

Visual perception

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Why does visualization work?

Typically, **tasks** that can be performed on large multi-element displays in **less than 200 to 250 milliseconds (msec)** are considered **preattentive**.

Healey, C. G., & Enns, J. T. (2012). Attention and visual memory in visualization and computer graphics. *IEEE Transactions on Visualization and Computer Graphics*, 18(7), 1170–88.

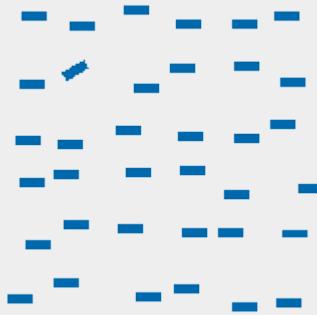
Why does visualization work?

“Preattentive features **pop-out**.”

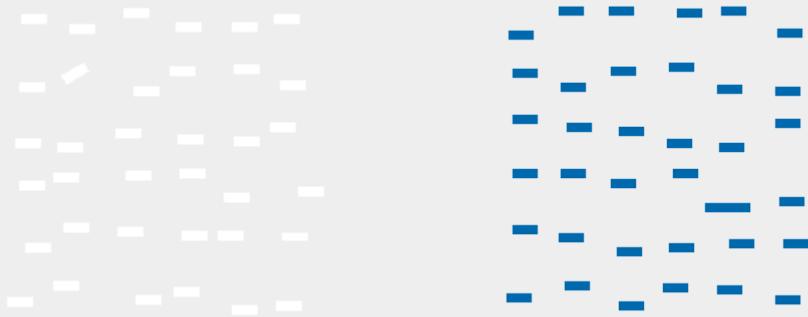
Joe Schwabish (2016) at PRB data viz workshop

Drawing attention **Preattentive features**

Line orientation



Line length



Closure



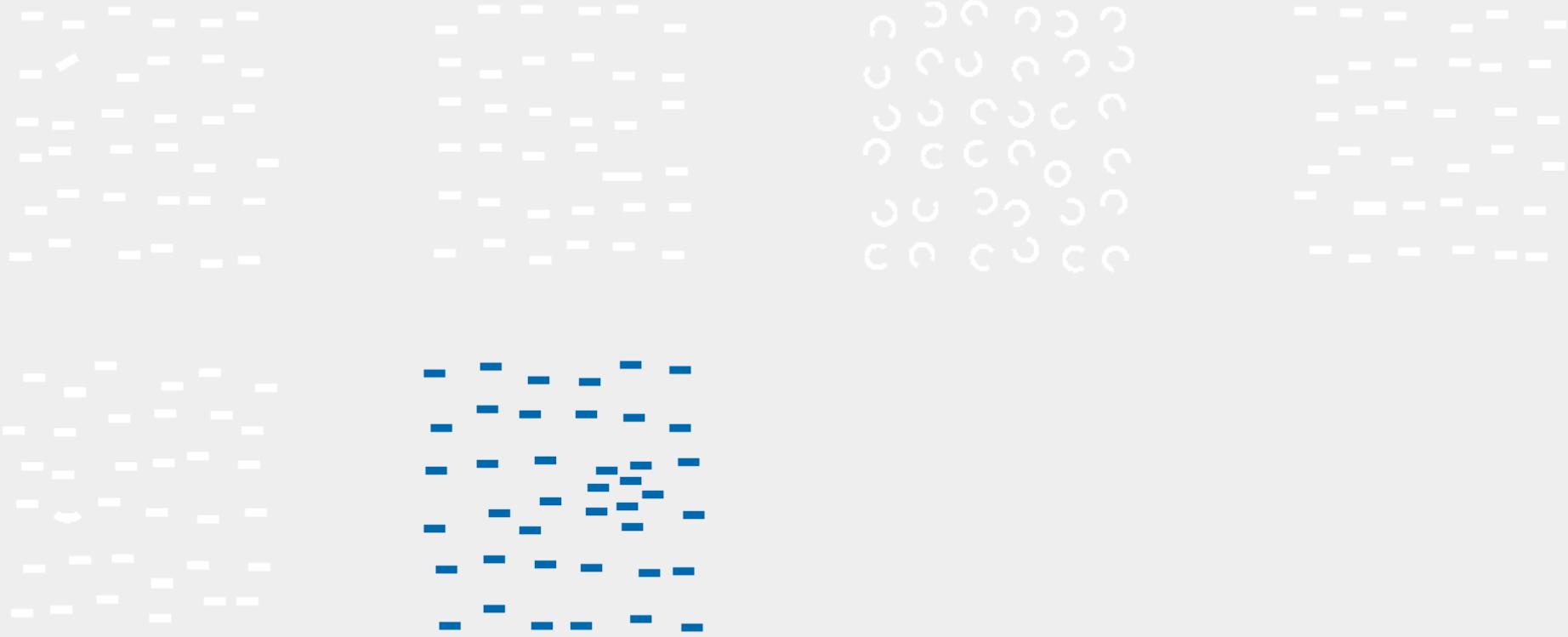
Size



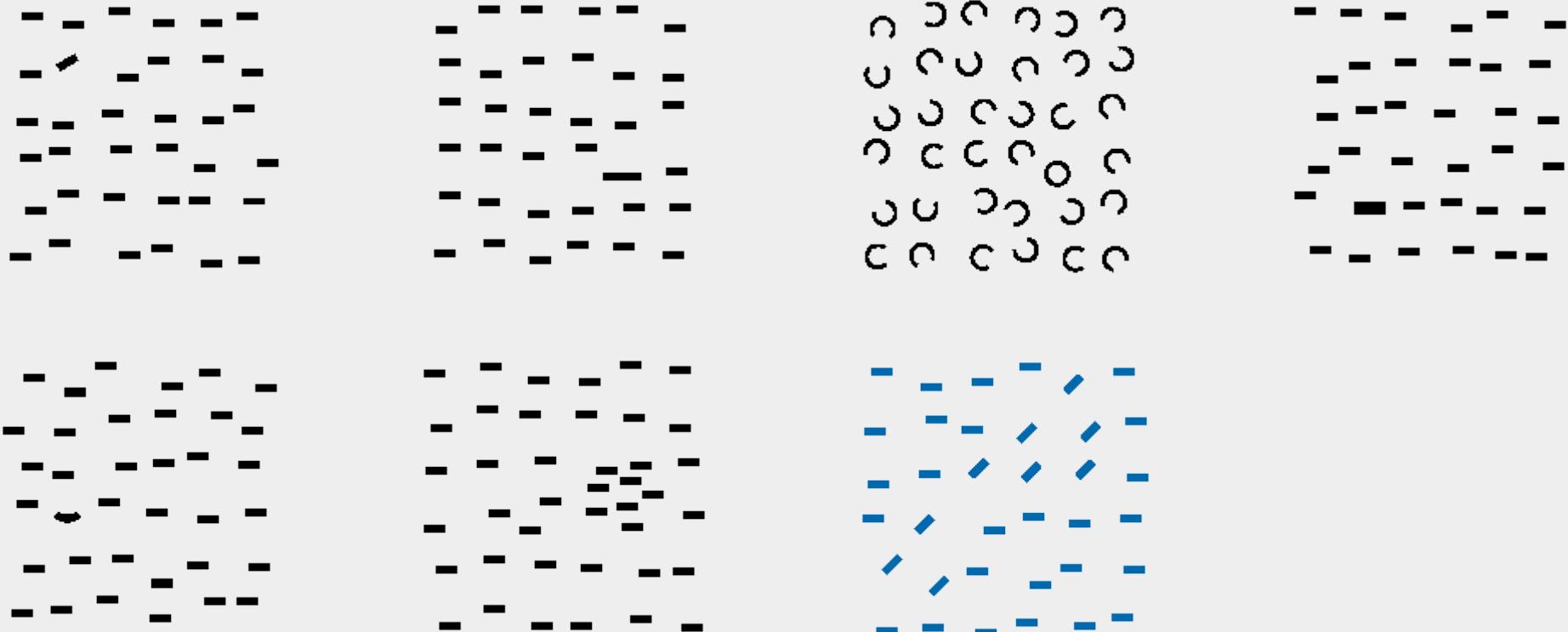
Curvature



Density



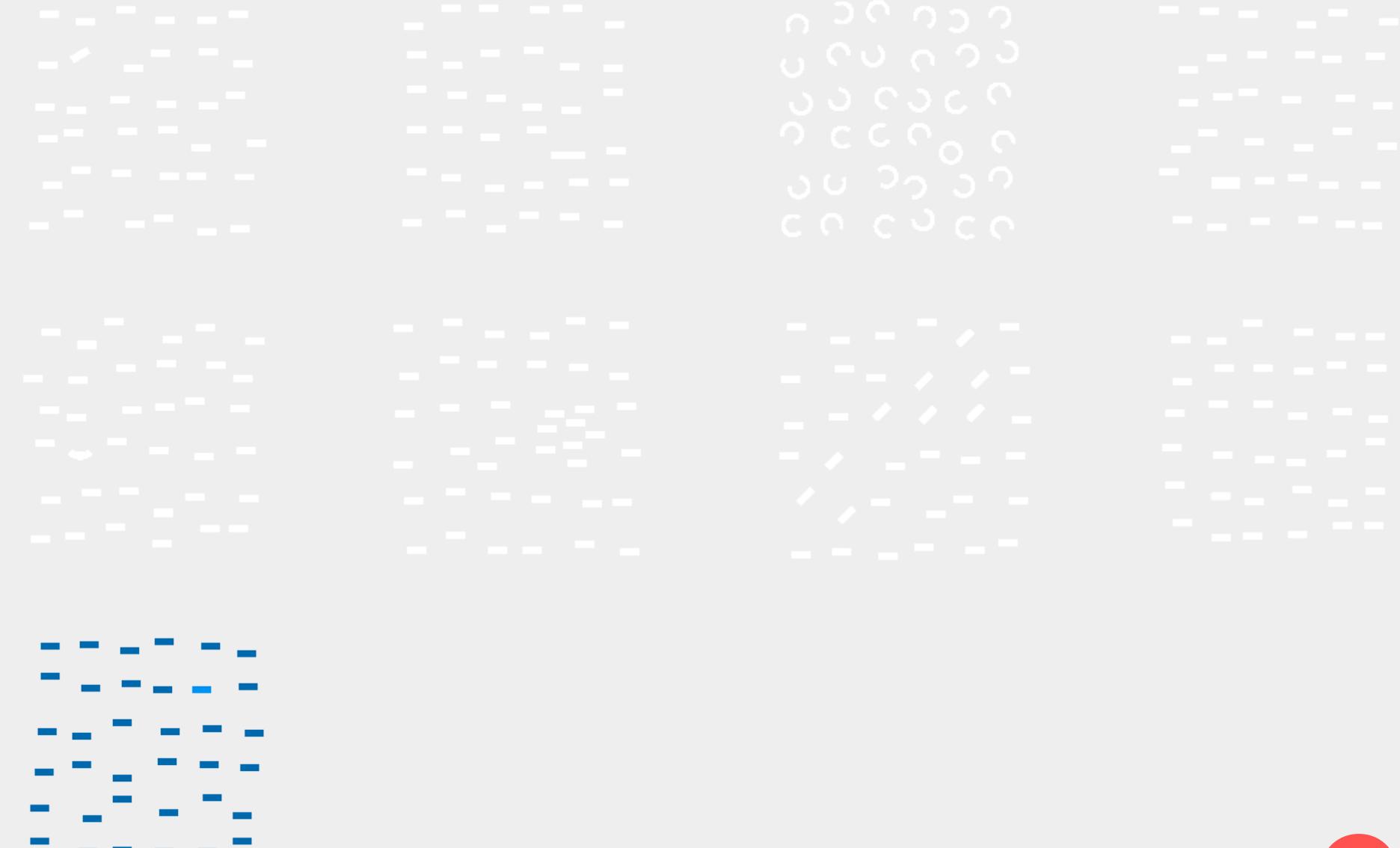
Number



Colour (hue)



Intensity



Source: Christopher G. Healey

Intersection

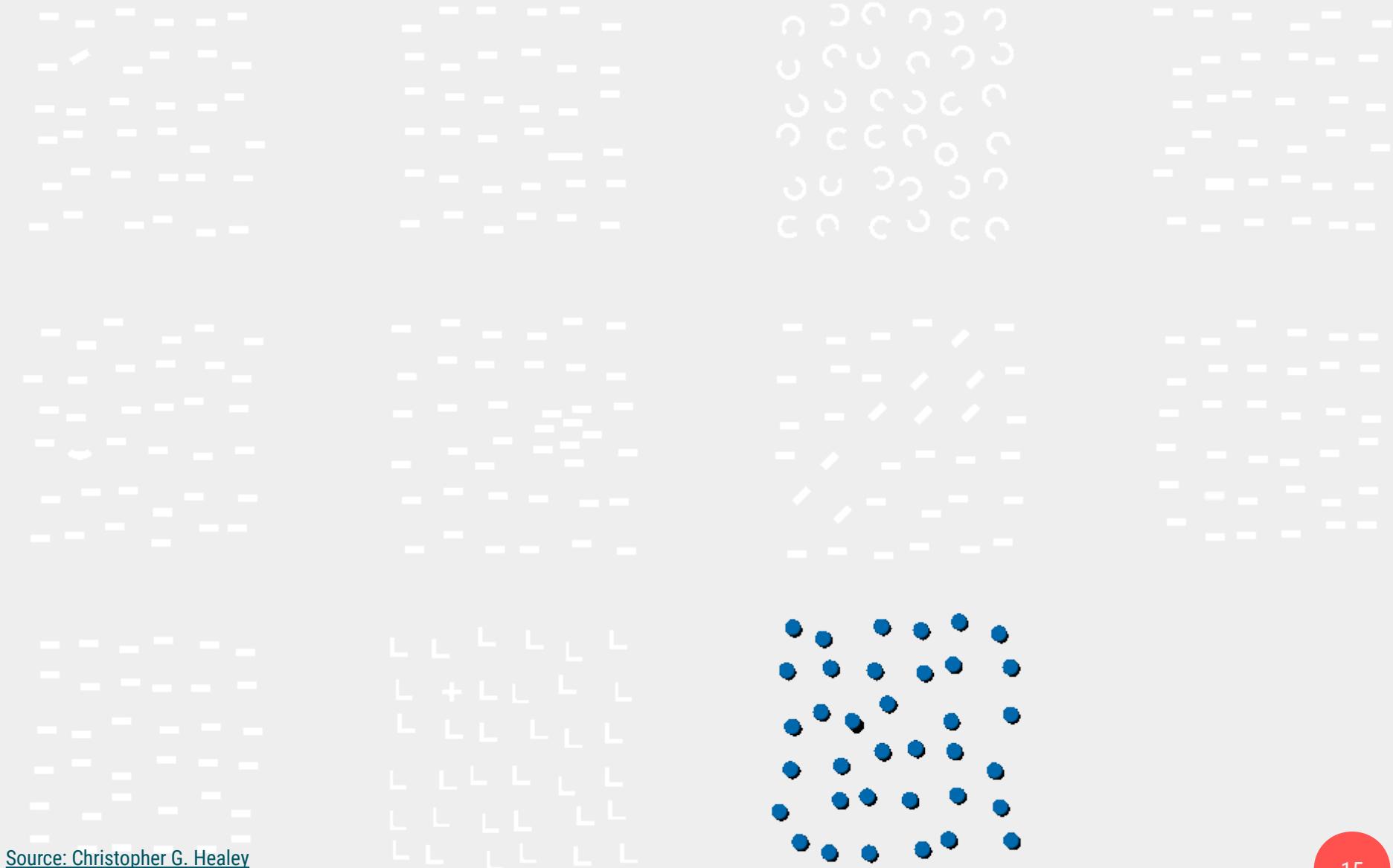
L L L L L
L + L L L
L L L L L
L L L L L
L L L L L

Source: Christopher G. Healey

IDEM 181

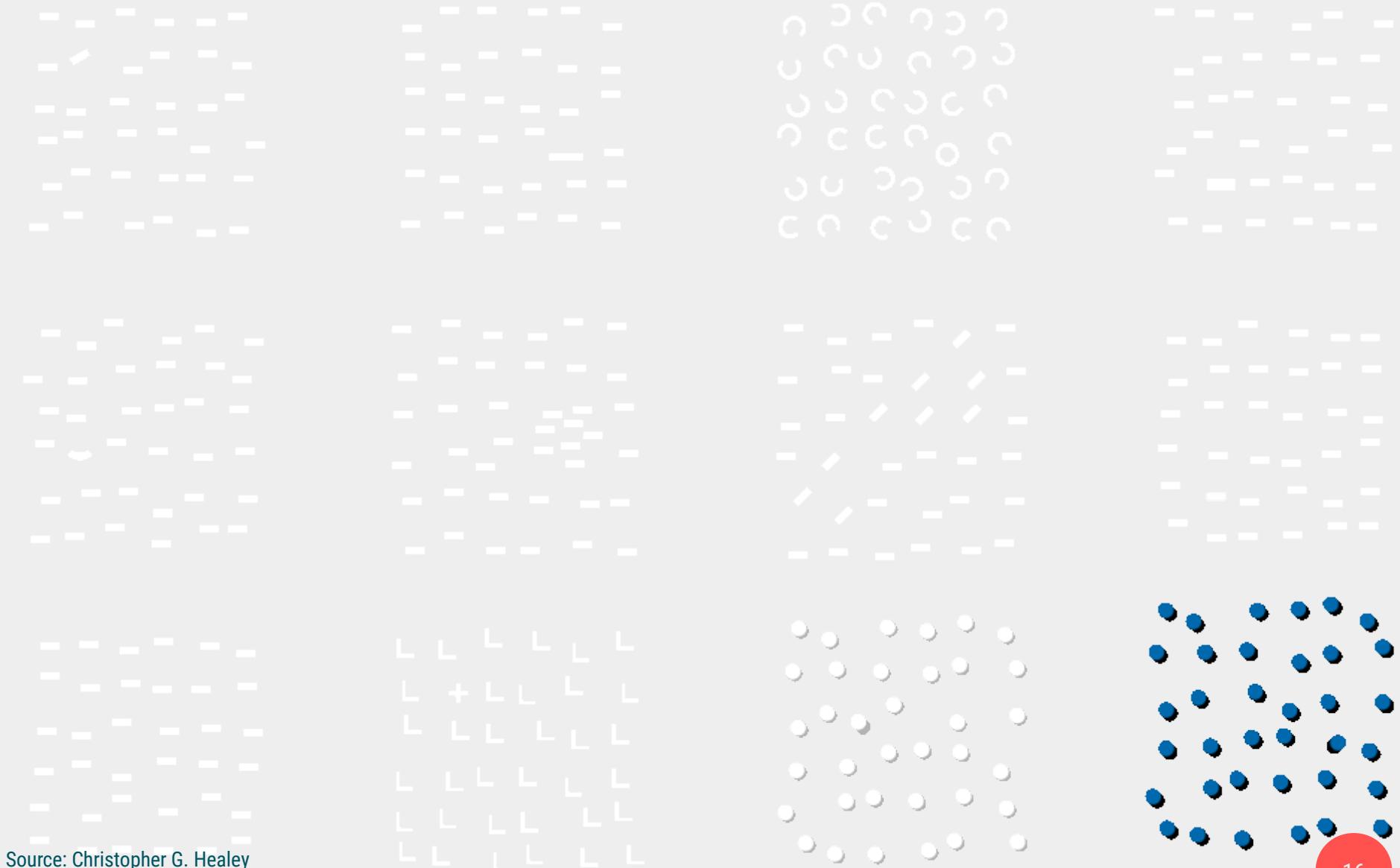
Jonas Schöley – Visual perception

3D depth cues



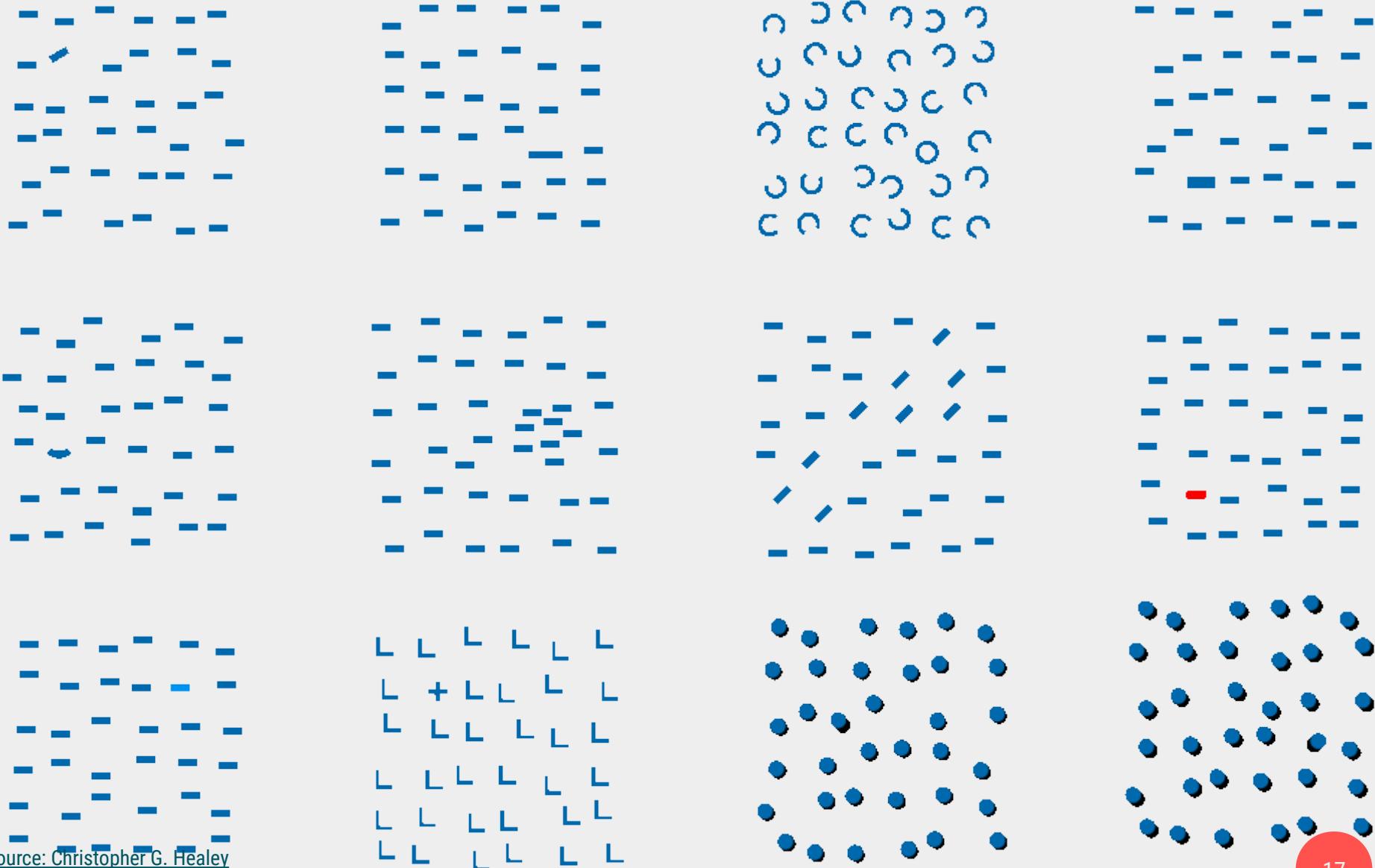
Source: Christopher G. Healey

Lighting direction



Source: Christopher G. Healey

Preattentive features



Source: Christopher G. Healey

Forming the whole from its parts
Gestalt psychology

Gestalt psychology

Gestalt (German): form, pattern

How do people **organize visual information?**

How do people **unify visual sensations into a **whole**?**

Proximity

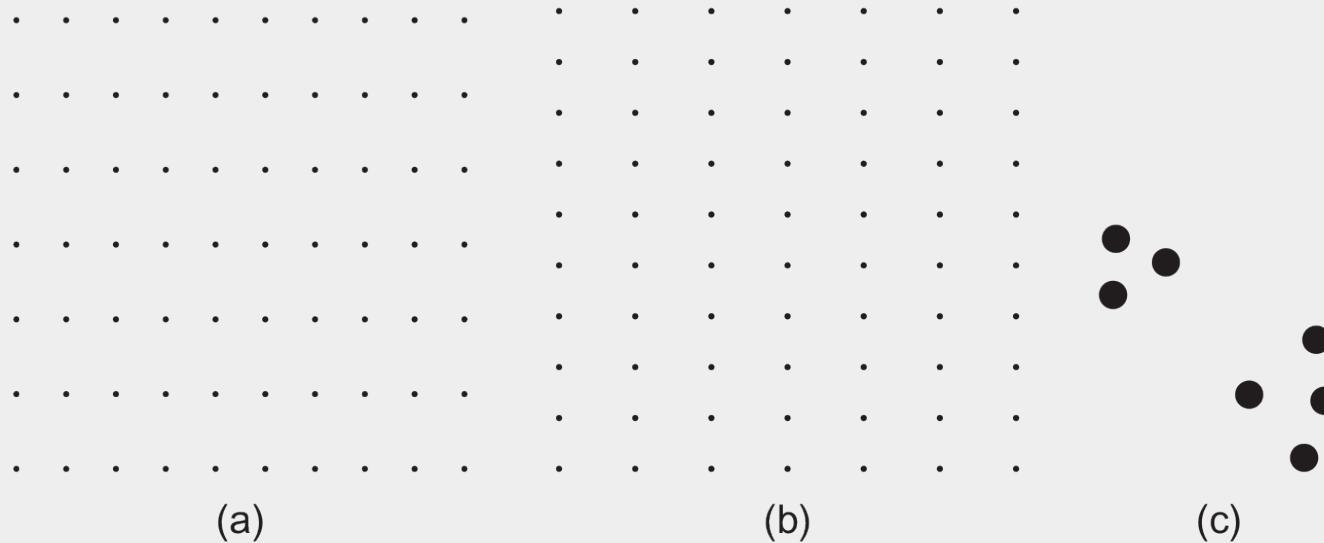


Figure 6.2 Spatial proximity is a powerful cue for perceptual organization. A matrix of dots is perceived as rows on the left (a) and columns on the right (b). In (c) we perceive two groups of dots because of proximity relationships.

Ware, C. (2013). Information Visualization. Perception for Design (3rd ed.). p. 182.

Proximity



(c) Jonas Schöley 2016

Connectedness

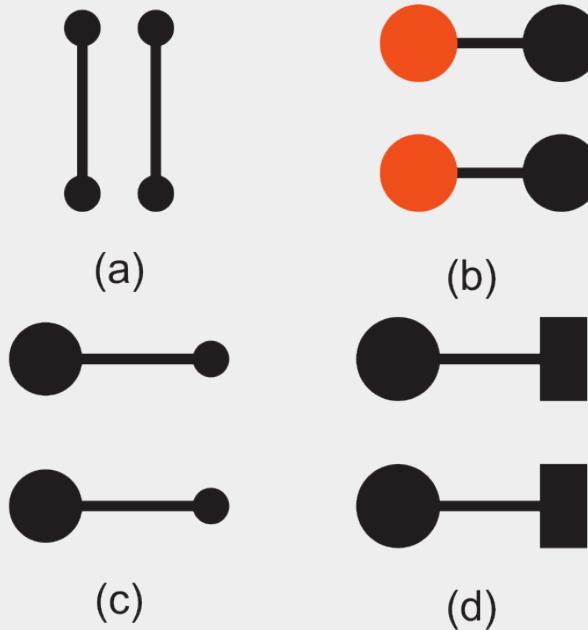
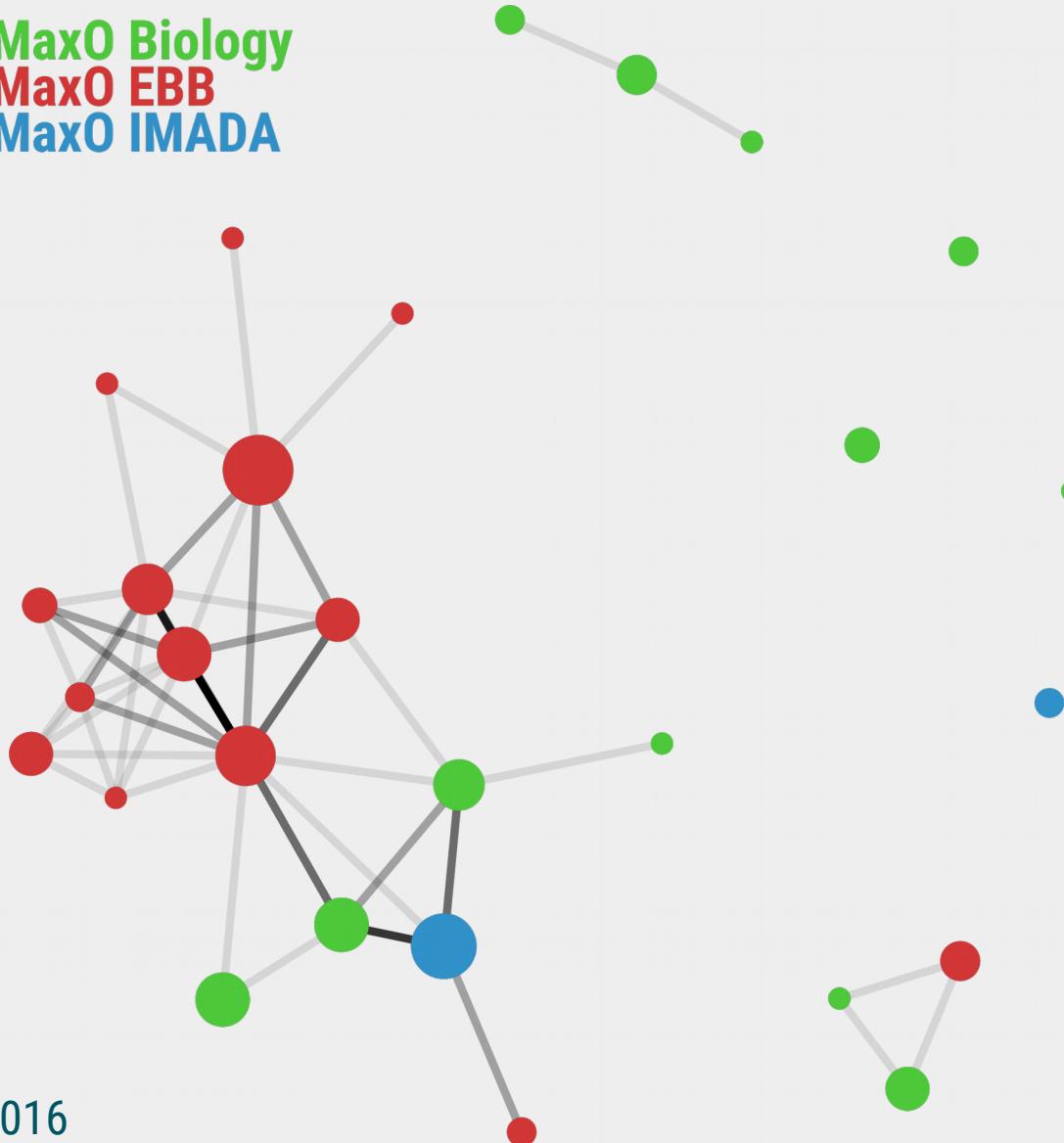


Figure 6.5 Connectedness is a powerful grouping principle that is stronger than (a) proximity, (b) color, (c) size, or (d) shape.

Ware, C. (2013). Information Visualization. Perception for Design (3rd ed.). p. 184.

Connectedness

MaxO Biology
MaxO EBB
MaxO IMADA



(c) Jonas Schöley 2016

Continuity

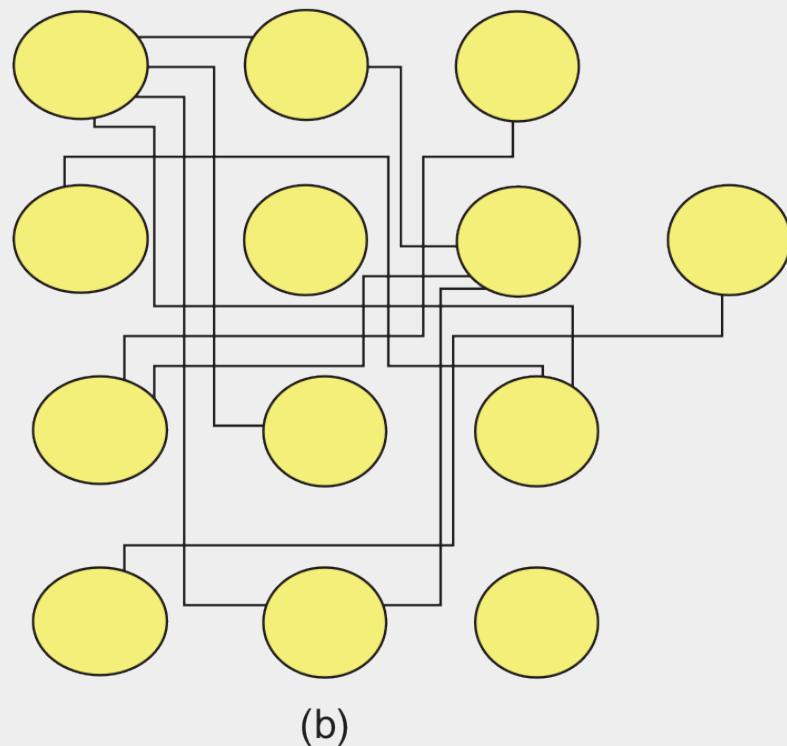
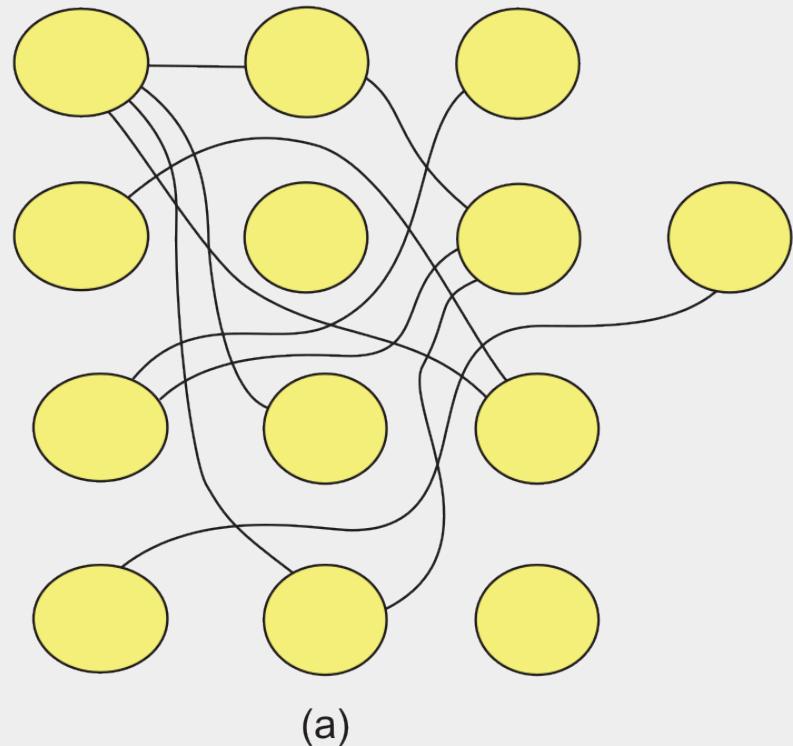
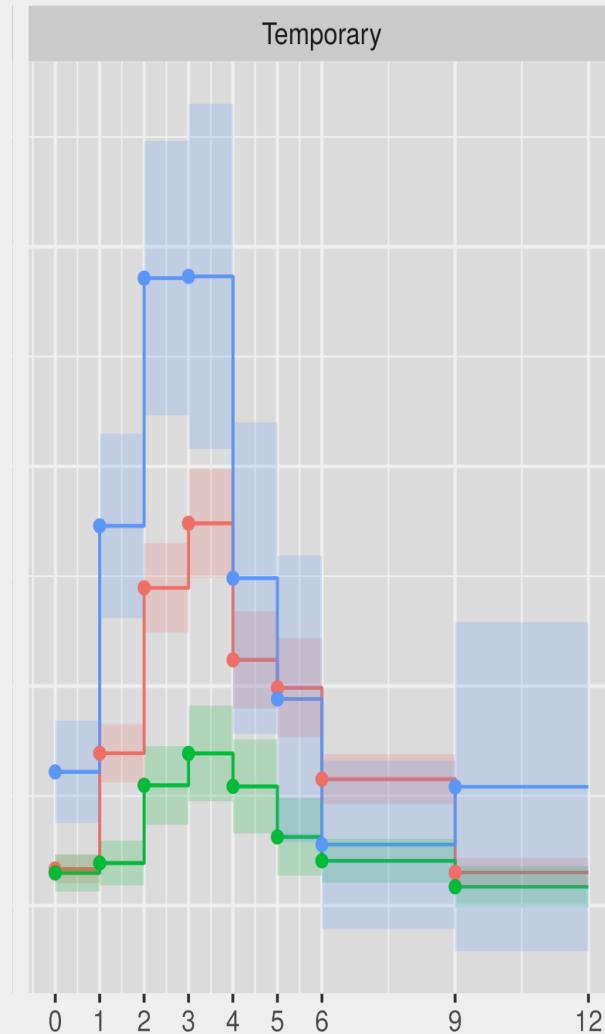
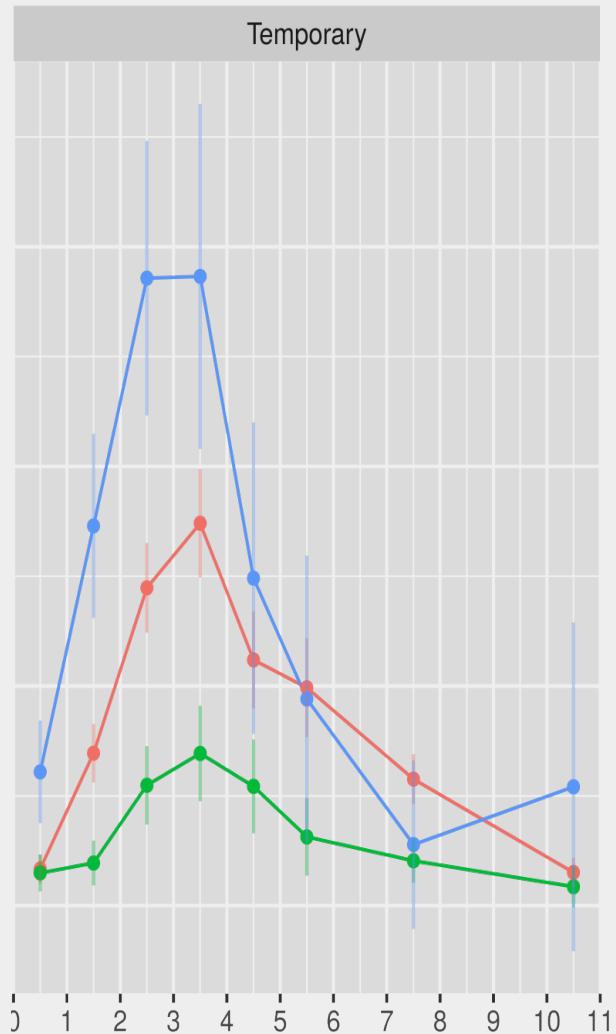


Figure 6.7 In (a), smooth continuous contours are used to connect nodes in the diagram; in (b), lines with abrupt changes in direction are used. It is much easier to perceive connections with the smooth contours.

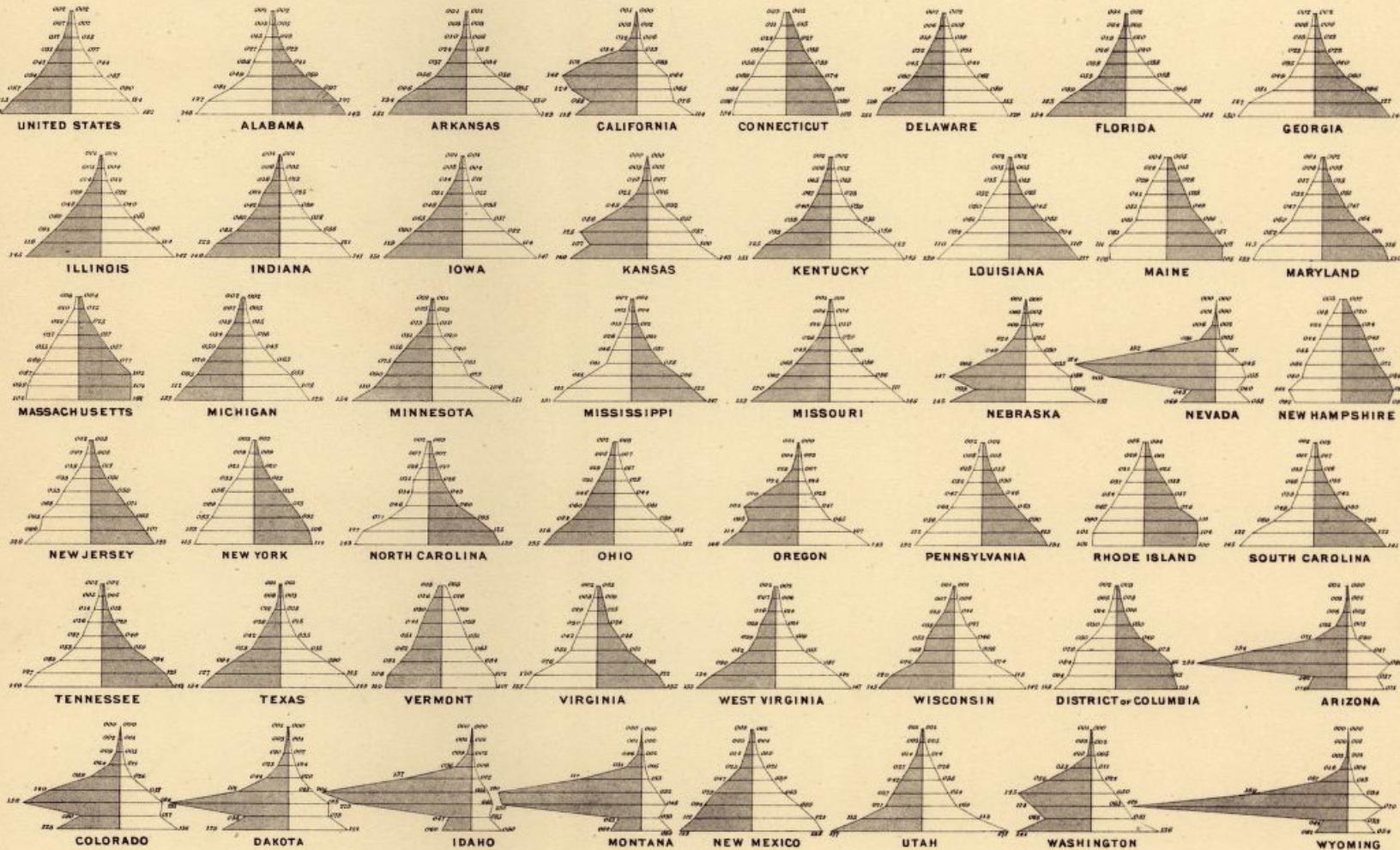
Ware, C. (2013). Information Visualization. Perception for Design (3rd ed.). p. 184.

Continuity



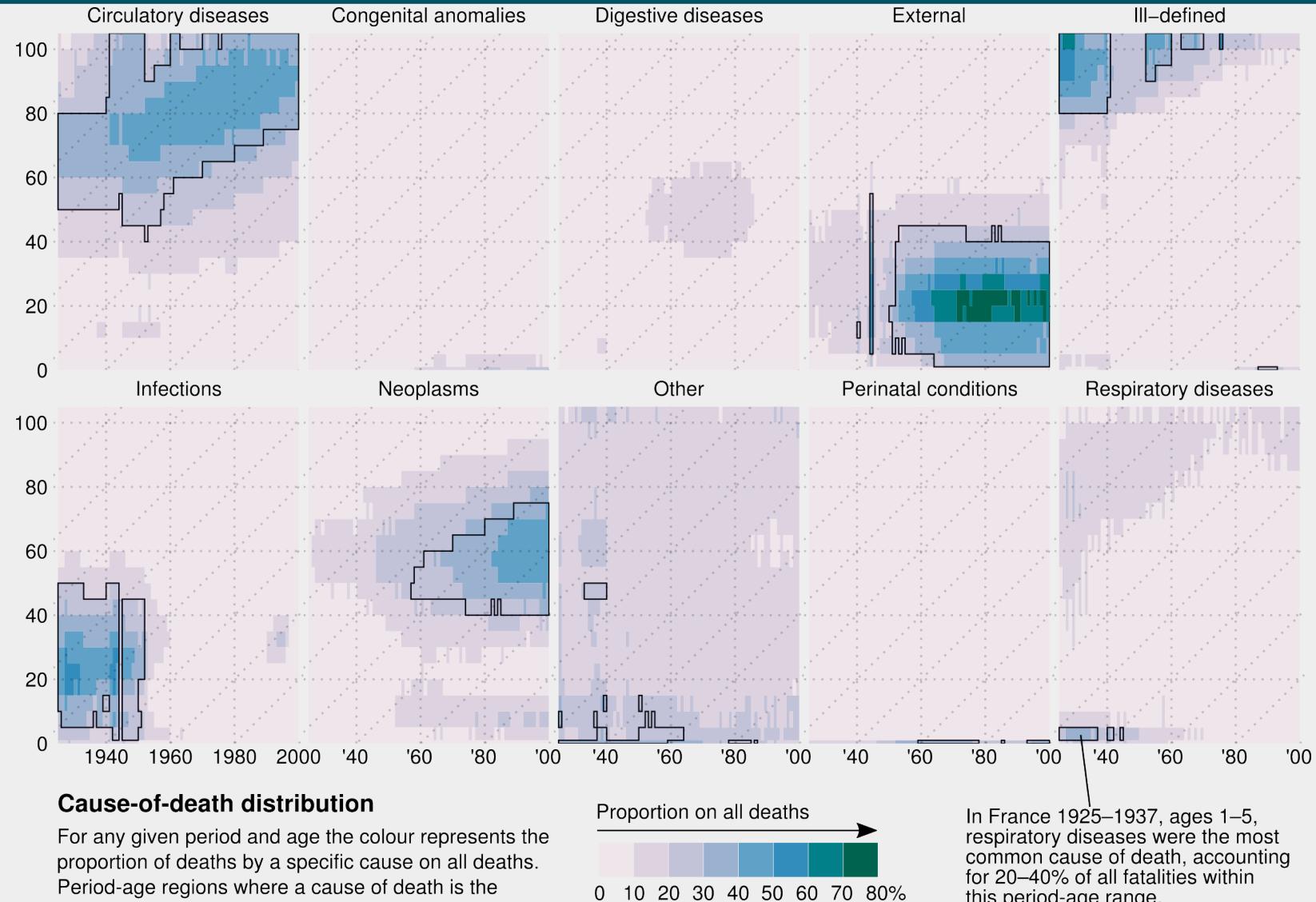
Symmetry

2. - AGGREGATE POPULATION 1870. BY STATES AND TERRITORIES.



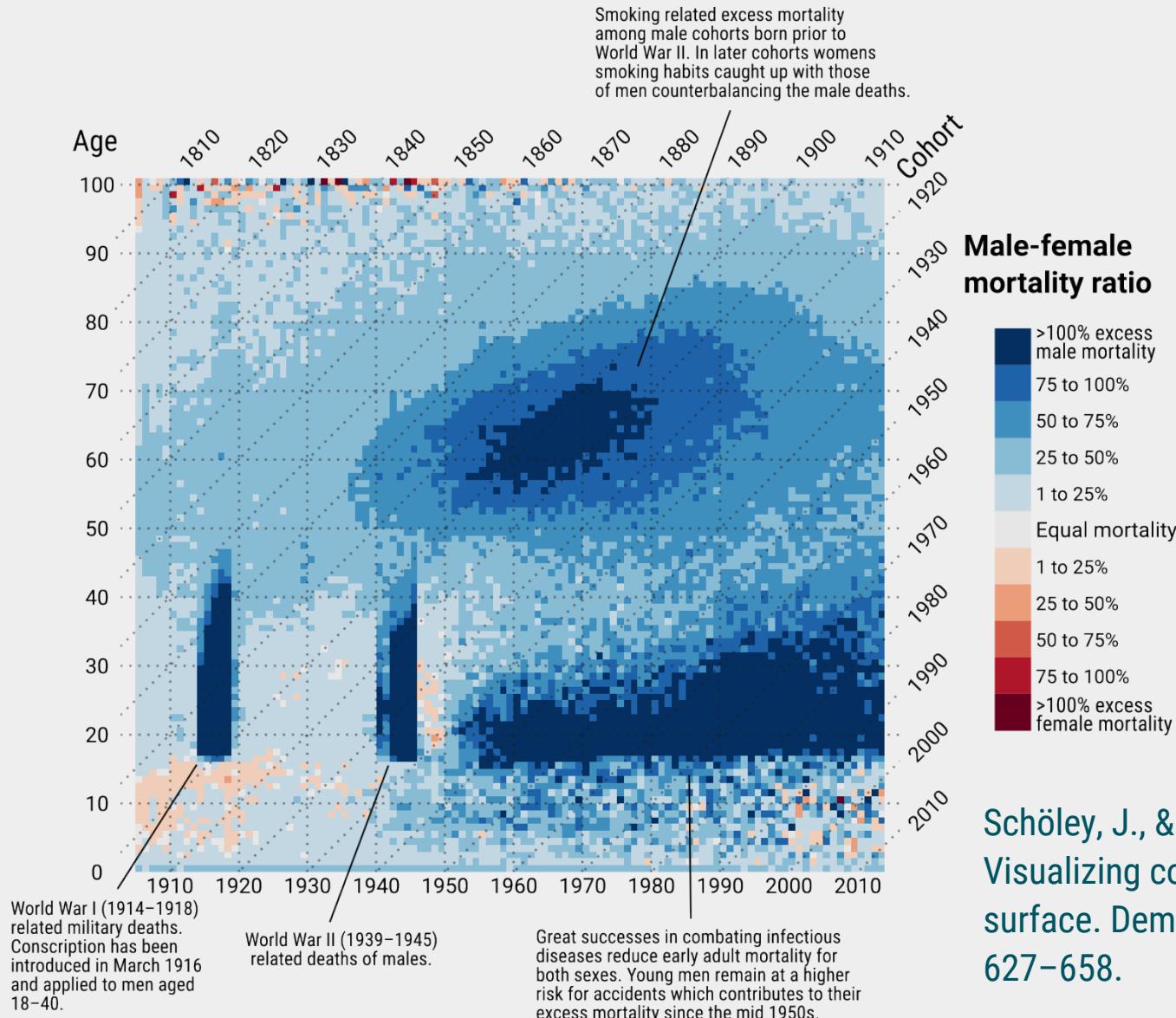
Walker, F. A. (1874). Statistical Atlas of the United States Based on the Results of the Ninth Census.

Closure and common region



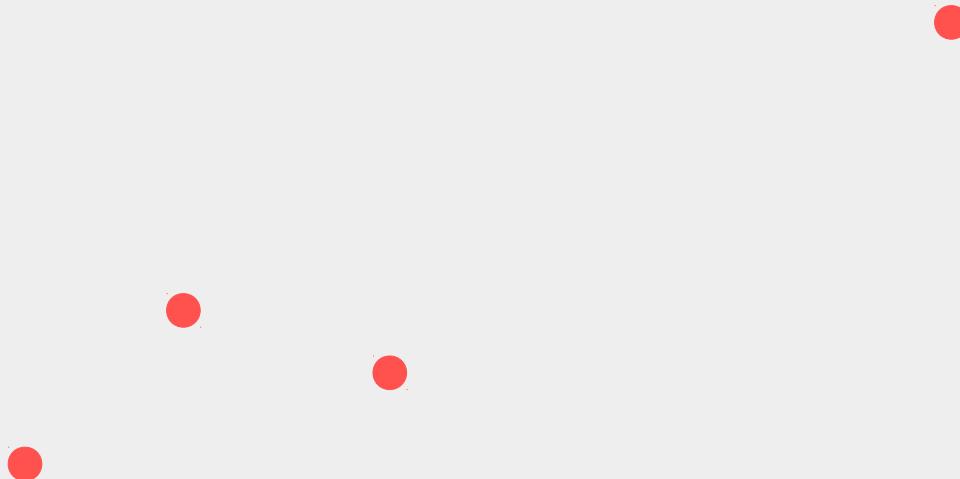
Schöley, J., & Willekens, F. (2017). Visualizing compositional data on the Lexis surface.

Closure and common region



Schöley, J., & Willekens, F. (2017). Visualizing compositional data on the Lexis surface. *Demographic Research*, 36(1), 627–658.

The atoms of any visualization: Marks



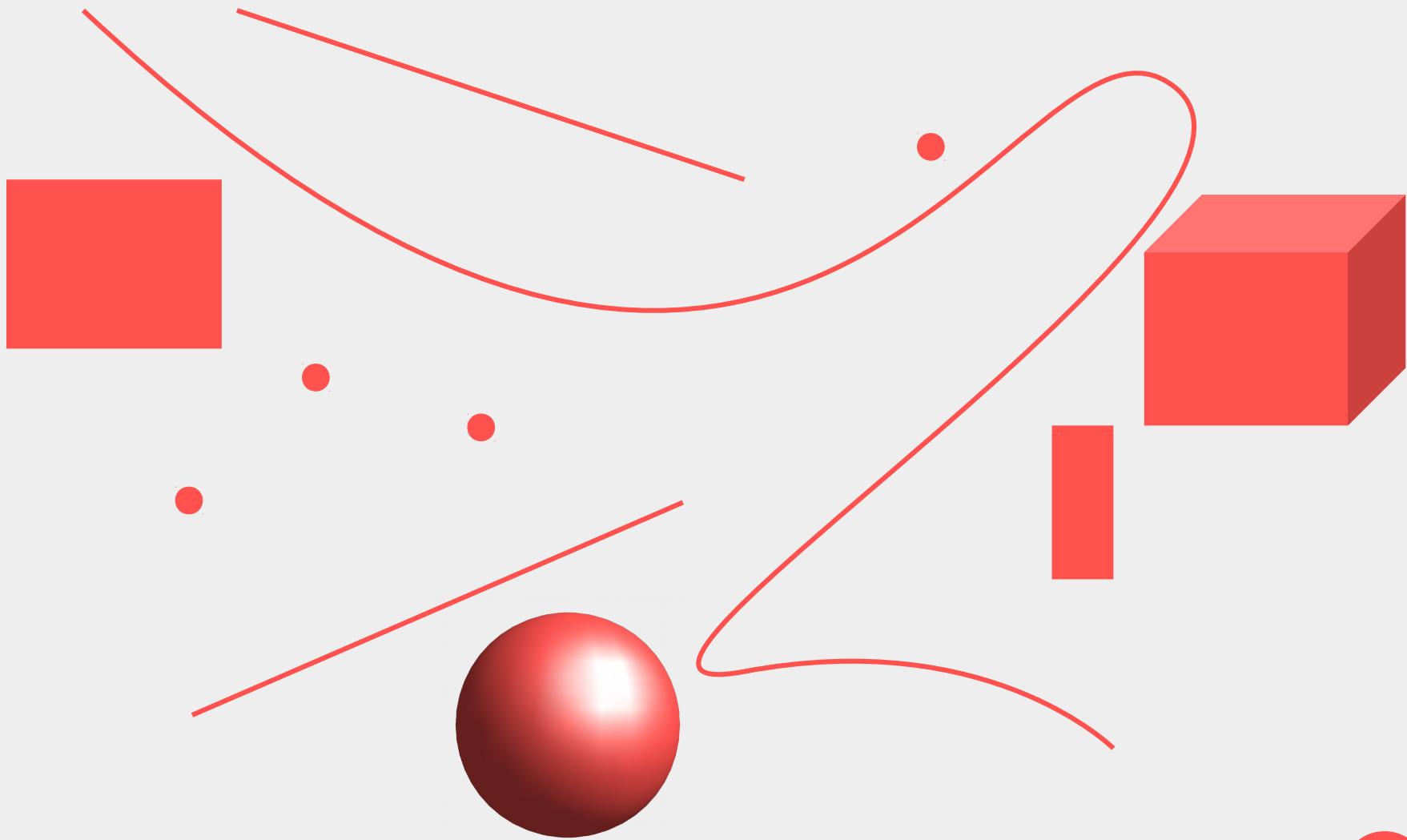
The atoms of any visualization: Marks



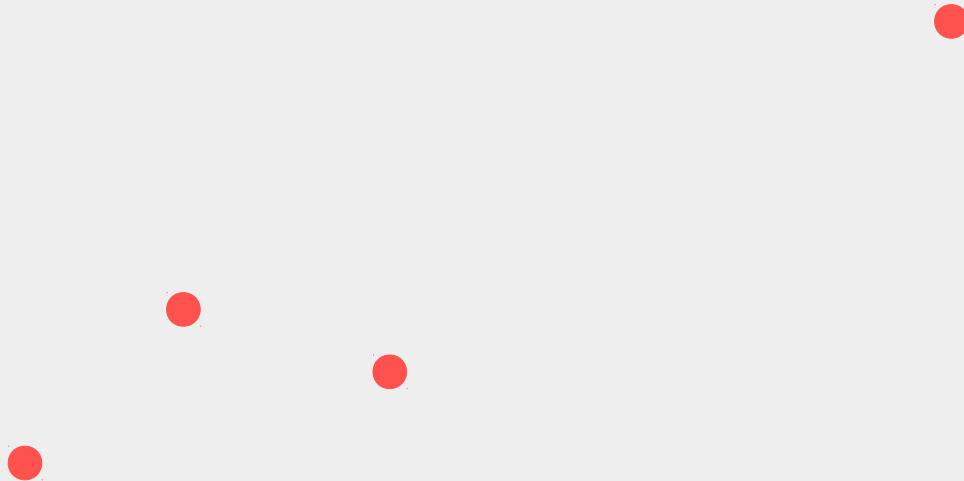
The atoms of any visualization: Marks



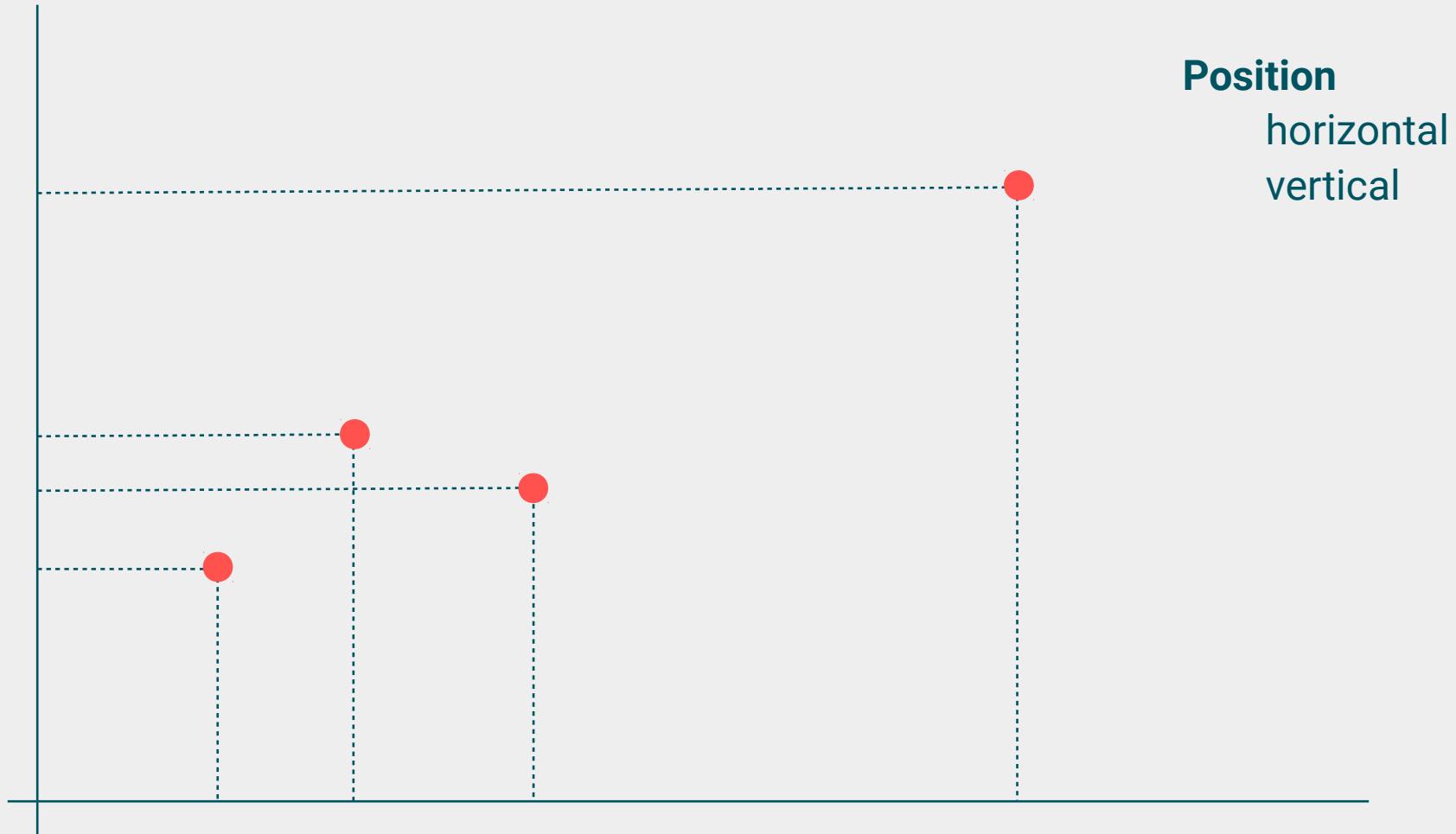
The atoms of any visualization: Marks



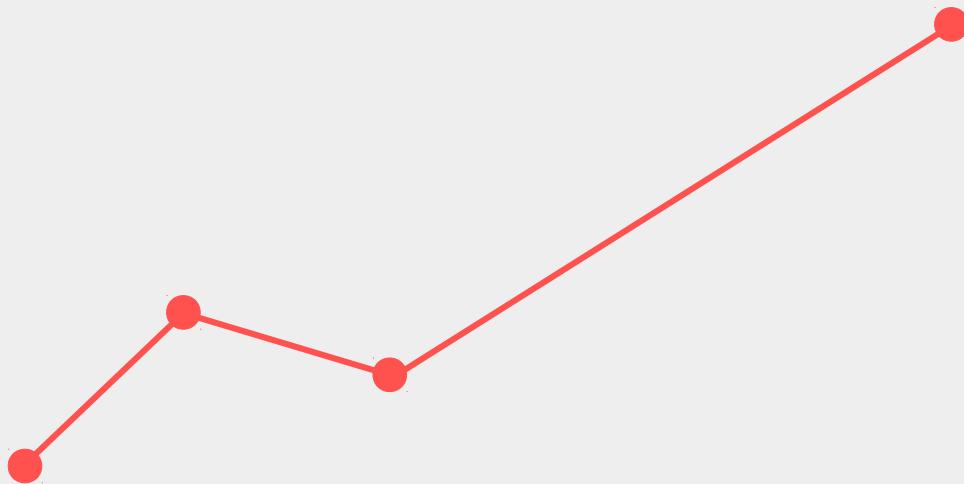
Assigning marks to visual channels



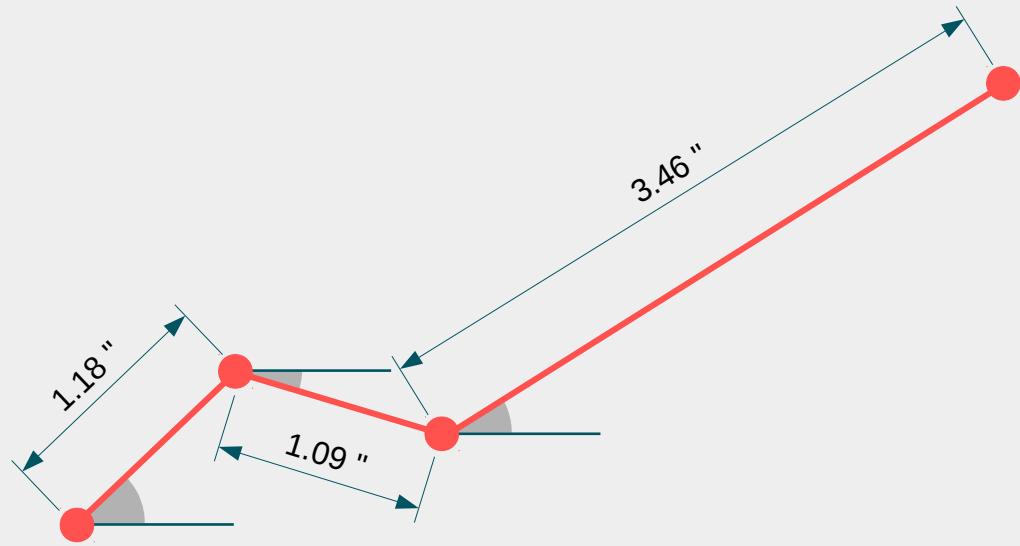
Assigning marks to visual channels



Assigning marks to visual channels



Assigning marks to visual channels



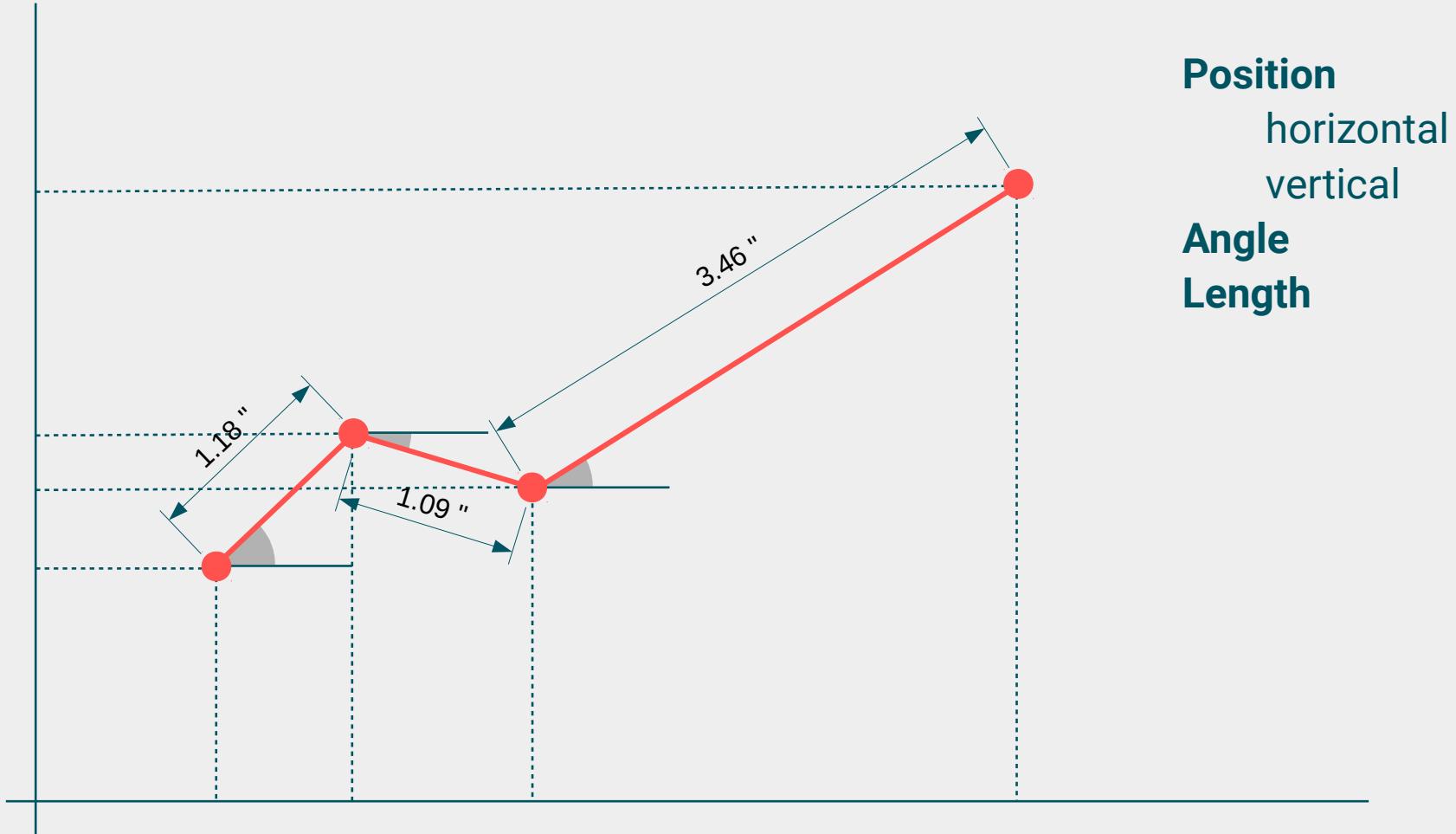
Position

horizontal
vertical

Angle

Length

Assigning marks to visual channels



Position

horizontal
vertical

Angle

Length

Visual primitives in data viz

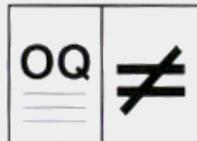
VARIABLES OF THE IMAGE

XY 2 DIMENSIONS OF THE PLANE

Z

SIZE

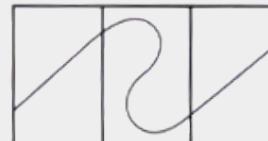
VALUE



POINT



LINE

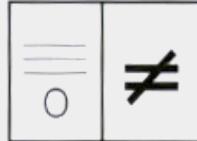


AREA (ZONE)



DIFFERENTIAL VARIABLES

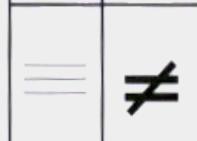
TEXTURE



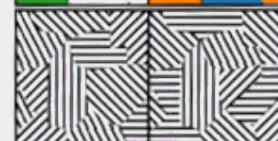
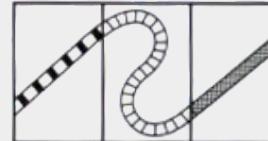
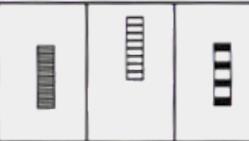
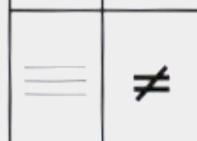
COLOR



ORIENTATION

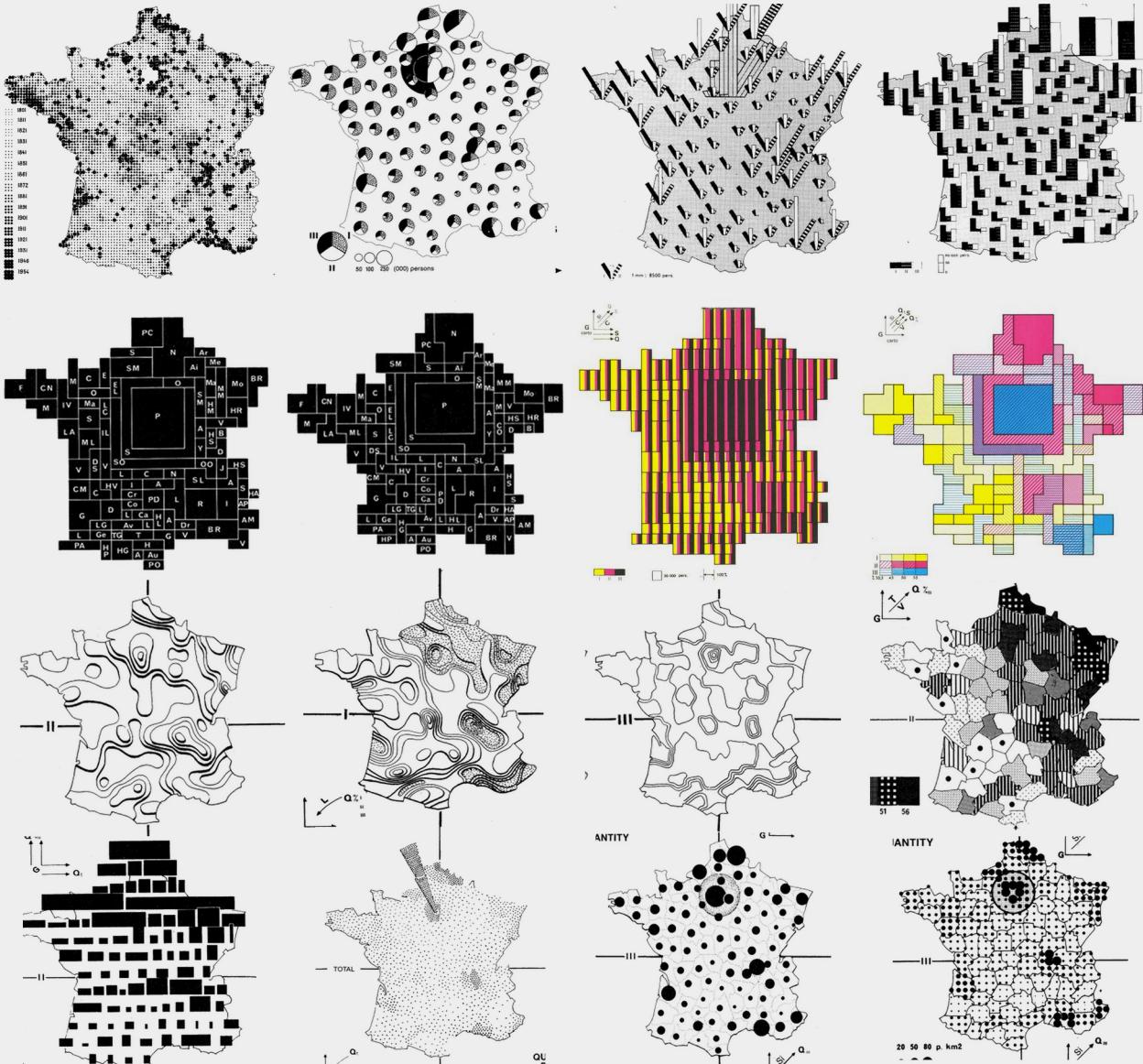


SHAPE



Jaques Bertin. (1967). Sémiologie Graphique. Les diagrammes, les réseaux, les cartes.

Visual primitives in data viz

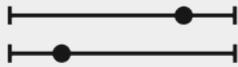


Jaques Bertin. (1967).
Sémiologie Graphique. Les
diagrammes, les réseaux, les
cartes.

A hierarchy of visual channels

→ Magnitude Channels: Ordered Attributes

Position on common scale



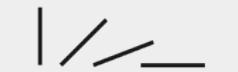
Position on unaligned scale



Length (1D size)



Tilt/angle



Area (2D size)



Depth (3D position)



Color luminance



Color saturation



Curvature



Volume (3D size)



→ Identity Channels: Categorical Attributes

Spatial region



Color hue



Motion



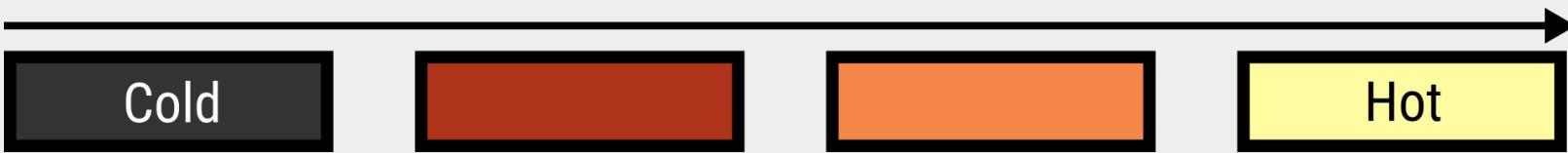
Shape



Effectiveness
▲ Most Effective ▼ Least Effective
Same

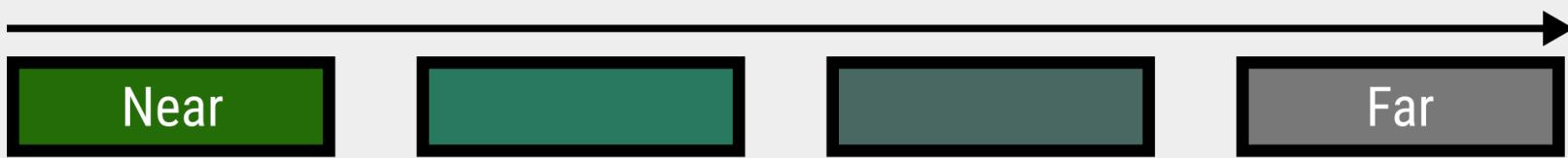
Color

Color-coding magnitudes



Hawaii Volcano Observatory (2003). http://hvo.wr.usgs.gov/multimedia/archive/2003/May/20030503-0021_DAS_large.jpg

Color-coding magnitudes



Milan Cernak (2011). "Pieniny from Magura".

Color-coding categories

Operations

Captain

Sciences

Command



CBS Television.

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Perceptual color dimensions



Luminance

dark



bright

Saturation

pale



saturated

Hue

reddish

greenish

blueish

yellowish

Matching color and data dimensions

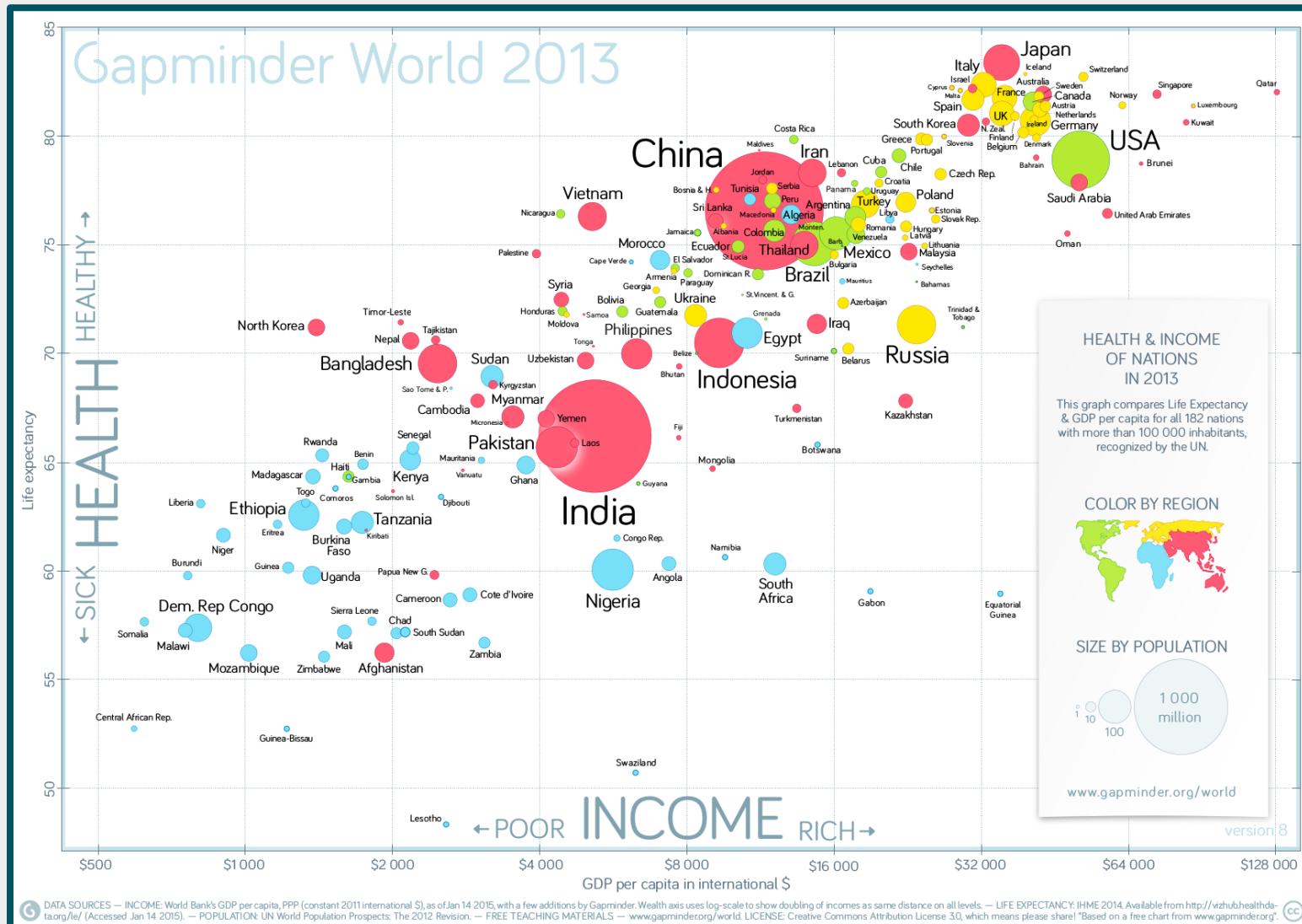
Magnitudes (ordered)



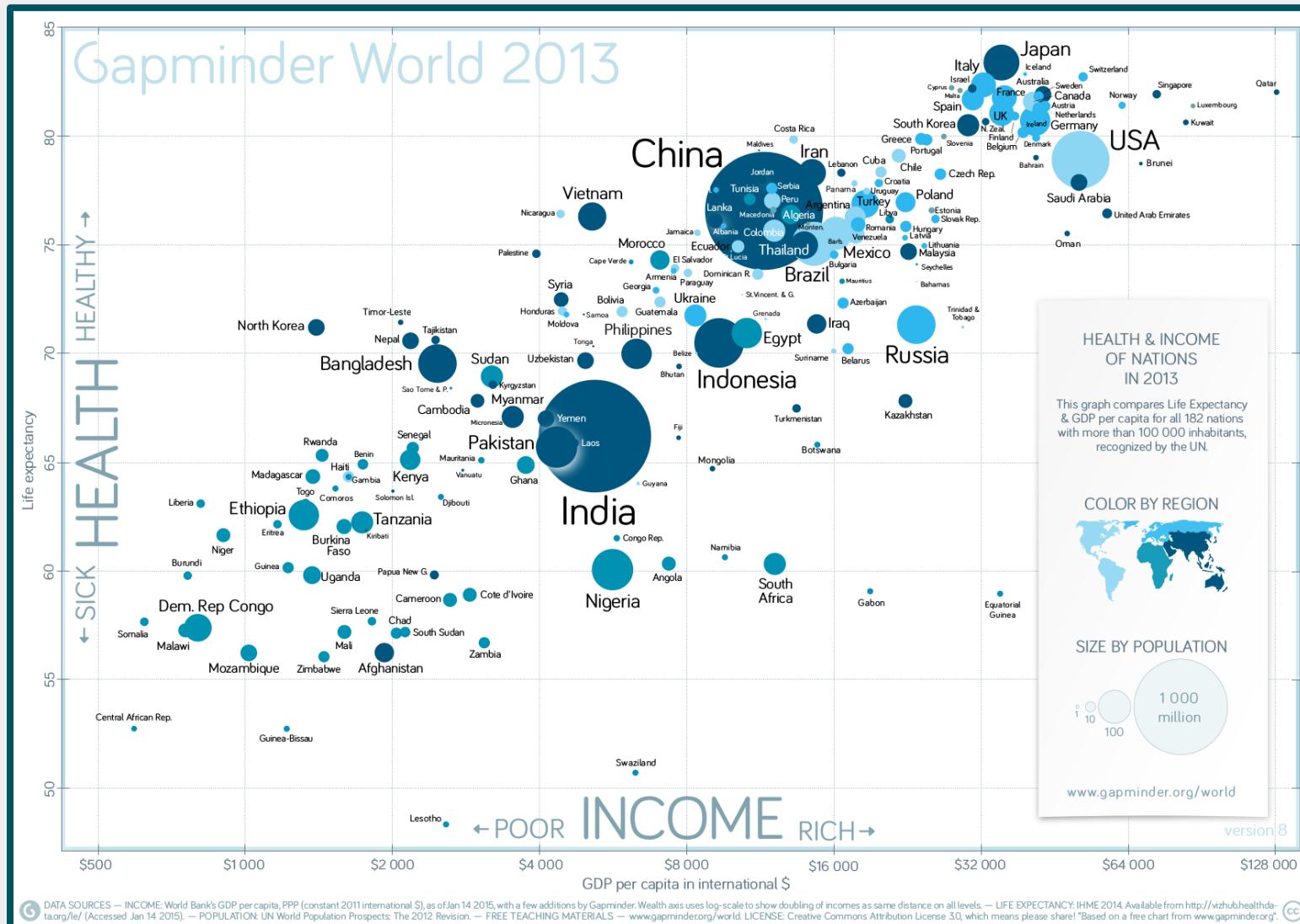
Categories (unordered)



Color-coding categories

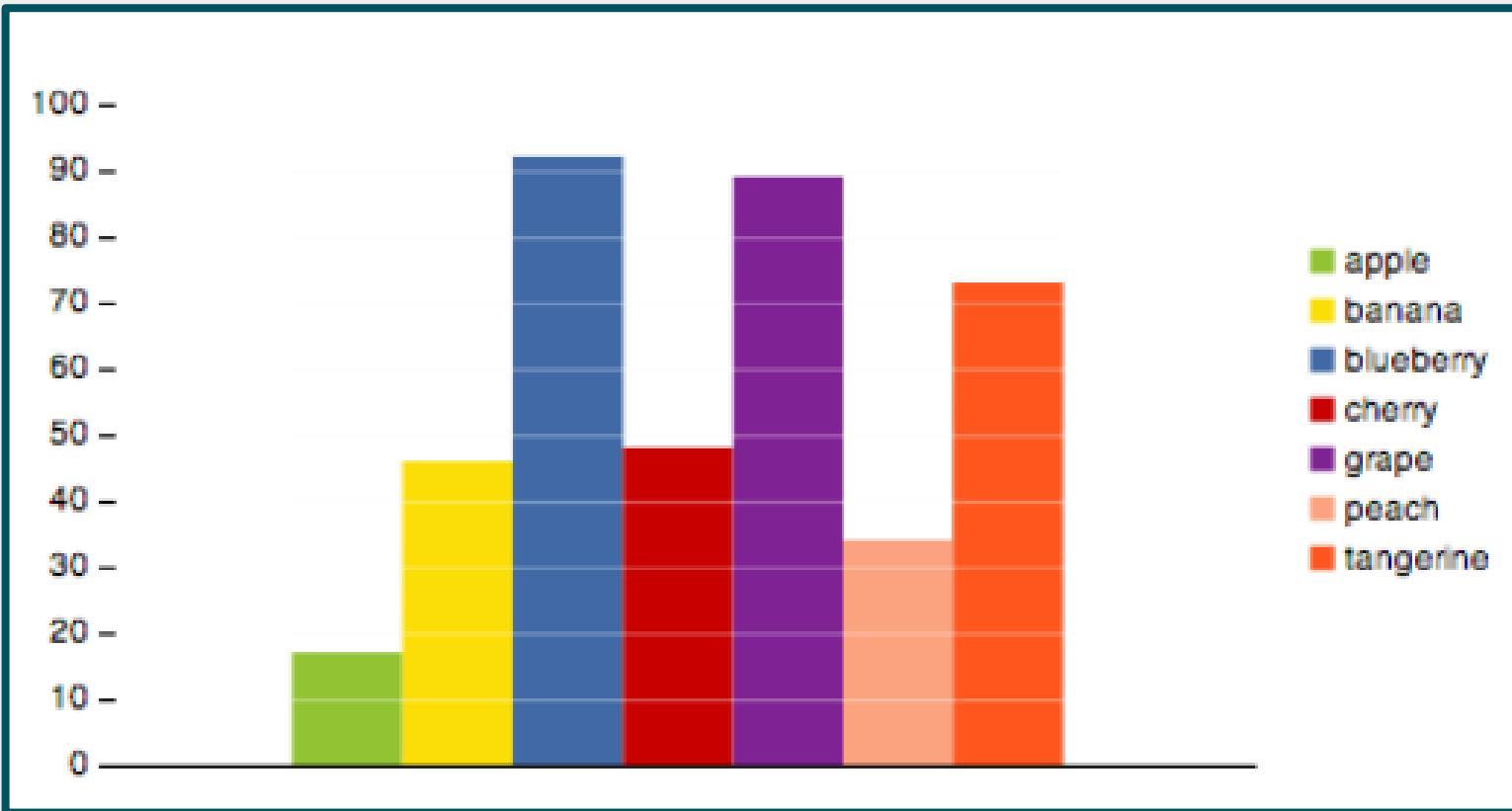


Ineffective color-coding



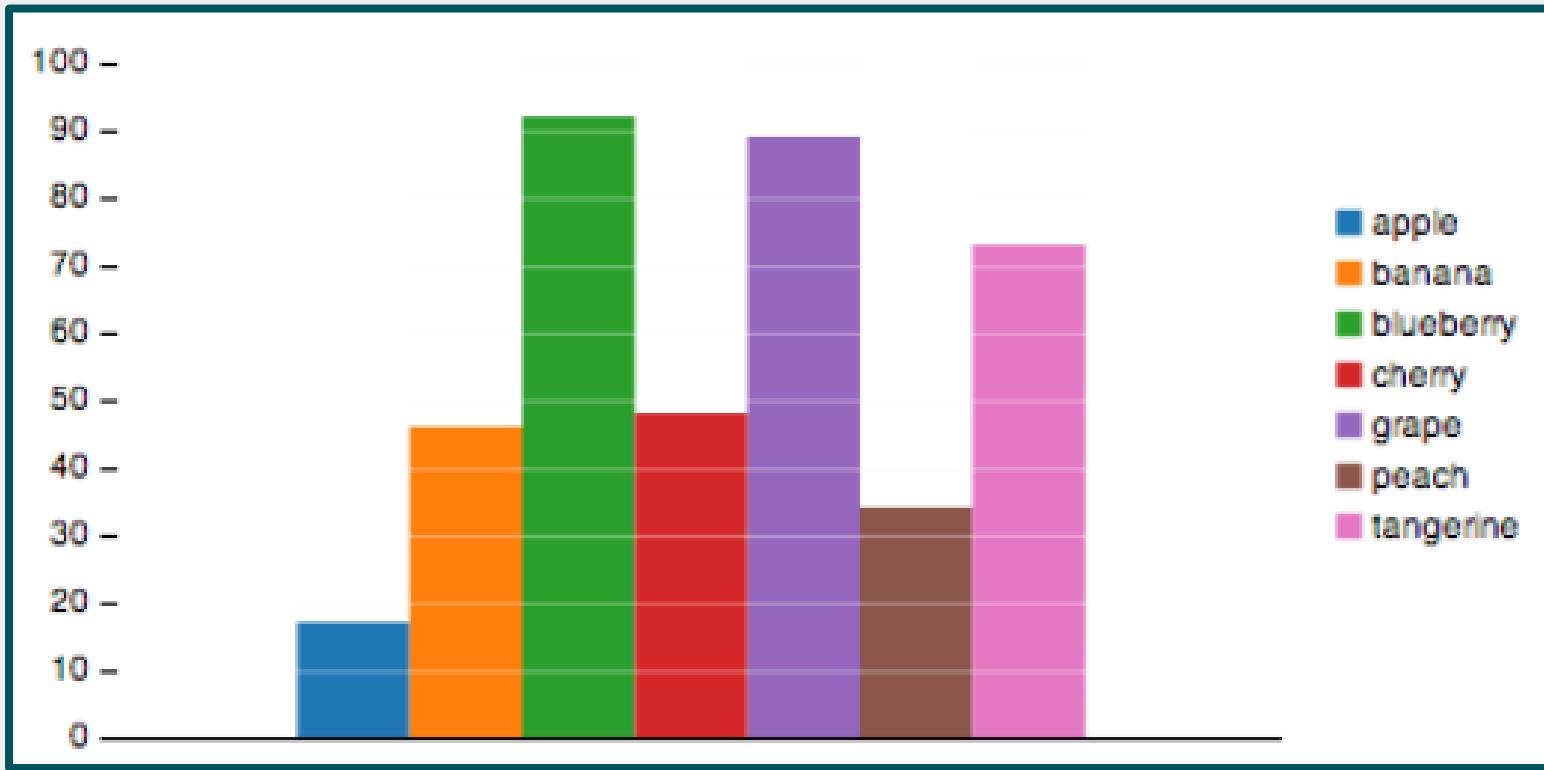
Redrawn from Gapminder World (2014).

Semantically resonant colors



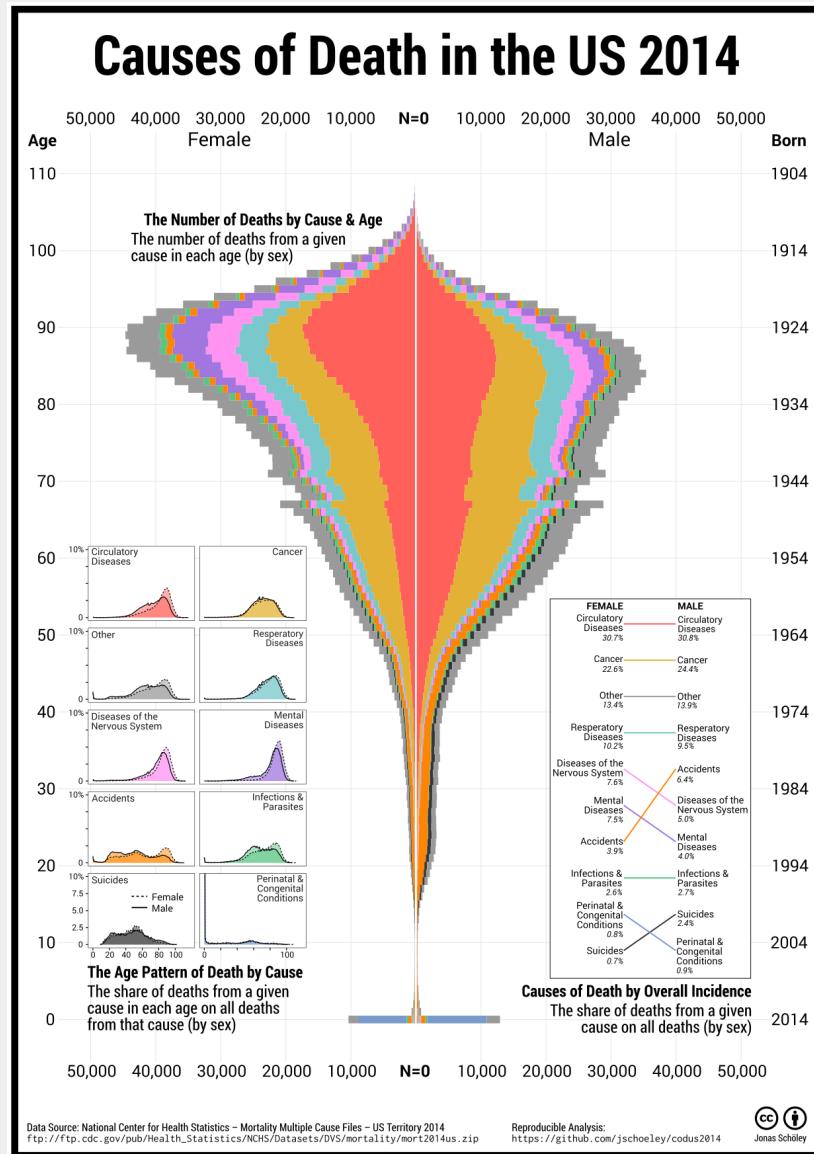
Sharon Lin et al. (2013). "Selecting Semantically-Resonant Colors for Data Visualization". In: Computer Graphics Forum 32.3, pp. 401–410.

Semantically resonant colors

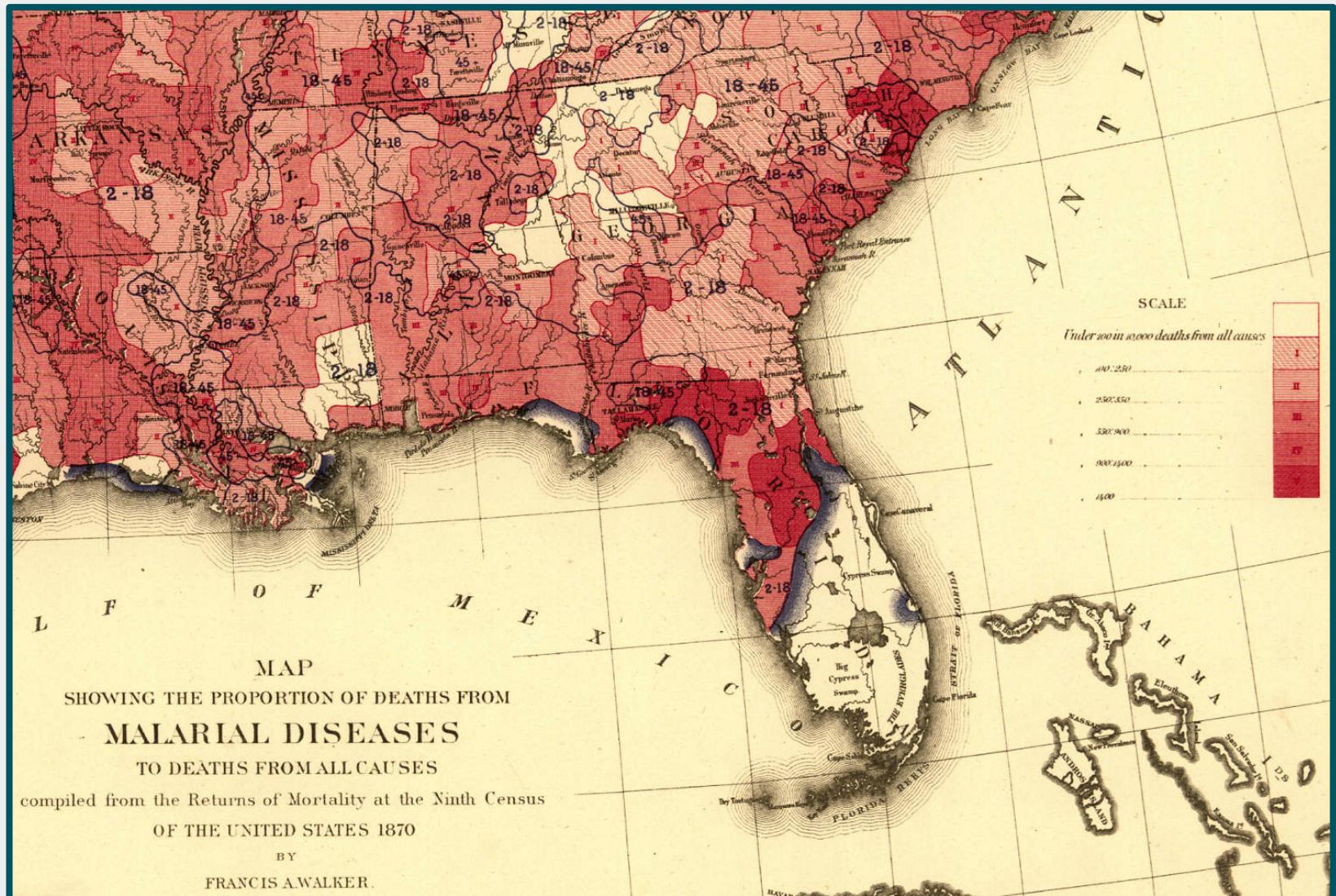


Sharon Lin et al. (2013).

How would you color death?

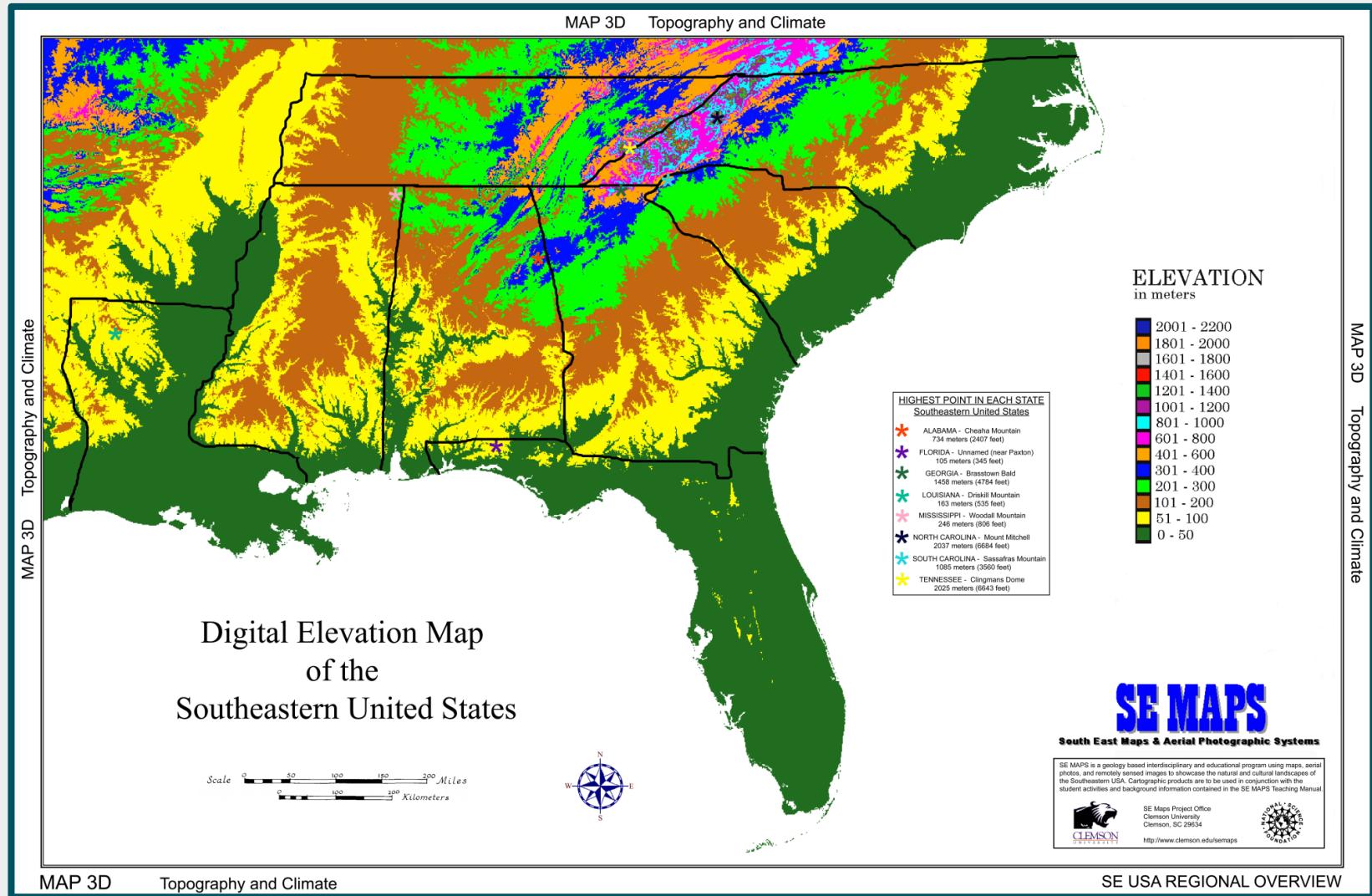


Color-coding magnitudes



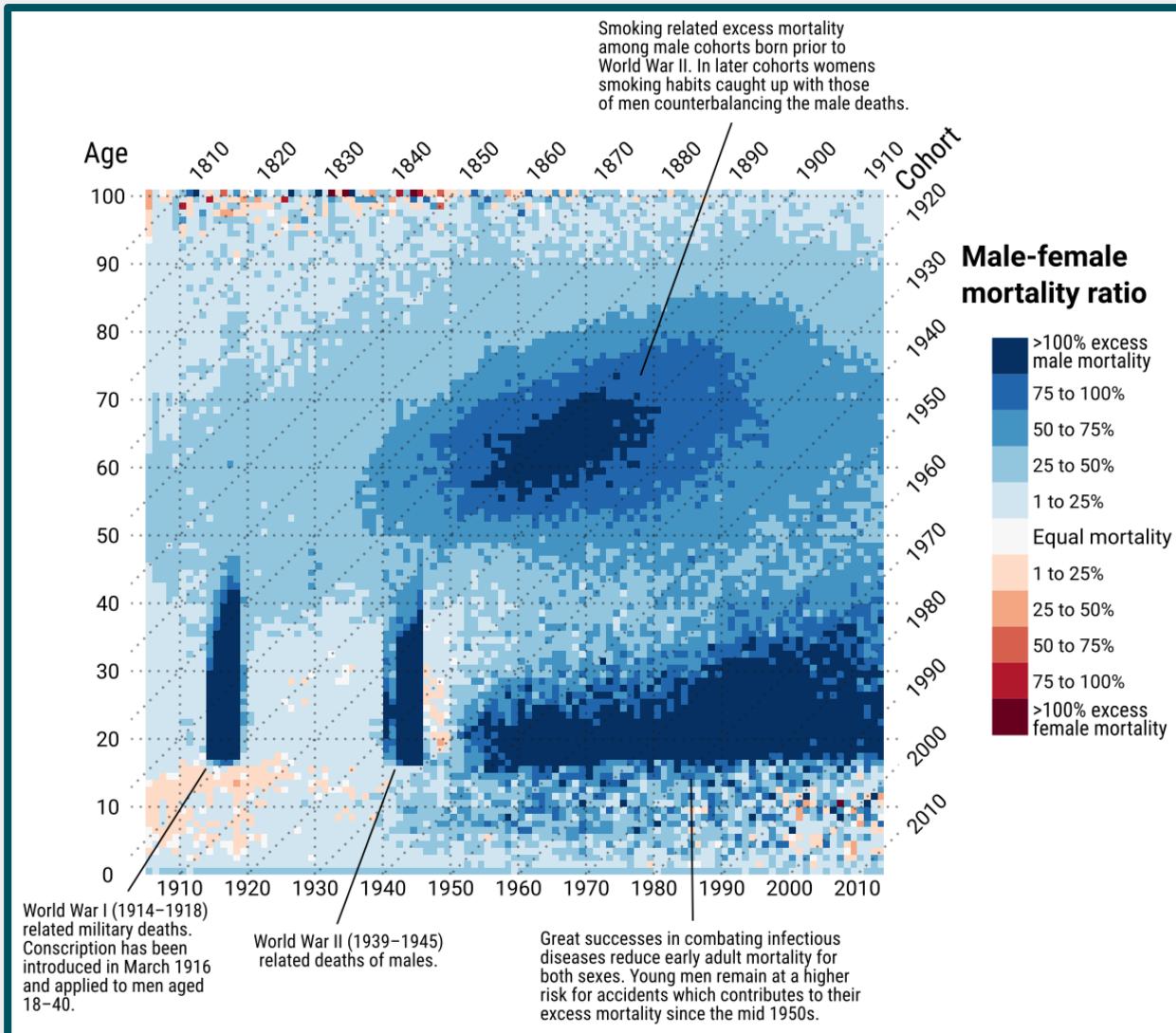
Cutout from Francis Walker (1874). "Statistical Atlas of the United States". <https://www.loc.gov/item/05019329/>

Ineffective color-coding



South East Maps & Aerial Photographic Systems. <http://www.clemson.edu/ces/geolk12/semaps/seregional/hires/digielmap.jpg>

Color-coding divergent magnitudes

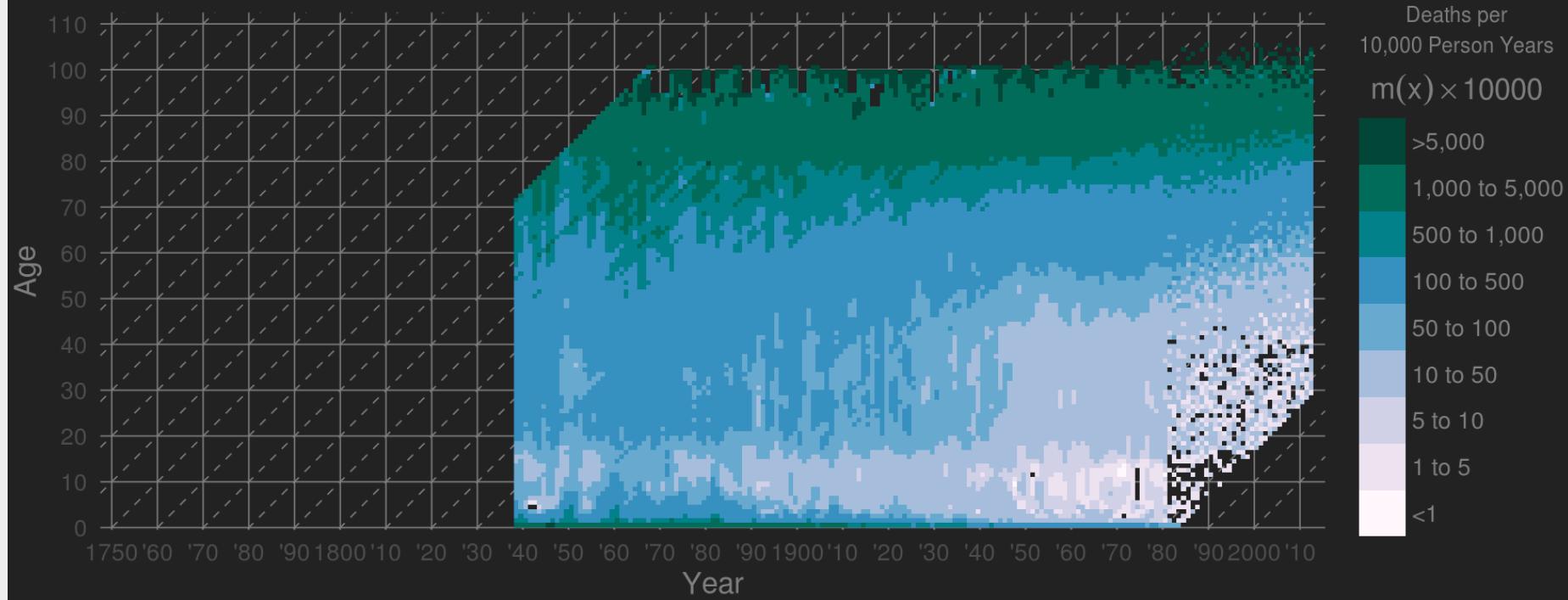


Schöley (2016). "Visualizing compositional data on the Lexis surface." Data: HMD.

Discrete color scales

Mortality Rates of Iceland

Cohort 1838 to 2012, Male



Jonas Schöley (2016). "The Human Mortality Explorer". jschoeley.shinyapps.io/hmdexp

Continuous color scales



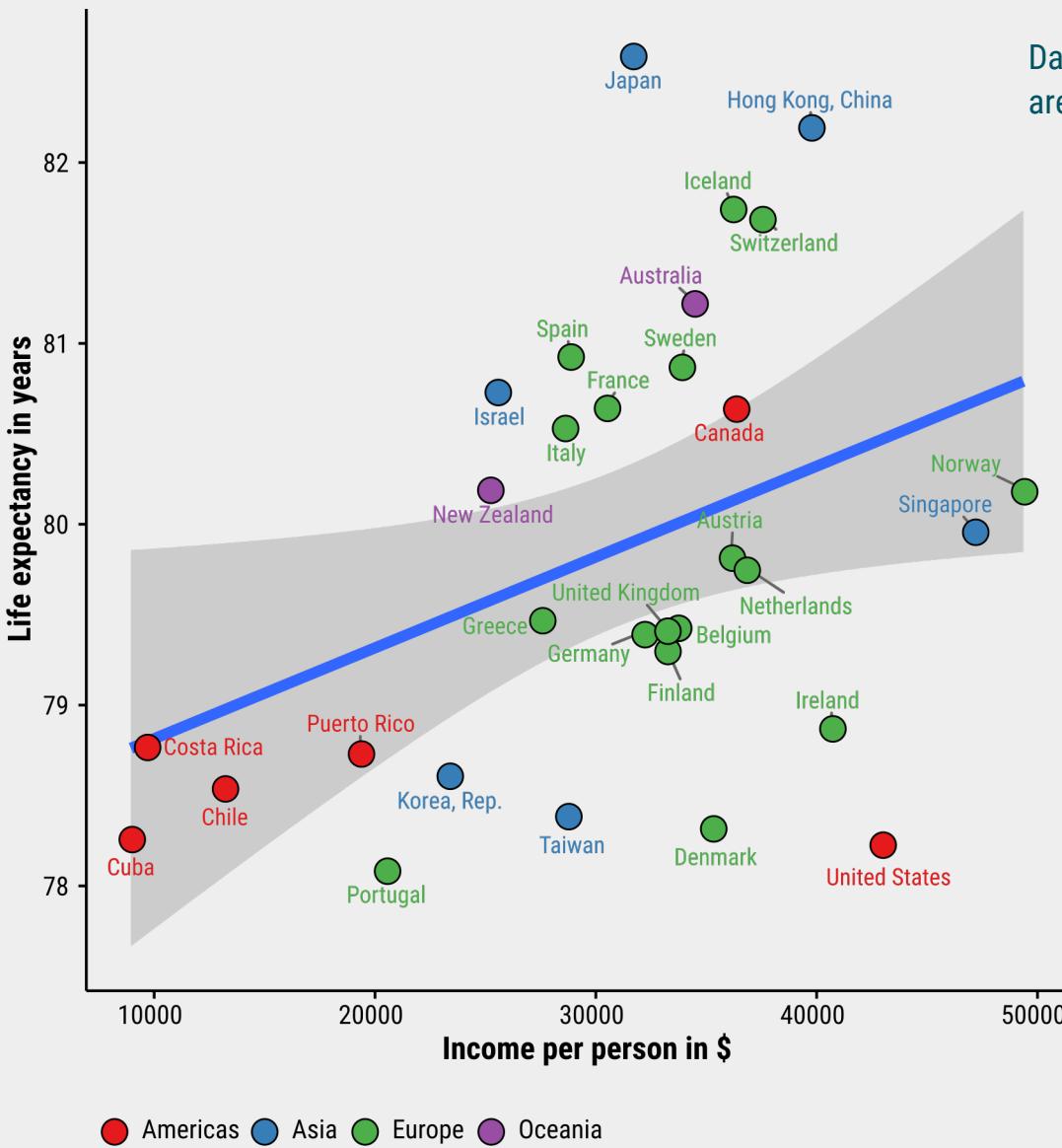
Jonas Schöley (2016). "The Human Mortality Explorer". jschoeley.shinyapps.io/hmdexp

Separating foreground & background

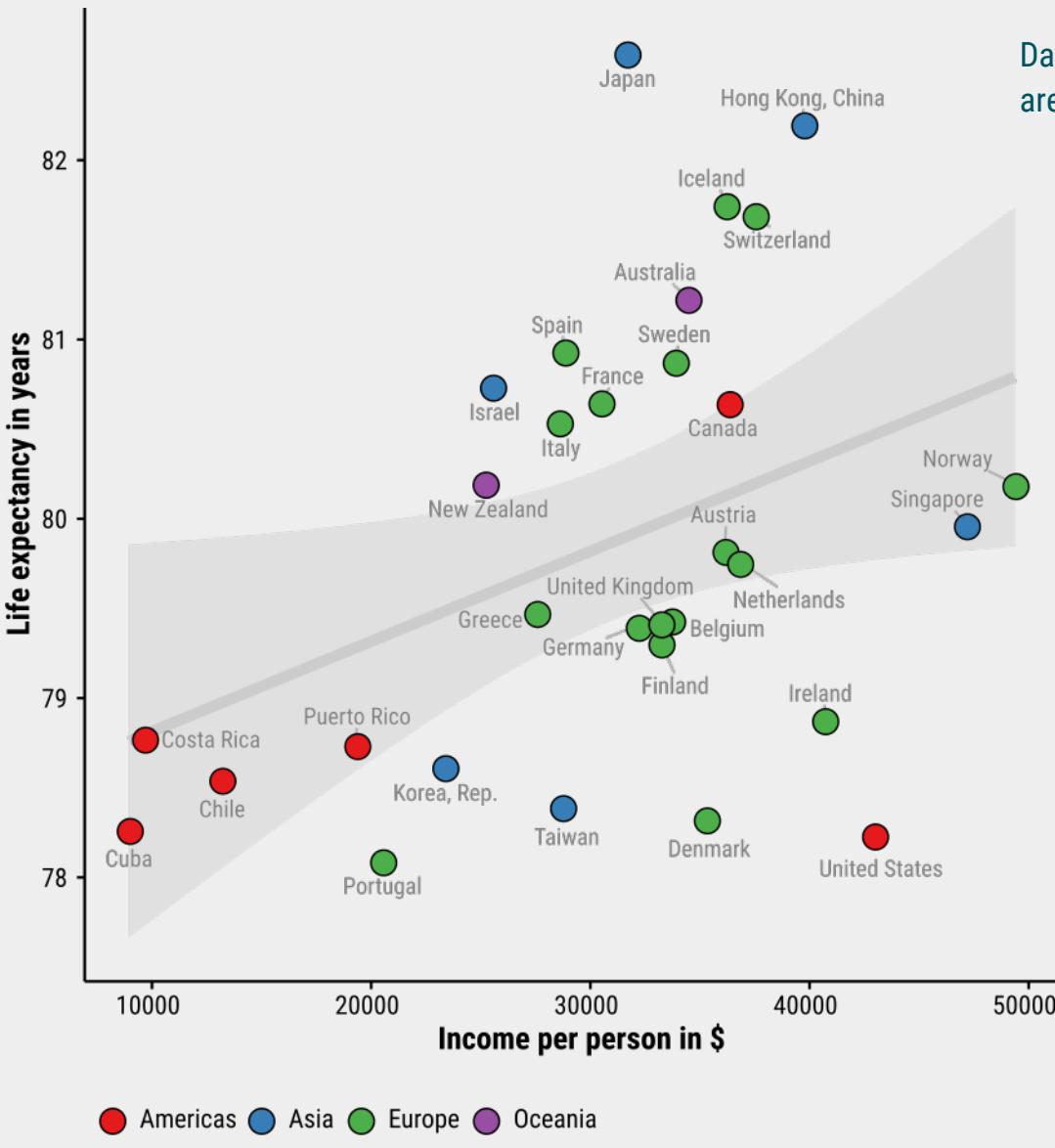


Pablo Picasso (1905). "Au Lapin Agile".

Separating foreground & background

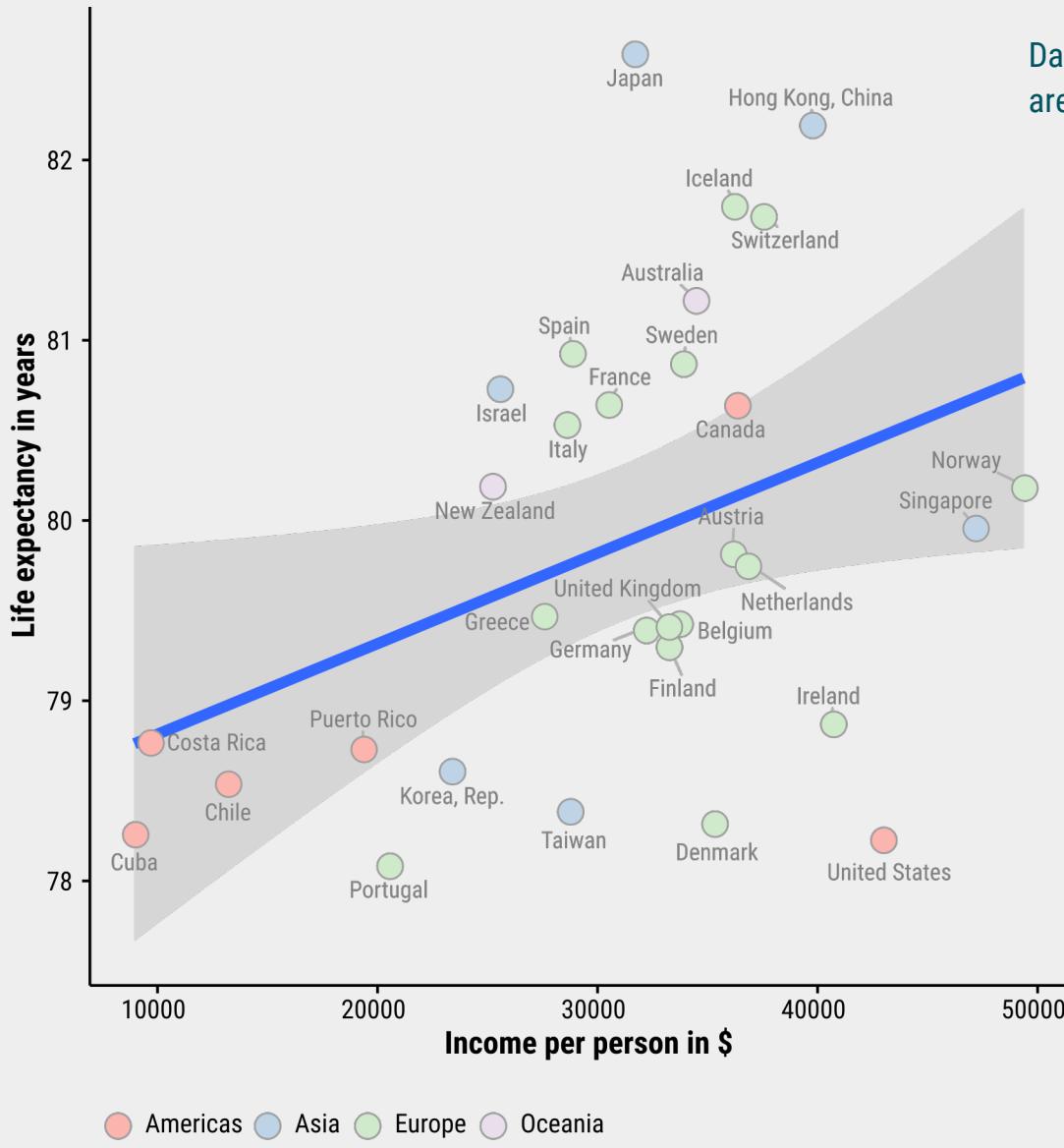


Separating foreground & background

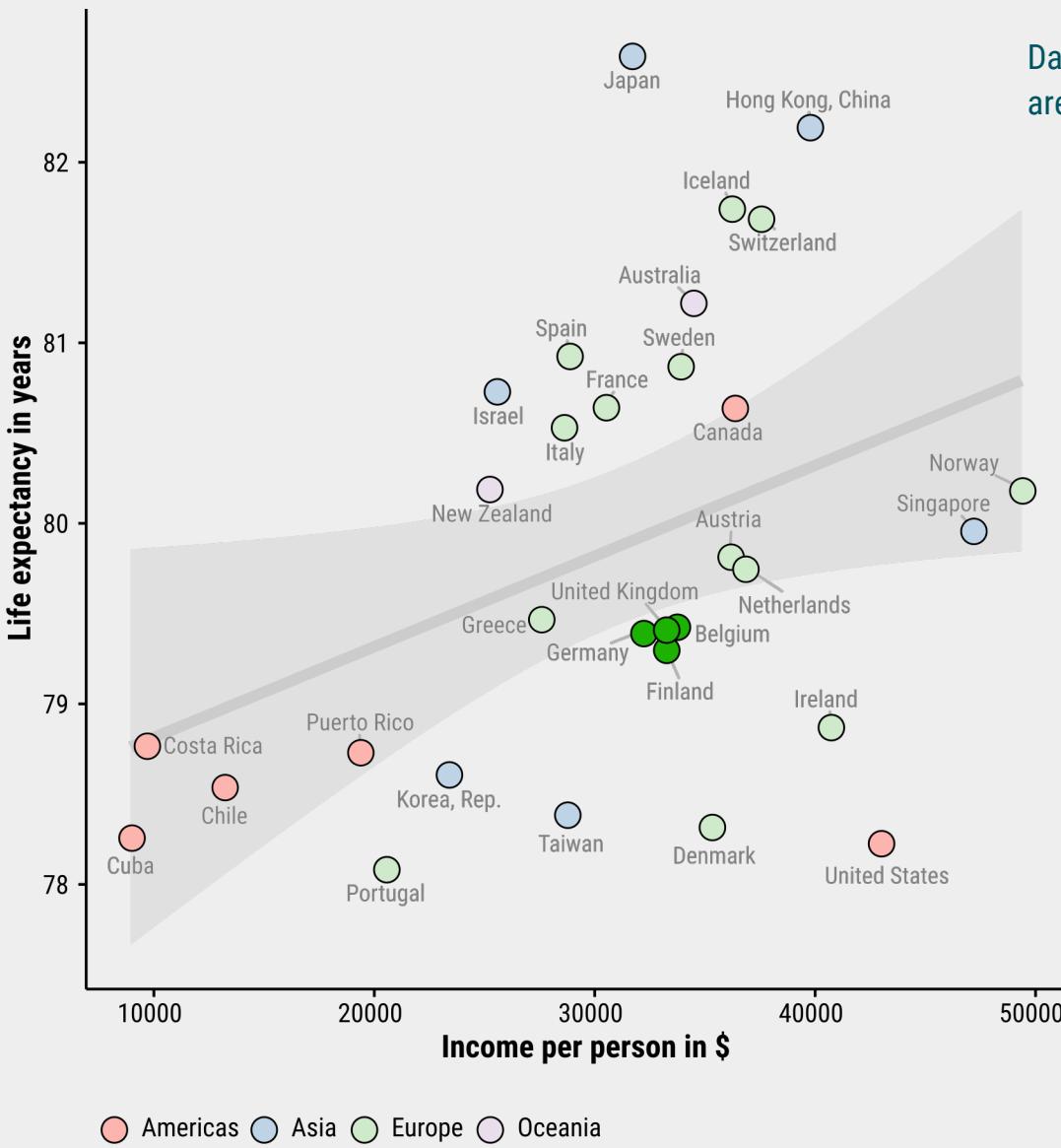


Data: gapminder.org – displayed are data for the year 2007.

Separating foreground & background



Separating foreground & background



Data: gapminder.org – displayed are data for the year 2007.

Further reading

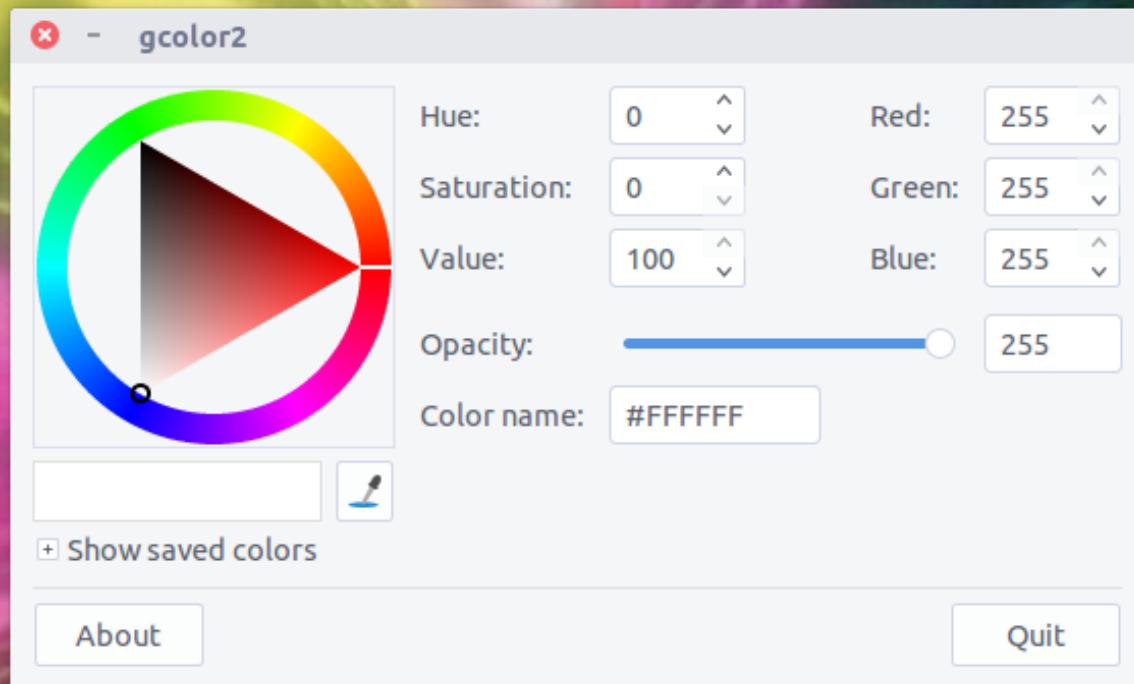
Brilliant color advice from NASA

earthobservatory.nasa.gov/blogs/elegantfigures/2013/08/05/subtleties-of-color-part-1-of-6

Seminal paper on construction of qualitative, sequential, divergent color scales Brewer, Cynthia A. 1994. "Guidelines for Use of the Perceptual Dimensions of Color for Mapping and Visualization." In SPIE, edited by Jan Bares, 2171:54–63. doi:10.1117/12.175328.

Color scales for data-viz colorbrewer2.org

You take control!



Slides available at
github.com/jschoeley/idem_viz

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Twitter: @rettungstweet