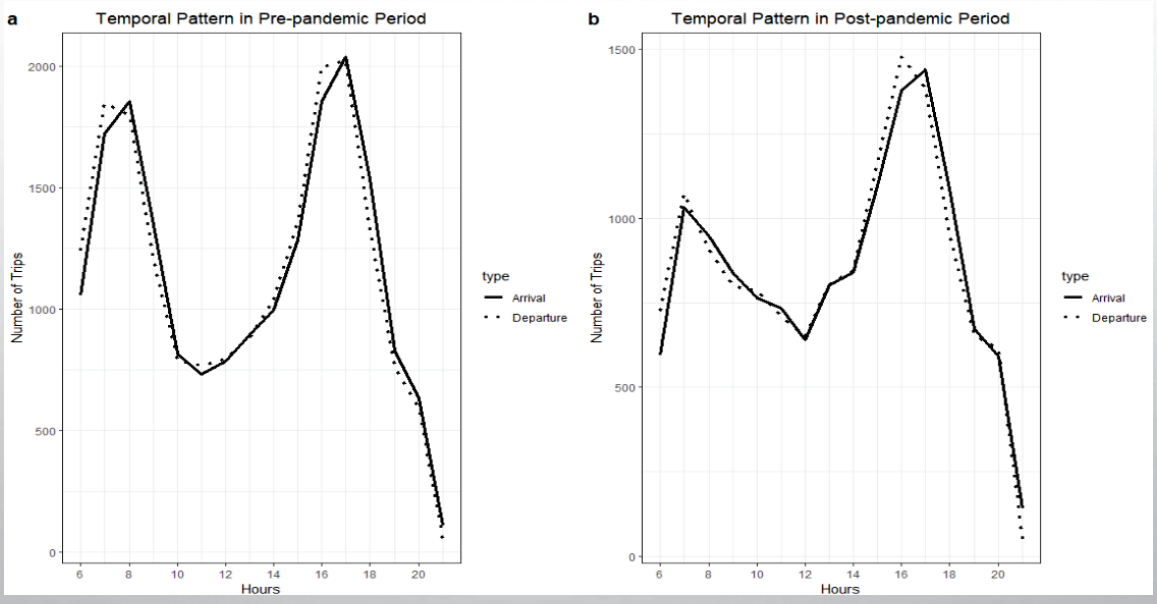
PRELIMINARY PROCESSING

Part 1: A dive into spatio-temporal patterns

EIGENDECOMPOSITION



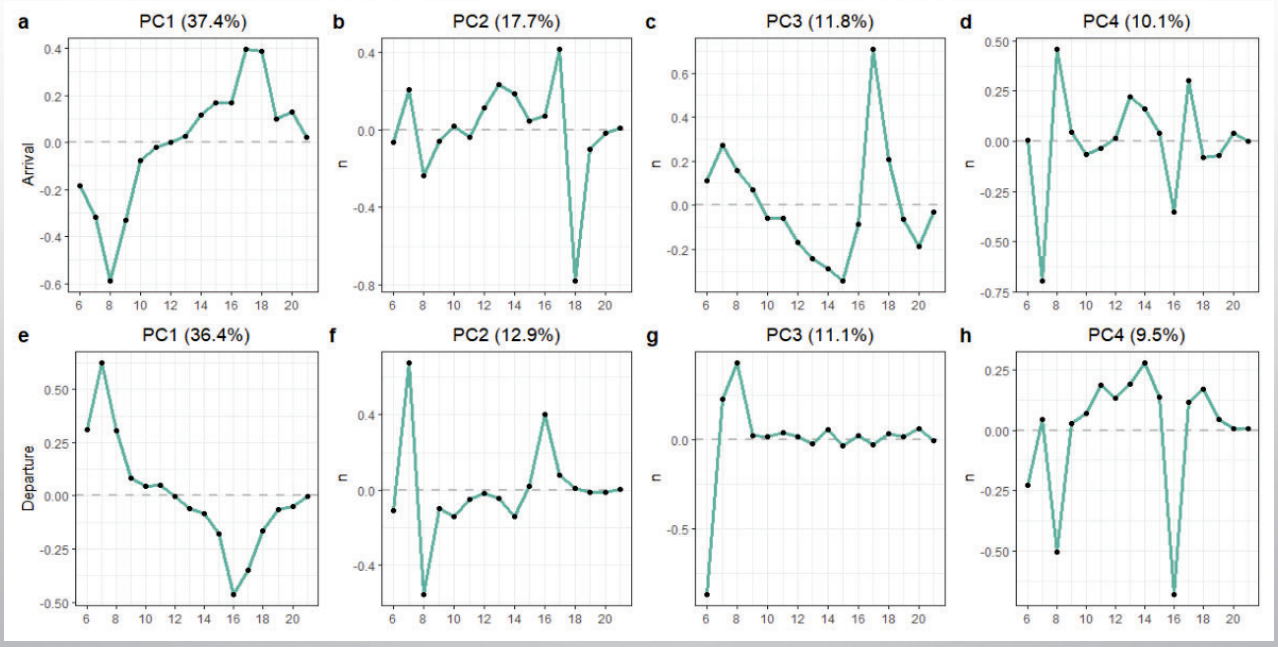
MICROTRANSIT TRIPS



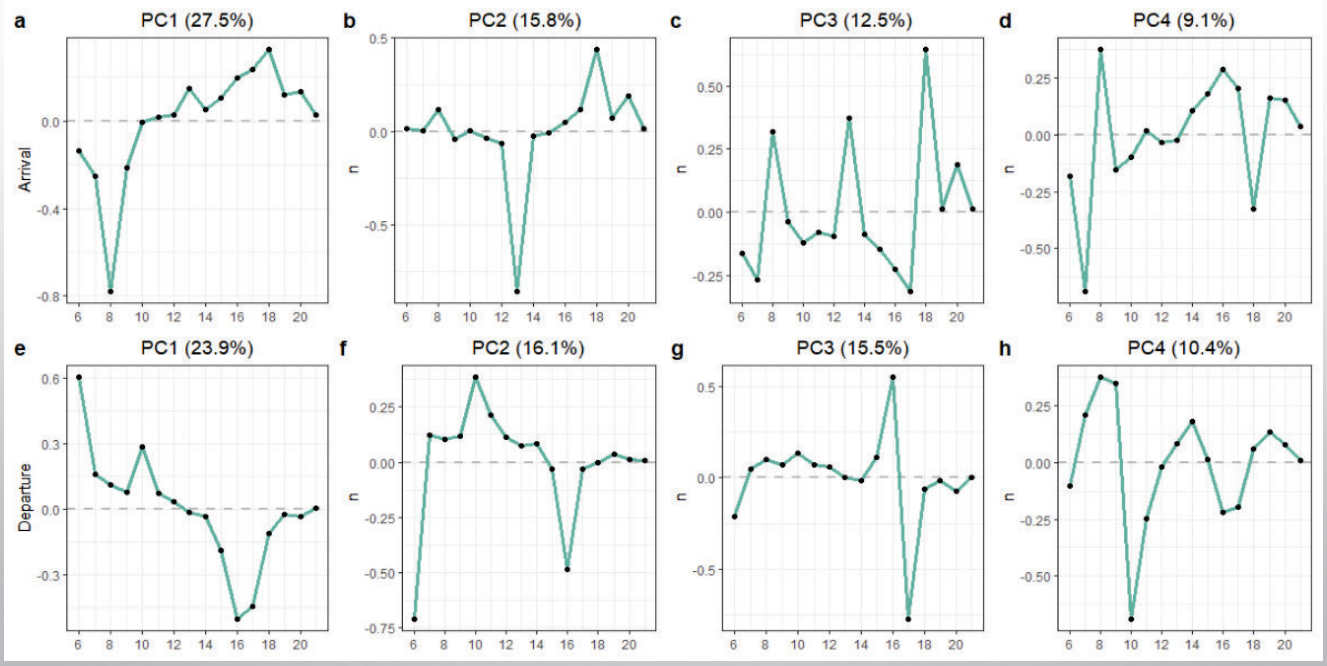
PCA RESULTS

	Total Var	PC1	PC2	PC3	PC4
Pre/Dep.	0.088	37.4%	17.7%	11.8%	10.1%
Pre/Arr.	0.073	36.4%	12.9%	11.1%	9.5%
Post/Dep.	0.098	23.9%	16.1%	15.5%	10.4%
Post/Arr.	0.096	27.5%	15.8%	12.5%	9.1%

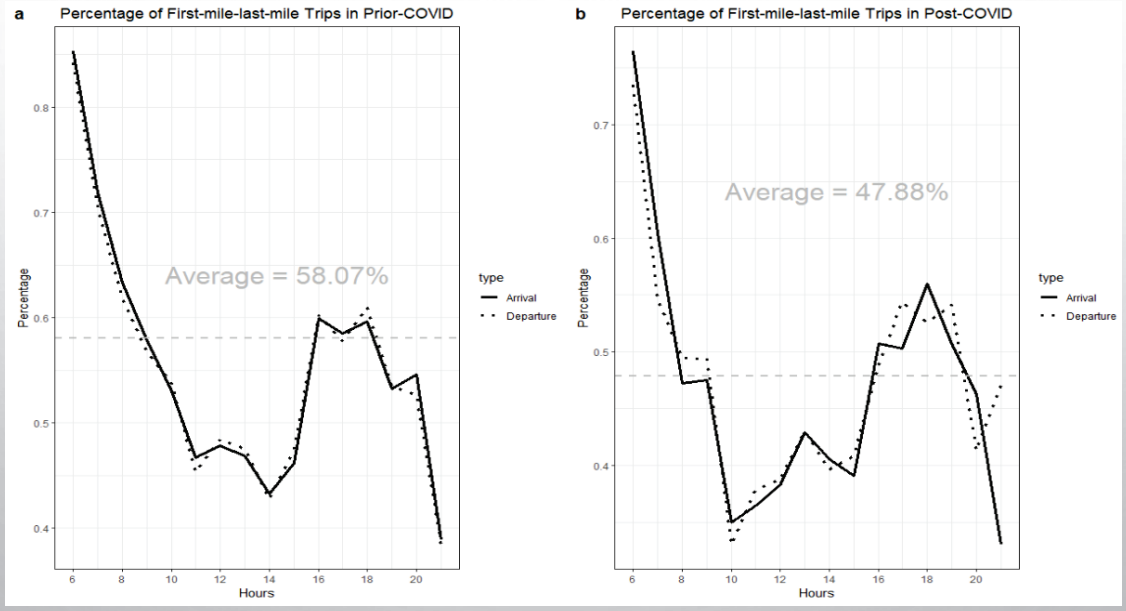
PRE-COVID



POST-COVID



FIRST-MILE/ LAST-MILE TRIPS

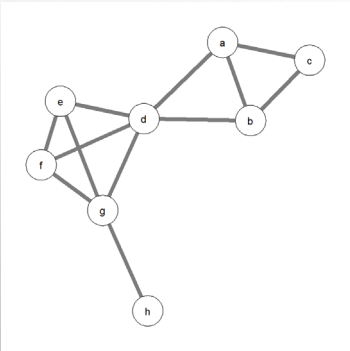


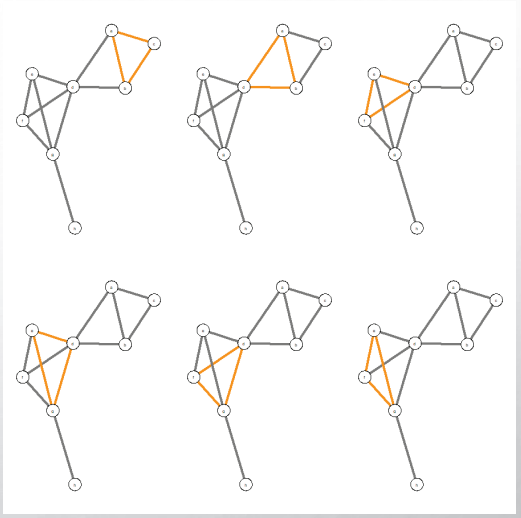
TAKE-AWAY

- There are reductions in microtransit activity along with first mile/last mile trips.
- Transit-dependent users remain inelastic despite the threats brought by COVID-19.
- First mile/last mile trips can be the major source of variation in both periods
- There is a dispersive trend for pick-up and drop-off locations and the emergence of new travel patterns

Part 2: Detect Communities Structures

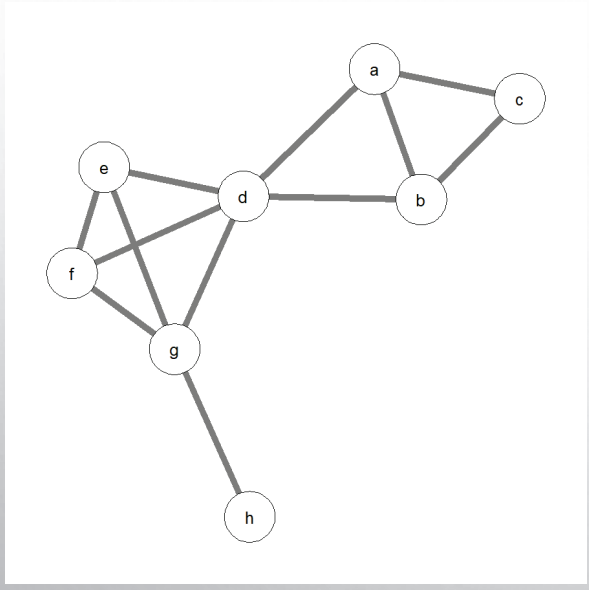
K-CLIQUE PERCOLATION – 3-CLIQUE

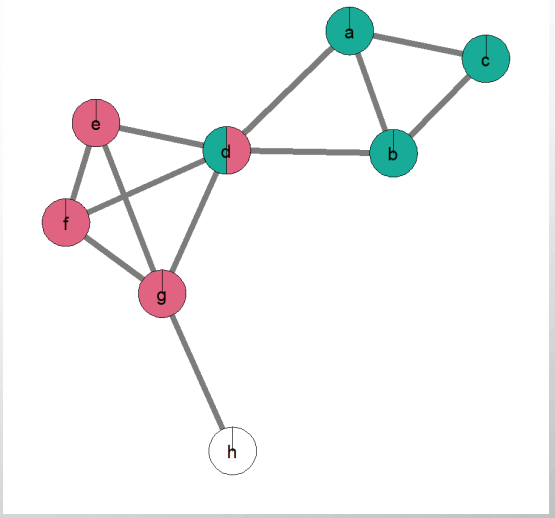




k-cliques, are fully connected networks with k nodes. (k is greater than 2)

K-CLIQUE PERCOLATION – UNWEIGHTED

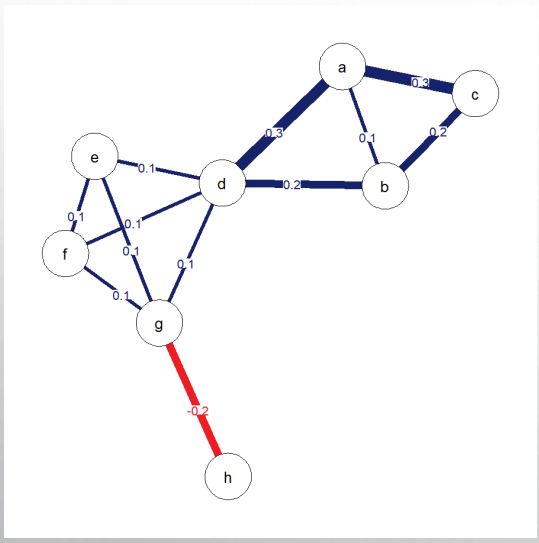


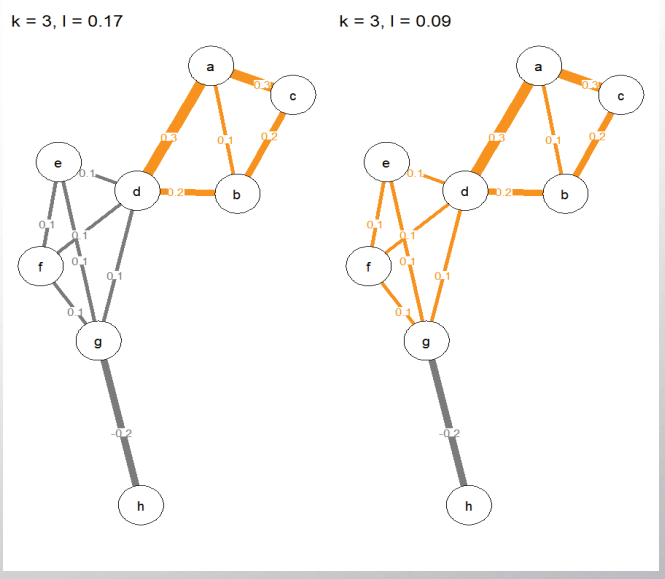


A k-clique community is the union of all possible adjacent k-cliques

2 communities detected!

K-CLIQUE PERCOLATION – WEIGHTED





$$I = \left(\sum_{1 \le m \le n \le k} W_{m,n} \right)^{\frac{2}{k(k-1)}}$$

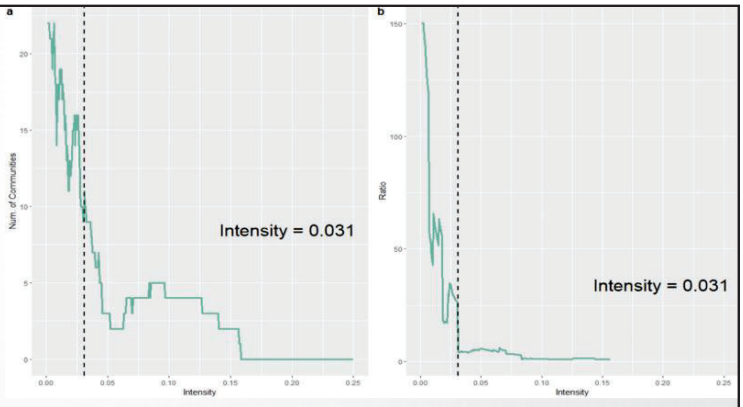
CLUSTERING COEFFICIENT

A ***clustering coefficient*** is a measure of the degree to which nodes in a graph tend to cluster together.

1. Large ***clustering coefficient*** of node *i* means that the nodes around *i* are tightly connected
2. low ***clustering coefficient*** of node *i* means that the nodes around *i* are barely connected
3. We can use ***clustering coefficient*** to estimate the level of network overlap

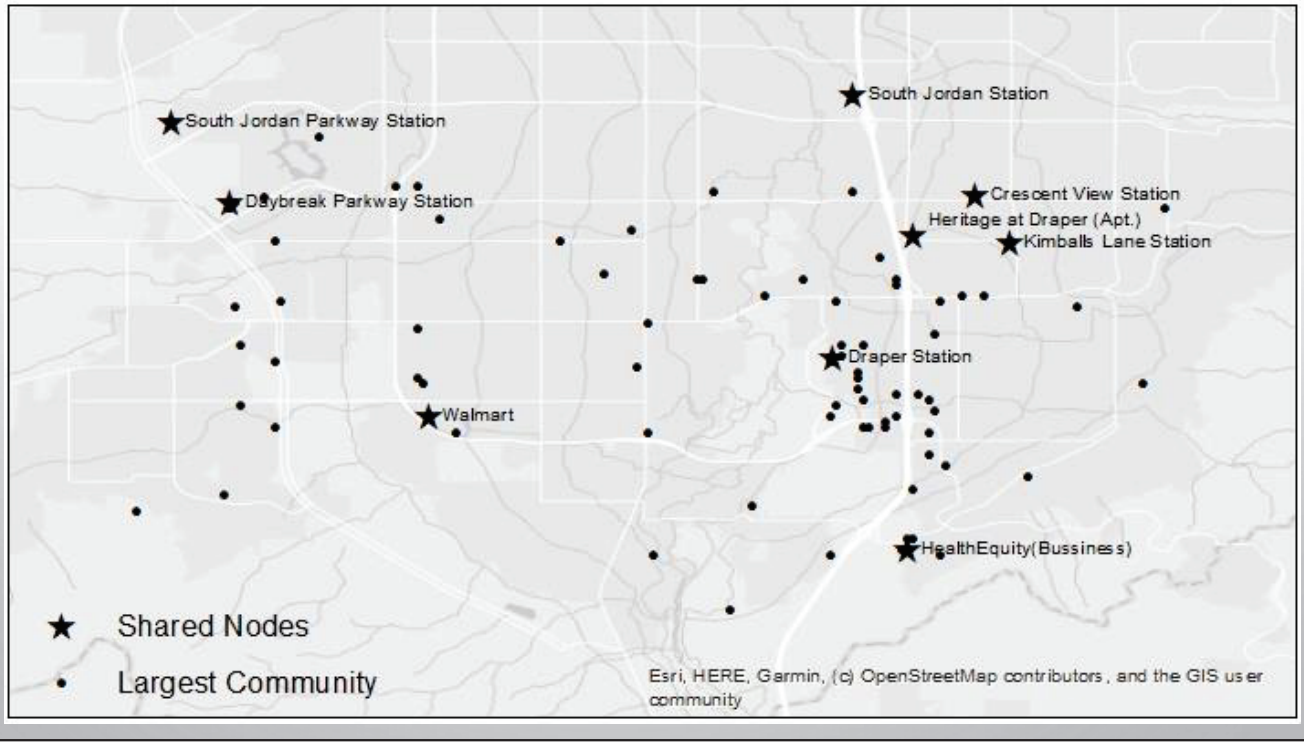
$$C_i = \frac{1}{s_i(n_i - 1)} \sum_{j,k} \frac{(w_{ij} + w_{ik})}{2} a_{ij} a_{jk} a_{ik} \; j, k \in N$$

NETWORK

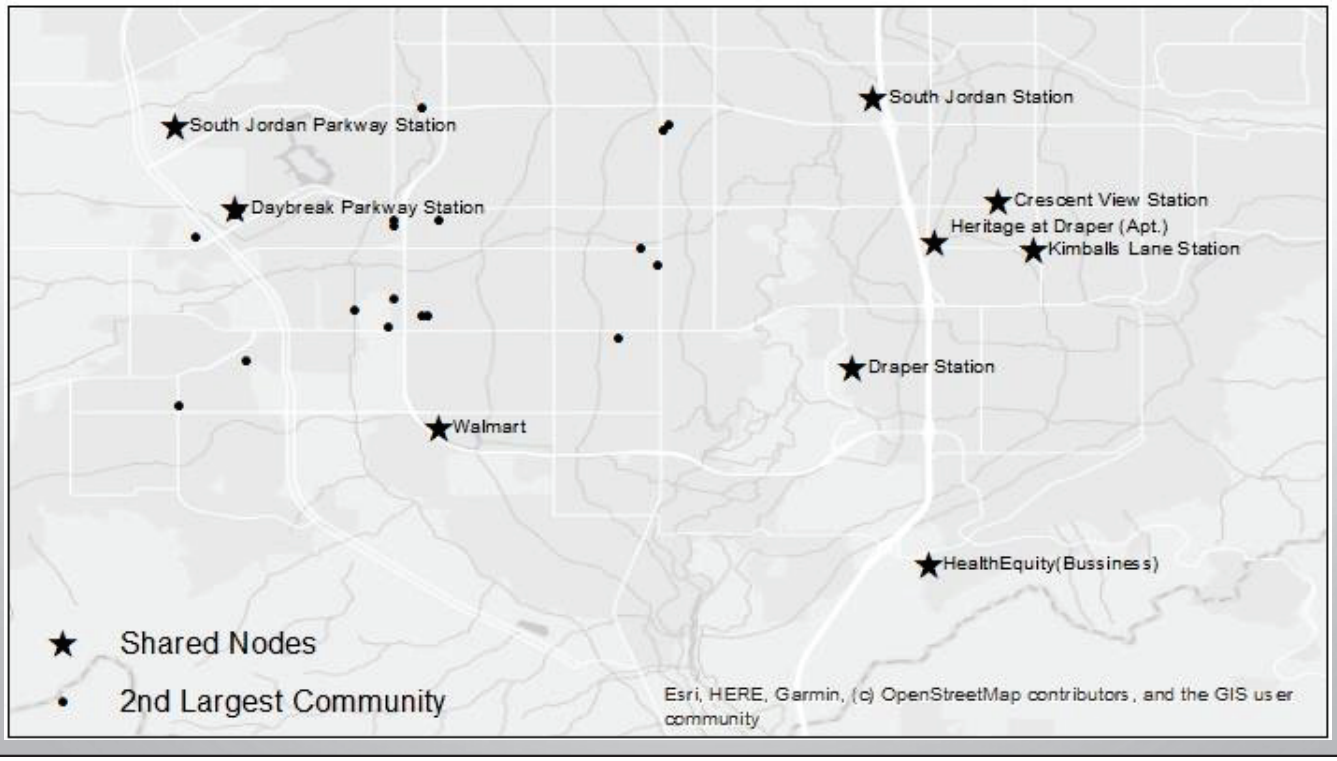


- Nodes: pick-up and drop-off locations
- Edges: Trips
- Weights: $\frac{trip\ count\ on\ link}{maximal\ trip\ count\ across\ all\ links}$
- $k = 3$

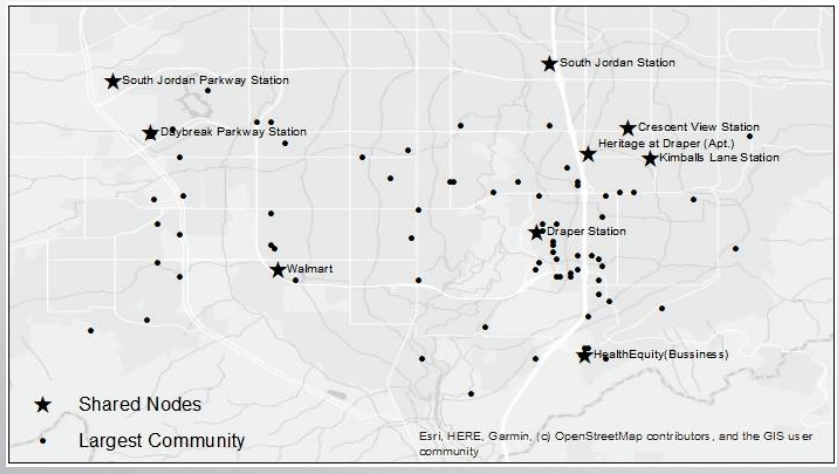
PRE-COVID



PRE-COVID

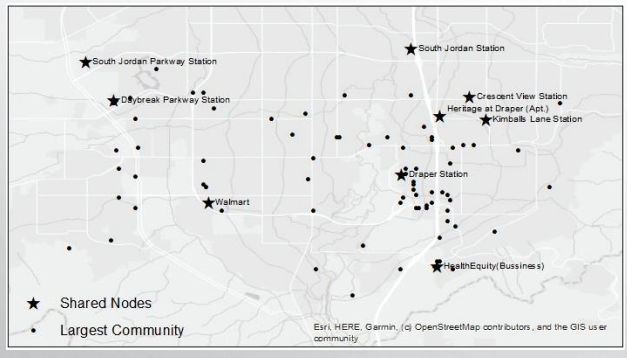


SHARED NODES – PRE-COVID



Shared Nodes
South Jordan Parkway Station
Daybreak Parkway Station
South Jordan Station
Crescent View Station
Draper Station
Kimballs Lane Station
Walmart
HealthEquity (business)
Heritage at Draper (Apt.)

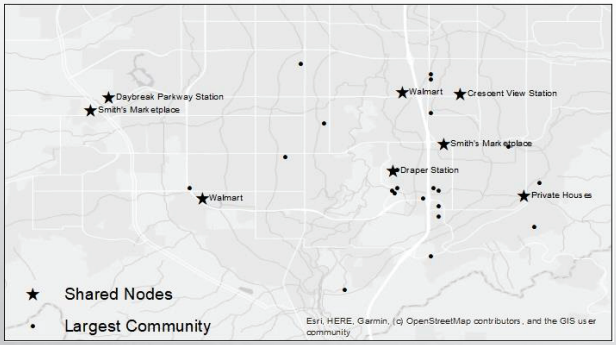
SHARED NODES – PRE-COVID



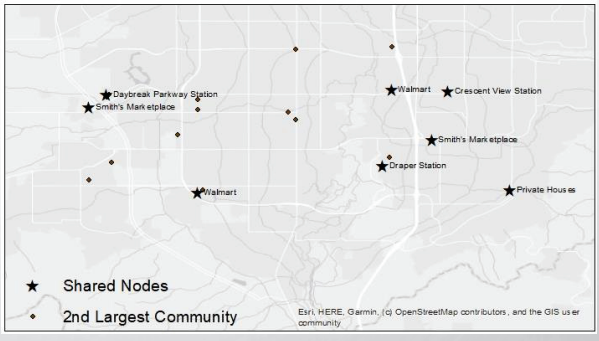
The hub-and-spoke distribution

Shared Nodes	Clustering Coefficient
South Jordan Parkway Station	0.021
Daybreak Parkway Station	0.036
South Jordan Station	0.023
Crescent View Station	0.041
Draper Station	0.017
Kimballs Lane Station	0.049
Walmart	0.16
HealthEquity (business)	0.21
Heritage at Draper (Apt.)	0.32

POST-COVID



(a)



(b)

CONCLUSIONS

- Overall, first mile/last mile trips can be the major source of variation in both periods.
- First mile/last mile trips declined, but the hourly distribution remained nearly identical, suggesting transit dependency for many riders.
- The communities surrounding transit stations take the form of hub-and-spoke systems, with transit stations serving as traffic distribution centers while the surrounding nodes are disconnected. For other popular locales, connections are more dispersed, demonstrating a point-to-point distribution style.

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Thank you for participating!

Please take a moment to complete the evaluation included in the reminder email.

We appreciate your feedback.

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