Street View for Whom?

An Initial Examination of Google Street View's Urban Coverage and Socioeconomic Indicators in the US

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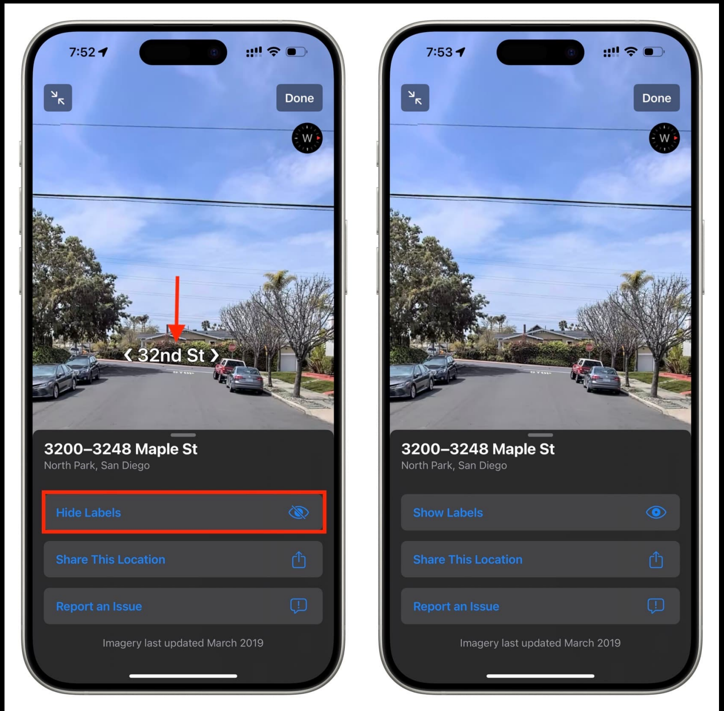
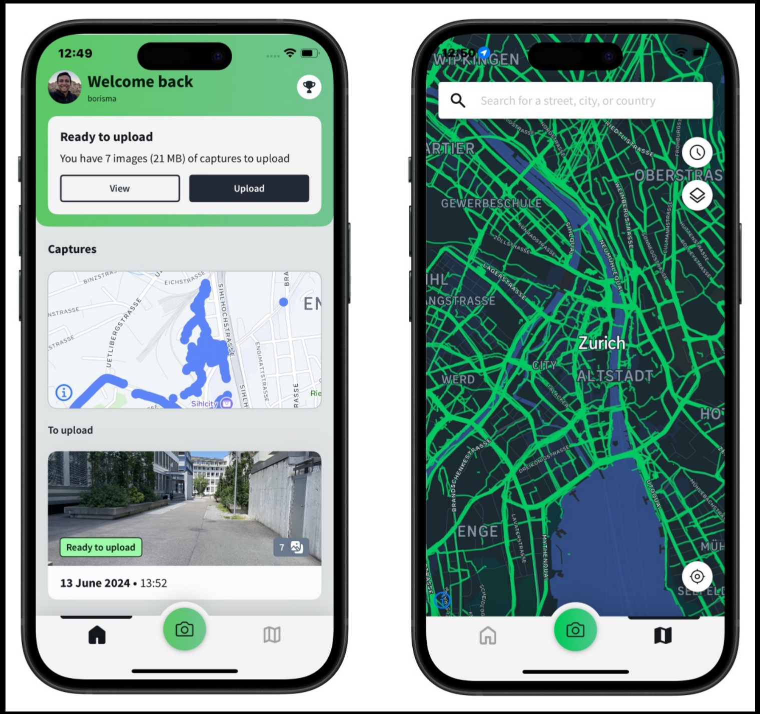
STREET-LEVEL IMAGERY HAS BECOME FUNDIMENTAL TO URBAN INFORMATICS, SUPPORTING DIVERSE RESEARCH ACROSS VARIOUS FIELDS.

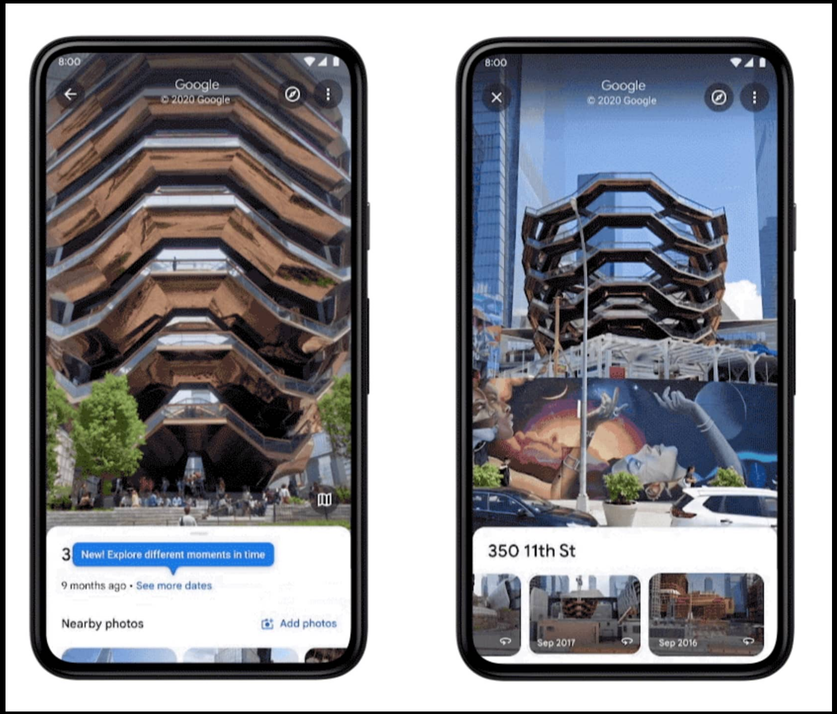
MAJOR PROVIDERS



Apple Lookaround



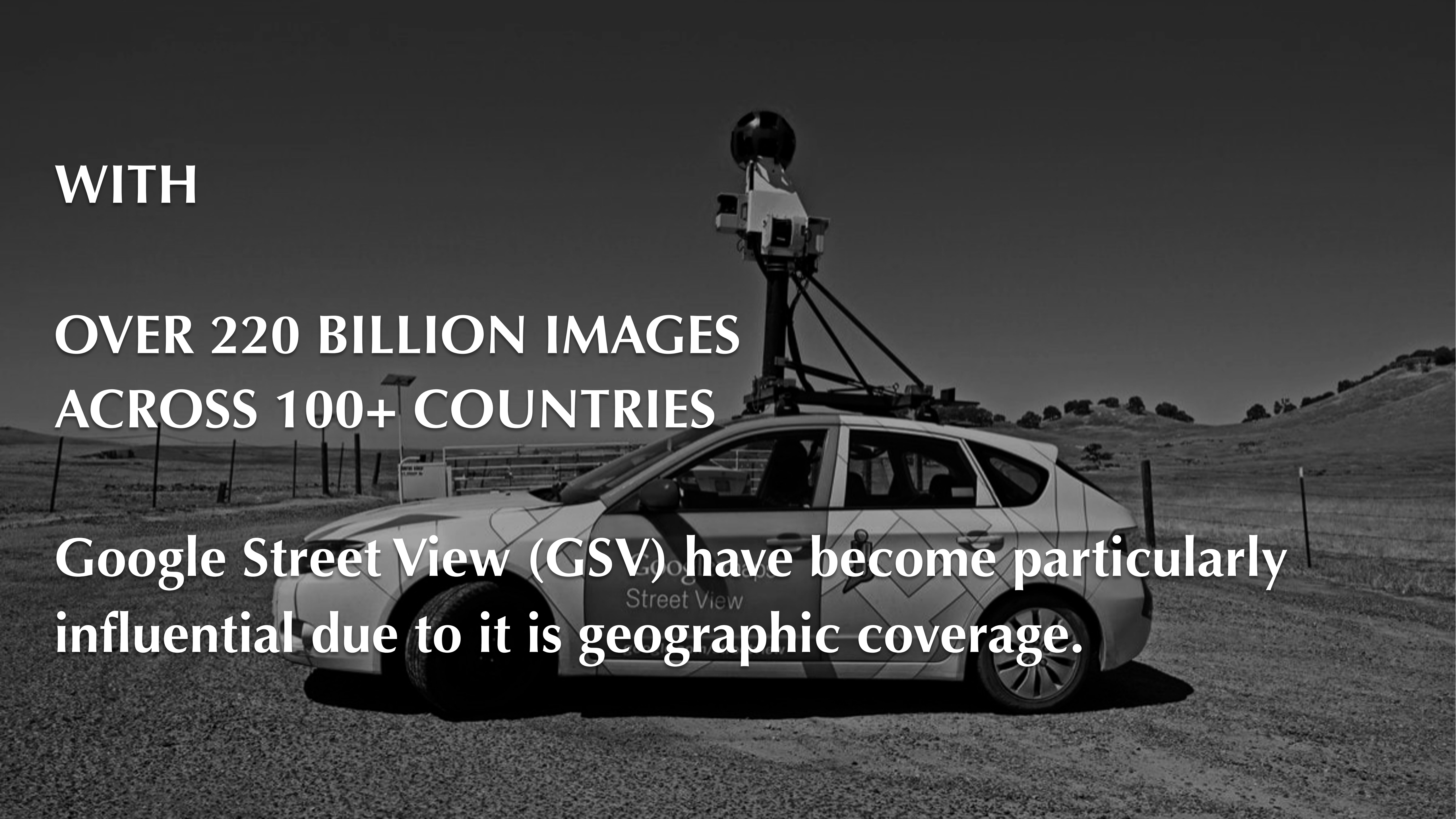
Mapillary (Meta)



Google Street View

Also have…

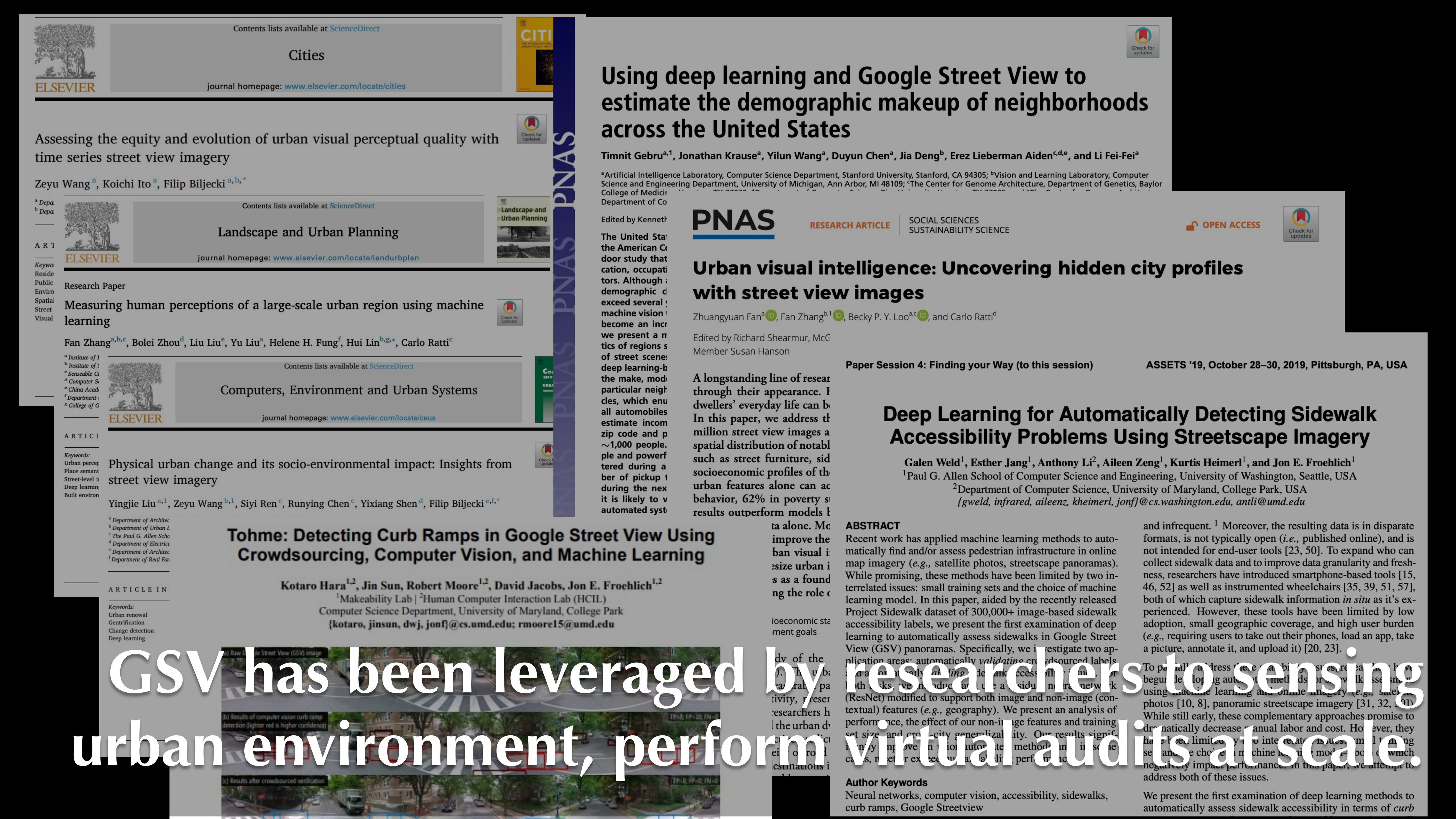
BaiduMaps, KartaView, Grabmaps, etc.



WITH

OVER 220 BILLION IMAGES
ACROSS 100+ COUNTRIES

Google Street View (GSV) have become particularly influential due to it is geographic coverage.


Cities
Assessing the equity and evolution of urban visual perceptual quality with time series street view imagery
Zeyu Wang, Koichi Ito, Filip Biljecki
Landscape and Urban Planning
Research Paper
Measuring human perceptions of a large-scale urban region using machine learning
Fan Zhang, Bolei Zhou, Liu Liu, Yu Liu, Helene H. Fung, Hui Lin, Carlo Ratti
Computers, Environment and Urban Systems
Physical urban change and its socio-environmental impact: Insights from street view imagery
Yingjie Liu, Zeyu Wang, Siyi Ren, Runying Chen, Yixiang Shen, Filip Biljecki
Using deep learning and Google Street View to estimate the demographic makeup of neighborhoods across the United States
Timnit Gebru, Jonathan Krause, Yilun Wang, Duyun Chen, Jia Deng, Erez Lieberman Aiden, and Li Fei-Fei
PNAS
RESEARCH ARTICLE
SOCIAL SCIENCES
SUSTAINABILITY SCIENCE
OPEN ACCESS
Urban visual intelligence: Uncovering hidden city profiles with street view images
Zhuangyuan Fan, Fan Zhang, Becky P. Y. Loo, and Carlo Ratti
Paper Session 4: Finding your Way (to this session)
ASSETS '19, October 28–30, 2019, Pittsburgh, PA, USA
Deep Learning for Automatically Detecting Sidewalk Accessibility Problems Using Streetscape Imagery
Galen Weld, Esther Jang, Anthony Li, Aileen Zeng, Kurtis Heimerl, and Jon E. Froehlich
Tohme: Detecting Curb Ramps in Google Street View Using Crowdsourcing, Computer Vision, and Machine Learning
Kotaro Hara, Jin Sun, Robert Moore, David Jacobs, Jon E. Froehlich
GSV has been leveraged by researchers to sensing urban environment, perform virtual audits at scale.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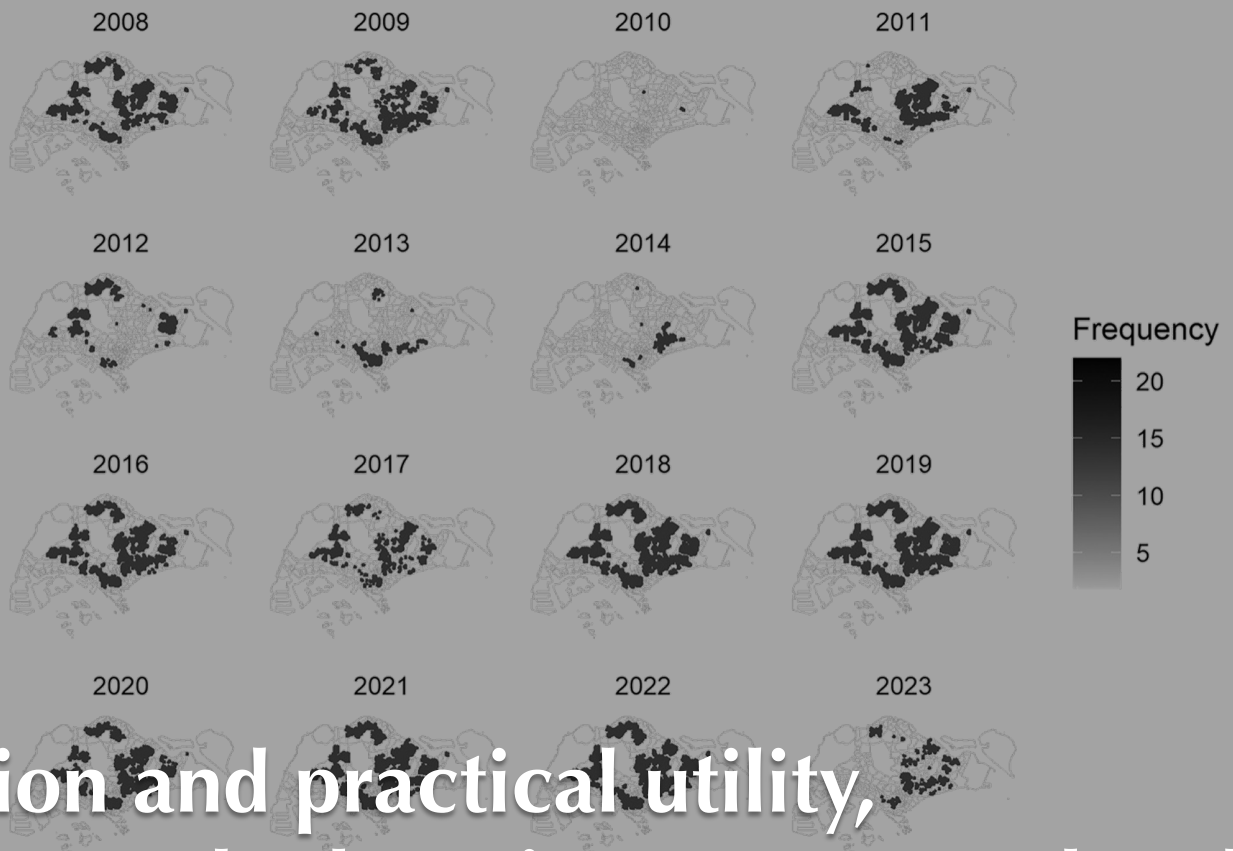
COMMENT | 13 August 2023

Putting Africa on the map

A lack of street view imagery in many countries mean valuable data isn't available to researchers.

By Mette Bendixen, Tawanda Kanhema & Lars L. Iversen

The spatio-temporal distribution of images retrieved from Google Street View in Singapore

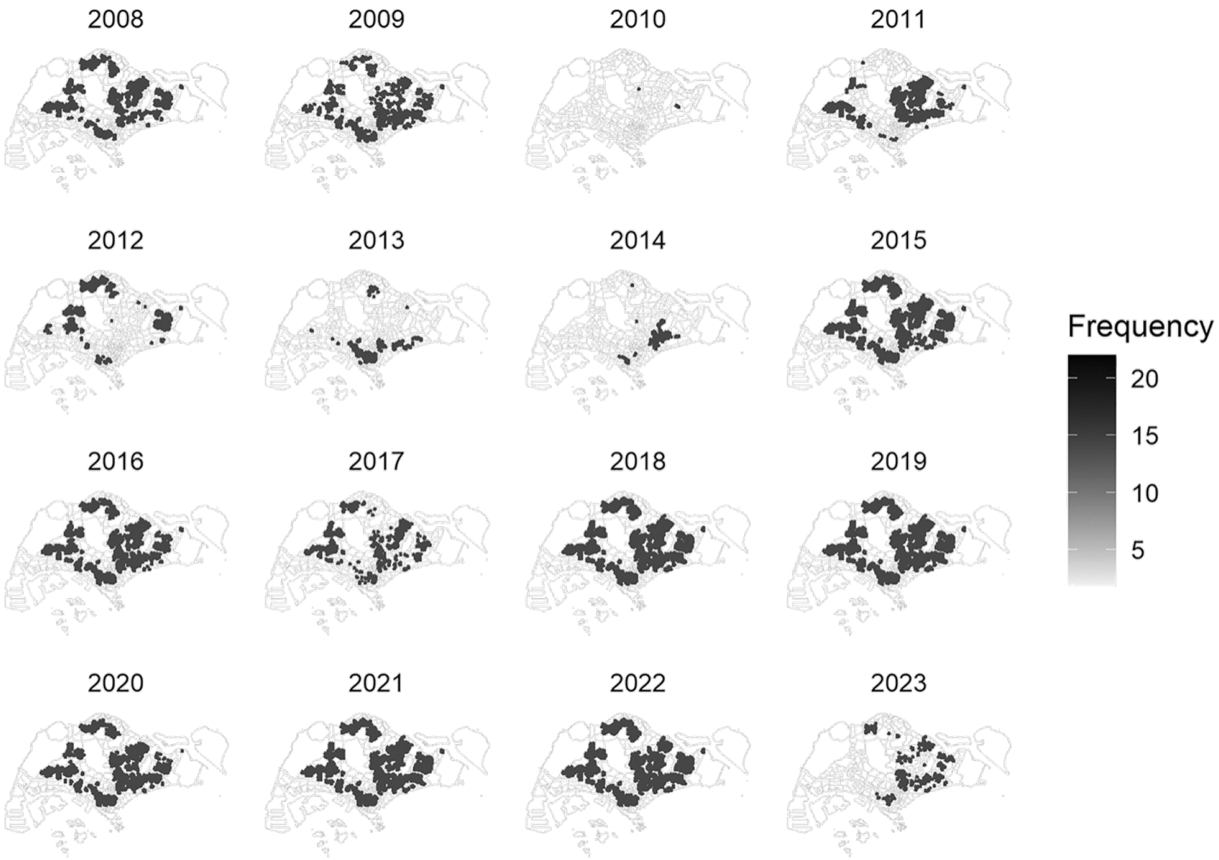


Despite GSV's widespread adoption and practical utility, disparities in how frequently or recently these images are updated across neighborhoods and cities remain largely unexamined.

Source: Wang, Z., Ito, K., & Biljecki, F. (2024). Assessing the equity and evolution of urban visual perceptual quality with time series street view imagery. *Cities*, *145*, 104704.

Such disparities may reflect deeper inequalities in the digital representation of urban spaces, potentially biasing downstream analyses and influencing policy decisions.

The spatio-temporal distribution of images retrieved from Google Street View in Singapore



Source: Wang, Z., Ito, K., & Biljecki, F. (2024). Assessing the equity and evolution of urban visual perceptual quality with time series street view imagery. *Cities*, *145*, 104704.

Gaps

➔ Lack scalable and reproducible frameworks for integrating standardized demographic data with SVI metadata.

➔ Most analyses are limited to specific cities or regions, preventing broader geographic comparisons.

➔ Lacks accessible, interactive tools for transparent exploration of spatial representation patterns.

We developed a scalable framework that integrates GSV metadata with standardized ACS data at the census block group level, enabling comparisons across urban contexts while providing an interactive platform for exploration of spatial disparities.

Pipeline

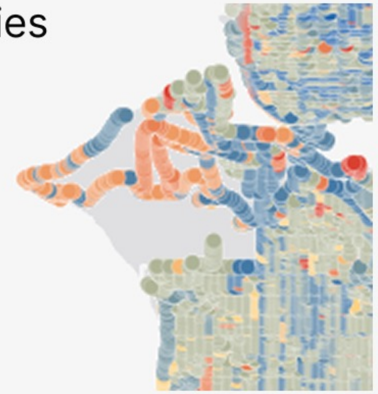
```
{bbox| min lat,
max lat, min lon,
max lon}
```

City Bounding Box (OSM)

Queries

Google Maps

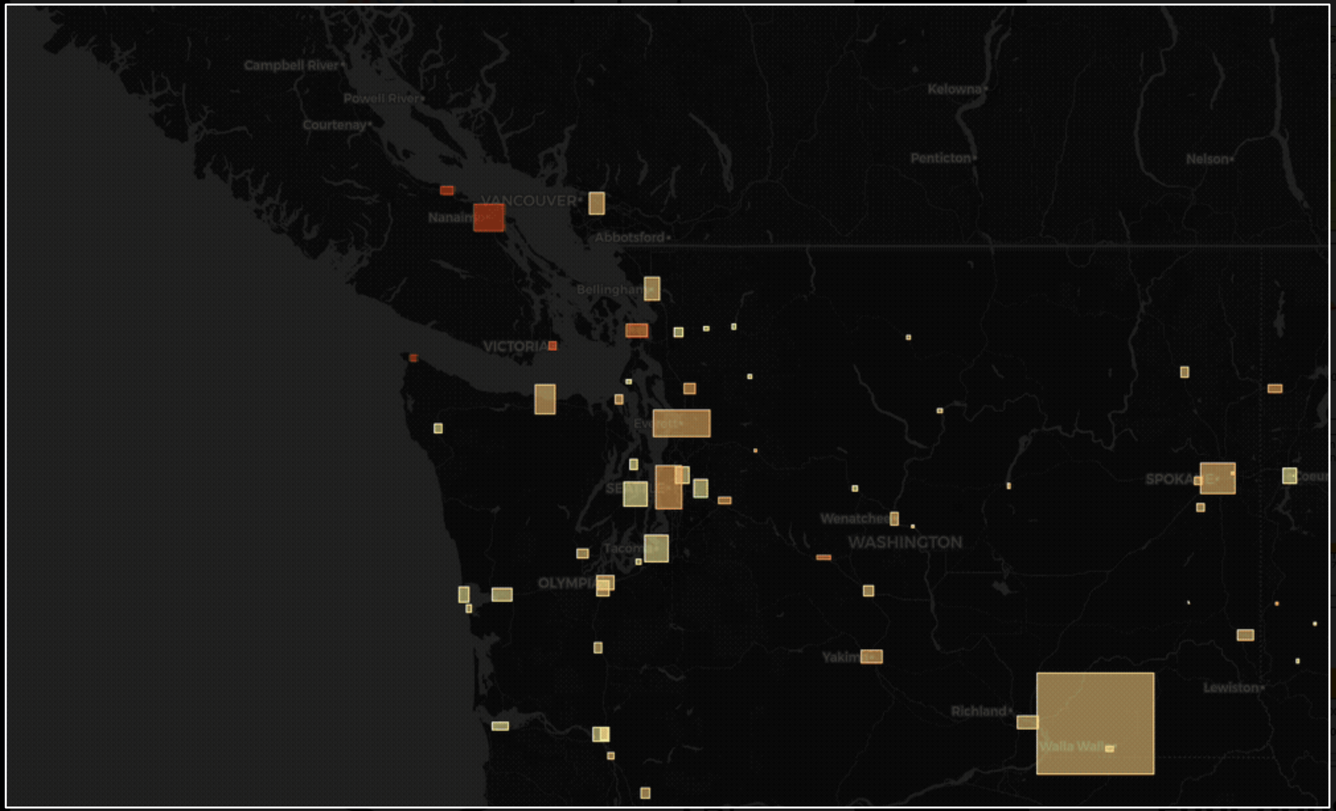
Street View Static API



Latest available GSV metadata

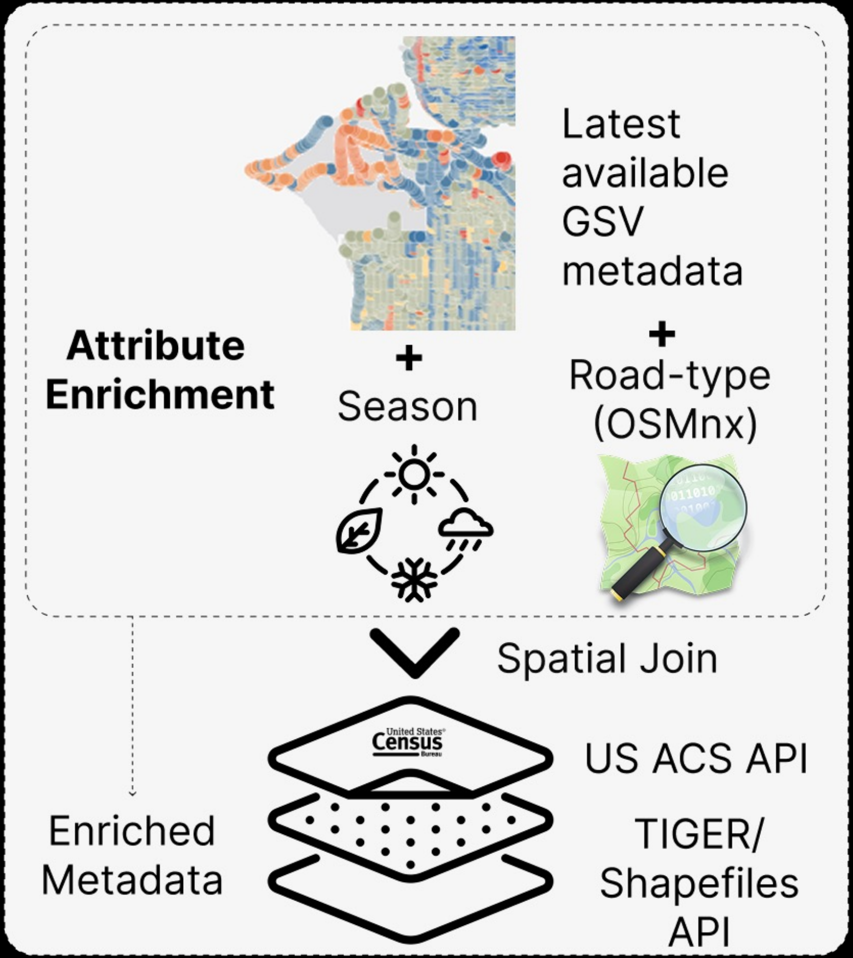
GSVTracker & Downloader

Bounding Boxes



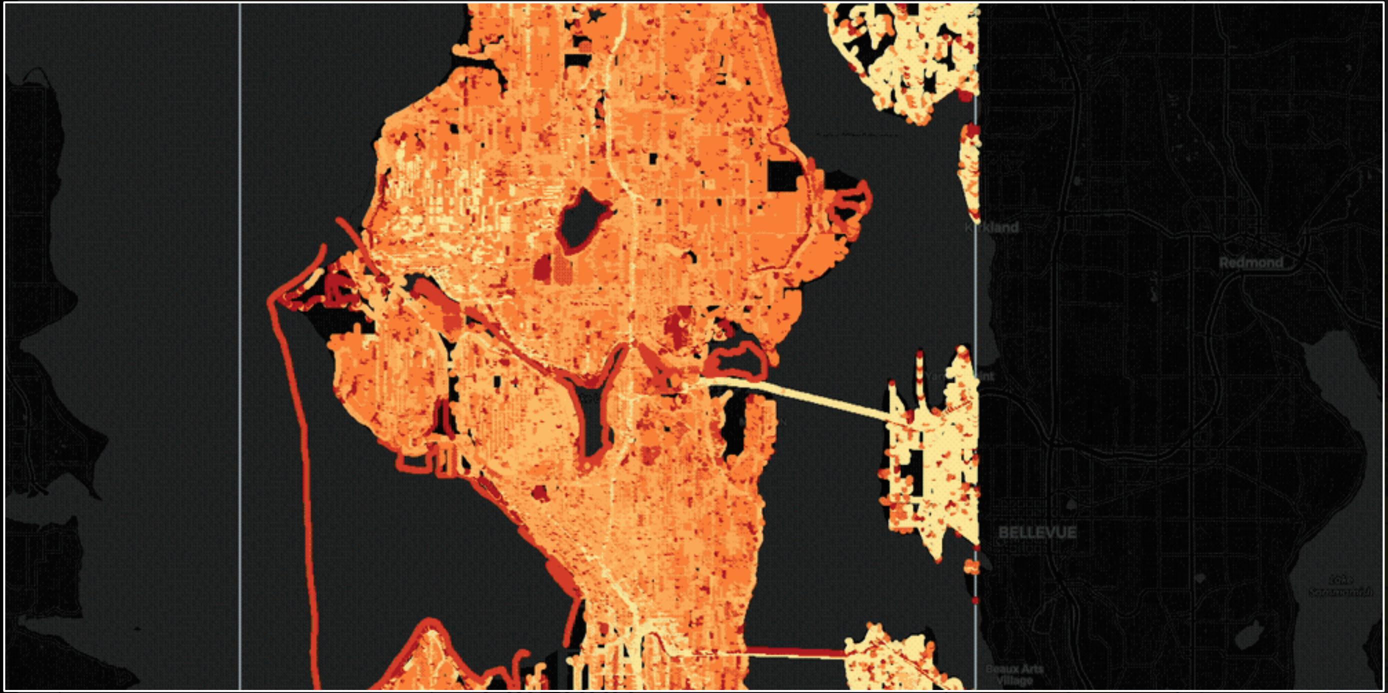
GSVantage
Interactive Tool

Pipeline

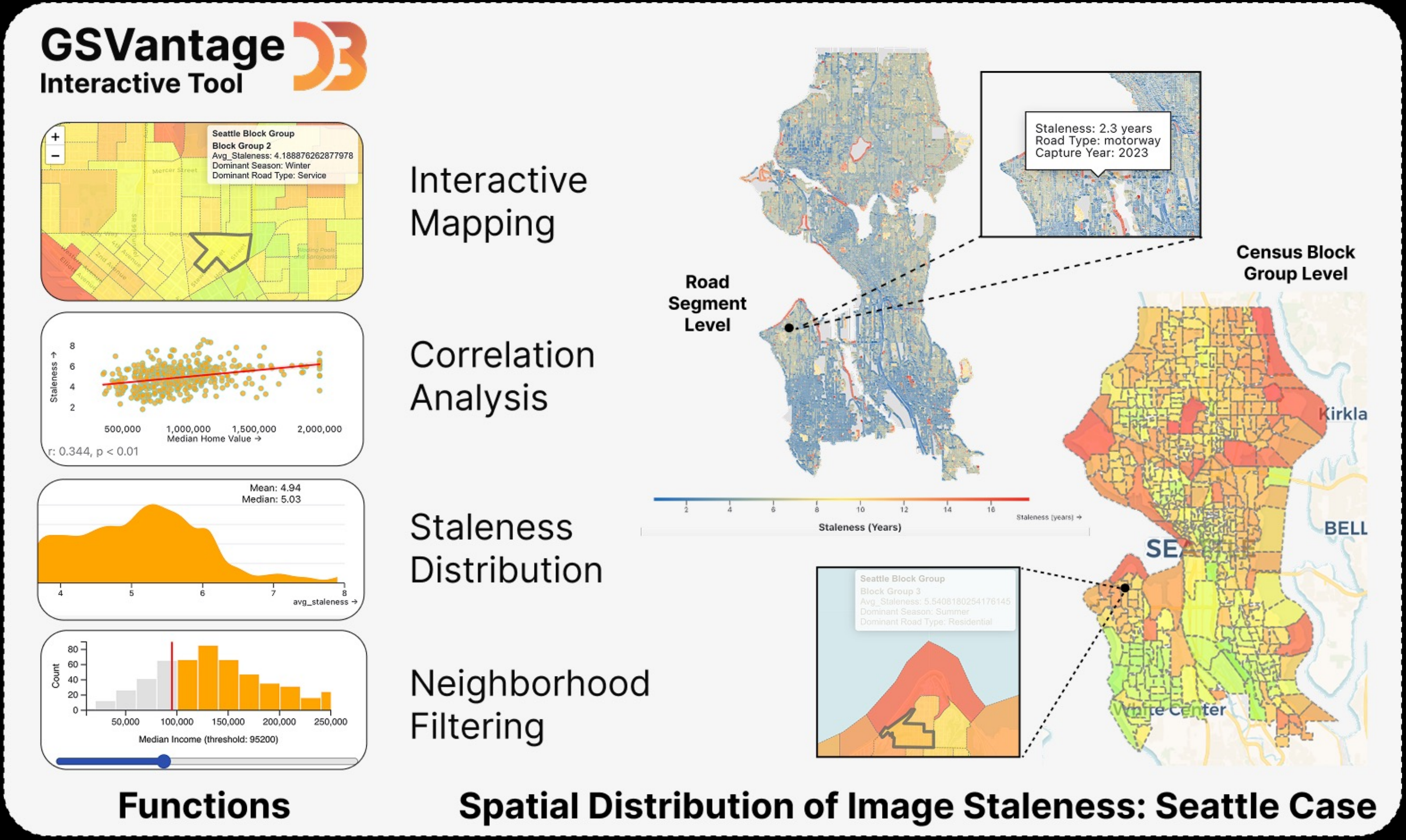


Enrichment & Integration

GSV Metadata

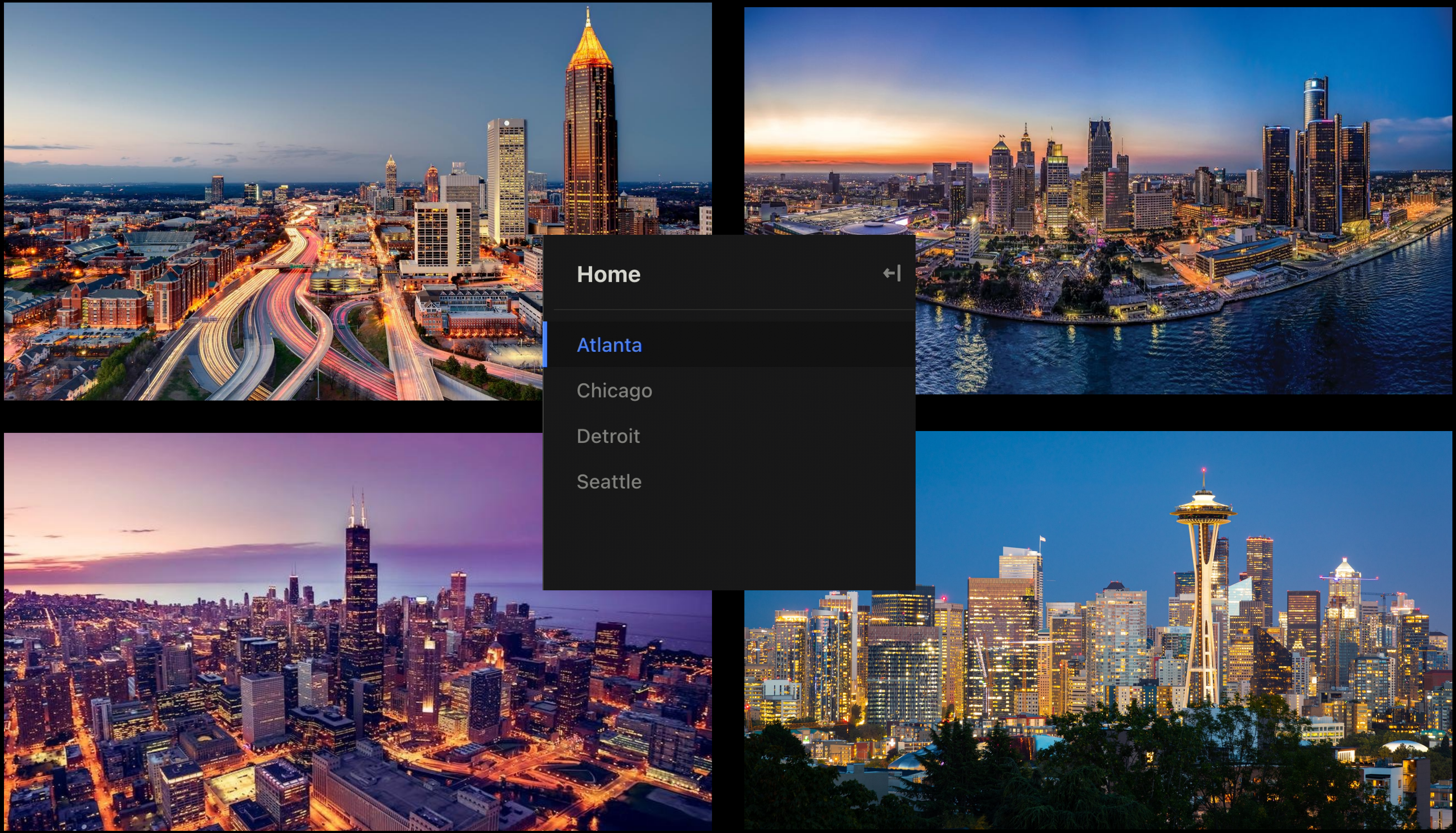


Pipeline

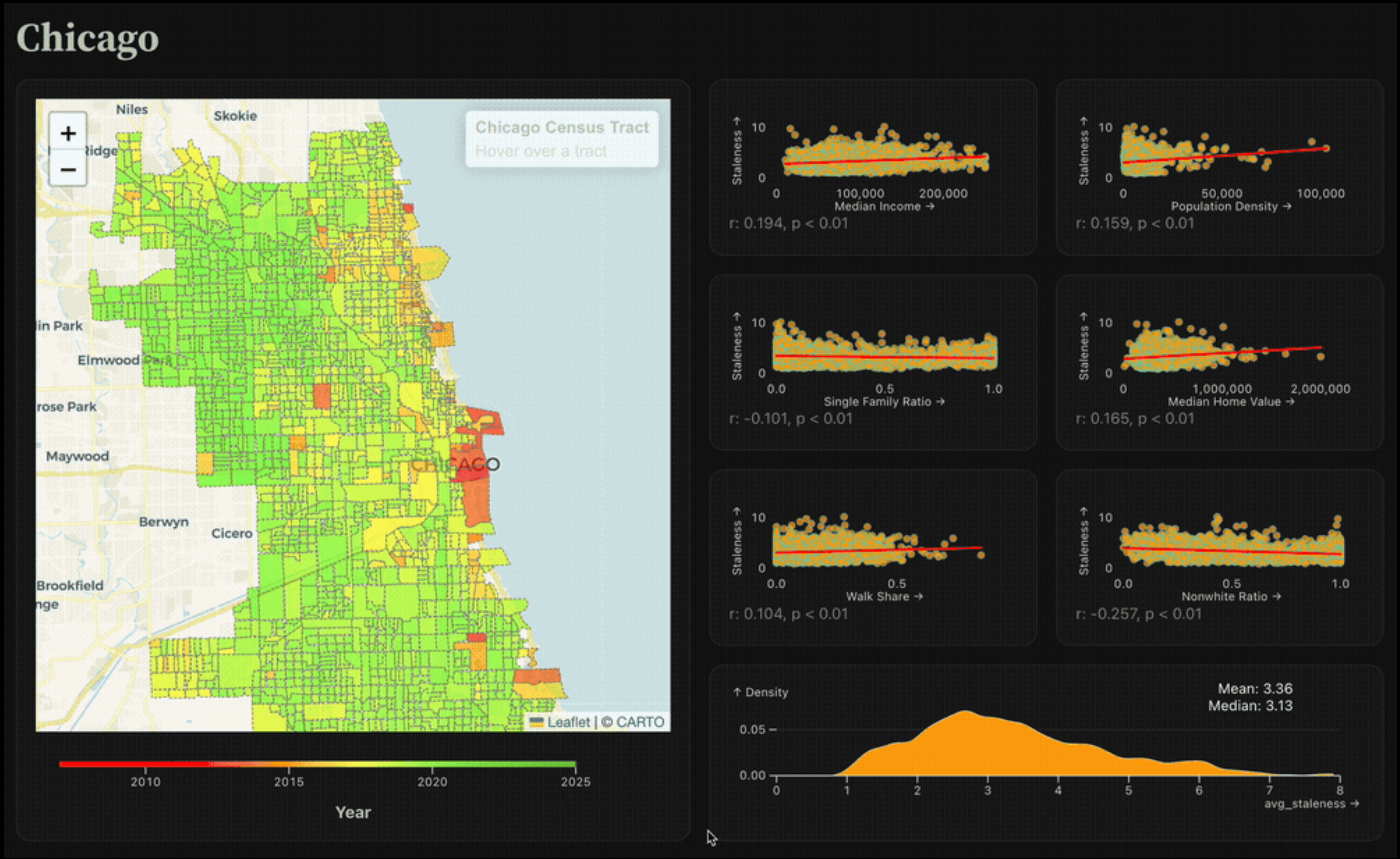


Correlation Analysis &
Visual Analytics Dashboard

Demo

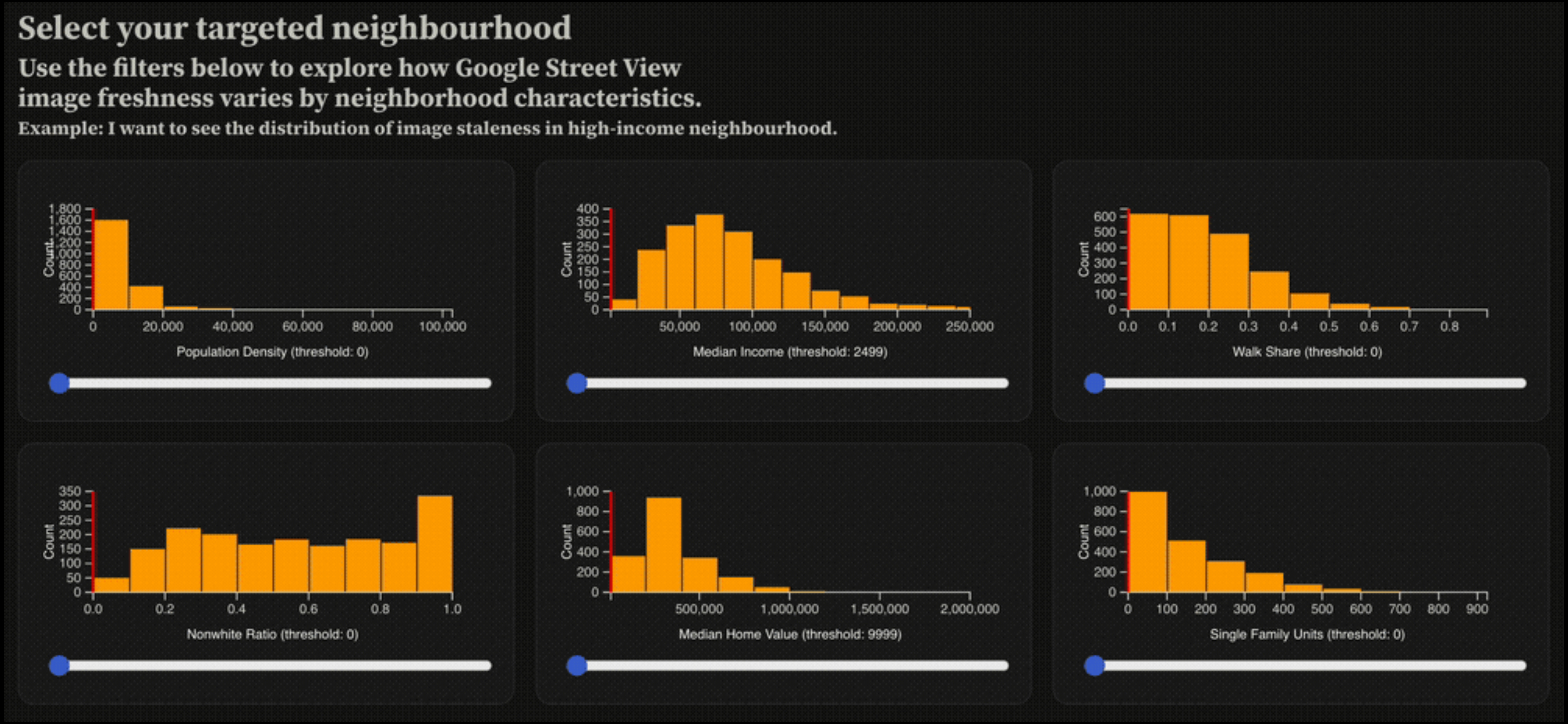


Demo

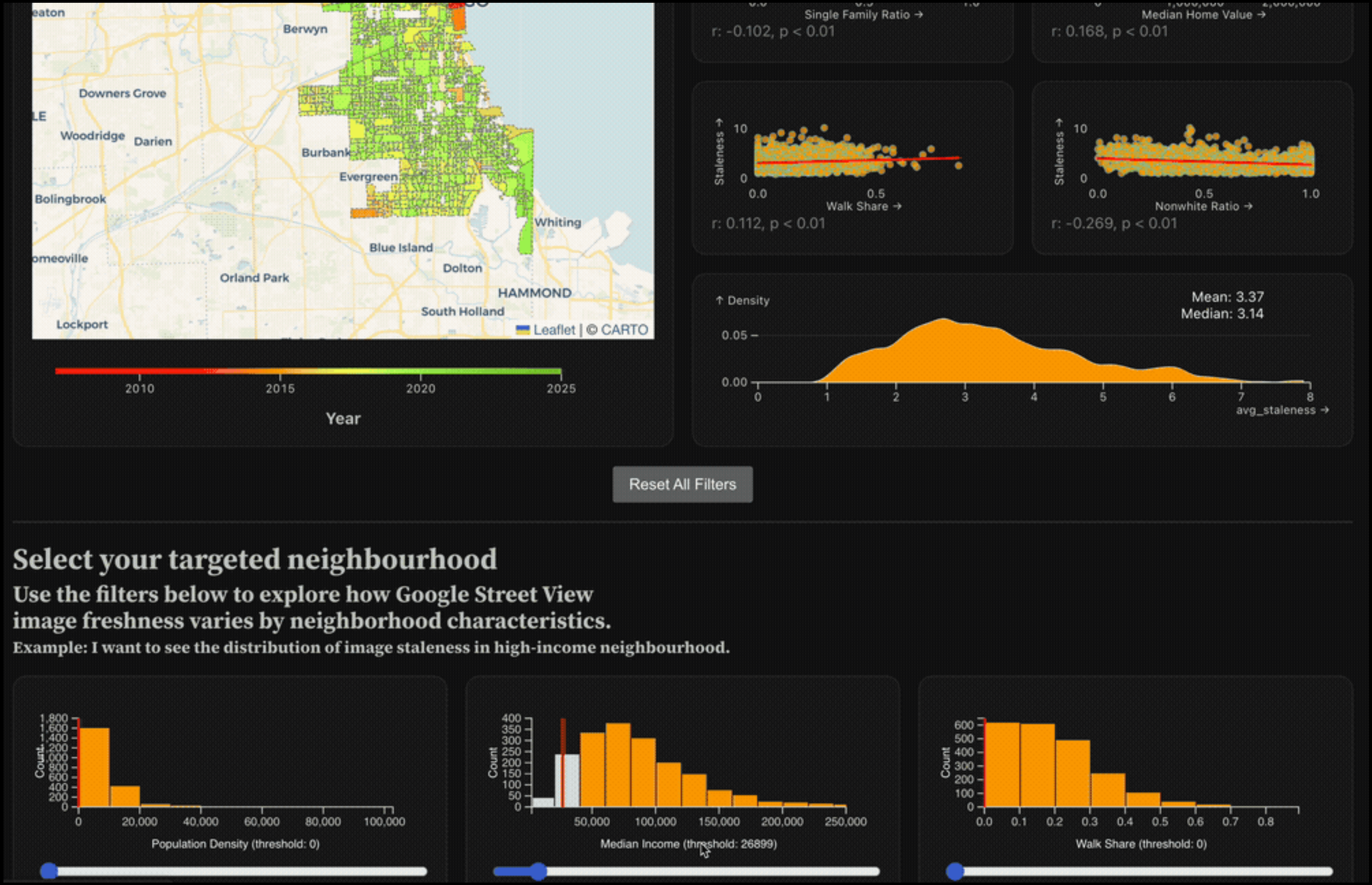


Chicago
Chicago Census Tract
Hover over a tract
Niles
Skokie
Elmwood Park
Maywood
Berwyn
Cicero
Brookfield
CHICAGO
Leaflet | © CARTO
2010
2015
2020
2025
Year
Staleness
Median Income
r: 0.194, p < 0.01
Population Density
r: 0.159, p < 0.01
Single Family Ratio
r: -0.101, p < 0.01
Median Home Value
r: 0.165, p < 0.01
Walk Share
r: 0.104, p < 0.01
Nonwhite Ratio
r: -0.257, p < 0.01
Density
Mean: 3.36
Median: 3.13
avg_staleness

Demo


Select your targeted neighbourhood
Use the filters below to explore how Google Street View
image freshness varies by neighborhood characteristics.
Example: I want to see the distribution of image staleness in high-income neighbourhood.
Count
Population Density (threshold: 0)
Count
Median Income (threshold: 2499)
Count
Walk Share (threshold: 0)
Count
Nonwhite Ratio (threshold: 0)
Count
Median Home Value (threshold: 9999)
Count
Single Family Units (threshold: 0)

Demo



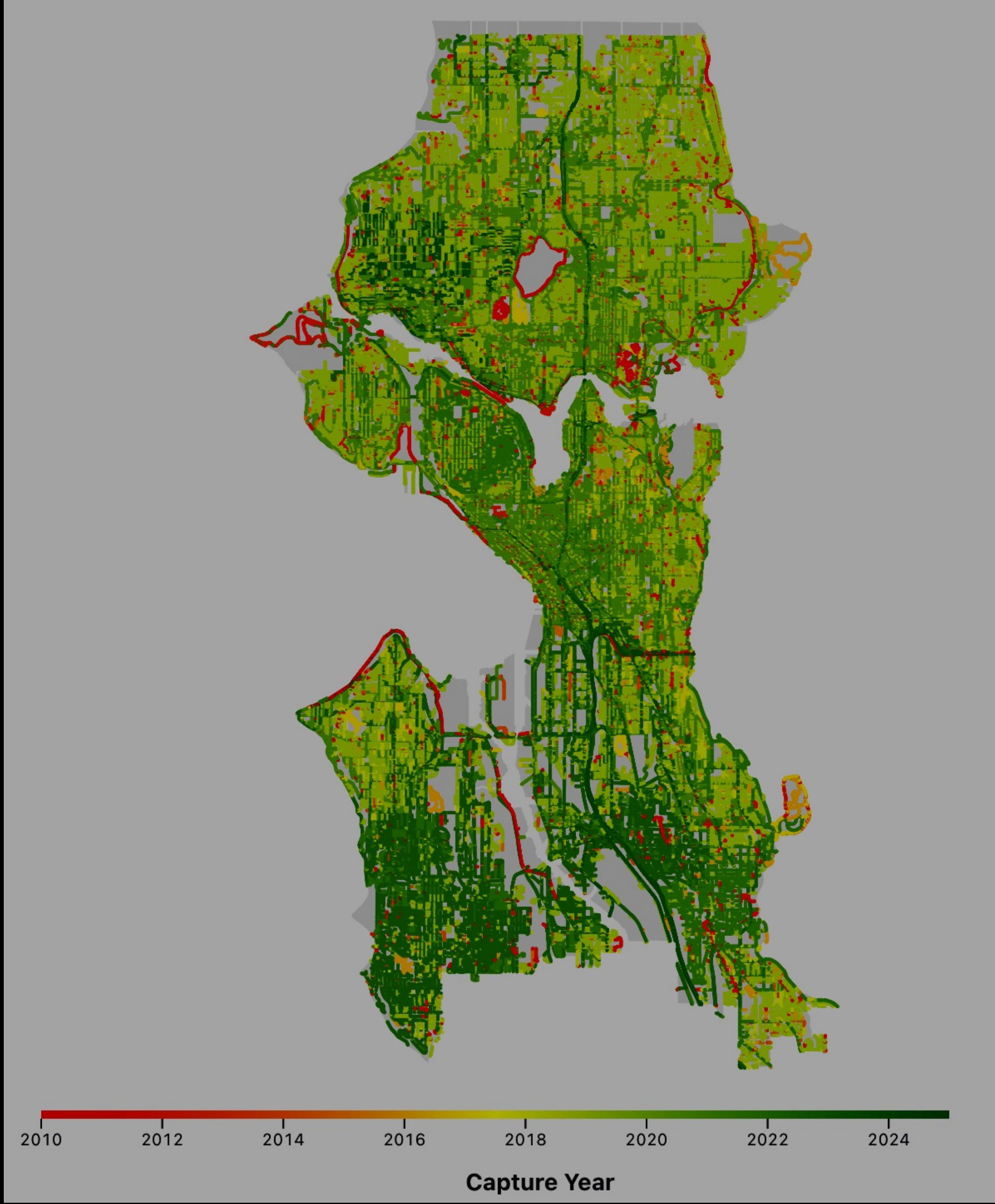
eaton
Berwyn
Downers Grove
Woodridge
Darien
Burbank
Evergreen
Bolingbrook
Whiting
Blue Island
Dolton
Orland Park
HAMMOND
South Holland
Lockport
Leaflet | © CARTO
2010
2015
2020
2025
Year
Single Family Ratio →
r: -0.102, p < 0.01
Median Home Value →
r: 0.168, p < 0.01
Staleness →
Walk Share →
r: 0.112, p < 0.01
Nonwhite Ratio →
r: -0.269, p < 0.01
↑ Density
Mean: 3.37
Median: 3.14
avg_staleness →
Reset All Filters
Select your targeted neighbourhood
Use the filters below to explore how Google Street View image freshness varies by neighborhood characteristics.
Example: I want to see the distribution of image staleness in high-income neighbourhood.
Count
Population Density (threshold: 0)
Median Income (threshold: 26899)
Walk Share (threshold: 0)

Initial Results

We observed a generally consistent "Digital Redlining" pattern in Google's SVI update frequency.

Neighborhoods that are higher-income, higher-value, pre-dominantly single-family, or suburban tend to exhibit higher image staleness;

while denser, pedestrian-oriented, and higher-minority communities receive more regular updates.

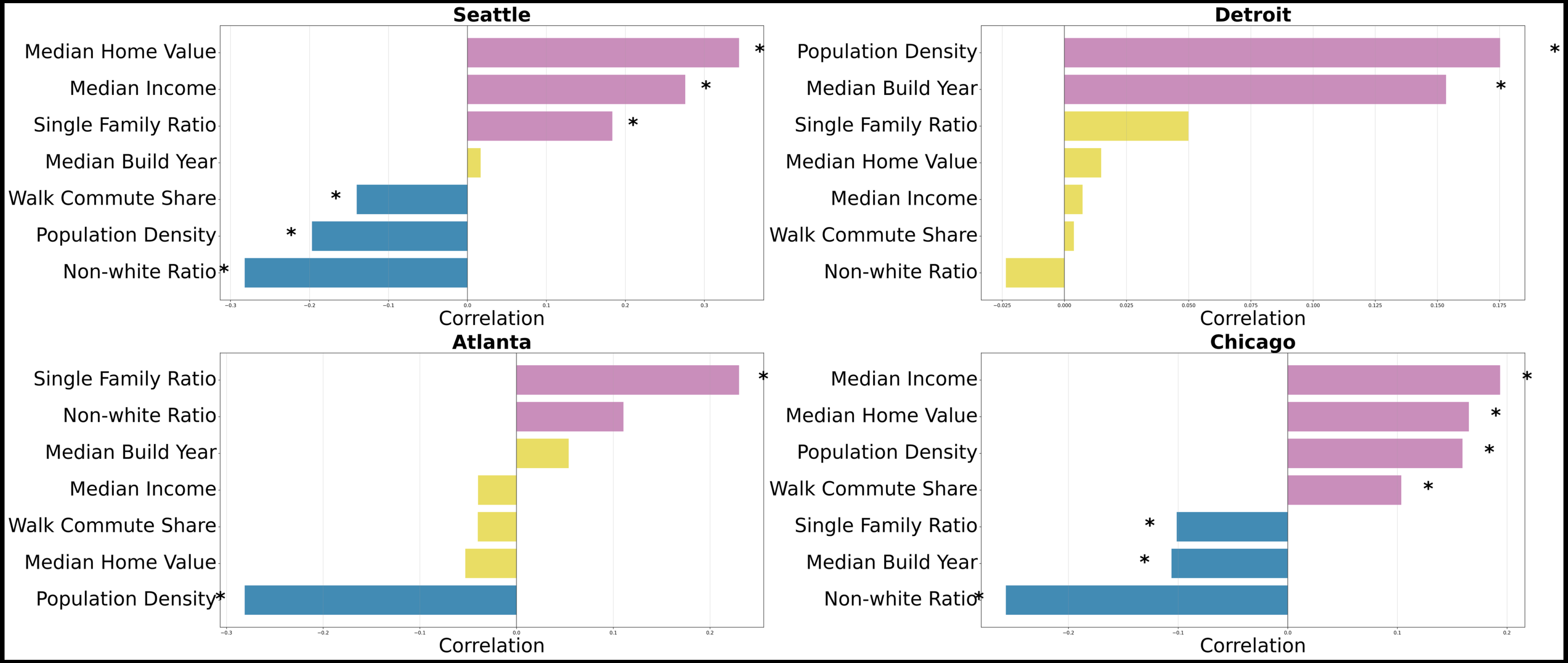


Initial Results: Are GSV updates spatially equitable?

Sufficient observations (N) | $N_{\text{Atlanta}} = 425$, $N_{\text{Chicago}} = 2142$, $N_{\text{Detroit}} = 622$, $N_{\text{Seattle}} = 537$

Consistent trends (Seattle, Chicago, Atlanta):

- ↑ Median Income / Home Value / Single-Family Ratio → **Older imagery**
- ↑ Population Density / Walk Commute Share / Non-white Ratio → **Fresher imagery**
- **Walk Commute Share** = most consistent predictor (r ≈ –0.2 to –0.3)
- Detroit = weaker / mixed results



Contributions

➔ Empirical evidence of spatial inequalities in widely used street-level imagery.

➔ An open-source extensible framework for integrating imagery, metadata with social economic data across diverse contexts.

➔ An interactive visualization tool that promotes transparency and supports audits of digital equity.

Limitations

➔ Spatial dependencies need further modeling.

➔ There may be selection bias in the choice of cities; including more cities would improve generalizability.

➔ Correlation $\neq$ causation.

Thank you

Project Repo

github.com/makeabilitylab/GSVantage

Let's Connect 🙋

LinkedIn

Google Scholar

Makeability Lab

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