Micromobility for Smart Cities: Planning, Design, and Operations

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Interstate Transit Research Symposium

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Our Team

Our lab members:

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Our collaborators:

- Lily Elefteriadou, Transportation Engineering, University of Florida
- Ruth Steiner, Urban and Regional Planning, University of Florida
- Virginia Sisiopiku, Transportation Engineering, University of Alabama at Birmingham
- Louis Merlin, Urban and Regional Planning, Florida Atlantic University
- Andrea Broaddus, Ford Motor Company

The Rise of Micromobility

Source: Dr. Xilei Zhao

Micromobility-Related Issues

- Curbside management
- Rebalancing and charging
- Competing with transit
- Safety
- Equity
- …

Source: CNN (2019)

Study Topics

- Estimate/infer e-scooter trips
- Analyze spatio-temporal patterns of e-scooter usage
- Micromobility & public transit

Washington DC as the case study area
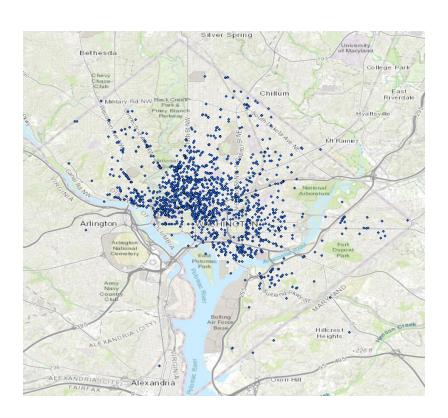
General Bikeshare Feed Specification (GBFS) Data

<u>Real-time</u> data feeds:

- Data accessed through public APIs
- API updates every 1 min or 5 min
- Shows locations of available vehicles

```
{"data":{"bikes":[{"bike_id":"12e1b4a2-f5be-4735-8de8-
52aae10f4a1e","lat":38.941481,"lon":-77.038561,"battery_level":54,"vehicl
e_type":"scooter","is_reserved":false,"is_disabled":false},
{"bike_id":"3bb1d21e-e7e9-4e80-af88-
1a481a7f50cd","lat":38.89741,"lon":-77.048607,"battery_level":97,"vehicle
_type":"scooter","is_reserved":false,"is_disabled":false},
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e_type":"scooter","is_reserved":false,"is_disabled":false},
{"bike_id":"a041a7a4-1339-410a-8f9b-
7d47ac9251e6","lat":38.9323489,"lon":-77.0402448,"battery_level":32,"vehi
cle_type":"scooter","is_reserved":false,"is_disabled":false},
```

An example of raw GBFS data

Understand the GBFS Data

Available e-scooters at 7:00 am on June 20, 2019

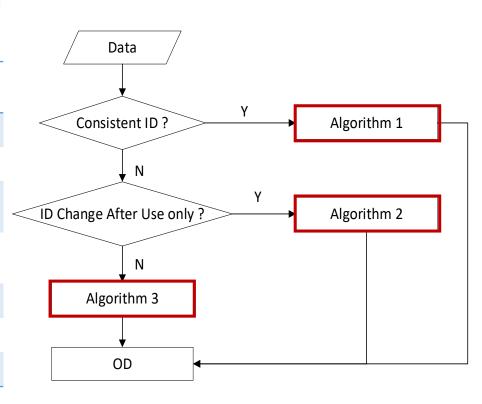GPS trajectory of an e-scooter (w/ static ID) on June 20, 2019

Supply

Infer e-scooter trips (demand)

Algorithms to Infer Trips from GBFS Data

E-scooter vendors operating in Washington DC in Feb 2020

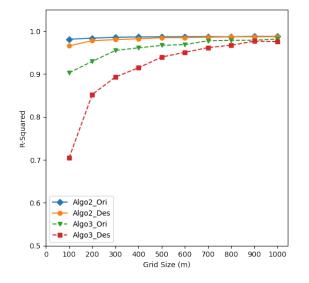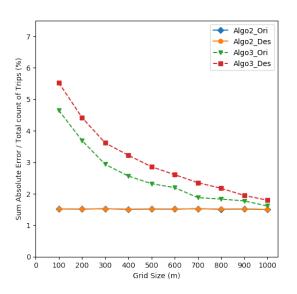| Vendor	Dynamic ID?	Dynamic ID Type	OD Info Available
Bird	Y	After use	Separate O and D
Jump	N	-	OD pair
Lime	Y	Every minute	Inferred separate O and D
Lyft	Y	Every minute	Inferred separate O and D
Razor	N	-	OD pair
Skip	N	-	OD pair
Spin	N	-	OD pair

Vehicle ID is the key

Xu, Y., Yan, X., Sisiopiku, V. P., Merlin, L. A., Xing, F., & Zhao, X. (2020). Micromobility trip origin and destination inference using General Bikeshare Feed Specification (GBFS) data. *Proceedings of Transportation Research Board 100th Annual Meeting*. (accepted)
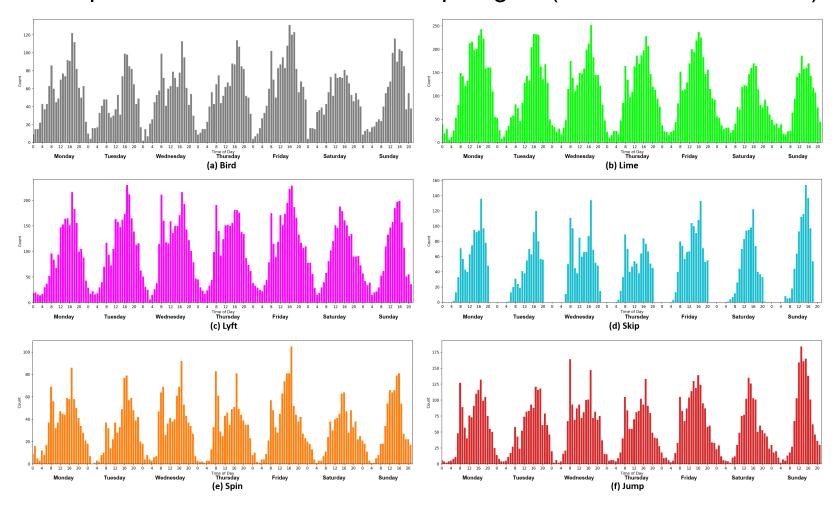
Algorithm Summary and Validation

Algorithm	Scenario	Output	Causes of errors
Algorithm 1	Static Vehicle ID	OD pairs	GPS error, data update frequency
Algorithm 2	Resetting Vehicle ID	Unlinked Os & Ds	GPS error, data update frequency, launch and elimination of vehicles
Algorithm 3	Dynamic Vehicle ID	Unlinked Os & Ds	GPS error, data update frequency, launch and elimination of vehicles, movement of e-scooters not in use

Temporal Distribution

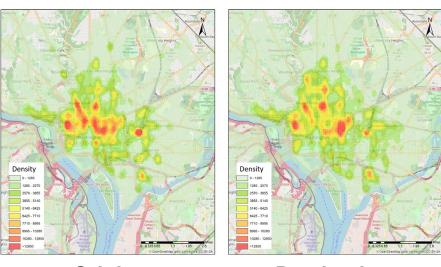Temporal distribution of inferred trip origins (2/24/2020 – 3/1/2020)

(a) Bird

(b) Lime

(c) Lyft

(d) Skip

(e) Spin

(f) Jump

Spatio-Temporal Distribution
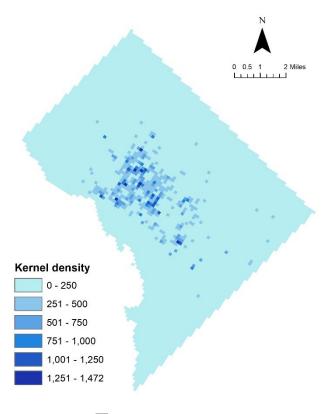
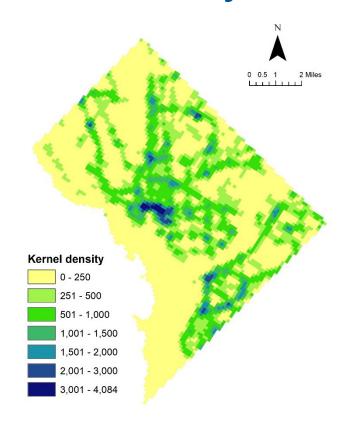**Morning peak**

Afternoon peak

Origin

Destination

Origin

Destination

Supply of Transit & Micromobility services

E-scooter
(7:00 am, Jun 2019)

Public Transit
(7:00 am, Jun 2019)
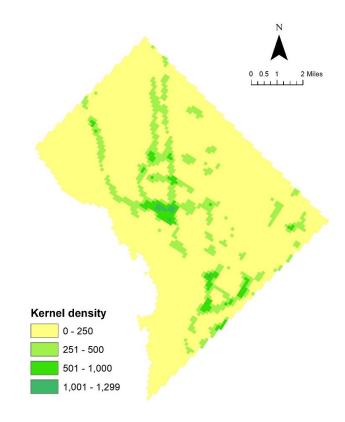
Supply of Transit & Micromobility services

E-scooter
(7:00 am, Jun 2020)

Public Transit
(7:00 am, Jun 2020)

Classifying Micromobility Trip Types

Trip type 1   Trip type 2   Trip type 3   Trip type 4

Greater competition   **Greater complement**

Legend

• Transit stop

Transit service coverage area

—— Direct transit line

① ② E-scooter trip ends

Classifying Micromobility Trip Types

Trip type 1   Trip type 2   Trip type 3   Trip type 4

Greater competition   **Greater complement**

June, 2019	76.4%	19.5%	3.7%	0.4%
June, 2020	75.4%	23.4%	1.2%	0.0%

These results are suggestive and <u>biased toward indicating greater competition</u> between e-scooters and transit.

First/Last-Mile Feeder to Transit?

First-mile feeder to transit

Integrated micromobility and metro trips

About 8%-15% e-scooter trips were last-mile feeder trips.

Ongoing STRIDE UTC project:
Five-city survey on micromobility and transit

- Miami, FL;
- Gainesville, FL;
- Washington DC;
- Birmingham, AL;
- Auburn, AL

Recap: micromobility research @UFTI

Scooter GPS trajectory data to study travel safety

Micromobility trip inference from raw GBFS data

Multi-city survey to understand scooter adoption and preference

Spatio-temporal analysis of scooter usage patterns

The micromobility and transit relationship

AI-based real-time prediction of scooter demand

Parking management; bike infrastructure planning

Multi-modal integration, MaaS, Mobility-on-Demand

Scooter fleet management (rebalancing, charging)

TECH TRANSFER

A platform for scooter monitoring and management

A crowdsourcing App to allow residents to report scooter incidents

WORK PIPELINES

Knowledge on micromobility planning, design, operations, and management

Big data analytics, GeoAI, machine learning, optimization, simulation

Transportation planning, policy analysis, social equity emphasis

Tool development (algorithms, software, visualization, Apps)

TEAM EXPERTISE

Questions?

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