

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

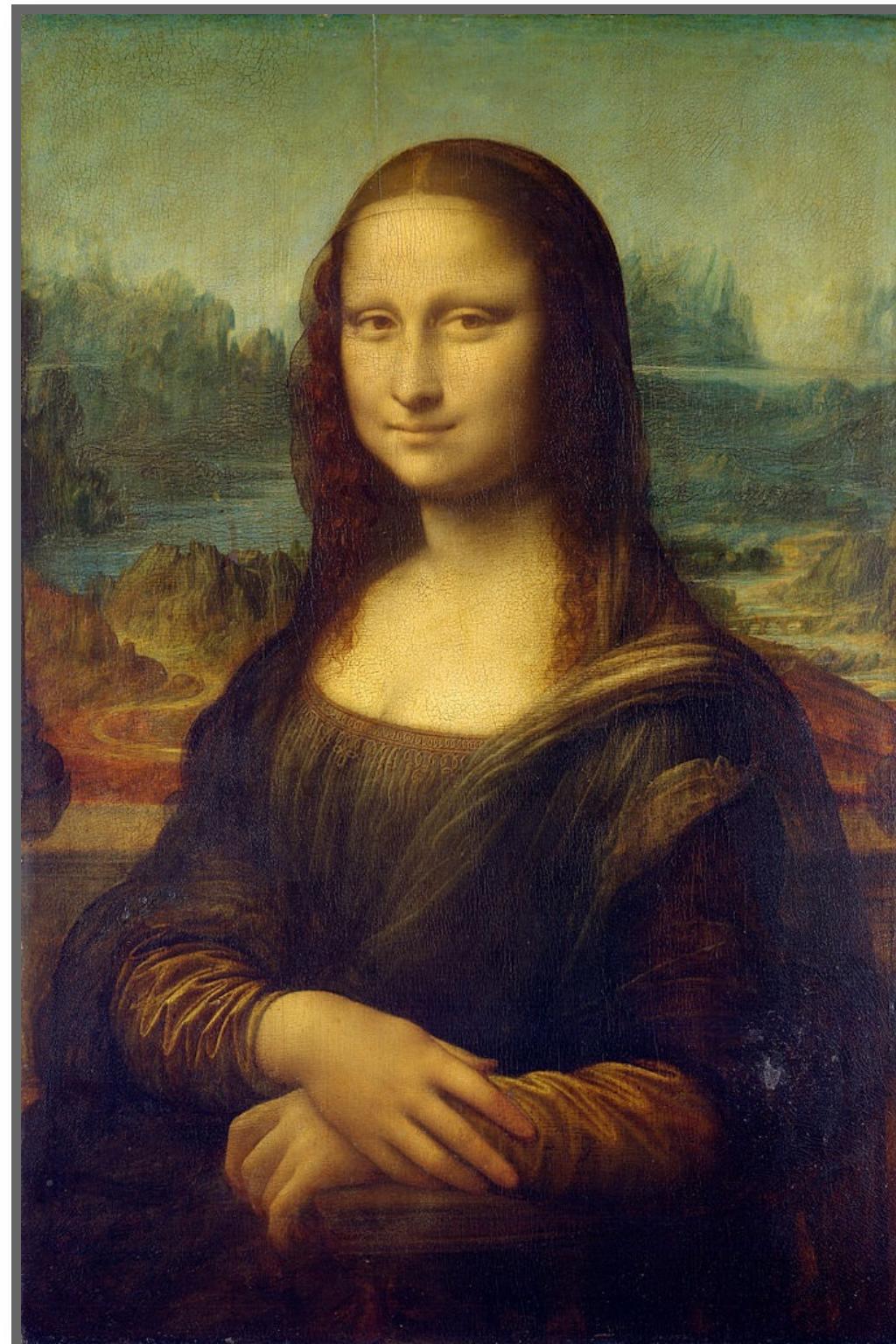
"Data graphics visually display measured quantities by means of the combined use of points, lines, a coordinate system, numbers, symbols, words, shading, and color."

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

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A bit of history

Maps

A bit of history

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

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Scatter plots

A bit of history

Maps --> Data Maps (XVIIth.C.) --> Time series (1786) -->
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

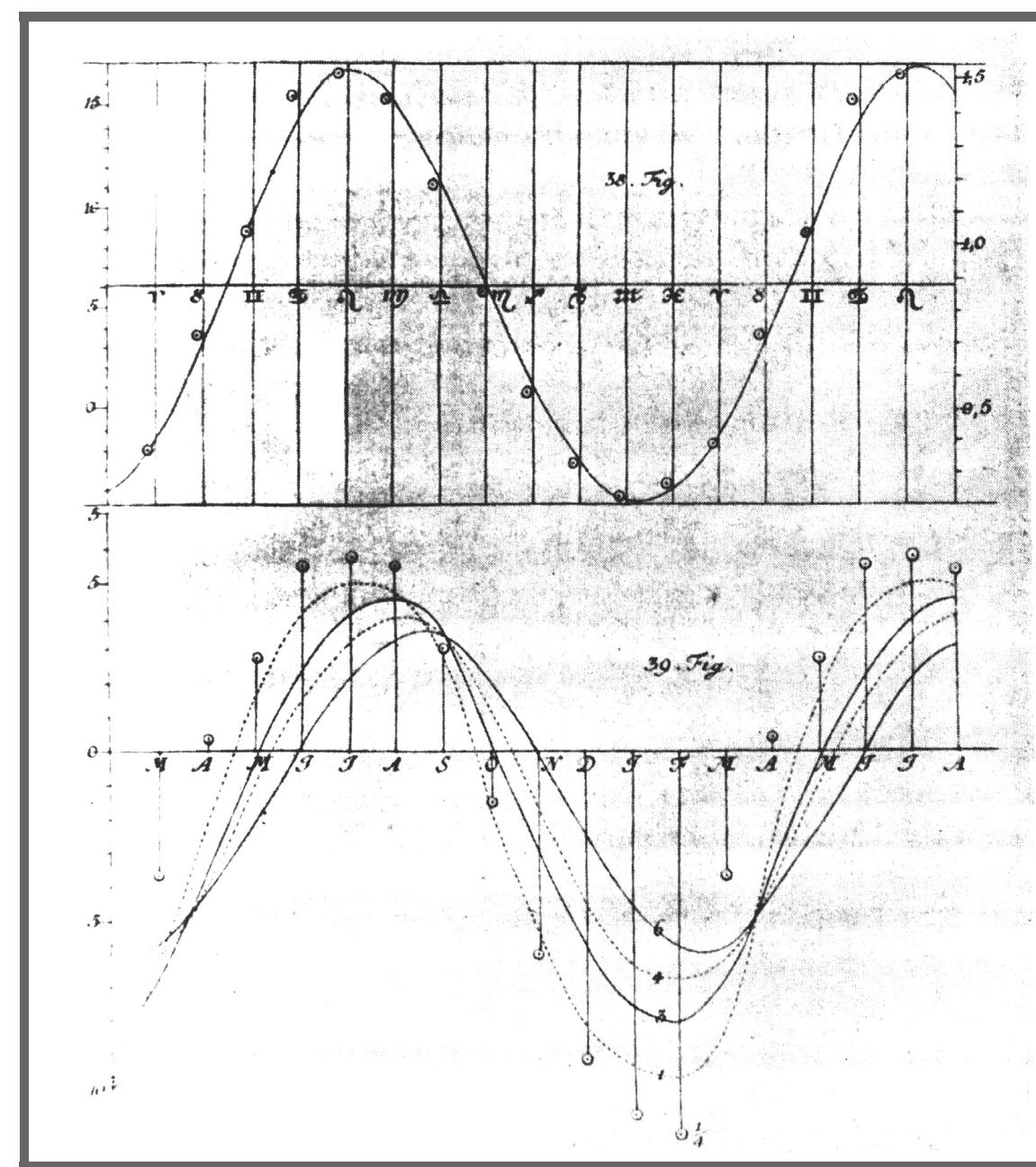
The Visual Display of Quantitative Information. Edward R. Tufte.

- 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...

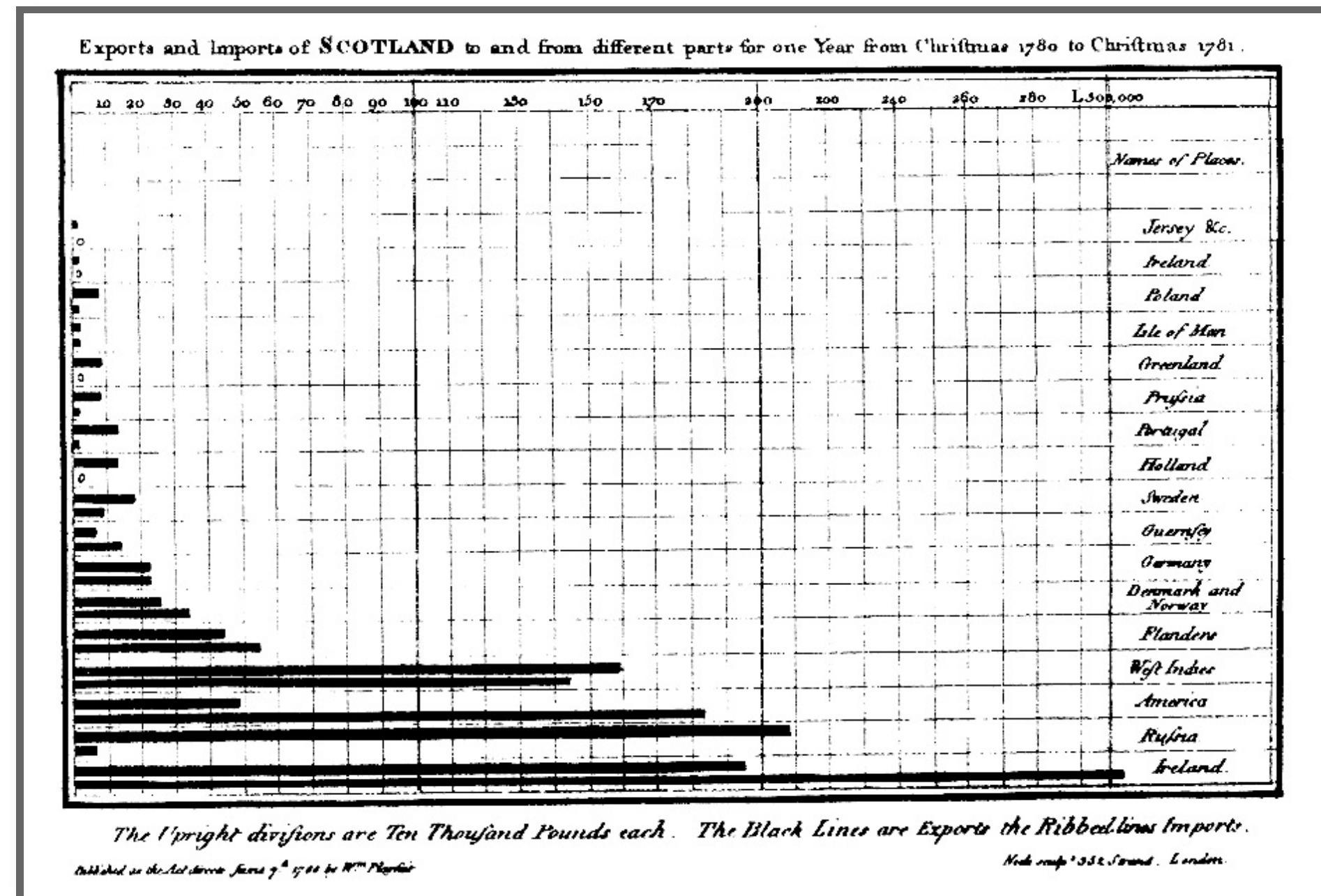
Time series

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



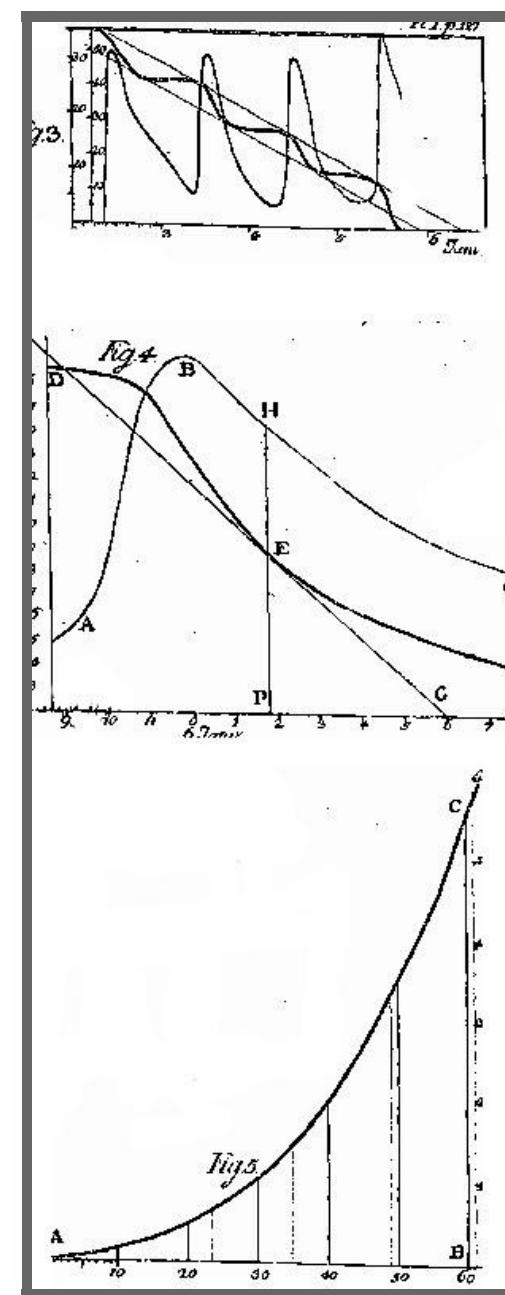
Bar chart

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



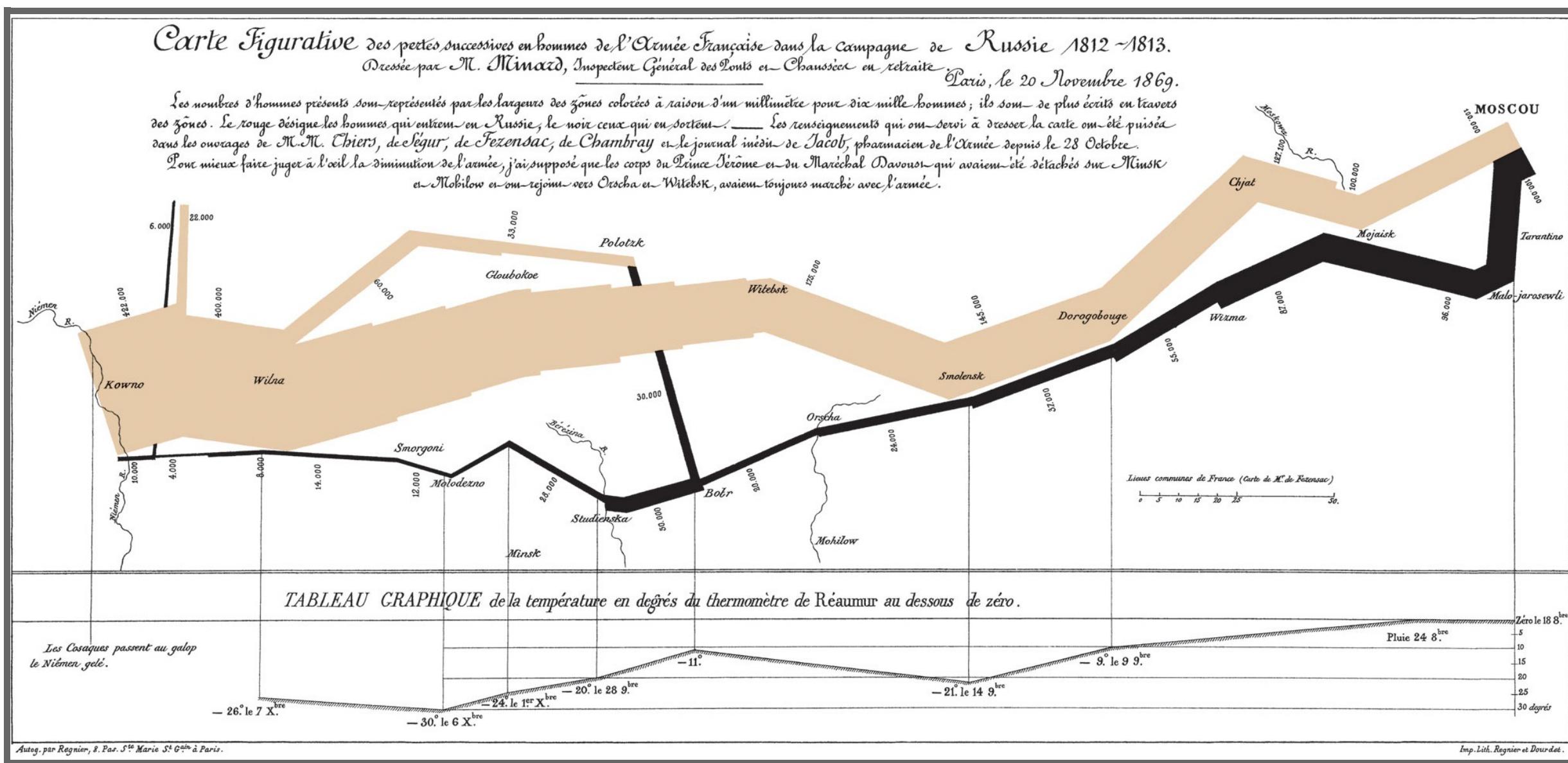
Abstract line plot

[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

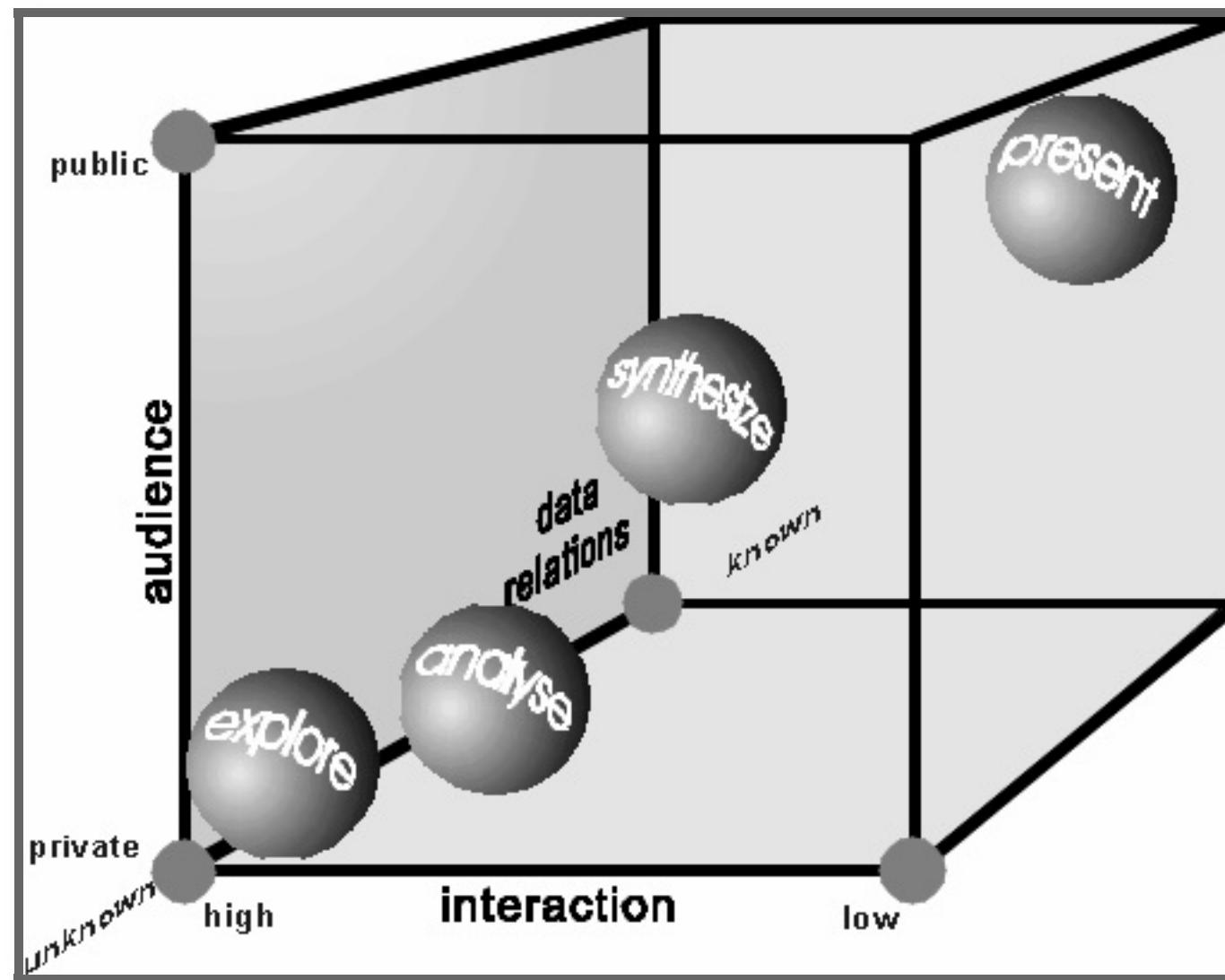
Maps can fulfill several needs

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

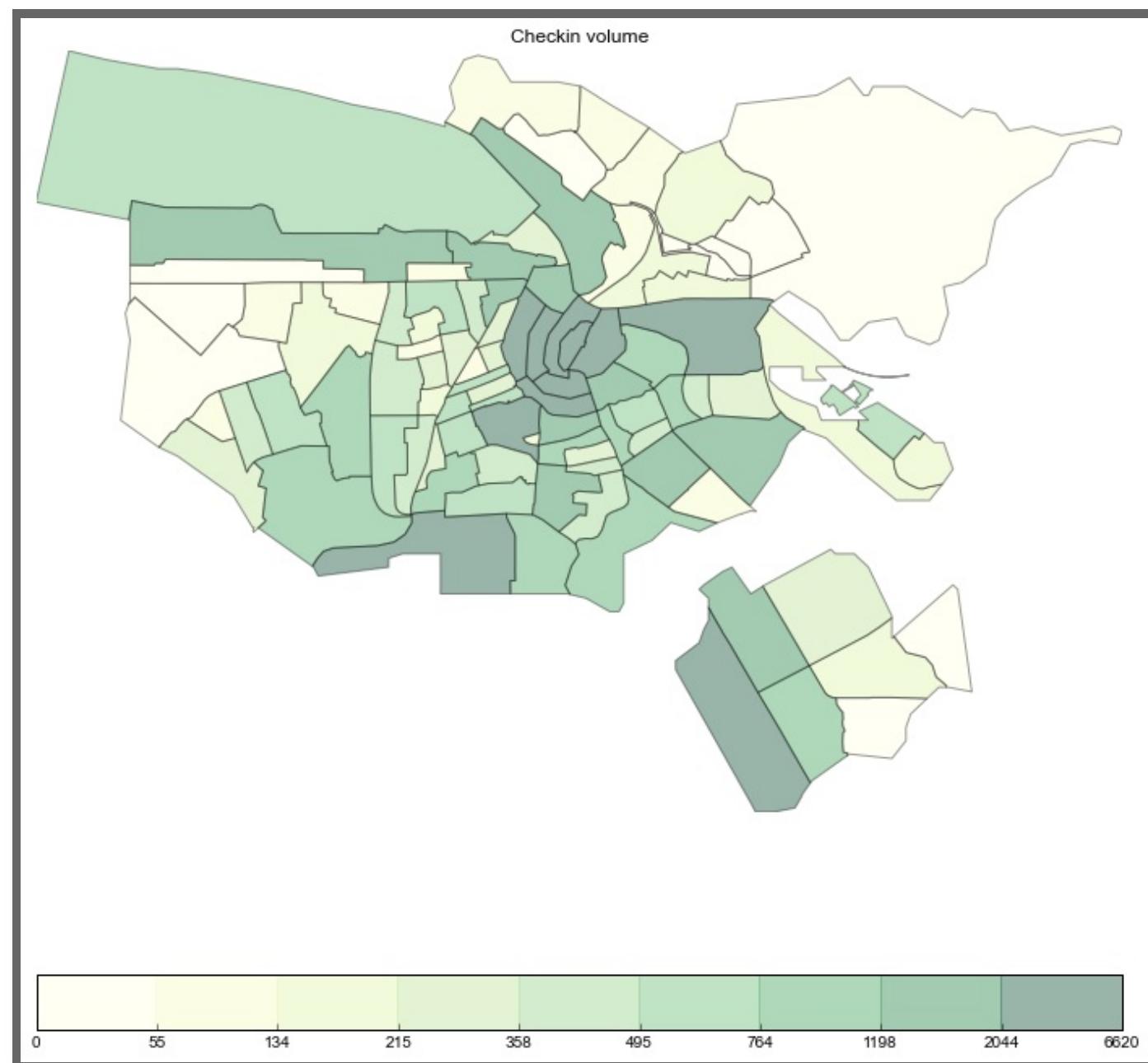


[Source]

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

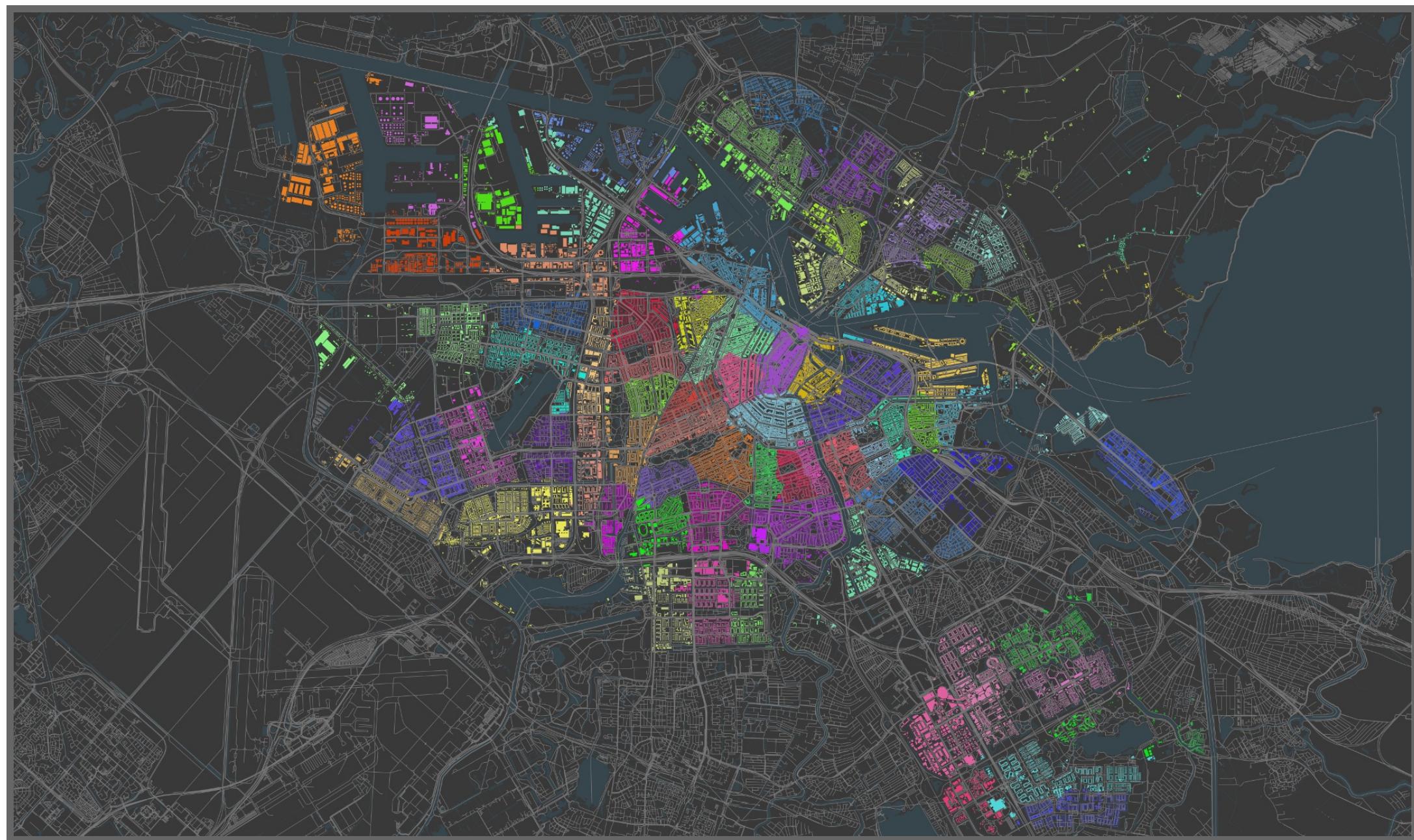
Fast maps

[[Source](#)]



Slow maps

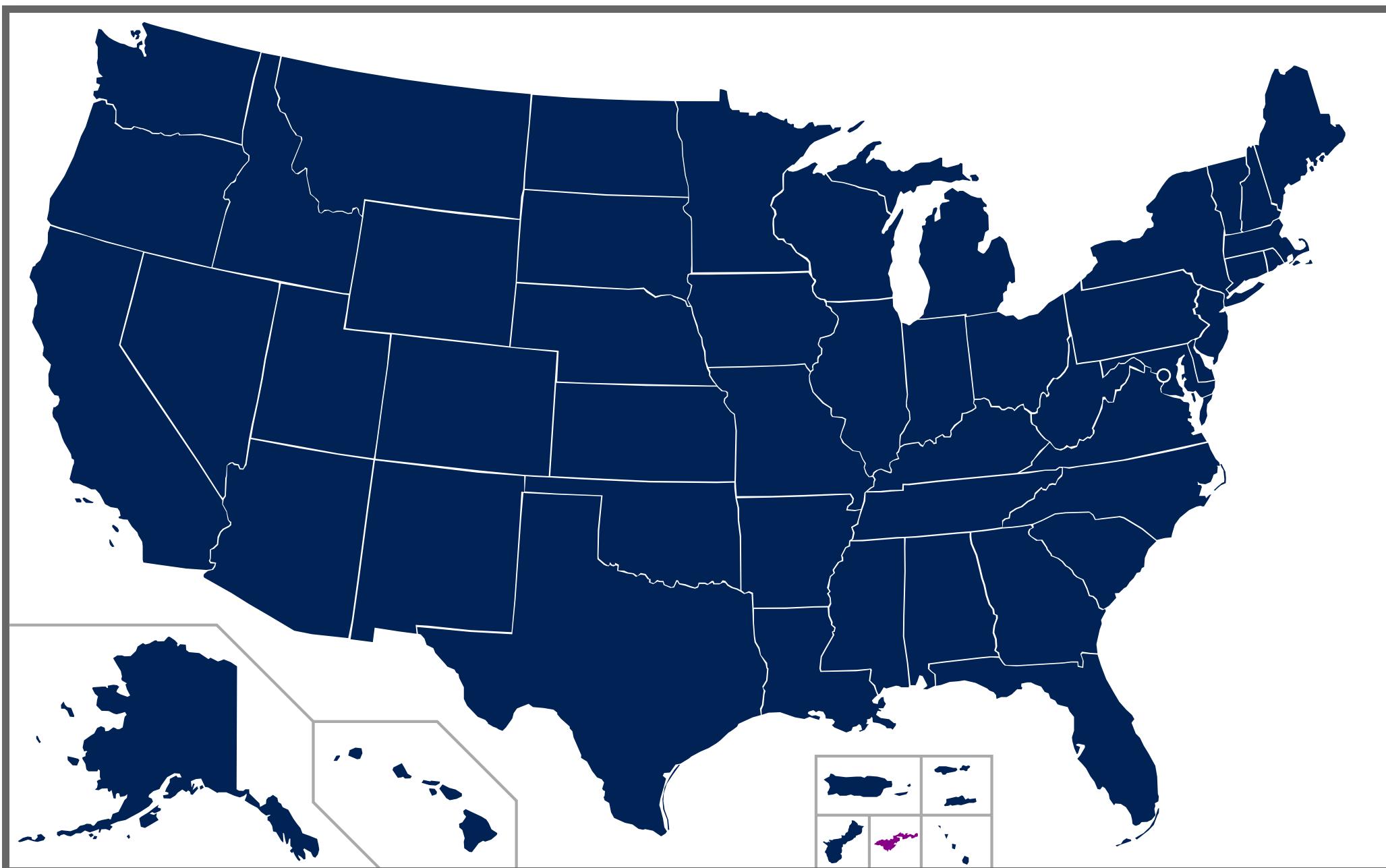
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Audience: *easy* and *hard* maps

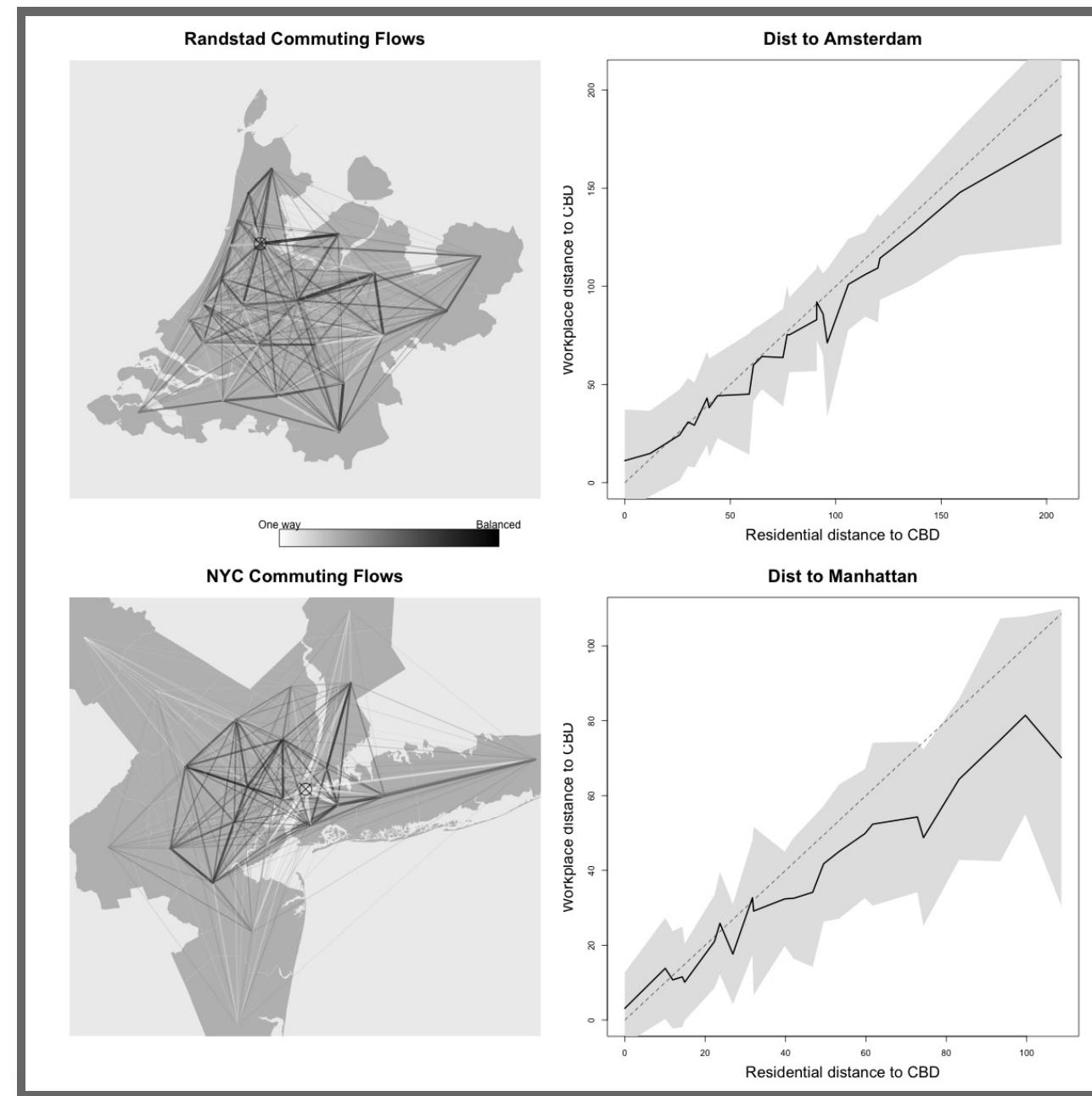
Easy map

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



Hard map

[[Source](#)]

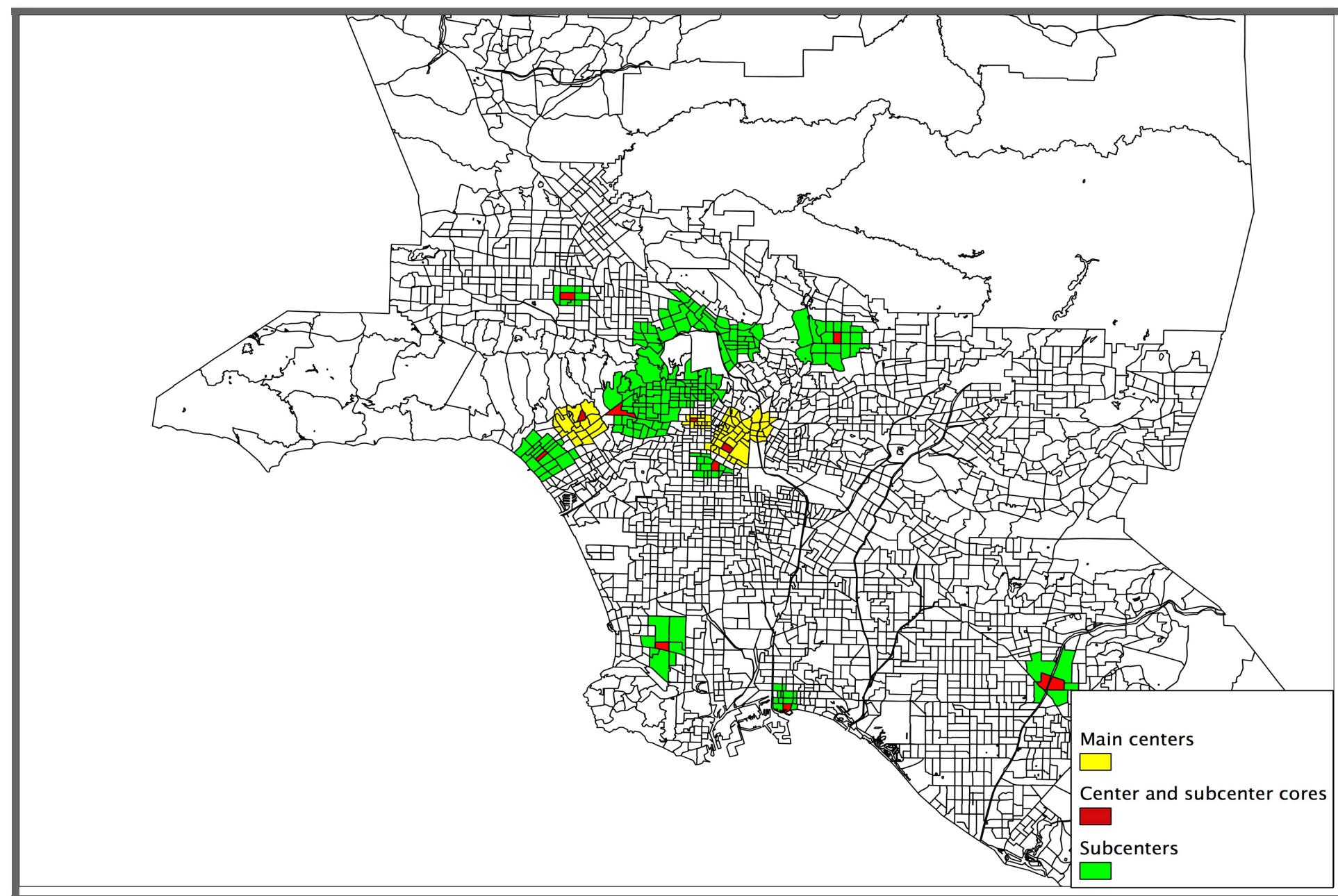


Interaction: one or many maps in one

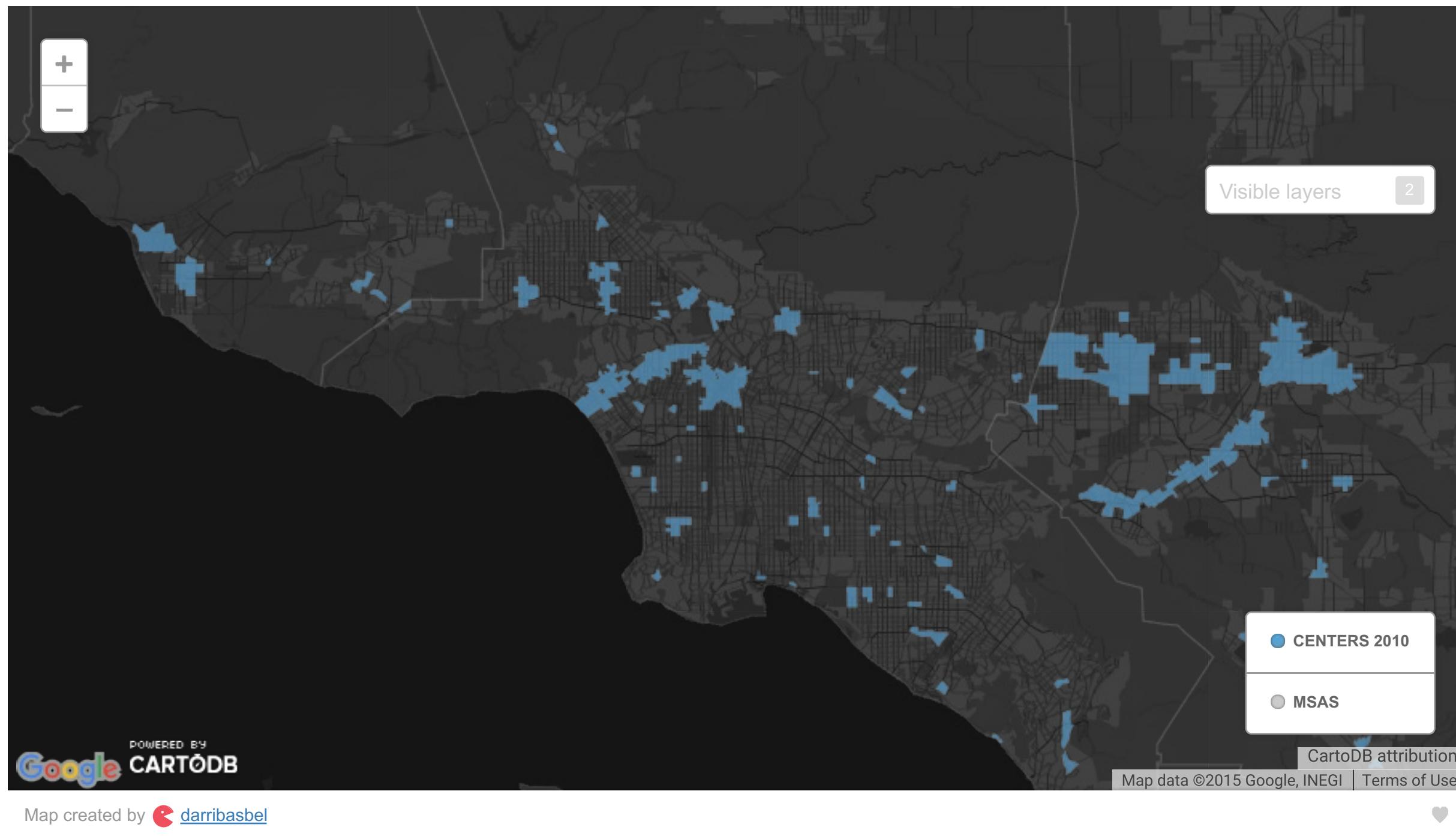
Talk about interaction, opportunity for discovery, and the end-user as explorer rather than mere consumer

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)

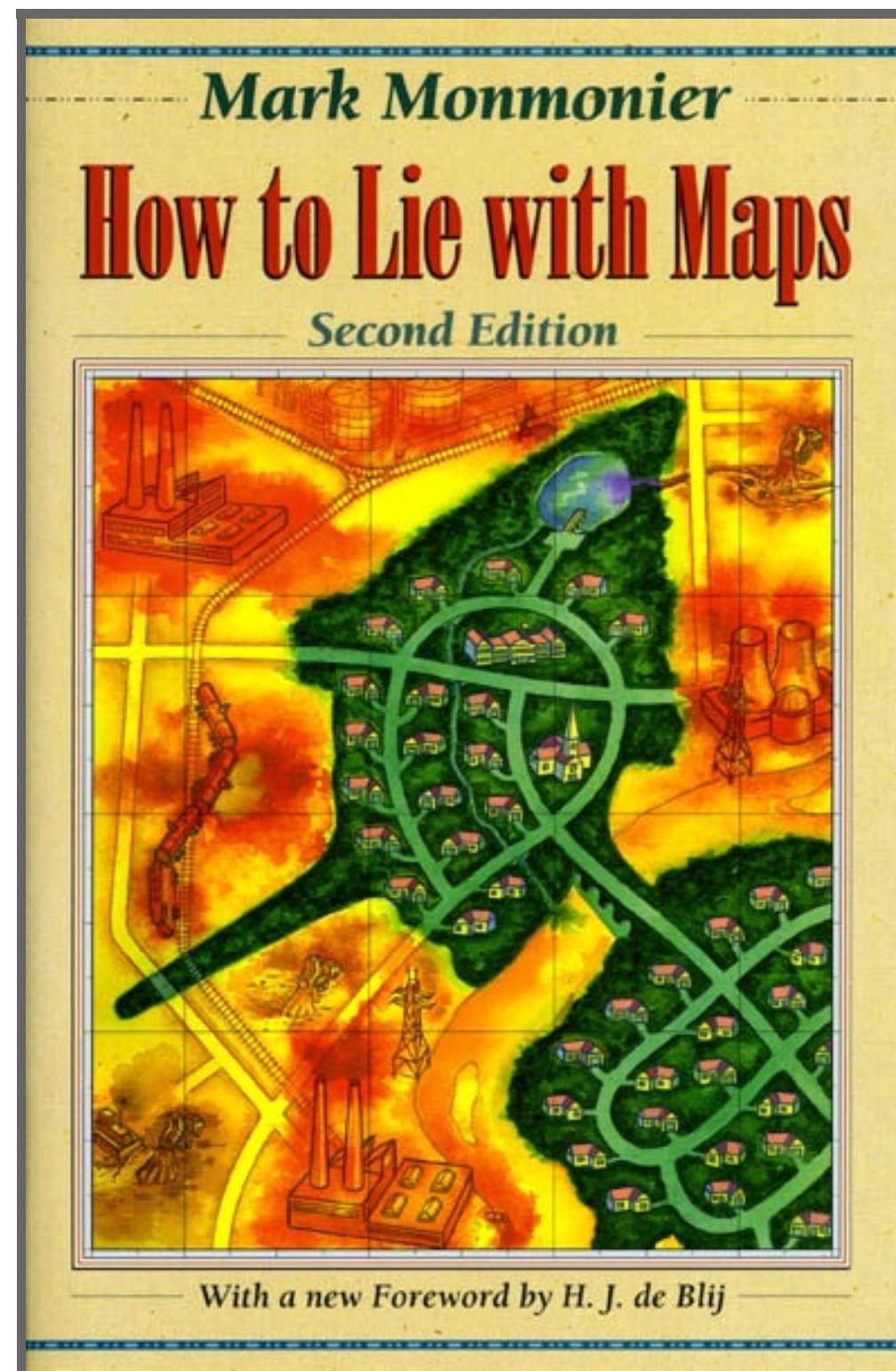
Static map



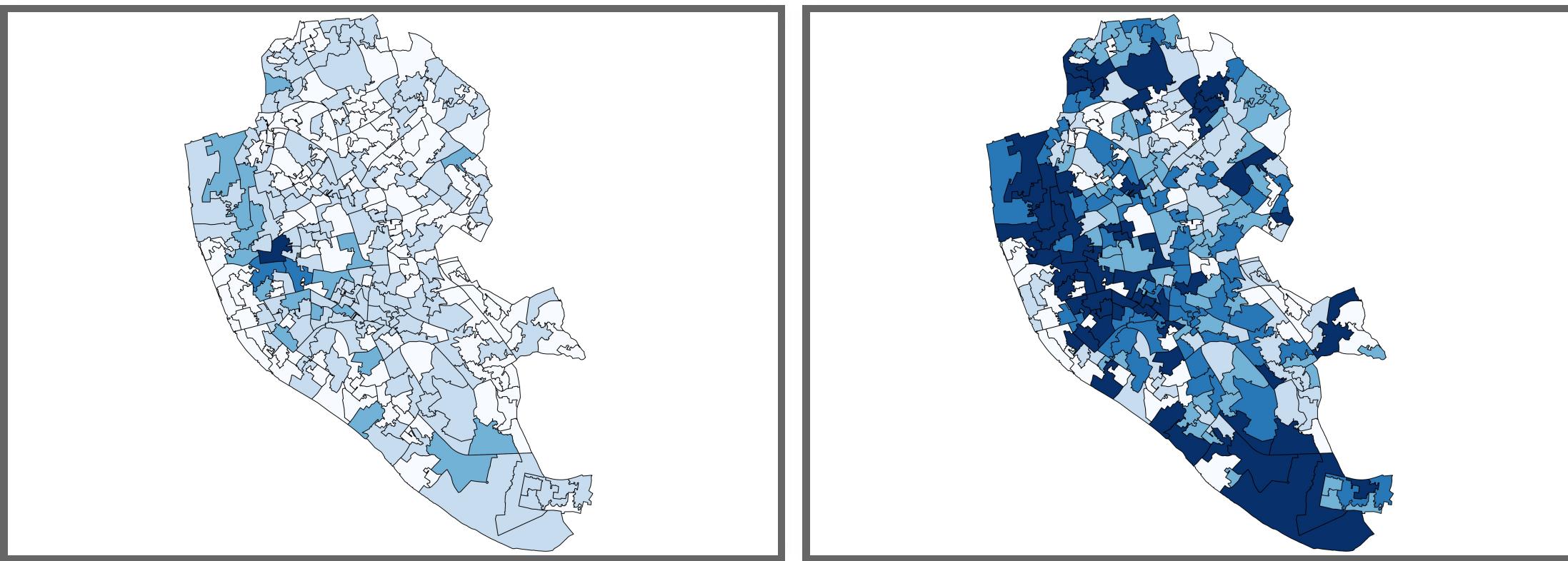
Interactive map



Dangers of GeoVisualization



How to lie with maps



How to lie with maps

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

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

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

How to lie with maps

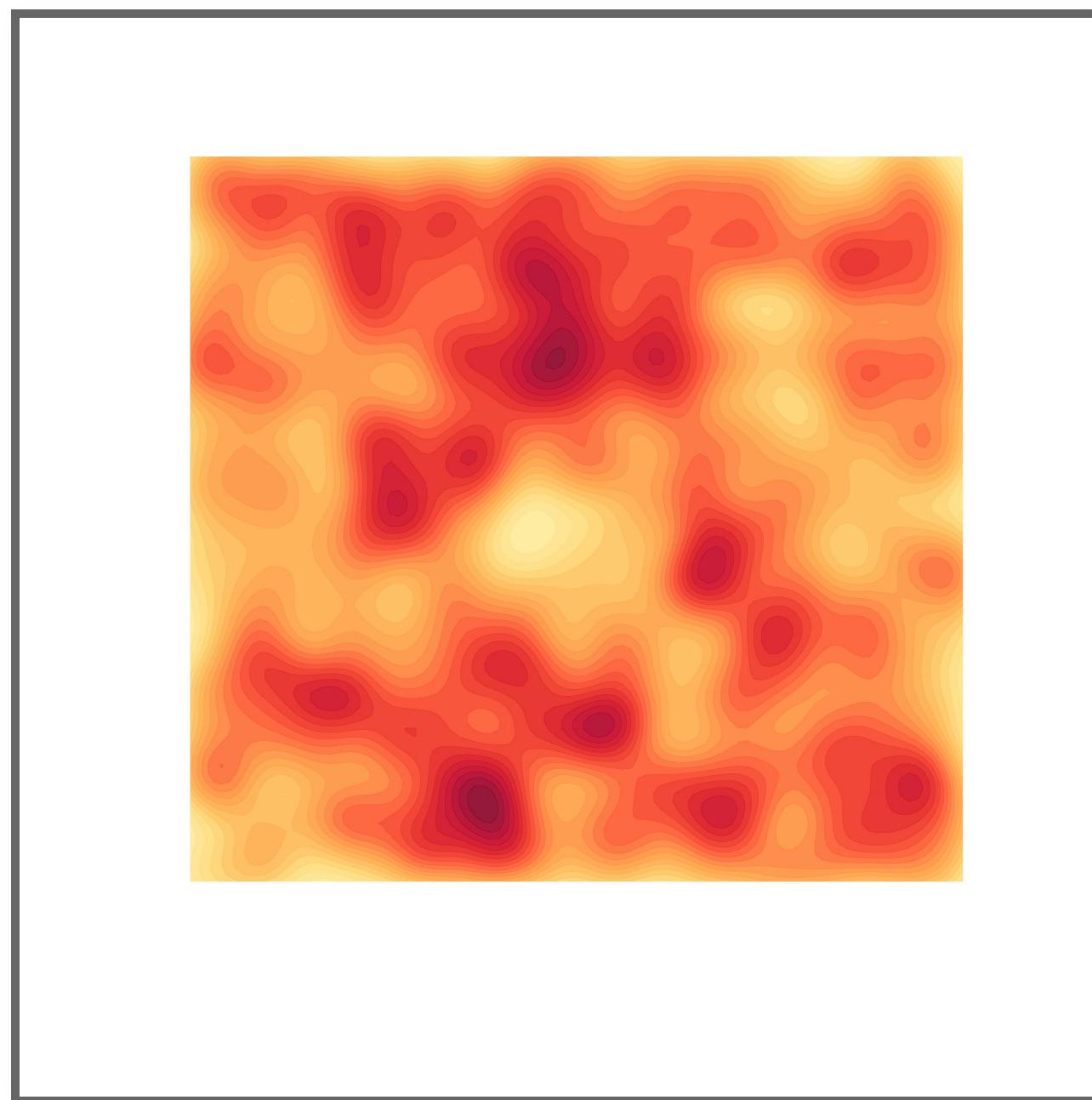
The human brain is so good at picking up patterns...

... 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"

How to *be truthful* with maps

"With great power comes great responsibility"

Statistics to the rescue!!!

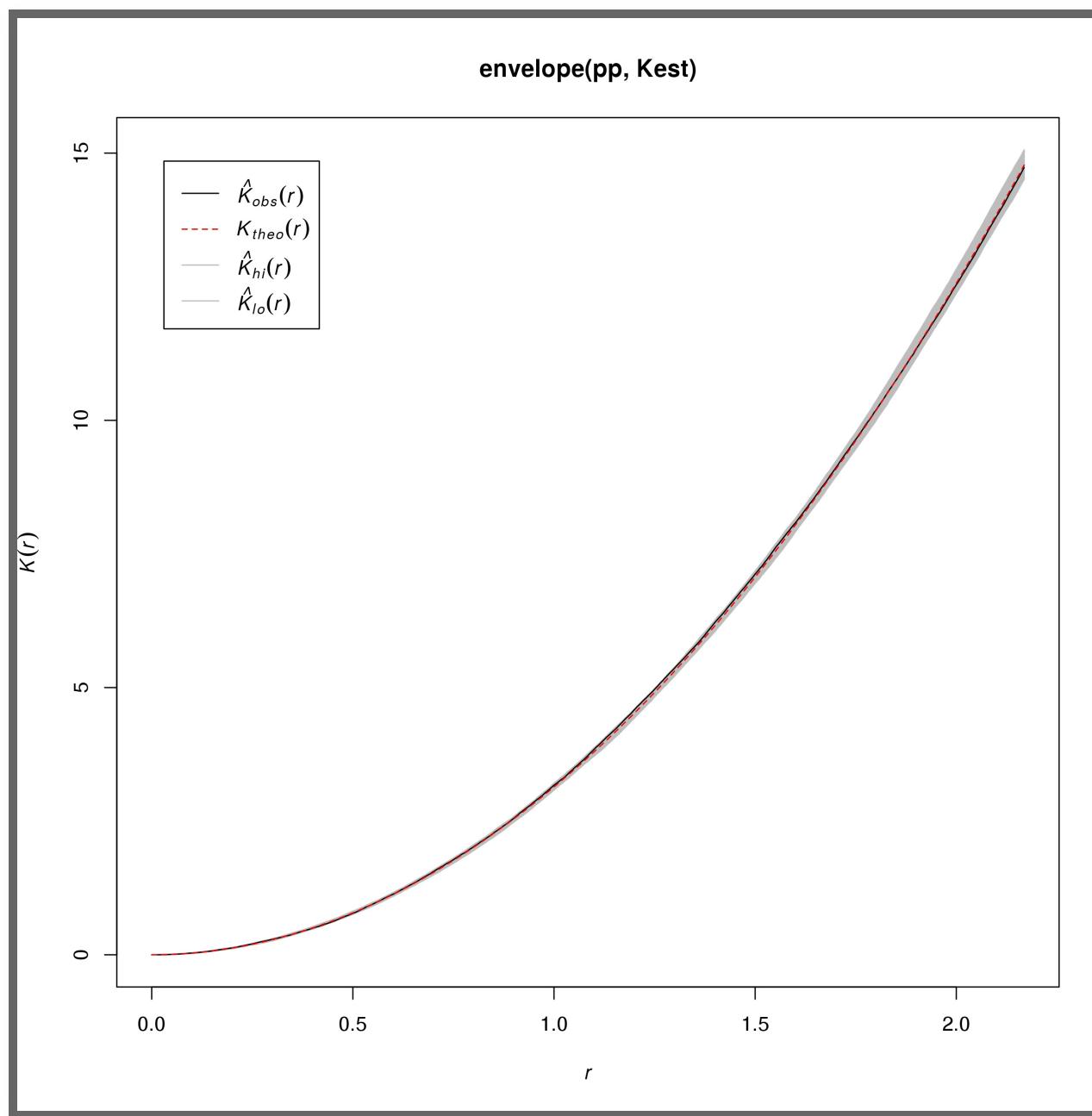
How to *be truthful* with maps

"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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