DATA VISUALIZATION

ABOUT MYSELF

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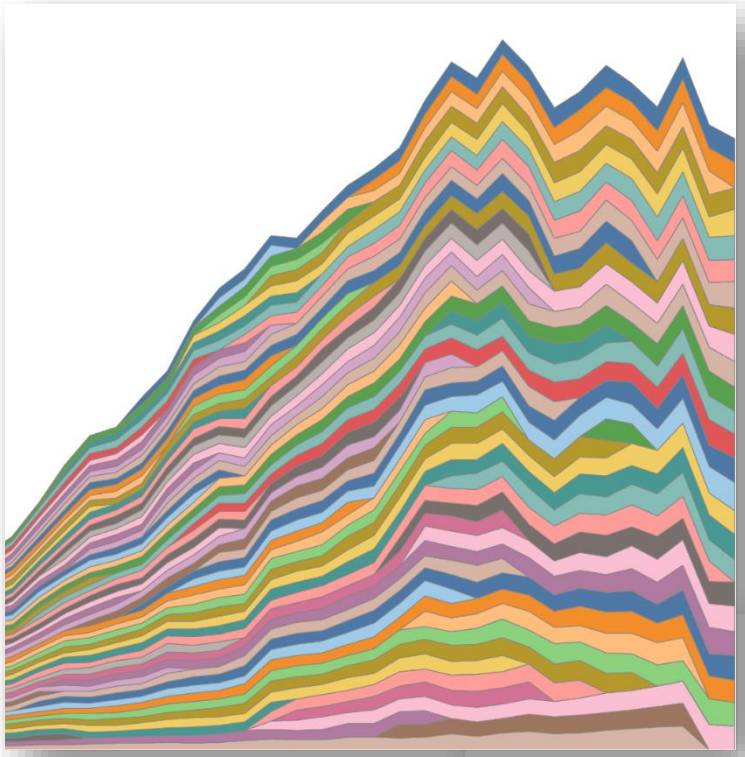
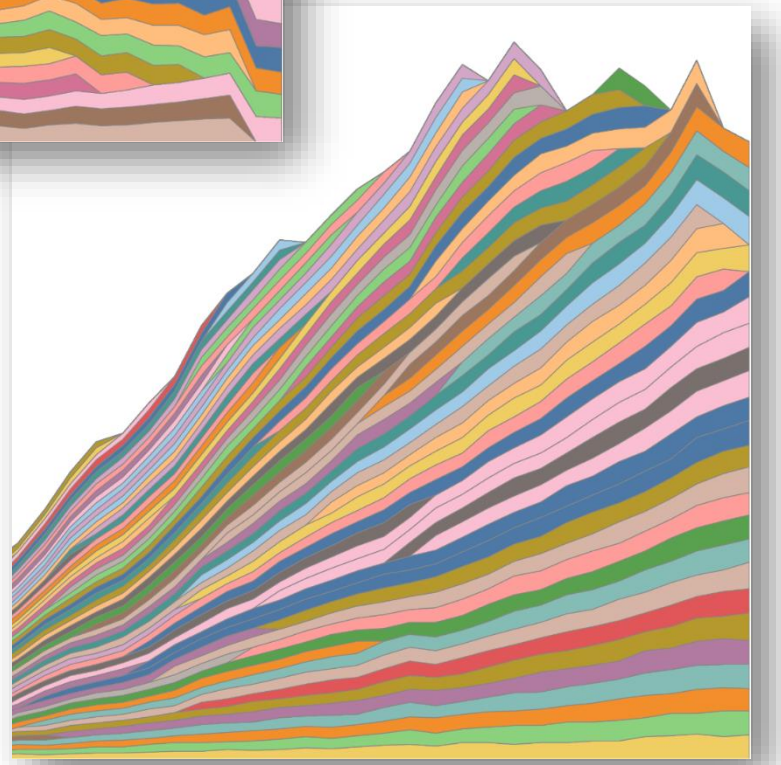
20 years of experience in visualization gathered at

- University of Rostock, Germany
- TU Graz, Austria
- University of Calgary, Canada
- Fraunhofer IGD, Germany
- IBM Visual Communications Lab, USA

Algorithm 2 FindBestPosition

```
1:  procedure FINDBESTPOSITION(order, f_i)
2:      /* Preprocessing Stage */
3:      gBelow ← 0
4:      gAbove ← f_i
5:      costBelow, costAbove, costLayer ← []
6:      for pos = 0 to length(order) − 1 do
7:          costBelow.add(cost_layer(order[pos], gBelow))
8:          costAbove.add(cost_layer(order[pos], gAbove))
9:          costLayer.add(cost_layer(f_i, gBelow))
10:         gBelow ← gBelow + order[pos]
11:         gAbove ← gAbove + order[pos]
12:     end for
13:     costLayer.add(cost_layer(f_i, gBelow))
14:
15:     /* Testing Stage */
16:     currentCost ← costLayer[0] + Σ_{l=0}^{j−2} costAbove[l]
17:     bestIndex ← 0, bestCost ← currentCost
18:     for pos = 1 to length(order) − 1 do
19:         currentCost += costBelow[pos − 1]
20:         currentCost -= costAbove[pos − 1]
21:         currentCost += costLayer[pos]
22:         currentCost -= costLayer[pos − 1]
23:         if currentCost < bestCost then
24:             bestIndex ← pos, bestCost ← currentCost
25:         end if
26:     end for
27:     return bestIndex
28: end procedure
```





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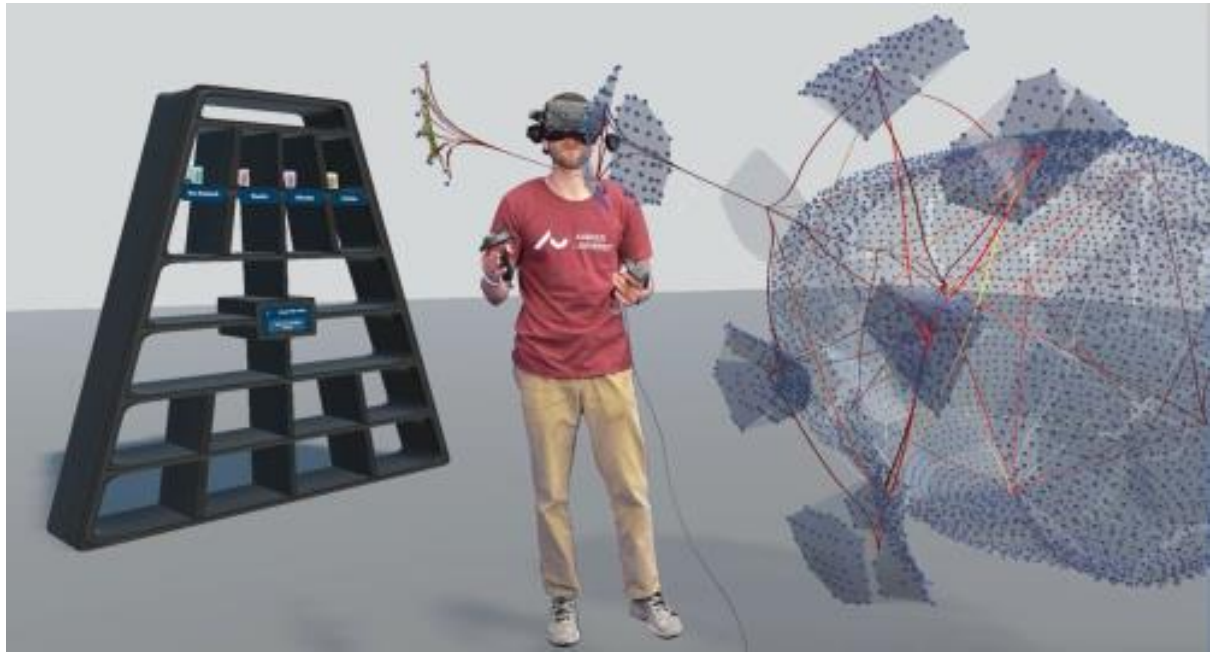
https://vis-au.github.io/stackedcharts/



https://vis-au.github.io/scivis23/

How to cite this site?

Check out other surveys!

treevis.net - A Visual Bibliography of Tree Visualization 2.0 by Hans-Jörg Schulz

v.04-SEP-2023

Dimensionality: All

Representation: All

Alignment: All

Fulltext Search

Techniques Shown: 339

https://treevis.net

TODAY'S AGENDA

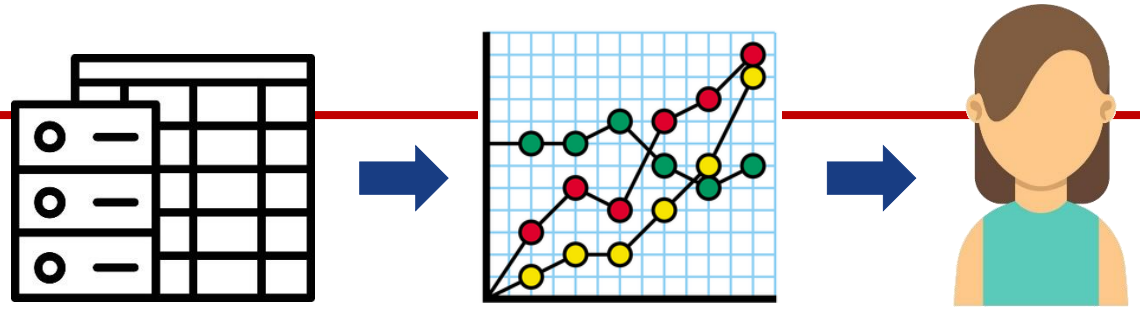
- **Part 1: Introduction to Data Visualization**
  - What is data visualization?
  - How not to do data visualization?
- **Part 2: Guidelines for Creating Data Visualizations**
  - What makes a good data visualization?
  - How to do data visualization?
- **Part 3: Choosing the Right Tools**
  - A brief introduction to Vega-Lite
  - An even briefer introduction to D3.js
- **Part 4: From Data Visualization to Visual Analytics & Recap**
  - What is Visual Analytics?
  - Recap

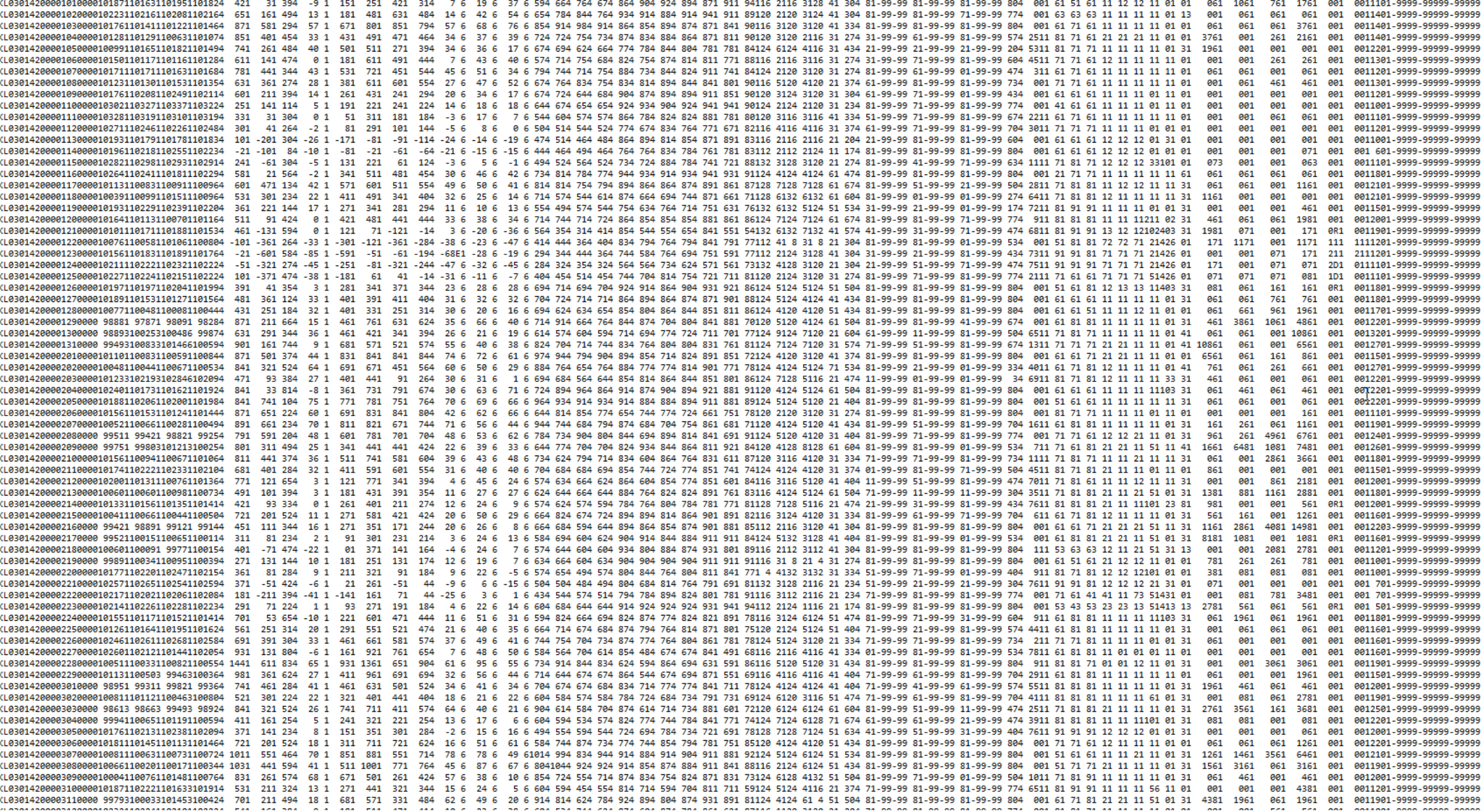
This is YOUR lecture!

PART 1: INTRODUCTION

NOT ALL PROBLEMS IN THE WORLD ARE A GOOD FIT FOR COMPUTATIONAL SOLUTIONS!

- Intractable problems (e.g., Halting problem)
- Computationally complex problems (e.g., Factorization in Crypto)
- Ill-specified problems (e.g., plausibility checking or pattern detection)





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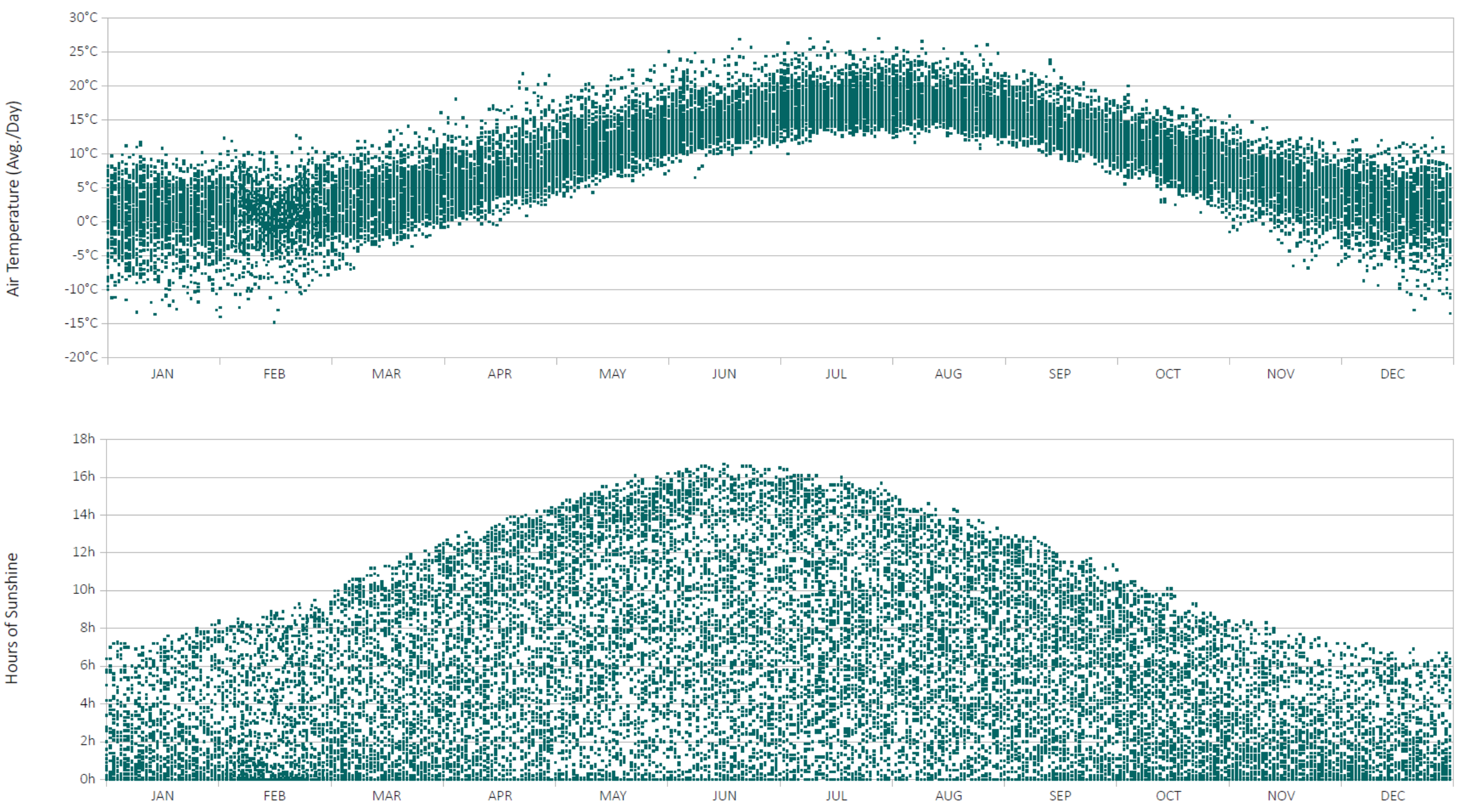

Air Temperature (Avg./Day)
30°C
25°C
20°C
15°C
10°C
5°C
0°C
-5°C
-10°C
-15°C
-20°C
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Hours of Sunshine
18h
16h
14h
12h
10h
8h
6h
4h
2h
0h
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

WHY NOT JUST USE STATISTICS?

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Mean(x) = 9.0

Mean(y) = 7.5

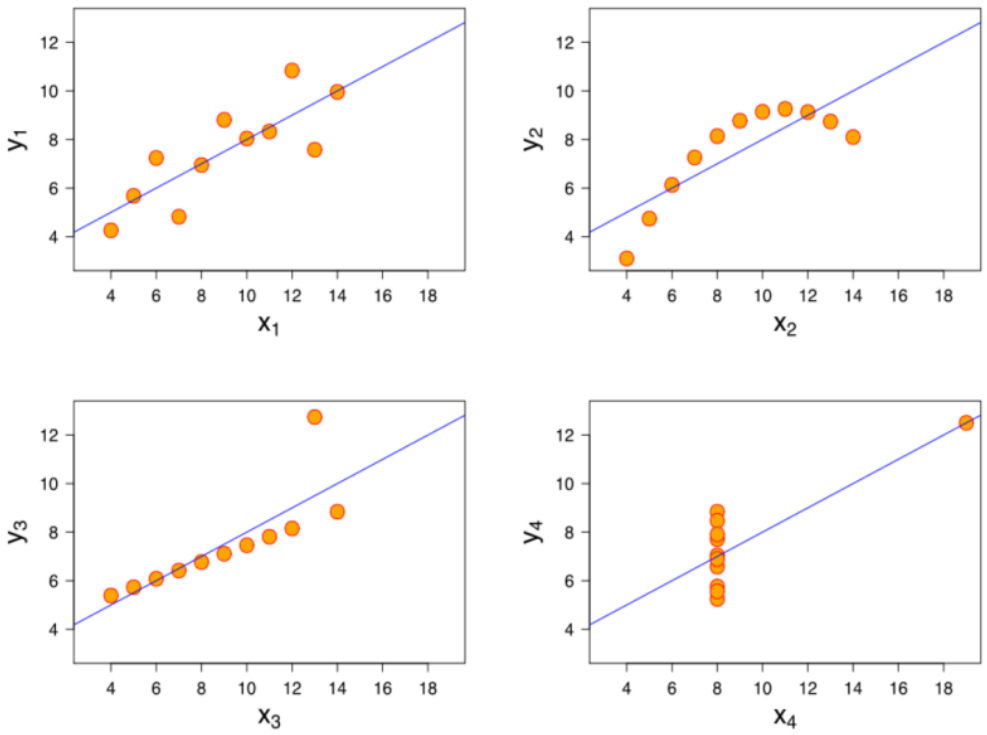
Variance(x) = 11.0

Variance(y) = 4.1

Correlation(x,y) = 0.816

Regression line:

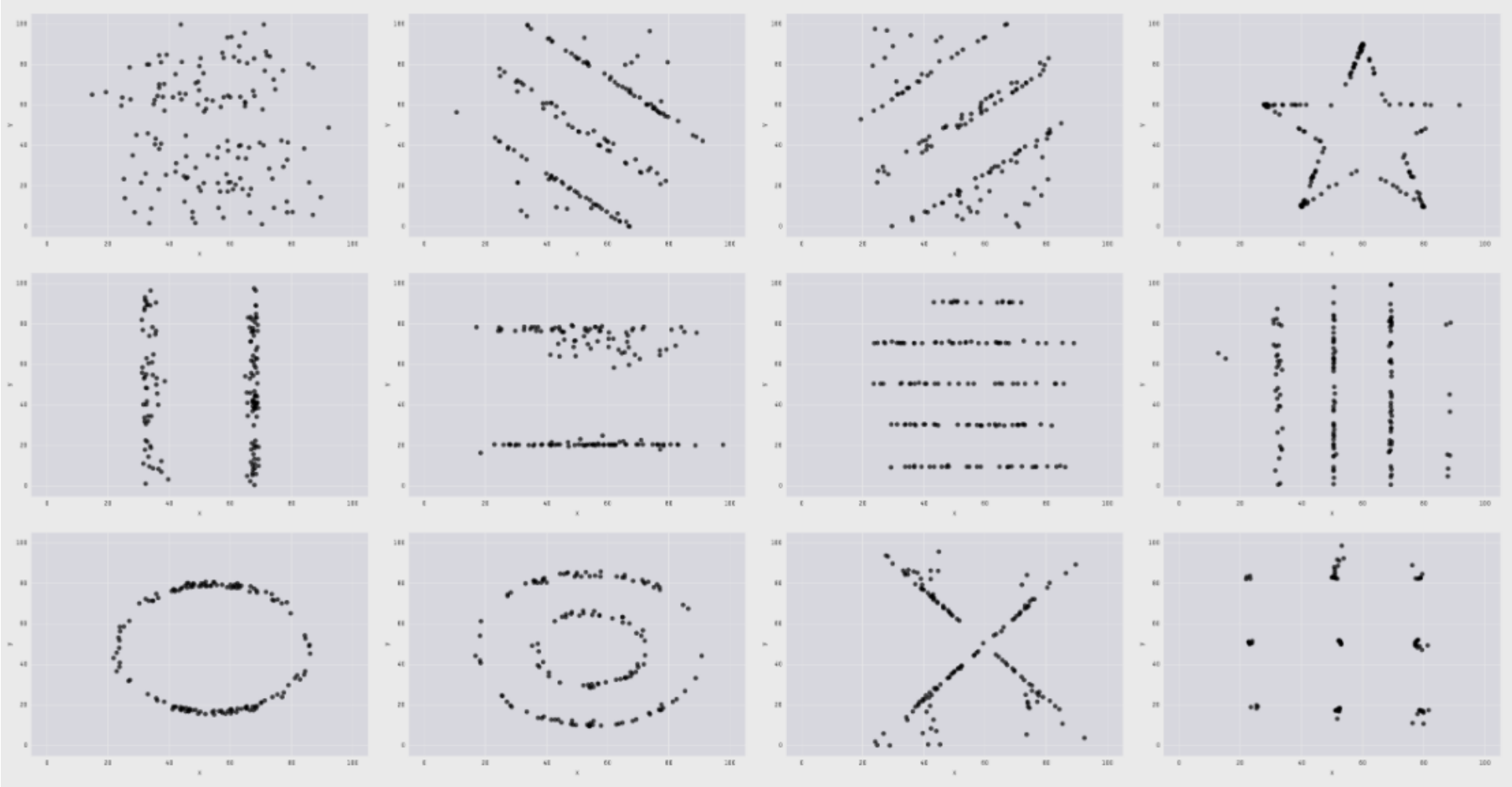
$y = 3.0 + 0.5x$



Source: [Anscombe 1973]

Image Source: Wikipedia

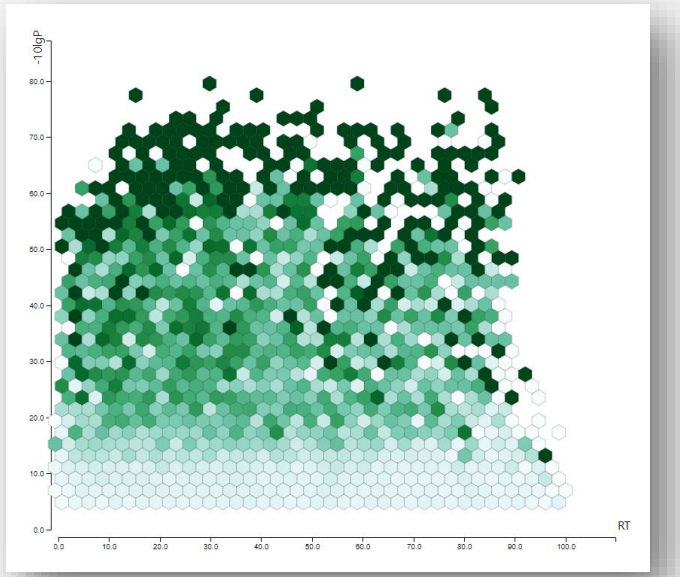
THE DATASAUR [CAIRO 2016]

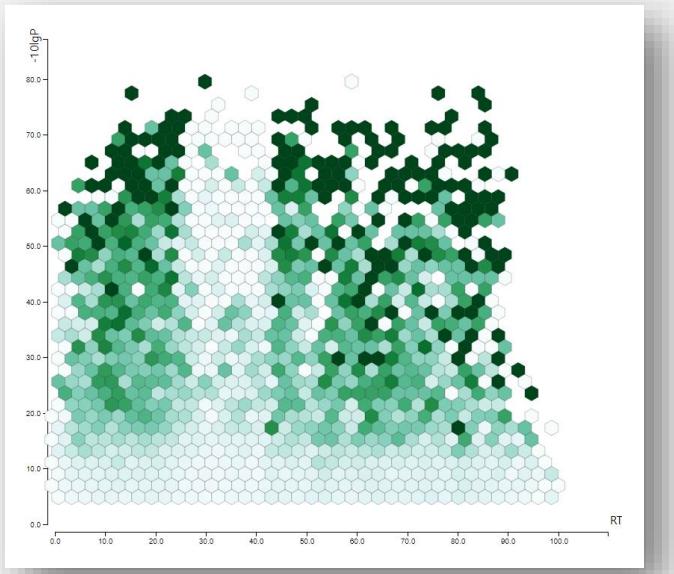


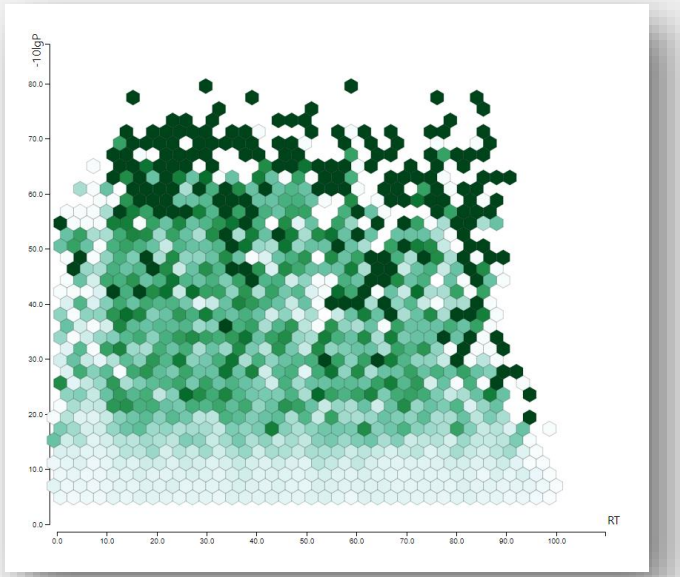
Mean(x) = 54.26
Mean(y) = 47.83

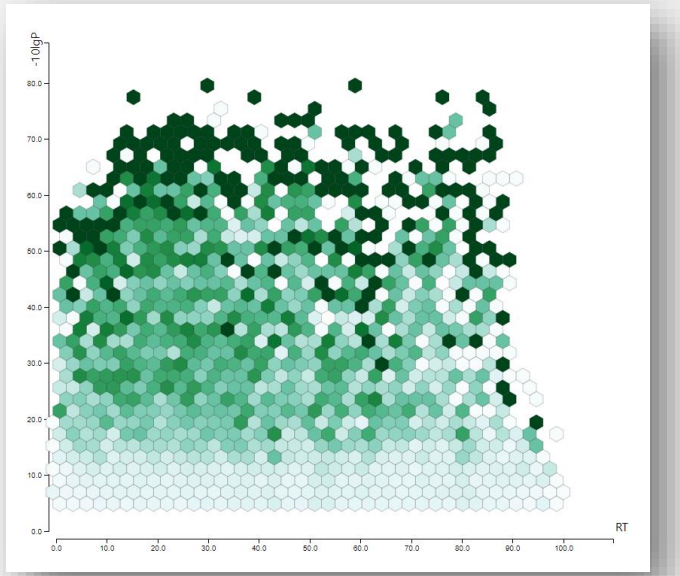
Std. Dev(x) = 16.76
Std. Dev(y) = 26.93

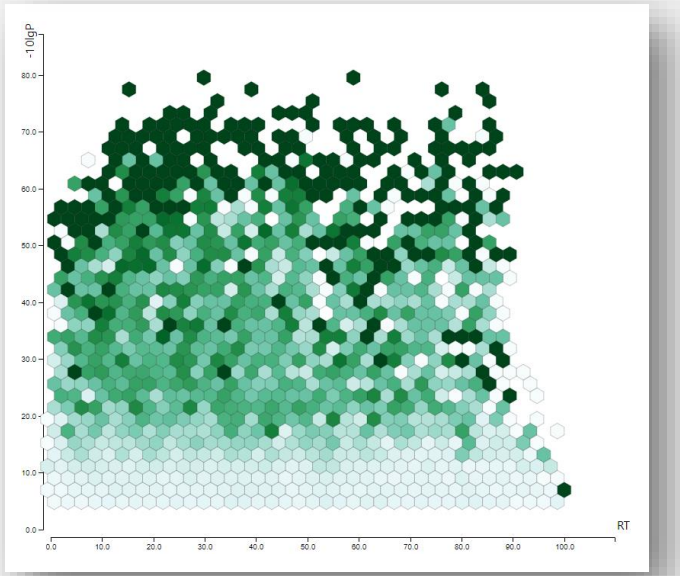
Correlation(x,y) = -0.06

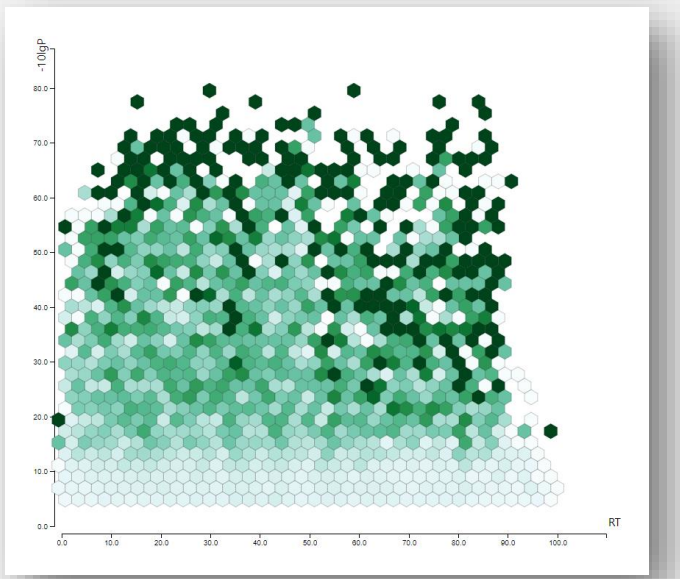








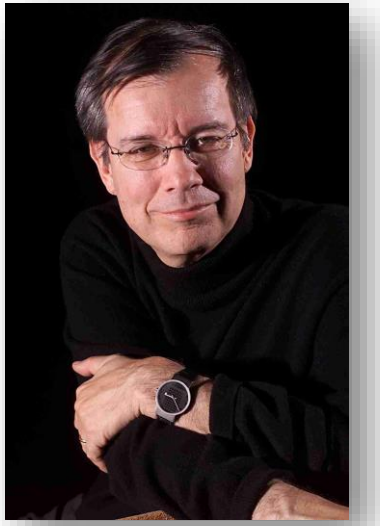




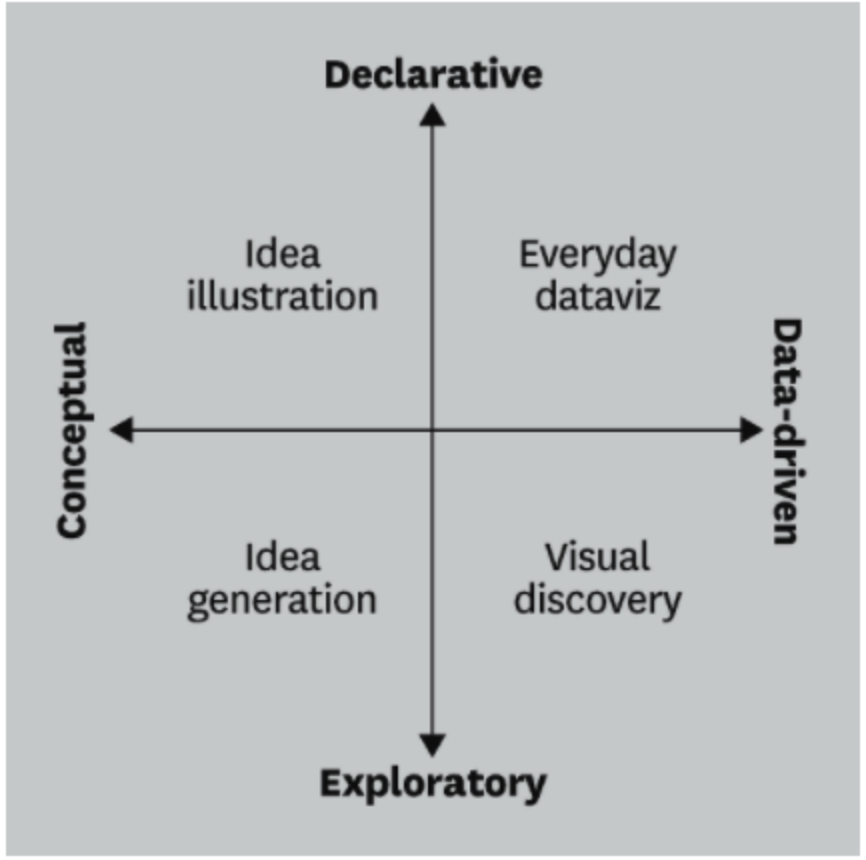
Data: Søren Drud-Heydary Nielsen | Visualization: Harith Rathish

“The purpose of information visualization is to amplify cognitive performance, not just to create interesting pictures. Information visualizations should do for the mind what automobiles do for the feet.”

[Card 2008]



WHAT IS VISUALIZATION?



Is the information *conceptual* or *data-driven*?

ideas **stats**

Am I *declaring* something or *exploring* something?

present **discover**

[Berinato 2016]

DECLARATIVE, DATA-DRIVEN

EVERYDAY DATAVIZ

INFO TYPE: Simple, low volume

TYPICAL SETTING: Formal, presentations

PRIMARY SKILLS: Design, storytelling

GOALS: Affirming, setting context

EXPLORATORY, DATA-DRIVEN

Example: SAS Predictive Analytics

VISUAL DISCOVERY

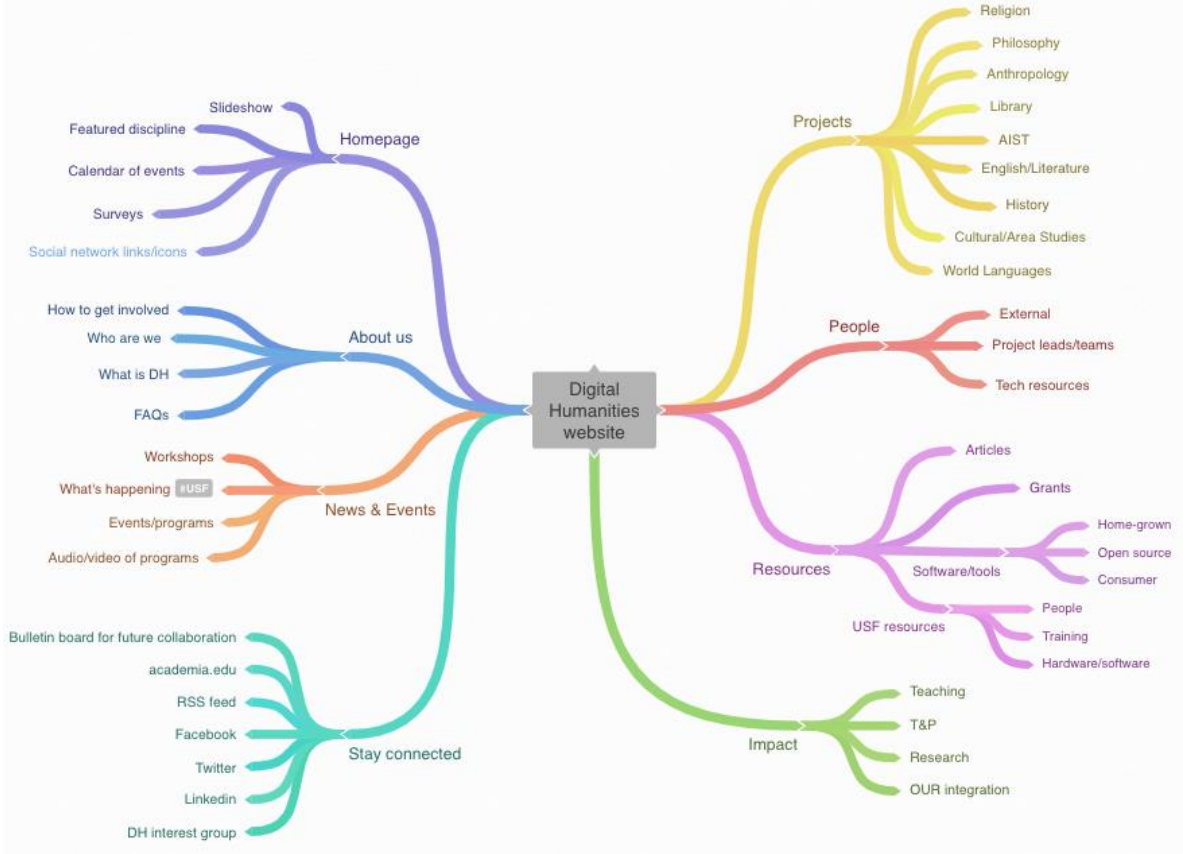
INFO TYPE: Big data, complex, dynamic

TYPICAL SETTING: Working sessions, testing, analysis

PRIMARY SKILLS: Business intelligence, programming, paired analysis

GOALS: Trend spotting, sense making, deep analysis

EXPLORATORY, CONCEPTUAL



Example: Mindmap

IDEA GENERATION

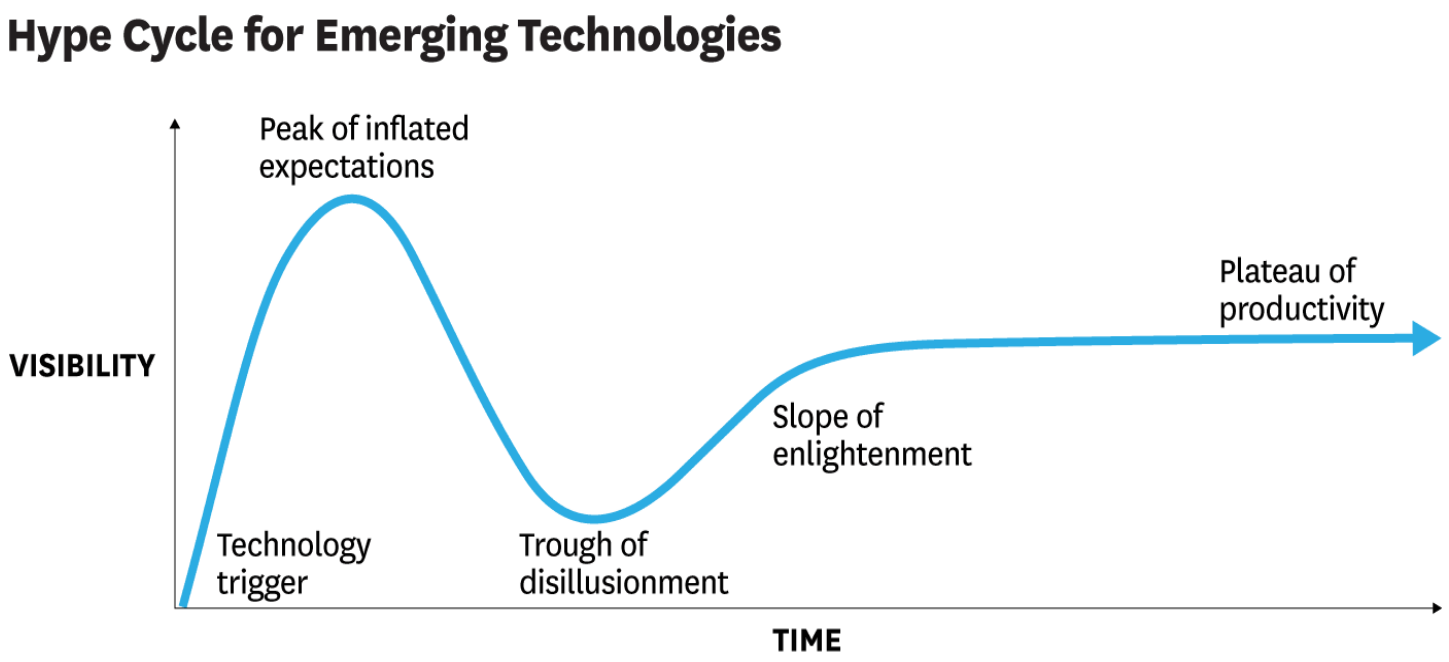
INFO TYPE: Complex, undefined

TYPICAL SETTING: Working session, brainstorming

PRIMARY SKILLS: Team-building, facilitation

GOALS: Problem solving, discovery, innovation

DECLARATIVE, CONCEPTUAL



IDEA ILLUSTRATION

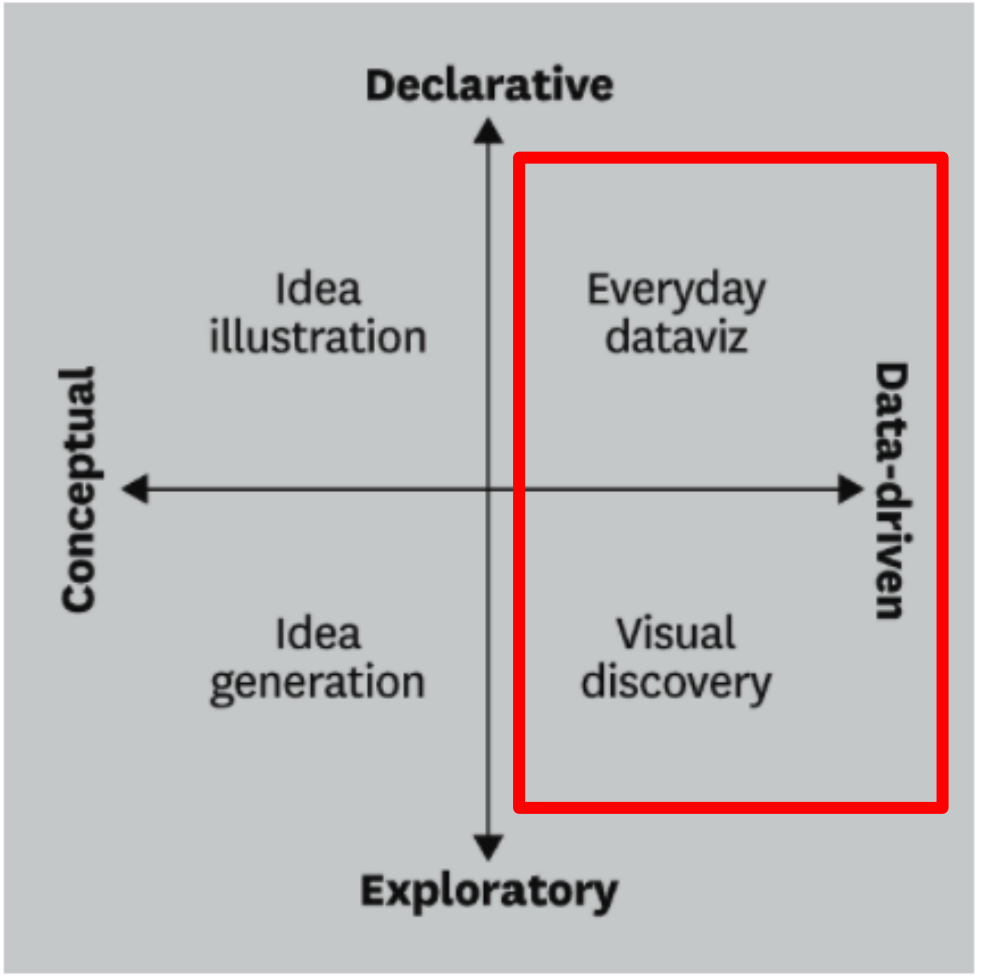
INFO TYPE: Process, framework

TYPICAL SETTING: Presentations, teaching

PRIMARY SKILLS: Design, editing

GOALS: Learning, simplifying, explaining

WHAT IS DATA VISUALIZATION?



[Berinato 2016]

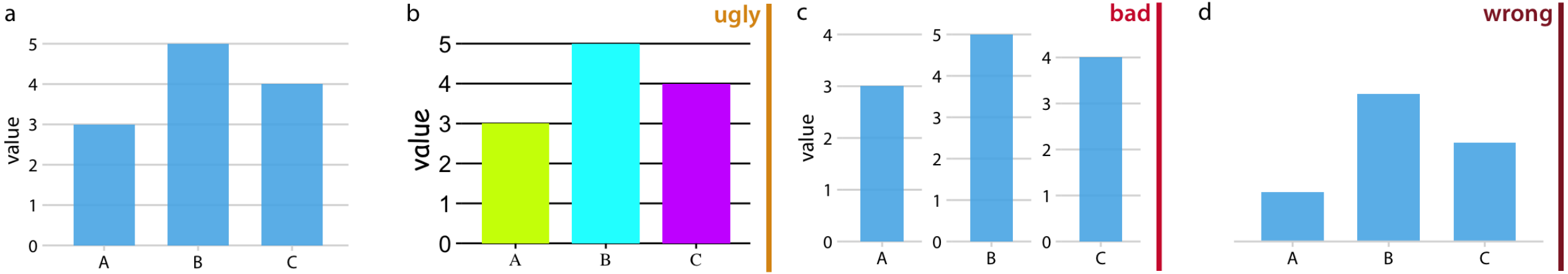
VISUALIZATIONS AS STUMBLING BLOCKS

AARHUS UNIVERSITY
NATURAL SCIENCES

DATA VISUALIZATION
8 NOVEMBER 2023

HANS-JÖRG SCHULZ
ASSOCIATE PROFESSOR

WHAT MAKES A BAD VISUALIZATION?



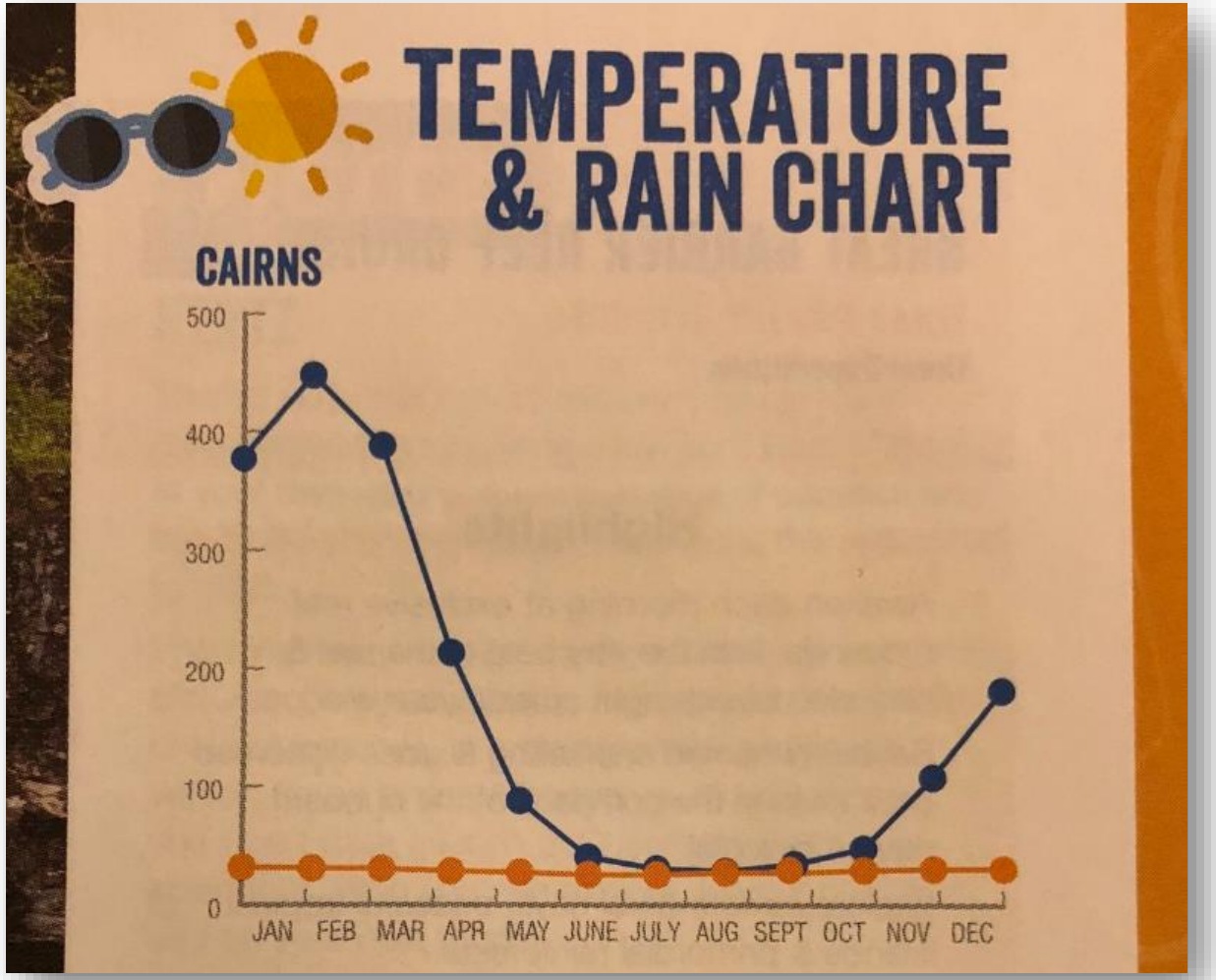
ugly—A figure that has aesthetic problems but otherwise is clear and informative.

bad—A figure that has problems related to perception; it may be unclear, confusing, overly complicated, or deceiving.

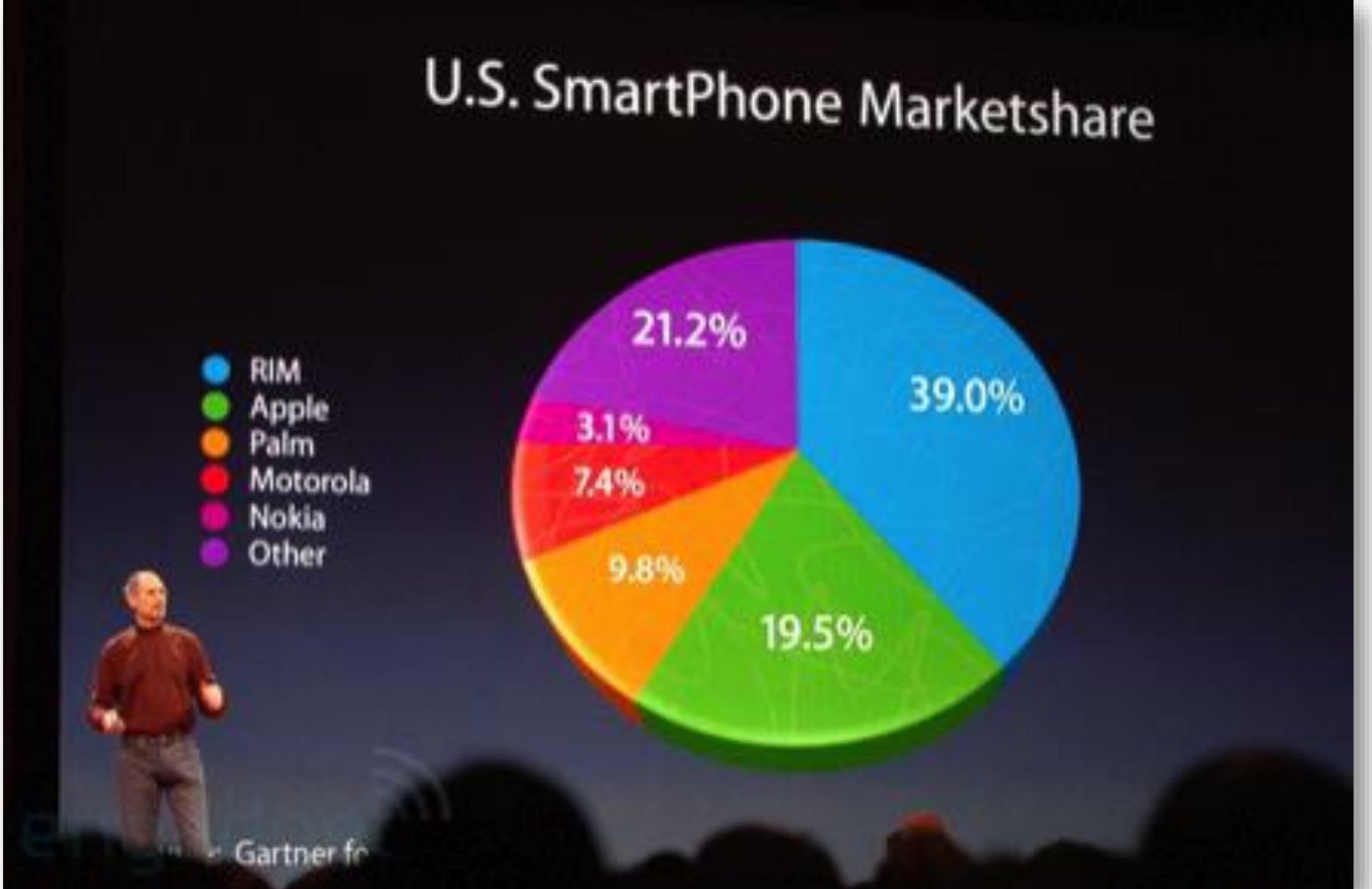
wrong—A figure that has problems related to mathematics; it is objectively incorrect.

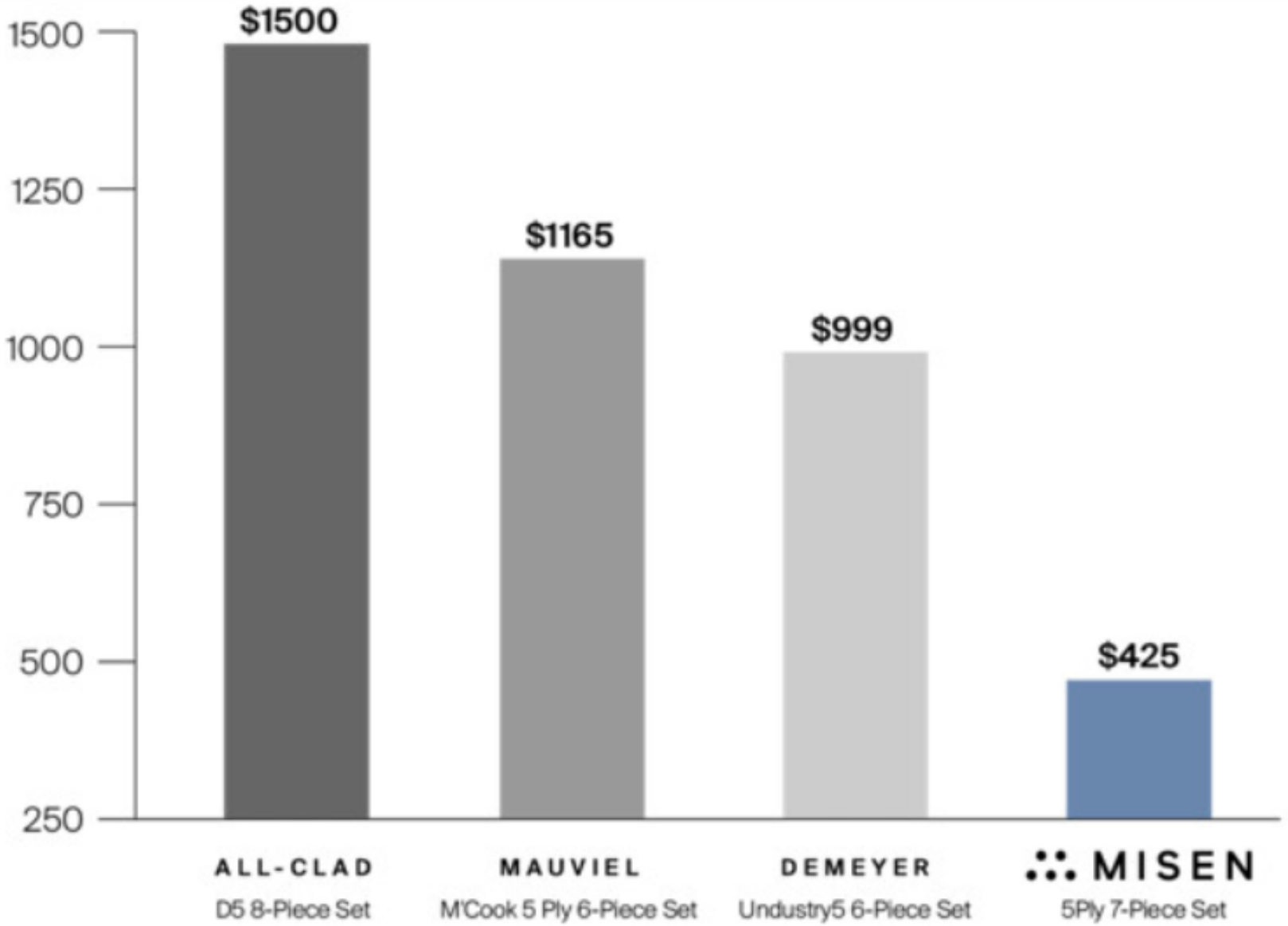
“WRONG VISUALIZATIONS”

“BAD VISUALIZATIONS”

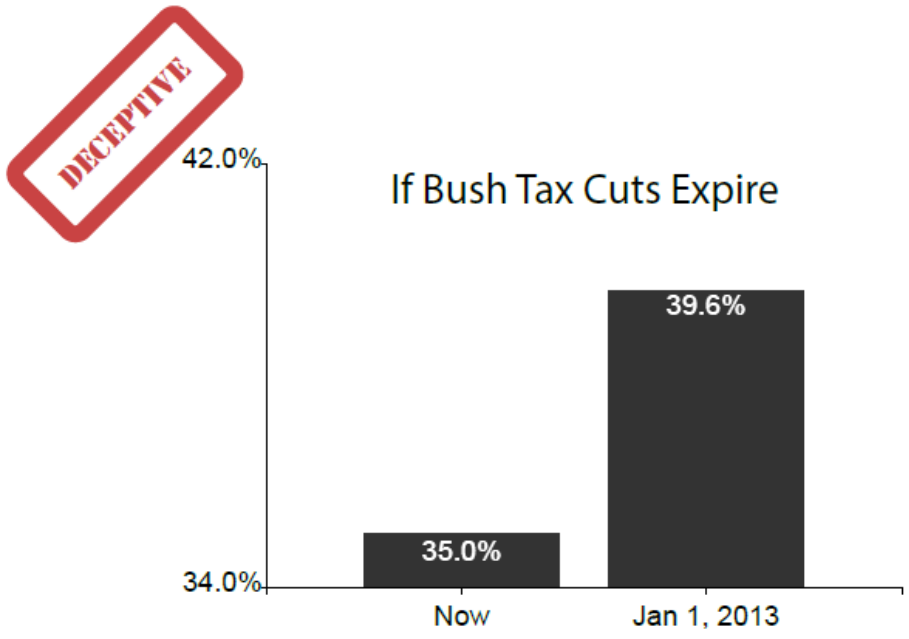


“UGLY VISUALIZATIONS”


U.S. SmartPhone Marketshare
RIM
Apple
Palm
Motorola
Nokia
Other
21.2%
39.0%
3.1%
7.4%
9.8%
19.5%
Gartner fo

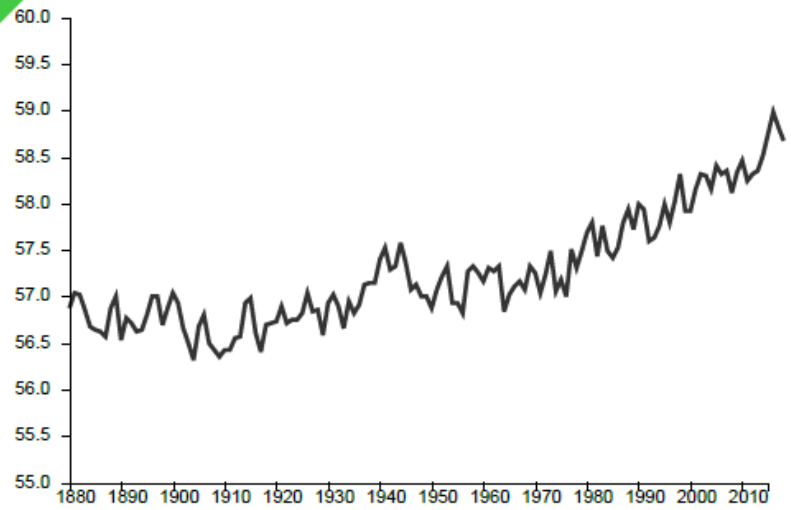

1500
1250
1000
750
500
250
$1500
$1165
$999
$425
ALL-CLAD
D5 8-Piece Set
MAUVIEL
M'Cook 5 Ply 6-Piece Set
DEMEYER
Undustry5 6-Piece Set
MISEN
5Ply 7-Piece Set

THE BAR / COLUMN CHART

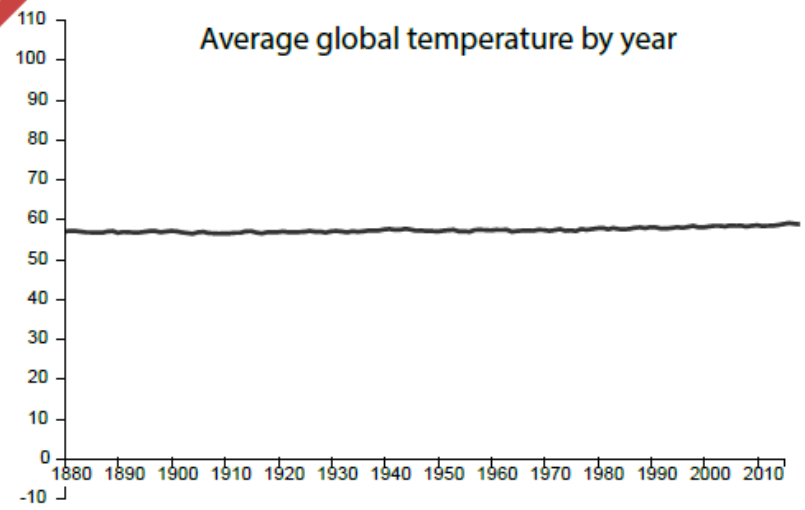


THE LINE CHART

HONEST

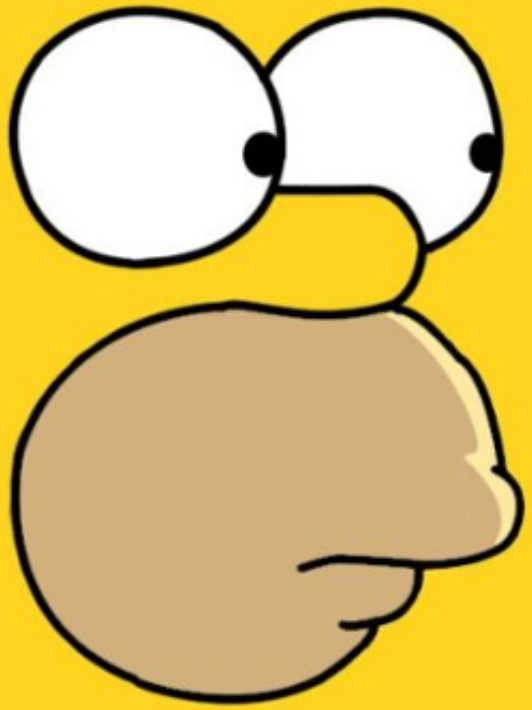


DECEPTIVE




Age of 2019's
Richest People
(1-50)
Frequency
14
12
10
8
6
4
2
0
2
4
5
11
10
13
5
30 - 39
39 - 48
48 - 57
57 - 67
67 - 77
77 - 86
86 - 95
Age

The Simpsons



Rating Category

- Great
- Good
- Regular
- Bad
- Garbage

Episode \ Season	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	8,2	8,2	8,6	8,5	8,5	8,7	9,0	8,4	9,1	7,6	7,3	7,6	7,5	7,6	7,5	7,4	6,1	7,5	6,6	7,2	7,0	6,1	7,0	6,3	6,8	5,6	5,6	6,0	6,7	6,2	5,7
2	7,7	8,2	7,8	8,2	9,2	8,1	8,3	9,2	7,0	8,2	7,5	7,5	7,0	7,3	7,3	6,8	6,8	6,6	6,5	6,9	6,5	6,7	7,0	7,2	6,9	6,8	6,6	6,5	6,5	6,0	5,8
3	7,4	8,3	8,2	9,0	8,6	5,9	8,4	8,1	8,1	7,6	7,5	7,0	7,1	7,1	6,9	7,1	6,9	6,6	7,1	6,8	6,1	6,6	6,4	6,8	6,3	6,4	7,0	7,0	6,1	6,1	6,5
4	7,7	8,1	8,6	7,8	8,9	8,6	8,8	7,7	8,2	8,0	7,7	7,1	7,0	7,0	7,0	6,4	7,3	6,8	6,7	7,0	7,3	7,0	6,4	6,6	6,4	7,4	7,5	6,9	7,1	5,9	6,9
5	8,0	7,5	8,5	8,5	8,8	8,3	8,5	8,3	8,2	7,3	7,8	7,0	7,6	6,7	7,1	7,0	6,9	6,7	6,9	6,5	6,6	7,1	7,0	6,2	6,8	6,2	6,6	6,3	6,3	7,0	6,1
6	7,6	8,0	7,7	8,2	8,1	9,2	8,6	8,1	7,7	7,6	7,3	7,7	7,1	7,3	6,4	7,1	6,8	6,6	6,5	7,0	6,6	6,3	7,9	6,2	6,3	7,9	6,7	6,8	6,3	6,5	5,2
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8	7,7	8,4	7,9	8,2	8,7	8,6	8,6	8,8	8,1	7,3	7,1	7,9	6,9	7,3	6,6	6,2	7,0	7,1	7,1	6,5	7,1	6,7	6,0	7,1	6,4	6,3	6,8	6,6	6,8	6,4	7,3
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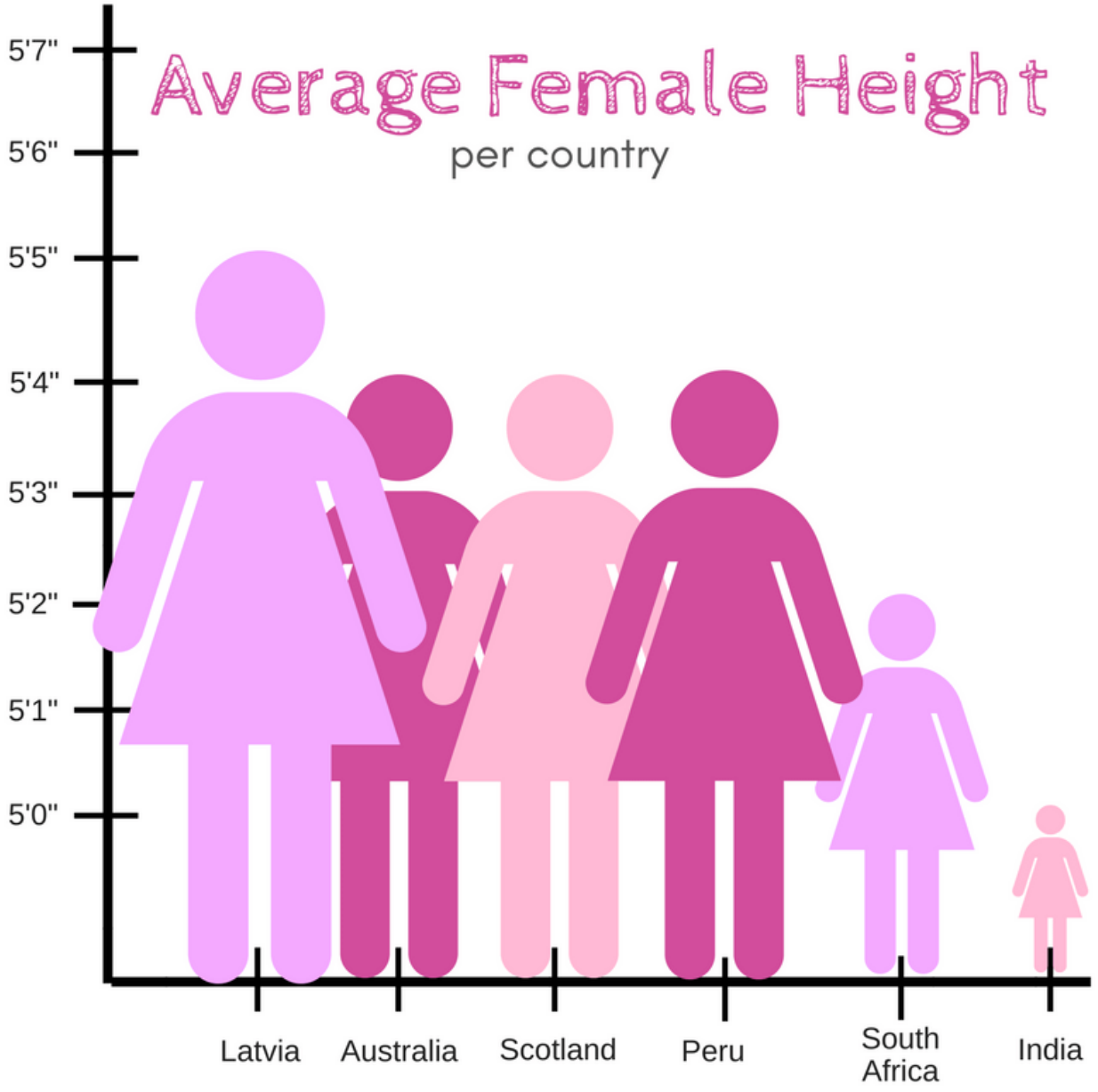
14		7,5	8,0	8,2	8,2	8,7	7,7	8,0	8,2	7,3	7,7	7,2	7,2	6,8	6,7	6,7	7,0	6,8	7,3	6,2	6,9	7,1	6,9	6,0	6,5	6,5	6,5	6,4	6,1	6,2	7,4
15		8,3	8,1	8,4	8,9	8,6	7,7	8,8	7,5	7,3	7,3	7,5	7,0	7,1	6,7	7,2	6,4	6,2	6,6	6,6	7,0	6,6	6,8	6,8	6,8	6,4	6,3	6,5	6,4	6,4	6,6
16		7,5	8,3	8,4	8,5	8,5	8,2	8,2	7,7	7,5	7,3	6,6	7,7	7,1	7,0	7,4	6,3	7,0	5,9	7,1	5,6	5,9	7,2	6,9	6,7	6,6	7,1	6,5	6,3	5,7	6,6
17		7,6	8,7	9,1	7,9	7,9	8,9	8,0	8,0	7,7	7,0	6,8	5,4	7,1	6,6	7,1	7,2	7,2	6,7	7,1	6,5	6,1	6,9	6,3	6,3	6,5	6,3	6,9	6,8	6,3	7,1
18		8,0	8,2	7,1	8,4	8,5	8,1	8,9	7,9	7,4	7,3	8,6	7,7	6,9	7,0	6,6	6,7	5,8	7,0	6,9	6,8	6,8	7,0	6,3	6,8	6,6	6,2	6,1	7,1	4,6	
19		8,5	7,8	8,1	8,4	8,3	8,2	8,2	8,2	7,6	6,5	7,2	6,7	6,7	7,3	7,2	7,1	6,9	6,9	7,1	6,8	6,4	7,5	6,6	5,6	6,7	7,1	6,9	6,7	6,1	
20		7,9	8,0	8,1	8,3	8,2	8,6	7,7	7,8	7,3	7,1	7,2	7,1	6,7	7,2	7,0	6,6	6,8	6,3	6,3	7,1	7,0	6,7	6,1	7,8	6,0	6,7	6,1	6,8	5,2	
21		8,3	8,3	7,7	7,6	8,1	8,9	7,9	7,9	7,1	7,2	7,0	7,0	6,6	6,2	7,2	7,0	8,1		7,2	6,8	7,1	6,5	7,0	6,5	6,5	6,2	6,5	7,7	5,1	
22		7,9	7,8	8,2	8,1	8,2	8,4	8,1	8,4	7,4	7,9		7,8	7,7	7,2		6,3	7,1			7,2	6,9	3,9	6,7	6,5	6,8	6,7			5,9	
23			7,8			8,2	8,1	9,3	8,2	8,0											6,4									5,8	
24			8,3			8,8	8,0	7,2	7,8																						
25						9,2	8,4	7,9	8,1																						

Data: Internet Movie Database https://www.imdb.com/interfaces/
Idea: https://www.espinof.com/animacion/guia-de-supervivencia-de-los-simpson-el-momento-definitivo-en-que-la-serie-co..

Hannes Benne


Average Female Height
per country
5'7"
5'6"
5'5"
5'4"
5'3"
5'2"
5'1"
5'0"
Latvia
Australia
Scotland
Peru
South Africa
India

Misleading graph

From Wikipedia, the free encyclopedia

In statistics, a **misleading graph**, also known as a **distorted graph**, is a graph that misrepresents data, constituting a misuse of statistics and with the result that an incorrect conclusion may be derived from it.

Graphs may be misleading by being excessively complex or poorly constructed. Even when constructed to display the characteristics of their data accurately, graphs can be subject to different interpretations, or unintended kinds of data can seemingly and ultimately erroneously be derived.[1]

Misleading graphs may be created intentionally to hinder the proper interpretation of data or accidentally due to unfamiliarity with graphing software, misinterpretation of data, or because data cannot be accurately conveyed. Misleading graphs are often used in false advertising. One of the first authors to write about misleading graphs was Darrell Huff, publisher of the 1954 book *How to Lie with Statistics*.

The field of data visualization describes ways to present information that avoids creating misleading graphs.

Contents [hide]

Part of a series on Statistics

Data visualization

Major dimensions

Exploratory data analysis · Information design · Interactive data visualization · Descriptive statistics · Inferential statistics · Statistical graphics · Plot · Data analysis · Infographic · Data science

Important figures

Tamara Munzner · Ben Shneiderman · John W. Tukey · Edward Tufte · Simon Wardley · Hans Rosling · David McCandless · Alexander Osterwalder · Ed Hawkins · Hadley Wickham · Leland Wilkinson · Mike Bostock · Jeffrey Heer · Ihab Ilyas

Information graphic types

Line chart · Bar chart · Histogram · Scatterplot · Boxplot · Pareto chart · Pie chart · Area chart · Control chart · Run chart · Stem-and-leaf display · Cartogram · Small multiple · Sparkline · Table · Marimekko chart

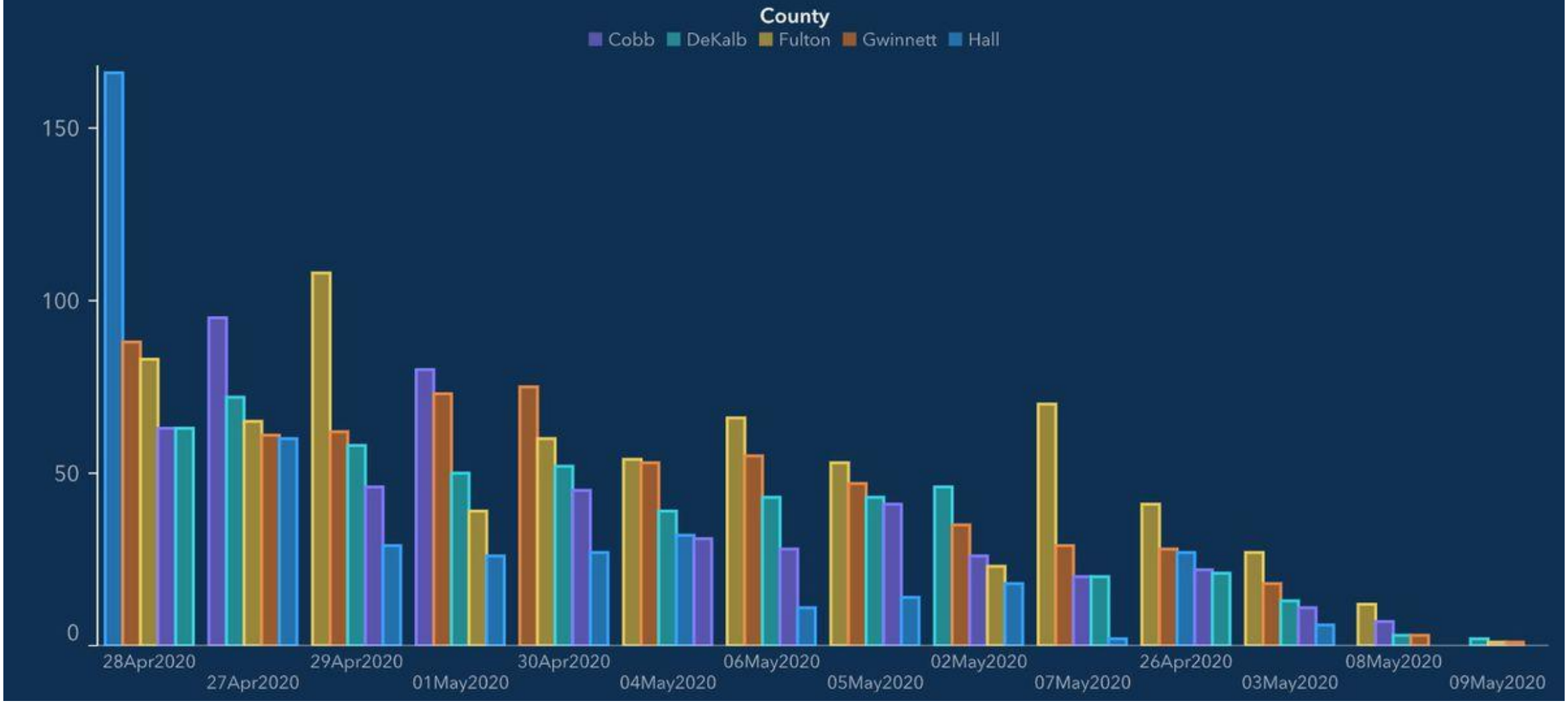
Related topics

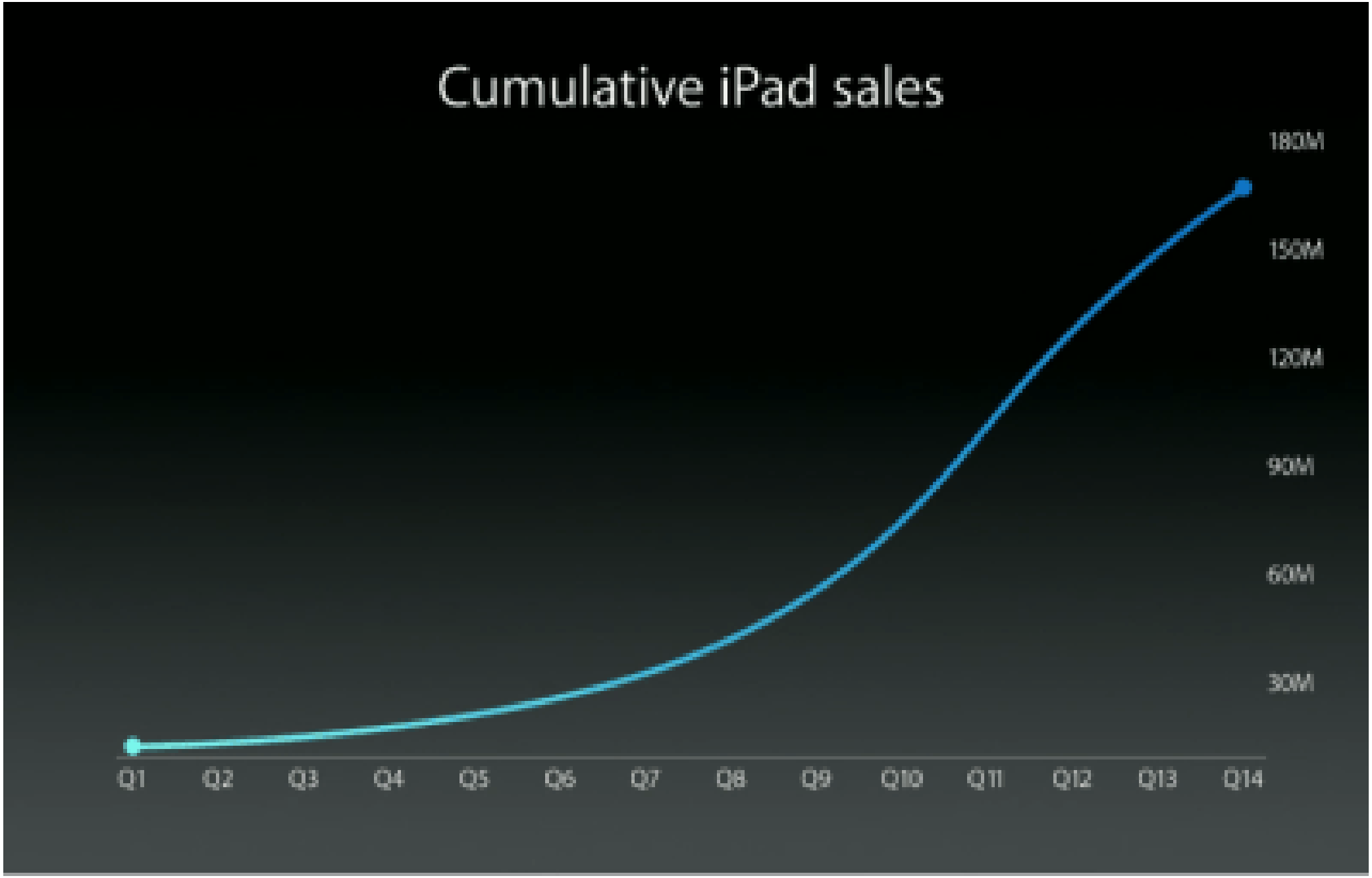
Data · Information · Big data · Database · Chartjunk · Visual perception · Regression analysis · Statistical model · **Misleading graph**

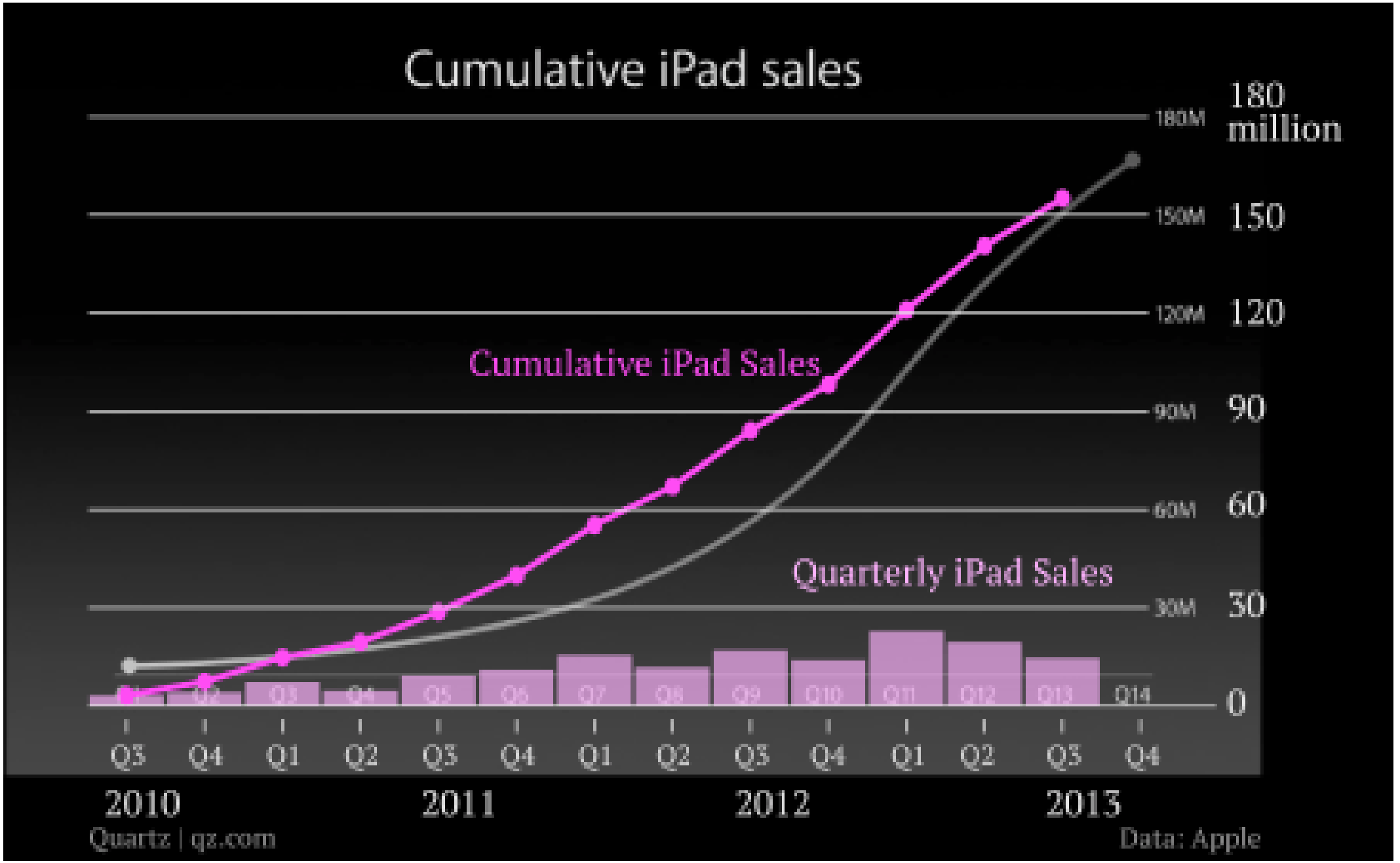
V · T · E

Top 5 Counties with the Greatest Number of Confirmed COVID-19 Cases

The chart below represents the most impacted counties over the past 15 days and the number of cases over time. The table below also represents the number of deaths and hospitalizations in each of those impacted counties.

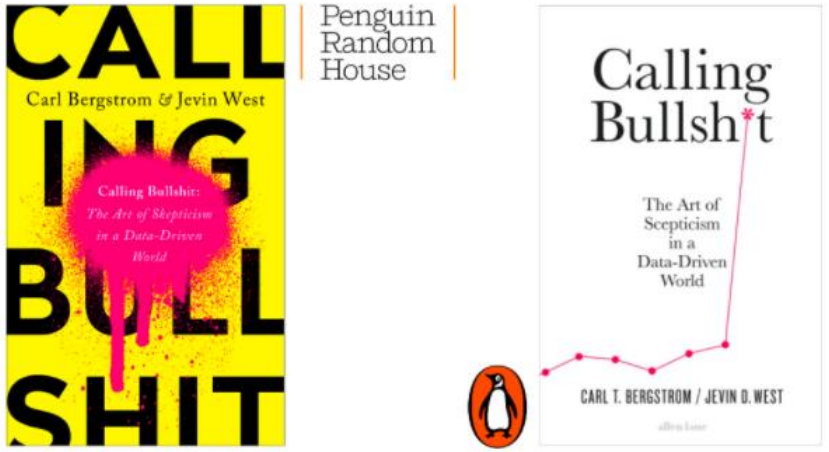



Cumulative iPad sales
180M
150M
120M
90M
60M
30M
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14


Cumulative iPad sales
180M
150M
120M
90M
60M
30M
0
180 million
150
120
90
60
30
Cumulative iPad Sales
Quarterly iPad Sales
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
2010
2011
2012
2013
Quartz | qz.com
Data: Apple

Calling Bullshit

Data Reasoning in a Digital World



Now available! *Calling Bullshit: The Art of Skepticism in a Data-Driven World*, by Carl Bergstrom and Jevin West. Available here.

The world is awash in bullshit. Politicians are unconstrained by facts. Science is conducted by press release. Higher education rewards bullshit over analytic thought. Startup culture elevates bullshit to high art. Advertisers wink conspiratorially and invite us to join them in seeing through all the bullshit —

PART 2: GUIDELINES

EXPRESSIVENESS: WHAT'S YOUR DATA?

	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

VISUALIZATION FUNDAMENTALS: MARKS

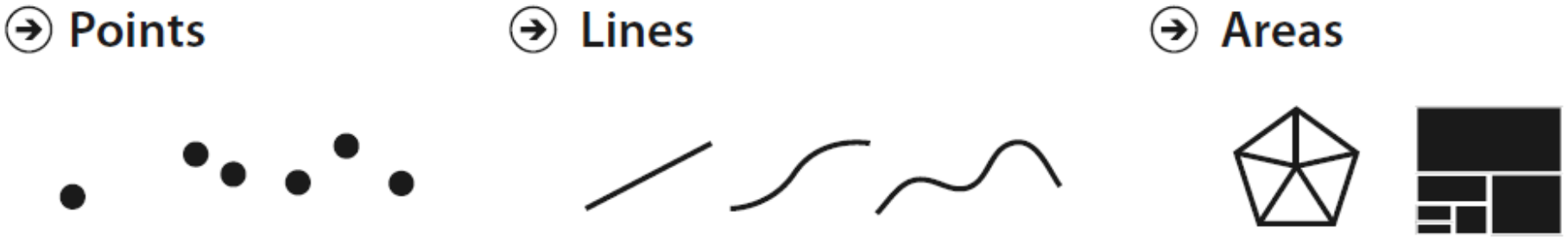


Image source: Munzner 2014

VISUALIZATION FUNDAMENTALS: CHANNELS

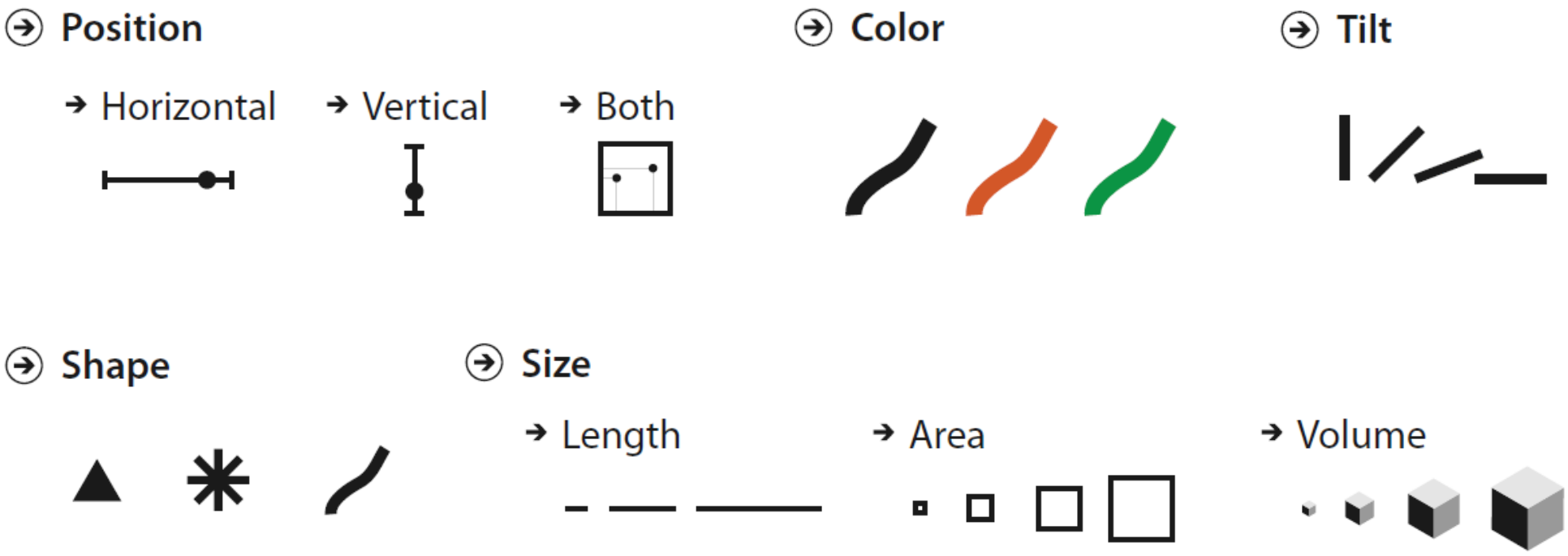


Image source: Munzner 2014

VISUALIZATION FUNDAMENTALS: EXPRESSIVENESS

categorical data:

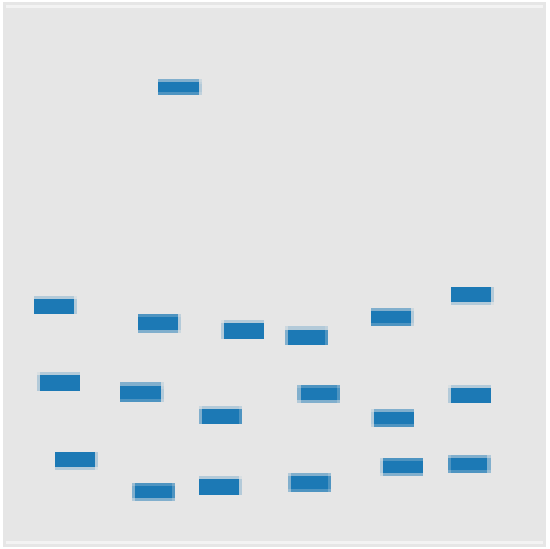
ordinal data:

discrete data:

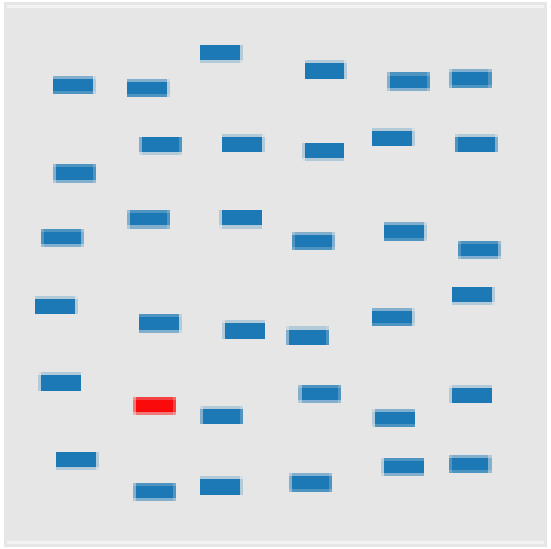
continuous data:

Rule #1: Map your data onto matching channels

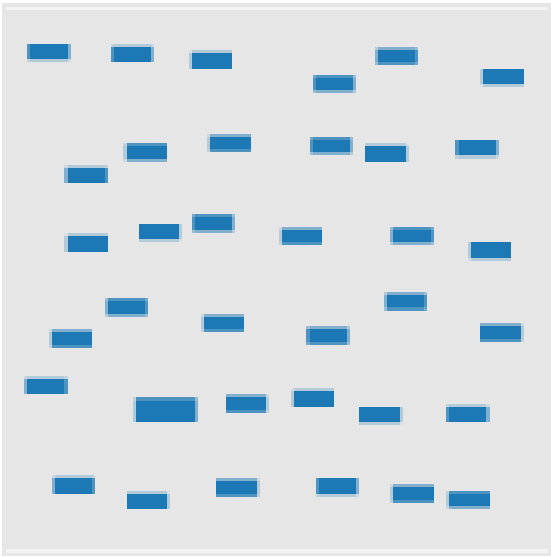
VISUALIZATION FUNDAMENTALS: PRECEDENCE



Position



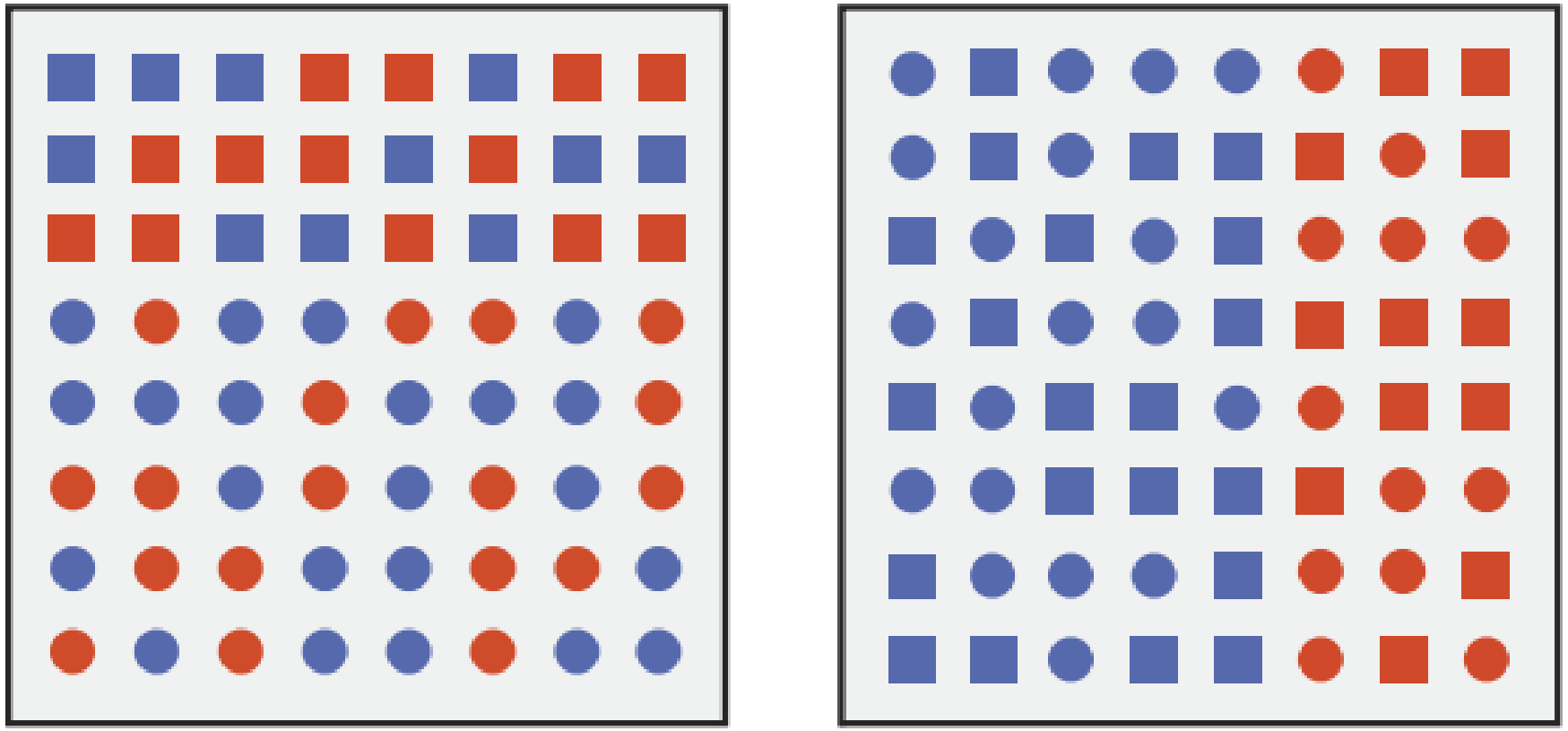
Color



Size

Image source: uxpractical.com

VISUALIZATION FUNDAMENTALS: PRECEDENCE



Hue-on-form hierarchy

MAPPING FUNDAMENTALS: PRECEDENCE

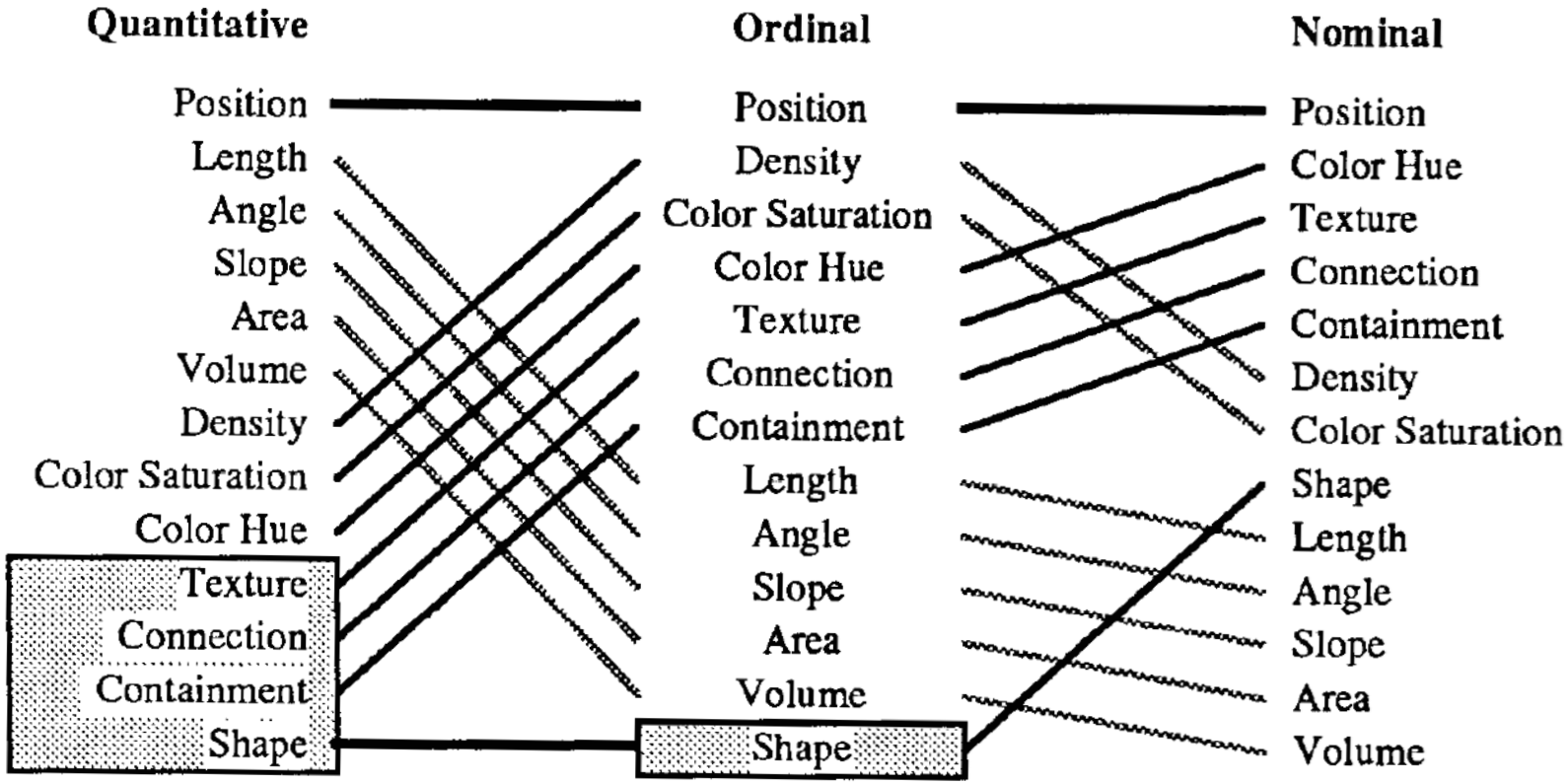
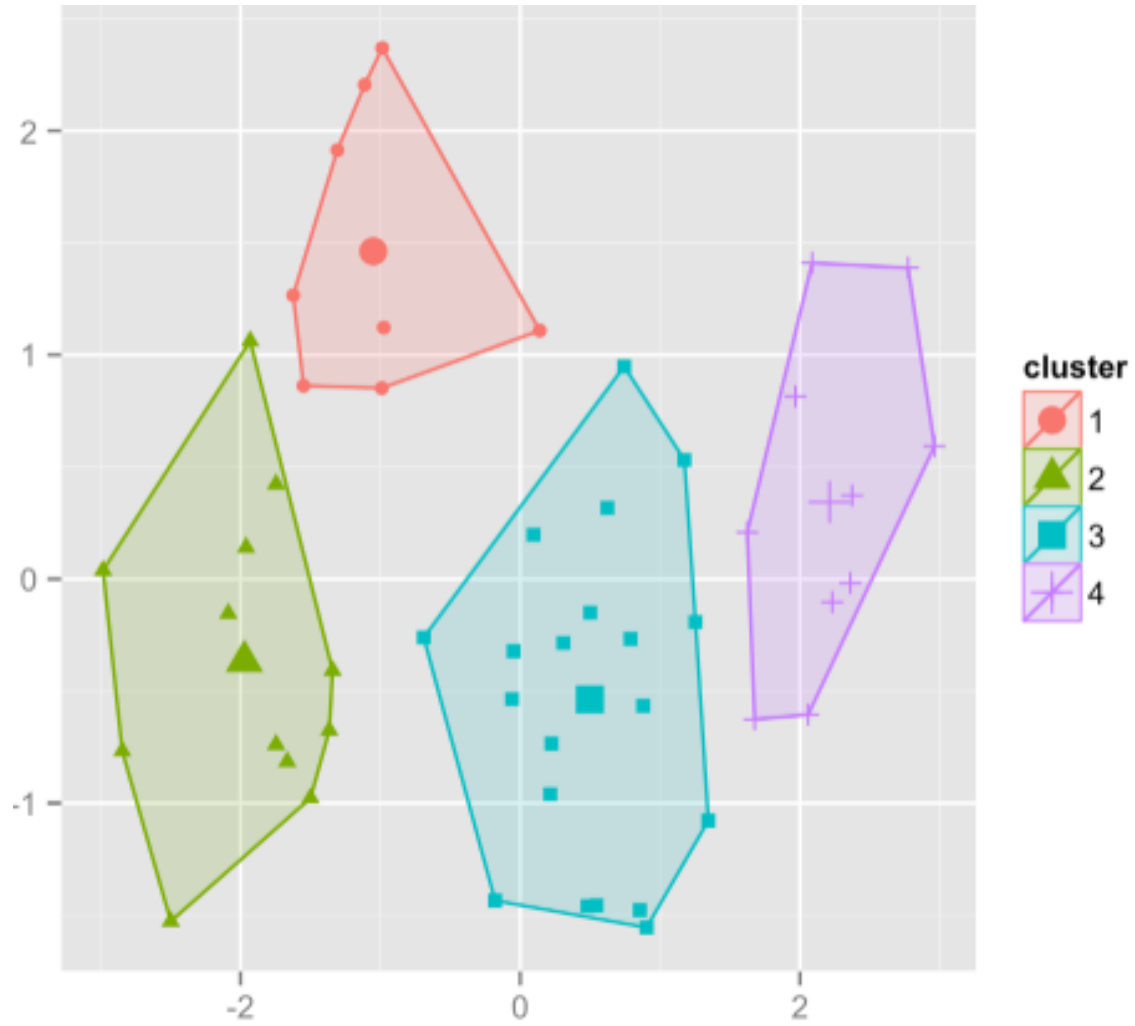


Image source: Mackinlay 1986

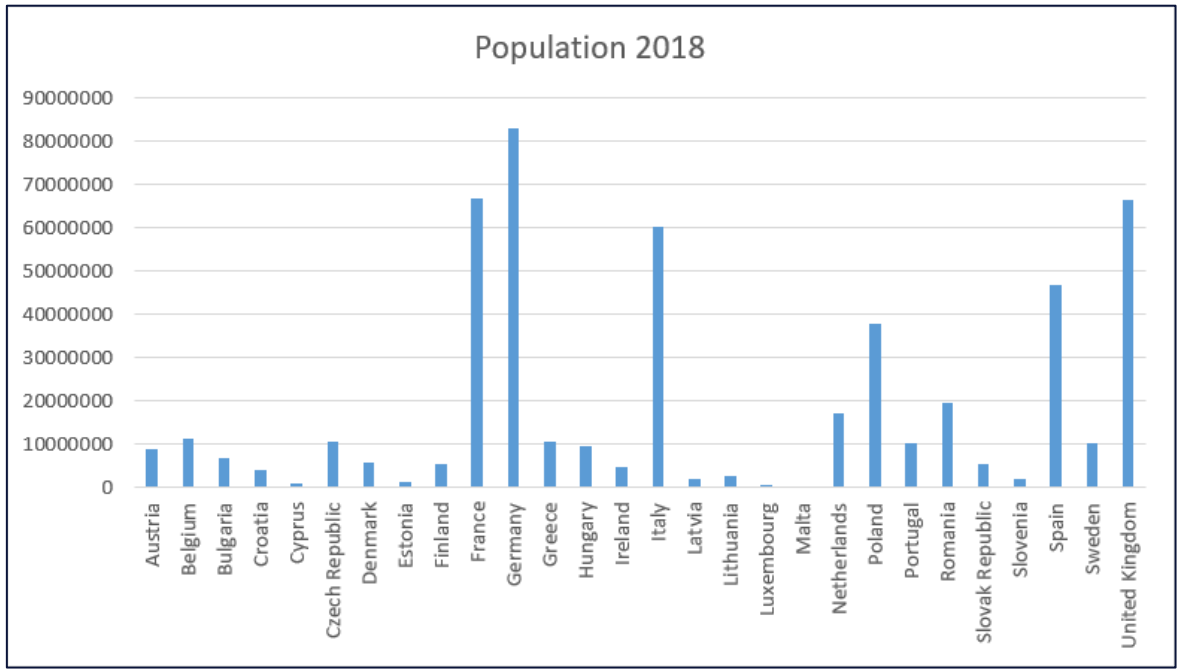
Rule #2: Map your data in order of importance to channels

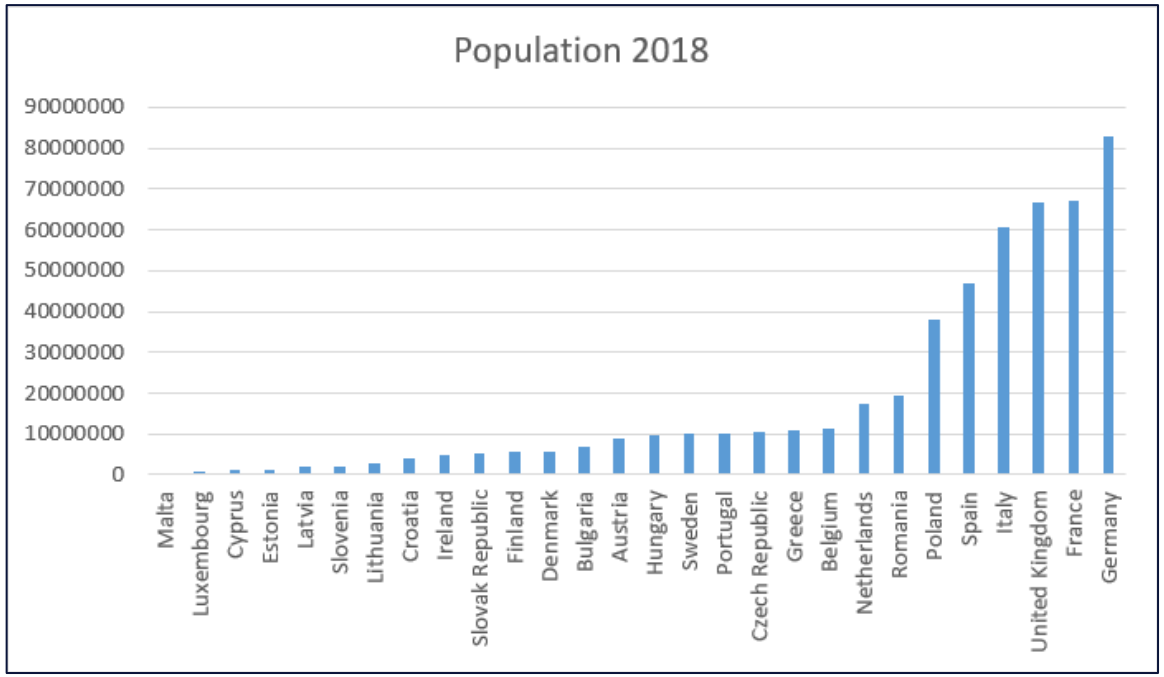
DOUBLE ENCODING FOR EVEN MORE OOOMPH!



Rule #3: Encode the main message in multiple channels.

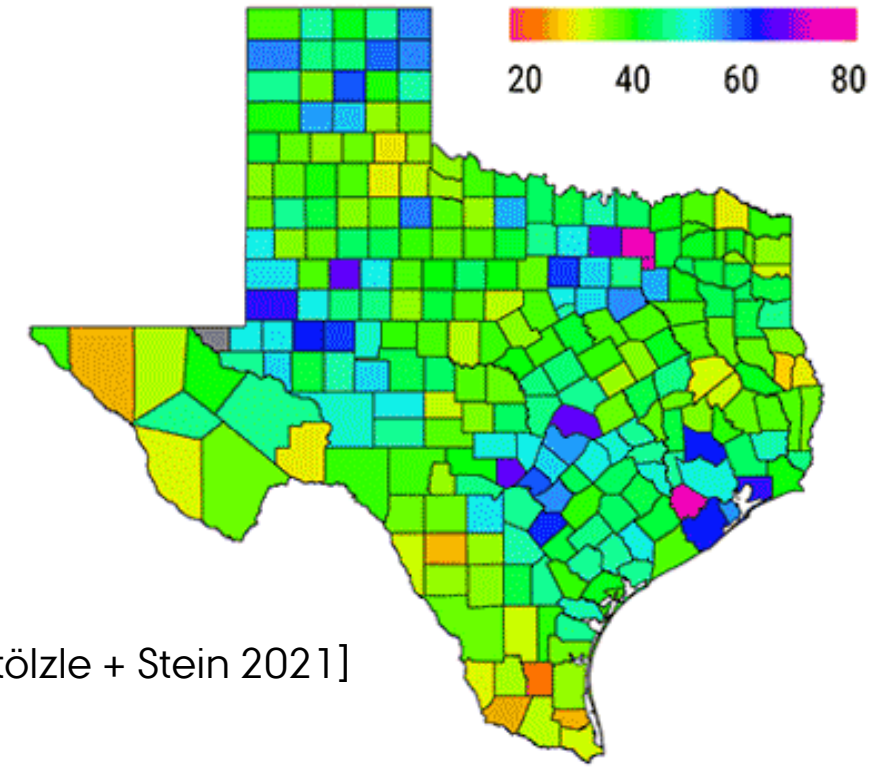
EFFECTIVENESS: WHAT IS THE TASK?



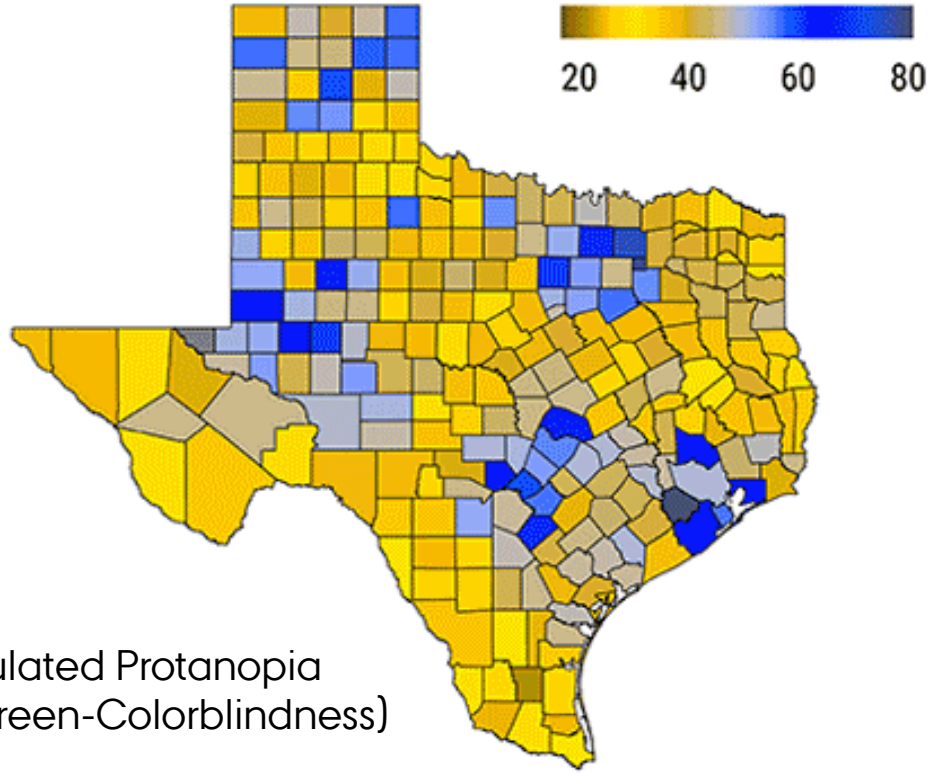


Rule #4: Adjust your chart to best support the reading task.

EFFECTIVENESS: WHO ARE YOUR READERS?

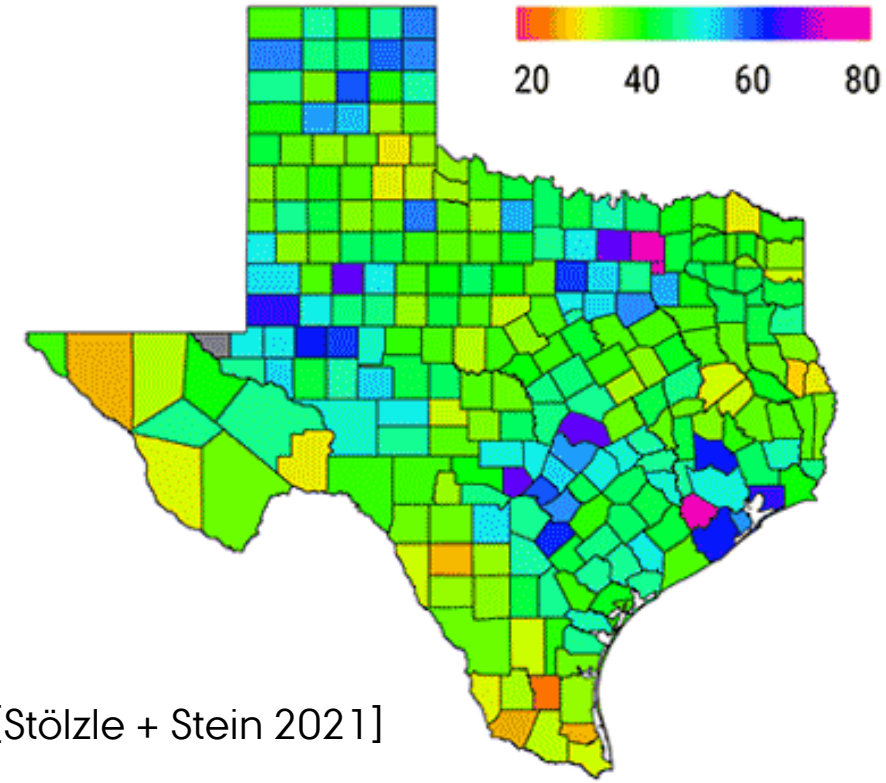


[Stölzle + Stein 2021]

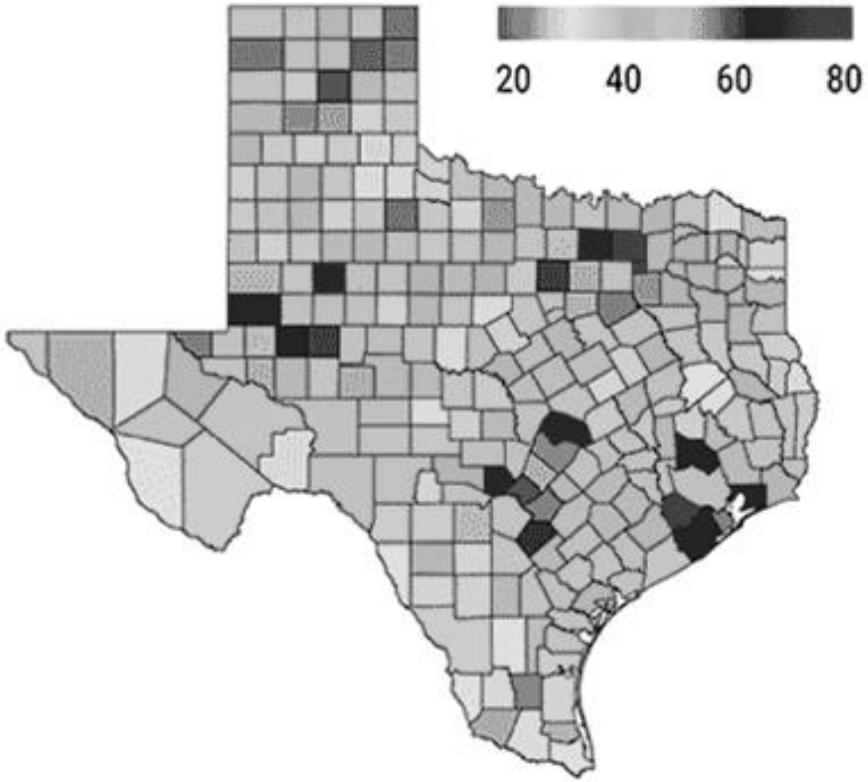


Simulated Protanopia
(Red-Green-Colorblindness)

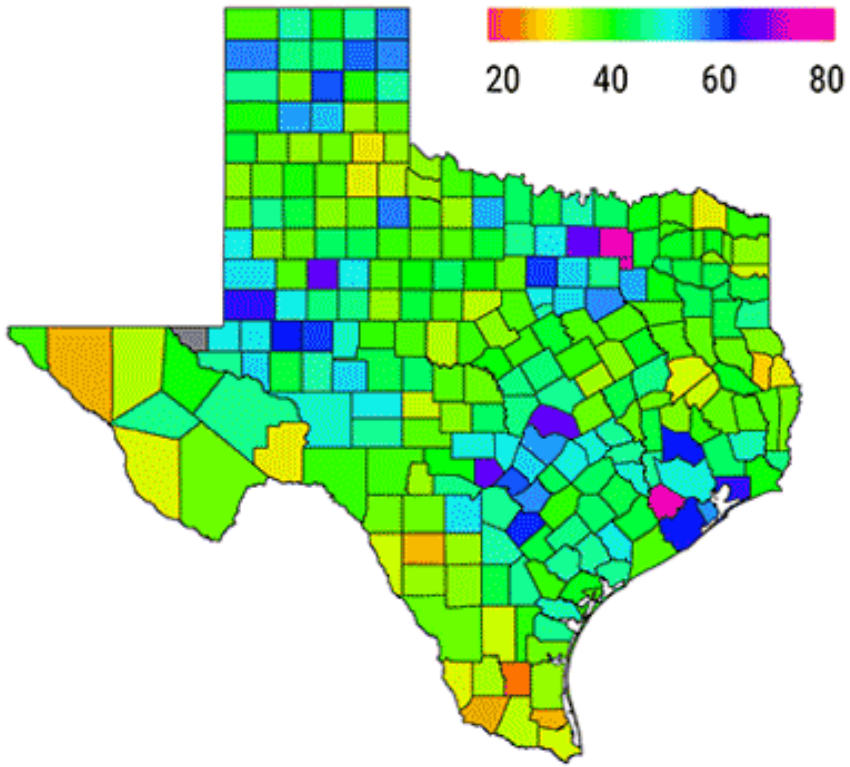
EFFECTIVENESS: WHAT CAN HAPPEN?

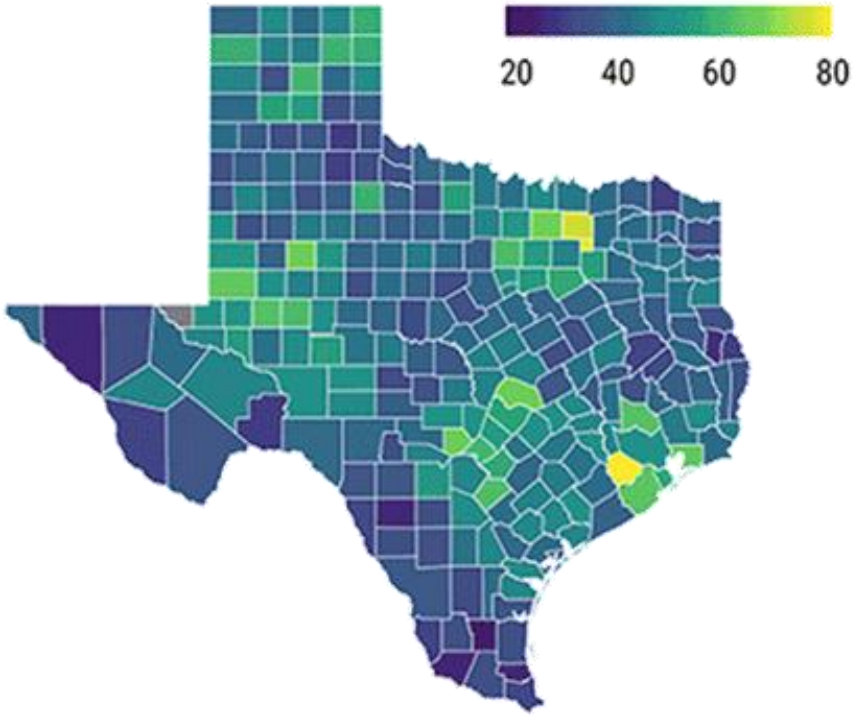


[Stölzle + Stein 2021]



EFFECTIVENESS: WHO ARE THE READERS?

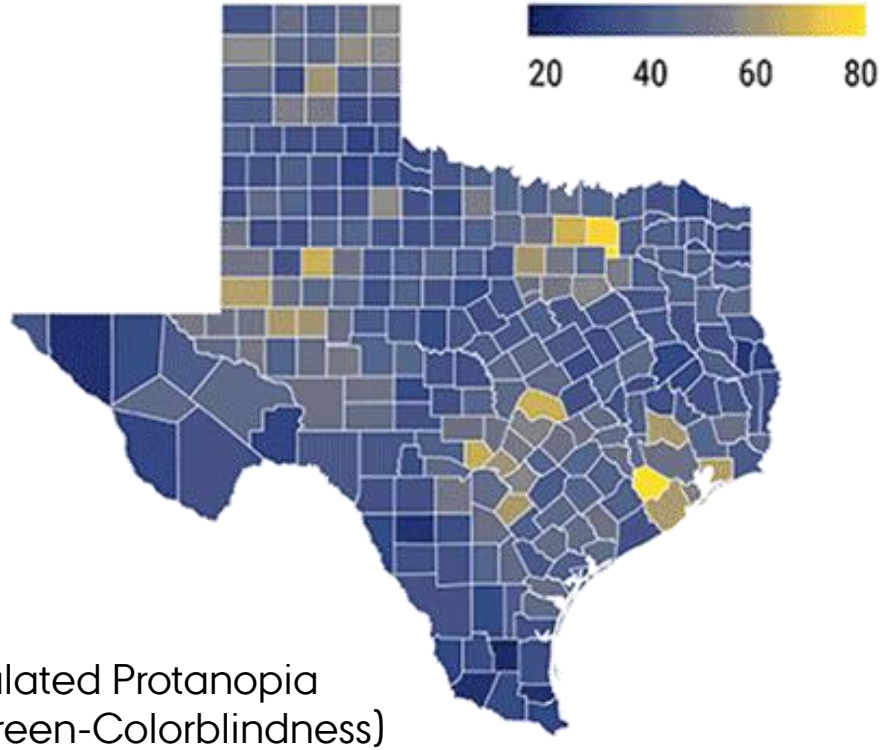




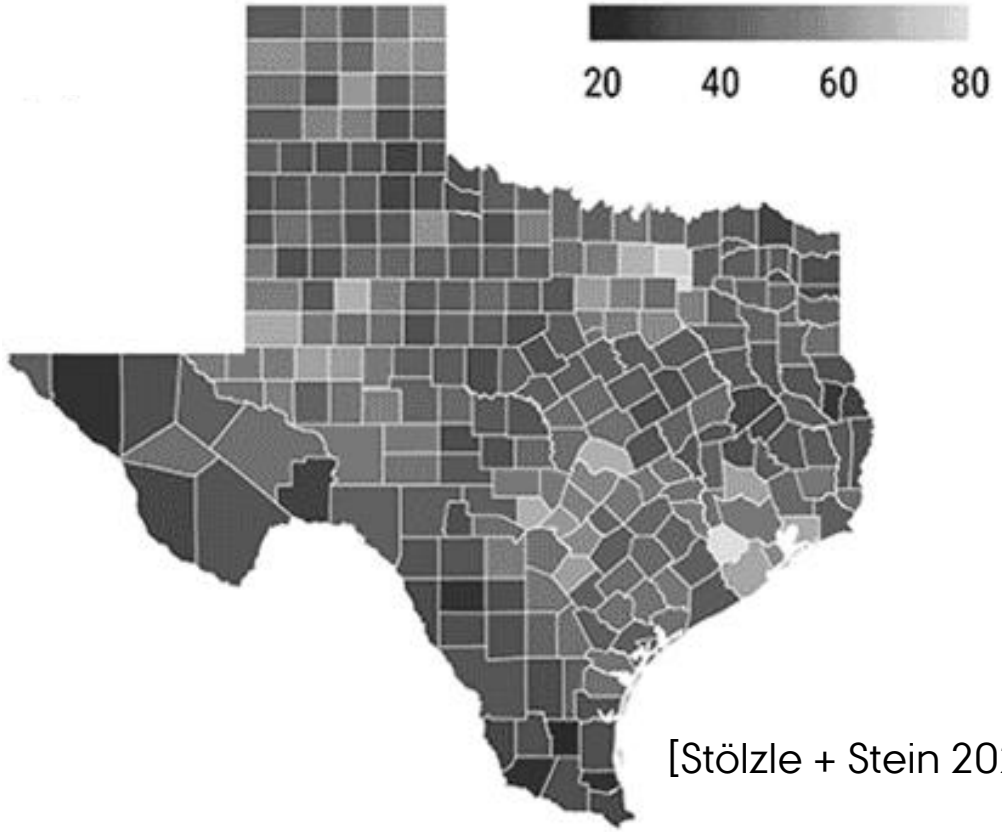
rainbow

viridis

EFFECTIVENESS: WHO ARE YOUR READERS?



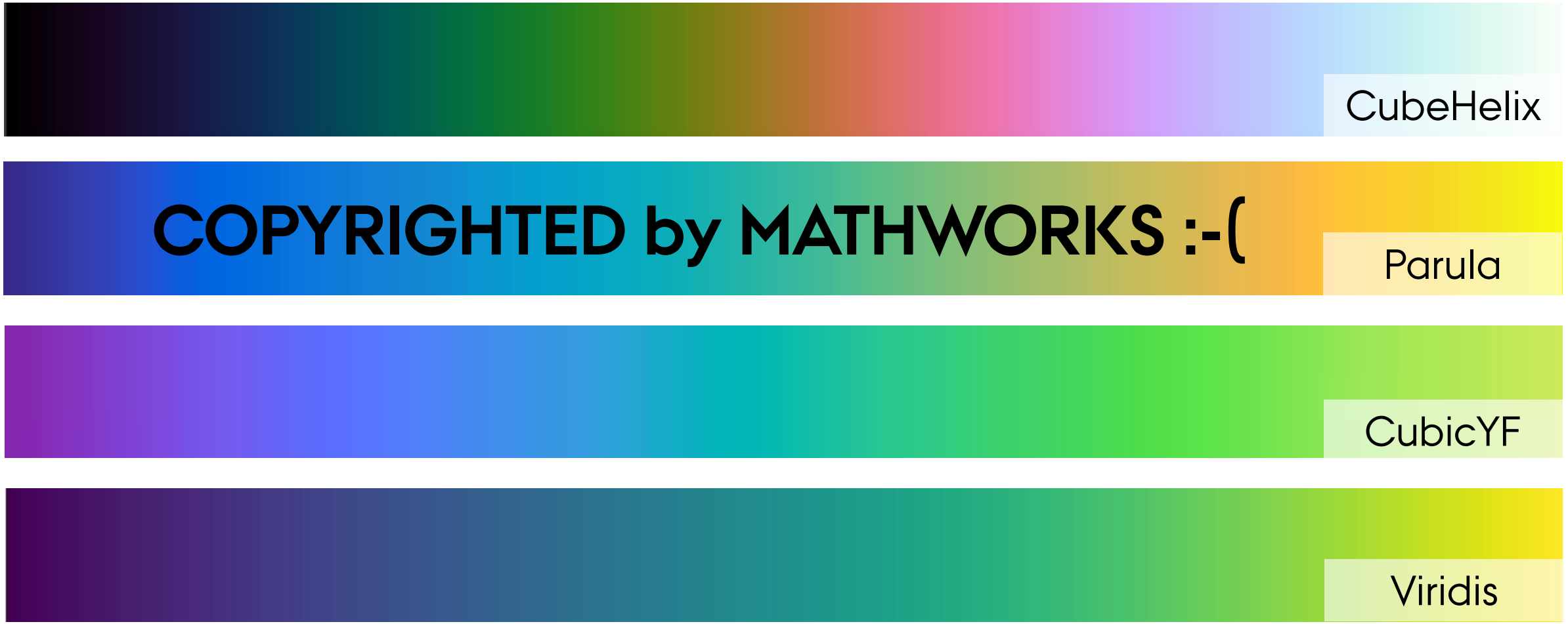
Simulated Protanopia
(Red-Green-Colorblindness)

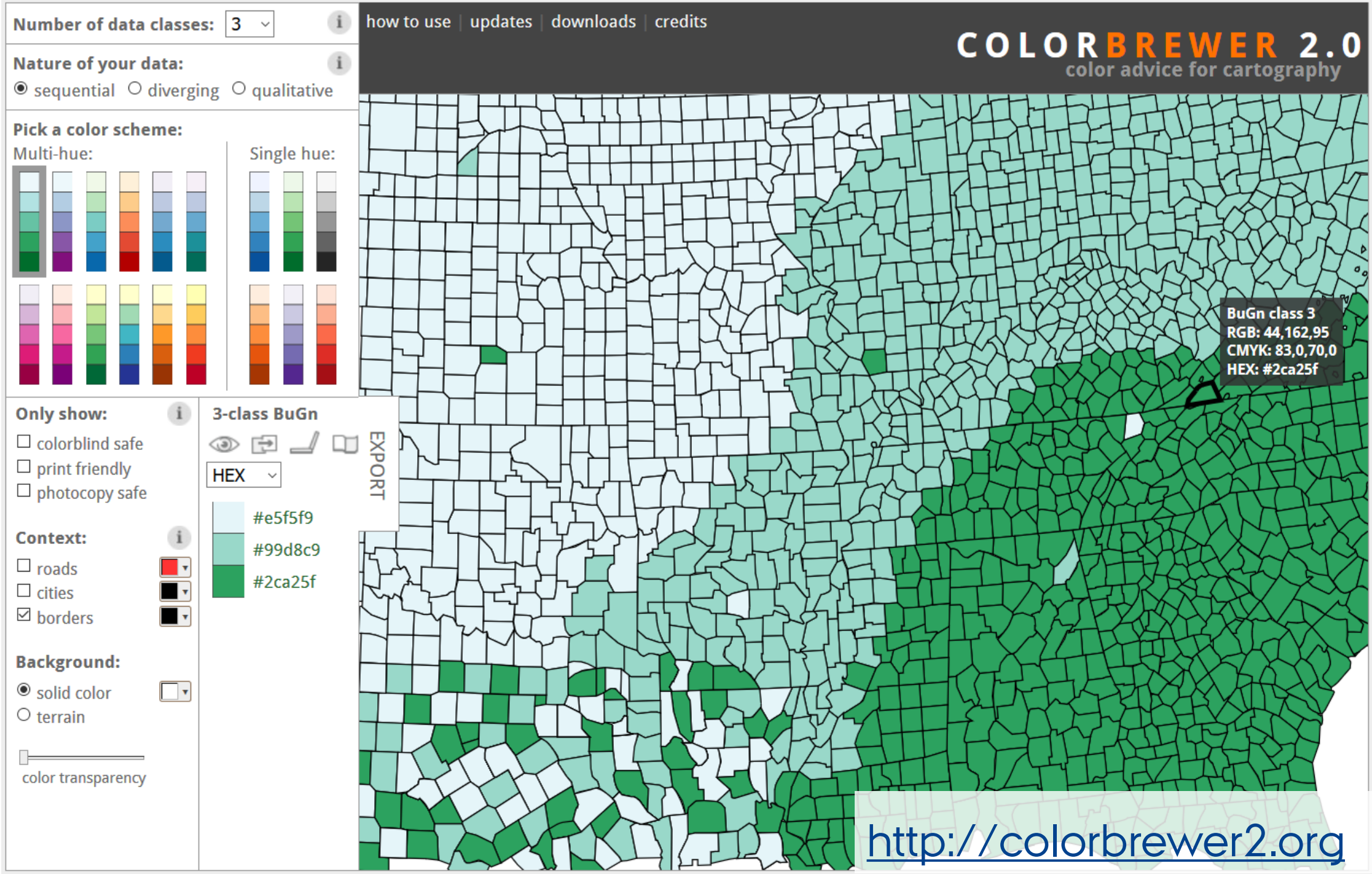


[Stölzle + Stein 2021]

Rule #5: Adjust your chart to be inclusive & flexible.

RAINBOW ALTERNATIVES




Number of data classes: 3
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
3-class BuGn
EXPORT
HEX
#e5f5f9
#99d8c9
#2ca25f
how to use
updates
downloads
credits
COLORBREWER 2.0
color advice for cartography
BuGn class 3
RGB: 44,162,95
CMYK: 83,0,70,0
HEX: #2ca25f
http://colorbrewer2.org

Colorgorical Source

Generate

Number of colors

5

Score importance

Perceptual Distance

Name Difference

Pair Preference

Name Uniqueness

Select hue filters

90°

180°

0°

270°

Drag wheel, or add angle:

to # +

Select lightness range

25 to 85

Add starting colors

#F00, rgb(0,0,0)

+

Results: Color space Hex RGB Lab LCH Array format " ' No quote Charts Clear all

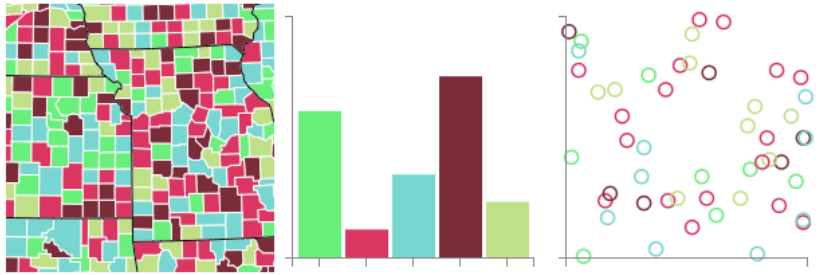
["rgb(105,239,123)", "rgb(218,54,97)", "rgb(119,214

rgb(105,239,123) + start

rgb(218,54,97) + start

rgb(119,214,207) + start

rgb(122,44,57) + start



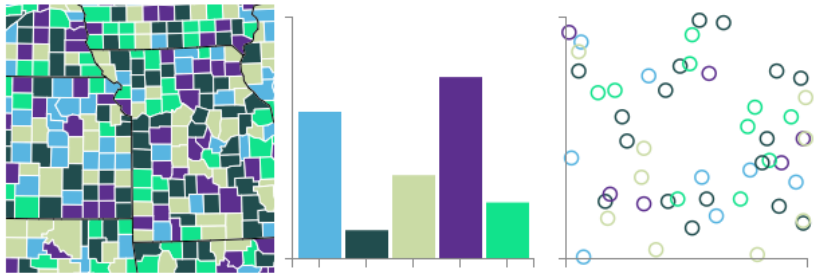
["rgb(88,181,225)", "rgb(33,77,78)", "rgb(202,219,1

rgb(88,181,225) + start

rgb(33,77,78) + start

rgb(202,219,165) + start

rgb(92,47,142) + start



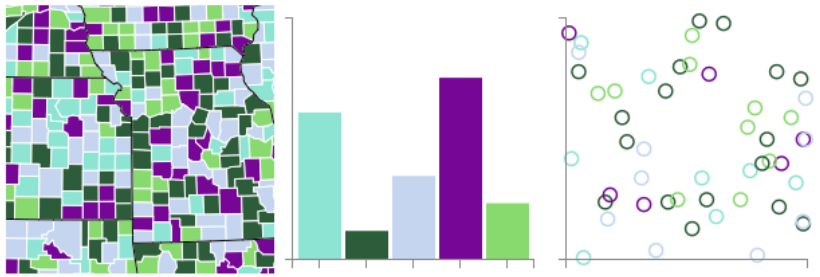
["rgb(141,228,211)", "rgb(44,92,57)", "rgb(197,213,

rgb(141,228,211) + start

rgb(44,92,57) + start

rgb(197,213,240) + start

rgb(118,7,150) + start



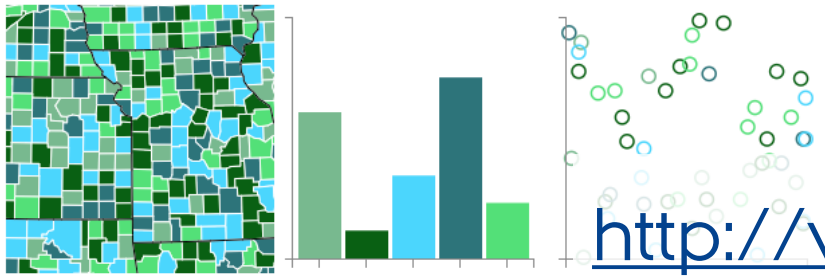
["rgb(120,185,143)", "rgb(9,96,19)", "rgb(75,214,25

rgb(120,185,143) + start

rgb(9,96,19) + start

rgb(75,214,253) + start

rgb(45,116,122) + start



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

Colblindor

Home CVD Essentials Color Blindness Tests Color Tools Contact

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 **C**olor **BLI**ndness **S**imulator 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 **C**olor **BLI**ndness **S**imulator. It is also possible to zoom and move your images around using your mouse – try it out, I hope you like it.

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

ANDROID APP ON Google play

CVD Categories

Academic Animals Children News People Pics Professions Publications Stories Tests Thoughts Tools Web

Recent Articles

https://www.color-blindness.com/coblis-color-blindness-simulator/

EFFICIENCY: THE CHART SHOULDN'T BE MORE COMPLEX THAN THE DATA!

RULE #6: DON'T USE 3D!

THE PERILS OF 3D

- **Occlusion**
- Perspective Distortion
- Non-anchored points
- Navigation / Orientation (Lost in Space)
- Selection
- Technical Issue – e.g., Font Rendering

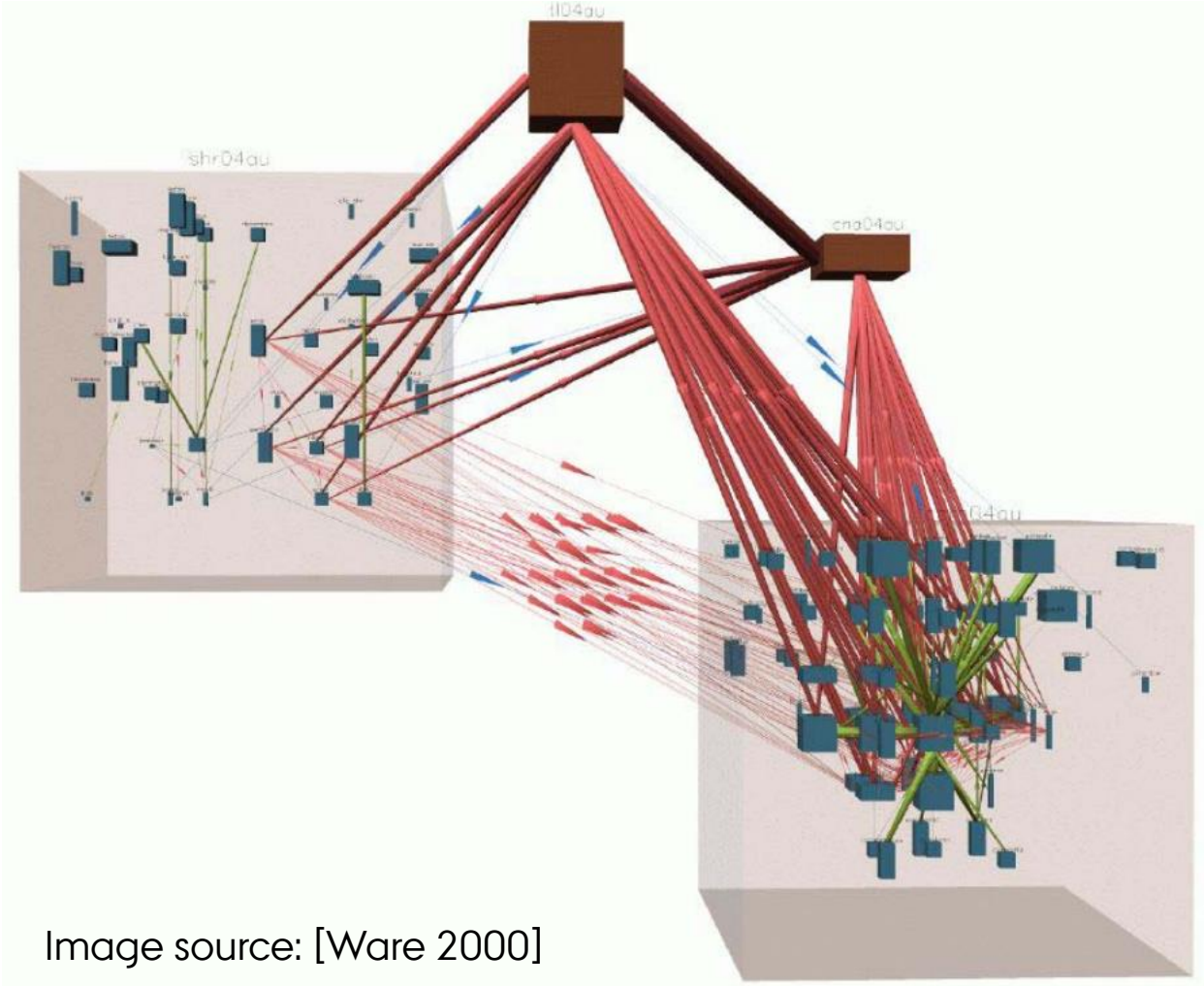


Image source: [Ware 2000]

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

THE PERILS OF 3D

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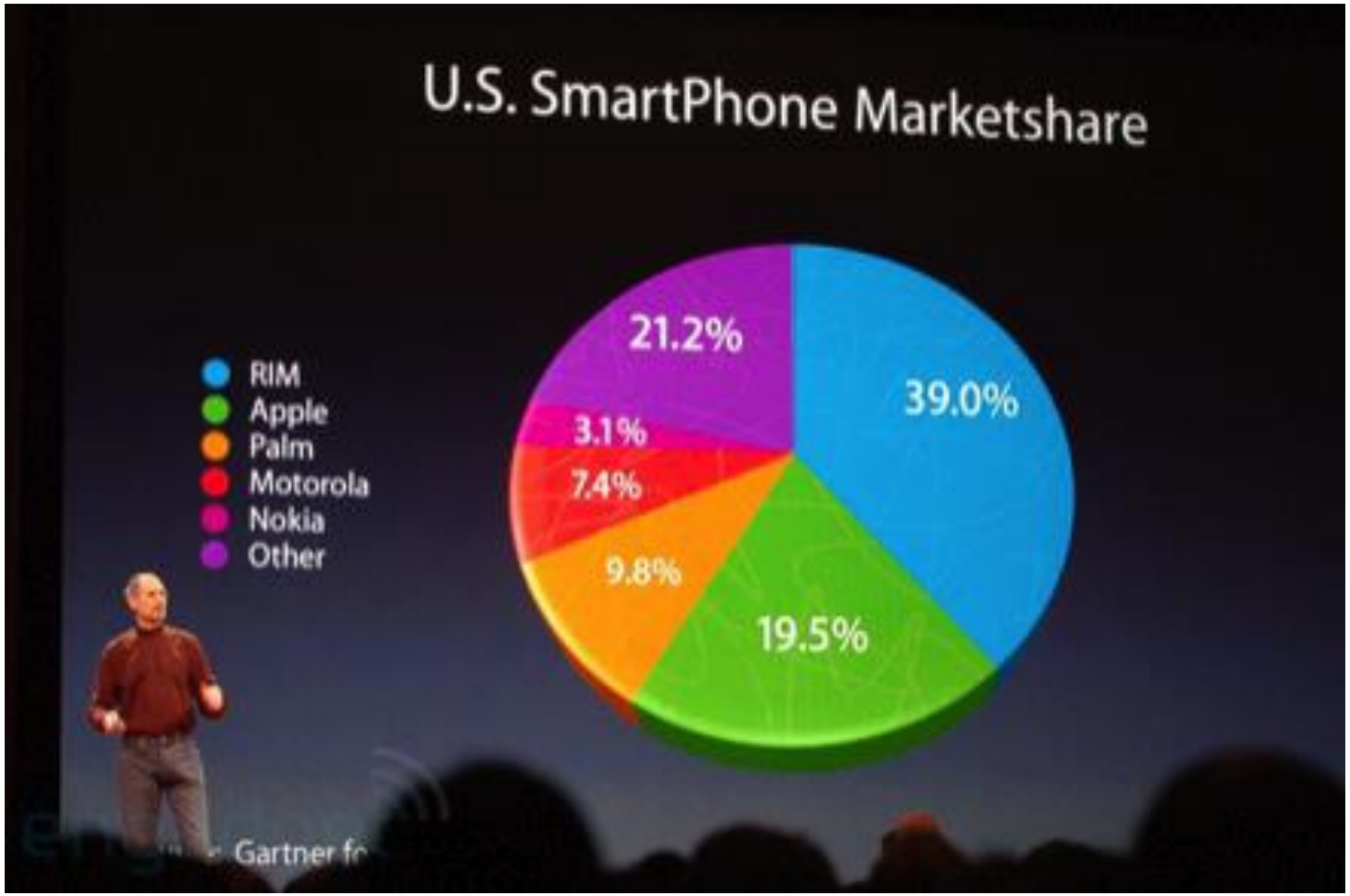

Image source: Macworld 2008, engadget.com

THE PERILS OF 3D

- Occlusion
- Perspective Distortion
- **Non-anchored points**
- Navigation / Orientation (Lost in Space)
- Selection
- Technical Issue – e.g., Font Rendering

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

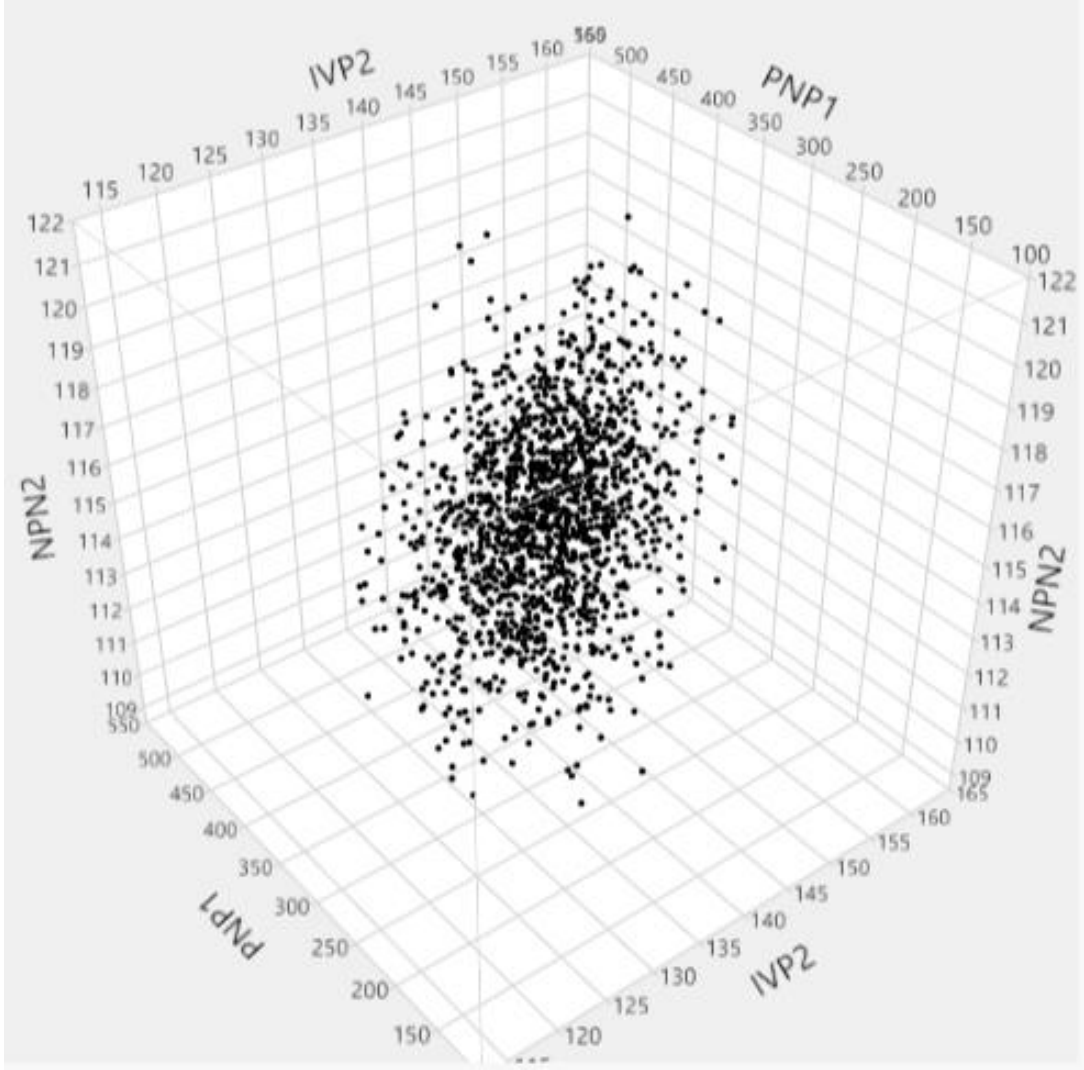

Image source:
https://community.jmp.com/t5/Discussions/3D-Scatterplot-Animation/td-p/49016

THE PERILS OF 3D

- Occlusion
- Perspective Distortion
- Non-anchored points
- **Navigation / Orientation (Lost in Space)**
- Selection
- Technical Issue – e.g., Font Rendering

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

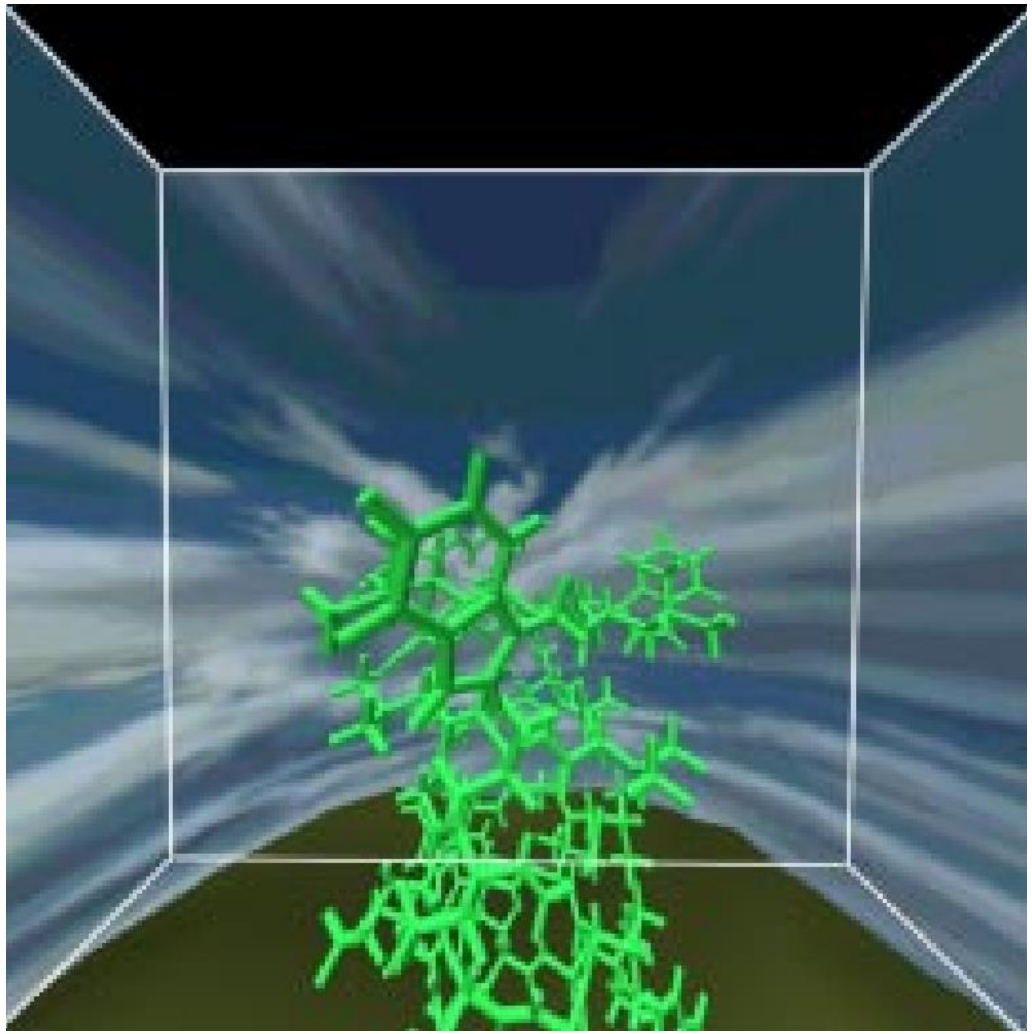

Image source: [Hanson et al.1997]

THE PERILS OF 3D

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- Perspective Distortion
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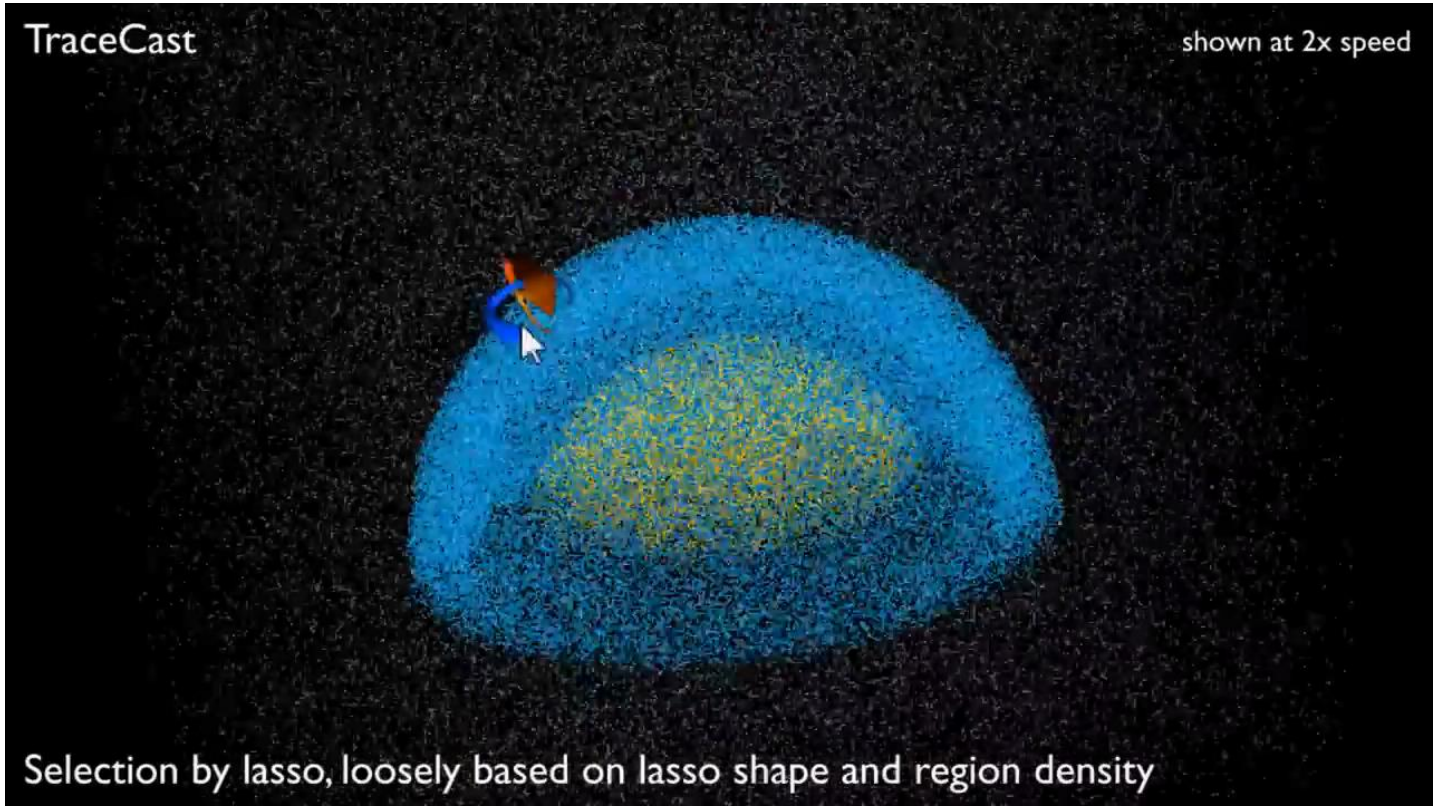
- Technical Issue – e.g., Font Rendering



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

Video source: Yu et al. 2016

THE PERILS OF 3D

- Occlusion
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Adapted from Brath 2014:
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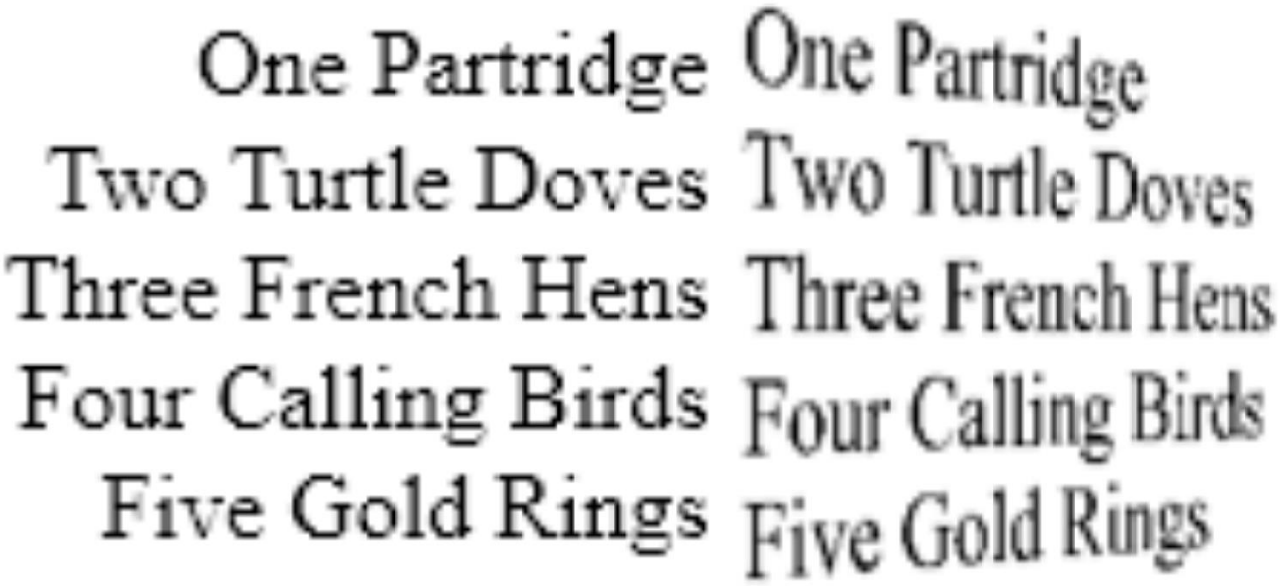
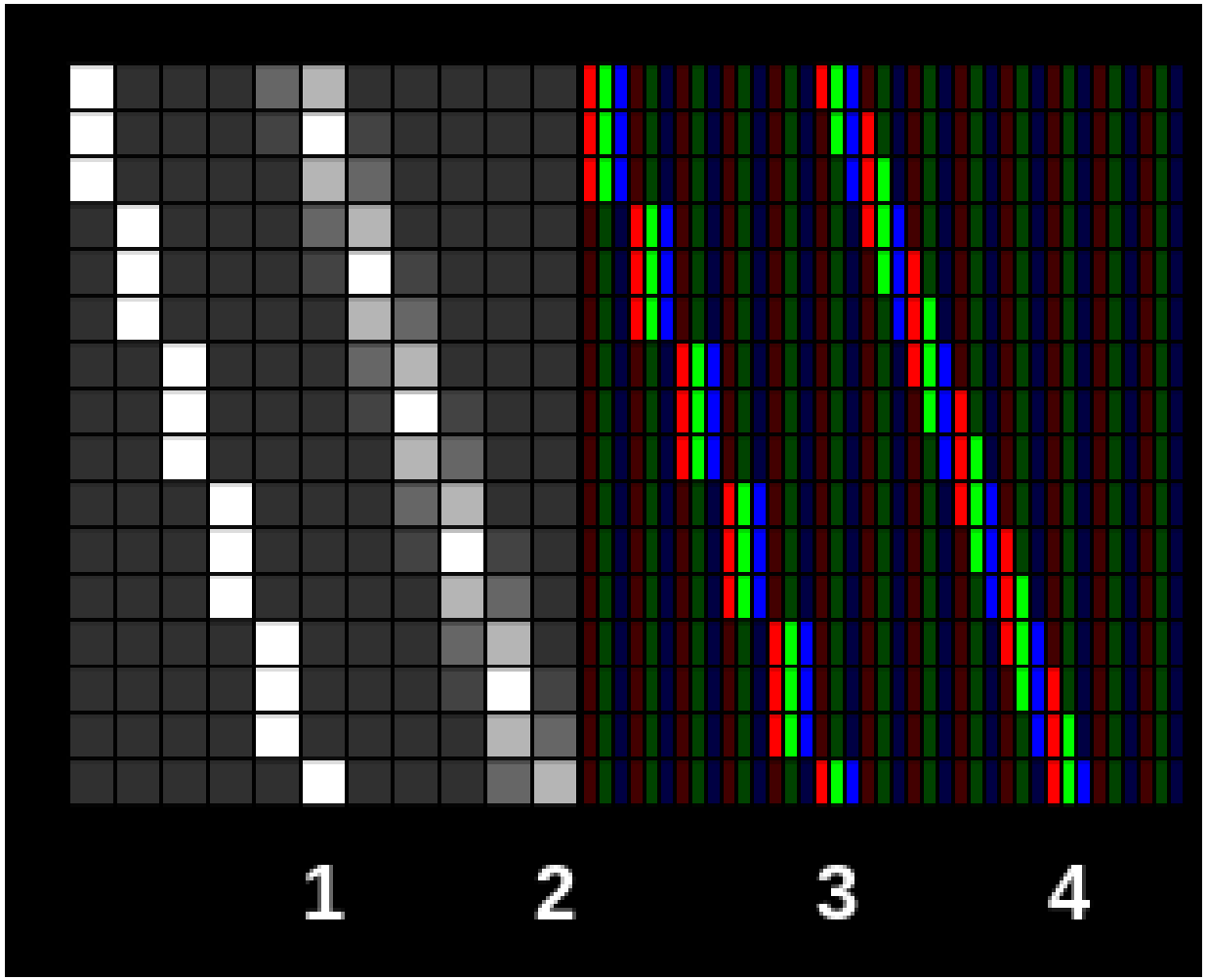
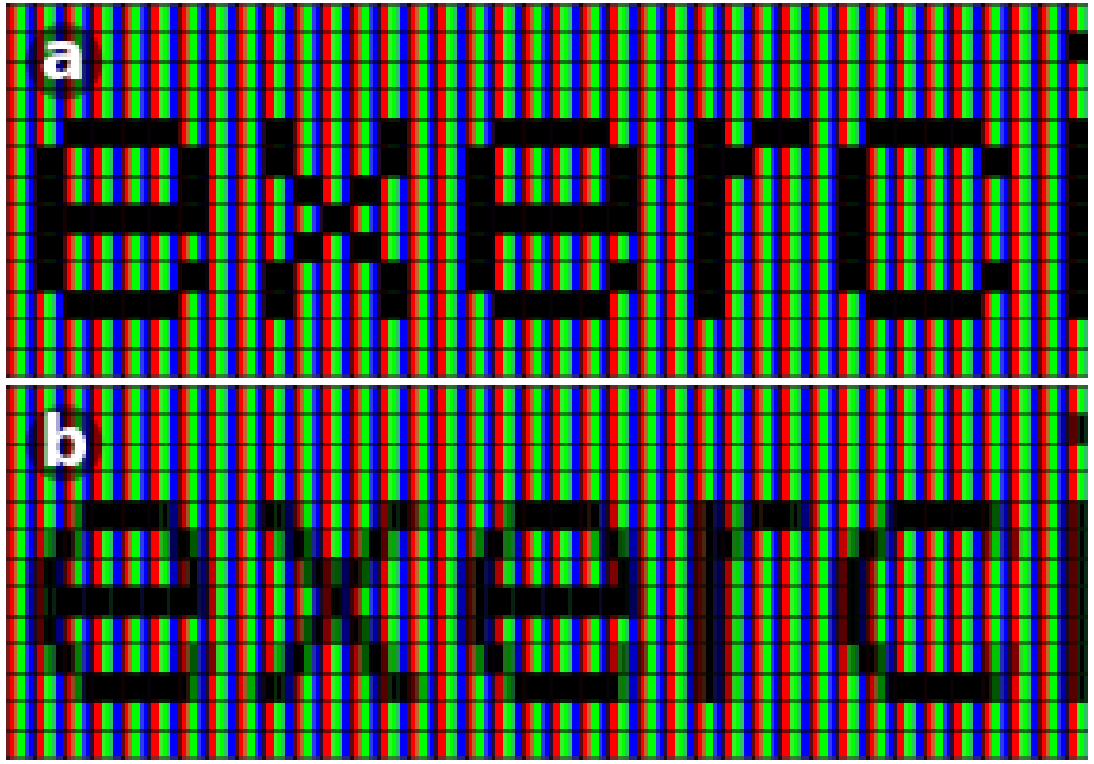


ClearType/FreeType vs. Anti-Aliasing

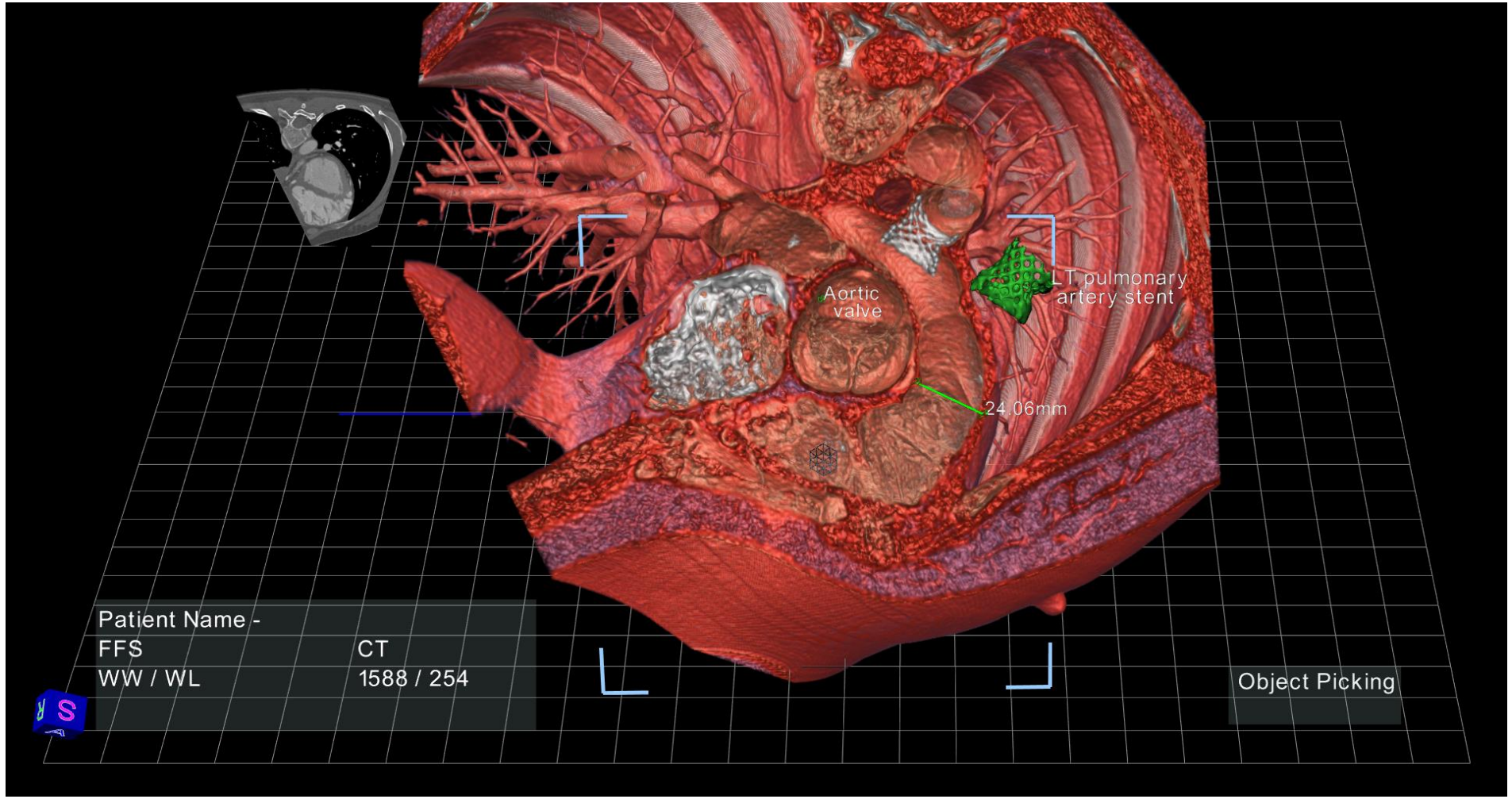
Image source: Brath 2014

INTERLUDE: SUBPIXEL RENDERING





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



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

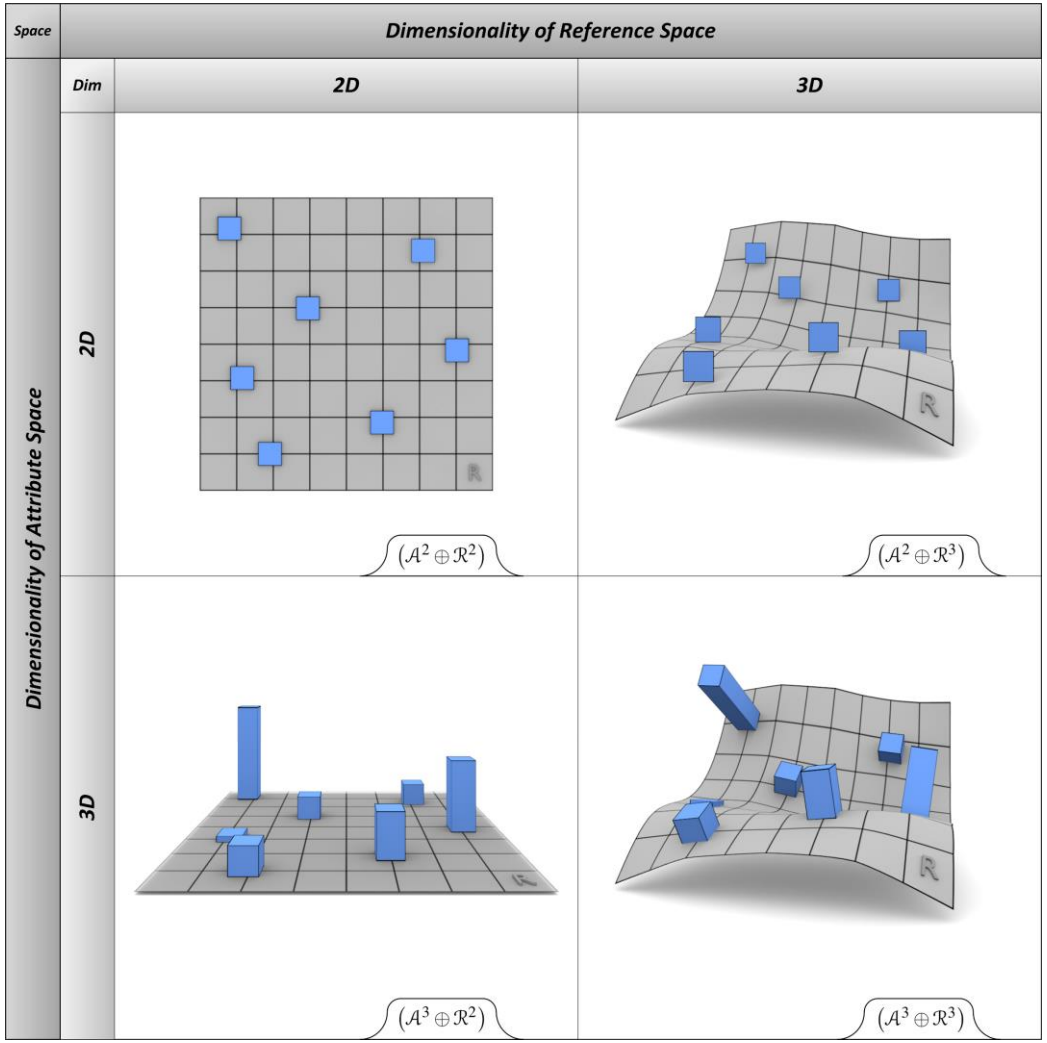


Image source: Dübel et al. 2014

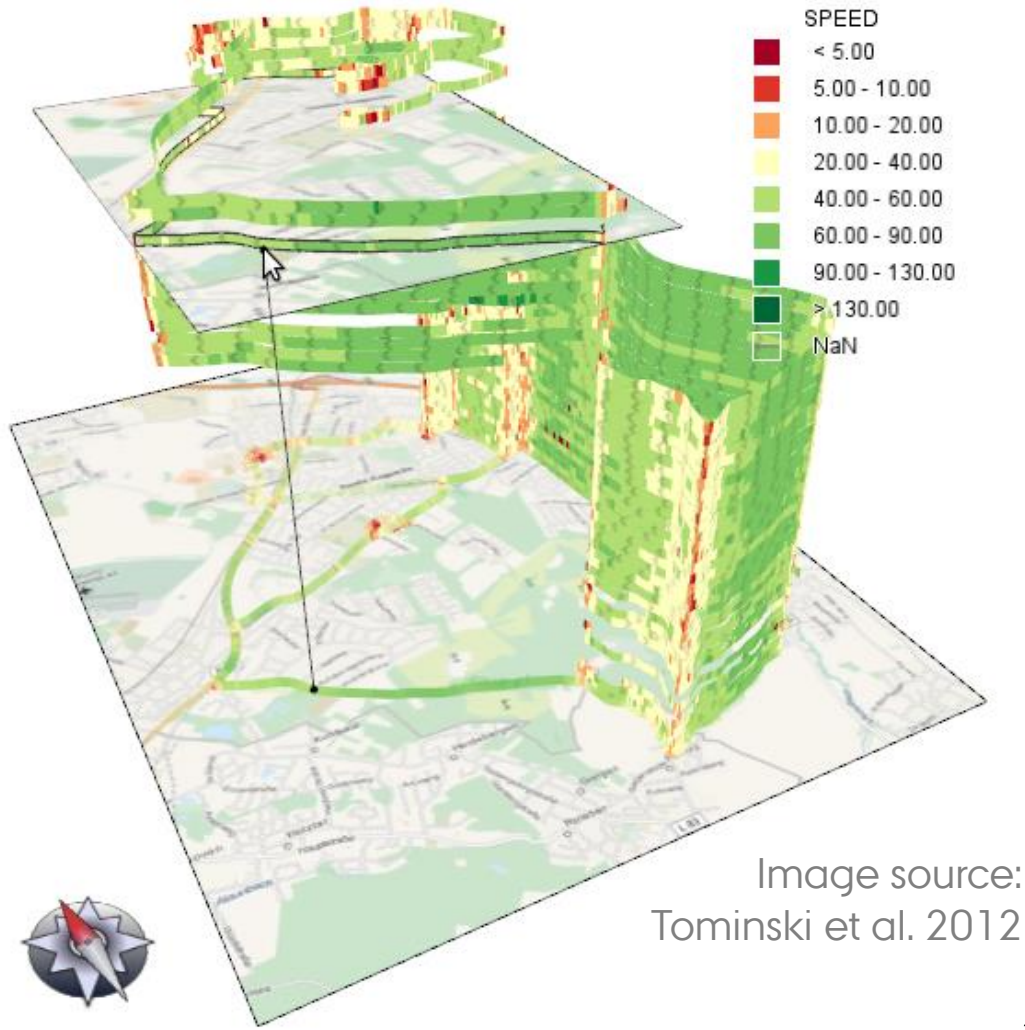
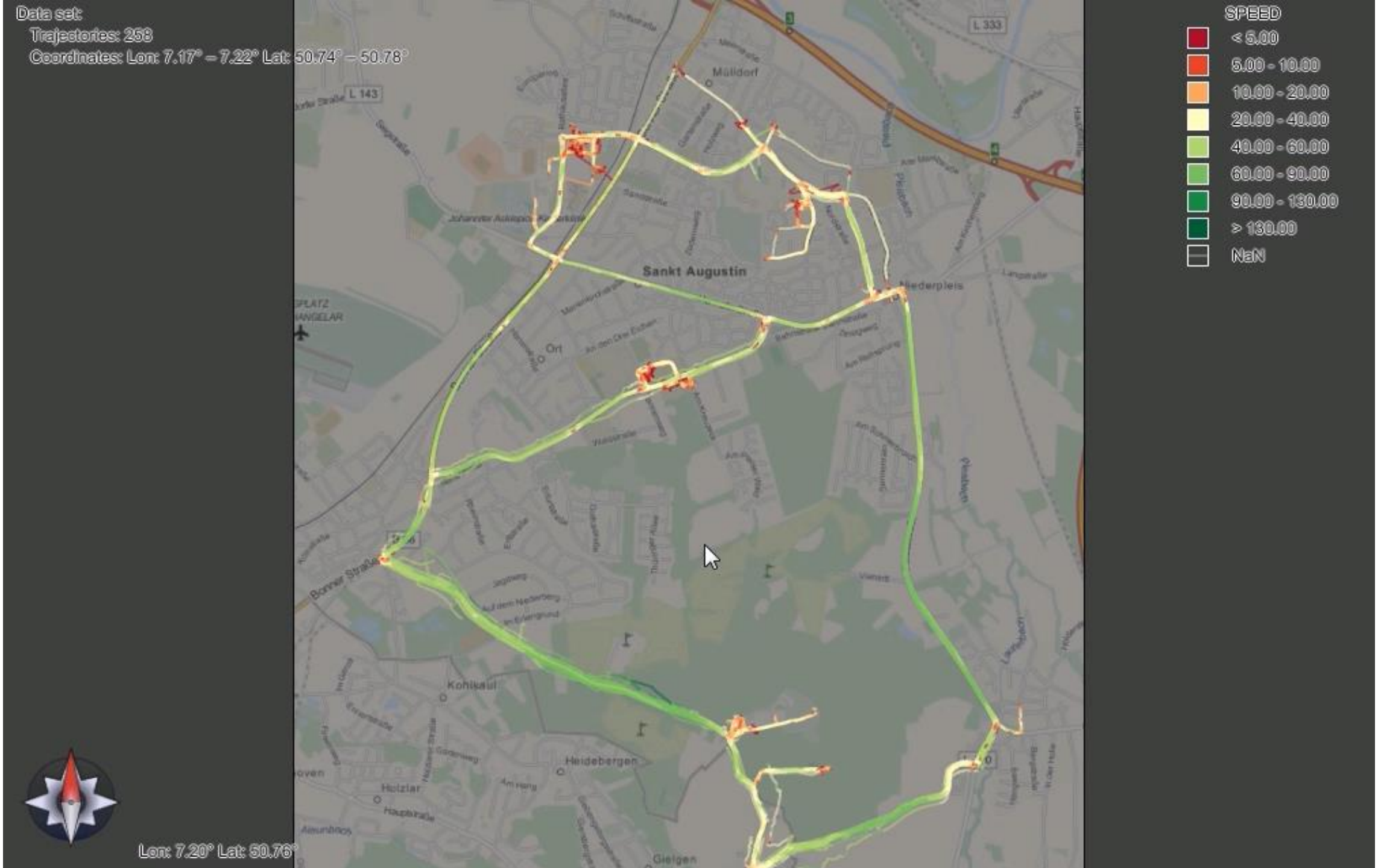
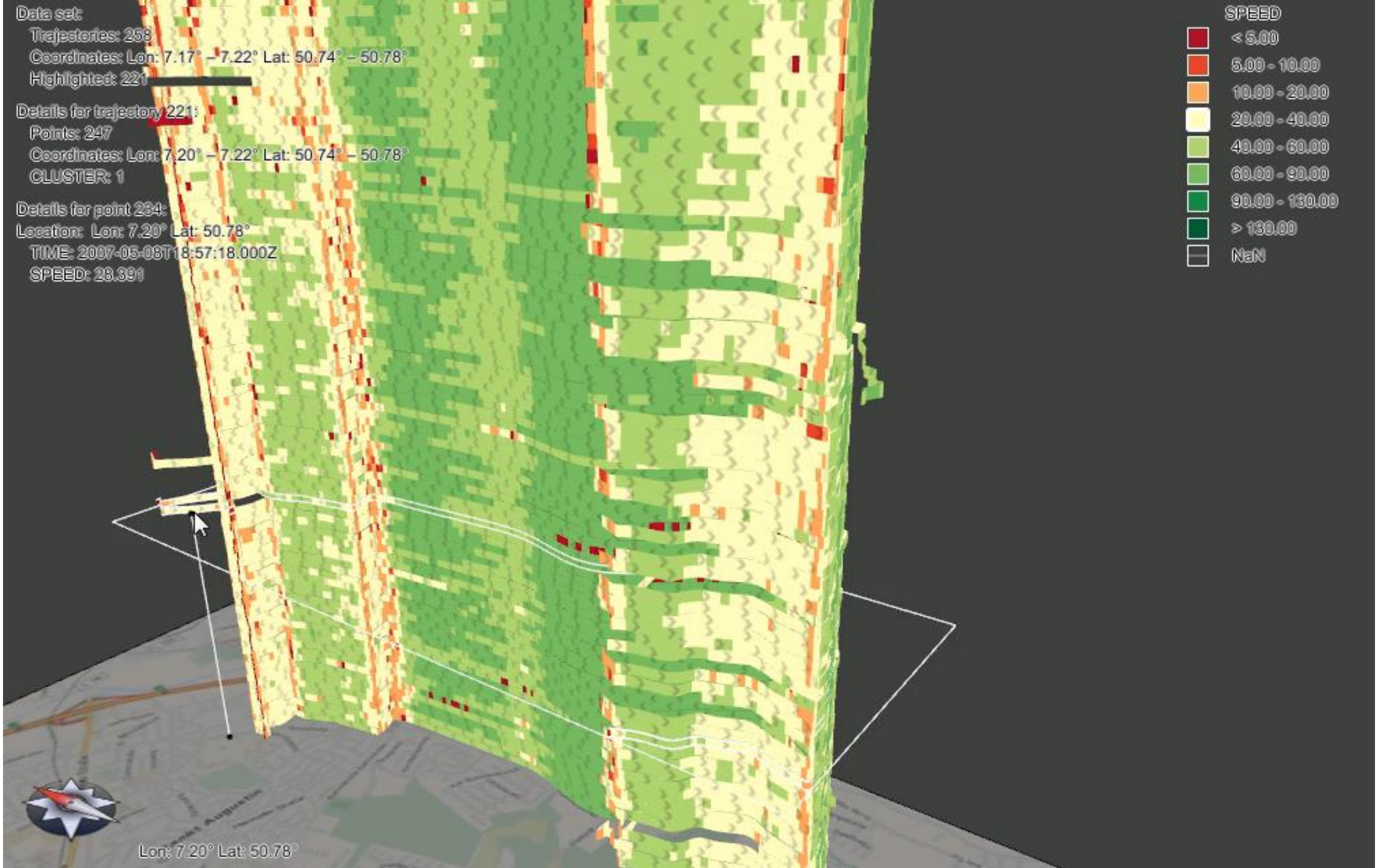


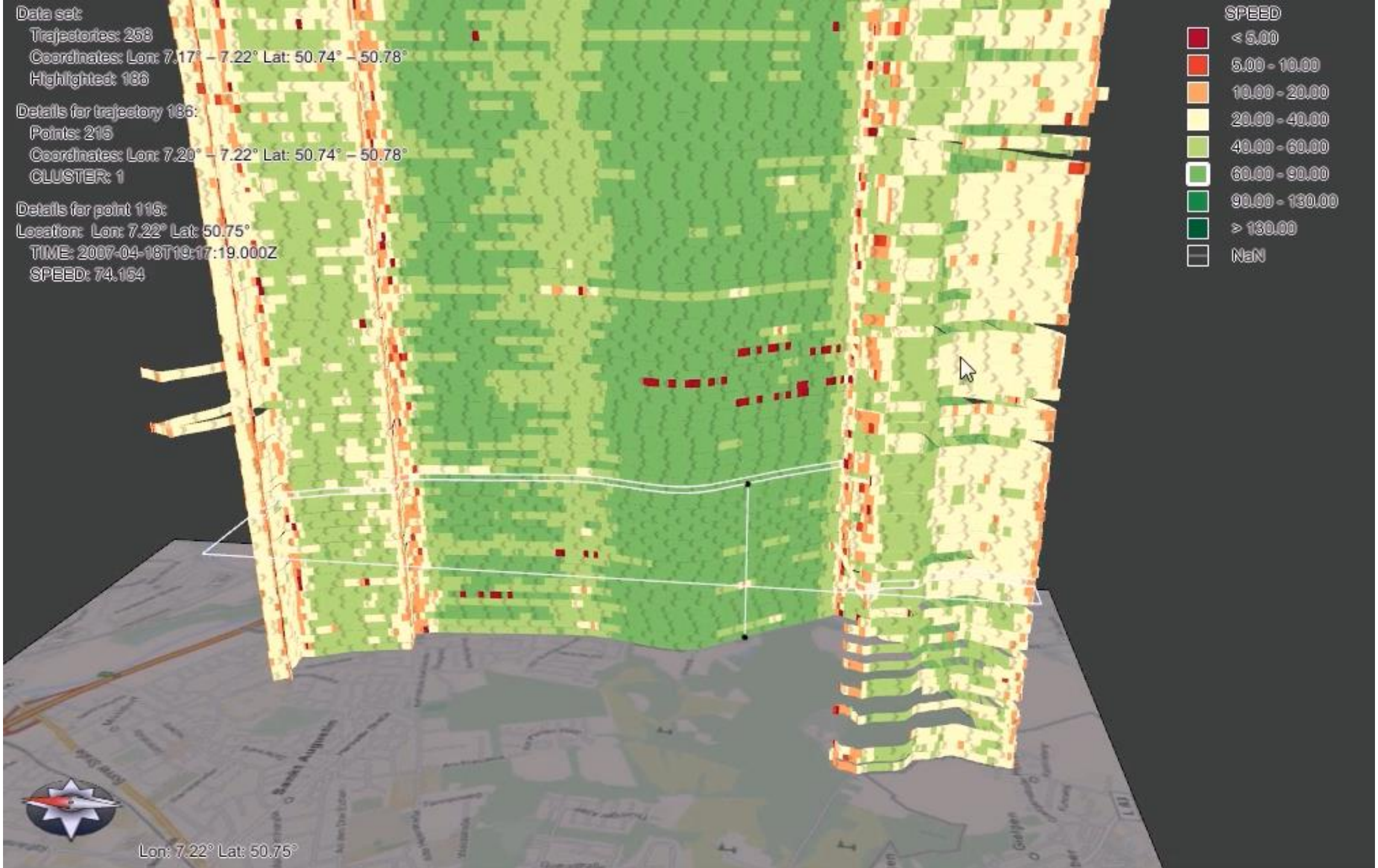
Image source: Tominski et al. 2012



Video source: Tominski et al. 2012



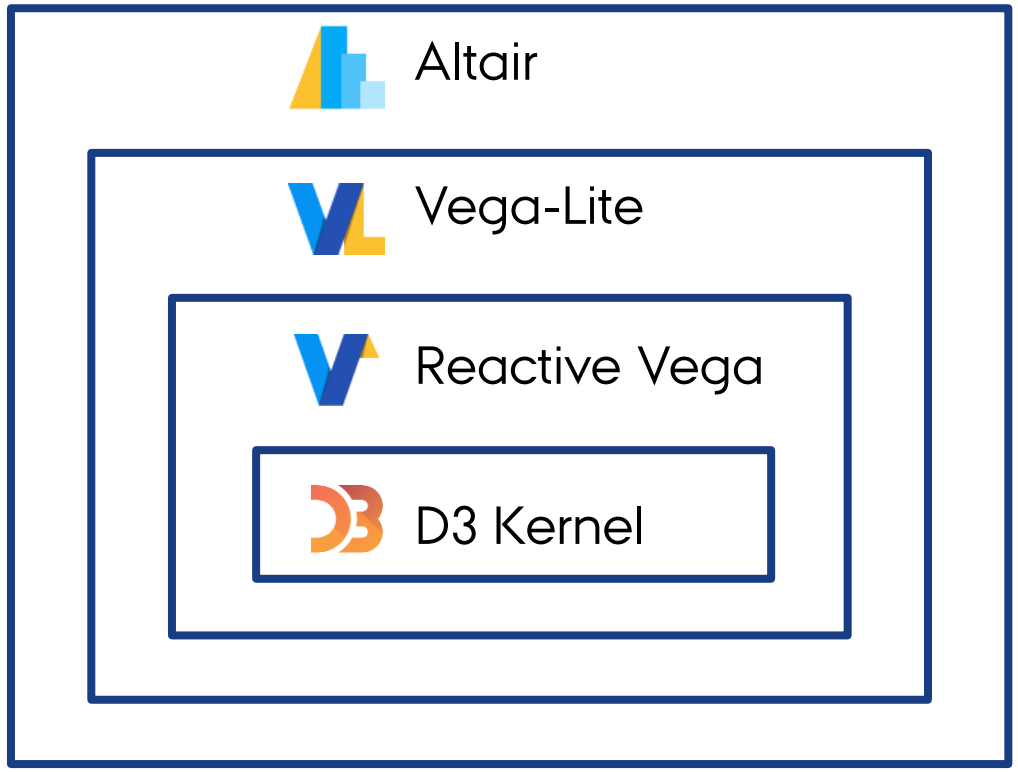
Video source: Tominski et al. 2012



Video source: Tominski et al. 2012

PART 3: TOOLING

THE D3/VEGA STACK



Python wrapper for Vega-Lite → NumPy, Pandas

abstraction of Vega, less flexible,

still highly customizable, but declarative

ultimate degree of customization

VEGA-LITE

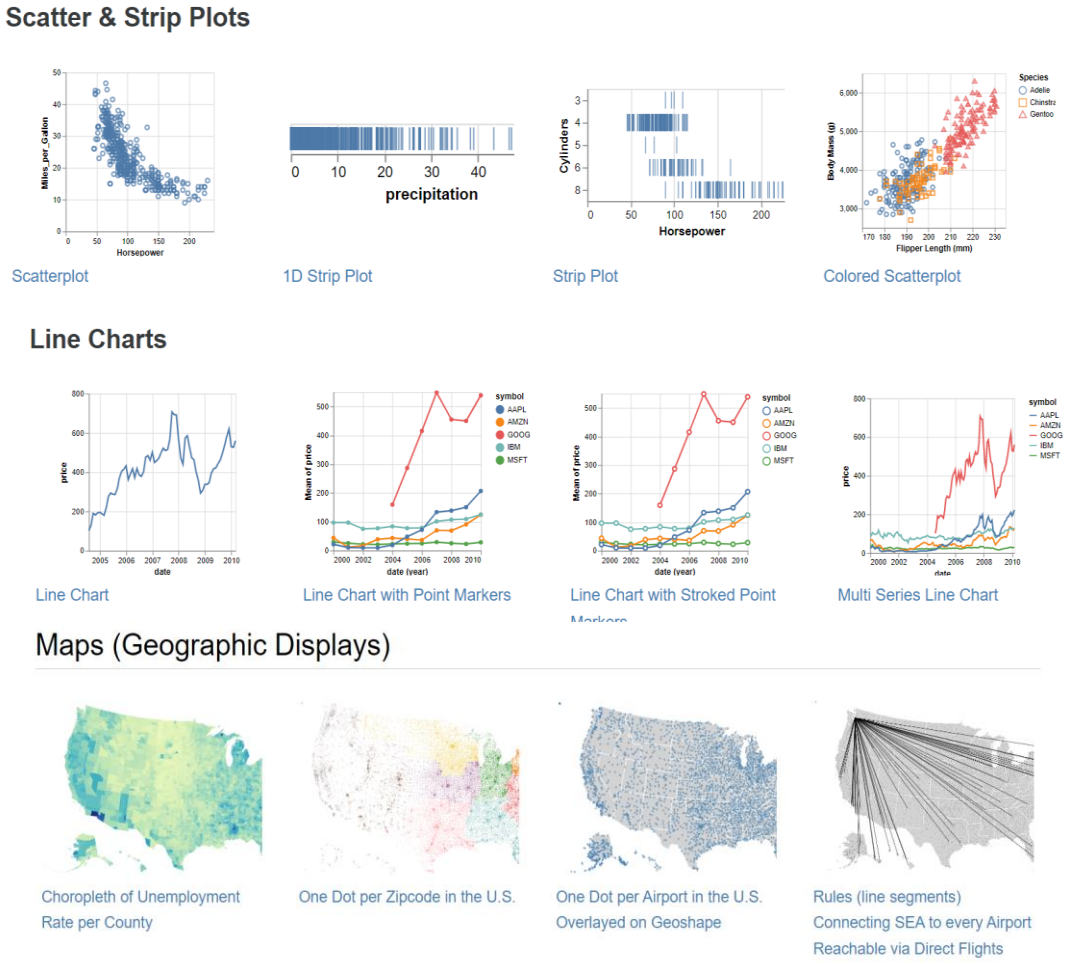
Declarative visualization grammar

Less code, less debugging!

Interaction defined through grammar!

Many presets and defaults

vega.github.io/vega-lite/



Vega-Lite Tutorial

> Welcome to the tutorial on Vega-Lite - a declarative visualization grammar! It provides a concise JSON syntax for supporting quick creation of visualizations to support analysis. You can read more about Vega-Lite at vega.github.io/vega-lite.
> Here, you will find videos explaining the features of Vega-Lite, code walkthroughs for each feature and examples of visualizations.

Play video - Opens a new tab playing the video

Copy Embed - Copies HTML code to embed the video

View Code - Opens the online Vega-Lite Editor with the JSON code

1. Introduction

1 Overview of Vega-Lite

Introducting Vega-Lite, a declarative visualization grammar that makes coding visualizations easier! This video compares imperative vs. declarative visualizations, motivate the use of Vega-Lite and the structure of the Vega stack.

References

1. *Vega-Lite Home Page*

1.1 JSON and the online Vega Editor

Checking out the online editor and a brief overview of the Vega-Lite JSON schema

References

1. *JSON Introduction*

https://vis-au.github.io/vl/

EXAMPLE

Go here: https://vega.github.io/editor/

Final example: https://tinyurl.com/vegademo

A SUPER-QUICK INTRODUCTION TO D3.JS

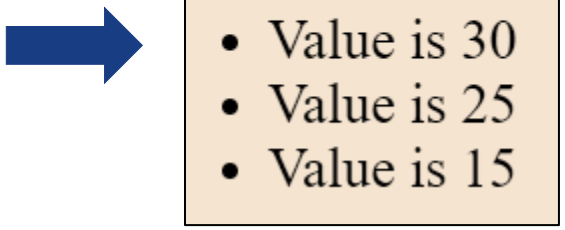
AARHUS UNIVERSITY
NATURAL SCIENCES

DATA VISUALIZATION
8 NOVEMBER 2023

HANS-JÖRG SCHULZ
ASSOCIATE PROFESSOR

```
<script type = "text/javascript" src = "d3.v6.min.js"></script>
<body>
  <ul id = "list">
    <li></li>
    <li></li>
    <li></li>
    <li></li>
    <li></li>
  </ul>

  <script>
    d3.select("#list").selectAll("li").data([10, 20, 30, 25, 15])
      .text(function(d) { return "Value is " + d; });
  </script>
 </body>
```



```
<script type = "text/javascript" src = "d3.v6.min.js"></script>
<body>
  <ul id = "list">
    <li></li>
    <li></li>
  </ul>
```

- Existing value is 10
- Existing value is 20
- New value is 30
- New value is 25
- New value is 15

```
  <script>
    d3.select("#list").selectAll("li").data([10, 20, 30, 25, 15])
      .text(function(d) { return "Existing value is " + d; })
      .enter().append("li").text(function(d) { return "New value is " + d; });
  </script>
</body>
```

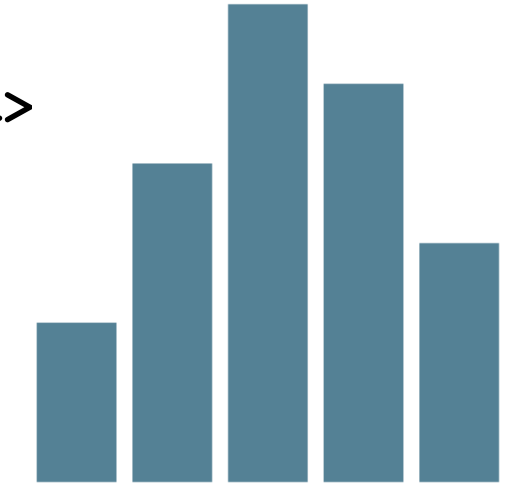
`enter()` returns all data items for which no document element exists

```
<script type = "text/javascript" src = "d3.v6.min.js"></script>
<body>
  <ul id = "list">
    <li></li>
    <li></li>
    <li></li>
    <li></li>
    <li></li>
    <li></li>
  </ul>
  <script>
    d3.select("#list").selectAll("li").data([10, 20, 30, 25, 15])
      .text(function(d) { return "Existing value is " + d; })
      .enter().append("li").text(function(d) { return "New value is " + d; })
      .exit().remove();
  </script>
 </body>
```

- Existing value is 10
- Existing value is 20
- Existing value is 30
- Existing value is 25
- Existing value is 15

`exit()` returns all document elements for which no data items exist

```
<script type = "text/javascript" src = "d3.v6.min.js"></script>
<body>
  <svg id="chart" width="500" height="300" />
  <script>
     data = [10, 20, 30, 25, 15];
     scaleFactor = 10, barWidth = 50, gapWidth = 10;
     graph = d3.select("#chart").selectAll("rect").data(data).enter()
             .append("rect")
             .attr("width", barWidth)
             .attr("height", function(d) { return scaleFactor * d; })
             .attr("x", function(d, i) { return i * (barWidth + gapWidth); })
             .attr("y", function(d) { return 300 - scaleFactor * d; })
             .attr("fill", "#548195");
   </script>
 </body>
```



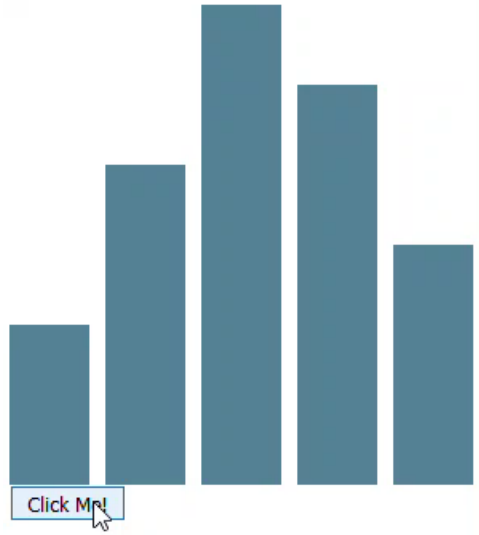
```
data = [[10, 20, 30, 25, 15],[15, 5, 25, 10, 30]];
current = 0;

... do everything as before ...


function switcheroo() {
     if(current == 0) { current = 1; } else { current = 0; }

    graph = d3.select("#chart").selectAll("rect").data(data[current]);

    graph.transition().duration(500)
            .attr("height", function(d) { return scaleFactor * d; })
            .attr("y", function(d) { return 300 - scaleFactor * d; });
}
... further down in the HTML code ...
<button type="button" onclick='switcheroo();'>Click Me!</button>
```



PART 4: VISUAL ANALYTICS

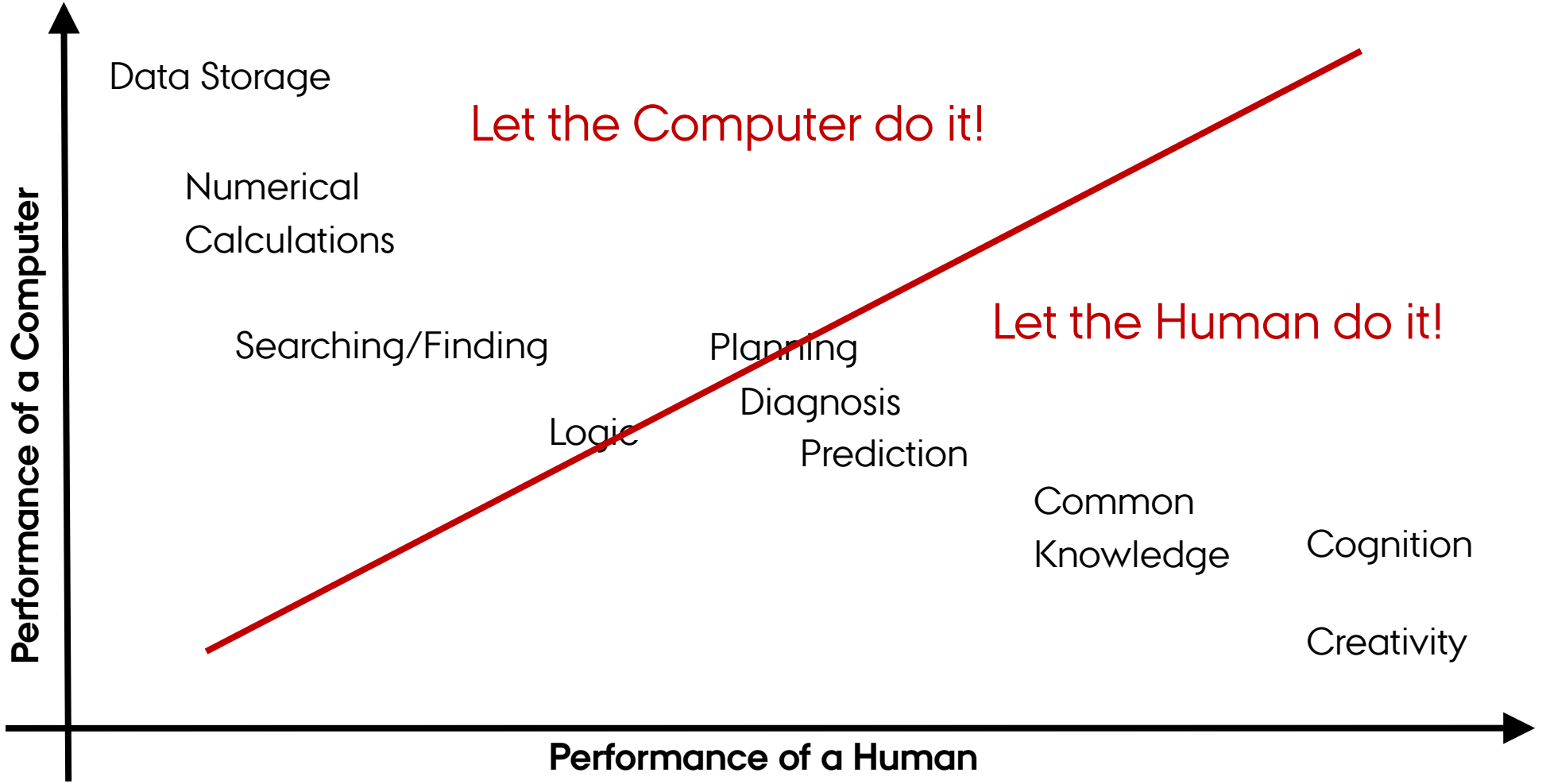
video source: https://youtu.be/5uGRGqCFryg

WHAT IS VISUAL ANALYTICS?

"Visual analytics combines the strengths of both worlds: On the one hand they take advantage of intelligent algorithms and vast computational power of modern computers and on the other hand they integrate human background knowledge and intuition to find a good solution."

Keim et al. 2009

WHY VA? – KEIM'S ABILITY MATRIX



adapted from Daniel Keim, Uni. Konstanz

Exploratory Analysis of Time-series with ChronoLenses

Jian Zhao
Fanny Chevalier
Emmanuel Pietriga
Ravin Balakrishnan

dgp
dynamic graphics project

ONTARIO COLLEGE OF ART & DESIGN

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE
INRIA
centre de recherche SACLAY - ILE-DE-FRANCE

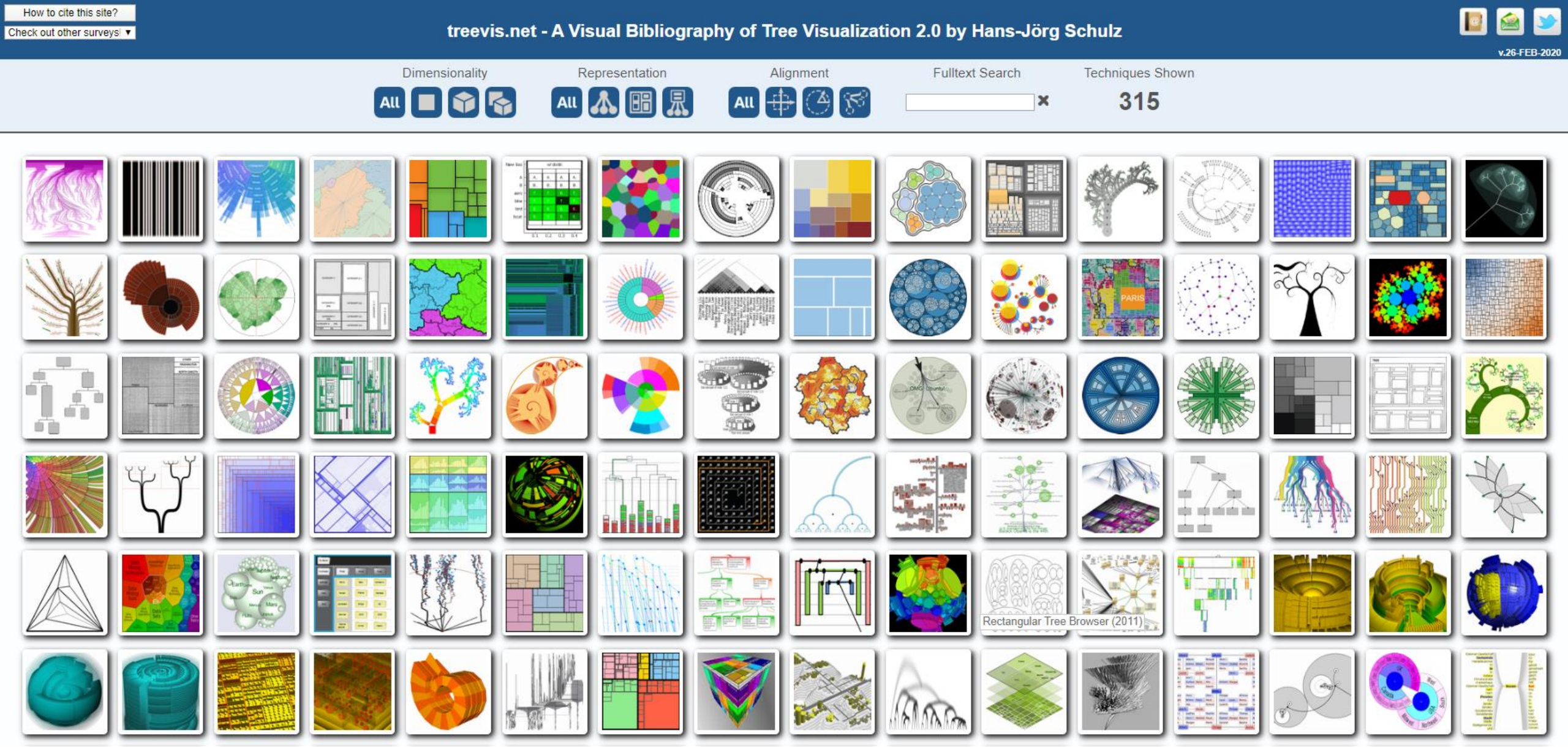
Interactive Exploration of Implicit and Explicit Relations in Faceted Datasets

Jian Zhao
Christopher Collins
Fanny Chevalier
Ravin Balakrishnan

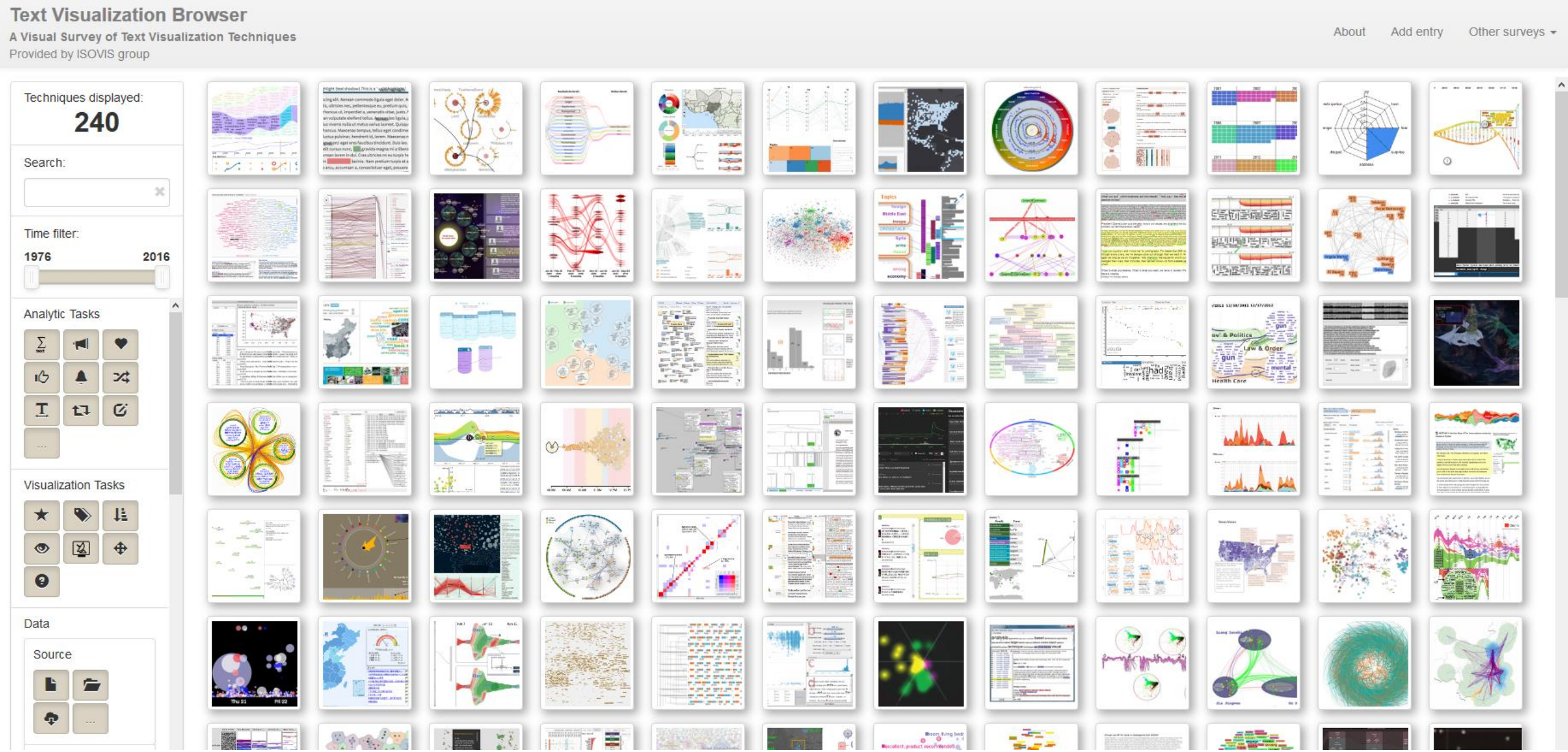
UNIVERSITY OF TORONTO

UOIT
CHALLENGE INNOVATE CONNECT

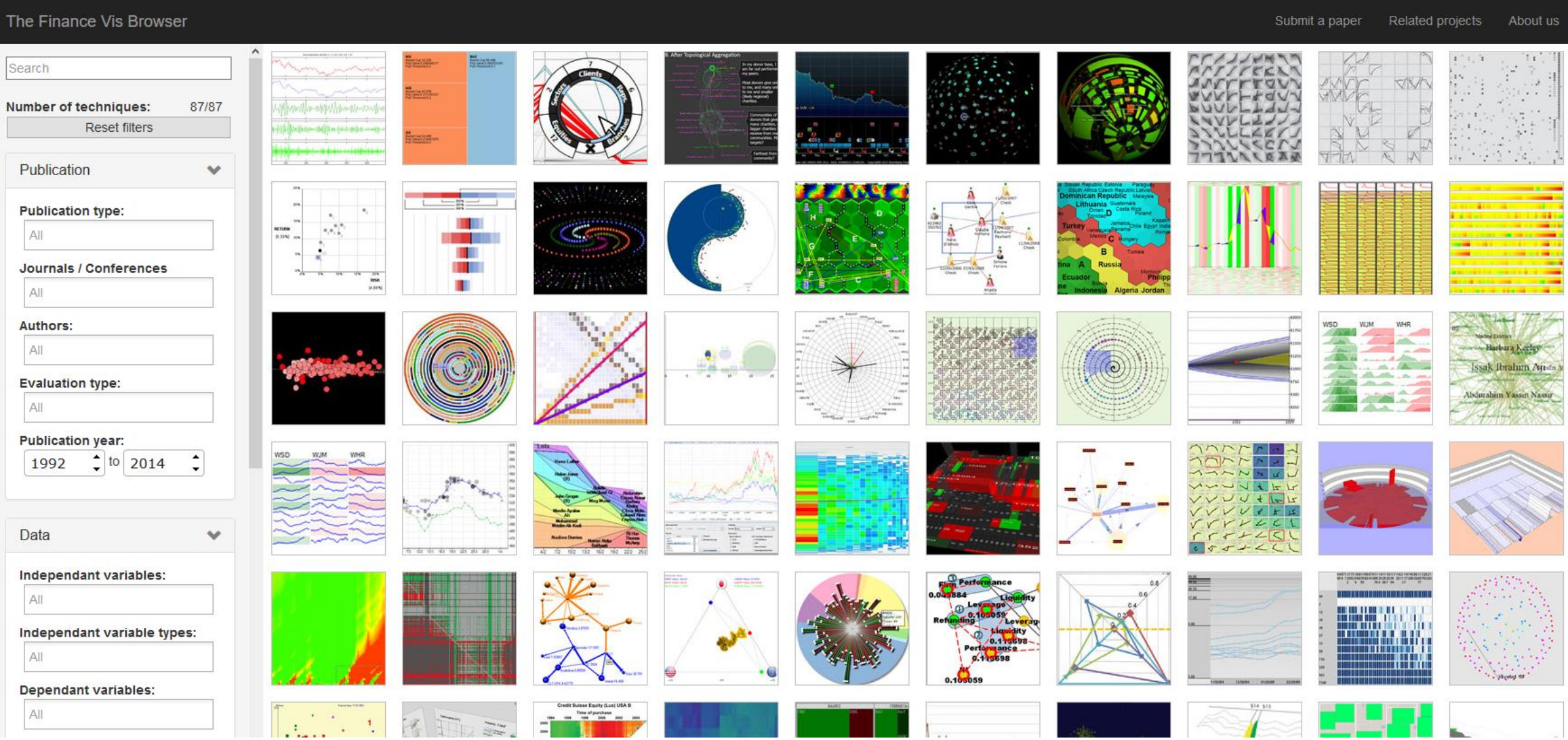
FURTHER POINTERS



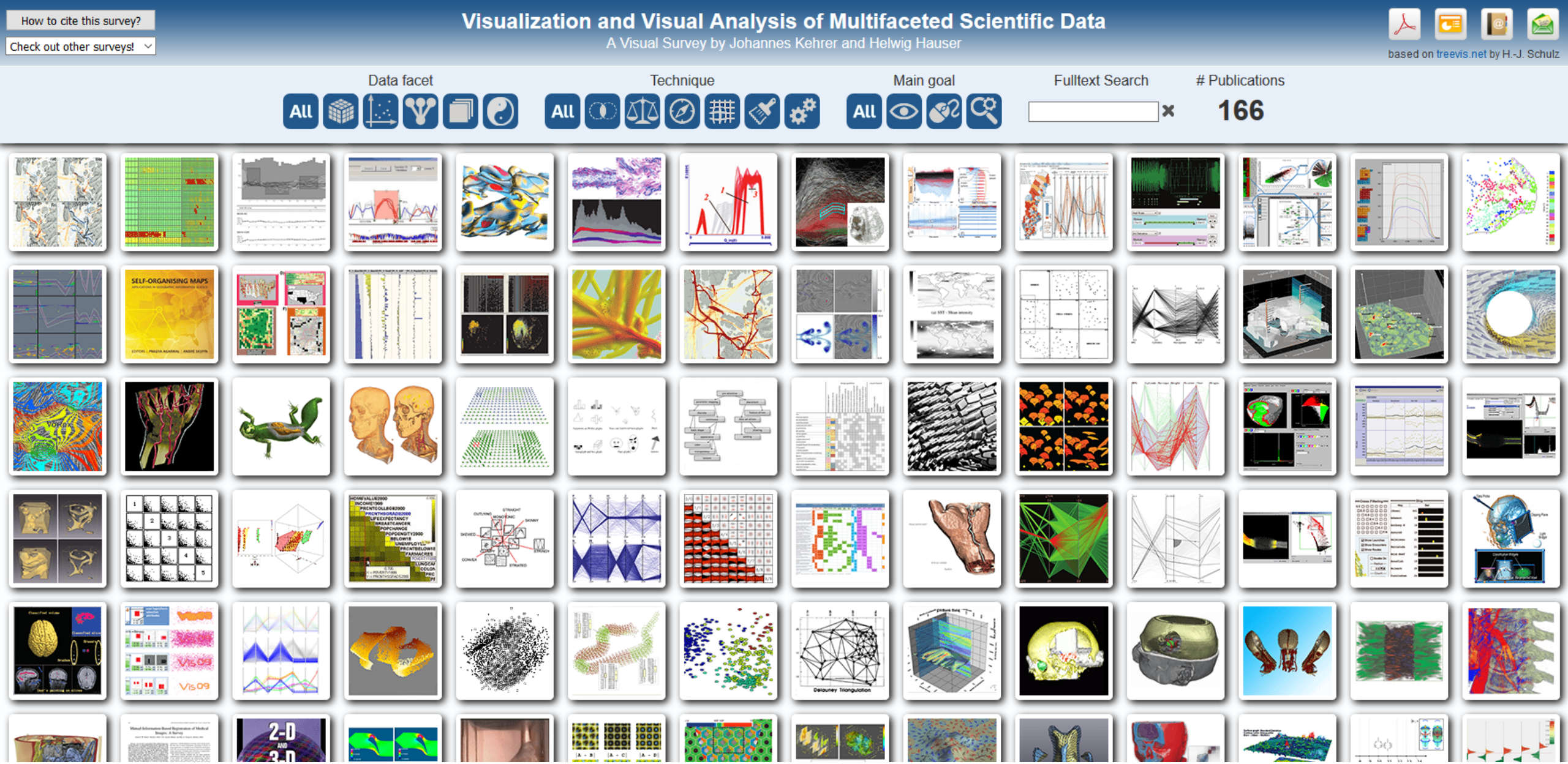
Visualization Techniques for Hierarchical Data – http://treevis.net



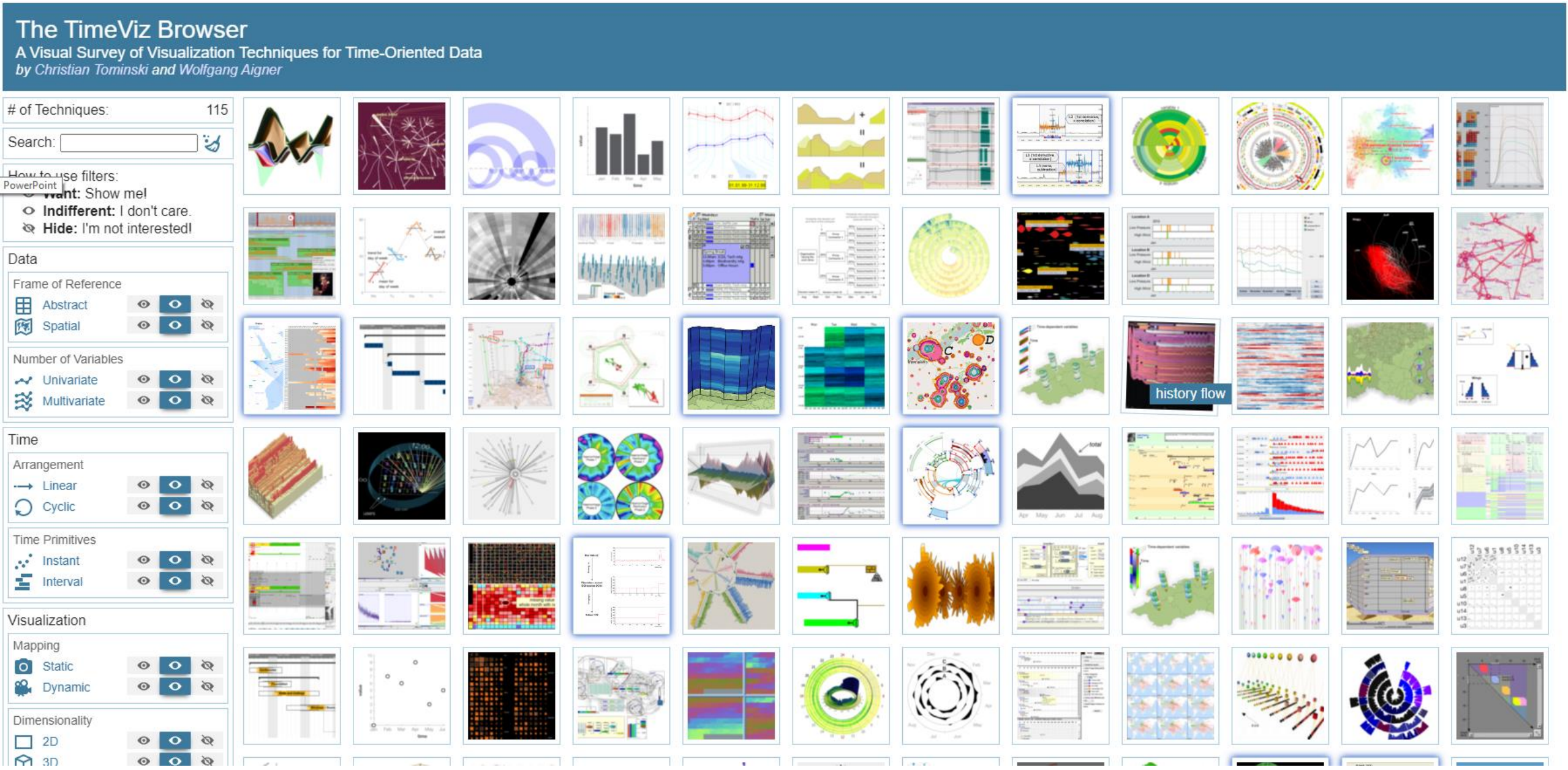
Visualization Techniques for Textual Data – http://textvis.lnu.se



Visualization Techniques for Financial Data – http://financevis.net

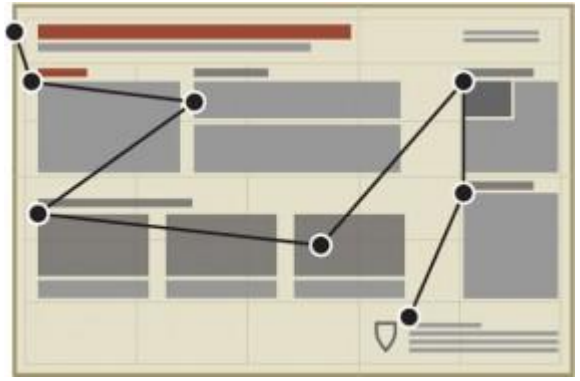


Visualization Techniques for Multifaceted Scientific Data – http://multivis.net

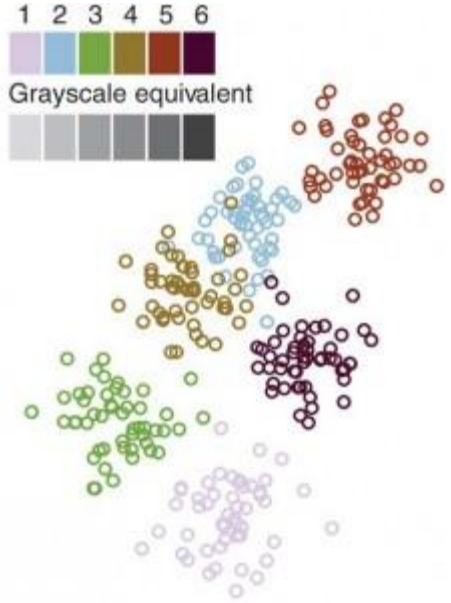


Visualization Techniques for Time Oriented Data – http://timeviz.net -> Browser

NATURE METHODS: “POINTS OF VIEW”

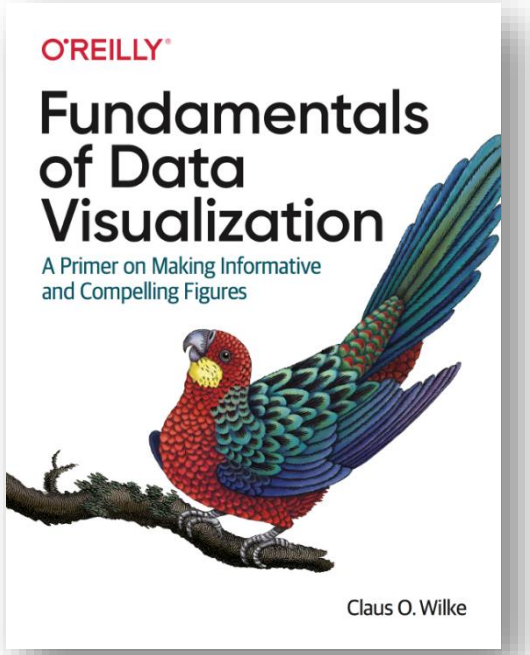


- Visual Design & Style
- Layout
- Negative Space
- Typography
- Labels & Callouts
- Color Coding
- Axes, Ticks, Grids
- Arrows
- Plot Types

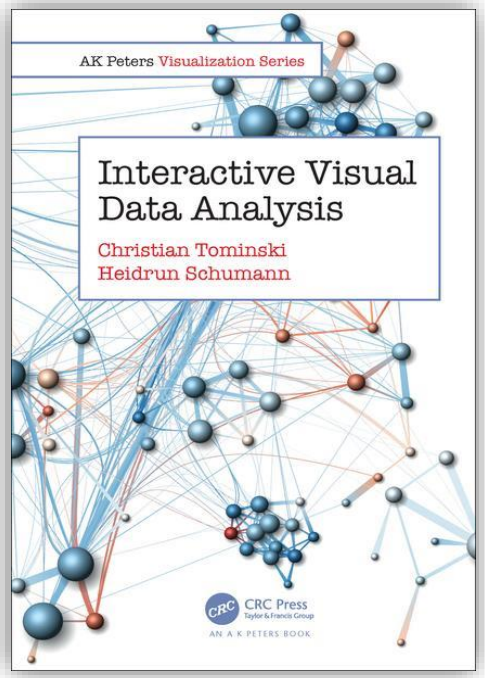


http://blogs.nature.com/methagora/2013/07/data-visualization-points-of-view.html

THE BOOKS I USE IN MY COURSES



Claus O. Wilke:
Fundamentals of
Data Visualization



Christian Tominski,
Heidrun Schumann:
Interactive Visual Data Analysis

Data Visualisation Workshop
DDSA, DDEA and DCA course

Next week

Data Visualisation Workshop

Are you working with a lot of data and want to make data-driven decisions? Would you like to help people see and interact with your research data more easily? Would you like to more clearly visualise patterns and relationships? Then join us for a two-day course in data visualisation from theoretical concepts to implementation!

This course is offered jointly by the Danish Data Science Academy, the Danish Cardiovascular Academy and the Danish Diabetes and Endocrine Academy.

Detailed description

Learn how to translate research data into visual representations making it easier for you and other scientists to understand and learn from the data. Learn how to generate visualisations to help you find patterns, trends and outliers in your data sets.

The Data Visualisation workshop is designed for early career researchers who wish to enhance their ability to communicate research findings effectively through visualisations. This two-day intensive course will provide you with a comprehensive understanding of theoretical concepts and practical techniques to transform complex data into insightful visual representations.

In this two-day course you will:

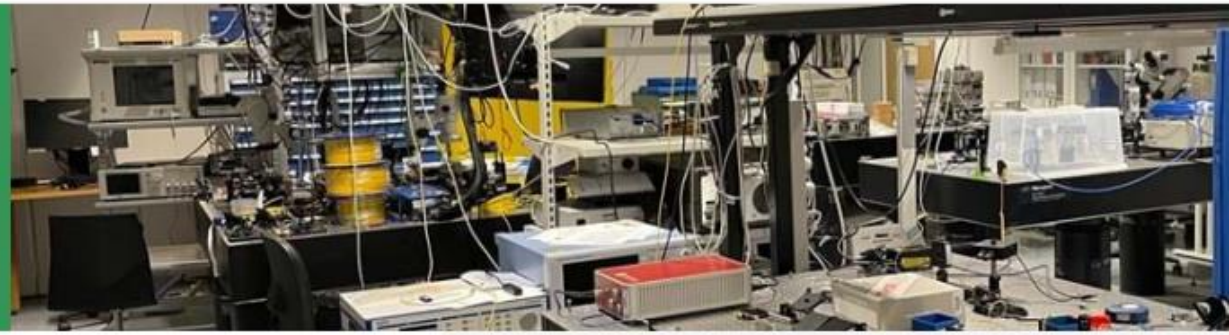
- Learn visualisation principles and foundations
- Discuss and analise your own visualisations
- Work on a domain-specific task using a data set provided
- Engage in guided group work on a visualisation design using the Five Design-Sheets Methodology
- Implement and present your work

During the two days, you'll also have the opportunity to engage in hands-on exercises, group discussions and peer feedback, get to know the other course participants and network with them and the speakers through dinner and social activities.

Dates: 15 – 16 November, 2023

Venue: Milling Hotel Park, Viaduktvej 28, 5500 Middelfart, Denmark

Vil du opkvalificeres



TechCircle tilbyder seminarer, kurser og workshops indenfor digitalisering, grøn omstilling og cirkulær økonomi.

Aktiviteterne er gratis for ansatte i mindre virksomheder (SMV'ere), iværksættere og det offentlige.

Skal du, dine medarbejdere eller kollegaer have et kompetenceløft indenfor digitalisering, IT, grøn omstilling eller cirkulær økonomi, så er aktiviteter fra TechCircle et godt tilbud.

Vi udbyder både endagsseminarer, længere kurser og workshops, hvor du sammen med ansatte fra andre virksomheder kan få nye kompetencer indenfor

Next February

← Back to results

★ Save course

Information Visualization

Next Summer

Description of qualifications

Objectives of the course:

At the end of this course, participants will have gained knowledge of data visualization as:

- A method of tightly interlinked graphic design, interaction design, and algorithm design (visualization design).
- A computational process that transforms input data into graphic representations (visualization pipeline).
- A tool for user-driven data analysis from preparation, via exploration and confirmation, to presentation (visual analytics).

Learning outcomes and competences:

At the end of this course, participants will be able to:

- Name, define, use, and relate general models and concepts in data visualization.
- Name, use, and explain concrete visualization techniques including their possibilities and limitations.
- Derive a visualization problem in terms of data, task, and technical context.
- Design, implement, and evaluate interactive visualization tech-

Instructor	Hans-Jörg Schulz http://hjschulz.net
Course coordinator	Hans-Jörg Schulz, hjschulz@cs.au.dk
Academic prerequisites	Basic knowledge in computer programming is required.
Forms of instruction	Lecture, Classroom instruction
Comments on form of instruction	Teaching dates for 2024: TBA Lectures: 3 hrs/day Classroom instruction: 2 hrs/day Project supervision: 1 hr/day
Exam details	**WRITTEN + TAKE-HOME ASSIGNMENT** WRITTEN **Exam time:** 2 hour(s) **Aid:** None

ECTS	10
Period	Spring semester 2024
Level	Master
Academic term	Summer
Hours - weeks - periods	6
Language of instruction	English
Course type	Summer University
Primary programme	Master's Degree Programme in Computer Science
Related educations	
Department	Department of Computer Science

PhD Position available!

ArtiPlex: Multiplex Analytics for Computer-supported Visual Artifact Detection in EEG Data

Hans-Jörg Schulz (PI)
Department of Computer Science
Aarhus University, DK

Kaare Mikkelsen (Co-PI)
Department of Electrical and
Computer Engineering
Aarhus University, DK

Visualization and Visual Analytics are used when automated analyses and computational processes by themselves fail – for example, when plausibility checks or judgment calls need to be made. In these cases, visualizations communicate data and computational results to human analysts who then, with their common sense and domain knowledge, use the visualization to reason and interact with the data. A data analysis challenge that requires a human expert in the loop is anomaly detection. That is because it is hard to formalize what an anomaly is and where the threshold between anomalous data and normal, albeit potentially noisy data lies. Anomalies are also highly context-dependent and what may be considered an anomaly in one scenario may be perfectly normal in another.

AARHUS
UNIVERSITY