



Understanding Individual-Space Relationships to Inform and Enhance Location-Based Applications

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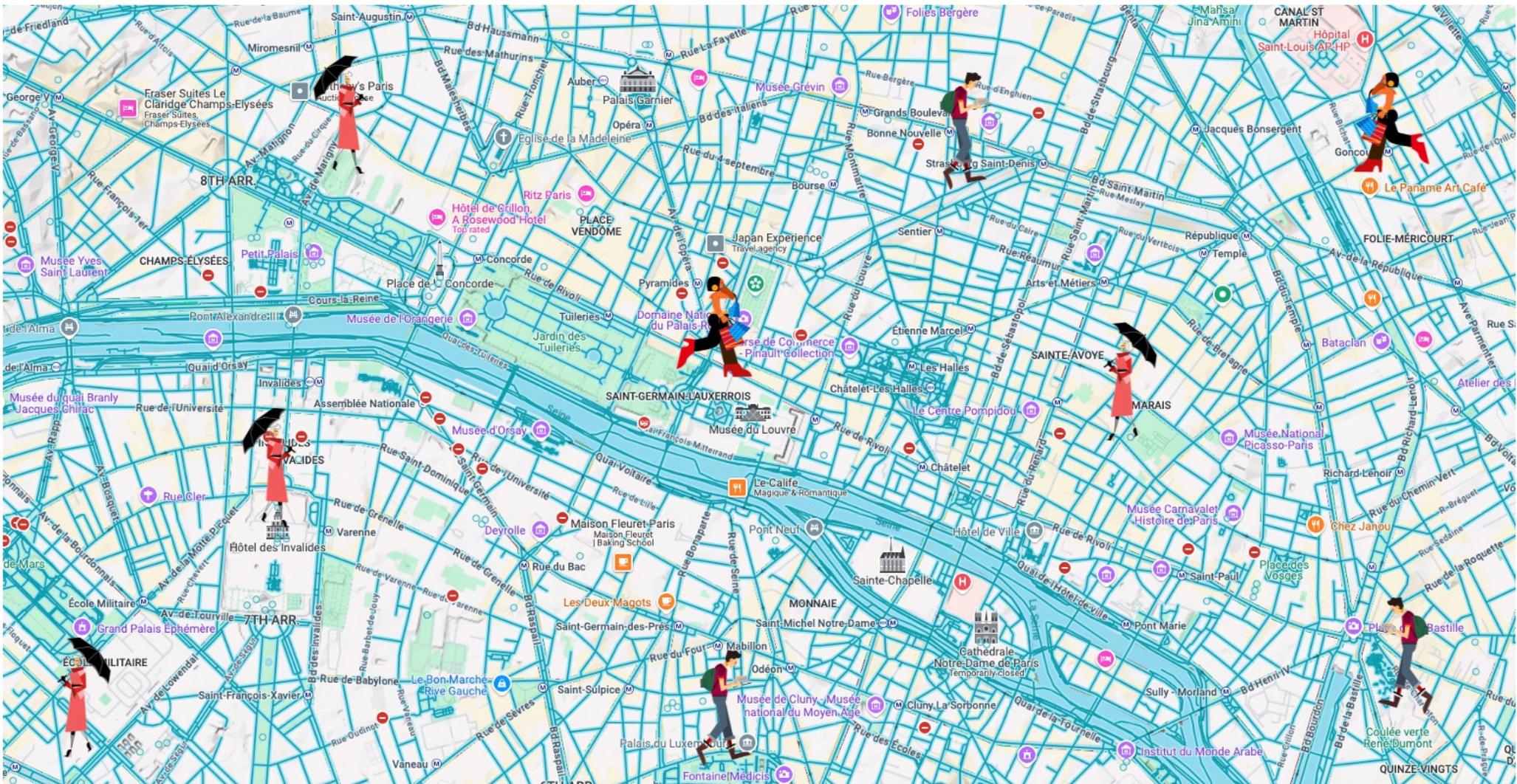


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Human-Space Relationships



Human-Space Relationships

Work



Discovery



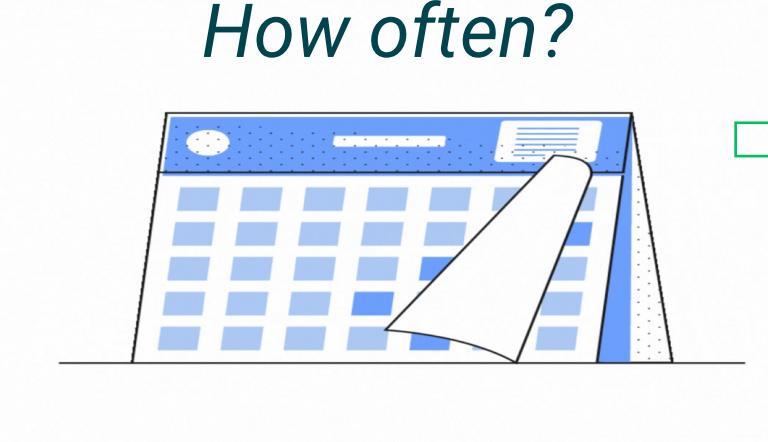
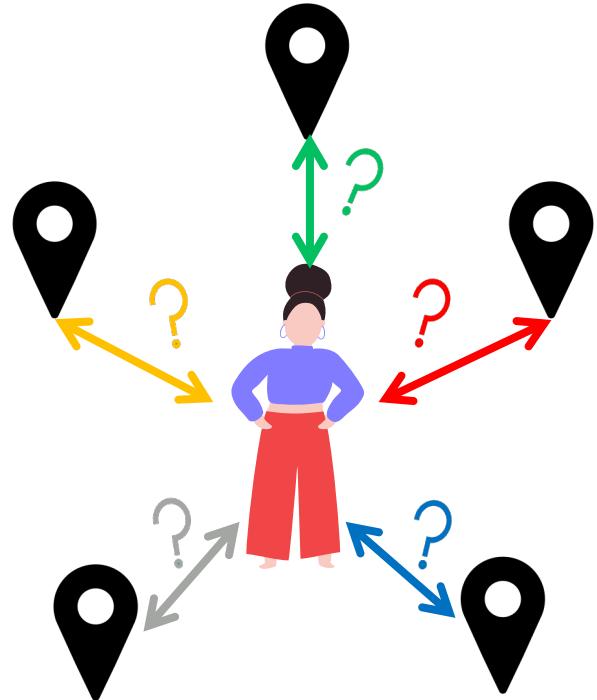
Regular



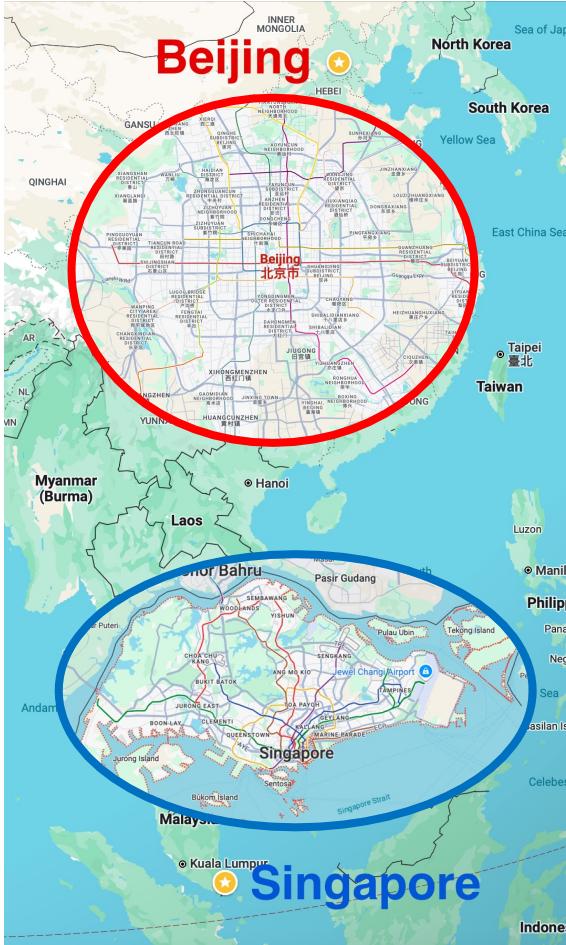
Casual



How to capture Individuals Perceptions of Space?



Mobility and POI Data



Mobility Data

Dataset	#Users	#Records	Time Period	Coverage
Singapore	144,795	264,246,258	December 1 st , 2022 – January 31 st , 2023	Singapore
Beijing (Geolife)	182	17,621	April 2007–August 2012	Beijing mostly

Pol PlanetSense Data

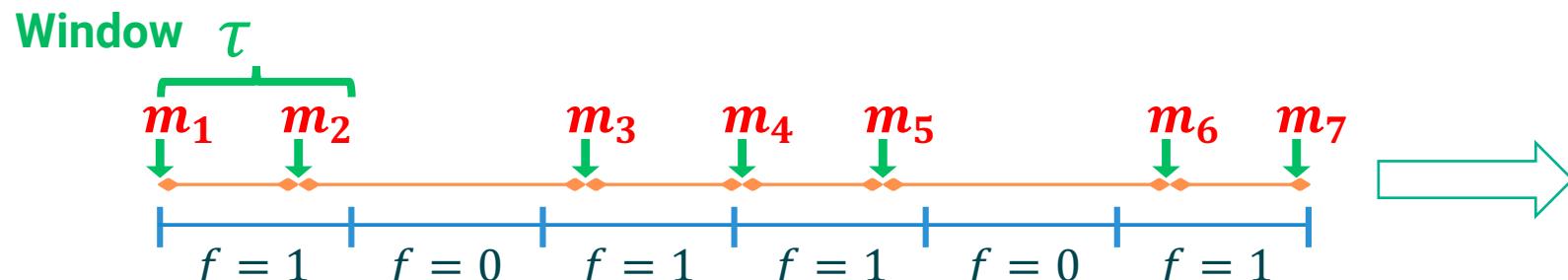
Dataset	#Pols
Singapore	238,690
Beijing	1,677,835

Mobility Data: Temporal Completeness

Mobility trace

$$\mathcal{D}_u = \{(m_1, t_1), (m_2, t_2), \dots, (m_n, t_n)\}$$

(lat_1, lon_1)

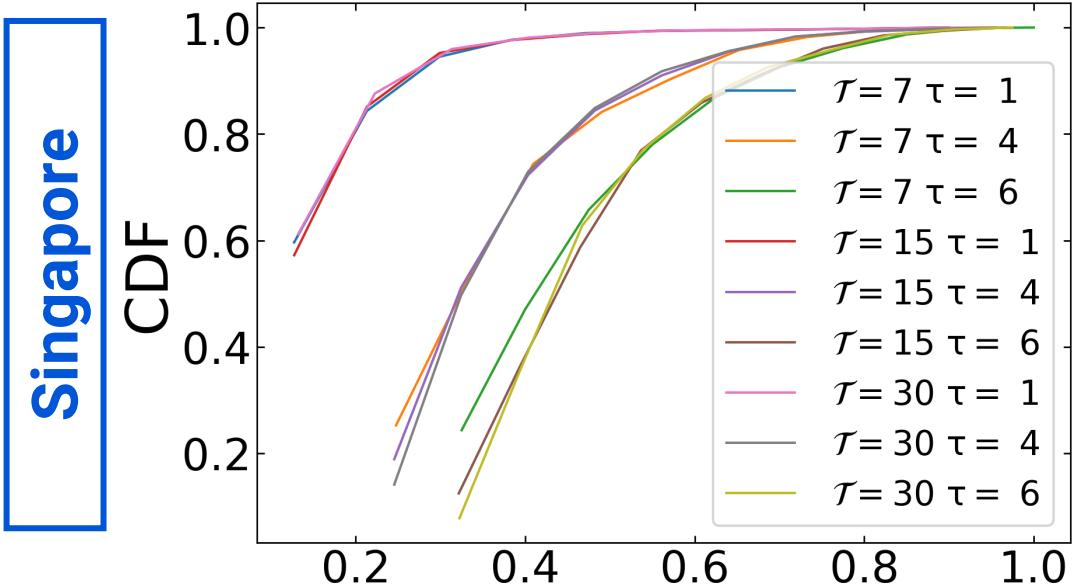


$$\mu_T(\mathcal{D}_u) = \frac{\tau}{P} \sum_{i=0}^{\frac{P}{\tau}} f_\tau(i)$$

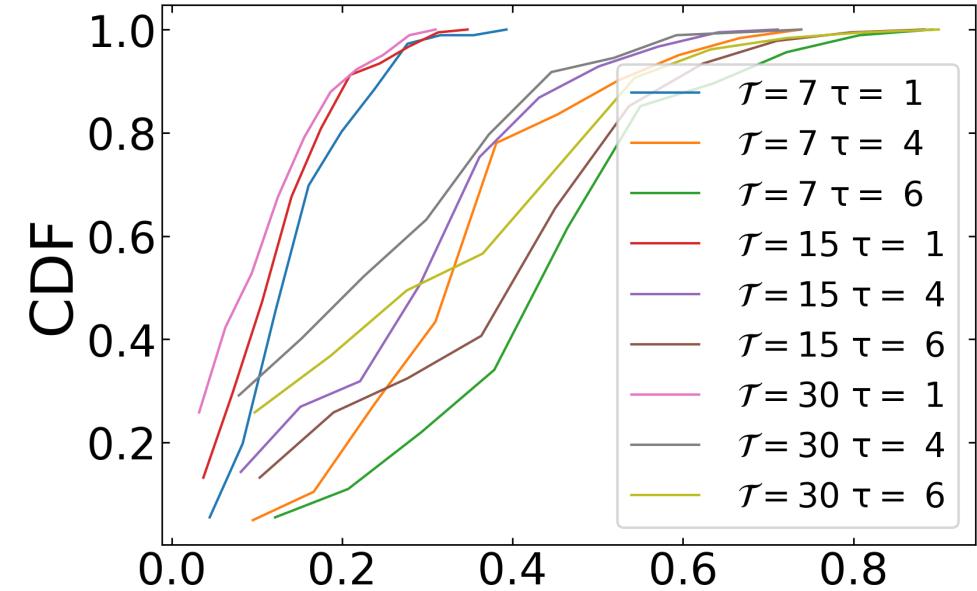
Observation Period = 24 hours

Mobility Data: Temporal Completeness

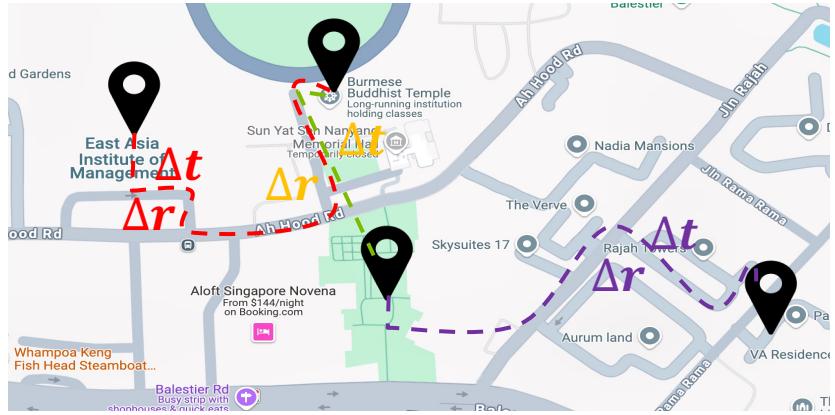
Window: $\tau \in \{1,4,6\}$



Data period: $\mathcal{T} \in \{7,15,30\}$



Mobility Data: Spatial Completeness

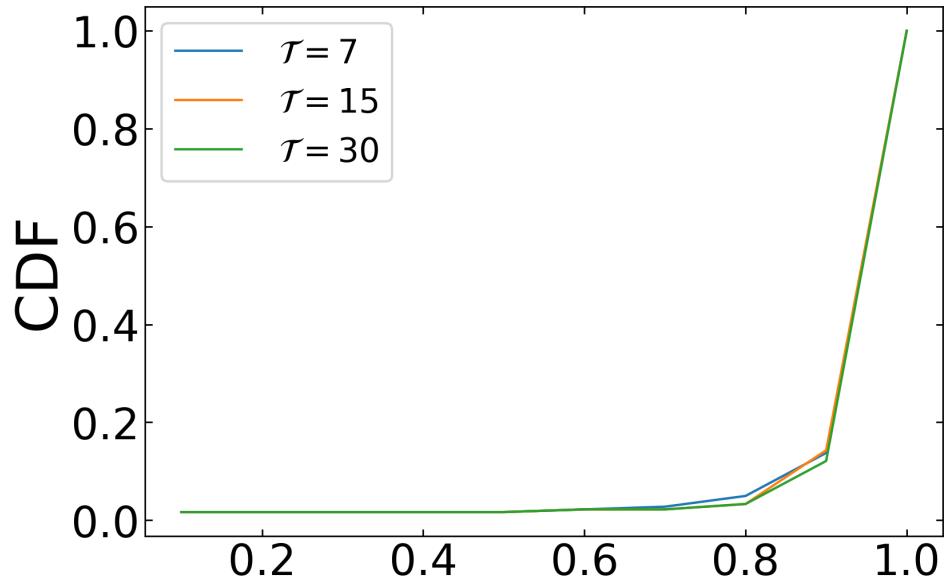


$$\mu_S(\mathcal{D}_u) = \frac{1}{N} \sum_{i=1}^N g(i)$$

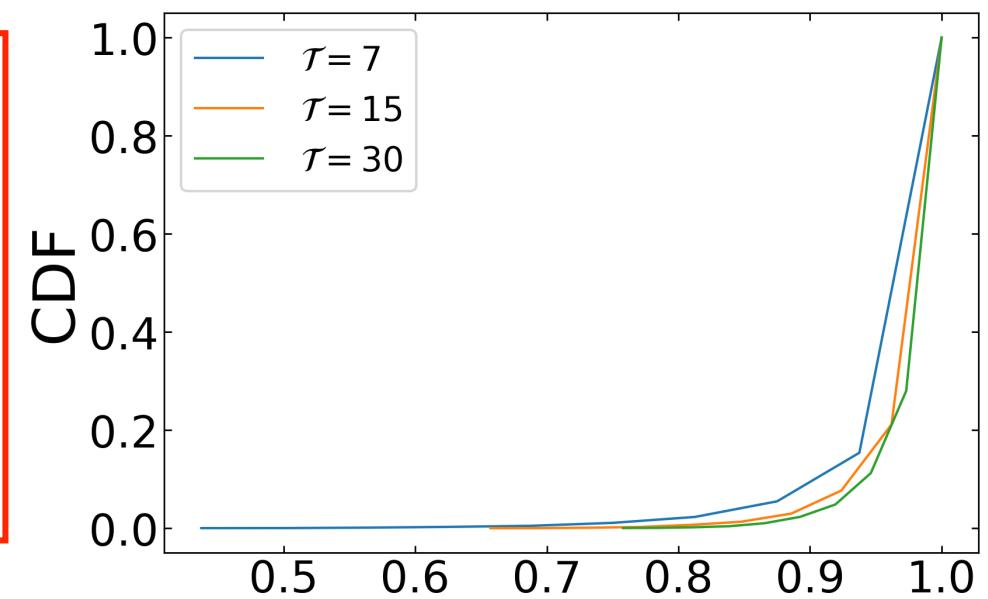
Number of records

$g = 1 \text{ if } \frac{\Delta r}{\Delta t} < \text{MAXSPEED}$
 $g = 0 \text{ else}$

Singapore



Beijing



Mobility Data: Spatial Completeness

Maximize

$\uparrow \#Users$ $\uparrow \#Days$ $\uparrow u_T$ $\uparrow u_S$

Singapore

$\mathcal{T} = 30 \text{ days}$

$\tau = 1 \text{ hour}$

Beijing

$\mathcal{T} = 15 \text{ days}$

$\tau = 1 \text{ hour}$



Conflate with Pol data

Visitation classification

Enriched mobility trace

$$\mathcal{D}_u = \{(lat_1, lon_1, t_1, PoI_1), (lat_2, lon_2, t_2, PoI_2), \dots, (lat_n, lon_n, t_n, PoI_n)\}$$

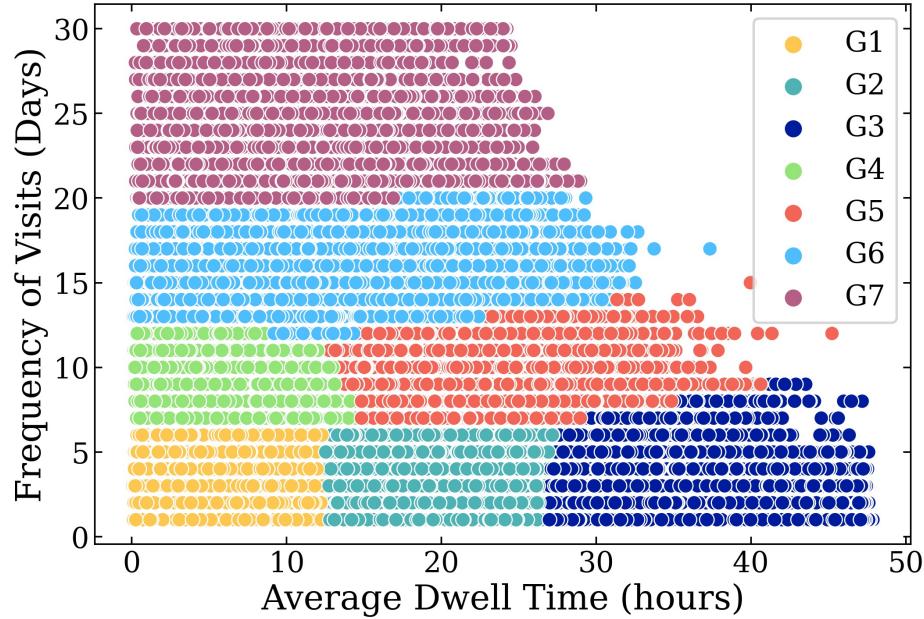
Pols	Frequency of visits	Dwell time
PoI_1	5 days	45 min
PoI_2	35 days	10 min
:	:	:
PoI_n	1 days	5 min



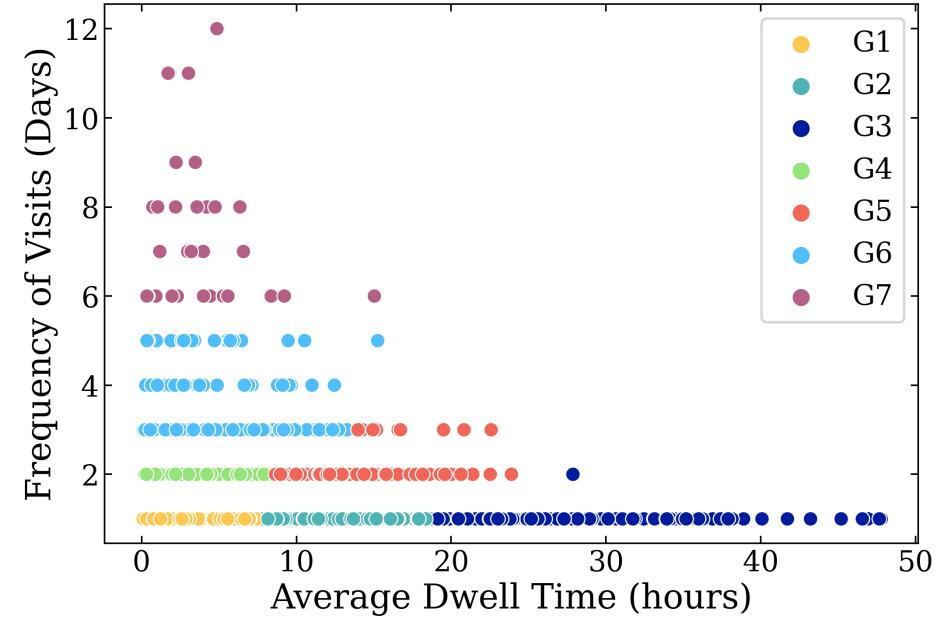
For each individual u and for each Pol

Visitation classification: Clustering

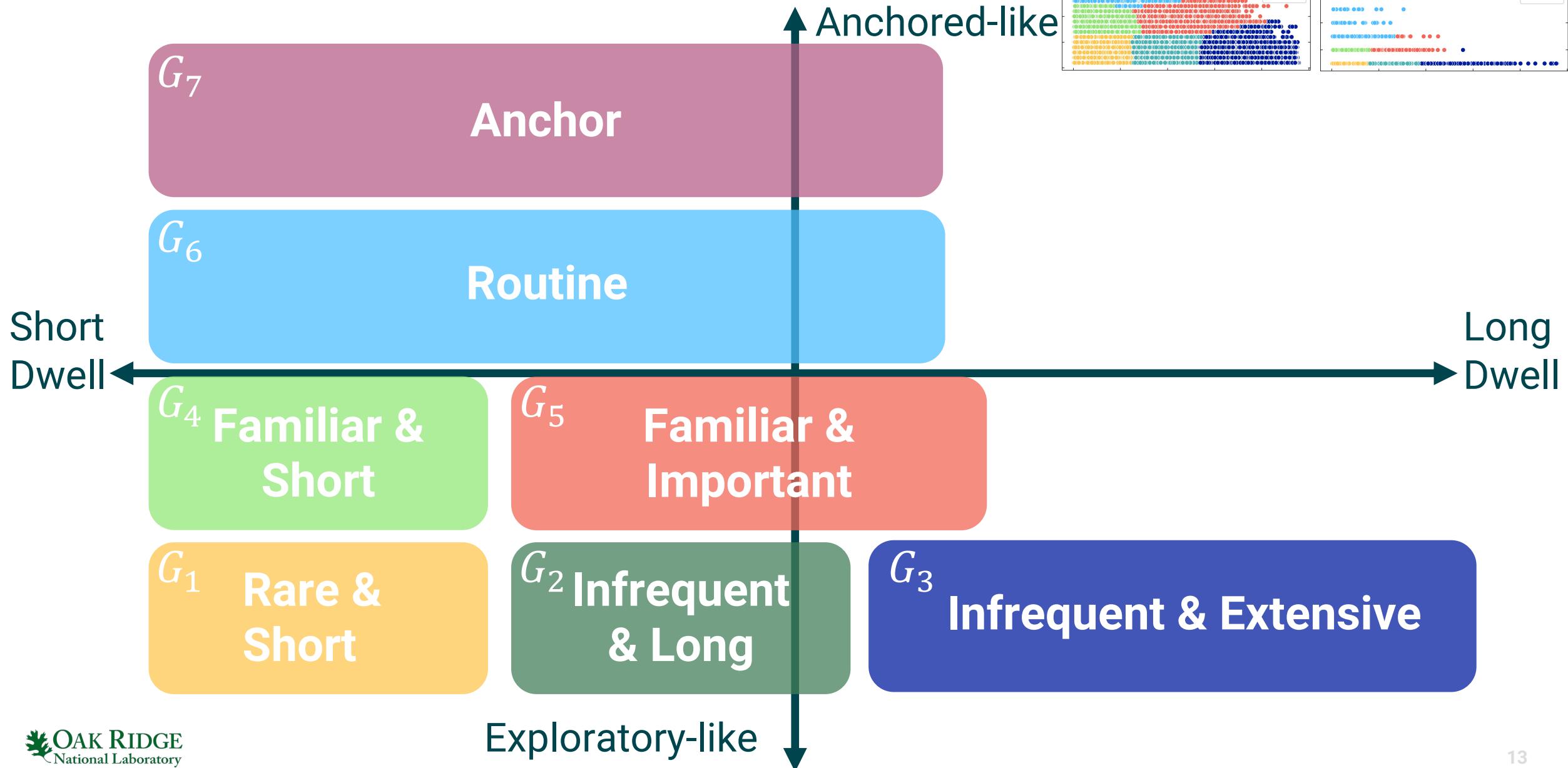
Singapore



Beijing

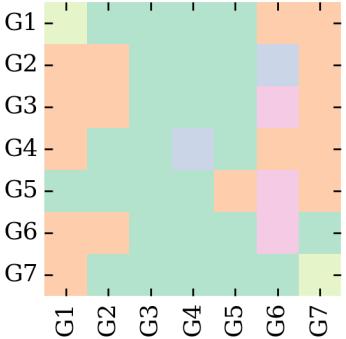


Visitation classification: Clustering

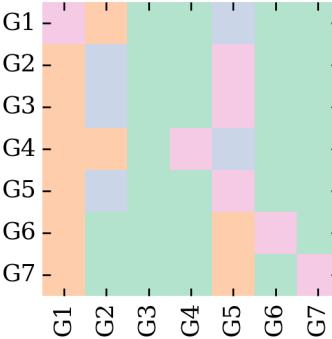


Visitation classification: Visitation Patterns

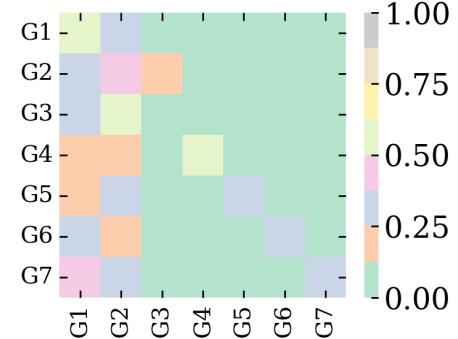
Singapore



- Routine Stability
- Occasional Exploration

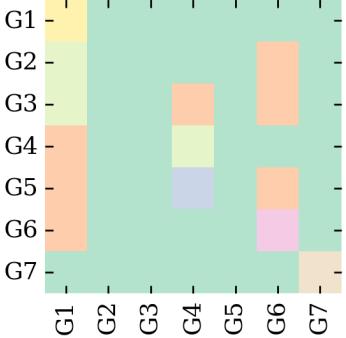


- Exploration
- Routine-Driven Stability

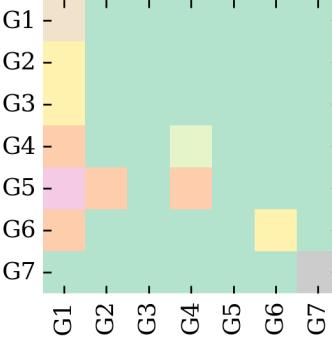


- High Exploration
- Dynamic Mobility

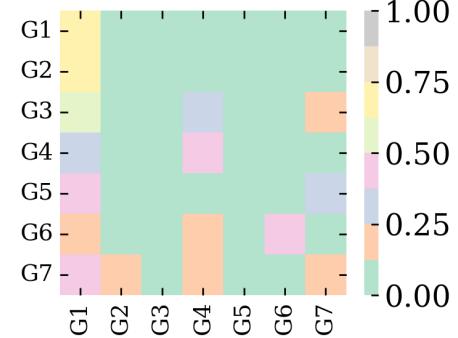
Beijing



- Brief Exploration
- Routine Anchors



- Routine-Breaking
- Anchored Consistency



- Predominantly Exploratory
- Low Routine

Visitation classification: Visitation Patterns

Singapore

- Dynamic frequency
- Longer novelty-seeking

Beijing

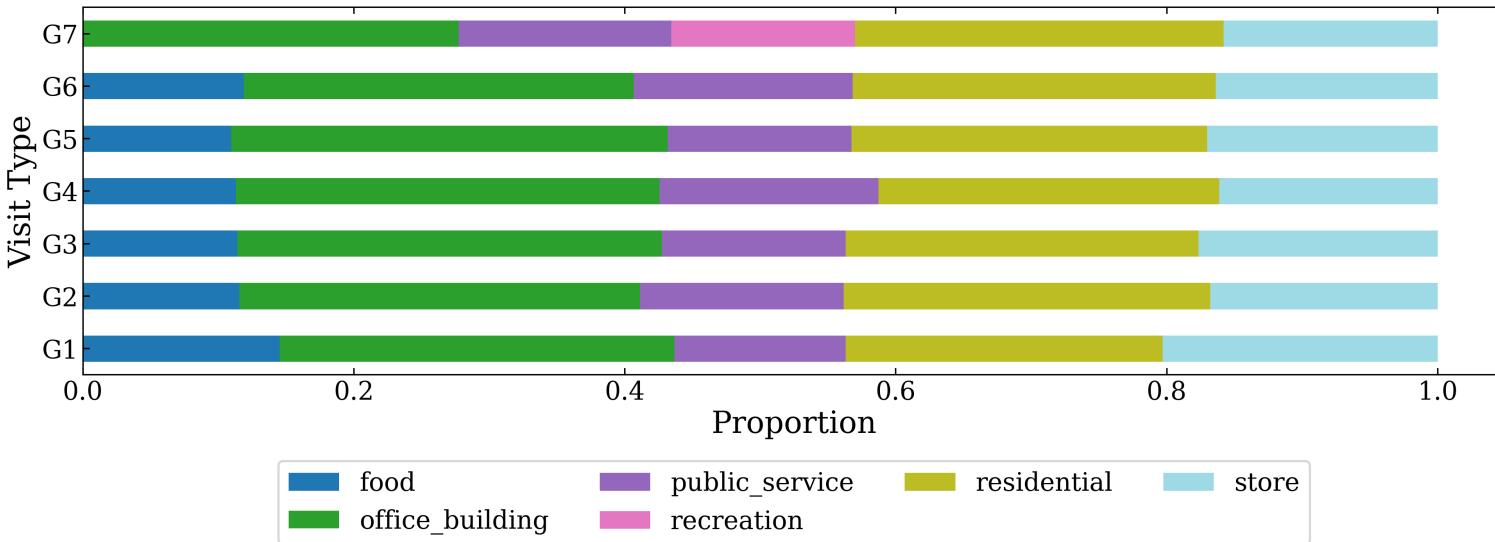
- Strong Routine



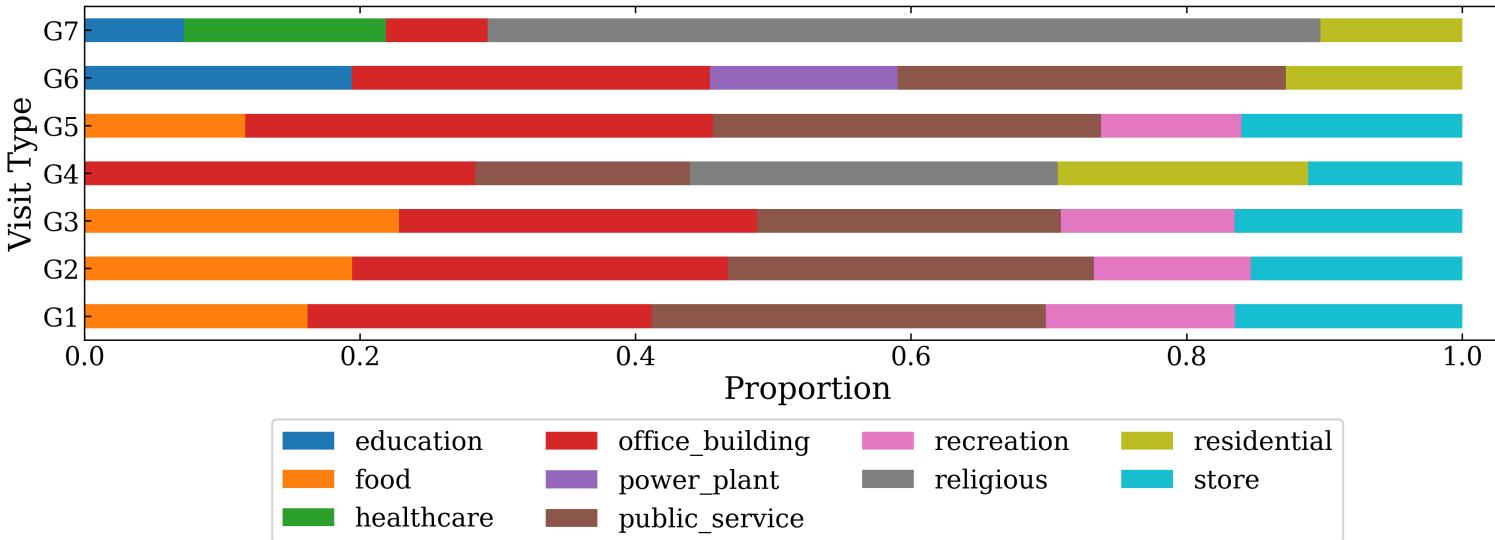
Urban settings shape distinct mobility patterns

Visitation classification: Semantic Patterns

Singapore



Beijing



Visitation classification: Semantic Patterns

Shared Trends

- Public_service, residential, and office_building

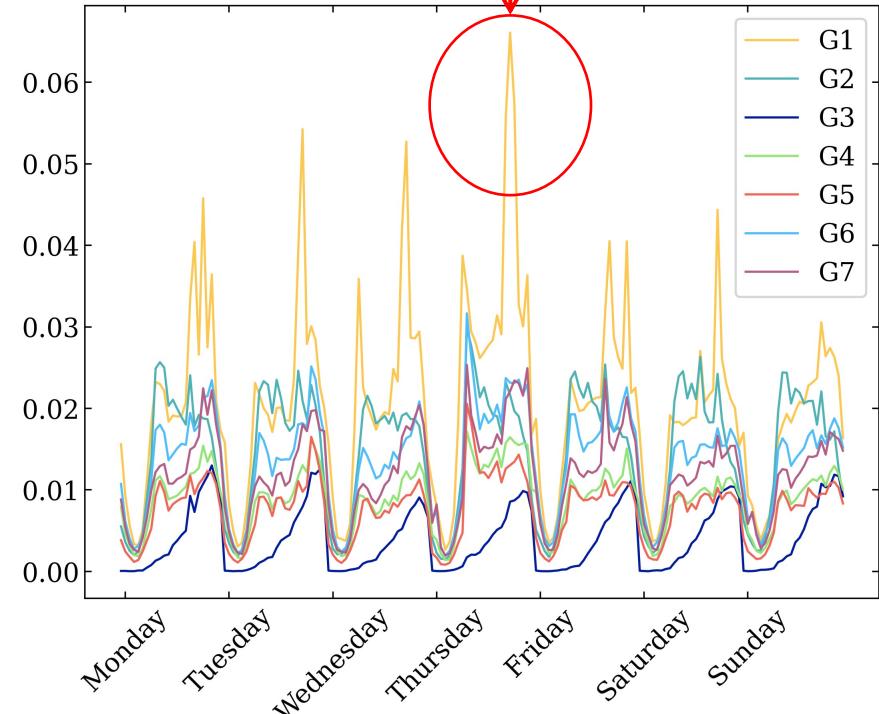
City-Specific

- **Singapore:** Recreation as anchor
- **Beijing:** Diverse semantics food, education, and power-related

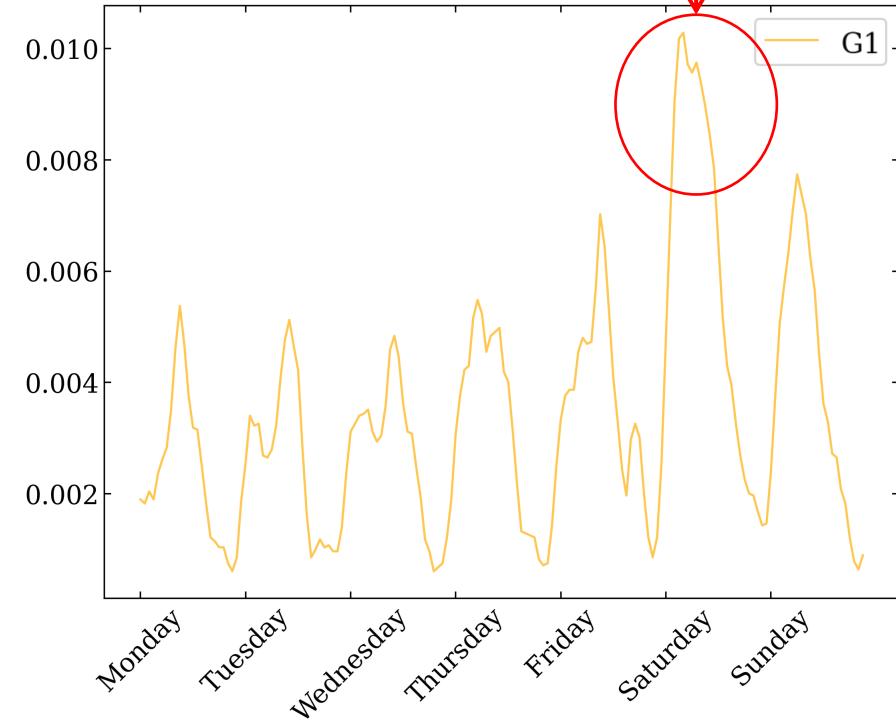
Visitation classification: Temporal Patterns

Social gatherings &
After-work meetups

Singapore

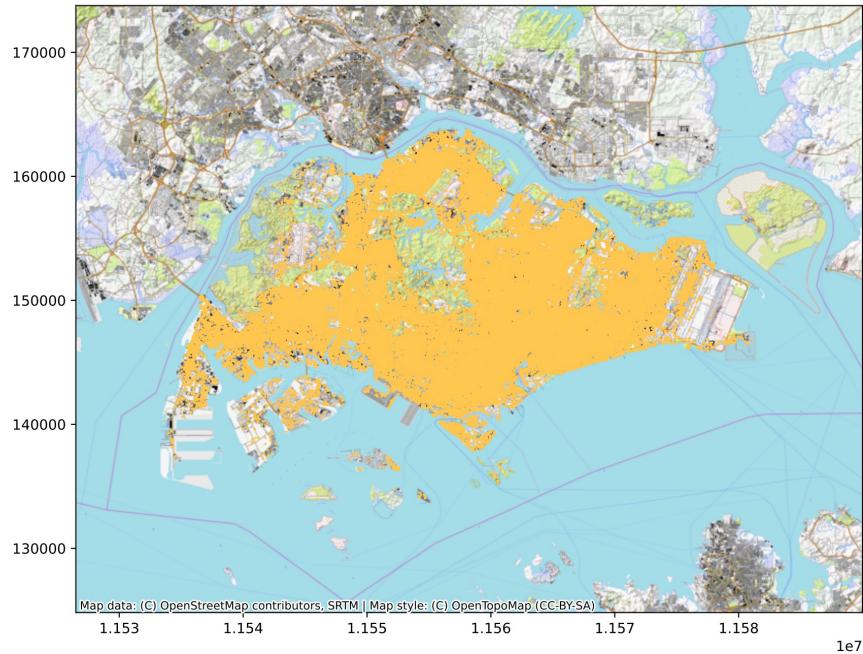


Beijing



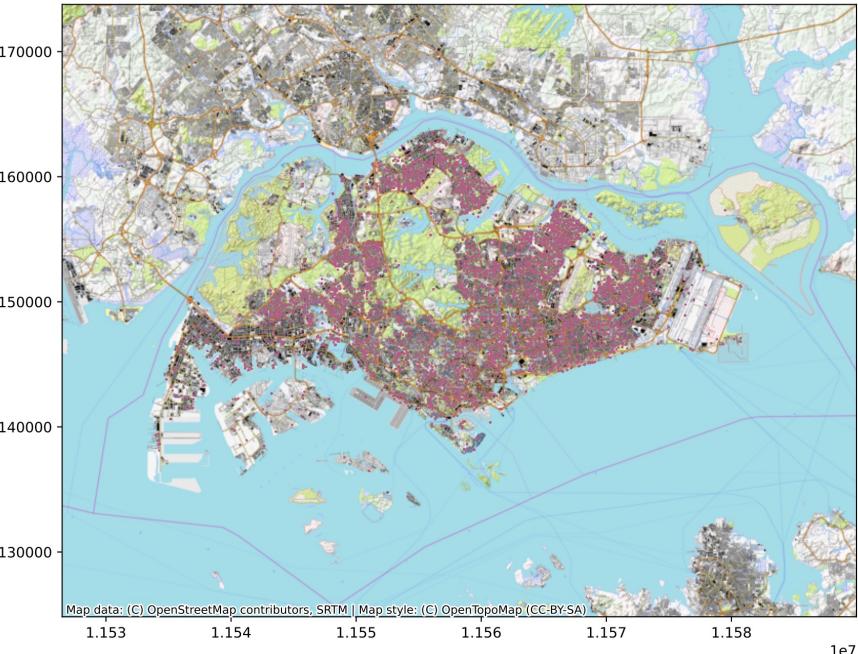
Different Temporal Patterns

Visitation classification: Spatial Exploitation



G1 exploratory-like

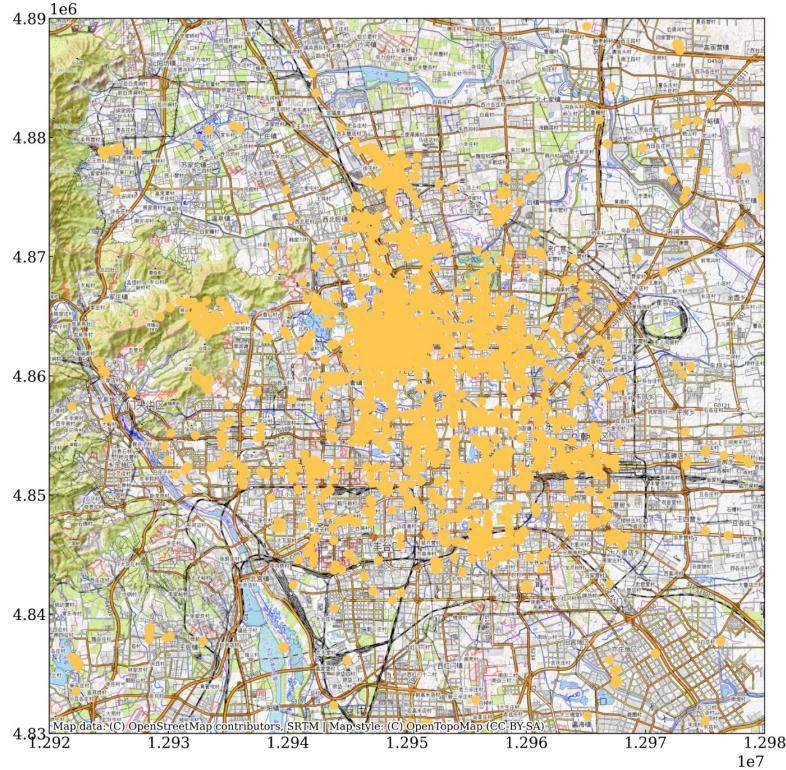
→ Broadly across the city



G7 anchor-like

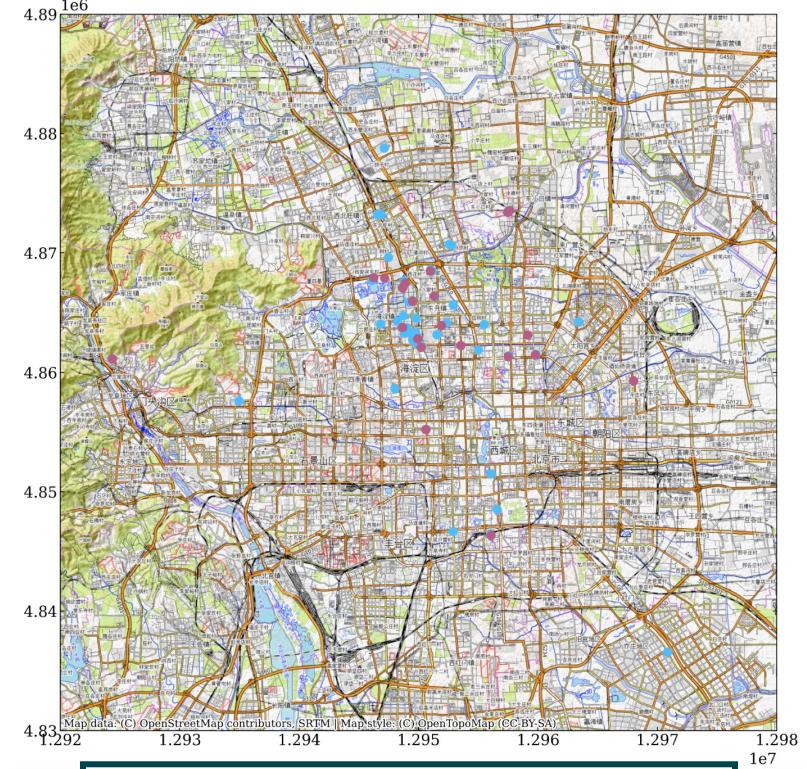
→ Residential Areas

Visitation classification: Spatial Exploitation



G1 exploratory-like

→ Broadly across the city



G6+G7 anchor-like

→ Pekin University & Haidian Business

Individuals-Space Relationships & Recommendation Systems

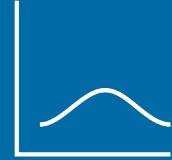
Context-Aware Recommendations

Frequent visitors → 

Exploratory visitors → 

Temporal and Spatial Personalization

When?



Where?



Routine and Novelty Balance



Dynamic Adaptation

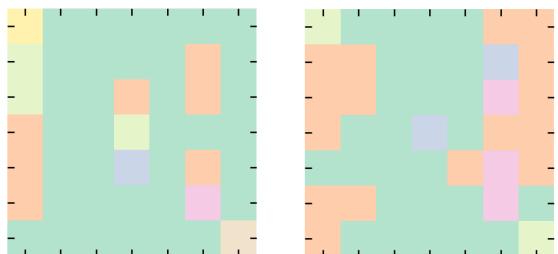


Conclusion

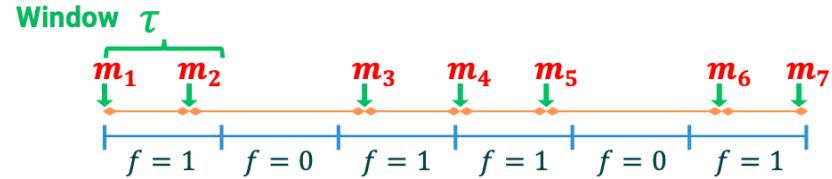
Mobility Data



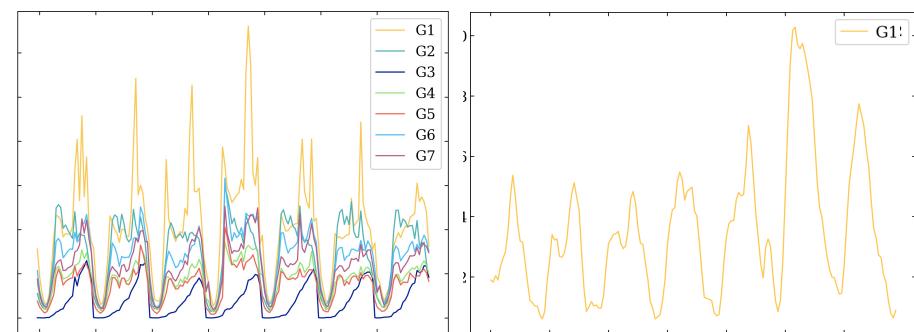
Visits Patterns



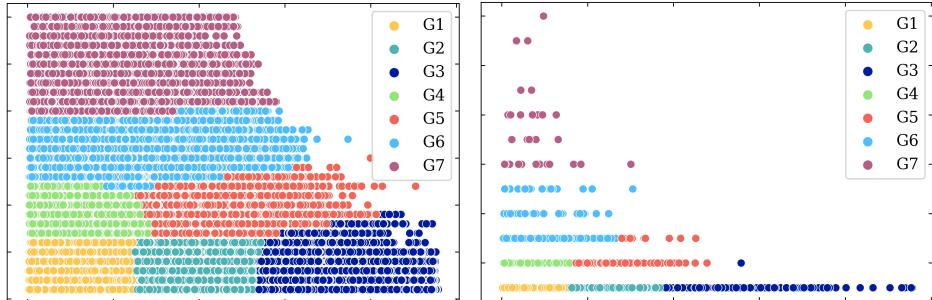
Temporal & Spatial Completeness



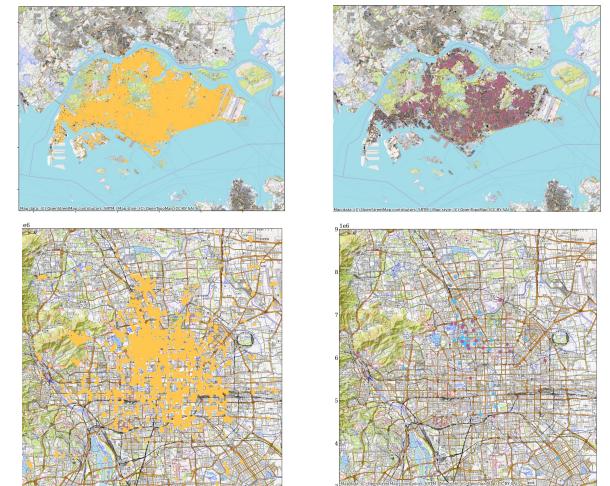
Temporal Patterns



Visits Groups



Spatial Exploitation





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Thank you ☺