Geographic Data Science - Lecture III

(Geo-)Visualization

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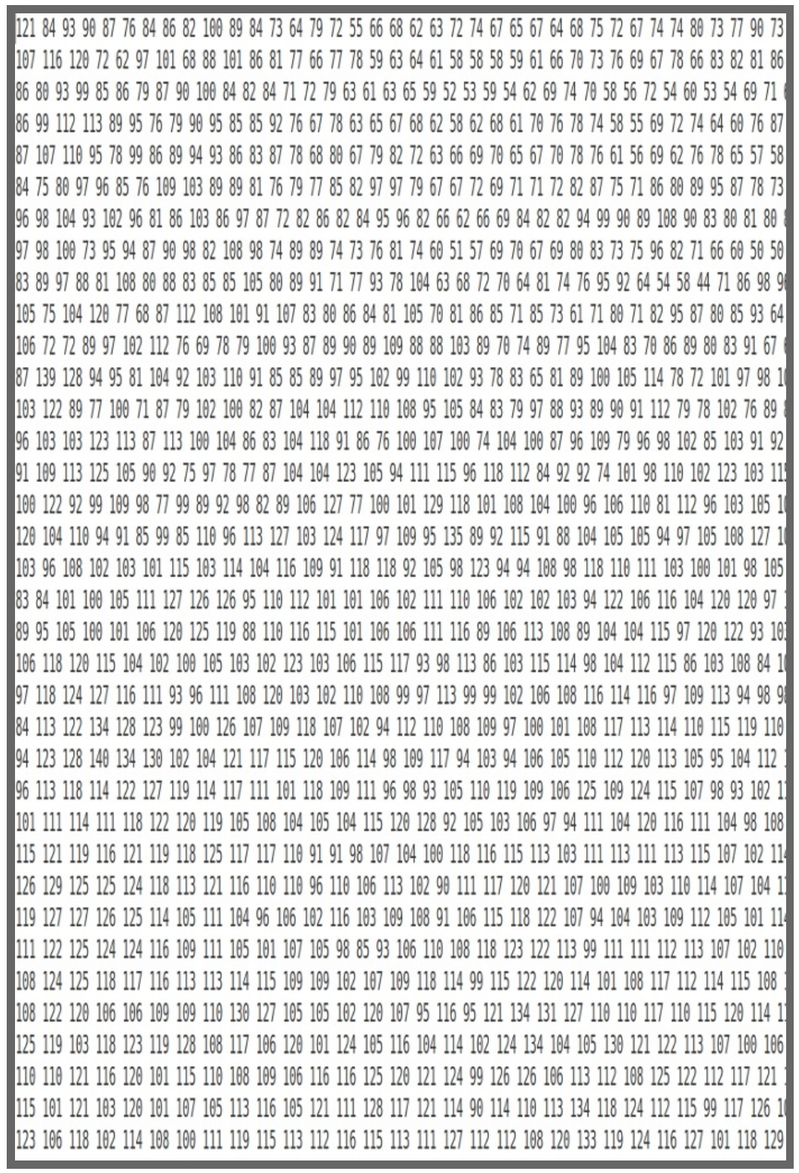
Today

- 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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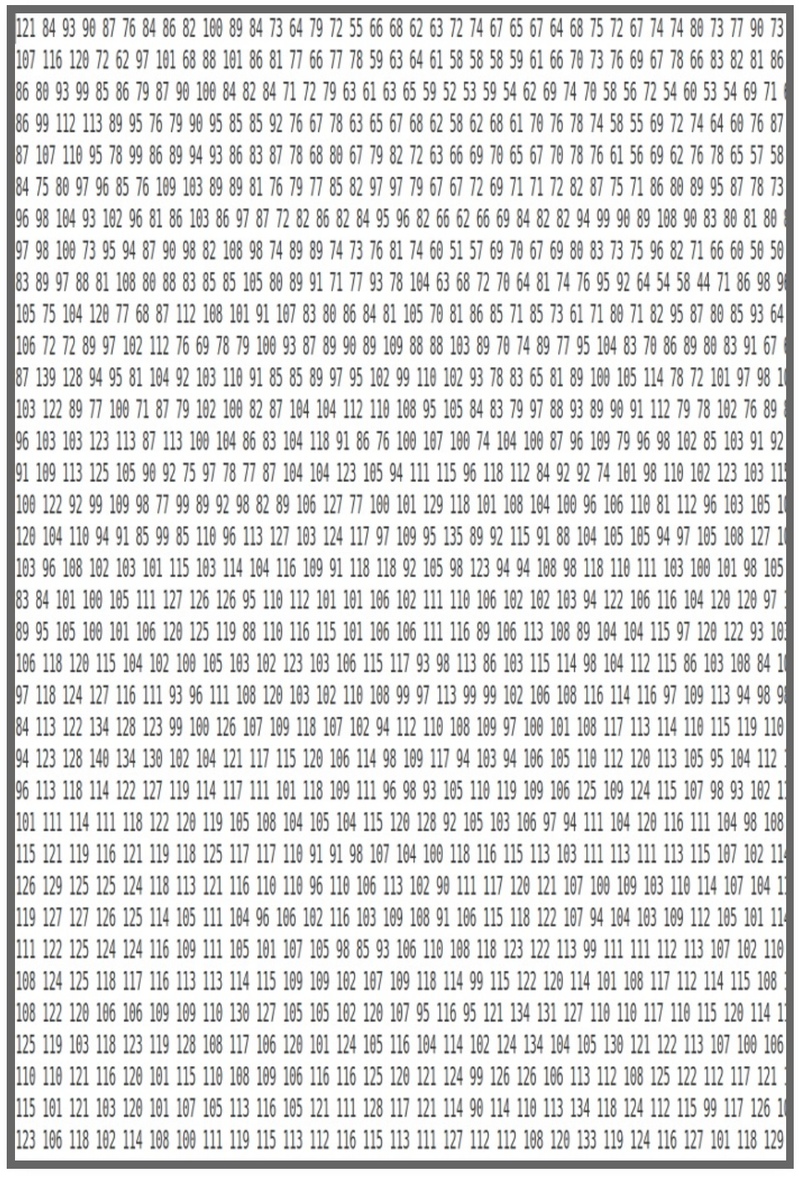

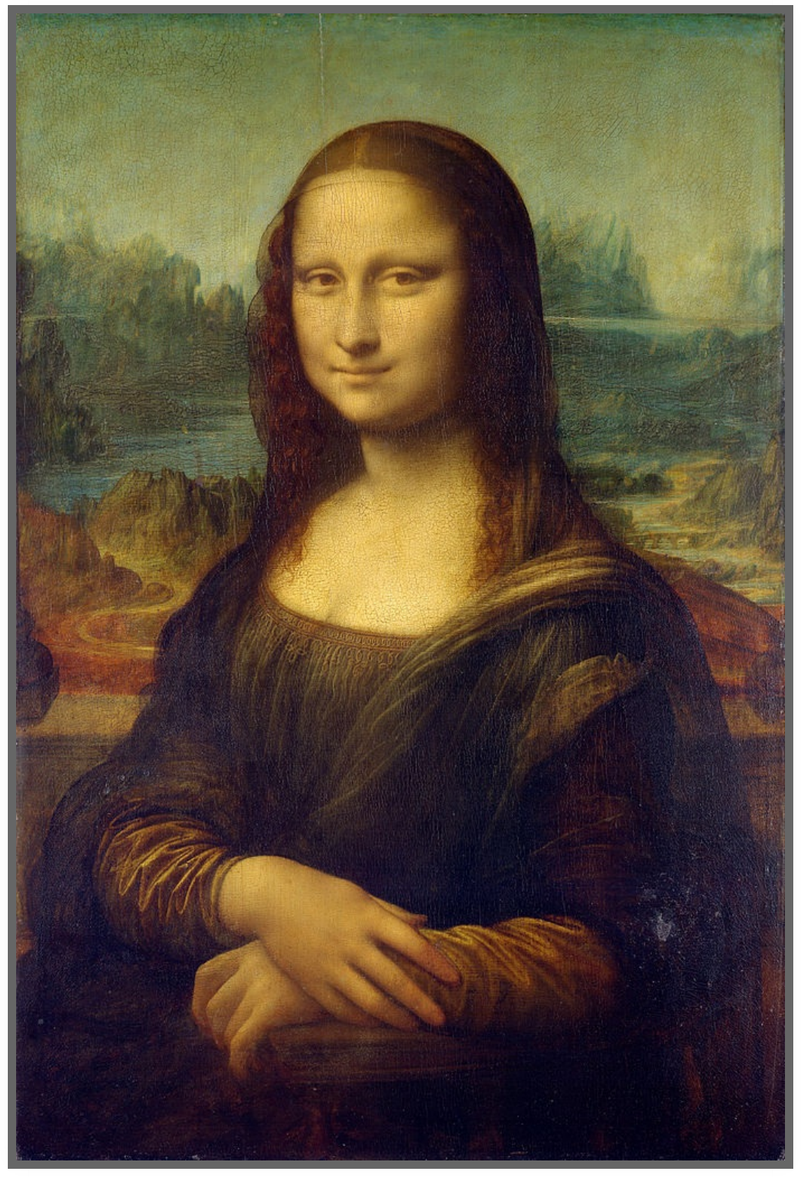

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A bit of history

Maps

A bit of history

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

A bit of history

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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

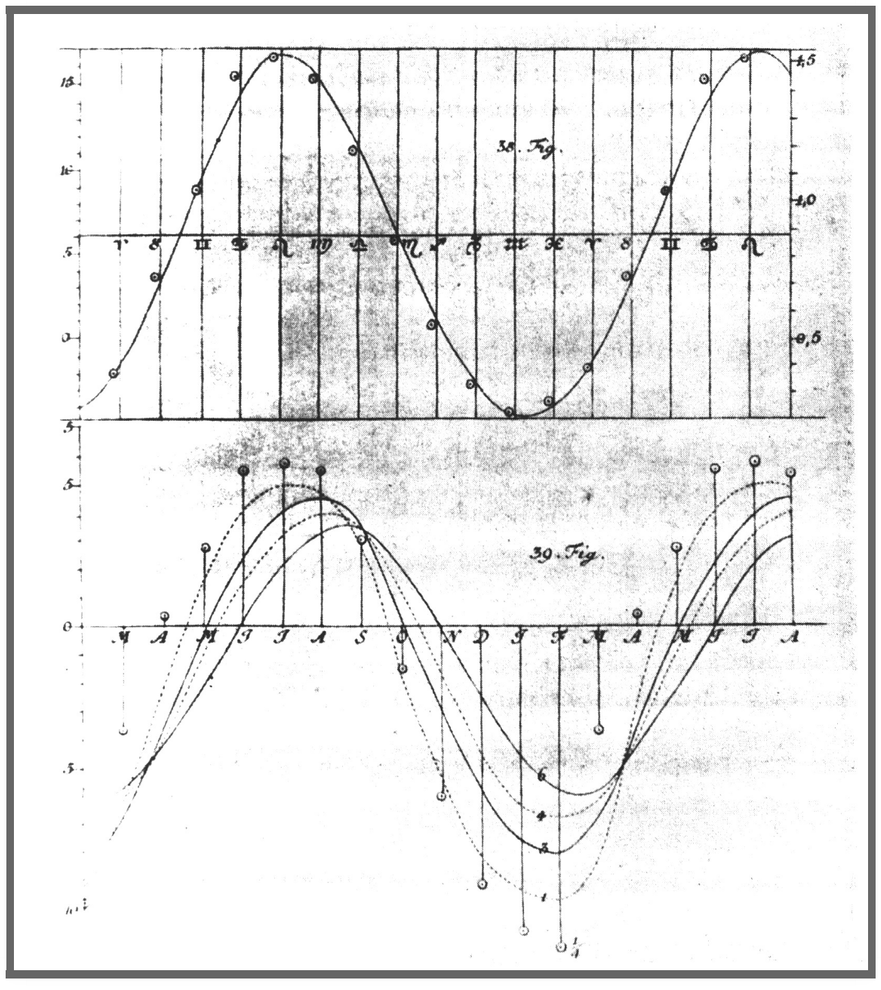
The Visual Display of Quantitative Information. Edward R. Tufte.

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

Learning by seeing time...

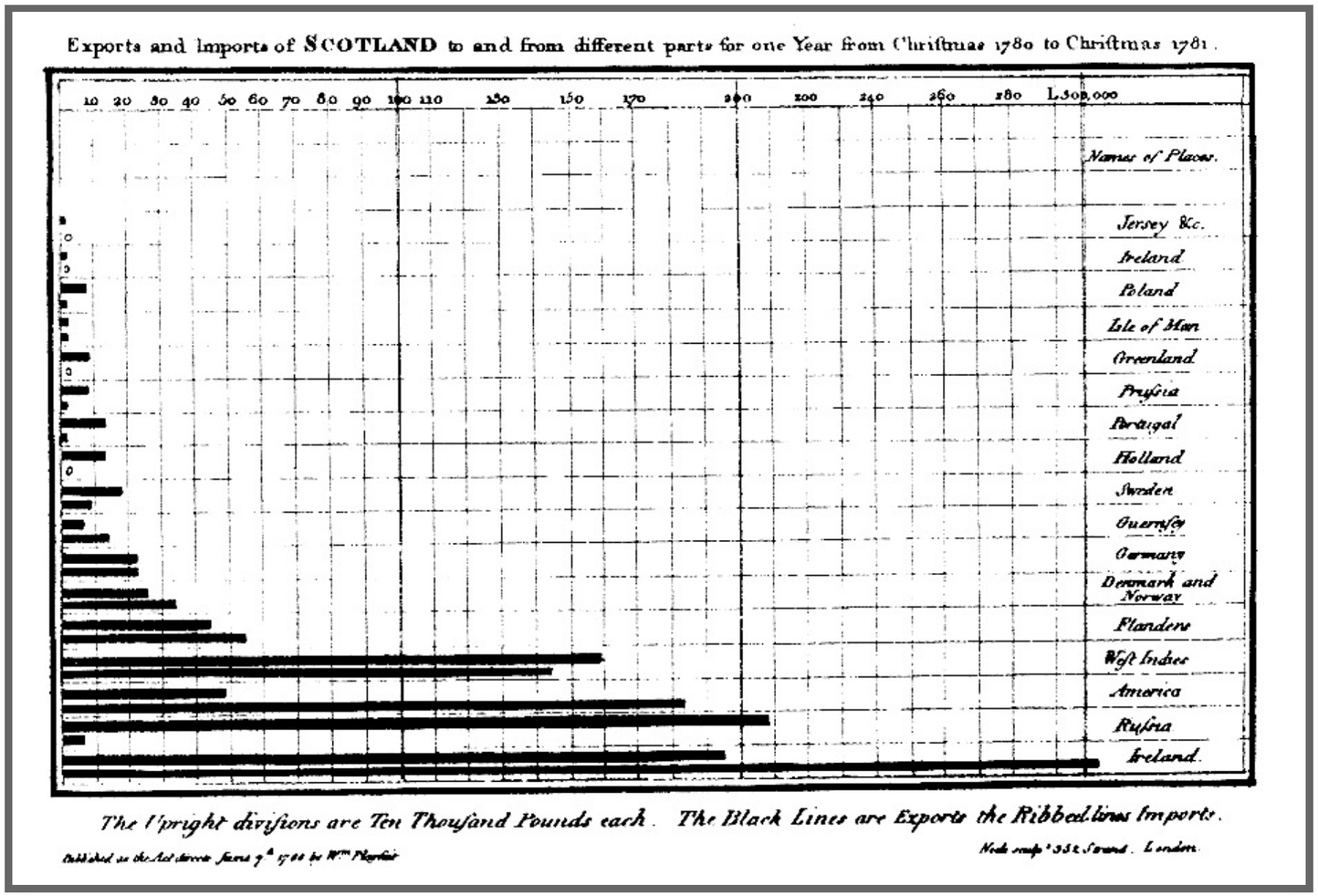
Time series

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



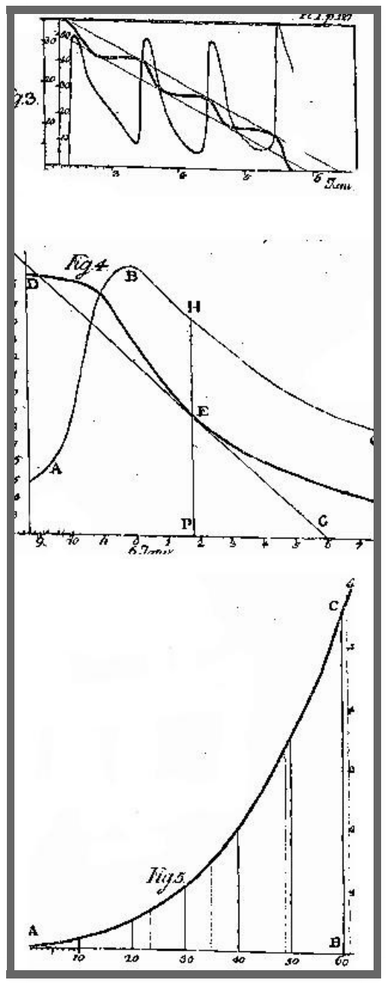
Bar chart

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



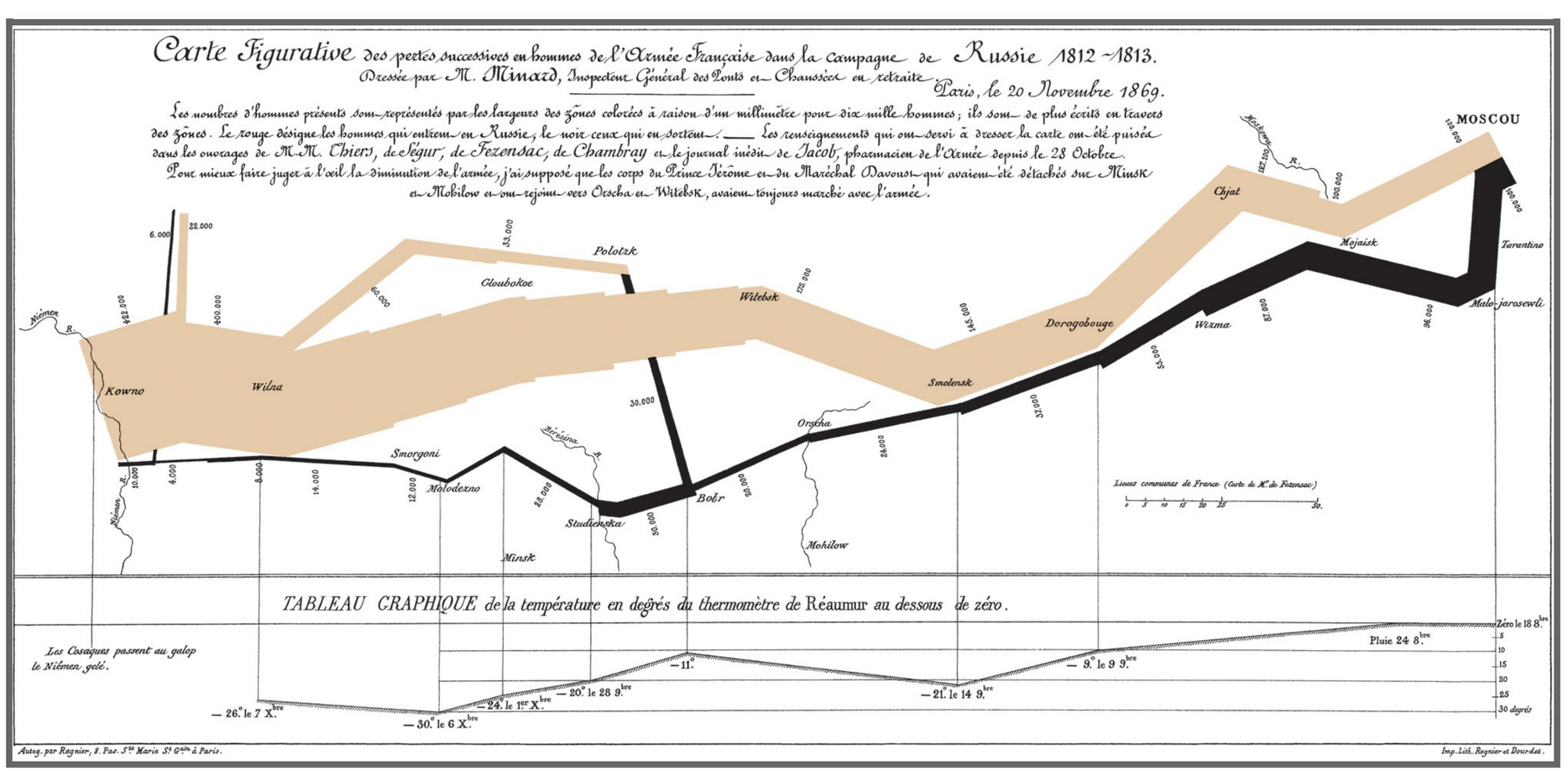
Abstract line plot

[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

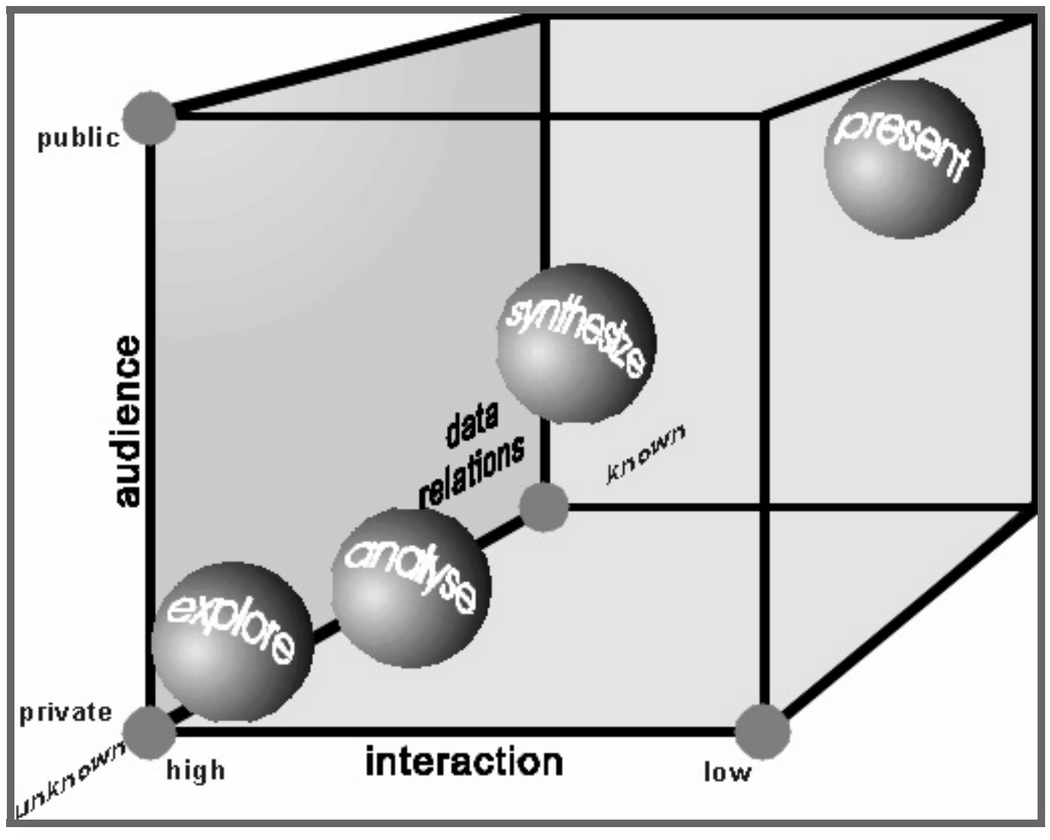
Maps can fulfill several needs

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

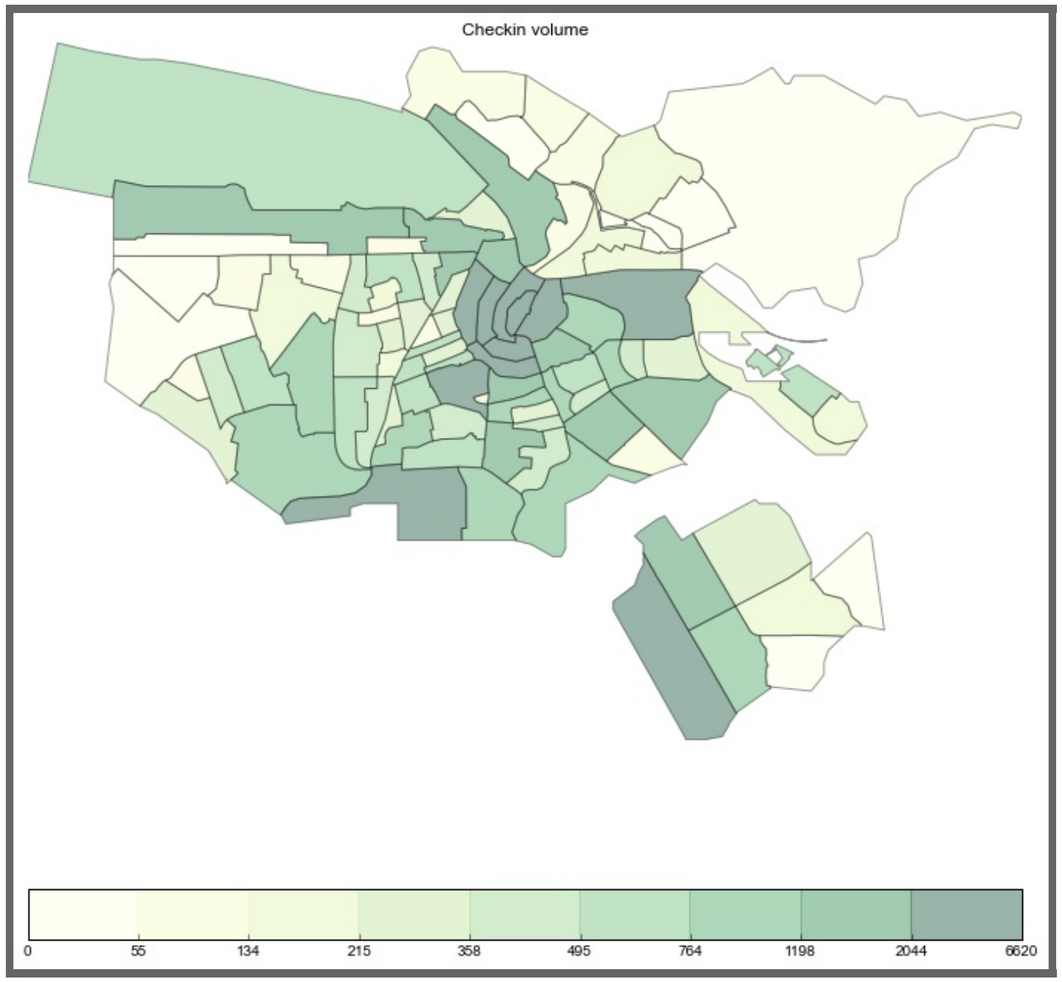


[Source]

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

Fast maps

[Source]



Slow maps

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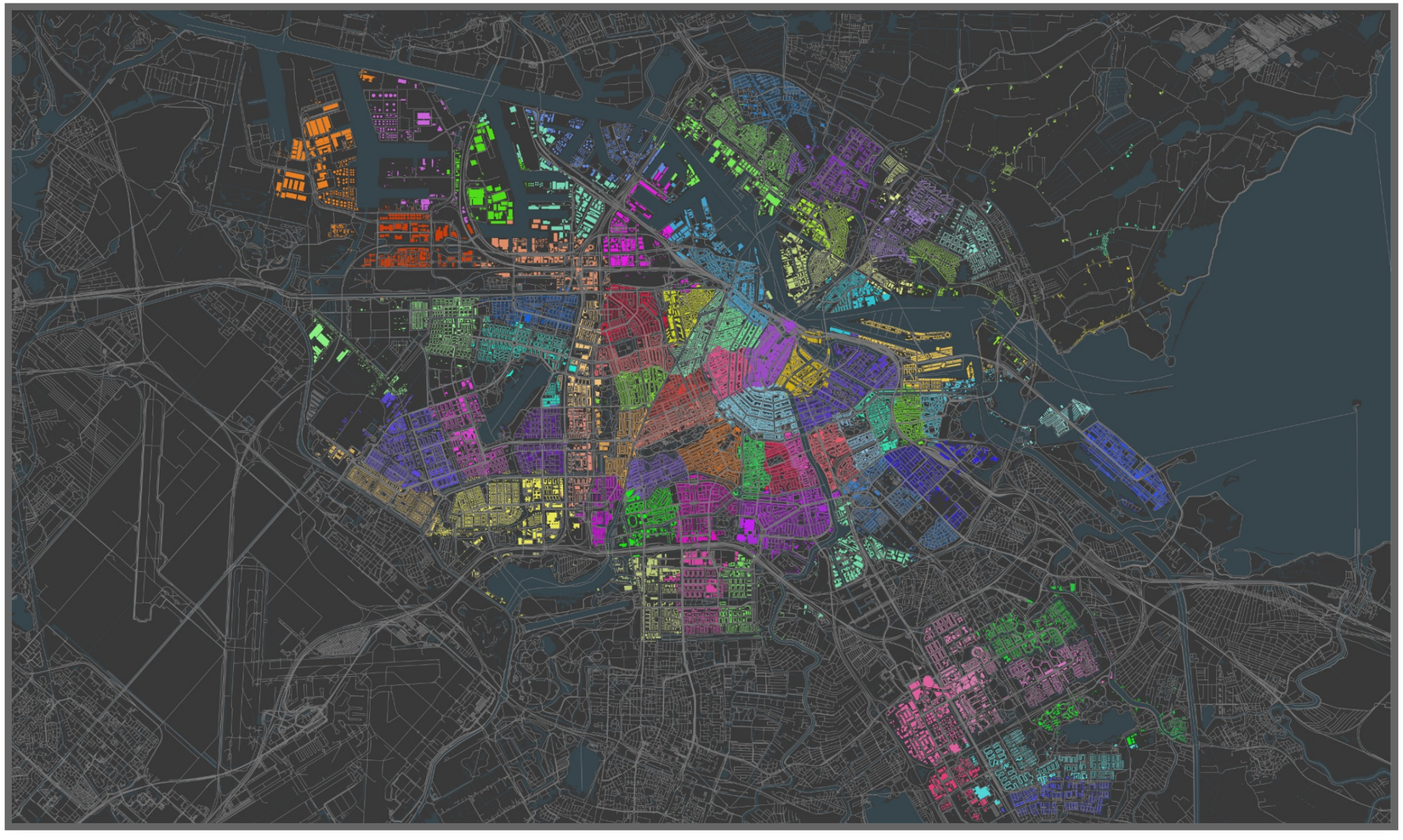
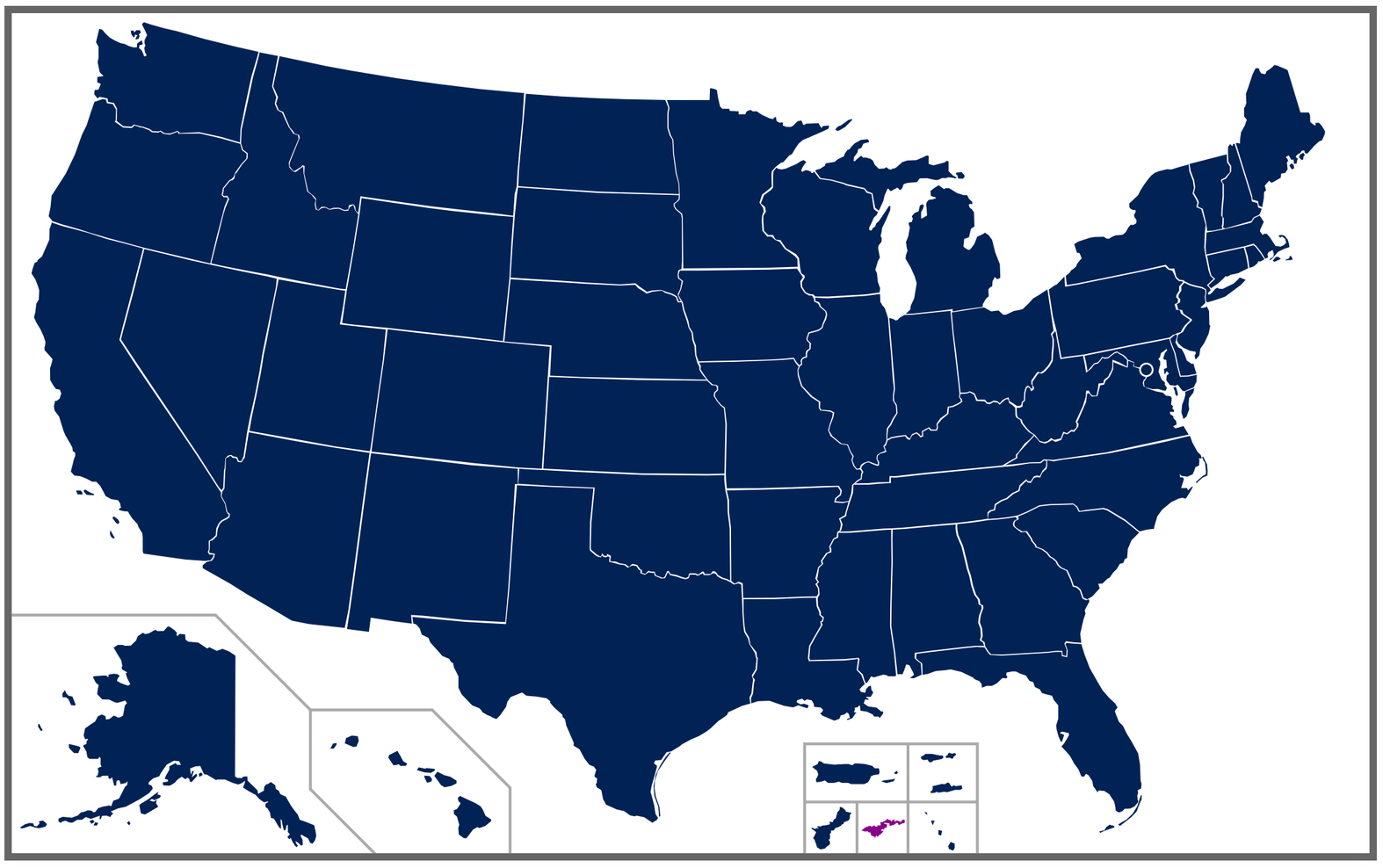


Audience: *easy* and *hard* maps

Easy map

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



Hard map

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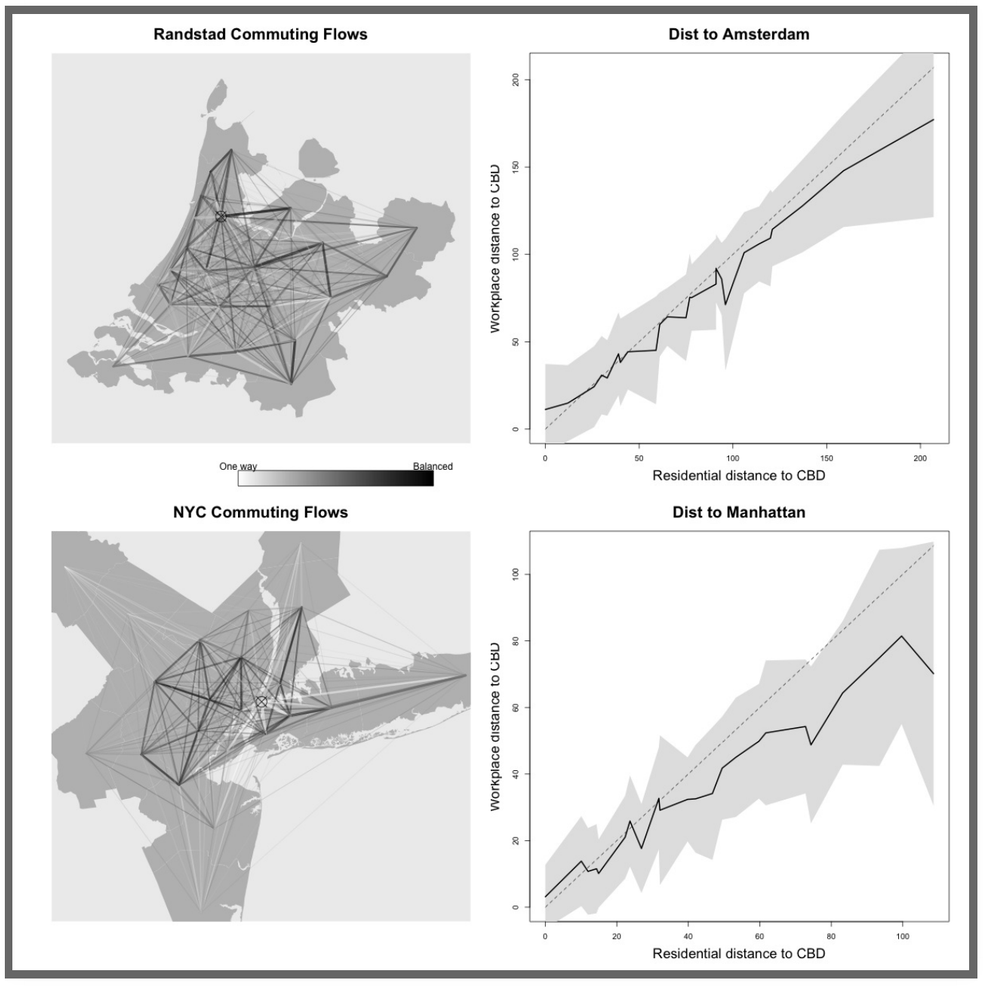
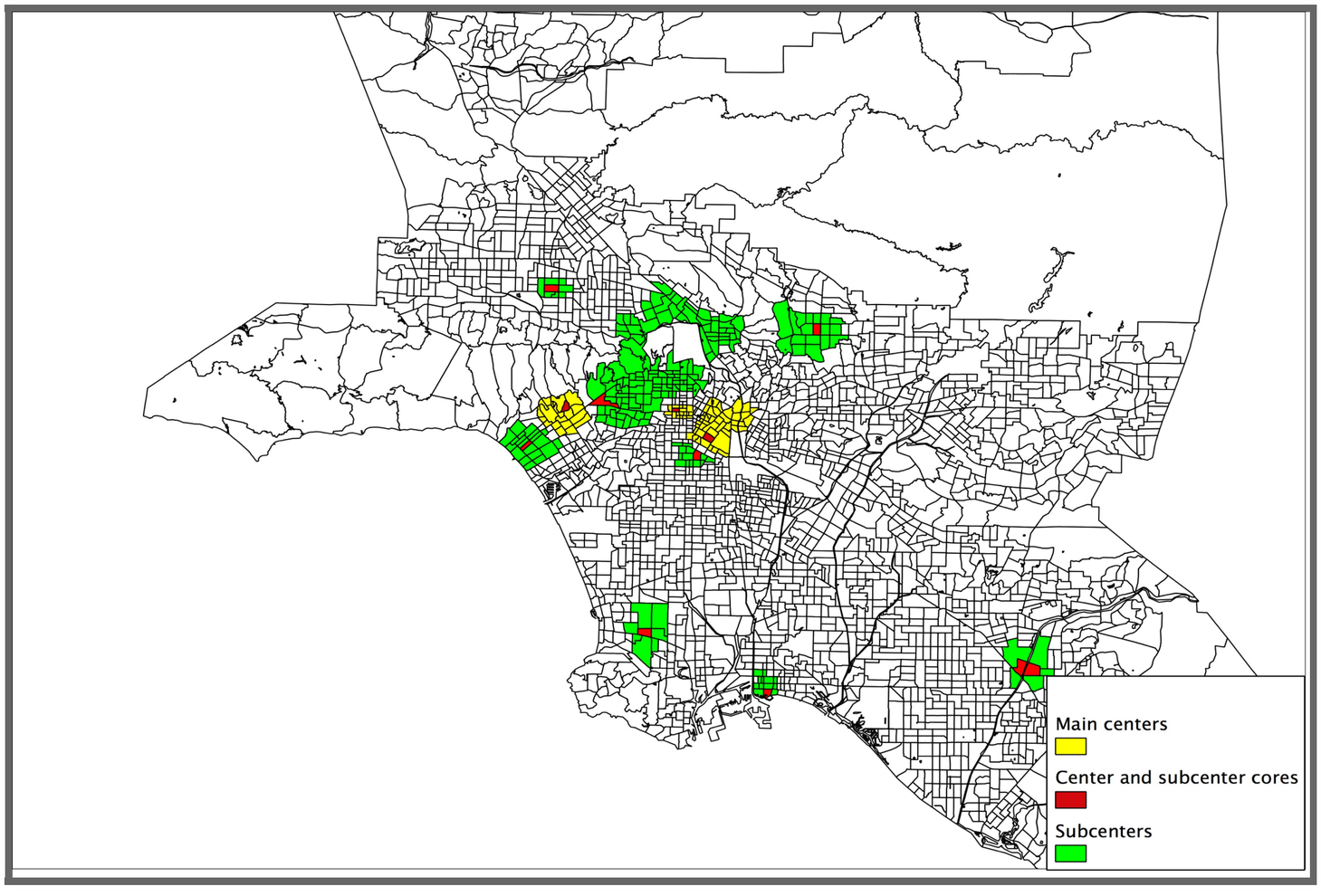
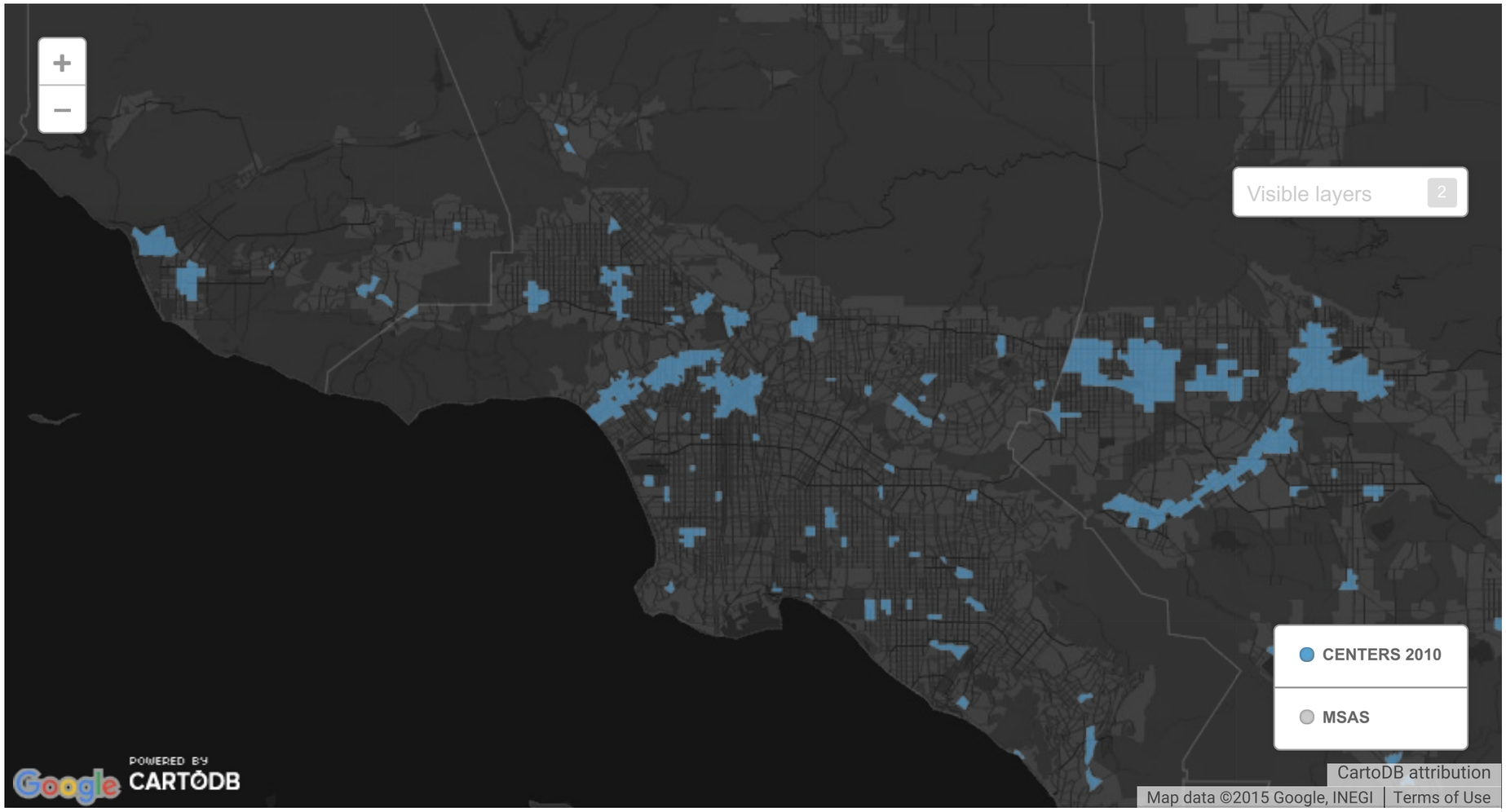


Interaction: one or many maps in one

Static map

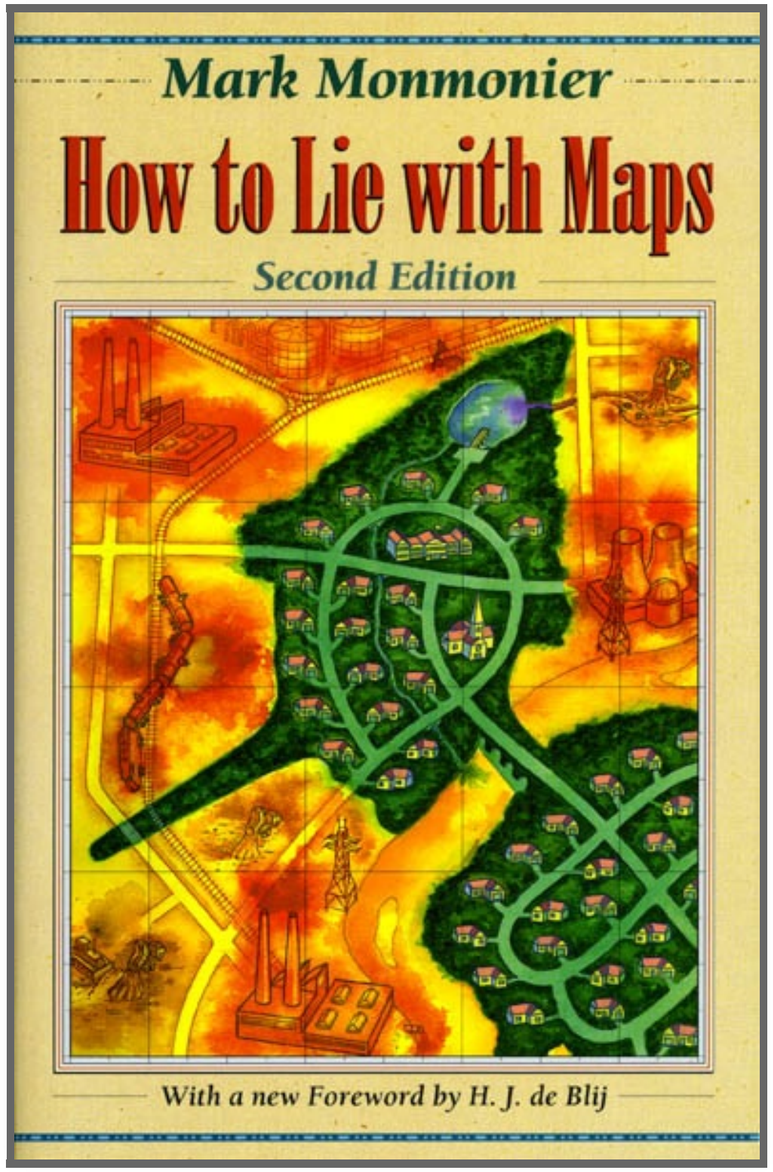


Interactive map

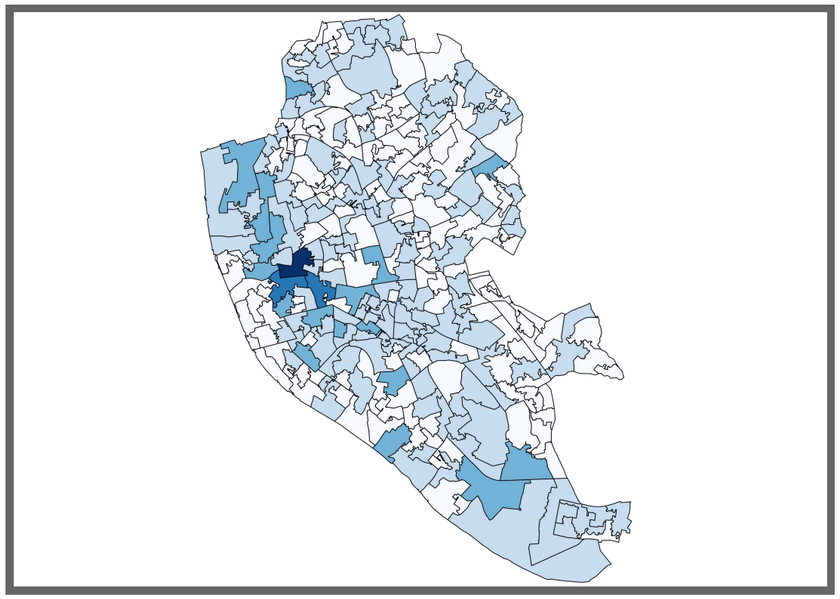


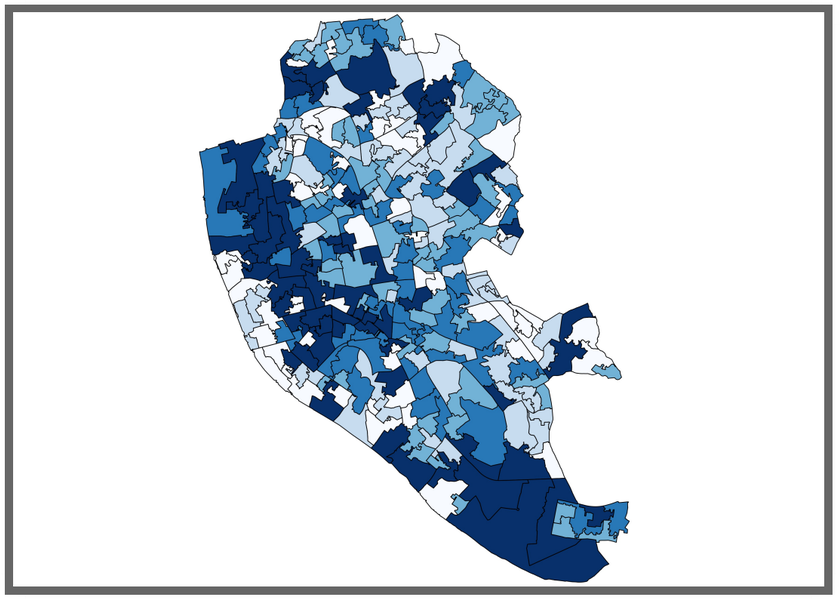
Map created by darribasbel

Dangers of GeoVisualization


Mark Monmonier
How to Lie with Maps
Second Edition
With a new Foreword by H. J. de Blij

How to lie with maps





How to lie with maps

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

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

How to lie with maps

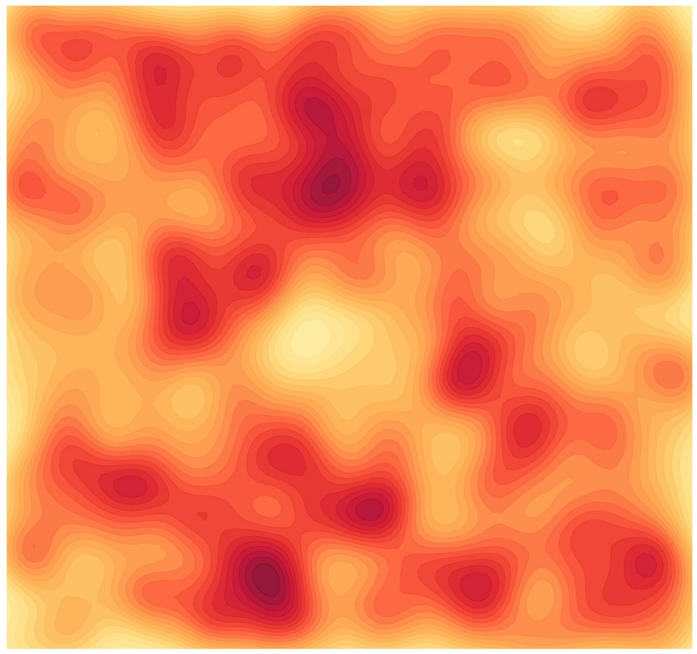
The human brain is so good a picking up patterns...

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

Patternicity (Shermer, 2008) *The tendencey 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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Statistics to the rescue!!!

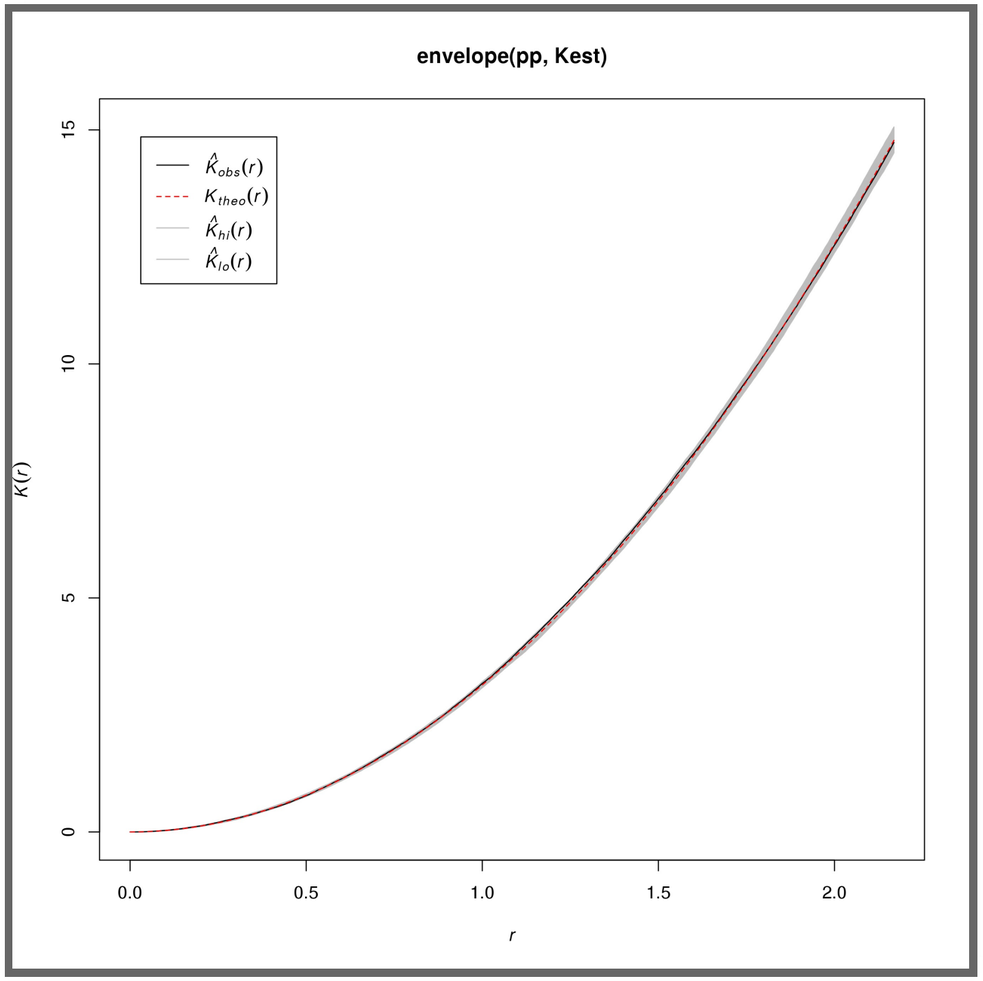
How to *be truthful* with maps

"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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