Categorizing Urban Space based on Visitor Density and Diversity
A view through social media data

I-Ting Chuang, University of Auckland
Qingqing Chen (Presenter), University at Buffalo
Ate Poorthuis, KU Leuven

March 16, 2023

spatial@ucsb
CENTER FOR SPATIAL STUDIES
Spatial Lightning Talks
THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND
University at Buffalo
The State University of New York
KU LEUVEN

Vital & sustainable city

Density

Diversity

Dynamic & active city life

- The diversity of people is a challenging concept to operationalize within the context of urban spaces.

- Focus on only one of the two aspects misses important aspects of the variety of urban spaces

"User" dimension – Social dimension visitor-based approach

Manuscript

Categorizing urban space based on visitor density and diversity: A view through social media data

I-Ting Chuang [1], Qingqing Chen [2], and Ate Poorthuis [3]

Abstract
Analyses of urban spaces have often stressed the importance of both the density and diversity of the people they attract. However, the diversity of people is a challenging concept to operationalize within the context of urban spaces, which is why many evaluations of urban space have relied primarily on density-based measures. We argue that a focus on only one of the two aspects misses important aspects of the variety of urban spaces in our cities. To address this, we design a methodology that evaluates both the density and diversity of human behavior in urban spaces based on geosocial media data. We operationalize density as the frequency of tweets from visitors to a particular location and diversity as the variety of the home neighborhoods of those visitors. Taking Singapore as a test case, we identify networks between the home neighborhoods of 28k Twitter users based on 2.2 million geolocated tweets collected between 2012 and 2016. Based on these data, we categorize the urban landscape of Singapore into four "performance" categories, namely High-Density/High-Diversity, High-Density/Low-Diversity, Low-Density/High-Diversity, and Low-Density/Low-Diversity. Our findings illustrate that this combined indicator provides useful nuance compared to differentiation between well and less performing spaces based on density alone. By enabling a categorization of urban spaces that fits closer to the diversity of human behavior in these spaces, human mobility data sets, such as the social media data we use, open the door to a practical evaluation of the design and planning of our heterogeneous urban environment.

## Home-Destination Networks → Local Density → Social Diversity

Home-Destination Networks

- Singapore as test case
- Customize the size of a place (i.e. a 300m grid cell)
- Identify home location: '*homelocation*' package *(Chen and Poorthuis, 2021)*
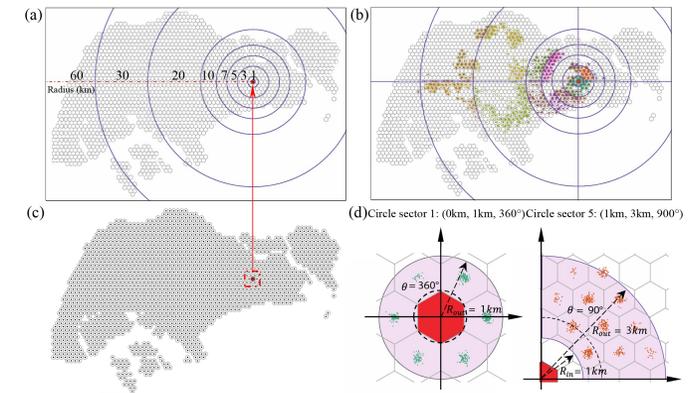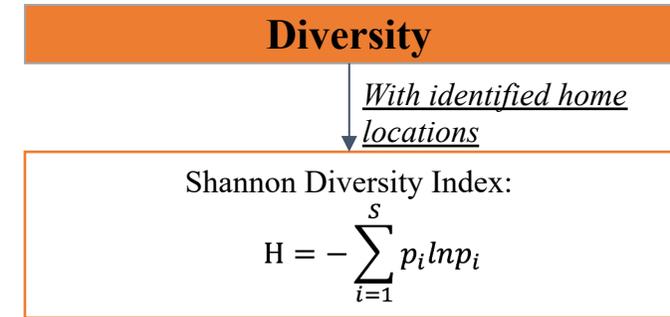- Construct home-to-destination networks

>

Local Density

Density: visitor density in a local context of 1km radius derived from the geo-location to people's presence in a particular place.

Density

Within 1km radius

Local Density:
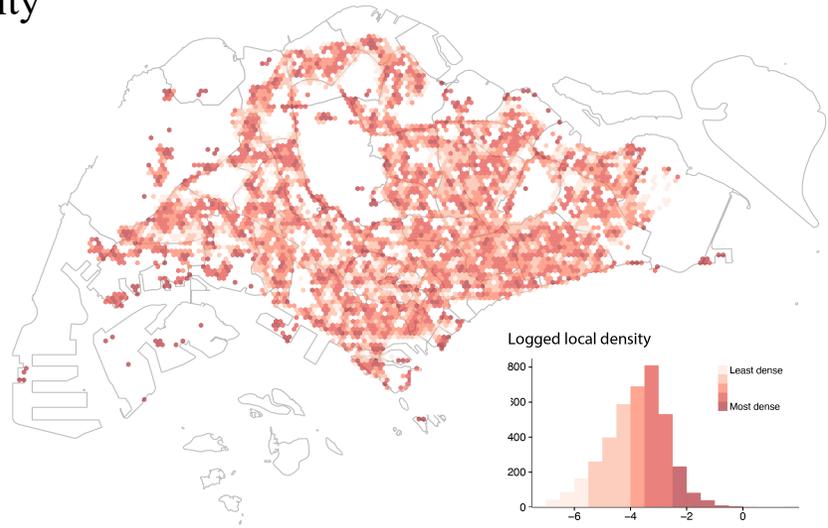
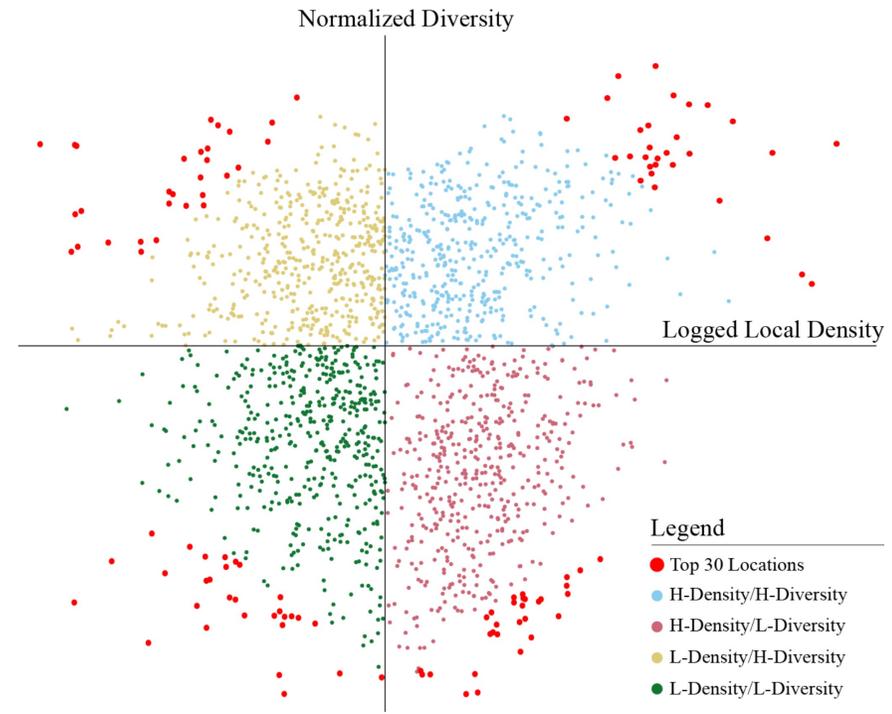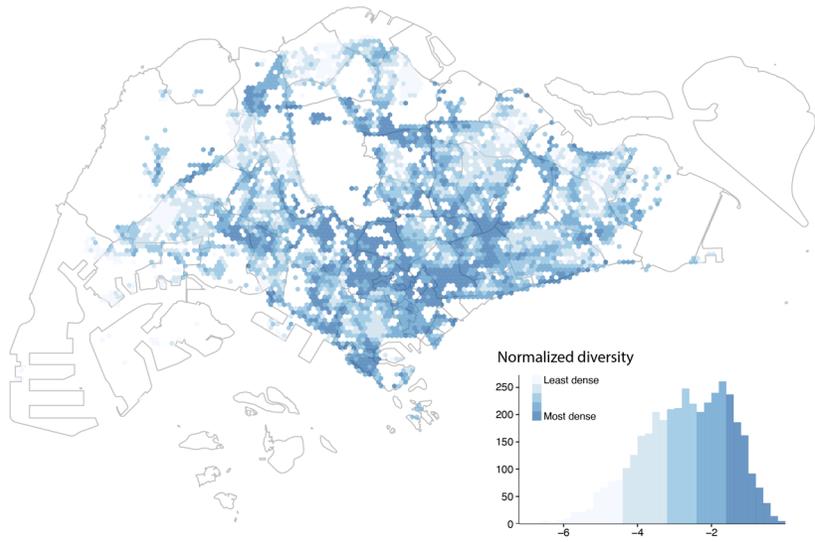$$D_i = \frac{N_i}{\sum_{j=1}^{k} N_j}$$
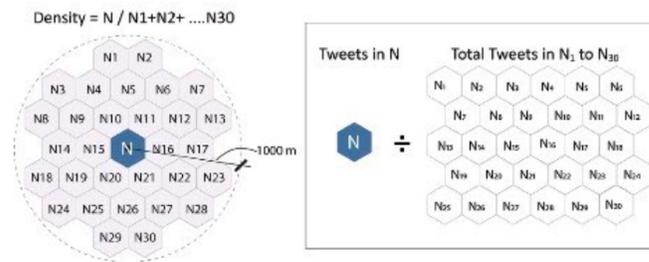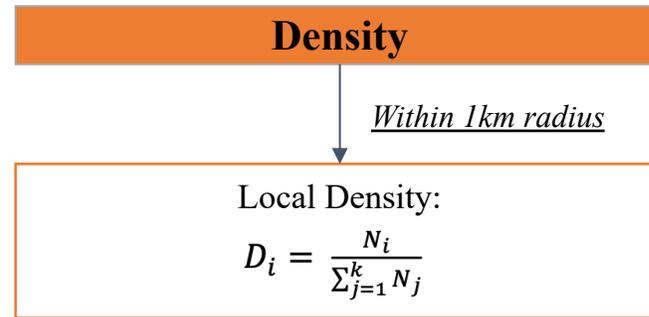
Social Diversity

Diversity: variety of home locations of social media users visit to each geographical location across the city *(Chen et al., 2021).*
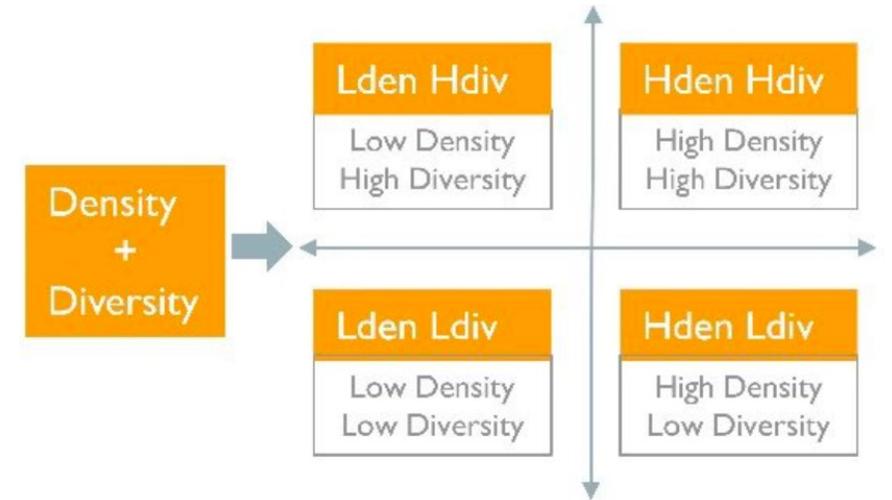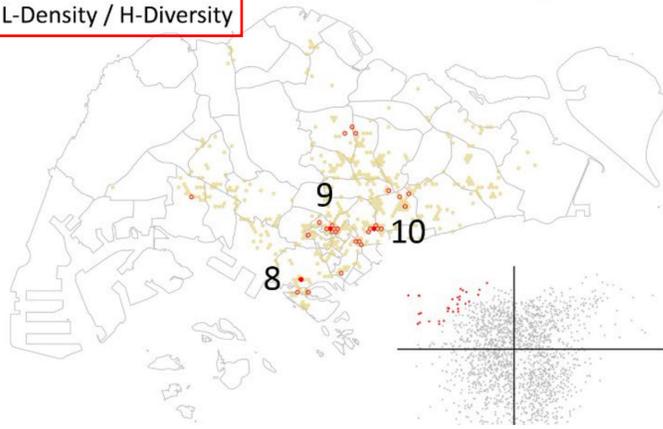
Diversity

With identified home locations

Shannon Diversity Index:

$$H = -\sum_{i=1}^{S} p_i \ln p_i$$

Chen, Q. and Poorthuis, A. (2021) Identifying home locations in human mobility data: an open-source R package for comparison and reproducibility. International Journal of Geographical Information Science, Pages 1425-1448, https://doi.org/10.1080/13658816.2021.1887489

Chen, Q., Chuang, I.-T. and Poorthuis, A. (2021) Entangled footprints: Understanding urban neighborhoods by measuring distance, diversity, and direction of flows in Singapore. Computers, Computers, Environment and Urban Systems, 90, p. 101708. https://doi.org/10.1016/j.compenvurbsys.2021.101708

Density

Diversity

Logged local density

Least dense

Most dense

Normalized diversity

Least dense

Most dense

Normalized Diversity

Logged Local Density

Legend

- Top 30 Locations
- H-Density/H-Diversity
- H-Density/L-Diversity
- L-Density/H-Diversity
- L-Density/L-Diversity

Density + Diversity

Lden Hdiv
Low Density
High Diversity

Hden Hdiv
High Density
High Diversity

Lden Ldiv
Low Density
Low Diversity

Hden Ldiv
High Density
Low Diversity

Istana Domain/green recreation spaces: successful urban precedent that can easily be overlook with solely focusing on the density index.
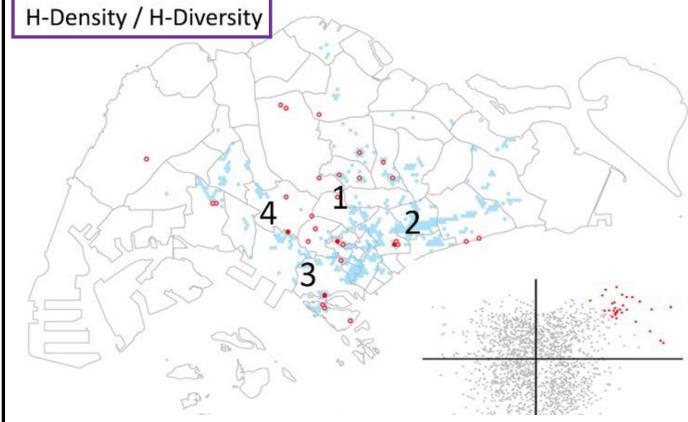

L-Density / H-Diversity

8.Faber Park
9.Istana Park
10. Sports Stadium

Prominent transportation hub/ history landmark destination/expatriate social enclave

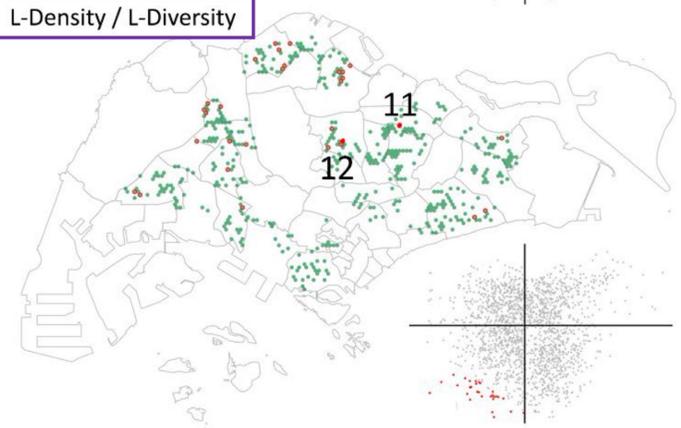

H-Density / H-Diversity

1.ION Orchard
2.Old Airport Road
3.Vivo City
4. Holland Village

L-Density / L-Diversity
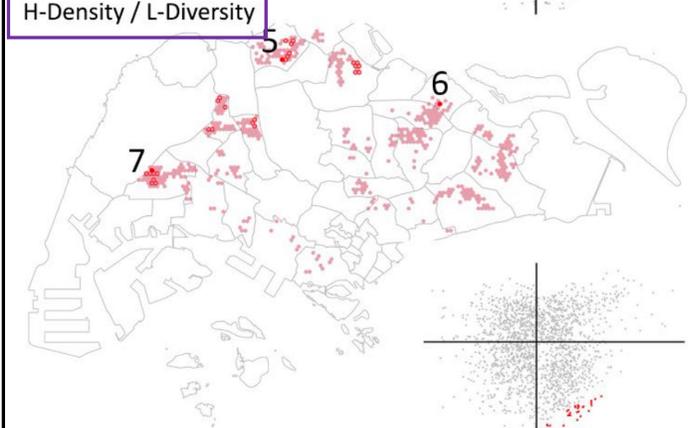
11.Upper Thomson
12.Serangoon Terrace

H-Density / L-Diversity

5. Causeway Point Mall
6.Punggol Plaza
7.Pioneer Mall

Landed property neighborhoods/places along the country's periphery adjacent to open green.

Dense residential community/local shopping centers: self-contained to cater primarily to locals.

Although both the *density* and *diversity* of participants in urban spaces play a key role for the vitality of the city, the two concepts should be treated as *independent, uncorrelated* variables and be taken into account *TOGETHER*.

The study further widen the use of **social media data** for urban analysis by adding the *dimension of diversity* to existing (density-based) approaches to understand urban spaces based on human behavior.
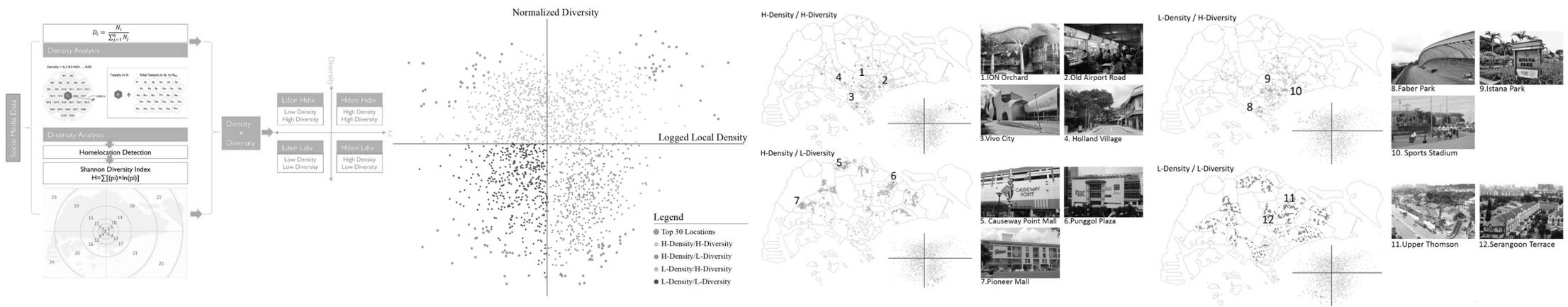
THANK YOU FOR YOUR ATTENTION

✉ *qchen47@buffalo.edu*

🖥 *https://urbansenses.org*

🐦 *@qingqingchen77*