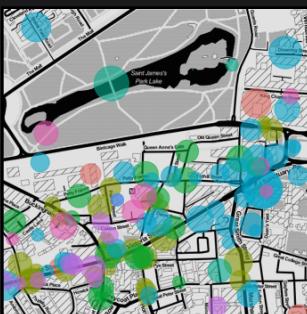
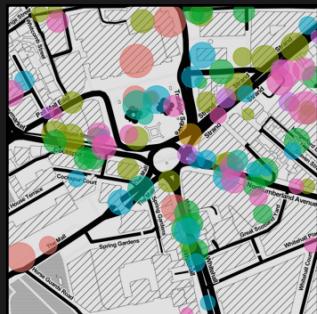
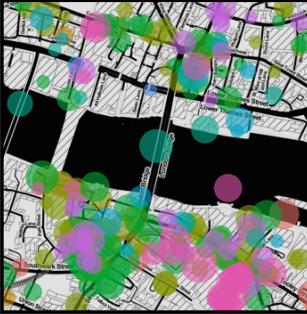


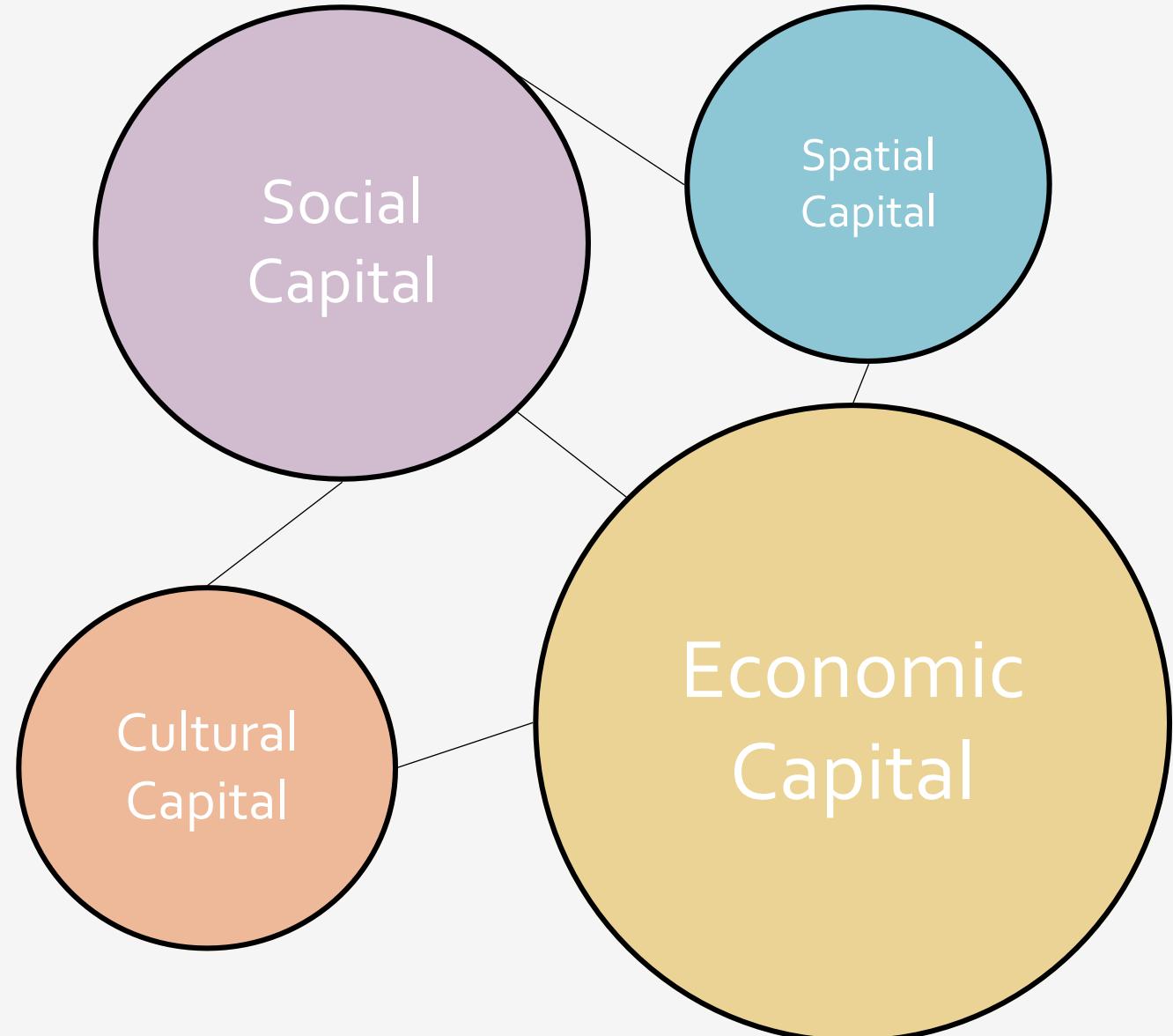
PEOPLE-PLACE NETWORKS: MEASURING SOCIAL, ECONOMIC & CULTURAL CAPITAL IN CITIES



DESLAVA HRISTOVA
DATA SCIENTIST

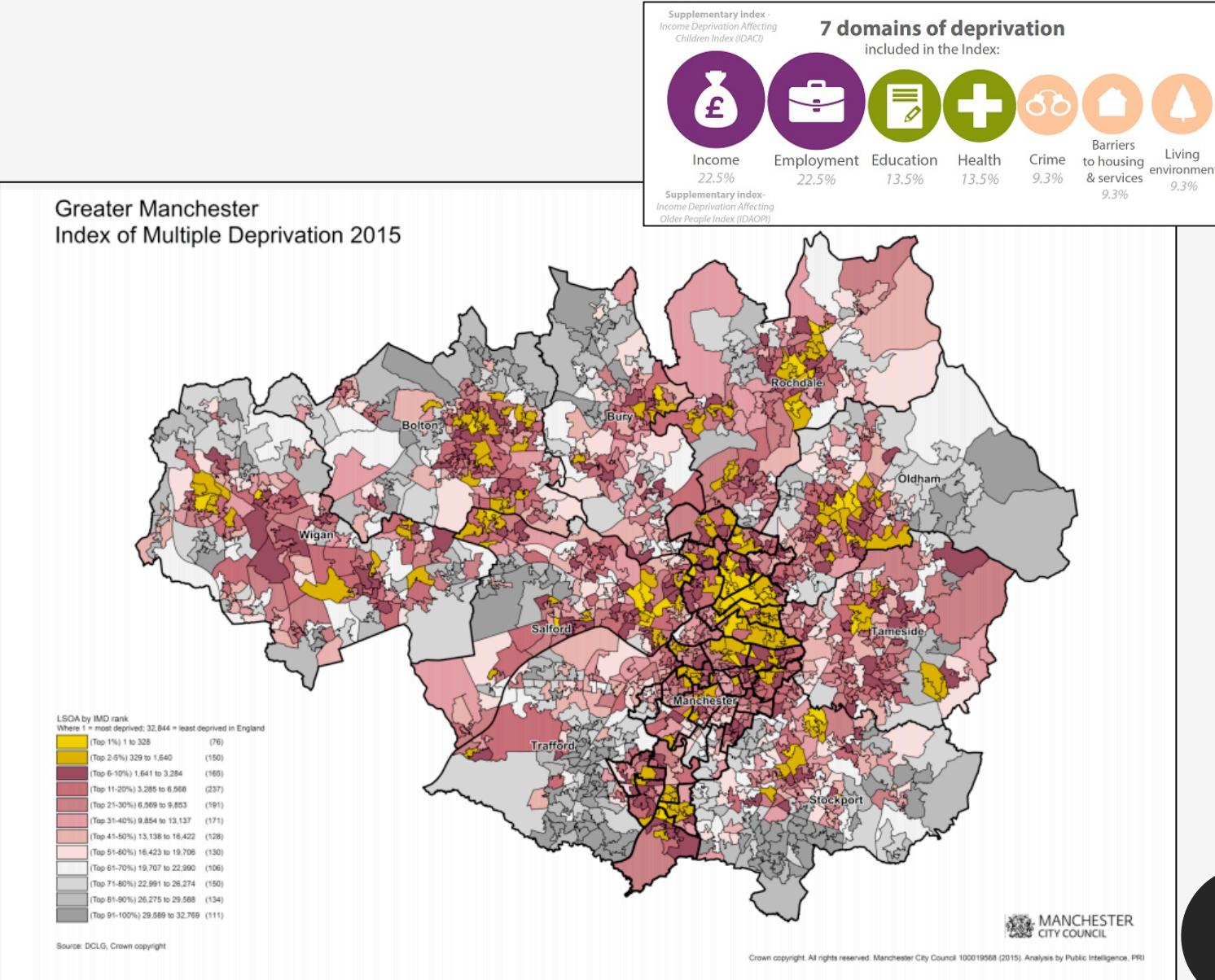
Forms of Urban Capital

What is capital? "That part of a man's stock which he expects to afford him revenue" –Adam Smith, 1759. Forms of capital have been defined across many disciplines – most notably in the field of economics. However, many other forms of symbolic capital have been defined in sociology and urbanism which are all interlinked.



Success & The City

How do we measure success in cities?
Urban development is the process of
social, cultural, economic and
physical development of cities, along with
the underlying causes of this process...



Success or failure?: Symptoms of Gentrification

- Influx of more affluent residents
- Displacement of original residents
- Population demographics diversity
- Employment industry of new residents
- Lowering deprivation and crime rates
- Rapid increase in housing prices
- Proliferation of amenities (coffee shops)
- Economic growth and investment
- Social media, Airbnb, Uber?

Ruth Glass (1964). London: aspects of change. London: MacGibbon & Kee.

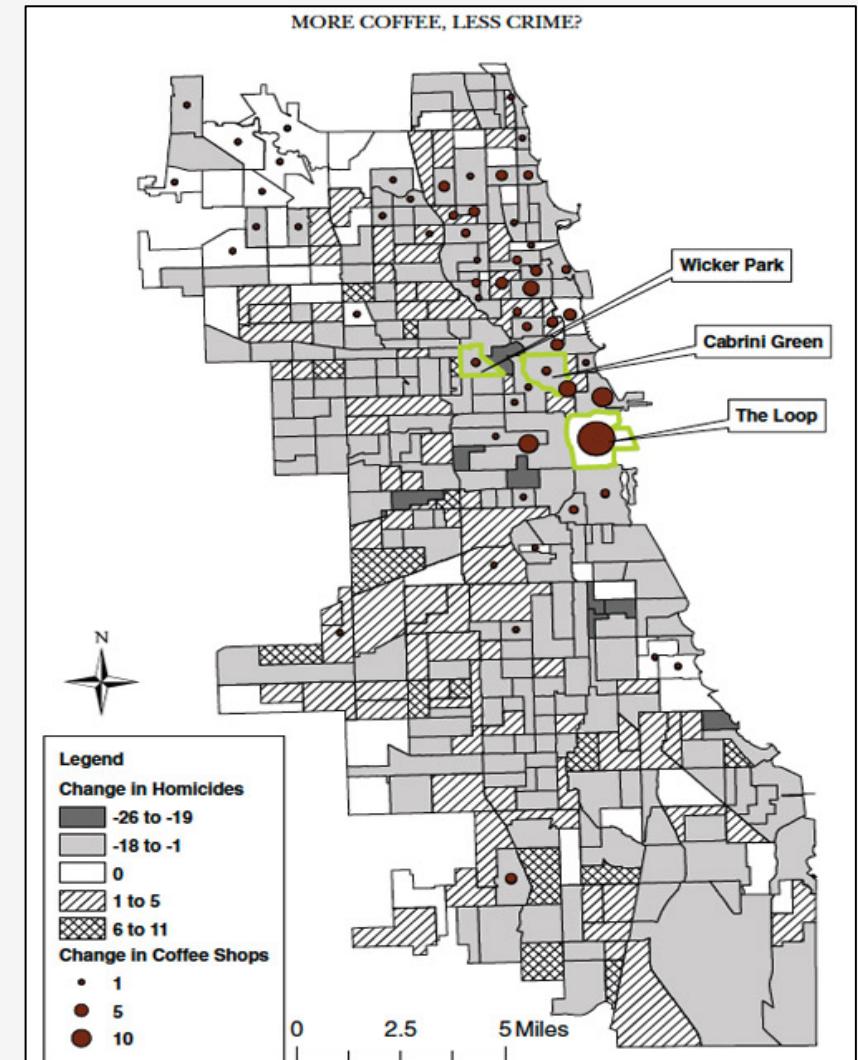
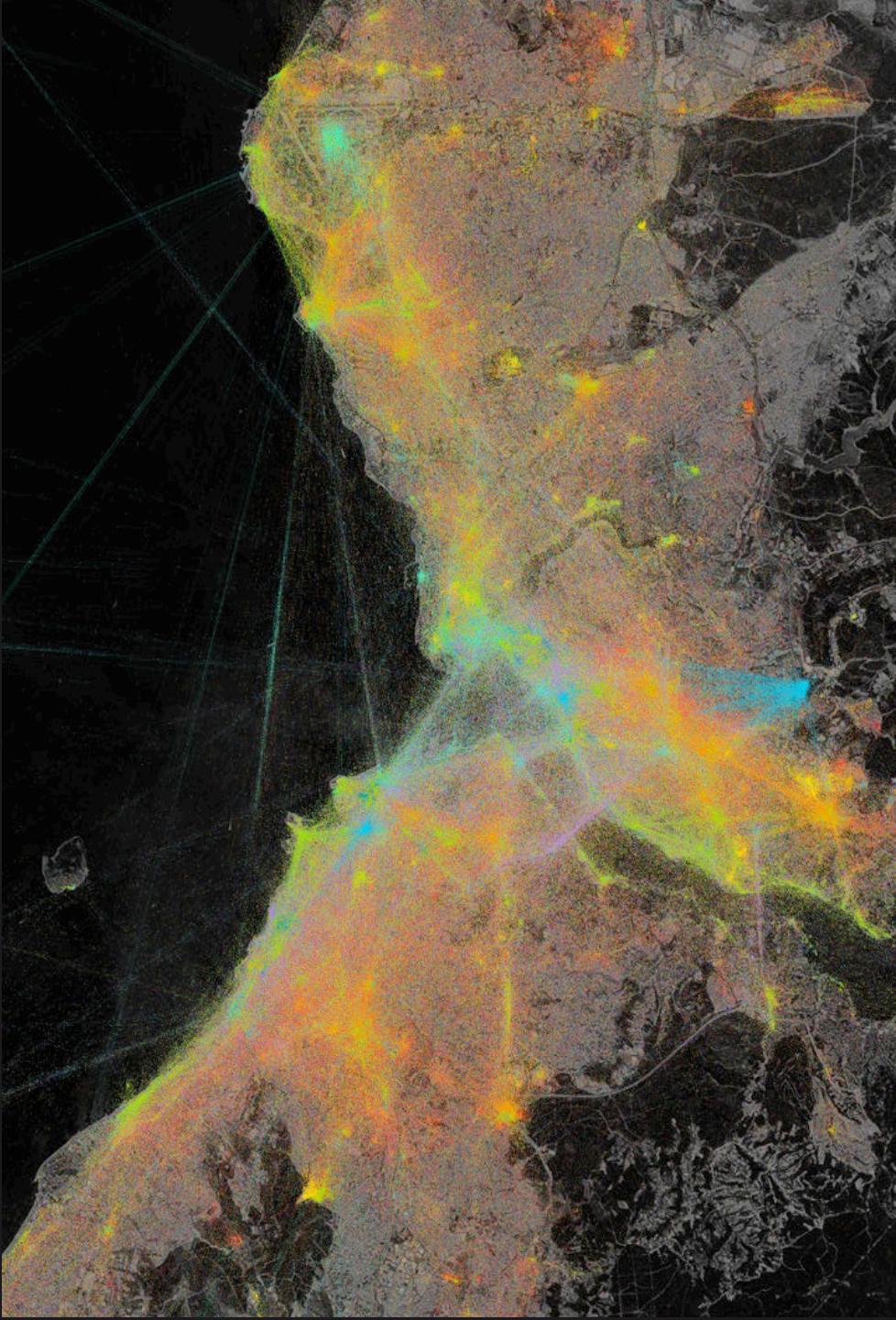


FIG. 4. Chicago neighborhood change in homicides and coffee shops, 1991 to 2005.

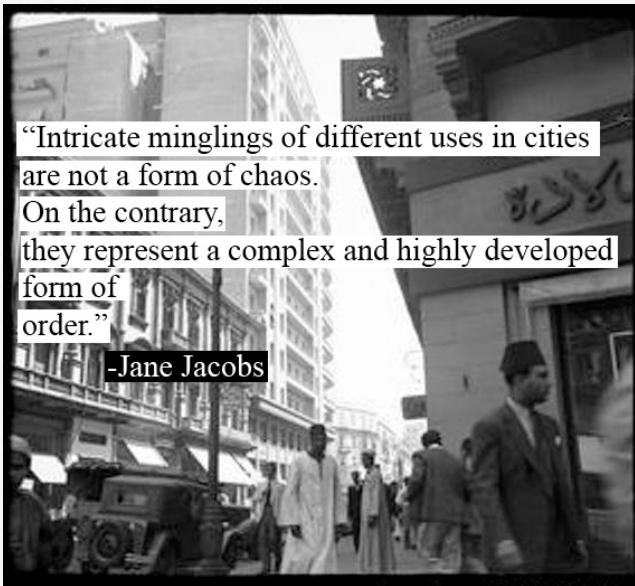
Papachristos, Andrew V., et al. "More coffee, less crime? The relationship between gentrification and neighborhood crime rates in Chicago, 1991 to 2005." *City & Community* 10.3 (2011): 215-240.

SPATIAL CAPITAL:

*What spatial
characteristics make
places successful?*



Urban Diversity



60's-80's

- **Urban vitality: community**
 - eyes on the street
 - mixed primary use
 - walkability
 - ("death" = elimination of pedestrian activity)

90's-present

- **Inequality: density**
 - services vs amenities
 - segregation
 - housing price surge
 - displacement
- **Good city form: urban planning**
 - urban morphology
 - mental mapping
 - human values
 - "imageability"
- **Creative class**
 - purveyors of creativity
 - 25% of all employed people
 - economic impact on cities

Jane Jacobs. *The Death and Life of Great American Cities*. Vintage Books, 1961.
Kevin Lynch. *Good City Form*. MIT Press, 1984.
Richard Florida. *Cities and the Creative Class*. 2003.
Edward Glaeser. *Triumph of the City*. Penguin, 2011.

Urban Vitality 2.0

Work from 2015 operationalized Jacob's principles of urban vitality: mixed primary use, short street blocks, diverse buildings and density of human activity. They found a relationship between these four criteria and urban vitality in Seoul, Korea. In 2016 the same analysis carried out in several Italian cities showed similar results, indicating that Jacob's views of the built environment were overall valid in large-scale computational urban studies.

$$\text{LUM}_i = - \sum_{j=1}^n \frac{P_{i,j} \log(P_{i,j})}{\log(n)}$$

Mixed Primary Use

Land Use Mix of a neighbourhood where $P_{i,j}$ is the percentage of sq ft with land use j in district i and n is the number of possible land uses.

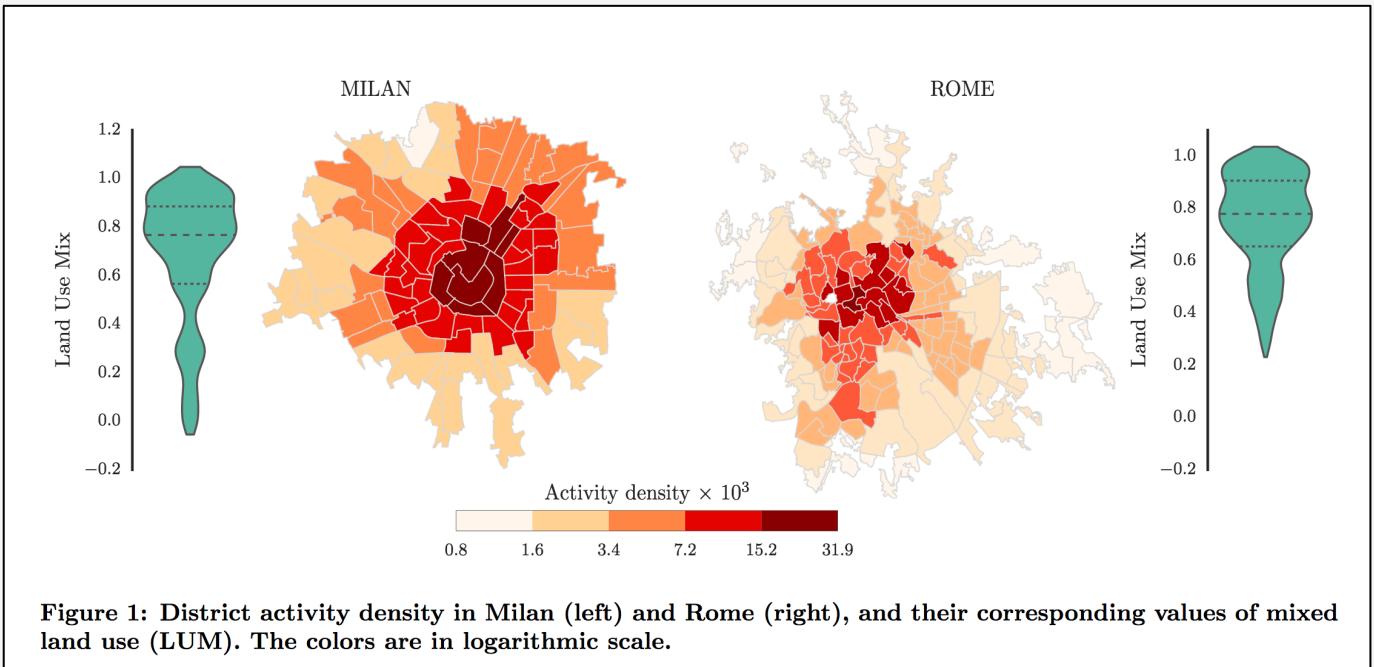


Figure 1: District activity density in Milan (left) and Rome (right), and their corresponding values of mixed land use (LUM). The colors are in logarithmic scale.

Land use in Rome is more mixed than Milan, which has more functional areas. In Milan, activity density (urban vitality) is experienced only in mixed districts, similar to Jacob's observations in NYC.

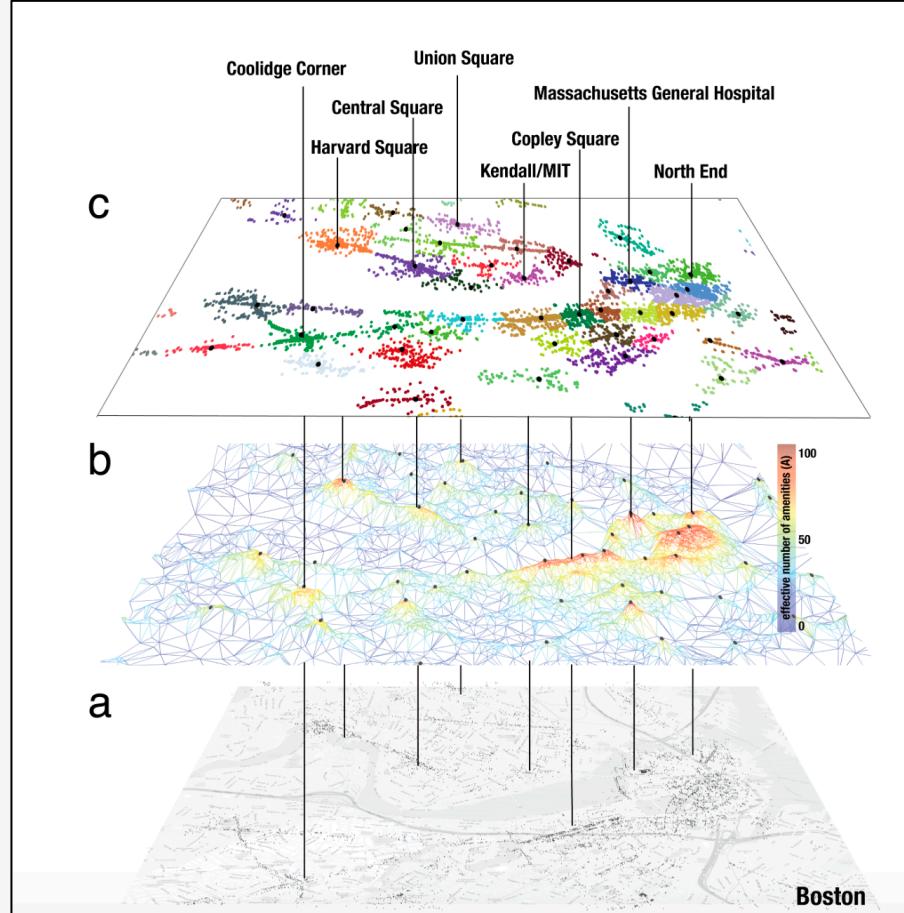
Walkability & Mixed Use

Clustering neighbourhood amenities by walkability allows for building colocation correlations between amenity types and to recommend places that are missing from a neighbourhood based on predictive modelling.

$$A_i = \sum_{j=1}^N e^{-\gamma d_{ij}},$$

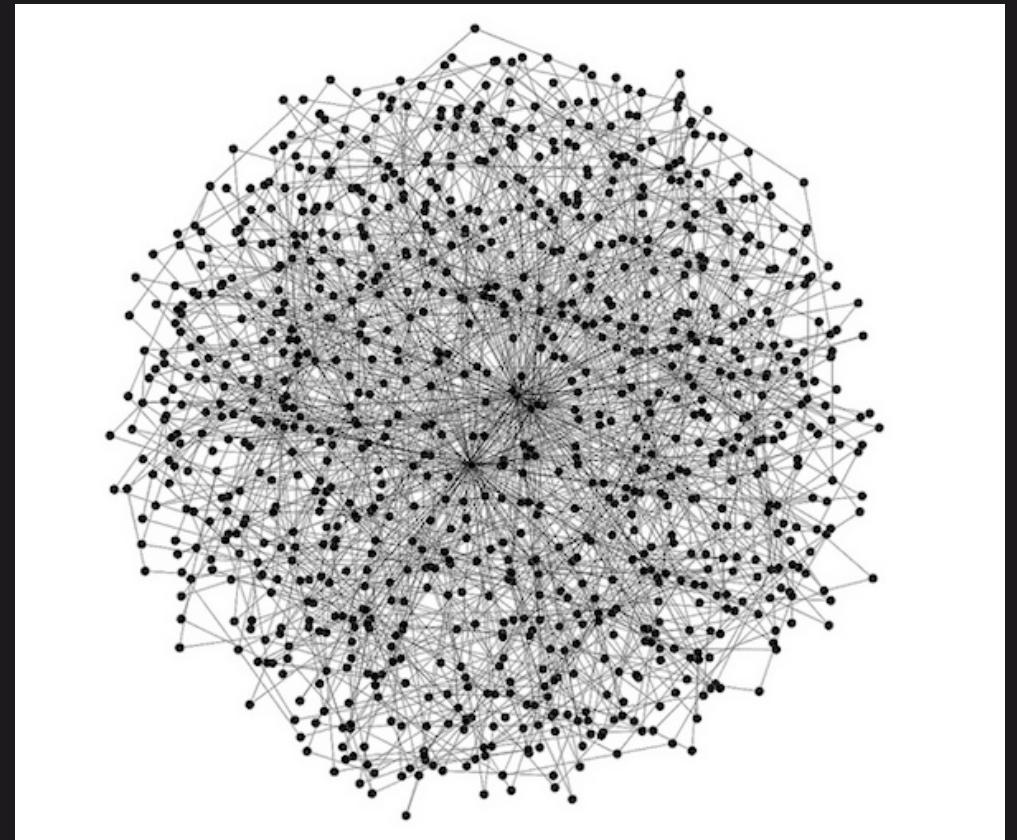
Effective number of amenities

Number of amenities that can be reached by walking from location i, where d_{ij} is the distance between i and j weighted by a distance decay parameter



Meaningful neighborhoods are discovered when $\gamma=16$, which implies that the contribution of an amenity to the effective number of amenities of a location roughly halves every 62.5 meters and becomes negligible at about 500 meters.

SOCIAL CAPITAL: *What social constructs make places successful?*

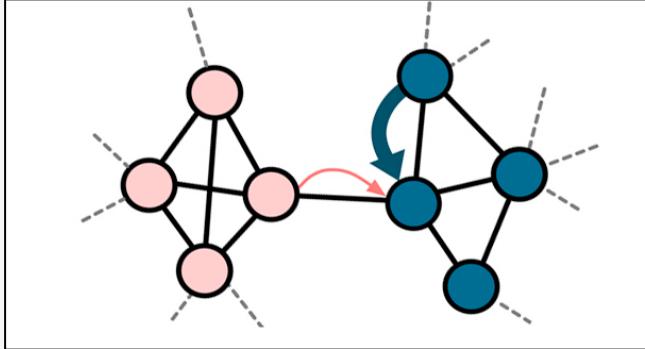


The Value of Social Networks

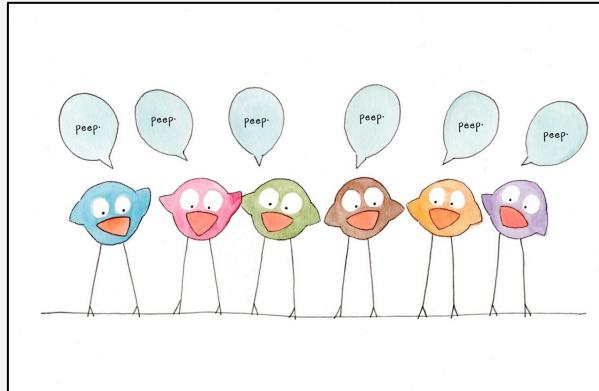
"Creativity is just connecting things. When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something."

– Steve Jobs, Wired 1995

Defying social forces can result in a competitive advantage

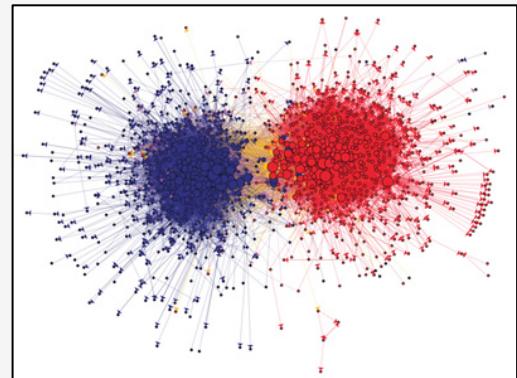


Social forces such as preferential attachment and homophily can result in homogeneous groups



Social networks are composed of groups of people and the links between them. Bonds within groups are stronger than bonds between groups. Homogeneous groups can suffer from localization of resources but social brokers bridge groups.

Segregation or polarization may occur in extreme cases of closely knit communities.

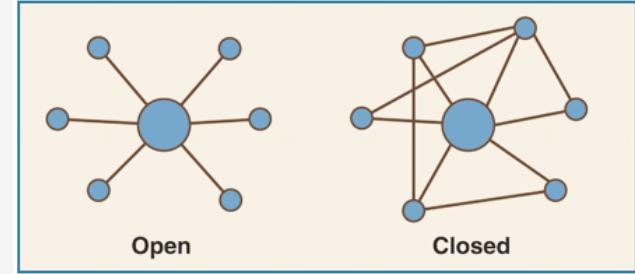
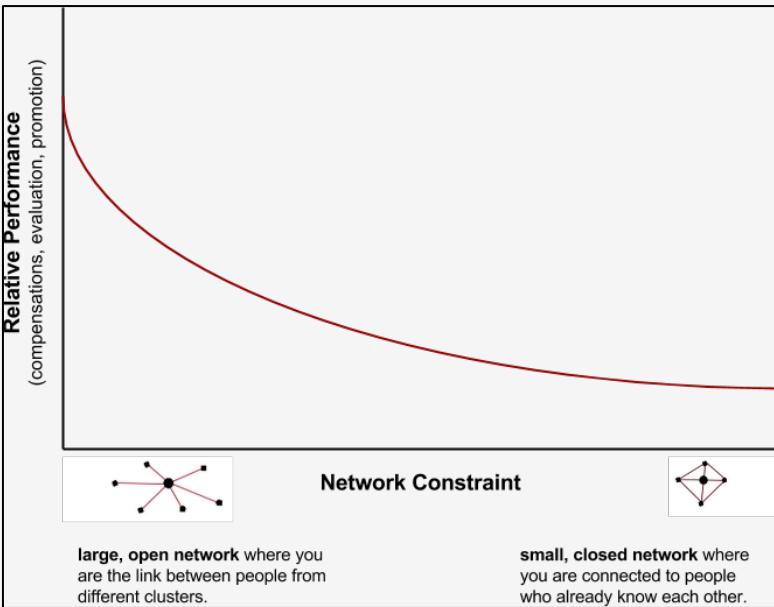


Economic Capital & Social Networks

Social brokers tend to have open network structures associated with a competitive advantage in the social network – they usually also earn more as Ronald Burt's experiments within organisations show.

Half of the predicted difference in career success can be accounted for by network constraint, also referred to as structural holes in the egonetwork of an individual.

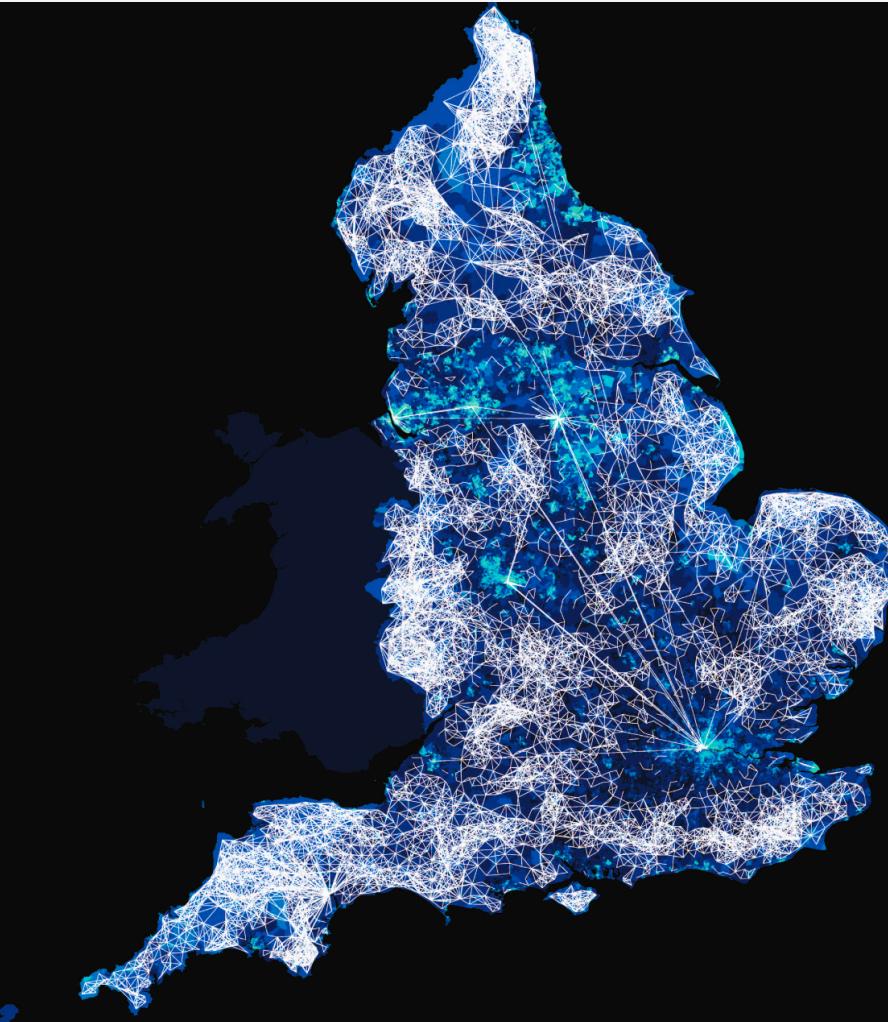
$$S_i = \sum_j \left[1 - \sum_q p_{iq} m_{jq} \right]$$



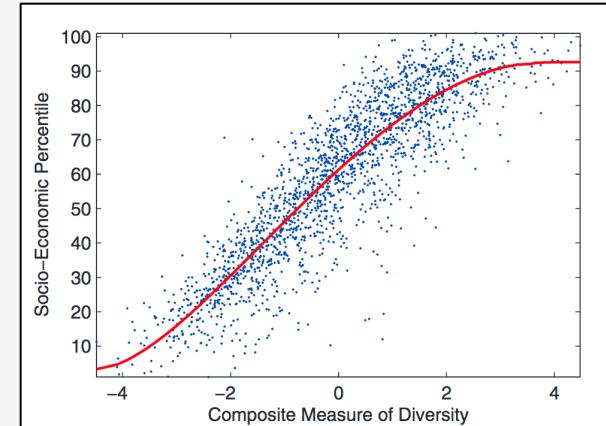
As an individual with an open network, you (a) receive information benefits from diverse sources and (b) have the power to redistribute (control) novel information.

Communication Diversity & Economic Health

"Communication diversity is a key indicator of an economically healthy community."

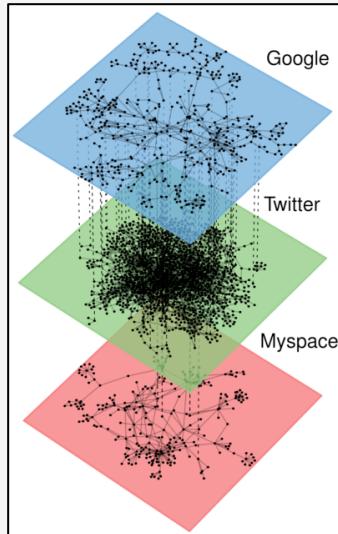


Communication data: 90% of mobile phones and 99% of landlines in August 2005.



Relationship between socioeconomic rank (IMD) and social network diversity. Diversity is the composite of Burt's structural holes measure and entropy.

Multilayer Social Networks



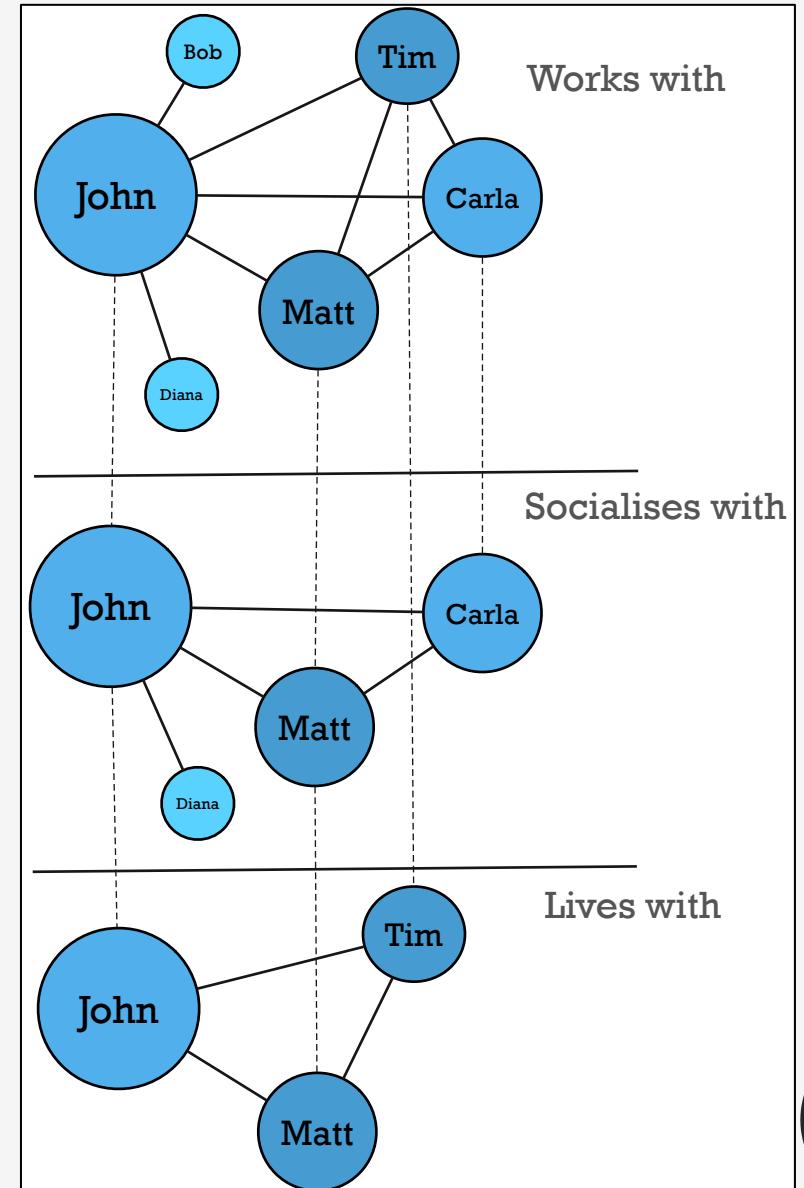
Multilayer network models capture multiple heterogeneous interactions.

A multilayer network can be thought of as a collection of graphs.

$$\mathcal{M} = \{G^1(V^1, E^1), \dots, G^\alpha(V^\alpha, E^\alpha), \dots, G^M(V^m, E^m)\}$$

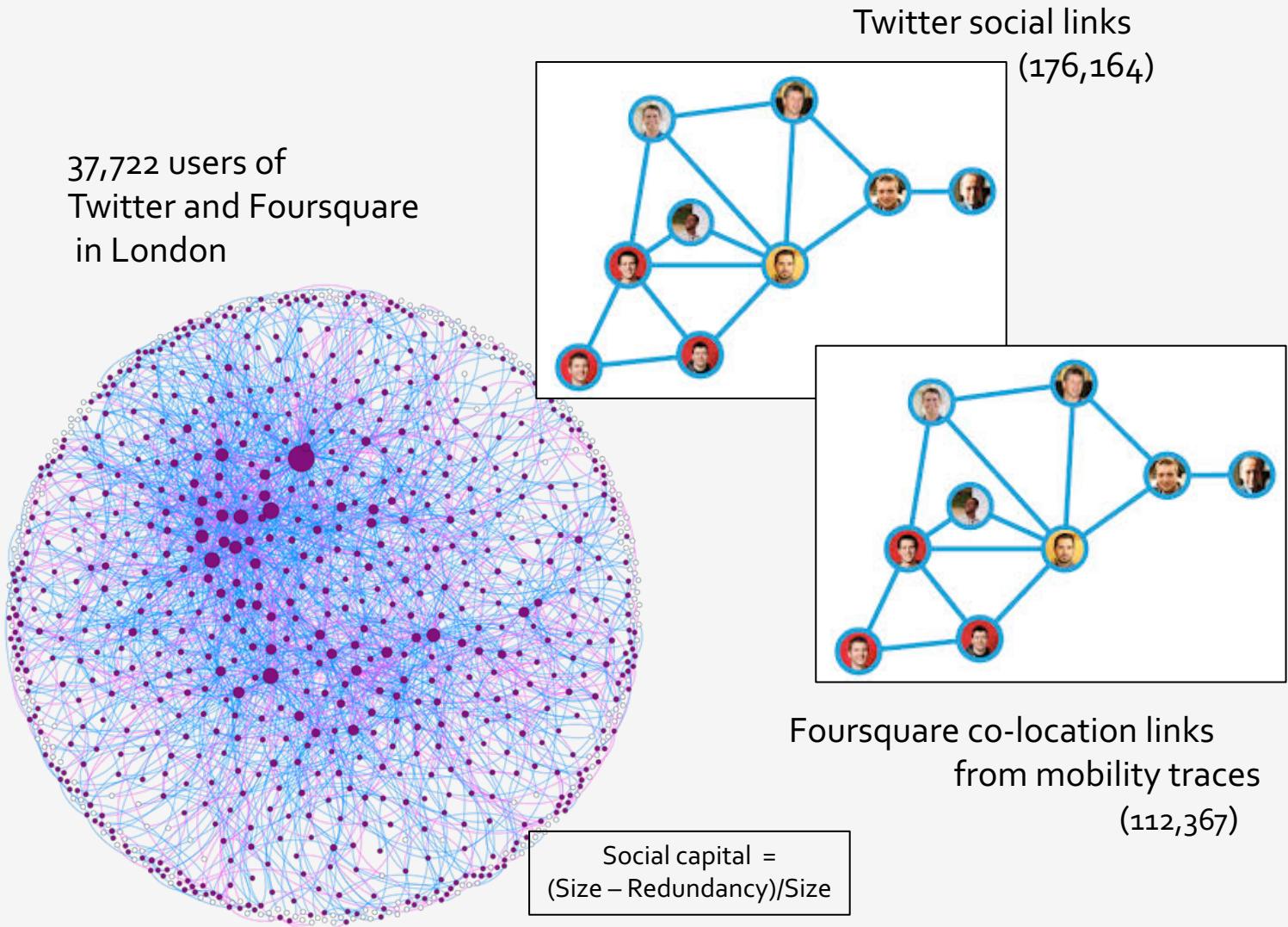
The multilayer neighbourhood of a node can be defined as the union or intersection of its single-layer neighbourhoods.

$$N_{\mathcal{M}}(i) = \{N_\alpha(i) \cup N_\beta(i) \dots \cup N_m(i)\}$$

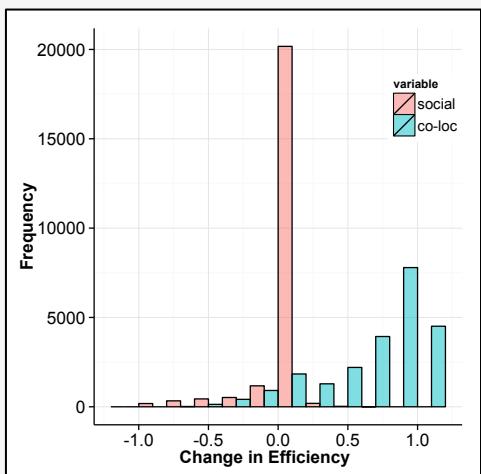


Multilayer Social Capital

Most studies of structural holes consider a single layer of interaction. In reality our social networks are multilayer. Here we study how social capital is generated through the principle of structural holes in the social network on both the physical (offline) and digital (online) social layers.

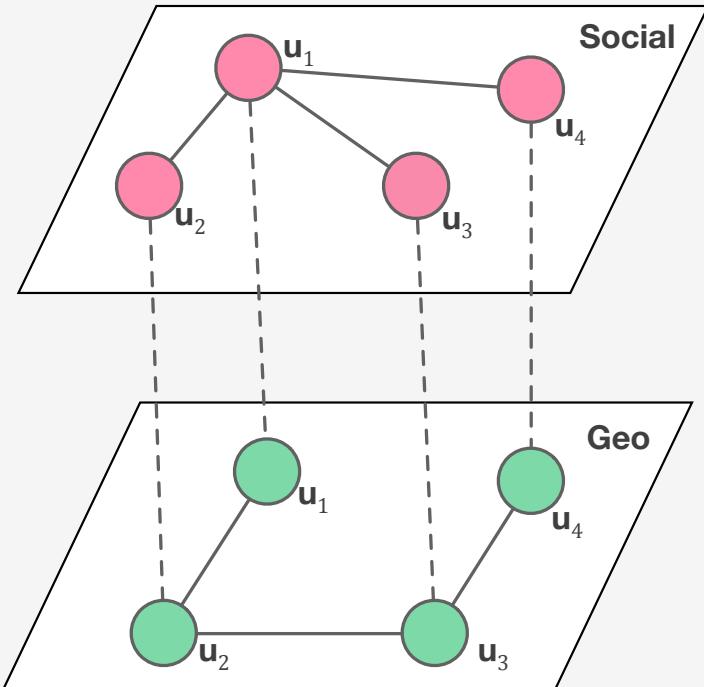


Geo-Social Capital

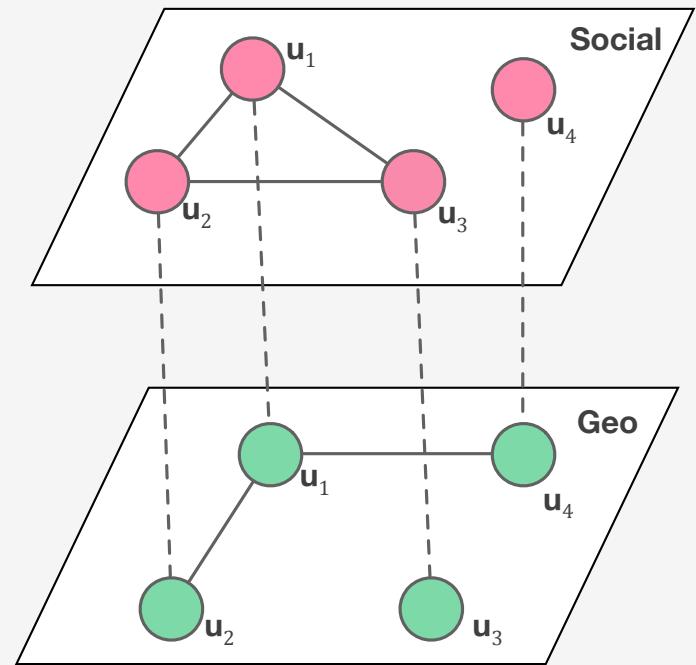


When considering the added information from another layer in computing the social capital of a node, in more than half of cases there was no effect on online capital. However, when there was an effect it was quite significant – typically overestimating social capital from the social (online) layer only or underestimating geographical capital from the offline layer.

Overestimating Social Capital



Underestimating Social Capital



Third Places

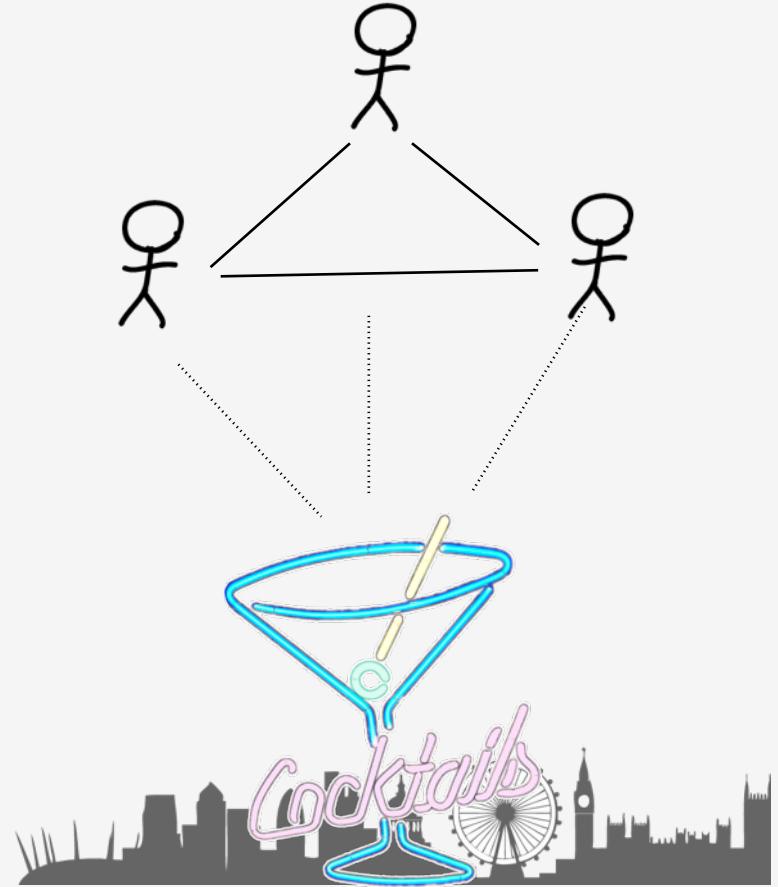


"Cafés, Coffee Shops, Bookstores, Bars, Hair Salons and Other Hangouts at the Heart of a Community."

In community building, the **third place** (or **third space**) is the social surroundings separate from the two usual social environments of home ("first place") and the office ("second place"). Examples of **third places** would be environments such as cafes, clubs, public libraries, or parks.

Putnam describes social capital and the presence of third places as broad societal measure of community health. He transformed social capital from a concept related to individuals to an attribute possessed by collectives.

Open network structures (aka "structural holes") are associated with having an advantageous position in the social network but what about the place network?

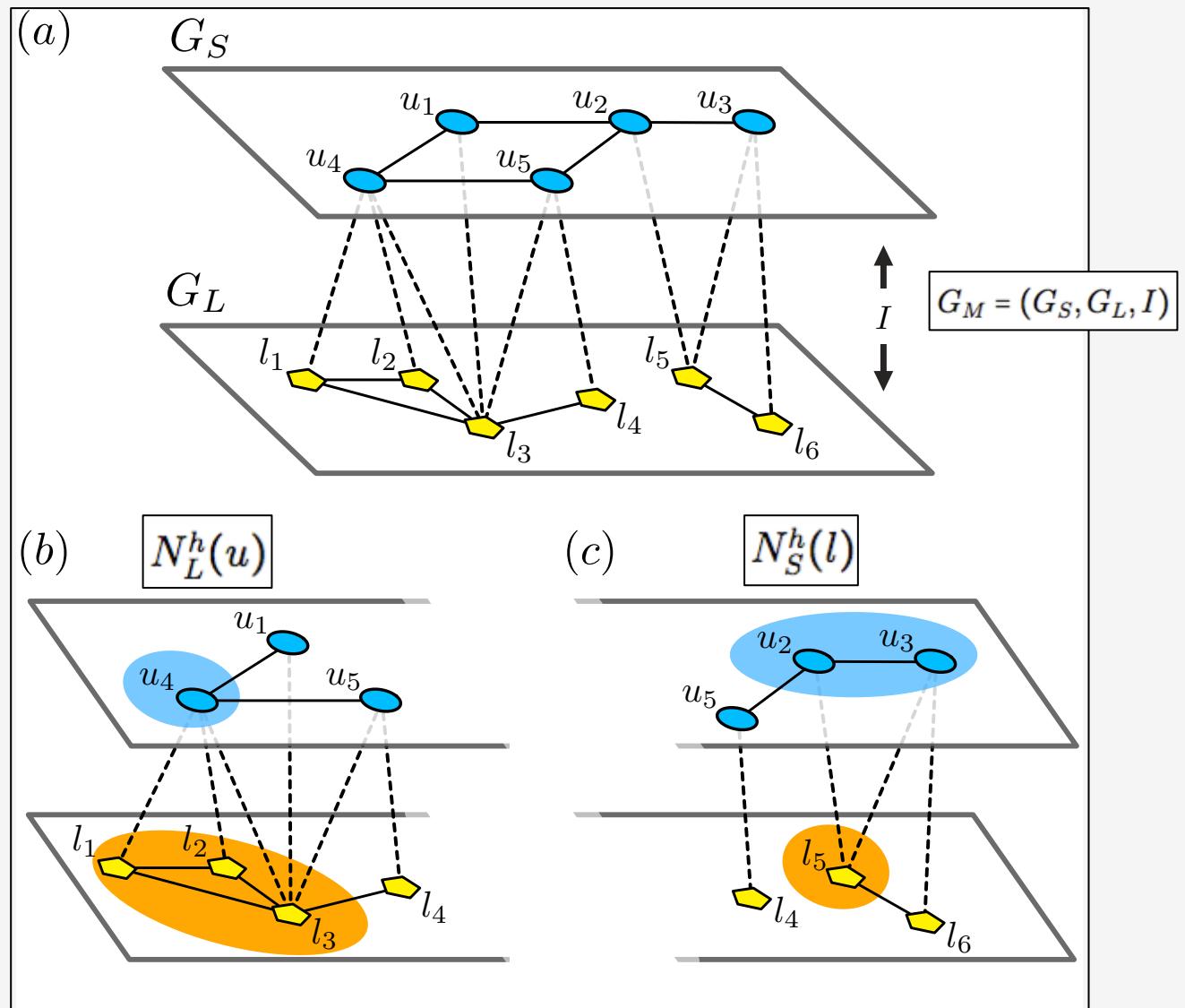


Geo-Social Brokerage

Ray Oldenburg, *The Great Good Place*, De Capo Press, 1989.
Robert Putnam, *Bowling Alone: America's declining social capital*, 1995.

Urban Geo-Social Network Model

We can model urban areas as a multilayer interconnected network of people and the places they visit.



Social Brokerage of Places

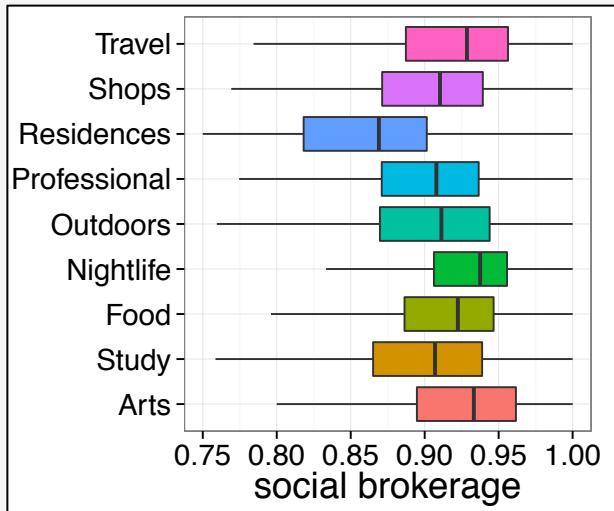
Data (Dec2010-Sept2011)

- 549,797 Foursquare checkins
- 42K Foursquare venues
- 3M transitions
- 36,926 users
- 432,929 social links



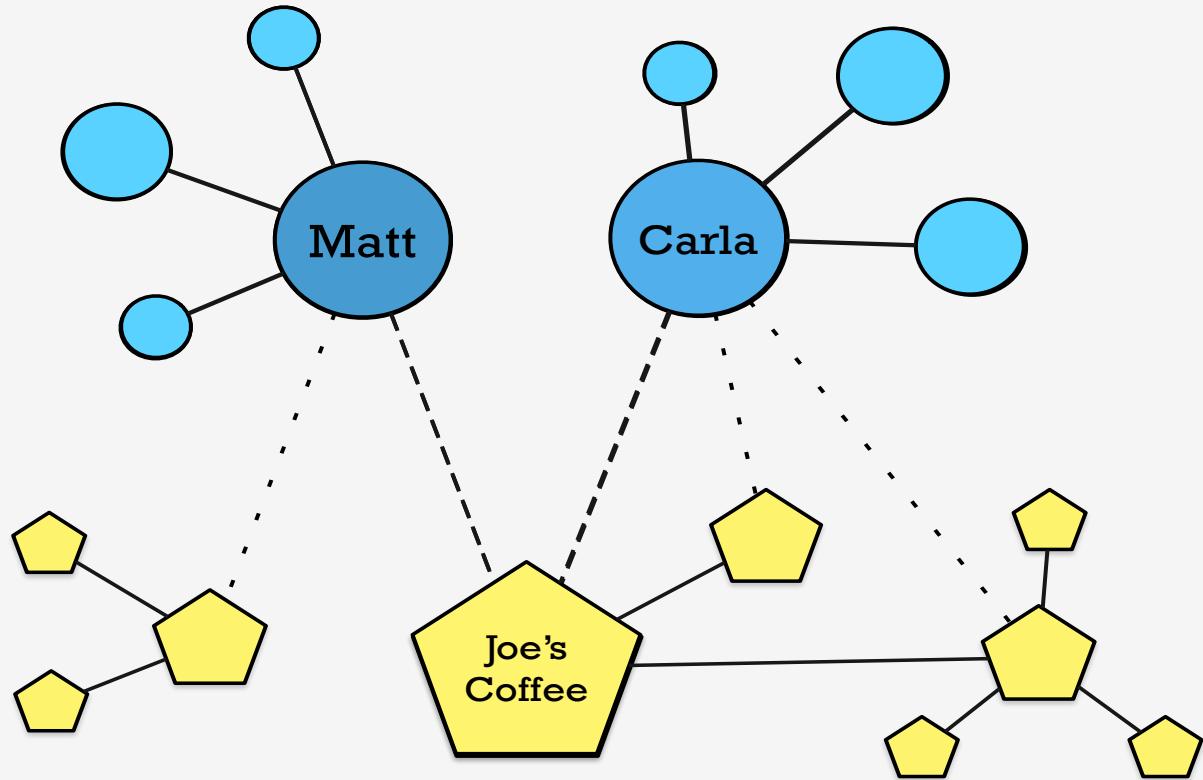
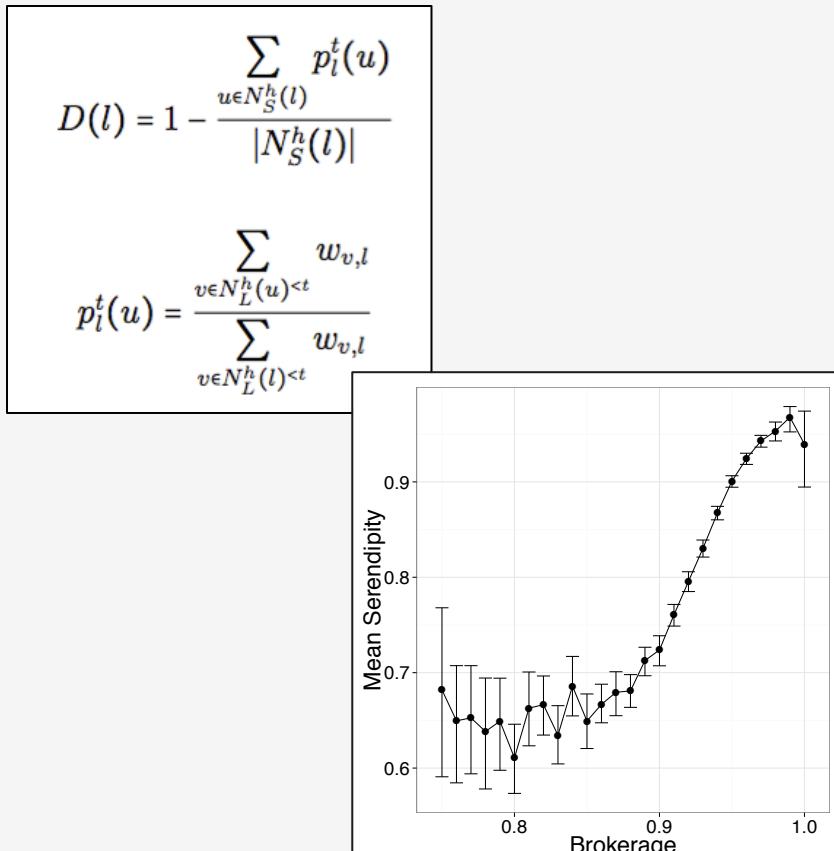
$$B(l) = |N_S^h(l)| - \frac{\sum_{u,v \in N_S^h(l)} e_{u,v}}{|N_S^h(l)|}$$

The brokerage of a place is the extent to which it brings together strangers vs friends. It is computed as the number of visitors to a place less the density of connections between the visitors of a place (redundancy).



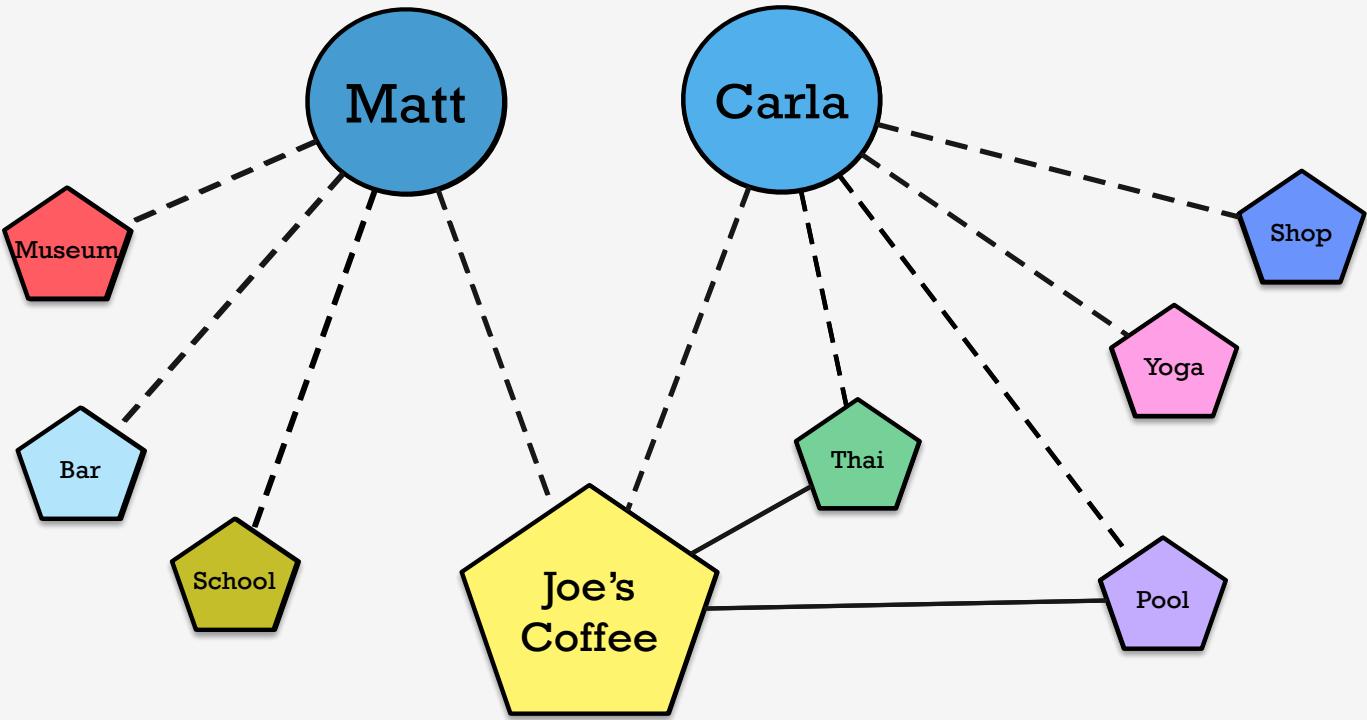
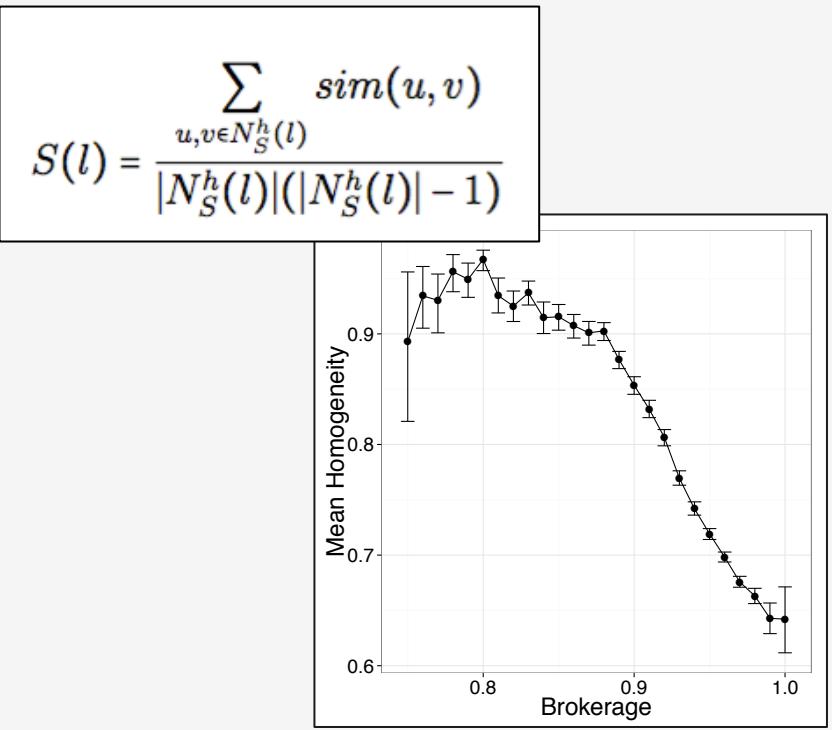
Category	Bridging role	Bonding role
Travel	Motel	B&B
Shops	Mall	Laundry
Residences	Apartment Building	Home
Professional	Courthouse	Emergency Room
Outdoors	Bridge	Vineyard
Nightlife	Gay Bar	Strip Club
Food	Dumplings	Fried Chicken
Study	Bookstore	Classroom
Arts	Art Museum	Football

Serendipity



Places with high serendipity values are those which have the potential to induce chance encounters among its visitors.

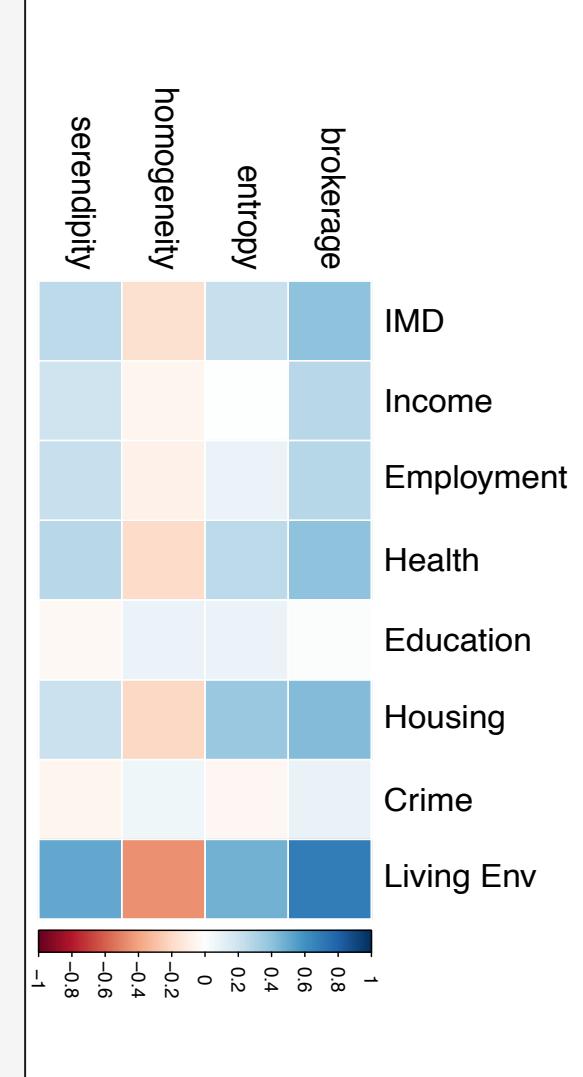
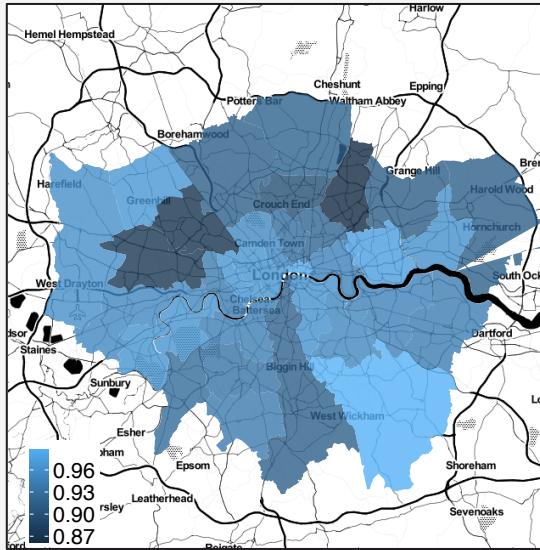
Visitor Diversity



How diverse are visitors based on their category preferences?

Urban Development & Social Diversity

Neighbourhood brokerage correlates with deprivation.
Higher brokerage means higher deprivation?

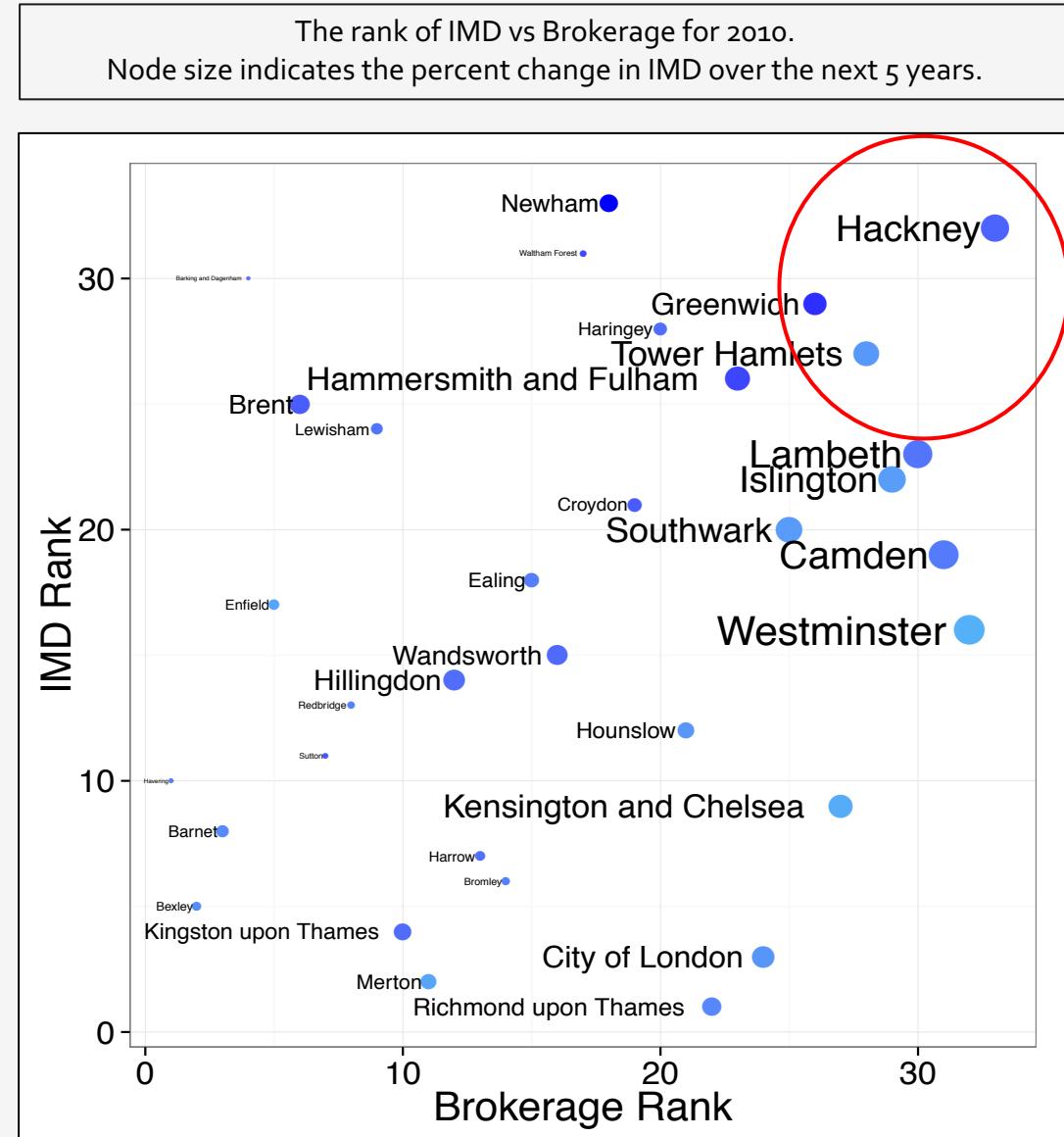


Spearman correlation between IMD and Urban Social Diversity measures.

Gentrification = Diversity + Deprivation?



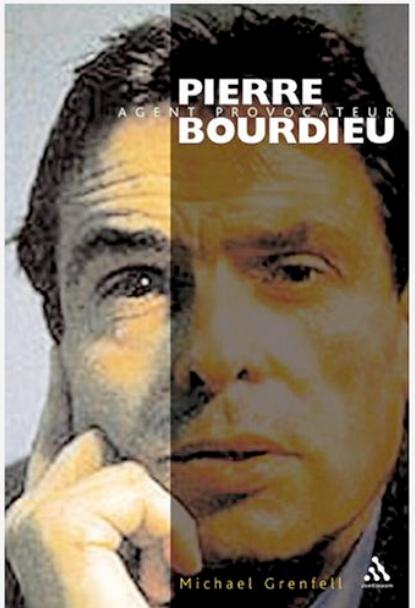
High deprivation and high diversity in 2010 signal gentrification in 2015.



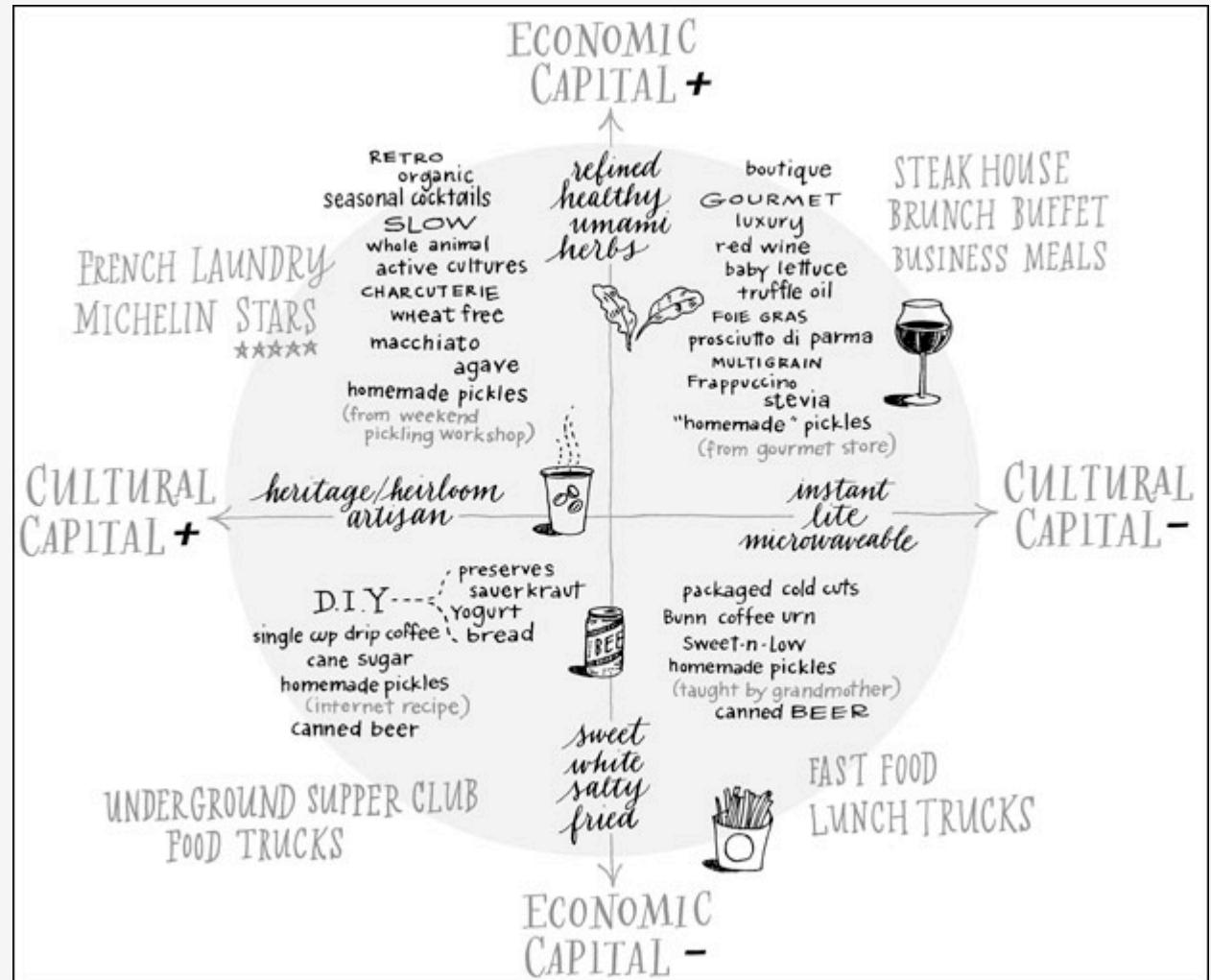
CULTURAL CAPITAL: *Does culture make places successful?*



Cultural Capital



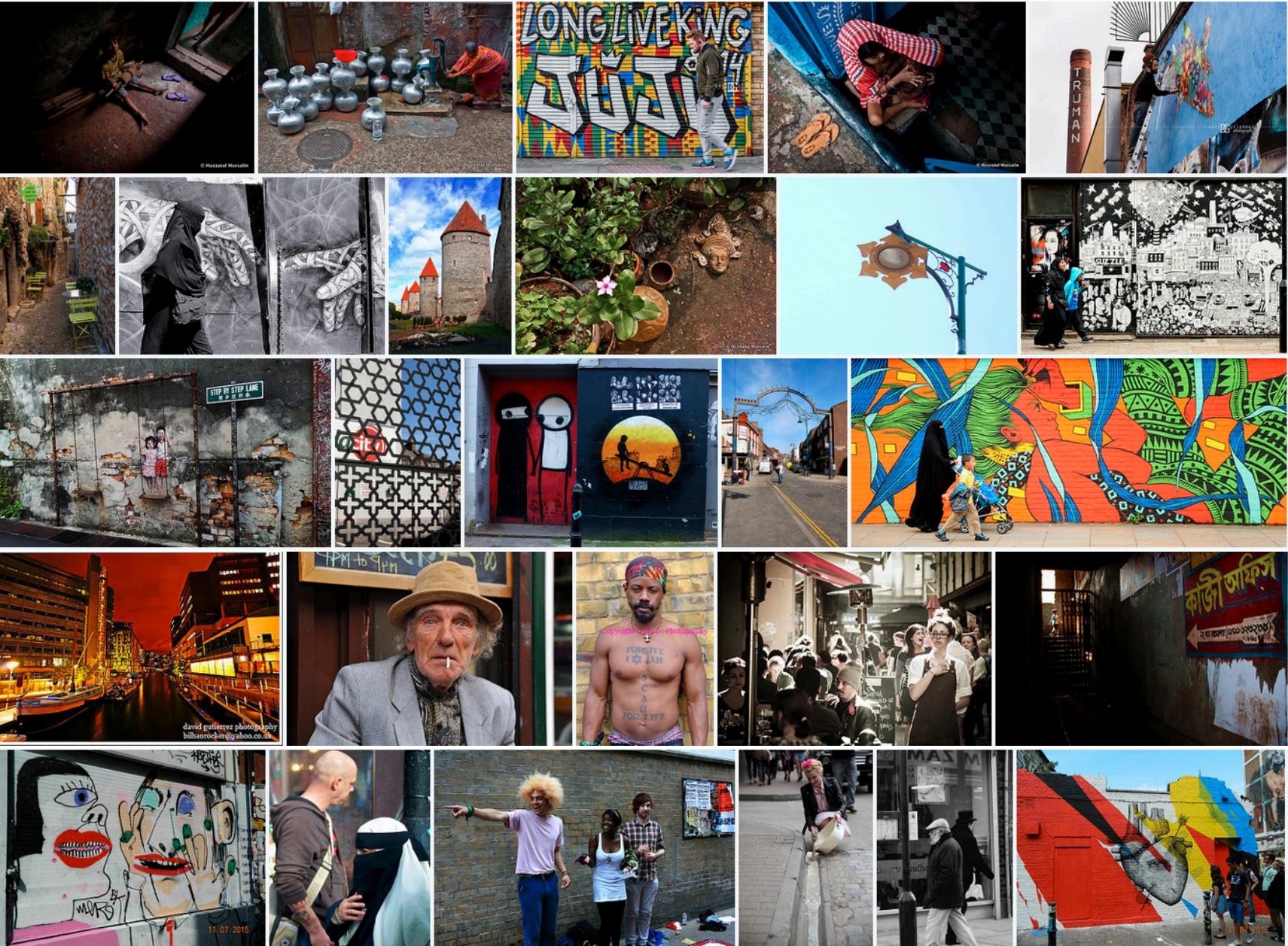
Cultural and economic capital can both be acquired and one can be converted into the other.



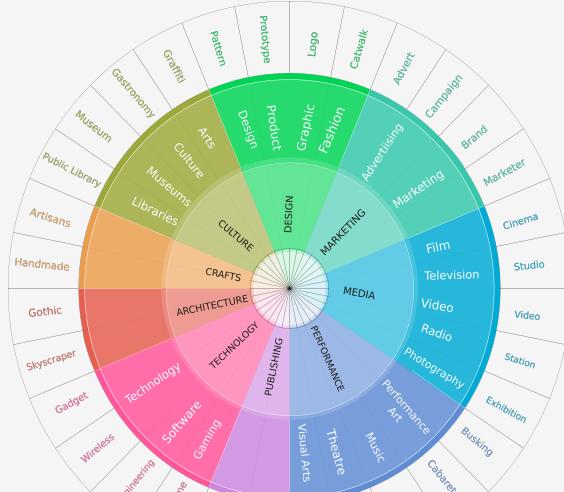
Pierre Bourdieu. *Distinction: A Social Critique of the Judgement of Taste*. 1979.

Gastronomica: The Journal of Critical Food Studies. <http://www.gastronomica.org/bourdies-food-space/>

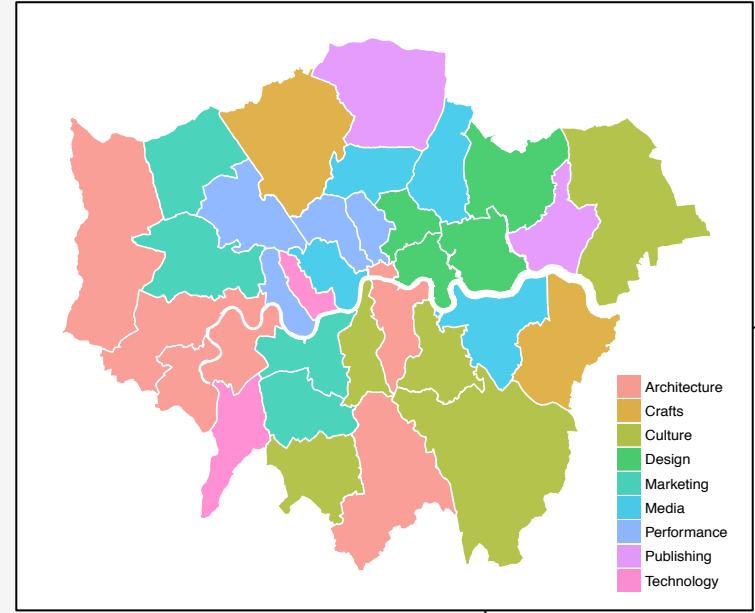
Culture & Regeneration



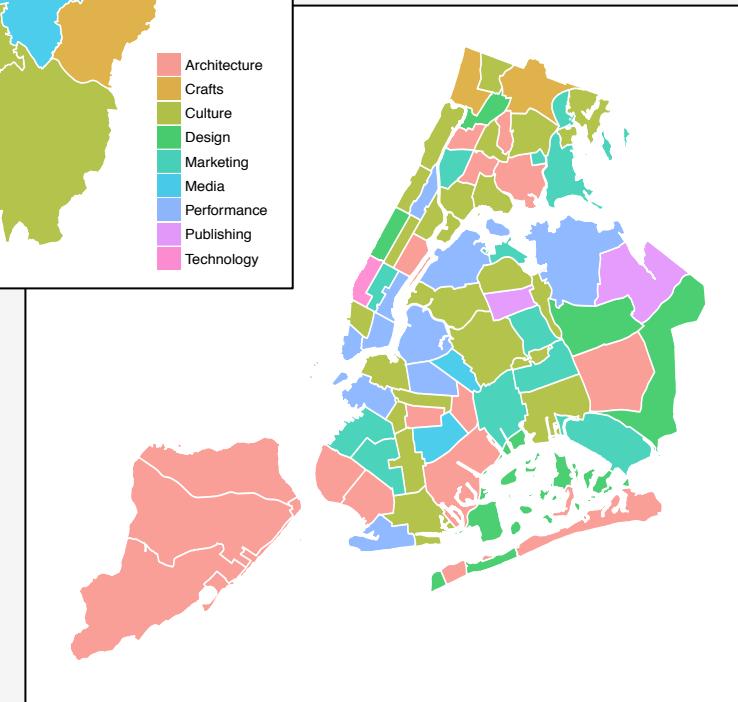
[Digital] Cultural Capital



We can measure the digital cultural capital of places by quantifying the amount of cultural activities that take place in a neighbourhood and their type using a taxonomy of cultural terms to mine Flickr photo tags.



We build a taxonomy of 263 cultural terms from the hierarchy of Wikipedia articles related to 9 top level categories.

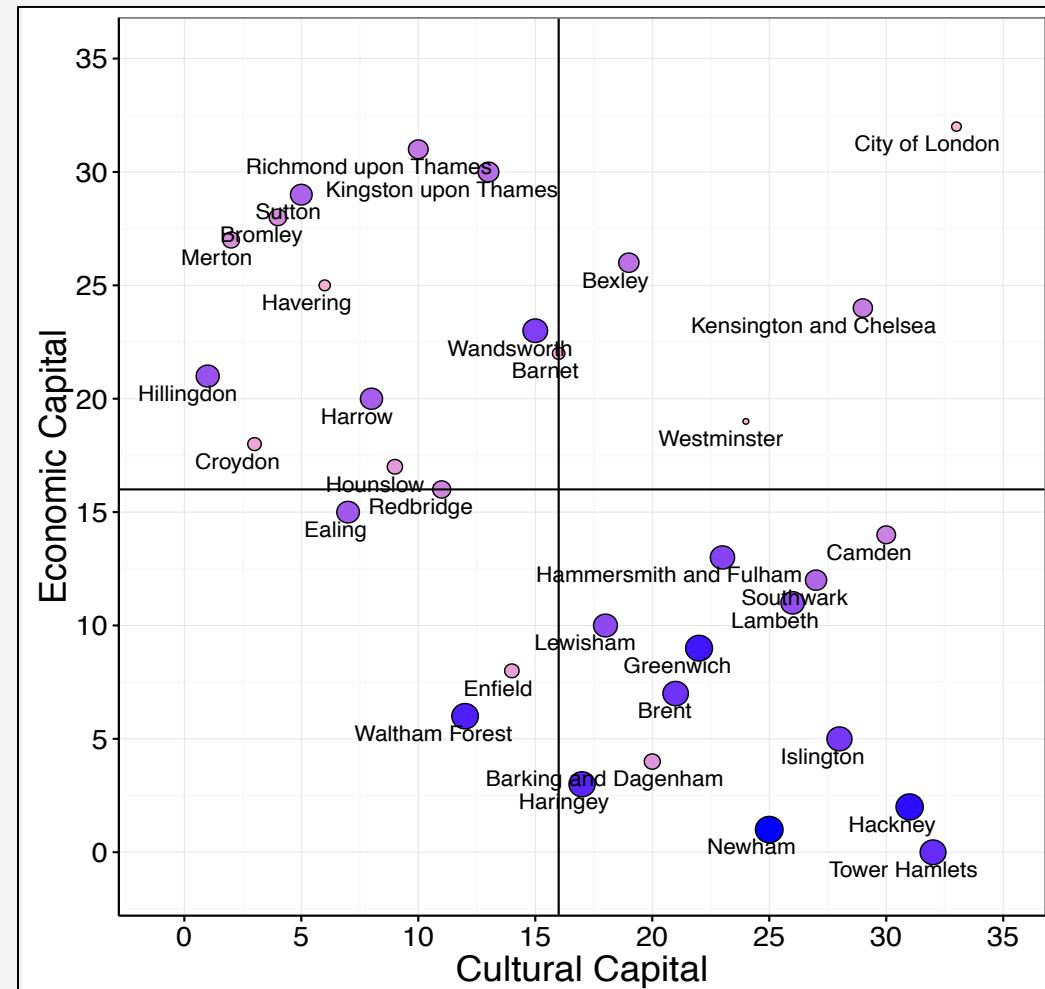


Cultural vs Economic Capital

Recreating Bordieu's cultural vs economic capital plots for neighbourhoods shows that high cultural capital but low economic capital in 2010 is indicative of gentrifying neighbourhoods in 2015.

$$capital(l) = \frac{capital_l - \mu(capital)}{\sigma(capital)}$$

Economic capital (income) rank vs Cultural capital rank (Flickr) for neighbourhoods in 2010. Color and size indicate the percent change in IMD.

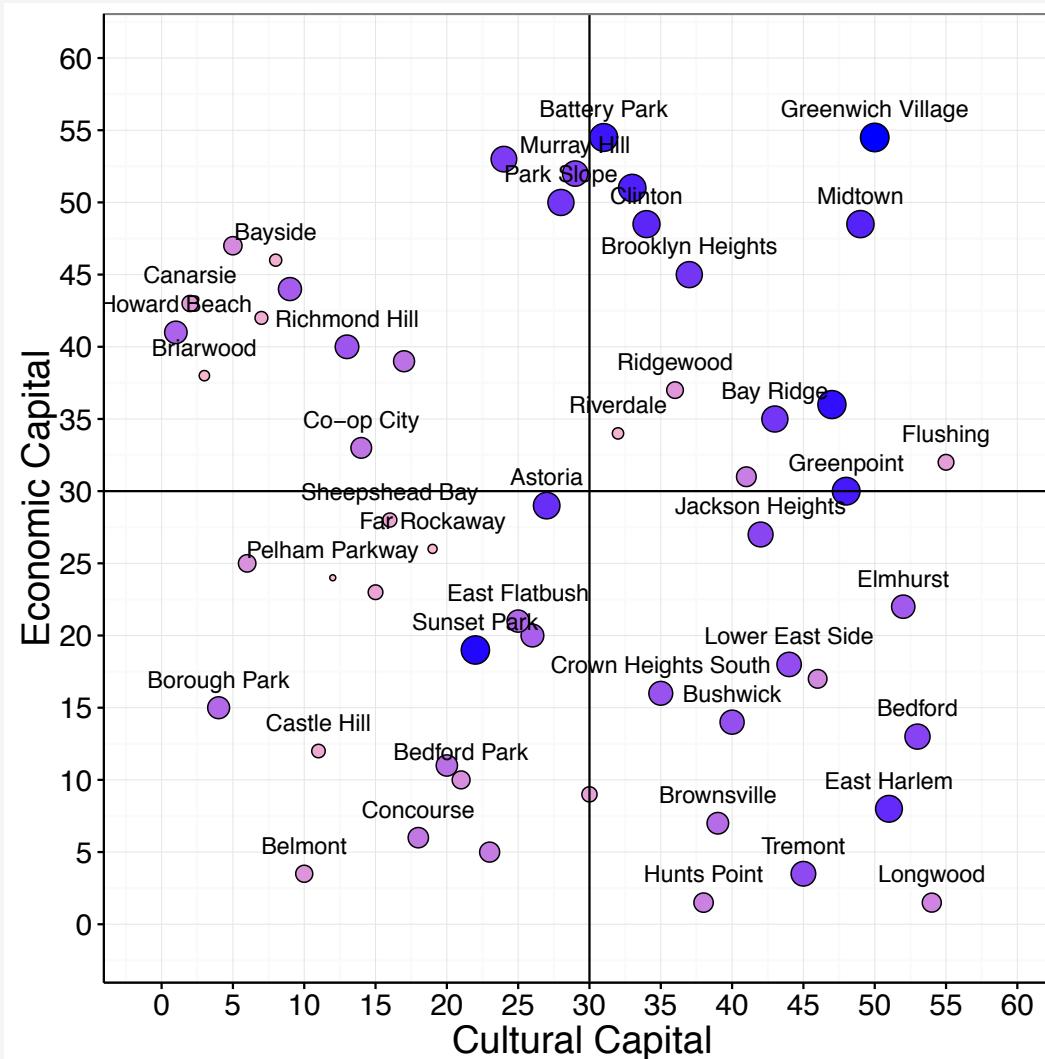


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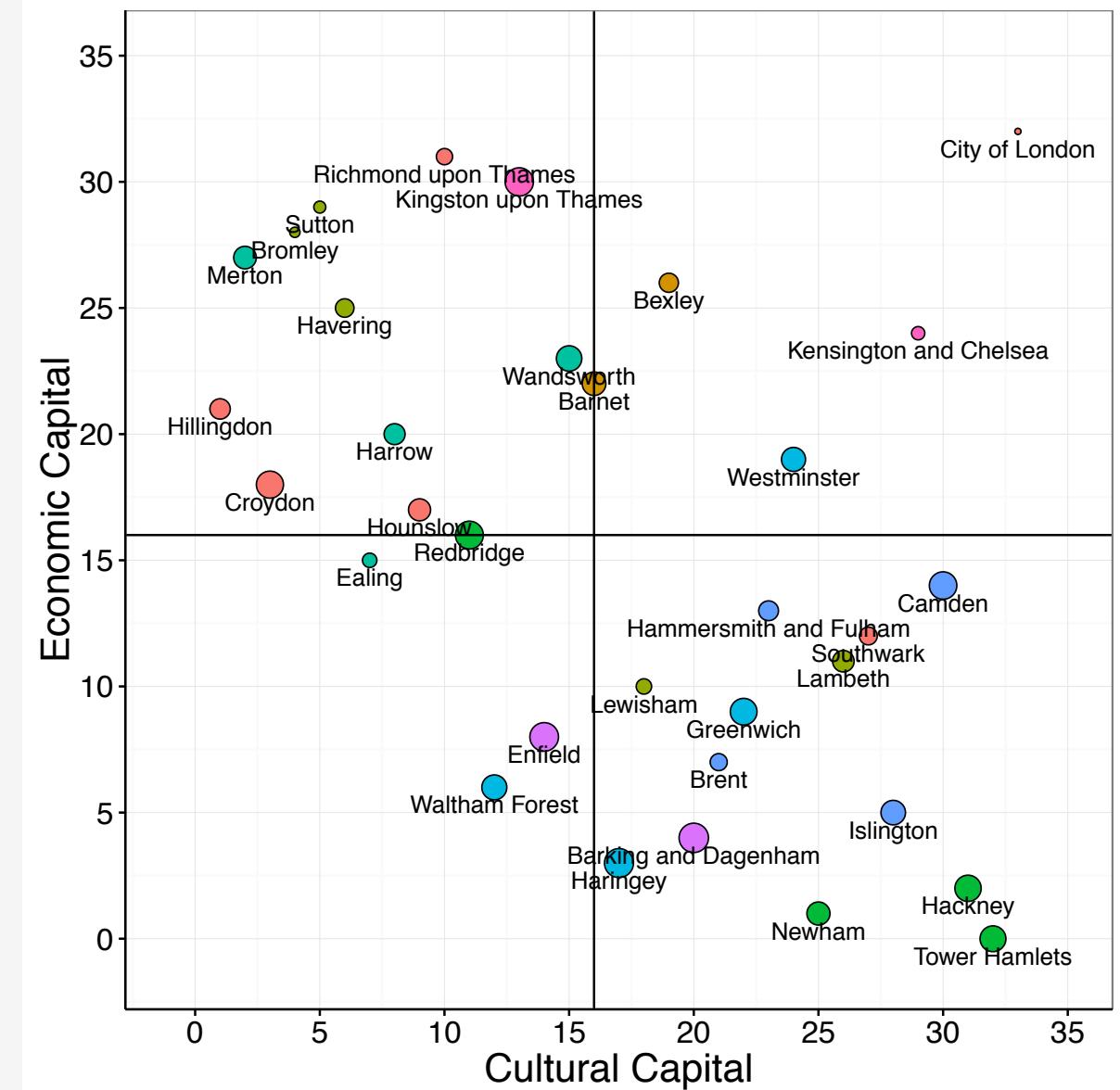
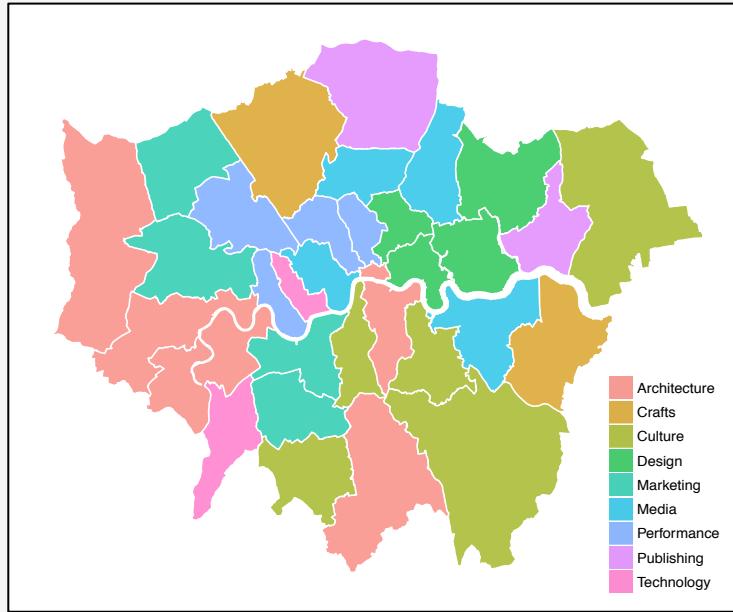
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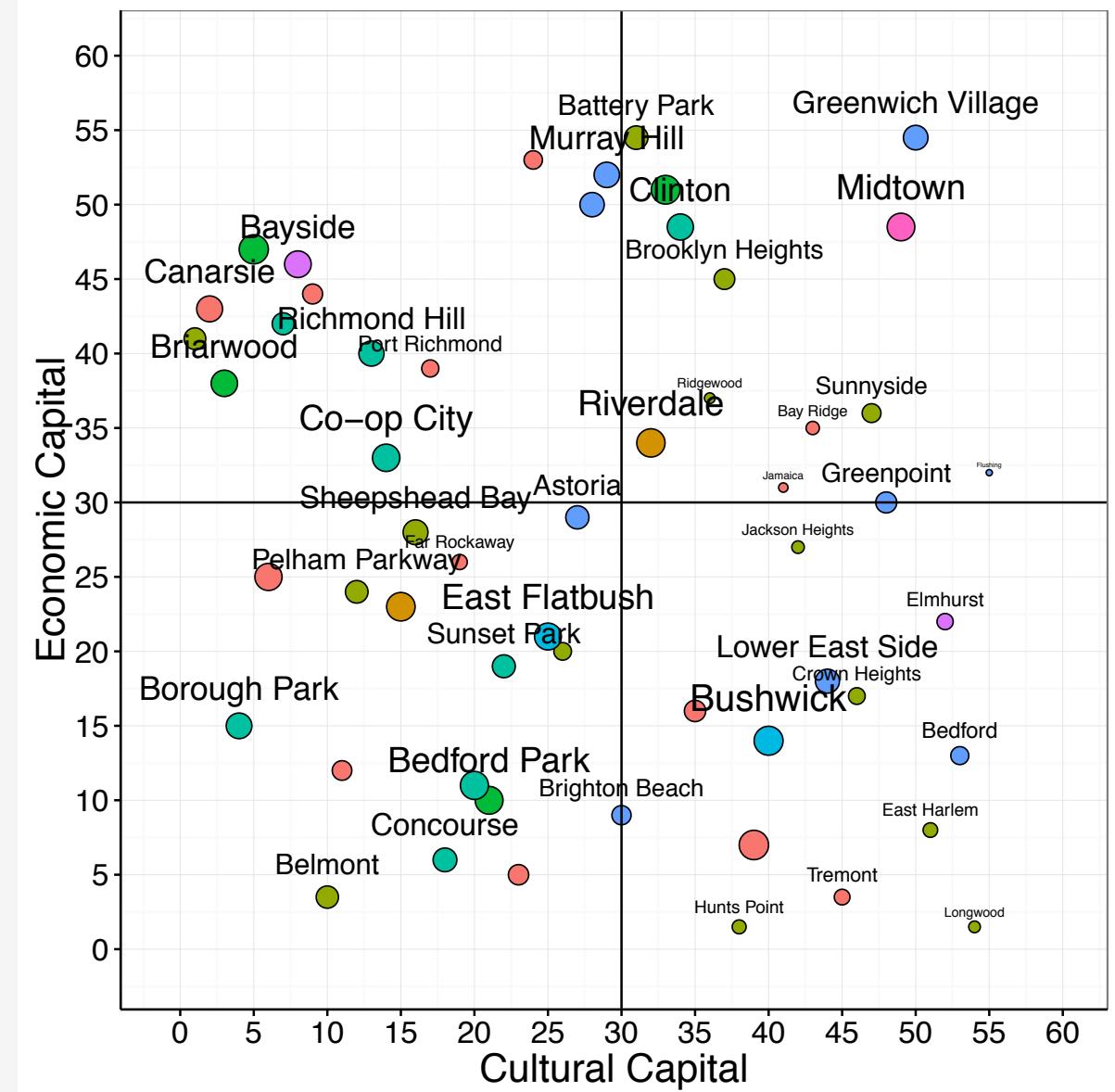
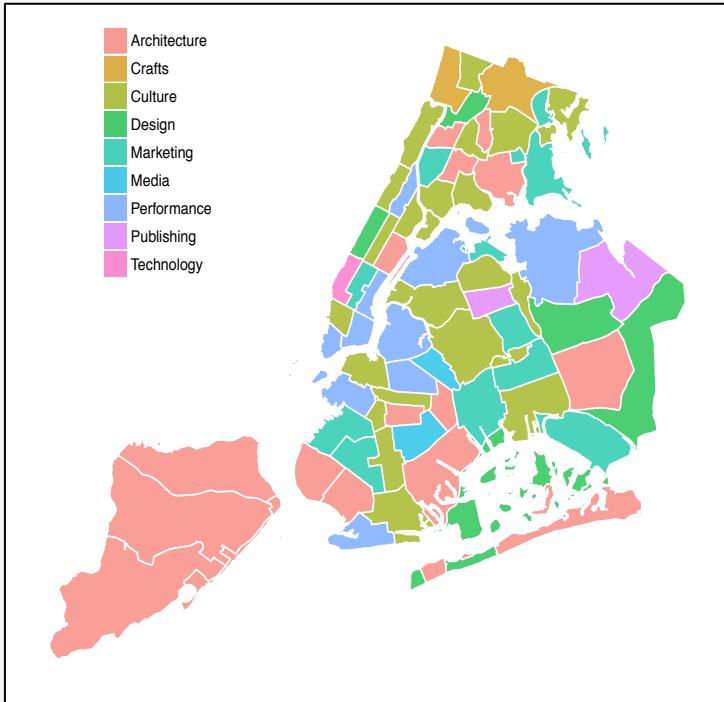
Economic capital (income) rank vs Cultural capital rank (Flickr) for neighbourhoods in 2010. Color and size indicate the percent change in SVI (Social Vulnerability Index).



Cultural Specialization

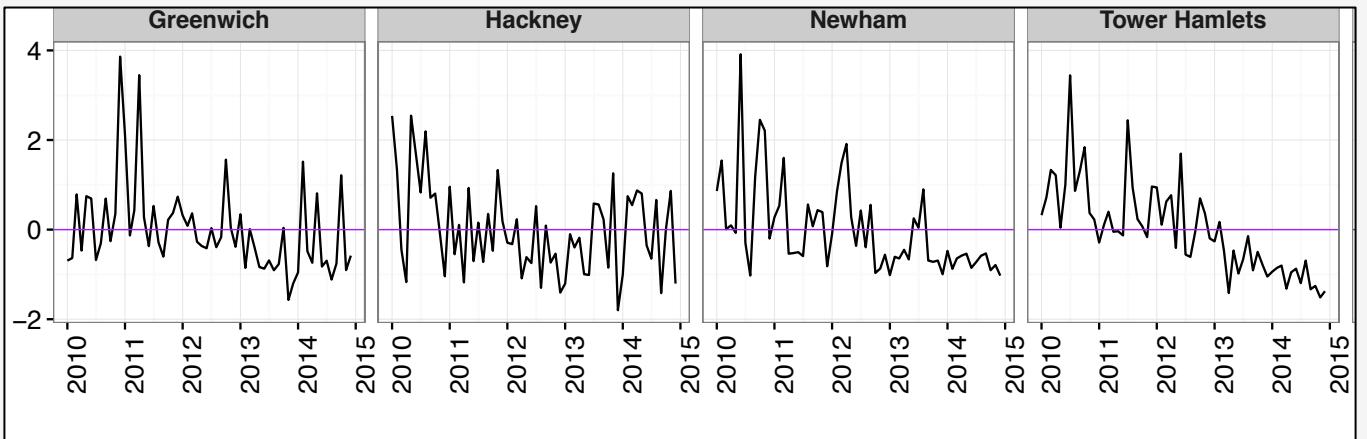


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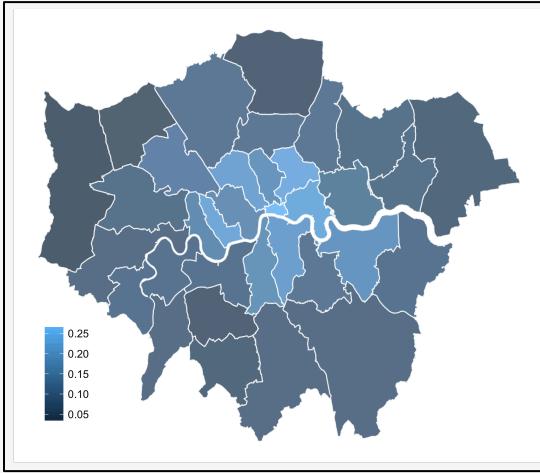


Predicting up-and-coming neighbourhoods

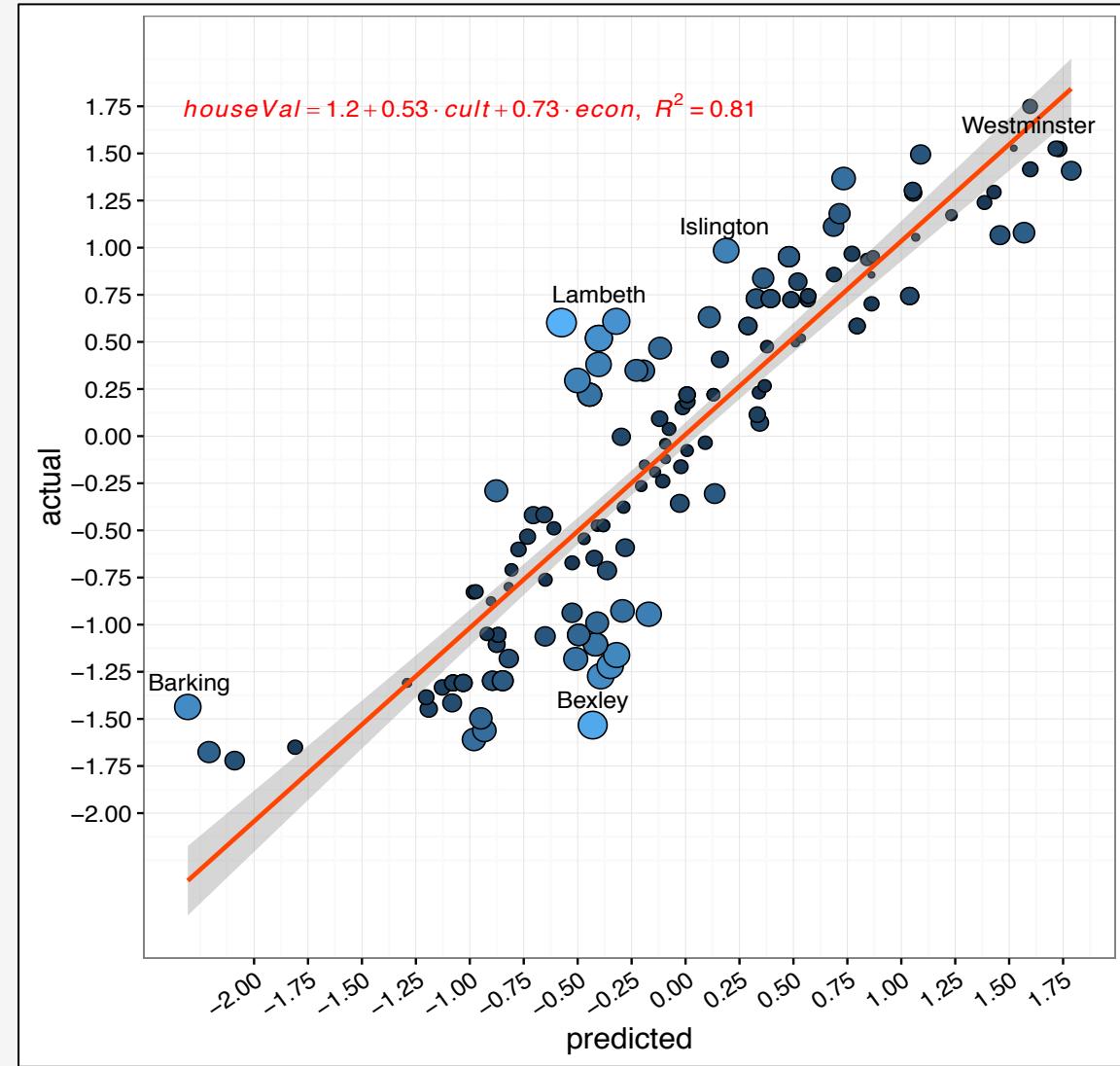
While IMD data is available only once every 5 years, social media data is real-time. This way, we can track changes in urban social networks and anticipate both positive and negative aspects of gentrification.



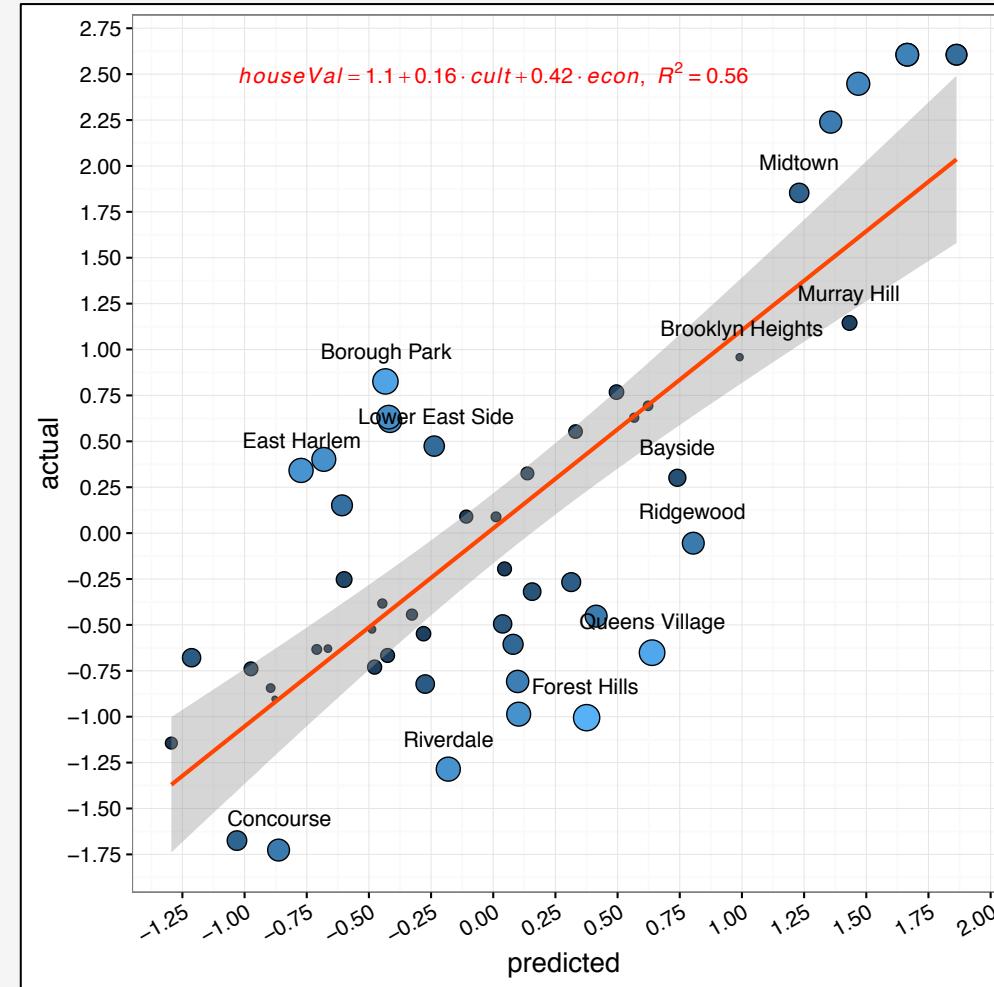
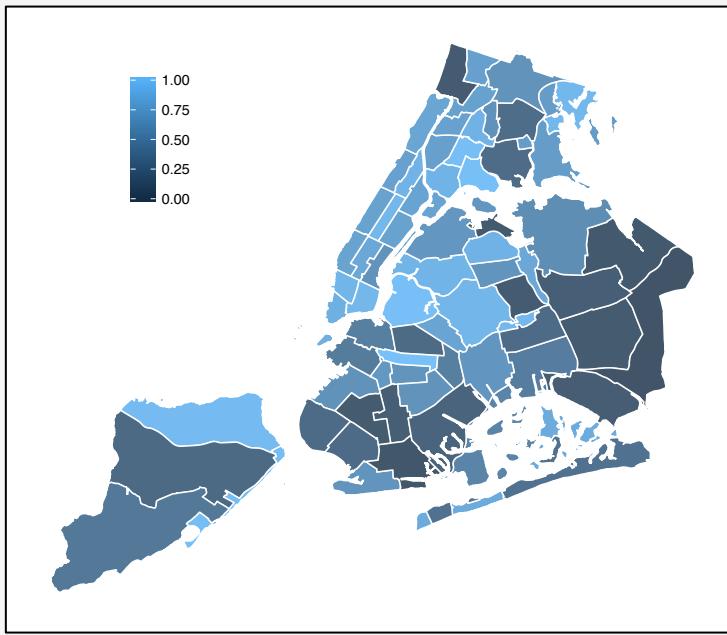
Housing price prediction

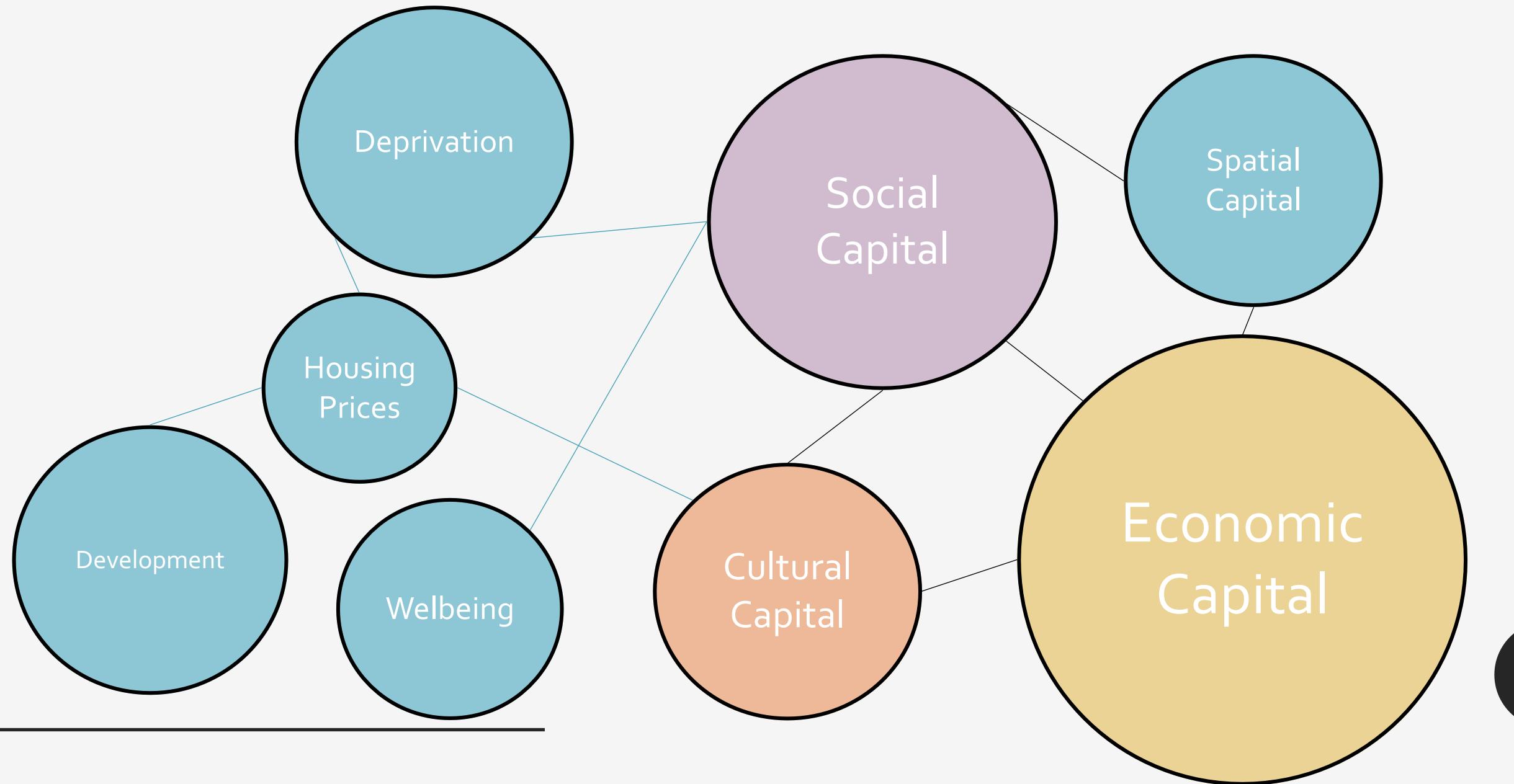


One of the most severe effects of gentrification is sudden housing price rises.
Using only public income data and Flickr photos related to cultural activities, we can predict a great deal of these price fluctuations.



Housing price prediction



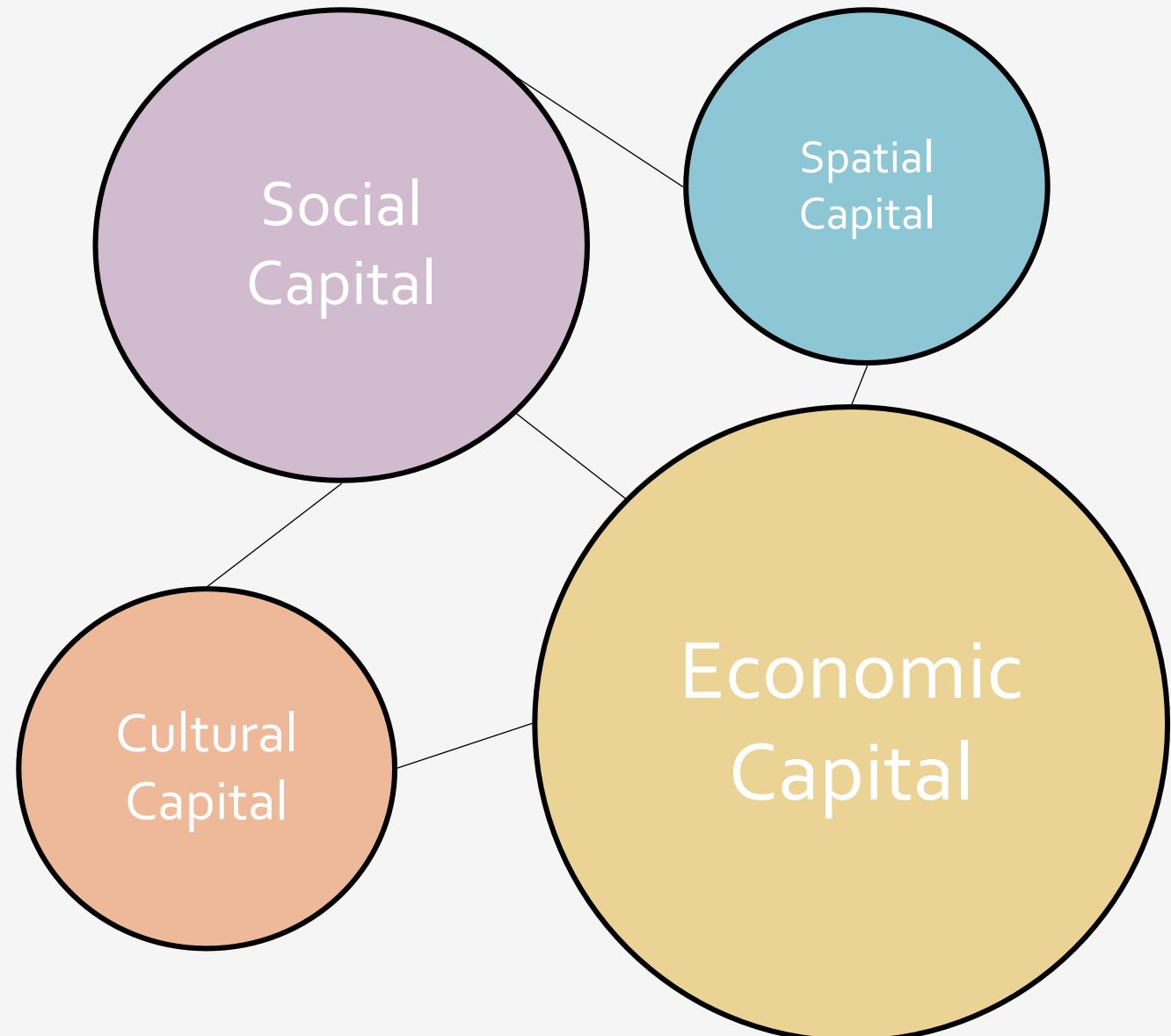


PRACTICAL SESSION:
MEASURING
GENTRIFICATION IN
MONTRÉAL



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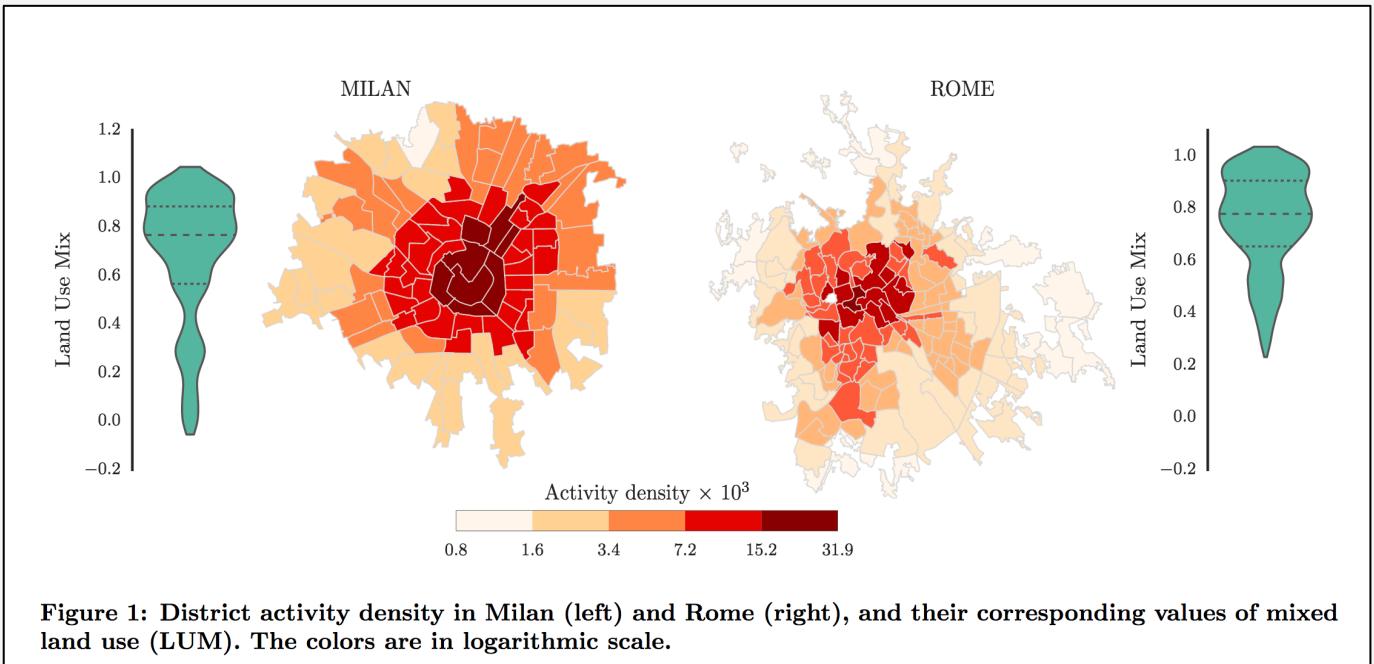
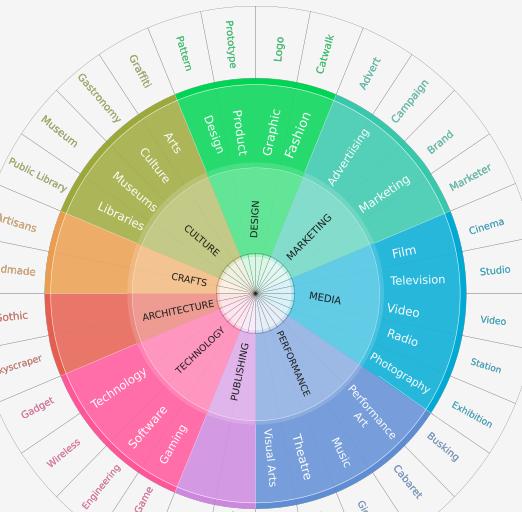


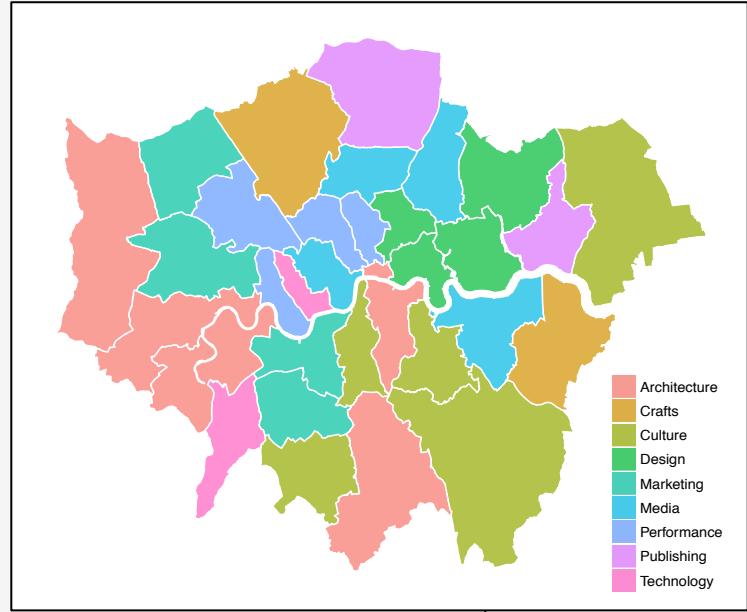
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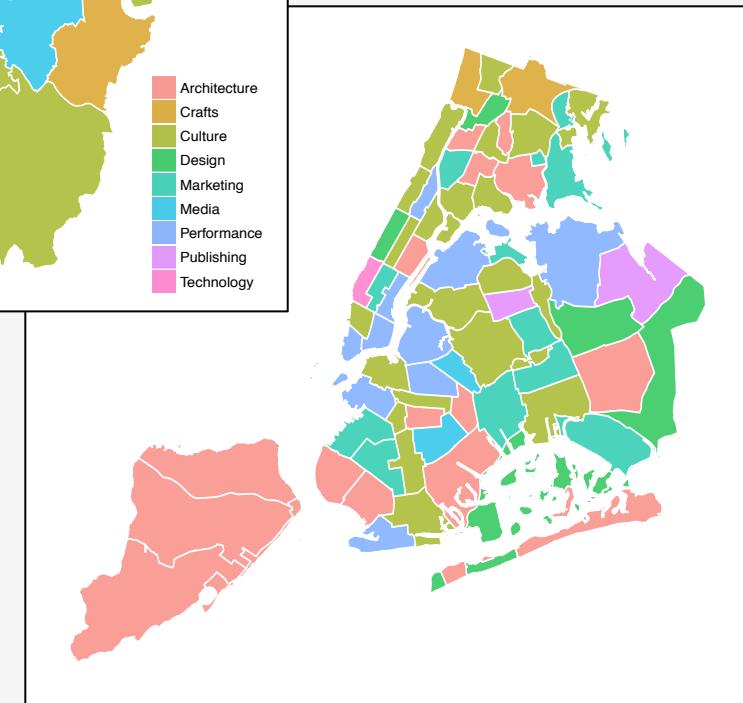
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We build a taxonomy of 263 cultural terms from the hierarchy of Wikipedia articles related to 9 top level categories.



Social Capital 2.0

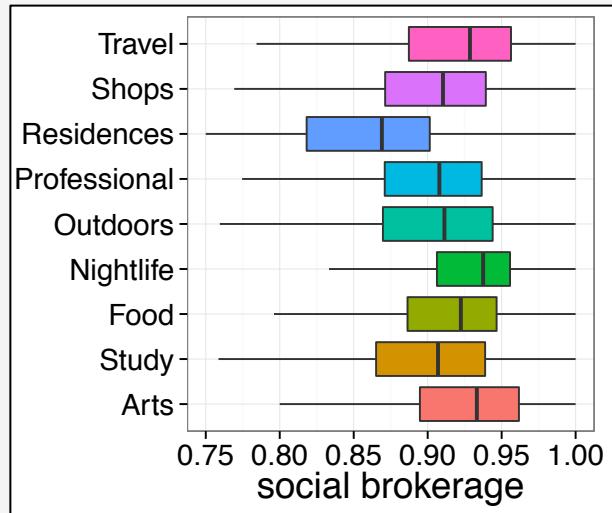
Data (Dec2010-Sept2011)

- 549,797 Foursquare checkins
- 42K Foursquare venues
- 3M transitions
- 36,926 users
- 432,929 social links



$$B(l) = |N_S^h(l)| - \frac{\sum_{u,v \in N_S^h(l)} e_{u,v}}{|N_S^h(l)|}$$

The brokerage of a place is the extent to which it brings together strangers vs friends. It is computed as the number of visitors to a place less the density of connections between the visitors of a place (redundancy).

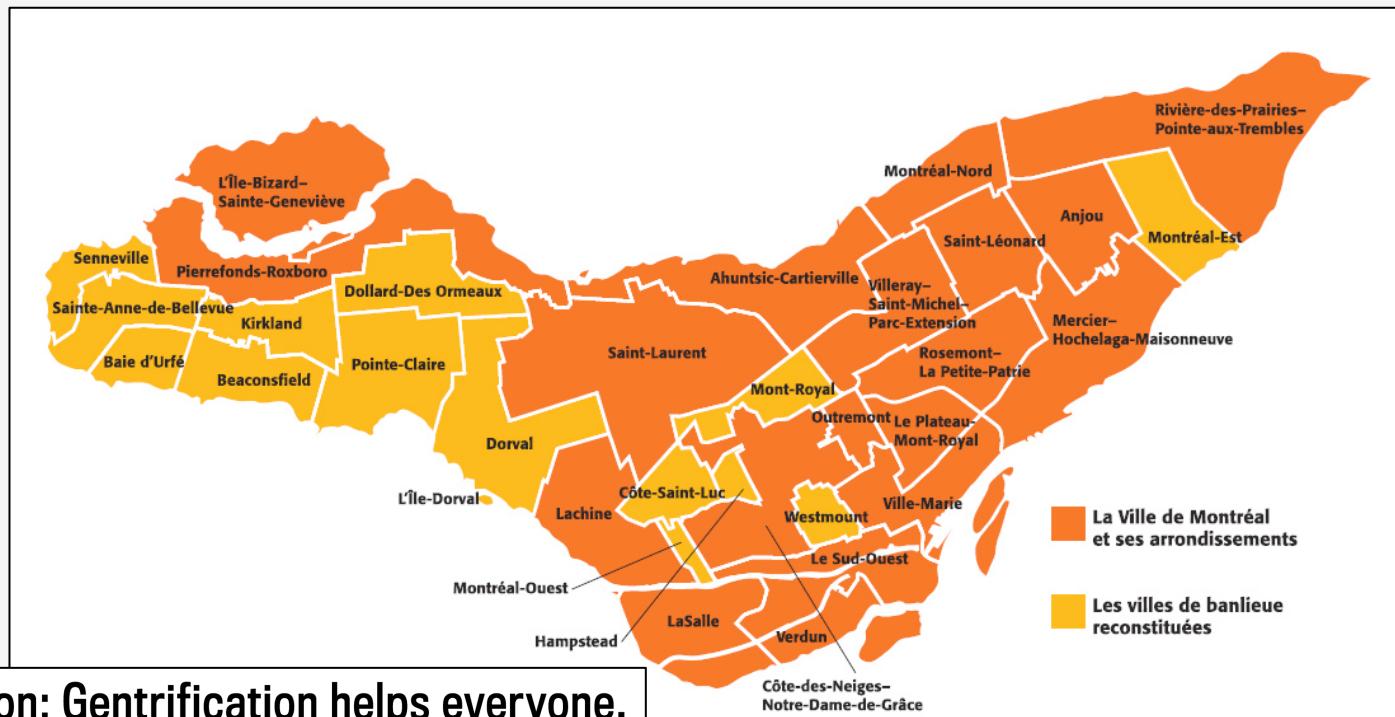


Category	Bridging role	Bonding role
Travel	Motel	B&B
Shops	Mall	Laundry
Residences	Apartment Building	Home
Professional	Courthouse	Emergency Room
Outdoors	Bridge	Vineyard
Nightlife	Gay Bar	Strip Club
Food	Dumplings	Fried Chicken
Study	Bookstore	Classroom
Arts	Art Museum	Football

Montreal

- 19 Boroughs (arrondissements)
- 1.6M total population
- Average house price: \$364K
- Average 2-bed rent: \$760

Number (map) ↗	Borough	Population Canada 2011 Census ^[1]	Area in km ²	Density per km ²
1.	Ahuntsic-Cartierville	126,891	24.2	5,252.1
2.	Anjou	41,928	13.7	3,064.9
3.	Côte-des-Neiges–Notre-Dame-de-Grâce	165,031	21.4	7,697.3
4.	Lachine	41,616	17.7	2,348.5
5.	LaSalle	74,276	16.3	4,565.2
6.	Le Plateau-Mont-Royal	100,390	8.1	12,348.1
7.	Le Sud-Ouest	71,546	15.7	4,562.9
8.	L'Île-Bizard–Sainte-Geneviève	18,097	23.6	766.8
9.	Mercier–Hochelaga-Maisonneuve	131,483	25.4	5,174.5
10.	Montréal-Nord	83,868	11.1	7,589.9
11.	Outremont	23,566	3.9	6,121.0
12.	Pierrefonds-Roxboro	68,410	27.1	2,528.1
13.	Rivière-des-Prairies–Pointe-aux-Trembles	106,437	42.3	2,517.4
14.	Rosemont–La Petite-Patrie	134,038	15.9	8,456.7
15.	Saint-Laurent	93,842	42.8	2,194.1
16.	Saint-Léonard	75,707	13.5	5,612.1
17.	Verdun	66,158	9.7	6,809.9
18.	Ville-Marie	84,013	16.5	5,085.5
19.	Villeray–Saint-Michel–Parc-Extension	142,222	16.5	8,624.7



Opinion: Gentrification helps everyone, be it in St-Henri, HoMa or elsewhere

VINCENT GELOSO, SPECIAL TO MONTREAL GAZETTE

More from Vincent Geloso, Special to Montreal Gazette

JASMIN GUÉNETTE, SPECIAL TO MONTREAL GAZETTE

More from Jasmin Guénette, Special to Montreal Gazette

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Cities
Gentrified world

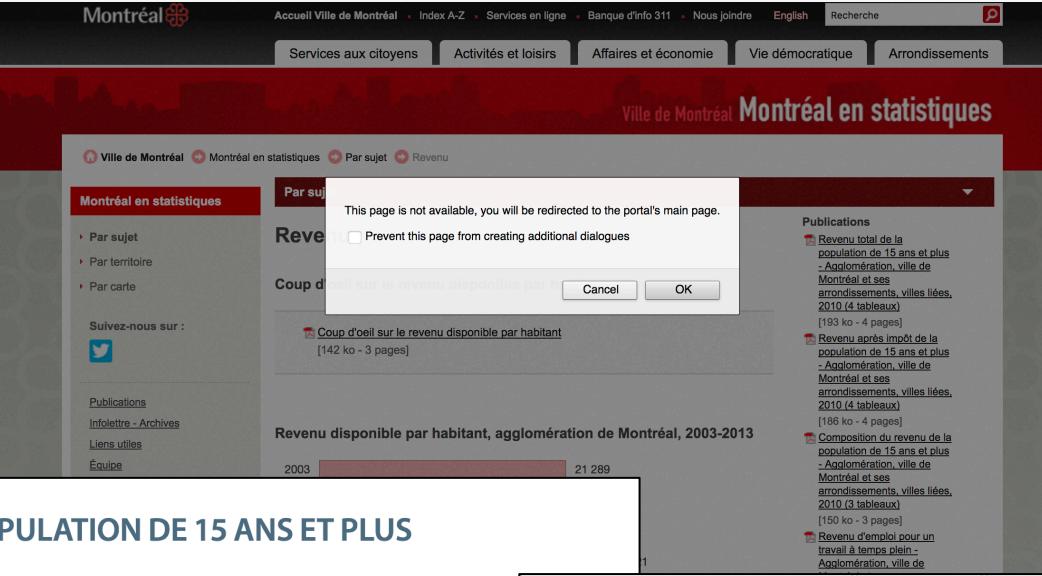
The one-in-six rule: can Montreal fight gentrification by banning restaurants?

A controversial law limiting new restaurant openings in Montreal's Saint-Henri area has pitted business owners against those who believe they are fighting for the very survival of Canada's 'culture capital'. Who is right?

Montreal Data

- % of population with income +60K
- % of population with income -10K

19 boroughs
2005/2010



	Revenu total de la population de 15 ans et plus	Sans revenu	Avec un revenu	M		
AGGLOMERATION DE MONTREAL	1 557 040	80 185	5,1%	1 476 855	94,9%	157 665
Ville de Montréal	1 364 810	69 390	5,1%	1 295 420	94,9%	137 350
Ahuntsic-Cartierville	102 830	5 110	5,0%	97 725	95,0%	9 265
Anjou	34 830	1 755	5,0%	33 080	95,0%	2 645
Côte-des-Neiges–Notre-Dame-de-Grâce	135 590	8 600	6,3%	126 990	93,7%	17 780
Lachine	33 355	1 715	5,1%	31 640	94,9%	3 110
LaSalle	61 425	3 425	5,6%	58 005	94,4%	5 555
Le Plateau-Mont-Royal	87 730	3 100	3,5%	84 630	96,5%	10 110
Le Sud-Ouest	60 345	2 980	4,9%	57 370	95,1%	5 775
L'Île-Bizard–Sainte-Geneviève	14 580	825	5,7%	13 755	94,3%	1 425
Mercier–Hochelaga–Maisonneuve	111 330	4 360	3,9%	106 970	96,1%	9 390
Montréal-Nord	65 865	3 960	6,0%	61 905	94,0%	6 535
Outremont	17 890	1 005	5,6%	16 885	94,4%	1 545
Pierrefonds-Roxboro	54 715	3 535	6,5%	51 185	93,5%	5 445

	Population de 15 ans et plus ayant un revenu	Moins de 10 000 \$	10 000 \$ à 19 999 \$		
AGGLOMERATION DE MONTREAL	1,454,860	323,475	22.2%	341,940	23.5%
Ville de Montréal	1,276,405	288,850	22.6%	310,515	24.3%
Ahuntsic-Cartierville	99,490	21,585	21.7%	24,720	24.8%
Anjou	33,135	5,915	17.9%	7,170	21.6%
Côte-des-Neiges–Notre-Dame-de-Grâce	125,795	33,900	26.9%	30,720	24.4%
Lachine	32,090	6,155	19.2%	6,875	21.4%
LaSalle	59,755	11,730	19.6%	13,600	22.8%
Le Plateau-Mont-Royal	82,645	18,595	22.5%	18,340	22.2%
Le Sud-Ouest	54,715	14,215	26.0%	14,205	26.0%
L'Île-Bizard–Sainte-Geneviève	13,090	2,495	19.1%	2,360	18.0%
Mercier–Hochelaga–Maisonneuve	104,335	22,340	21.4%	24,760	23.7%
Montréal-Nord	63,775	15,320	24.0%	19,040	29.9%
Outremont	17,295	3,025	17.5%	2,970	17.2%
Pierrefonds-Roxboro	48,260	9,935	20.6%	9,225	19.1%
Rivière-des-Prairies–Pointe-aux-Trembles	80,650	15,345	19.0%	17,615	21.8%
Rosemont–La Petite-Patrie	110,800	23,035	20.8%	26,665	24.1%
Saint-Laurent	64,800	15,075	23.3%	16,605	25.6%
Saint-Léonard	56,765	11,955	21.1%	15,210	26.8%
Verdun	53,075	11,710	22.1%	11,435	21.5%
Ville-Marie	64,660	18,380	28.4%	15,285	23.6%
Villeray–Saint-Michel–Parc-Extension	111,275	28,140	25.3%	33,715	30.3%

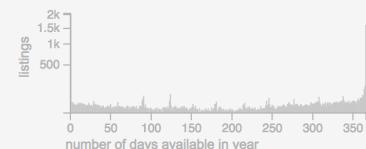
Airbnb Listings

Availability

An Airbnb host can setup a calendar for their listing so that it is only available for a few days or weeks a year.

Other listings are available all year round (except for when it is already booked).

Entire homes or apartments **highly available** year-round for tourists, probably don't have the owner present, could be illegal, and more importantly, are displacing residents.



Listings per Host

Some Airbnb hosts have multiple listings.

A host may list separate rooms in the same apartment, or multiple apartments or homes available in their entirety.

Hosts with multiple listings are more likely to be running a business, are unlikely to be living in the property, and in violation of most short term rental laws designed to protect residential housing.



10,619 Listings 2016

Only highly available

64.5%
high availability

6,845 (64.5%)
listings w **high** availability

3,774 (35.5%)
listings w **low** availability

196.8 (53.9%)
days/year

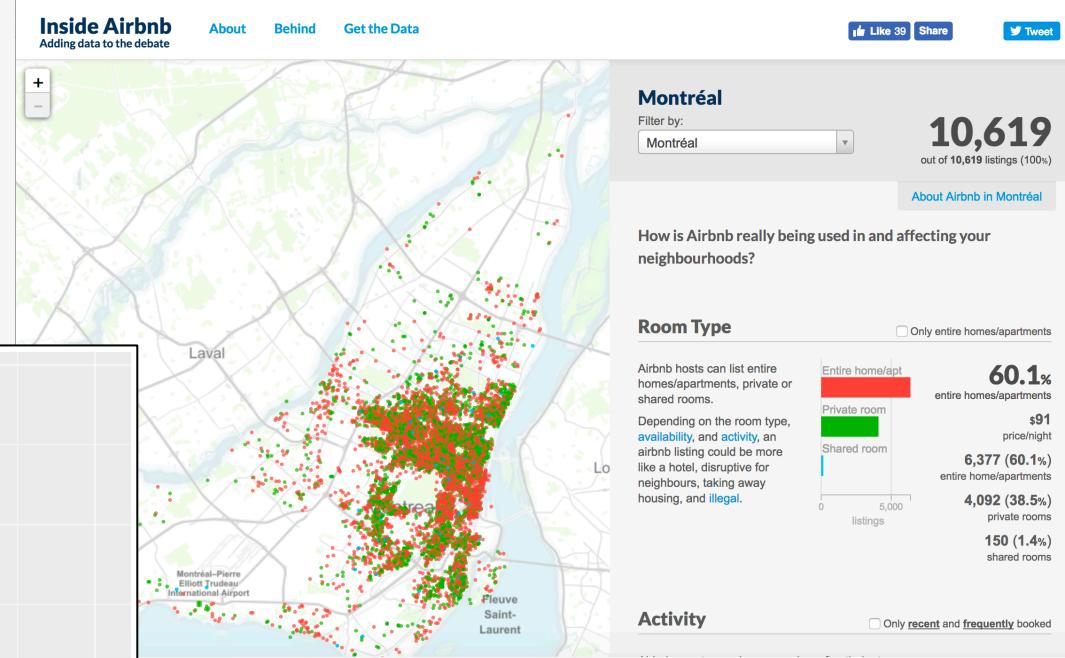


Only multi-listings

31.4%
multi-listings

7,283 (68.6%)
single listings

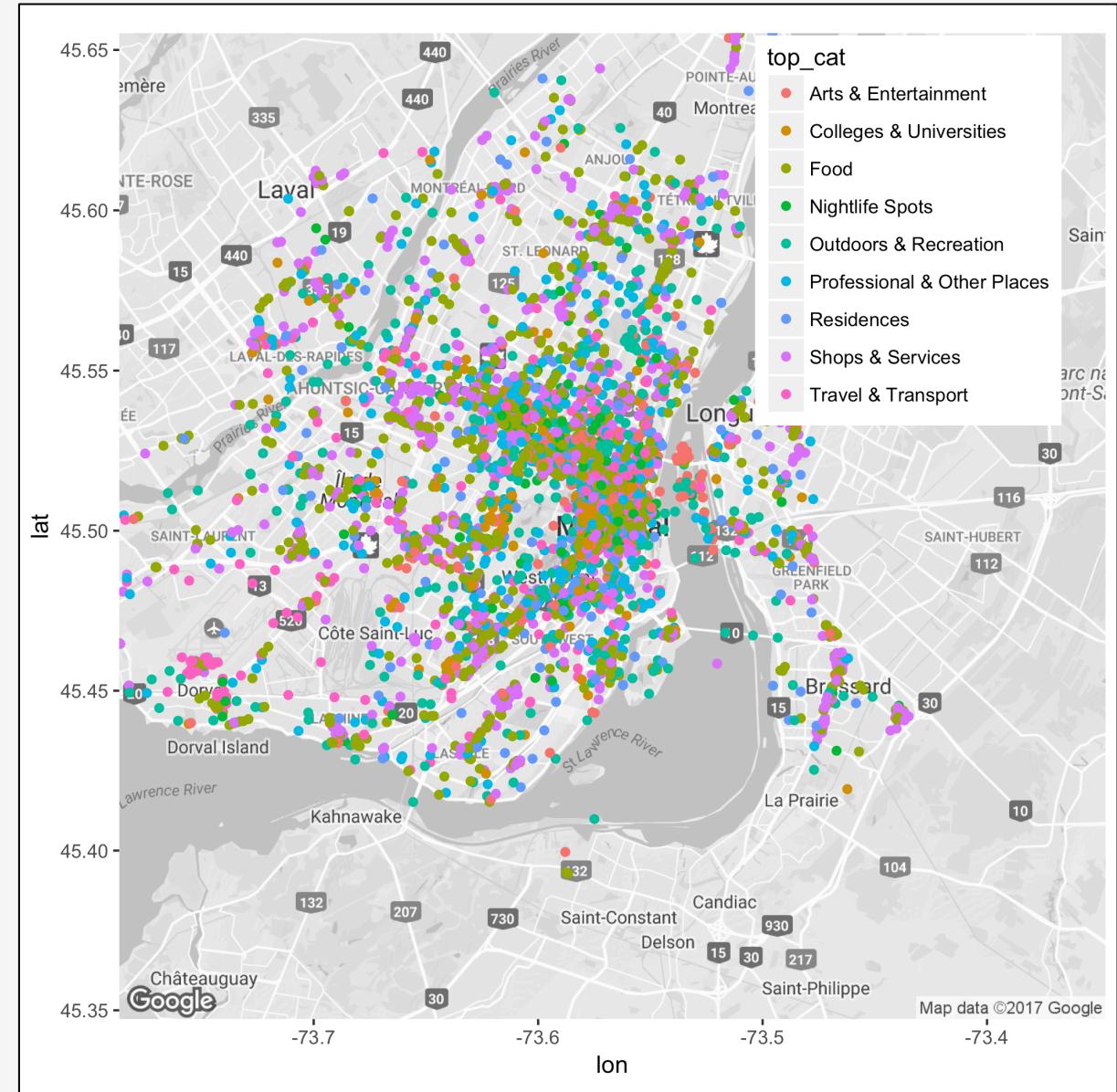
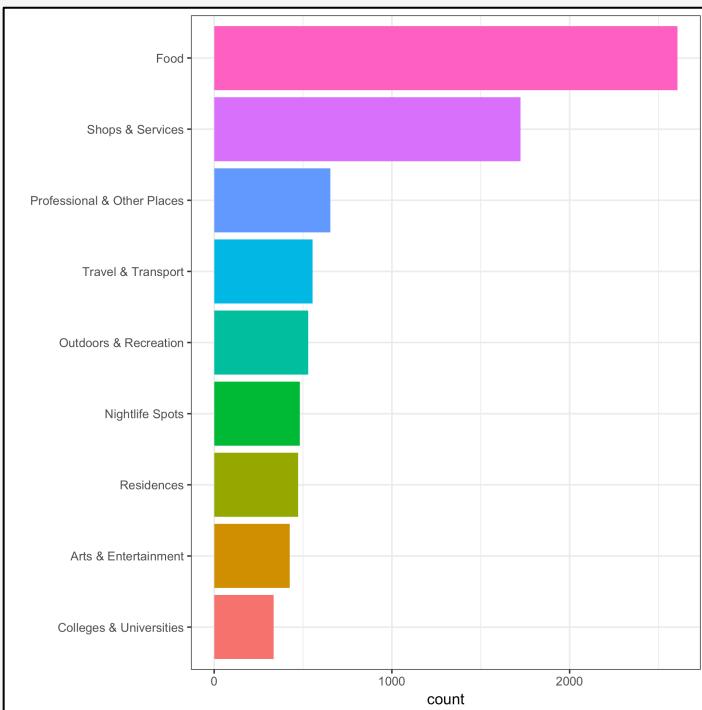
3,336 (31.4%)
multi-listings



- "How many listings are in my neighbourhood and where are they?"
- "How many houses and apartments are being rented out frequently to tourists and not to long-term residents?"
- "How much are hosts making from renting to tourists (compare that to long-term rentals)?"
- "Which hosts are running a business with multiple listings and where they?"

Foursquare Venues

2010 crawl
7,781 venues
6,813 users



Setting up

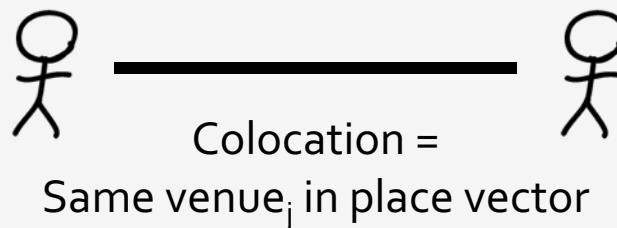
- Compute social, cultural and spatial capital
- Observe relationships between the forms of capital
- Compare Airbnb listing prices to levels of symbolic capital
- Explain Airbnb prices with income and capital metrics

```
load_data.py
```

```
1 import csv
2 import datetime
3
4 class MontrealDataLoader:
5
6     def __init__(self):
7
8         self.load_venues()
9         self.load_users_to_venues()
10
11    def load_venues(self):
12        #venue_id, coords, type, checkins, users, name, neighbourhood
13        self.venues = {}
14        f = csv.reader(open('../data/neighbourhood_venues.csv'))
15        f.next()
16        for line in f:
17            self.venues[line[1]] = tuple(line[2:11])
18
19    def load_users_to_venues(self):
20        #user_id, venue_id, datetime
21        self.venues_to_users = {}
22        self.users_to_venues = {}
23        with open('../data/montreal_trajectories_newcrawl.txt') as f:
24            for line in f:
25                splits = line.split('*;;;;*')
26                user_id = int(splits[0])
27                info = eval(splits[1])
28                for c in info:
29                    venue = c[0]
30                    self.venues_to_users.setdefault(venue, set())
31                    self.users_to_venues.setdefault(user_id, set())
32                    self.venues_to_users[venue].add(user_id)
33                    self.users_to_venues[user_id].add(venue)
```

Measuring Social Capital

Structural hole =
 U_1, U_2 are not co-located outside $venue_i$



$$S_i = \sum_j \left[1 - \sum_q p_{iq} m_{jq} \right]$$

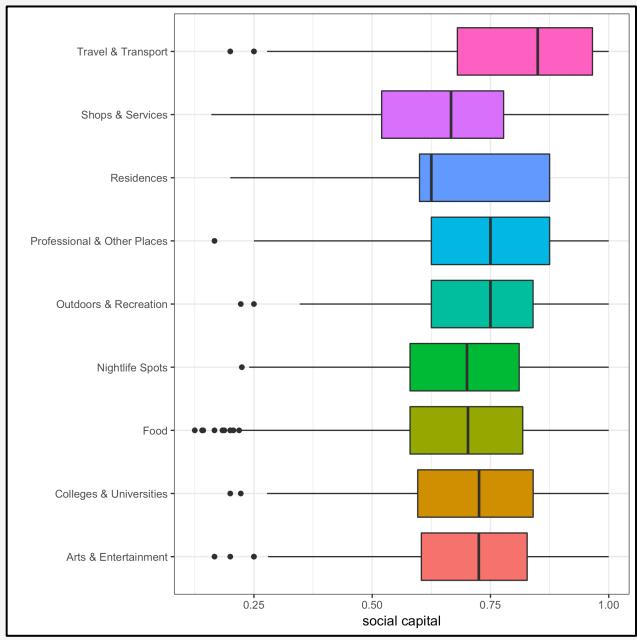


$$\text{effective size} = n - \frac{2t}{n}$$

```
urban_capital.py *  
  
def social_capital_venue(visitors,user_vecs):  
    #compute social capital of a venue in the form [user_id,...]  
    colocs = 0 #number of colocation links b/w visitors  
    n = len(visitors) #number of visitors  
    if n > 3:  
        for visitor_a in range(0,n):  
            for visitor_b in range(visitor_a,n):  
                if visitor_a is not visitor_b: #for every pair of visitors  
                    #user_vecs is a dict of user_id:[venue_id,...]  
                    coloc = colocation(visitors[visitor_a],visitors[visitor_b],user_vecs)  
                    colocs += coloc  
  
                density = float(colocs/((n*(n-1))/2))  
                redundancy = float(density*(n-1))  
                efficiency = float((n-redundancy)/n)  
  
    return efficiency  
  
def colocation(usera,userb,user_vecs):  
    #test if two users have been colocated more than twice  
    venuesa = user_vecs[usera]  
    venuesb = user_vecs[userb]  
    coloc = venuesa.intersection(venuesb)  
    if len(coloc) > 2:  
        return 1  
    return 0
```

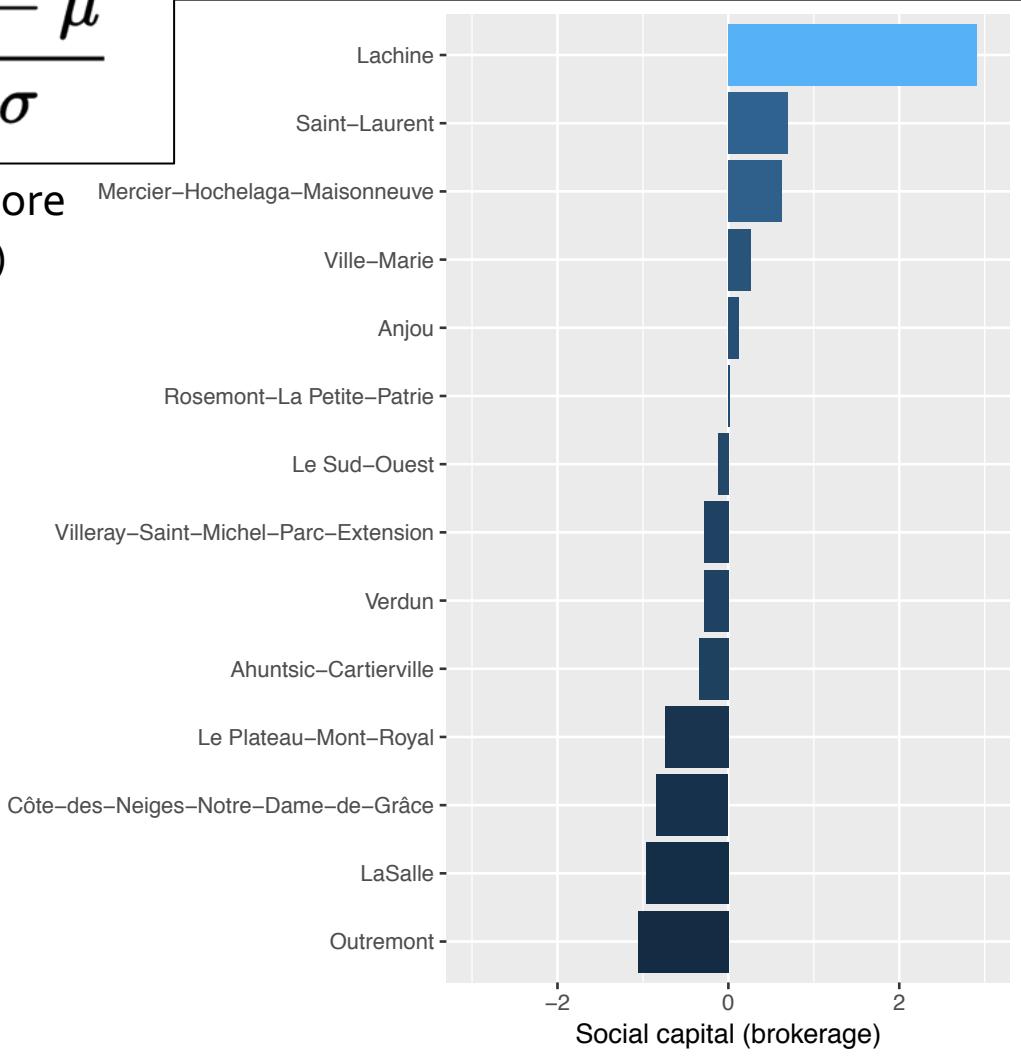
We build a co-location network by placing a link between users who have visited the same venues more than n times.

Measuring Social Capital



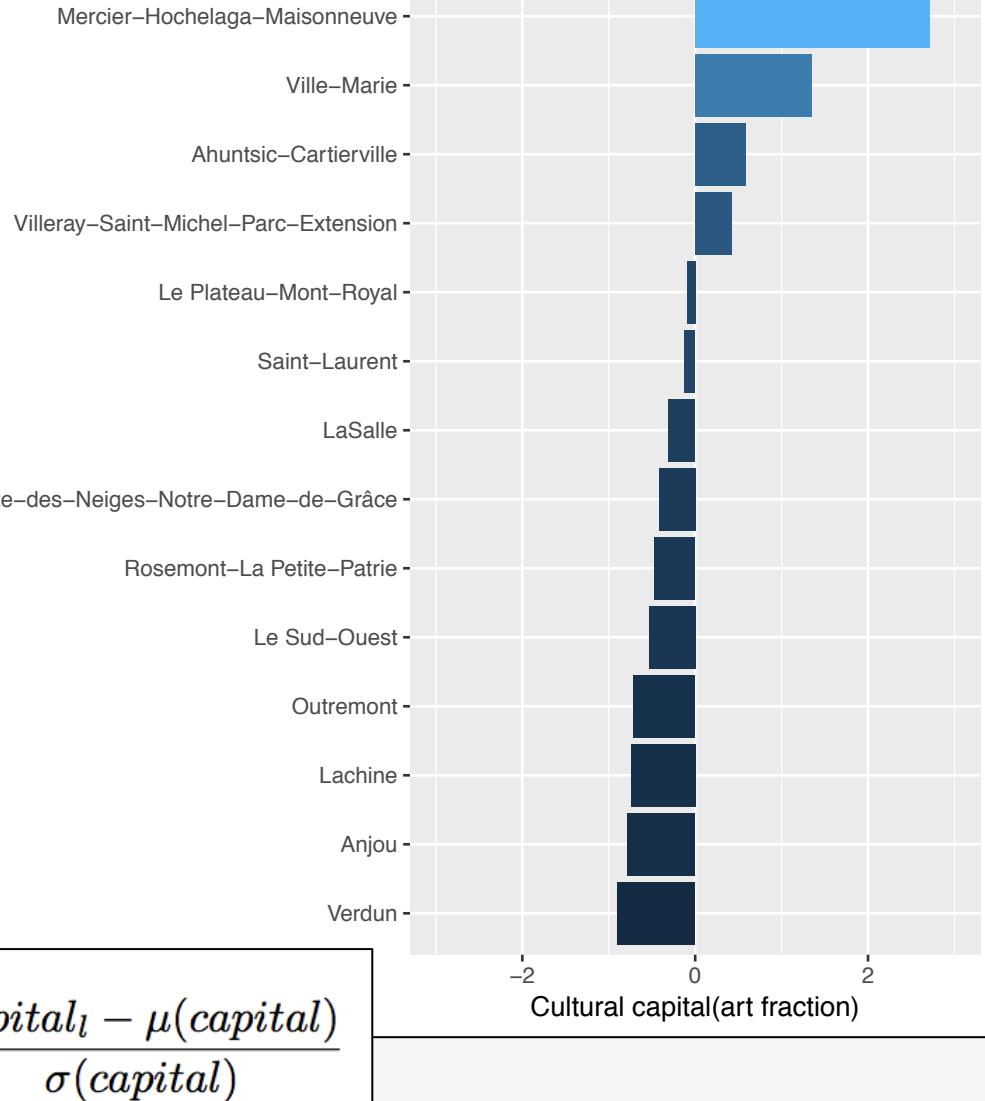
$$z = \frac{x - \mu}{\sigma}$$

Standard score
(z-score)



Measuring Cultural Capital

```
urban_capital.py *  
1 from __future__ import division  
2 from math import log  
3 from load_data import MontrealDataLoader  
4 import csv  
5  
def cultural_capital(hoods):  
    #hoods[hood]:{'category':no_checkins}  
    hood_cult = {}  
    for hood in hoods:  
        if 'Arts & Entertainment' in hoods[hood]:  
            cult = hoods[hood]['Arts & Entertainment']  
            total = sum(hoods[hood].values())  
            hood_cult[hood] = float(cult/total)  
  
    return hood_cult
```



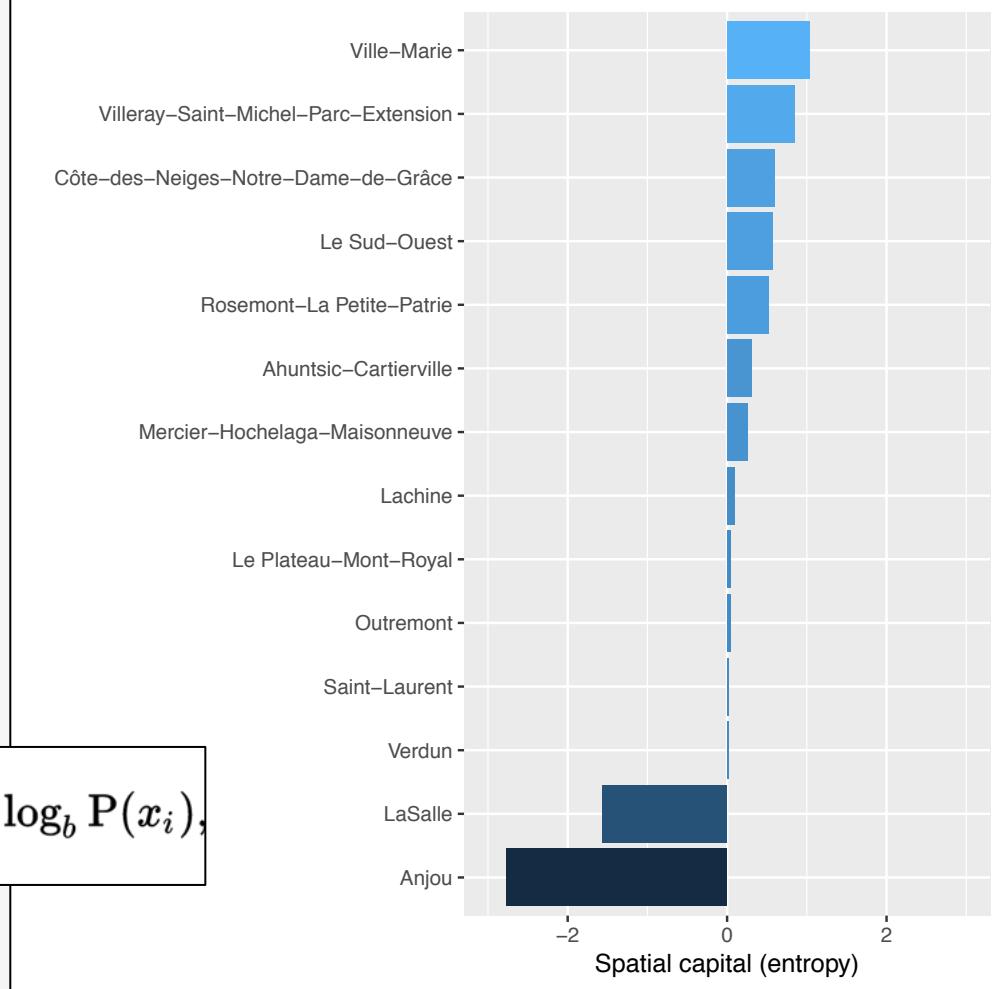
$$capital(l) = \frac{capital_l - \mu(capital)}{\sigma(capital)}$$

Measuring Spatial Capital

```
urban_capital.py
from __future__ import division
from math import log
from load_data import MontrealDataLoader
import csv

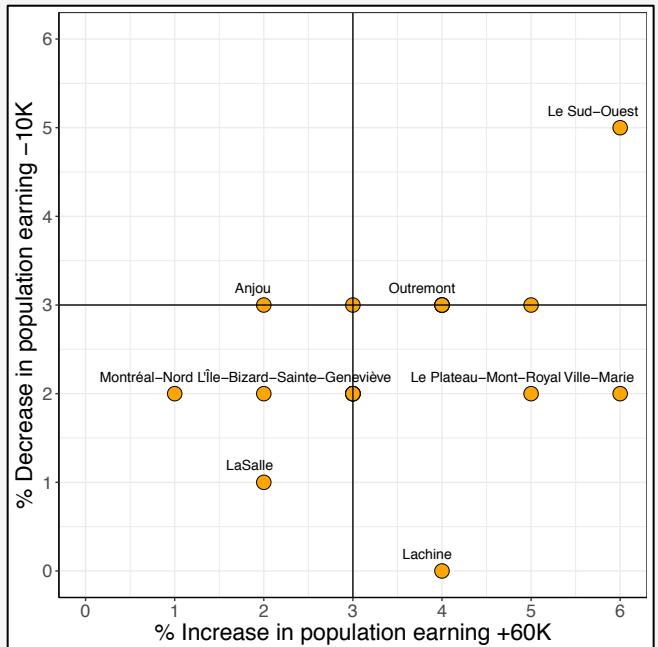
def cat_entropy(hoods):
    #hoods[hood]:{'category':number of checkins...}
    hood_ent = {}
    for hood in hoods:
        ent = 0
        total = sum(hoods[hood].values())
        for cat in hoods[hood]:
            if total is not 0:
                prob = float(hoods[hood][cat]/total)
                e = prob*log(prob,2)
                ent += e
        hood_ent[hood] = -round(ent,2)
    return hood_ent
```

$$-\sum_{i=1}^n P(x_i) \log_b P(x_i),$$

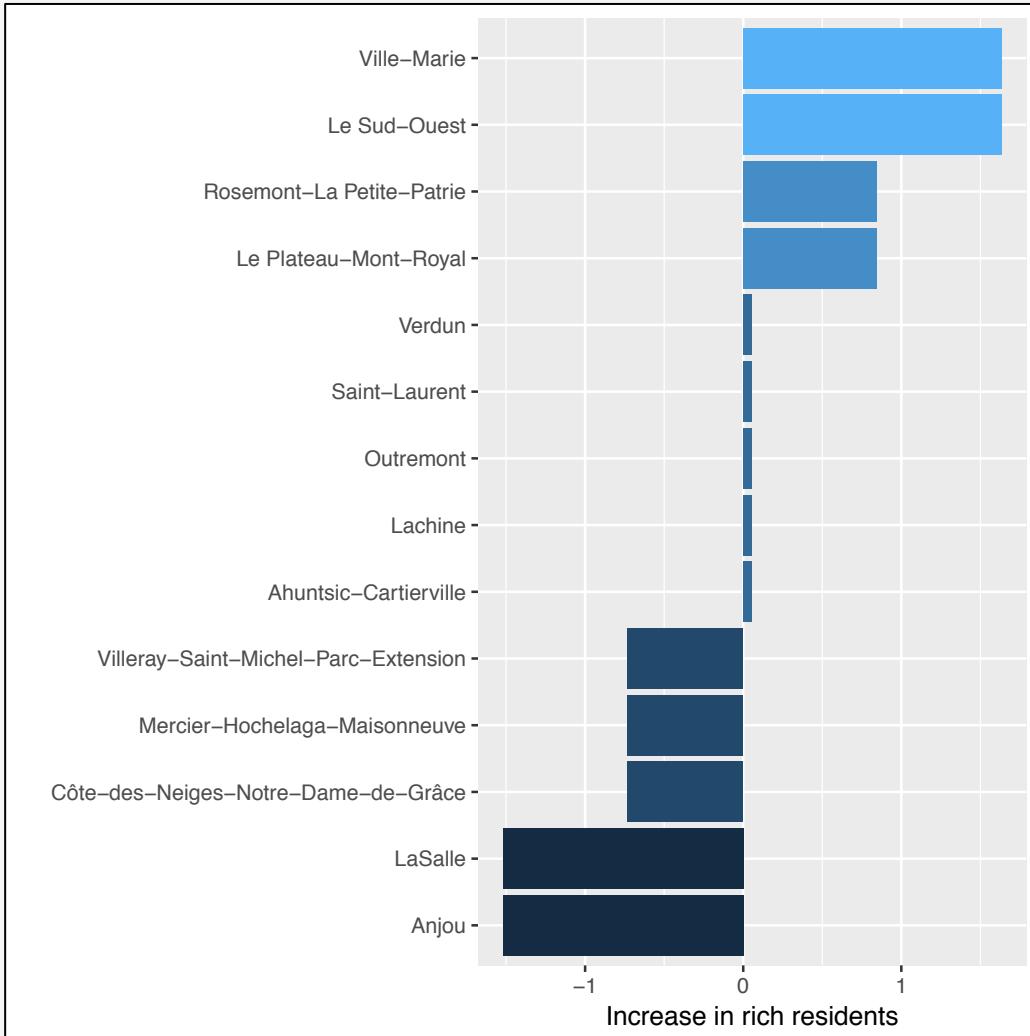


The Shannon entropy between categories of Foursquare venues in an area can be used as a measure of the mixed use of a neighbourhood. P is the probability of a random checking having the category d. Higher entropy means more mixed use.

Social Displacement



An increase in percent of wealthy residents and decrease in lower income residents is linked to gentrification.

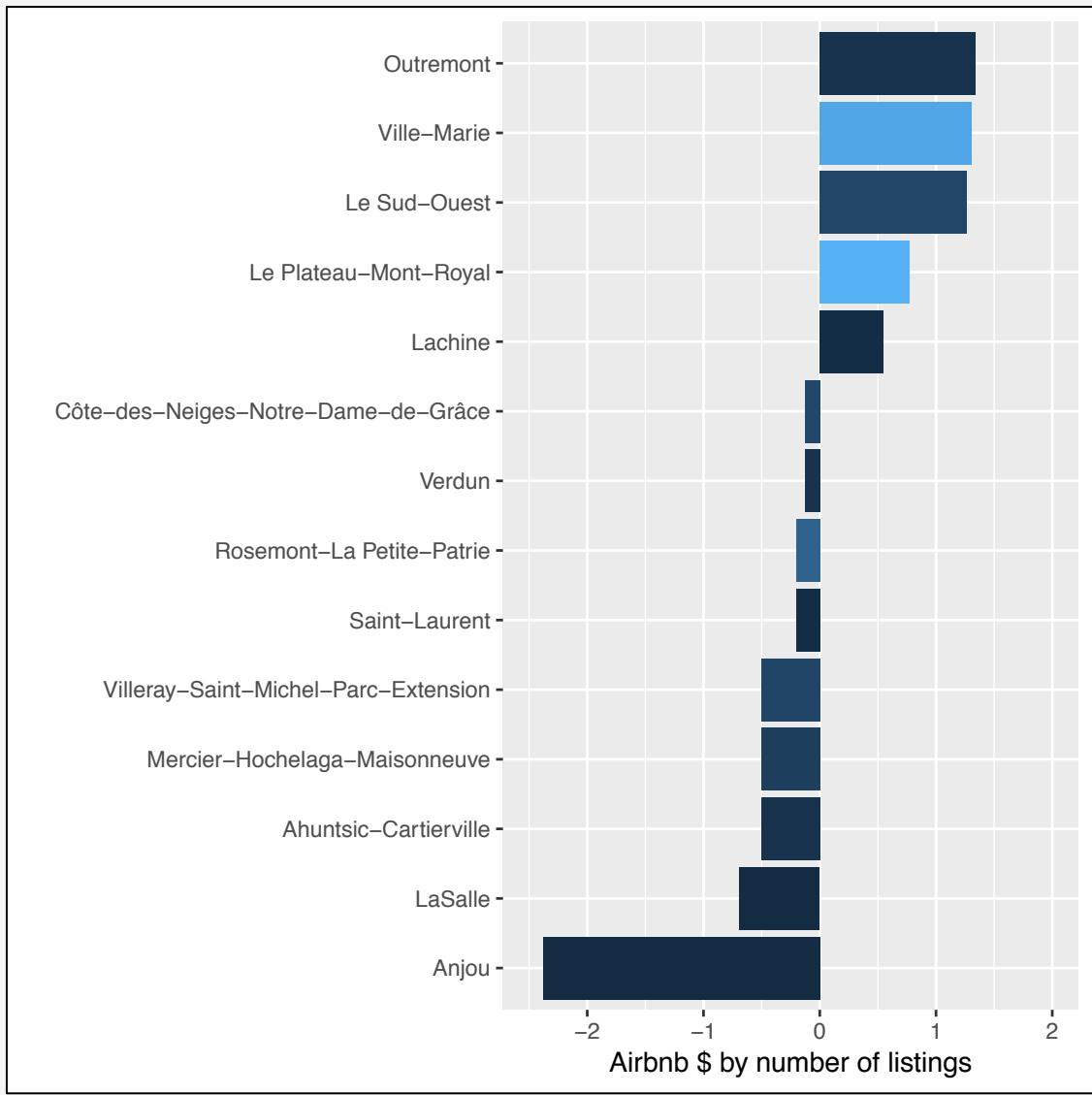


Airbnb Listings



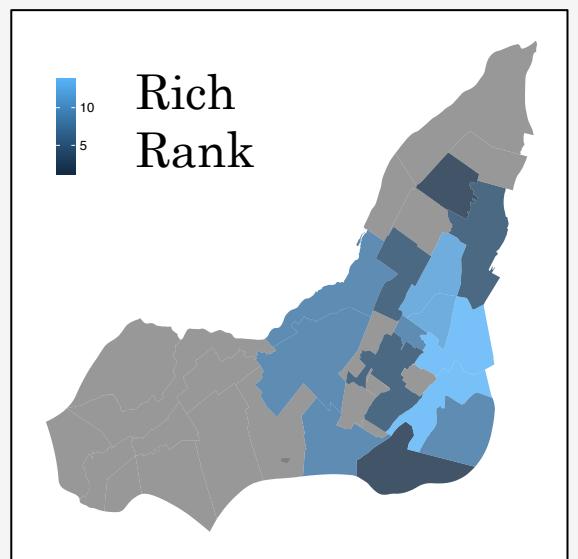
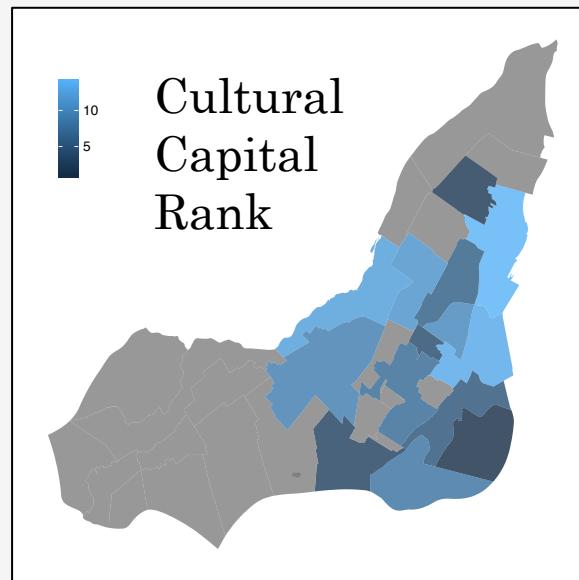
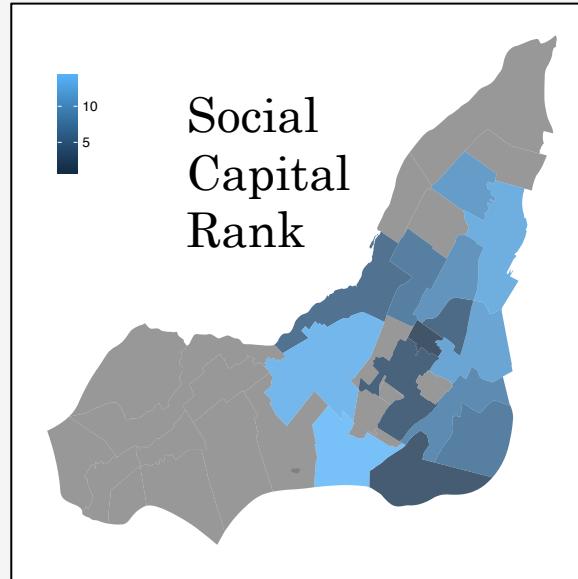
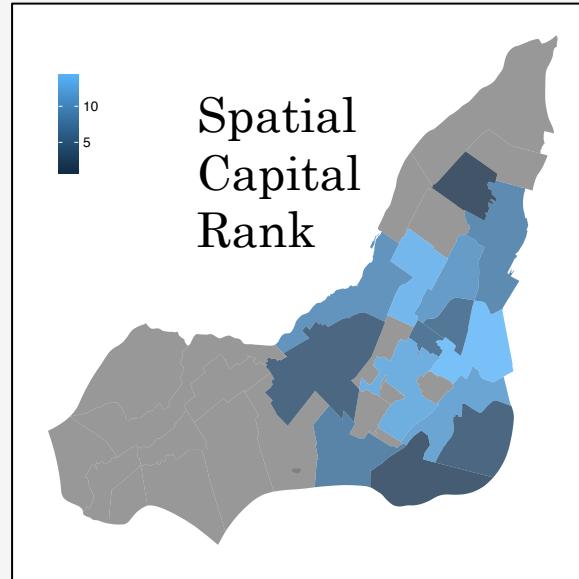
Outremont has high median prices and low availability.
Ville-Marie has high median prices and high availability.
Anjou has low prices and high availability...

Color = number of listings
X = price \$ deviation from the mean



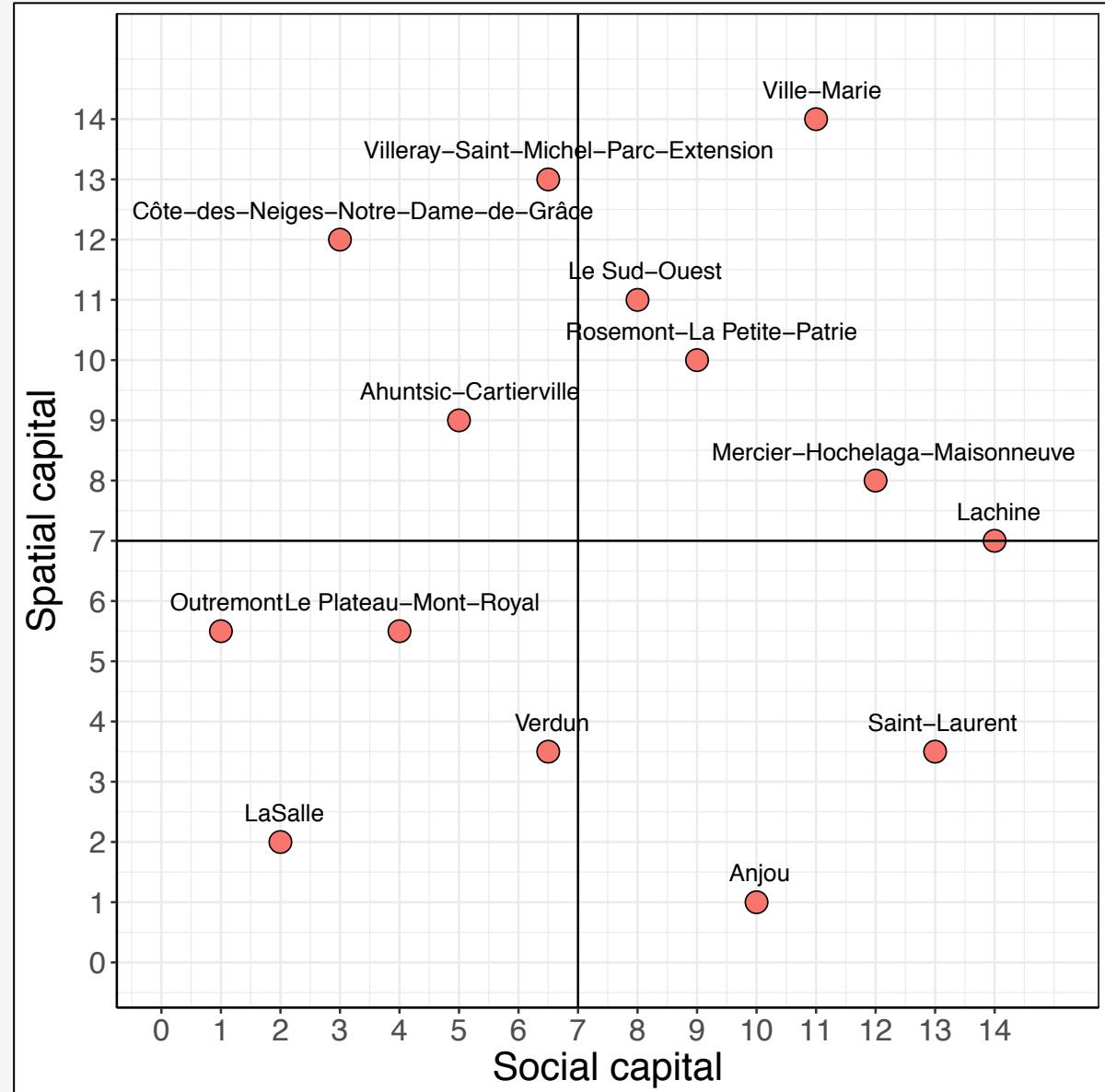
Geographic Distribution

- Generally, central areas are more mixed use (higher entropy)
- Social capital (bonding) is higher in peripheral neighbourhoods
- Cultural capital is mixed across geography
- The increase in wealthy residents is primarily in central parts of the city



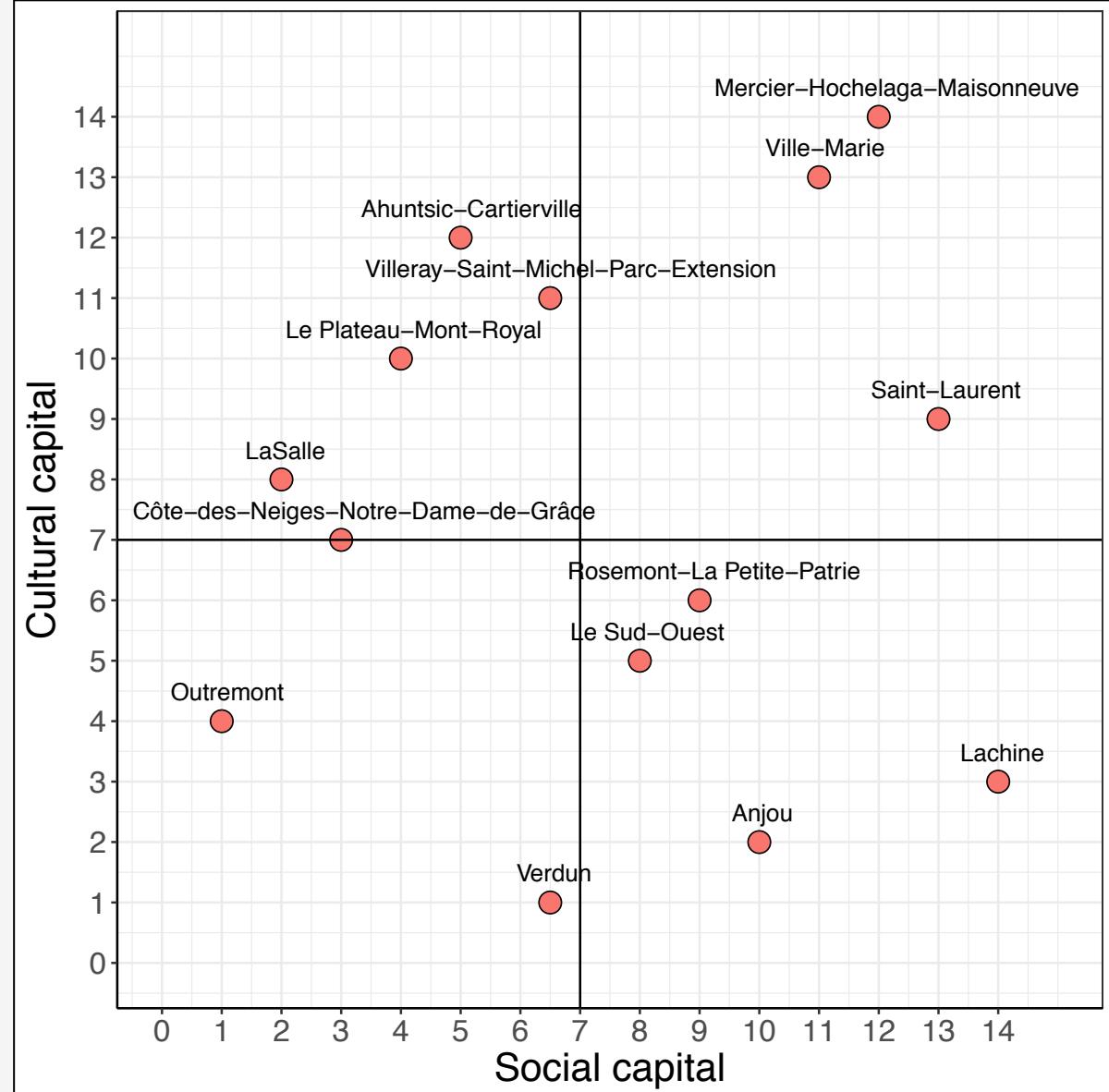
Social & Spatial Capital

Neighbourhoods which rank high in spatial and social capital have mixed use and bring together strangers. This relates to Jane Jacob's theory of urban vitality.



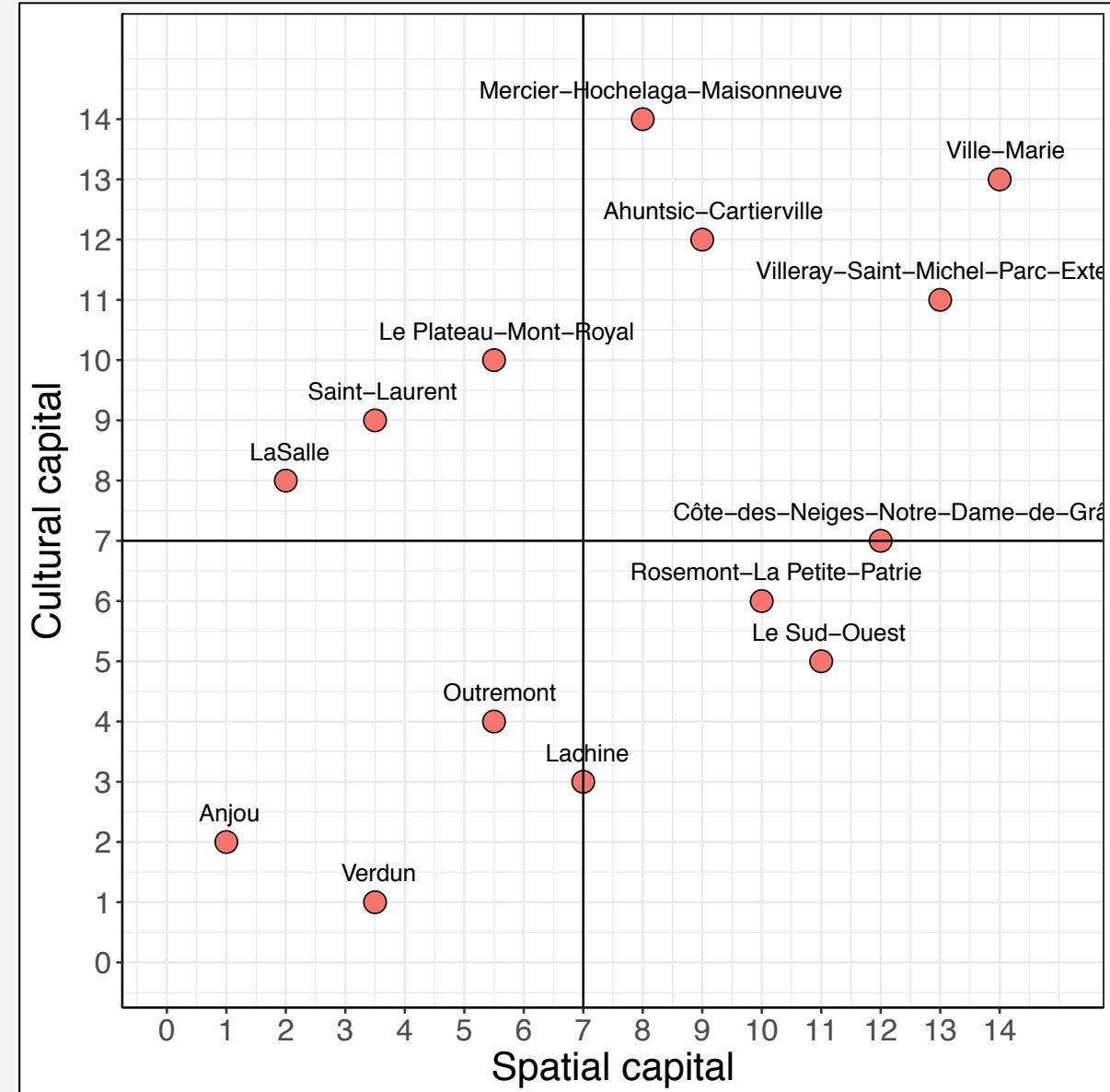
Social & Cultural Capital

Art-related venues tend to have high social capital, therefore neighbourhoods which tend to have high cultural capital also have high social capital.



Spatial & Cultural Capital

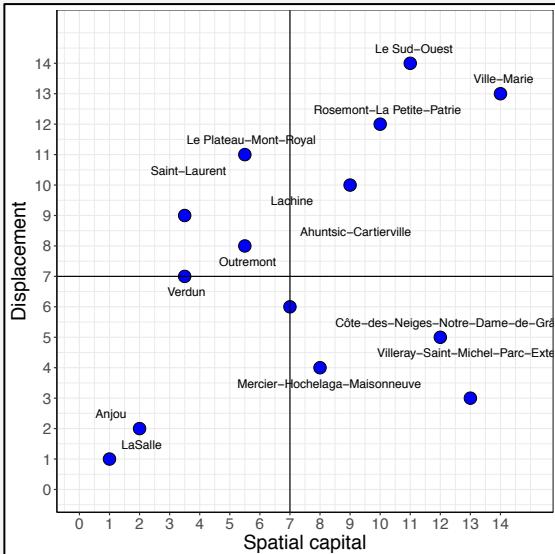
Neighbourhoods with high entropy (spatial capital) tend to also have high cultural capital.



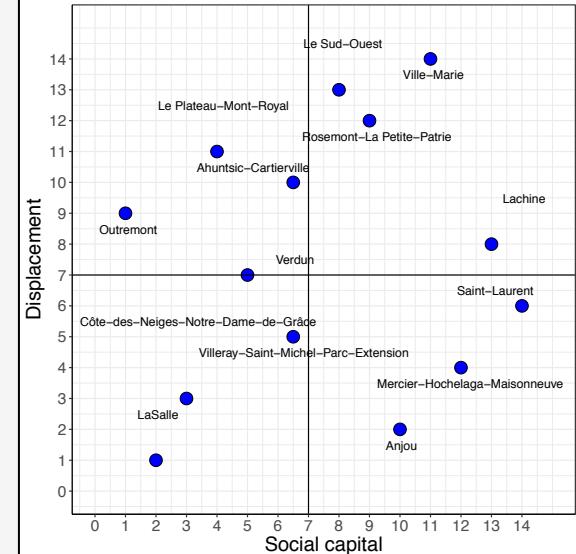
Forms of Capital & Displacement

Higher spatial and social capital relate to higher displacement.
Displacement in 2010 is strongly correlated to the price of an Airbnb listings in Montreal in 2016.

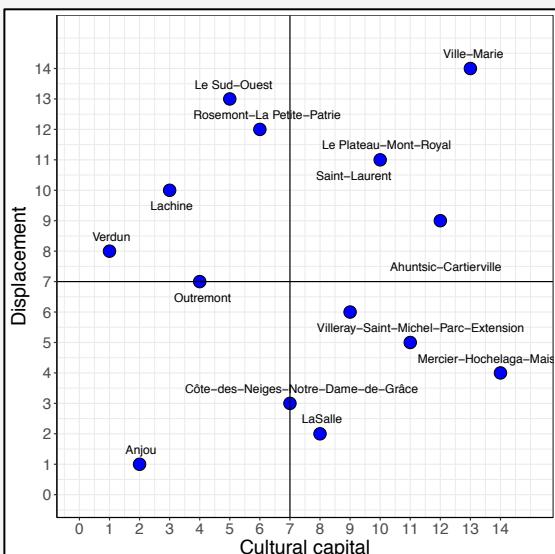
$r = 0.65, p = 0.01$



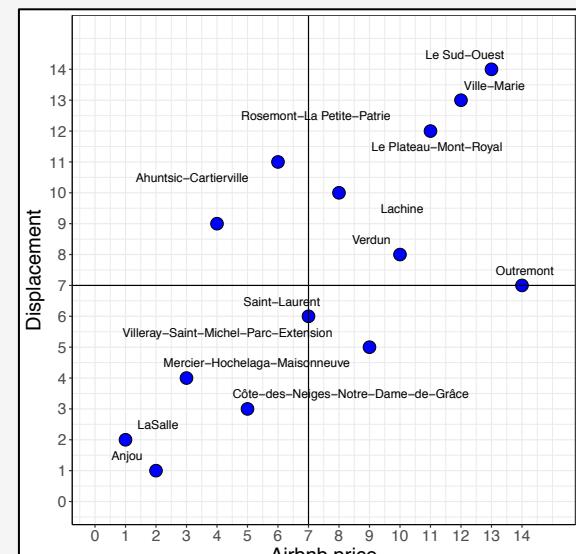
$r = 0.45, p = 0.1$



$r = 0.16, p = 0.7$



$r = 0.79, p < 0.001$

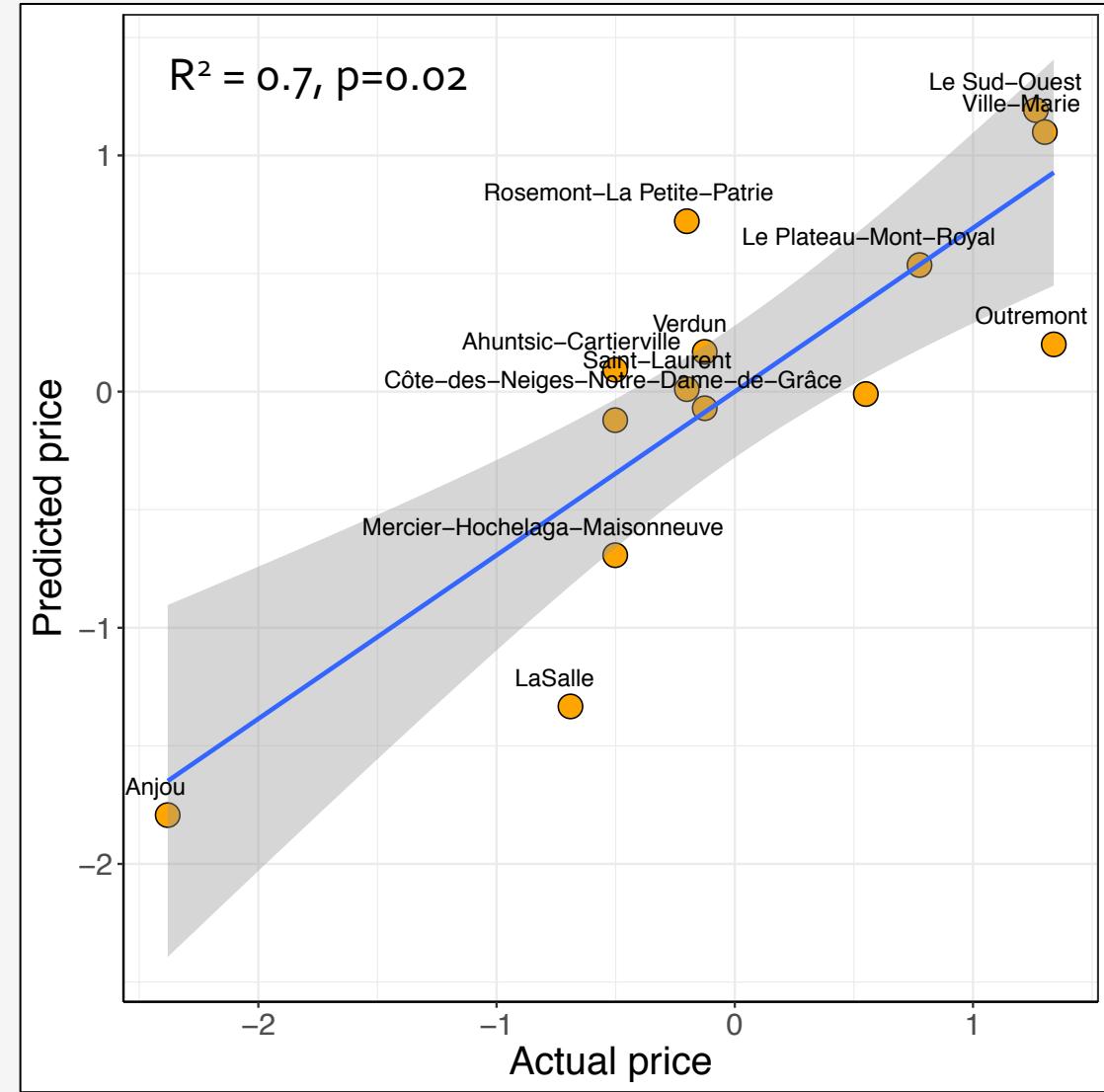


Airbnb Listing Prices

Model	R ²	Significance
Cultural capital	-	-
Social capital	-	-
Spatial capital	0.48	***
Displacement	0.61	***
Cultural capital + displacement	0.62	***
Social capital + displacement	0.62	***
Spatial capital + displacement	0.67	***

Combined Model

$$\text{airbnb}_\$ \sim a * \text{capital}_{\text{sp}} + b * \text{capital}_{\text{soc}} + c * \text{capital}_{\text{cult}} + d * \text{displacement} + \text{bias}$$



*Happy
Birthday!!*

