

VISUAL ENCODING

Please find a different seat from last week!



1. INTRODUCTION

2. VISUAL ENCODING

3. BASIC CHART TYPES

4. INTERACTION

5. VISUALIZATION DESIGN

6. DATA PREPROCESSING

7. RECAP 1st Half

8. MULTIVARIATE DATAVIS

9. TEMPORAL DATAVIS

10. GEOSPATIAL DATAVIS

11. GRAPH DATAVIS

12. 3D DATAVIS

13. VISUAL ANALYTICS

14. RECAP 2nd Half

Basics

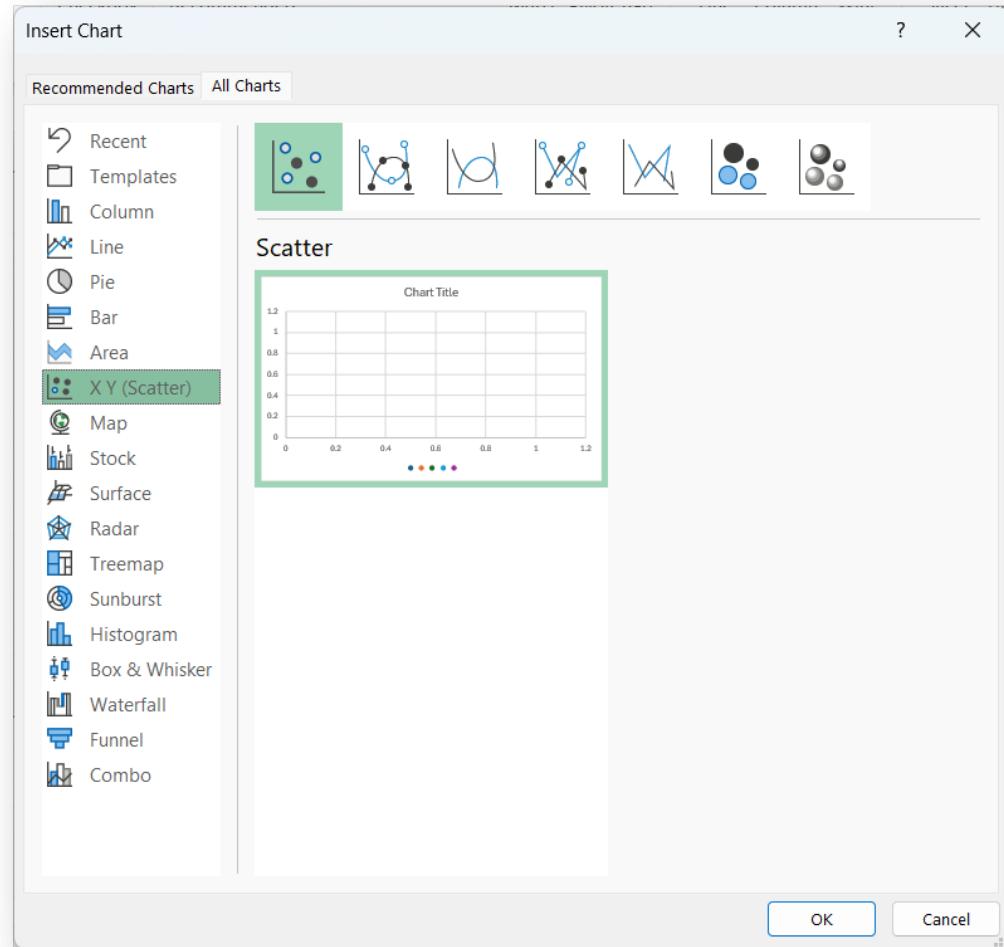
Visualization
Building Blocks
& Processes

Visualization
Techniques

Visualization
Applications



WHY TALK ABOUT VISUAL MAPPING?



- **Need to parametrize a preset chart**
-> e.g., which color scale to use
- **Need to adjust a base chart**
-> e.g., to counter a perceptual bias
- **Need to build your own chart type**
-> e.g., to tailor it to a dataset
- **Need to detect when someone tries to deceive you with a chart**
-> Visual Literacy

OVERVIEW

- Marks & Channels
- Dimensionality
- Labeling
- Rendering



MARKS & CHANNELS



MARKS = VISUAL OBJECTS

→ Points



→ Lines



→ Areas



CHANNELS = PROPERTIES OF MARKS

④ Position

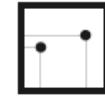
→ Horizontal



→ Vertical



→ Both



④ Color



④ Tilt



④ Shape



④ Size

→ Length



→ Area



→ Volume



DATA TYPES

	Quantitative Data		Qualitative Data	
	Continuous Data	Discrete Data	Ordinal Data	Categorical Data
Interpolate	✓			
Difference	✓	✓		
Sort	✓	✓	✓	
Match	✓	✓	✓	✓

Adapted from [Stevens 1946] – DOI: 10.1126/science.103.2684.677

MAPPING CRITERION 1: EXPRESSIVENESS

categorical data:



ordinal data:



discrete data:



continuous data:



MAPPING CRITERION 2: EFFECTIVENESS

categorical data:



ordinal data:



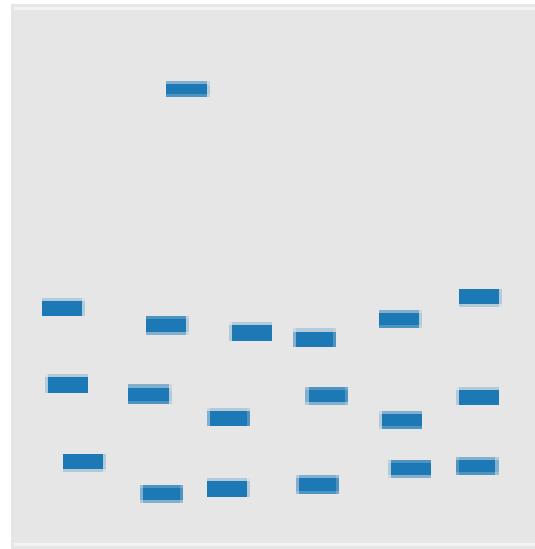
discrete data:



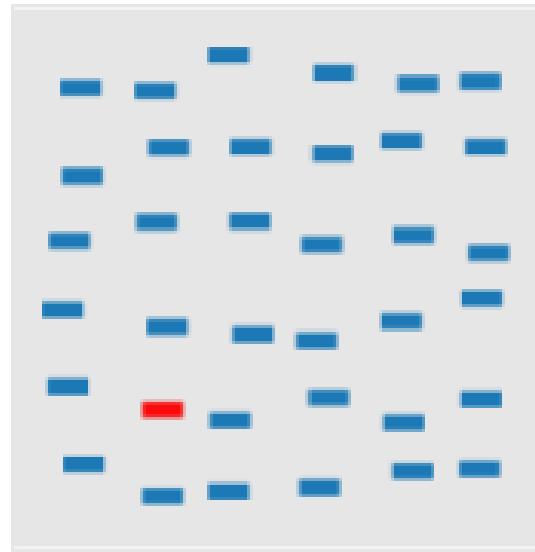
continuous data:



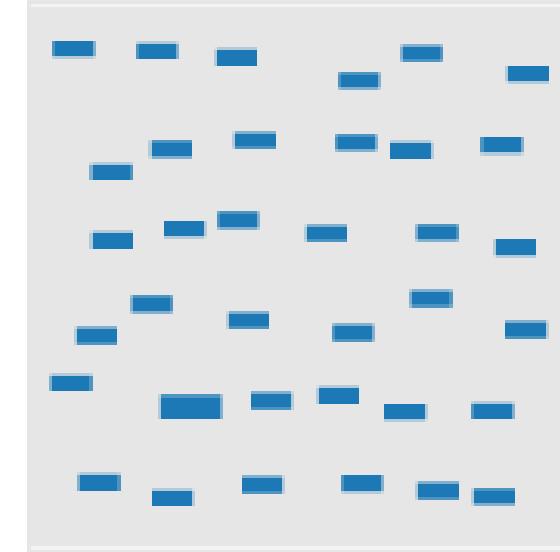
PRECEDENCE AMONG VISUAL SIGNALS: PREATTENTIVE VISUAL CUES



Position



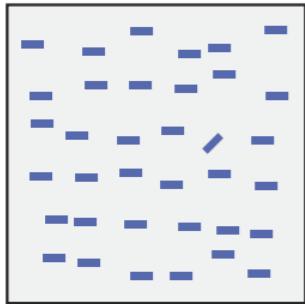
Color



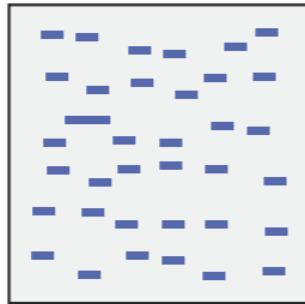
Size

Image source: uxpractical.com

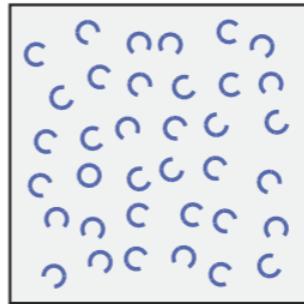
PREATTENTIVE VISUAL CUES



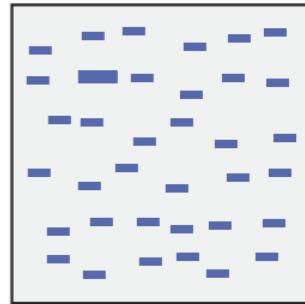
orientation



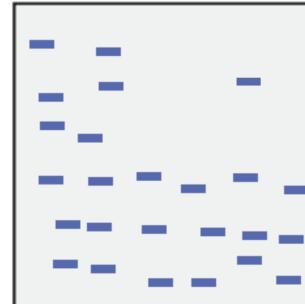
length



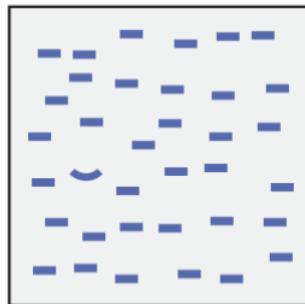
closure



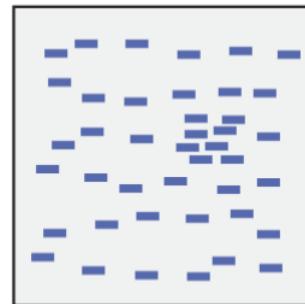
size



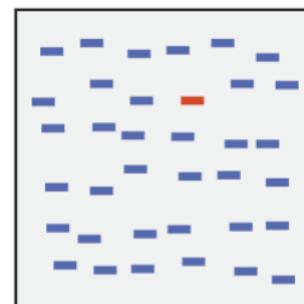
position



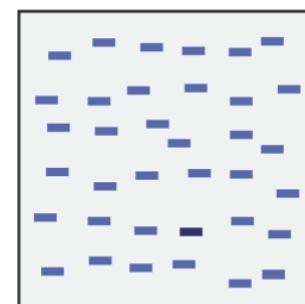
curvature



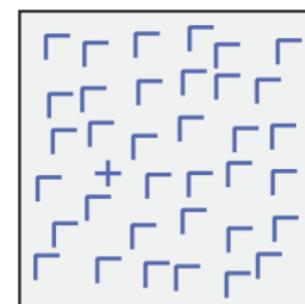
density



hue



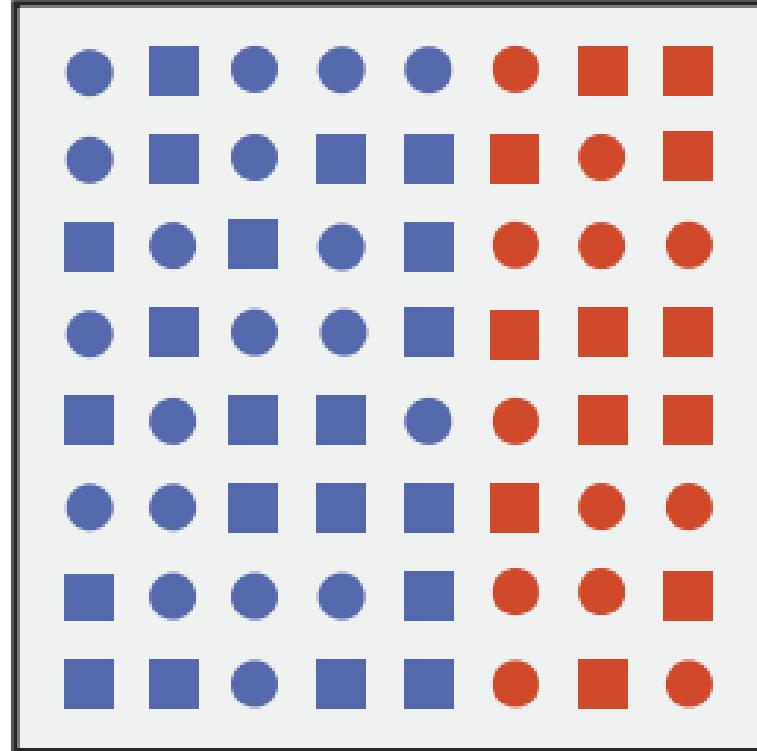
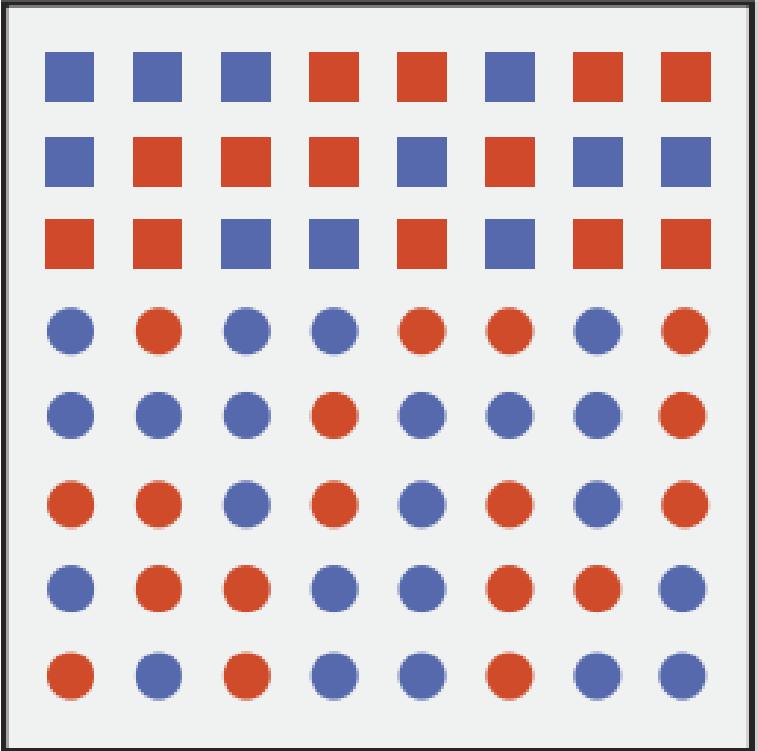
luminance



shape



PREATTENTIVE VISUAL CUES



Hue-on-form hierarchy



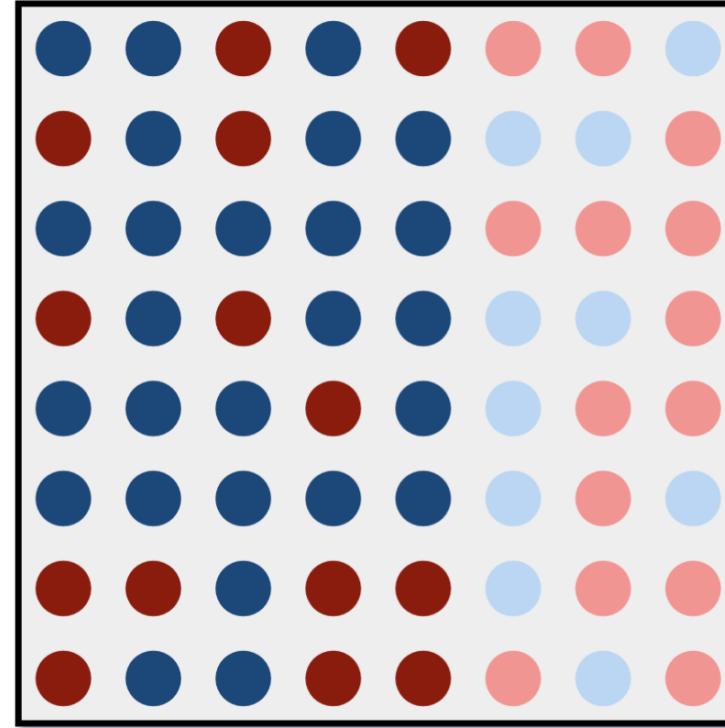
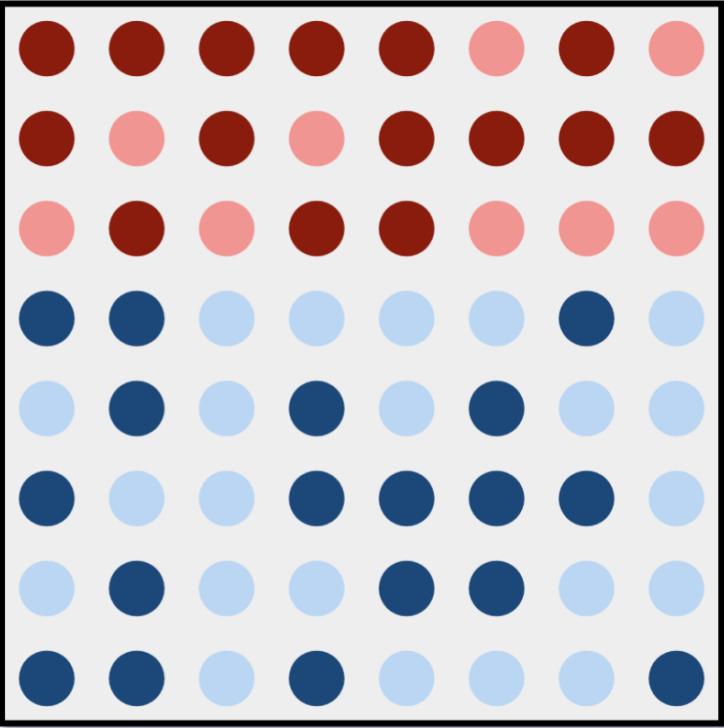
AARHUS
UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

DAVI - ENCODING
FALL 2025

HANS-JÖRG SCHULZ
ASSOCIATE PROFESSOR



PREATTENTIVE VISUAL CUES



Luminance-on-hue hierarchy



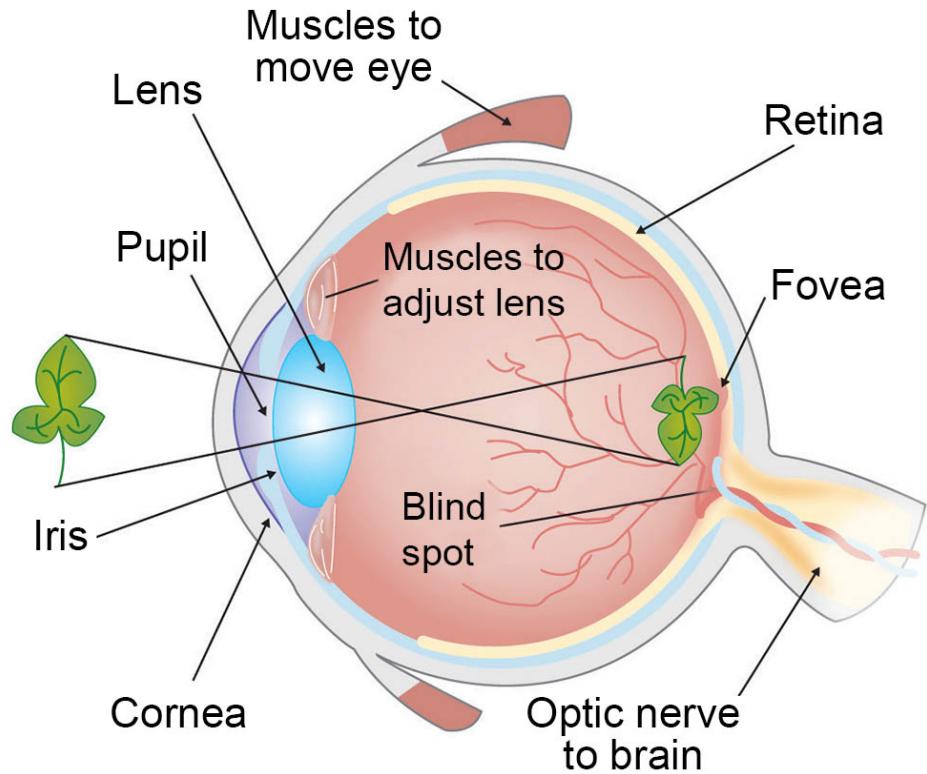
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INTERLUDE: THE HUMAN EYE



Pupil: to adjust brightness

Lens: to adjust focus

Retina: the projection surface at the back of the eye

Fovea/Macula: for high-res color perception
under daylight (photopic vision)

-> ca. 64% red cones

-> ca. 32% green cones

-> ca. 2% blue cones

6-7 million cones

Remainder of Retina: for low-res brightness perception
under low light levels (scotopic vision)

-> 120 million rods

Blind spot where the optic nerve runs from
the eye to the brain

MAPPING CRITERION 2: EFFECTIVENESS

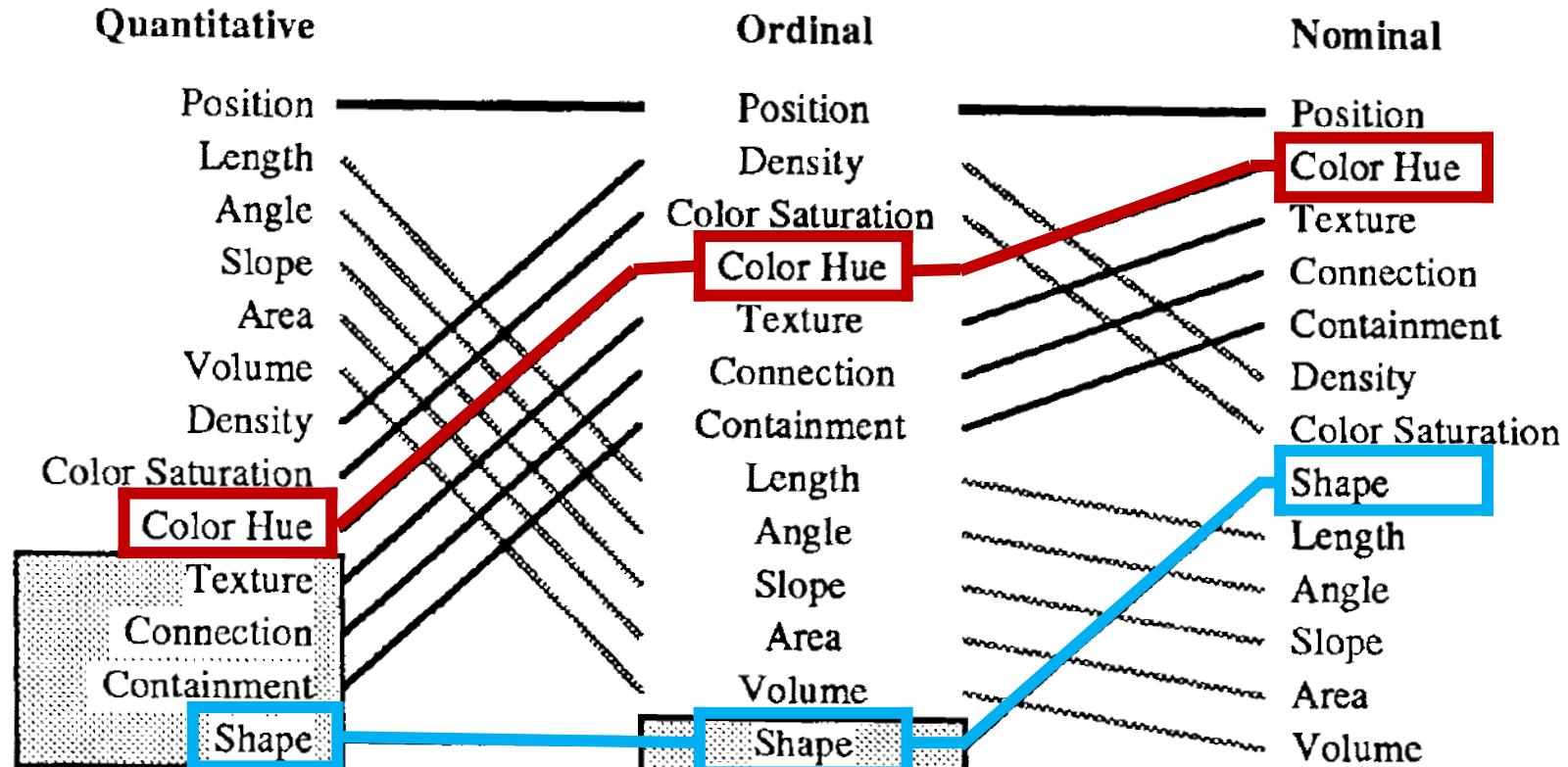
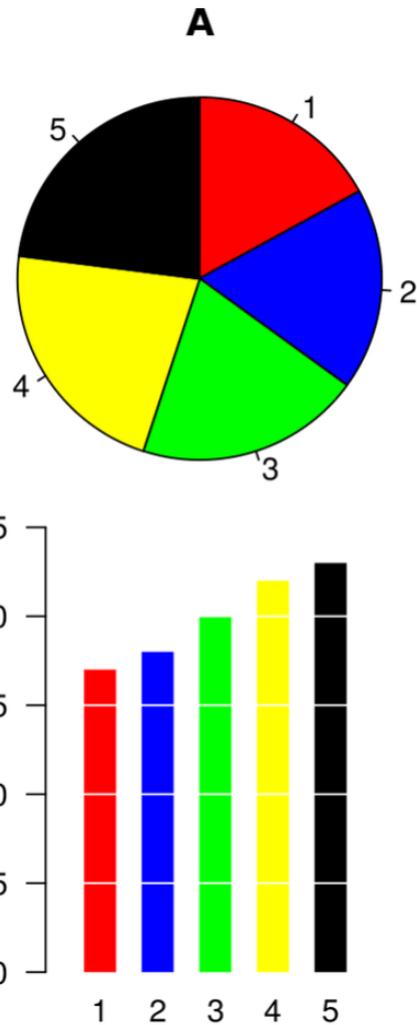


Fig. 15. Ranking of perceptual tasks. The tasks shown in the gray boxes are not relevant to these types of data.

ON PIE CHARTS (& DONUT CHARTS)

Image source: Wikipedia



LET'S REVISIT MACKINLAY'S SCHEMA

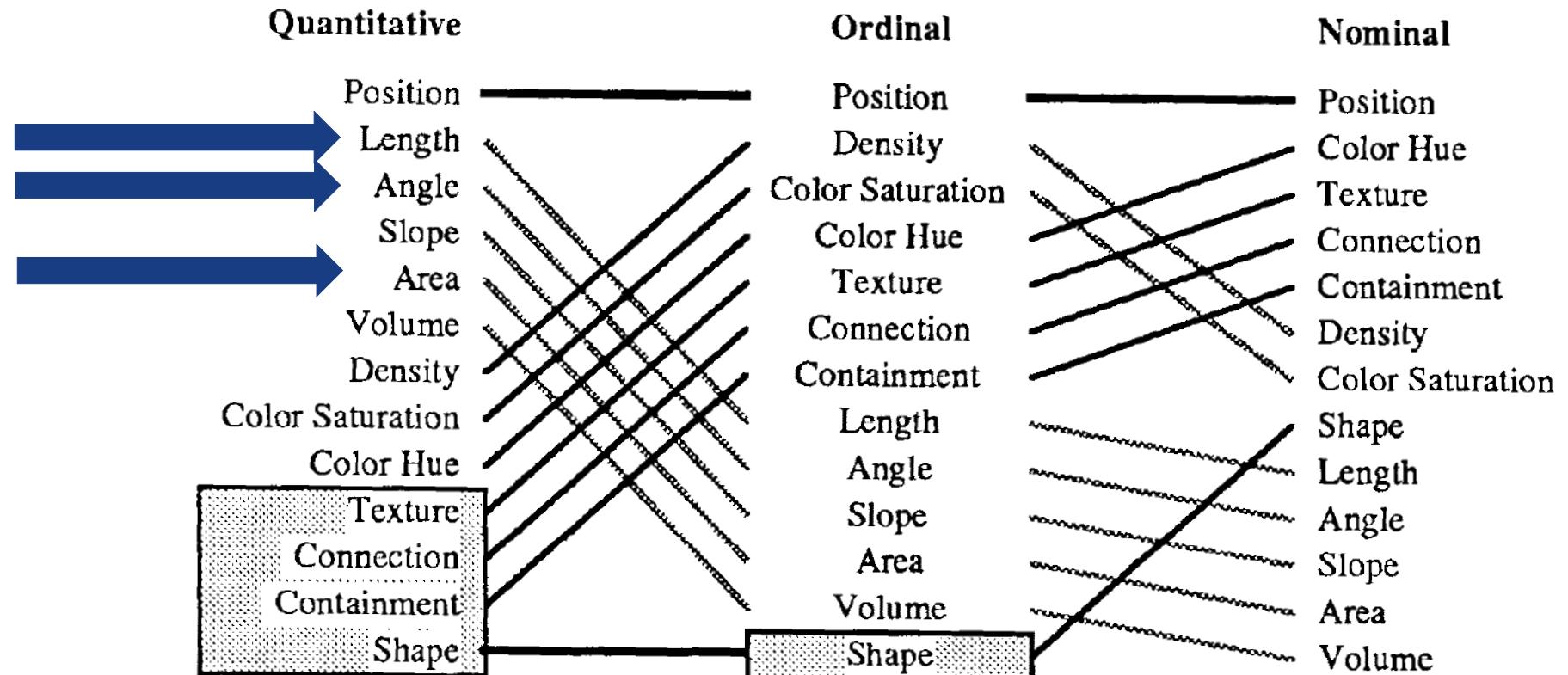
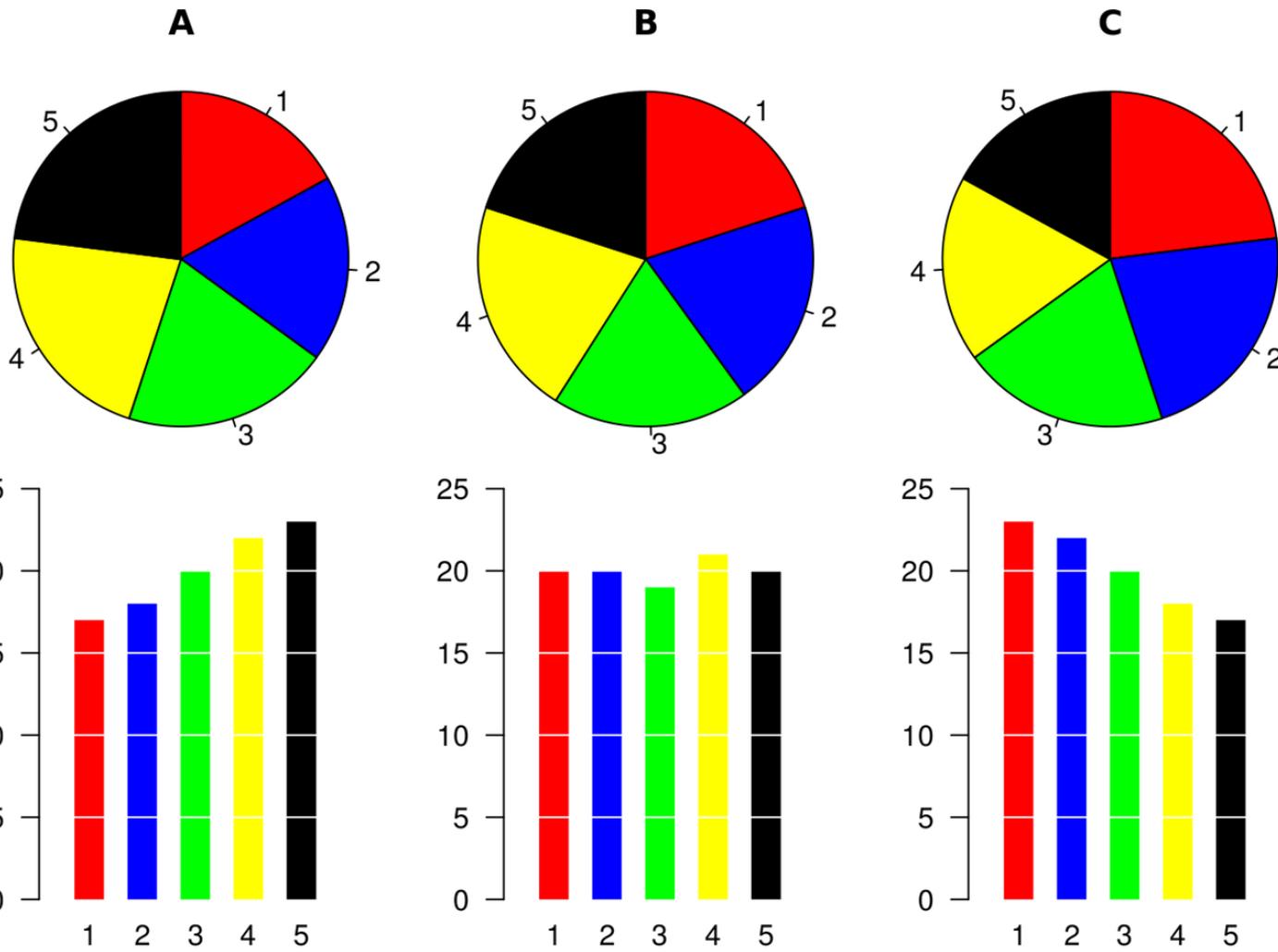


Fig. 15. Ranking of perceptual tasks. The tasks shown in the gray boxes are not relevant to these types of data.

ON PIE CHARTS (& DONUT CHARTS)

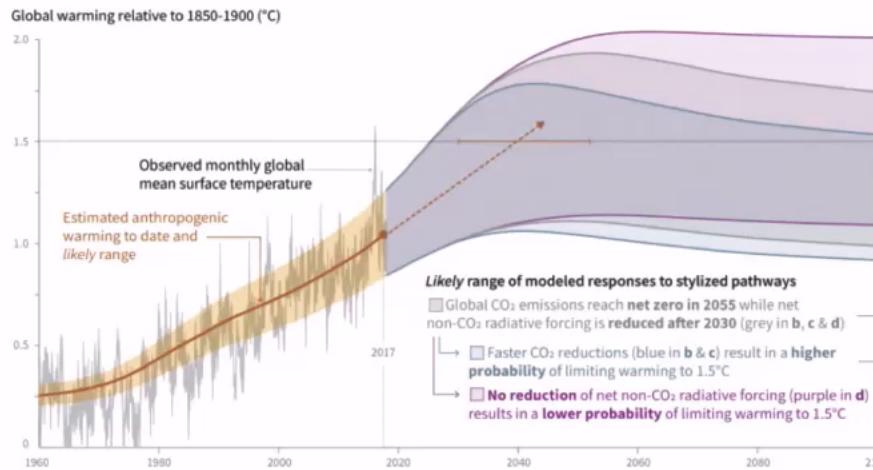
Image source: Wikipedia



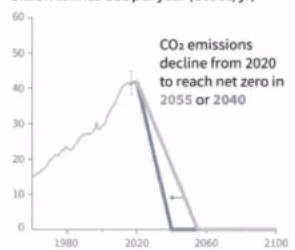


Cumulative emissions of CO₂ and future non-CO₂ radiative forcing determine the probability of limiting warming to 1.5°C

a) Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways

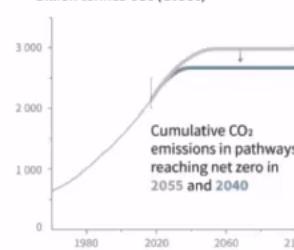


b) Stylized net global CO₂ emission pathways
Billion tonnes CO₂ per year (GtCO₂/yr)



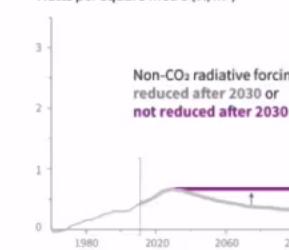
Faster immediate CO₂ emission reductions limit cumulative CO₂ emissions shown in panel (c).

c) Cumulative net CO₂ emissions
Billion tonnes CO₂ (GtCO₂)



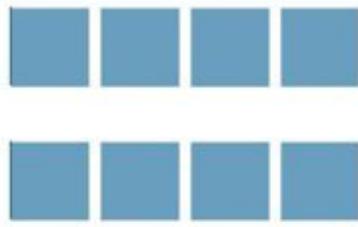
Maximum temperature rise is determined by cumulative net CO₂ emissions and net non-CO₂ radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.

d) Non-CO₂ radiative forcing pathways
Watts per square metre (W/m²)

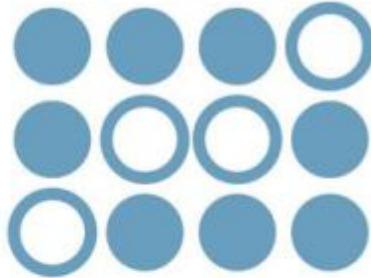


GESTALT PRINCIPLES OF GROUPING

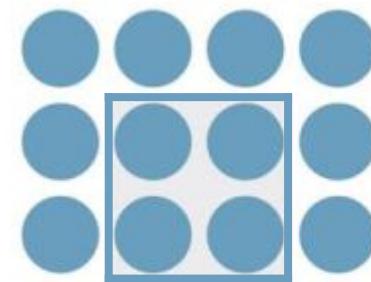
Proximity



Similarity



Enclosure



Connection



Continuity



Symmetry



Figure & Ground



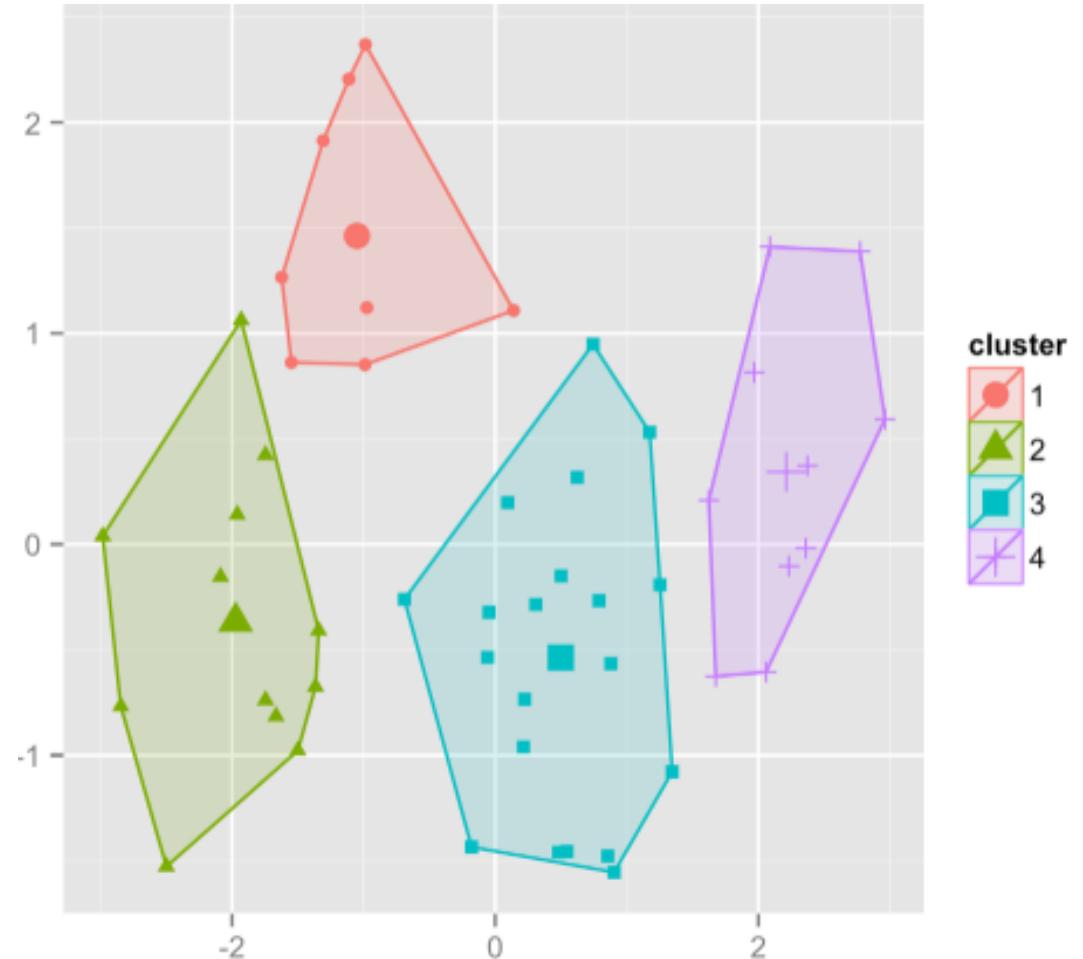
Closure



Common Fate



WHEN TO USE THE GESTALT PRINCIPLES?



Which Gestalt principles can you find in this visualization?

- Proximity
- Similarity in Color
- Similarity in Shape
- Enclosure

DEFINITIONS

A visualization is **expressive** if it encodes all the data relations intended and no other data relations.

A visualization is **effective** if it best exploits the capabilities of the output medium and the human visual system (and supports the task).

Mapping Criterion 3: Appropriateness (Book: Efficiency)

A visualization is **appropriate** if it balances the tradeoff between efforts required for creating it and the benefits yielded by it.

MARKS: DIMENSIONALITY



THE PERILS OF 3D

- **Occlusion**
- Perspective Distortion
- Non-anchored points
- Navigation / Orientation
(Lost in Space)
- Selection

Adapted from Brath 2014:
3D InfoVis is here to stay: Deal with it

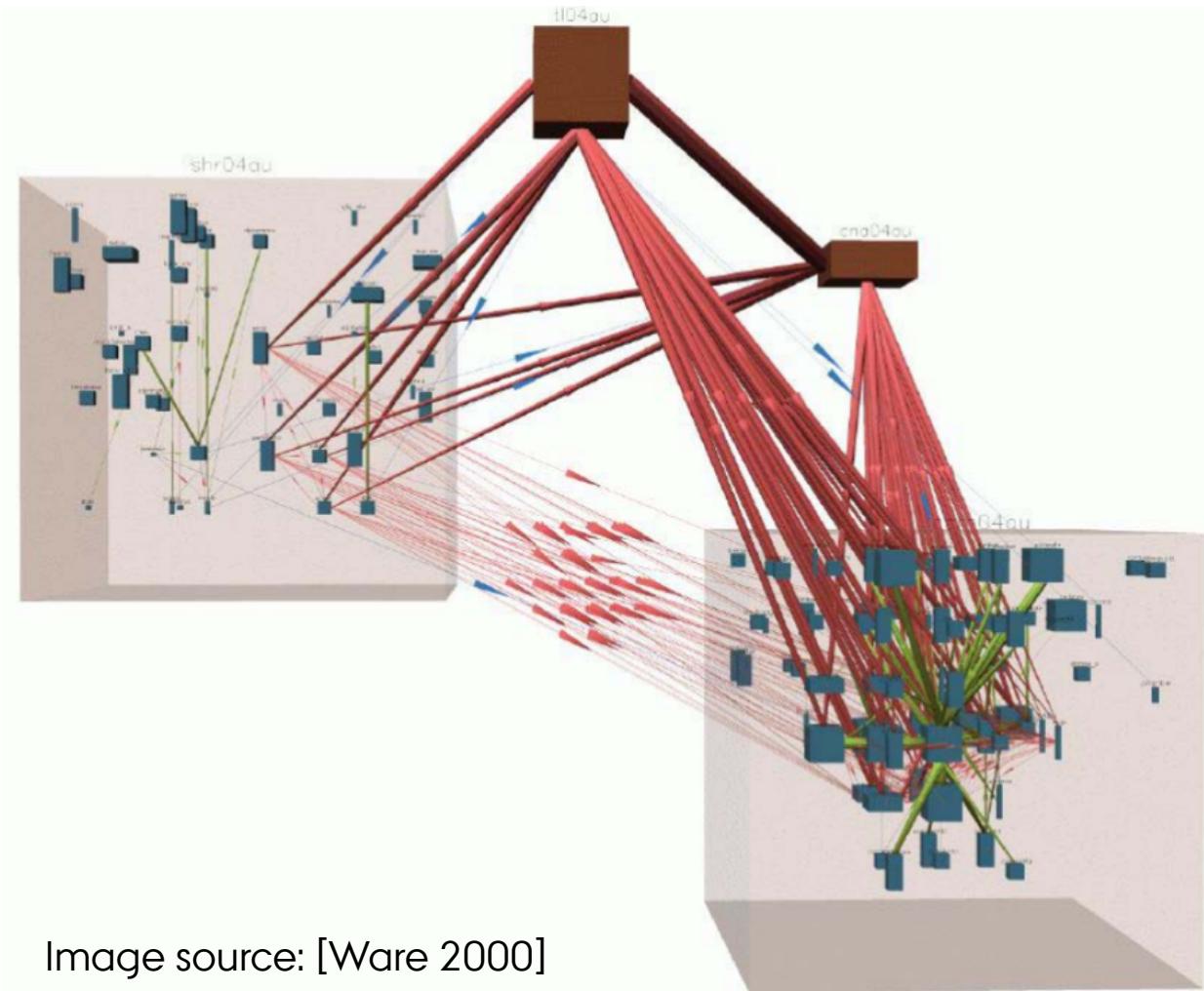


Image source: [Ware 2000]



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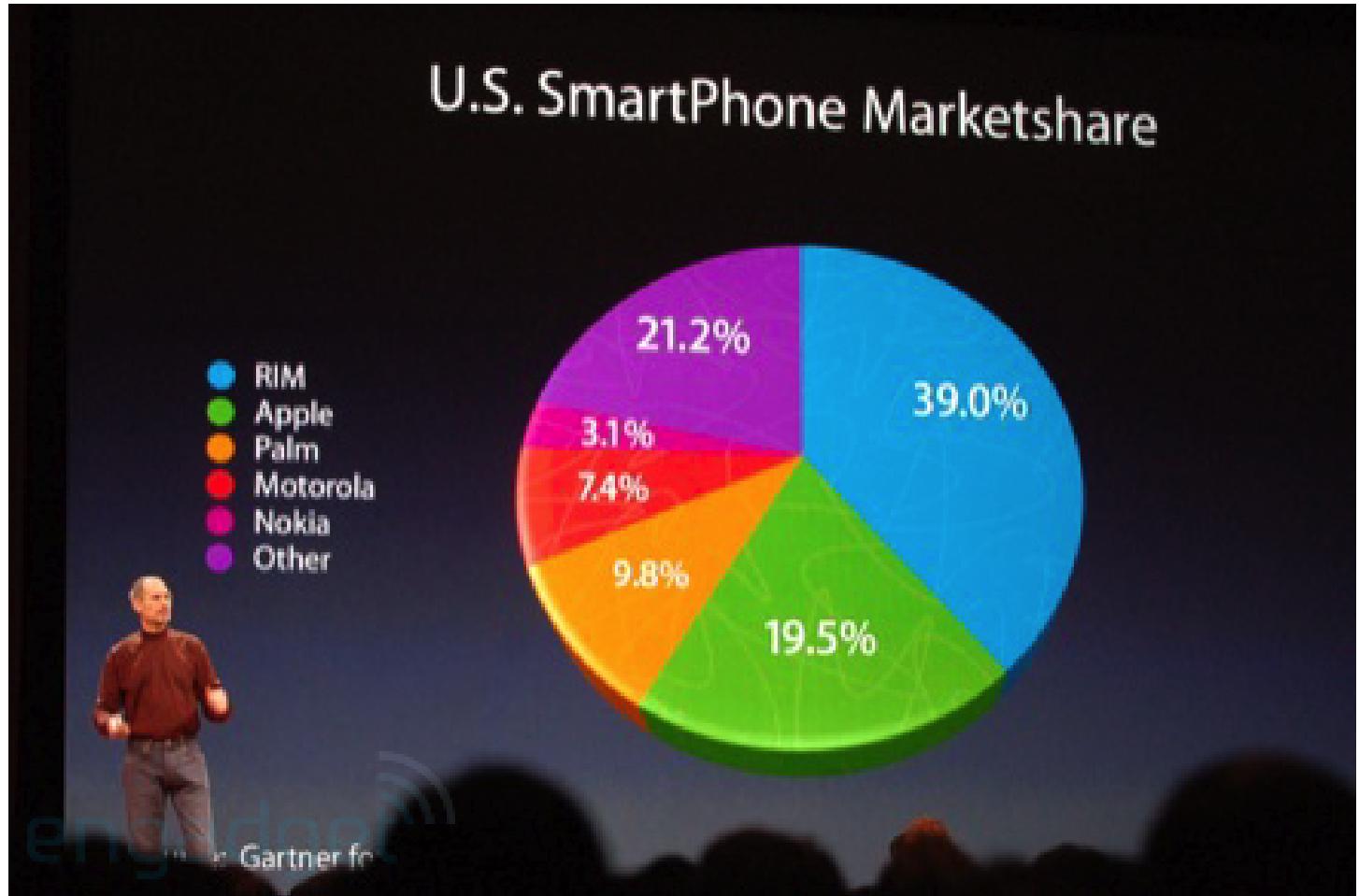


Image source: Macworld 2008, engadget.com

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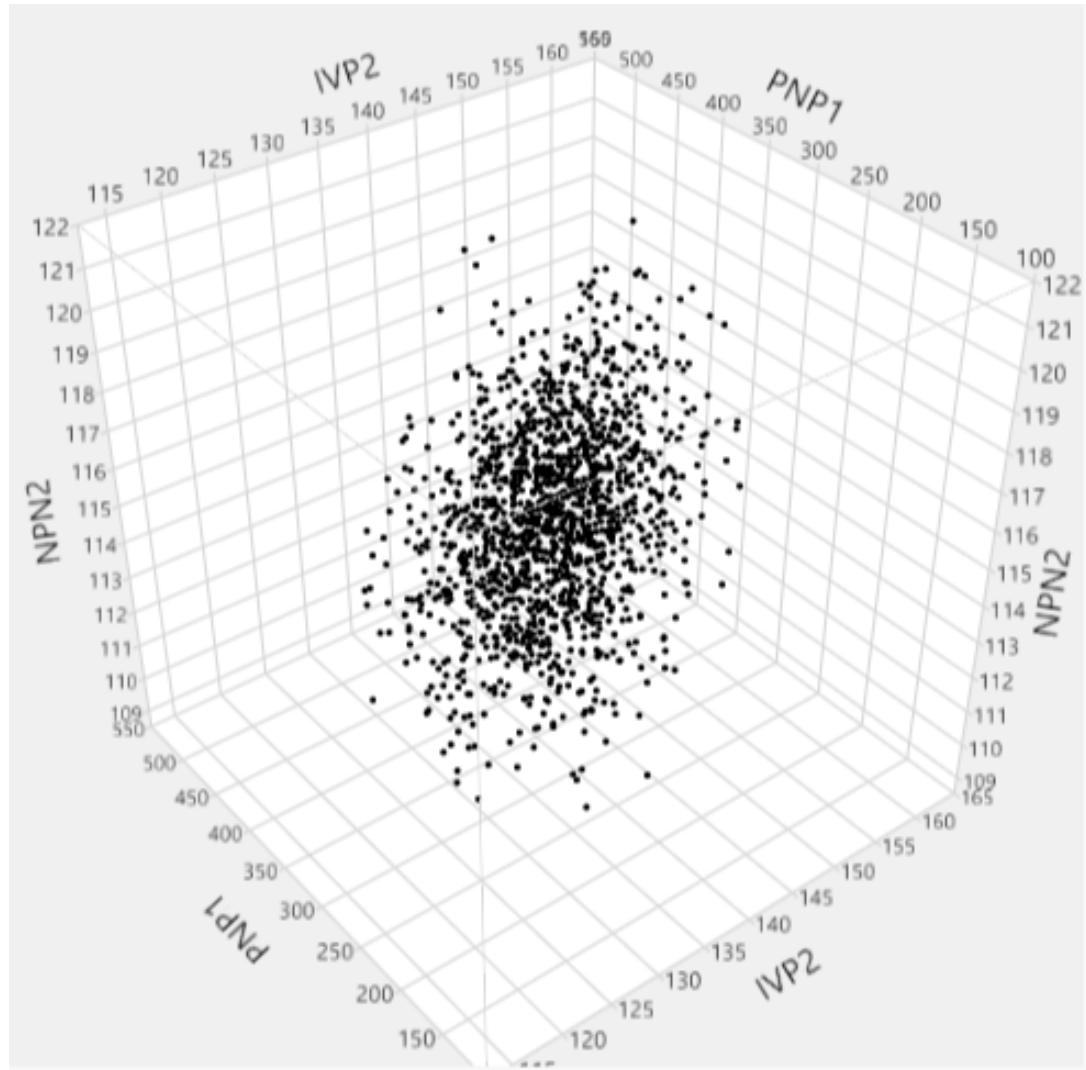


Image source:
<https://communityjmp.com/t5/Discussions/3D-Scatterplot-Animation/td-p/49016>

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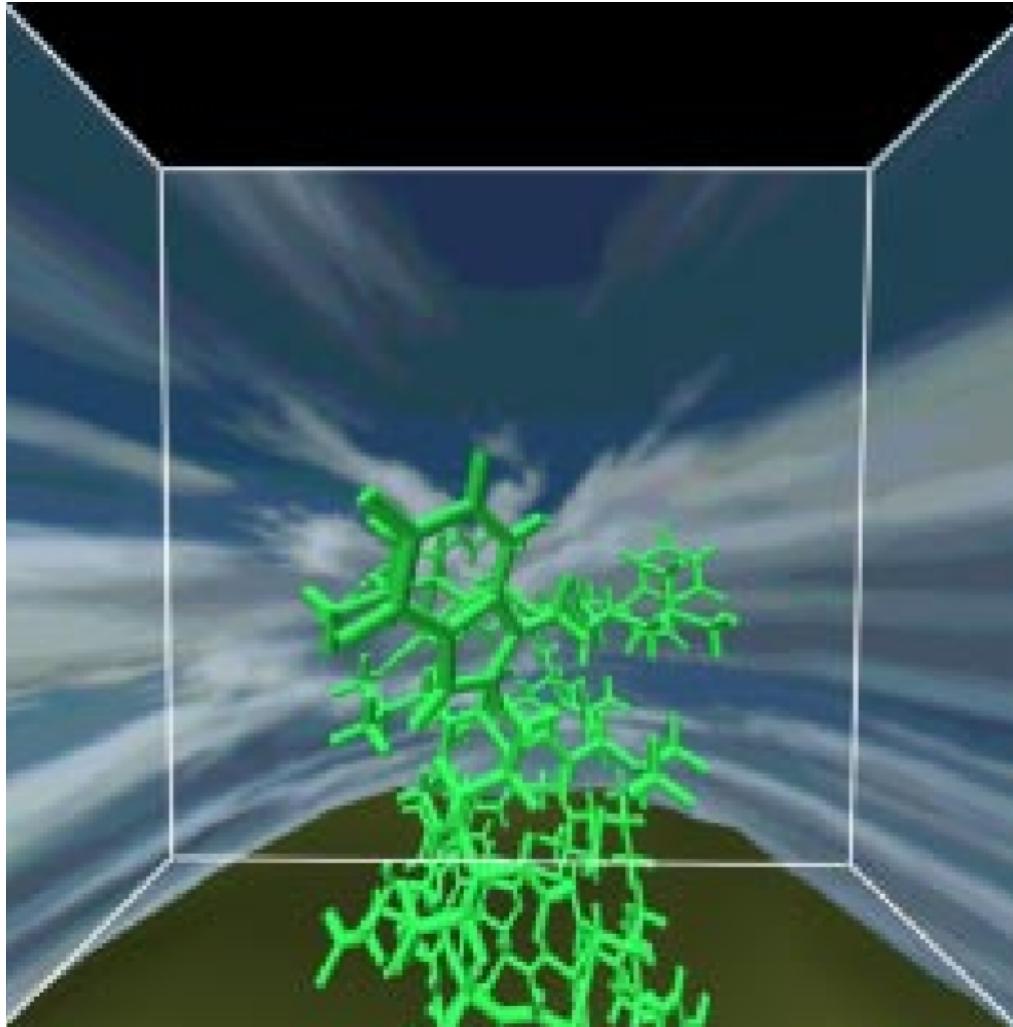
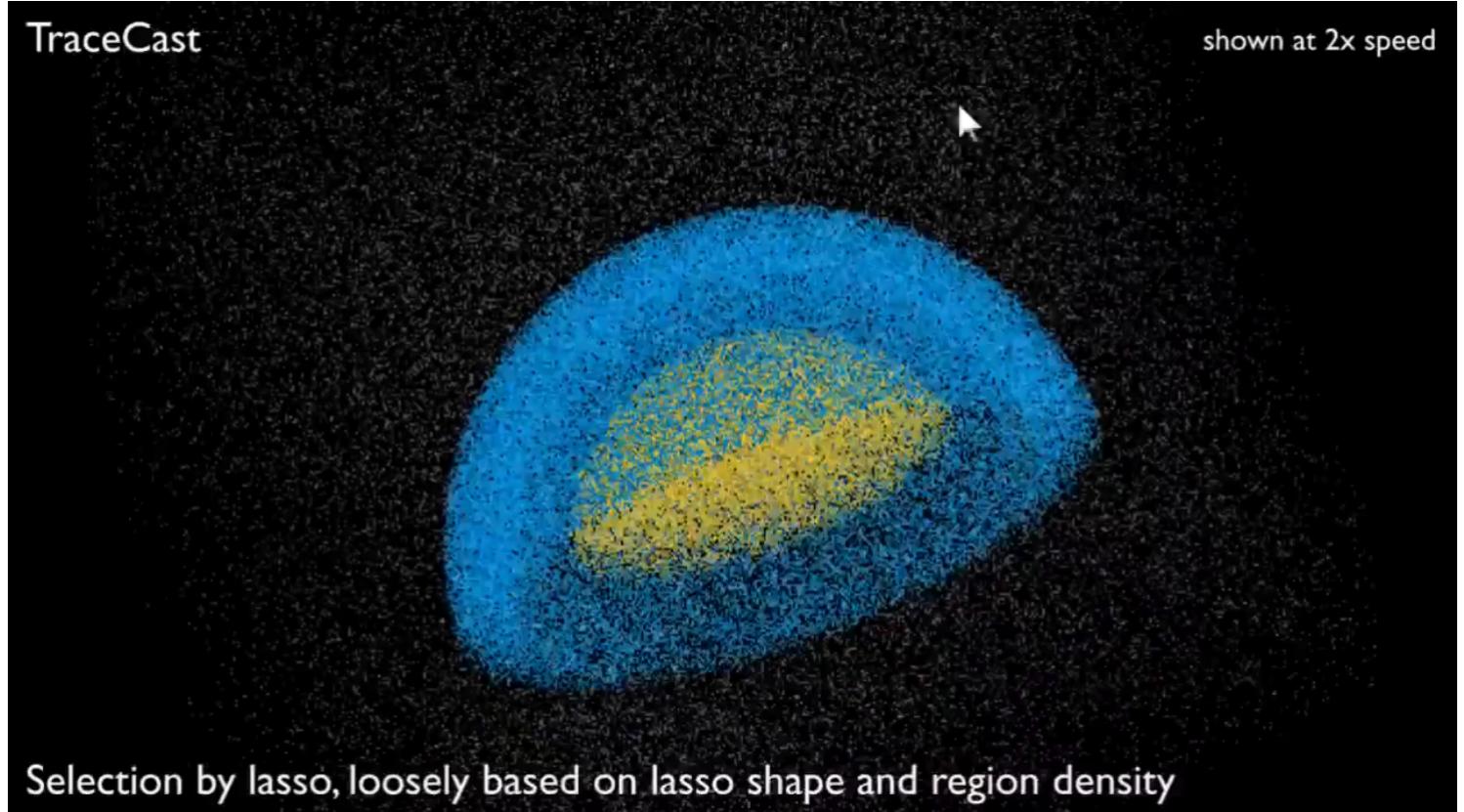


Image source: [Hanson et al.1997]

THE PERILS OF 3D

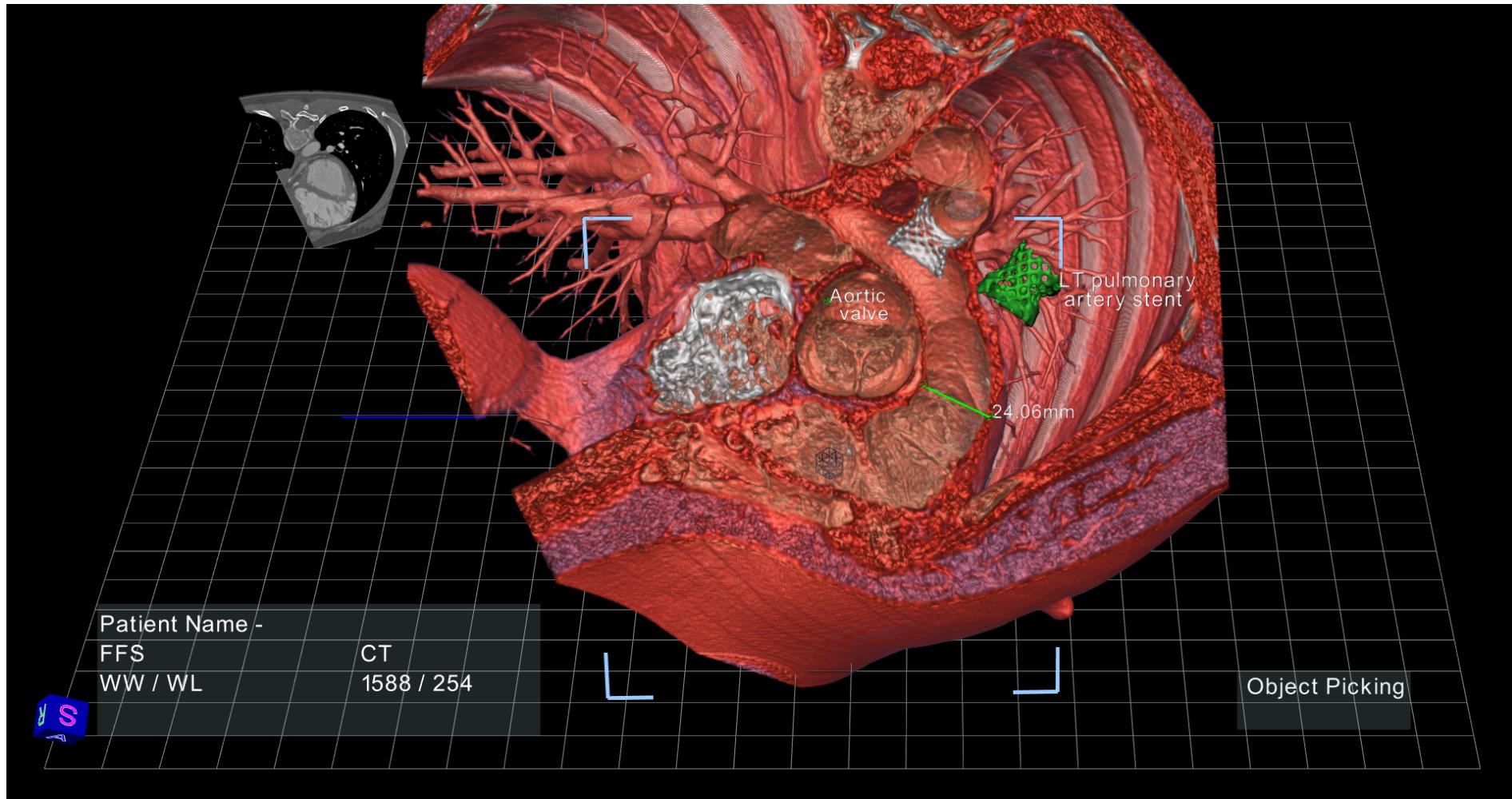
- Occlusion
- Perspective Distortion
- Non-anchored points
- Navigation / Orientation
(Lost in Space)
- **Selection**



Adapted from Brath 2014:
3D InfoVis is here to stay: Deal with it

Video source: Yu et al. 2016

ONLY USE 3D VIS FOR 3D DATA (VOLVIS)



USE 2.5D IF YOU MUST GO BEYOND 2D...

Image source: Dübel et al. 2014

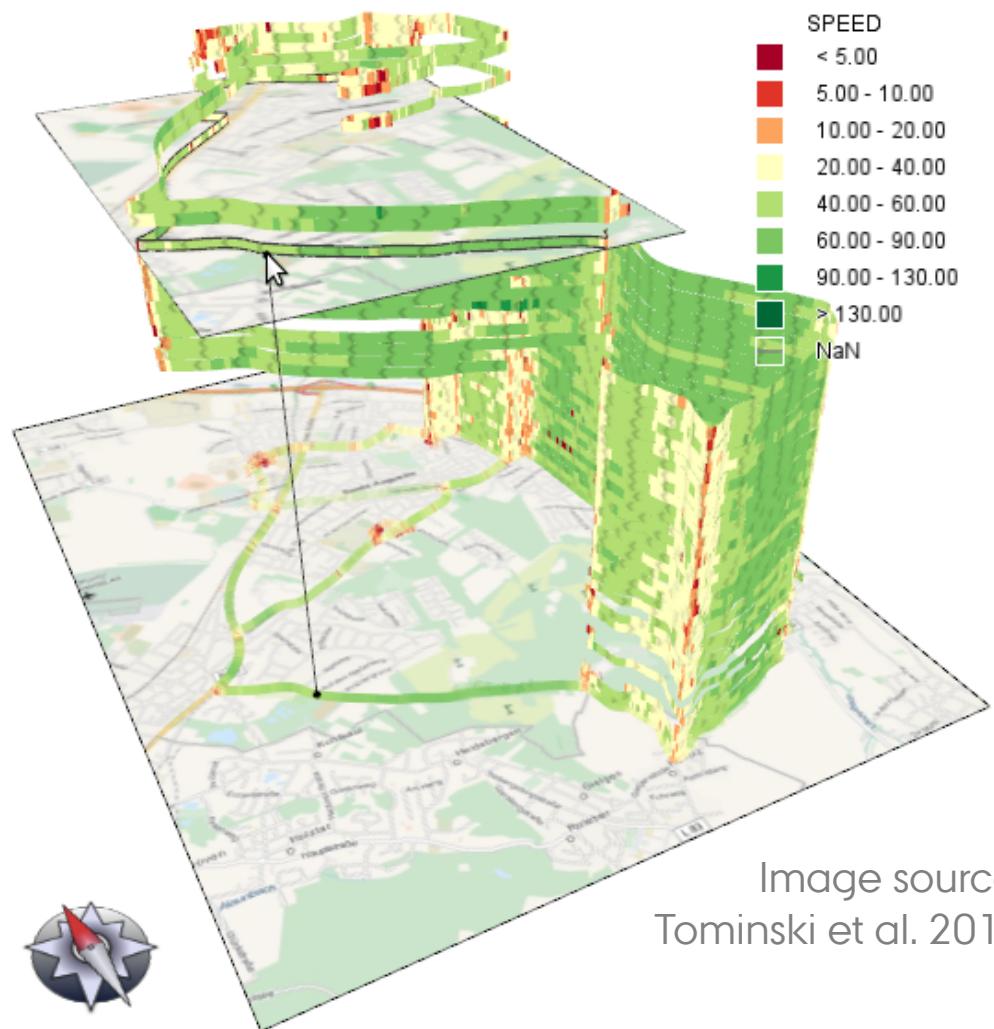
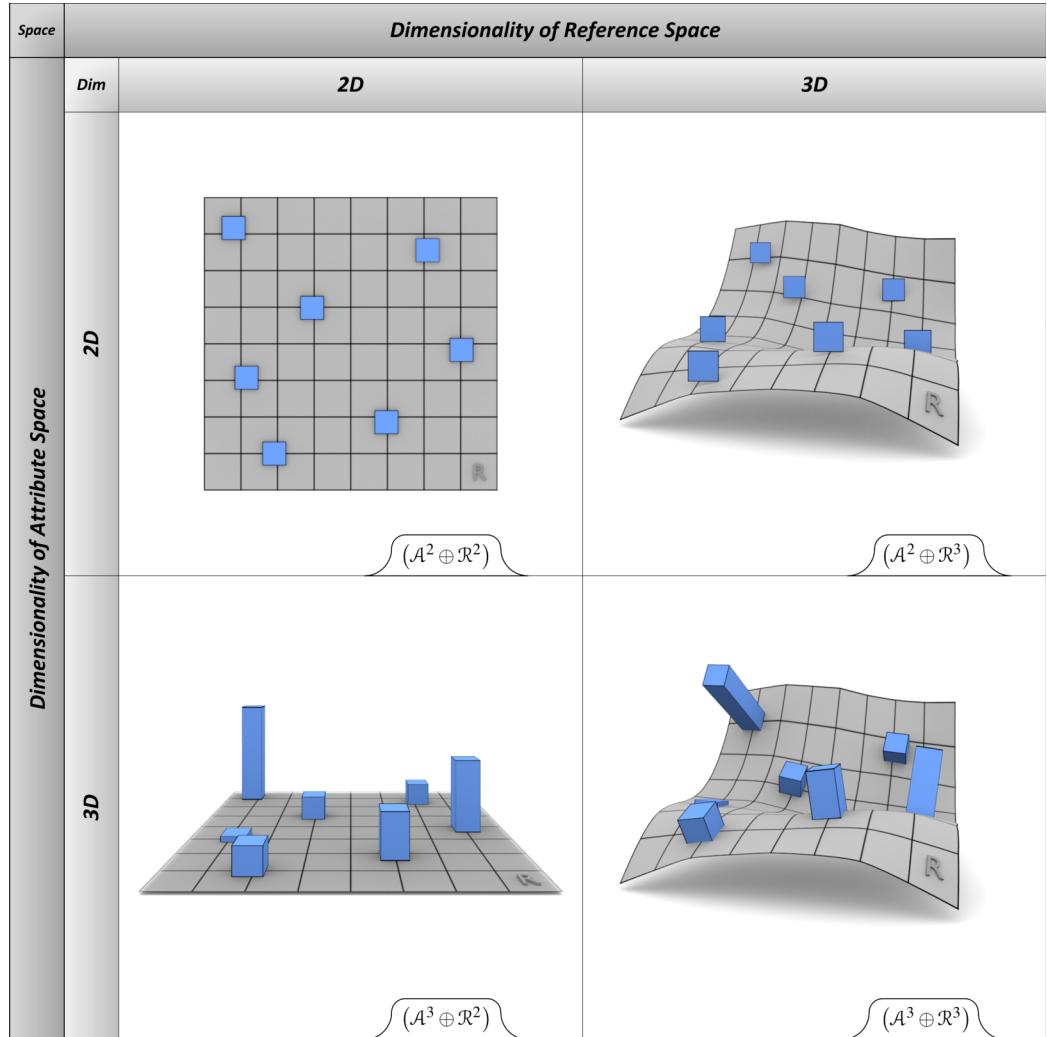


Image source:
Tominski et al. 2012



Data set:

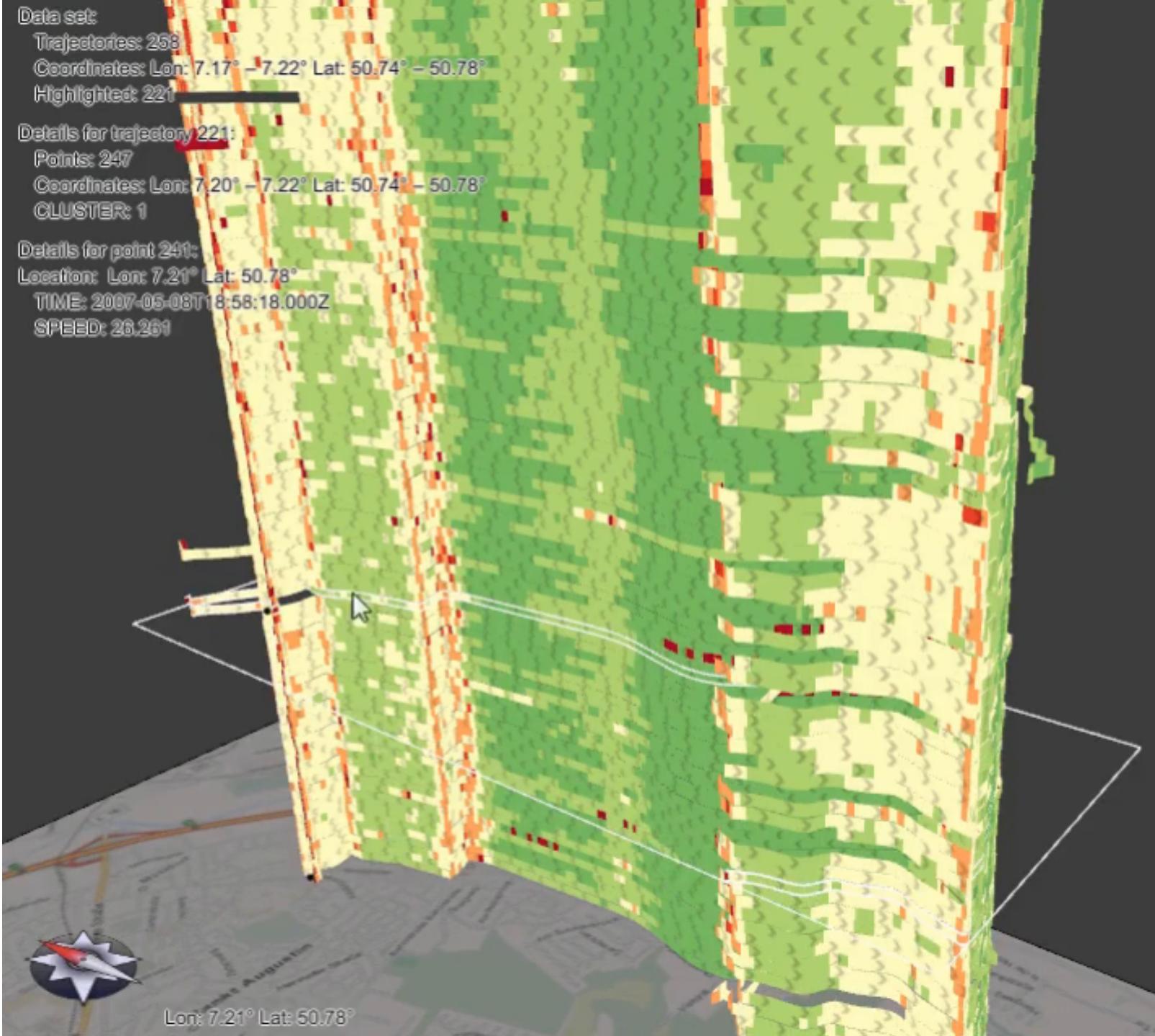
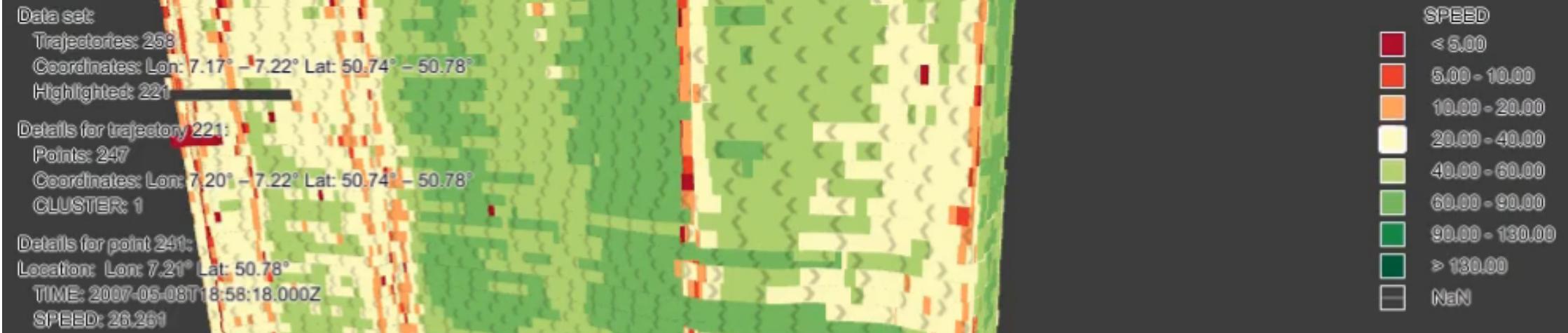
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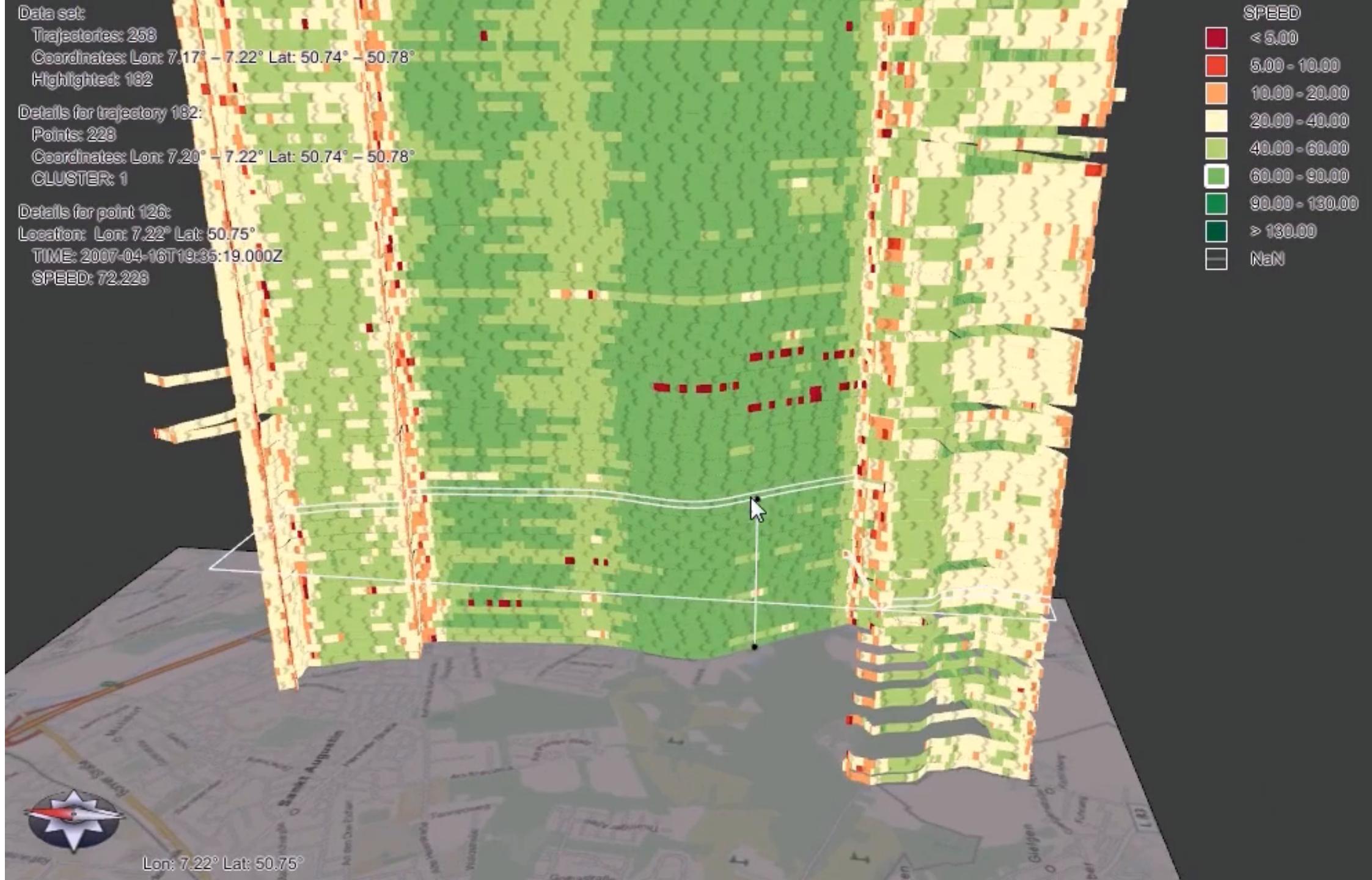
Coordinates: Lon: 7.17° - 7.22° Lat: 60.74° - 60.78°



Lon: 7.20° Lat: 60.76°







Video source: Tominski et al. 2012

CHANNELS: COLOR



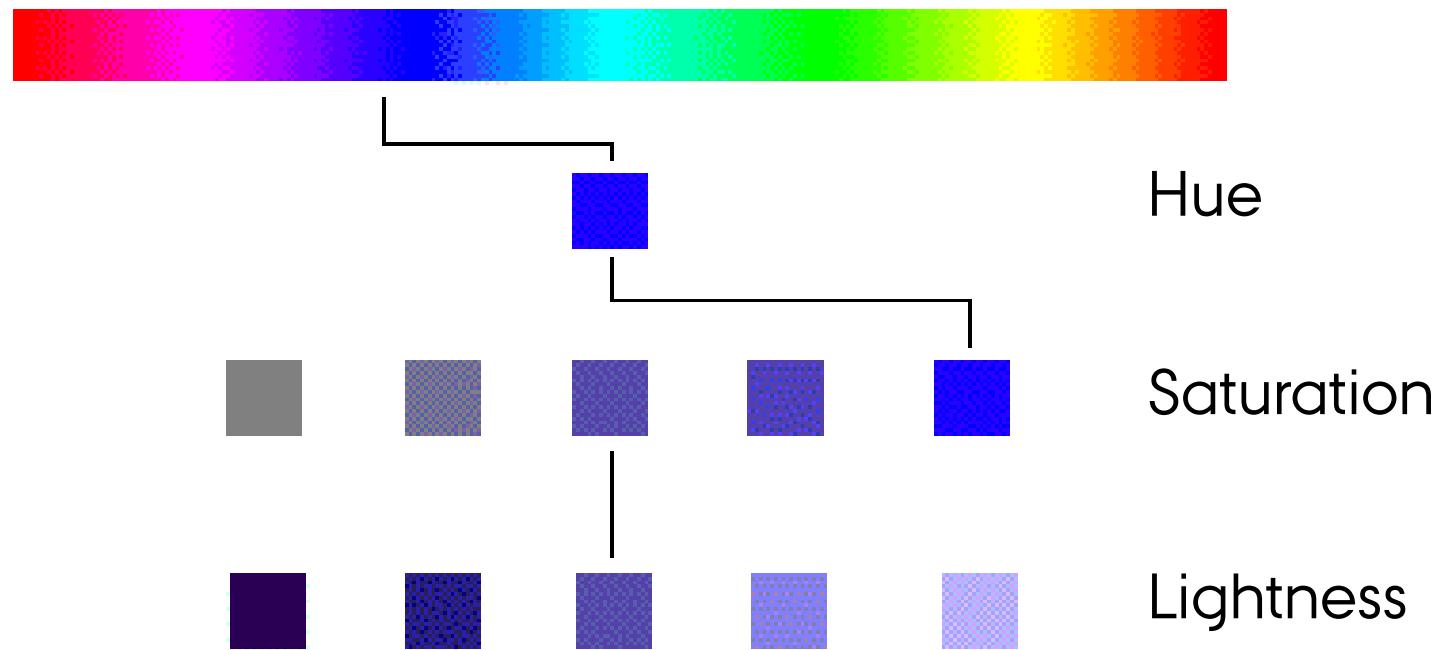
WHAT IS COLOR?

Color = Composite of *Hue*, *Saturation*, and *Lightness*

Hue = Wavelength

Saturation = Intensity from gray to pure, vivid color

Lightness = Brightness from black to colorful to white



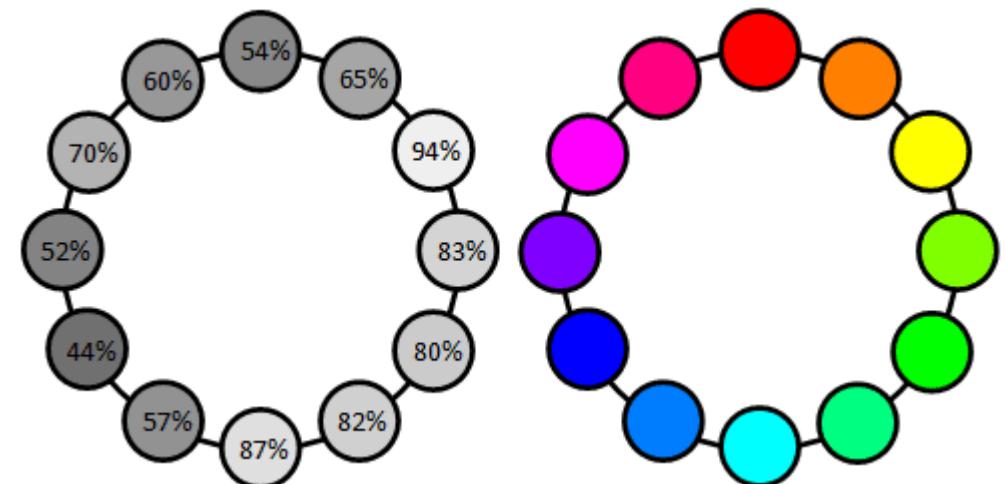
WHAT IS CONTRAST?

Luminance = visually perceived brightness
(sometimes *Color Temperature*)

Contrast = difference in luminance

$$\text{Luminance Std.} = (0.2126 * R + 0.7152 * G + 0.0722 * B)$$

$$\text{Luminance Photoshop} = \sqrt{0.299 * R^2 + 0.587 * G^2 + 0.114 * B^2}$$



HIGH CONTRAST GRAPHICS

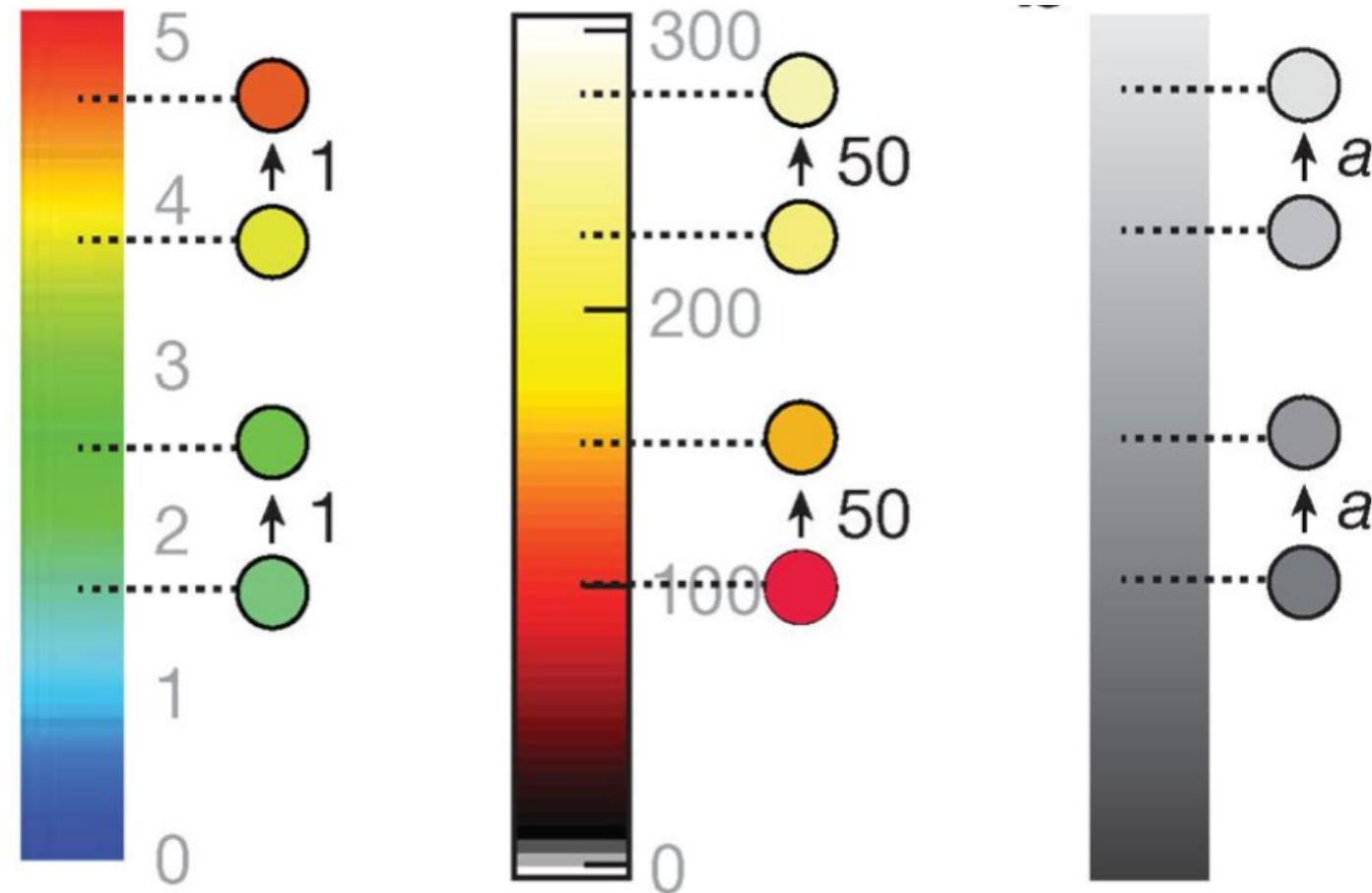


Formula @ <https://www.w3.org/TR/WCAG20-TECHS/G18.html#G18-tests>

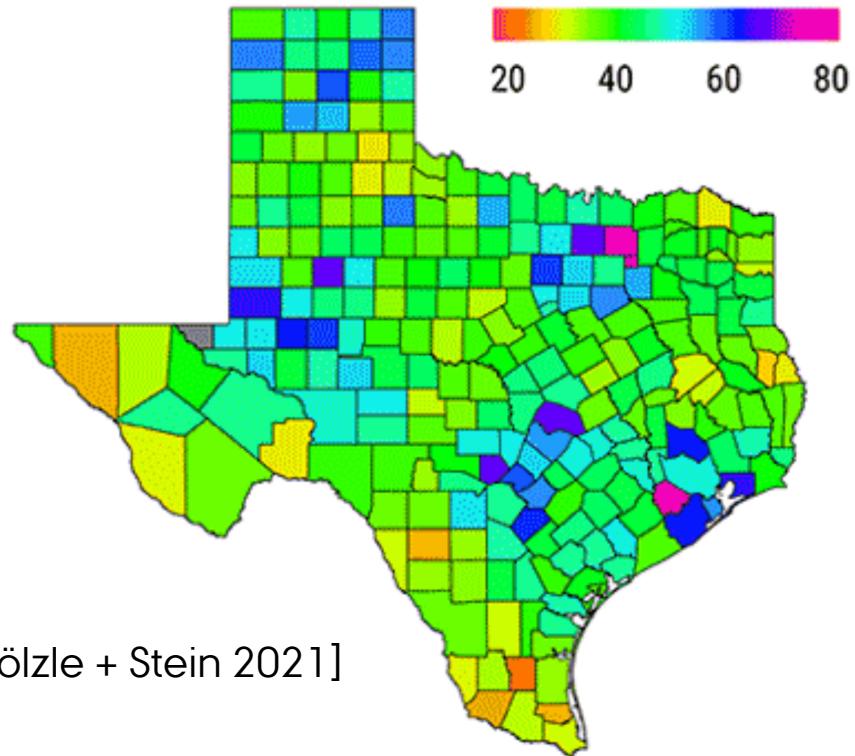
Image source: <https://observablehq.com/@frankelavsky/high-contrast-for-data-visualization-with-examples>

1. PERCEPTUALLY EQUIDISTANT COLOR SCALES

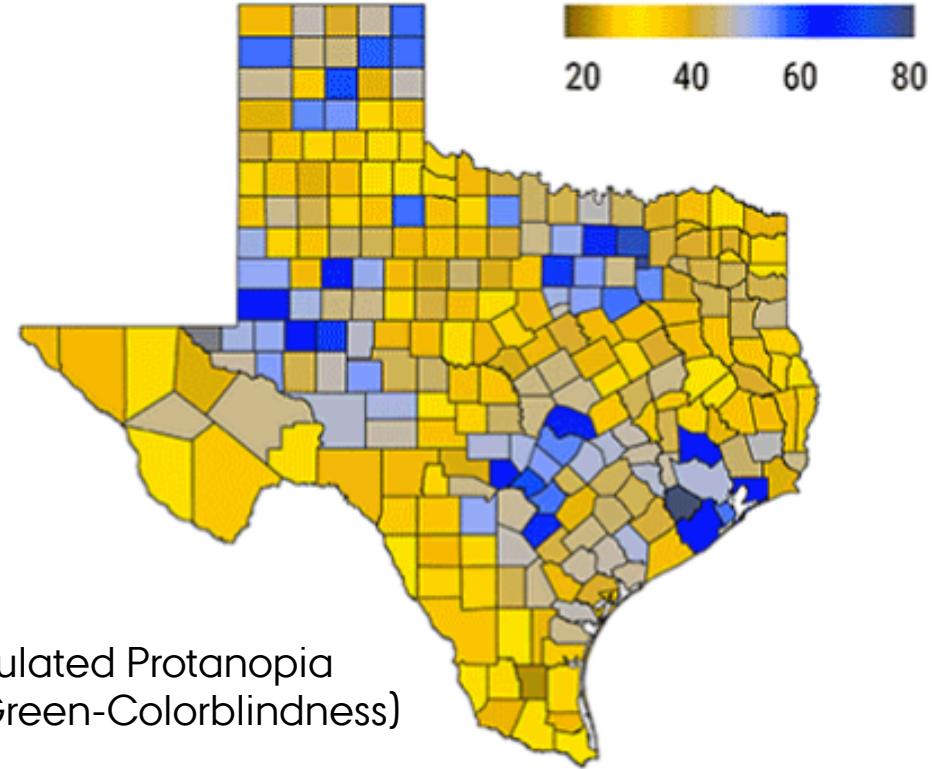
Not all color scales are created ~~equal~~ equidistant!



2. COLORBLIND-SAFE COLOR SCALES



[Stölzle + Stein 2021]



Simulated Protanopia
(Red-Green-Colorblindness)



Coblis – Color Blindness Simulator

If you are not suffering from a color vision deficiency it is very hard to imagine how it looks like to be colorblind. The **Color BLIndness Simulator** can close this gap for you. Just play around with it and get a feeling of how it is to have a color vision handicap.

As all the calculations are made on your local machine, no images are uploaded to the server. Therefore you can use images as big as you like, there are no restrictions. Be aware, there are some issues for the "Lens feature" on Edge and Internet Explorer. All others should support everything just fine.

So go ahead, choose an image through the upload functionality or just drag and drop your image in the center of our **Color BLIndness Simulator**. It is also possible to zoom and move your images around using your mouse – try it out, I hope you like it.

Drag and drop or paste your file in the area below or: [Choose File](#) No file chosen

 [Search](#)

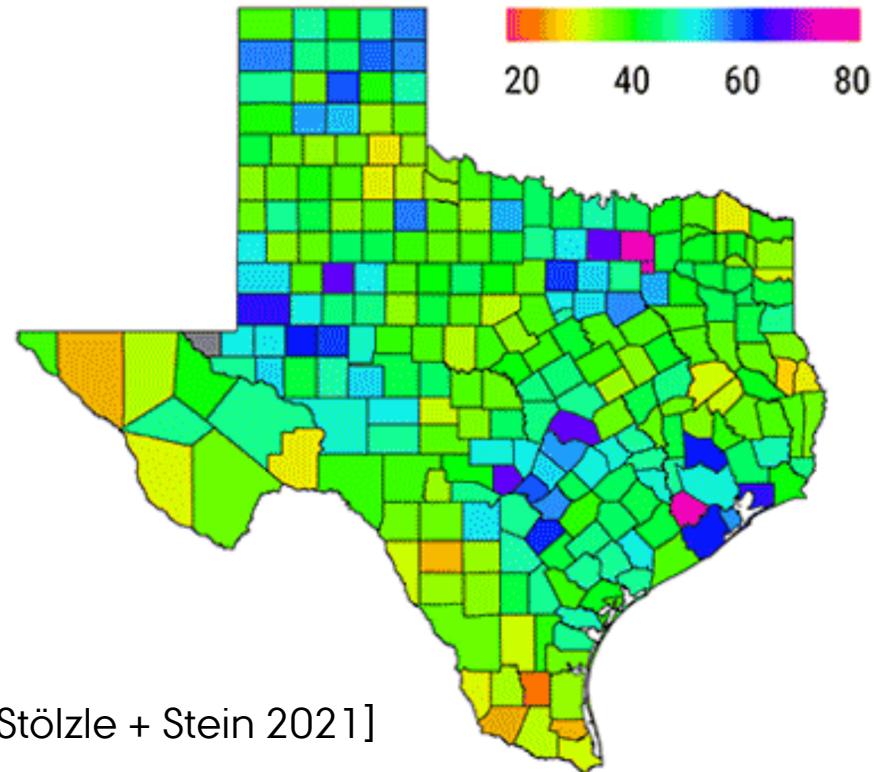
FREE Color Blind Check

New kind of color blindness test! Try [Color Blind Check](#) and test type and severity of your color vision deficiency. Easy and fun!
Info at www.colorblindcheck.com

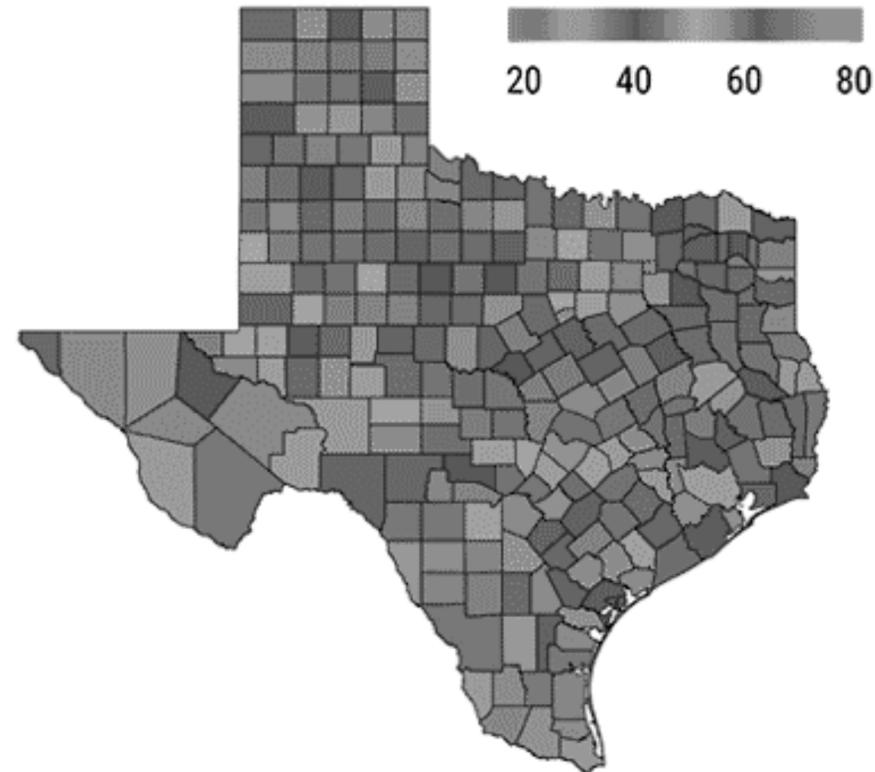


CVD Categories

3. COLOR SCALES W/ INCREASING LUMINANCE



[Stölzle + Stein 2021]



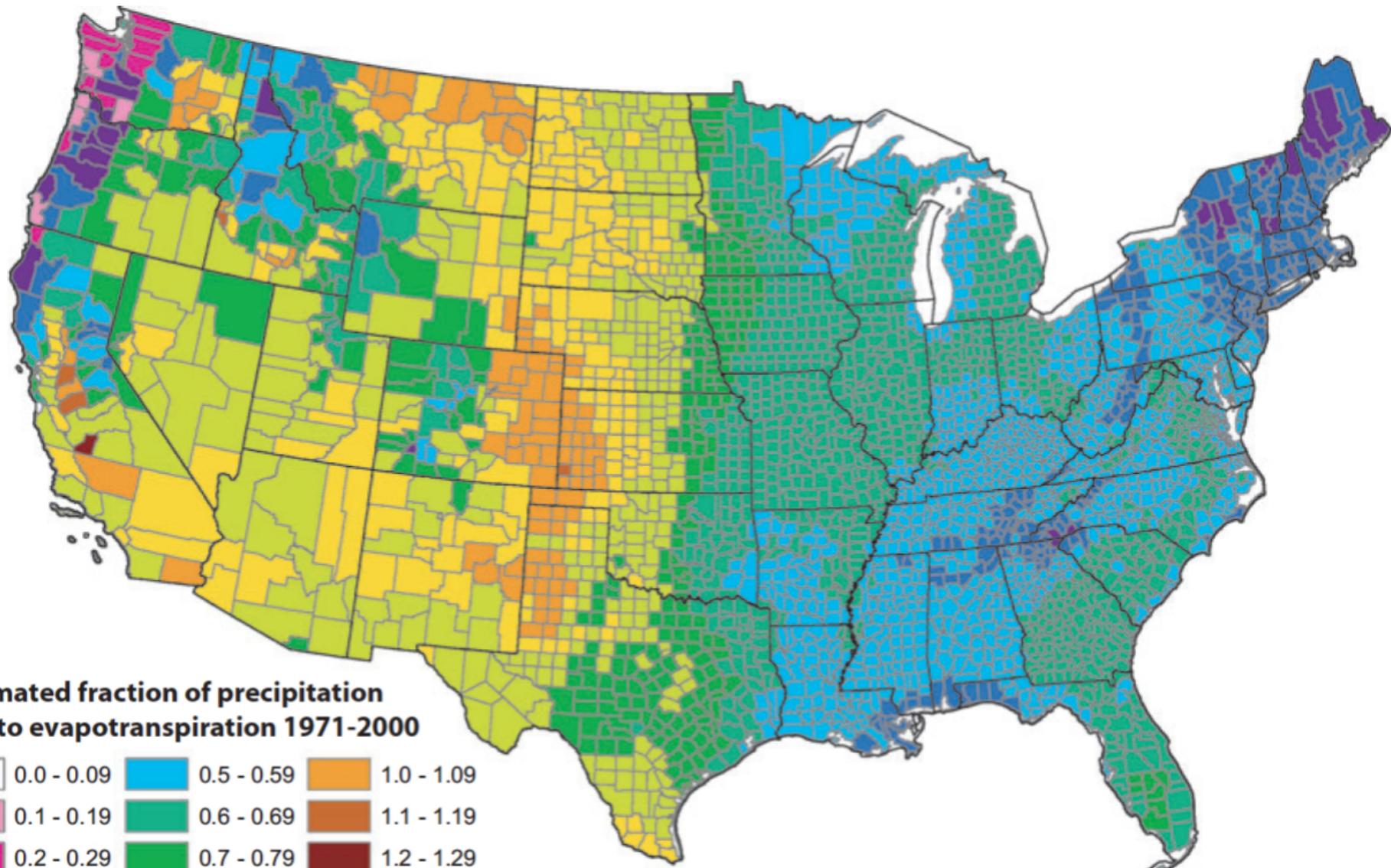


Image source: <https://eagereyes.org/basics/rainbow-color-map>

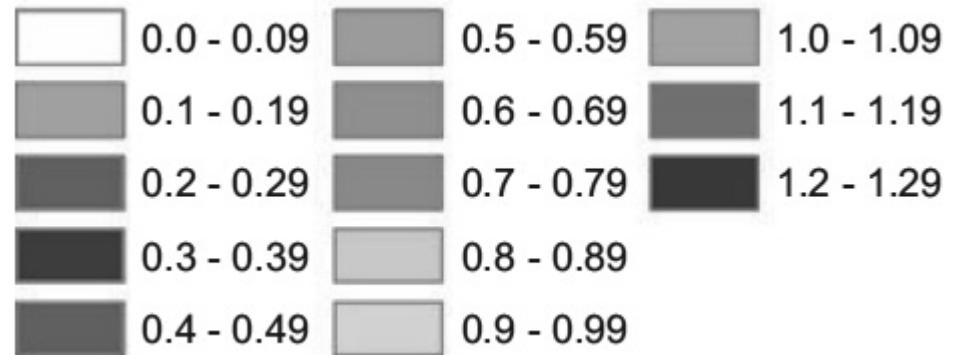
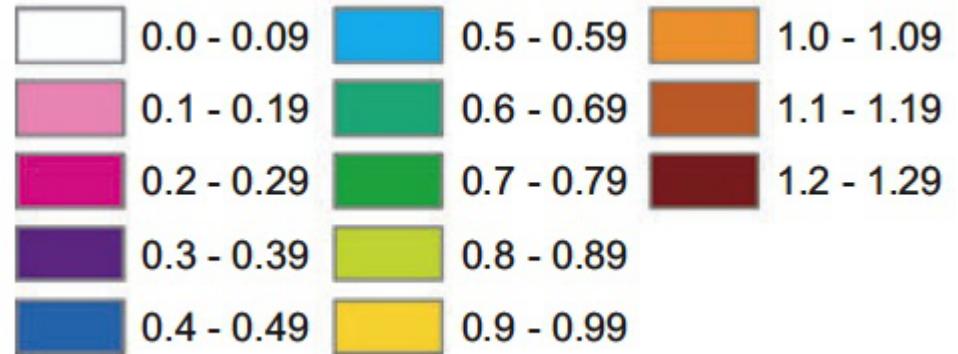
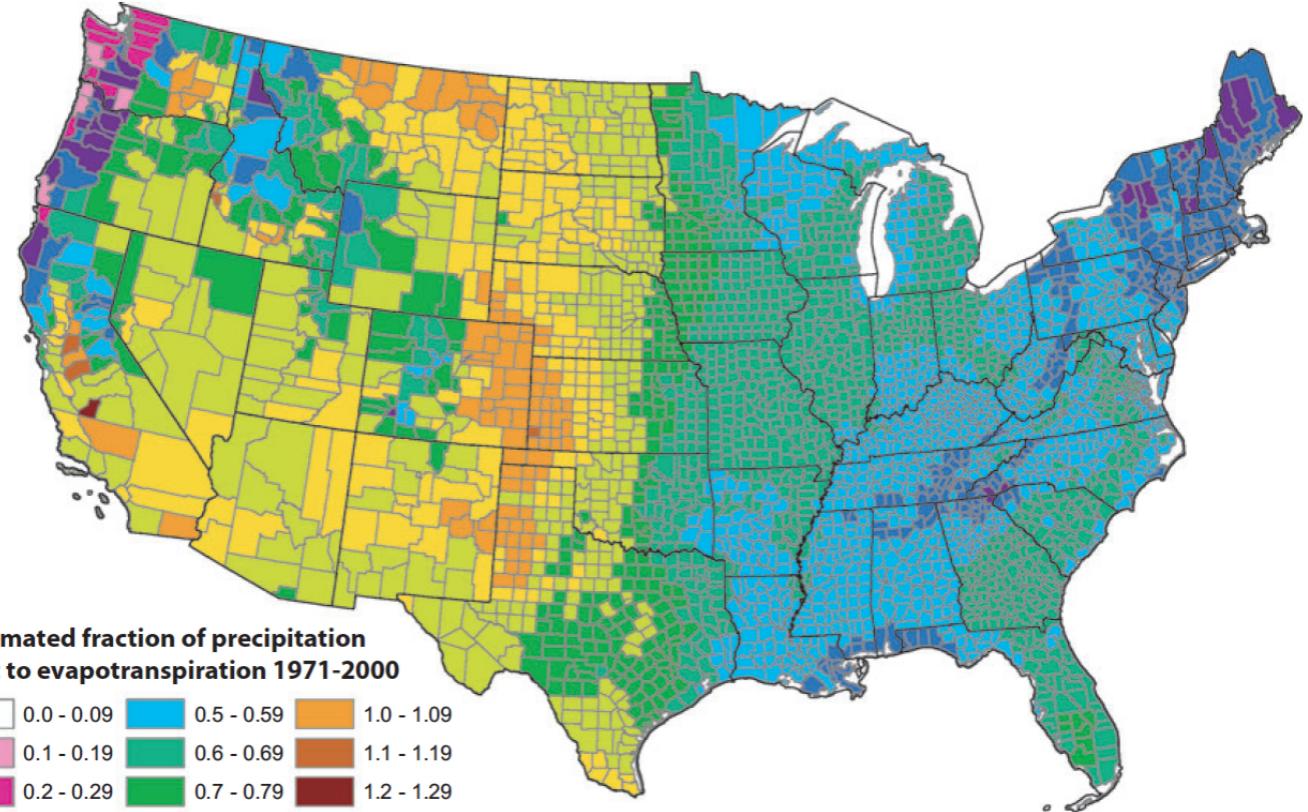
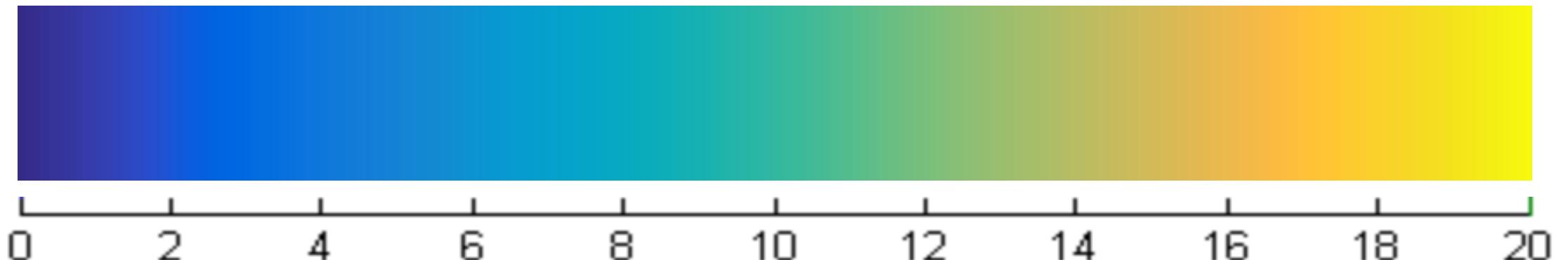
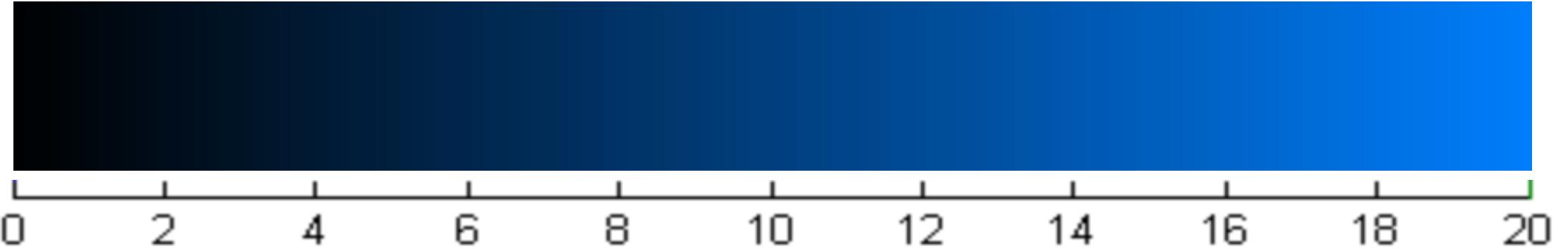


Image source: <https://eagereyes.org/basics/rainbow-color-map>

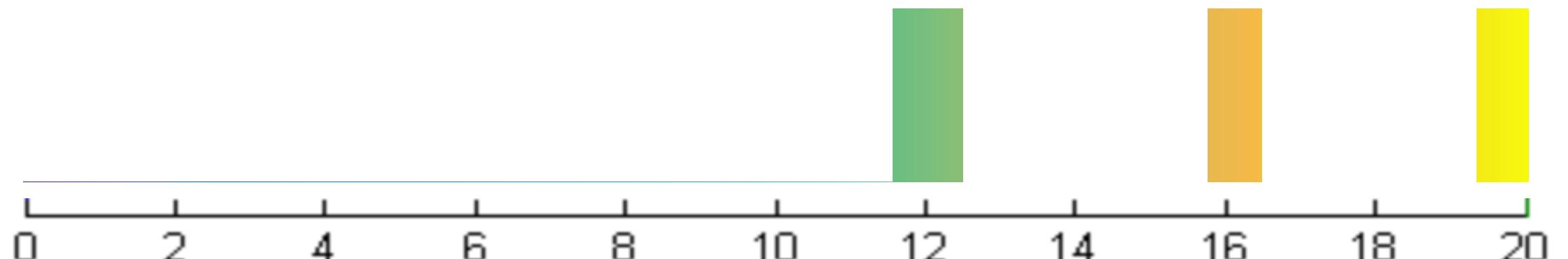
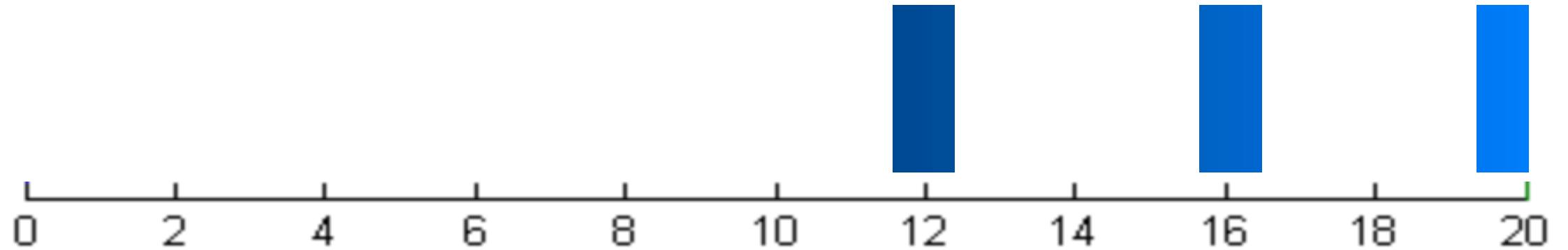
SEQUENTIAL, MULTI-HUE COLOR SCALES



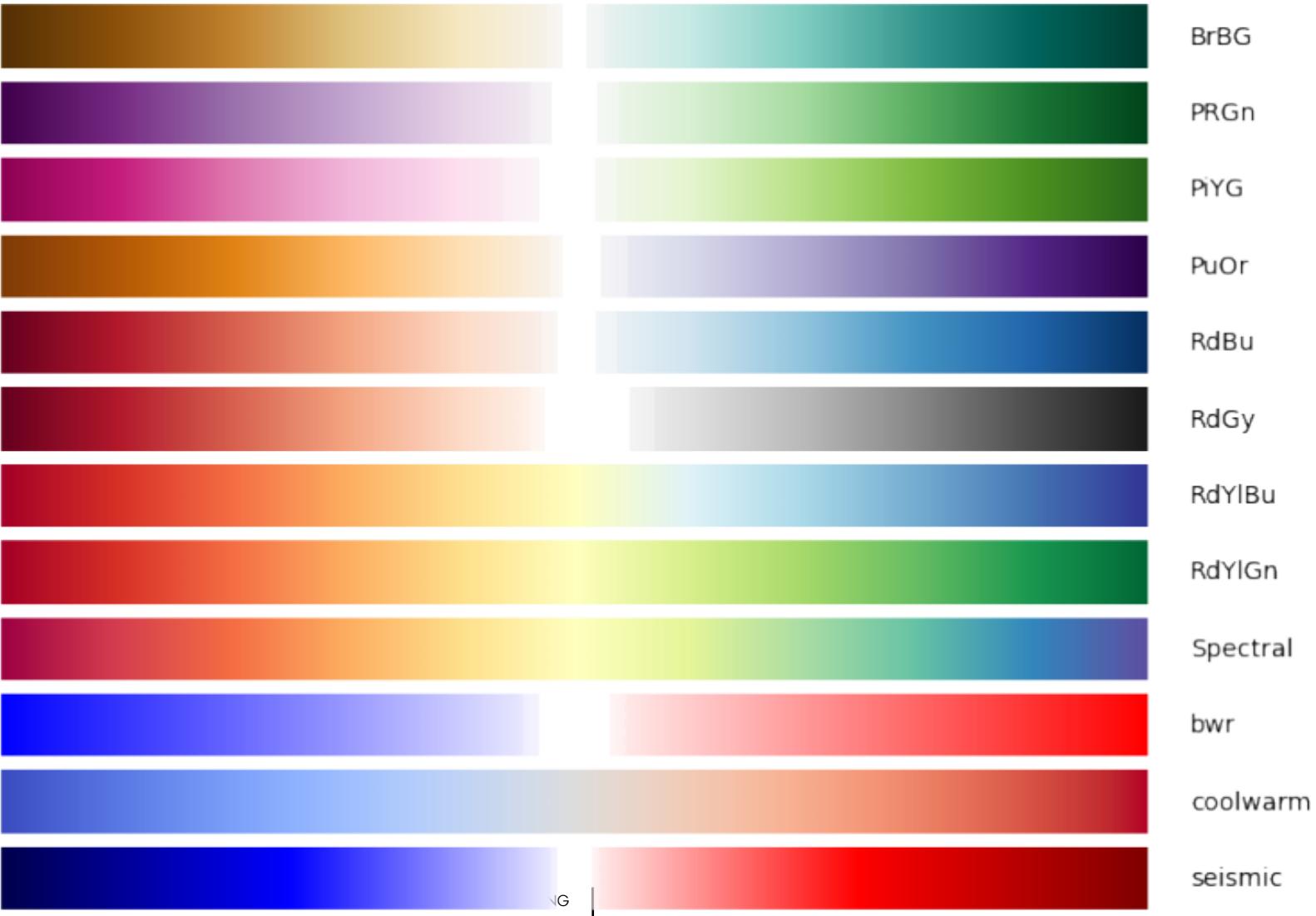
MULTI-HUE VS. SINGLE-HUE COLOR SCALES



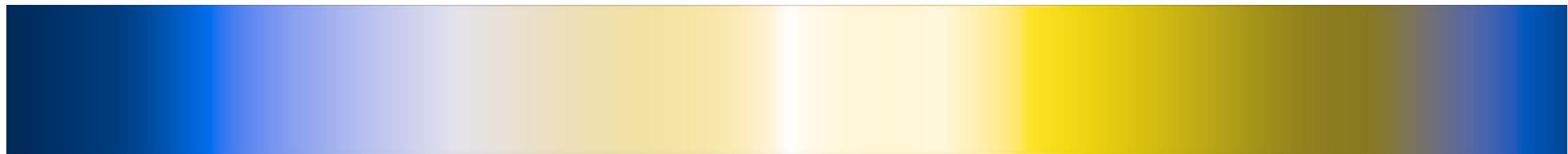
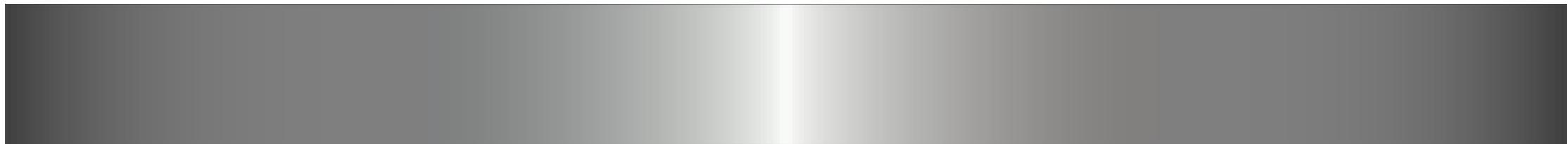
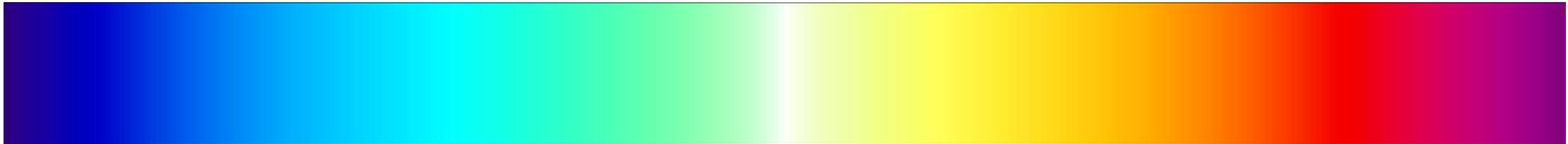
MULTI-HUE VS. SINGLE-HUE COLOR SCALES



DIVERGING COLOR SCALES



IS IT POSSIBLE TO HAVE A DIVERGING MULTI-HUE COLOR SCALE?



https://www.ncl.ucar.edu/Document/Graphics/ColorTables/NCV_jaisnd.shtml

Number of data classes: 3

[how to use](#) | [updates](#) | [downloads](#) | [credits](#)

COLORBREWER 2.0

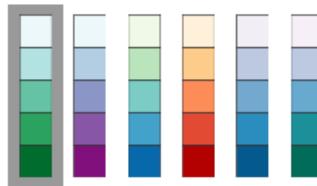
color advice for cartography

Nature of your data:

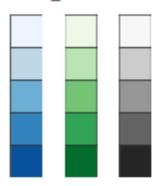
sequential diverging qualitative

Pick a color scheme:

Multi-hue:



Single hue:



Only show:

- colorblind safe
- print friendly
- photocopy safe

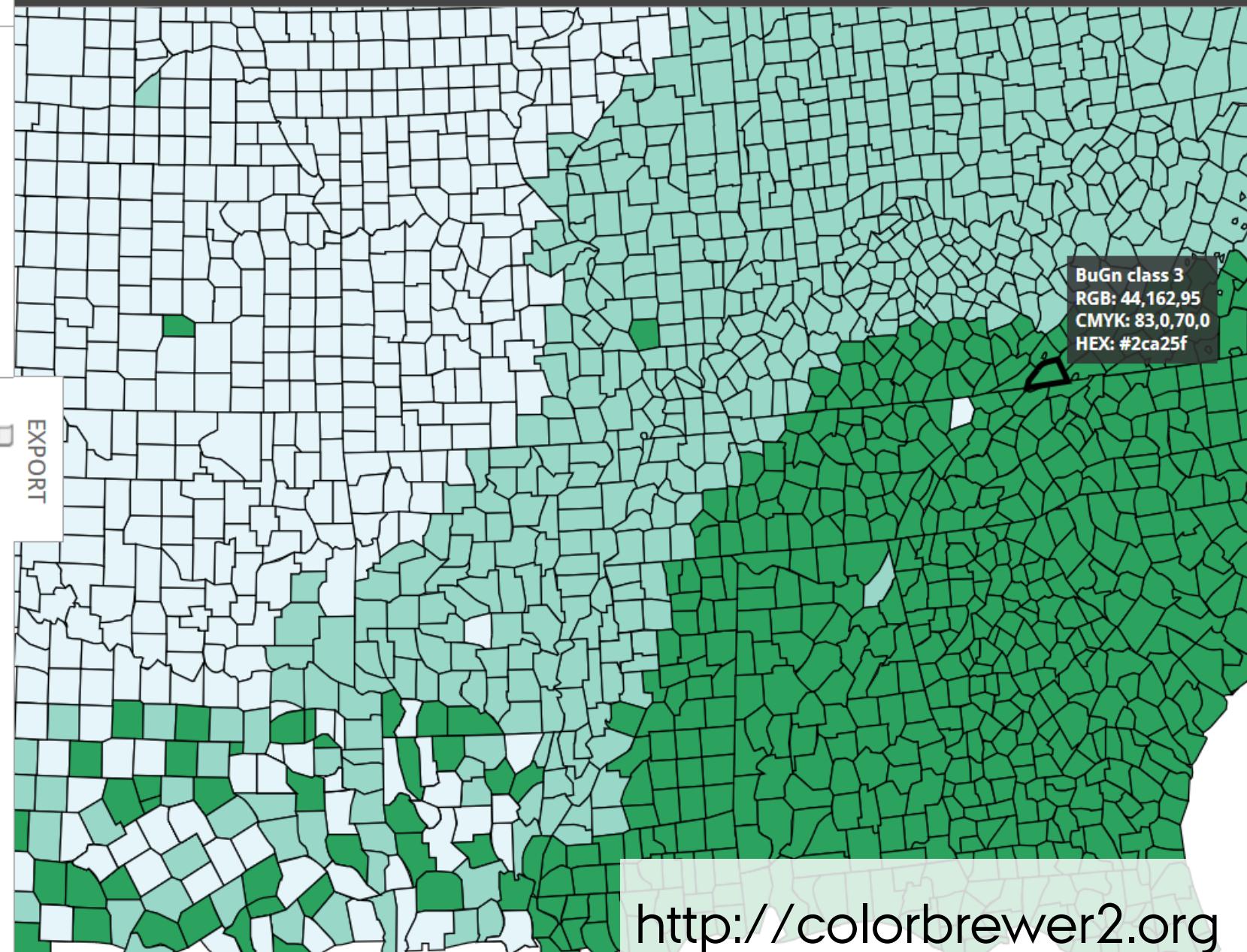
Context:

- roads
- cities
- borders

Background:

- solid color
- terrain

color transparency



Generate

The Colorgorical interface displays four generated color palettes, each consisting of a color swatch, a histogram, and a scatter plot.

Top Palette:

- Color space: Hex, RGB, Lab, LCH
- Array format: No quote
- Charts: Bar, Dot
- Clear all

Color Swatches (Top Palette):

- rgb(105,239,123)
- rgb(218,54,97)
- rgb(119,214,207)
- rgb(122,44,57)

Color Swatches (Second Palette):

- rgb(88,181,225)
- rgb(33,77,78)
- rgb(202,219,165)
- rgb(92,47,142)

Color Swatches (Third Palette):

- rgb(141,228,211)
- rgb(44,92,57)
- rgb(197,213,240)
- rgb(118,7,150)

Color Swatches (Fourth Palette):

- rgb(120,185,143)
- rgb(9,96,19)
- rgb(75,214,253)
- rgb(45,116,122)

Number of colors: 5

Score importance:

- Perceptual Distance
- Name Difference
- Pair Preference
- Name Uniqueness

Select hue filters:

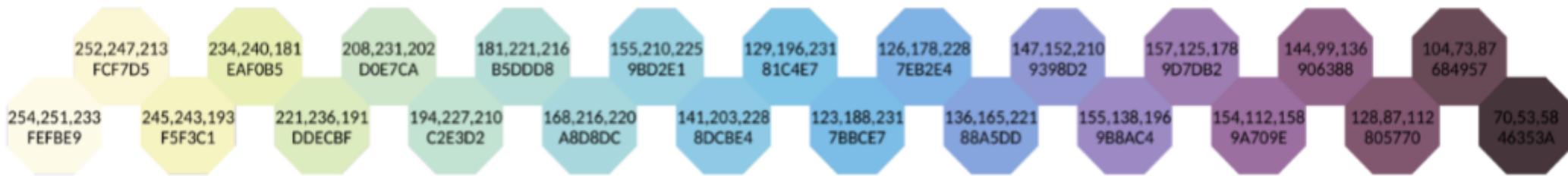
<http://vrl.cs.brown.edu/color>

PAUL TOL'S QUANTITATIVE COLORS

Incandescent



Iridescent



Nightfall



<https://personal.sron.nl/~pault/>



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ASSOCIATE PROFESSOR



PAUL TOL'S QUALITATIVE COLORS



<https://personal.sron.nl/~pault/>



LABELING



FAVOR DIRECT LABELING OVER LEGENDS

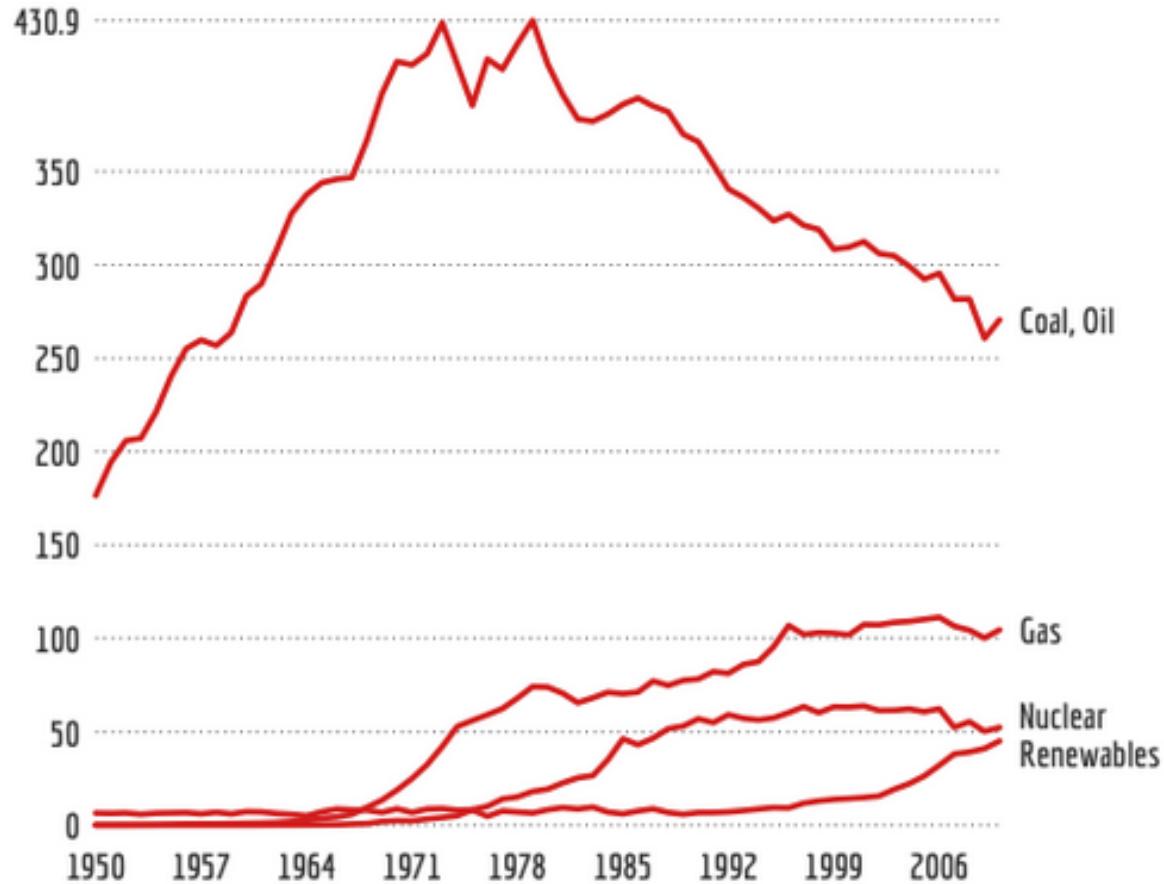
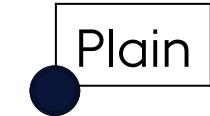


Image Source: <https://www.vis4.net/blog/2012/06/doing-the-line-charts-right/>

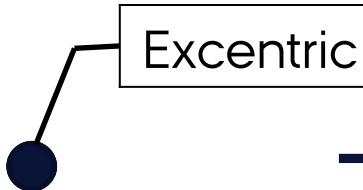
LABEL TYPES FOR DIRECT LABELING



- simple placement
- good attribution
- high likelihood of occlusion in dense areas



- good attribution
- hampered readability
- problematic for longer labels



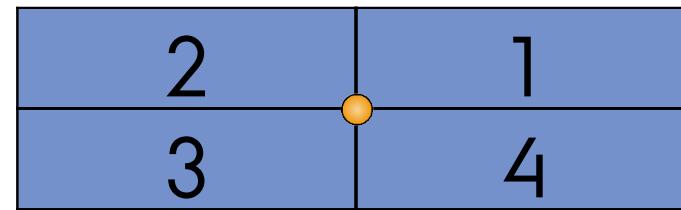
- connecting link adds to visual complexity
(especially in the presence of edges)
- can alleviate occlusion to some degree

PARTICLE-BASED LABELING

adapted from [Luboschik et al. 2008]
DOI: 10.1109/TVCG.2008.152

STAGE 1: Attempt to place a plain label

1. The 4-Position Model



2. The 8-Position Model

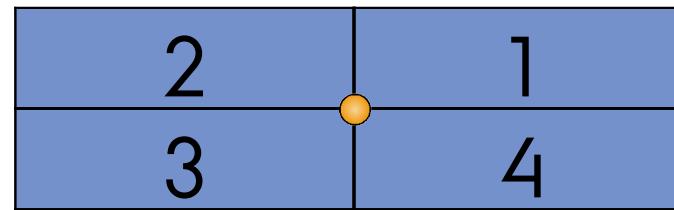
3. The Slider Model

PARTICLE-BASED LABELING

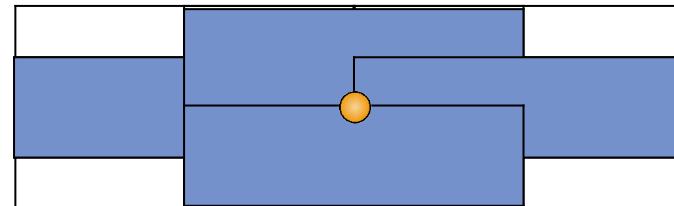
adapted from [Luboschik et al. 2008]
DOI: 10.1109/TVCG.2008.152

STAGE 1: Attempt to place a plain label

1. The 4-Position Model



2. The 8-Position Model



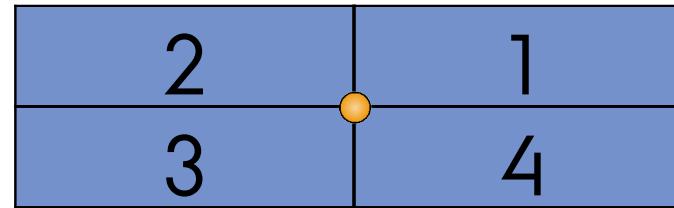
3. The Slider Model

PARTICLE-BASED LABELING

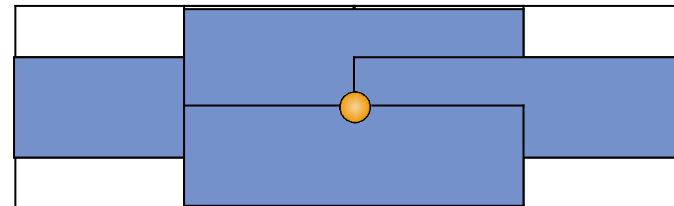
adapted from [Luboschik et al. 2008]
DOI: 10.1109/TVCG.2008.152

STAGE 1: Attempt to place a plain label

1. The 4-Position Model



2. The 8-Position Model



3. The Slider Model



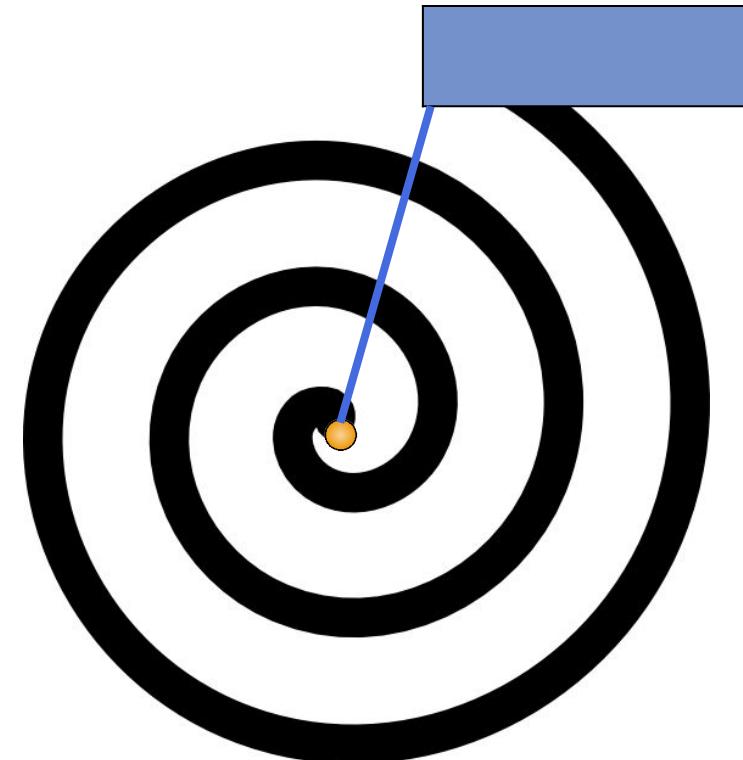
A PRINCIPAL LABELING PROCEDURE

STAGE 2: Attempt to place an excentric label

Move the label along a spiral path until a suitable position is found.

How to do the collision detection efficiently?
Particles → Video

adapted from [Luboschik et al. 2008]
DOI: 10.1109/TVCG.2008.152





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[Luboschik et al. 2008]
DOI: 10.1109/TVCG.2008.152

RENDERING



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ASSOCIATE PROFESSOR



ALL KINDS OF DRAWING STYLES...

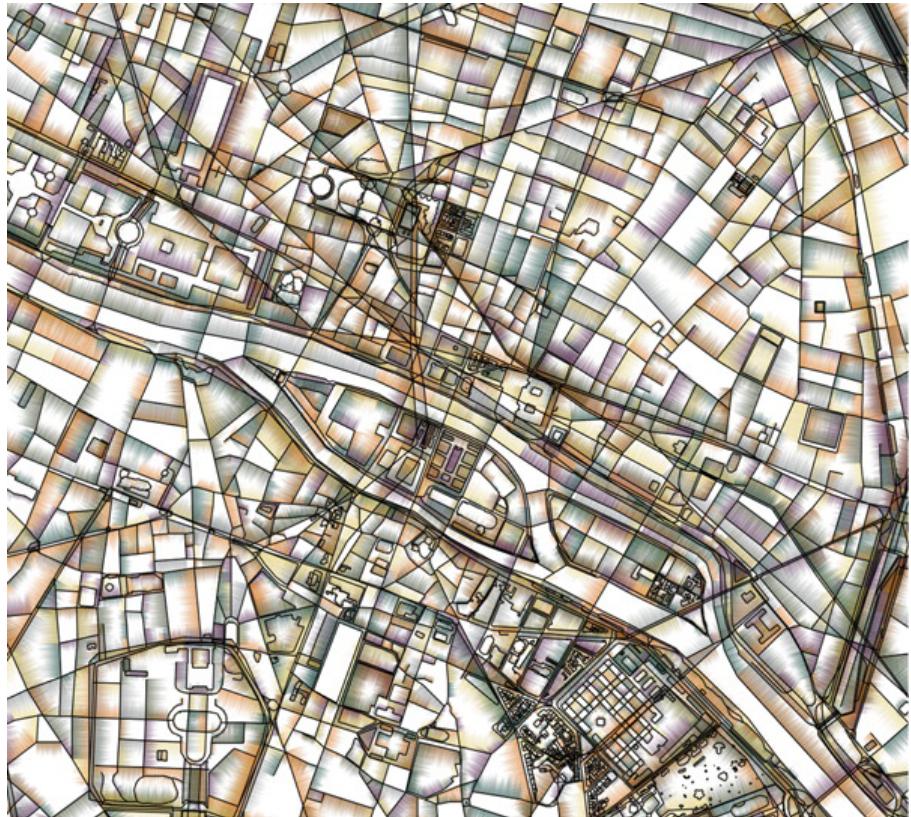


Image source: [Isenberg 2013]

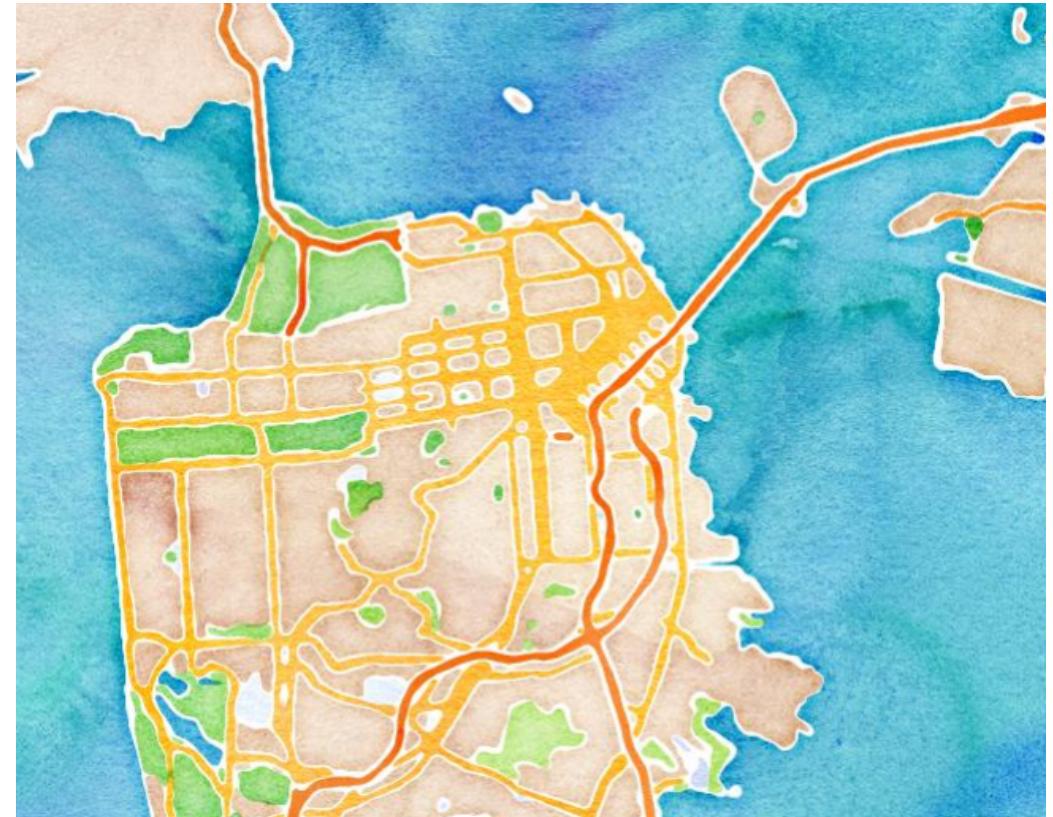


Image source: <http://kelsocartography.com/blog/?p=4228>

IMPRESSIONISTIC VISUALIZATION

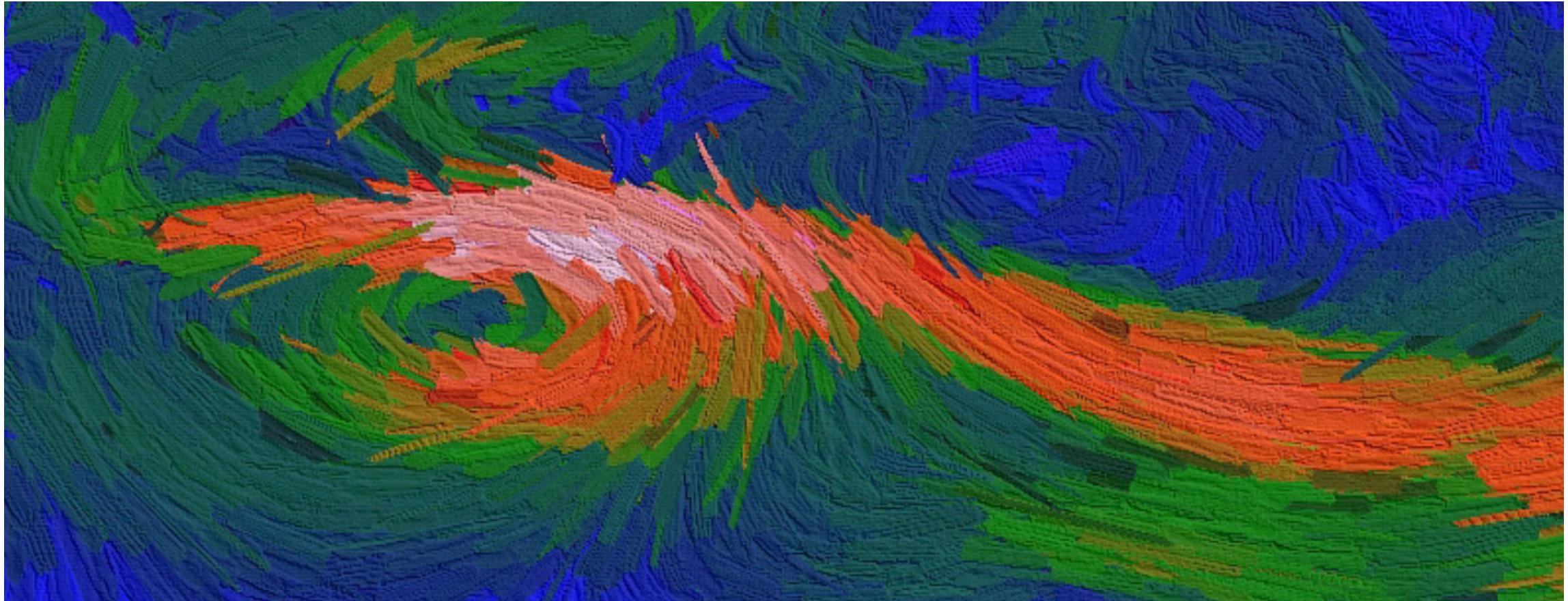


Image source: [Tateosian et al. 2007]



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...NOT ONLY FOR MAPS

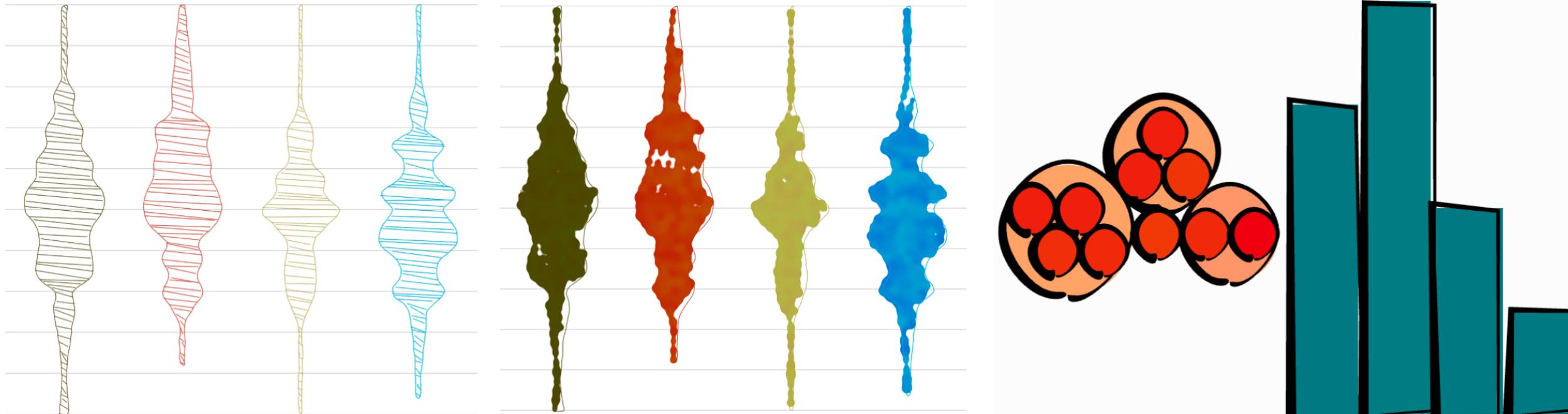
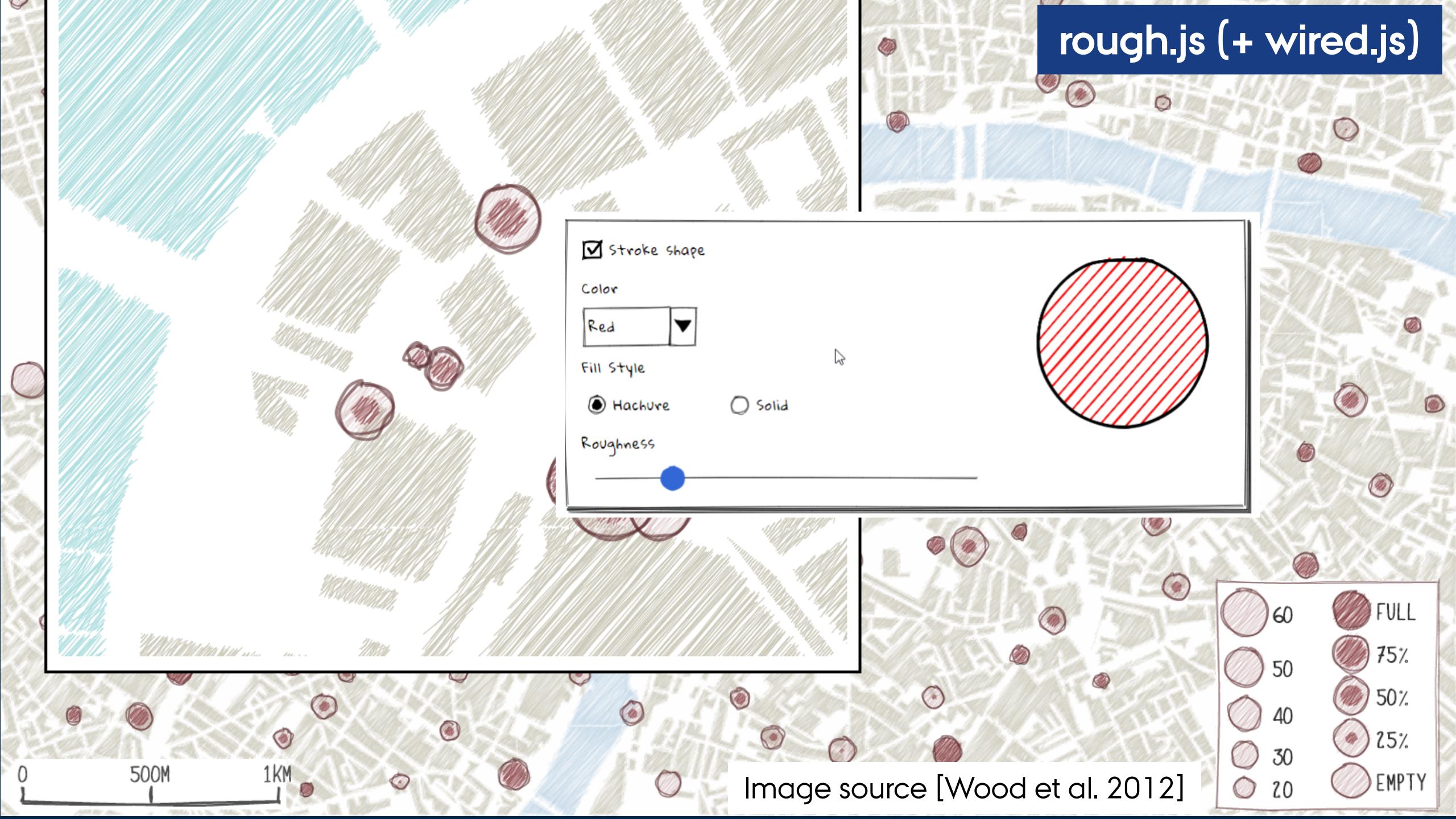


Image source: https://medium.com/@Elijah_Meeks/sketchy-data-visualization-in-semiotic-5811a52f59bc

rough.js (+ wired.js)



HOW TO HATCH

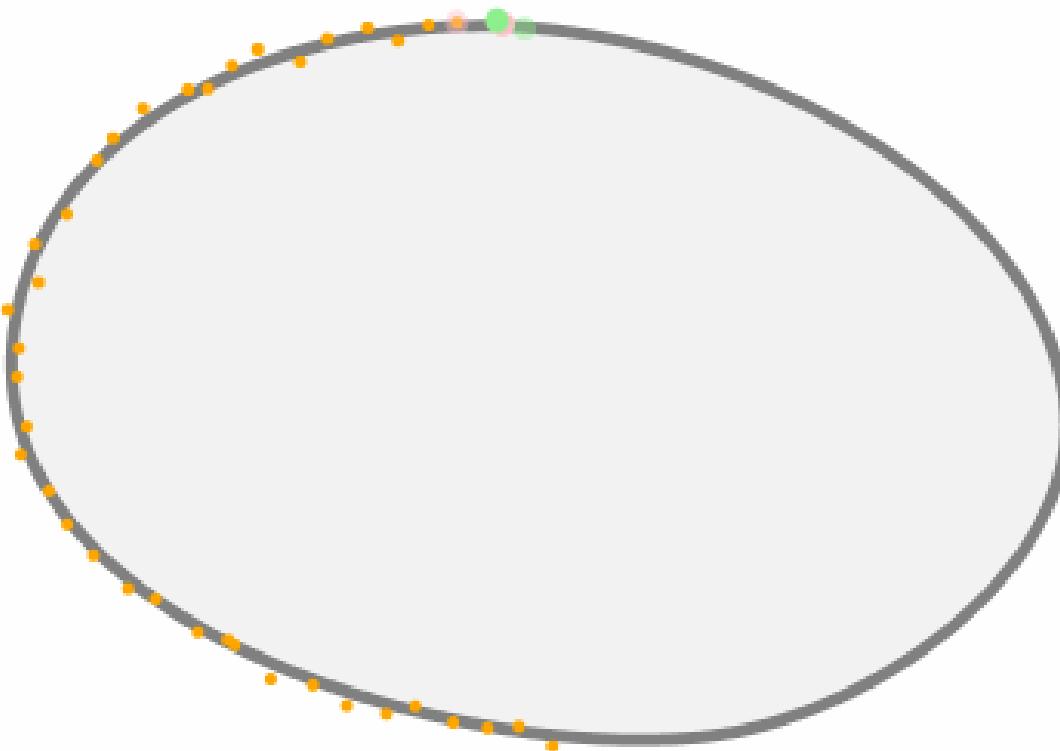
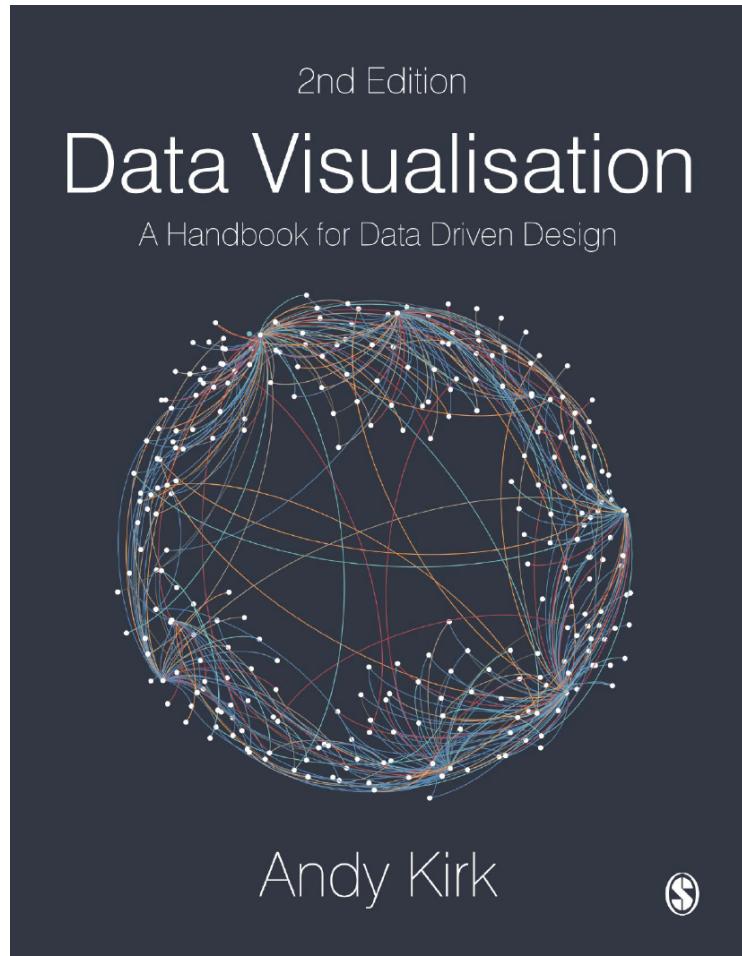


Image source: https://medium.com/@Elijah_Meeks/sketchy-data-visualization-in-semiotic-5811a52f59bc

LIST OF LITERATURE SOURCES

- Perception in Visualization: <https://www.csc2.ncsu.edu/faculty/healey/PP/>
Paper: <https://doi.org/10.1109/TVCG.2011.127>
- Gregory 1991 – Optical Illusions: <https://doi.org/10.1068/p200001>
- Stevens 1946 – Data Types/Scales: <https://doi.org/10.1126/science.103.2684.677>
- Mackinley 1986: <https://doi.org/10.1145/22949.22950>
- Munzner 2014: <https://www.cs.ubc.ca/~tmm/vadbook/> (chapter 5)
- Brath 2014 – 3D: <https://doi.org/10.1109/3DVis.2014.7160096>
- Ware 2000: <https://doi.org/10.1075/ij.10.3.07war>
- Hanson et al. 1997: <https://doi.org/10.1109/DAGSTUHL.1997.1423106>
- Yu et al. 2016: <https://doi.org/10.1109/tvcg.2015.2467202>
- Dübel et al. 2014: <https://doi.org/10.1109/3DVis.2014.7160094>
- Tominski et al. 2012: <https://doi.org/10.1109/TVCG.2012.265>
- Stoelzle + Stein 2021: <https://doi.org/10.5194/hess-25-4549-2021>
- Luboschik et al. 2008: <https://doi.org/10.1109/TVCG.2008.152>
- Gooch 2010: <https://doi.org/10.1145/1809939.1809958>
- Tateosian et al. 2007: <https://doi.org/10.1145/1274871.1274886>
- Isenberg 2013: <https://doi.org/10.1179/1743277412Y.0000000007>

WEEKLY READING FOR NEXT WEEK



BULLET CHART
ALSO KNOWN AS (No other names)

REPRESENTATION DESCRIPTION
A bullet chart is effectively a bar chart displaying quantitative values for different categories. It consists of three main parts: a central vertical axis, a horizontal baseline, and one or more bars extending above or below the baseline. The length of each bar represents a quantitative value. The bars are typically colored to distinguish between categories. The chart includes numerical tick marks on both the vertical axis and the bars themselves.

EXAMPLE Comparing the batting averages for the current top 20 ranked batsmen in international Test cricket.

Top 20 Ranked Batters

RANK	NAME	COUNTRY
1	Virat Kohli	IND
2	Steve Smith	AUS
3	Kane Williamson	NZ
4	Joe Root	ENG
5	David Warner	AUS
6	Cheteshwar Pujara	IND
7	Shivnarine Chanderpaul	WI
8	Shreyas Iyer	IND
9	Adnan Marnam	SA
10	Umar Akmal	PAK
11	Ross Taylor	NZ
12	Haseeb Hameed	PAK
13	François du Plessis	SA
14	Ahar Ali	PAK
15	Kusal Mendis	SL
16	Jenny Bairstow	ENG
17	Ajinkya Rahane	IND
18	Shakib Al Hasan	BAN
19	Kraig Brathwaite	WI
20	Prithvi Shaw	IND

Figure 6.6 The Top 20 Ranked Batters

PRESENTATION TIPS

ANNOTATION: The inclusion of chart apparatus devices like tick marks and gridlines can help increase the precision of judging the quantitative values. If you include scale labels you should not need to label each bar value directly, as this will lead to label overload. Any colours used to indicate meaningful bandings or markers should be explained through the inclusion of a legend.

COMPOSITION: The bars should be proportionally sized according to the associated quantitative value – nothing more, nothing less – otherwise the perception of the sizes will be distorted. Most commonly, this means setting the quantitative values to an origin of zero. There is no significant difference in perception between vertically or horizontally arranged bullet charts; it will depend on which layout makes it easiest to accommodate the range of values and to read the item labels associated with each bar. Aim to make the sorting of values in the chart as meaningful as possible.

HEAT MAP
ALSO KNOWN AS Matrix chart, mosaic plot, table chart

REPRESENTATION DESCRIPTION
A heat map displays quantitative values across the intersections of two categorical axes with each distinct value presented across the row and column axes. Each cell in the matrix contains a point mark with the attribute of colour (usually, colour lightness).

EXAMPLE Comparing the average number of daily births across England and Wales between 1995 and 2014.

How popular do you think your own birthday is?
Average daily births, England and Wales, 1995 to 2014

Figure 6.14 How Popular is Your Birthday?, by ONS Content team

BOX-AND-WHISKER PLOT
ALSO KNOWN AS Box plot, candlestick chart, OHLC chart

REPRESENTATION DESCRIPTION
A box-and-whisker plot displays the distribution and shape of a series of quantitative values for different categories. The display is formed by a combination of lines and point markers to indicate (through position and thickness), typically, five different statistical measures. Three of the statistical values are common to all plots: the first quartile (25th percentile), the second quartile (or median) and the third quartile (75th percentile) values. These are displayed with a box (effectively a wide bar) positioned and sized according to the first and third quartile values with a marker indicating the median. The remaining two statistical values vary in definition: usually the minimum and maximum values or the 10th and 90th percentiles. These statistical values are represented by extending a line beyond the bottom and top of the main box to join with a point marker indicating the appropriate position. These are the whiskers. A single plot will be produced for each relevant, discrete category grouping.

Ranking the Ivies

EXAMPLE Comparing the distribution of annual earnings 10 years after starting school for graduates across the eight Ivy League colleges.

Figure 6.20 This Chart Shows How Much More Ivy League Grads Make Than You, by Christopher Ingraham (Washington Post)

PRESENTATION TIPS

ANNOTATION: Direct value labelling is possible but normally a clear legend is required to determine the exact quantitative values represented by the colours, even if the order of magnitude is clear.

COLOUR: Decisions need to be made about whether to use a smooth color gradient or a categorical color palette. Different approaches will affect the patterns that emerge. There is no single 'best' approach, but it is important to consider, especially when you have many categories, how the colors will be perceived.

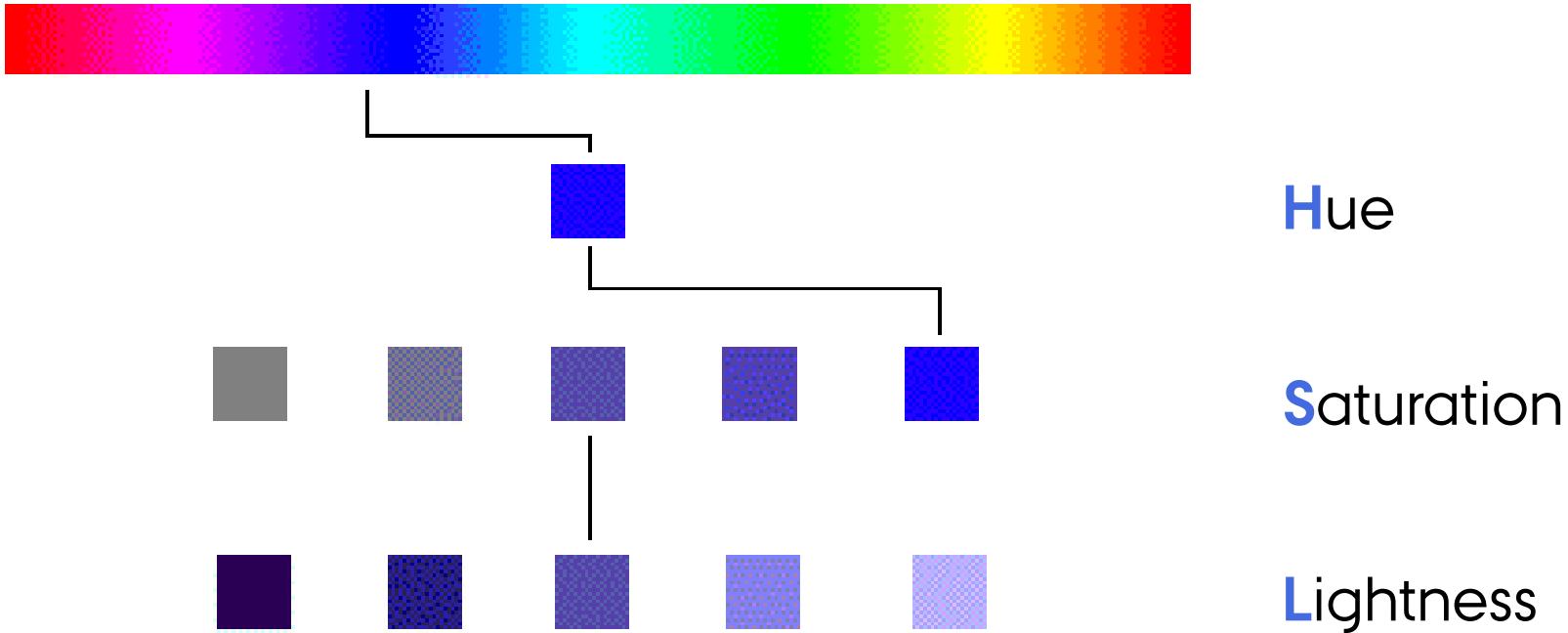
VARIATIONS & ALTERNATIVES

Variations mainly concern changing the number of statistical measures included in the display. Sometimes you might remove the 'whiskers' to show just the 25th and 75th percentiles through the lower and upper parts of the 'box'. The 'candlestick chart' (or OHLC chart) used in stock market analysis to track the opening, highest, lowest and closing prices of stocks) uses a similar method and is often used to show the distribution and milestone quantitative values for events that encounter constant change, such as stock market analysis over a given time frame based on showing the opening, highest, lowest and closing prices.

ADVANCED COLORS



THE HSL COLOR DEFINITION



A DESIGNER'S VIEW ON COLOR



Tone := color + gray



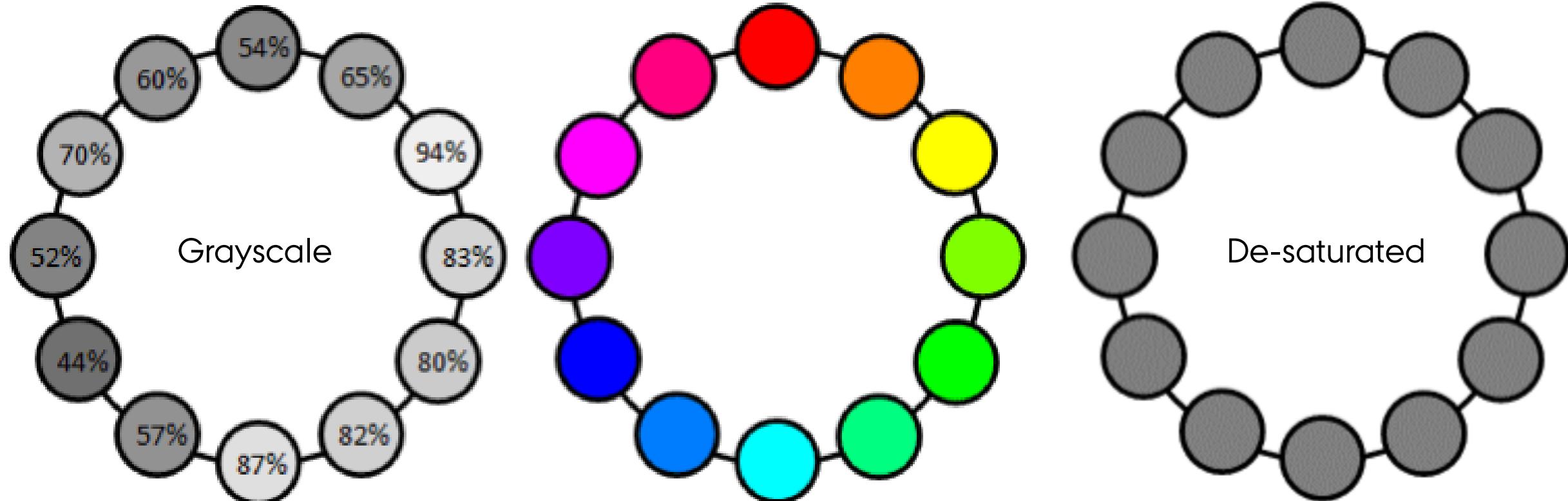
Tint := color + white



Shade := color + black



LUMINANCE VS. LIGHTNESS

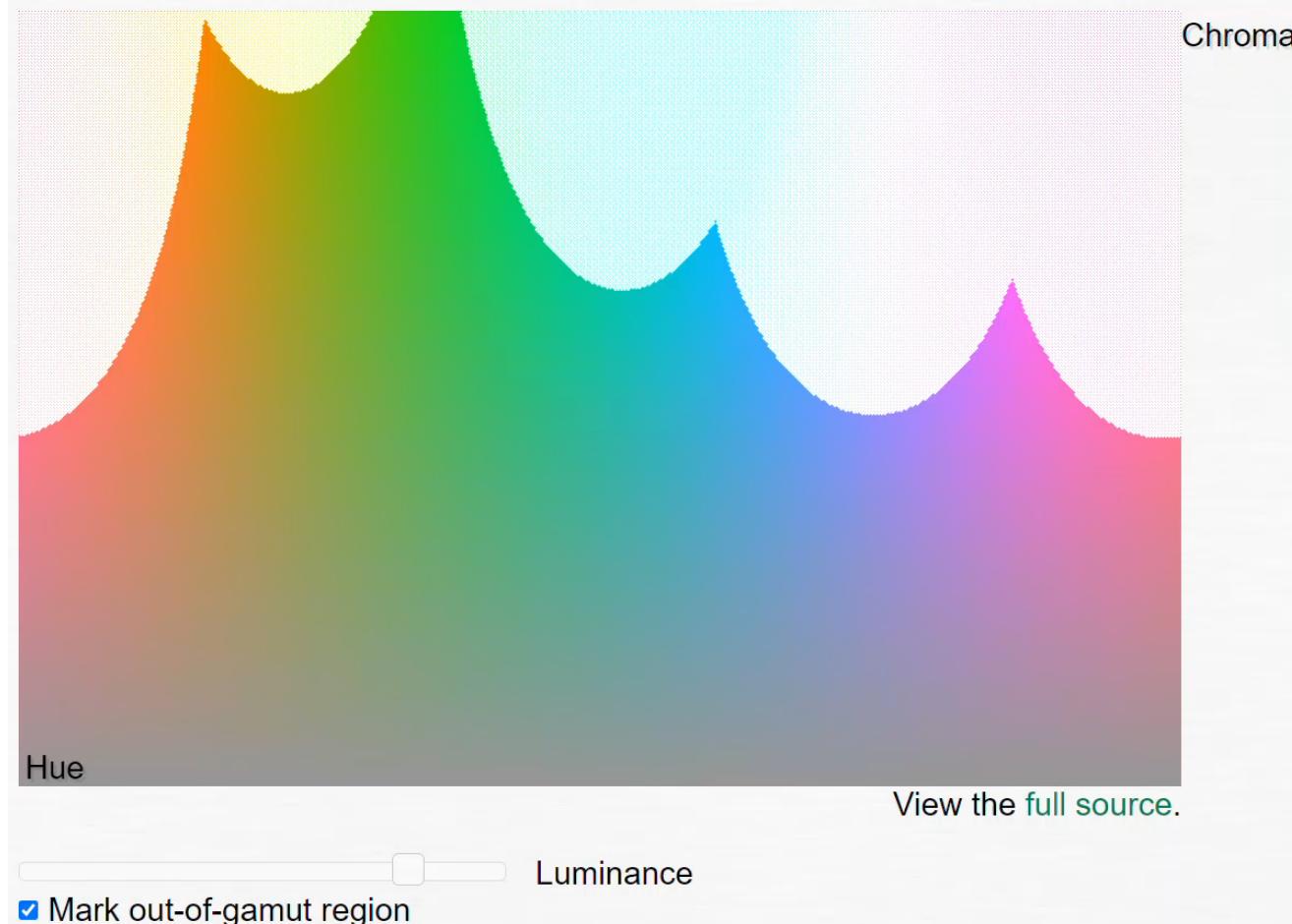


HCL - A PERCEPTUAL COLOR SPACE

H = hue

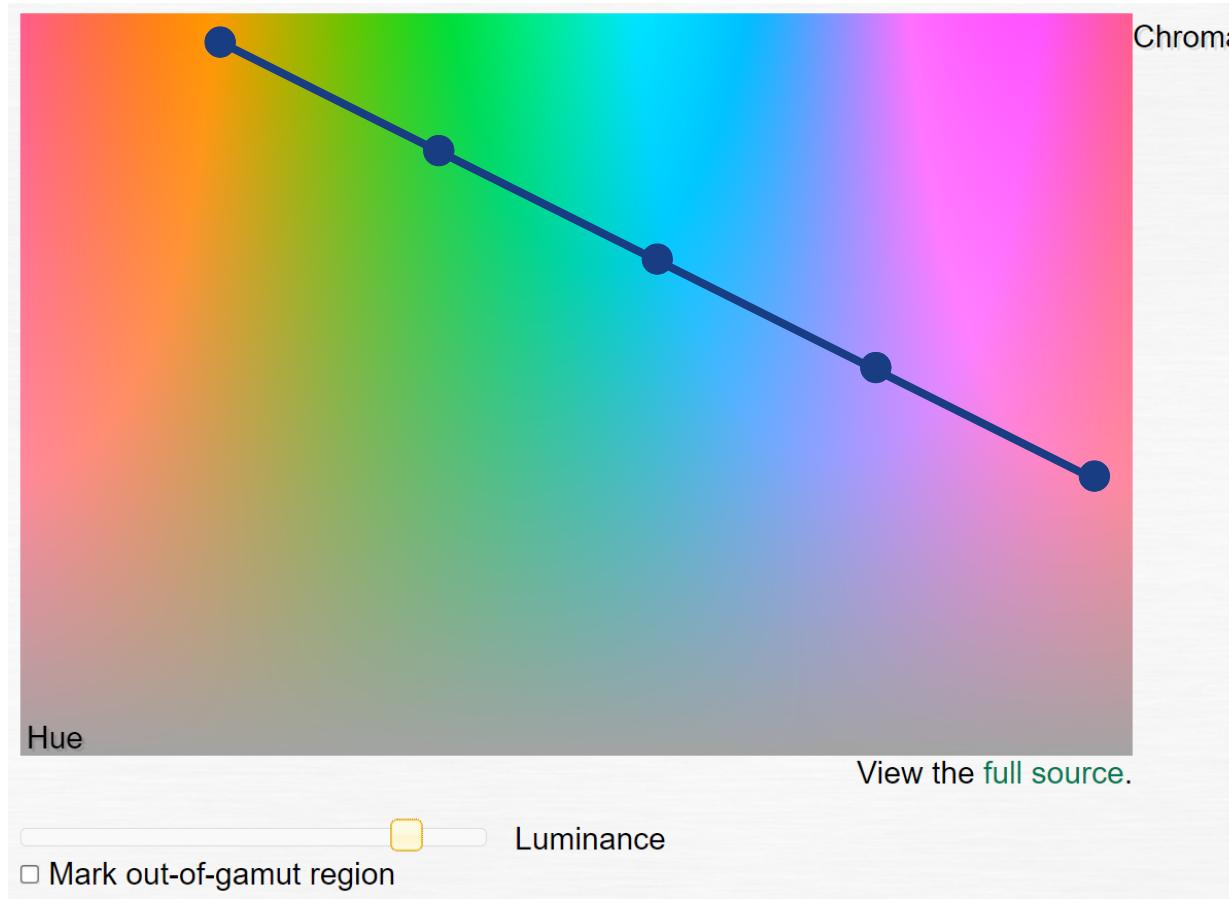
C = chroma

L = luminance



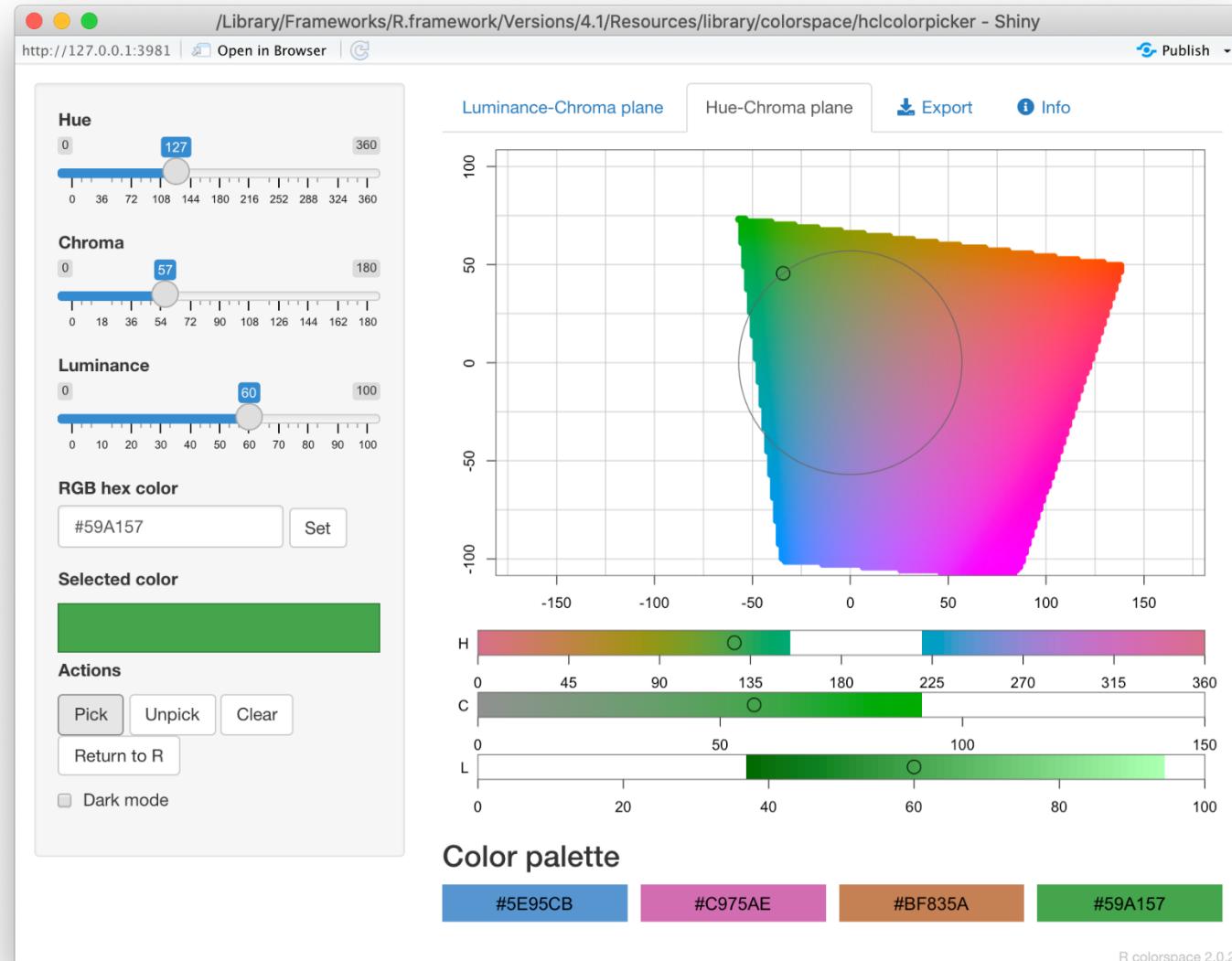
<https://cscheid.github.io/lux/demos/hcl/hcl.html>

HCL - A PERCEPTUAL COLOR SPACE



Colors	Luminance	Lightness

HCL COLOR PICKER

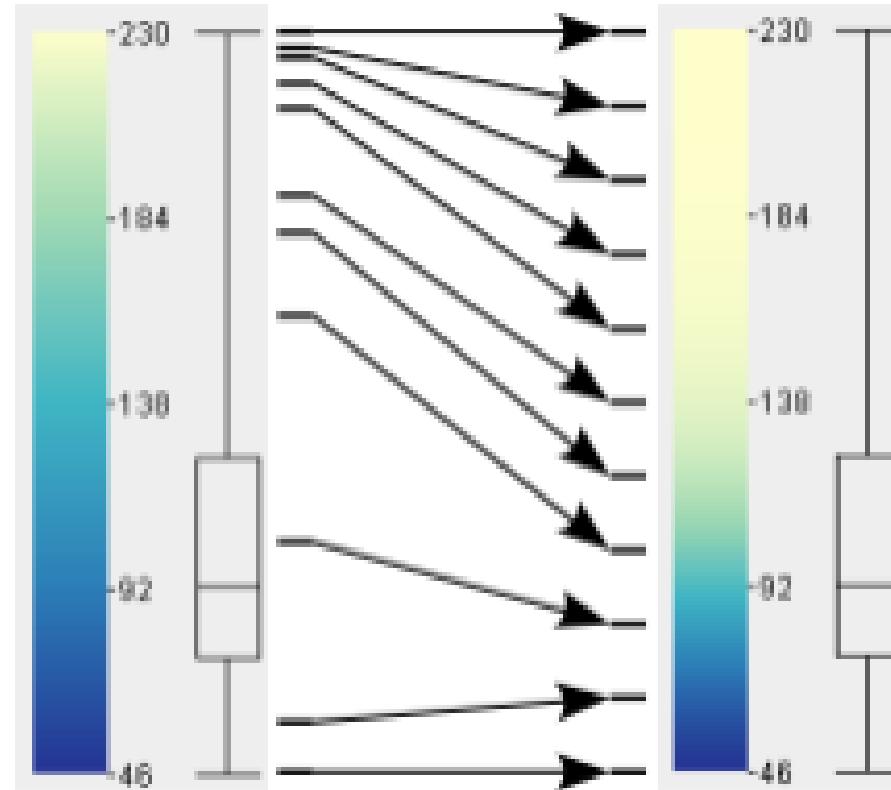


COLOR CODING FOR DIFFERENT DATA CHARACTERISTICS



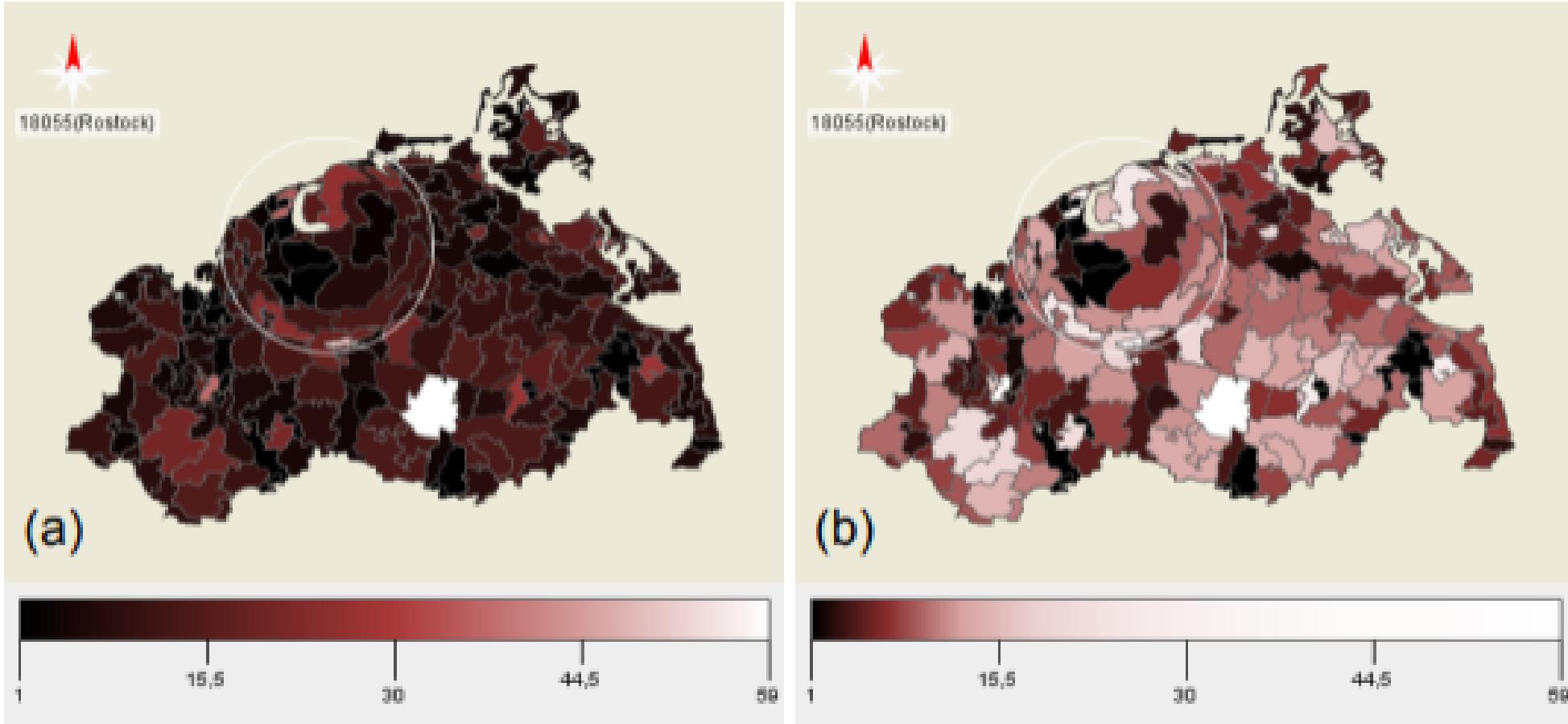
HISTOGRAM EQUALIZED COLOR CODING

[Tominski et al. 2008]

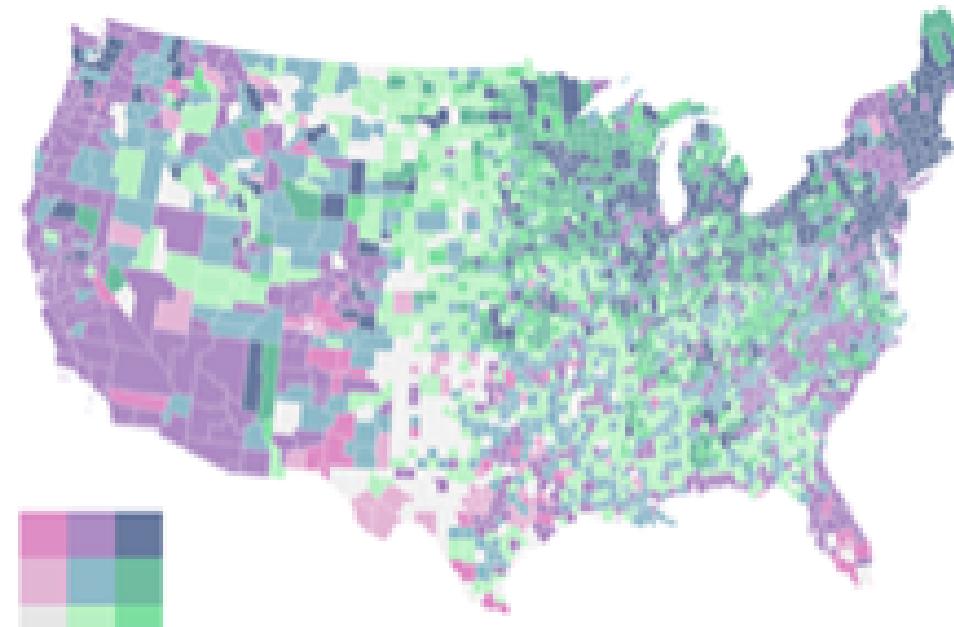
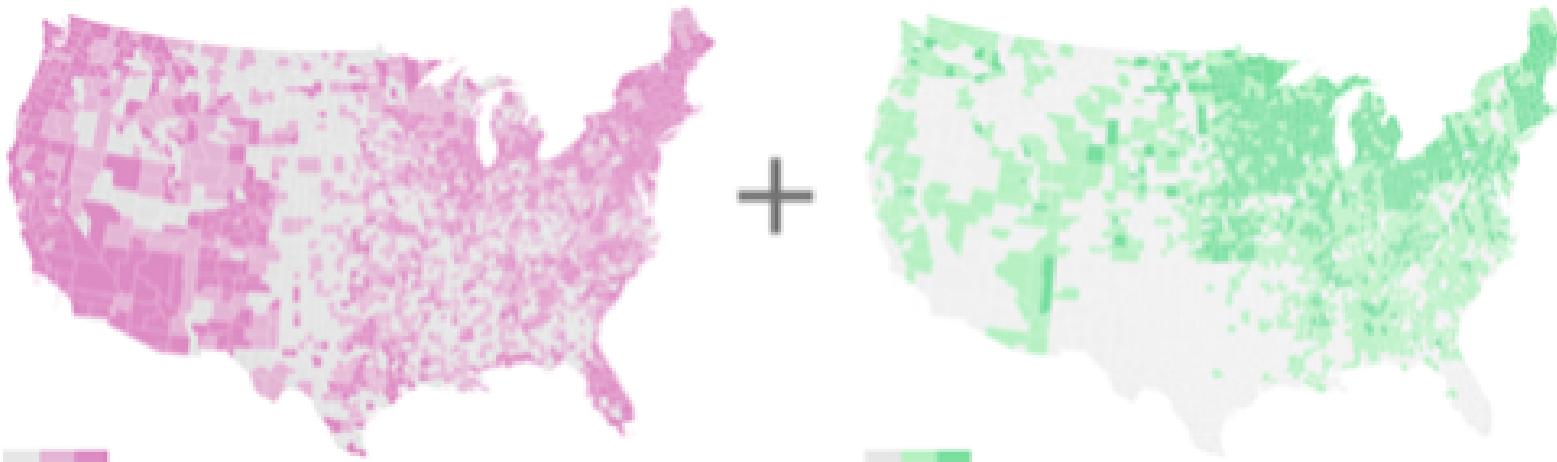


HISTOGRAM EQUALIZED COLOR CODING

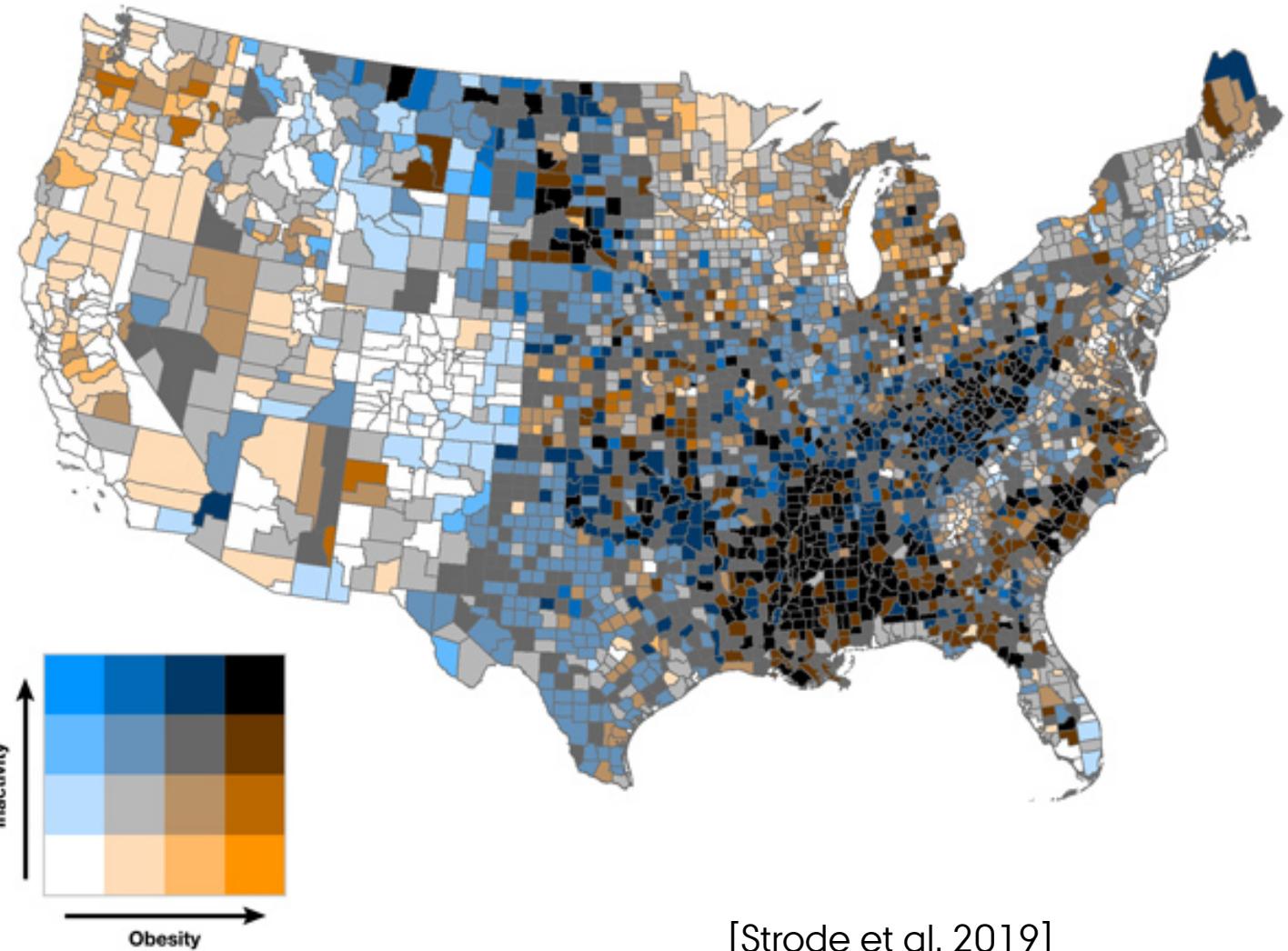
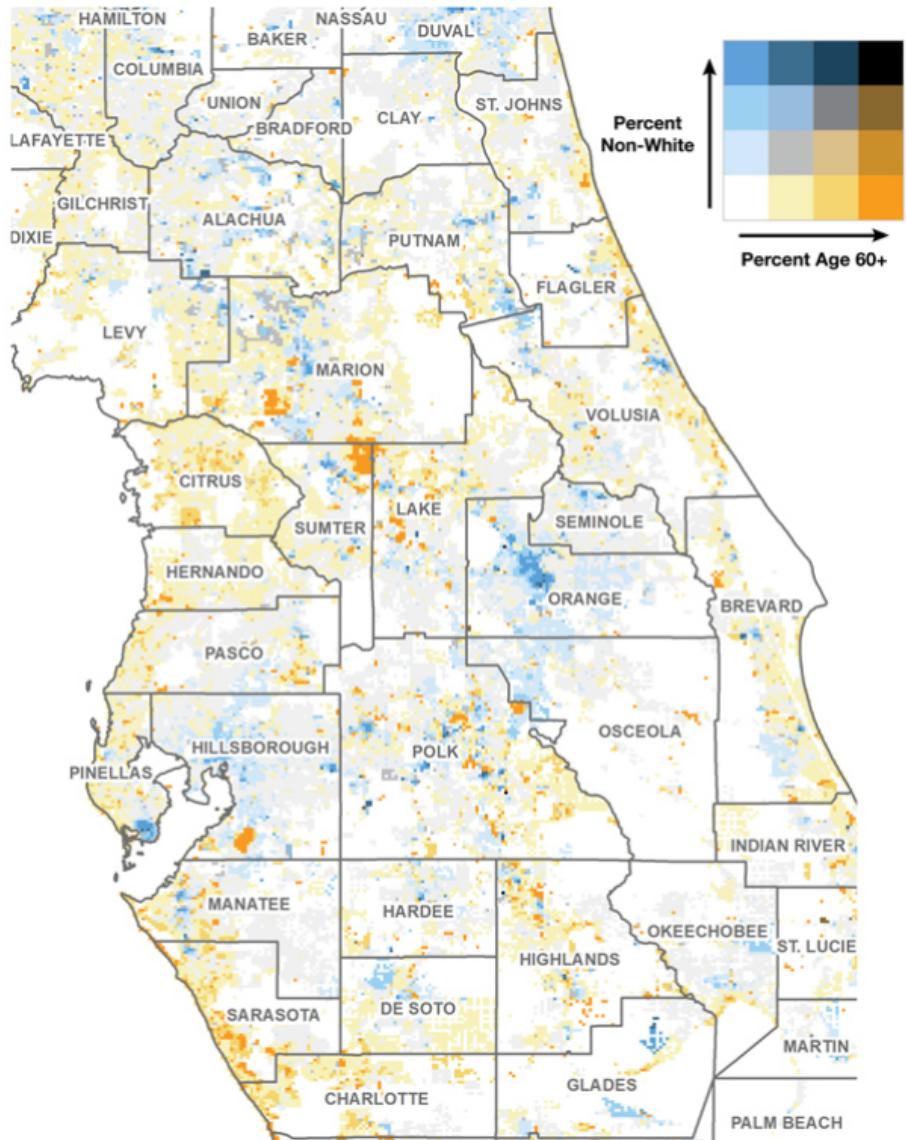
[Tominski et al. 2008]



BIVARIATE COLOR SCALES

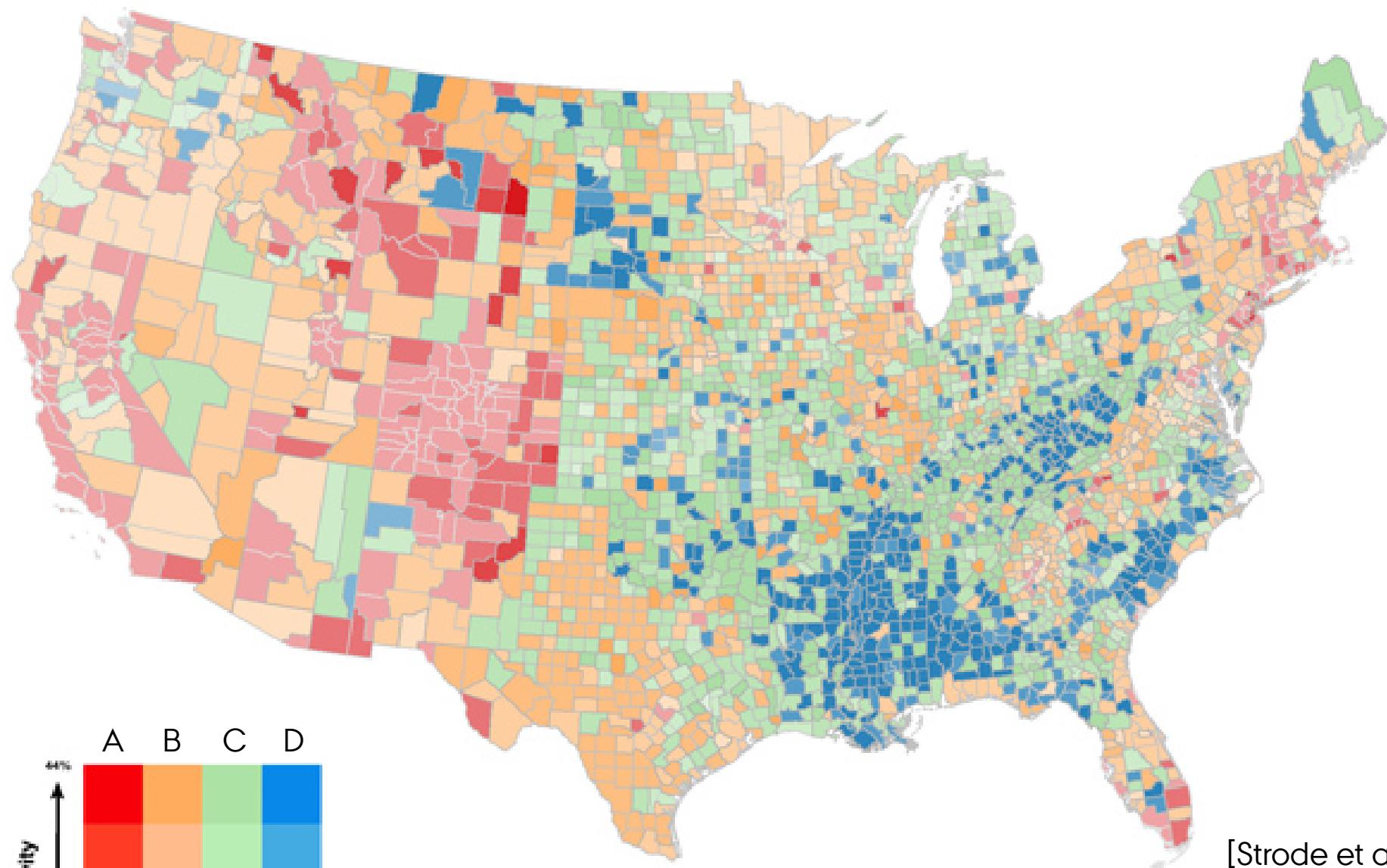


<https://www.joshuastevens.net/cartography/make-a-bivariate-choropleth-map/>



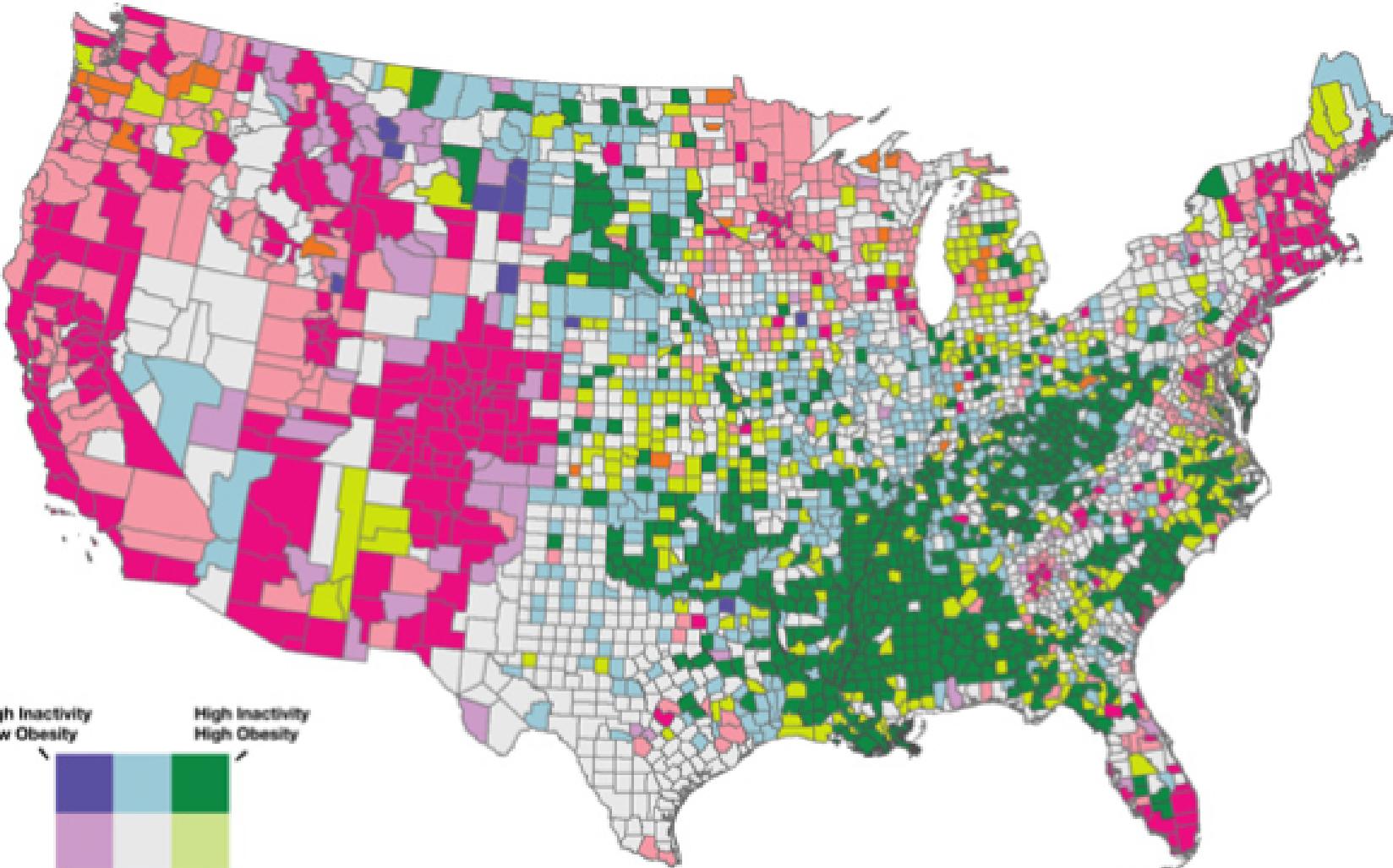
[Strode et al. 2019]



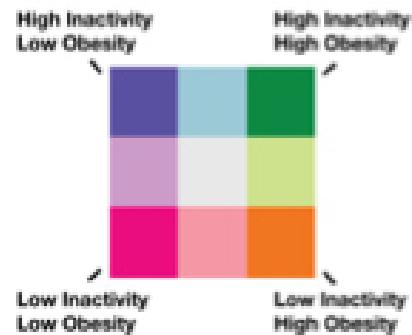


[Strode et al. 2019]

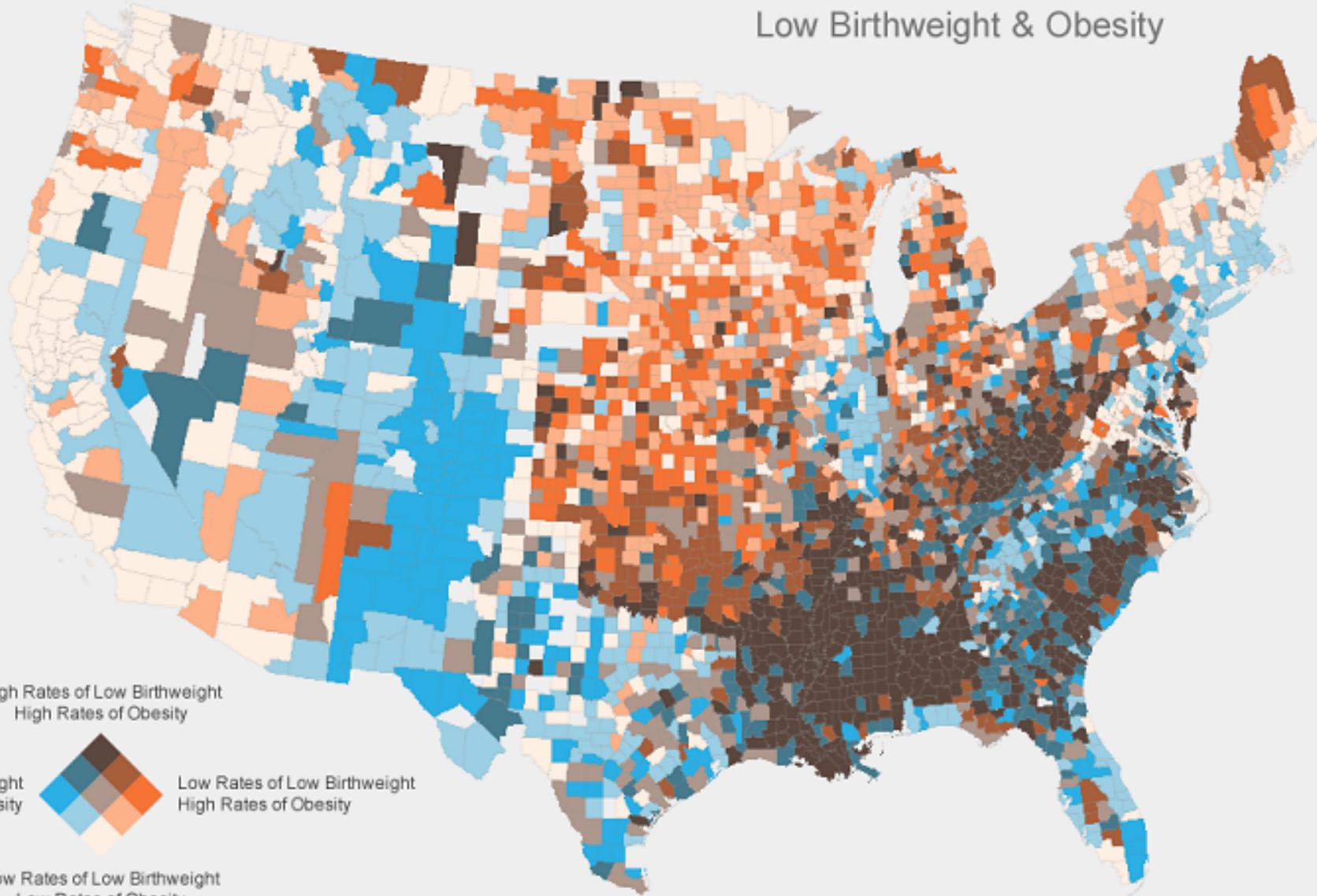




[Strode et al. 2019]



Low Birthweight & Obesity



Data: www.countyhealthrankings.org



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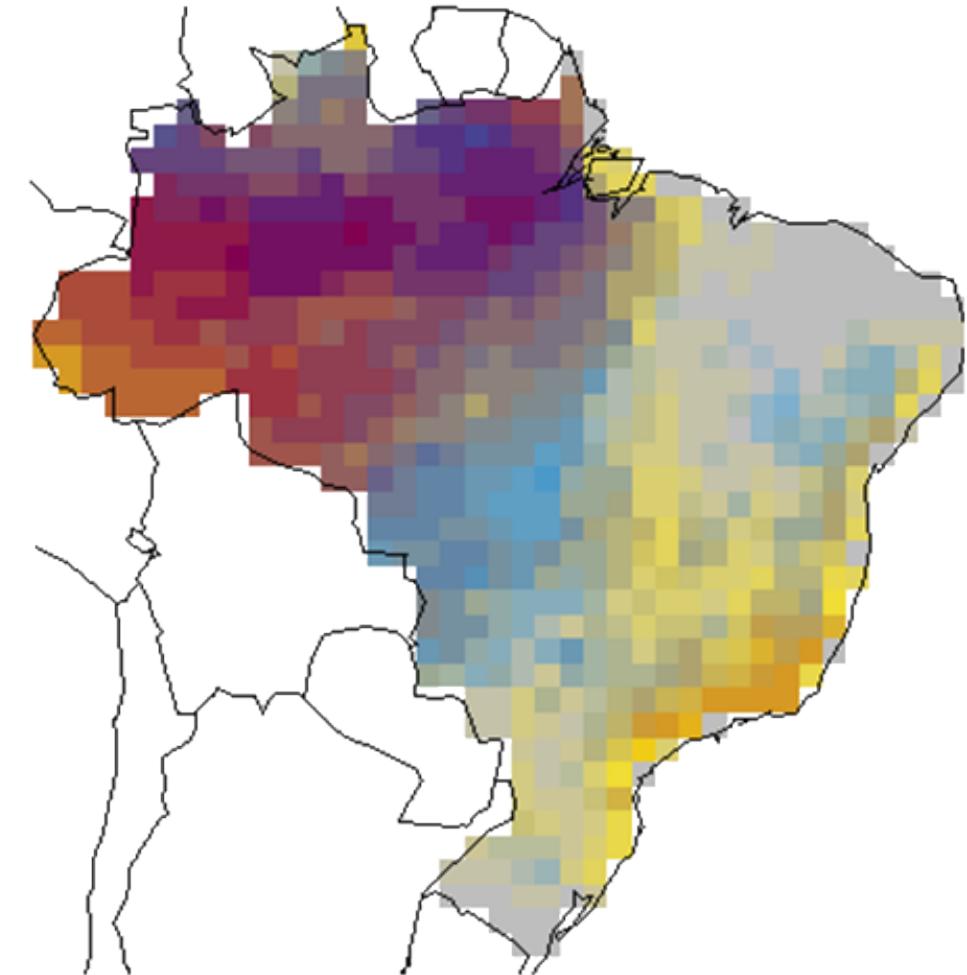
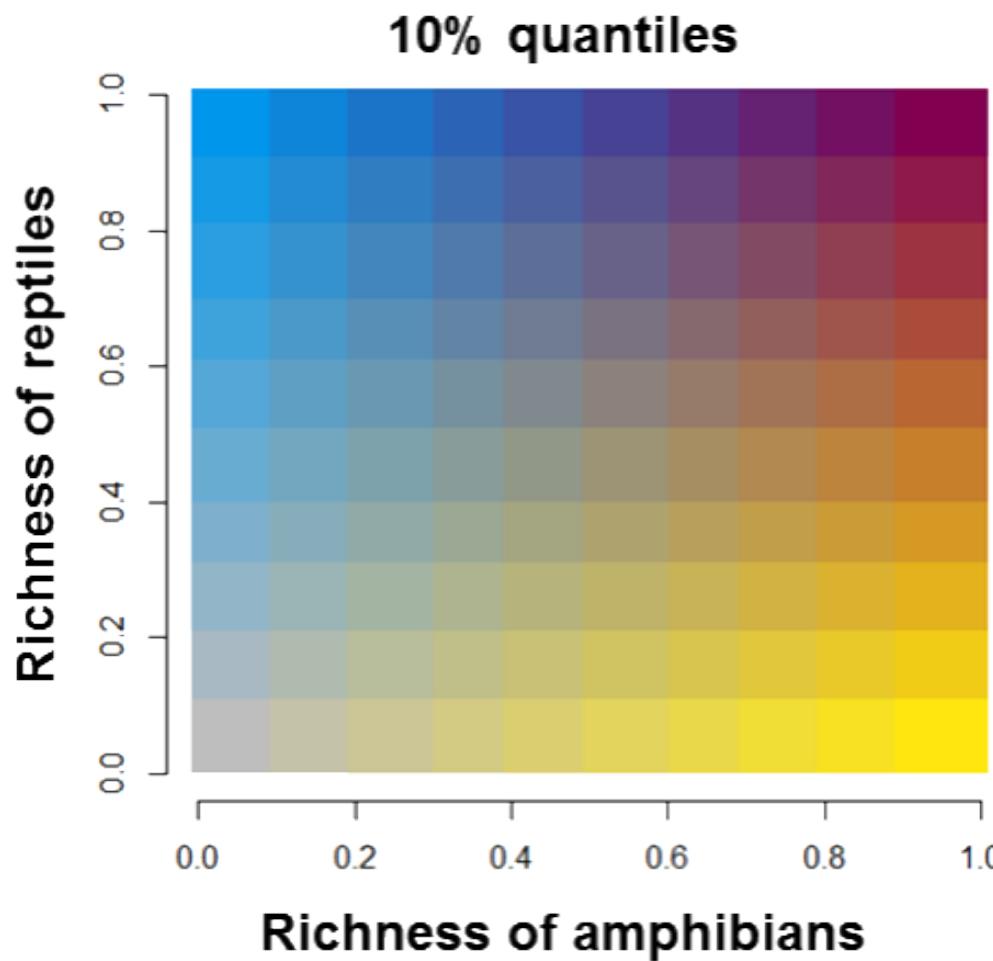
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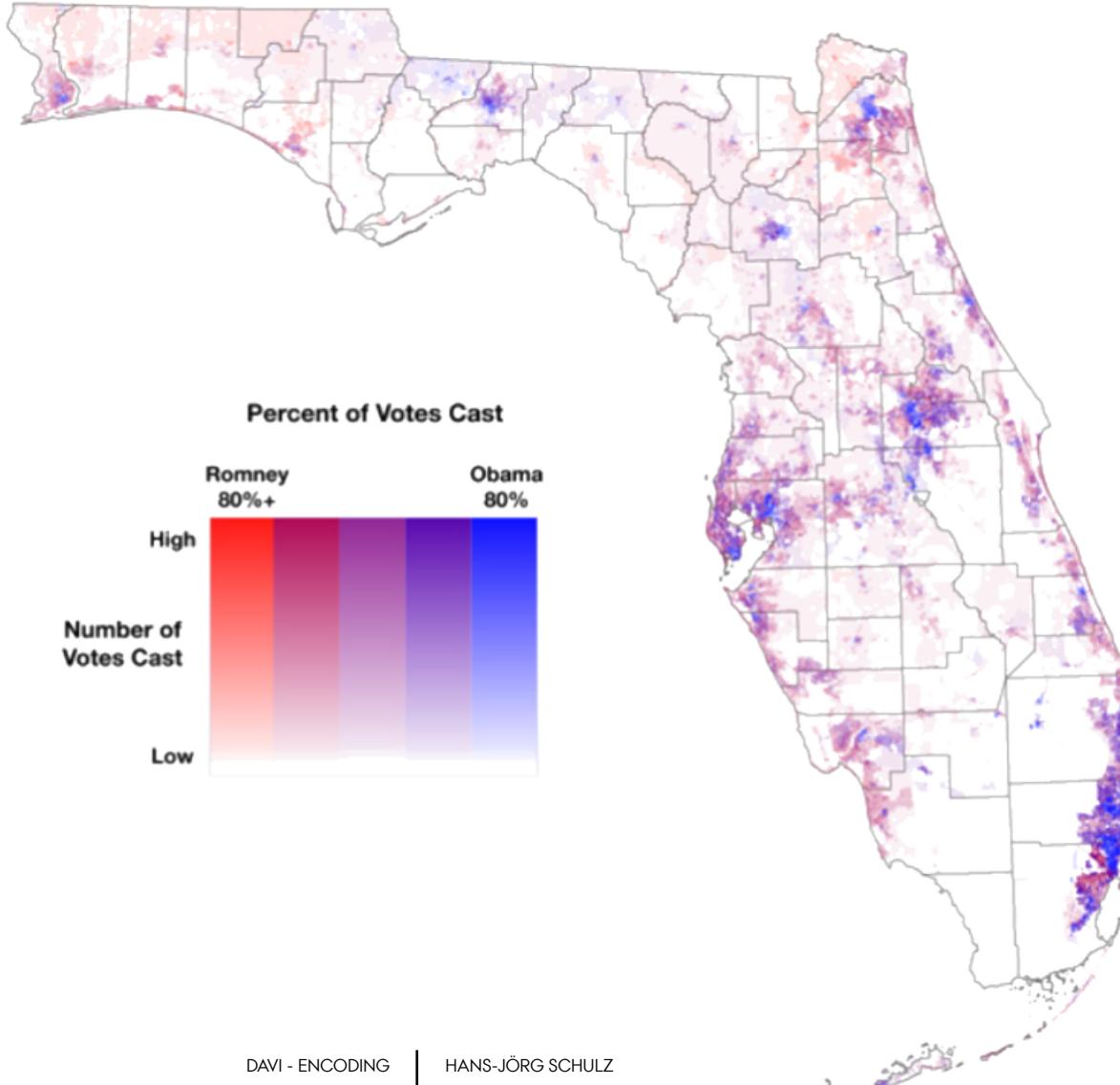


TOO MANY SUBDIVISIONS

<https://rfunctions.blogspot.com/2015/03/bivariate-maps-bivariatemap-function.html>



NO SUBDIVISIONS AT ALL



[Strode et al. 2019]



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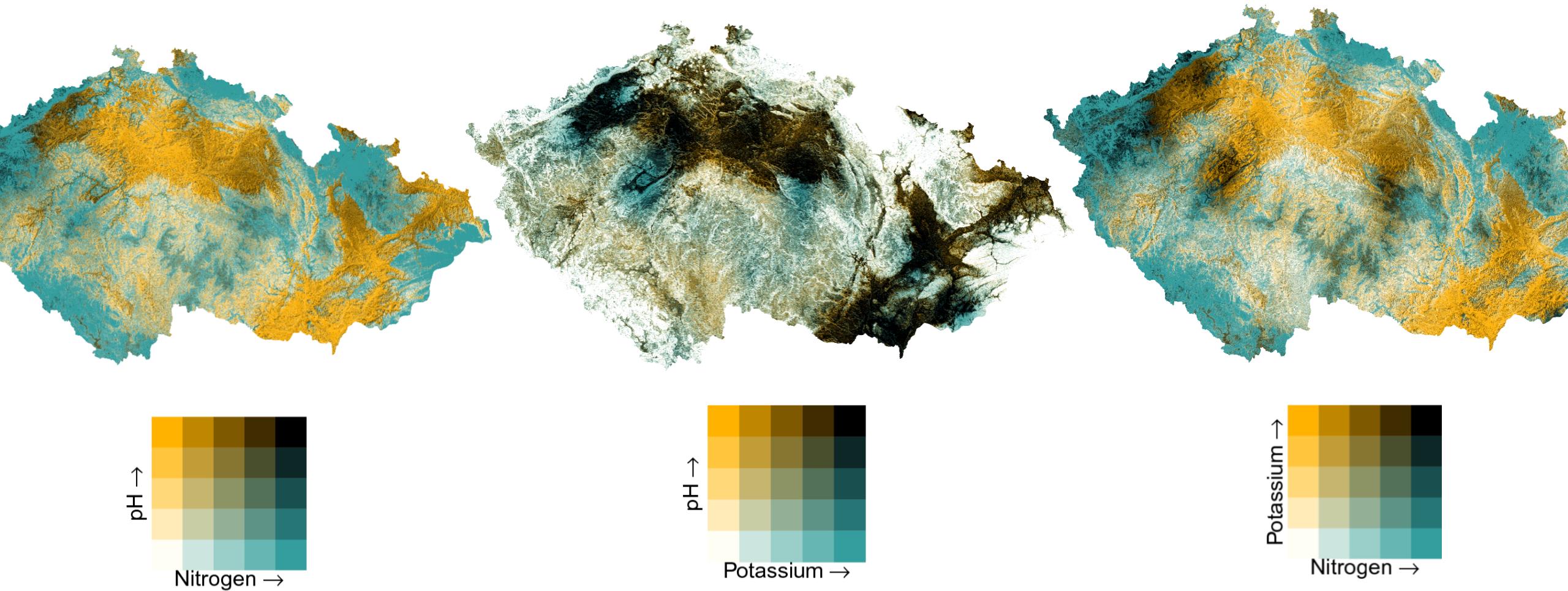
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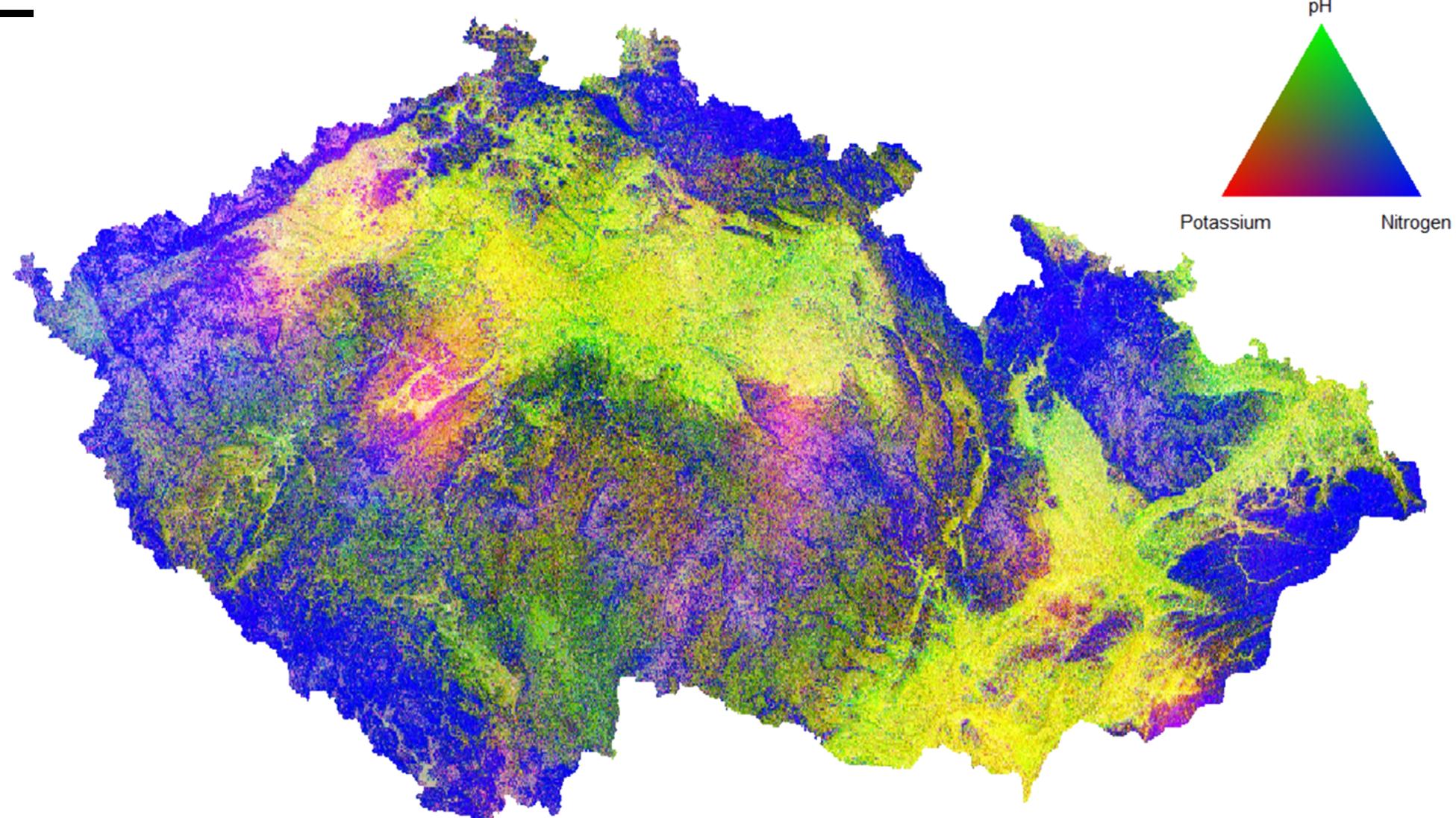
TOO MANY ATTRIBUTES

[Kebonye et al. 2022]



TOO MANY ATTRIBUTES

[Kebonye et al. 2022]



COLOR PALETTES TO GET YOU STARTED



<https://www.joshuastevens.net/cartography/make-a-bivariate-choropleth-map/>

COLOR CODING FOR DIFFERENT TASKS



TASK-DRIVEN COLOR CODING

[Tominski et al. 2008]

Identification



Unsegmented

Localization

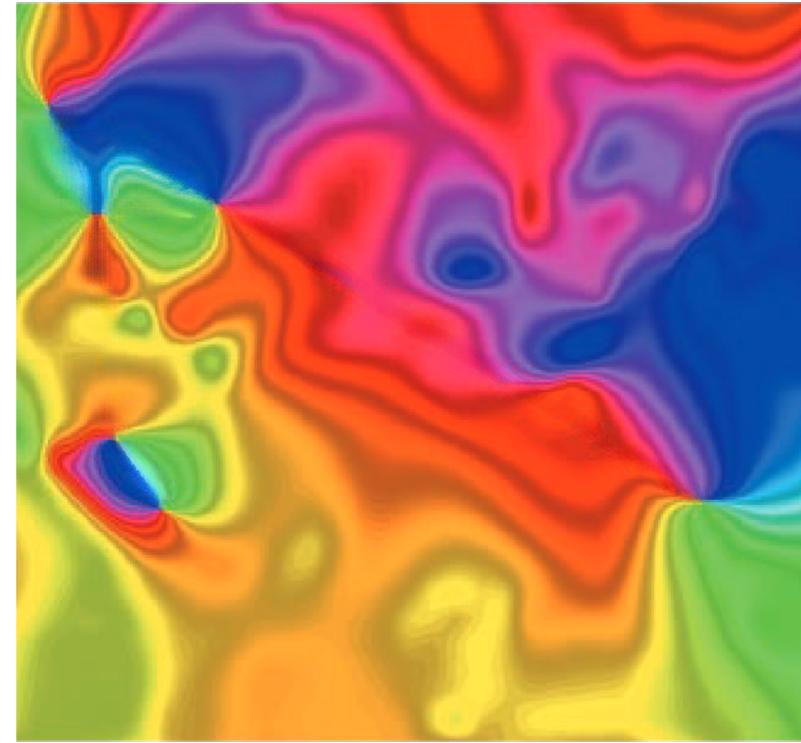
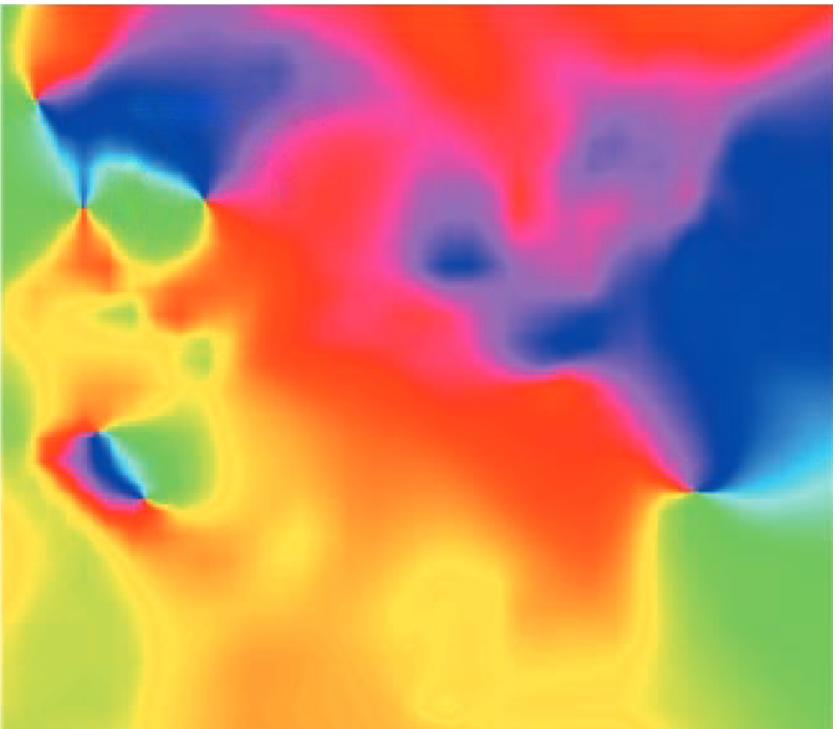


Segmented



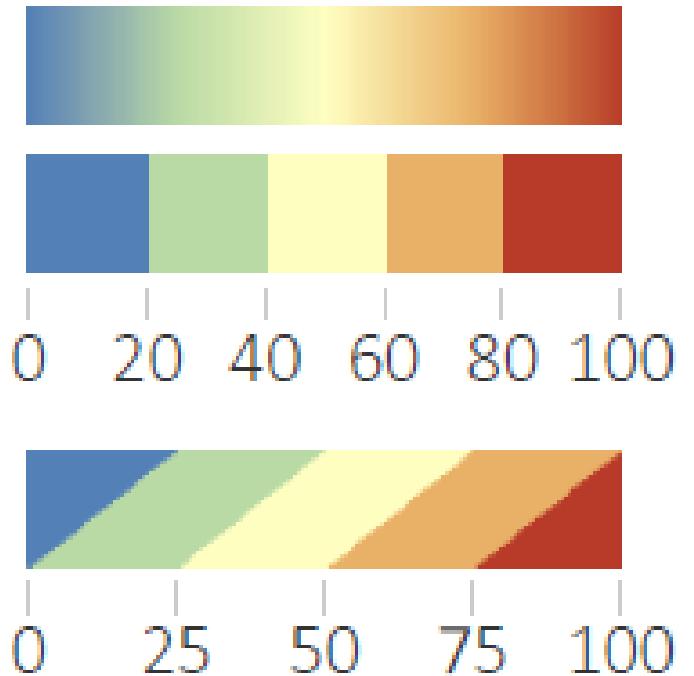
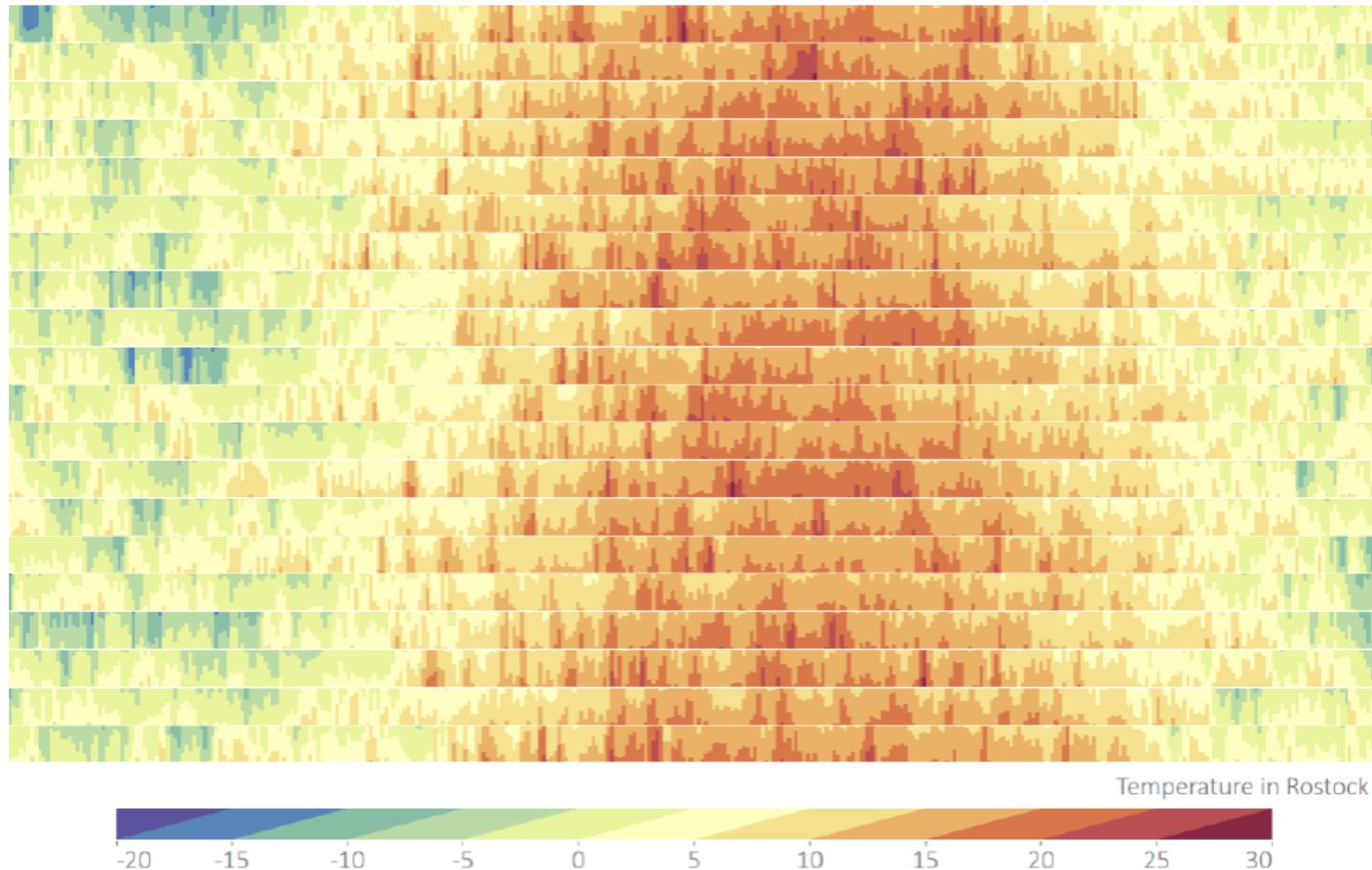
ENHANCED COLOR MAPS

[Wong et al. 2002]

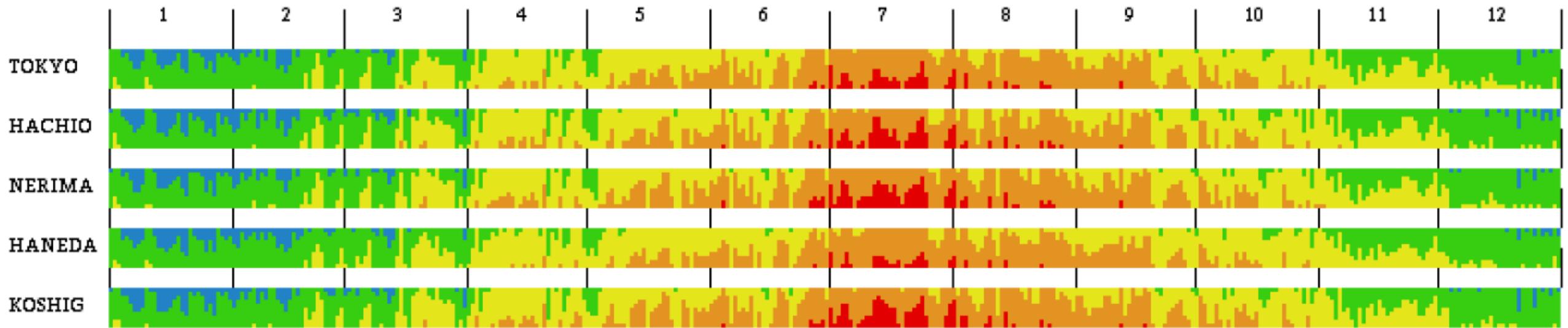


TWO-TONE PSEUDO COLORS

[Saito et al. 2005]

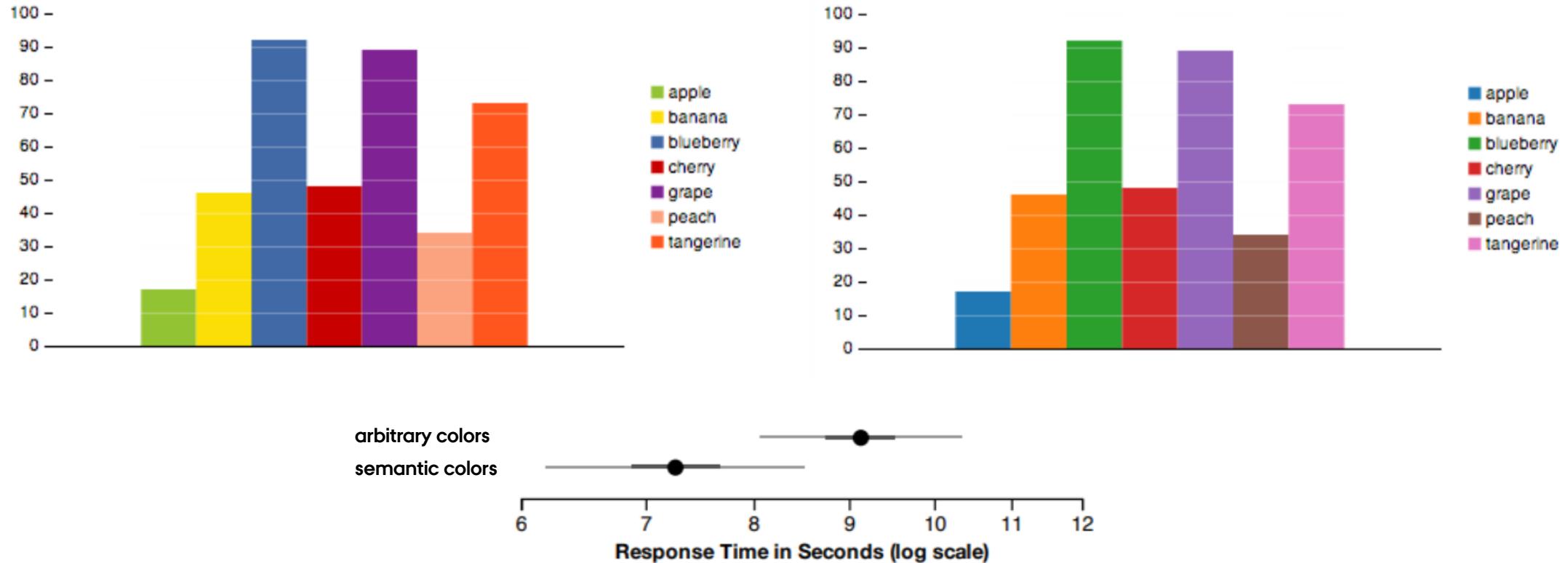


2001



(a) maximum temperature

SEMANTIC COLOR CODING



Lin et al.: “Selecting Semantically-Resonant Colors for Data Visualization”, EuroVis 2013

COLOR USE ACROSS CULTURES

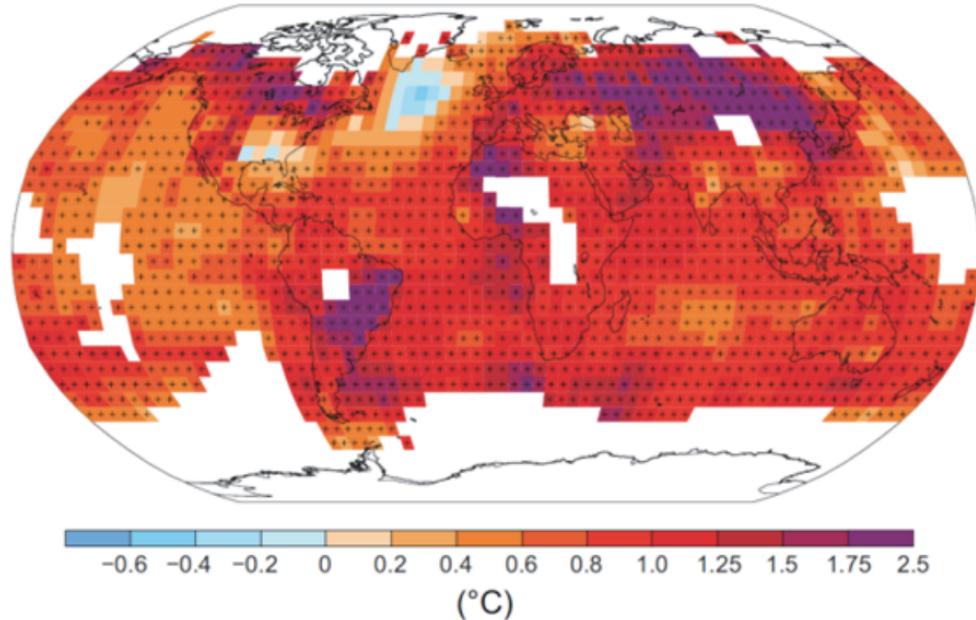
- In many cultures, blue is a masculine symbol. But in China, it is associated with women.
- In many Asian countries, red is the color of long life, happiness, celebrations, prosperity, joy, and good luck. On the other hand, some African countries associate red with death.
- In Western cultures, brides wear white, because it is associated with cleanliness, purity, peace and elegance. However, in Korea, China and other countries in Asia, it's a symbol of bad luck, mourning and death, thus the color is worn only during funerals.

Source: <https://www.daytranslations.com/blog/color-psychology/>

-> Ahmad et al.: "When Red Means Good, Bad, or Canada: Exploring People's Reasoning for Choosing Color Palettes", IEEE VIS 2021

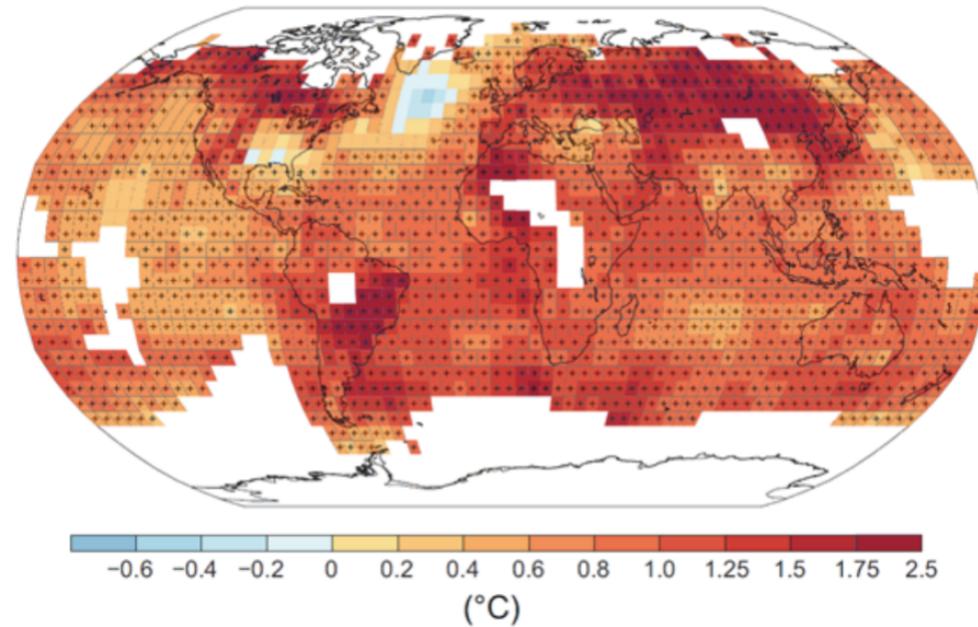
IMPLICATIONS FOR VISUALIZATION

Observed change in surface temperature 1901–2012



Powerlessness, disillusioning, discouraging, fear

Observed change in surface temperature 1901–2012



Call for action, more hope, less judgmental

Schneider, Nocke: "The Feeling of Red and Blue – A Constructive Critique of Color Mapping in Visual Climate Change Communication", Handbook of Climate Change Communication: Vol. 2, pp.289-303, 2017



RECOMMENDED LISTENING

<https://datastori.es>

DATA STORIES

A podcast on data visualization with Enrico Bertini and Moritz Stefaner

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22/06/2012

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Data Stories

007 | Color (feat. Gregor Aisch)

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Data Stories

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COLOR RESOURCES

- <https://colorbrewer2.org>
 - <http://vrl.cs.brown.edu/color>
 - <https://davidjohnstone.net/lch-lab-colour-gradient-picker>
 - <http://www.ccctool.com>
 - <https://www.color-blindness.com/coblis-color-blindness-simulator/>
 - <https://personal.sron.nl/~pault/>
 - <https://vis4.net/chromajs/>
- > <https://gka.github.io/palettes/>
- > <http://tristen.ca/hcl-picker/>
- <https://hihayk.github.io/scale/>
 - <https://jenniferbourn.com/color-tools/>



LIST OF LITERATURE SOURCES

- Tominski et al. 2008: <https://doi.org/10.1109/IV.2008.24>
- Wong et al. 2002: <https://doi.org/10.1057/PALGRAVE.IVS.9500024>
- Saito et al. 2005: <https://doi.org/10.1109/INFVIS.2005.1532144>
- Schneider, Nocke 2017: https://doi.org/10.1007/978-3-319-70066-3_19
- Strode et al. 2019: <http://doi.org/10.14714/CP94.1538>
- Kebonye et al. 2022: <https://doi.org/10.1007/s11119-022-09955-7>
- Ahmad et al. 2021: <https://doi.org/10.1109/VIS49827.2021.9623314>
- Lin et al. 2013: <https://doi.org/10.1111/cgf.12127>

