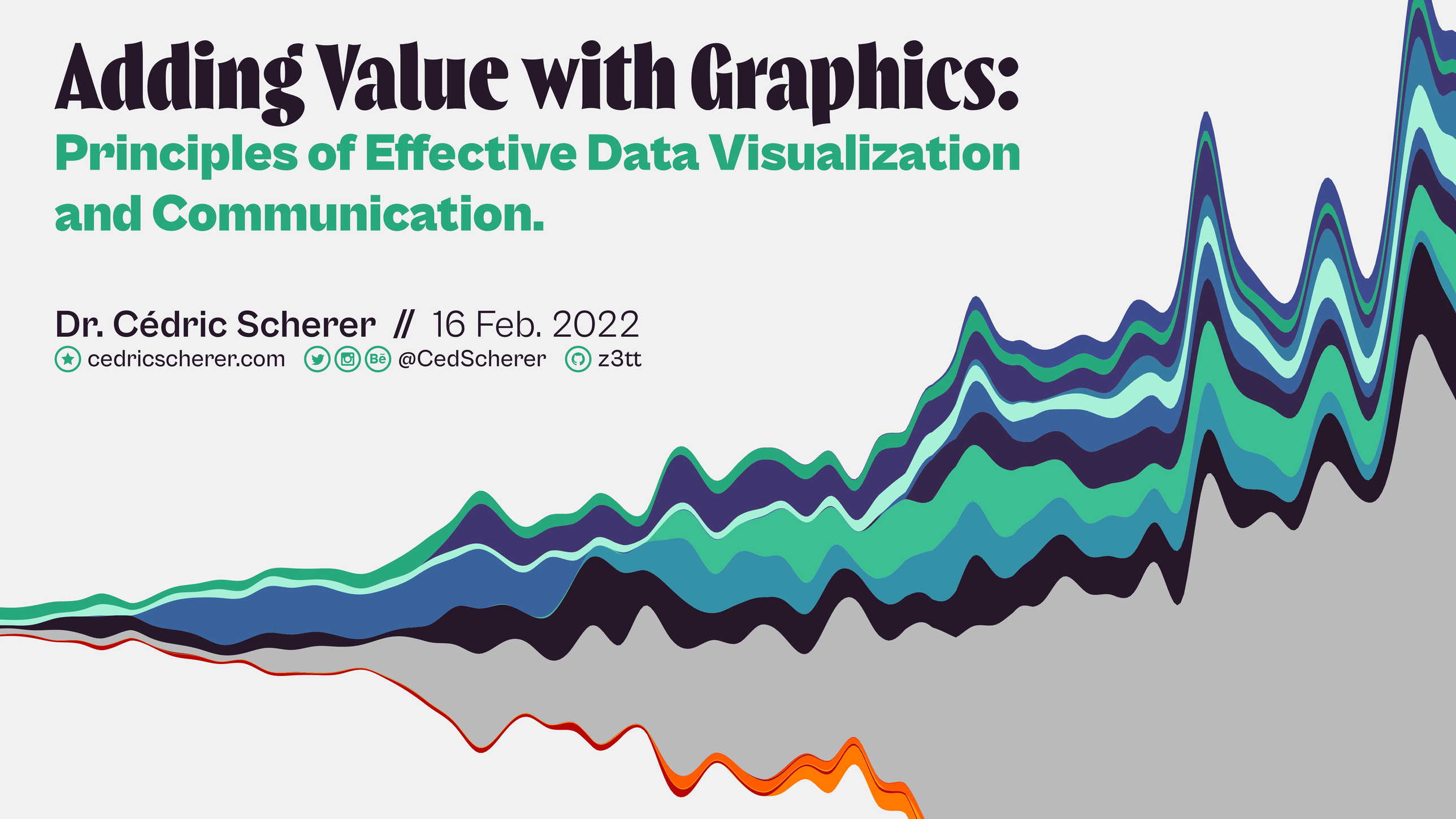
Adding Value with Graphics:

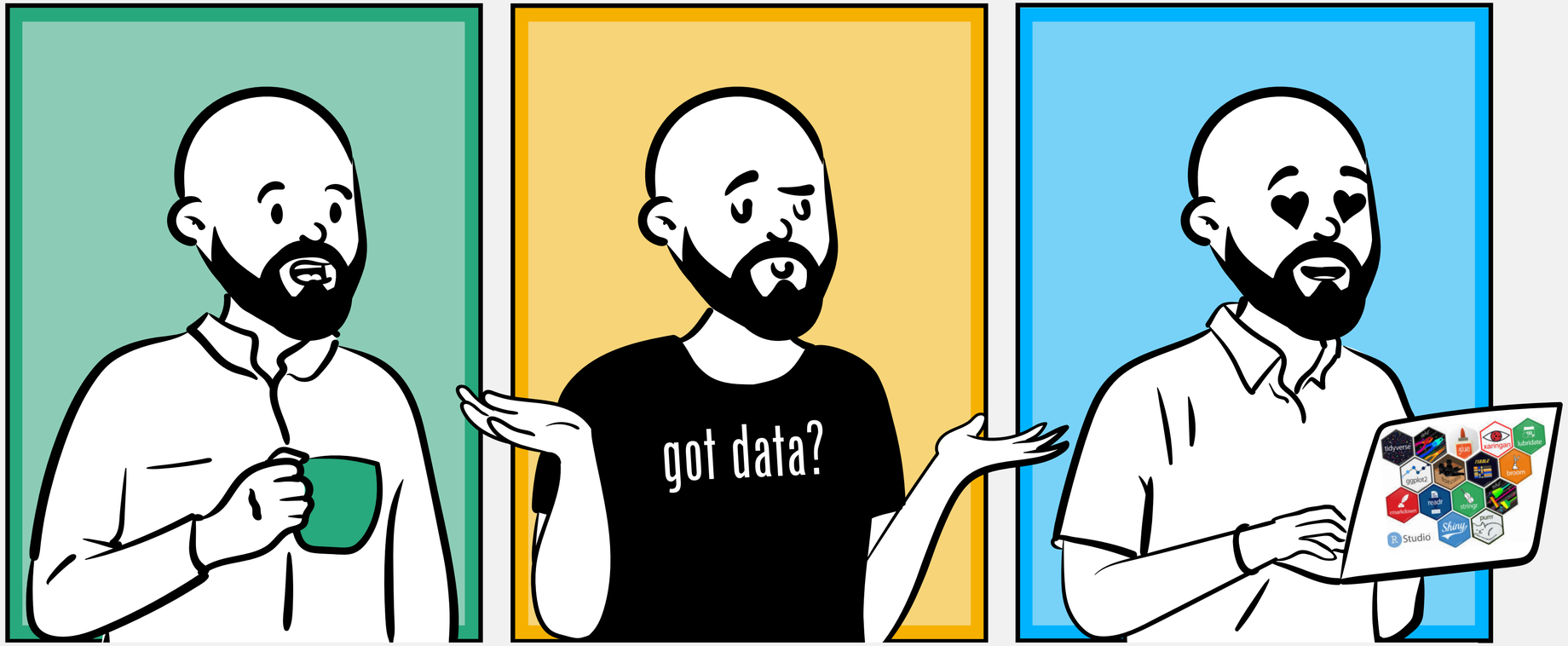
Principles of Effective Data Visualization and Communication.

Dr. Cédric Scherer // 16 Feb. 2022
cedricscherer.com @CedScherer z3tt



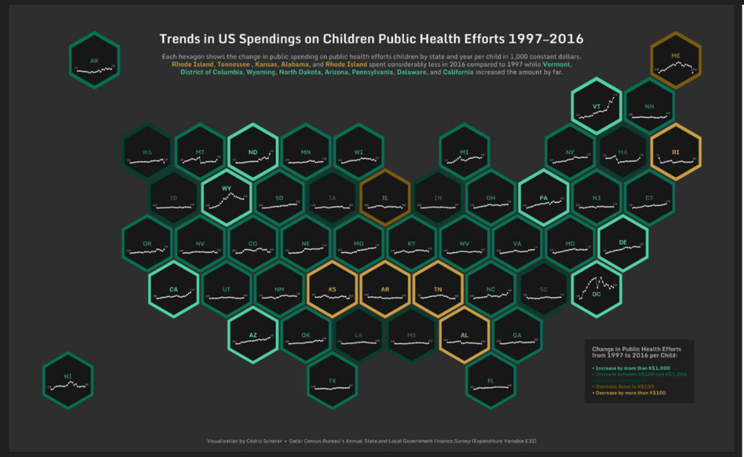
Cédric Scherer

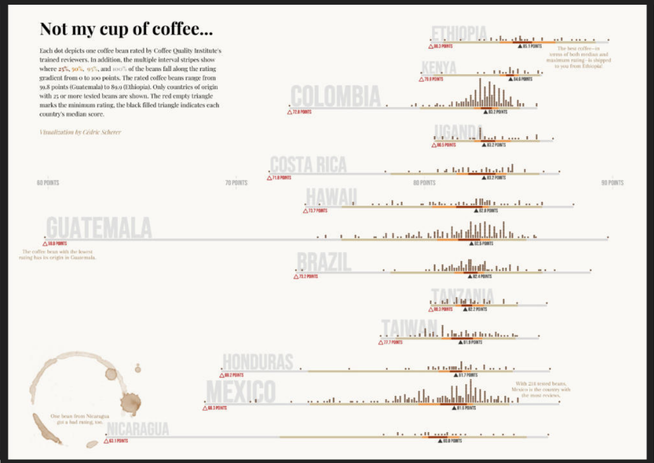
Independent Data Visualization Specialist
Computational Ecologist at IZW Berlin

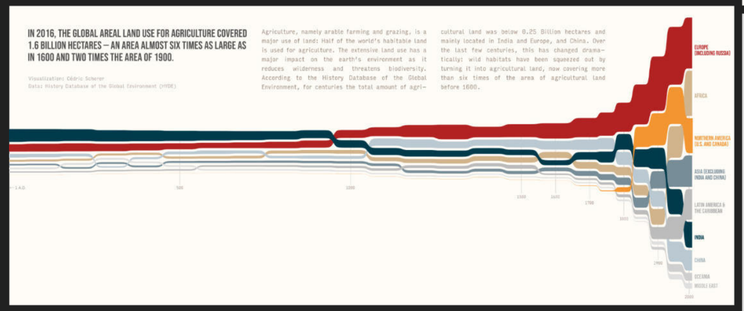


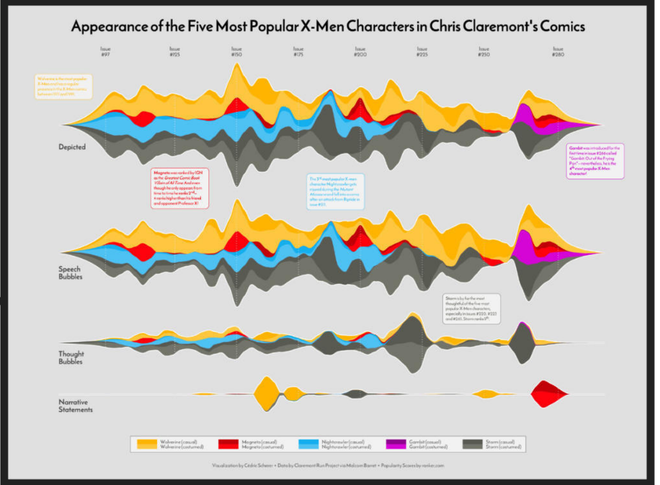
Consulting Coaching Coding

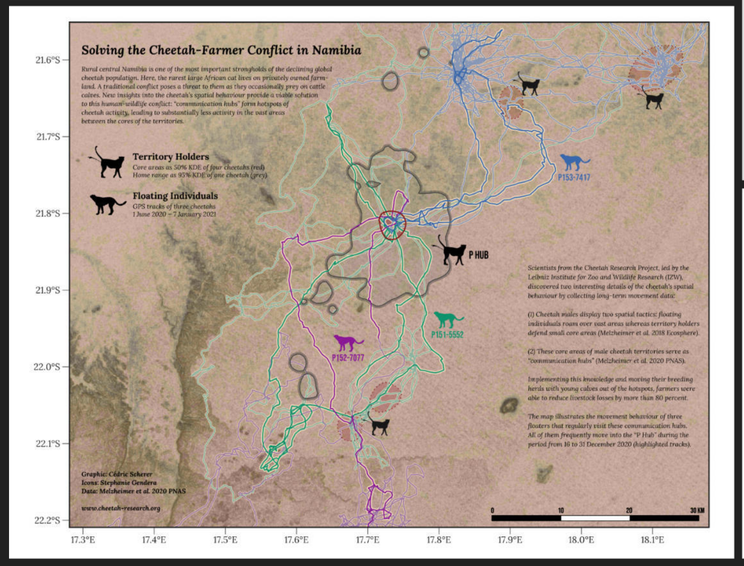
cedricscherer.com @CedScherer z3tt

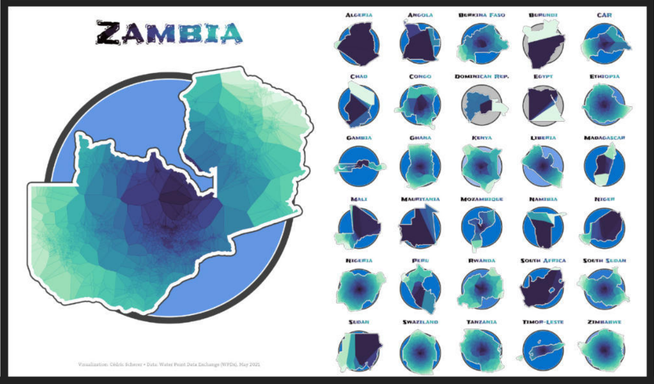










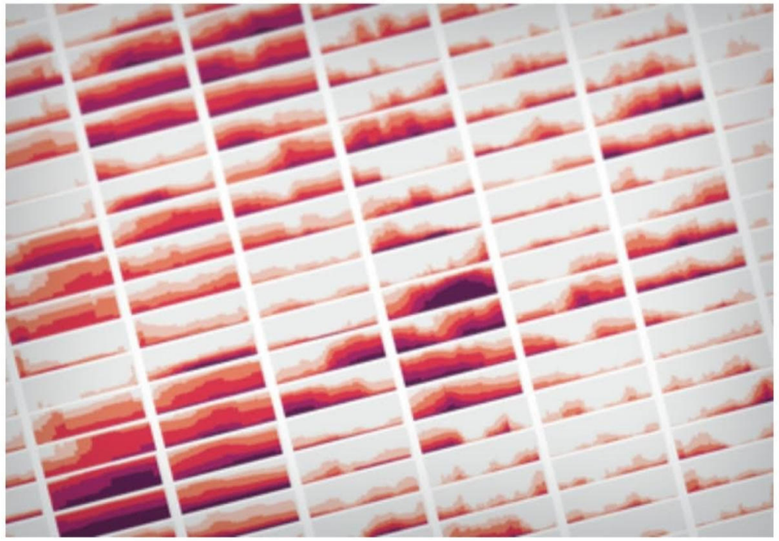


CLIMATE CHANGE

Climate Change Drives Escalating Drought

The past two decades have seen some of the most extreme dry periods in U.S. history

By Clara Moskowitz, Cédric Scherer, Georgios Karamanis | Scientific American November 2021 Issue



Credit: Cédric Scherer and Georgios Karamanis

cedricscherer.com

CÉDRIC SCHERER

Data Visualization & Computational Ecology

The World's Countries Colored by Their First Letter

While preparing the mapping section for a Pearson–O'Reilly training, I got the idea to visualize the first letter of each country. And got especially curious about how much landmass each letter covers. Turns out: A, C and R are covering the largest areas!

Posted by Cédric · Friday, August 27, 2021

A Quick How-to on Labelling Bar Graphs in ggplot2

Bar charts are likely the most common chart type out there and come in several varieties. Most notably, Direct labels can increase accessibility of a bar graph. I got

Always coding. Passionate about design. Worried about nature. Proud dad.

cedricscherer.com

CÉDRIC SCHERER

BLOG GALLERY PORTFOLIO ABOUT ME LINKS

DATAVIZ TUTORIAL R TIDYVERSE GGPLOT2

A GGPLOT2 TUTORIAL FOR BEAUTIFUL PLOTTING IN R

Posted by Cédric on Monday, August 5, 2019

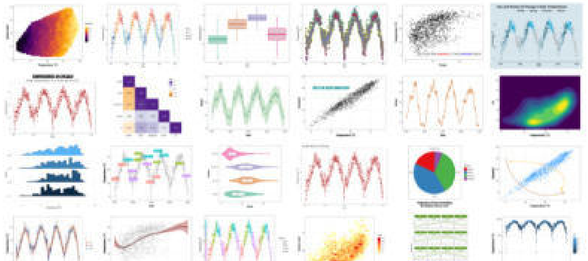
Last update: 2021-02-09

Introductory Words

I don't care, just show me the content!

Back in 2016, I had to prepare my PhD introductory talk and I started using `{ggplot2}` to visualize my data. I never liked the syntax and style of base plots in R, so I was quickly in love with ggplot. Especially useful was its faceting utility. But because I was short on time, I plotted these figures by trial and error and with the help of lots of googling. The resource I came always back to was a blog entry called **Beautiful plotting in R: A ggplot2 cheatsheet** by Zev Ross, updated last in January 2016. After giving the talk which contained some decent plots thanks to the blog post, I decided to go through this tutorial step-by-step. I learned so much from it and directly started modifying the codes and over the time I added additional code snippets, chart types and resources.

Since the blog entry by Zev Ross was not updated for some years and step by step this became a unique version of a tutorial, I decided to host the updated version on my GitHub. Now it finds its proper place on this homepage! (Plus I added a ton of other updates—just to name a few: The fantastic `{patchwork}`, `{ggtext}` and `{ggforce}` packages. How to deal with custom fonts and colors. A collection of R packages tailored to create interactive charts. And several other chart types including pie charts because everyone looooves pie charts!)



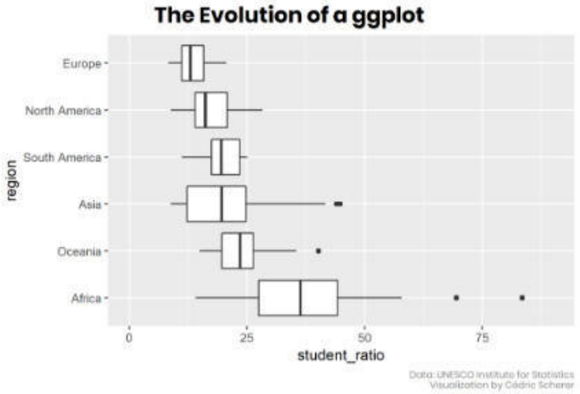
CÉDRIC SCHERER

BLOG GALLERY PORTFOLIO ABOUT ME LINKS

DATAVIZ TUTORIAL ANIMATIONS GGPLOT EVOLUTION R GGPLOT2 TIDYVERSE TIDYTUESDAY

THE EVOLUTION OF A GGPLOT (EP. 1)

Posted by Cédric on Friday, May 17, 2019



Aim of this Tutorial

In this series of blog posts, I aim to show you how to turn a default ggplot into a plot that visualizes information in an appealing and easily understandable way. The goal of each blog post is to provide a step-by-step tutorial explaining how my visualization have evolved from a typical

Data Visualization

is any graphical representation
of information and data.

Data Visualization

converts information into visual forms as quantifiable features.

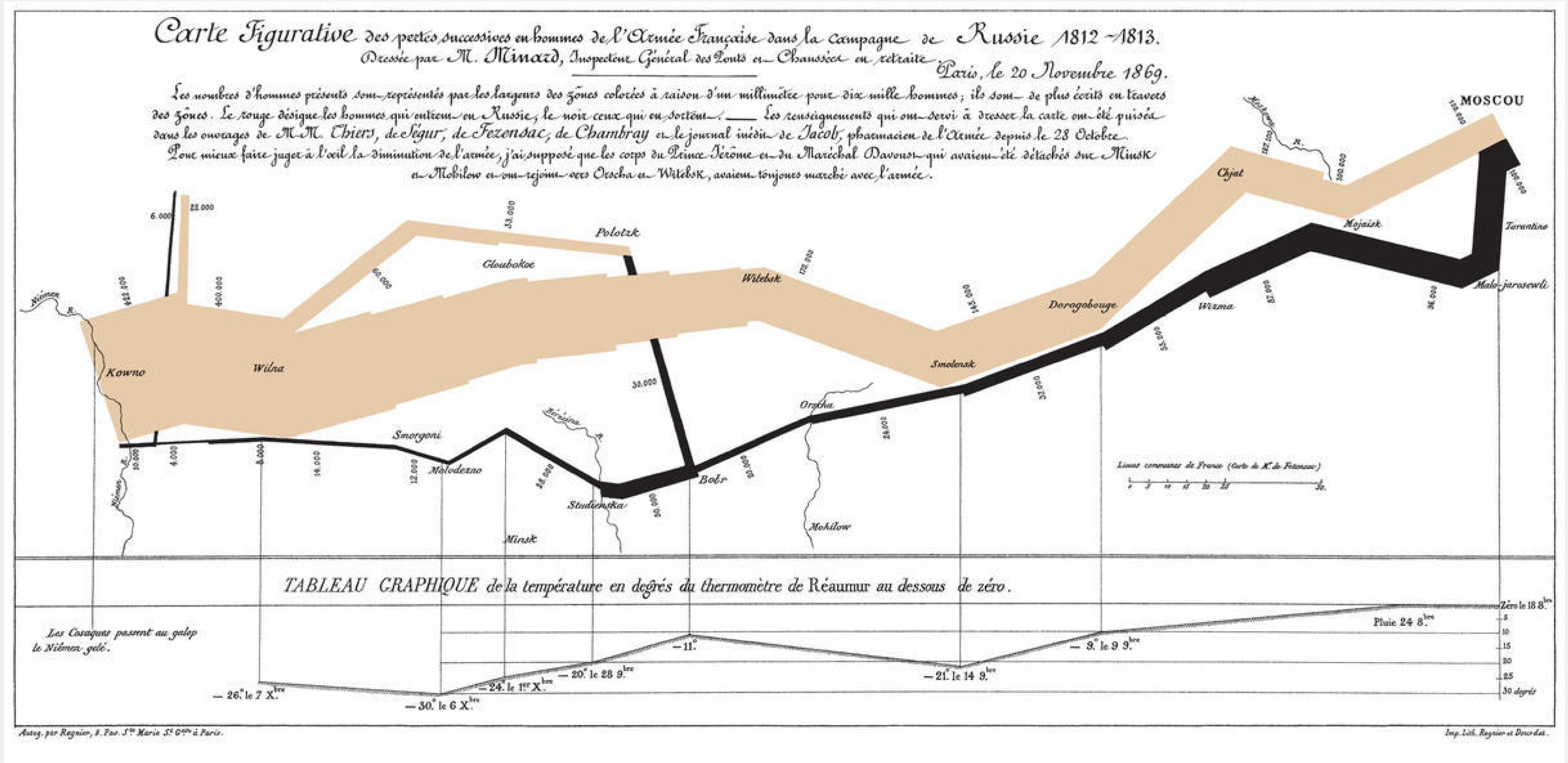
Data Visualization

helps to amplify cognition, gain insights, discover, explain, and make decisions.

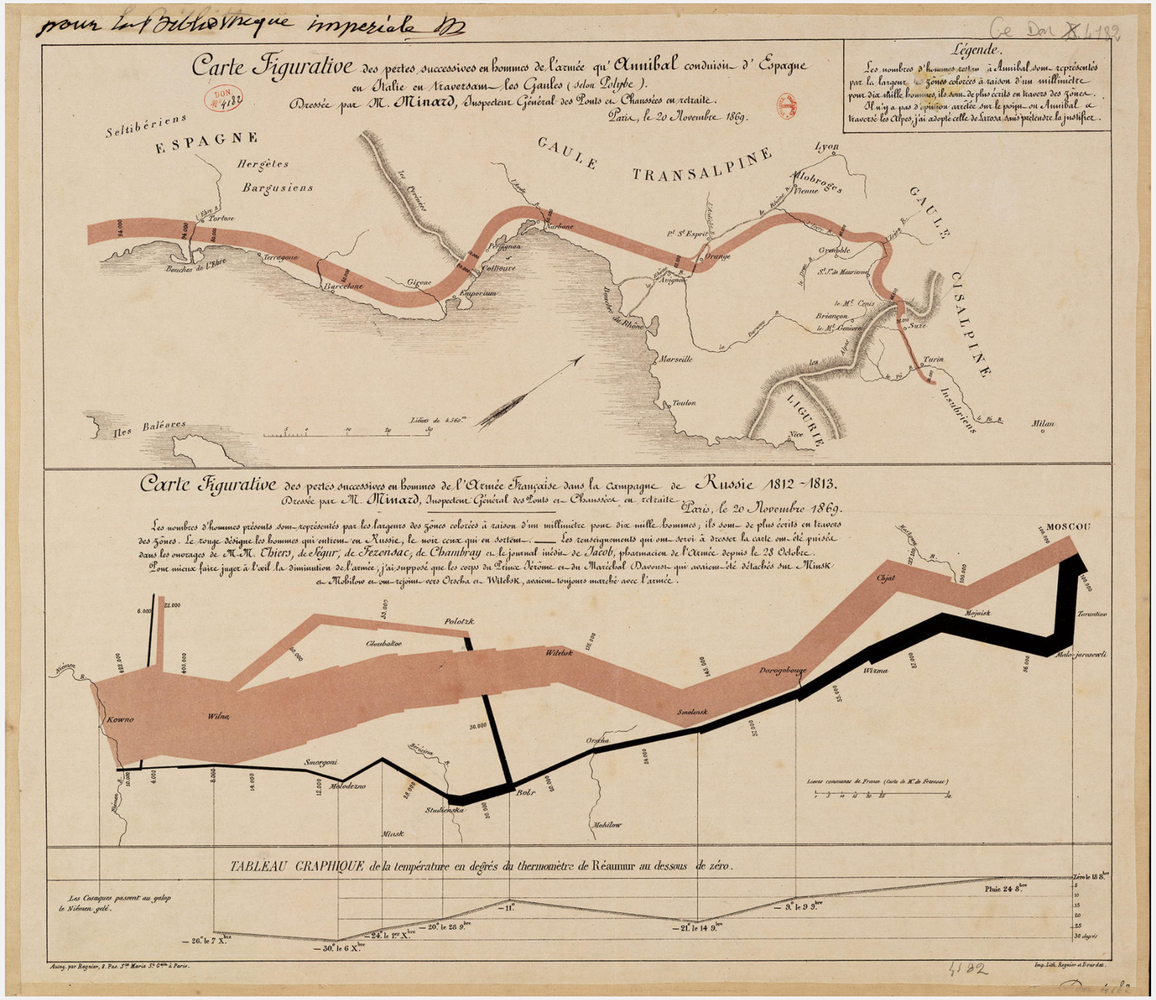
Data Visualization

is part art and part science.

Source: eazybi.com



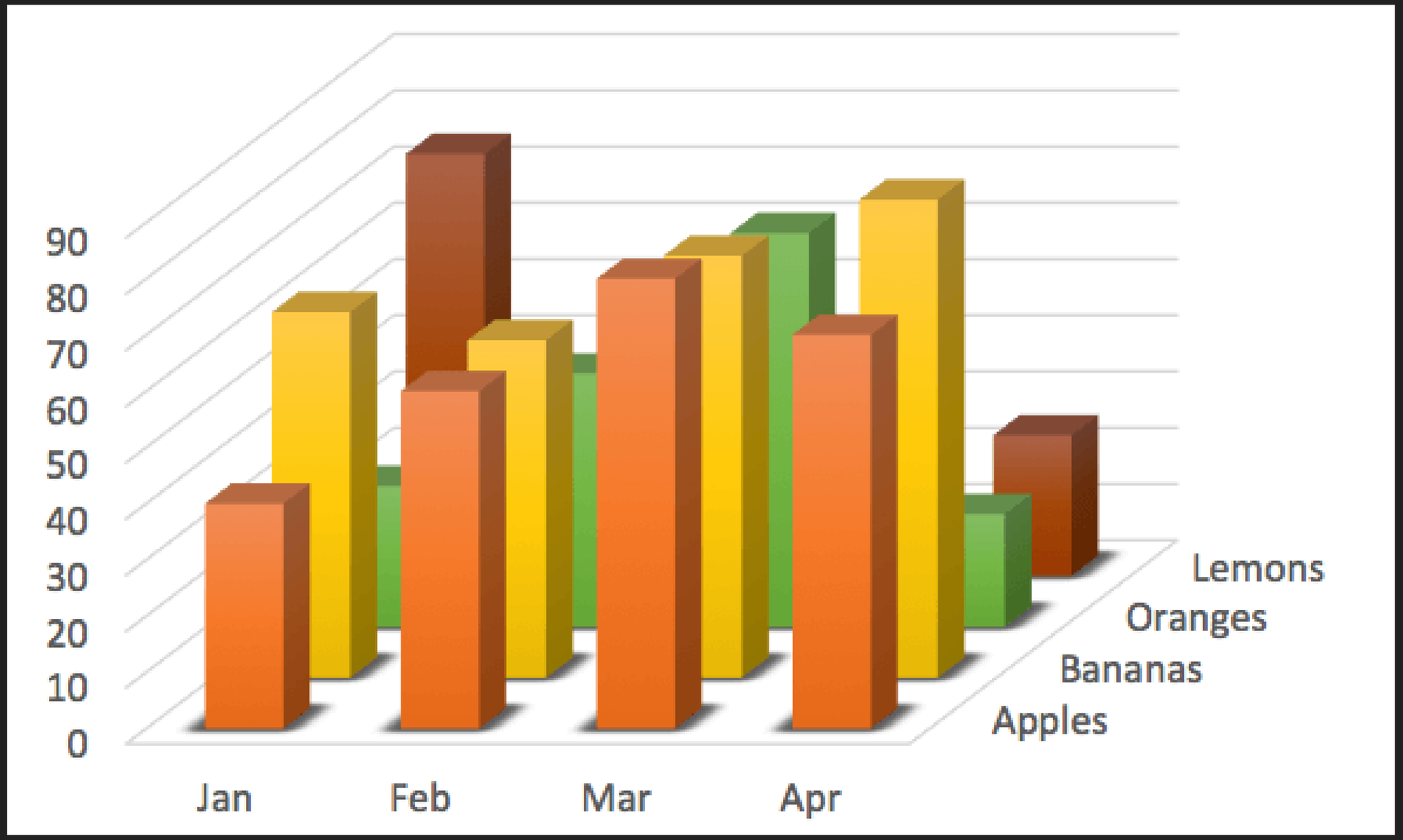
Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813 by Charles Joseph Minard



Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813 and Carte figurative des pertes successives en hommes de l'Armée qu'Annibal conduisit d'Espagne en Italie en traversant les Gaules (selon Polybe) by Charles Joseph Minard

- displays the progress of the troops of **Hannibal** (218 BC) and **Napoleon** (1812–1813)
- often considered as the **best statistical graphic ever** drawn

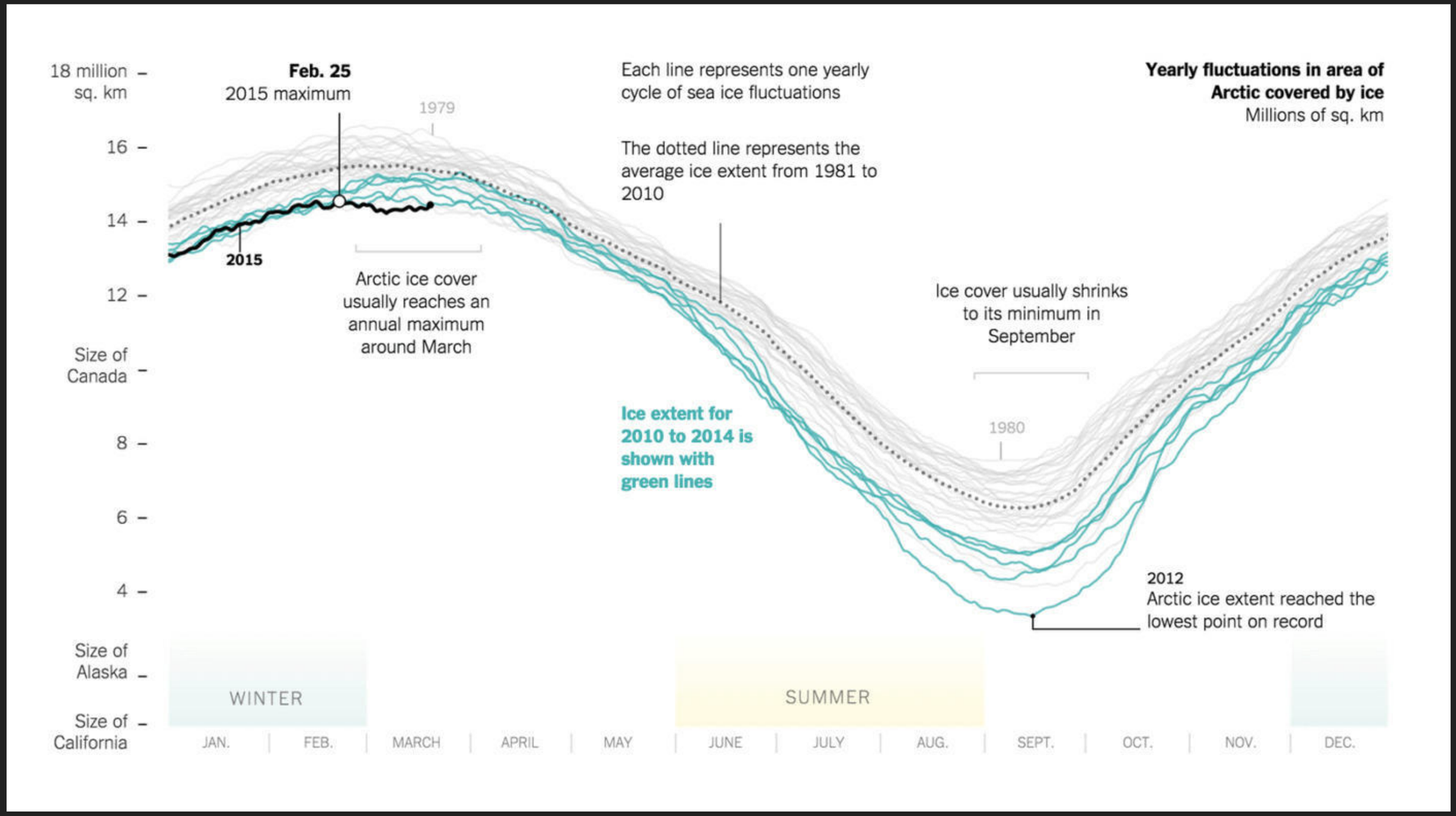
What makes it a bad data visualization?



What makes it a bad data visualization

- ☛ **substantive problems** (bad data / story)
- ☛ **aesthetic problems** (bad design)
- ☛ **perceptual problems** (bad encoding)

What makes it a good data visualization?



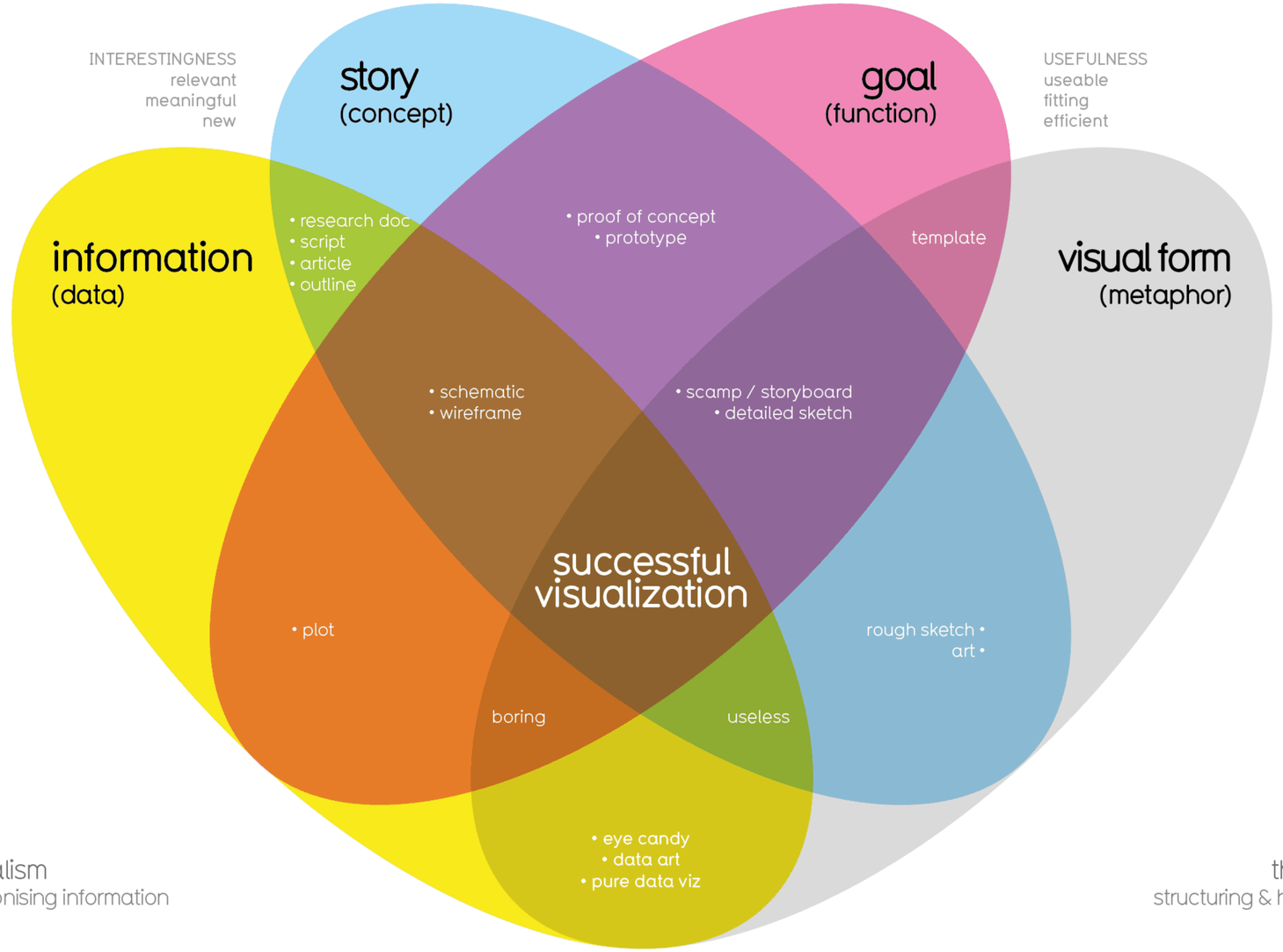
"Yearly Fluctuations in Area of Arctic Covered by Ice" by Derek Watkins (New York Times)

What makes it a good data visualization

- ☛ **INFORMATION** (integrity)
- ☛ **STORY** (interestingness)
- ☛ **GOAL** (usefulness)
- ☛ **VISUAL FORM** (beauty)

What Makes a Good Visualization?

explicit (implicit)



information
the art of journalism
structuring & harmonising information

visualization
the art of design
structuring & harmonising visuals

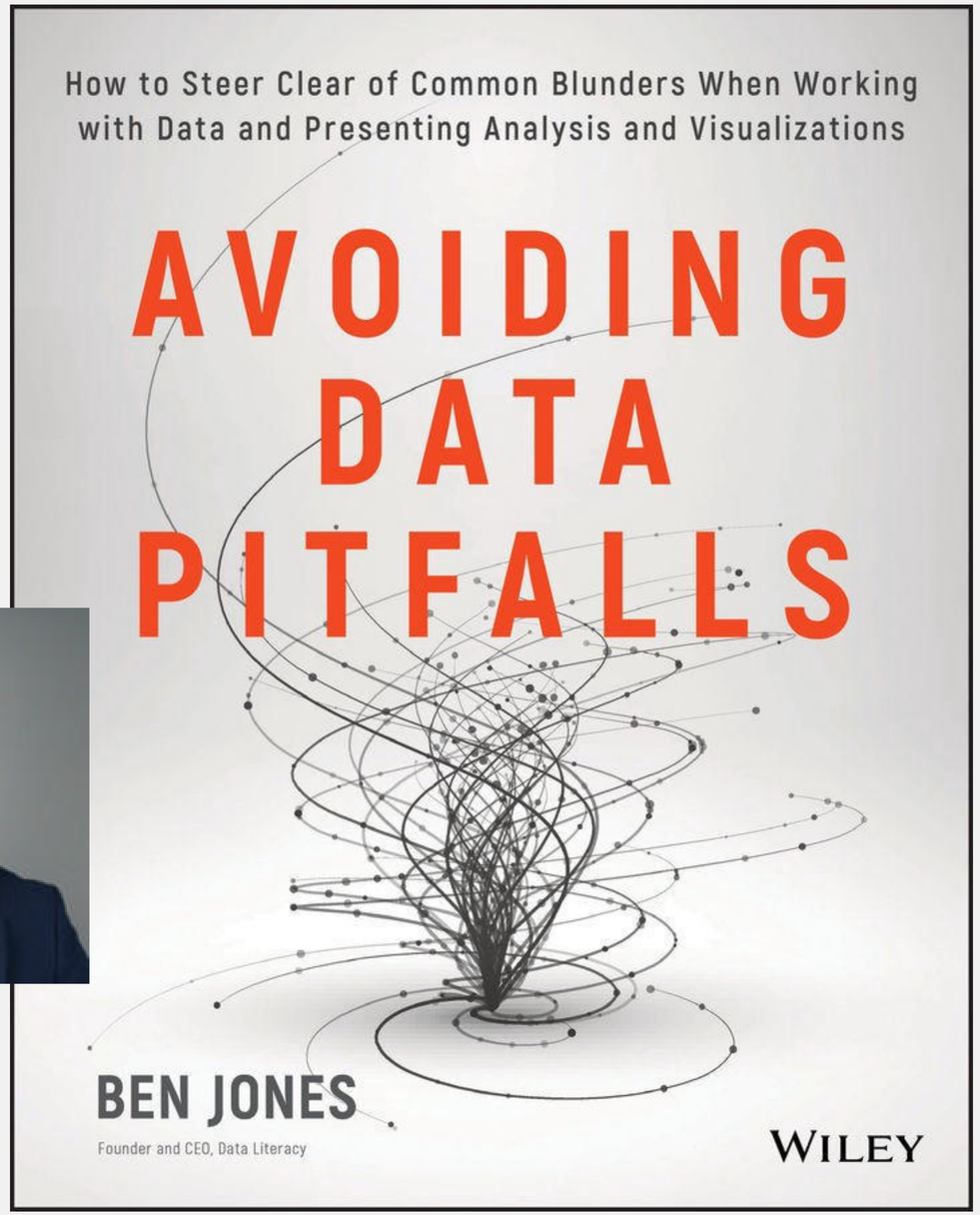
David McCandless
InformationisBeautiful.net

taken from new book
Knowledge is Beautiful

find out more
bit.ly/KIB_Books

INFORMATION

Understand your data and be accurate

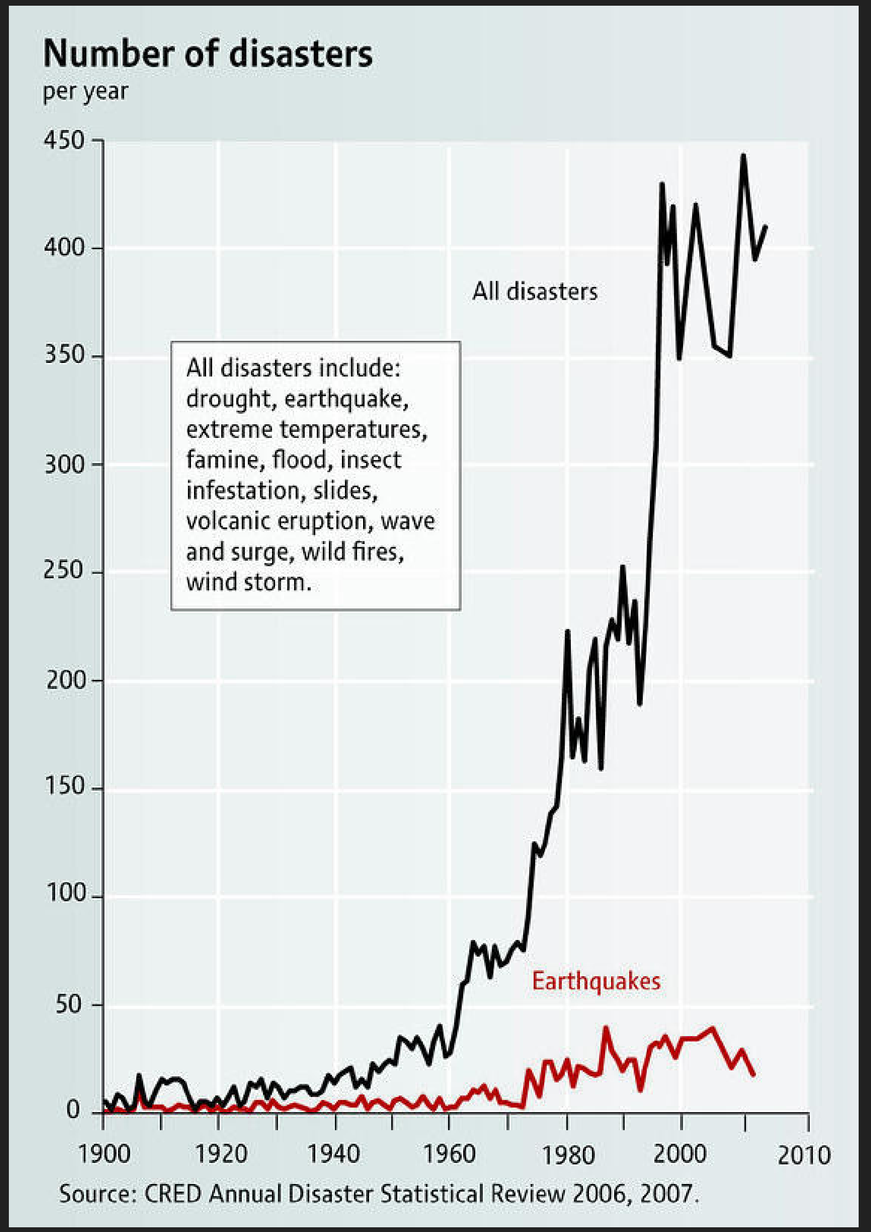

How to Steer Clear of Common Blunders When Working with Data and Presenting Analysis and Visualizations
AVOIDING DATA PITFALLS
BEN JONES
Founder and CEO, Data Literacy
WILEY

Our data is **never** a perfect reflection of the real world.

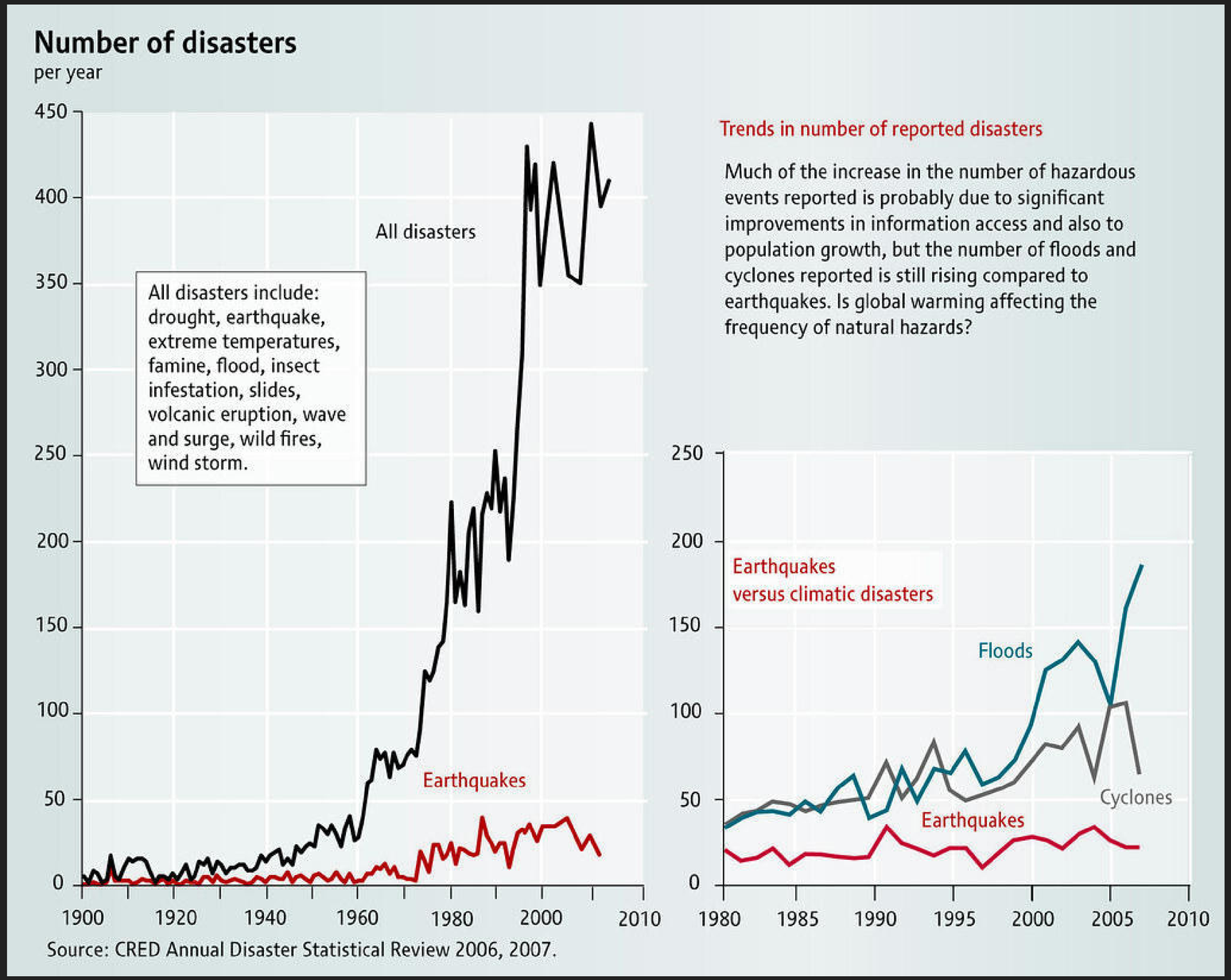
→ **only a subset:** not crime but reported crime

→ **collected by humans:** guesstimation, precision and errors

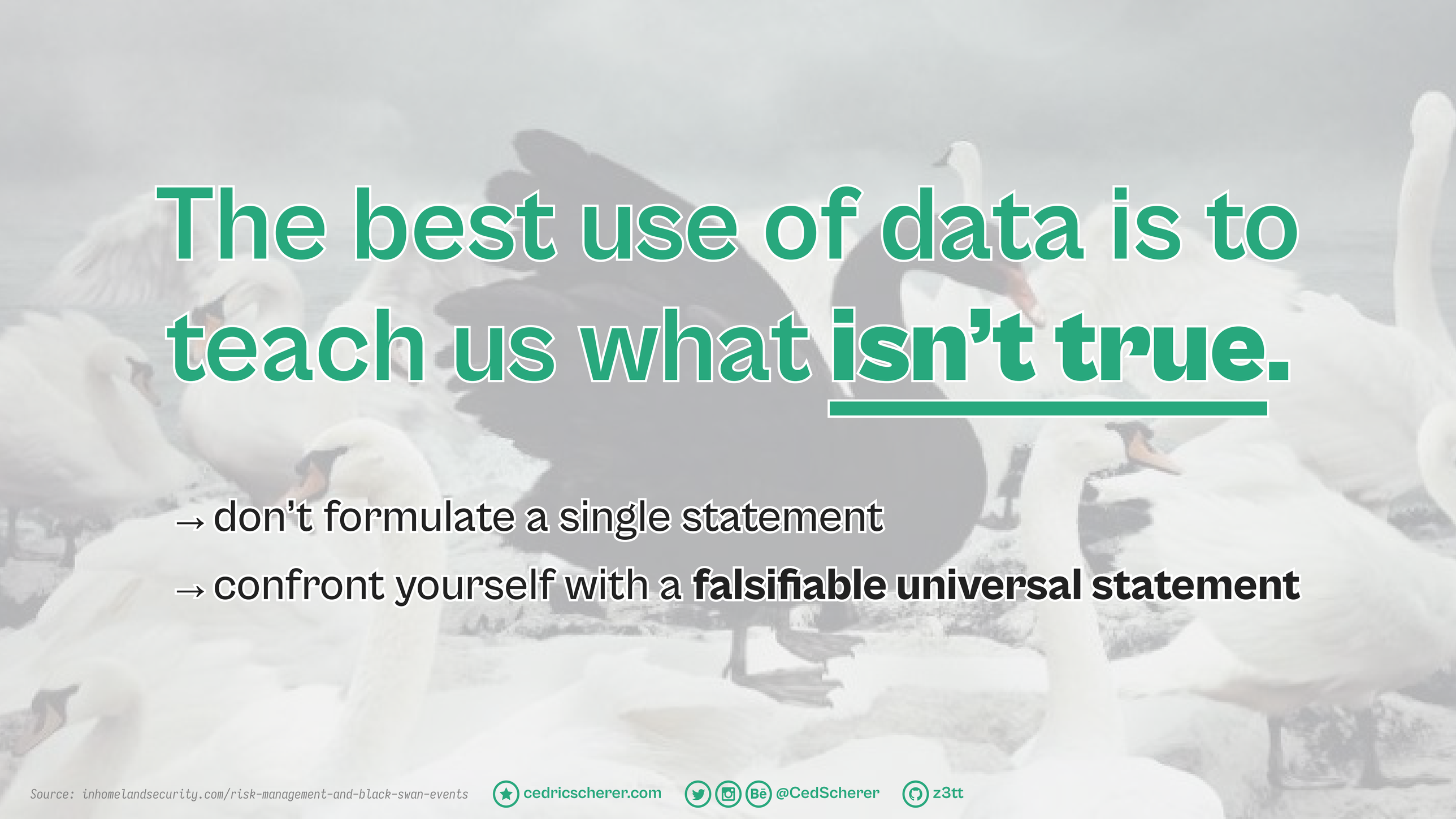
→ **collected by machines:** precisions and errors


Number of disasters
per year
450
400
350
300
250
200
150
100
50
0
All disasters
All disasters include: drought, earthquake, extreme temperatures, famine, flood, insect infestation, slides, volcanic eruption, wave and surge, wild fires, wind storm.
Earthquakes
1900
1920
1940
1960
1980
2000
2010
Source: CRED Annual Disaster Statistical Review 2006, 2007.

"Much of the increase of **hazardous events reported** is probably due to significant **improvements in information access**"



The best use of data is to teach us what **isn't true.**

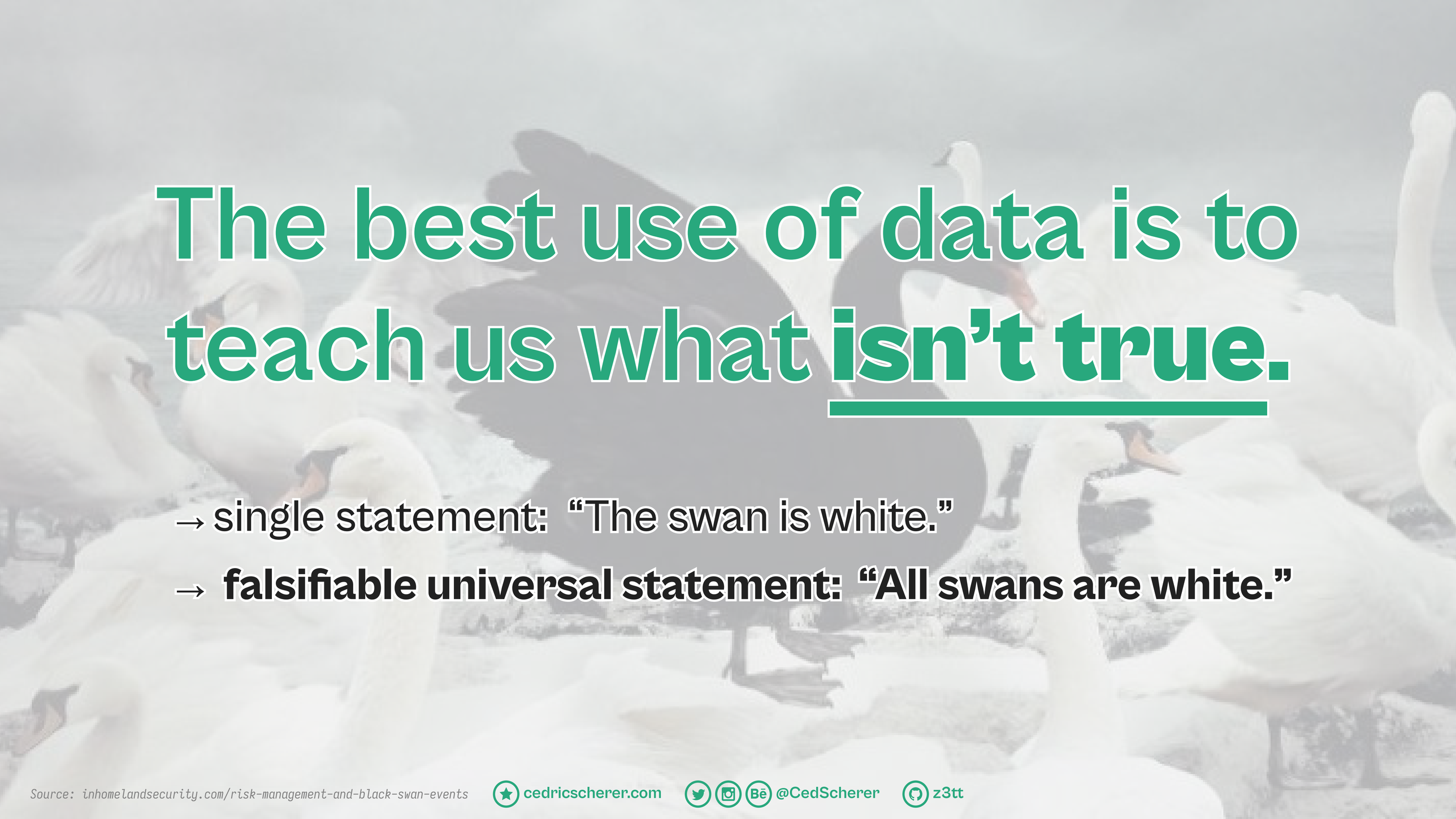


The best use of data is to teach us what **isn't true.**

→ don't formulate a single statement

→ confront yourself with a **falsifiable universal statement**

Source: inhomelandsecurity.com/risk-management-and-black-swan-events



The best use of data is to teach us what **isn't true.**

→ single statement: "The swan is white."

→ **falsifiable universal statement: "All swans are white."**

Source: inhomelandsecurity.com/risk-management-and-black-swan-events

STORY

Be clear about the message of your visualization

Who is my audience?

Which story is **interesting** for them?

Who is my audience?

Which story is **interesting** for them?

What are **relevant** details to include?

Who is my audience?

Which story is **interesting** for them?

What are **relevant** details to include?

Which variables are **meaningful** to them?

Who is my audience?

Which story is **interesting** for them?

What are **relevant** details to include?

Which variables are **meaningful** to them?

How will they **encounter** the visualization?

Who is my audience?

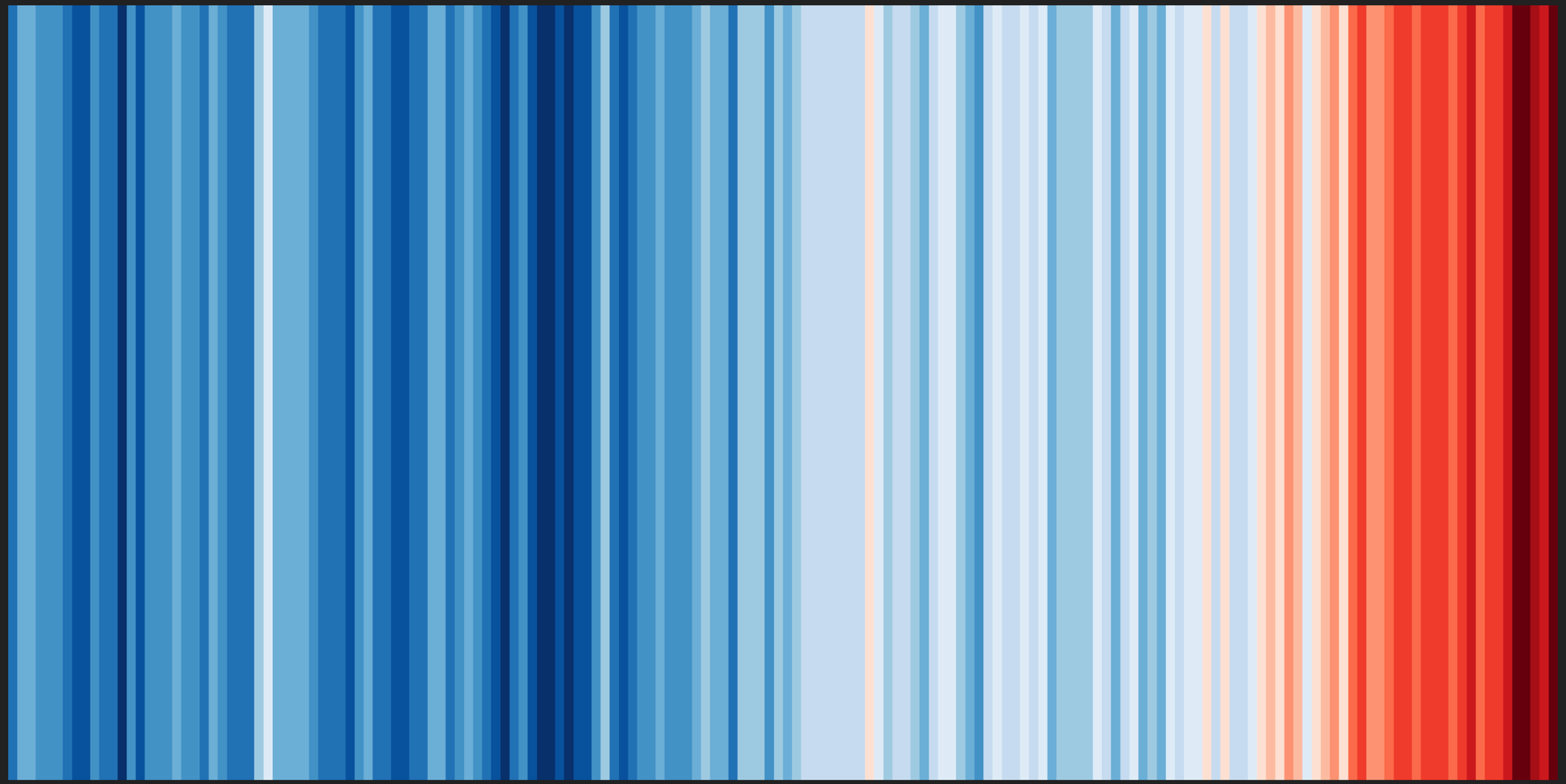
Which story is **interesting** for them?

What are **relevant** details to include?

Which variables are **meaningful** to them?

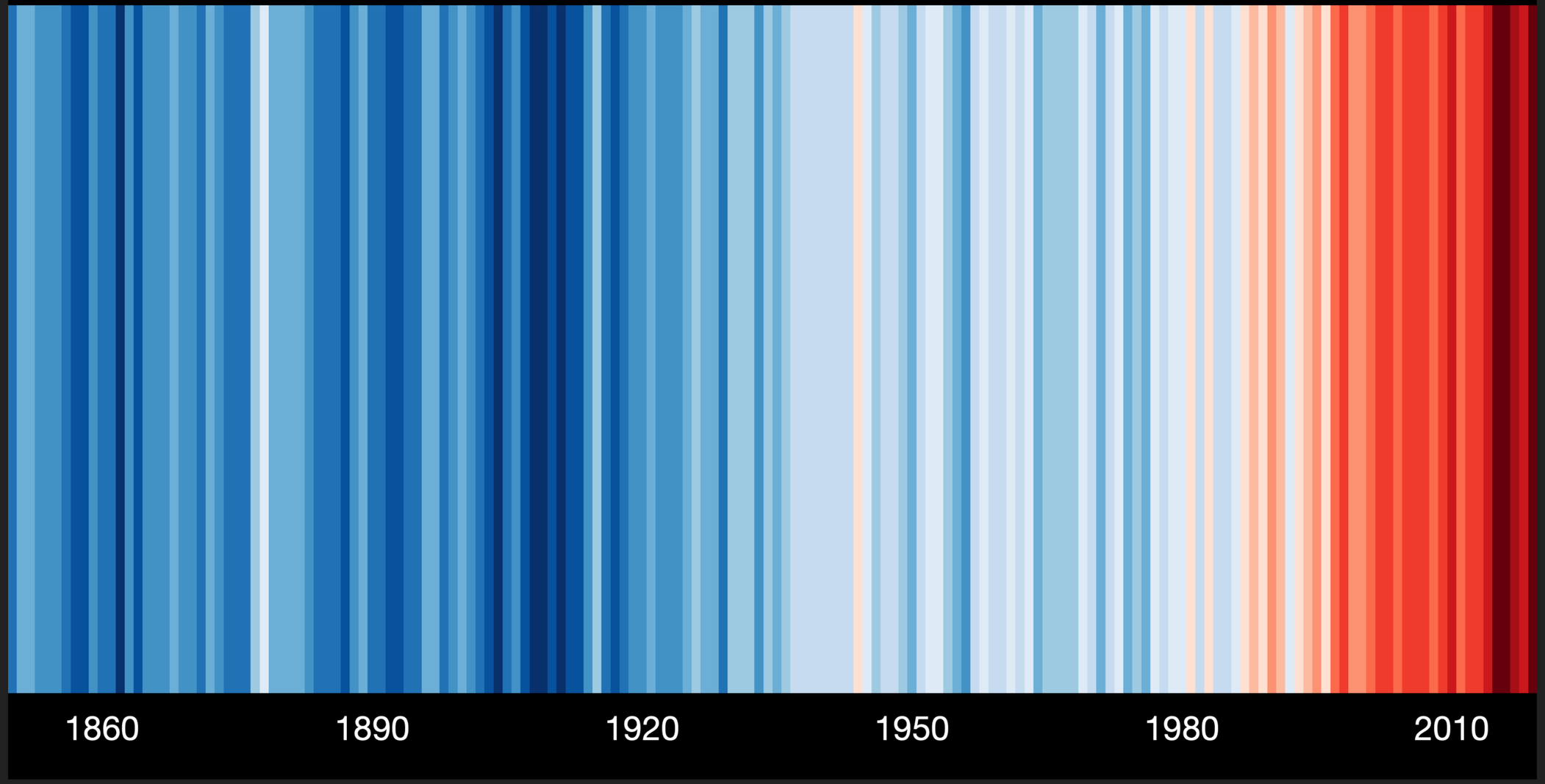
How will they **encounter** the visualization?

Do I need a visualization at all??



Warming Stripes by Ed Hawkins

Global temperature change (1850-2019)



Warming Stripes by Ed Hawkins

FAQ : Frequently asked questions

What are these graphics?

What do the graphics show?

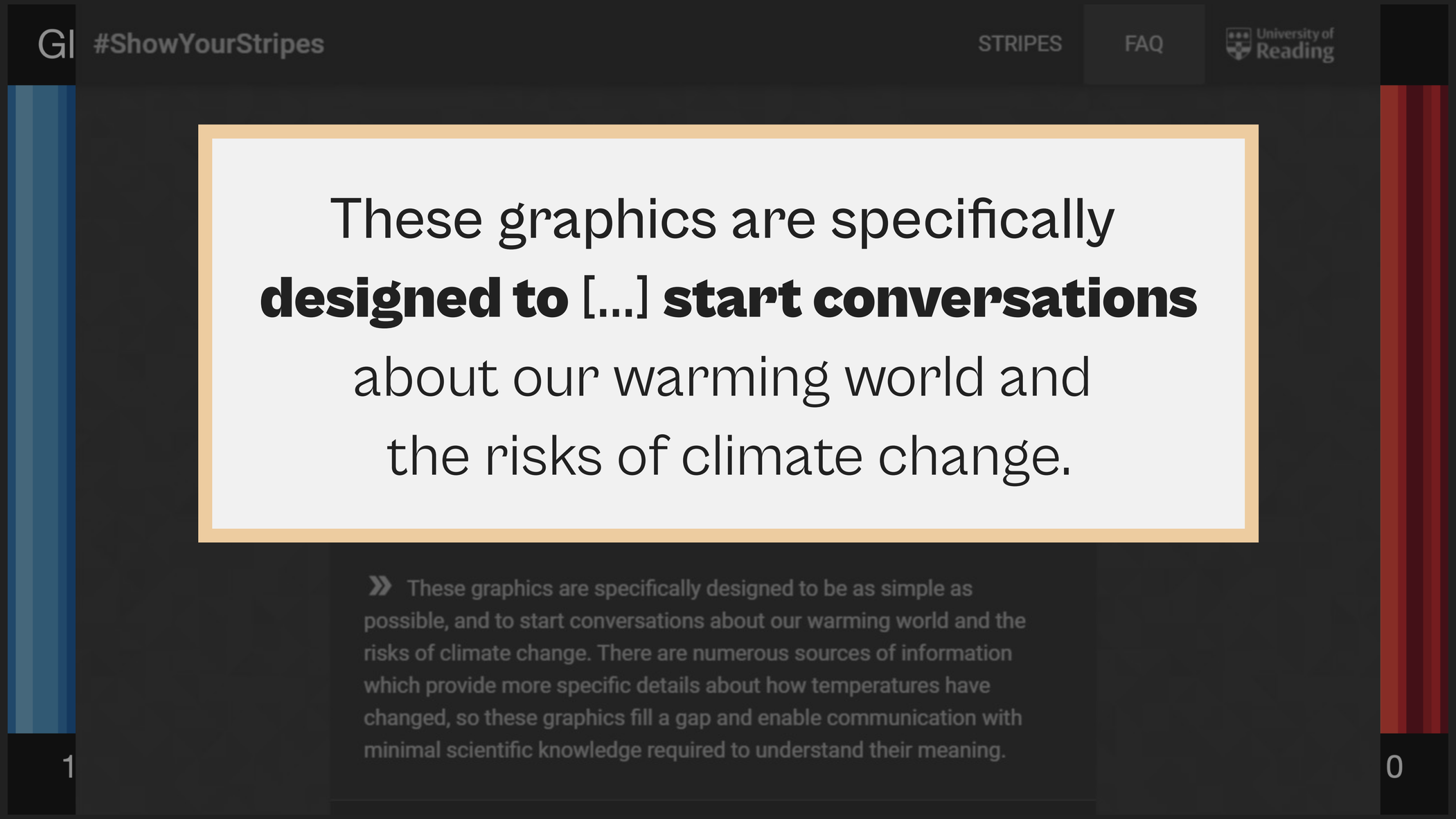
Why are there no numbers on the graphics?

» These graphics are specifically designed to be as simple as possible, and to start conversations about our warming world and the risks of climate change. There are numerous sources of information which provide more specific details about how temperatures have changed, so these graphics fill a gap and enable communication with minimal scientific knowledge required to understand their meaning.

1

0

showyourstripes.info/faq



These graphics are specifically
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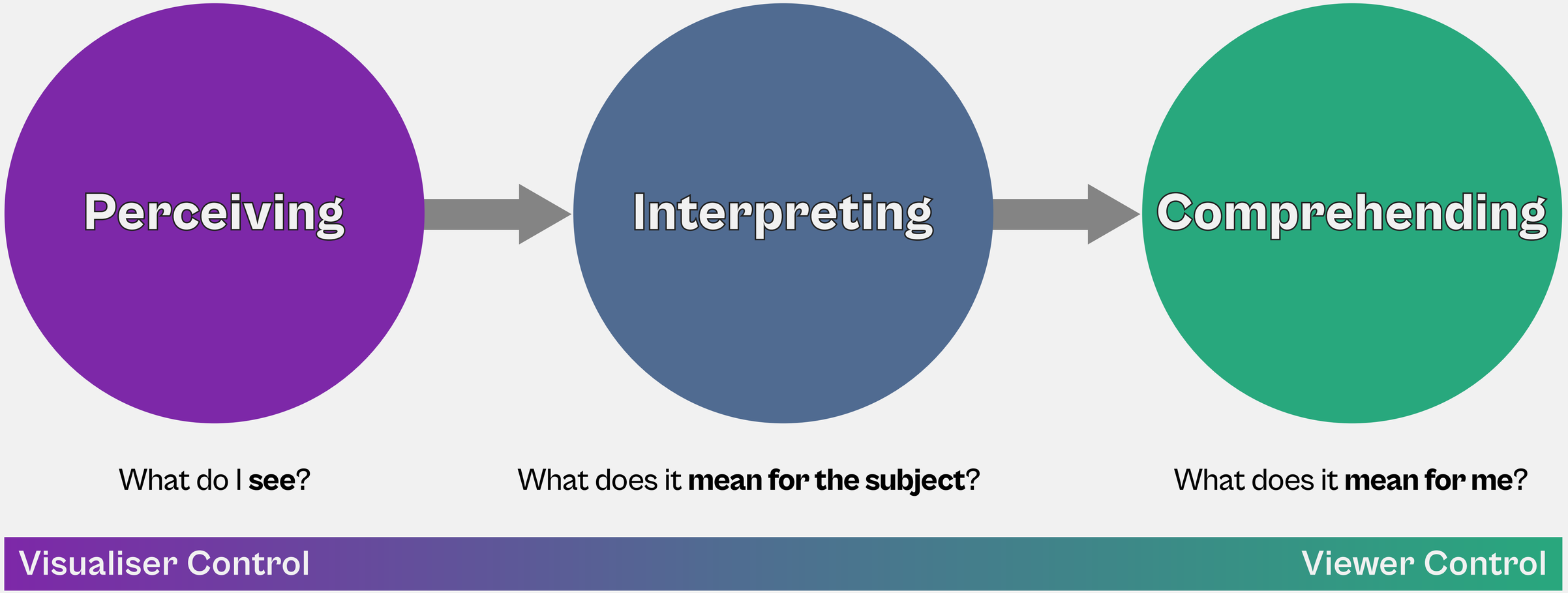
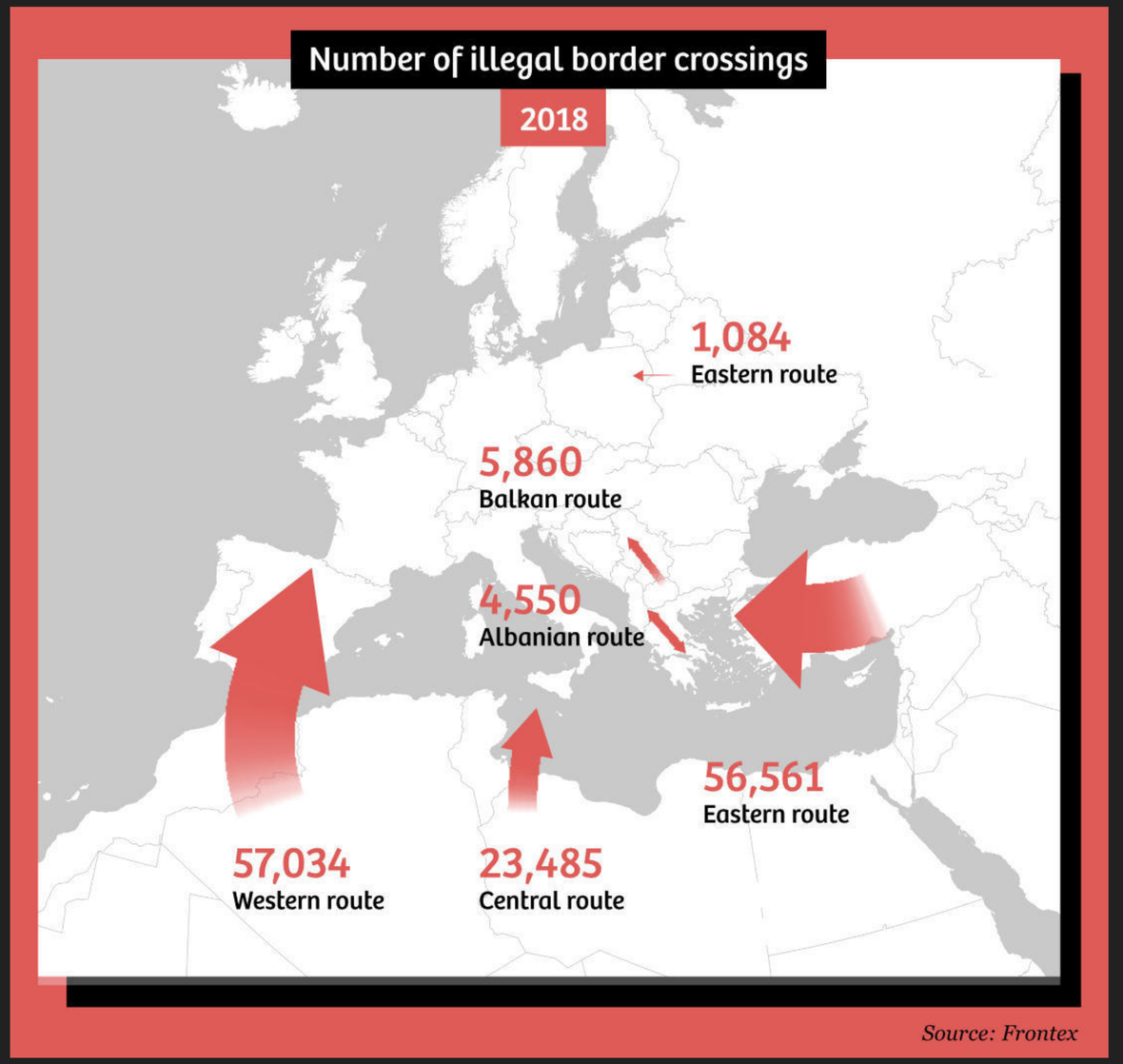
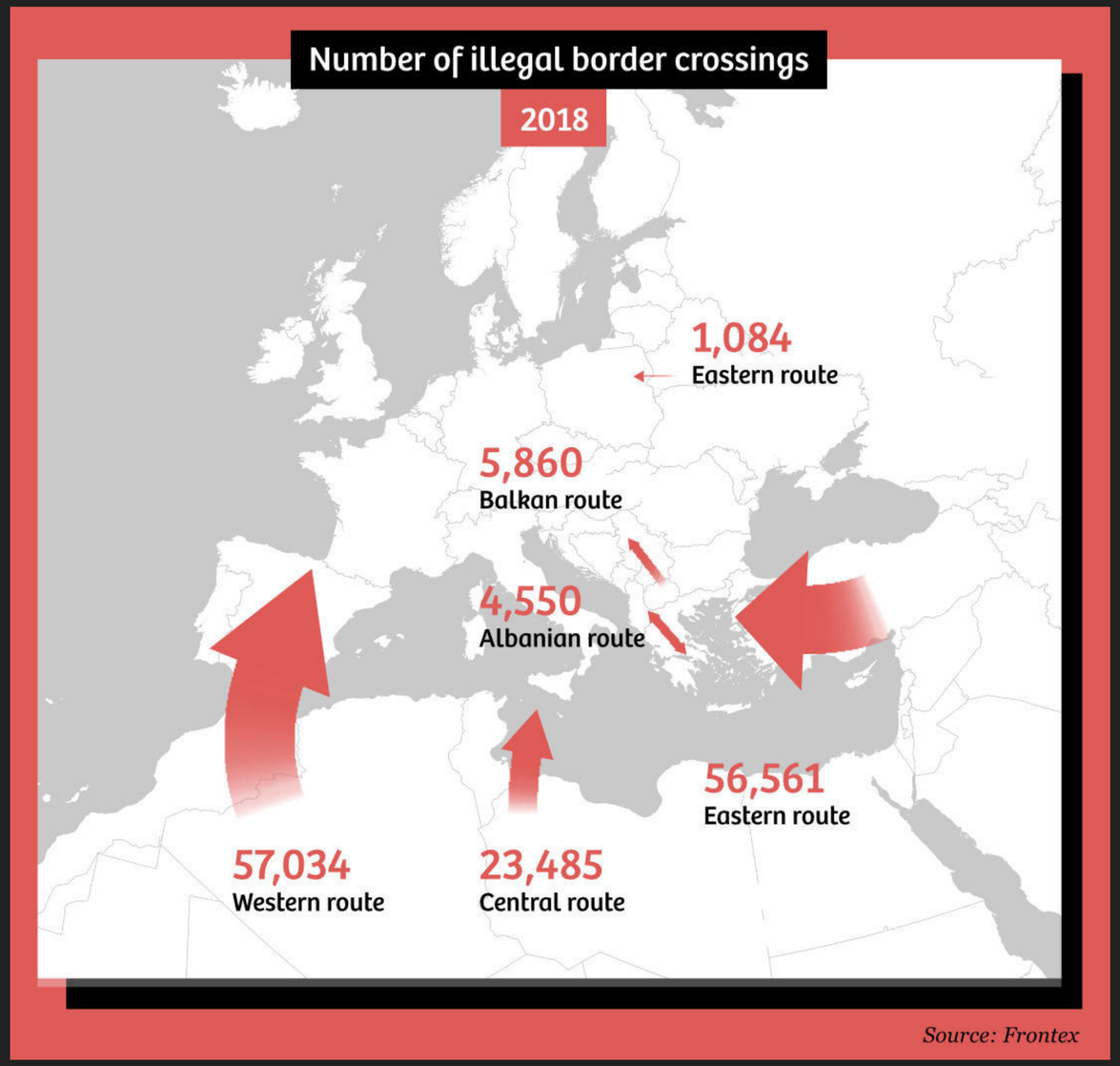
showyourstripes.info/faq

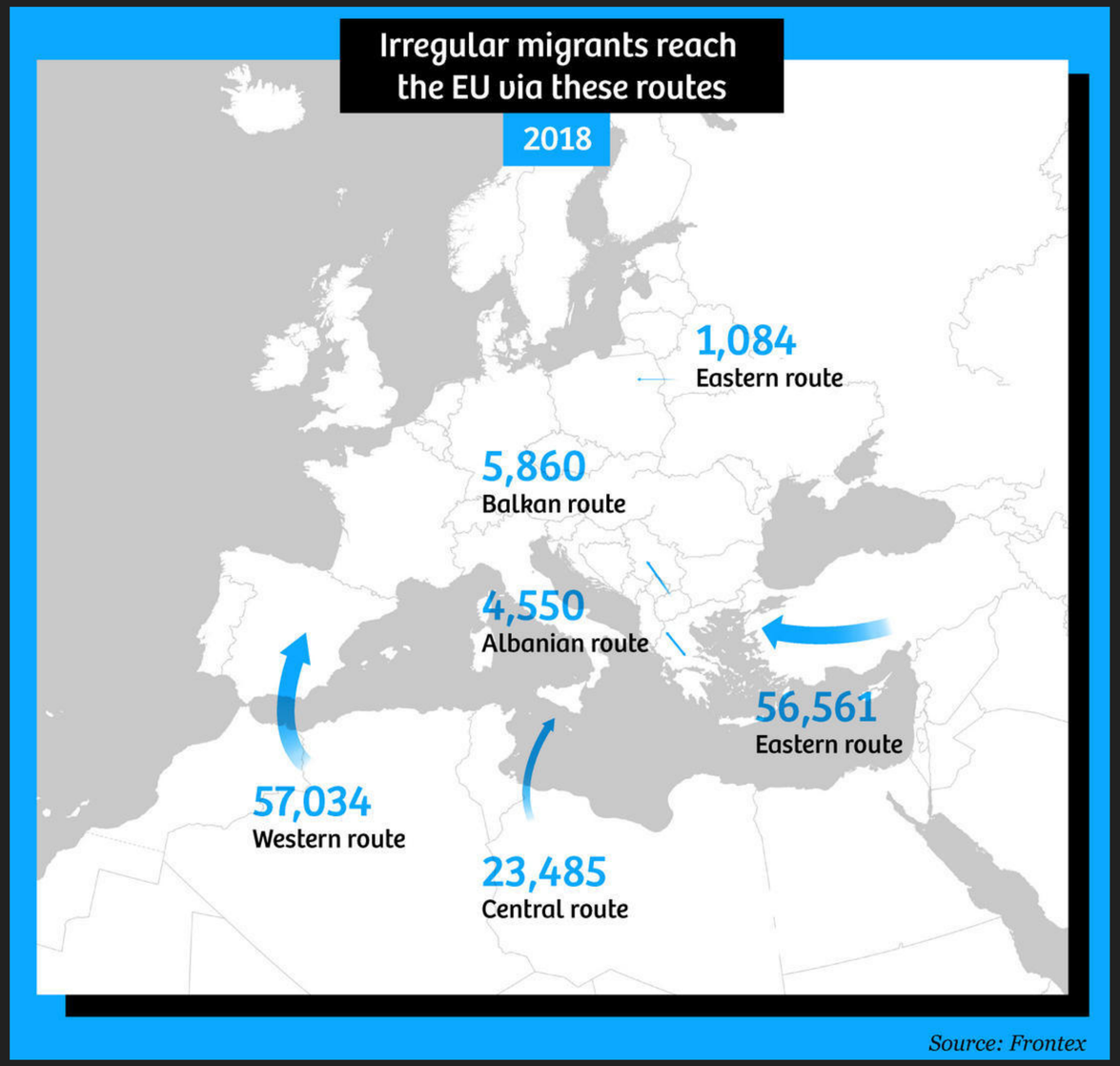


Scheme by Andy Kirk



"How maps in the media make us more negative about migrants" by Maite Vermeulen, Leon de Korte & Henk van Houtum





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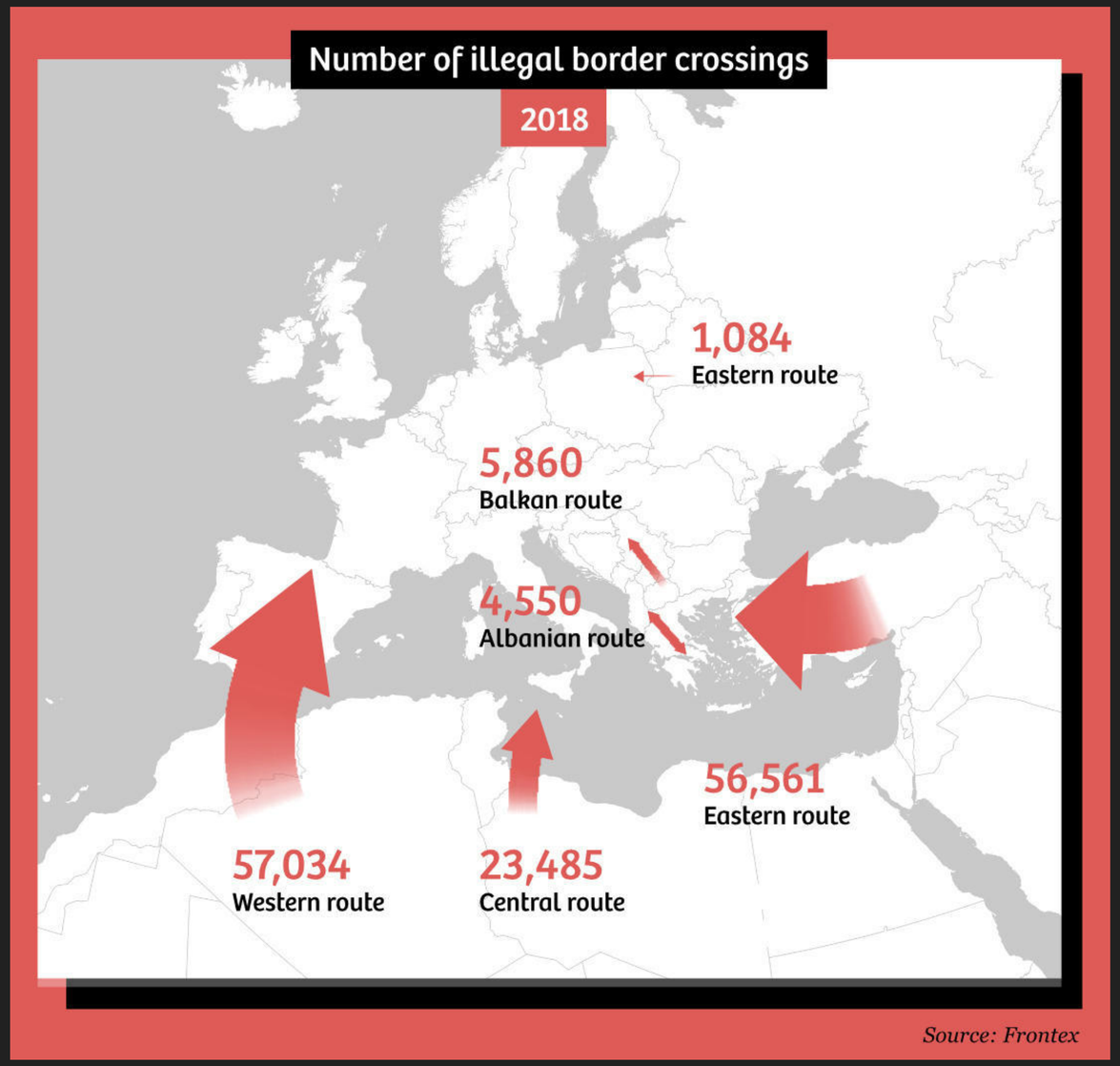

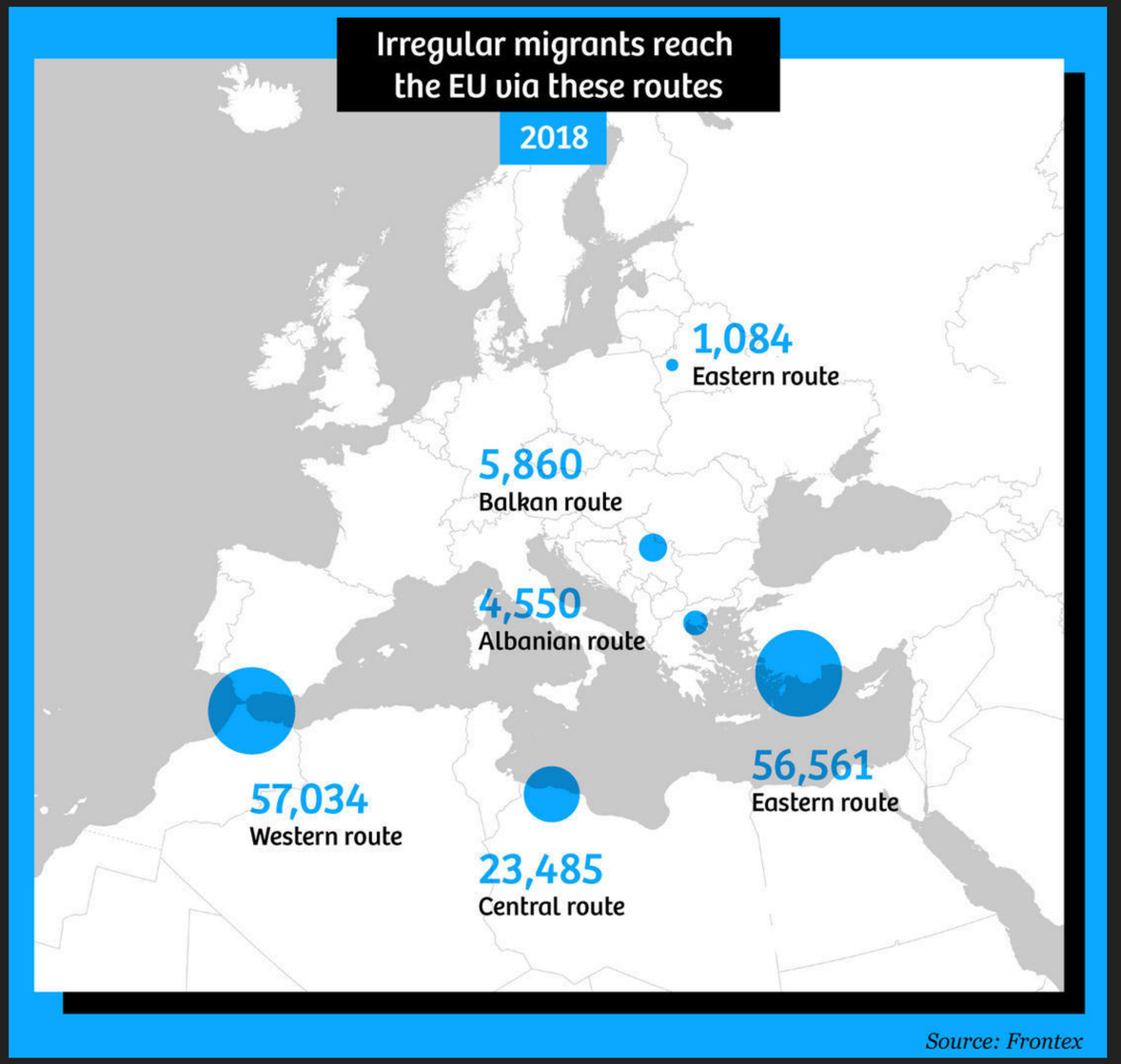

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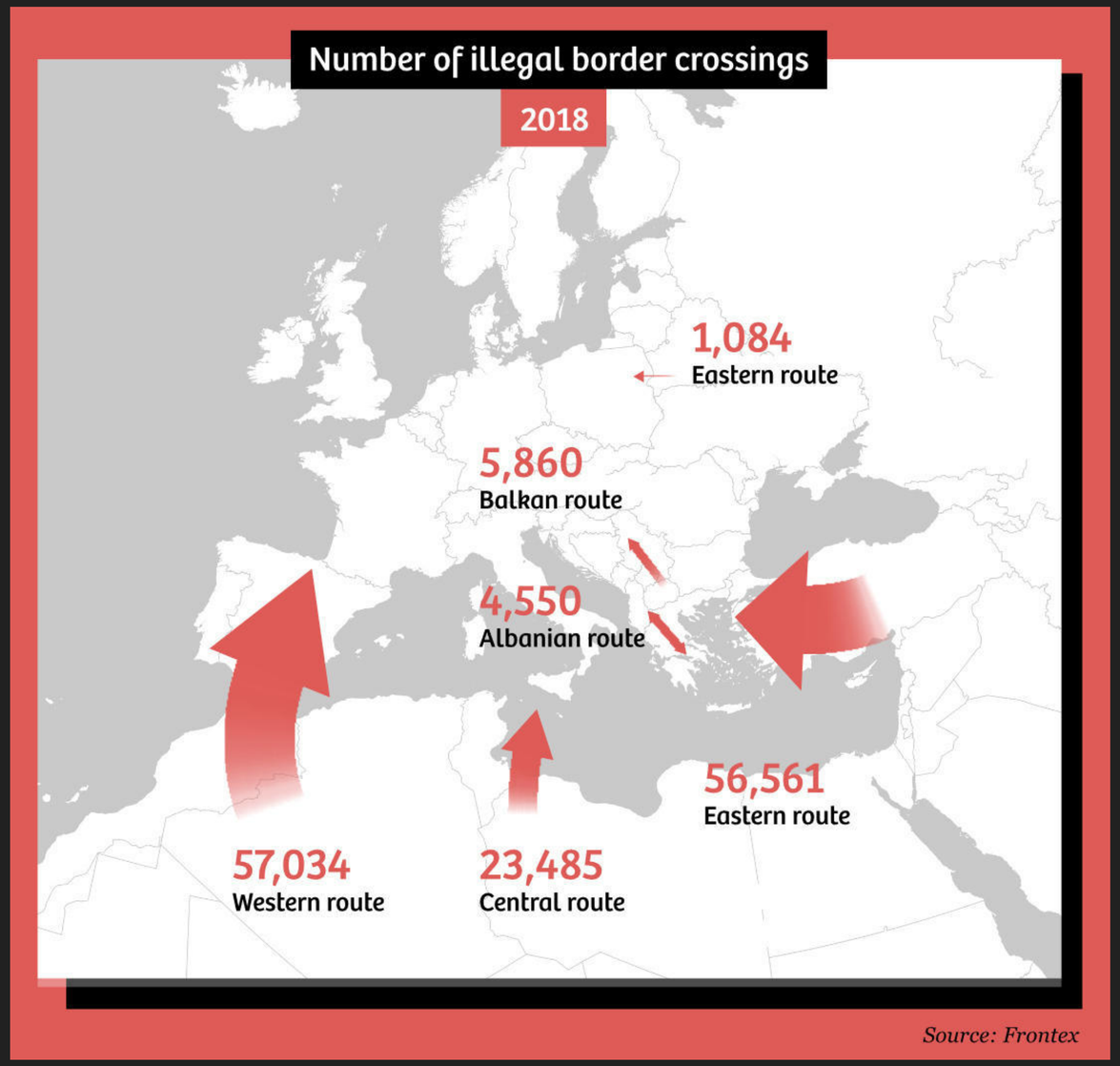

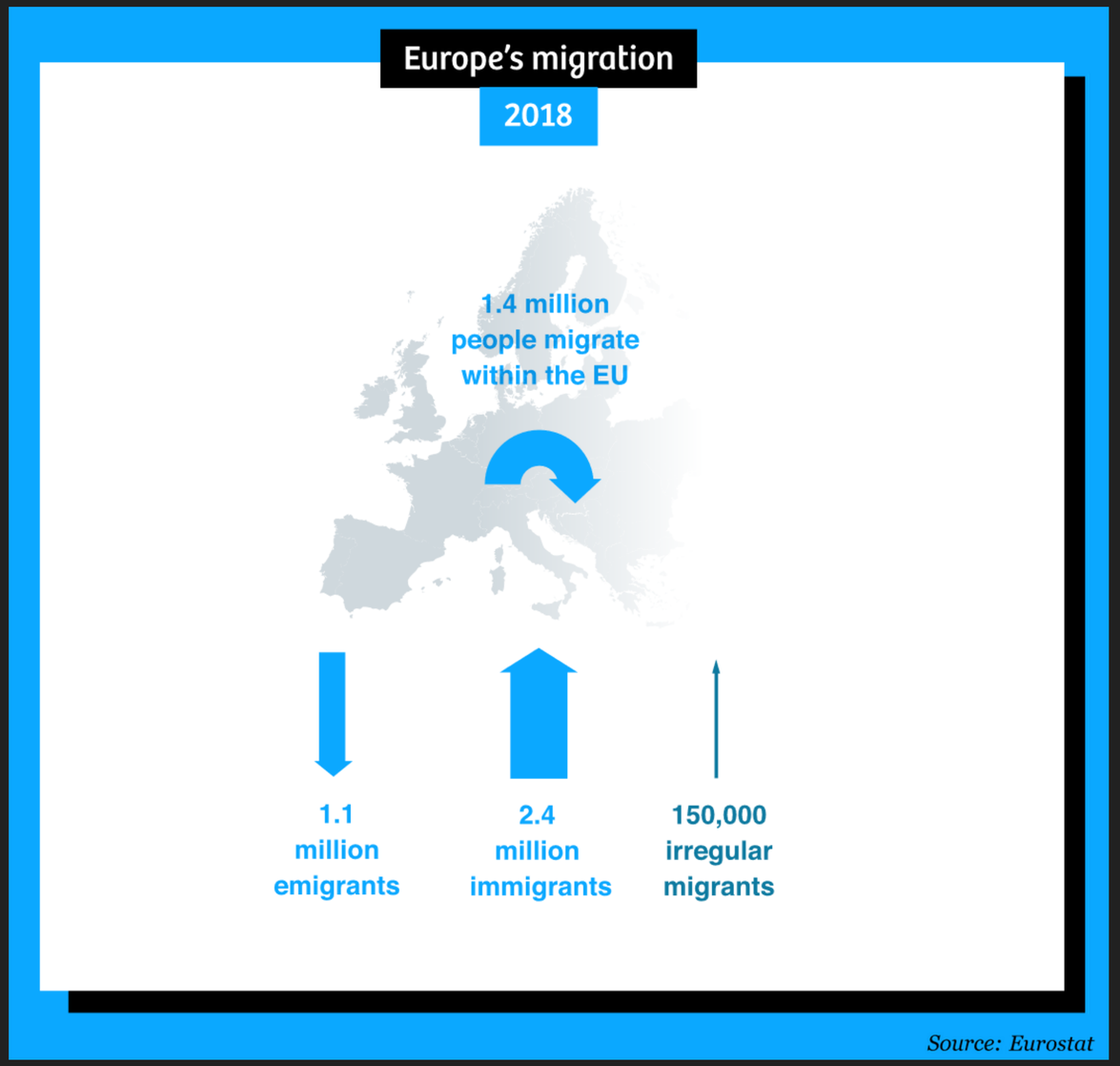

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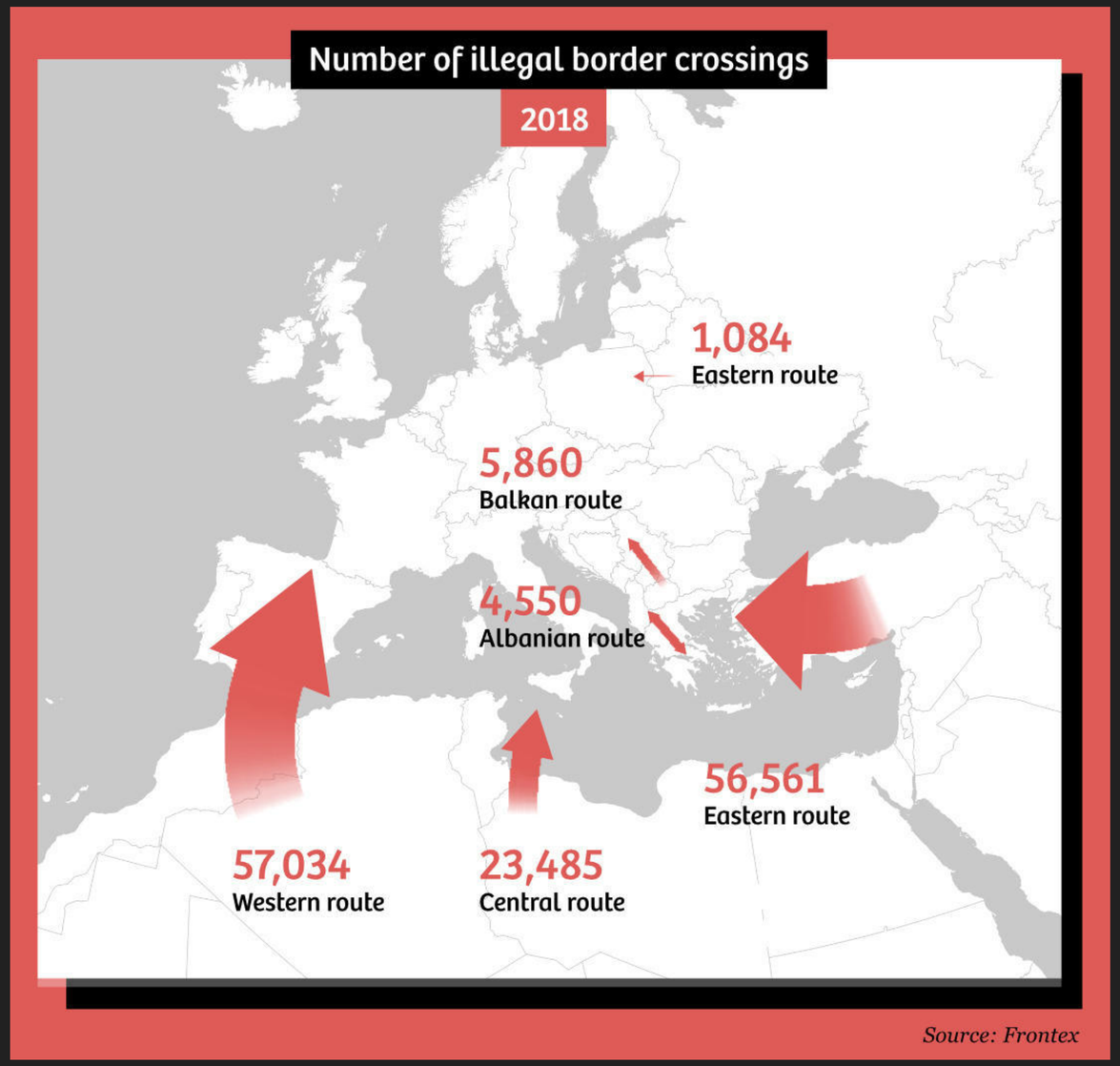

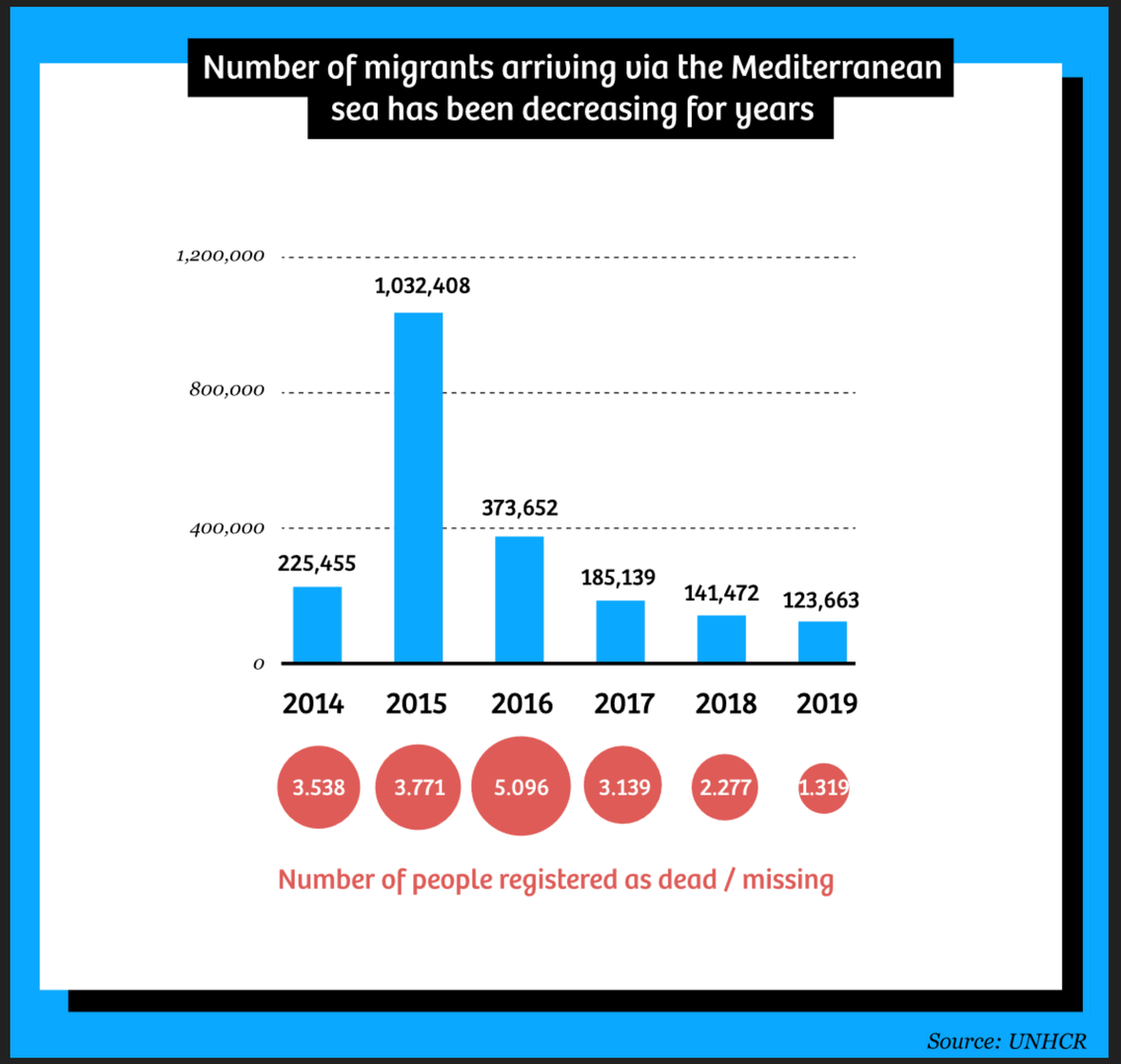

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GOAL

Select charts that successfully transport your story

Typology of Information Graphics

by Juuso Koponen & Jonatan Hildén, "Data Visualization Handbook" (2020), p. 25

Is the **information** conceptual or measurable?

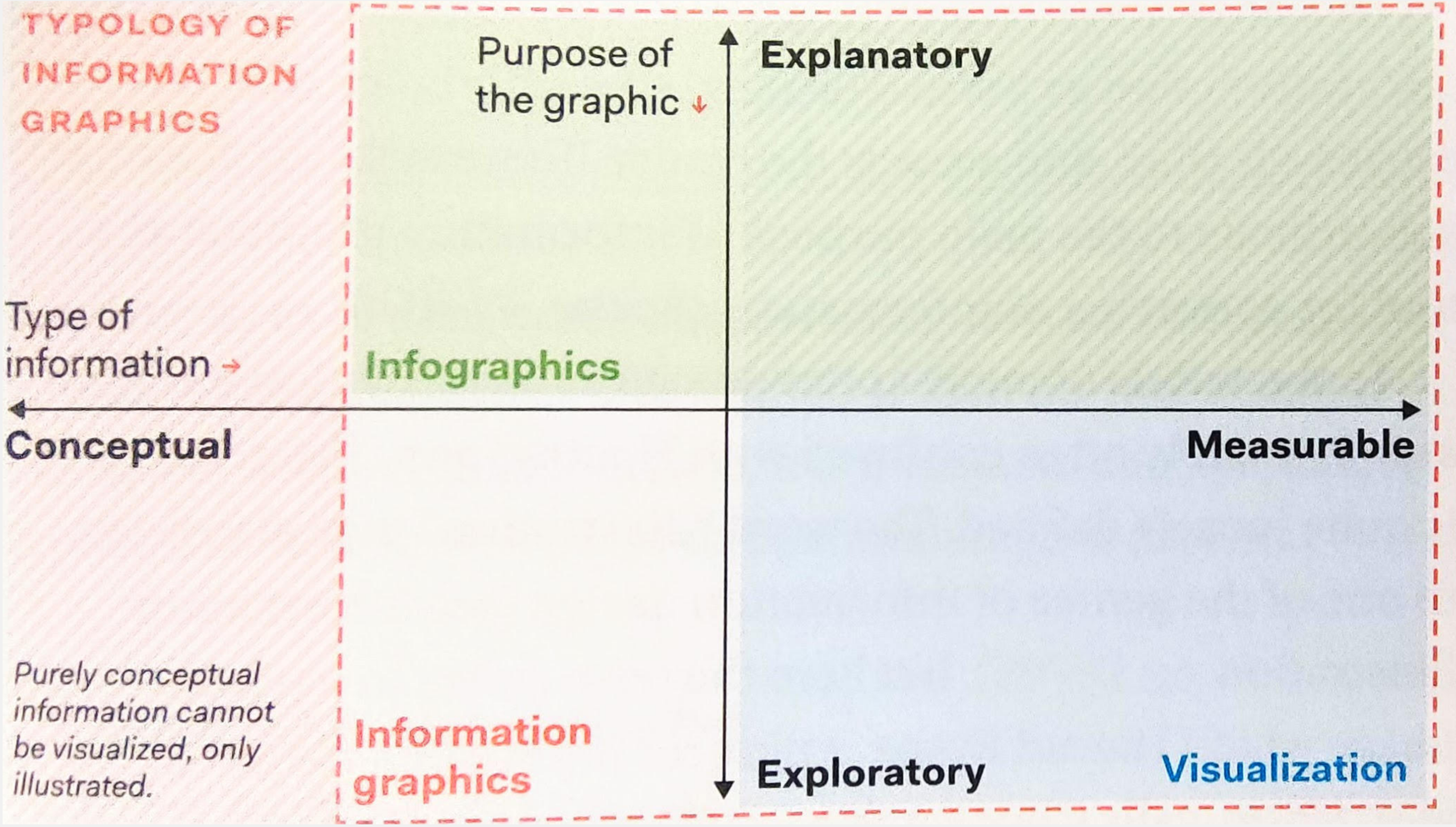
☛ **Type of information**: depict conceptual information <> convert information into visual forms

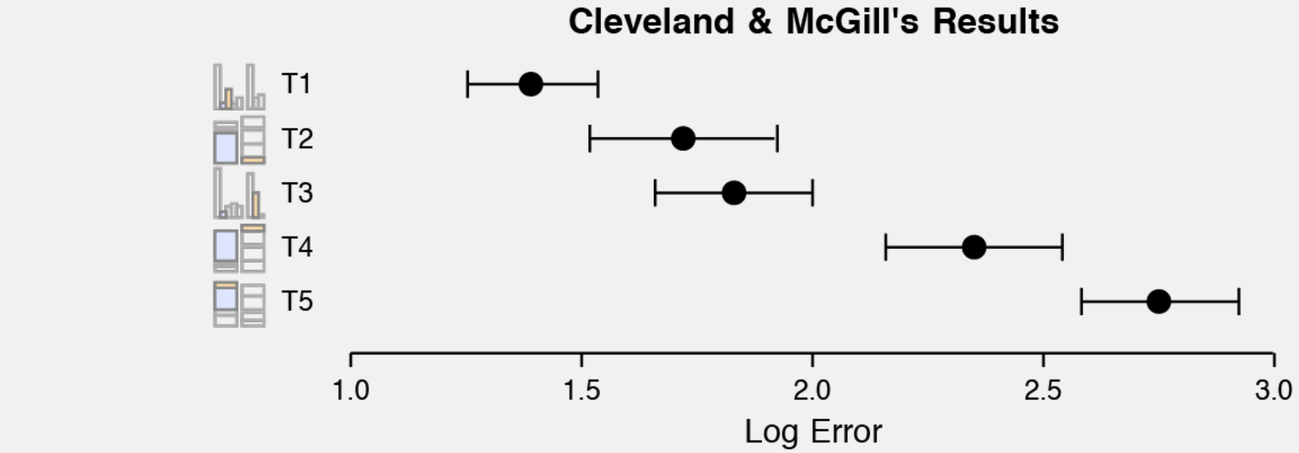
Is the **purpose** to explore or to explain the information?

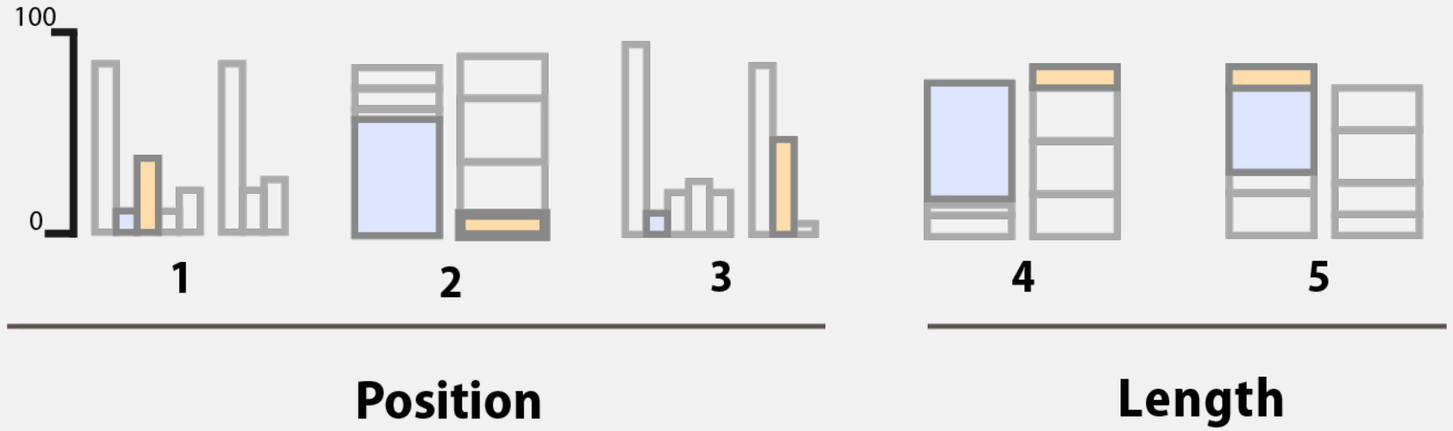
☛ **Purpose of the graphic**: facilite discovery <> communicate information

Typology of Information Graphics

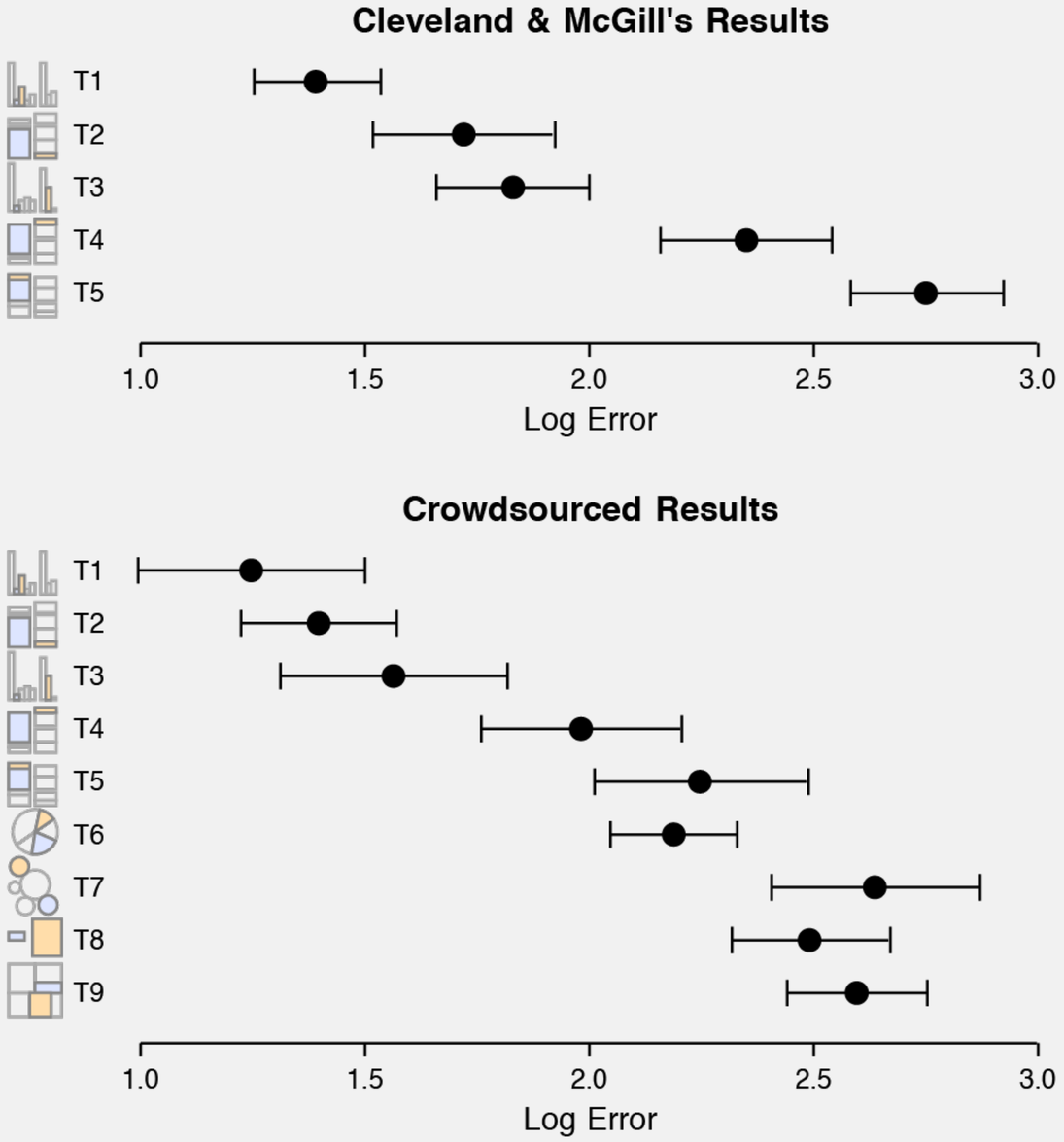
by Juuso Koponen & Jonatan Hildén, "Data Visualization Handbook" (2020), p. 25





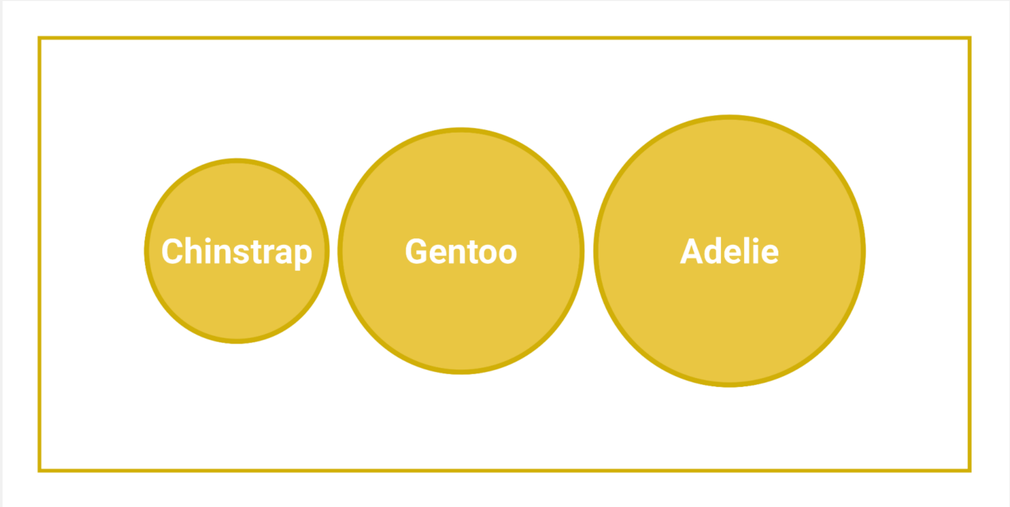


*Source: Kieran Healy's **"Data Visualization: A Practical Introduction"**; results based on Heer and Bostock, following Cleveland and McGill*

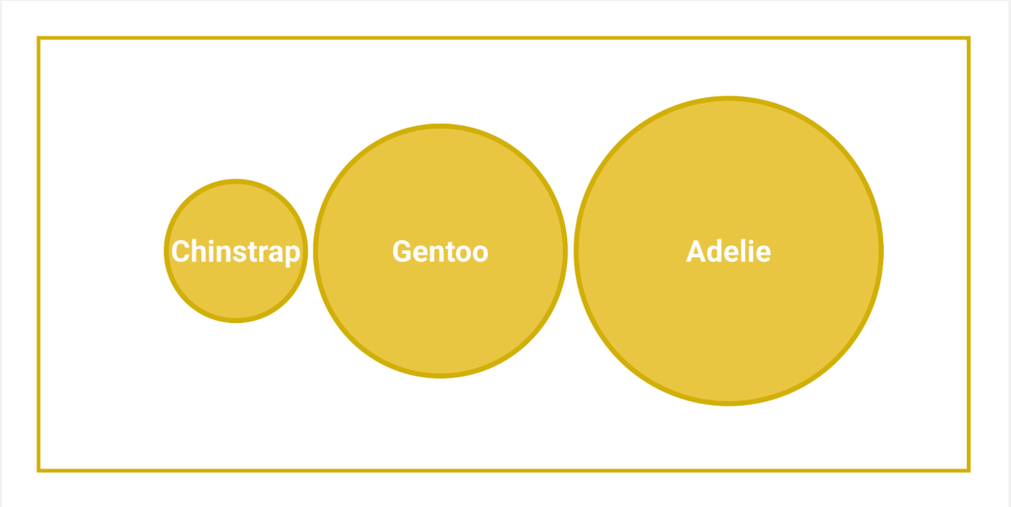


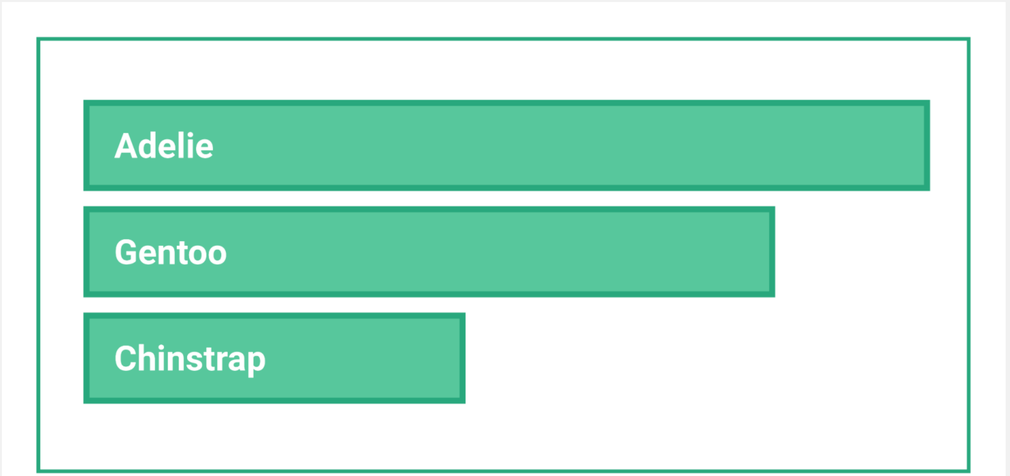
*Source: Kieran Healy's **"Data Visualization: A Practical Introduction"**; results based on Heer and Bostock, following Cleveland and McGill*

Always use area.



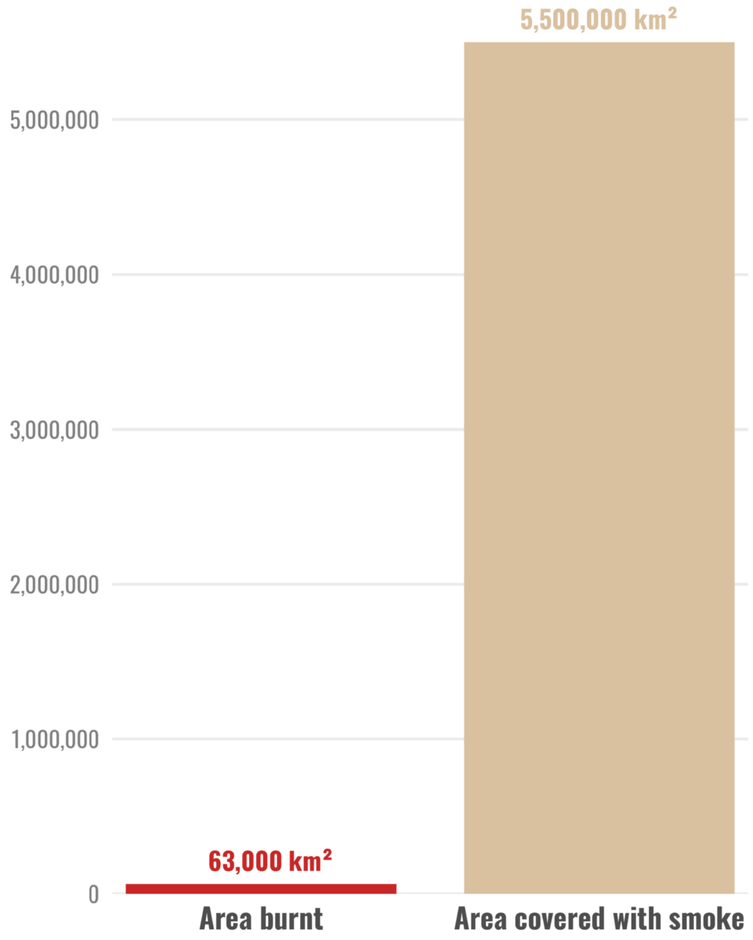
Never use radius!

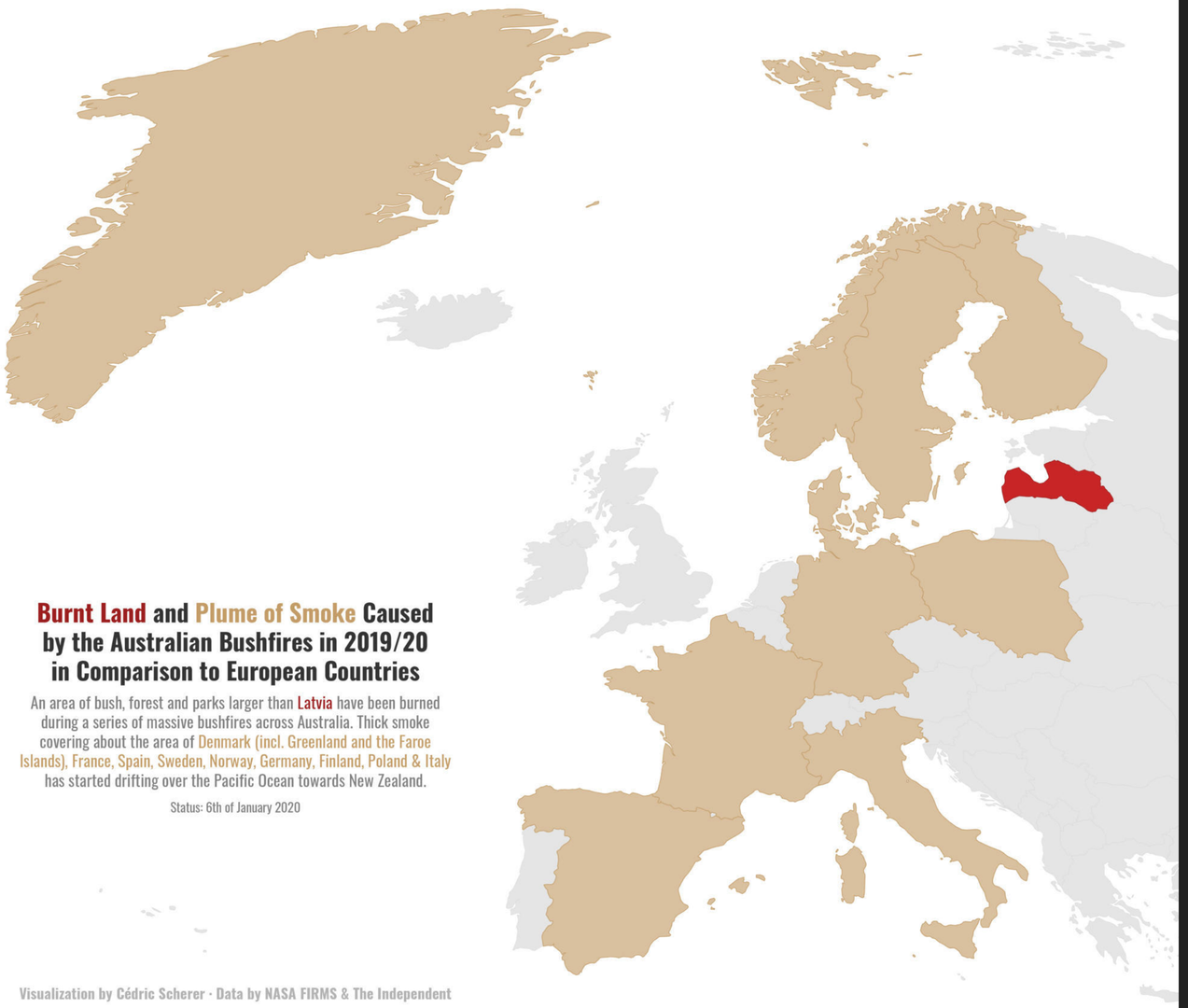




Burnt land and plume of smoke caused by the Australian bushfires in 2019/20

(as of 6th of January 2020)





Burnt Land and Plume of Smoke Caused by the Australian Bushfires in 2019/20 in Comparison to European Countries

An area of bush, forest and parks larger than Latvia have been burned during a series of massive bushfires across Australia. Thick smoke covering about the area of Denmark (incl. Greenland and the Faroe Islands), France, Spain, Sweden, Norway, Germany, Finland, Poland & Italy has started drifting over the Pacific Ocean towards New Zealand.

Status: 6th of January 2020

Visualization by Cédric Scherer · Data by NASA FIRMS & The Independent

PLOS | BIOLOGY

PERSPECTIVE

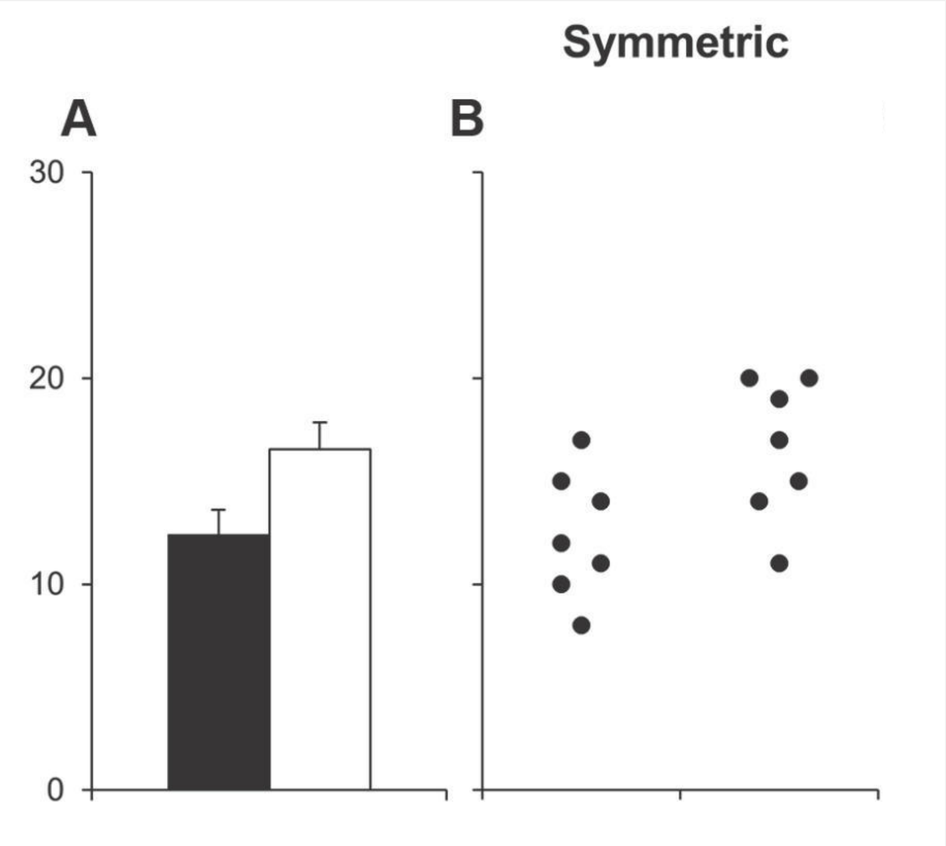
Beyond Bar and Line Graphs: Time for a New Data Presentation Paradigm

Tracey L. Weissgerber[1]*, Natasa M. Milic[1,2], Stacey J. Winham[3], Vesna D. Garovic[1]

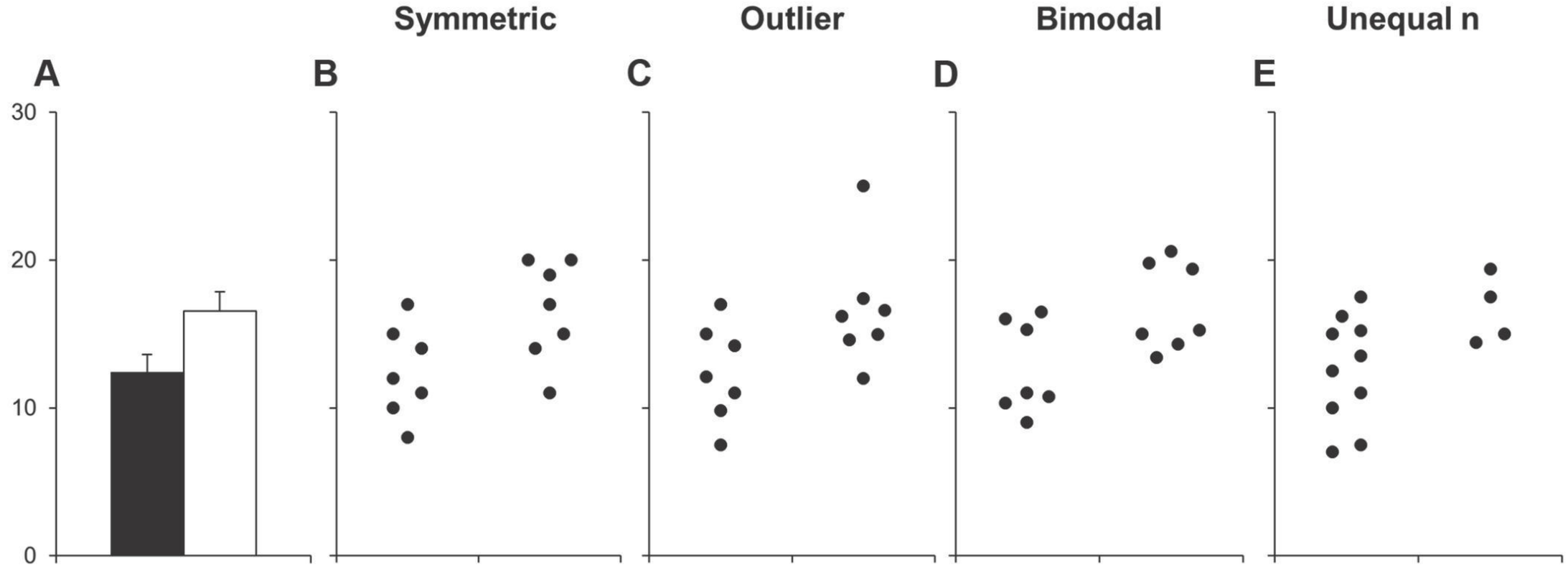
1 Division of Nephrology & Hypertension, Mayo Clinic, Rochester, Minnesota, United States of America, **2** Department of Biostatistics, Medical Faculty, University of Belgrade, Belgrade, Serbia, **3** Division of Biomedical Statistic and Informatics, Mayo Clinic, Rochester, Minnesota, United States of America

* weissgerber.tracey@mayo.edu

Weissgerber et al. (2015) PLoS Biology

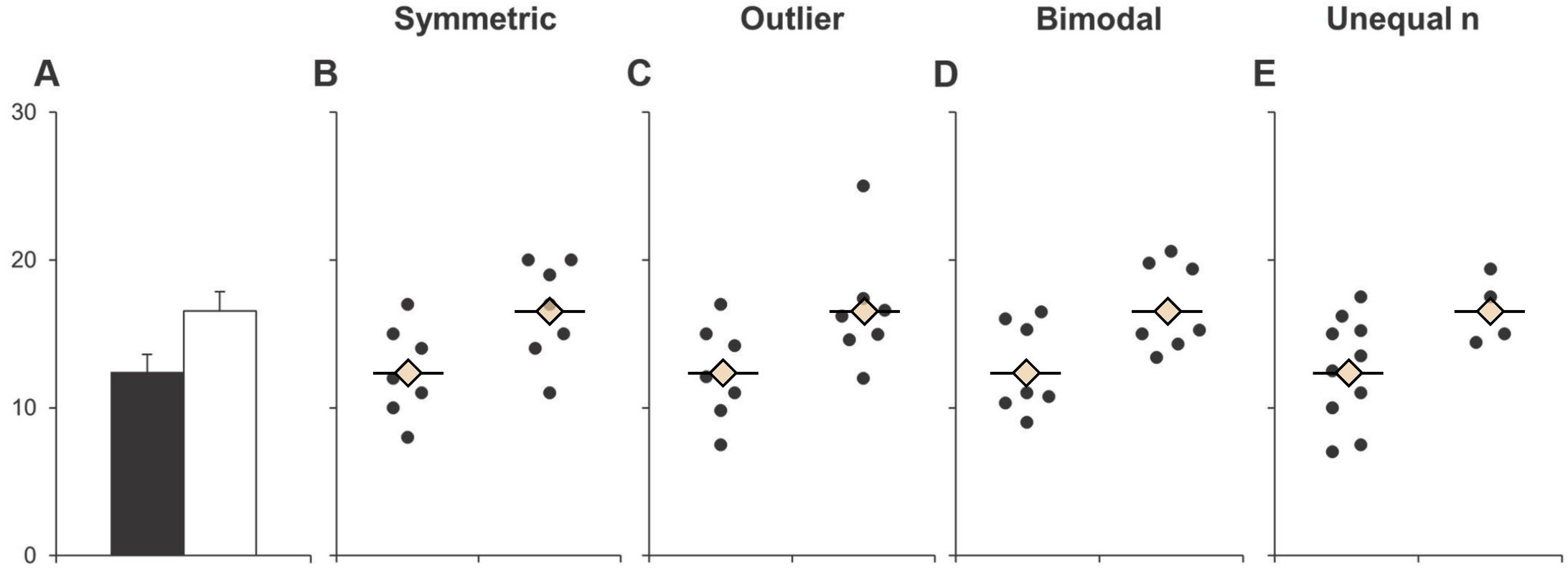


Weissgerber et al. (2015) PLoS Biology



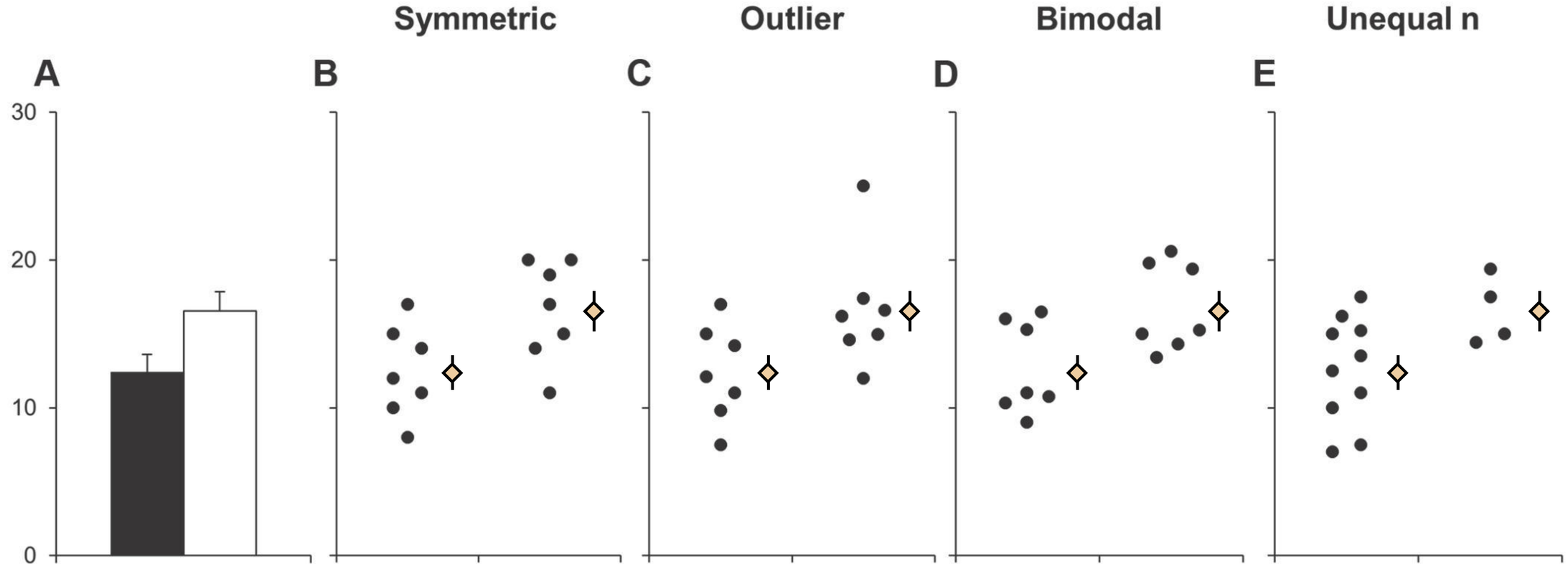
Test	p value			
T-test: Equal var.	0.035	0.050	0.026	0.063
T-test: Unequal var.	0.035	0.050	0.026	0.035
Wilcoxon	0.054	0.073	0.128	0.103

Weissgerber et al. (2015) PLoS Biology



Test	p value			
T-test: Equal var.	0.035	0.050	0.026	0.063
T-test: Unequal var.	0.035	0.050	0.026	0.035
Wilcoxon	0.054	0.073	0.128	0.103

Modified from Weissgerber et al. (2015) PLoS Biology



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T-test: Equal var.	0.035	0.050	0.026	0.063
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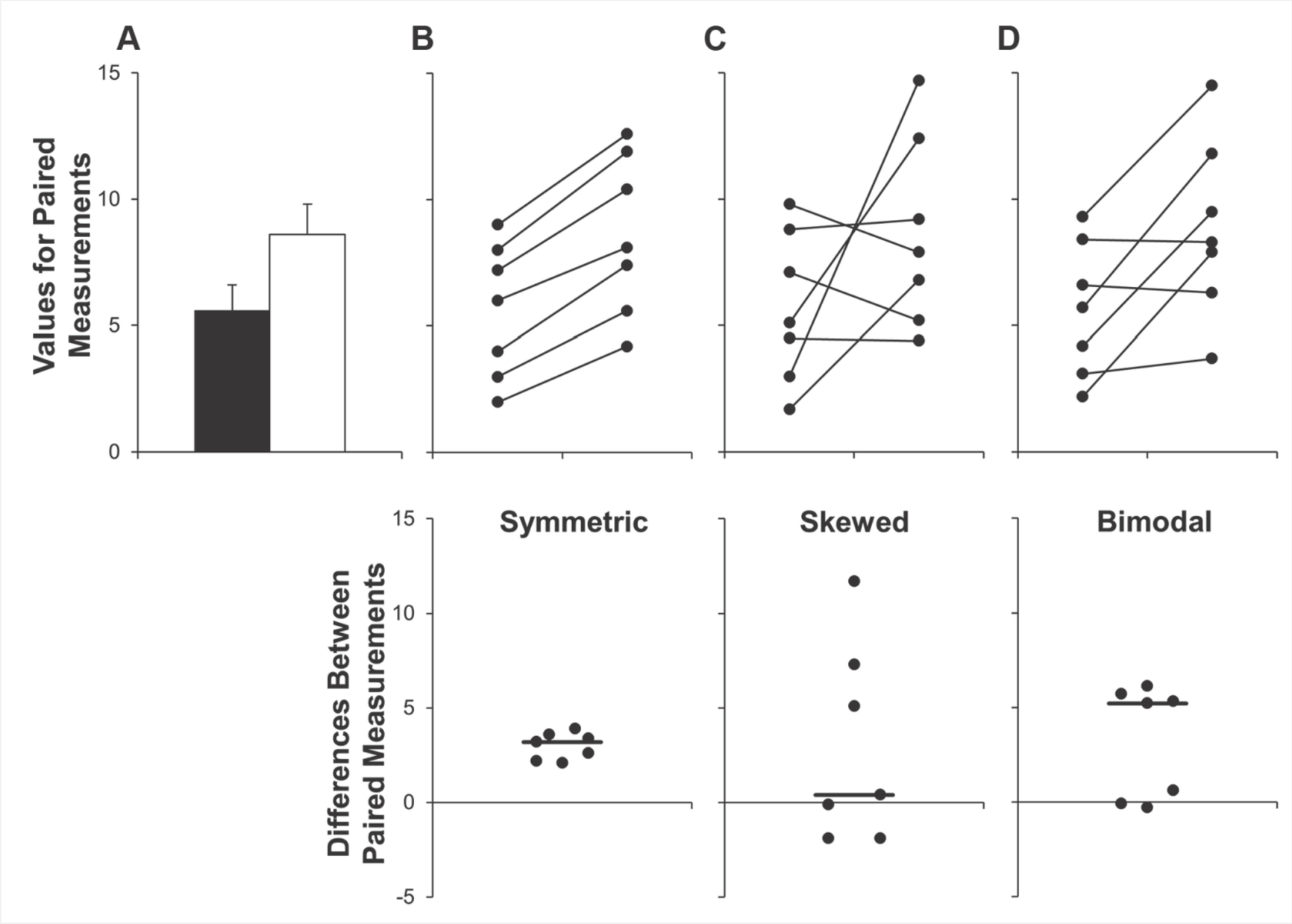
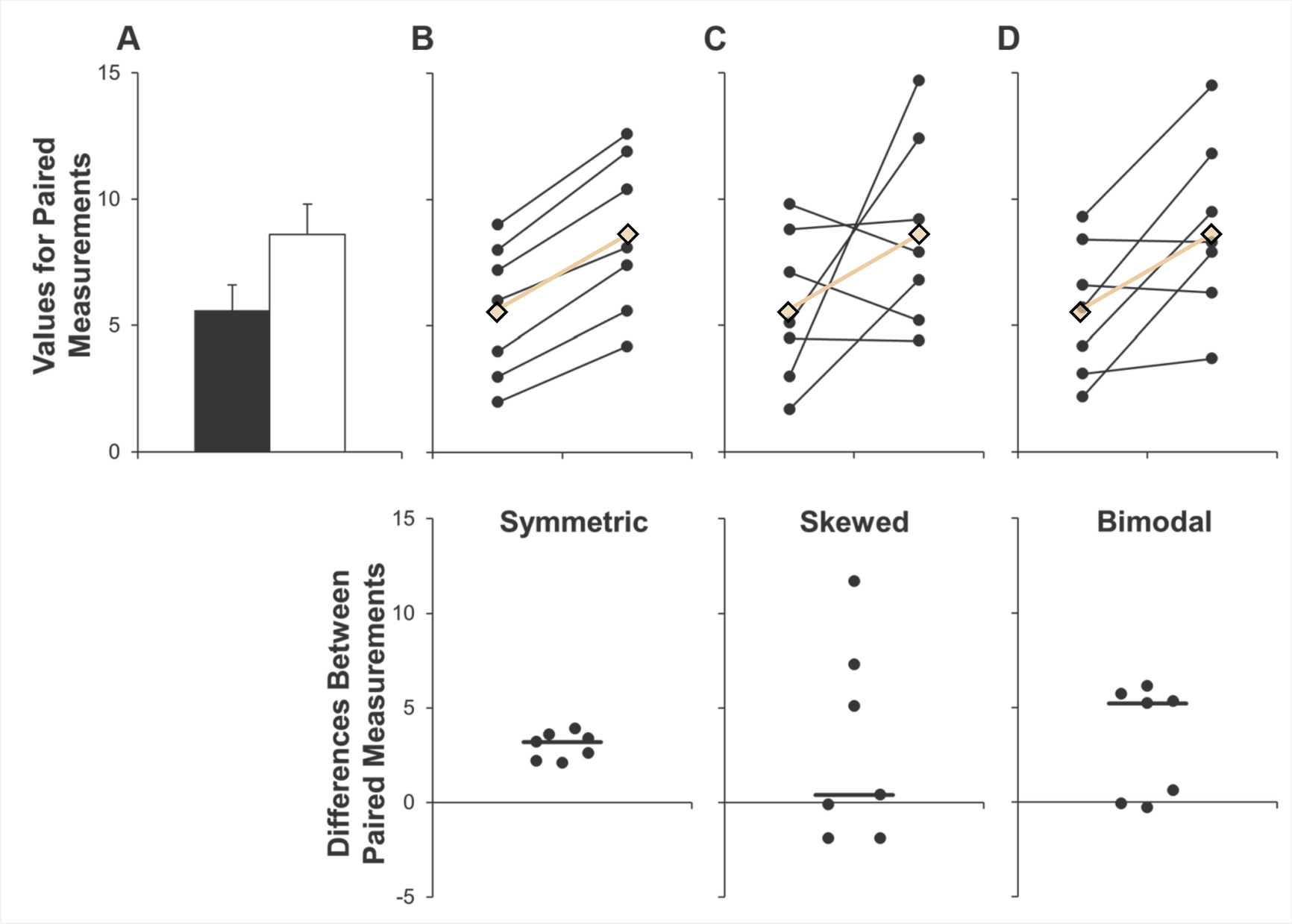
Modified from Weissgerber et al. (2015) PLoS Biology



Weissgerber et al. (2015) PLoS Biology

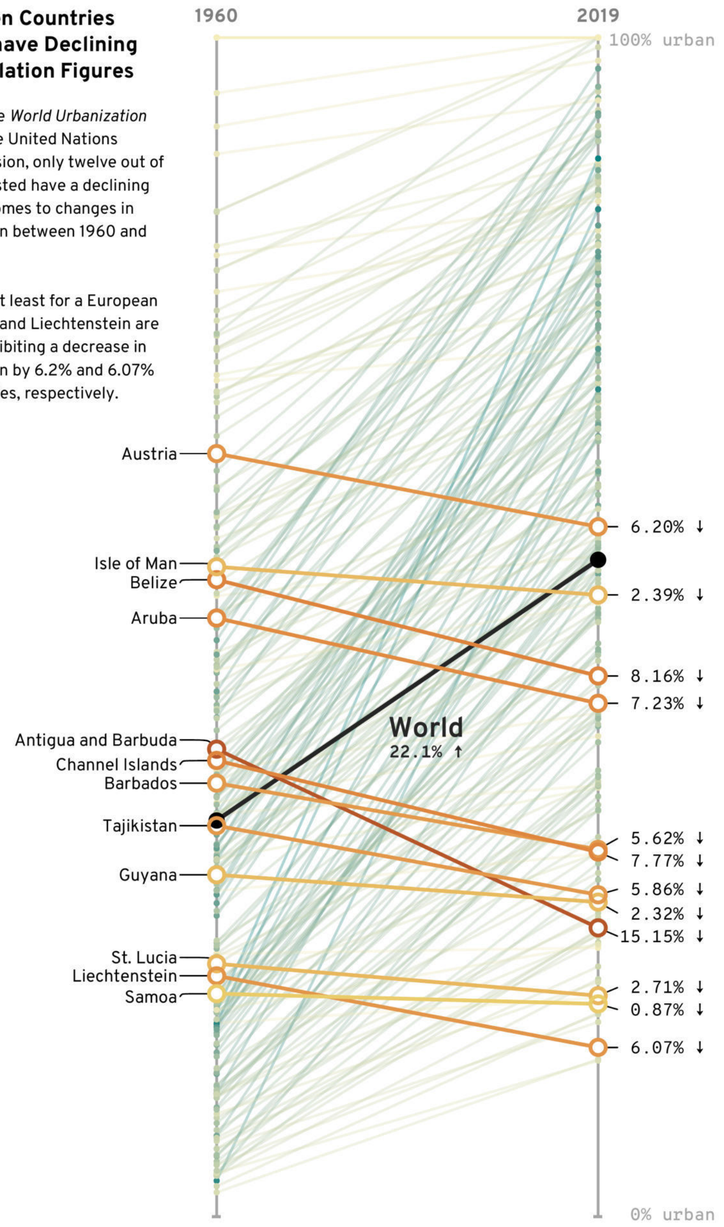


Weissgerber et al. (2015) PLoS Biology

Only a Dozen Countries Worldwide have Declining Urban Population Figures

According to the *World Urbanization Prospects* by the United Nations Population Division, only twelve out of 218 countries listed have a declining trend when it comes to changes in urban population between 1960 and 2019.

Surprinsingly—at least for a European citizen—Austria and Liechtenstein are amog these exhibiting a decrease in urban population by 6.2% and 6.07% within six decades, respectively.

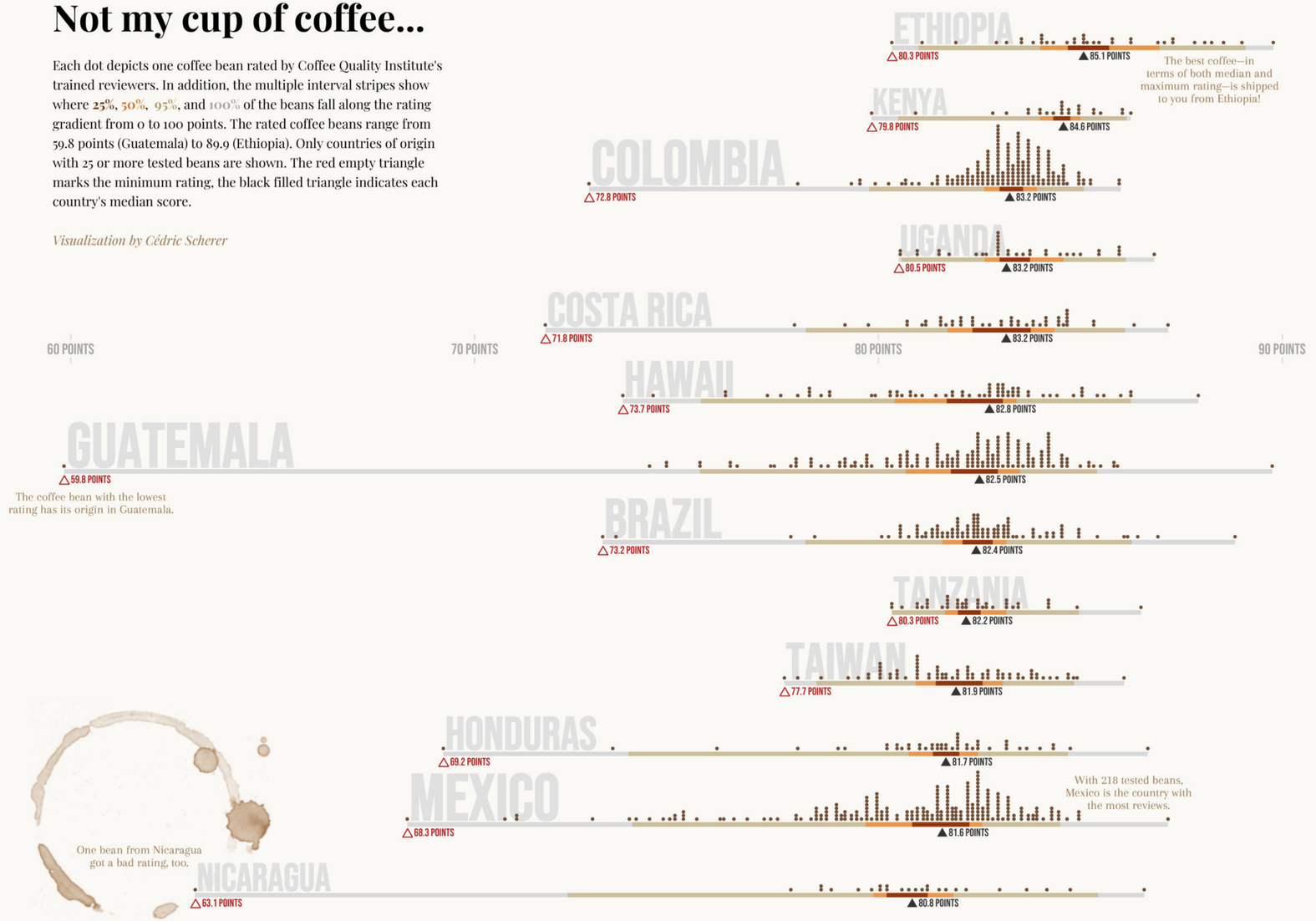


Visualization by Cédric Scherer | Data: United Nations Population Division. World Urbanization Prospects: 2018 Revision. | #30DayChartChallenge 2021 Day 5: Slope

Not my cup of coffee...

Each dot depicts one coffee bean rated by Coffee Quality Institute's trained reviewers. In addition, the multiple interval stripes show where 25%, 50%, 95%, and 100% of the beans fall along the rating gradient from 0 to 100 points. The rated coffee beans range from 59.8 points (Guatemala) to 89.9 (Ethiopia). Only countries of origin with 25 or more tested beans are shown. The red empty triangle marks the minimum rating, the black filled triangle indicates each country's median score.

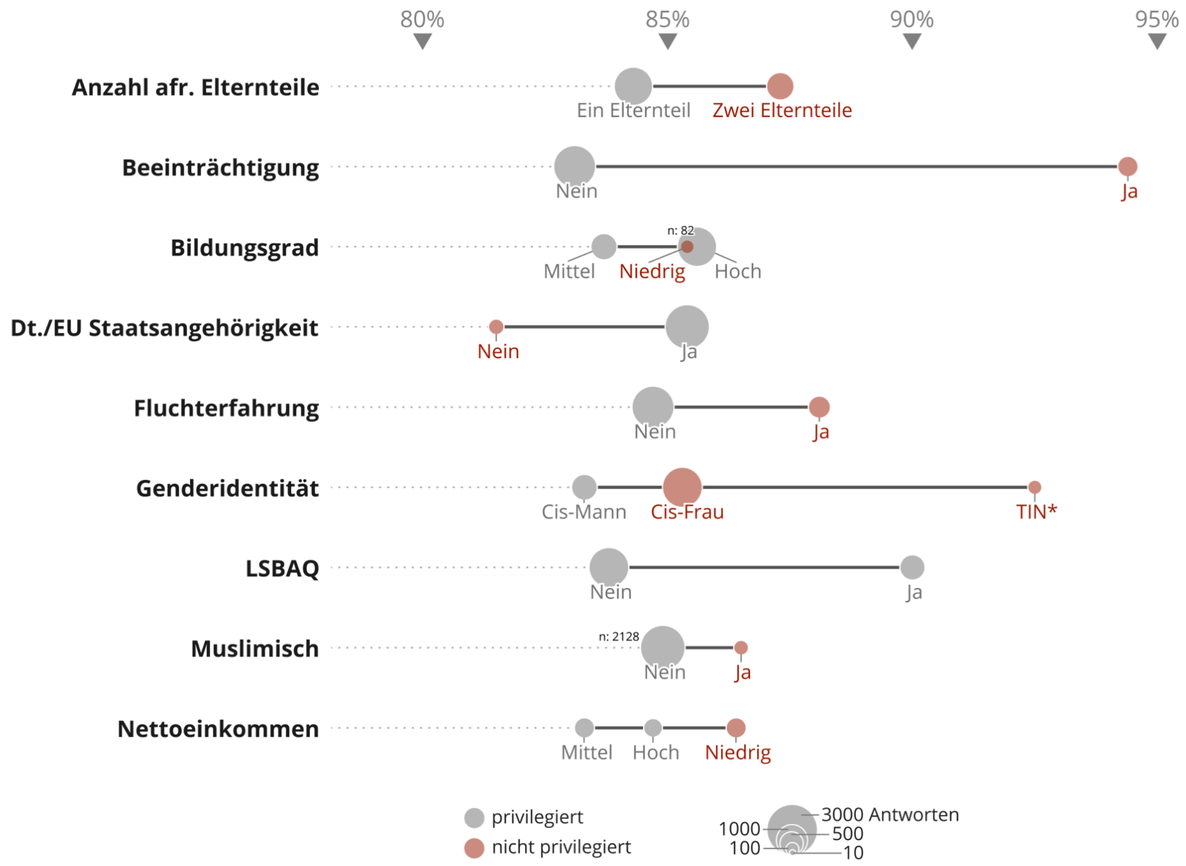
Visualization by Cédric Scherer



"Not my cup of coffee", #TidyTuesday Contribution

cedricscherer.com @CedScherer z3tt

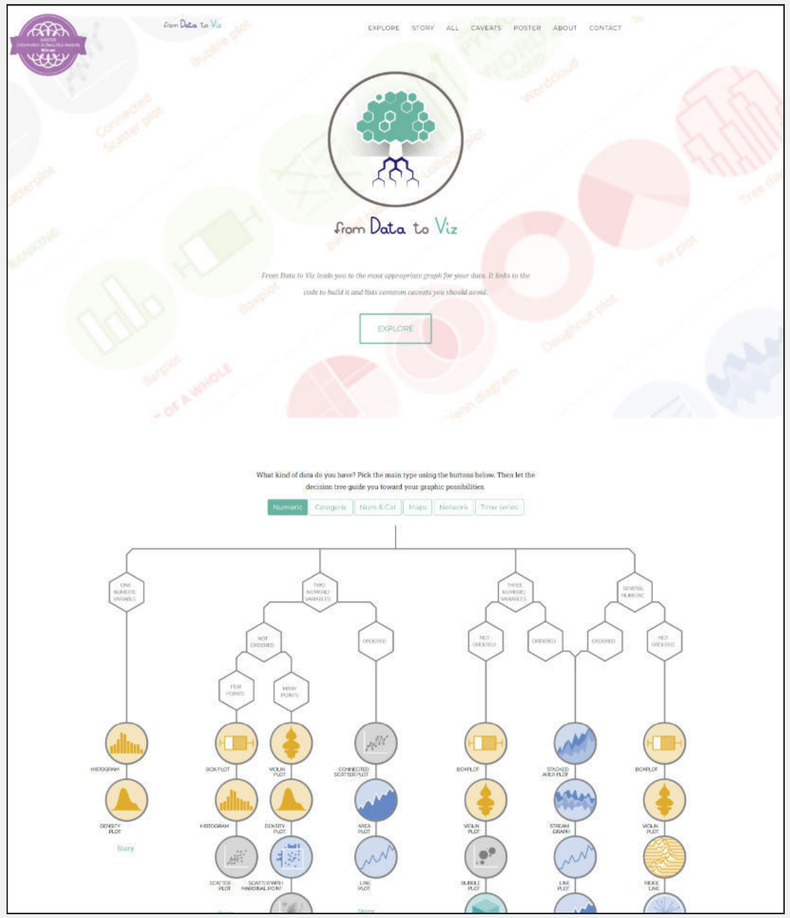
Häufigkeit von Diskriminierungserfahrungen entlang ausgewählter Vielfaltsdimensionen im Lebensbereich „Medien und Internet"



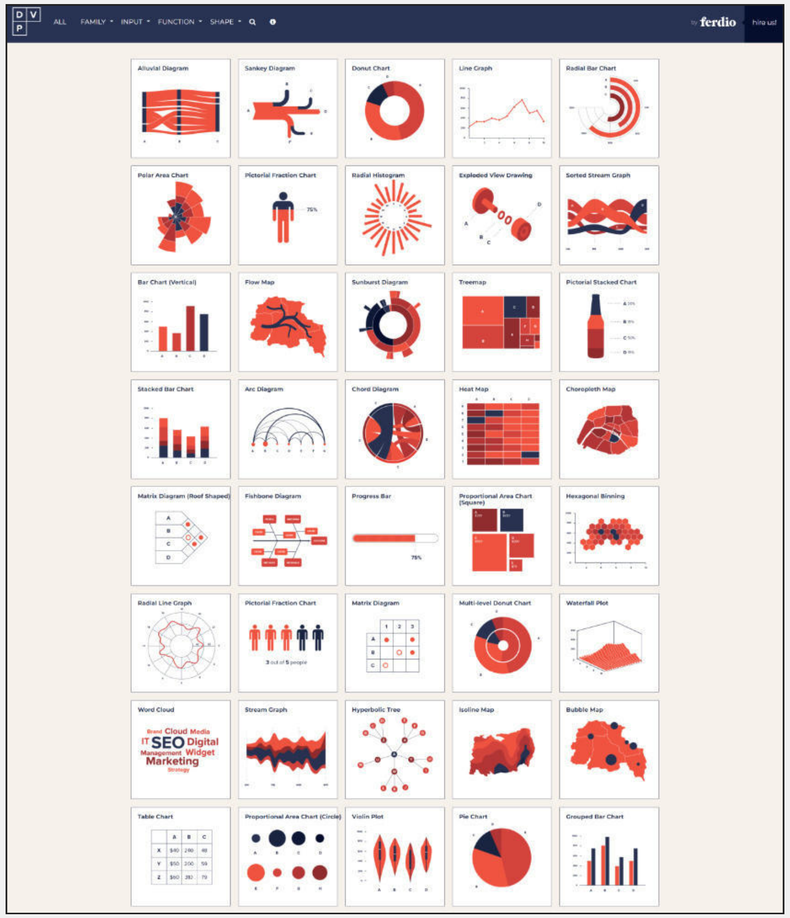
Lesebeispiel: *LSBAQ-Befragte des Afrozensus geben im Vergleich mit heterosexuellen Afrozensus-Befragten häufiger an, im Lebensbereich „Medien und Internet" in den letzten zwei Jahren Diskriminierung erlebt zu haben.*

Quelle: Abb. 46 in Aikins, M A; Bremberger,T; Aikins, J K; Gyamerah, D; Yıldırım-Caliman, D (2021): Afrozensus 2020 | Datenteam: Reiber, L; Vivanco, J | Design: Scherer, C

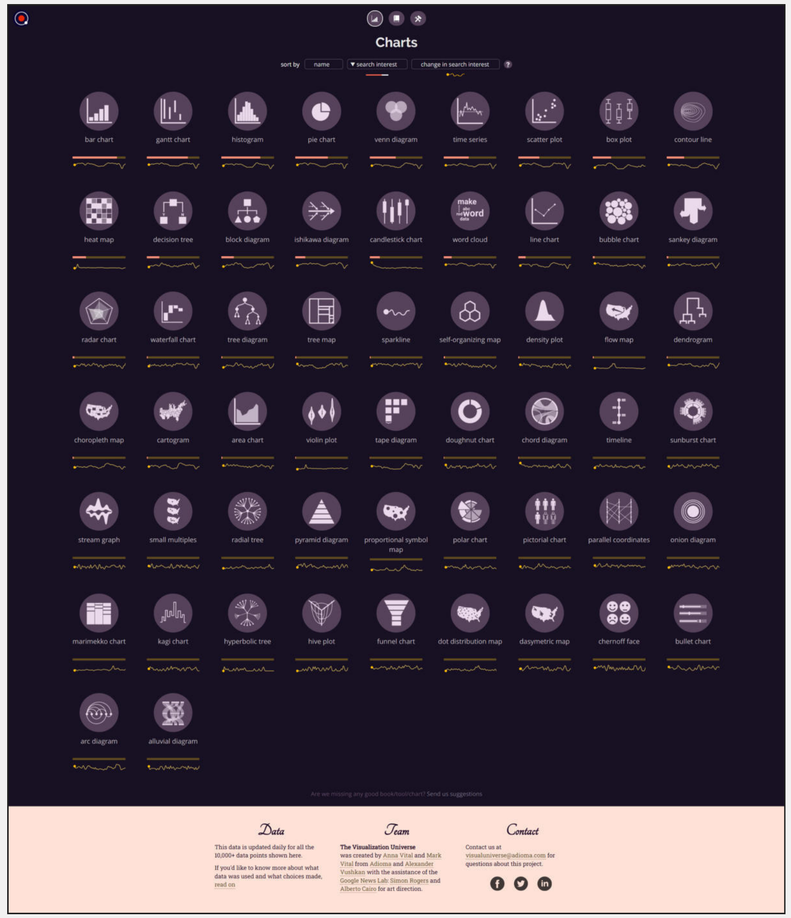
Abb. 46 "Afrozensus 2020" by Citizens For Europe & EOTO e.V.



data-to-viz.com

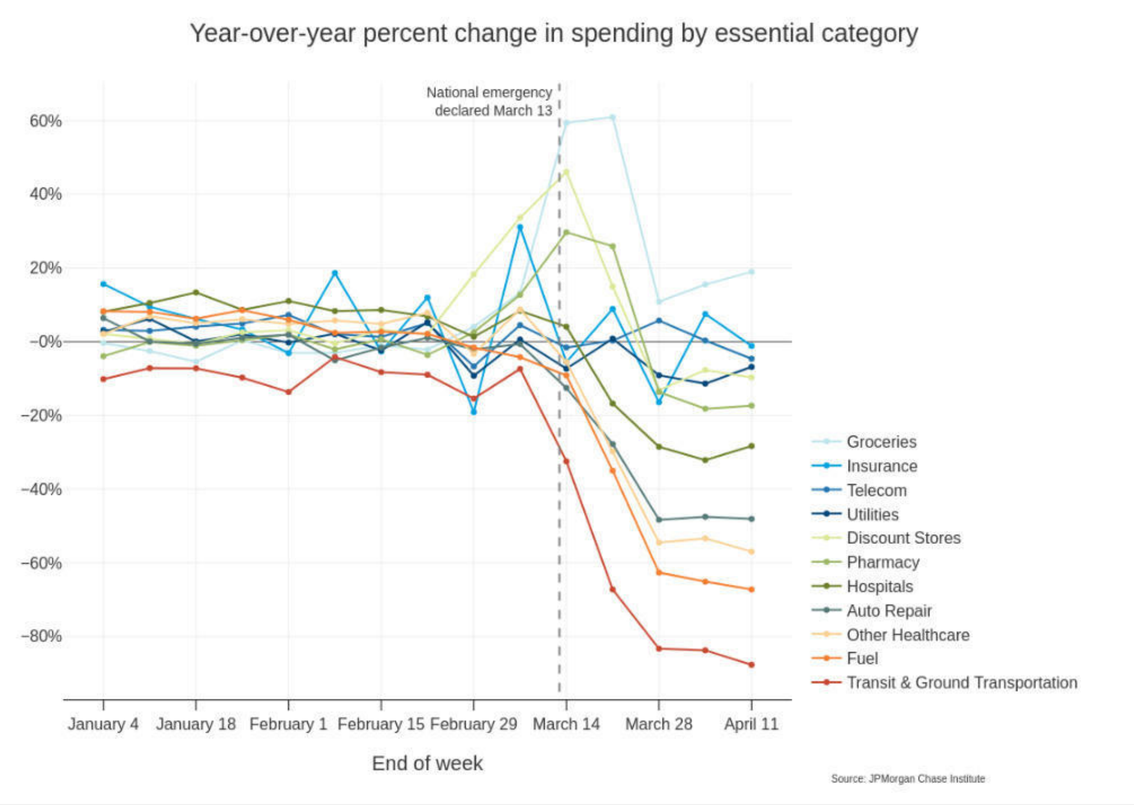


datavizproject.com

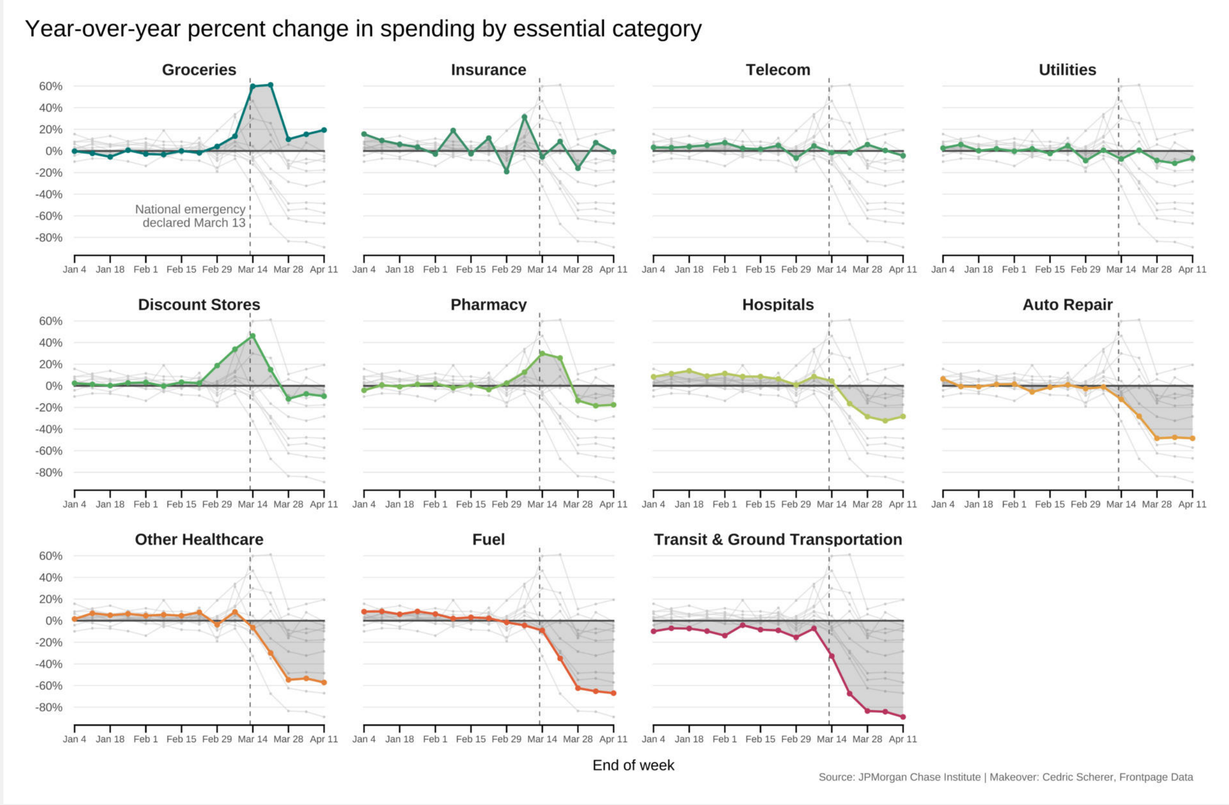


visualizationuniverse.com

The Power of Small Multiples



Original graphic by JPMorgan Chase Institute



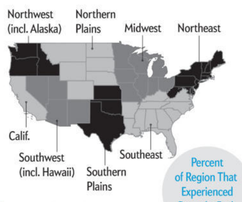
Makeover using small multiples

Text by Clara Moskowitz | Graphic by Cédric Scherer and Georgios Karamanis

Escalating Drought

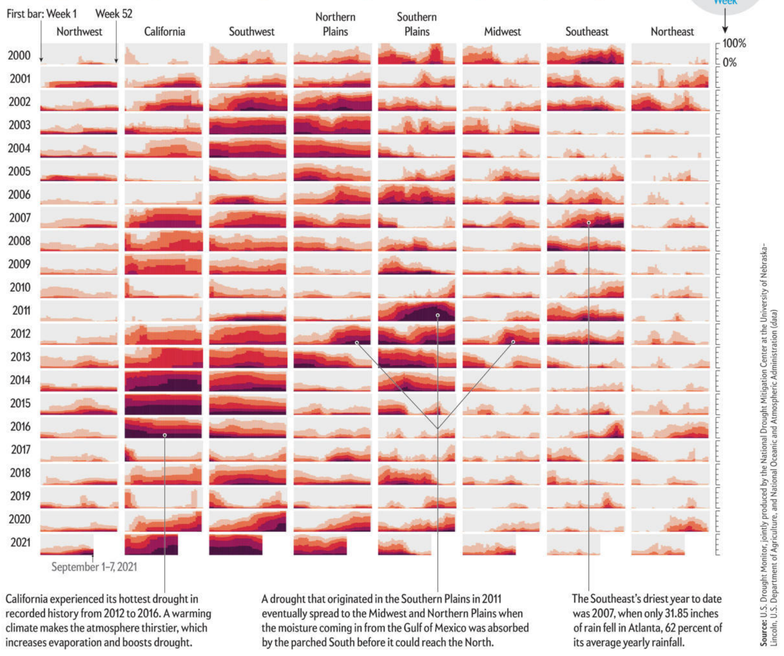
Climate change is intensifying periods of extreme dryness, particularly in the U.S. West

For more than 20 years the National Drought Mitigation Center (NDMC) has been monitoring dozens of indices of drought around the country, including satellite measurements of evaporation and color in vegetation, soil-moisture sensors, rainfall estimates, and river and streamflow levels. Although the agency's weekly assessments have identified periods of exceptional drought before, lately dryness has been ramping up. "The changing climate is definitely contributing to more natural disasters, drought being one of them," says Brian Fuchs, a climatologist who oversees the weekly report at the NDMC. "We're seeing more frequent and high-intensity episodes. This year some of these areas in the West have been in drought more than they have been without drought."



Drought Extent and Intensity by Region over Time

Category: Abnormally Dry | Moderate Drought | Severe Drought | Extreme Drought | Exceptional Drought

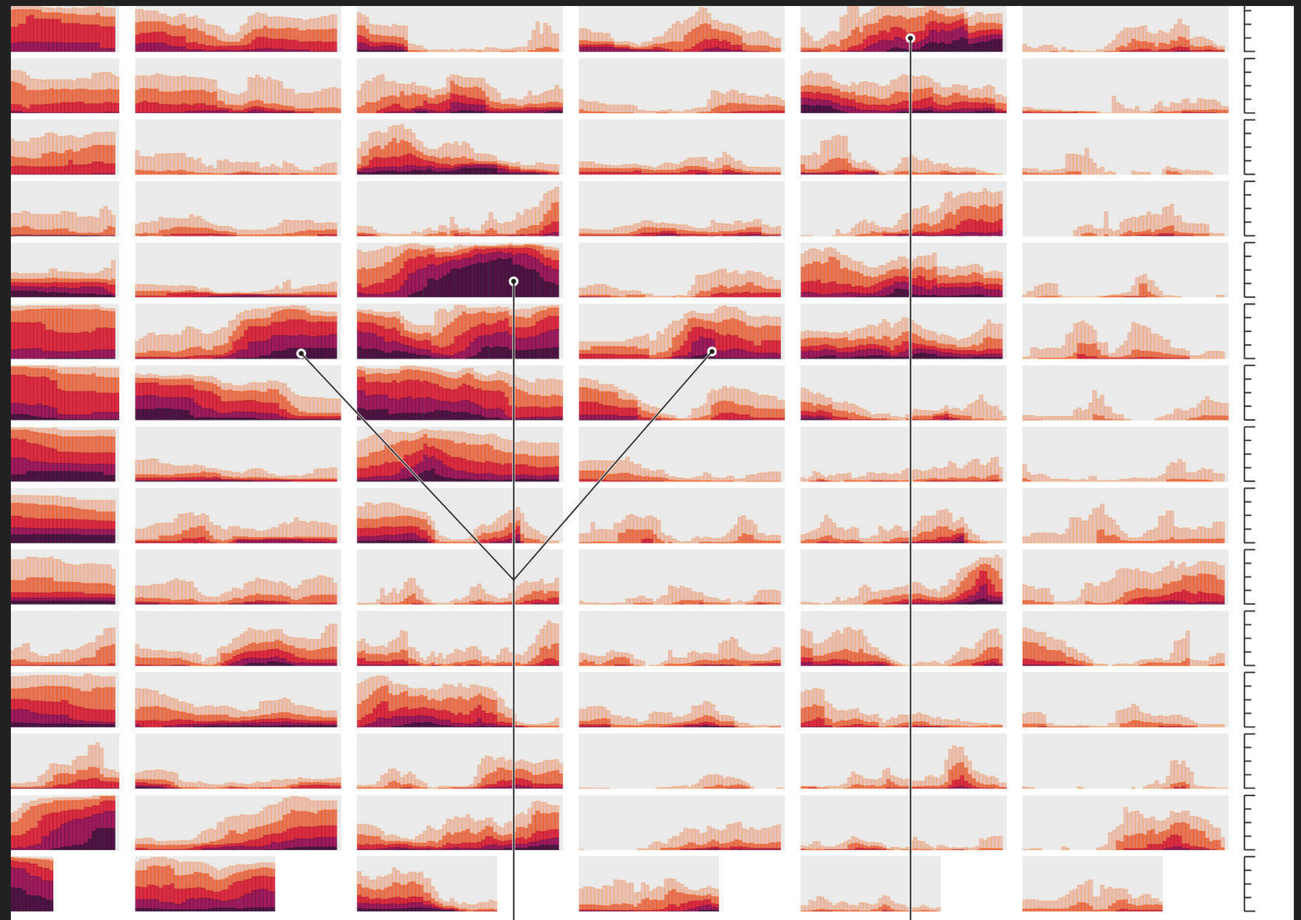


California experienced its hottest drought in recorded history from 2012 to 2016. A warming climate makes the atmosphere thirstier, which increases evaporation and boosts drought.

A drought that originated in the Southern Plains in 2011 eventually spread to the Midwest and Northern Plains when the moisture coming in from the Gulf of Mexico was absorbed by the parched South before it could reach the North.

The Southeast's driest year to date was 2007, when only 31.85 inches of rain fell in Atlanta, 62 percent of its average yearly rainfall.

Source: U.S. Drought Monitor, jointly produced by the National Drought Mitigation Center at the University of Nebraska–Lincoln, U.S. Department of Agriculture, and National Oceanic and Atmospheric Administration (data)



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"Escalating Drought", together with Georgios Karamanis for Scientific American, Issue Nov 2021

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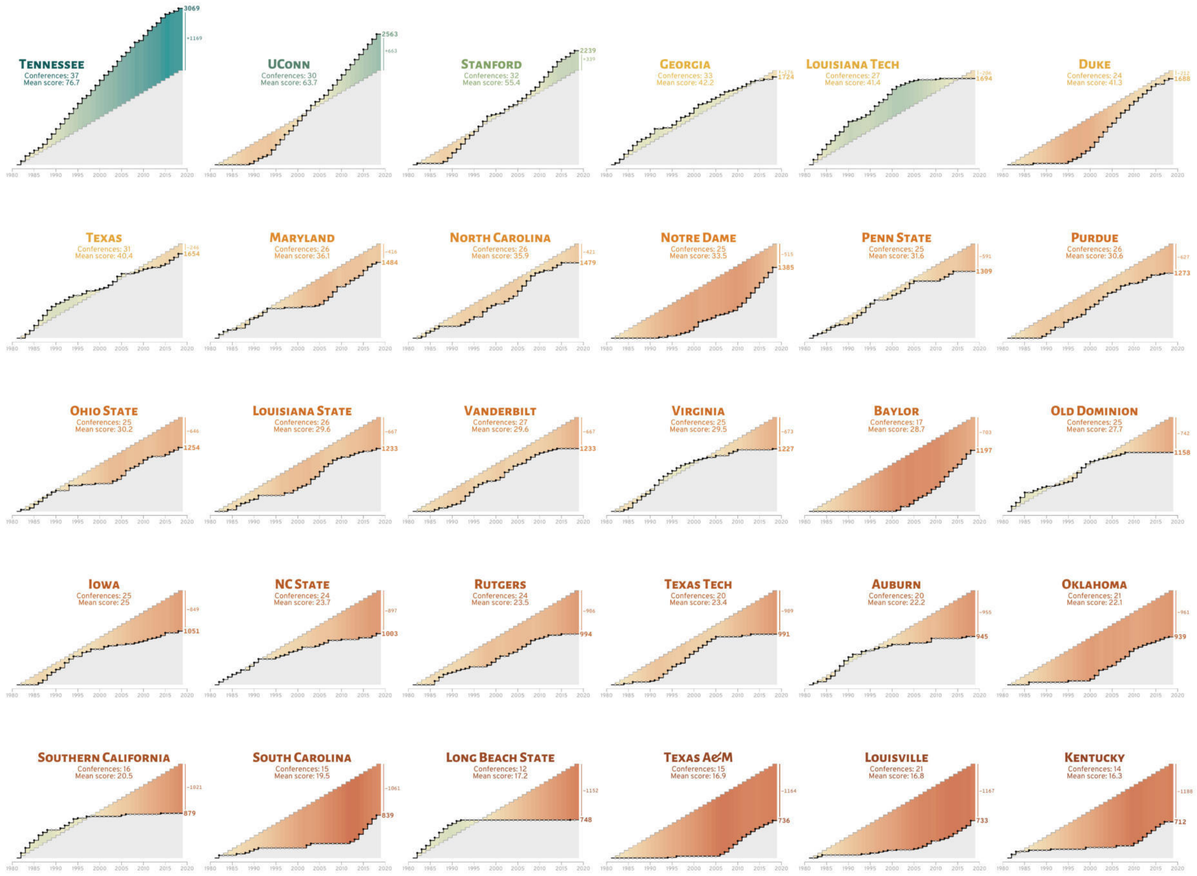
— The Rise & Fall of Women's College Basketball Dynasties —

A number of teams that were the titans of the early NCAA women's basketball tournament have struggled in recent decades. And in their place, a new ruling class of schools has emerged to become the defining programs of the modern age. FiveThirtyEight estimated the team strength over time based on NCAA Tournament seeds as a proxy in the absence of game-level data. To measure this, FiveThirtyEight awarded "seed points" in proportion to a given seed number's expected wins in the tournament, calibrated to a 100-point scale where the No. 1 seed gets 100 points, No. 2 gets 70 points, and so forth.

The visualization shows the cumulative sum of awarded seed points on a 100-point scale from the very first women's NCAA basketball tournaments in 1982 until 2018 in comparison to a hypothetical team that participated in all of the 37 conferences and gained half of the points each time (grey line). The curves highlight the fall of yesterday's women's basketball powerhouses such as **Louisiana Tech**, **Long Beach State**, **Southern California**, and **Old Dominion** that have been very good throughout the history of the women's tournament but have experienced big drop-offs in seed points over the last years. At the same time, schools such as **UConn**, **Stanford**, **Notre Dame**, **Baylor**, and **Duke** started slow but picked up steam into the present day. Some teams, such as **Tennessee**, have been relatively consistent throughout the NCAA era gathering always more seed points than an average team.
Shown are the top 30 college teams that participated in at least ten conferences between 1982 and 2018, sorted by the cumulative sum of seed points.



Visualization by Cédric Scherer · Data by FiveThirtyEight

"The Rise and Fall of Women's College Basketball Dynasties", #TidyTuesday Contribution

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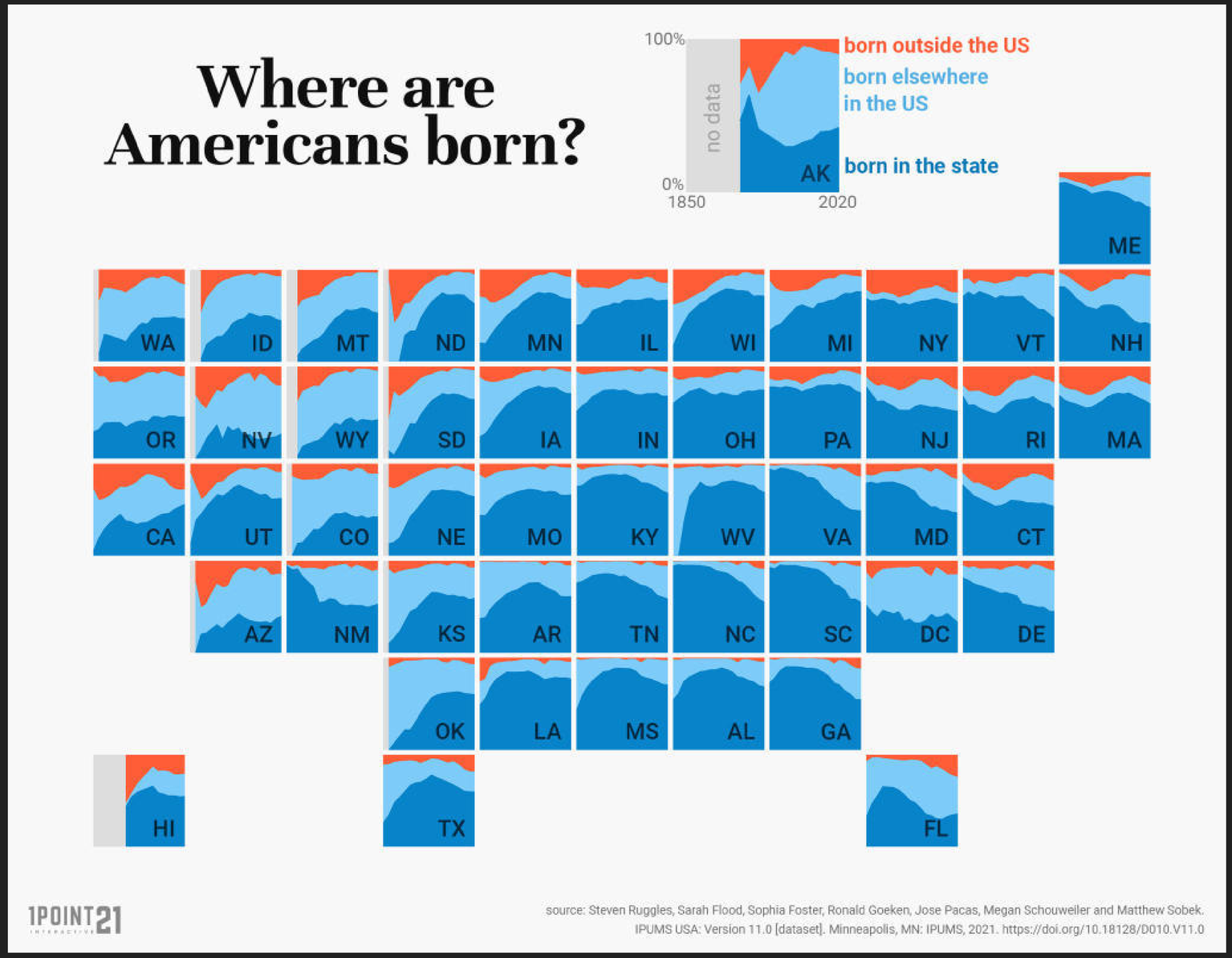


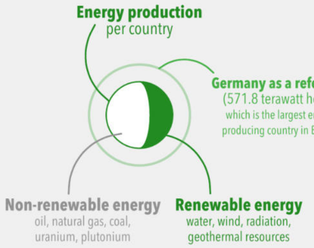
"Where are Americans born?" by @ErinDataViz

How European countries generated electricity in 2018

Germany is the largest energy producing country in Europe. It generates the most renewable and conventional thermal energy, representing 31% and 56% of its overall production respectively. **France** is the second largest energy European producer and by far the largest nuclear energy provider: 71% of its production is based on nuclear fission to generate heat.

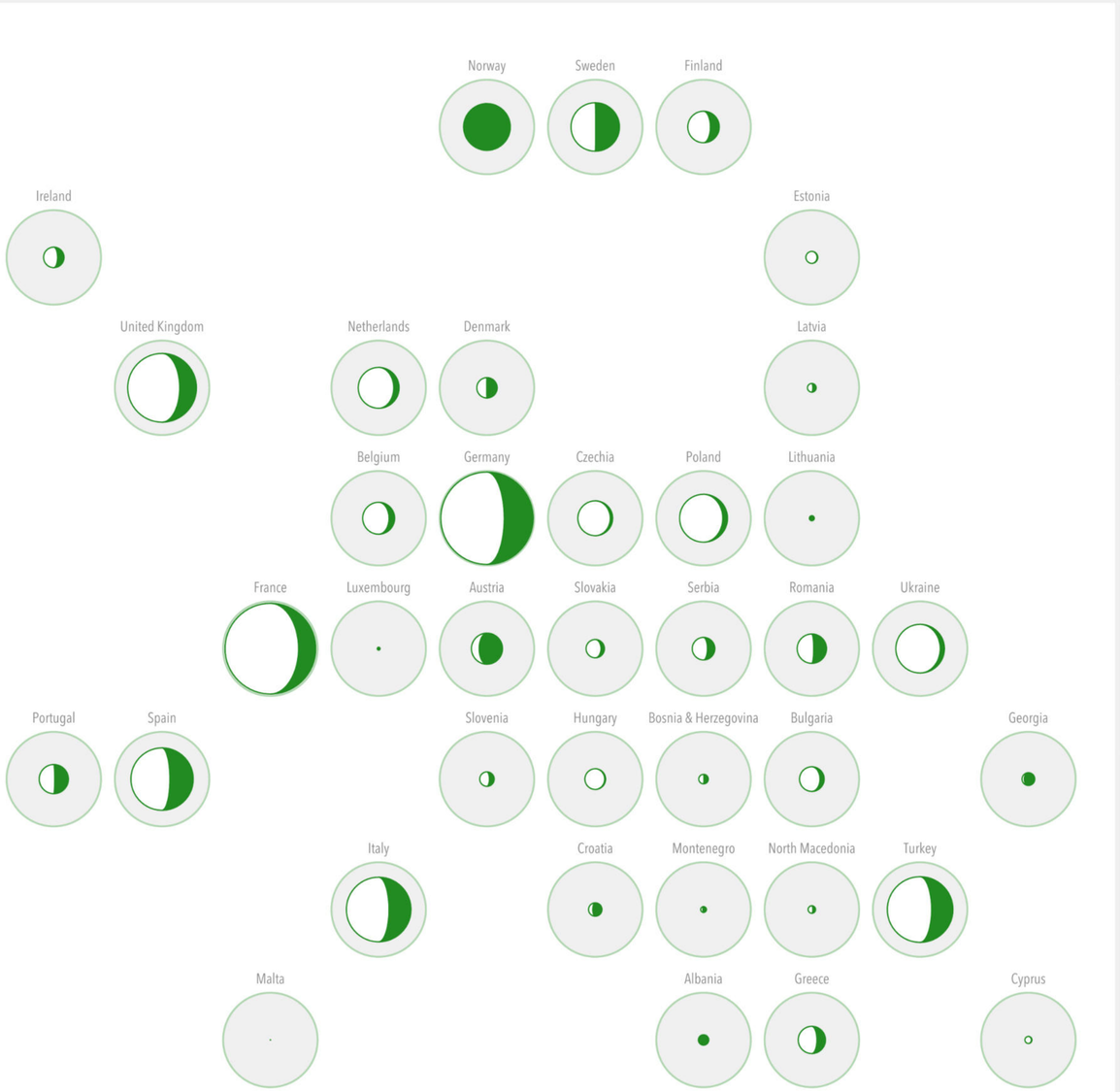
Renewable:	Nuclear:	Conventional thermal:
Germany	**France**	**Germany**
179.1 TWh	393.2 TWh	320.4 TWh
(31% of its production)	(71% of its production)	(56% of its production)

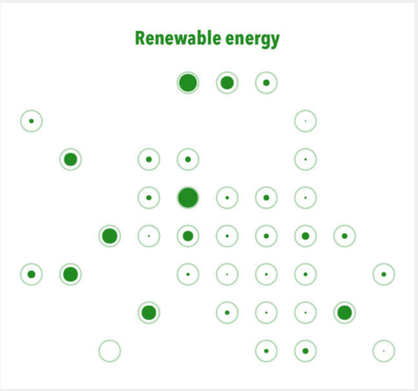
Renewable energy is energy that comes from resources that are naturally replenished such as sunlight, wind, water, and geothermal heat. Unlike fossil fuels, such as oil, natural gas and coal, or nuclear power sources such as uranium and plutonium, renewable energy regenerates naturally in a short period of time.

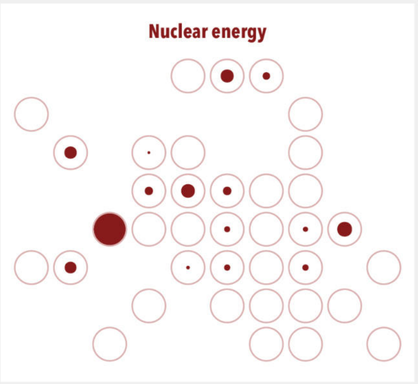


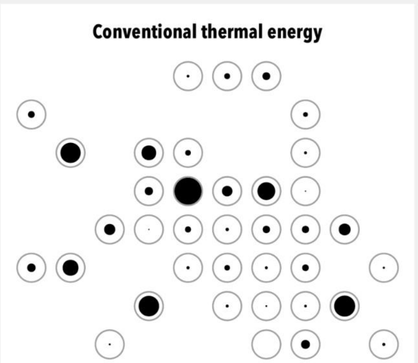
Norway had an electricity production almost entirely made up of renewable energy (98%). This makes Norway the second largest producer of this energy type in Europe. Interestingly, most of the renewable energy is produced by hydro power that take up 95% and only 3% by wind. In contrast, twelve European countries were reported to produce less than 20% of their energy with renewable resources: **Malta** (0%), **Hungary** (5%), **Estonia** (6%), **Czechia** (7%), **Cyprus** (9%), **Ukraine** (9%), **Poland** (10%), **Netherlands** (13%), **Bulgaria** (17%), **Belgium** (18%), **Slovakia** (19%), and **France** (19%).

Note: Energy production is mapped to the area of the circles.
Visualization by Cédric Scherer • Data by Eurostat









"How European countries generated electricity in 2018", #TidyTuesday Contribution

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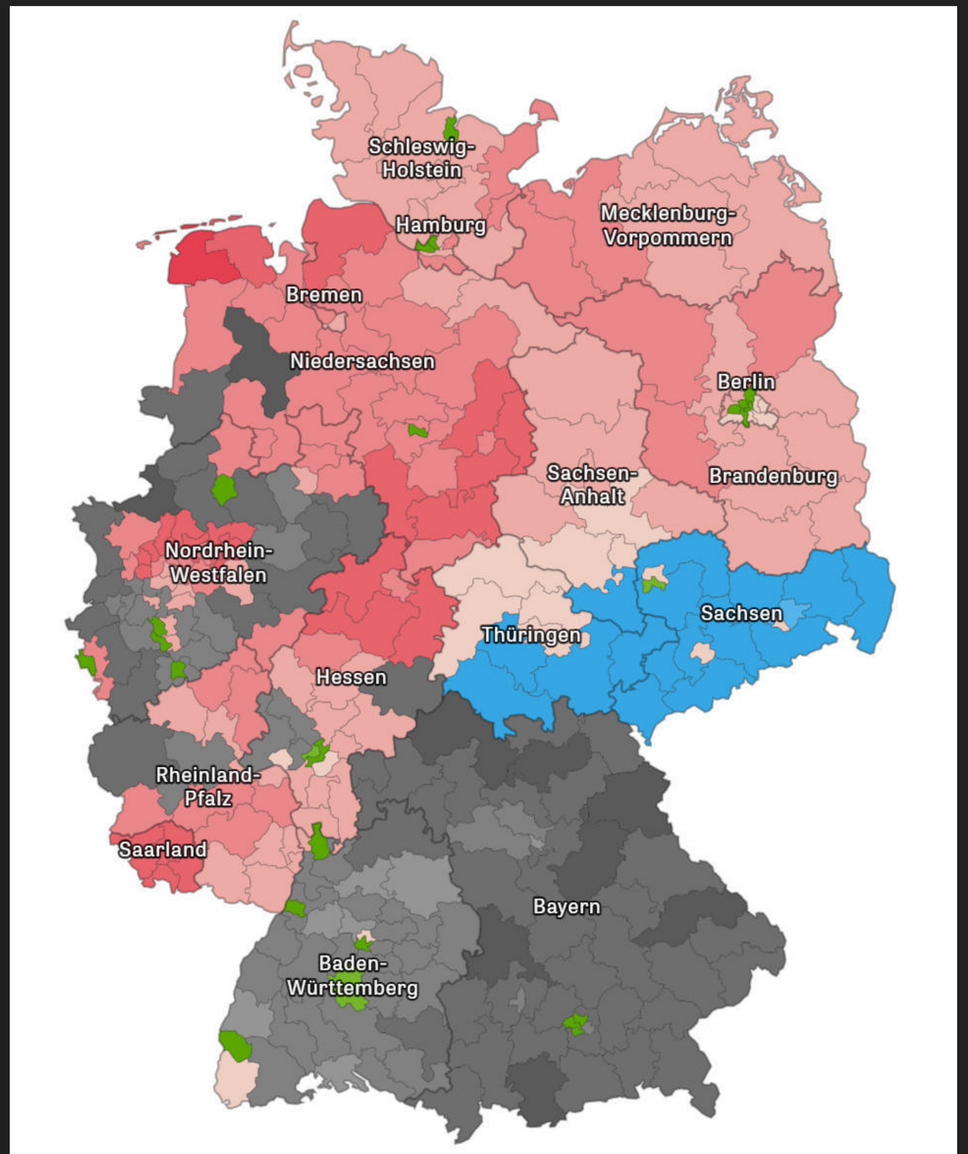

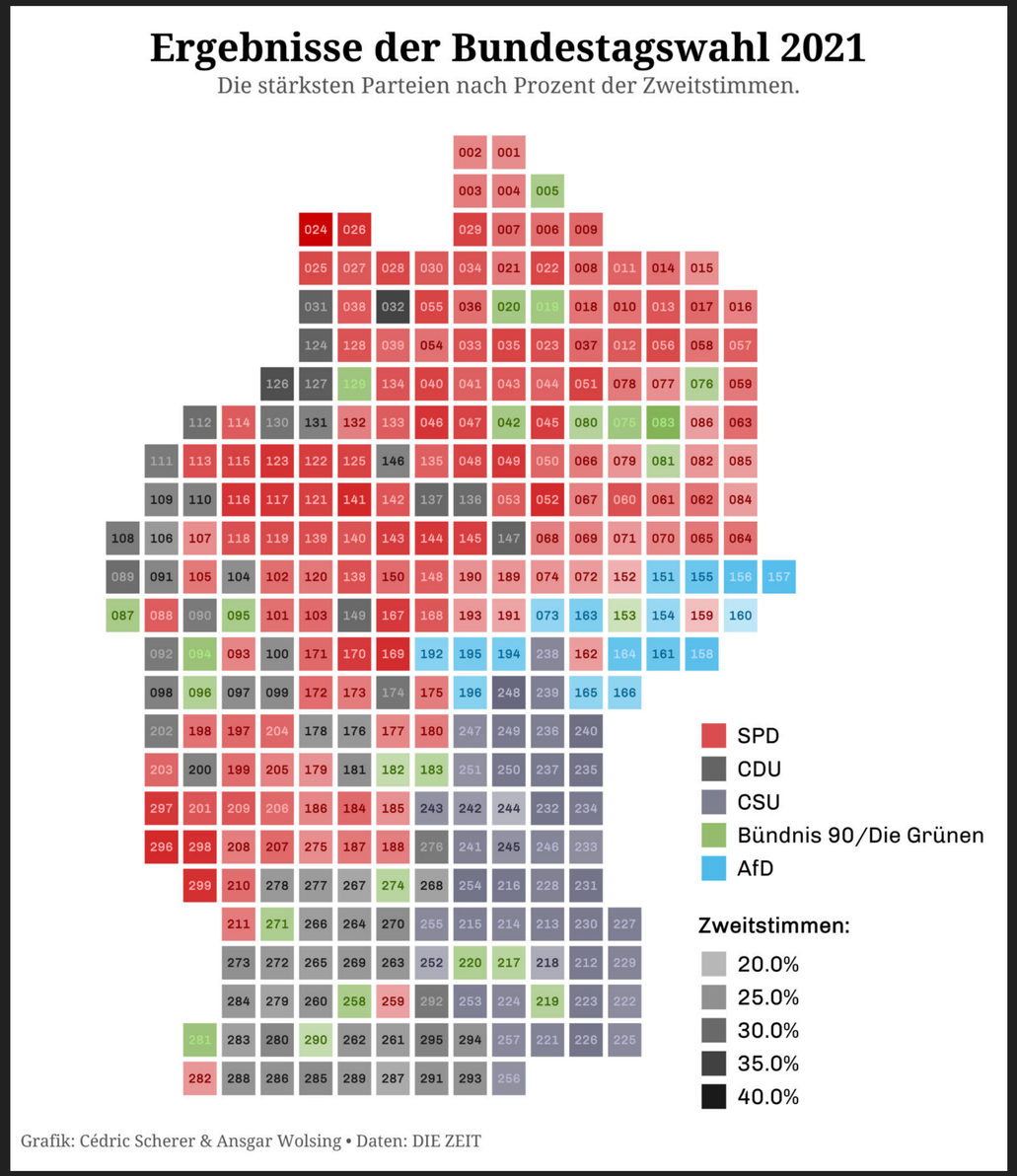

Left: Choropleth Map by Die Zeit | Right: Tile Grid Map by Cédric Scherer & Ansgar Wolsing

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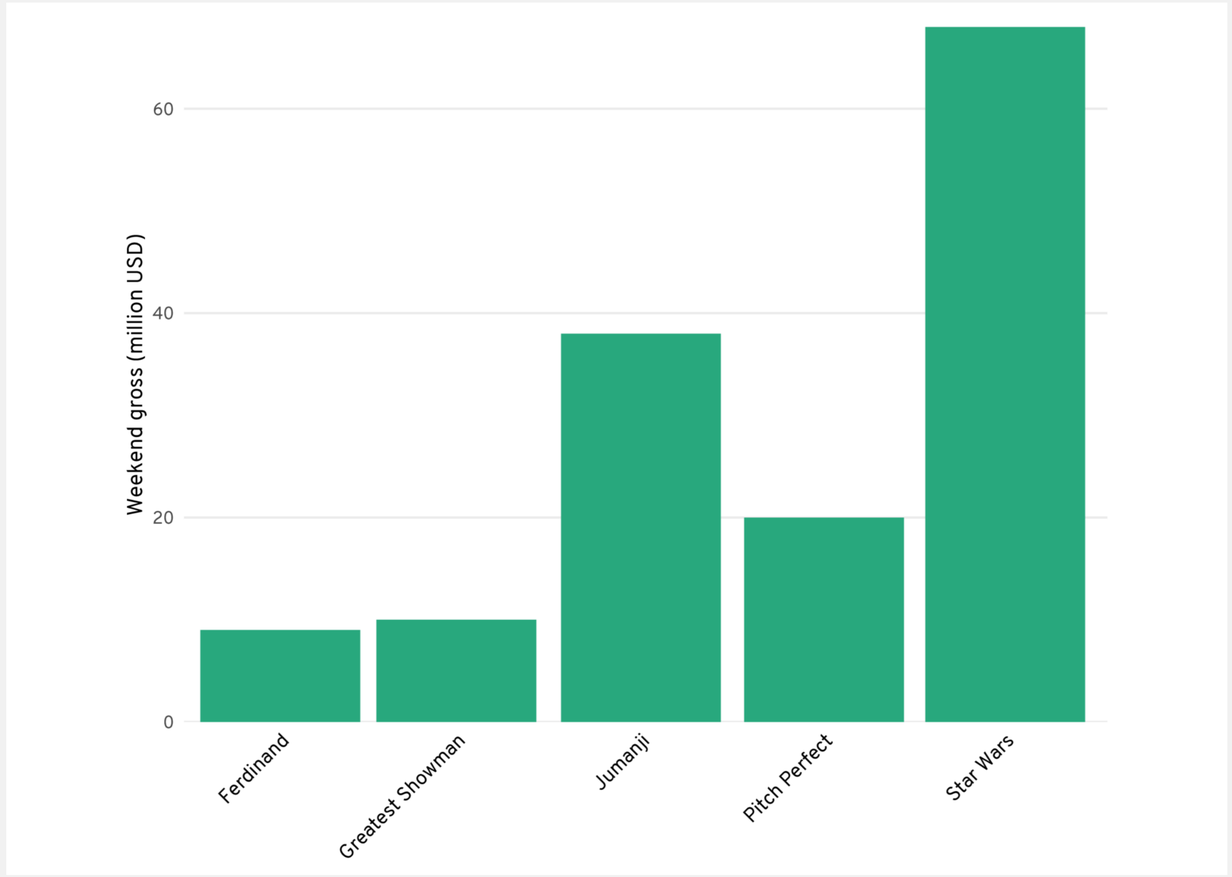
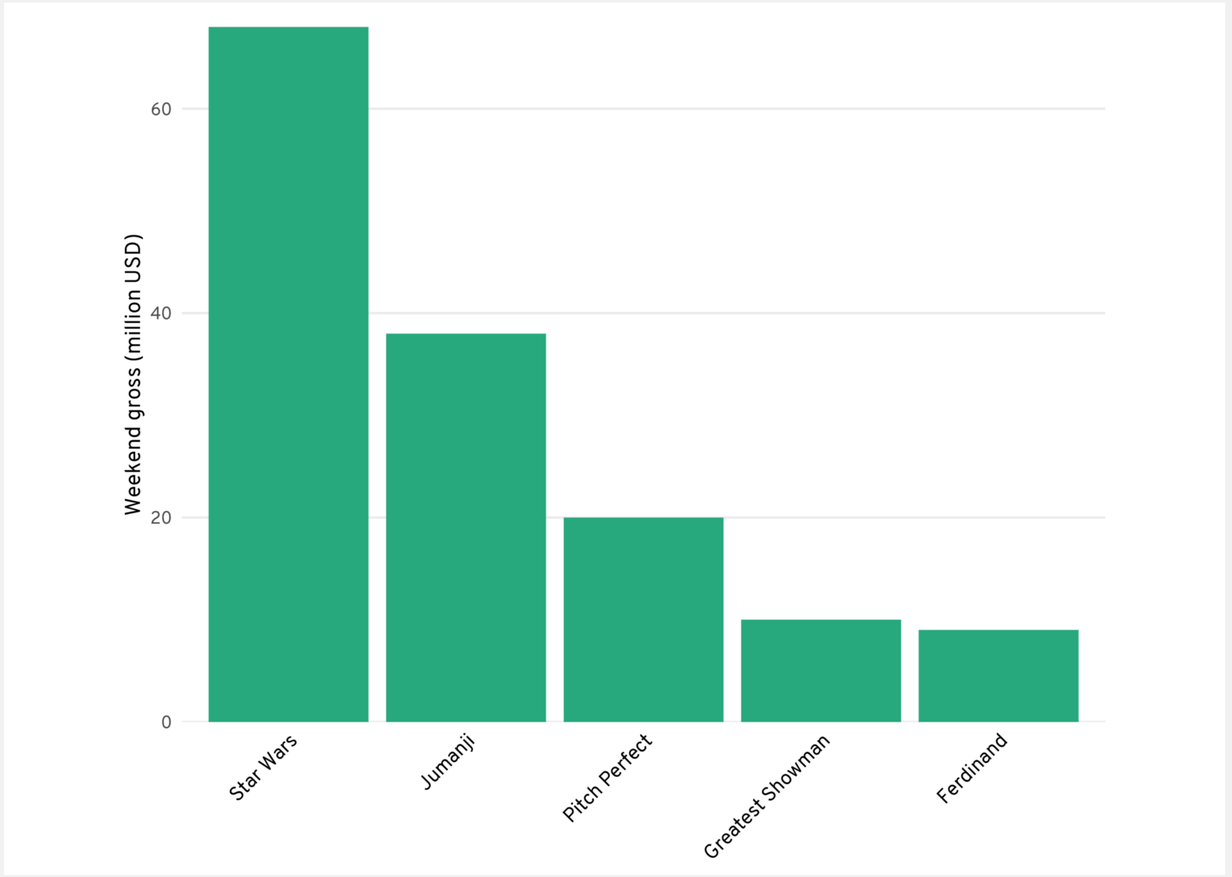
VISUAL FORM

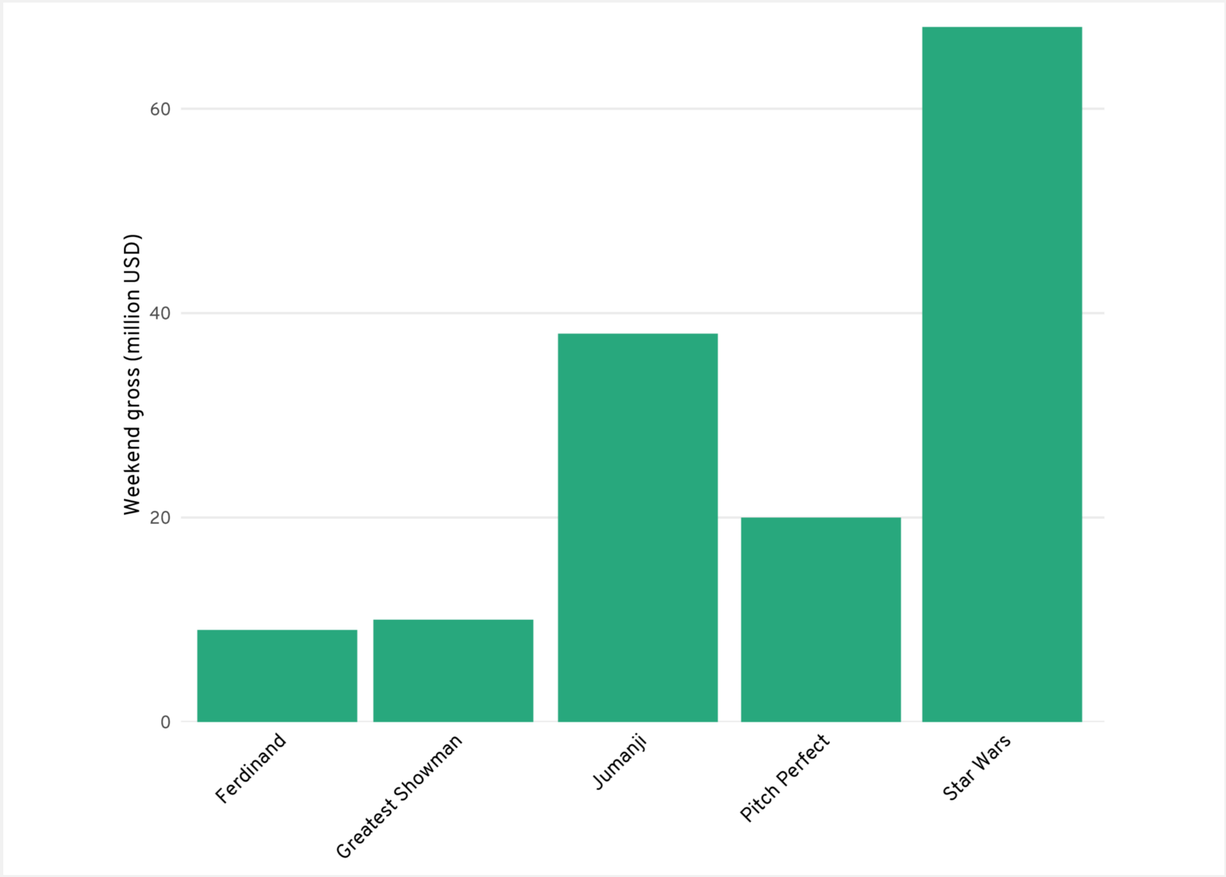
Follow design rules and data visualization principles

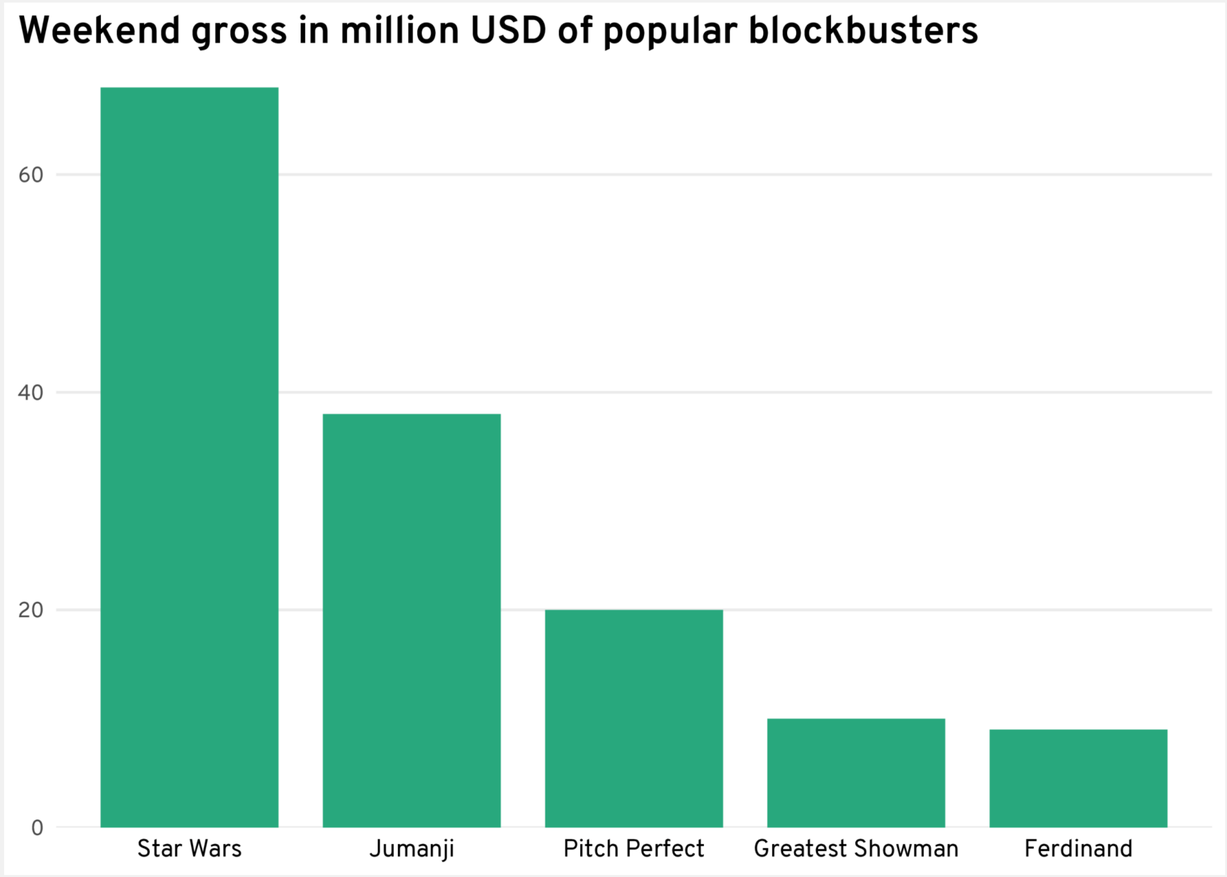
Order your data





Don’t rotate your text





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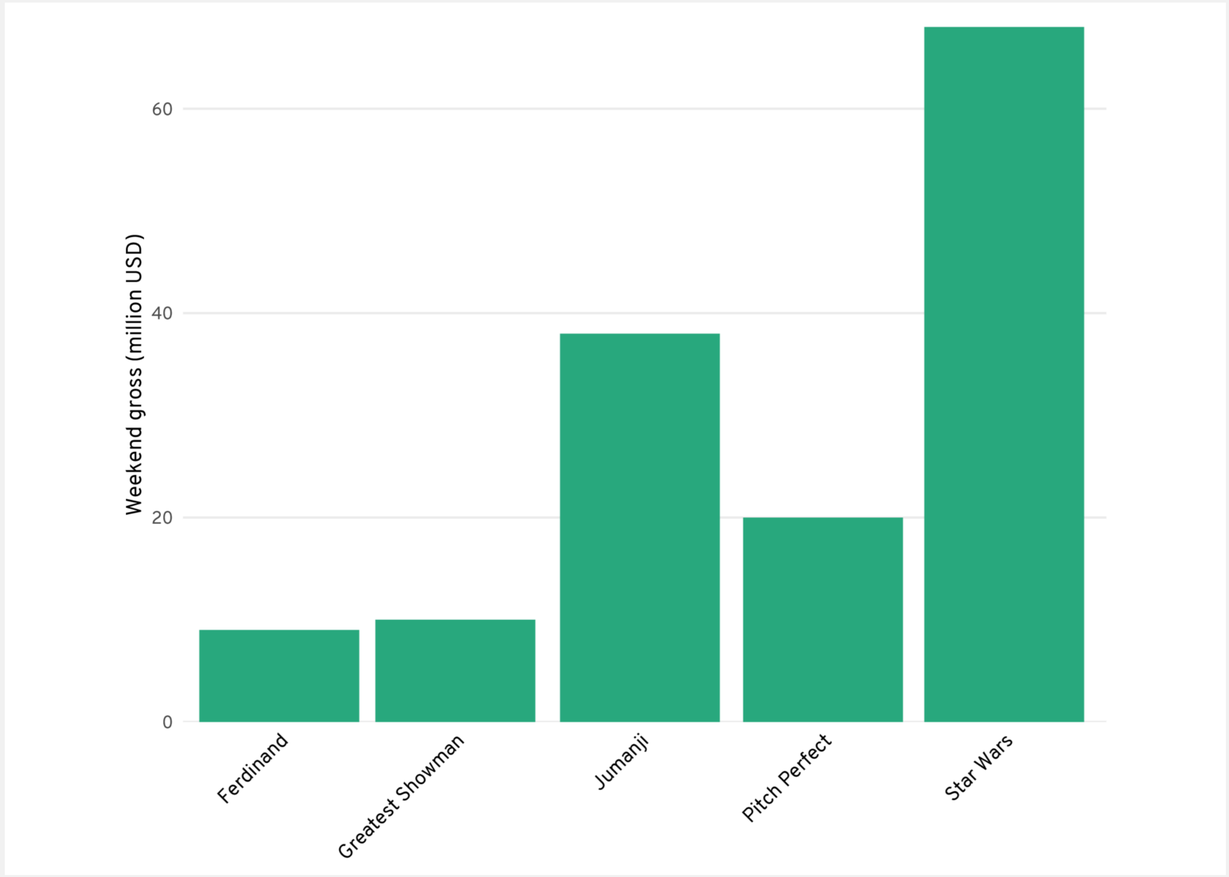
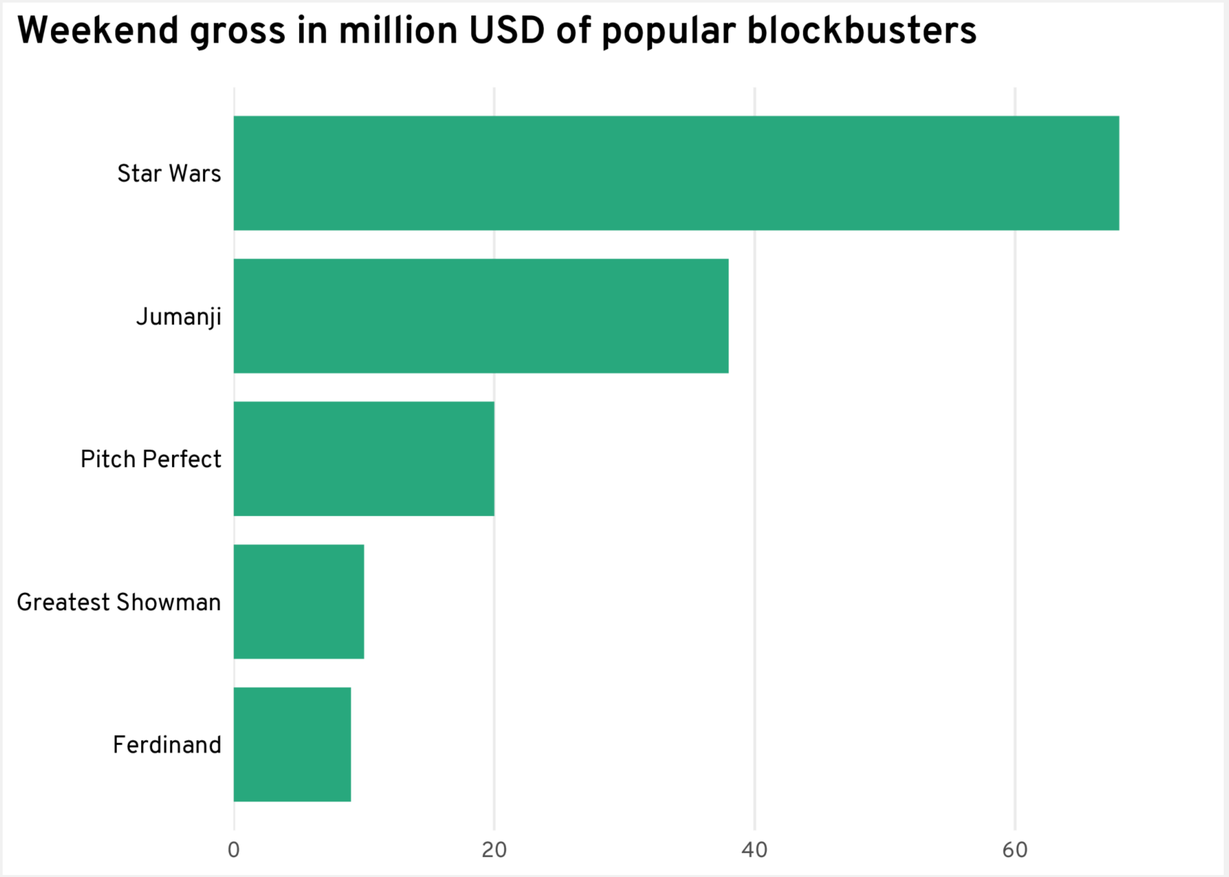
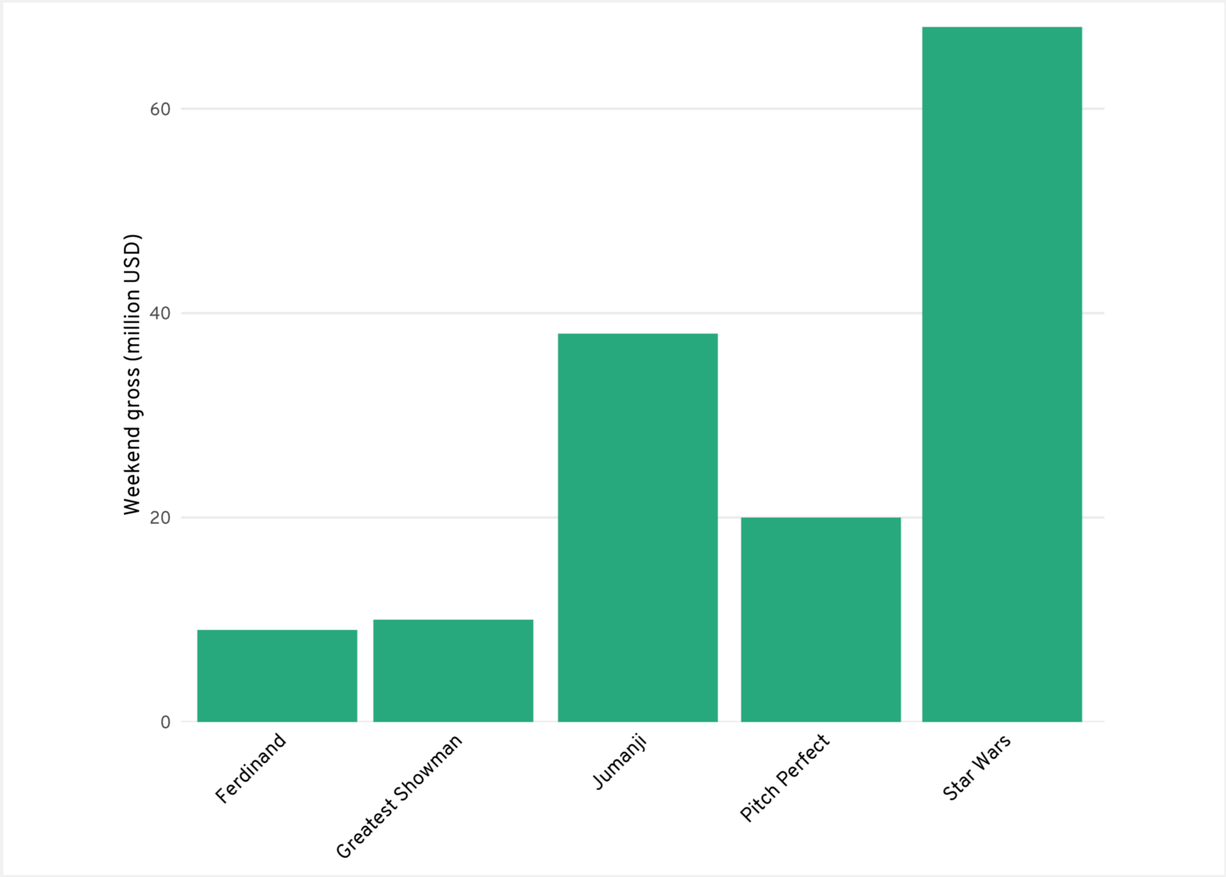
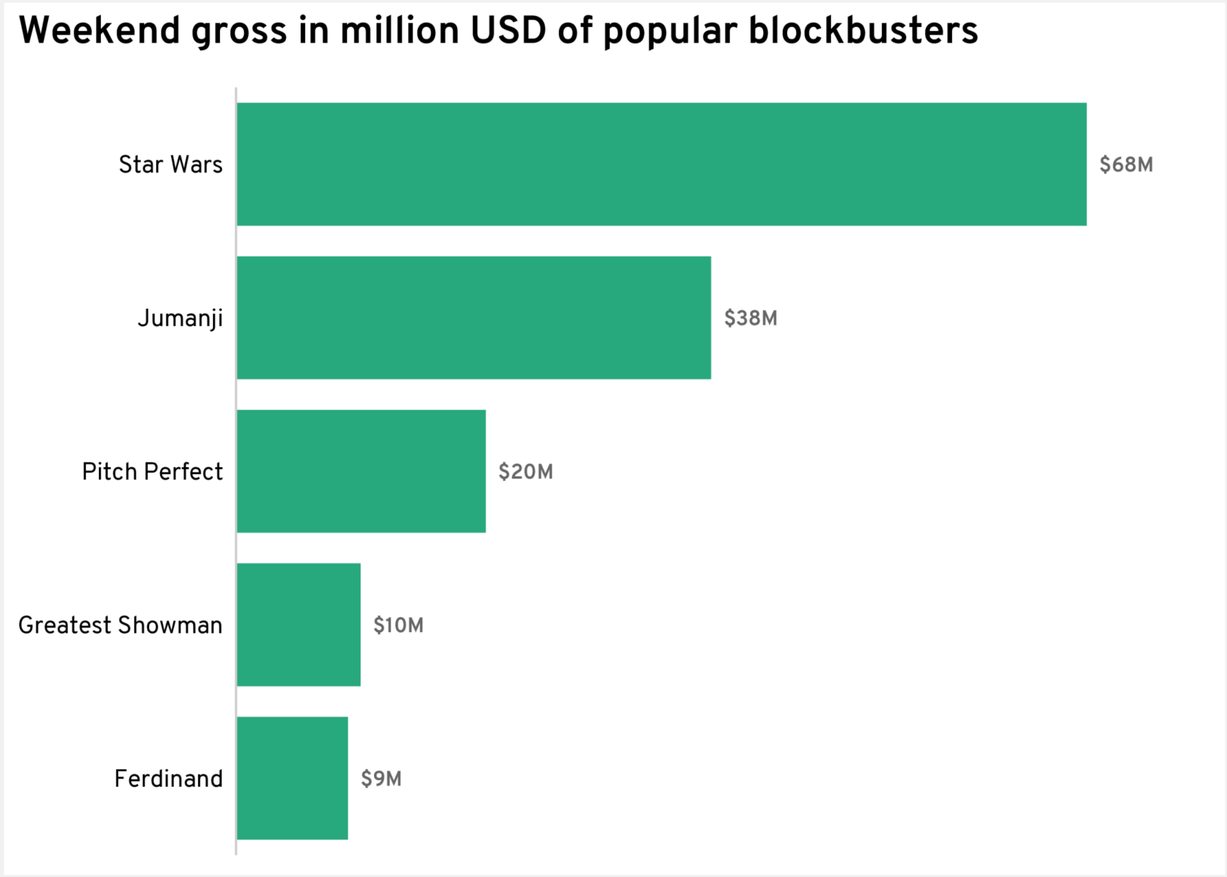


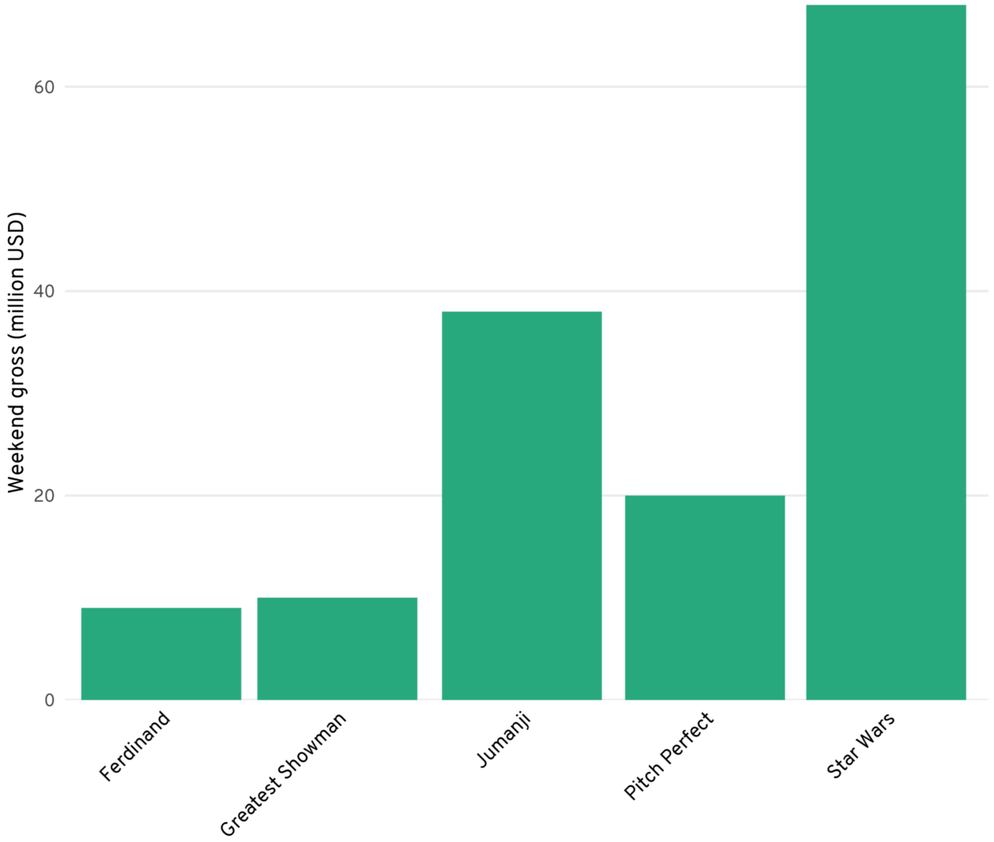


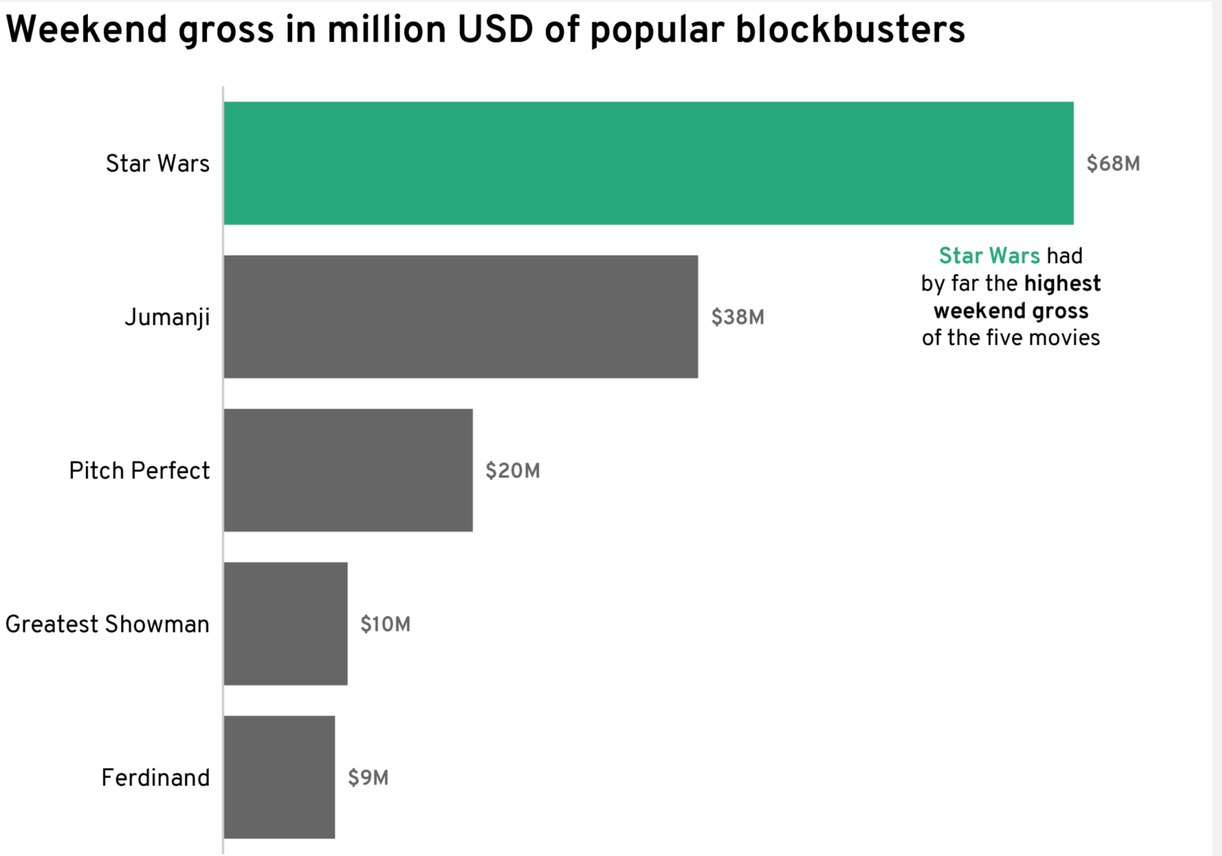
Add direct labels



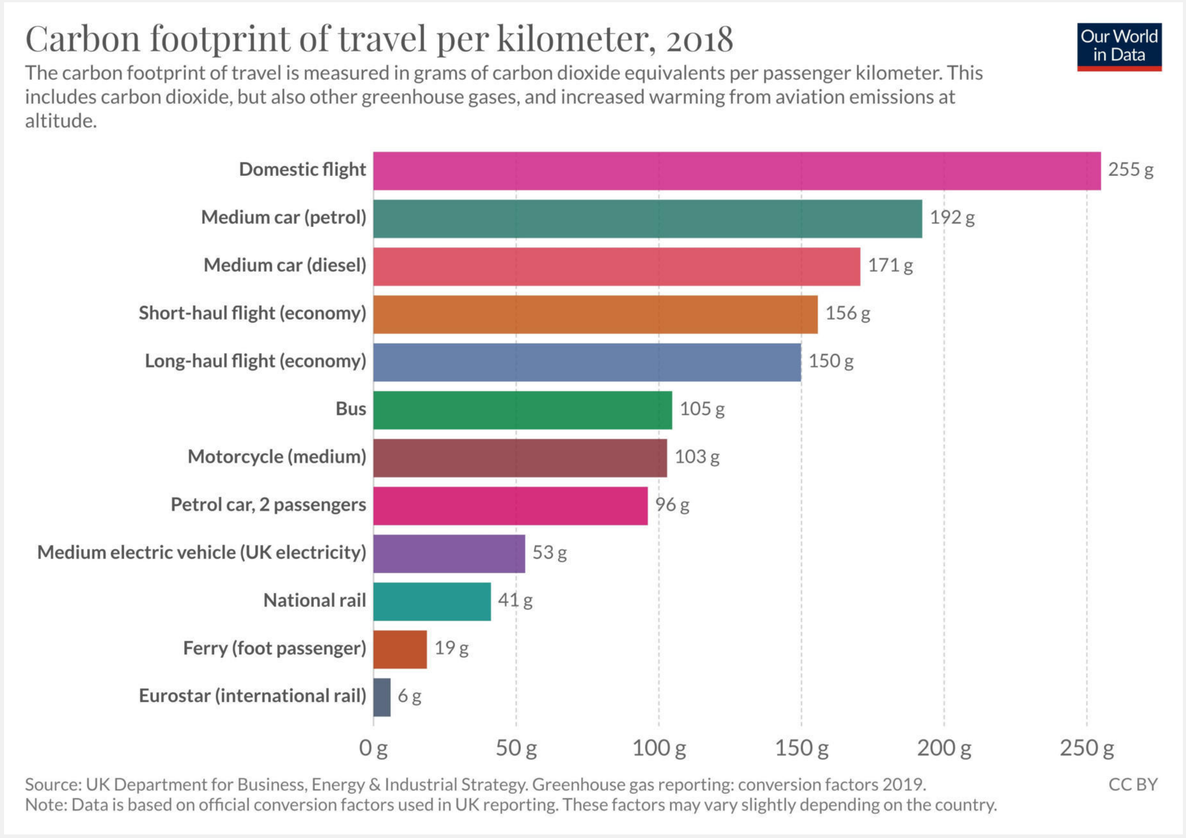


Use colors + annotations wisely

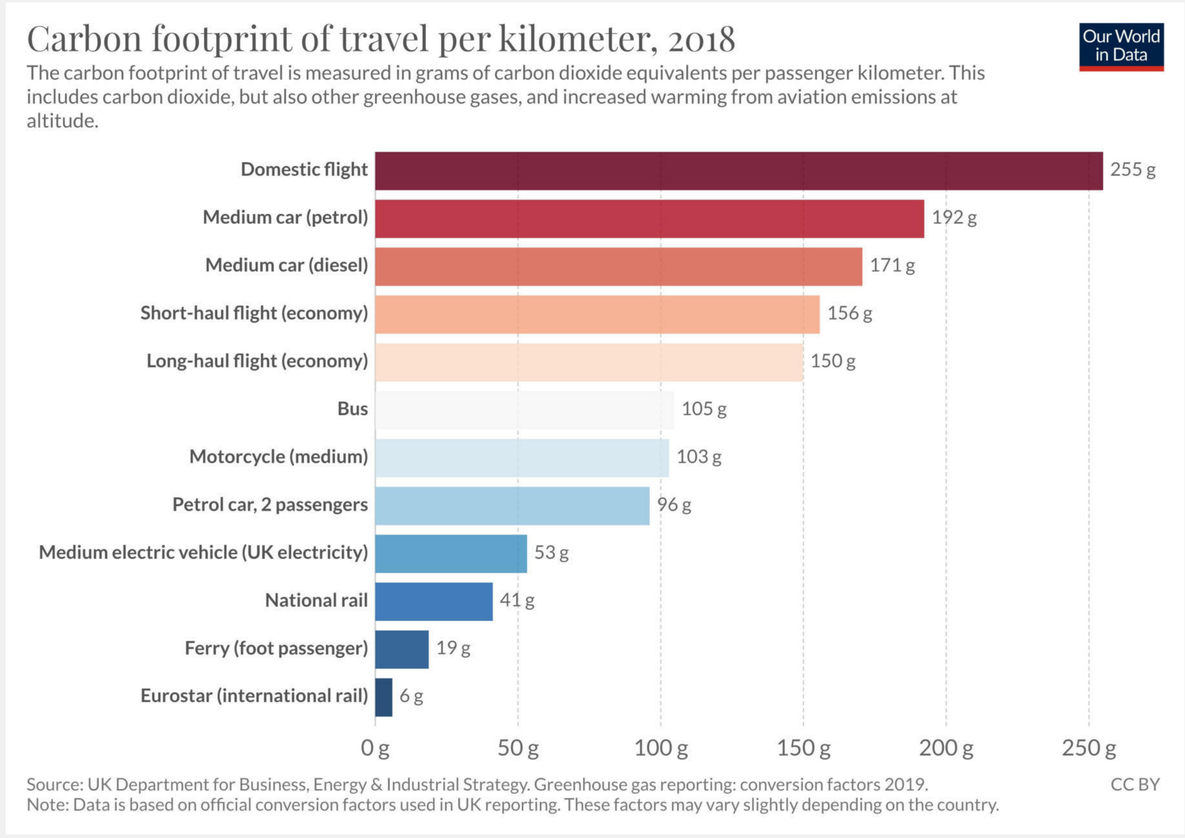




Use color wisely (and correctly)

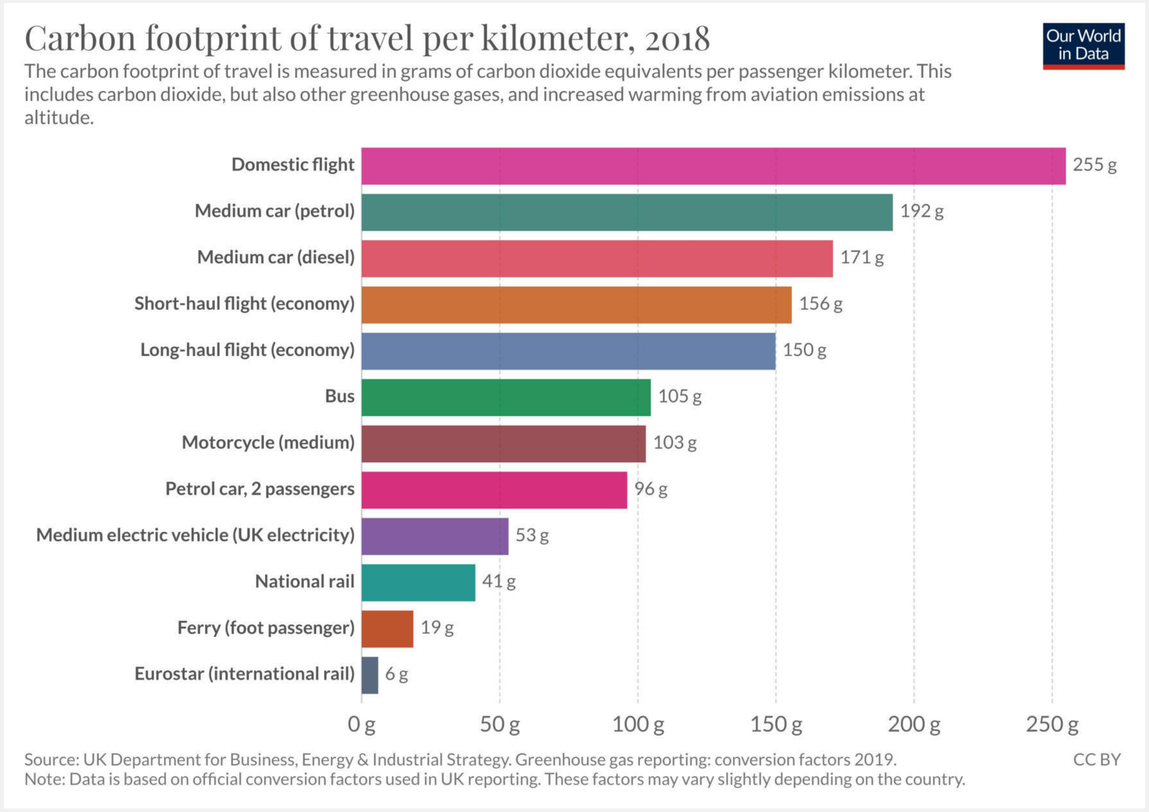


Original graphic with a random categorical palette

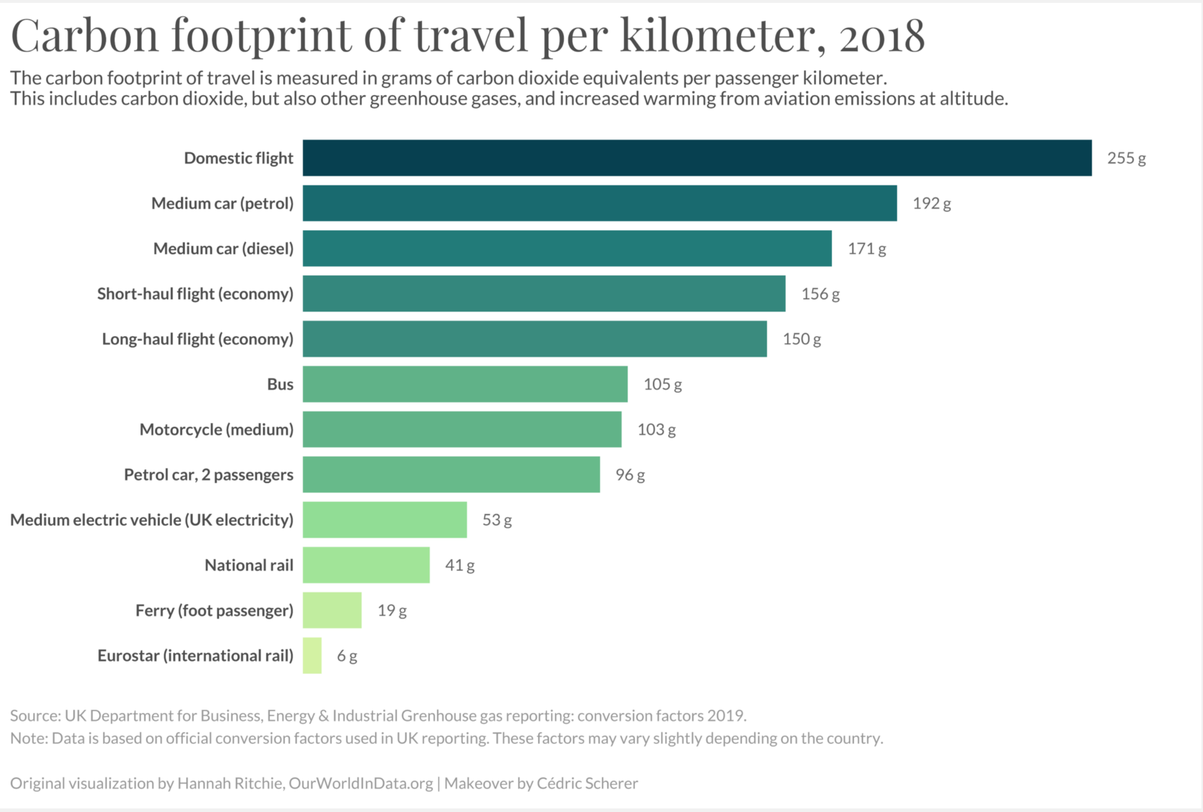


Reworked graphic using a diverging palette

Use color wisely (and correctly)

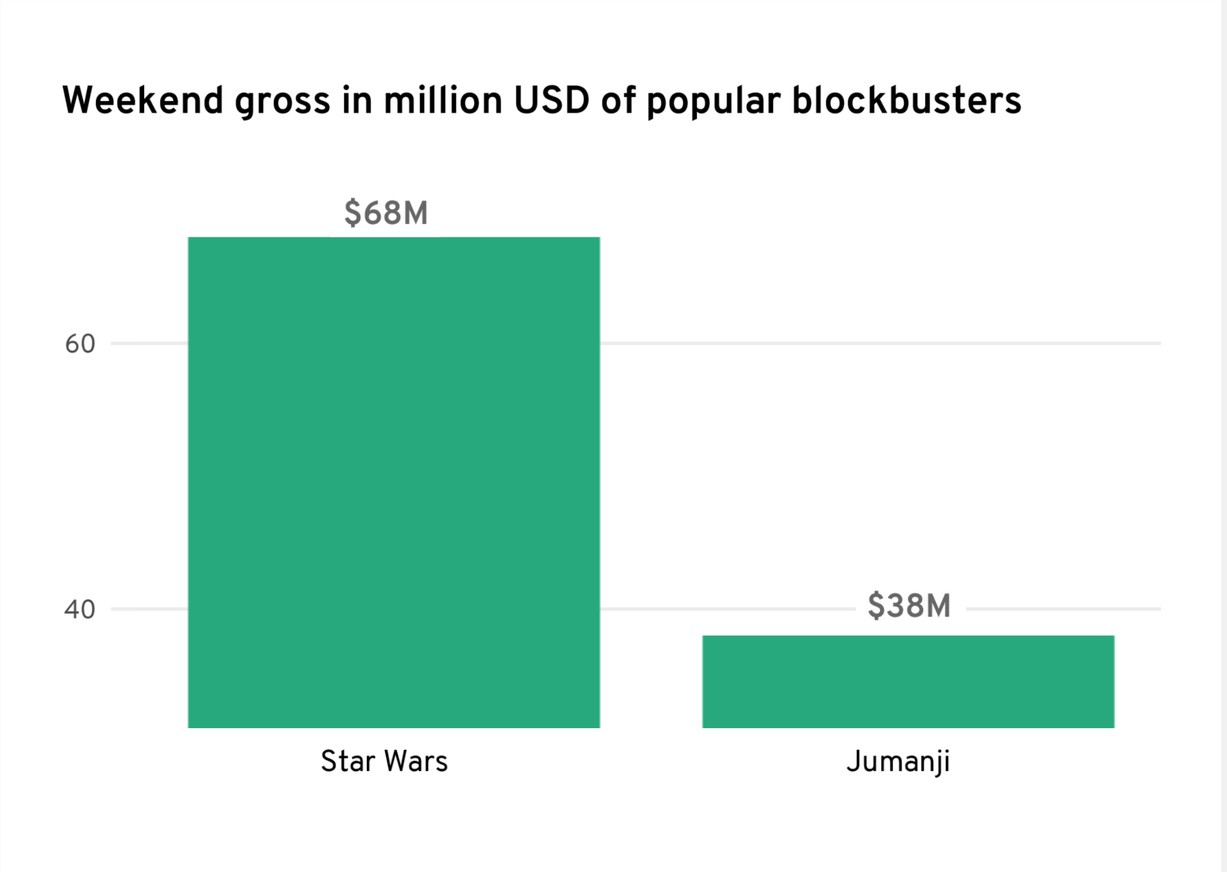


Original graphic with a random categorical palette

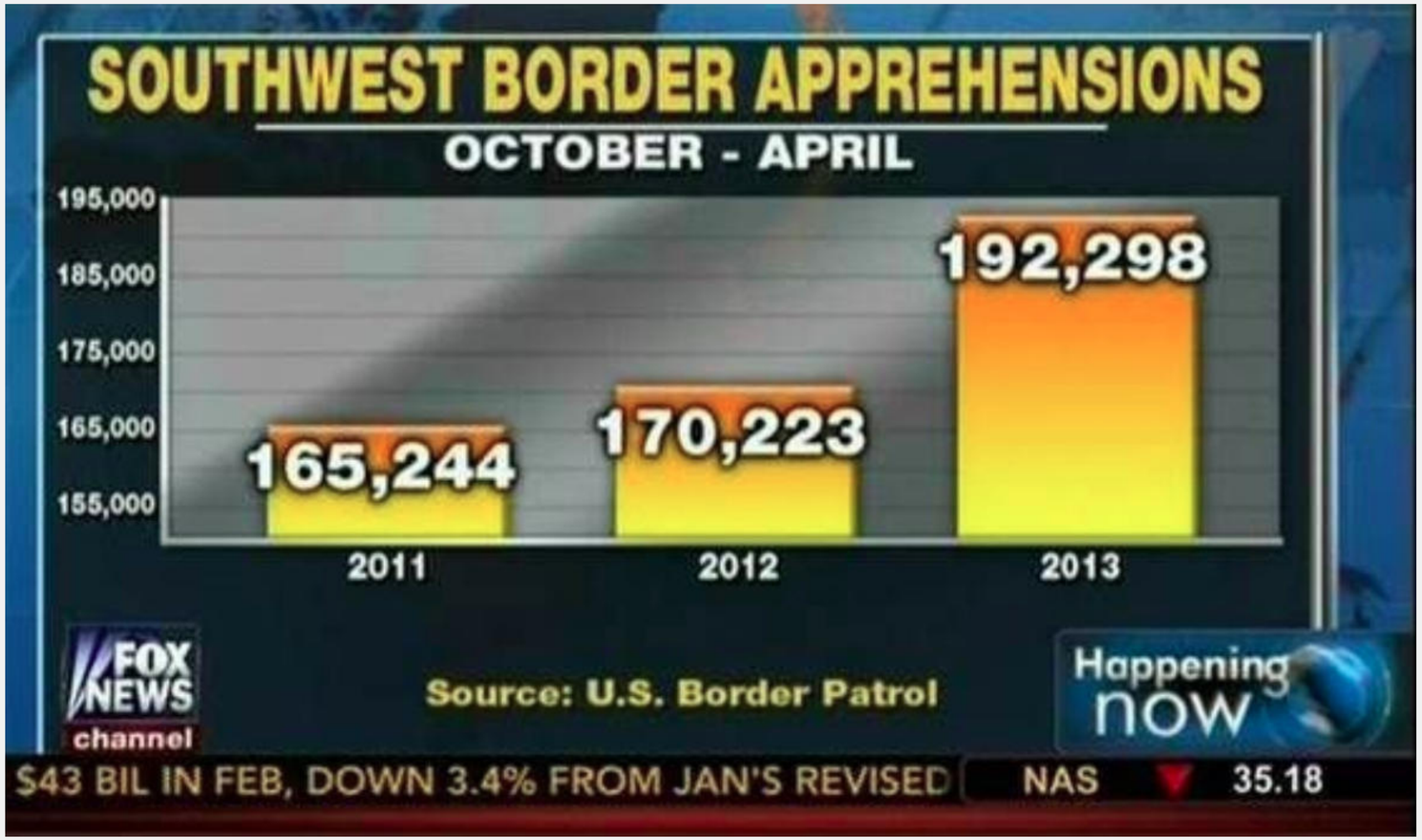


Makeover using a continuous palette

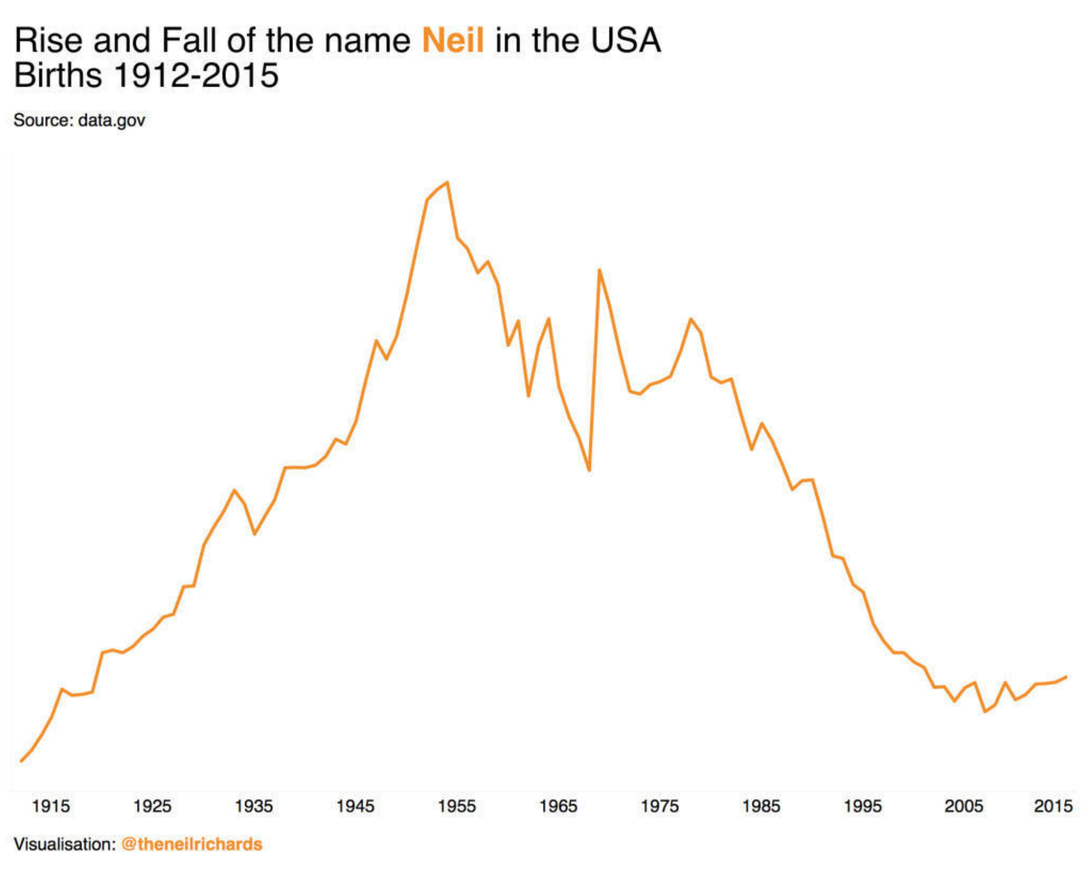
Always start at zero

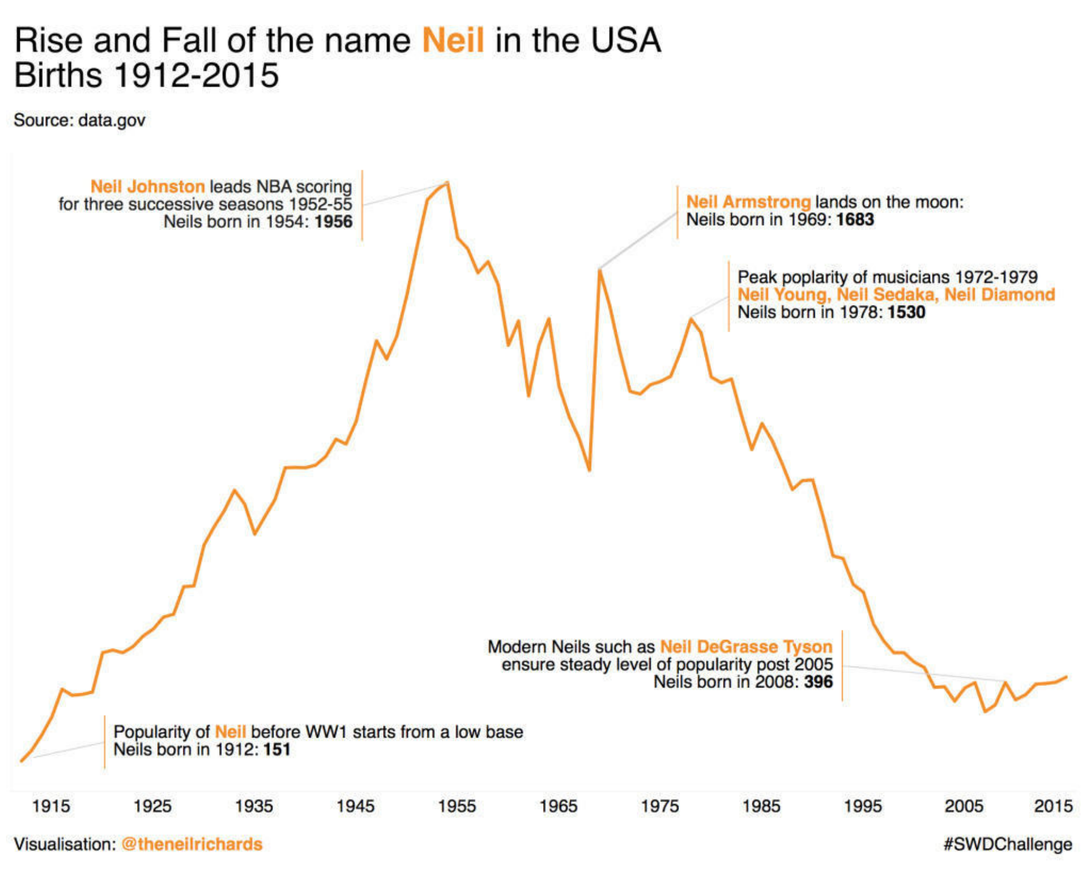


Always start at zero

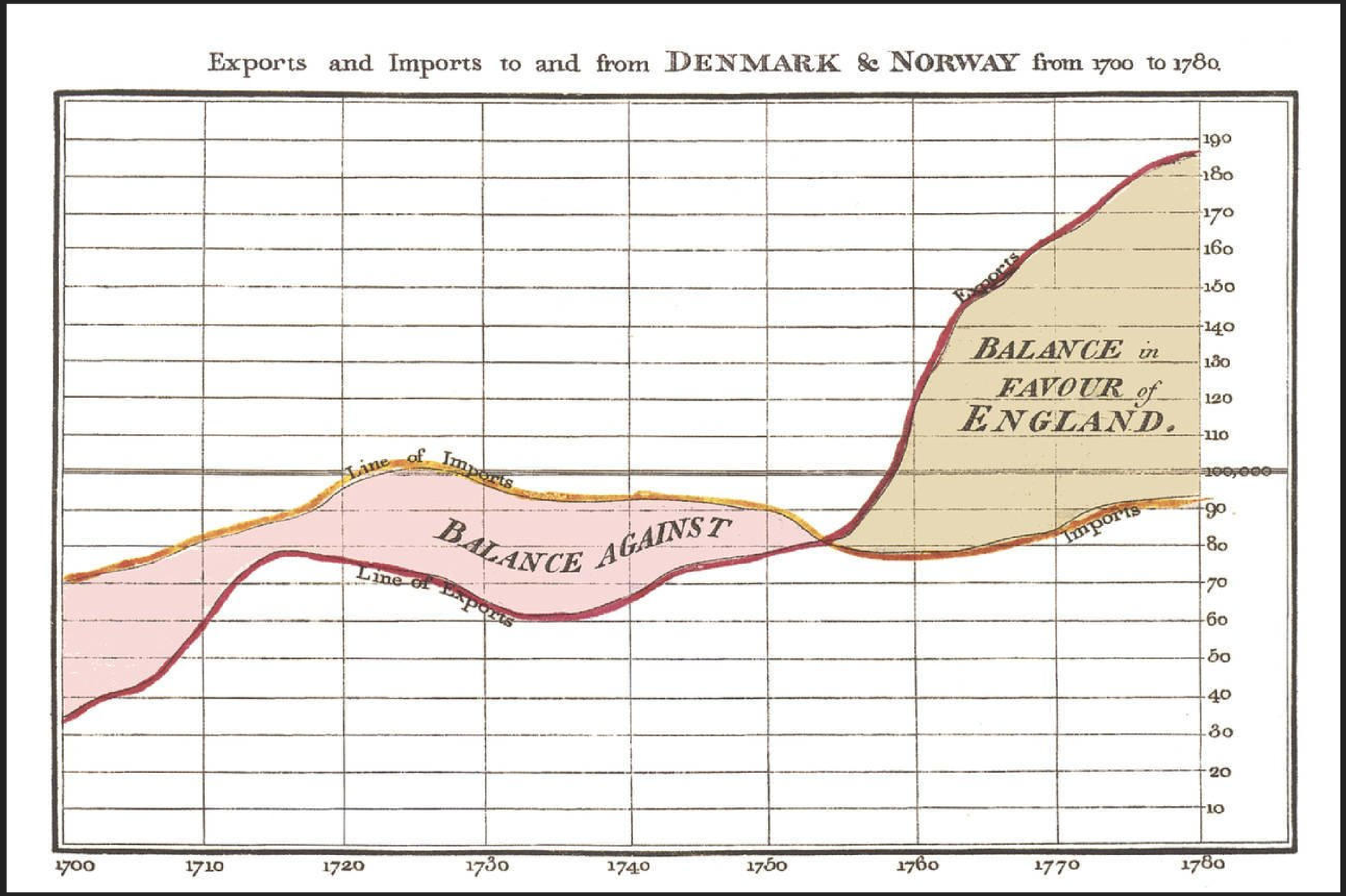


The Power of Annotations





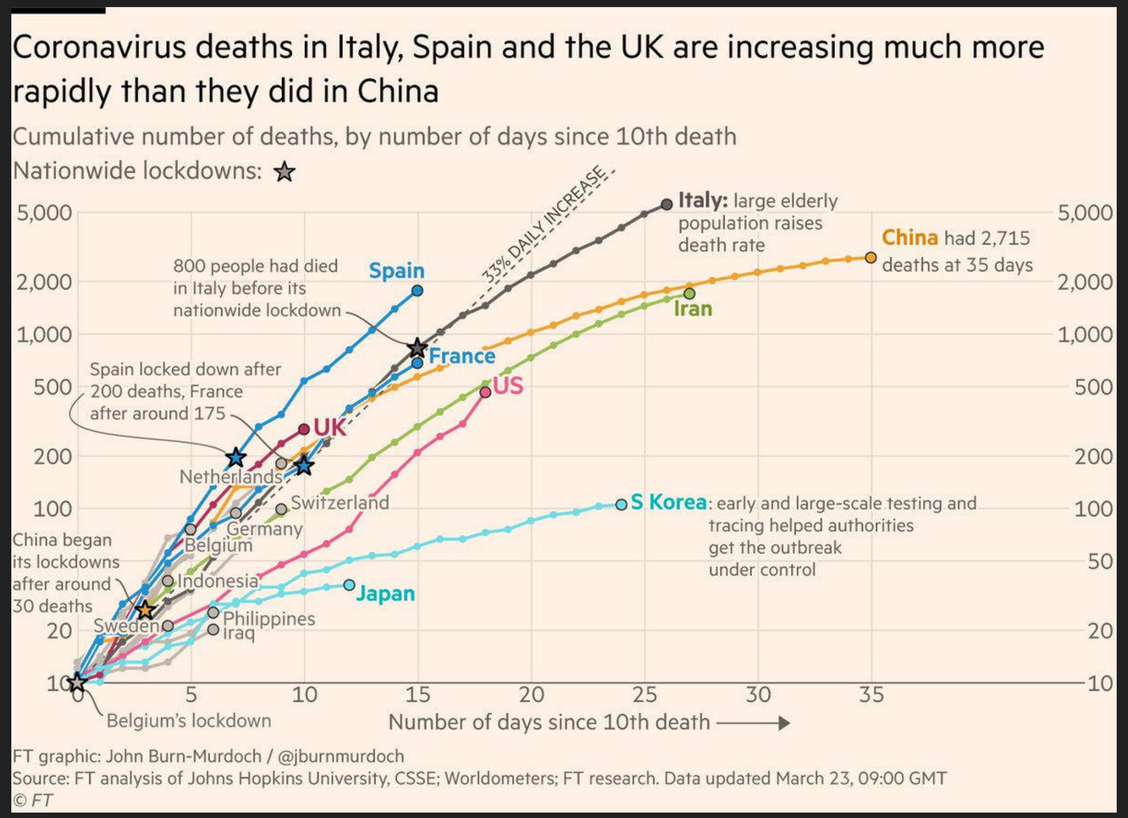
"Is white space always your friend?" by Neil Richards

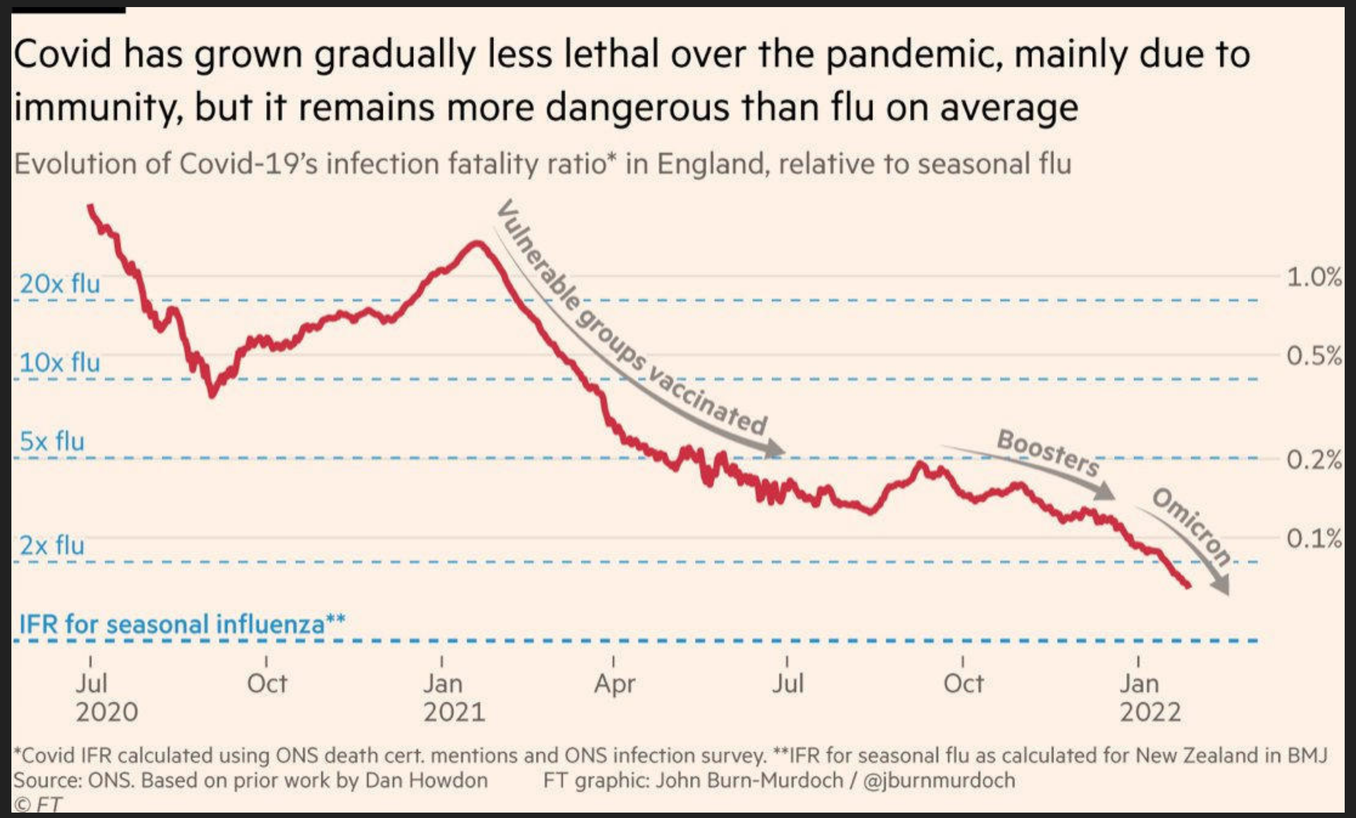


Annotated time-series chart by William Playfair from "The Commercial and Political Atlas and Statistical Breviary" (1786)

“The key thing we do is to add a title to the chart, as an entry point and to explain what is going on. **Text and other annotations add enourmous value for non-chart people.**”

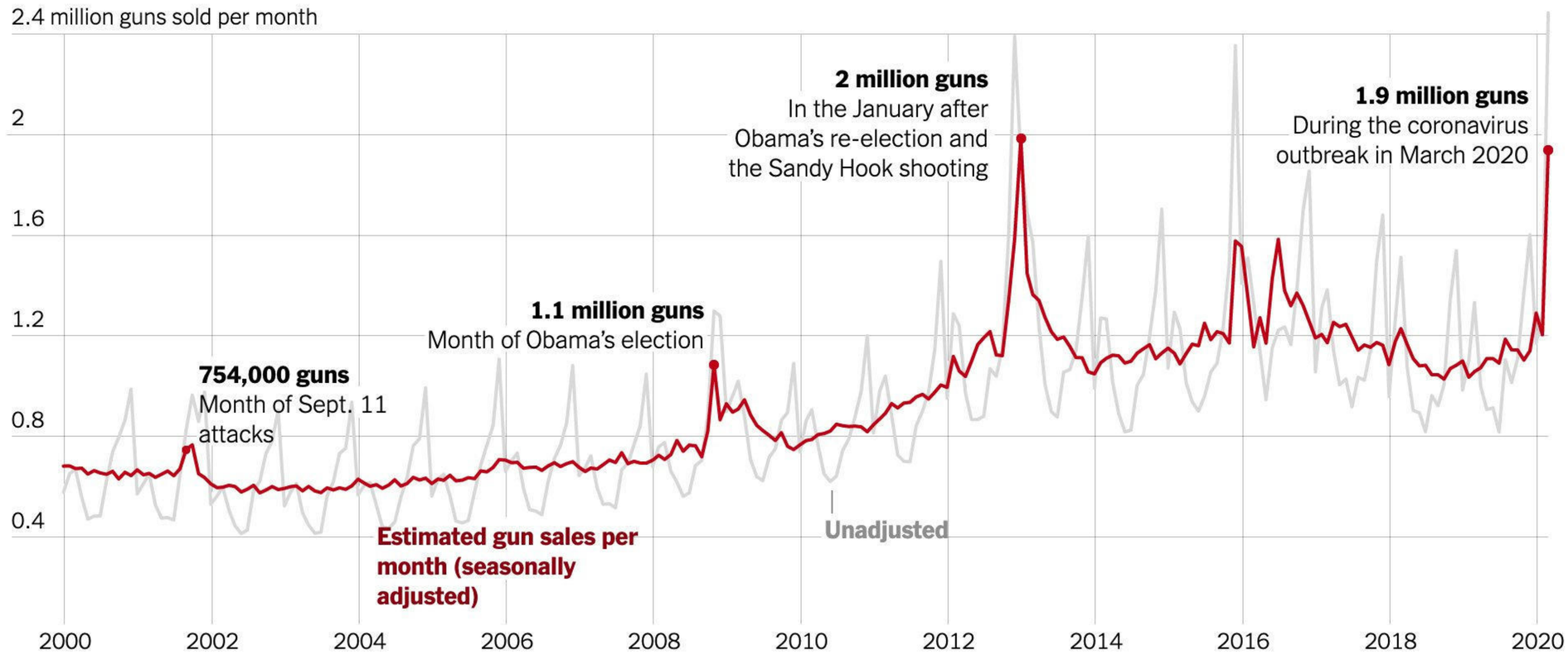
~ John Burn-Murdoch, Financial Times





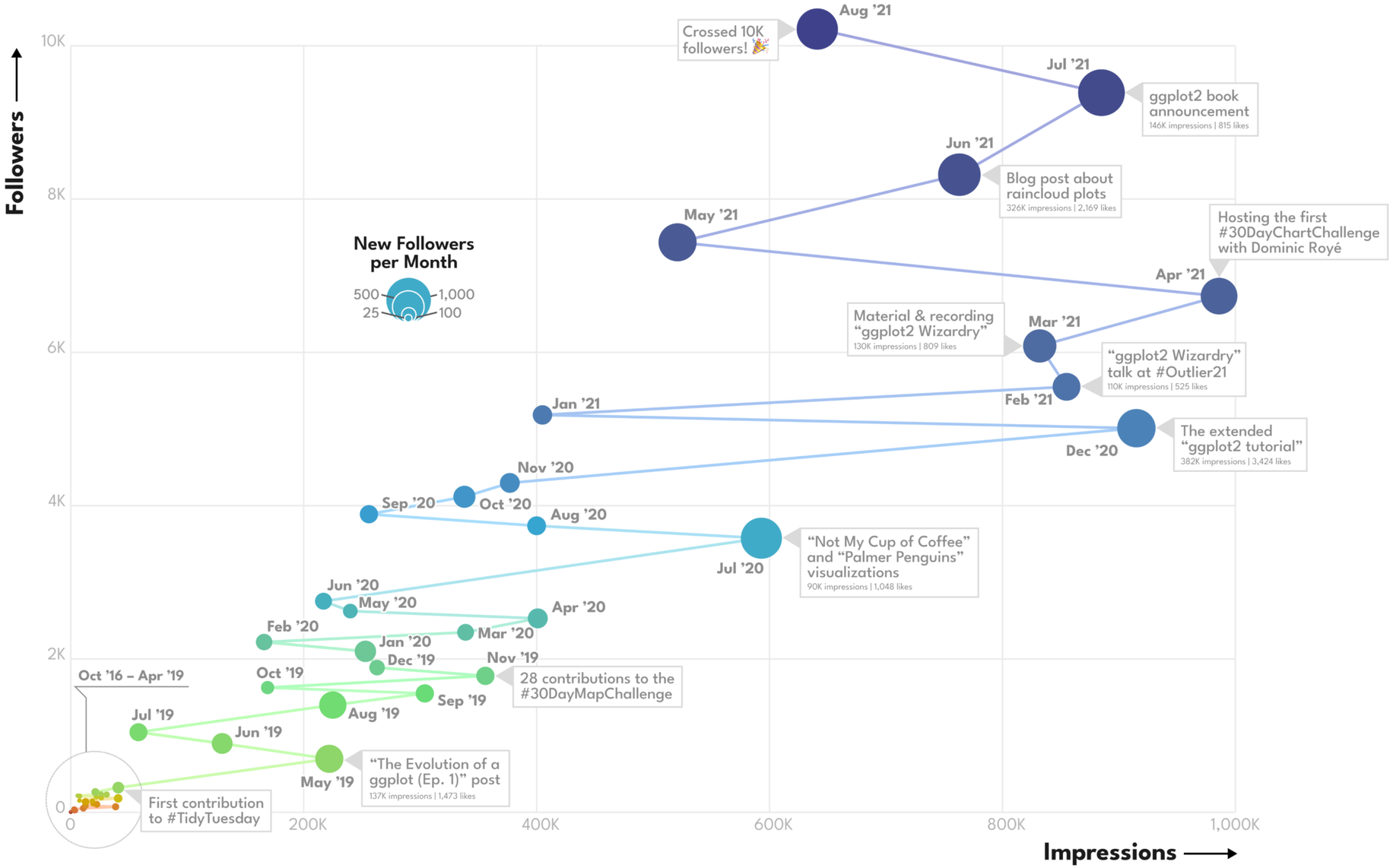
About 2 Million Guns Were Sold in the U.S. as Virus Fears Spread

By Keith Collins and David Yaffe-Bellany April 1, 2020



"About 2 Million Guns Were Sold in the U.S: as Virus Feats Spread" by Keith Collins and David Yaffe-Bellany (New York Times)

My Road to 10K on Twitter — Thank You All for Following!



Graphic: Cédric Scherer • Data: Twitter Analytics for @CédScherer

WRAP UP

Information

Understand your data and be accurate.

Story

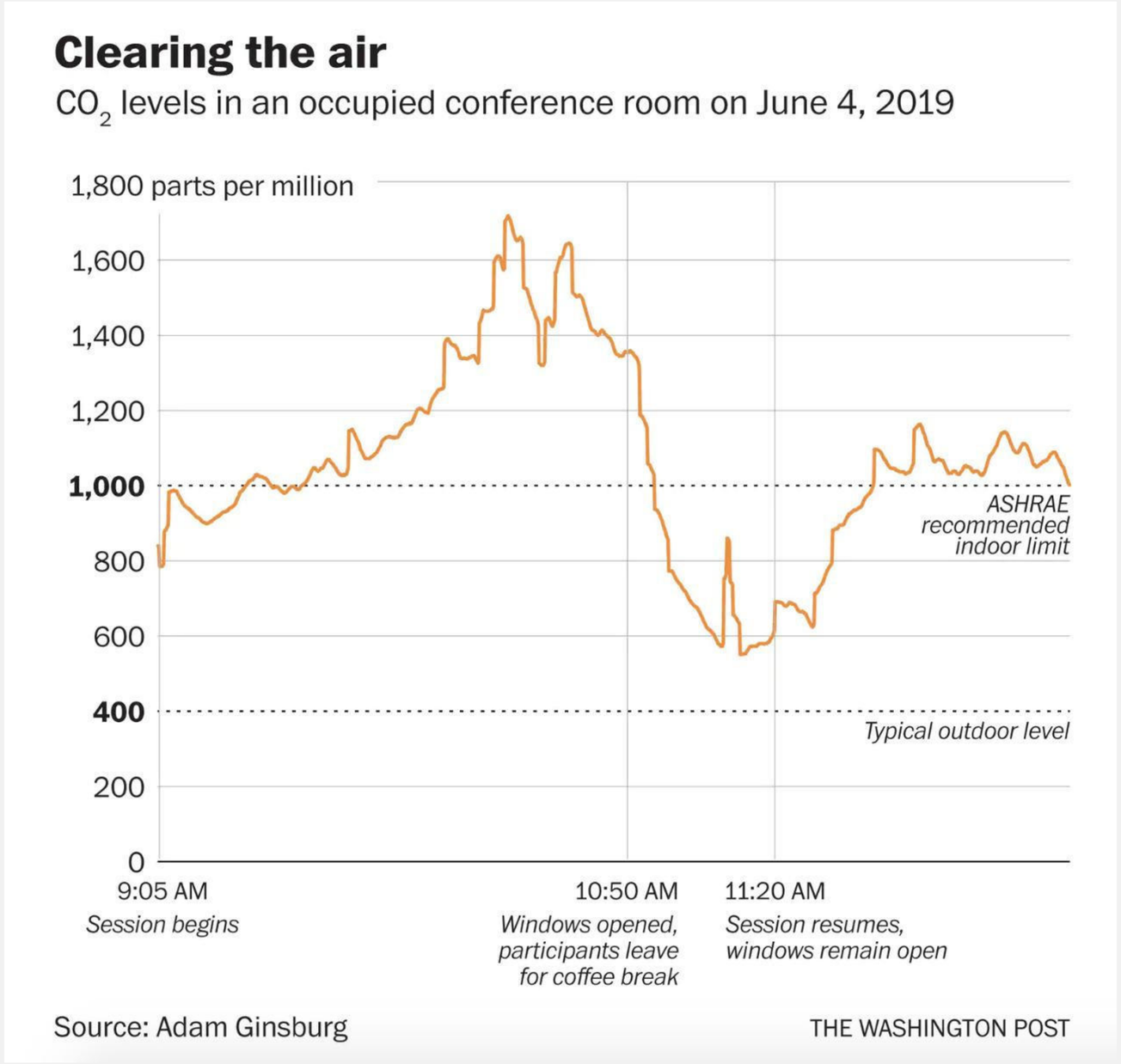
Be clear about the message of your visualization.

Goal

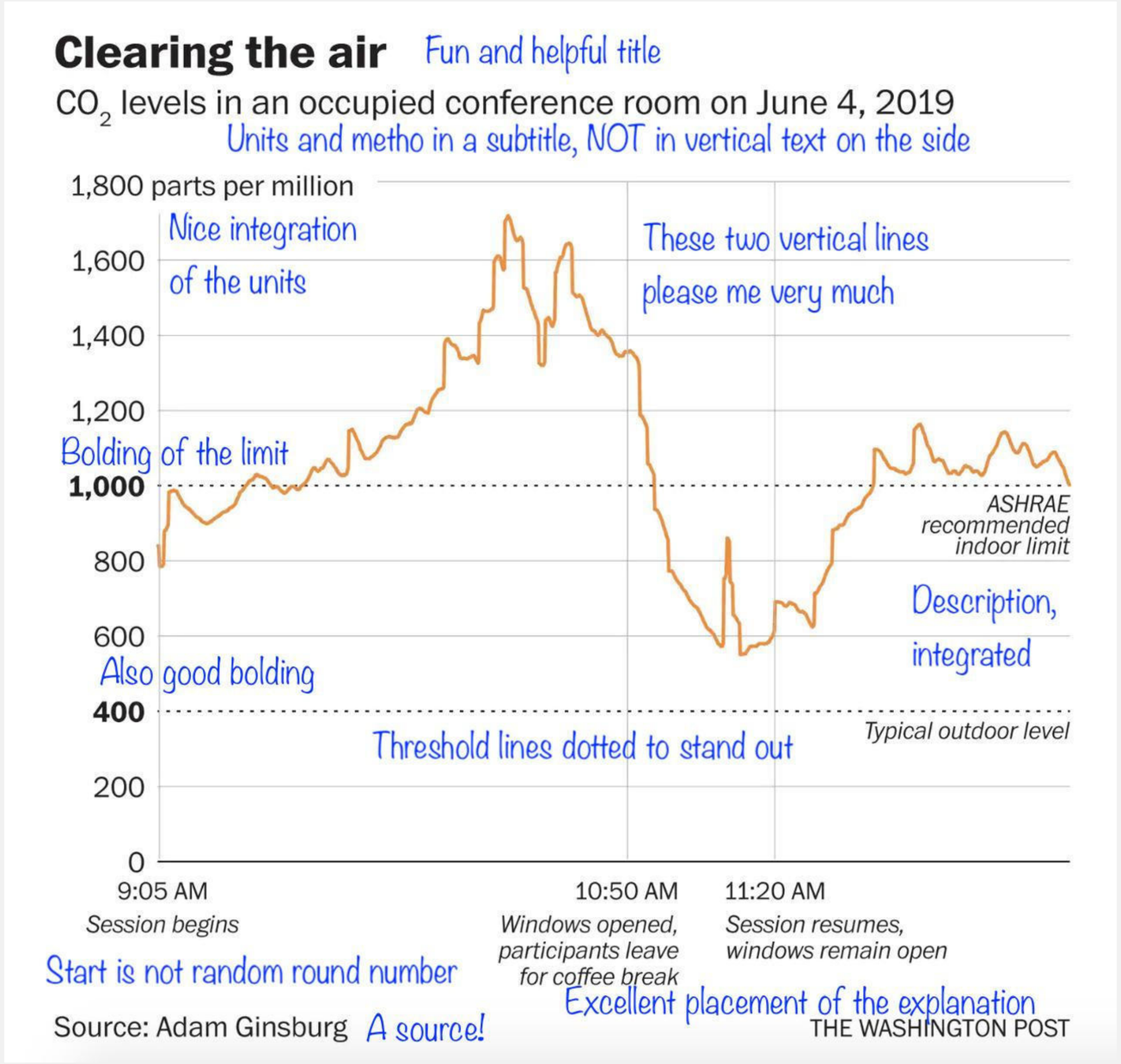
Select charts that successfully transport your story.

Visual Form

Follow design rules and data visualization principles.



"Clearin the Air" by Adam Ginsburg (Washington Post)



Notes by Francis Gagnon (Voilà)

Design for your audience.

- Choose charts based on your goal not tradition or novelity (only).
- Make sure your visualizations are accesible for everyone (colors, readability, ALT text).
- Use visual contrast to highlight important information.
- Provide meaningful labels.

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Be honest.

- Show the distribution of the raw data if possible.
- Don’t truncate bar charts, add spacing to truncated axes.
- Be consistent with axis scaling (especially in case of small multiples).

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Lend a helping hand.

- Use annotations and direct labels instead / in addition to captions and legends.
- Order your data, either by value or intrinsic ranking.
- Focus on the main message and reduce data complexity.
- Reveal information step by step (if applicable).

Thank you!

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Buy me a coffee

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