

# Geographic Data Science - Lecture III

## (Geo-)Visualization

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# Today

- Visualization
  - *What and why*
  - History
  - Examples
- Geovisualization
  - *What*
  - "A map for everyone"
  - Dangers of geovisualization

# Visualization

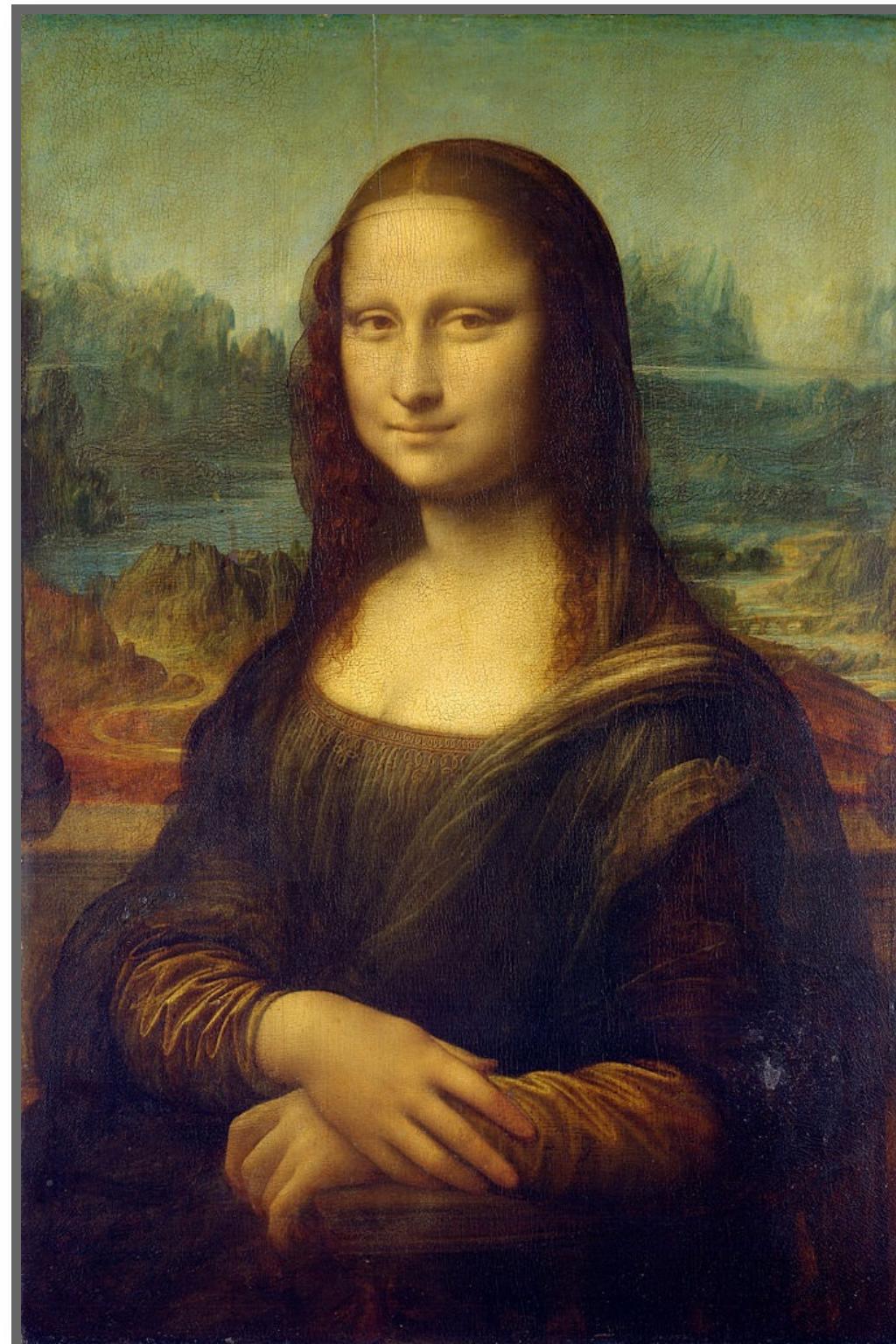
*"Data graphics visually display measured quantities by means of the combined use of points, lines, a coordinate system, numbers, symbols, words, shading, and color."*

*The Visual Display of Quantitative Information.* Edward R. Tufte.

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# A bit of history

Maps

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Maps --> Data Maps (XVIIth.C.)

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Scatter plots

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Scatter plots

- Surprisingly recent: 1750-1800 approx. (much later than many other advances in math and stats!)
- **William Playfair's** '*linear arithmetic*': encode/replace numbers in tables into visual representations.
- Other relevant names throughout history: Lambert, Minard, Marey.

# Visualization

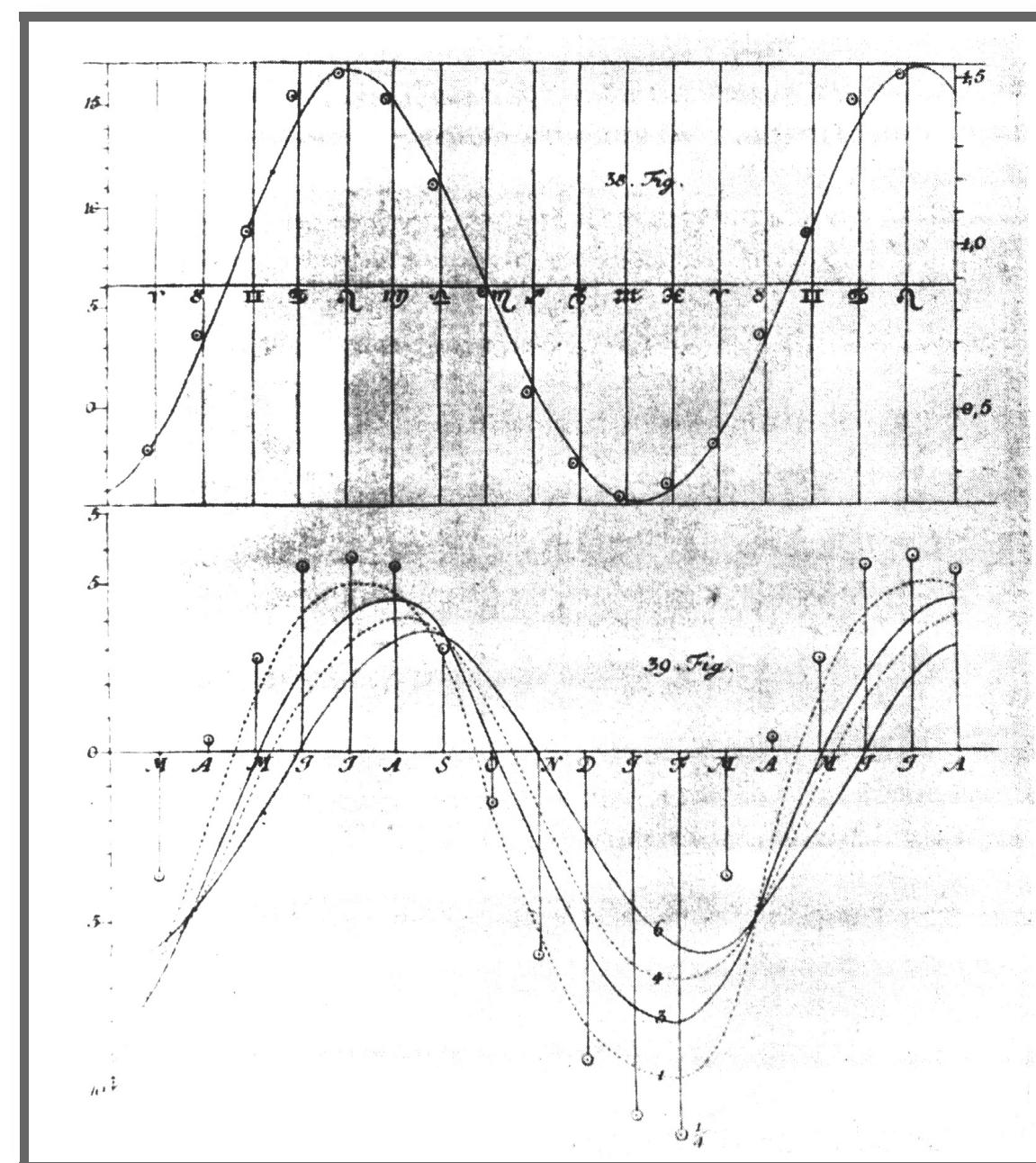
*The Visual Display of Quantitative Information.* Edward R. Tufte.

- By **encoding information visually**, they allow to present **large amounts** of numbers in a **meaningful** way.
- If well made, visualizations provide leads into the processes underlying the graphic.

Learning by seeing time...

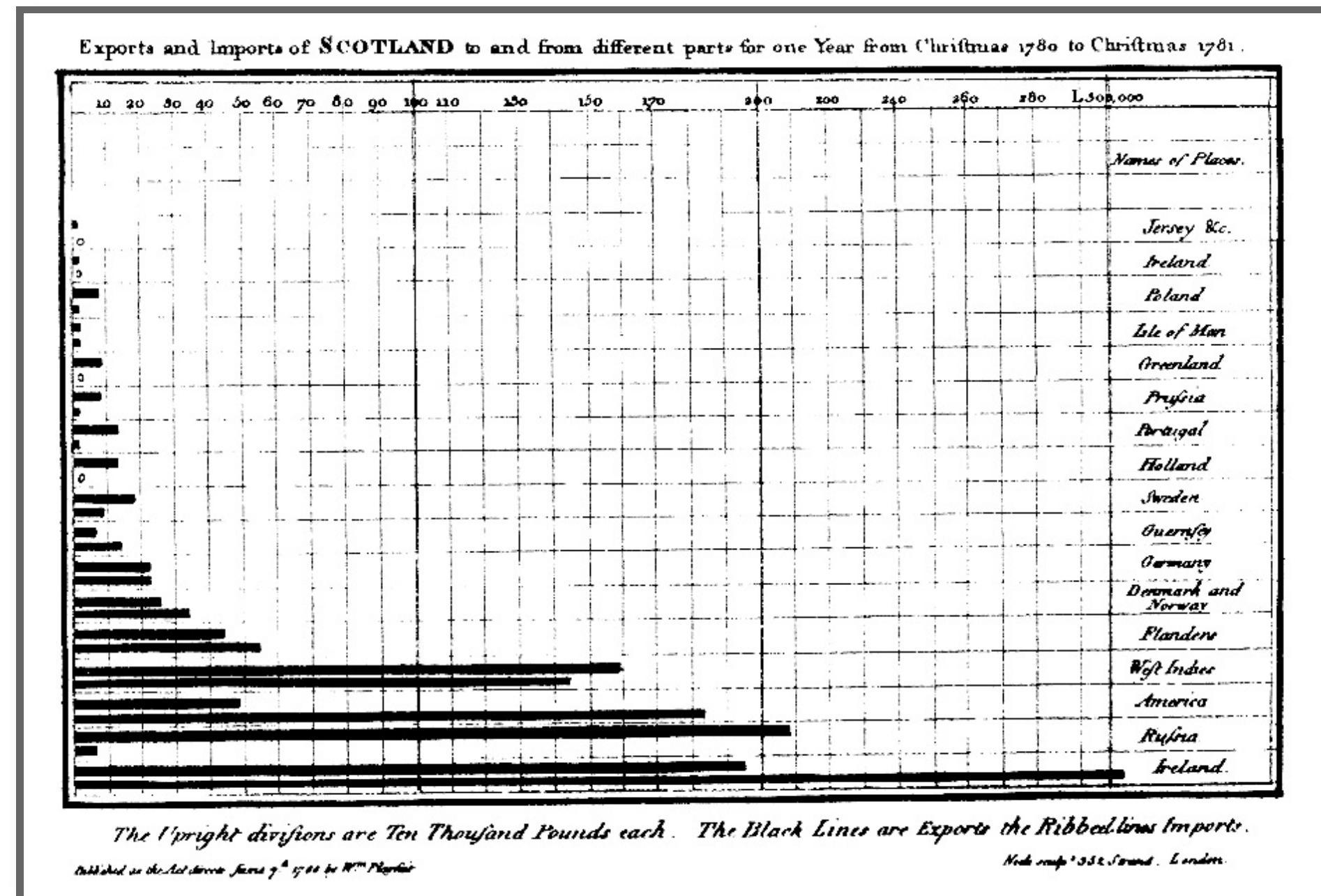
# Time series

[Source] XVIIIth. Cent. - *Pyrometrie* by J. H Lambert



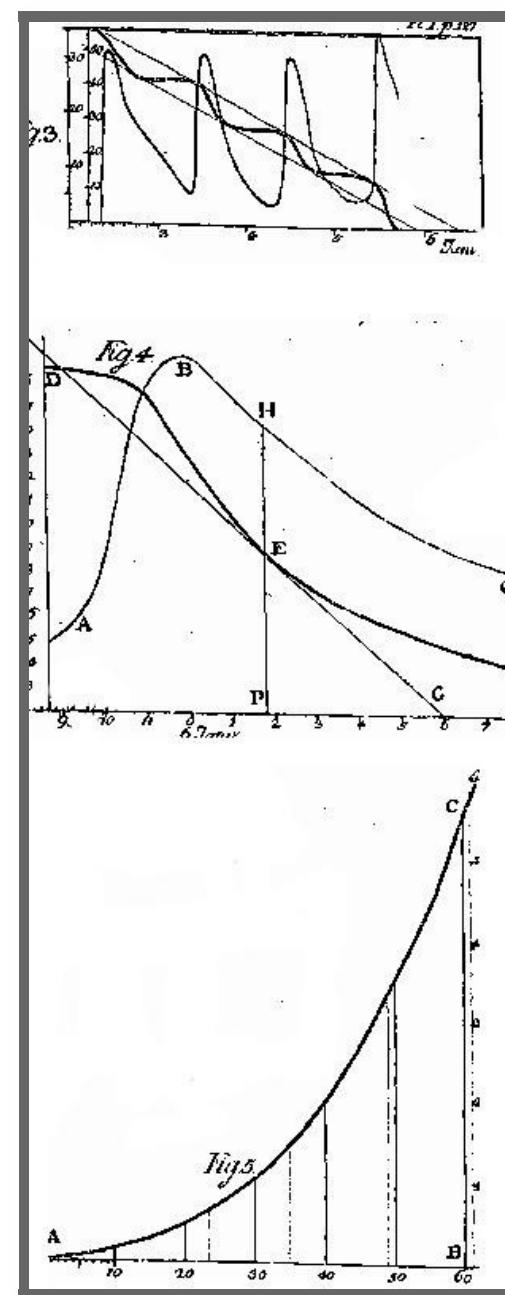
# Bar chart

[Source] Playfair's bar chart in The Commercial and Political Atlas  
(1786)



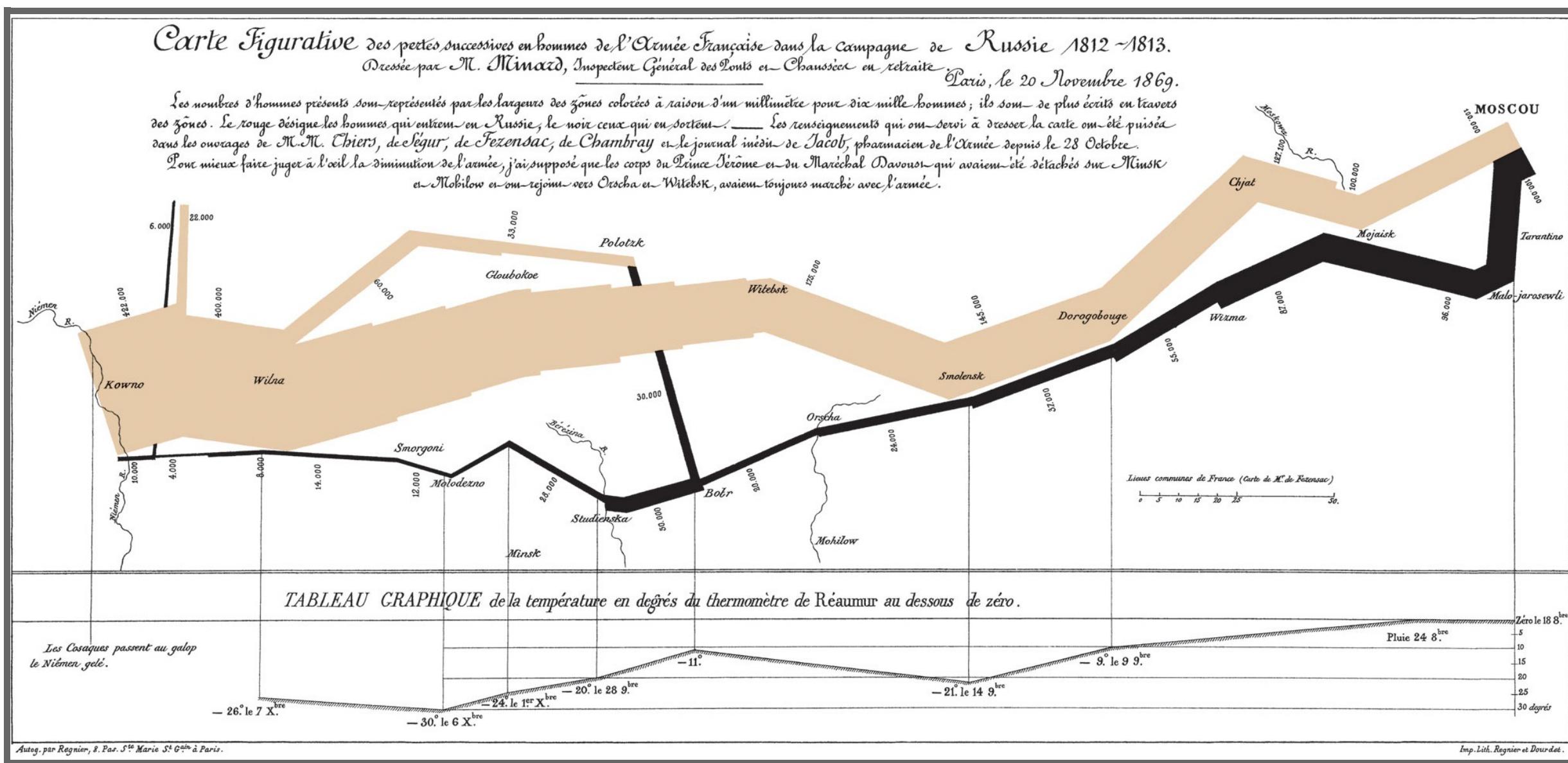
# Abstract line plot

[Source] Lambert - Evaporation rate against temperature, 1769



# Minard - Napoleon army map (XIXth. Cent.)

[Source] "It may well be the best statistical graphic ever drawn" (E. R. Tufte)



# Geovisualization

# Tufte (1983)

*"The most extensive data maps [...] place millions of bits of information on a single page before our eyes. No other method for the display of statistical information is so powerful"*

# MacEachren (1994)

*"Geographic visualization can be defined as the use of concrete visual representations --whether on paper or through computer displays or other media--to make spatial contexts and problems visible, so as to engage the most powerful human information processing abilities, those associated with vision."*

# GeoVisualization

- End goal is not to replace the human *in the loop*, but to **augment** her/him.
- Augmentation here comes through engaging the **pattern recognition** capabilities that our brain inherently has.
- Combines:
  - Traditional maps
  - Statistical maps
  - Statistical devices of other kind (charts, scatter plots, etc.)
- **Different roles** in the analysis process...

# A map for everyone

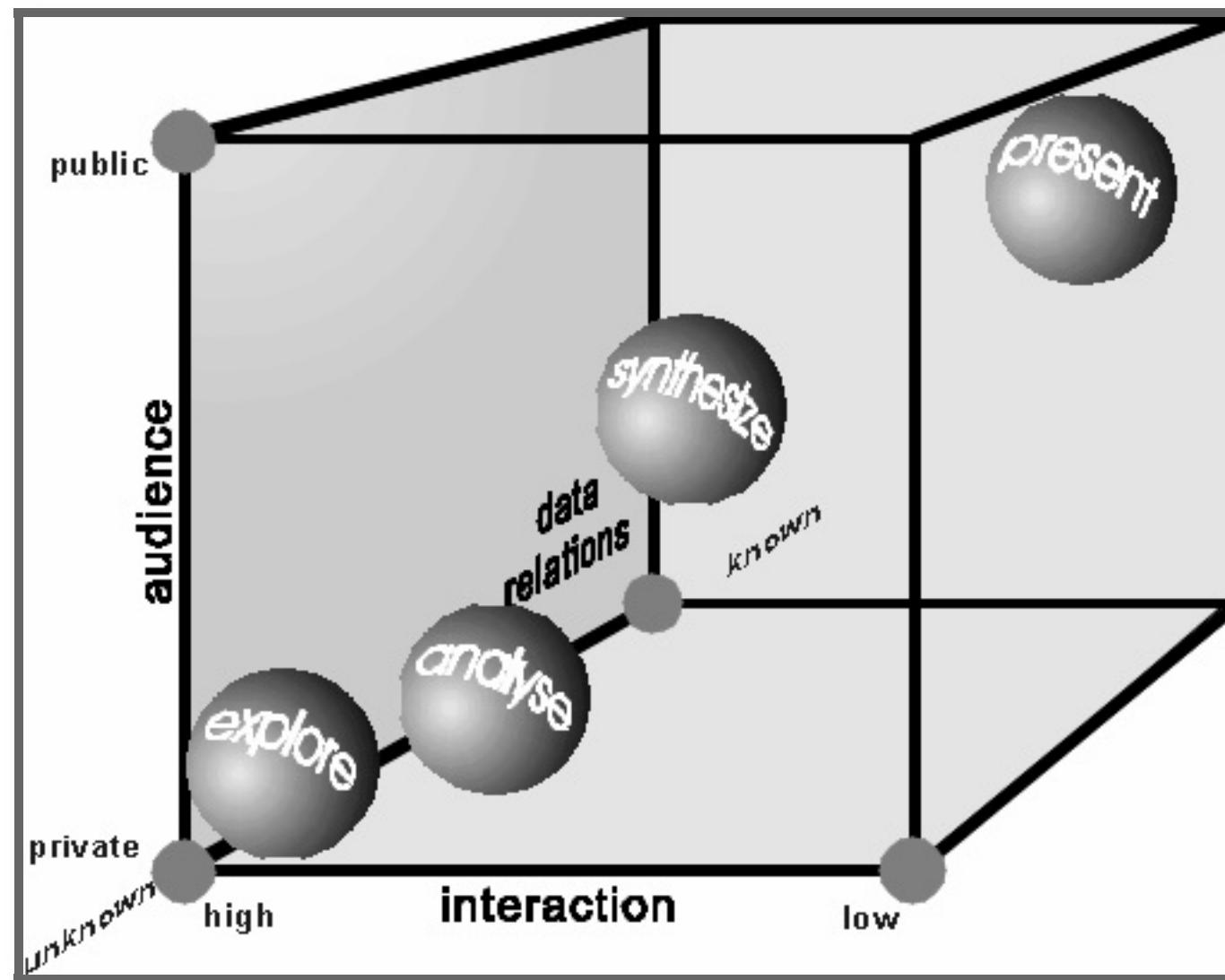
Maps can fulfill several needs

Depending on which one we want to stress, the best map will look very different

MacEachren & Kraak (1997) identify three main dimensions:

- Knowledge of what is being plotted
- Target audience
- Degree of interactivity

# MacEachren & Kraak (1997) map cube

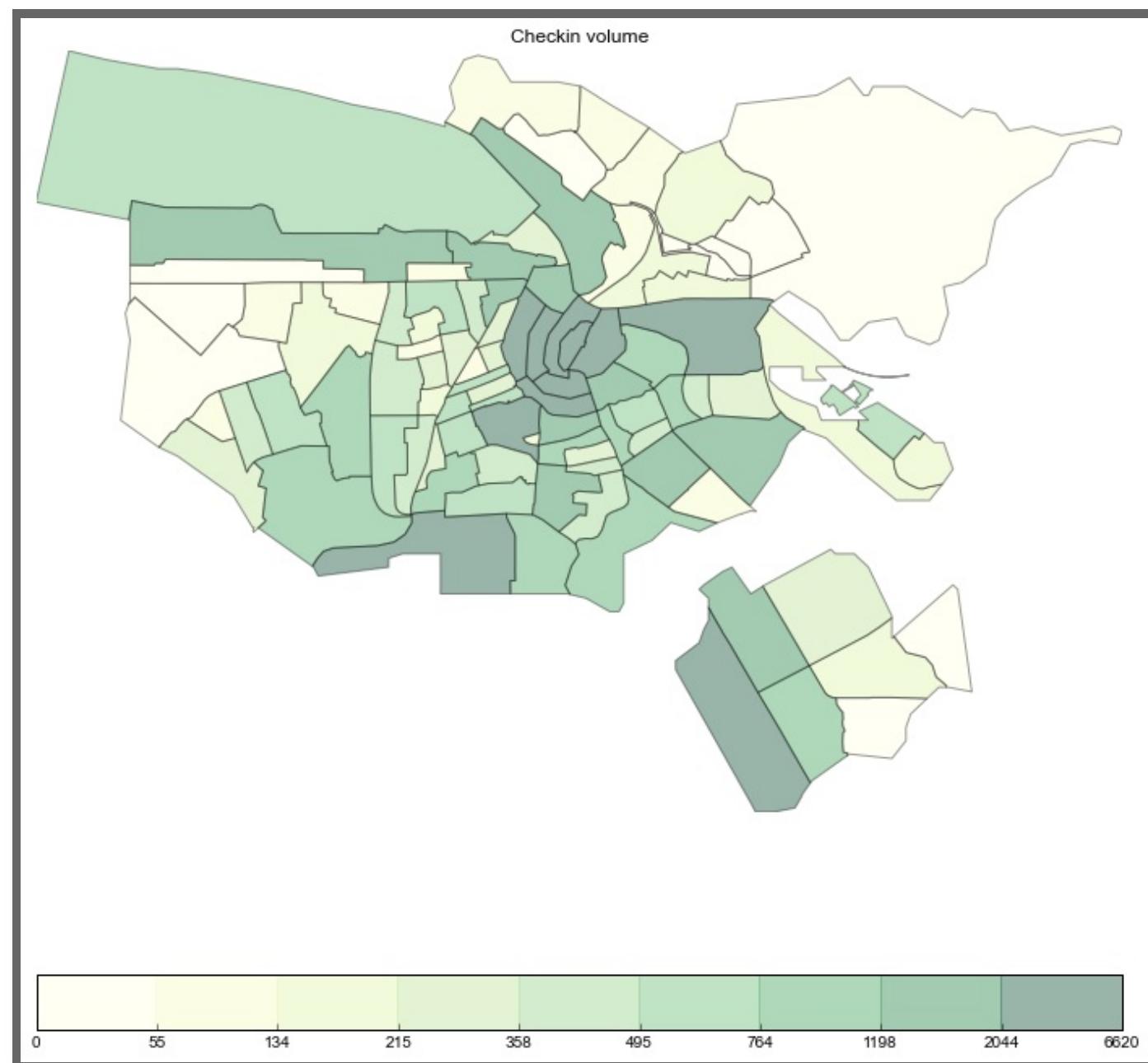


[Source]

Un/known: *fast* and *slow* maps

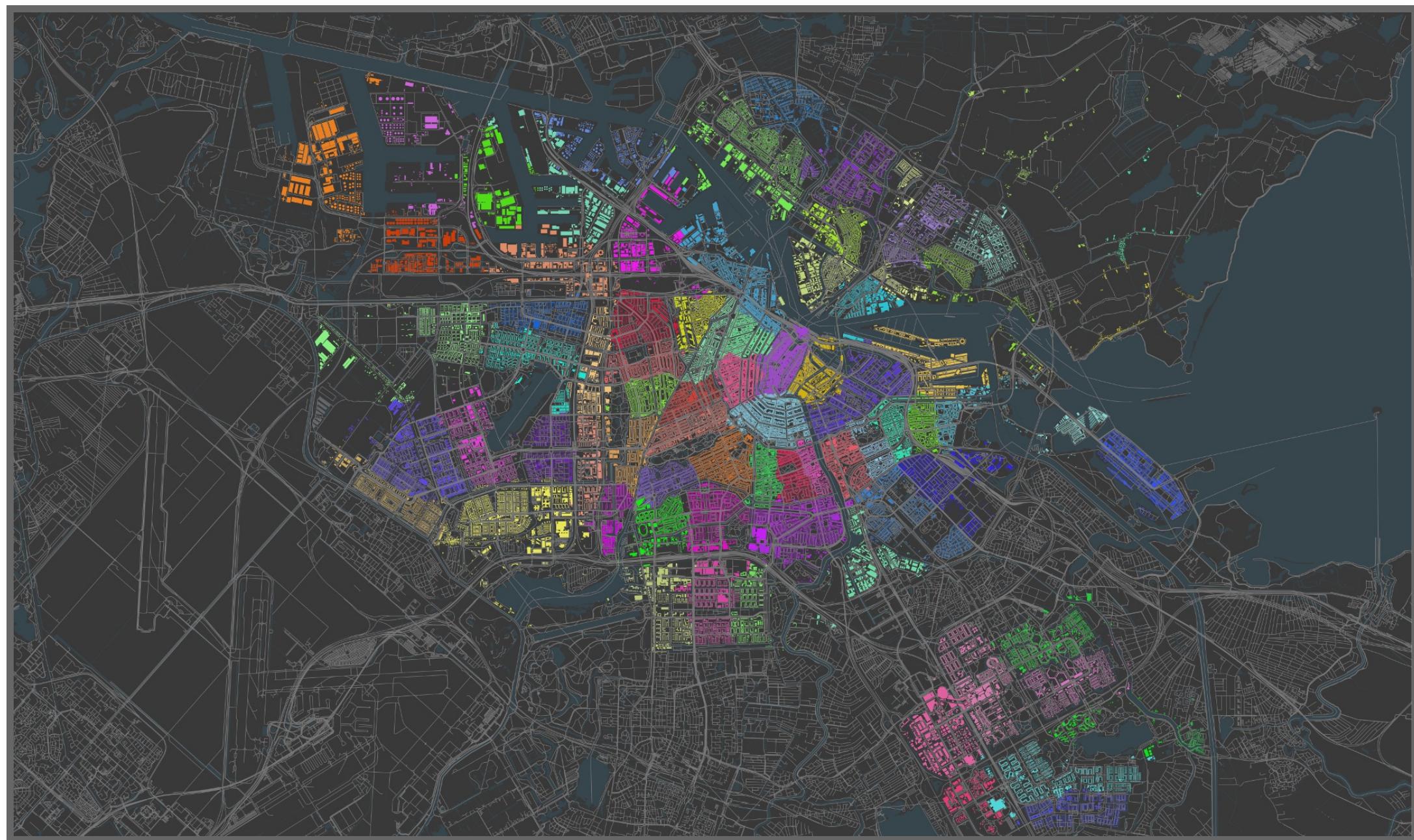
# Fast maps

[[Source](#)]



# Slow maps

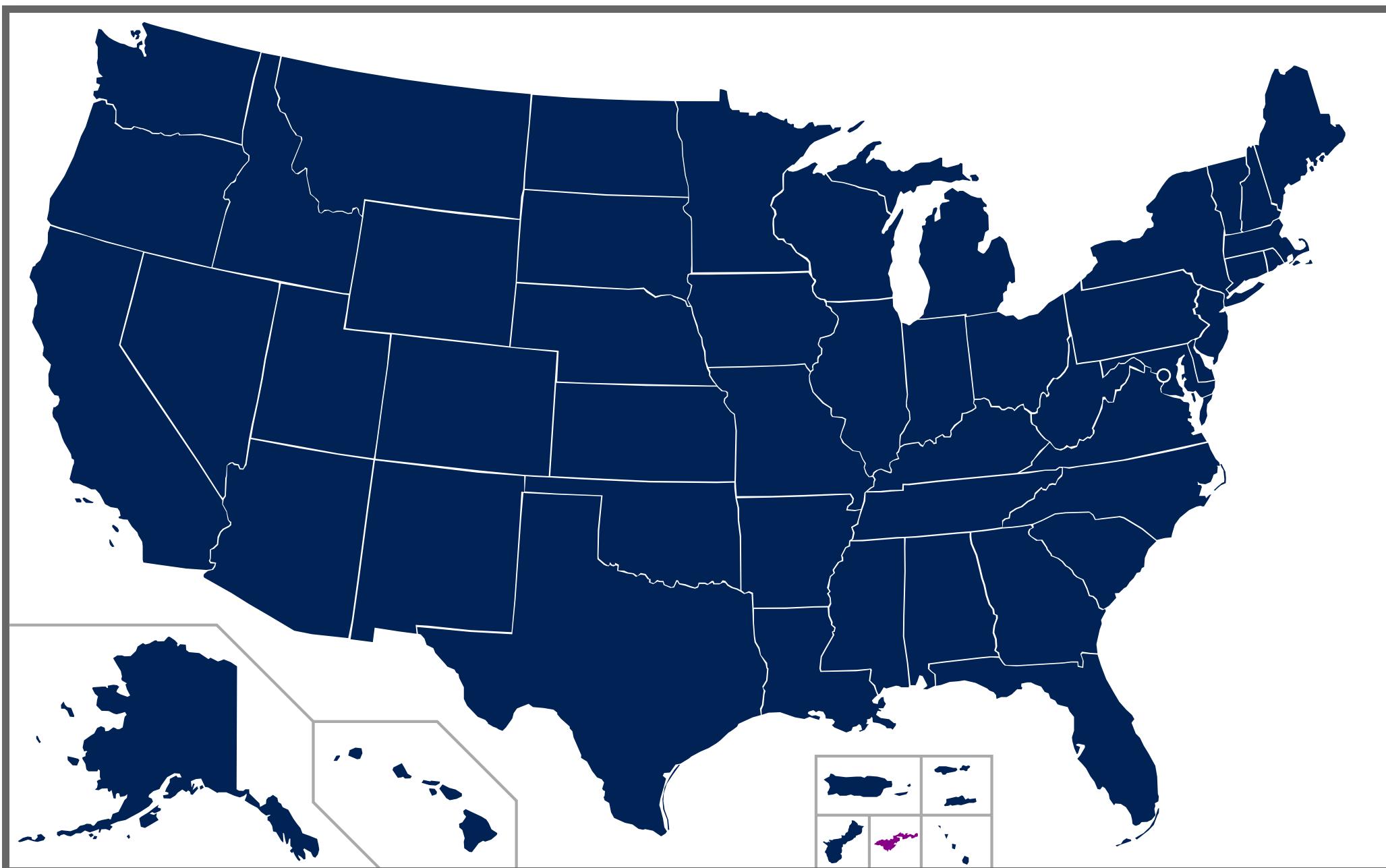
[[Source](#)]



Audience: *easy* and *hard* maps

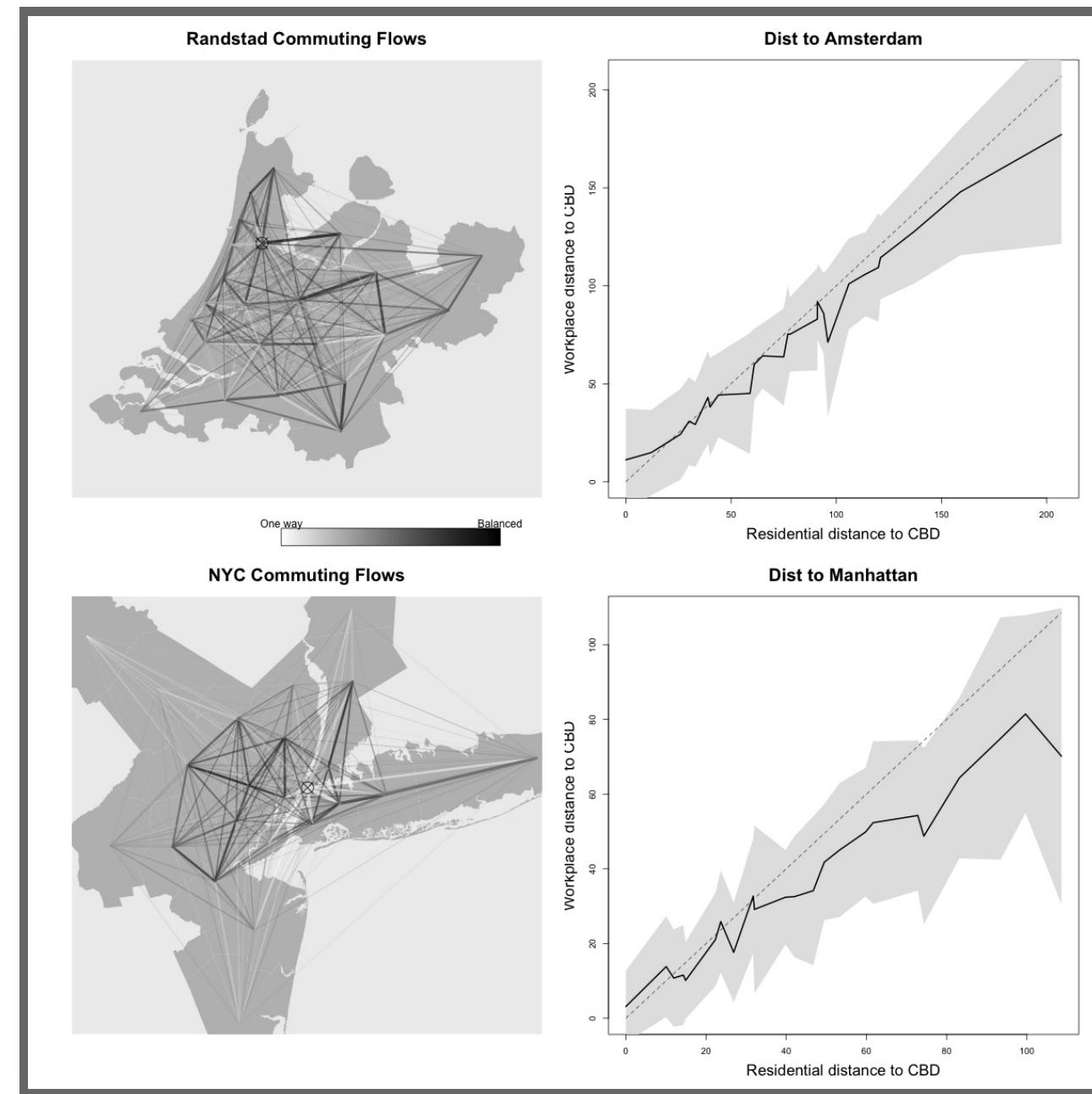
# Easy map

[Source] Map of same-sex marriage in the US, 2015



# Hard map

[[Source](#)]

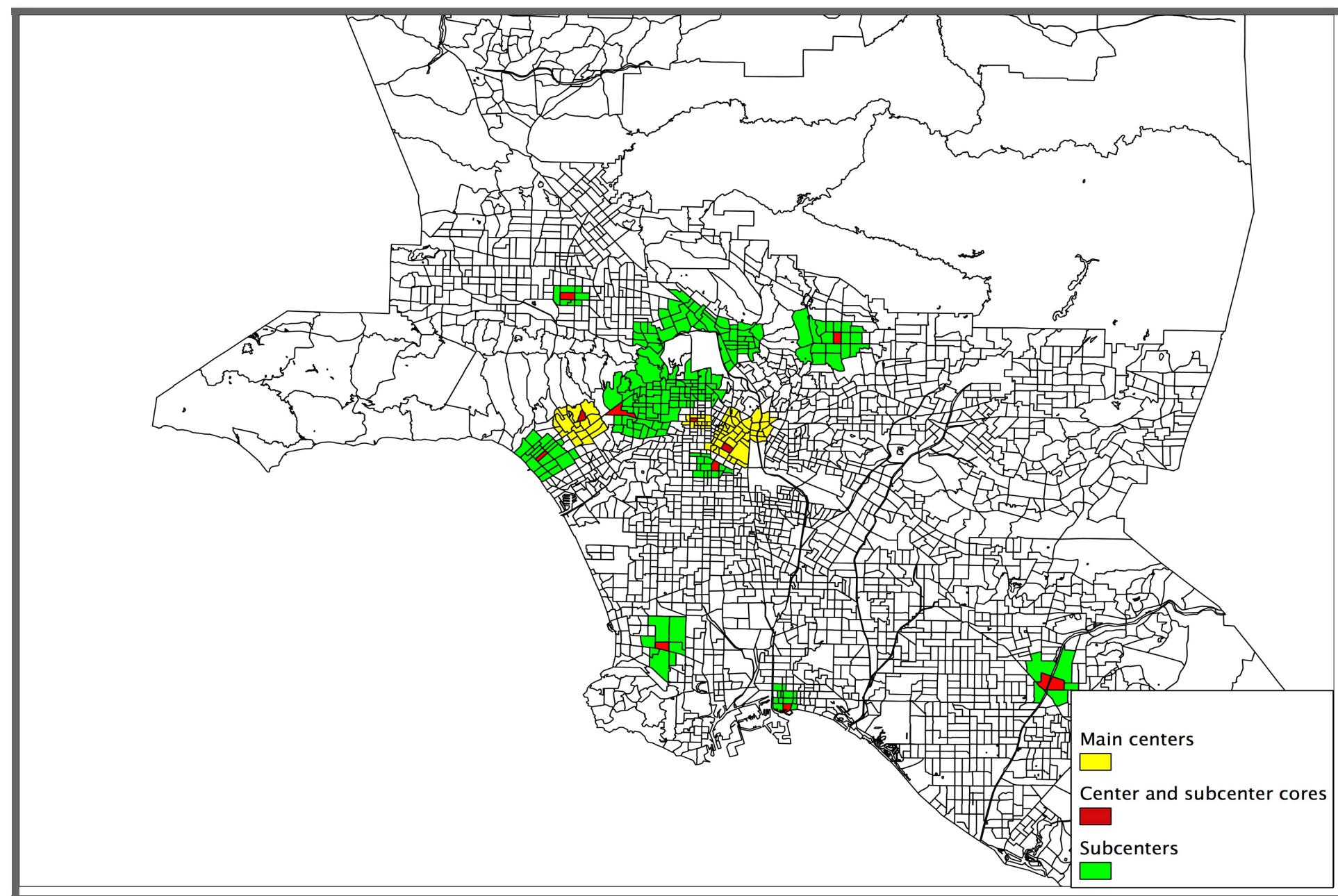


# Interaction: one or many maps in one

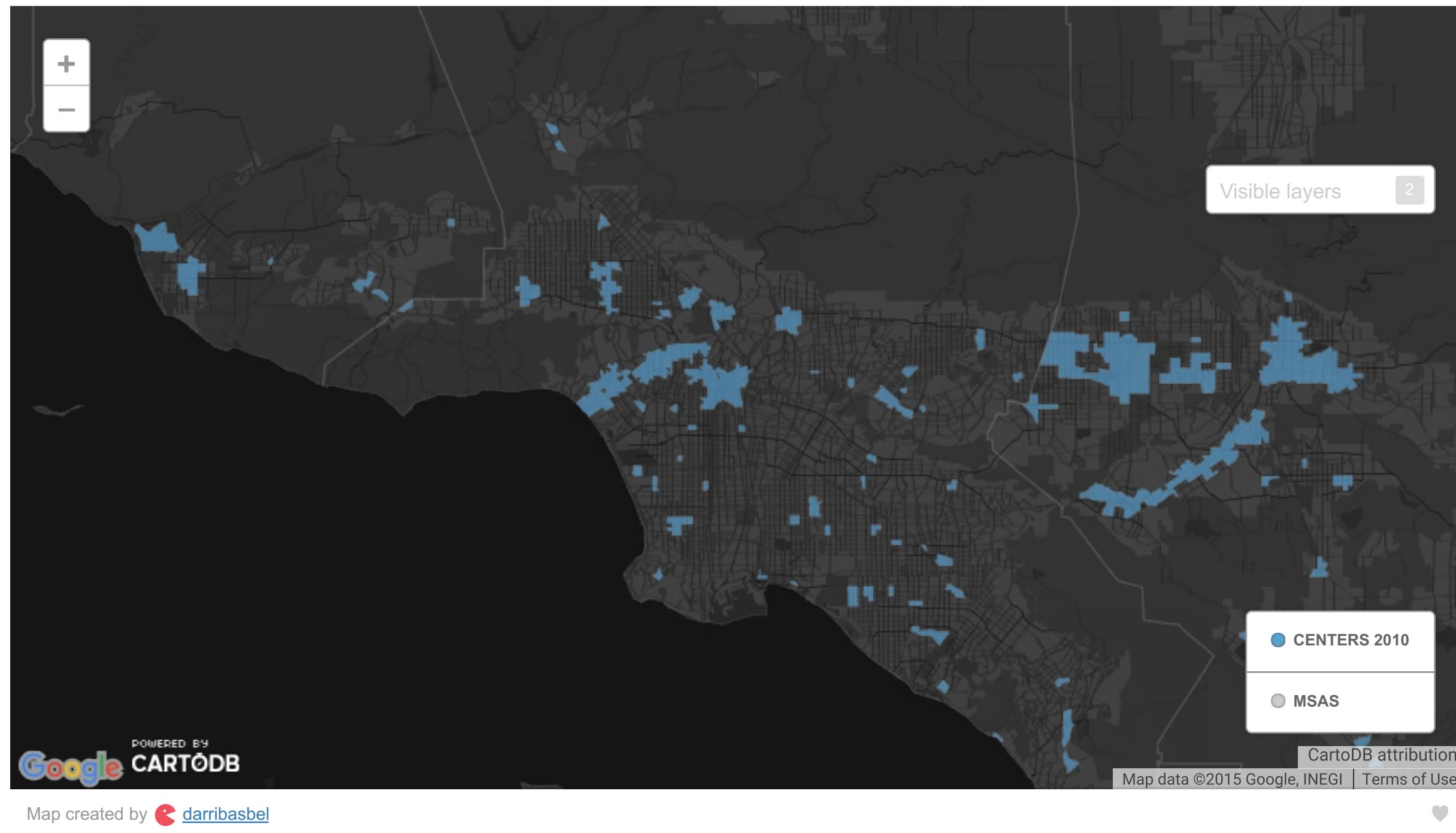
Talk about interaction, opportunity for discovery, and the end-user as explorer rather than mere consumer

Interactivity, however, not always desired: sometimes you need one-message, clear maps to make a case and you don't have time for rich interactive one. It also takes much more time (although changing)

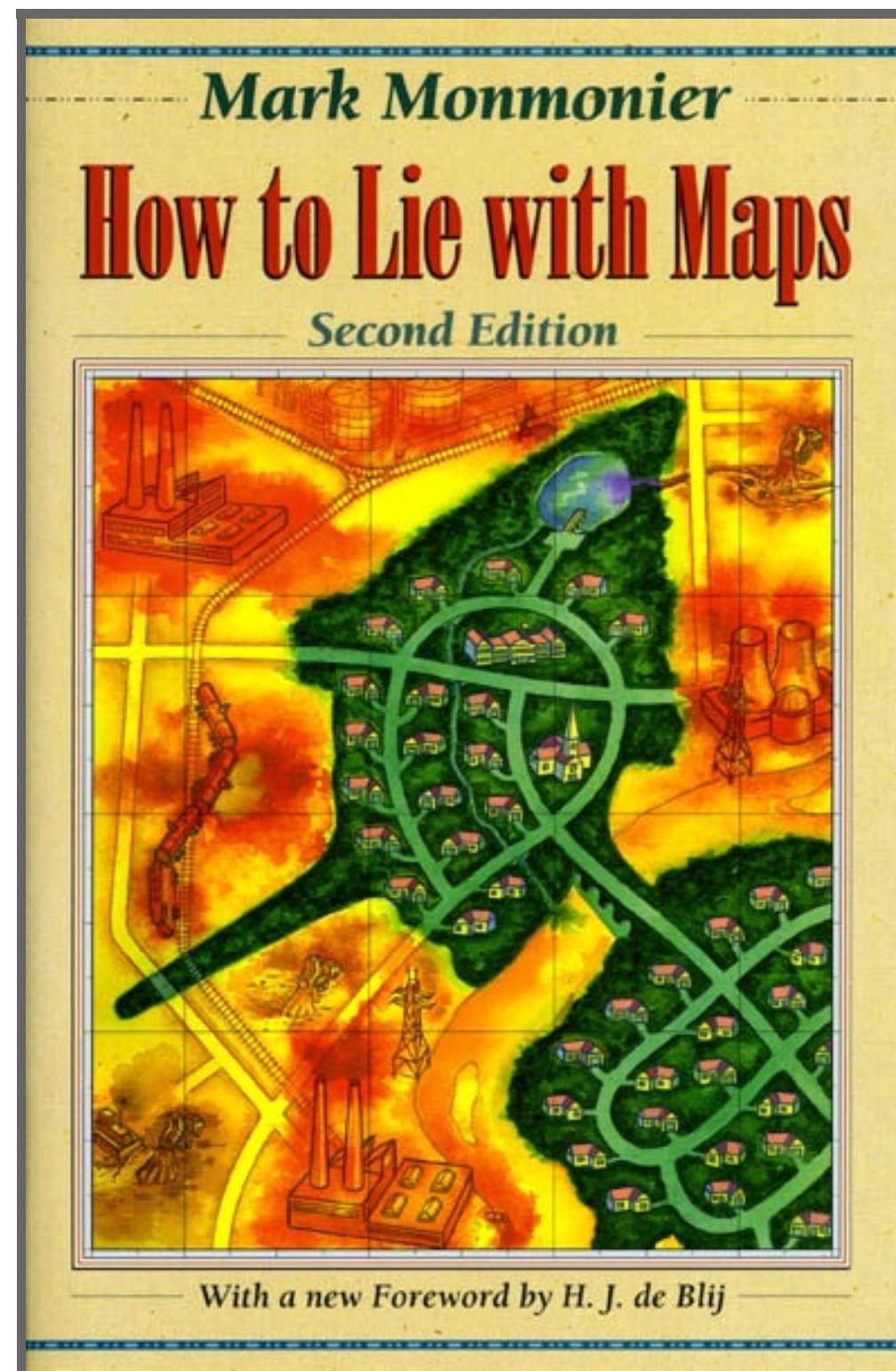
# Static map



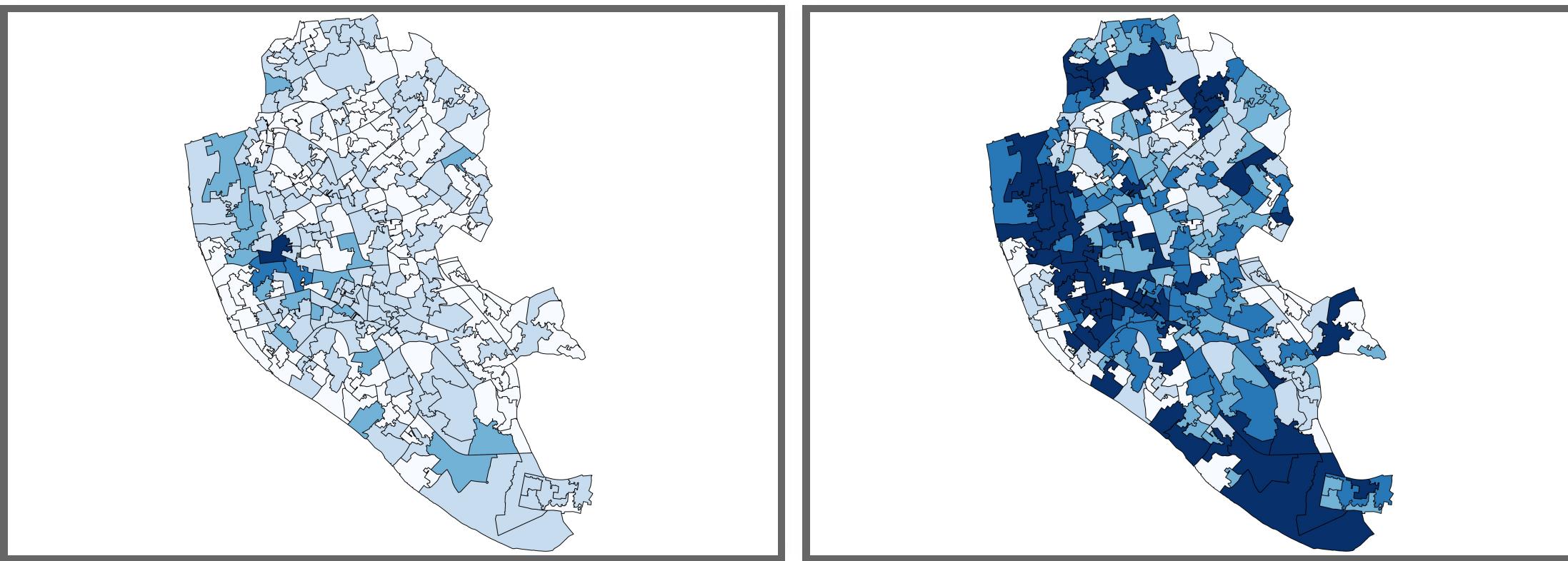
# Interactive map



# Dangers of GeoVisualization



# *How to lie with maps*



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**Patternicity** (Shermer, 2008) *The tendency to find meaningful patterns in meaningless noise*

# *How to lie with maps*

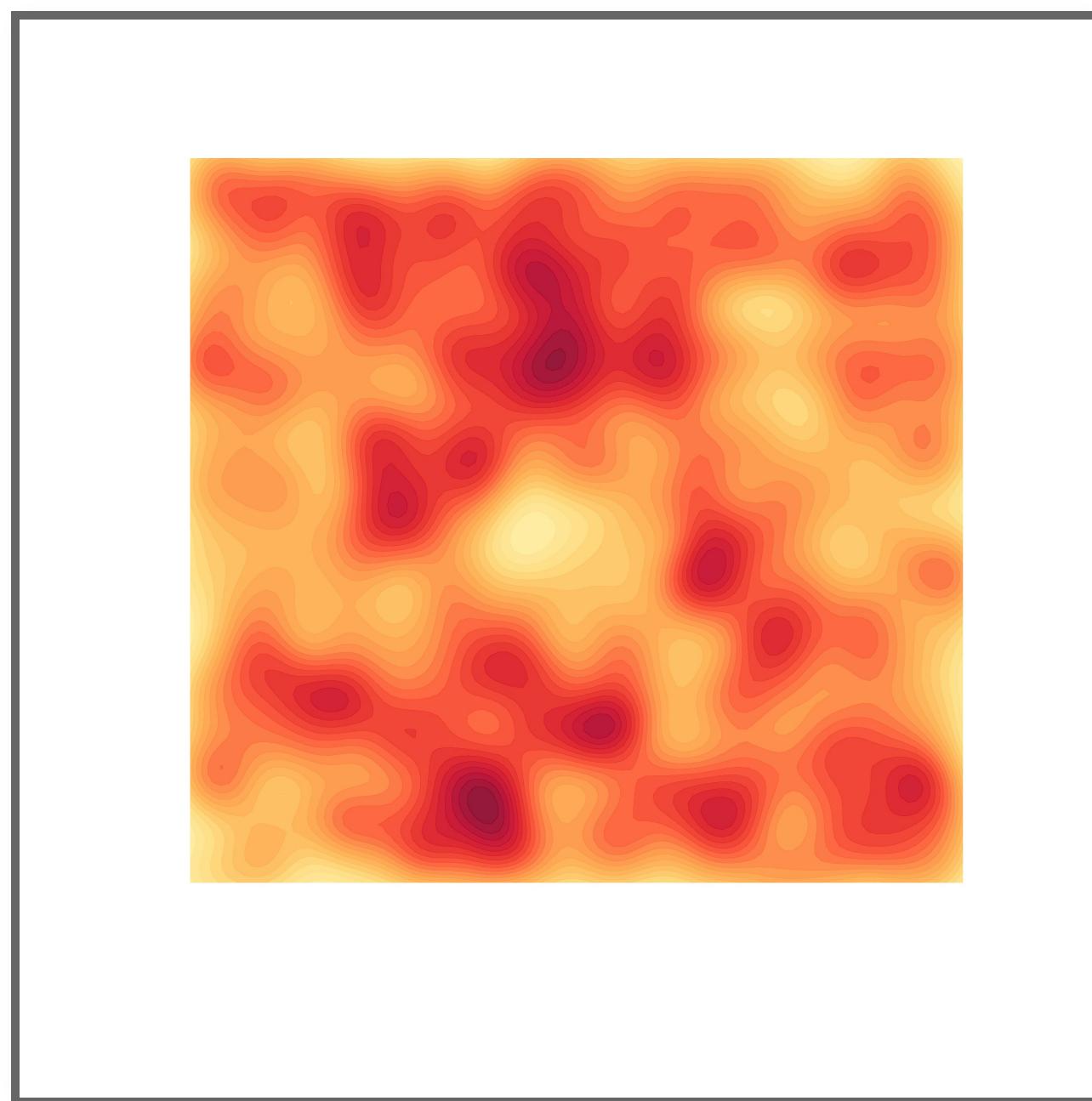
The human brain is so good at picking up patterns...

... that it finds them even where they don't exist!

**Patternicity** (Shermer, 2008) *The tendency to find meaningful patterns in meaningless noise*

**Apophenia** (Konrad, 1958) *The experience of seeing patterns or connections in random or meaningless data*

# Twitter clusters



# How to *be truthful* with maps

*"With great power comes great responsibility"*

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*"With great power comes great responsibility"*

**Statistics to the rescue!!!**

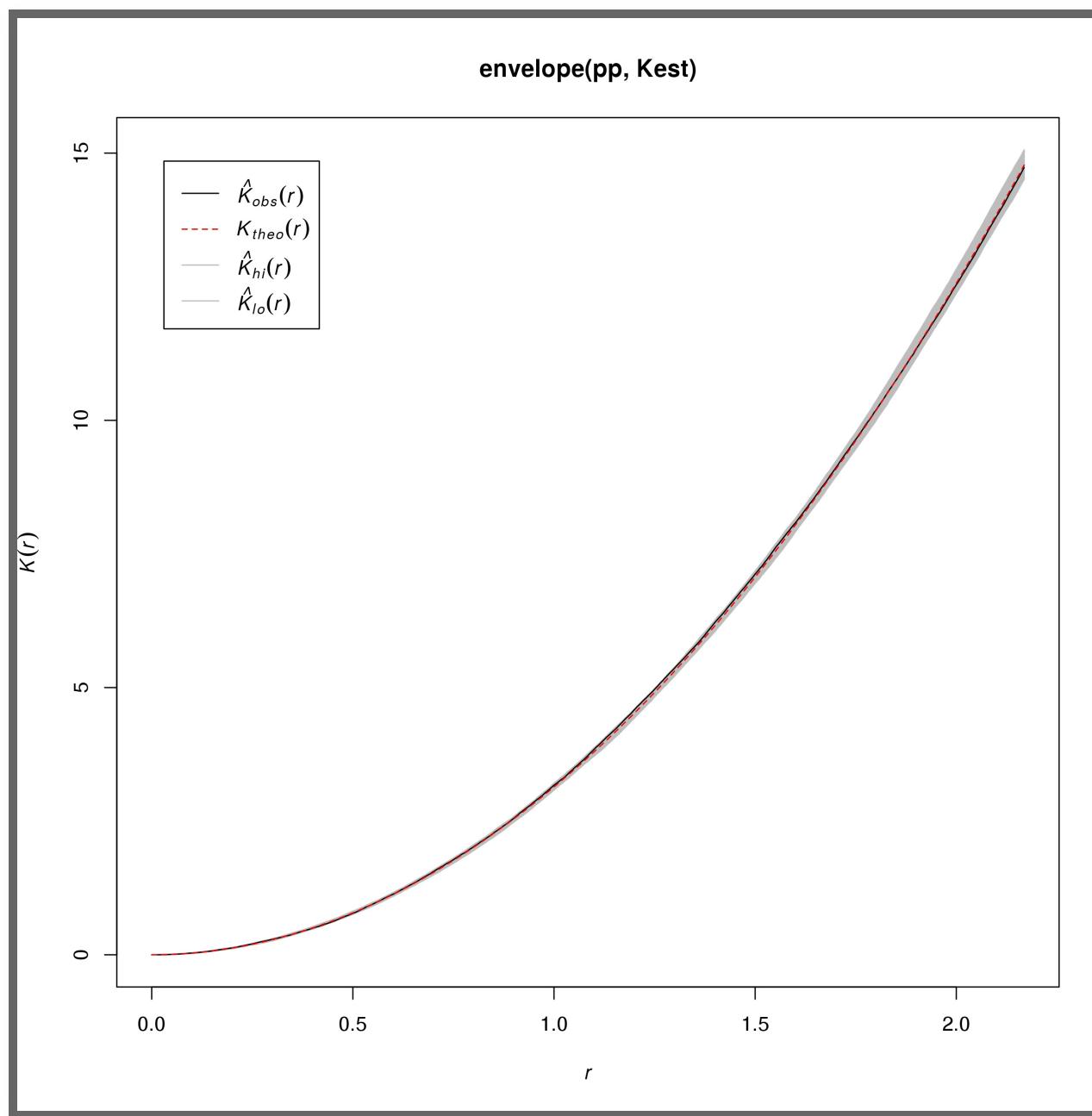
# How to *be truthful* with maps

*"With great power comes great responsibility"*

**Statistics to the rescue!!!**

- **Complement** and enhance visuals
- Help disentangling **true** from **spurious** patterns (a.k.a. identifying the "Jesus on the toast")
- **Reciprocity**: GeoVis can also enhance statistics and make them more useful

# Statistics for Twitter clusters



# Recapitulation

- Visualization of statistical data is a fairly **recent** phenomenon.
- Its power comes from engaging and **augmenting** the human in the loop, rather than replacing her/him.
- Its power **can be misused**, but there are methods to limit this risk.



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