Geographic Data Science - Lecture VIII

Grouping Data over Space

Dani Arribas-Bel

Today

- The need to group data
- Geodemographic analysis
- Non-spatial clustering
- Regionalization
- Examples "in the wild"

The need to group data

Everything should be made as simple as possible, but not simpler

Albert Einstein

The need to group data

- The world (and its problems) are **complex** and **multidimensional**
- **Univariate** analysis involves focusing **only one** way of measure the world

The need to group data

- The world (and its problems) are **complex** and **multidimensional**
- **Univariate** analysis involves focusing **only one** way of measure the world
- Sometimes, world issues are best understood as **multivariate**:
  - Percentage of foreign-born Vs. *What is a neighborhood?*
  - Years of schooling Vs. *Human development*
  - Monthly income Vs. *Deprivation*

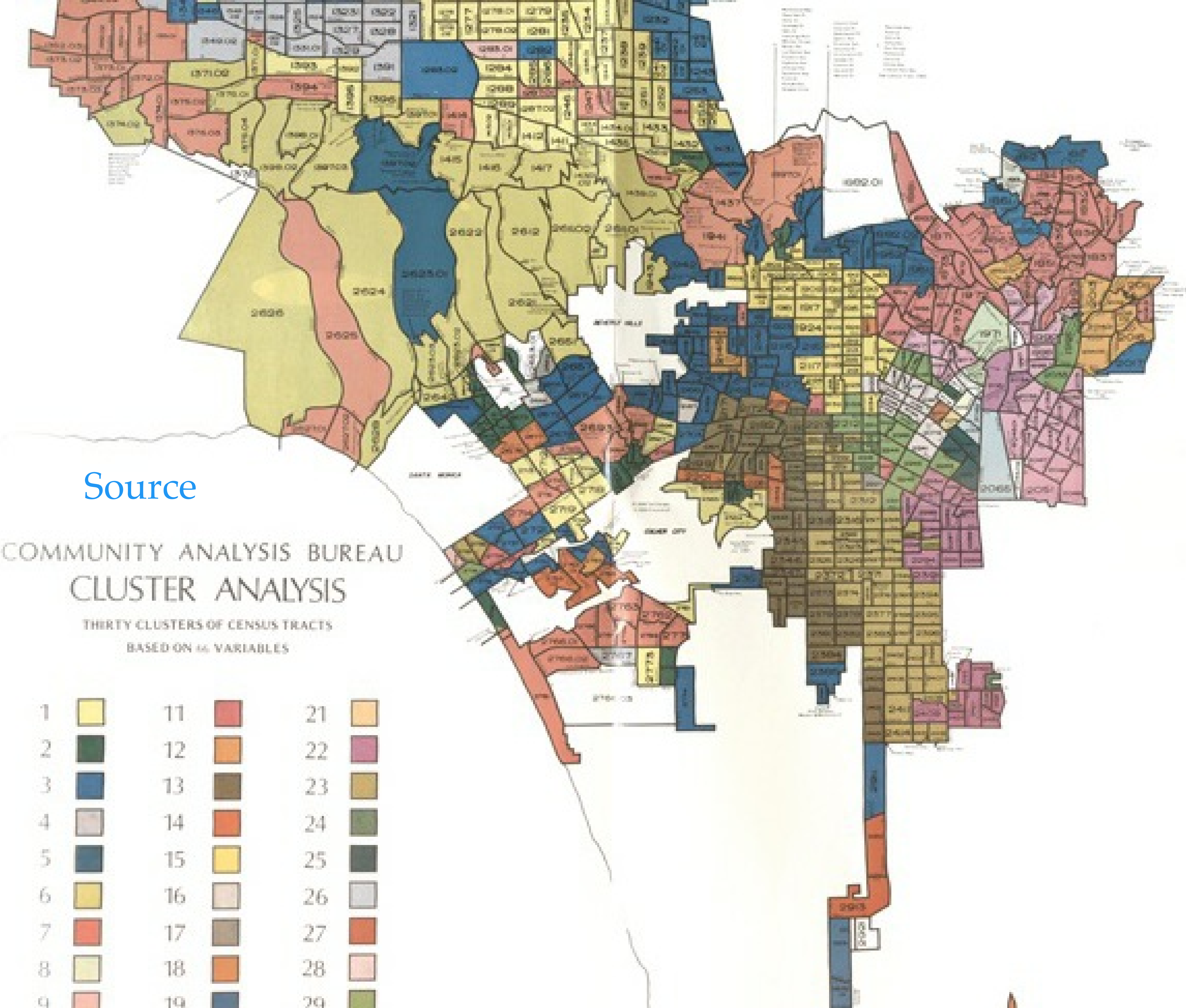
Grouping as *simplifying*

- Define a given number of categories based on **many characteristics** (multi-dimensional)
- Each observation in the category where it *fits best*
- Find the **category** where each observation *fits best*
- **Reduce complexity**, keep all the **relevant information**
- Produce easier-to-understand outputs

Geodemographic analysis

Geodemographic analysis

- Technique developed in 1970's attributed to Richard Webber
- **Identify similar neighborhoods** → Target urban deprivation funding
- Originated in the **Public** Sector (policy) and spread to the **Private** sector (marketing and business intelligence)


COMMUNITY ANALYSIS BUREAU
CLUSTER ANALYSIS
THIRTY CLUSTERS OF CENSUS TRACTS
BASED ON 66 VARIABLES
BEVERLY HILLS
SANTA MONICA
CULVER CITY
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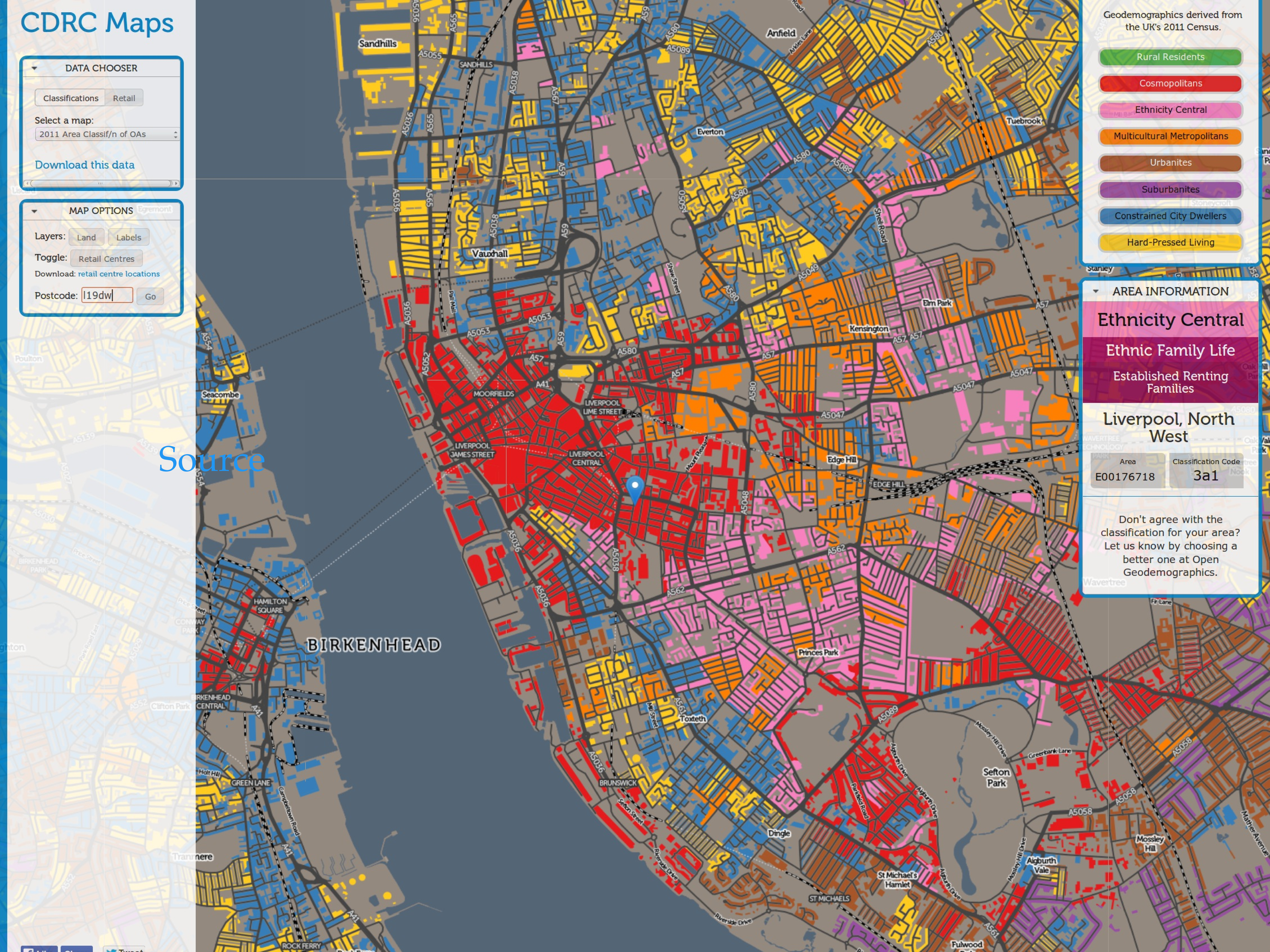

CDRC Maps
DATA CHOOSER
Classifications
Retail
Select a map:
2011 Area Classif/n of OAs
Download this data
MAP OPTIONS
Layers: Land Labels
Toggle: Retail Centres
Download: retail centre locations
Postcode: l19dw
Go
Source
Geodemographics derived from the UK's 2011 Census.
Rural Residents
Cosmopolitans
Ethnicity Central
Multicultural Metropolitans
Urbanites
Suburbanites
Constrained City Dwellers
Hard-Pressed Living
AREA INFORMATION
Ethnicity Central
Ethnic Family Life
Established Renting Families
Liverpool, North West
Area
E00176718
Classification Code
3a1
Don't agree with the classification for your area? Let us know by choosing a better one at Open Geodemographics.
BIRKENHEAD
Sandhills
Anfield
Everton
Tuebrook
Vauxhall
Kensington
Elm Park
Seacombe
MOORFIELDS
LIVERPOOL LIME STREET
LIVERPOOL JAMES STREET
LIVERPOOL CENTRAL
Edge Hill
EDGE HILL
HAMILTON SQUARE
BIRKENHEAD CENTRAL
Princes Park
Toxteth
Sefton Park
GREEN LANE
BRUNSWICK
Dingle
St Michael's Hamlet
ST MICHAELS
Mossley Hill
Aigburth Vale
Tranmere
ROCK FERRY
Fulwood

How do you segment/cluster observations over space?

- Statistical clustering
- Explicitly spatial clustering (regionalization)

Non-spatial clustering

Split a dataset into **groups** of observations that are **similar within** the group and **dissimilar between** groups, based on a series of **attributes**

Machine learning

Unsupervised

Machine learning

- The computer *learns* some of the properties of the dataset without the human specifying them

Unsupervised

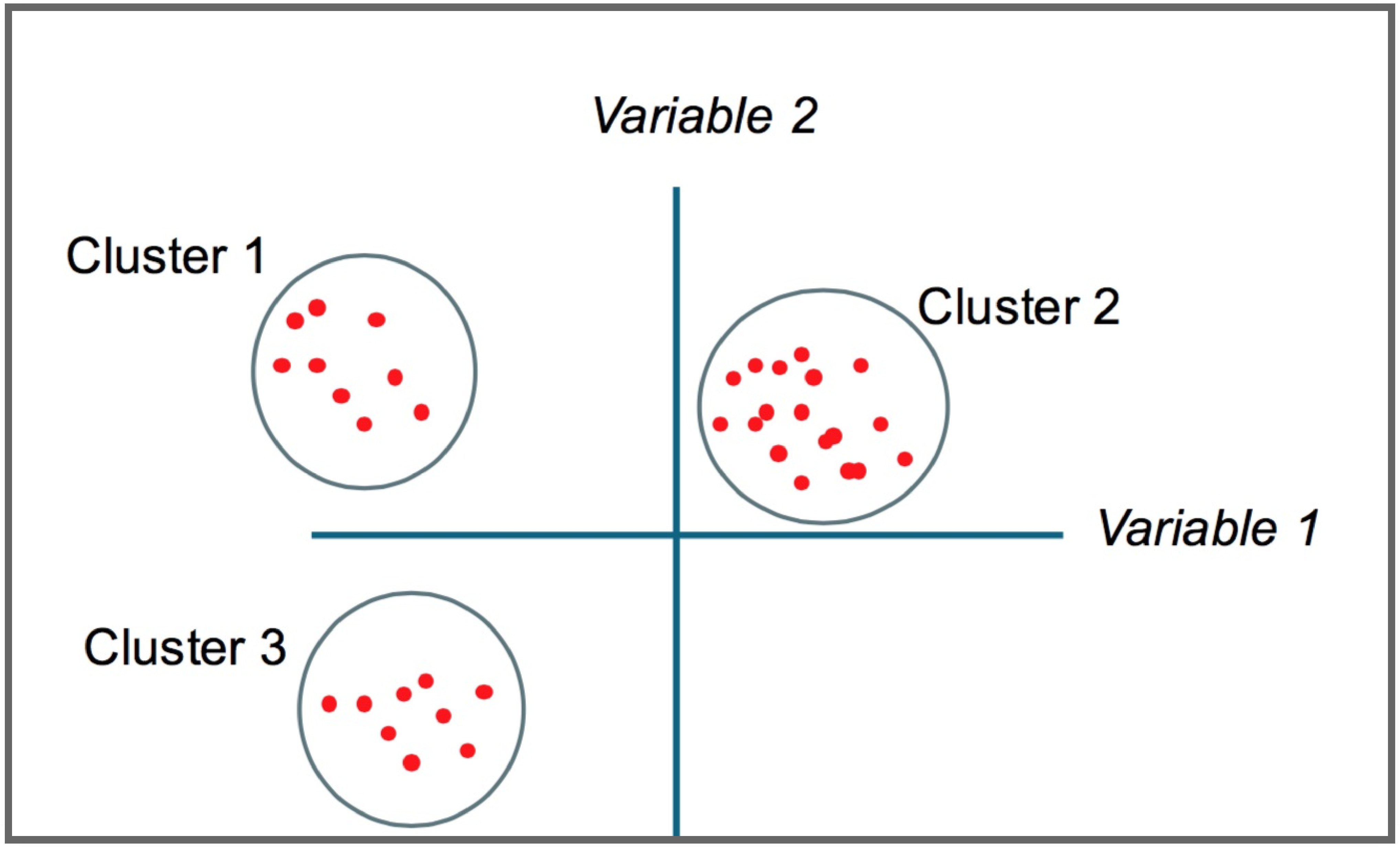
Machine learning

- The computer *learns* some of the properties of the dataset without the human specifying them

Unsupervised

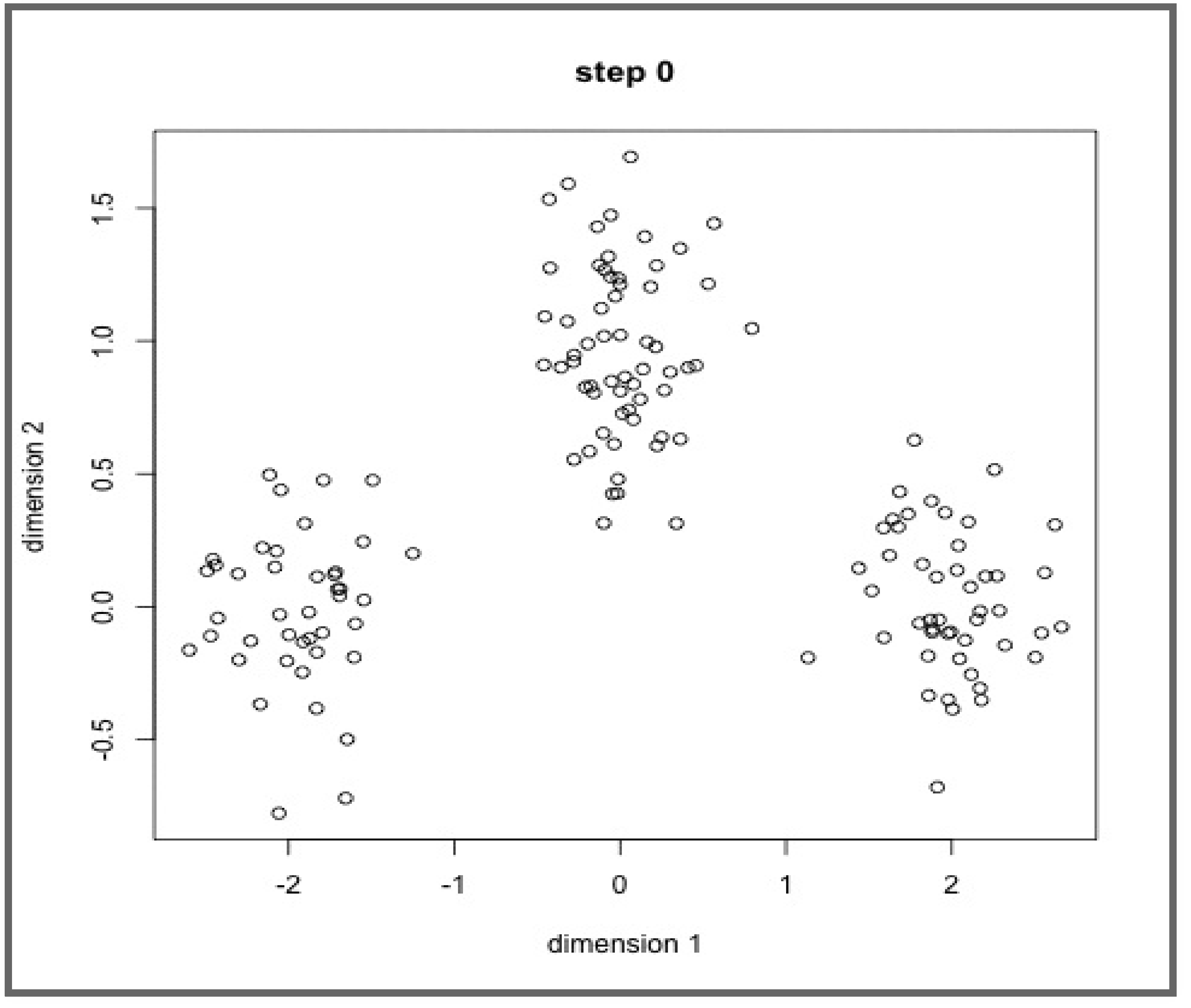
- There is no a-priori structure imposed on the classification $\rightarrow$ before the analysis, no observations is in a category

Intuition



K-means [Source]

K-means [Source]



More clustering...

- Hierarchical clustering
- Agglomerative clustering
- Spectral clustering
- Neural networks (e.g. Self-Organizing Maps)
- DBScan
- ...

Different properties, different best usecases

See interesting comparison table

Regionalization

Machine Learning

Spatial Machine Learning

Spatial Machine Learning

*Aggregating basic spatial units (**areas**) **into** larger units (**regions**)*

Regionalization

Split a dataset into **groups** of observations that are **similar within** the group and **dissimilar between** groups, based on a series of **attributes**...

Regionalization

Split a dataset into **groups** of observations that are **similar within** the group and **dissimilar between** groups, based on a series of **attributes**...

...with the additional constraint observations need to be **spatial neighbors**

Regionalization

Duque et al. (2007)

Regionalization

- All the methods aggregate geographical areas into a predefined number of regions, while optimizing a particular aggregation criterion;

Duque et al. (2007)

Regionalization

- The areas within a region must be geographically connected (the spatial contiguity constraint);

Duque et al. (2007)

Regionalization

- The number of regions must be smaller than or equal to the number of areas;

Duque et al. (2007)

Regionalization

- Each area must be assigned to one and only one region;

Duque et al. (2007)

Regionalization

- Each region must contain at least one area.

Duque et al. (2007)

Regionalization

- All the methods aggregate geographical areas into a predefined number of regions, while optimizing a particular aggregation criterion;
- The areas within a region must be geographically connected (the spatial contiguity constraint);
- The number of regions must be smaller than or equal to the number of areas;
- Each area must be assigned to one and only one region;
- Each region must contain at least one area.

Duque et al. (2007)

London example w/ AirBnb

Algorithms

- Automated Zoning Procedure (AZP)
- Arisel
- Max-P
- ...

See Duque et al. (2007) for an excellent, though advanced, overview

Examples

Census geographies

Environment and Planning A 1995, volume 27, pages 425–446

Algorithms for reengineering 1991 Census geography

S Openshaw, L Rao¶
School of Geography, University of Leeds, Leeds LS2 9JT, England
Received 22 April 1994; in revised form 6 October 1994

London Neighbourhood Guide - Airbnb Neighbourhoods - Mozilla Firefox

ondon Neigh... ×

Airbnb, Inc. (US) https://www.airbnb.co.uk/locations/london/neighborhoods

airbnb | Where are you going? | Browse | Sign Up | Log In | Help | List Your Space

s > London | Saved Neighbourhoods

Find a Neighbourhood in London

What kind of neighbourhood are you looking for?

Dining × Artsy 7 Nightlife 9 Shopping 15 Loved by Londoners 11 Touristy 14

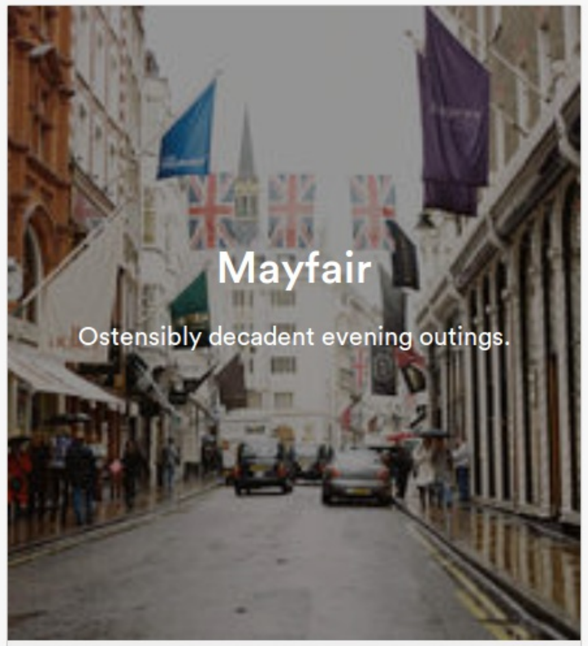
Great Transit 13 Museums & the Arts 10 Peace & Quiet 7 Along the River Thames 5 West End 7

23 neighbourhoods match **Dining**. See all listings

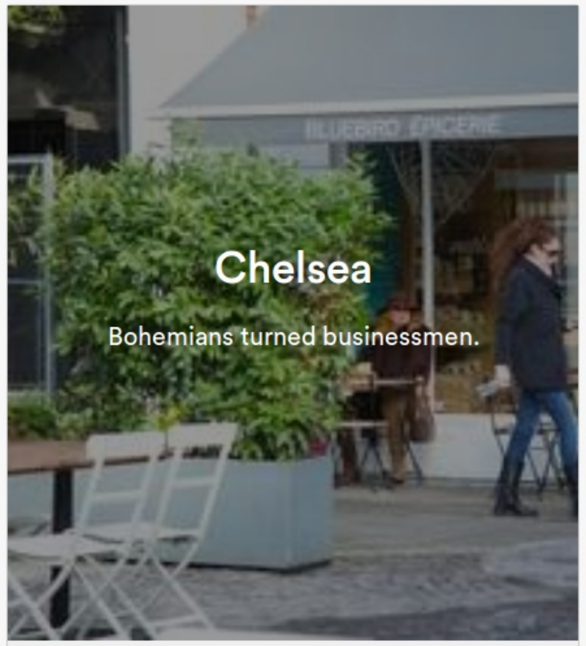
AirBnb neighborhoods

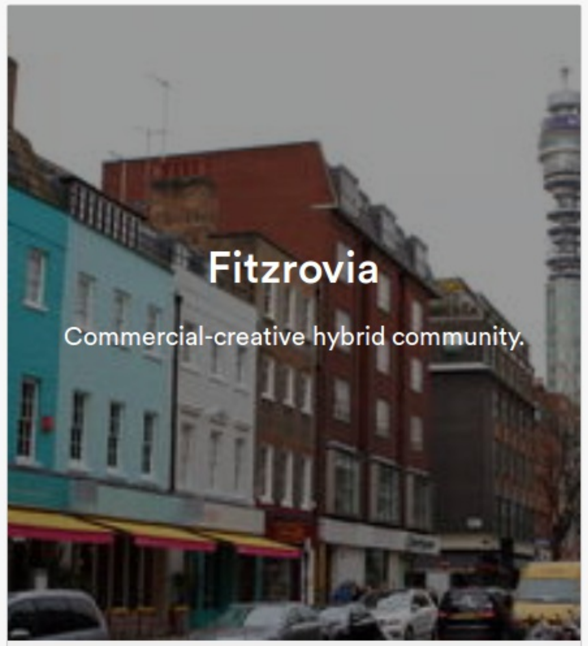
Eclectic • Open-minded • China Town • Lgbt Friendly

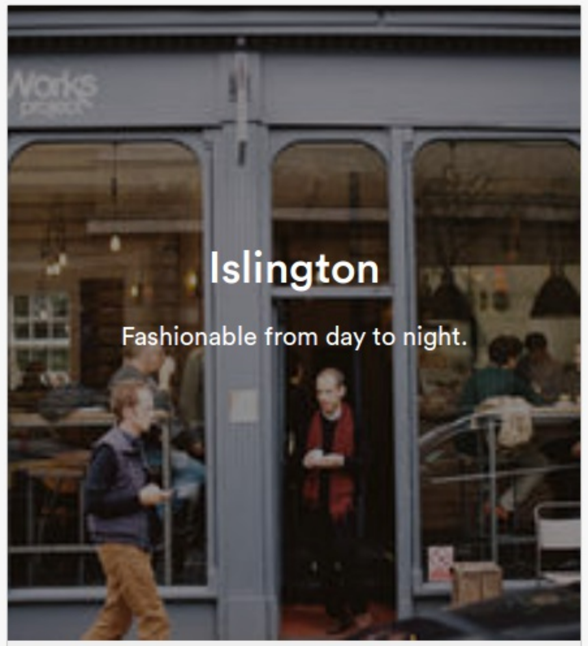
Buzzing • Curry • Arty • Graffiti



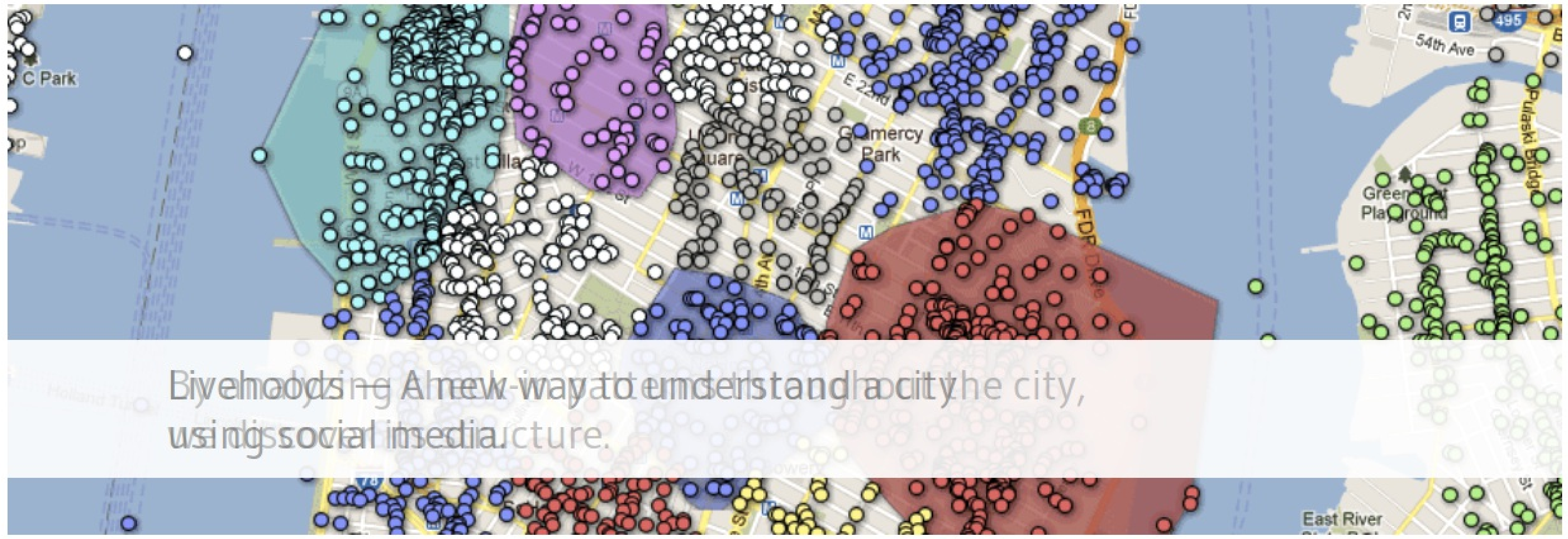
Luxury Shopping • Ballrooms • Heart Of London • Fashionable







/www.airbnb.co.uk/locations/london/soho



Re-Imagining the City in the Age of Social Media

Livehoods offer a new way to conceptualize the dynamics, structure, and character of a city by analyzing the social media its residents generate. By looking at people's checkin patterns at places across the city, we create a mapping of the different dynamic areas that comprise it. Each Livehood tells a different story of the people and places that shape it.

> MORE

Using Machine-Learning to Study Cities

Our research hypothesis is that the character of an urban area is defined not just by the the types of places found there, but also by the people that make it part of their daily life. To explore this idea, we use data from approximately 18 million check-ins collected from the location-based social network foursquare, and apply clustering algorithms to discover the different areas of the city.

> MORE

Livehoods

Current Maps

NYC > New York City

SFO > San Francisco

PIT > Pittsburgh

> More Maps

News and Press

Livehood at ICWSM
Our work with Livehoods won the best paper award at ICWSM in Dublin this June! **Watch the video from our presentation.**

Livehoods on CBC Radio
Justin was on the CBC Radio program Spark talking with host Nora Young about the Livehoods Project. **Listen to the full interview.**

Livehoods in the Atlantic
Livehoods appeared as the Map of the Day on the Atlantic's Cities blog. **See their post about us.**

Wired Insider
Wired's Insider blog says Livehoods is "taking a big swing" at minining insights into "cultural habits and how societies flow."
Read the full post.

> MORE

Recent Tweets

@tiffehr
Best map/location mashup I've seen in quite some time: **http://livehoods.org/maps/nyc#** (Via **http://roomthily.tumblr.com**)

@Werner
Livehoods is a cool CMU research project to visualize cities through the use of social media (**@foursquare** in this case) **http://wv.ly/IJZ3We**

@tomcoates
The 'Related' tab on **http://livehoods.org** is the best. See which neighboring places people travel too. Algorithmic divination of commuting!

@brainpicker
Forget neighborhoods, it's about Livehoods — Carnegie Mellon maps the dynamic character of cities through social media **http://j.mp/HzmkoN**

@kellan
clearly i live on the wrong side of the bqe - **http://livehoods.org/maps/nyc**

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Recapitulation