Human Networks and Economic Segregation

Gwin Promprated

Introduction

- The United States is very segregated.[1]
- People of different income levels do not interact outside of their income group

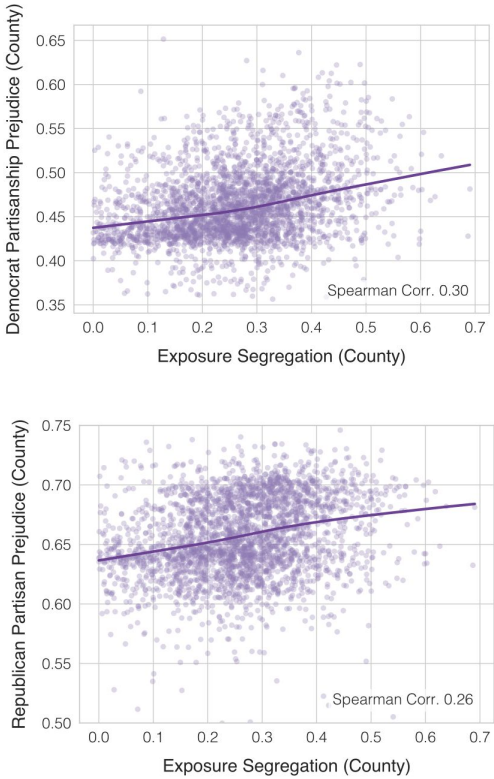
> **Cosmopolitan mixing hypothesis:**
>
> "In large cities, the combination of increased population diversity, constrained space, and accessible public transportation will bring diverse individuals into close physical proximity with one another—reducing everyday socioeconomic segregation."

- **Theory:** Large cities have more interaction between people of different economic levels than smaller cities and towns.
- Is this true?

[1]: I mean, just look at it.

Why do we care?

- Segregation is bad[citation needed]
- Specific reasons:
  - Reduces economic mobility
  - Creates health problems
  - Increases political polarization
- Reducing economic segregation will lead to improved public health and living conditions



(b)

Defining Exposure Segregation

- **Exposure Segregation (ES)**, defined as the extent to which individuals of different economic statuses are exposed to one another, for each geographic area in the U.S.

- Higher ES == More segregated area
- Higher ES == People from different economic brackets don't interact as much.

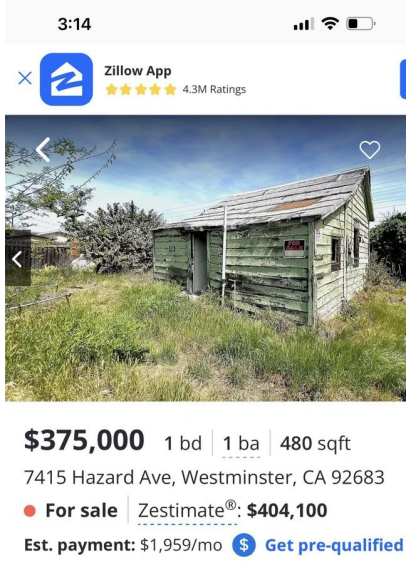
$$Exposure\ Segregation = Corr(SES, \overline{SES}_{exposures}) = \frac{\text{cov}\left(SES, \overline{SES}_{exposures}\right)}{\sigma_{SES}\sigma_{\overline{SES}_{exposures}}}$$

(correlation between the socioeconomic status (SES) of individuals residing in that geographical area, and the mean SES those that they cross paths with.)

Measuring Economic Segregation

- Determine Economic Class:
  - Dox the users
  - Find their address during the nighttime
  - Look up value of that house address on Zillow

- Measure Economic Segregation:
  - Use GPS Pings to track location
  - One interaction counts as being within 50m for at least 5 minutes



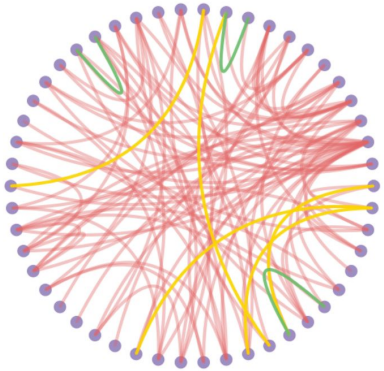
Inferring home location

We first infer a user's home latitude and longitude using their pings during local nighttime hours, based on best

Exposure Network

- Network of all interactions
  - Each node *n* is one of N= 9,567,559 individuals
  - Each connection is one interaction
    - 1,570,782,460 interactions
    - Edge attributes: Time, Latitude, Longitude

- Total Locations: 3211
  - 382 cities
  - 2829 counties



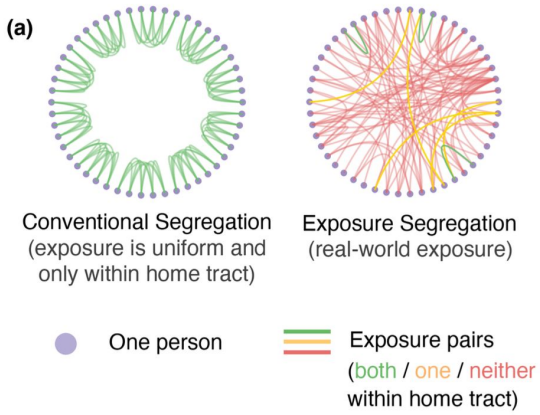
Exposure Segregation
(real-world exposure)

One person

Exposure pairs
(both / one / neither
within home tract)

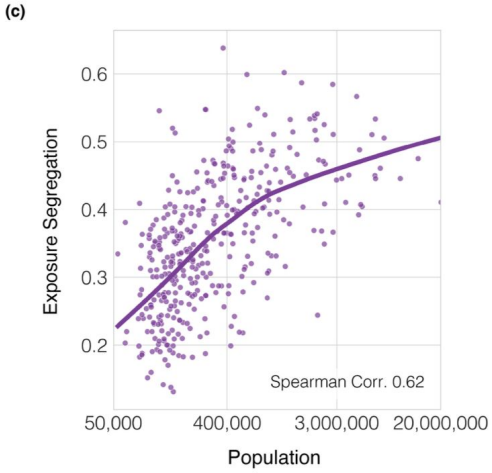
Comparison with other methods

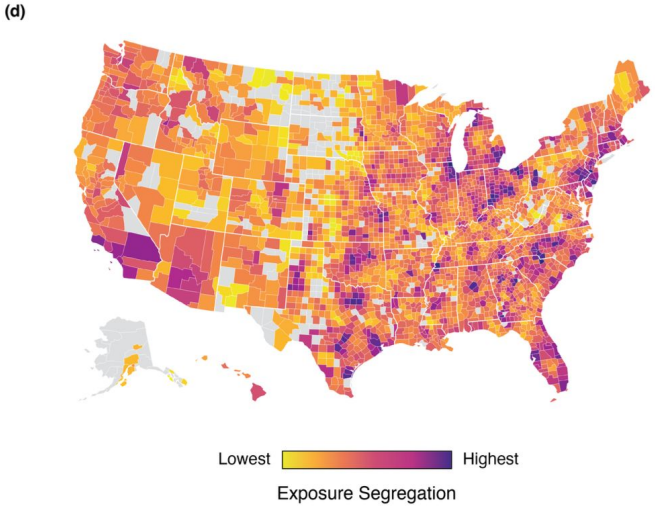
- Previous method of measuring segregation: Neighborhood Sorting Index
  - Assumes uniform and homophilic interactions
- However, most interactions occur outside of home tract
- New method is more robust

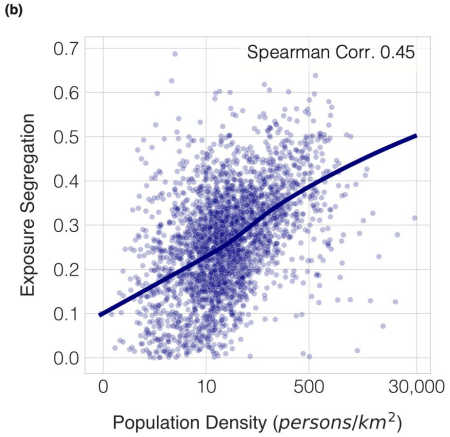


Results

- **"Exposure segregation is extremely high in large cities."**
- "The top 10 largest MSAs, by population size, are 67% more segregated than small MSAs with less than 100,000 residents"







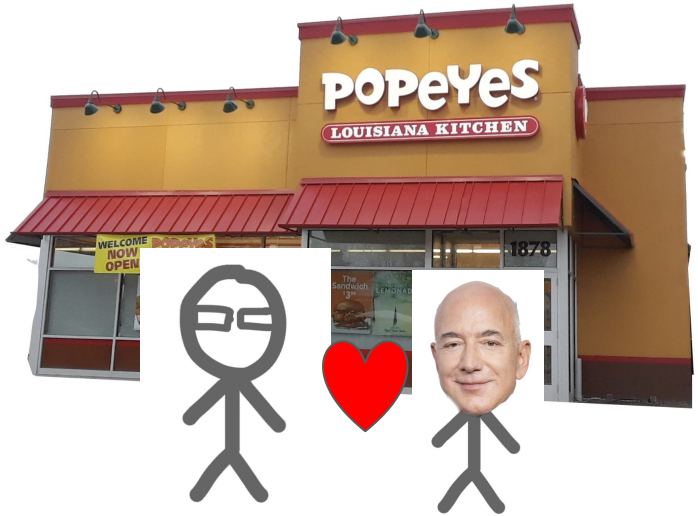
Why?

Gwin
Net Worth: $36.21

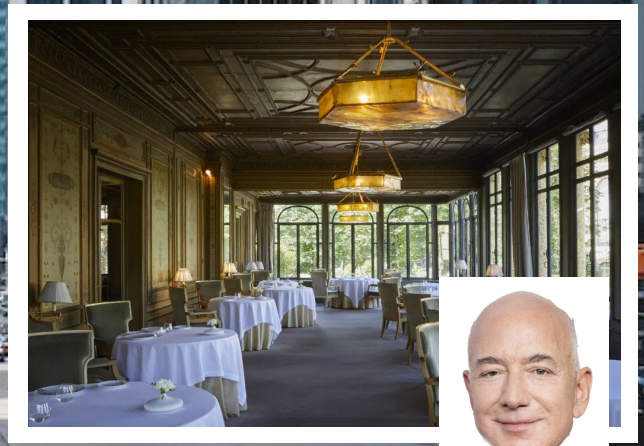
Daddy Bezos
Net Worth:
$169,000,000,000

Small Town (n <= 100,000)

Small Town (n <= 100,000)

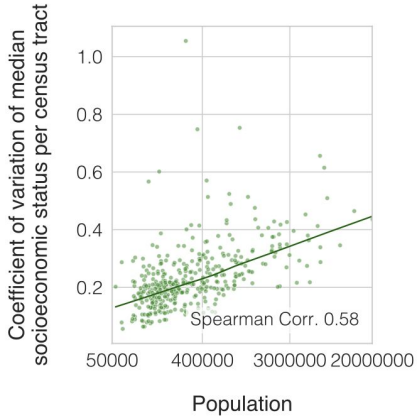


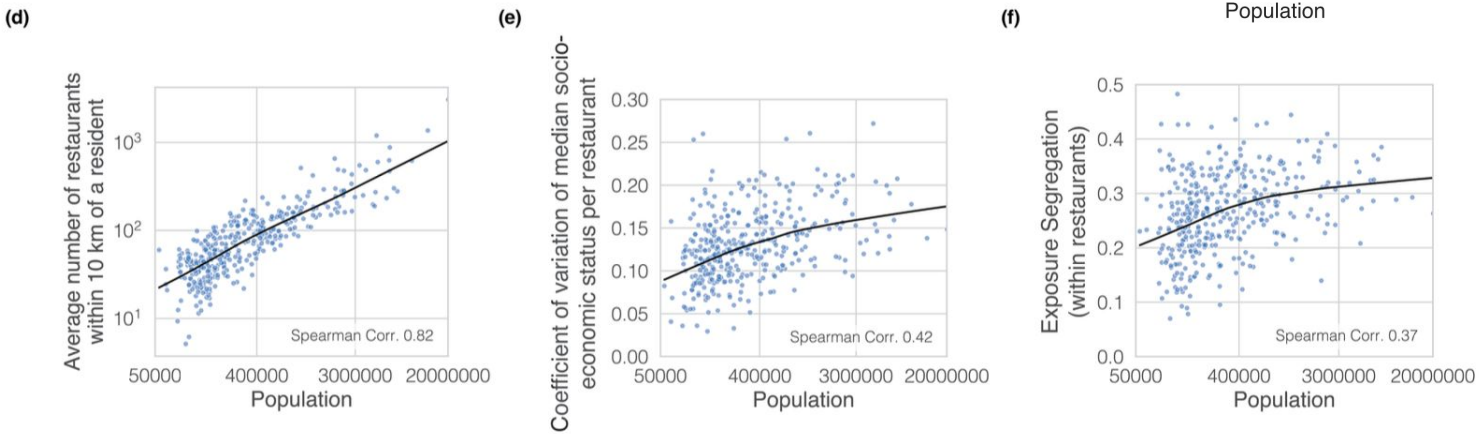
Big Town (n > 1,000,000)



Supporting Data

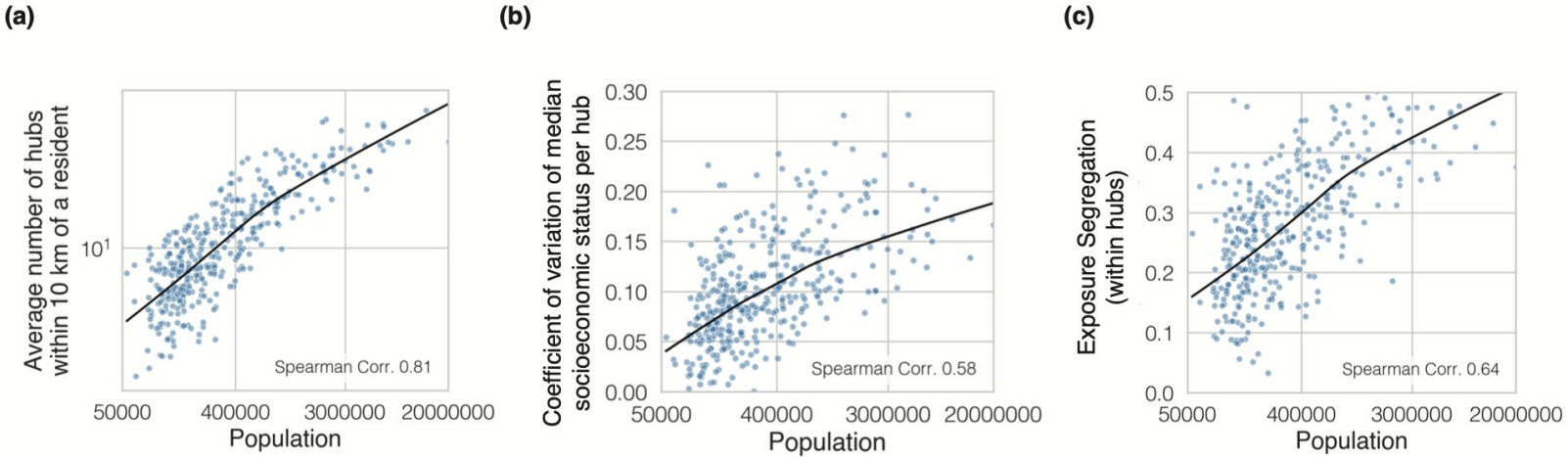
- Higher population correlates
  - Higher variety of restaurants
  - Higher variety of prices per restaurant
  - Higher variety of house prices
  - Higher exposure segregation





Supporting Data

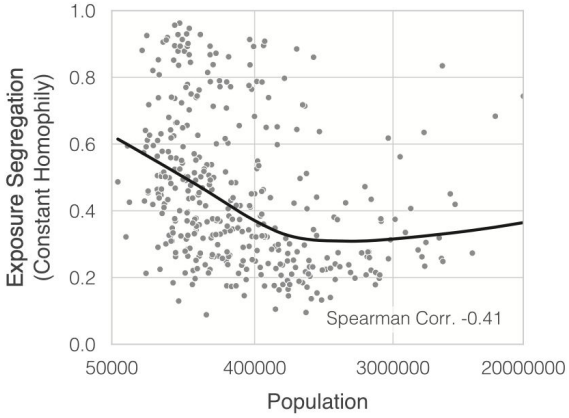
- Applies to all public places, not just restaurants
- Varies among the specific type of exposure hub



Alternate Explanation 1

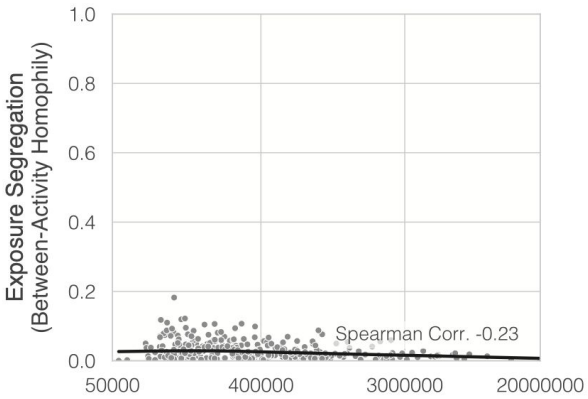
- Constant Homophily Explanation
  - People naturally interact more with people with same economic status
  - Cities have more people of the same economic status
- Test: null network model, in which which we preserve network nodes (individuals and their SES values) but randomize edges
  - Probability of exposure ($p_{i,j}$) between two individuals of ES_i and ES_j

$$p_{i,j} \propto \quad Similarity(ES_i, ES_j) = 1 - \frac{|ES_i - ES_j|}{max(ES) - min(ES)}$$



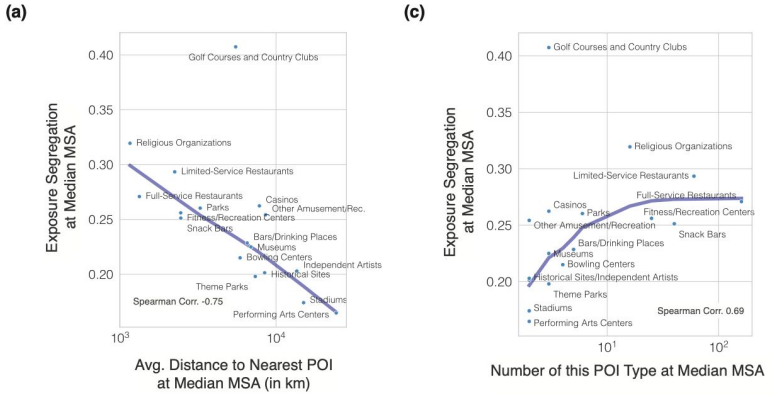
Alternate Explanation 2

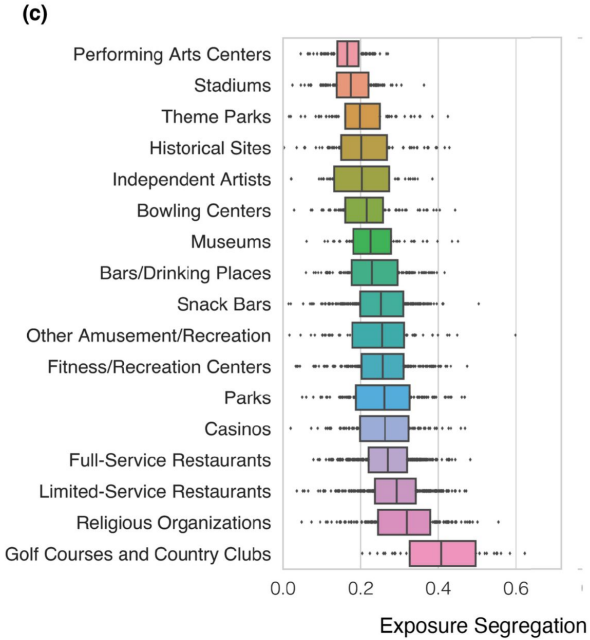
- Between Activity Theory
  - Large cities individuals choose different categories of activities which results in segregation
- Configuration model to configure network edges for each leisure category separately
- Maintain node degree, but filter by activity type
- No positive association between exposure segregation and population size



Breakdown of Different POI Segregation

- Various types of POI have different exposure segregation
- More locations == More segregation
- Farther distance == Less Segregation
  - service small socioeconomically homogeneous communities





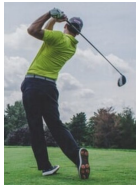
Golf Courses are Expensive

- Golf Courses are outliers (high distance, high economic segregation)
- Range of prices is far greater than any other industry
- Most expensive golf course 11717 times more expensive than cheapest
- Michelin star restaurant only 63 times more expensive than big mac

(c)

Metropolitan Statistical Area (MSA)	POI Name	SES	Minimum Cost of Entrance ($)
Chicago-Naperville-Elgin, IL-IN-WI	Wynstone Golf Club	High	40,000
	Flagg Creek Golf Course	Low	19
Los Angeles-Long Beach-Anaheim, CA	Coto de Caza Golf & Racquet Club	High	45,000
	Rancho Vista Golf Club	Low	129
Miami-Fort Lauderdale-West Palm Beach, FL	Old Palm Golf Club	High	199,200
	Eco Golf Club	Low	17
New York-Newark-Jersey City, NY-NJ-PA	Scarsdale Golf Club	High	8,900
	Weequahic Park Golf Course	Low	35
Phoenix-Mesa-Scottsdale, AZ	The Estancia Club	High	150,000
	Peoria Pines	Low	28

= 63x



= 11717x

Solutions?

- What are some ways to reduce economic segregation?

Bridging Index

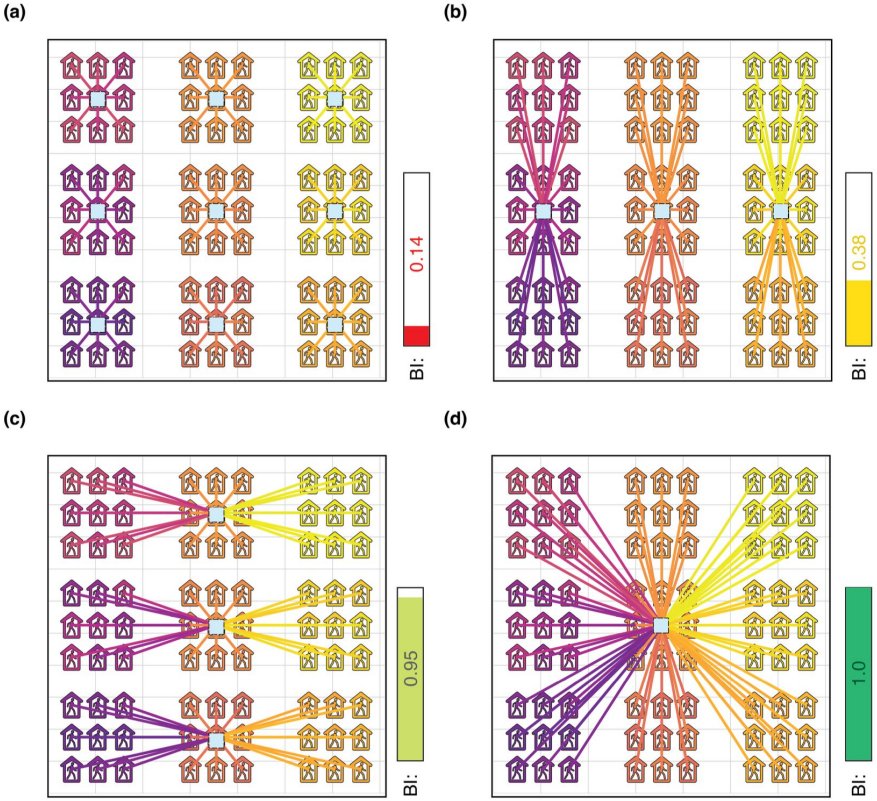
- Place frequently-visited POIs to act as "bridges" between diverse neighborhoods
  - Allows residents of nearby high-SES and low-SES neighborhoods to easily visit and cross paths
- **Bridging Index:** Measurement of how good of a "bridge" a place is

$$Bridging\ Index\ (BI) = \frac{Within\ Hub\ Economic\ Diversity}{Overall\ Economic\ Diversity} = \frac{\sum_{i=1}^{K} |\mathcal{C}_i| \cdot Gini\ Index(\mathcal{C}_i)}{|\mathcal{V}_A| \cdot Gini\ Index(\mathcal{V}_A)}$$

- Top 10 cities with highest BI 53.1% less segregated than 10 cities with lowest BI.

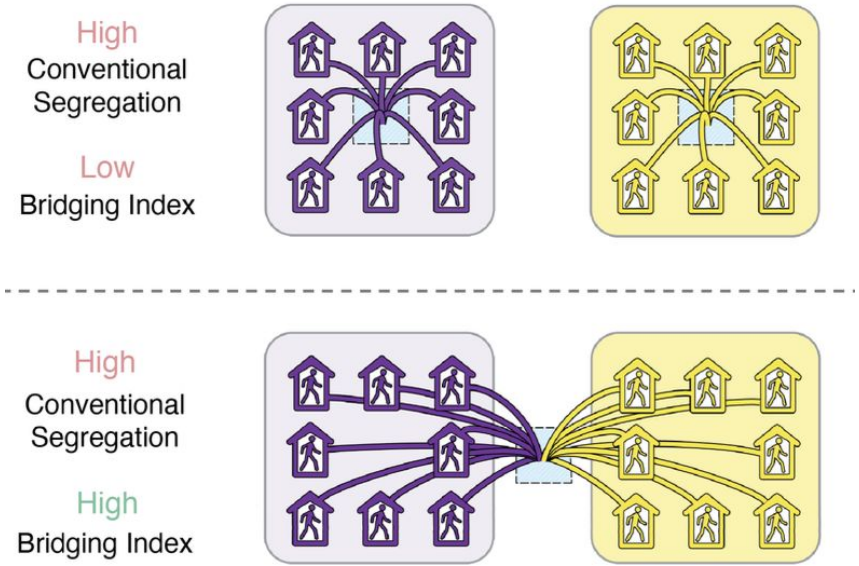
Bridging Index

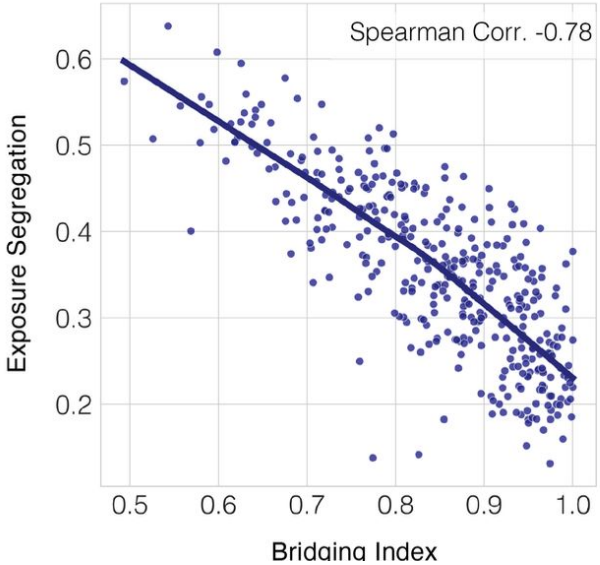
- POI features that contribute to a high bridging index include
  - Low amount of these POI
  - Placement in between different economic area



Bridging Index

- Exposure segregation is negatively correlated with bridging index

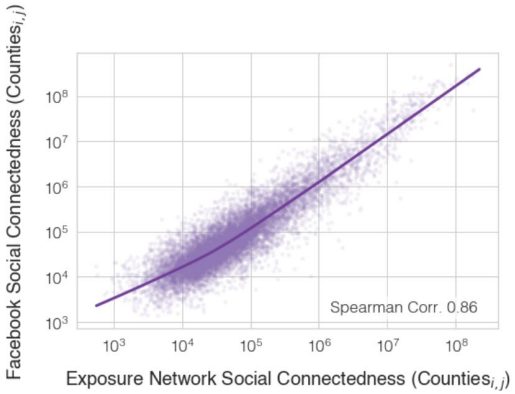


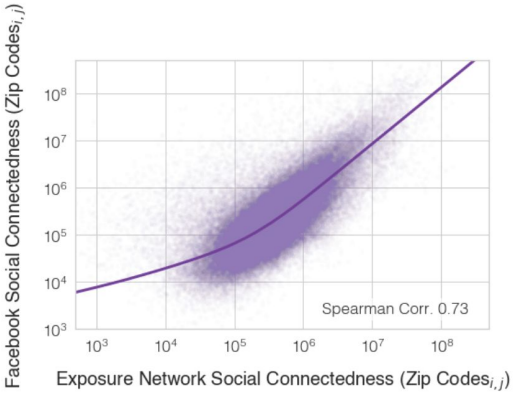


Does this work?

- Exposure Network predicts actual Facebook Social Connectedness
- Facebook Social Connectedness Index measures the relative probability of a Facebook friendship link between a given Facebook user in location i and a given user in location j

- Model shows that more connected (less segregated) communities have more friendships
- Strong correlations suggest that exposure segregation is likely related to segregation of friendships and other strong social ties.





Questions and Discussion

Bibliography

- Nilforoshan, Hamed, et al. "Human mobility networks reveal increased segregation in large cities." *Nature* (2023): 1-7.