Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

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Department of Civil & Coastal Engineering

Supply Market Analysis for Integration of Ridesharing and Public Bus

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Introduction

Public transit (Bus) vs. Ridesharing services

- **Complement: raise transit ridership?**
  - Users of ridesharing modes use transit more frequently in **large, population dense cities**, e.g. New York, Chicago (Feigon and Murphy, 2016; Pew Research Center, 2016; Zhang et al. 2018).
- **Compete: reduce transit ridership?**
  - Uber **competes** transit in small city; **complements** transit in large city. (Hall et al. 2018)
  - Ridesharing makes 6% reduction in bus services **(competes)**; 3% reduction in light rail services **(competes)**; 3% increase in commuter rail services. **(complements).** Survey from 4074 individuals in **7 major cities** (Boston, Chicago…) and **suburban areas**. (Clewlow and Mishra 2017)

Introduction

- **<u>Key factors affecting public transit & ridesharing mobility services</u>**
  - Relationship **unclear.**
  - **Factors:** city size, population, trip type, time…
- **<u>Objective</u>**
  - **Discover where and when** competes and complements.
  - Provide **integrative service guidance.**
  - Help transit **increase ridership**.
- **<u>Expected data analysis results</u>**
  - Provide **demand responsive** transit services.
  - Discover **first/last mile service demand**.
  - Give **suggestions** for new transit stations and routes.

Whim APP

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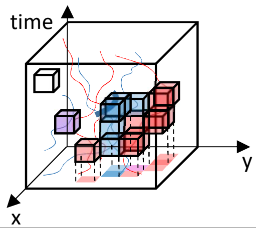
Research Approach Overview

Trip Data →



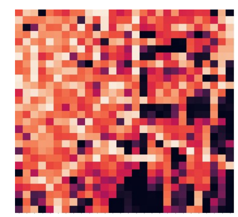
Spatiotemporal Statistical Analysis

Machine learning approach →

Analysis Results

- **Where and When competes /complements.**
- **First/last connection region.**
- **Suggestion for new transit stations and routes.**
- **…**

Demand prediction



Data Collection

■ Ridesharing mobility data

- DiDi data in Chengdu, China.
- **Vehicle trajectory data** (coordinates, 2-4s).
- **Pick-up, drop-off time\location.**

■ Transit data

- Transit **stops** and routes **coordinates**.
- Transit **arriving time** at each stop.

DiDi

Ridesharing APP in China

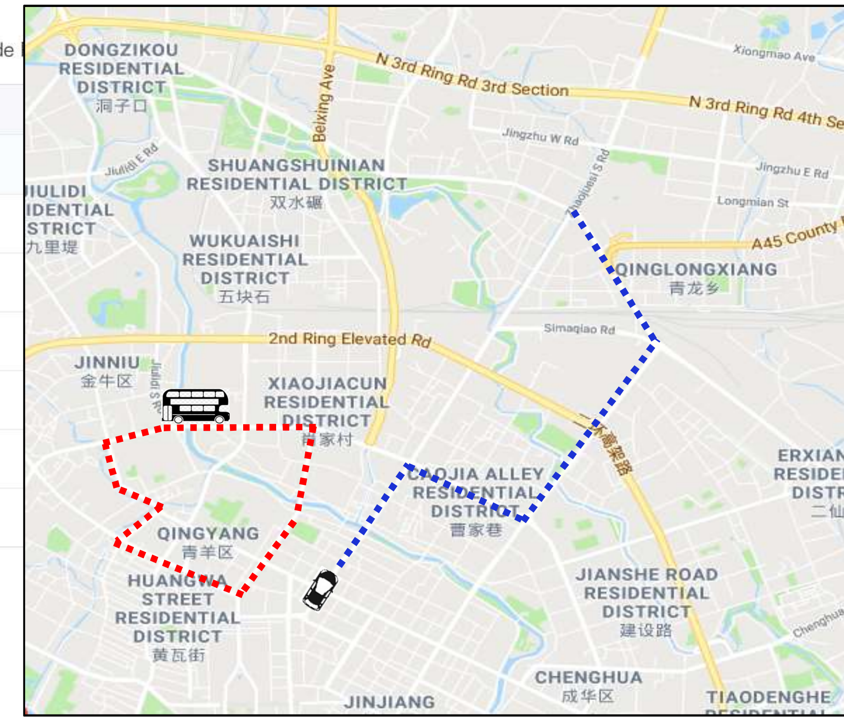
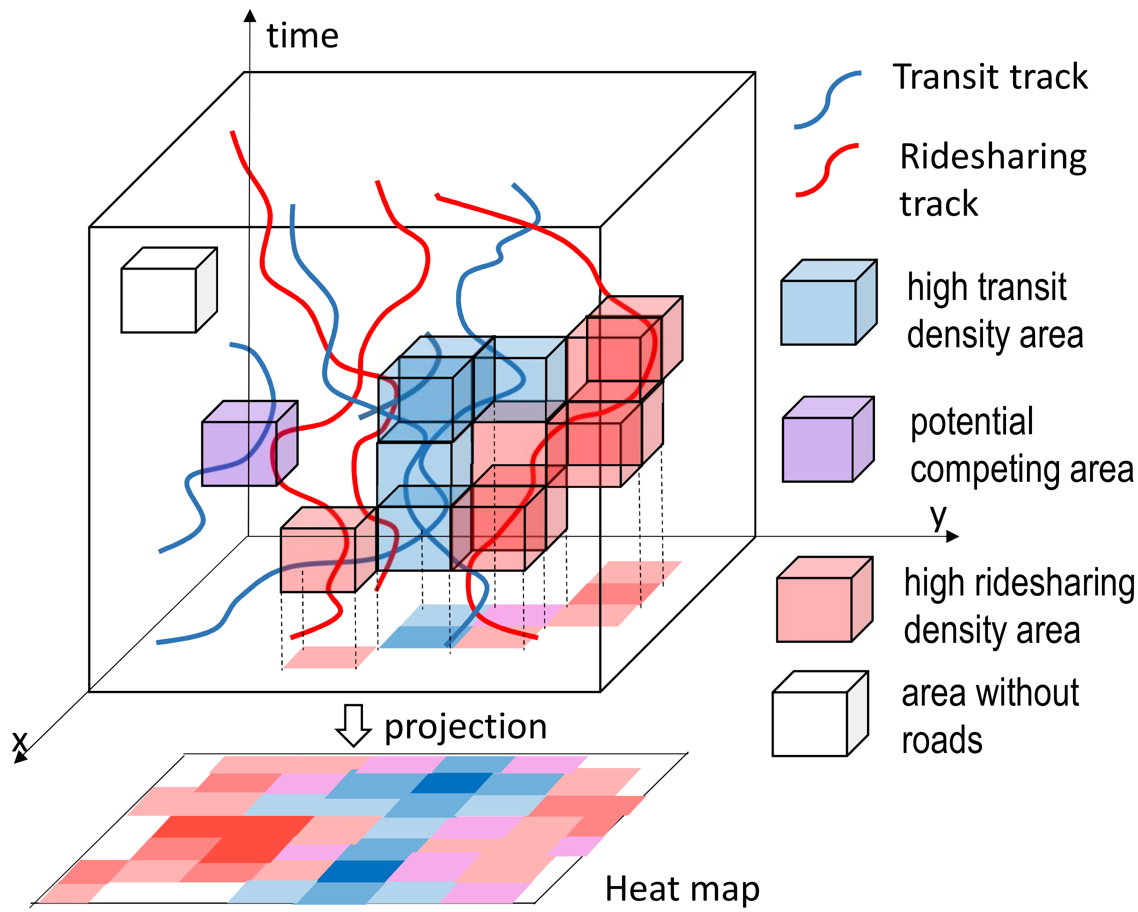


Figure 1. Map of Second Ring Road of Chengdu City

Methodology

- **<u>Spatiotemporal statistical analysis</u>**
  - Data in **3D space** (time and location)
  - Cut the space → small cells.
  - Calculate **ridesharing (R_r) and transit usage (R_t) ratios** within cells.
  - **Competitive area**: $R_t \approx R_r$.
  - **Complementary area**: $R_r >> R_t$ or $R_t >> R_r$
  - **<u>Output</u>:** Project into x-y → heat map.



- **Convolution LSTM Spatiotemporal Learning**
  - Convolutional neural network (CNN) is used to extract spatial features.
  - Long short-term memory (LSTM) memorize captured information, extract temporal features.
  - Predict spatiotemporal pattern → ConvLSTM

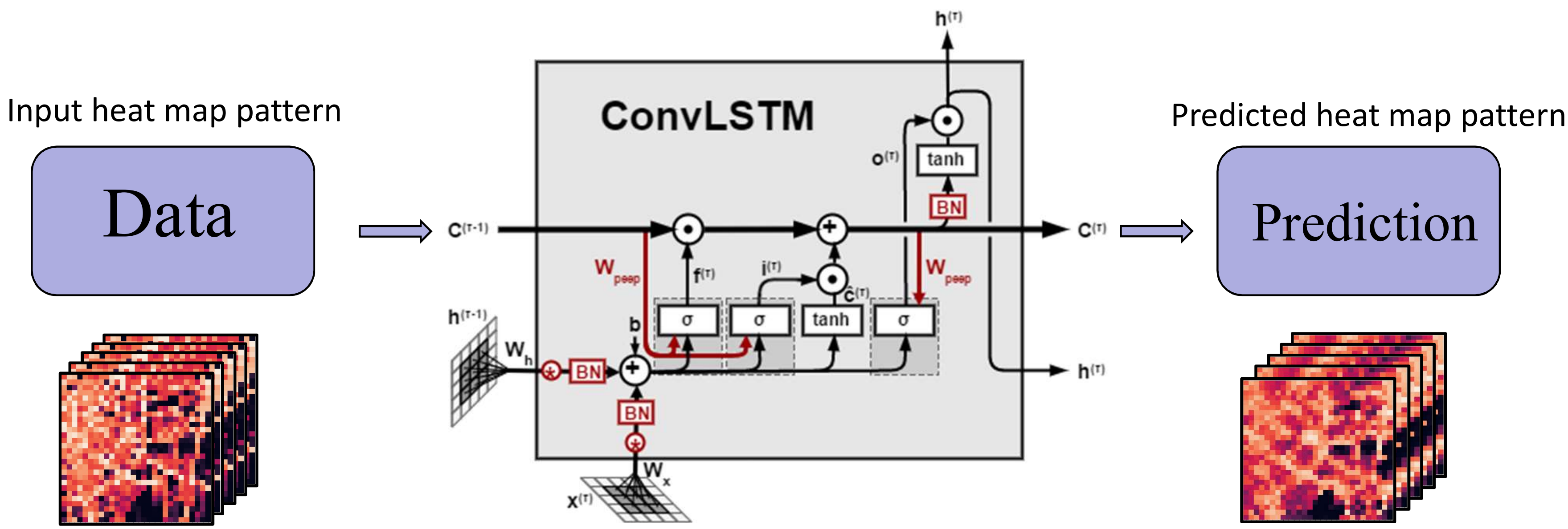


Figure 2. mechanisms of ConvLSTM

Results

Consistent Ridesharing (CR) Zones

Main Idea

- CR zones that are always dominated by ridesharing services as CR zones.
- CR zone ← passed by ridesharing trips (routes) during most of the time no matter where OD are located.
- Connecting CR zones: **potential transit route for regular bus service**.
- Individual CR zones→ **potential transit hubs for micro-bus**.

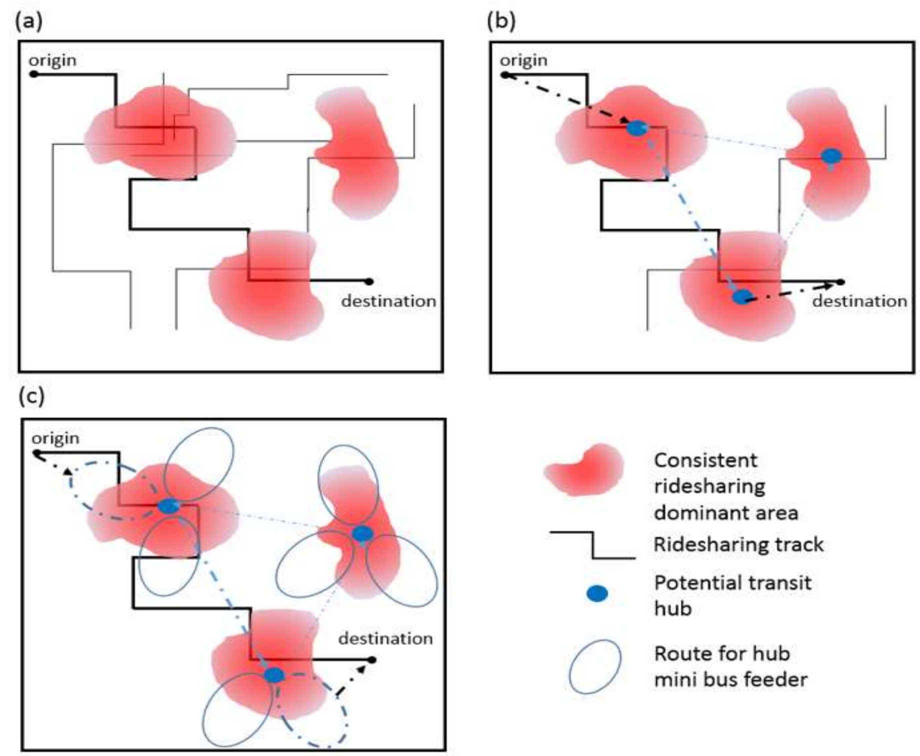


Figure 3. (a) Projected pattern of consistent ridesharing area during T (eg. 8am-9am); (b) Potential transit hub and route integrating ridesharing and transit; (c) Schematic representation of feeder minibus system for potential bus hub.

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Results

Ridesharing Zones Evolvement over A Day

A case study

- White area → Ridesharing dominant.
- Some areas are consistent white →CR zone →consistent demand.
- Some areas vary colors throughout a day.
- **Planning suggestion**
  → Potential new route
  → Potential micro-bus hubs

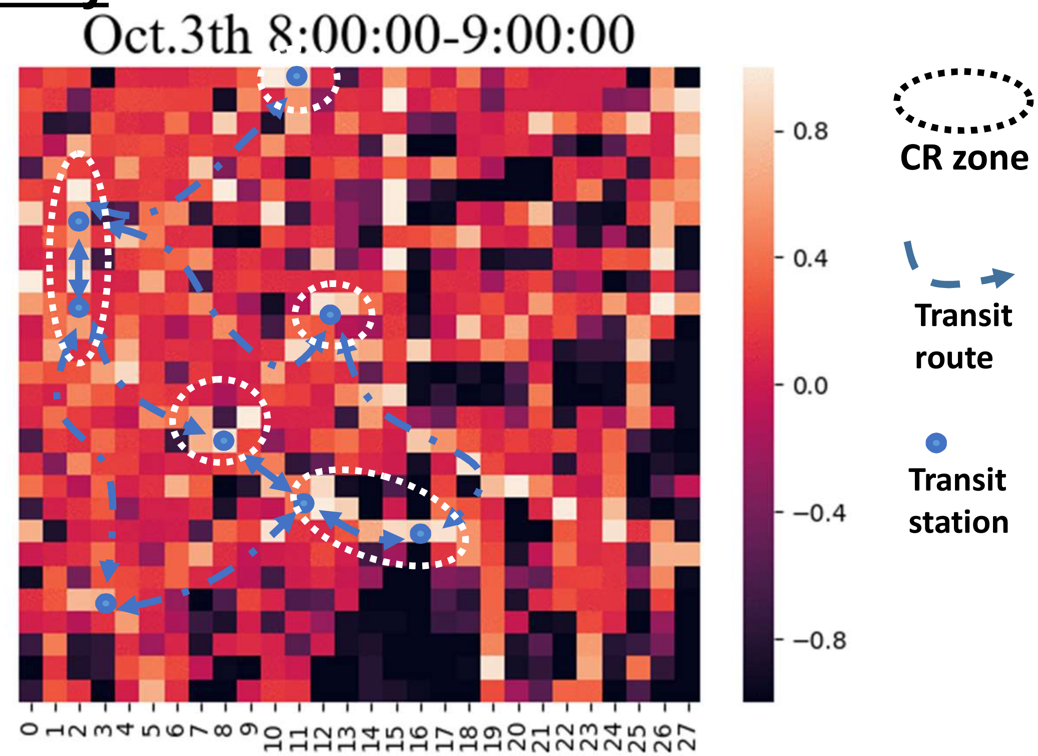


Figure 4. Pattern of ridesharing services frequency ratio distribution.

Suggestion for new route and station. Study horizon T, Oct 3st, 2016, Monday, 8AM to 9PM.

Results

Potential Transit First/Last Mile (FLM) Zones

- A zone: ridesharing dominant.
- B zone: transit dominant
- A is first/last mile (FLM) zone if:
  - A connects to B zone.
  - There are first/last mile orders in A, e.g. $A_1 \to A_2, A_1 \to A_1$
- Validation with bus station distribution and land use check.

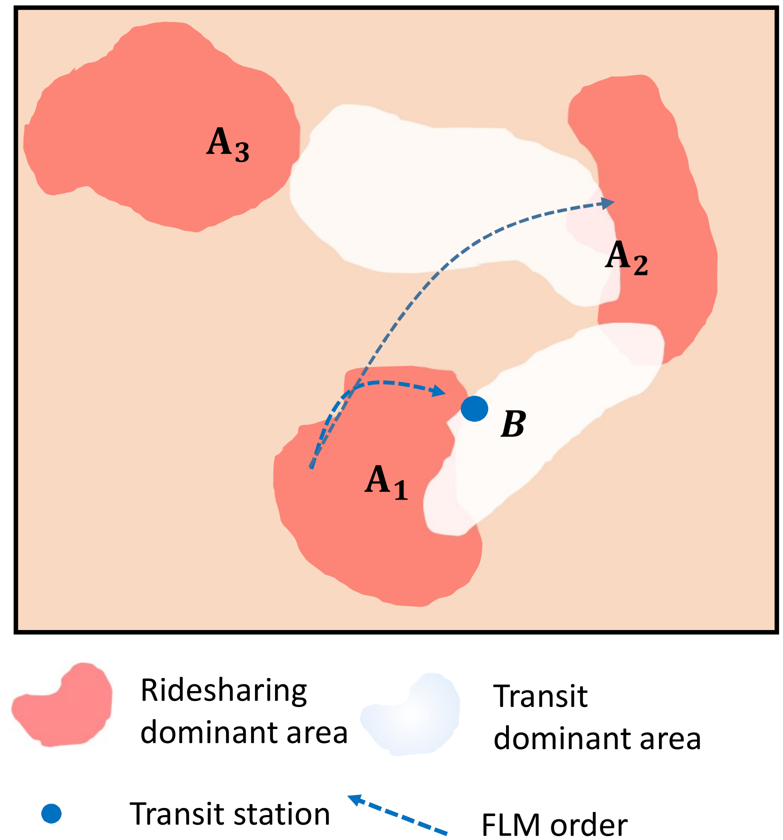


Figure 5. Schematic representation of first/last mile area pattern.

Results

- **Potential Transit First/Last Mile (FLM) Zones Validation**

A case study

- FLM zones and FLM demand distribution
- Validated with transit services distribution
  - Identified FLM zones have **lower transit services** density than surrounding areas.
  - Difficult to utilize transit services in FLM zones.

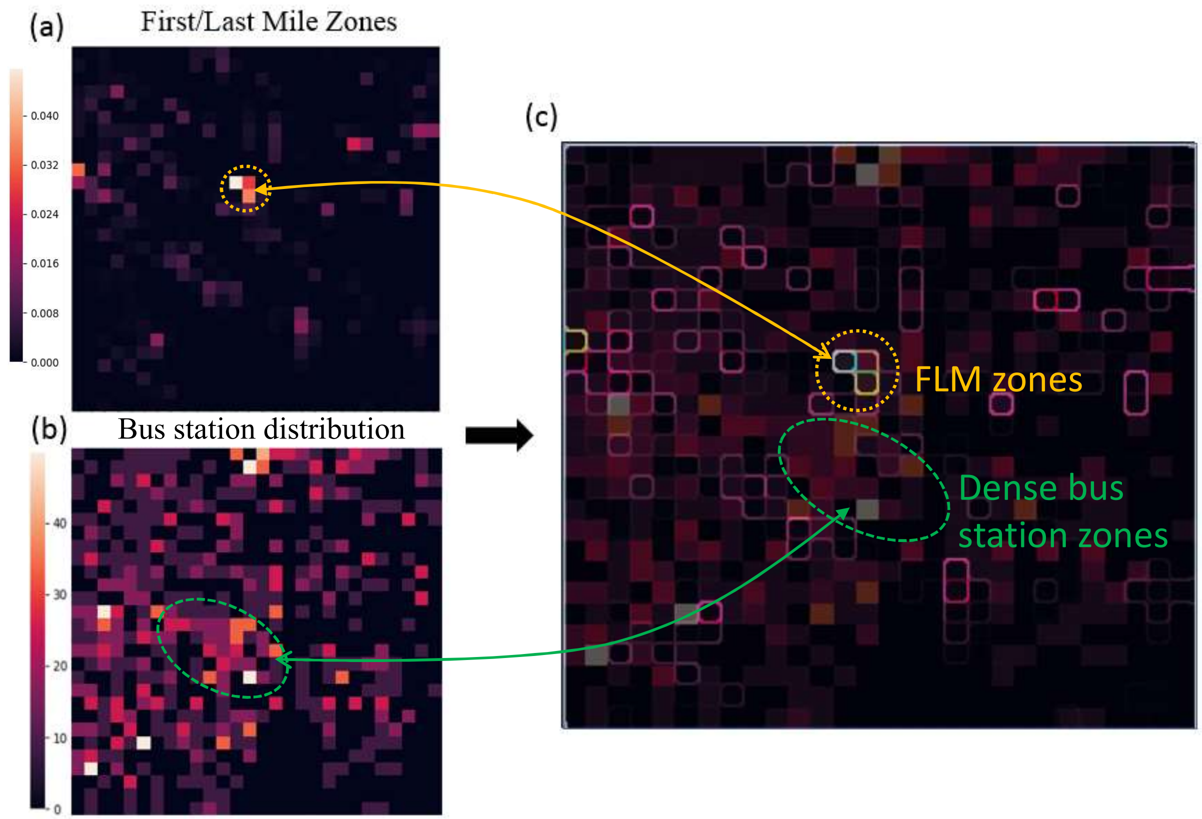


Figure 6. First/Last mile zones identification and validation. (a) Identified FLM zones, Oct 1st, 2016 to Oct30th, 2016, 8AM to 8PM. (b) transit services distribution map. (c) Overlap of FLM zones and transit services distribution.

Results

Potential Transit First/Last Mile (FLM) Zones Validation

- Validate top 9 FLM zones with **land use**.
- FLM zones → Residential ( ) or Commercial ( ), both have high population density/commute trips.

Micro-Bus

- **Around metro line** or suburban areas, but with **low transit services**.
- District is large; bus station is sparse within the area so it is not well connected to metro line → micro-bus (1,3; 4; 8)

New Route or Station

- The coverage of metro line is not enough such as FLM zones → new routes (2, 5, 6, 7)

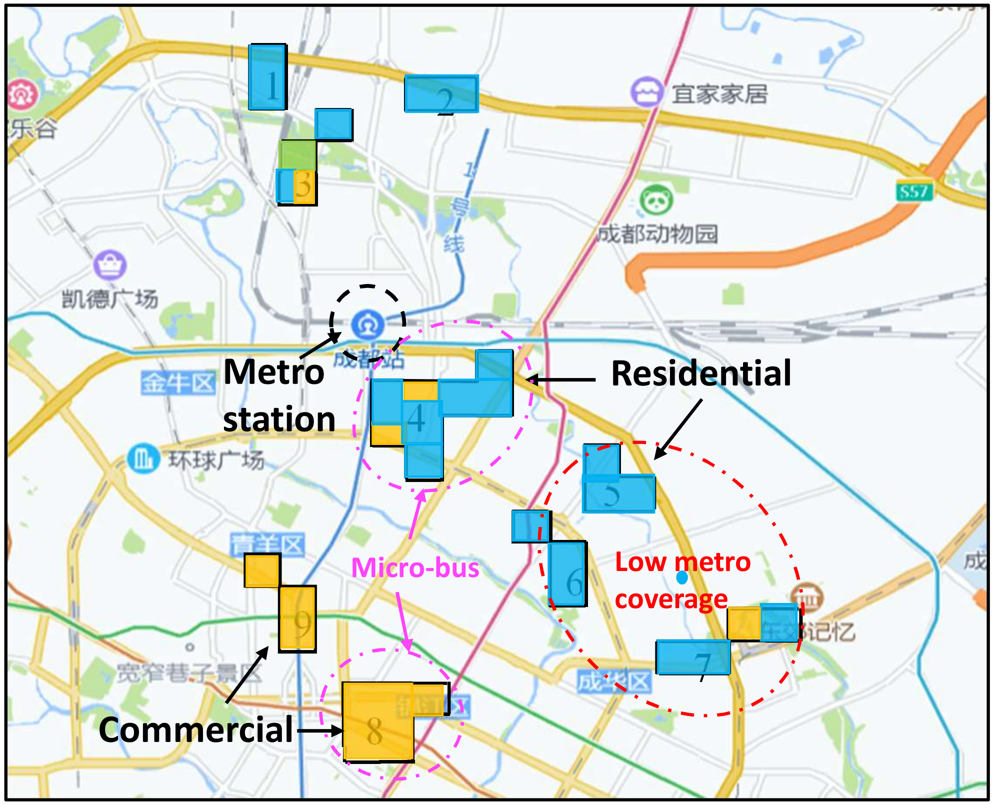
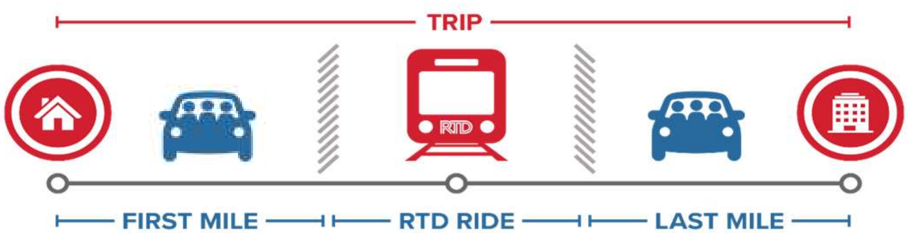


Figure 7. Land use validation for top FLM zones.

Results

Transit First/Last Mile Zones Evolvement over A Day

- Visualize FLM zones evolvement.
- Malls are closed → Commercial area is not active until 10am.
- Residential areas near metro station are more active than other areas.



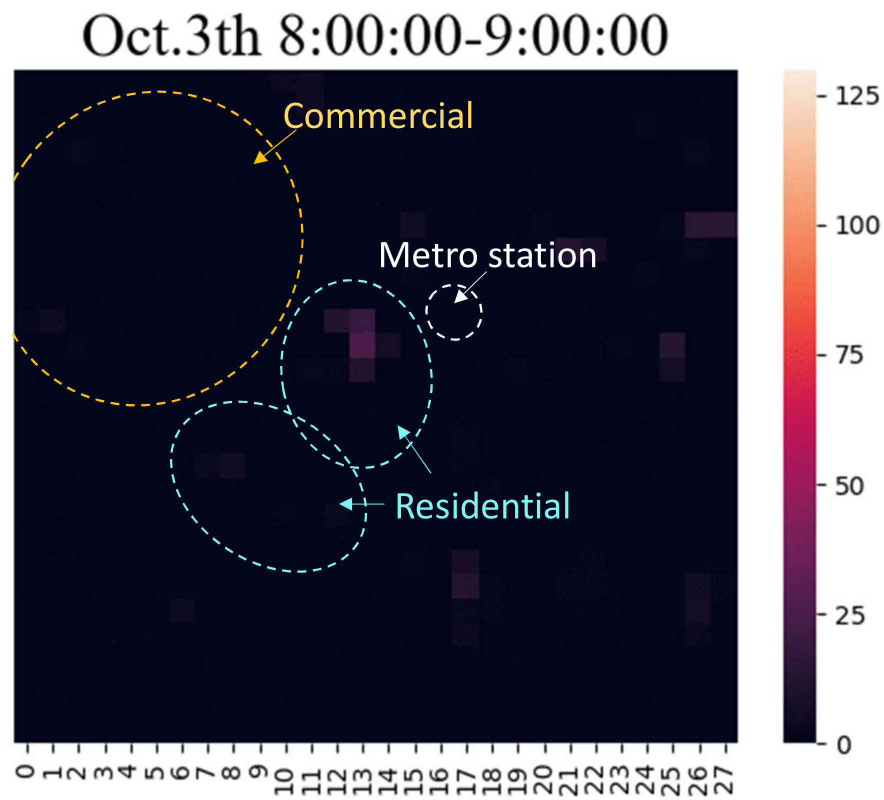


Figure 8. Pattern of first/last mile zones. Study horizon T, Oct 3st, 2016, Monday, 8AM to 9PM.

Conclusions

- **Main results**
  - Competitive /complementary areas between bus and ridesharing mods.
  - Spatiotemporal transit first/last mile zone identification.
  - Suggestion for new transit routes and stations.
- **Potential collaborations**
  - Assist micro-transit service by identifying service areas.
  - Help in discovering first/last mile demand.
  - Looking for other trip data to test/improve our model.

Reference

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5. Clewlow, R.R., Mishra, G.S., 2017. Disruptive transportation: The adoption, utilization, and impacts of ridesourcing in the United States (No. UCD-ITS-RR-17-07).Research Report–UCD-ITS-RR-17-07. University of California, Davis.

Thank You !

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