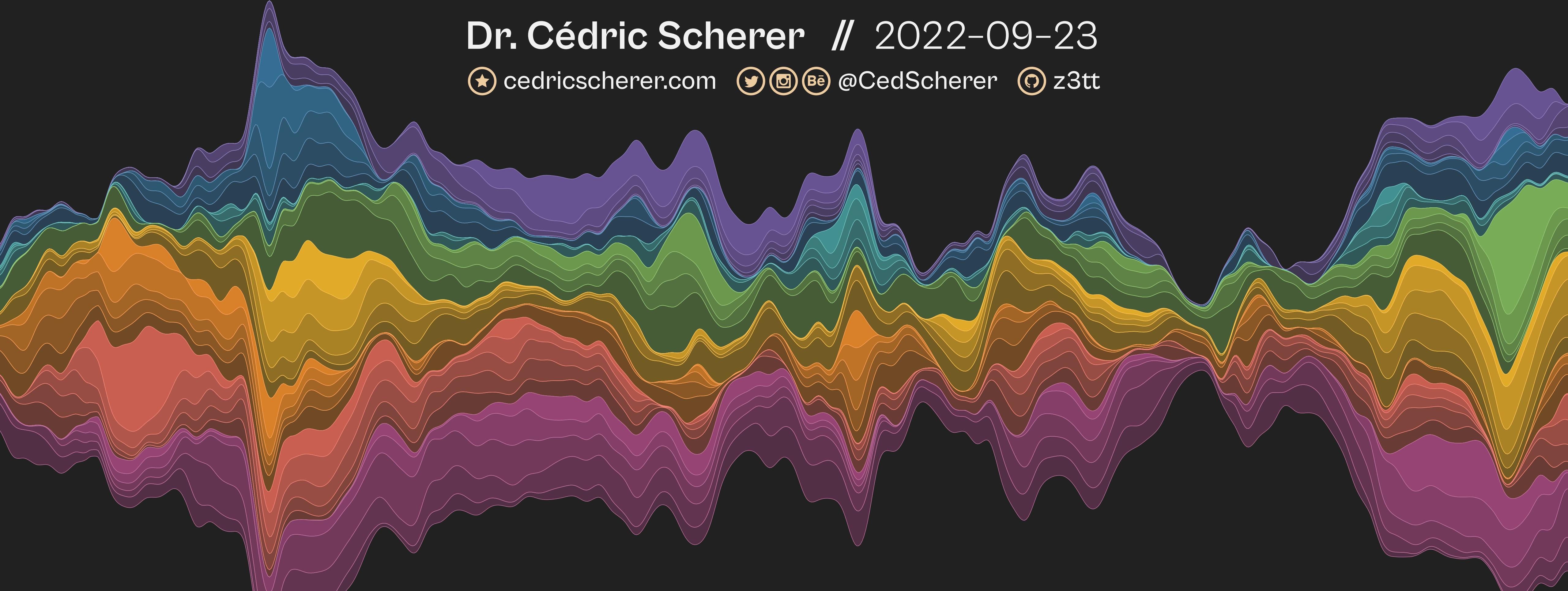


# Effective Data visualization

Design graphics that tell stories in an engaging way

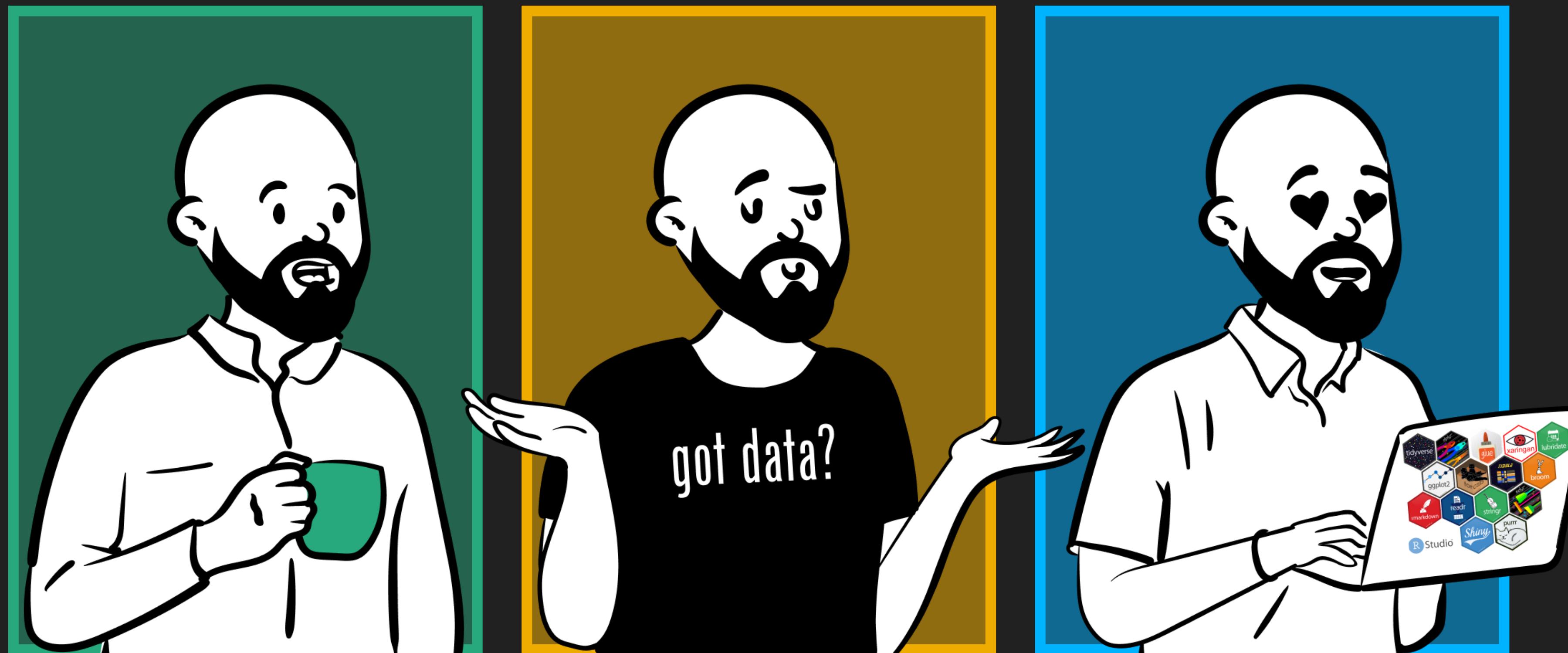
Dr. Cédric Scherer // 2022-09-23

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# Cédric Scherer

Independent Data Visualization Designer  
Computational Ecologist at IZW Berlin



Consulting

*Coaching*

Coding

# Data Visualization

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is any graphical representation  
of information and data.



# Data Visualization

---

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

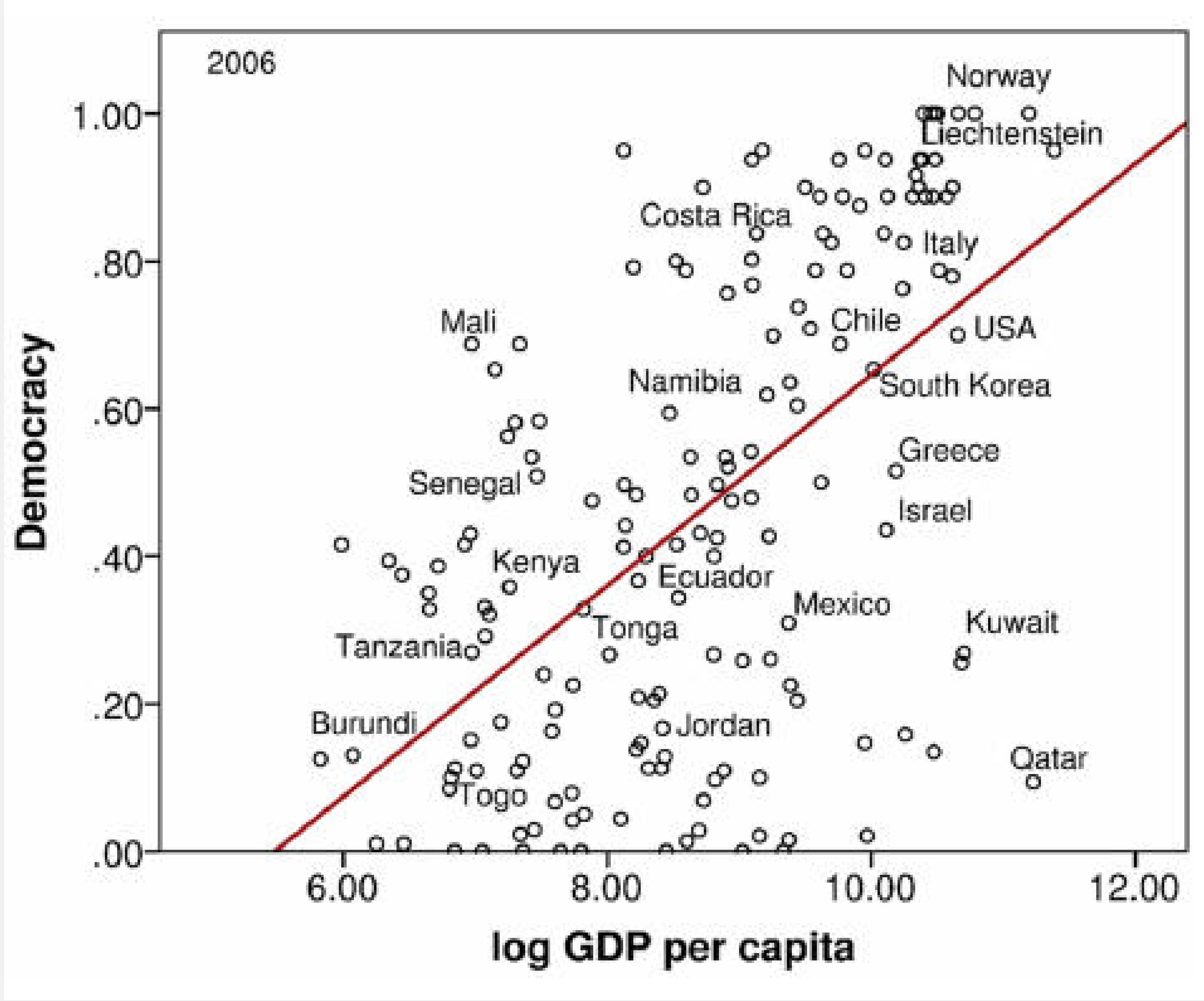


# Data Visualization

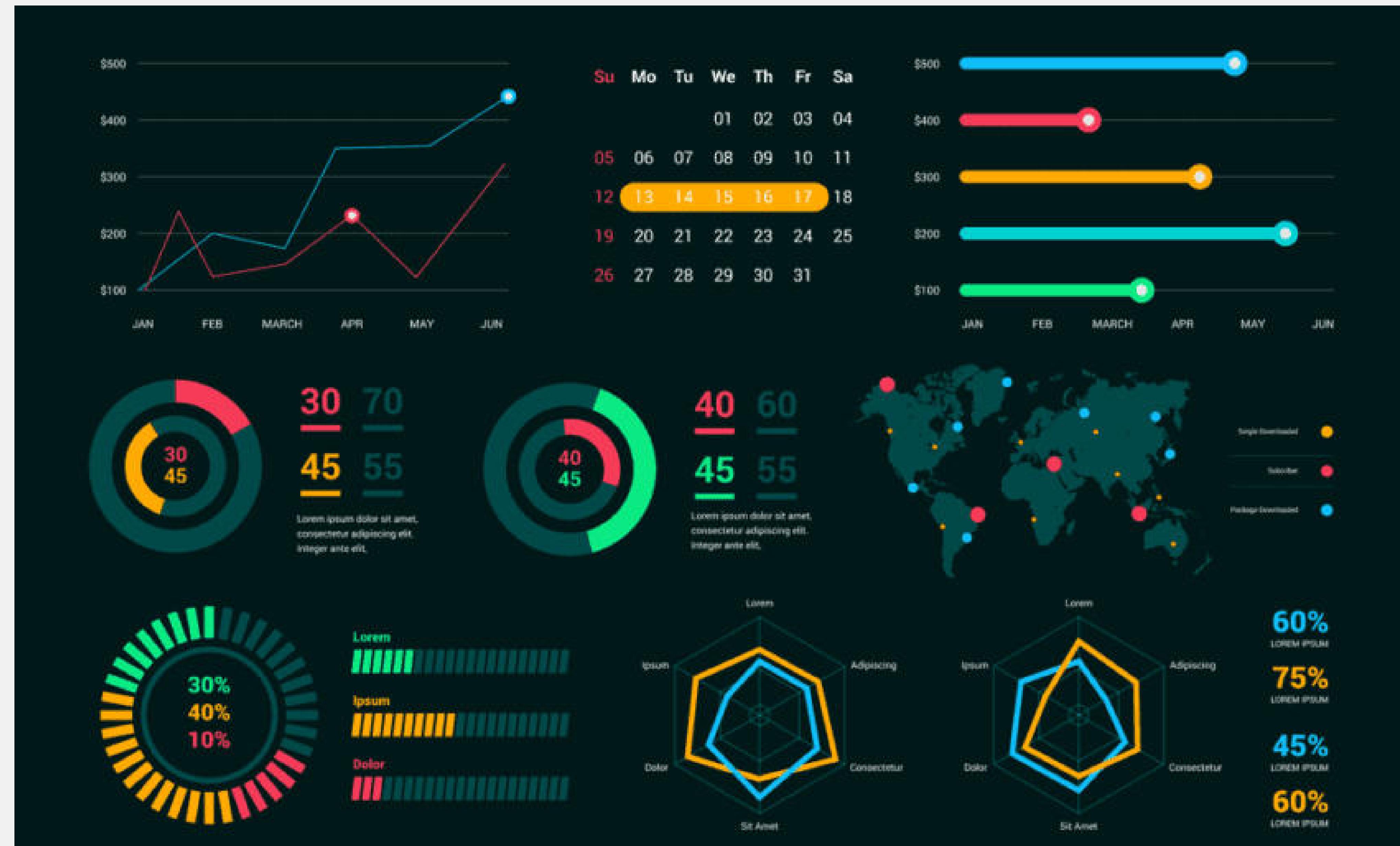
---

converts information into visual  
forms as quantifiable features.





Source: *Ranganathan et al. 2014*



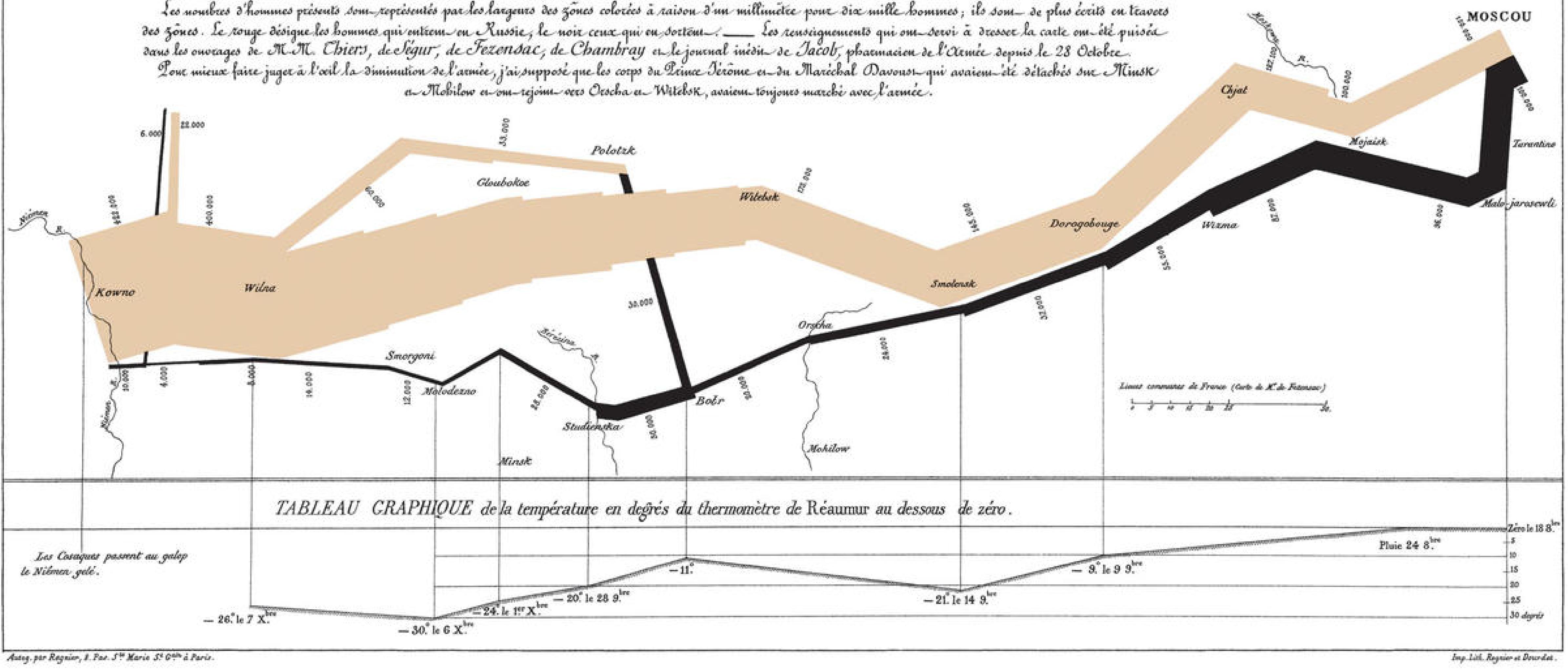
Source: [datameer.com](https://datameer.com)

# Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite Paris, le 20 Novembre 1869.

Les nombres d'hommes perdus sont représentés par les larges des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en lettres des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chier, de Segur, de Fezensac, de Charnbray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

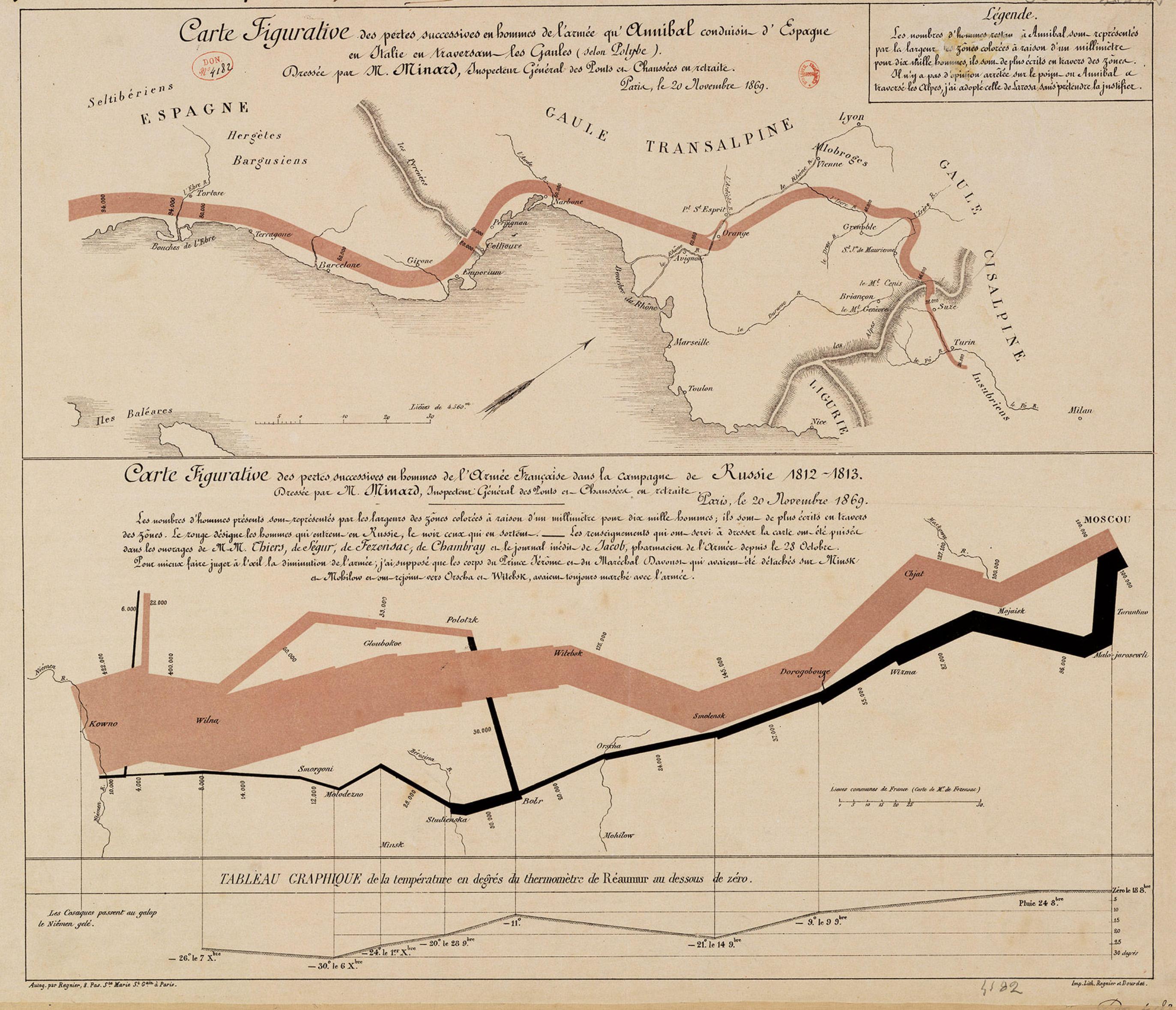
Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davout, qui avaient été détachés de Minsk à Mohilow et qui rejoignirent Osscha et Wilcok, avaient toujours marché avec l'armée.



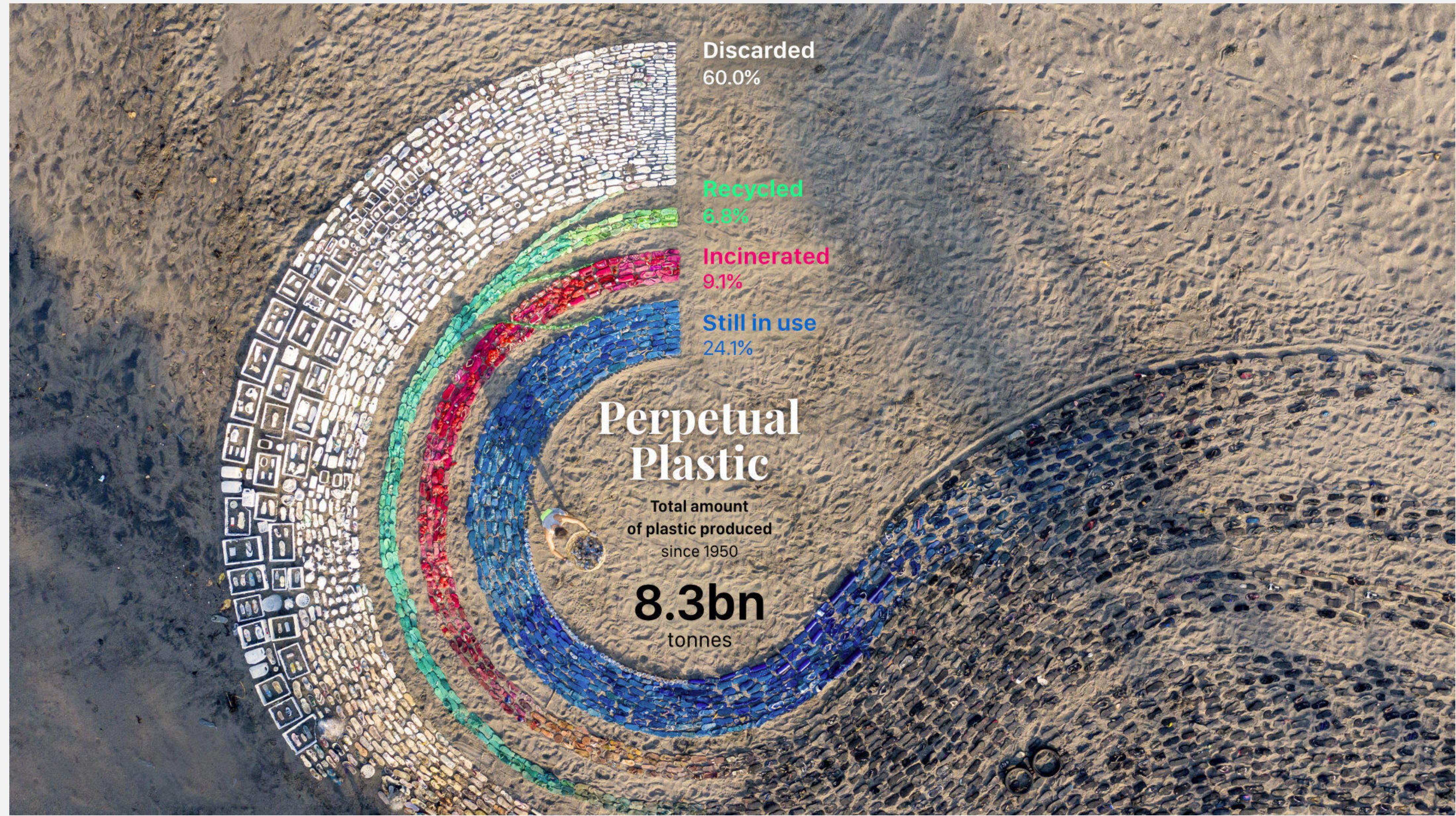
Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813 von Charles Joseph Minard

pour la Bibliothèque impériale

Ge Don X. 4182



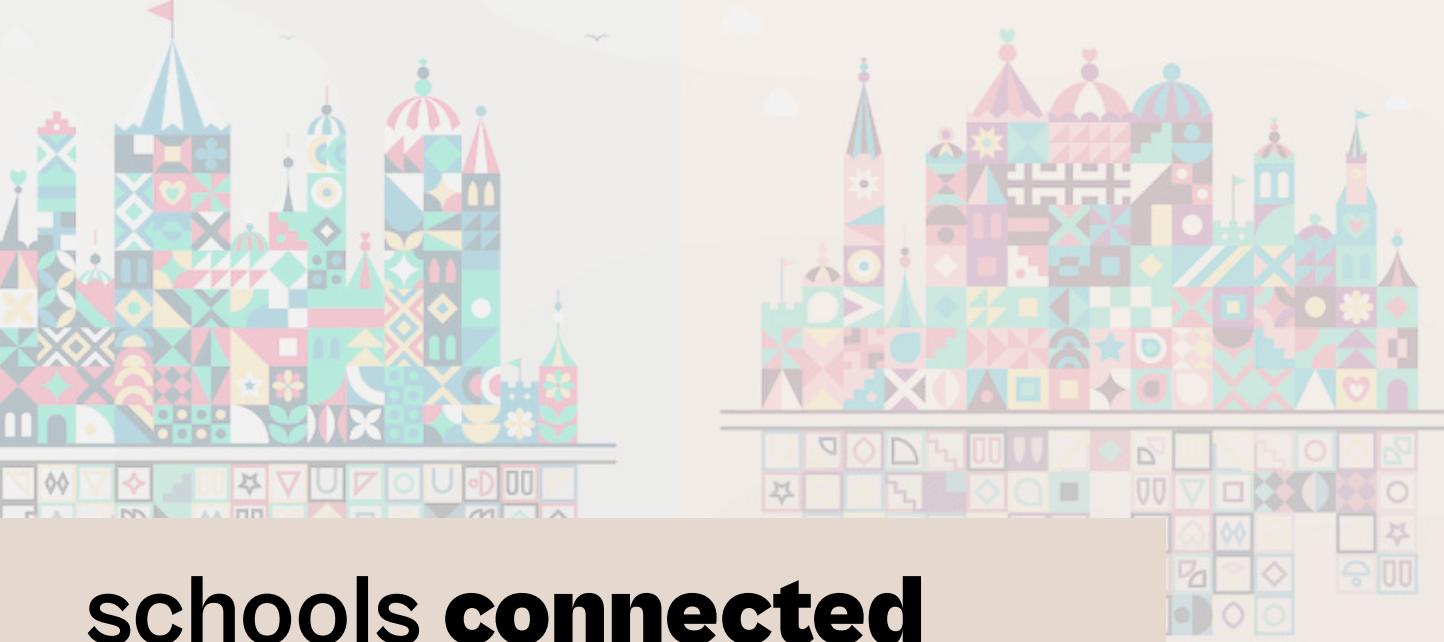
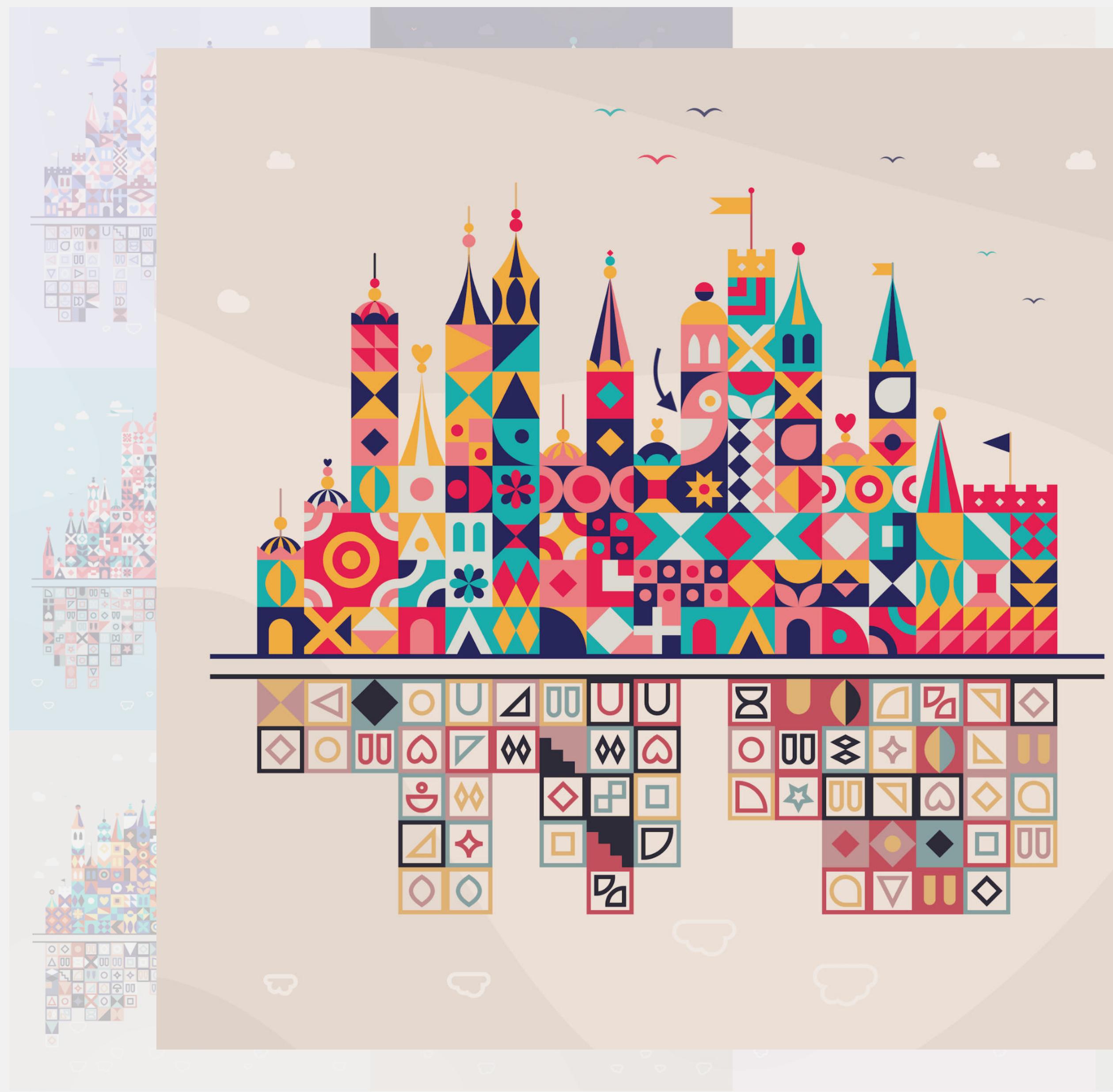
Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813 and Carte figurative des pertes successives en hommes de l'Armée qu'Annibal conduisit d'Espagne en Italie en traversant les Gaules (selon Polybe) by Charles Joseph Minard



Source: “*Perpetual Plastic*” by Liina Klauss, Skye Morét and Moritz Stefaner



Source: “*Patchwork Kingdoms*” by Nadieh Bremer



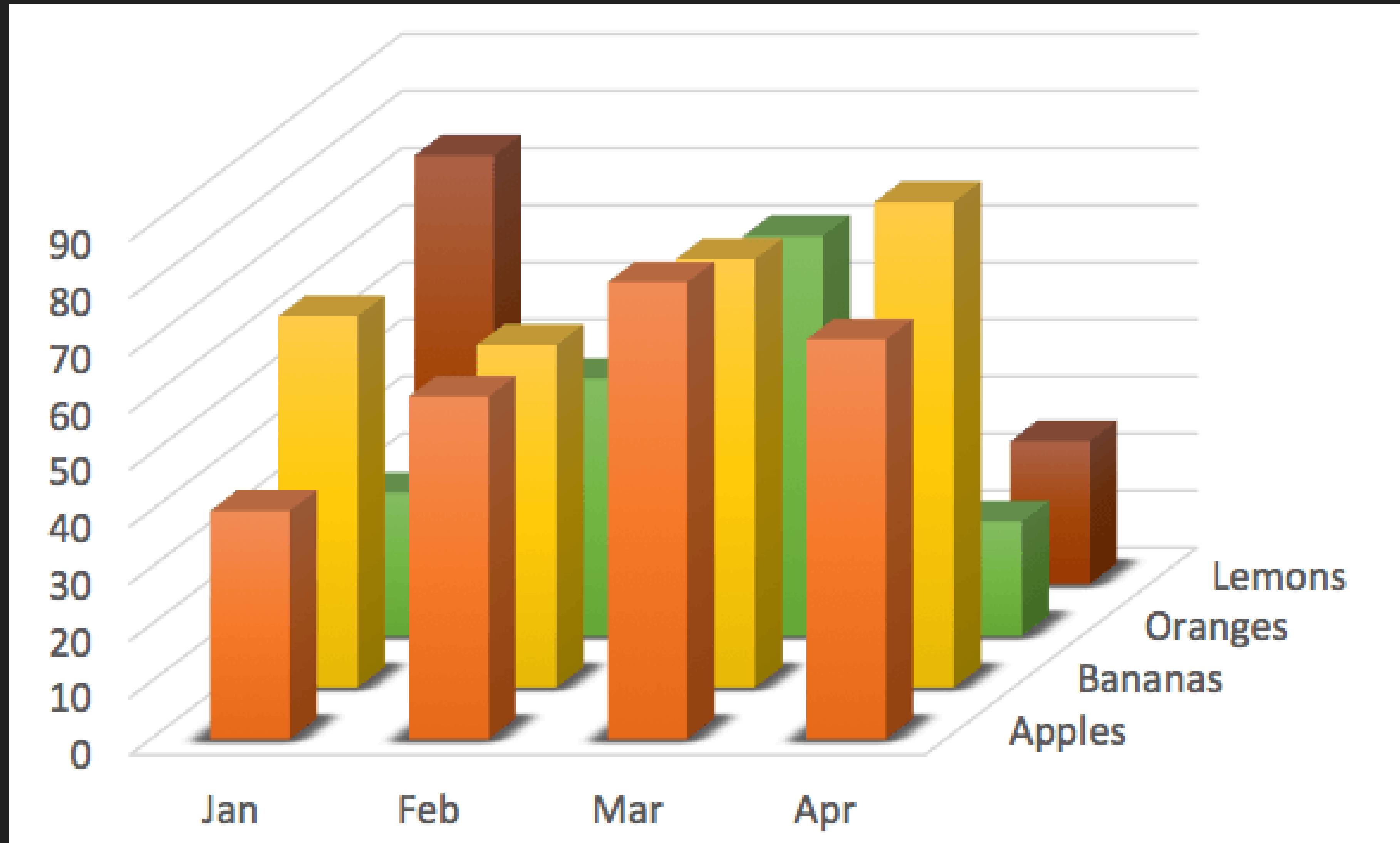
**schools connected  
to the internet**



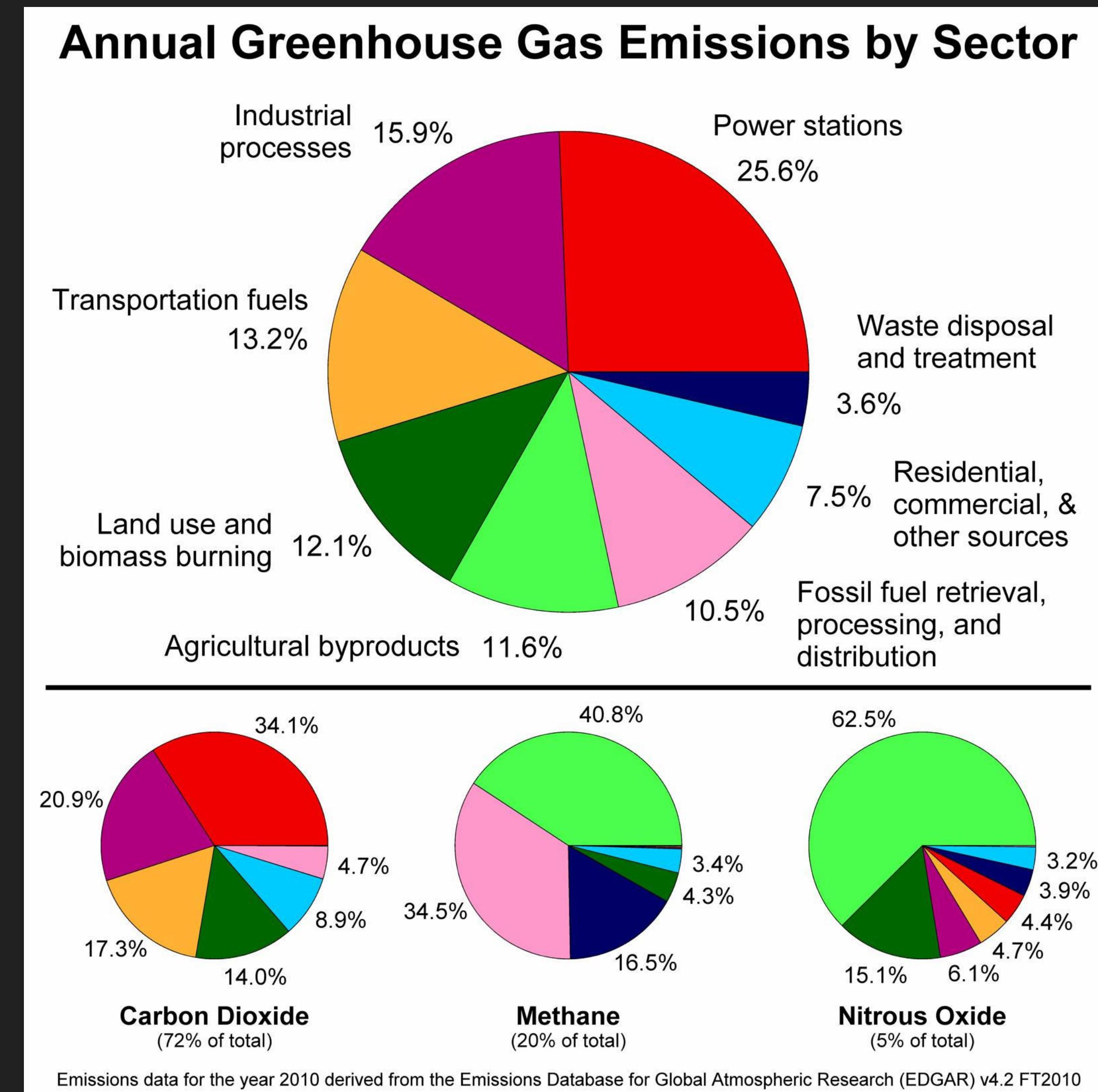
**schools not connected  
to the internet**

Source: “Patchwork Kingdoms” by Nadieh Bremer

# What makes it a bad data visualization?



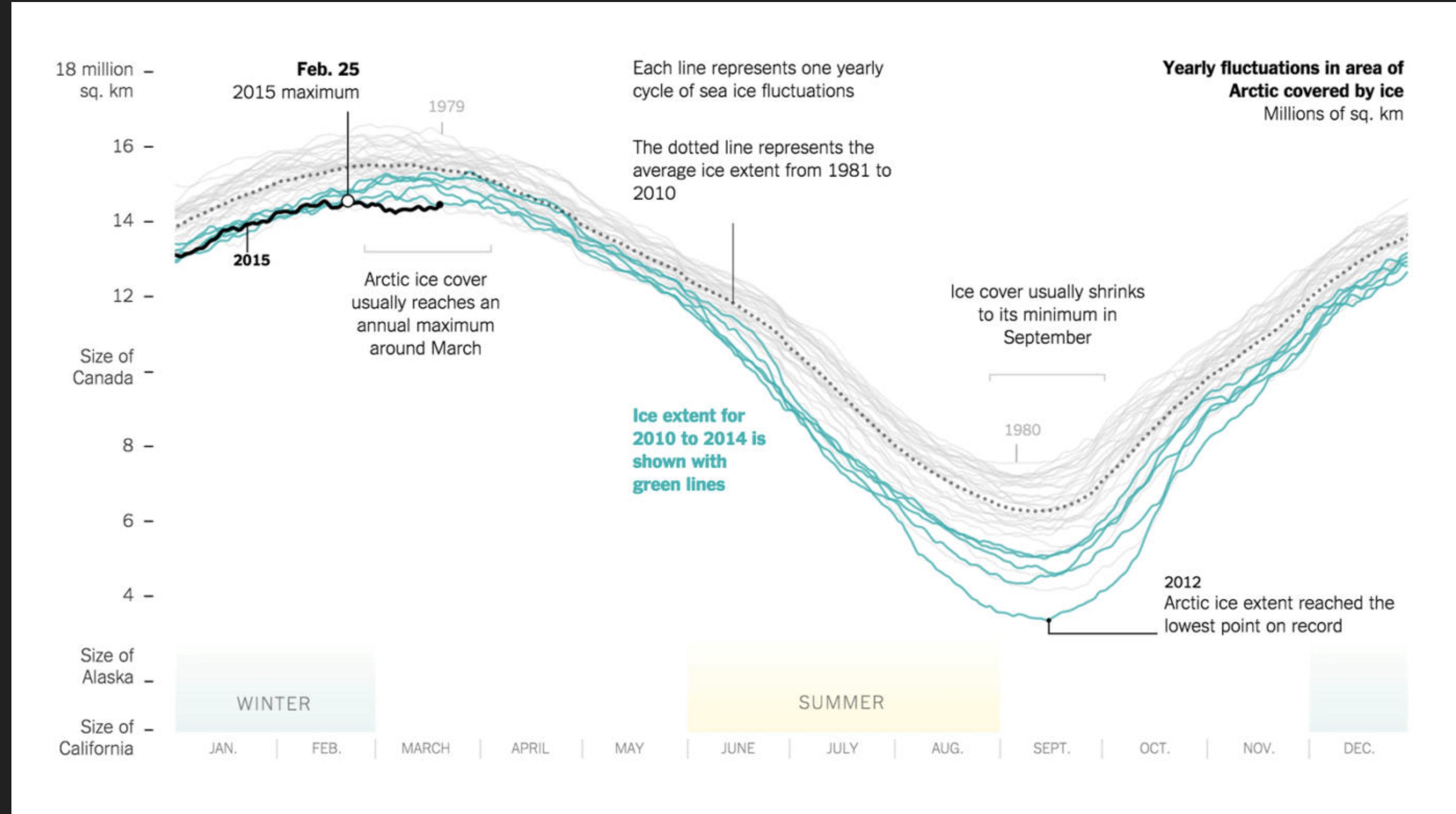
# What makes it a bad data visualization?



# 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?



Source: “*Yearly Fluctuations in Area of Arctic Covered by Ice*” by Derek Watkins (New York Times)

# What makes it a good data visualization?



**INFORMATION** (integrity)



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# What makes it a good data visualization?

→ **INFORMATION** (integrity)

→ **STORY** (interestingness)

# What makes it a good data visualization?

- ➔ **INFORMATION** (integrity)
- ➔ **STORY** (interestingness)
- ➔ **GOAL** (usefulness)

# What makes it a good data visualization?

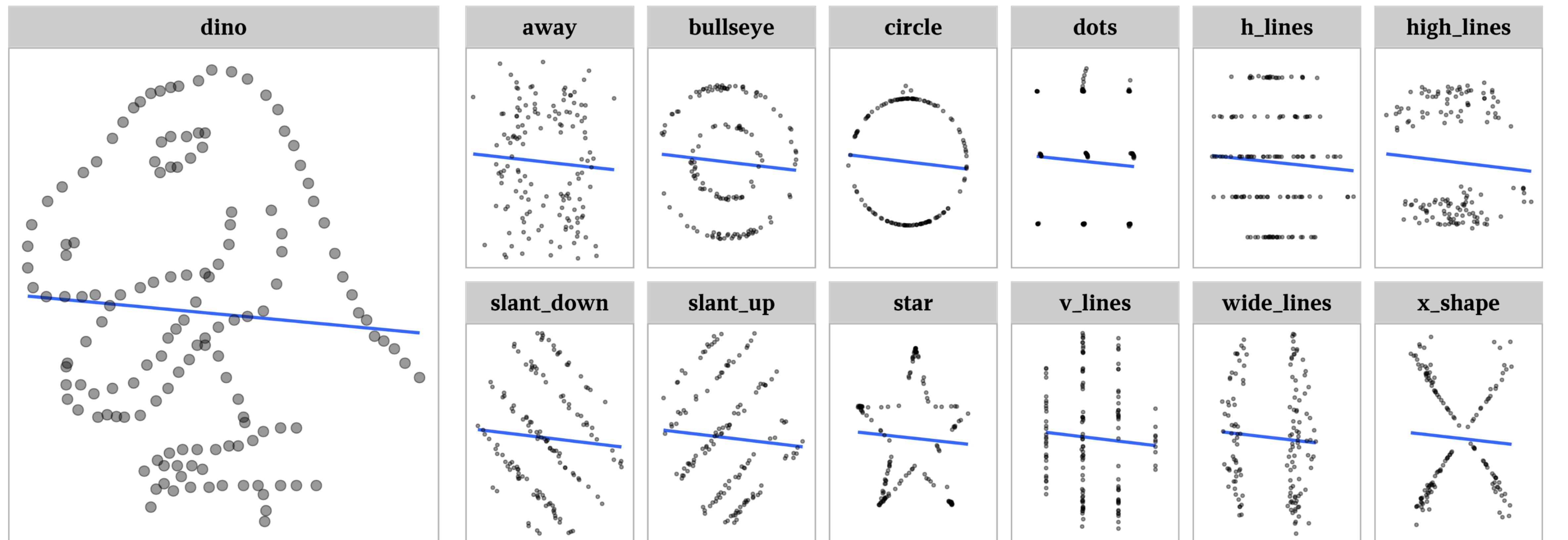
- ➔ **INFORMATION** (integrity)
- ➔ **STORY** (interestingness)
- ➔ **GOAL** (usefulness)
- ➔ **VISUAL FORM** (beauty)

# INFORMATION

---

Understand your data and be accurate

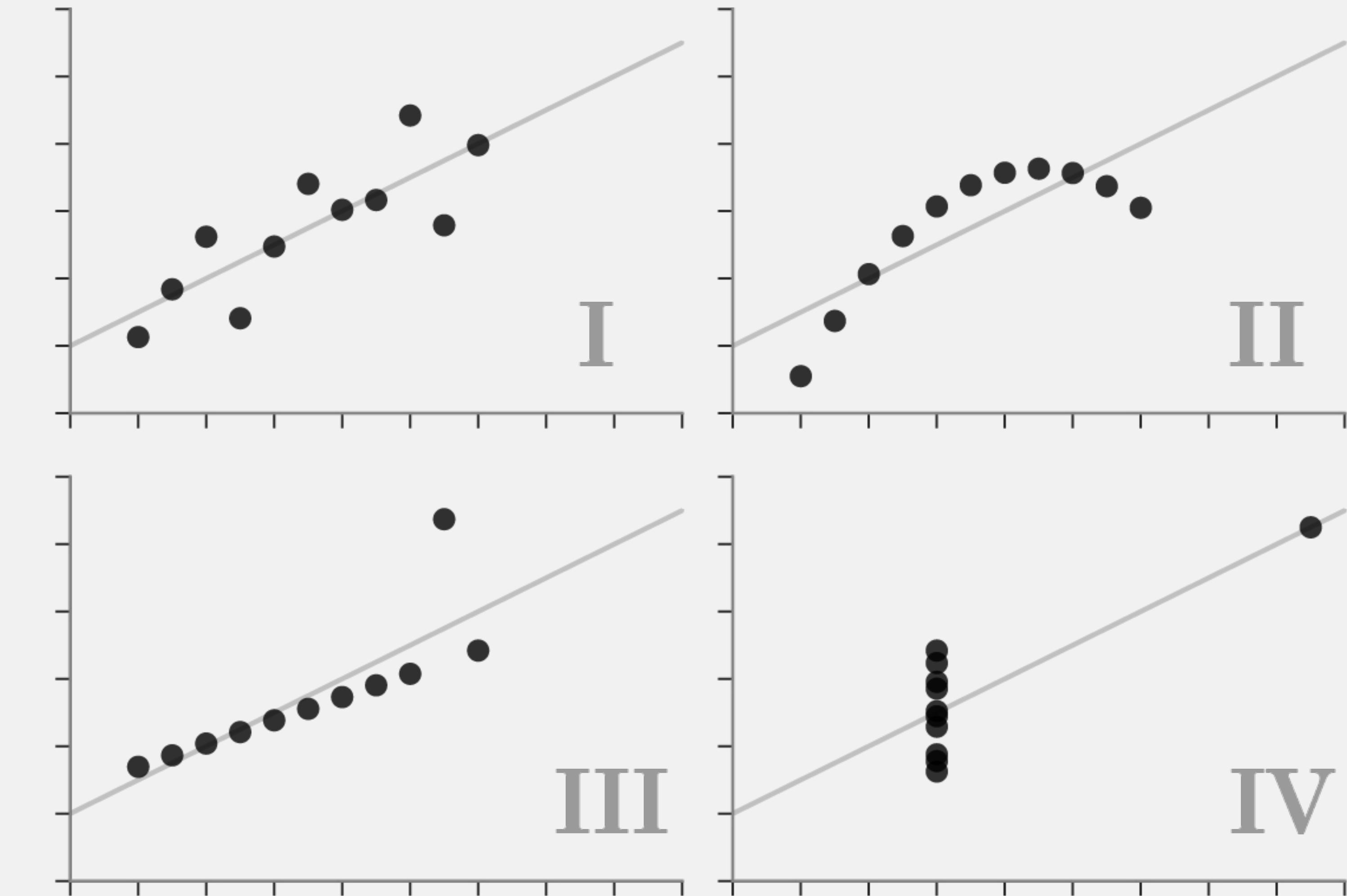
# Visualize Your Data



*“Same Stats, Different Graphs: Generating Datasets with Varied Appearance and Identical Statistics through Simulated Annealing”*  
by Justin Matejka & George Fitzmaurice, ACM SIGCHI Conference on Human Factors in Computing Systems 2017

# Anscombe's Quartet

**Each dataset has the same summary statistics  
but are visually distinct.**



*“Same Stats, Different Graphs: Generating Datasets with Varied Appearance and Identical Statistics through Simulated Annealing”*  
by Justin Matejka & George Fitzmaurice, ACM SIGCHI Conference on Human Factors in Computing Systems 2017

# Visualize Your Data

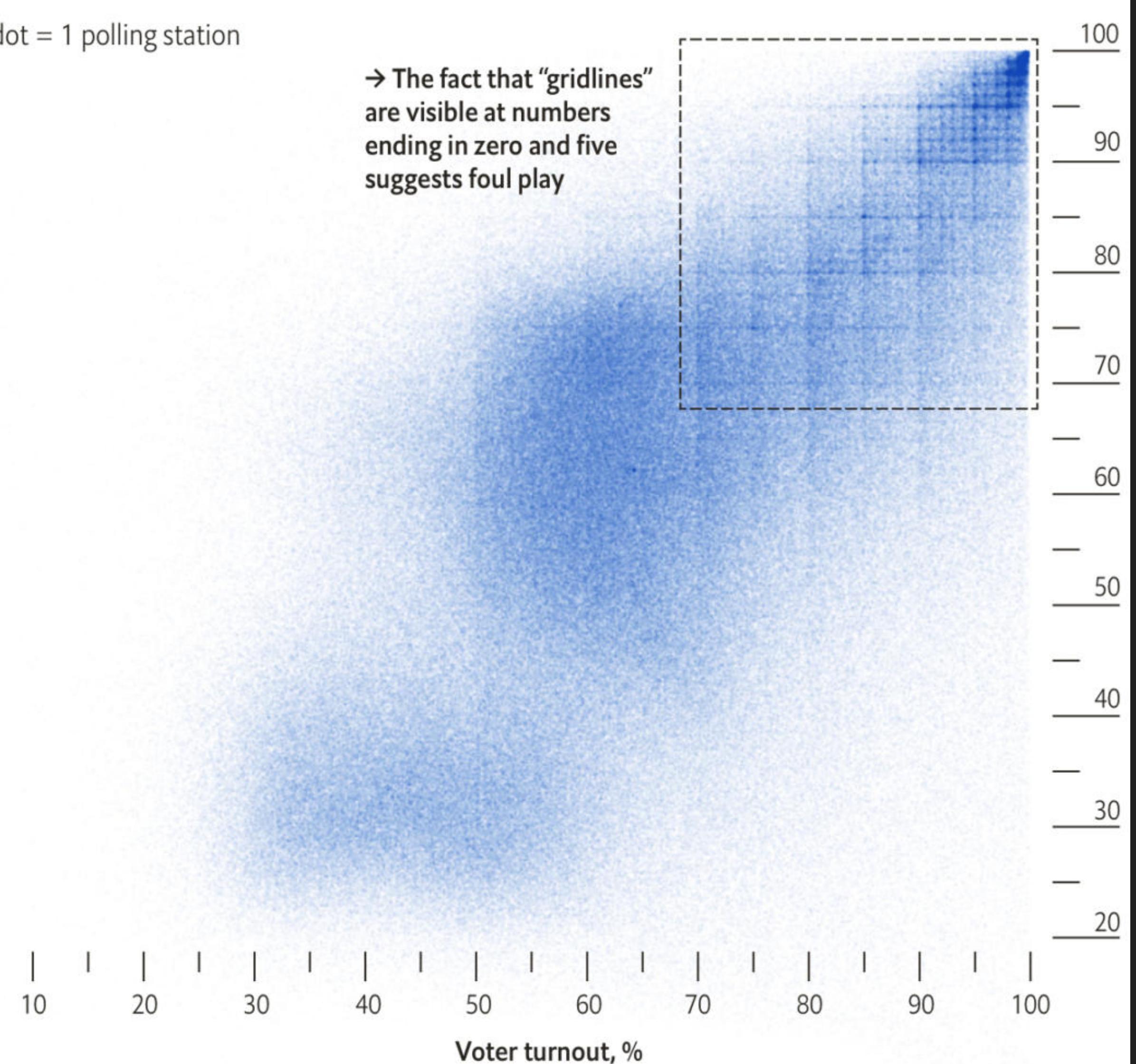
“When Dmitry Kobak and Sergey Shpilkin [...] analysed the results, they found that **an unusually high number of turnout and vote-share results were multiples of five** (eg, 50%, 55%, 60%), a tell-tale **sign of manipulation.**”

## Fair and square?

Russian federal elections, 2000-21

● 1 dot = 1 polling station

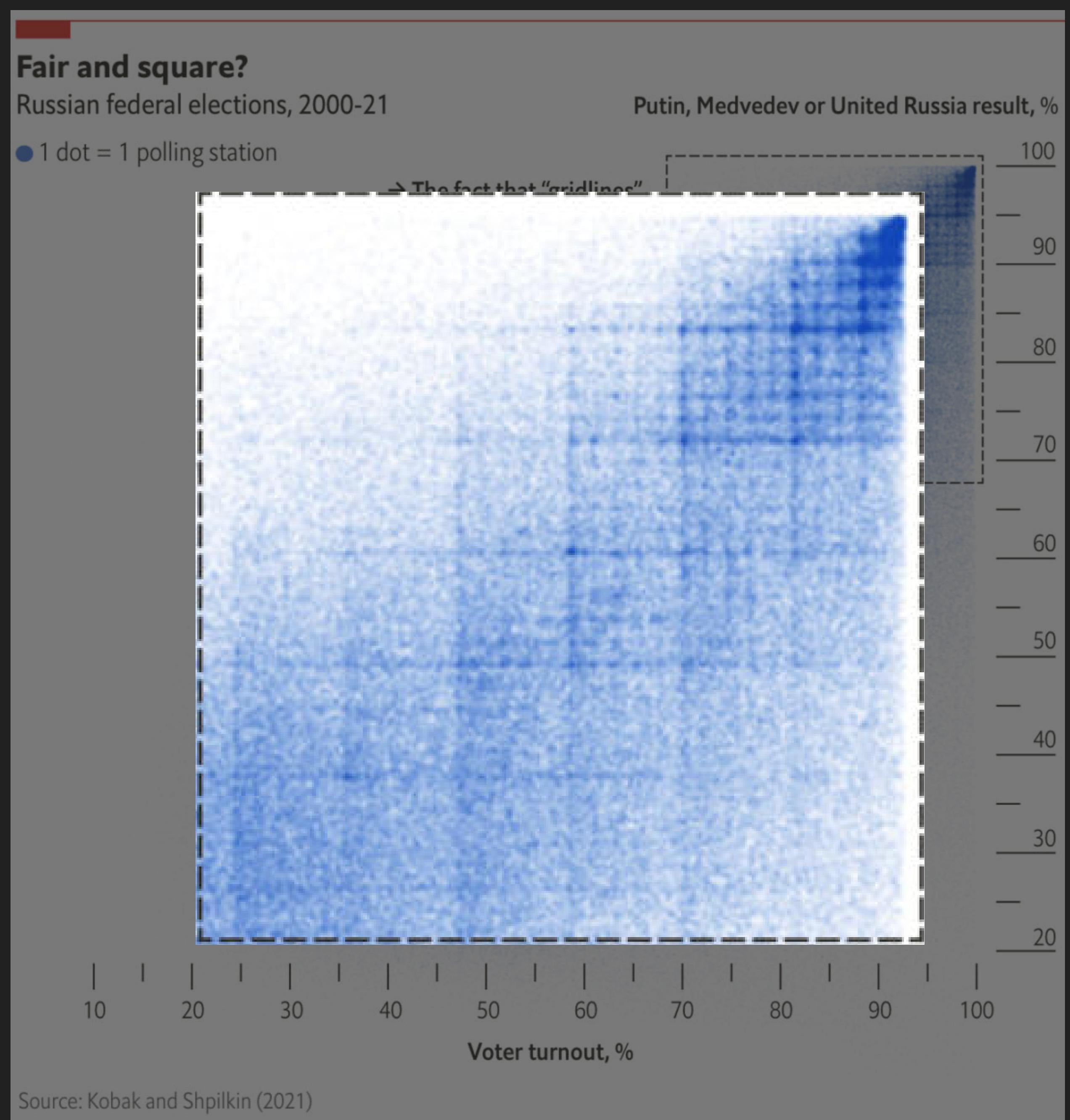
→ The fact that “gridlines” are visible at numbers ending in zero and five suggests foul play



Source: Kobak and Shpilkin (2021)

# Visualize Your Data

“When Dmitry Kobak and Sergey Shpilkin [...] analysed the results, they found that **an unusually high number of turnout and vote-share results were multiples of five** (eg, 50%, 55%, 60%), a tell-tale **sign of manipulation.**”

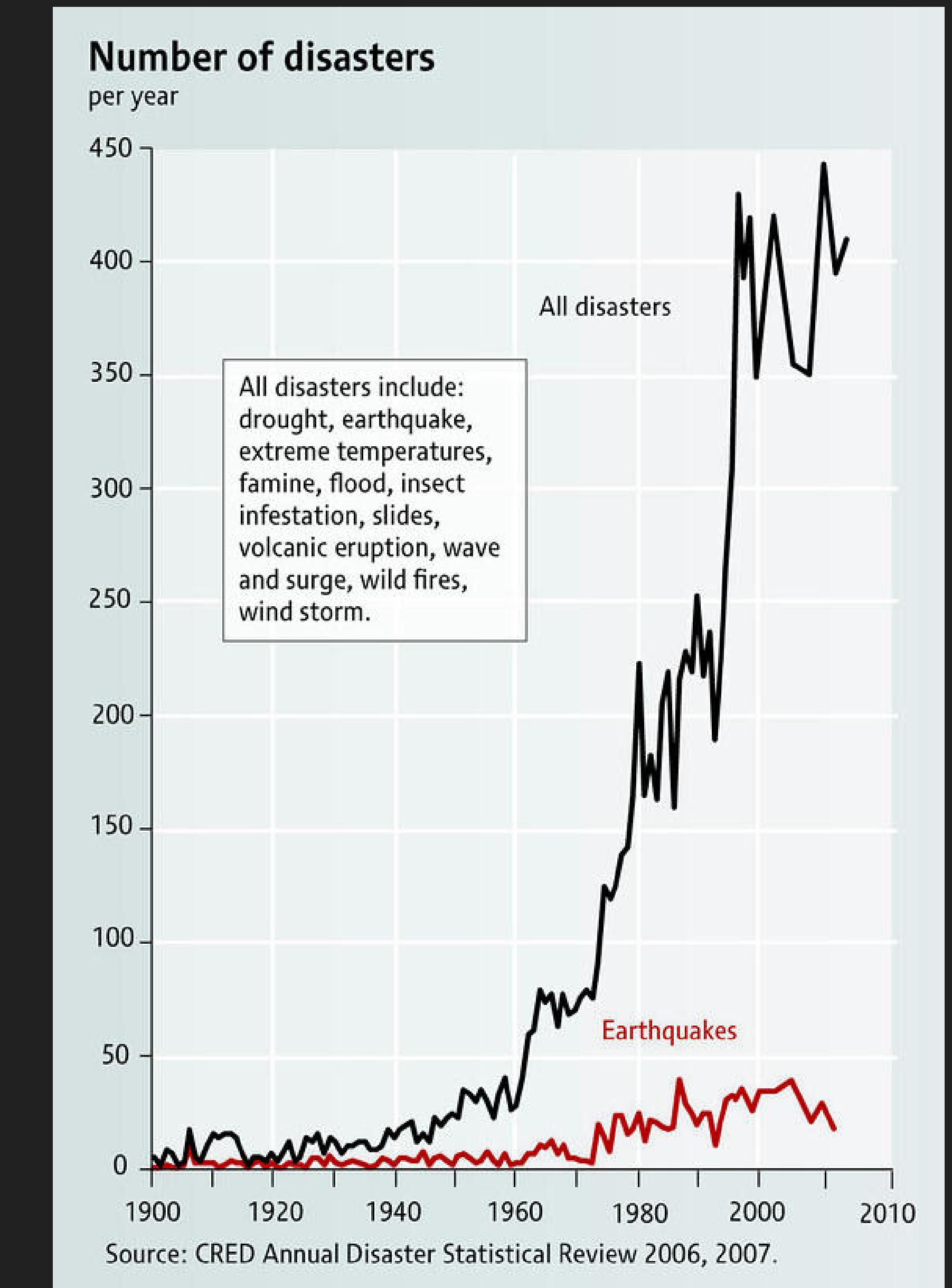


Our data is never a perfect  
reflection of the real world.



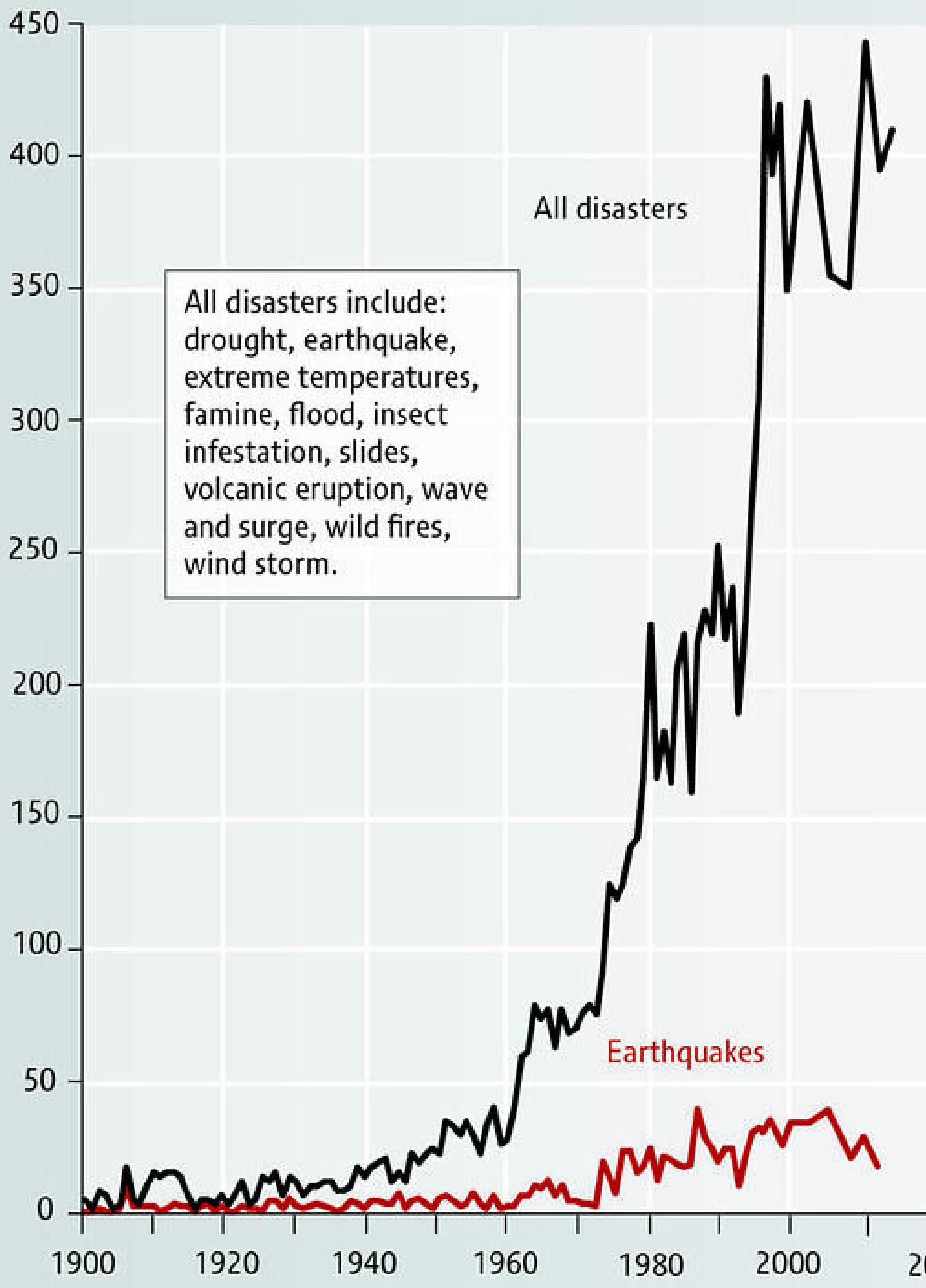
# Our data is never a perfect reflection of the real world.

- **only a subset:** not crime but reported crime
- **collected by humans:** guesstimation, precision and errors
- **collected by machines:** precisions and errors



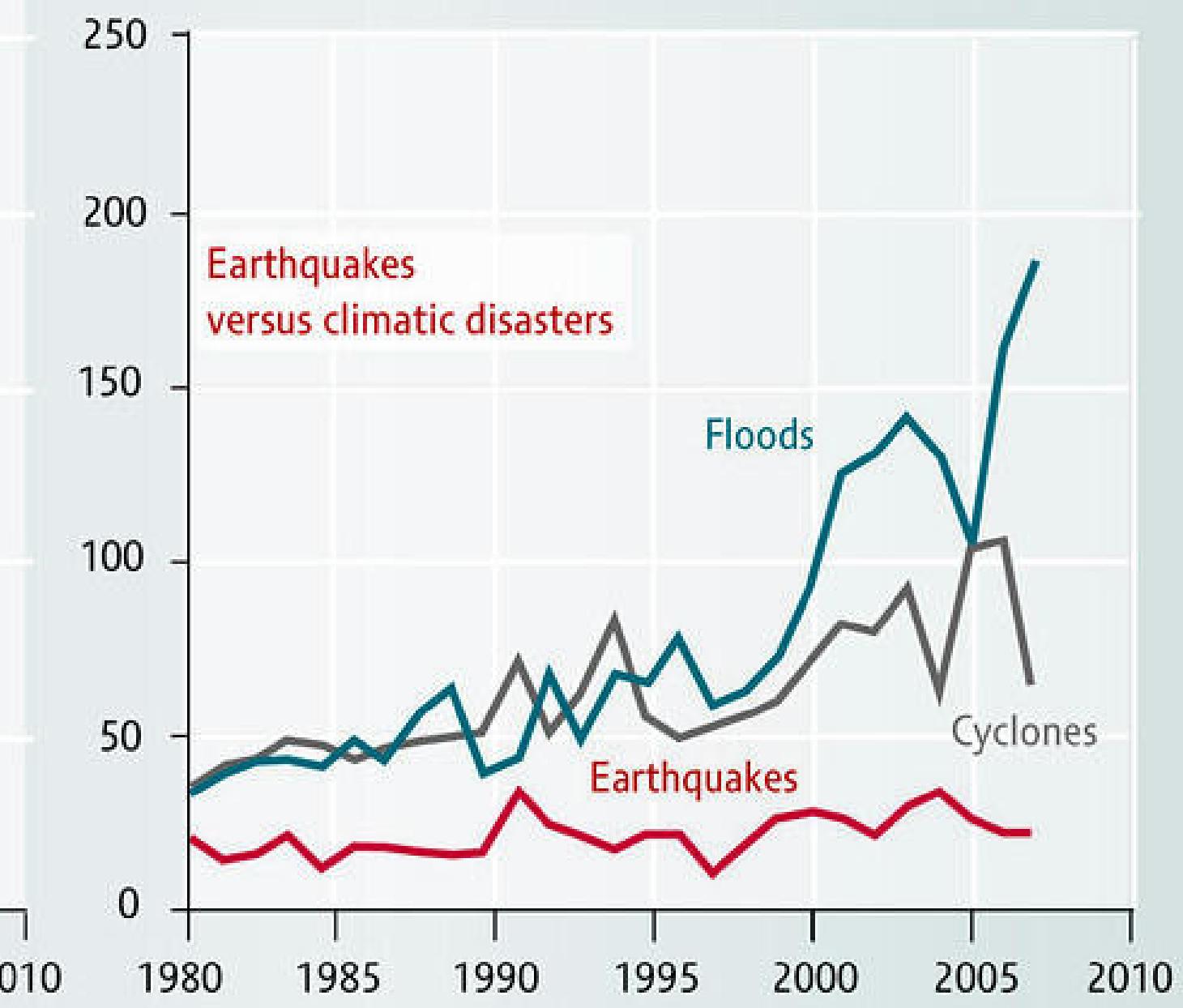
## Number of disasters

per year

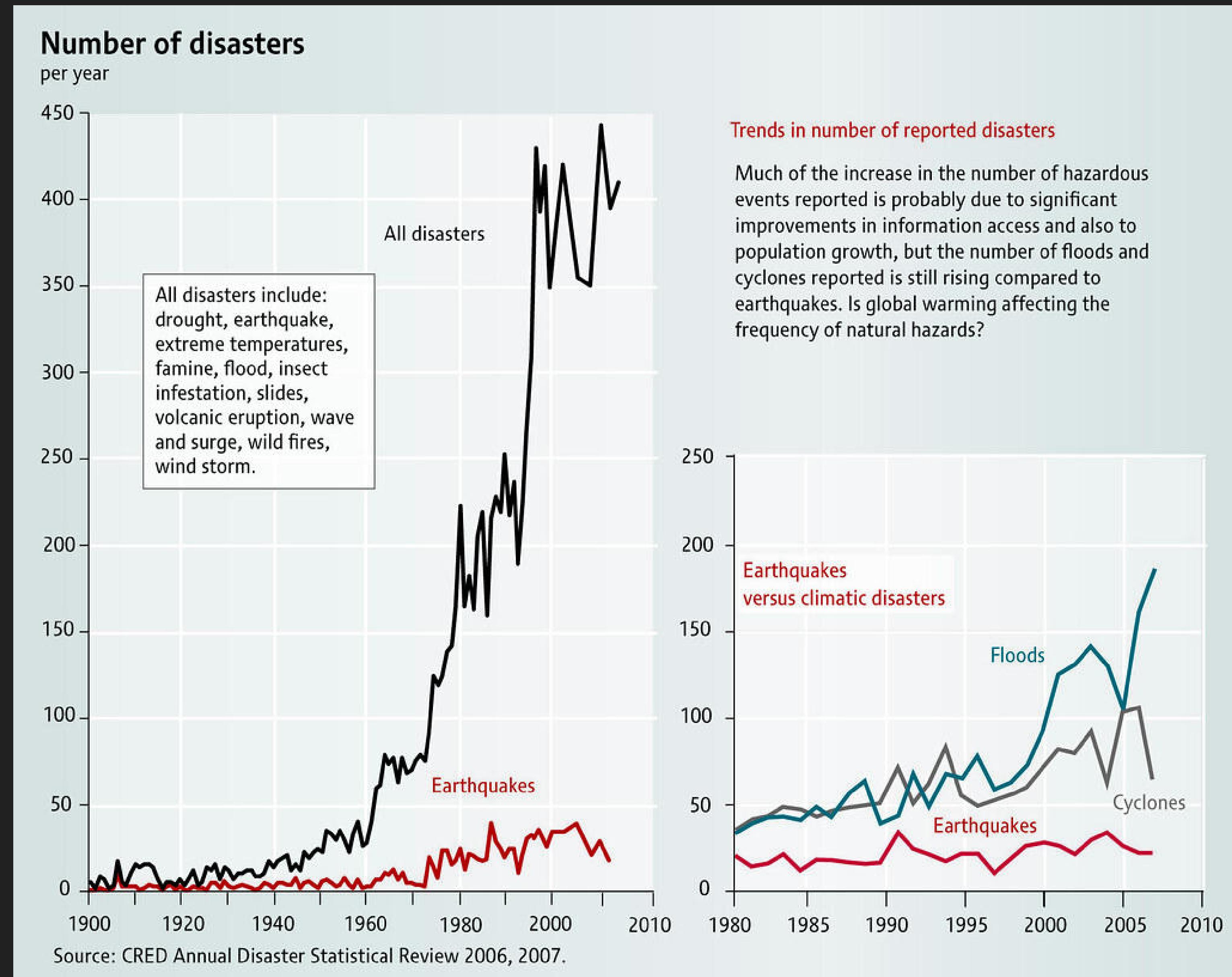


### Trends in number of reported disasters

Much of the increase in the number of hazardous events reported is probably due to significant improvements in information access and also to population growth, but the number of floods and cyclones reported is still rising compared to earthquakes. Is global warming affecting the frequency of natural hazards?

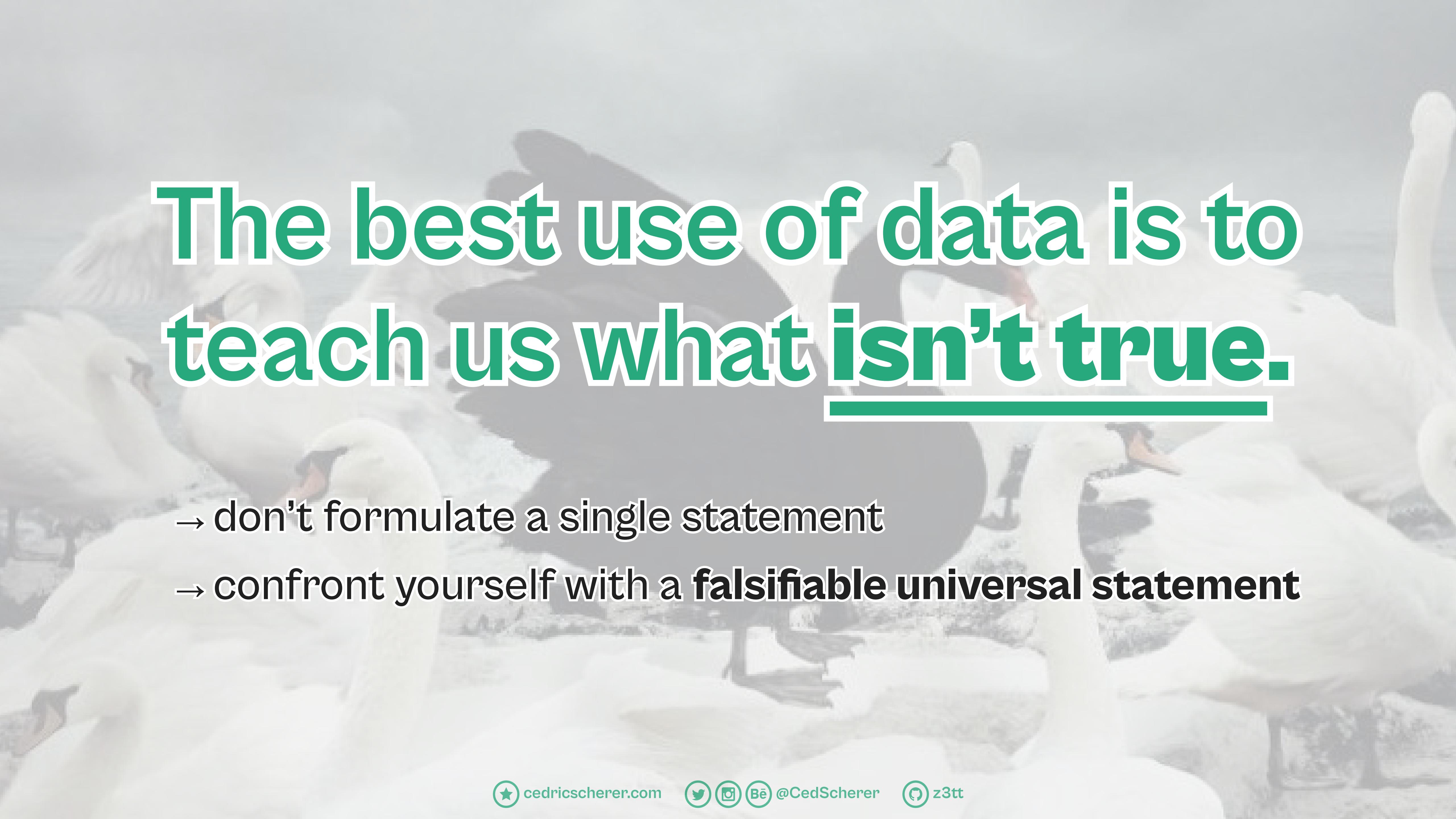


**“Much of the increase  
of hazardous events  
reported is probably  
due to significant  
improvements in  
information access”**



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**



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.”

# STORY

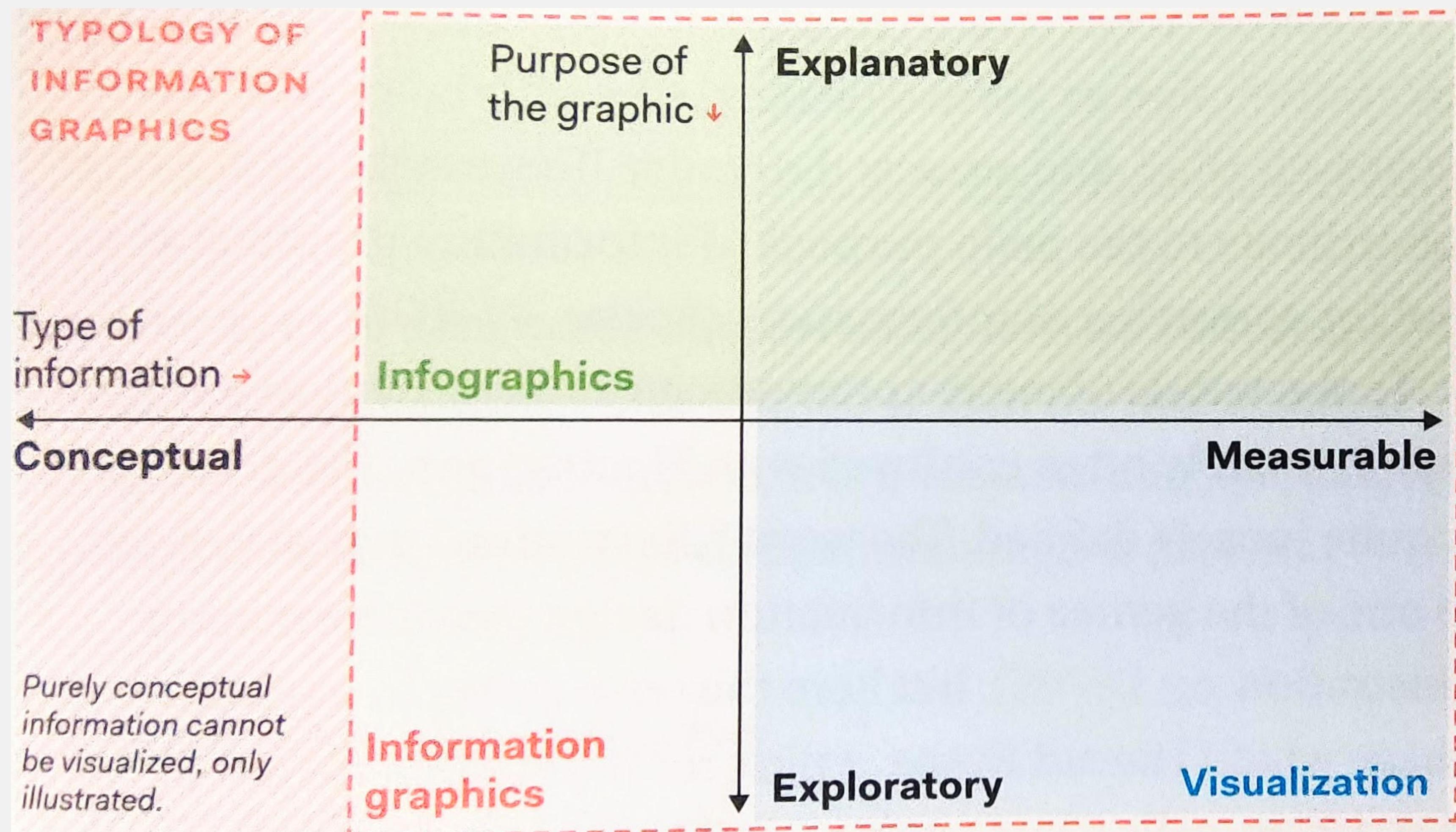
---

Be clear about the message of your graphic



# Typology of Information Graphics

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



# 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



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# 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:** facilitate discovery <> communicate information

**“A common truism about information visualization is that it is primarily about ‘showing the data’. [...]”**

While this might be true for scientific (or financial, or many other) application fields, there are many good uses of visualization that go beyond a precise, ‘neutral’ display of data.“

*Moritz Stefaner*

"Visualizations can be designed and experienced in various ways, by people of various backgrounds, and in various circumstances. That's why **reflecting on the purpose of a visualization is paramount before we design it—or before we critique it.**"

*Alberto Cairo*

*Excerpt from the foreword to "Data Sketches" by Nadieh Bremer & Shirley Wu (CRC Press 2021)*



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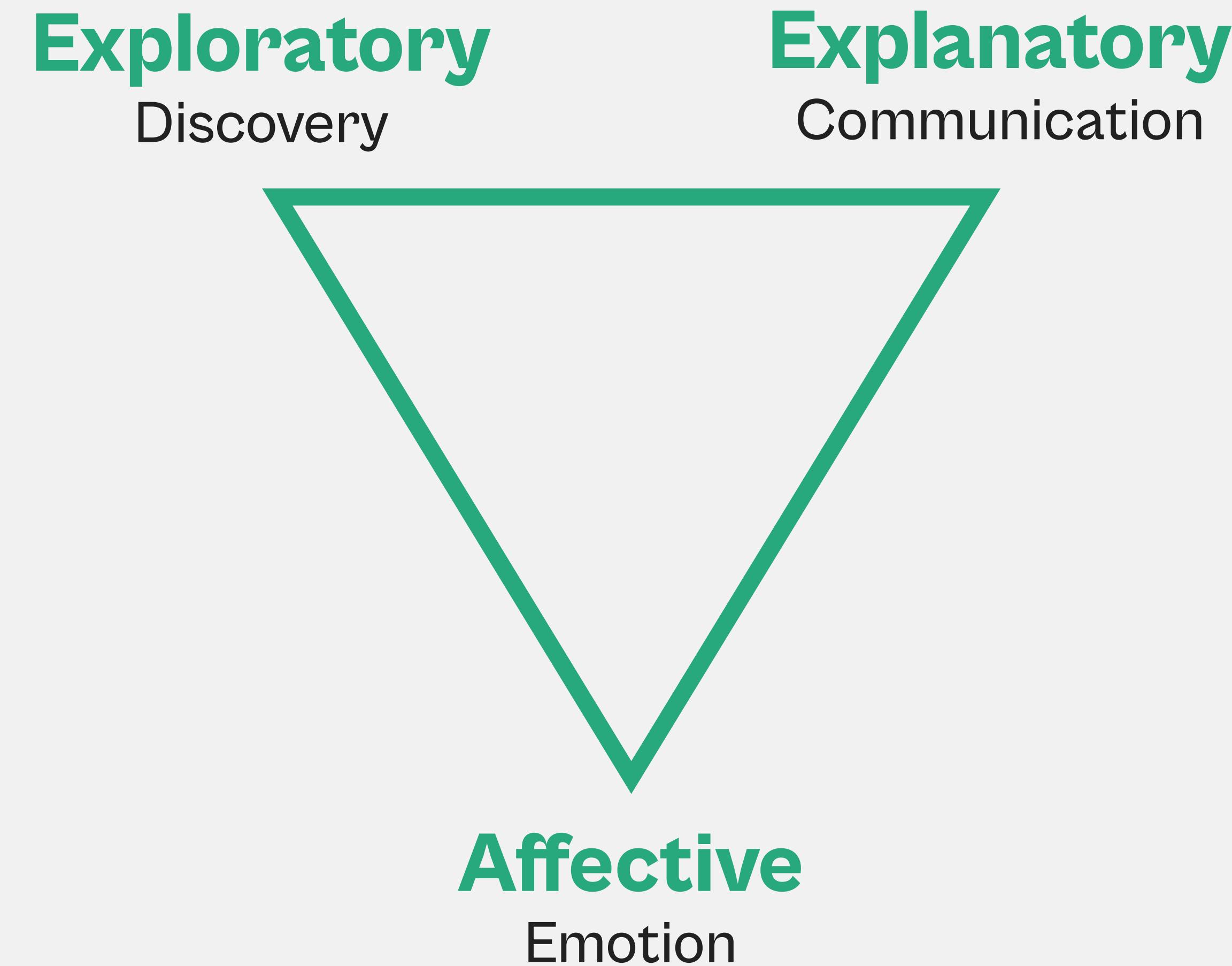


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# What is the purpose?



The “Vertices of Visualization” by Alberto Cairo,  
personal communication (modified version)

# What is the purpose?

**Exploratory**  
Discovery

**Explanatory**  
Communication

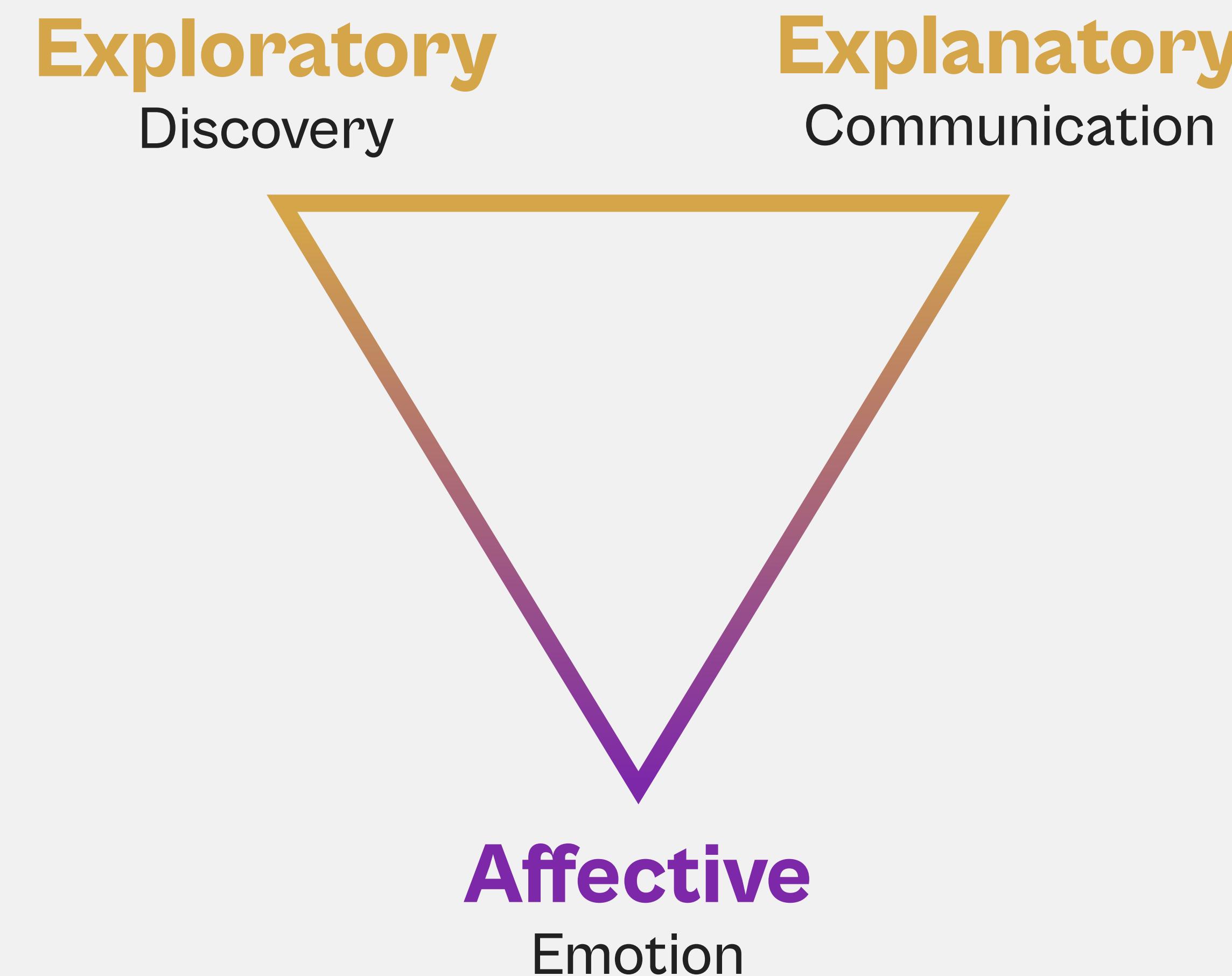
**Priority:**  
efficient + effective  
**Aim:**  
functional



**Affective**  
Emotion

The “Vertices of Visualization” by Alberto Cairo,  
personal communication (modified version)

# What is the purpose?



**Priority:**  
efficient + effective

**Response:**  
functional



**Priority:**  
creative + novel

**Response:**  
emotional

The “Vertices of Visualization” by Alberto Cairo,  
personal communication (modified version)

# Who is my audience?



Which story is **interesting** for them?



# Who is my audience?

- 🤩 Which story is **interesting** for them?
- 🤔 Which variables are **meaningful** to them?

# Who is my audience?

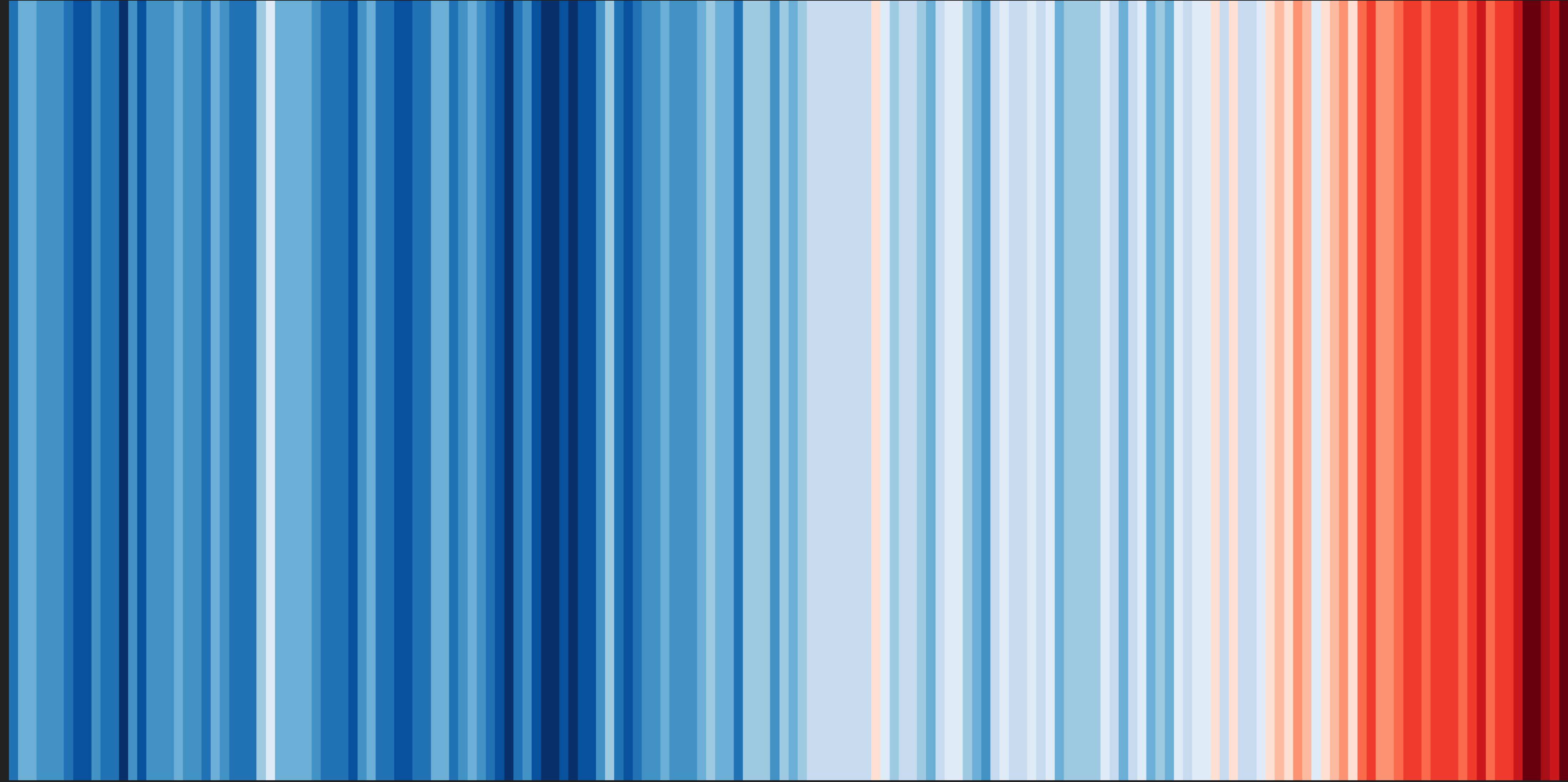
- 🤩 Which story is **interesting** for them?
- 🤔 Which variables are **meaningful** to them?
- 🤓 What are **relevant** details to include?

# Who is my audience?

- 🤩 Which story is **interesting** for them?
- 🤔 Which variables are **meaningful** to them?
- 🤓 What are **relevant** details to include?
- 👀 How will they **encounter** the visualization?

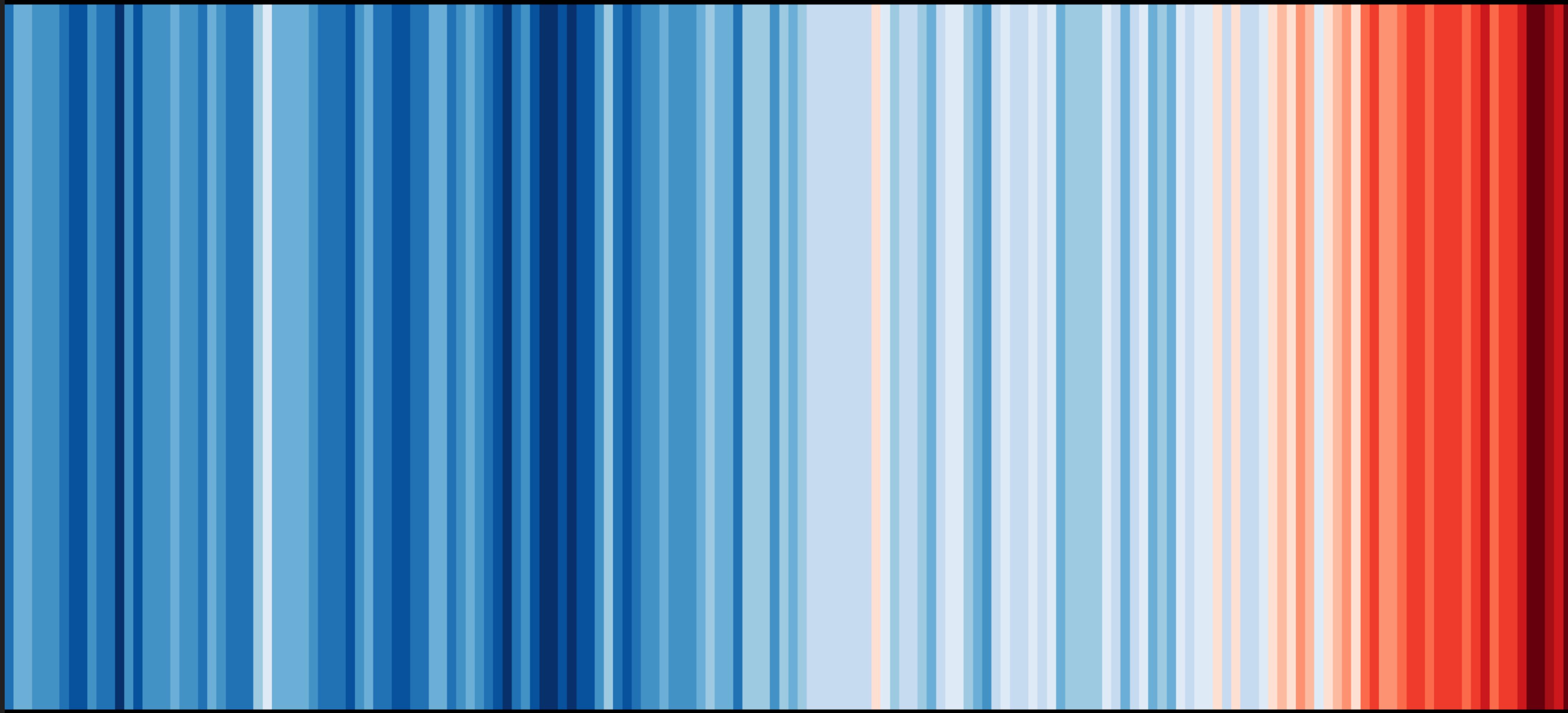
# Who is my audience?

- 🤩 Which story is **interesting** for them?
- 🤔 Which variables are **meaningful** to them?
- 🤓 What are **relevant** details to include?
- 🔍 How will they **encounter** the visualization?
- 😢 **Do I need a visualization at all?**



*Warming Stripes* by Ed Hawkins

# Global temperature change (1850-2019)



1860

1890

1920

1950

1980

2010

## 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.

1860

1890

1920

1950

1980

2010

*Warming Stripes by Ed Hawkins*

These graphics are specifically designed to [...] **start conversations** about our warming world and the risks of climate change.

» 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.

1860

1890

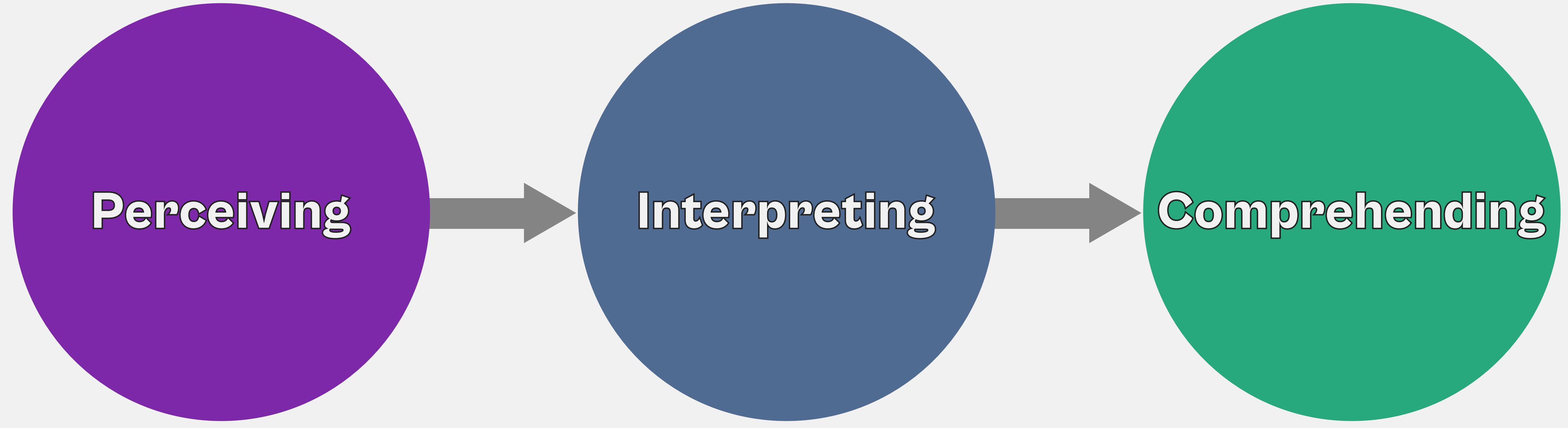
1920

1950

1980

2010

*Warming Stripes by Ed Hawkins*



Visualiser Control

Viewer Control

*Scheme by Andy Kirk*



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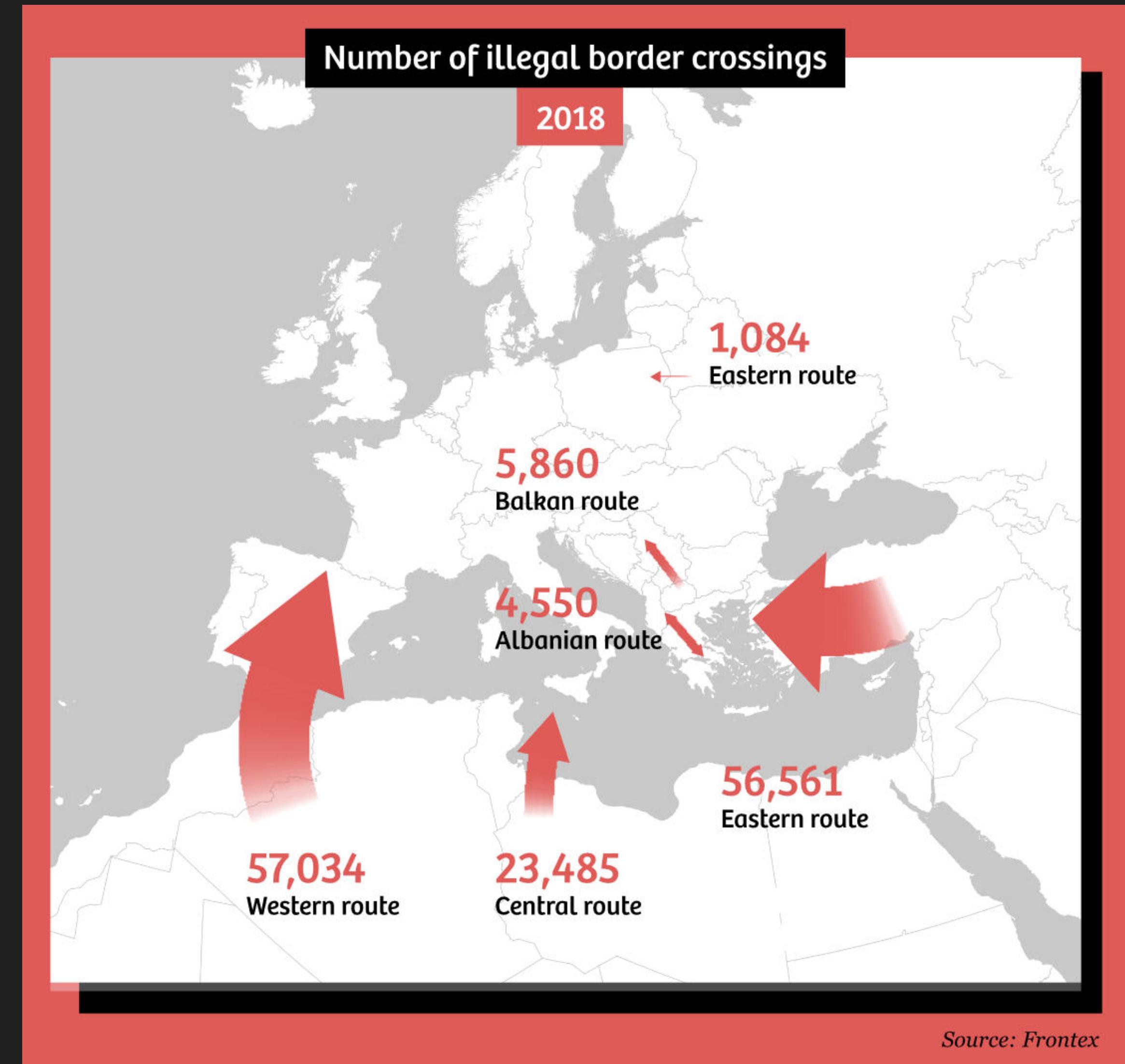
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# GOAL

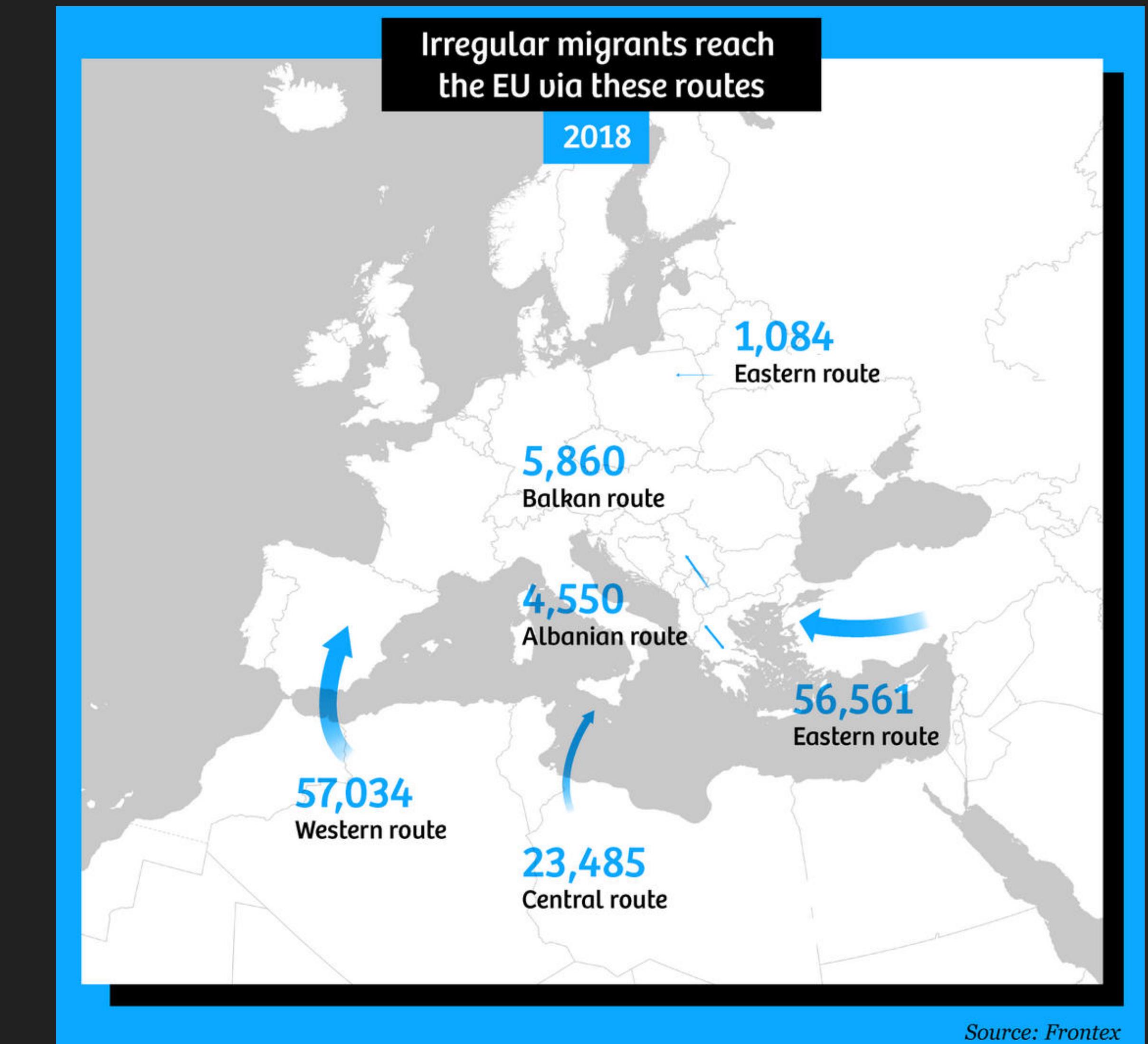
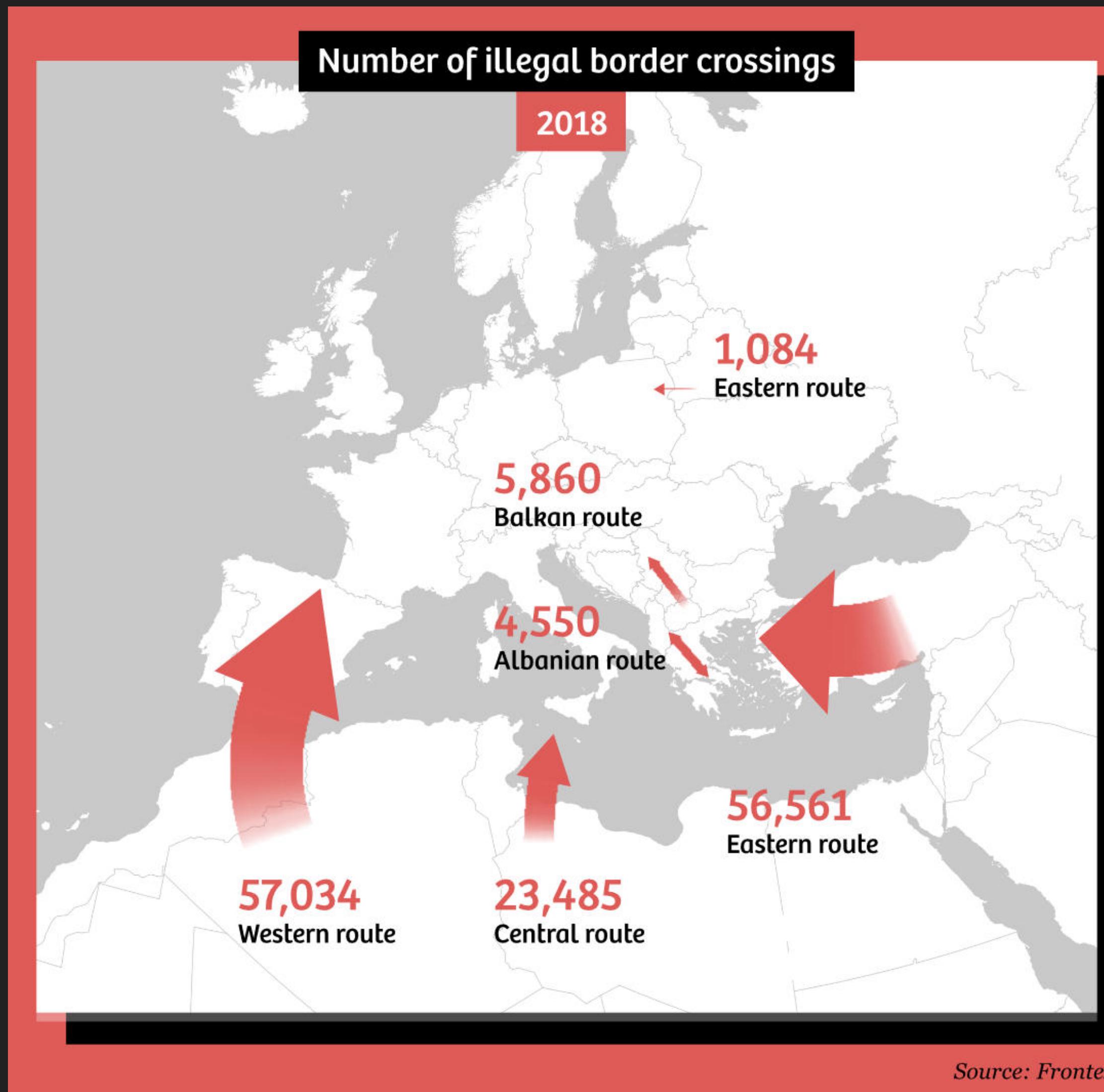
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Select charts that successfully tell your story

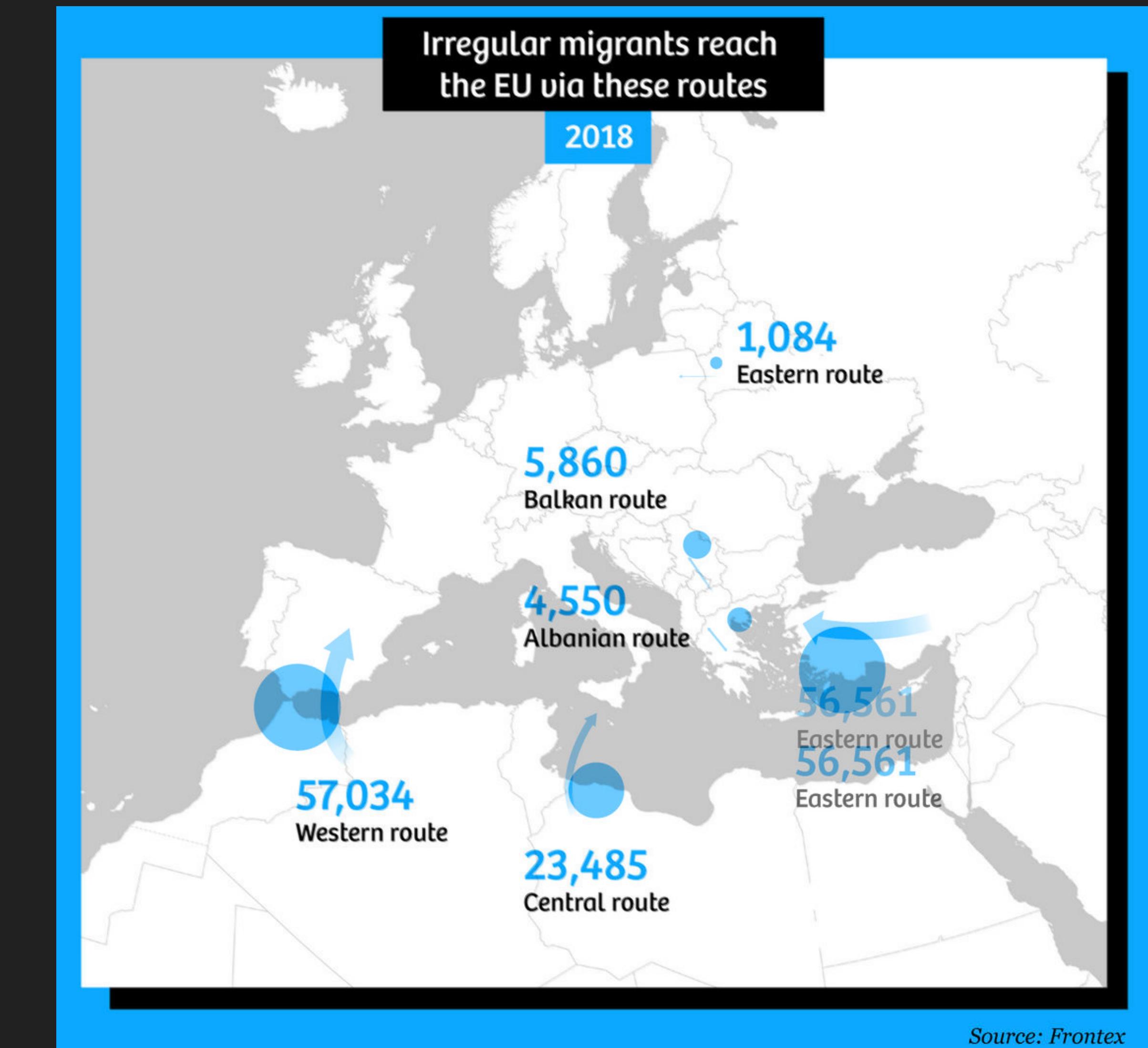
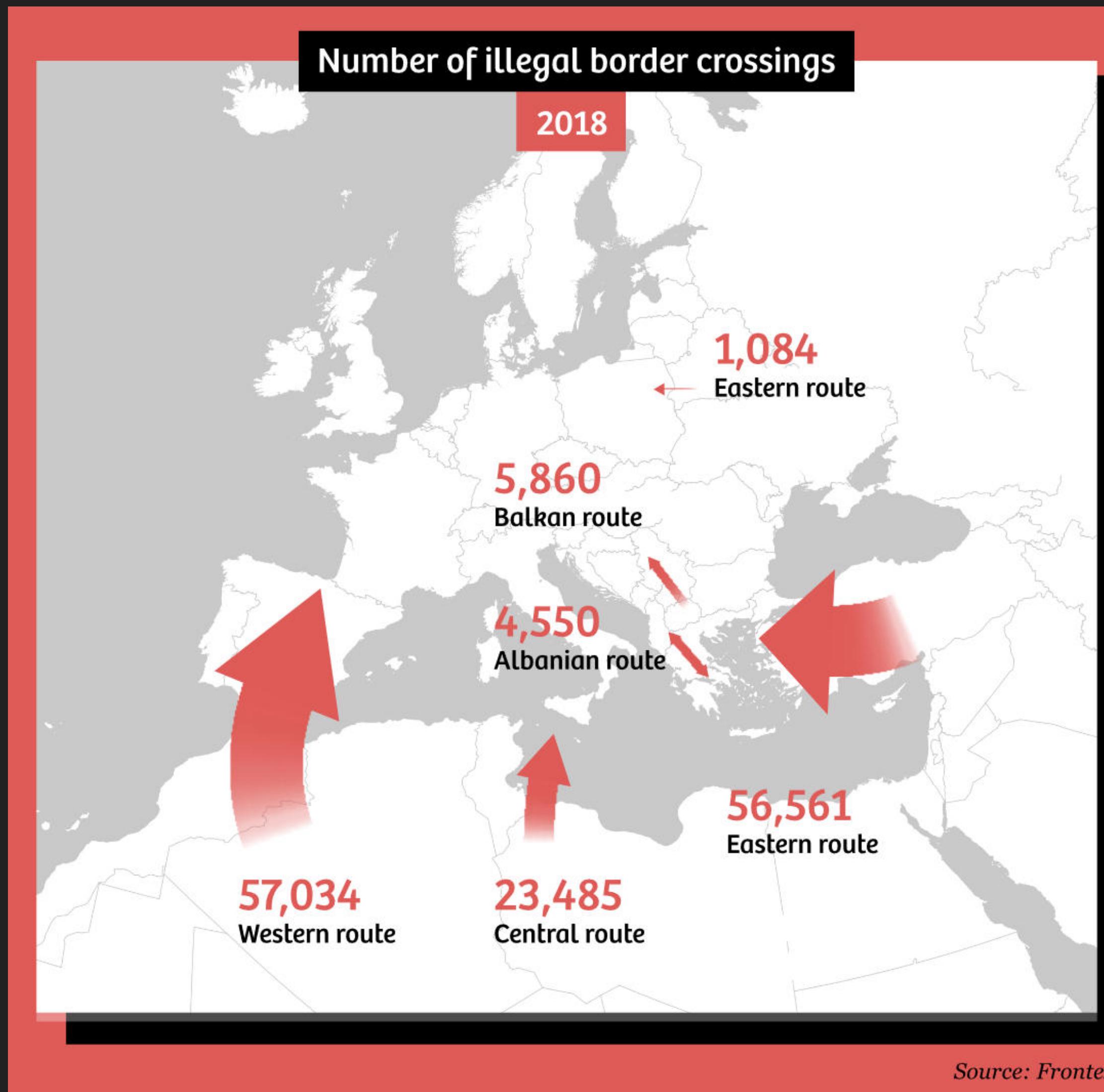




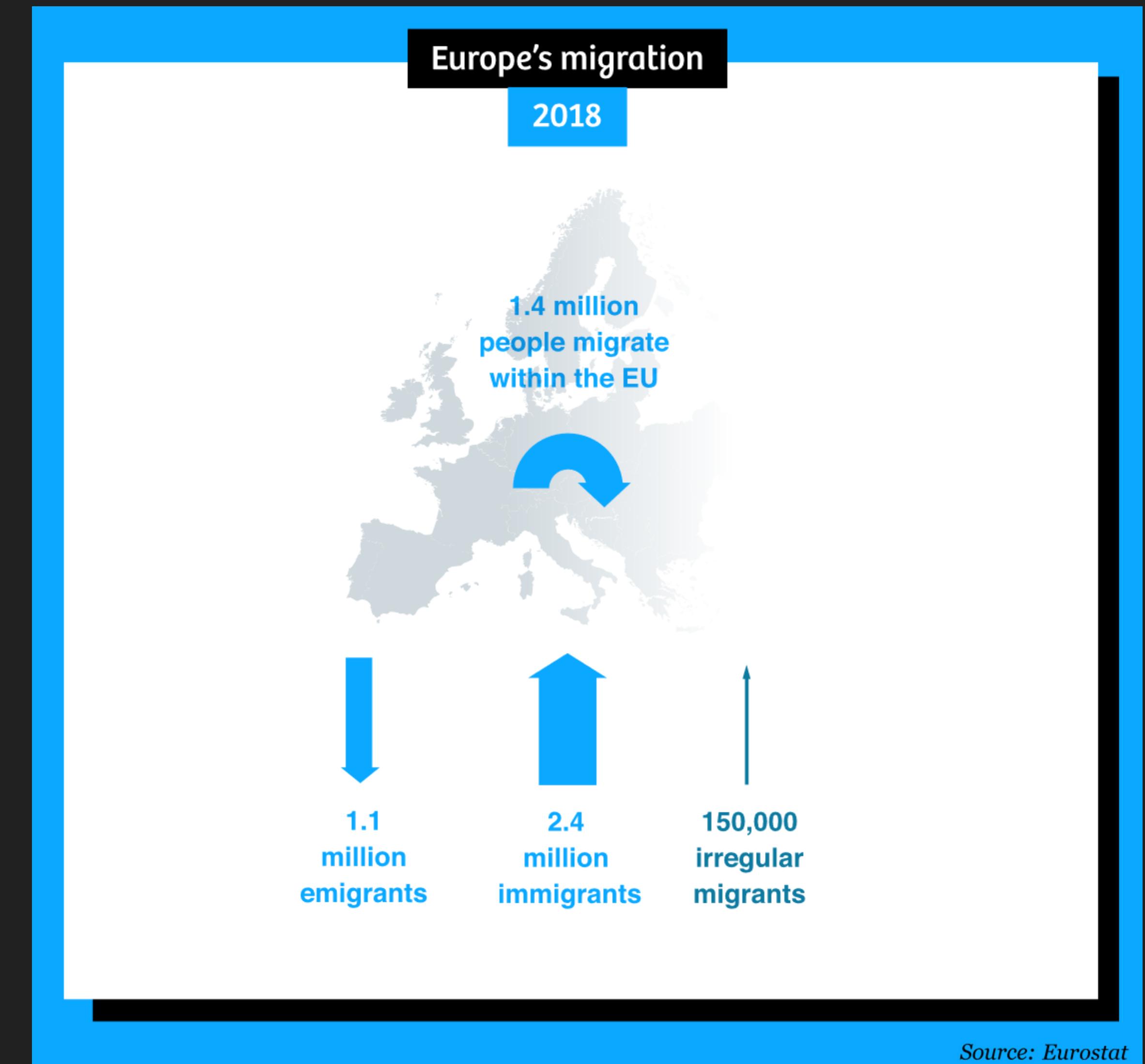
*“How maps in the media make us more negative about migrants” by Maite Vermeulen, Leon de Korte & Henk van Houtum*



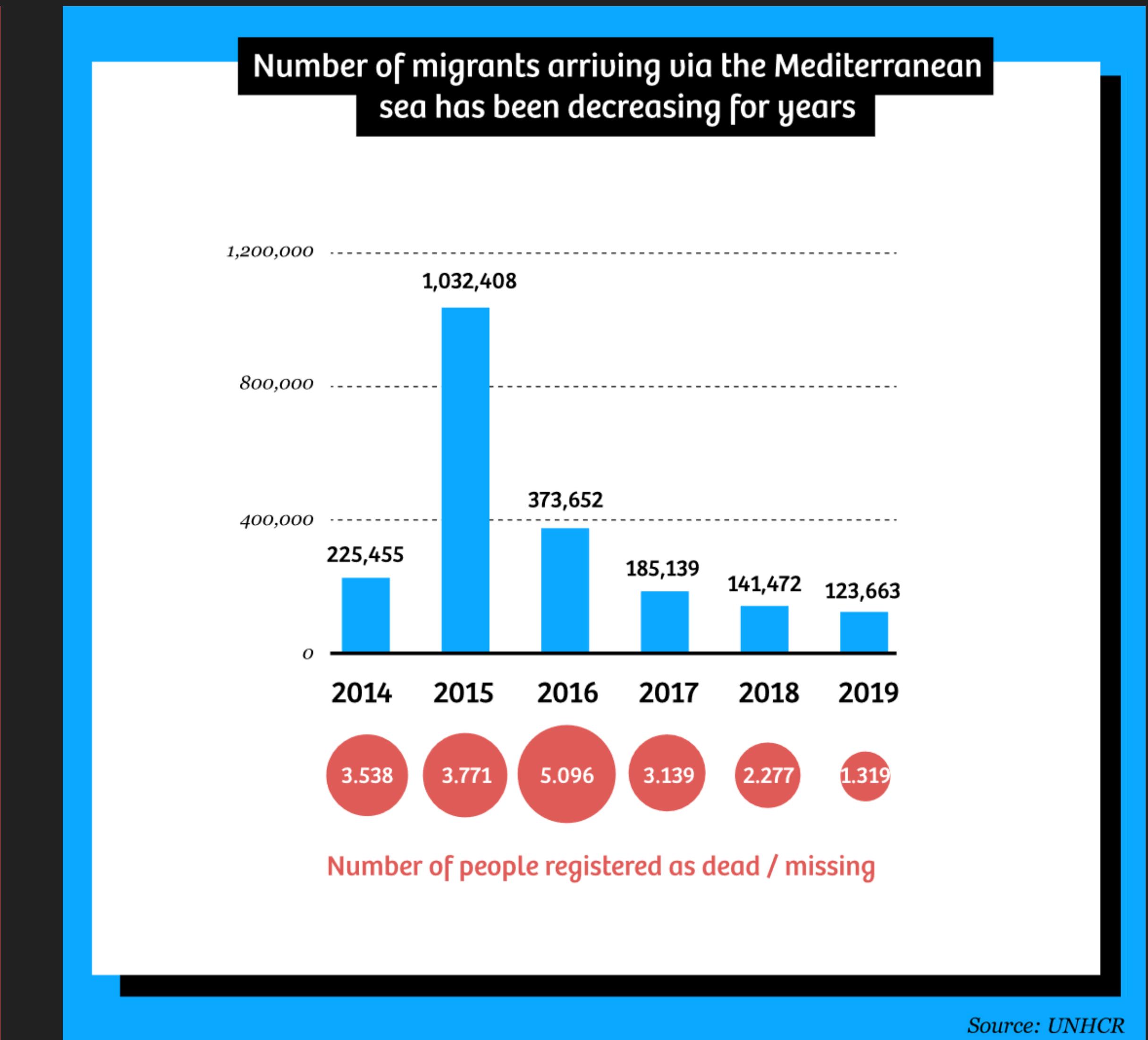
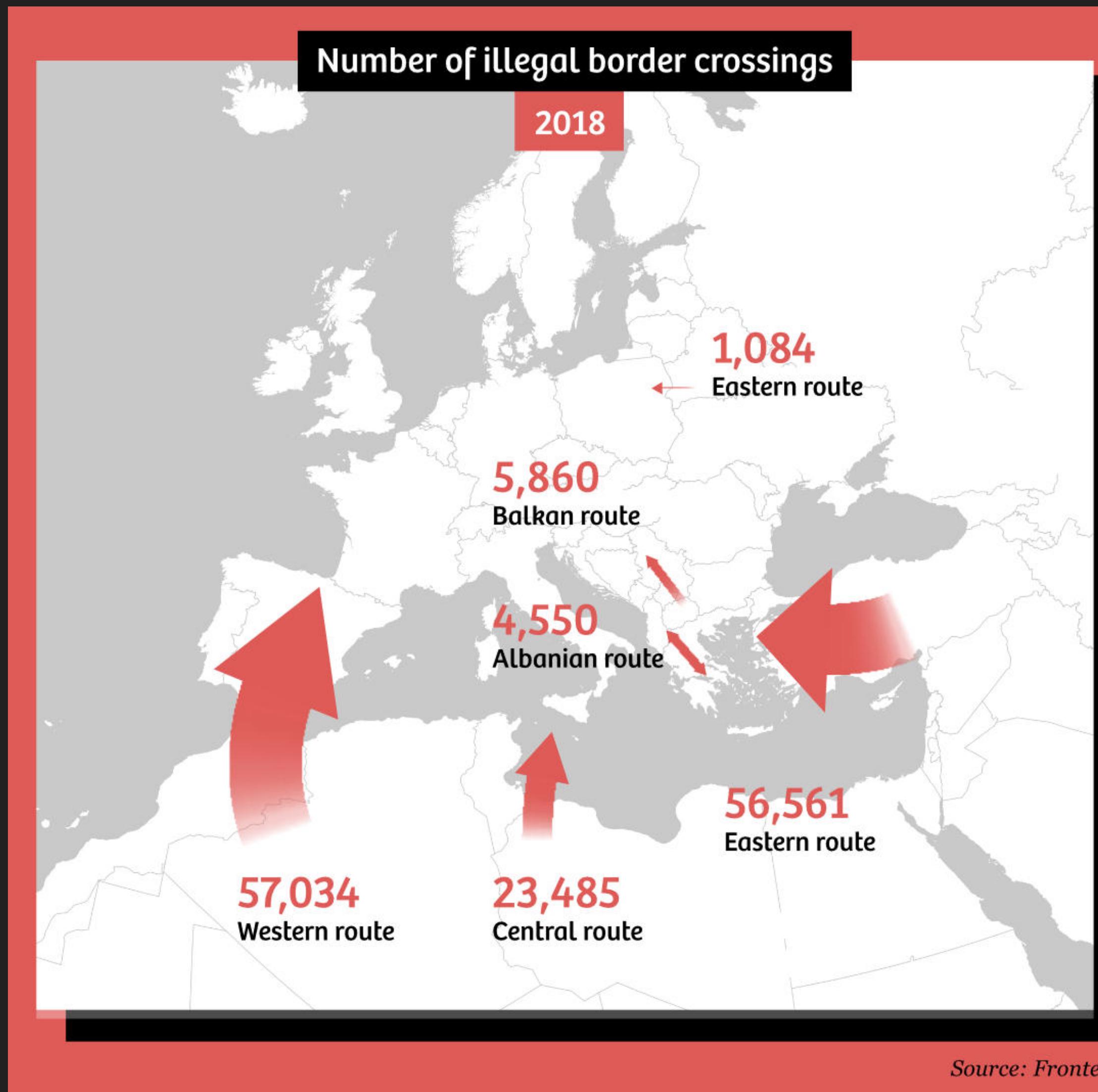
*“How maps in the media make us more negative about migrants” by Maite Vermeulen, Leon de Korte & Henk van Houtum*



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

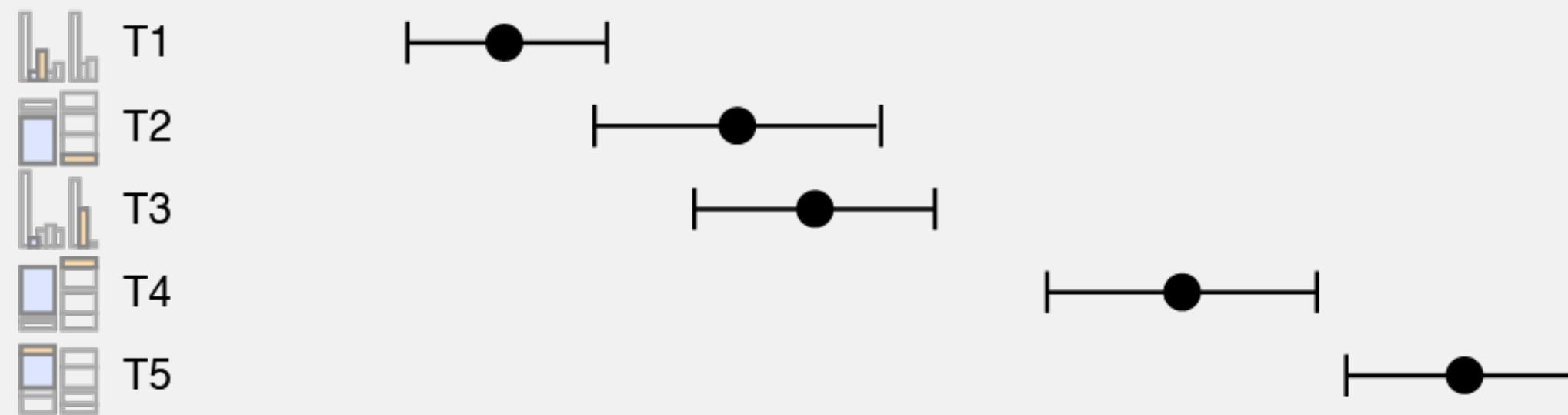


*“How maps in the media make us more negative about migrants” by Maite Vermeulen, Leon de Korte & Henk van Houtum*

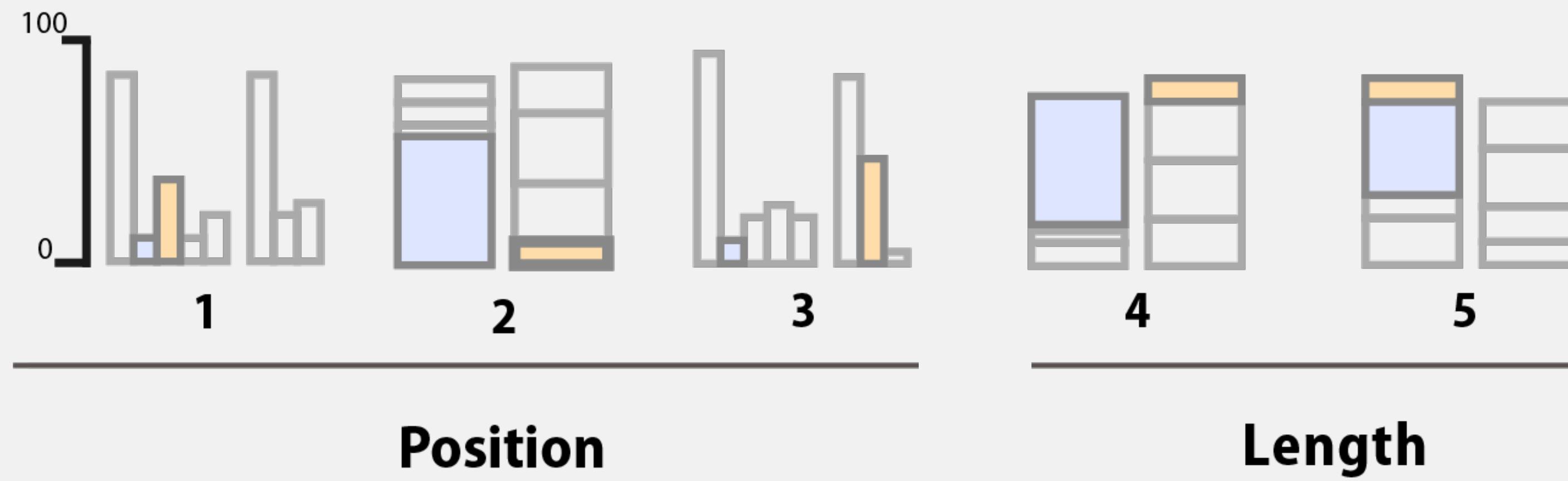


*“How maps in the media make us more negative about migrants” by Maite Vermeulen, Leon de Korte & Henk van Houtum*

### Cleveland & McGill's Results

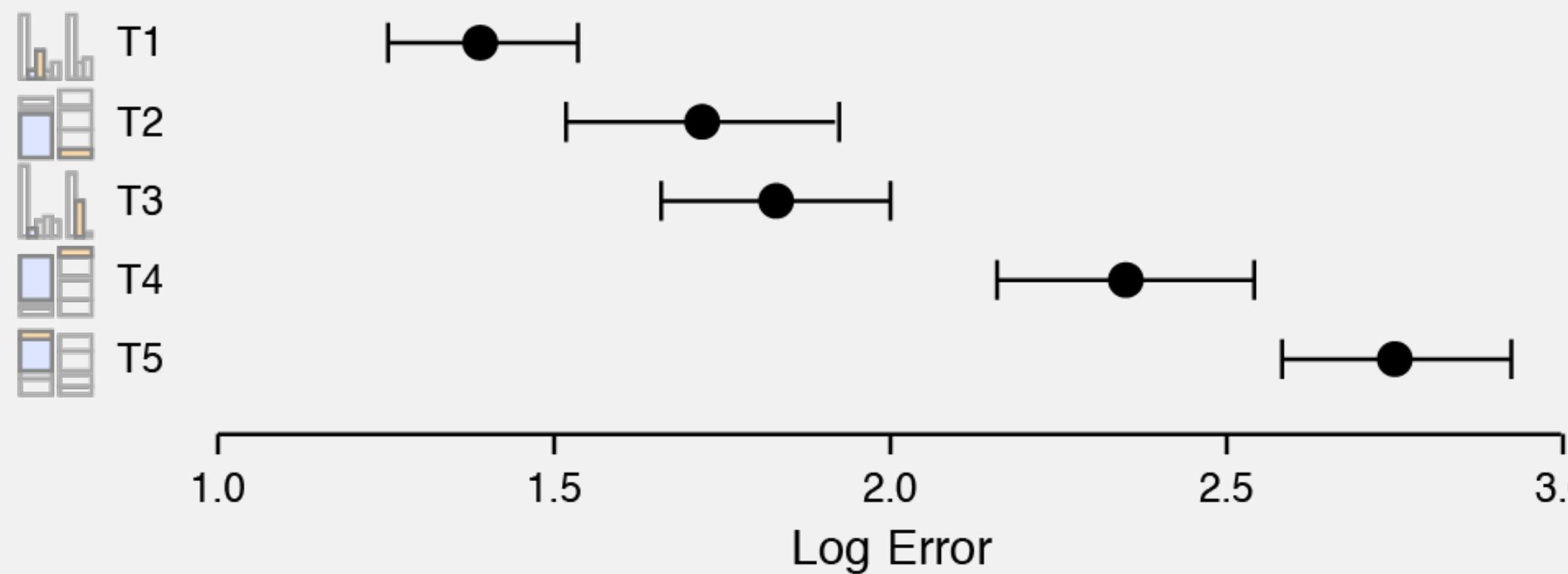


1.0      1.5      2.0      2.5      3.0  
Log Error

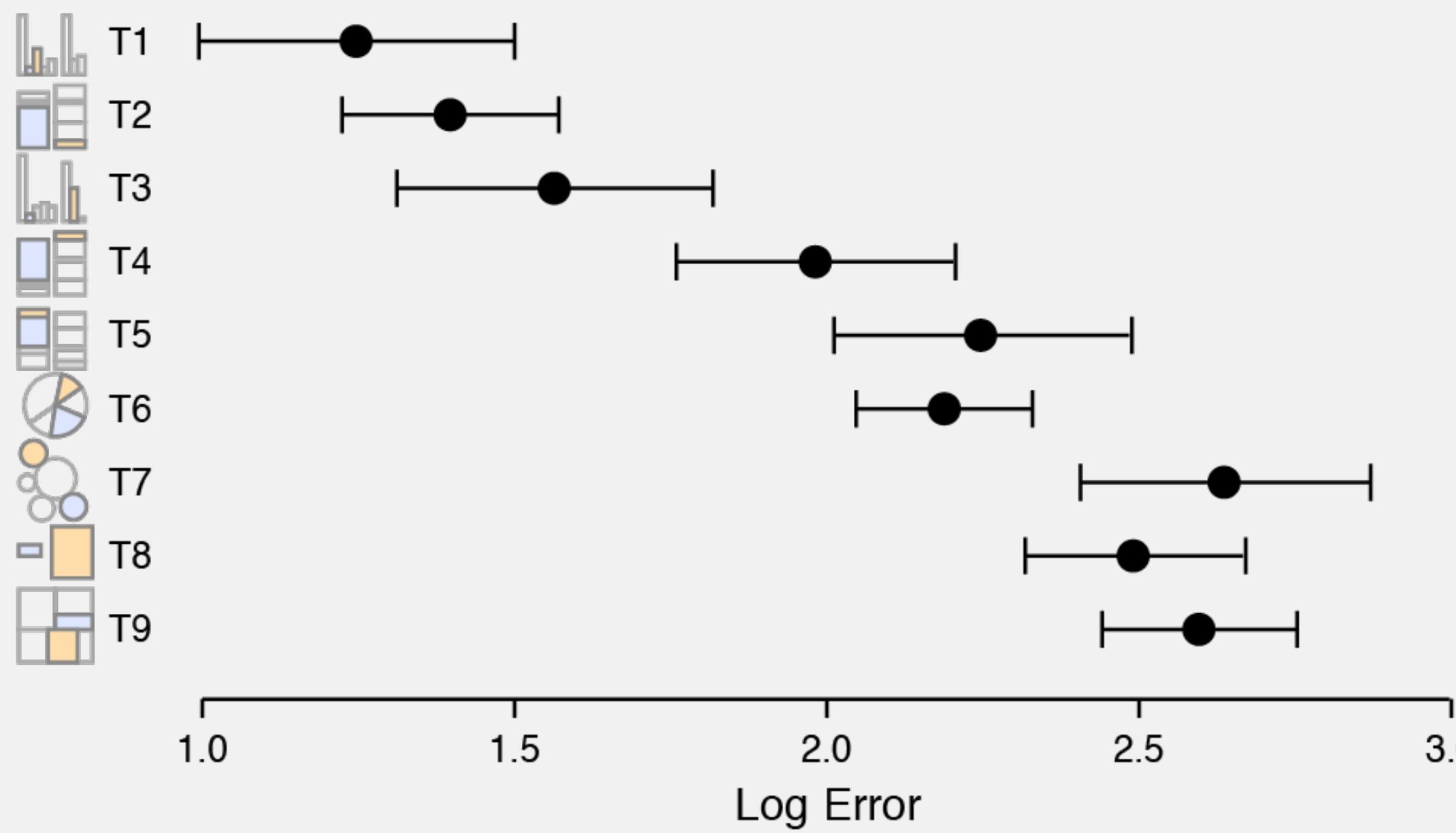


Source: Kieran Healy's ["Data Visualization: A Practical Introduction"](#); results based on Heer and Bostock, following Cleveland and McGill

### Cleveland & McGill's Results

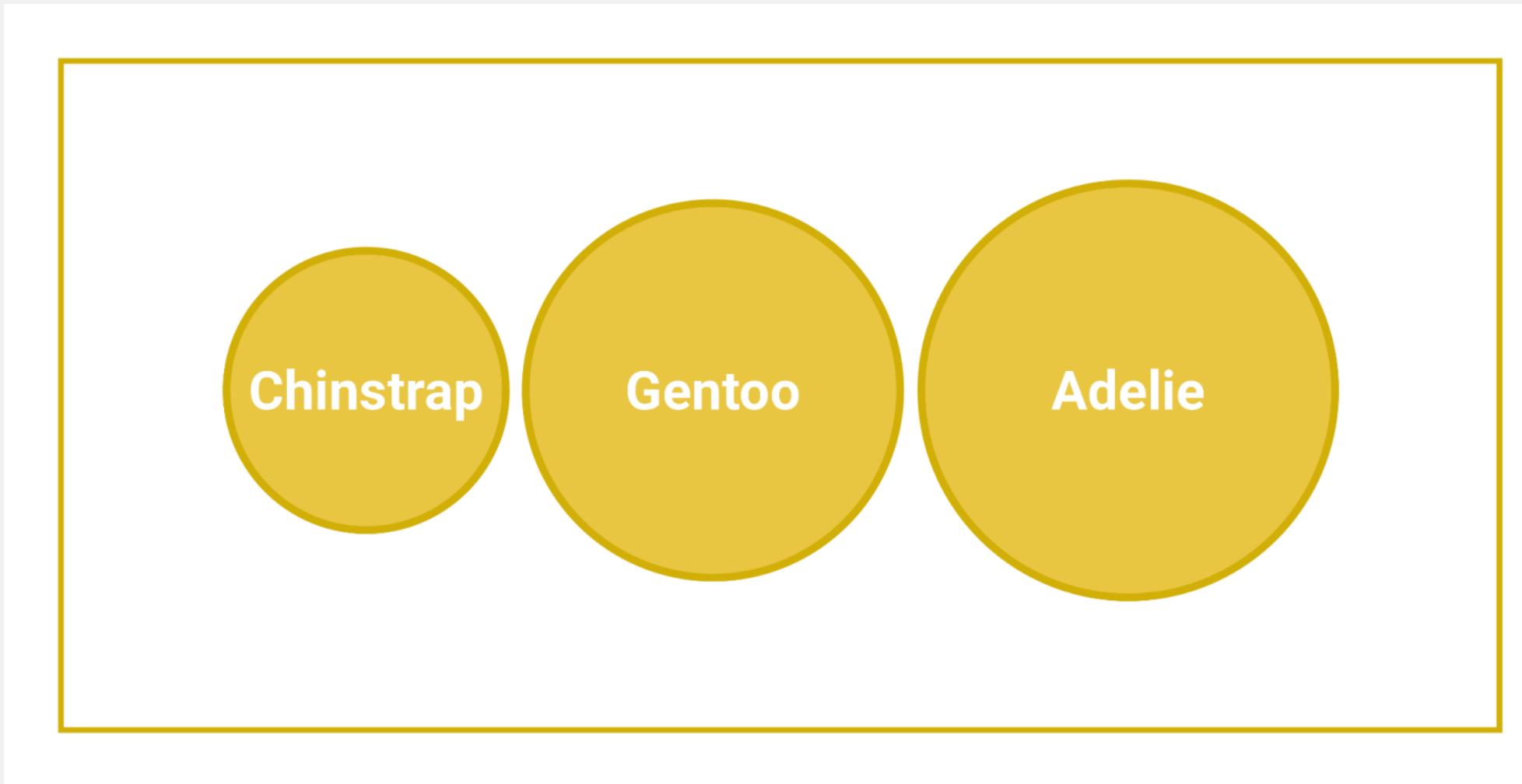


### Crowdsourced Results

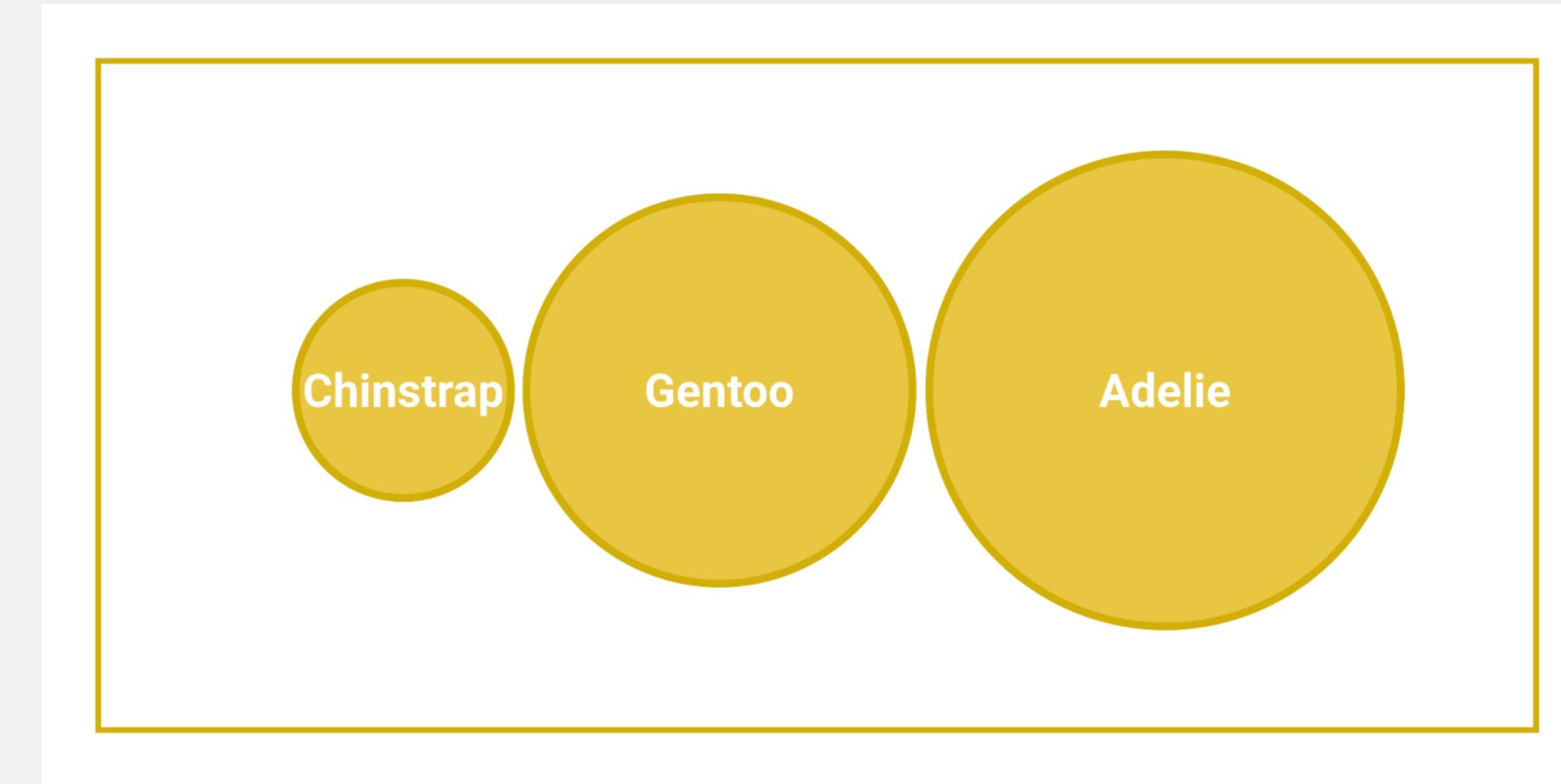


Source: Kieran Healy's "[Data Visualization: A Practical Introduction](#)"; results based on Heer and Bostock, following Cleveland and McGill

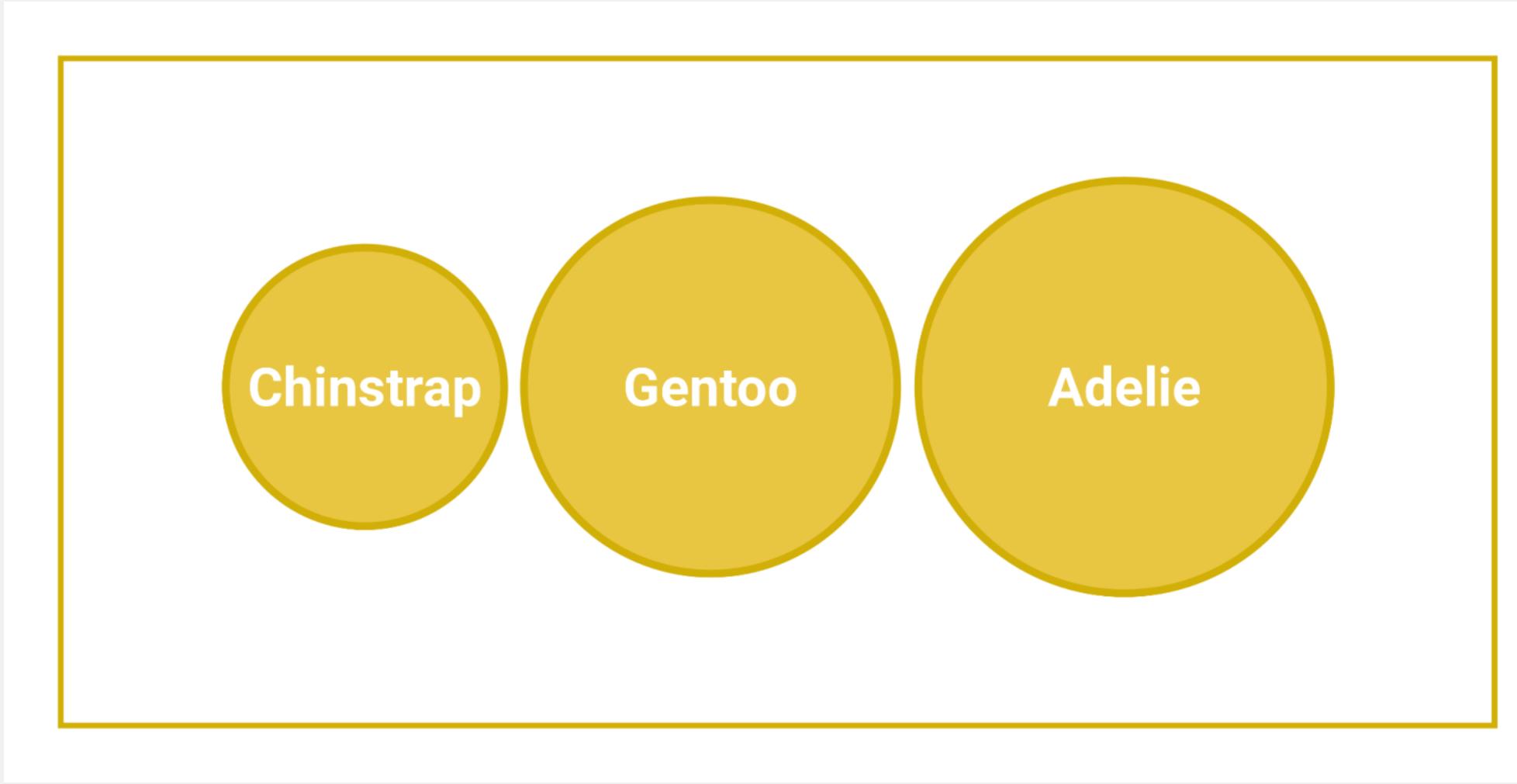
# Use area.



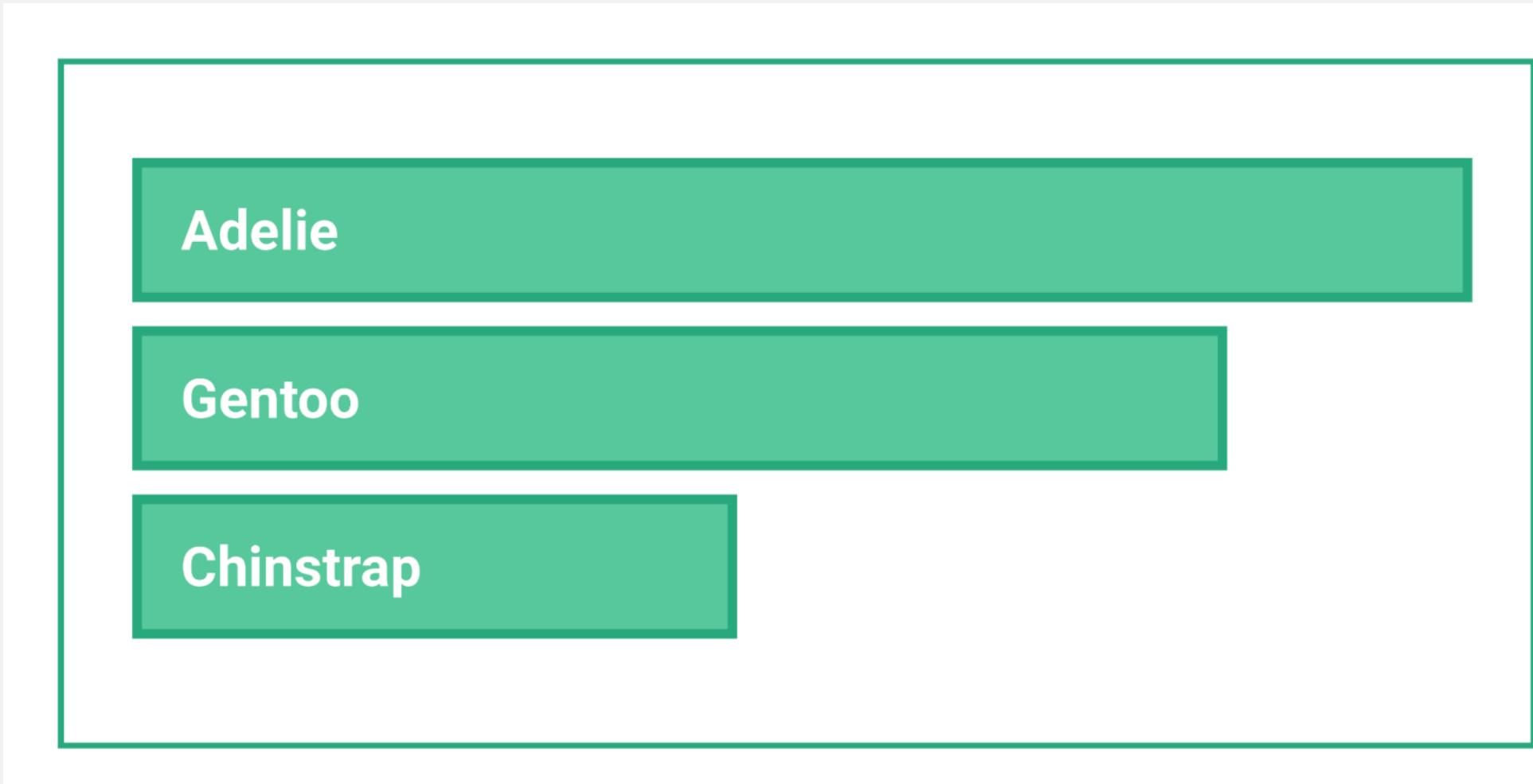
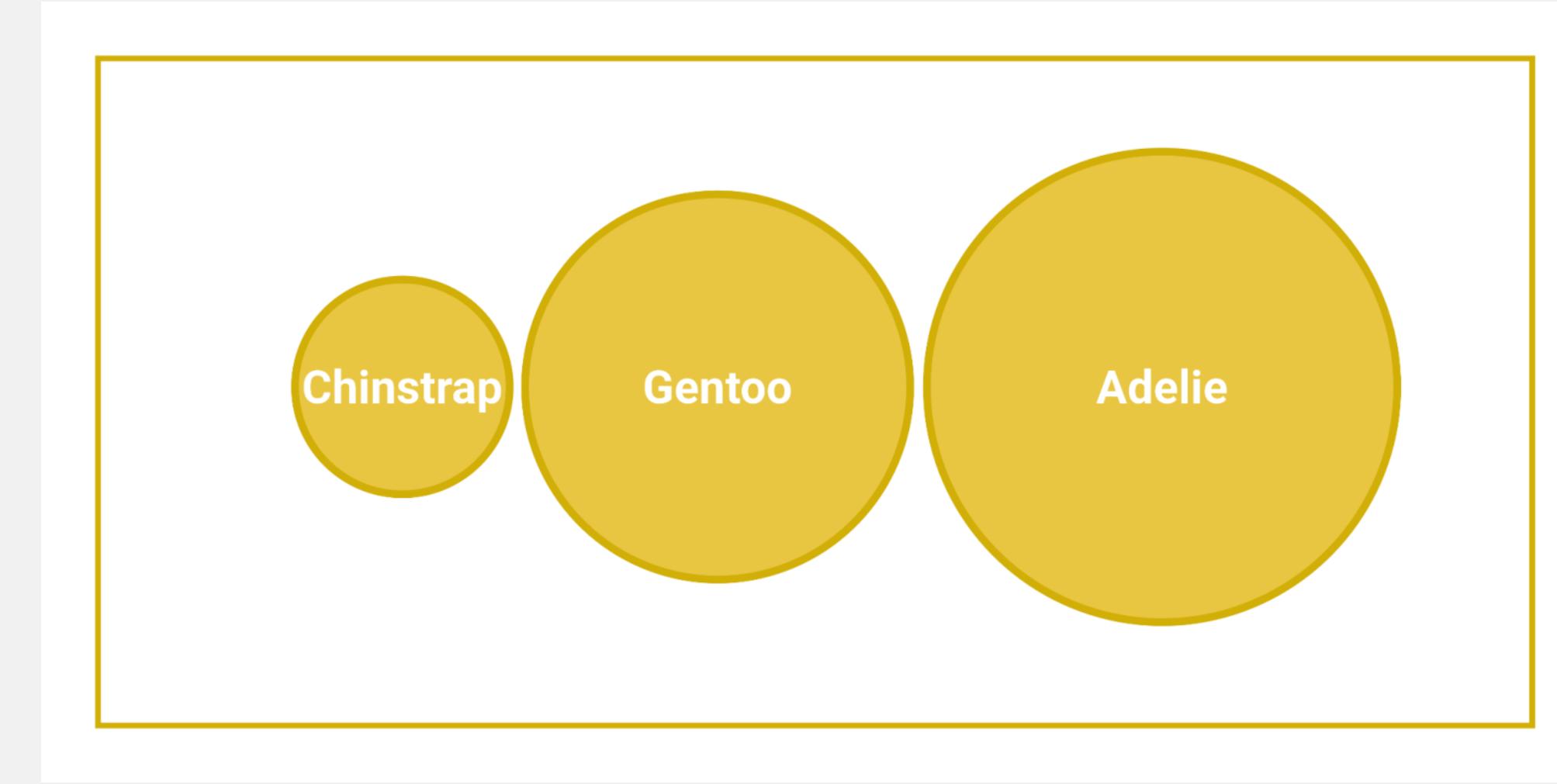
# Not radius!



# Use area.

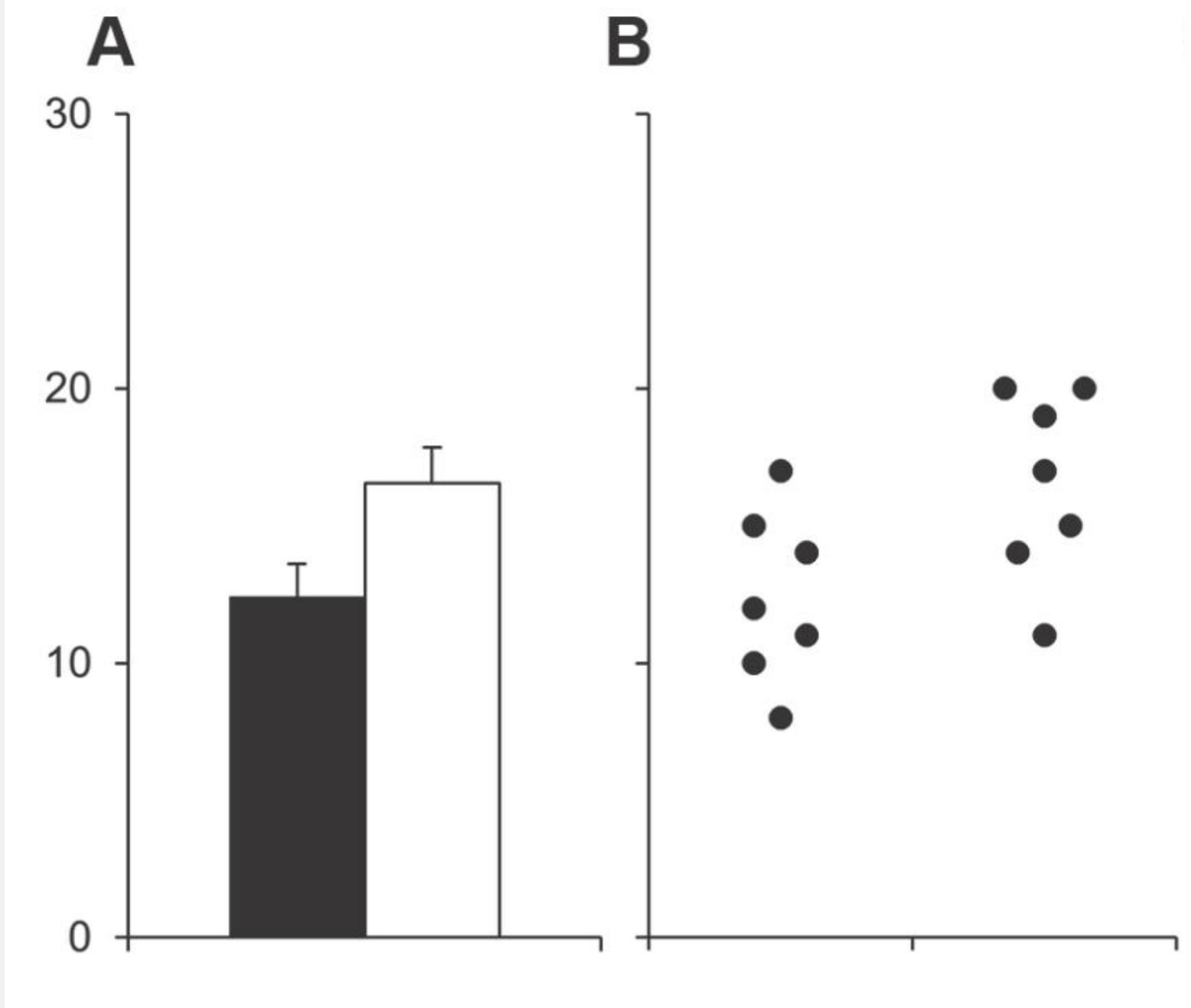


# Not radius!

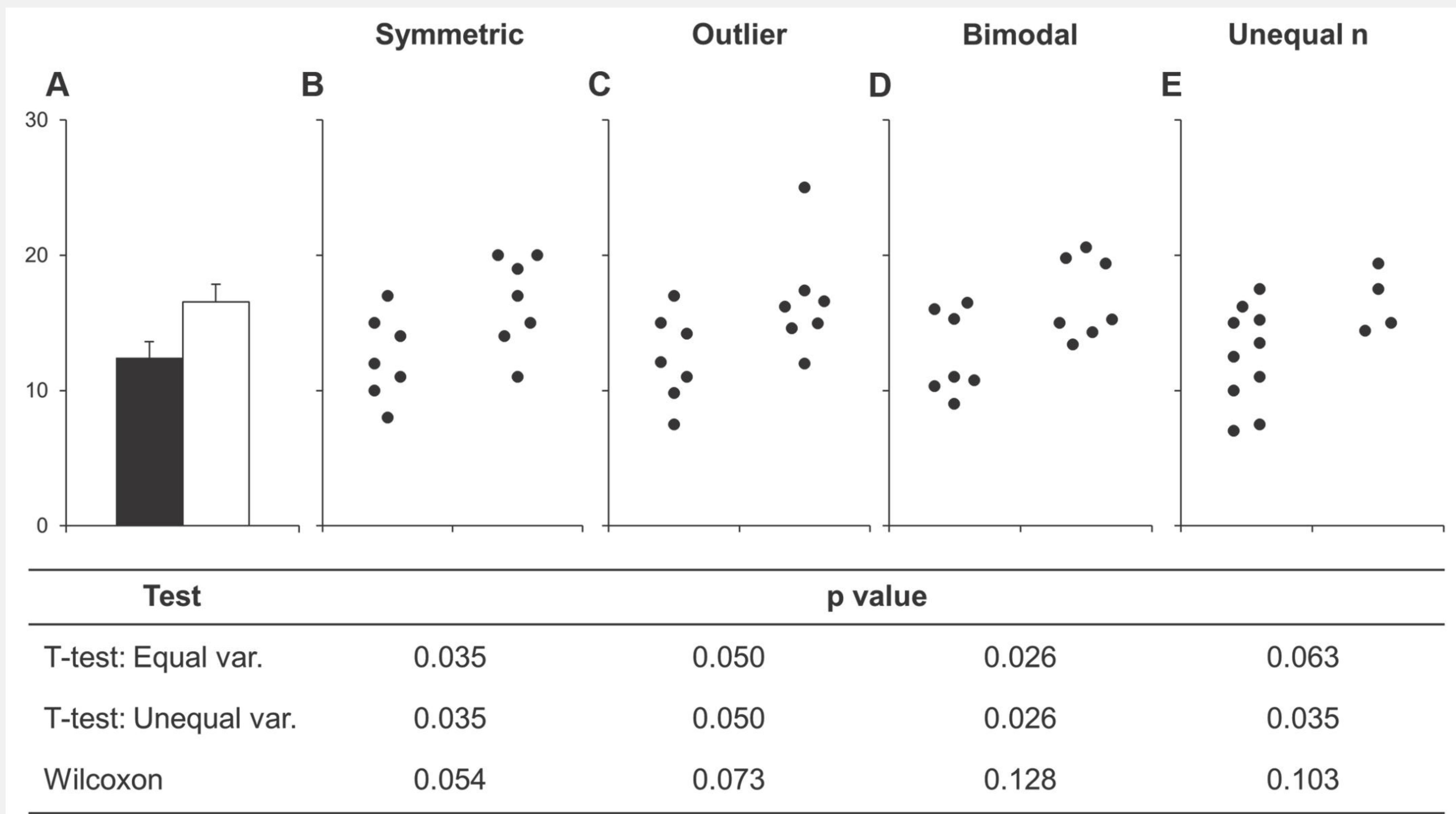


# or: bars!

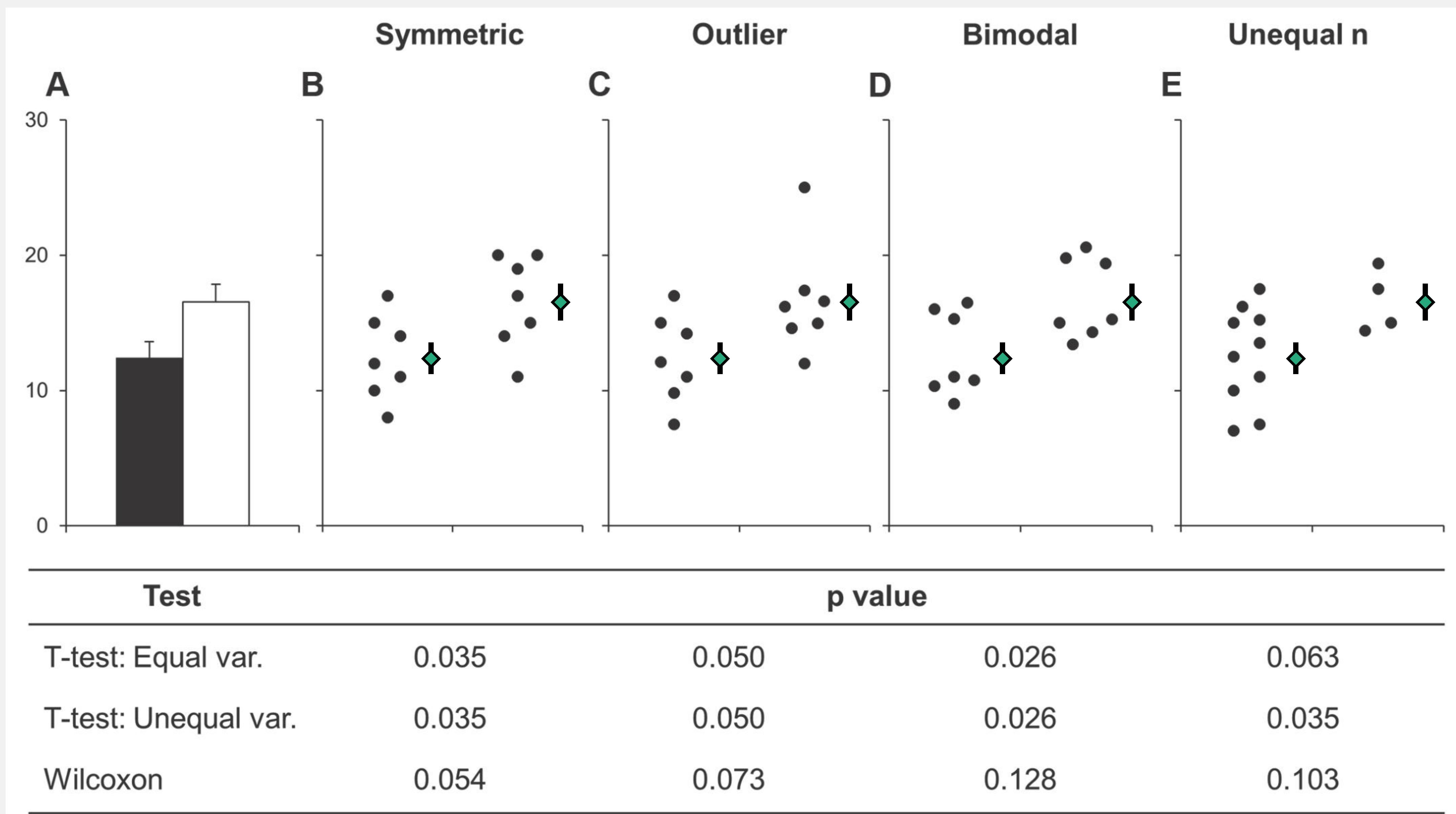
## Symmetric



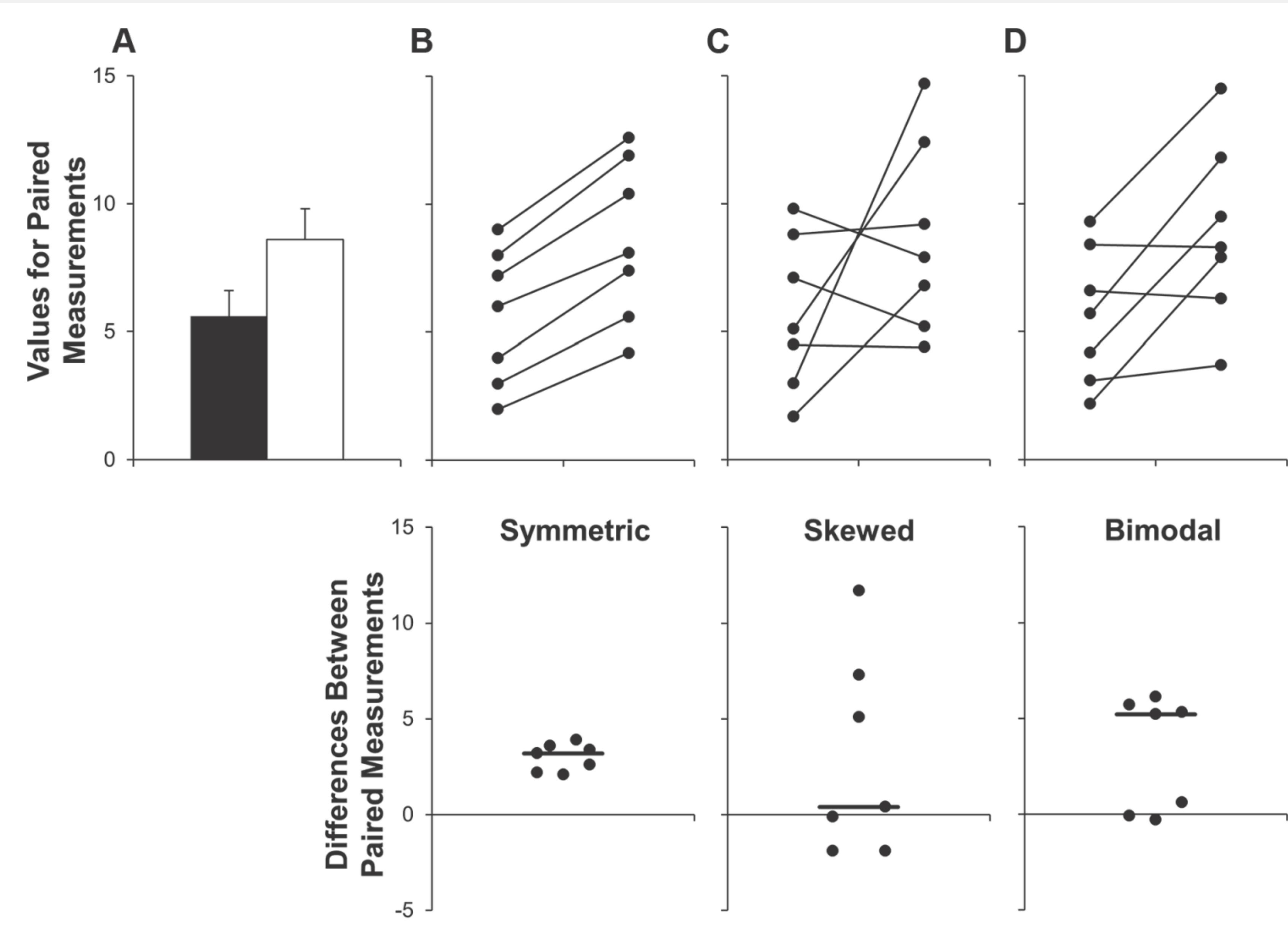
Source: Weissgerber et al. (2015) PLoS Biology



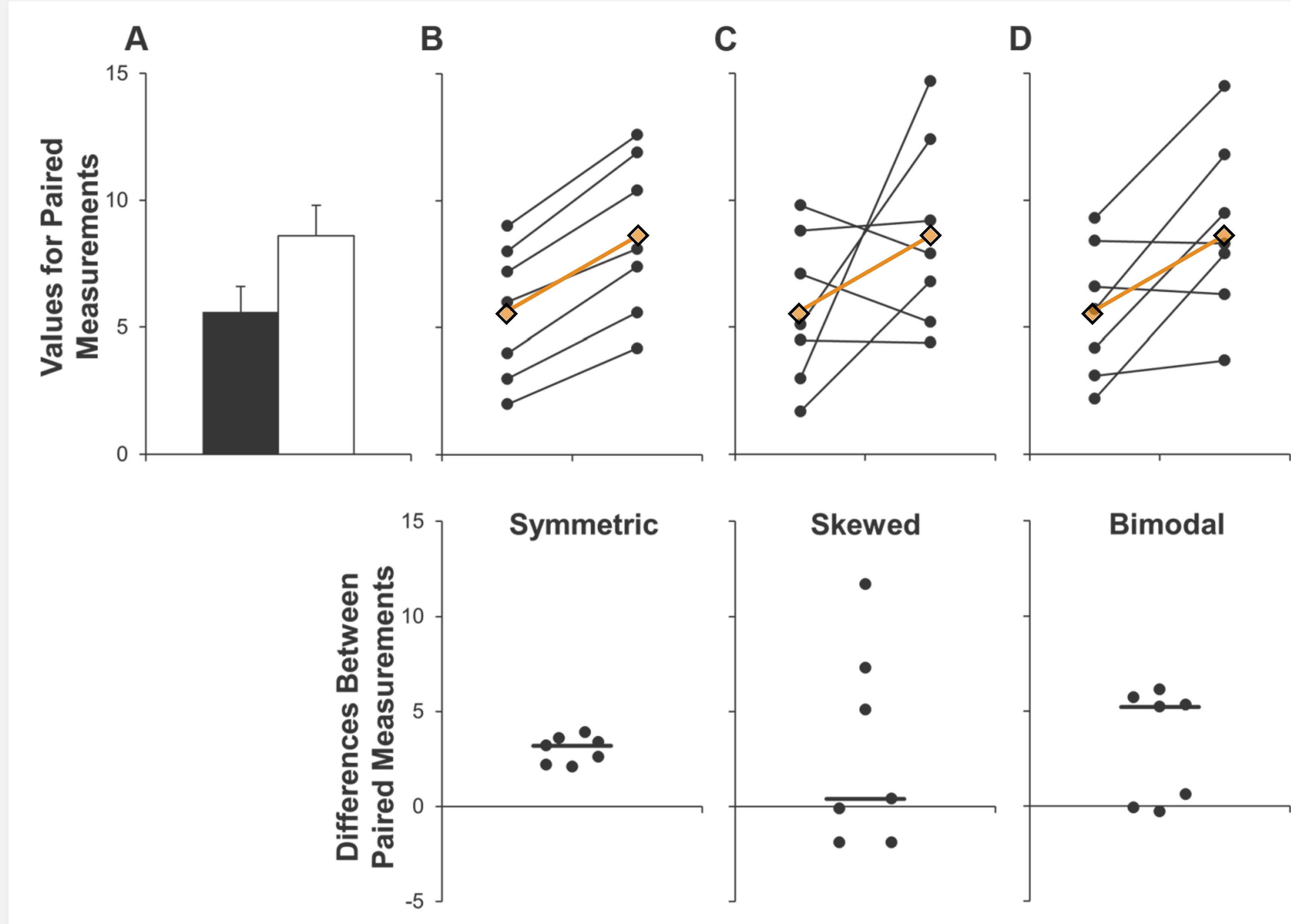
Source: Weissgerber et al. (2015) PLoS Biology



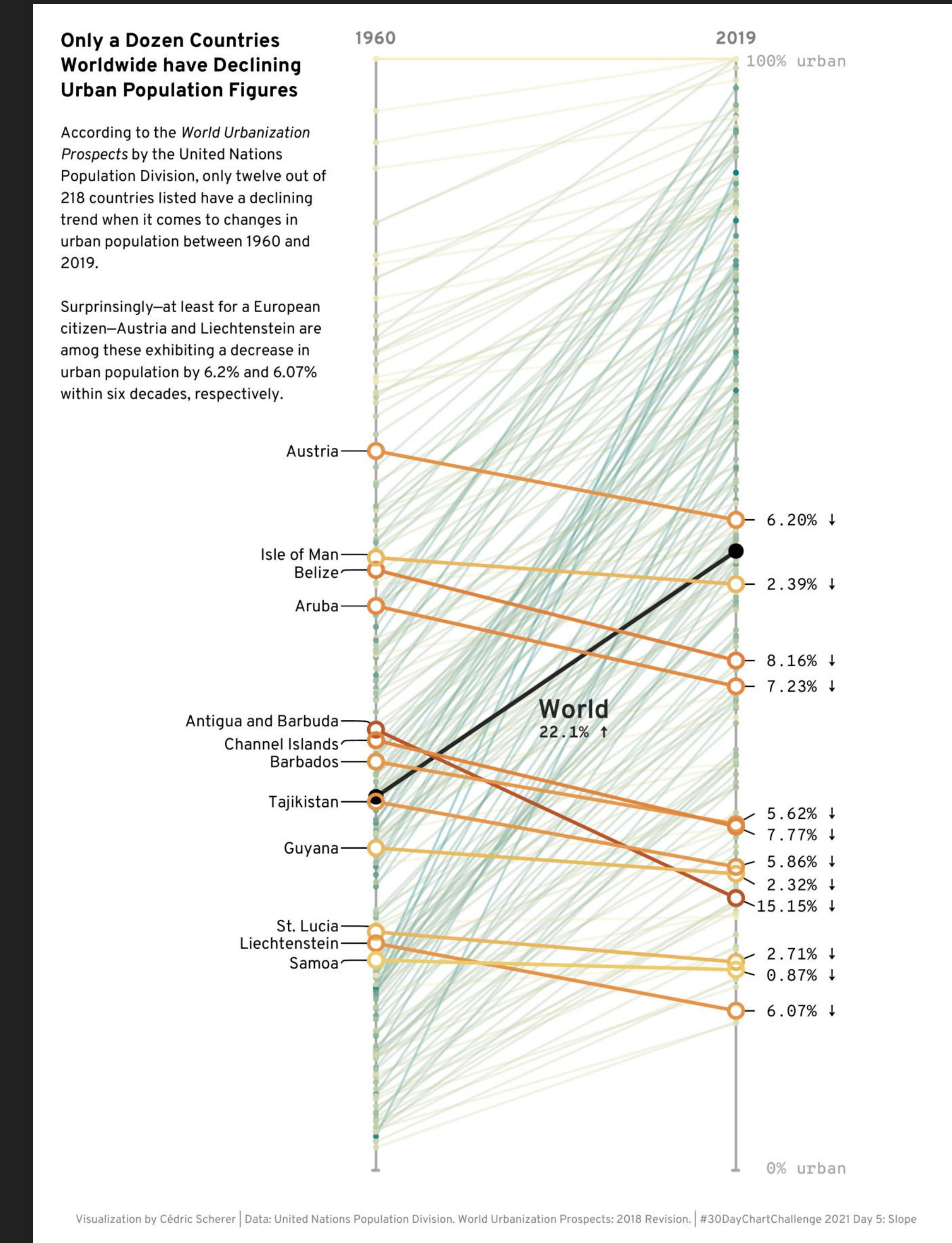
Modified from Weissgerber et al. (2015) PLoS Biology



Source: Weissgerber et al. (2015) PLoS Biology



Source: Weissgerber et al. (2015) PLoS Biology



*Urban Population Trends, #30DayChartChallenge Contribution*

# 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

60 POINTS

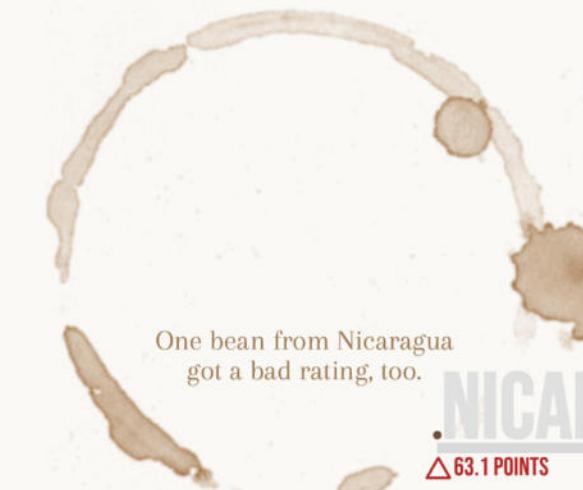
70 POINTS

80 POINTS

90 POINTS

## GUATEMALA

△ 59.8 POINTS  
The coffee bean with the lowest rating has its origin in Guatemala.



One bean from Nicaragua got a bad rating, too.

## NICARAGUA

△ 63.1 POINTS

## COSTA RICA

△ 71.8 POINTS

## HAWAII

△ 73.7 POINTS

## BRAZIL

△ 73.2 POINTS

## TANZANIA

△ 80.3 POINTS

## TAIWAN

△ 77.7 POINTS

## HONDURAS

△ 69.2 POINTS

## MEXICO

△ 68.3 POINTS

## COLOMBIA

△ 72.8 POINTS

## UGANDA

△ 80.5 POINTS

## ETHIOPIA

△ 80.3 POINTS

## KENYA

△ 79.8 POINTS

## TAIWAN

△ 81.9 POINTS

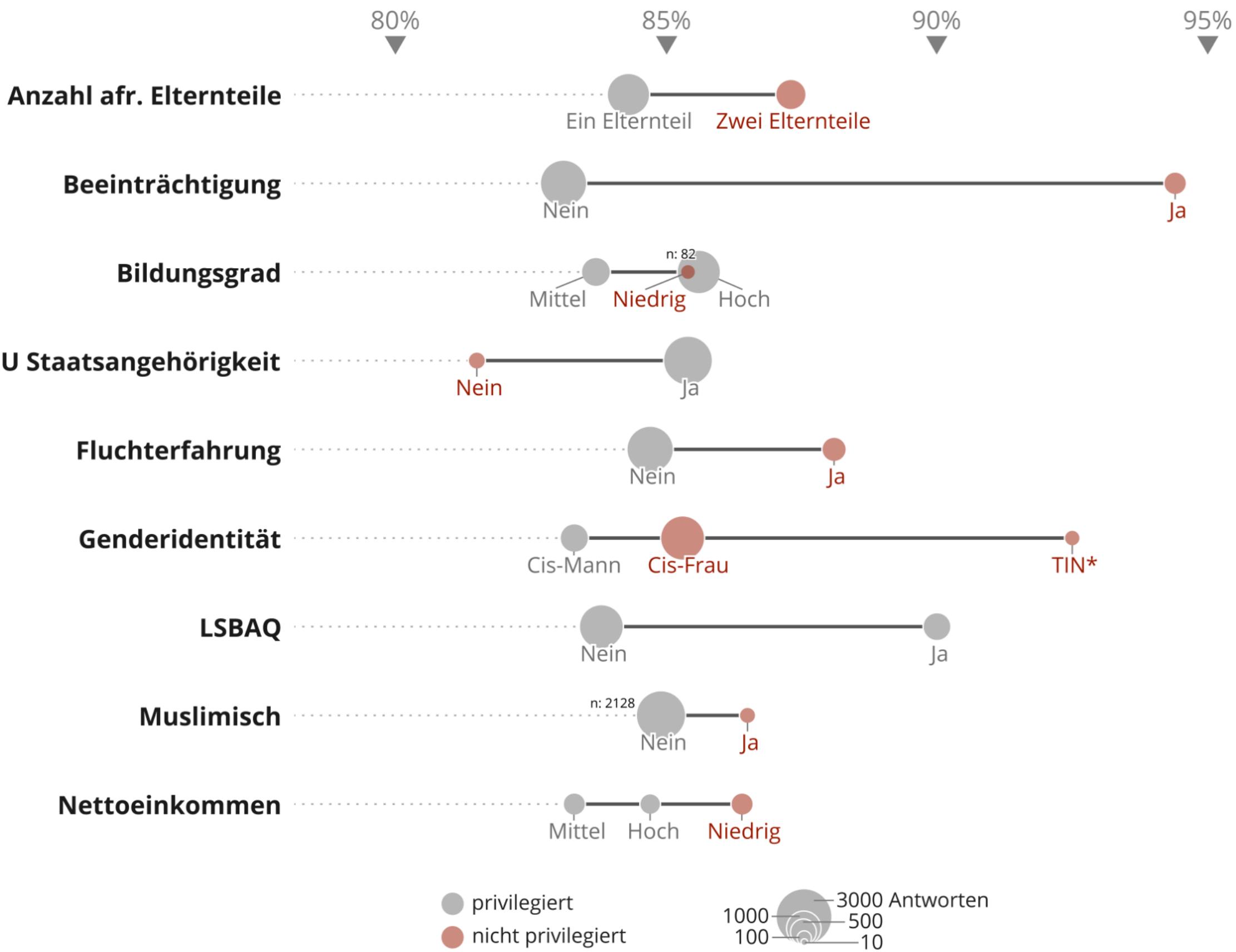
## ETHIOPIA

△ 85.1 POINTS

The best coffee—in terms of both median and maximum rating—is shipped to you from Ethiopia!

*"Not my cup of coffee", #TidyTuesday Contribution*

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



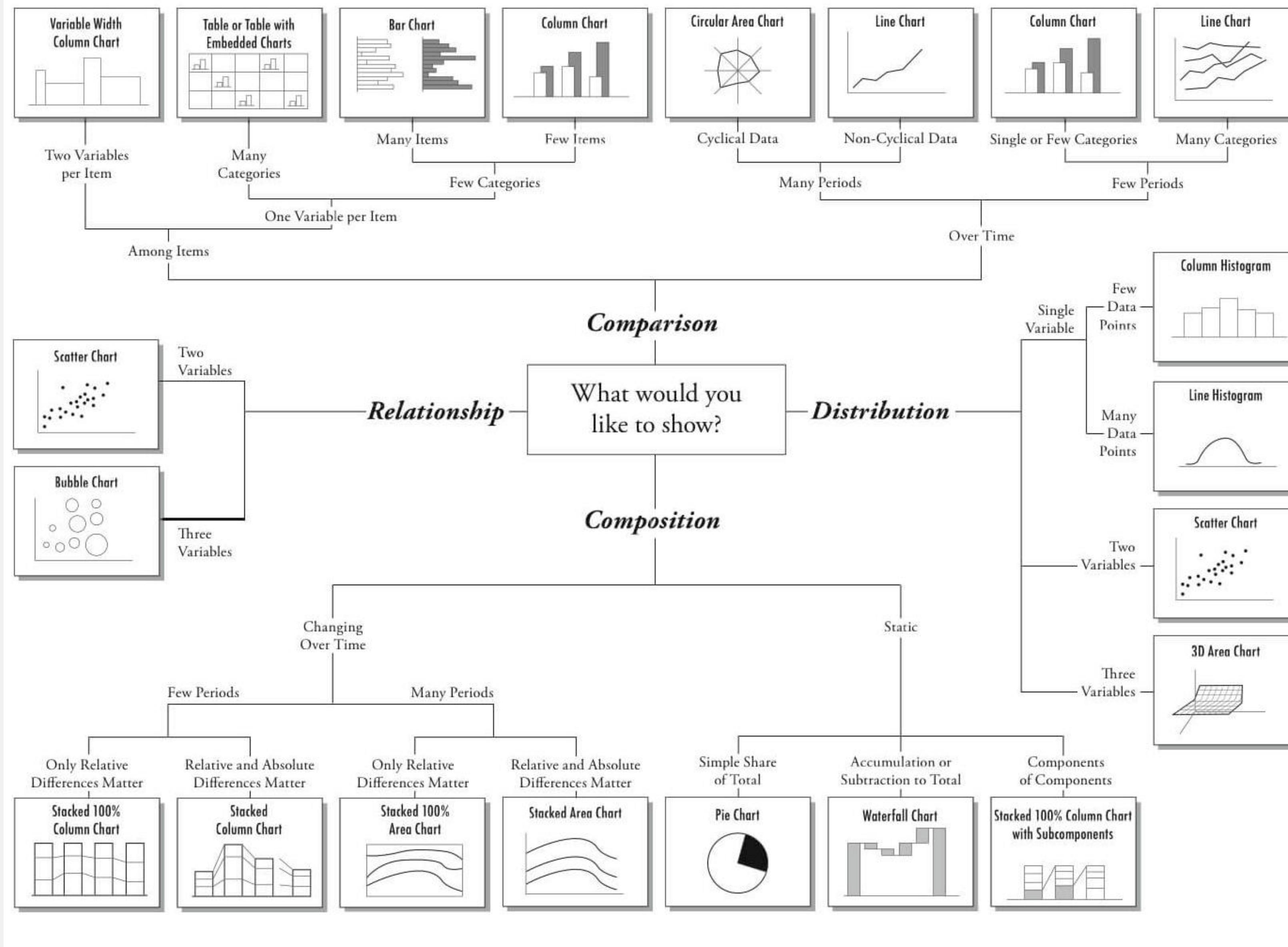
**Lesebeispiel:** LSBAQ-Befragte des Afrozensus geben im Vergleich mit heterosexuellen Afrozensus-Befragten häufiger an, im Lebensbereich „Medien und Internet“ in den letzten zwei Jahren Diskriminierung erlebt zu haben.

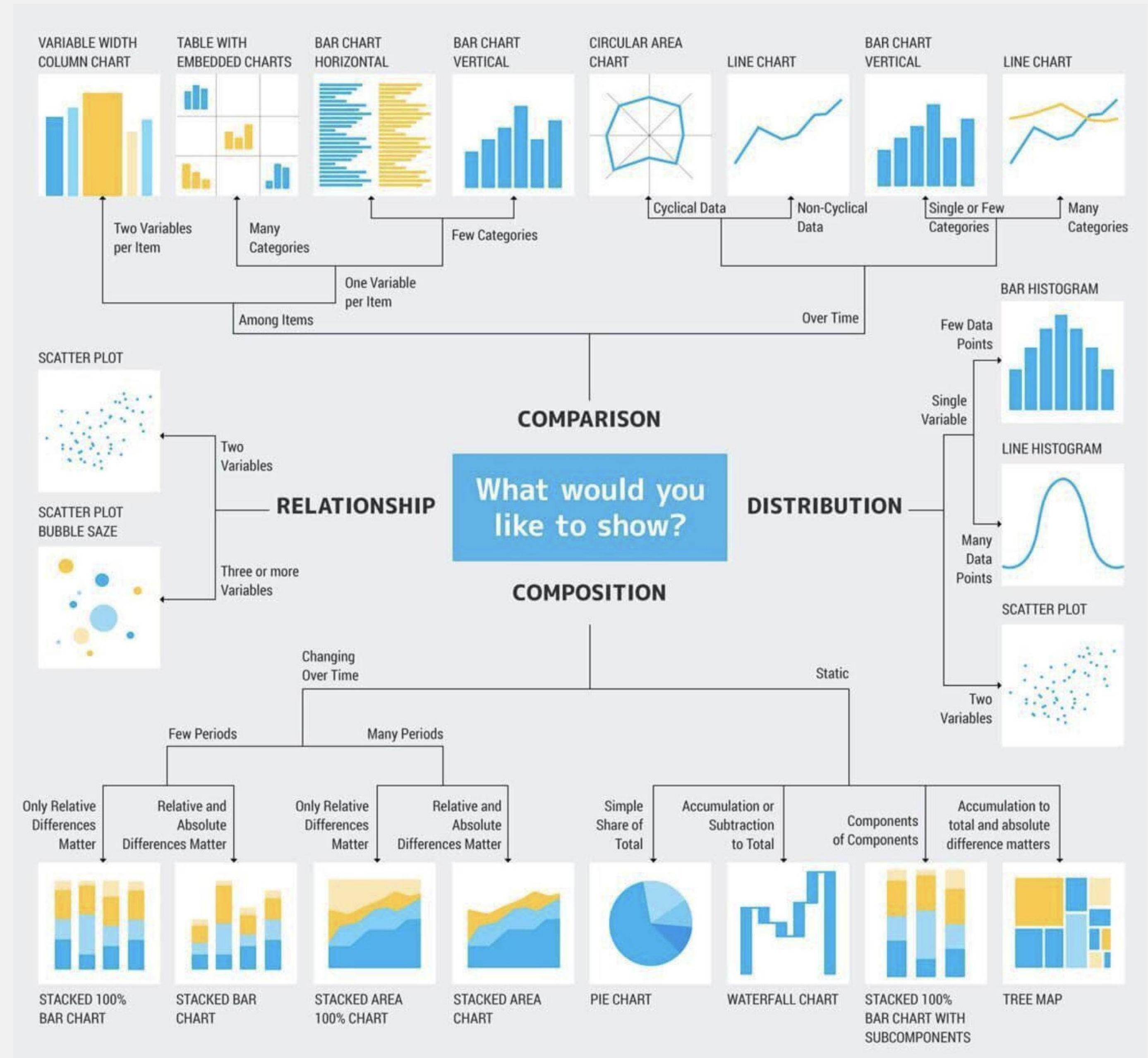
Quelle: Abb. 46 in Aikins, M A; Bremberger, T; Aikins, J K; Gyamerah, D; Yıldırım-Caliman, D (2021): Afrozensus 2020 | Datenteam: Reiber, L; Vivanco, J | Design: Scherer, C  
Lizenz: CC-BY-NC by EOTO & CFE | afrozensus.de

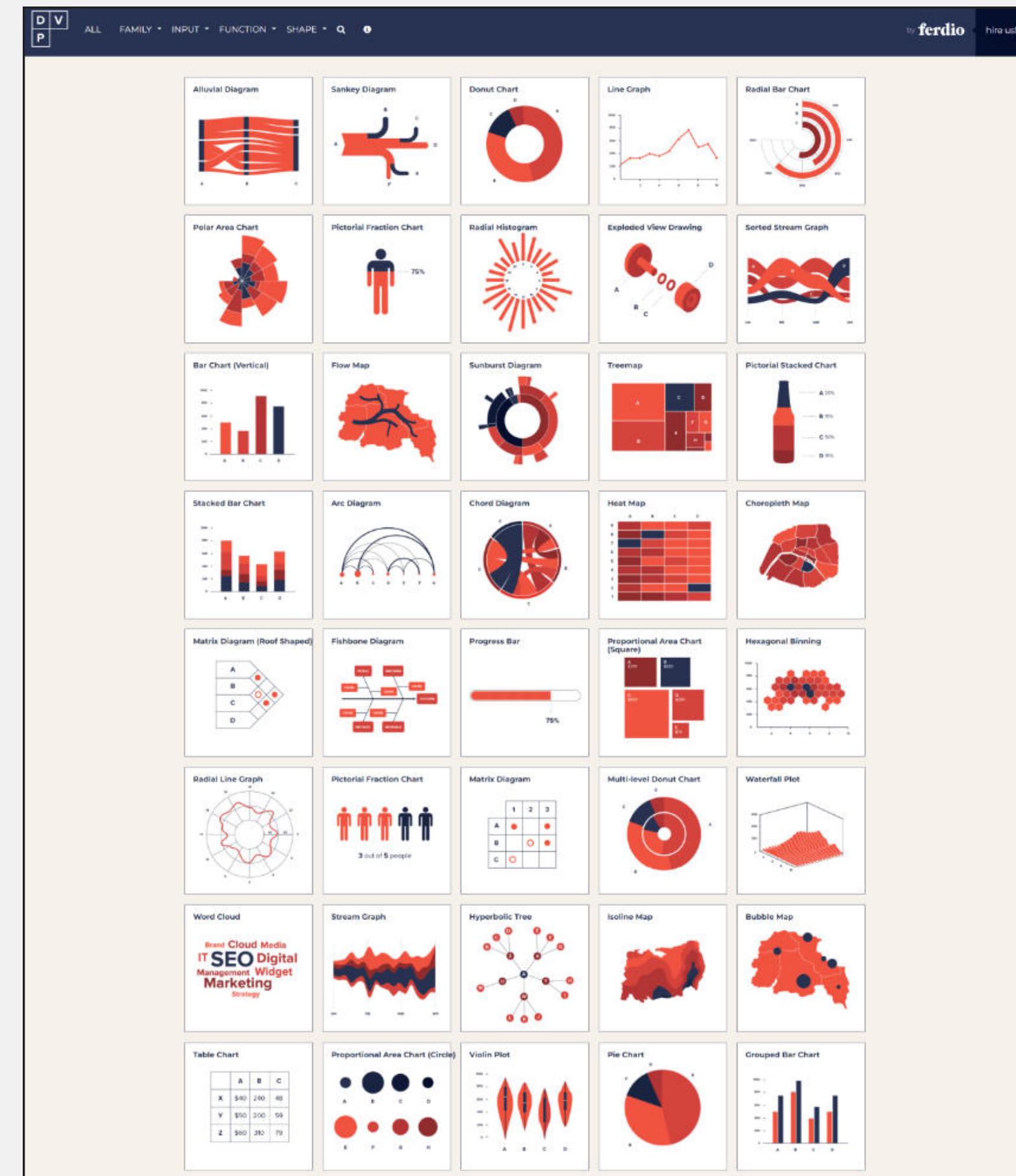
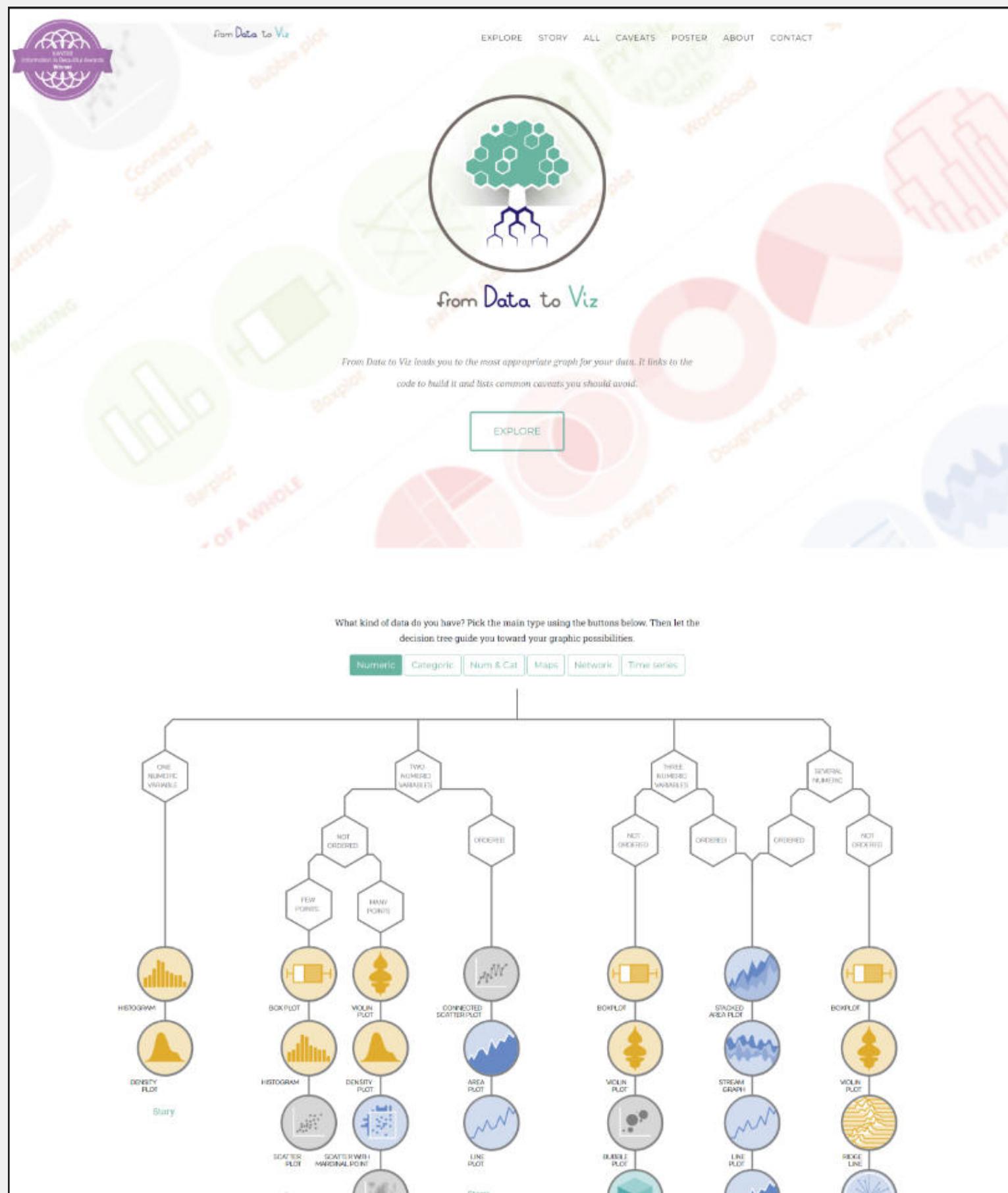
Source: “Afrozensus 2020” by Citizens For Europe & EOTO e.V.

# Chart Suggestions—A Thought-Starter

www.ExtremePresentation.com  
© 2009 A. Abela — a.v.abela@gmail.com







[data-to-viz.com](http://data-to-viz.com)

[datavizproject.com](http://datavizproject.com)

[visualizationuniverse.com](http://visualizationuniverse.com)



# from Data to Viz

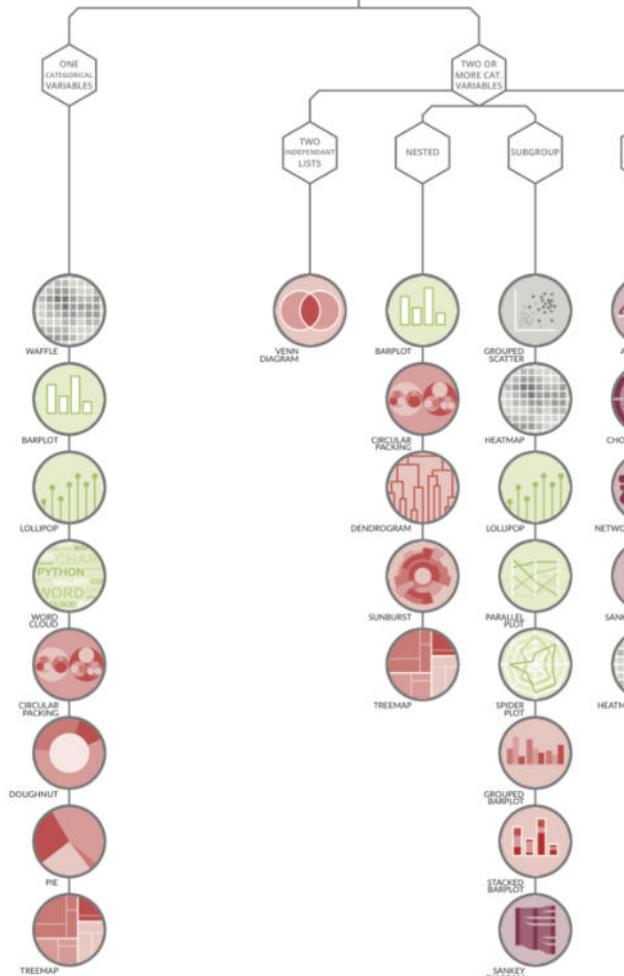
'From Data to Viz' is a classification of chart types based on input data format. It will help you find the perfect chart in three simple steps:

- 1 Identify what type of data you have.
- 2 Go to the corresponding decision tree and follow it down to a set of possible charts.
- 3 Choose the chart from the set that will suit your data and your needs best.

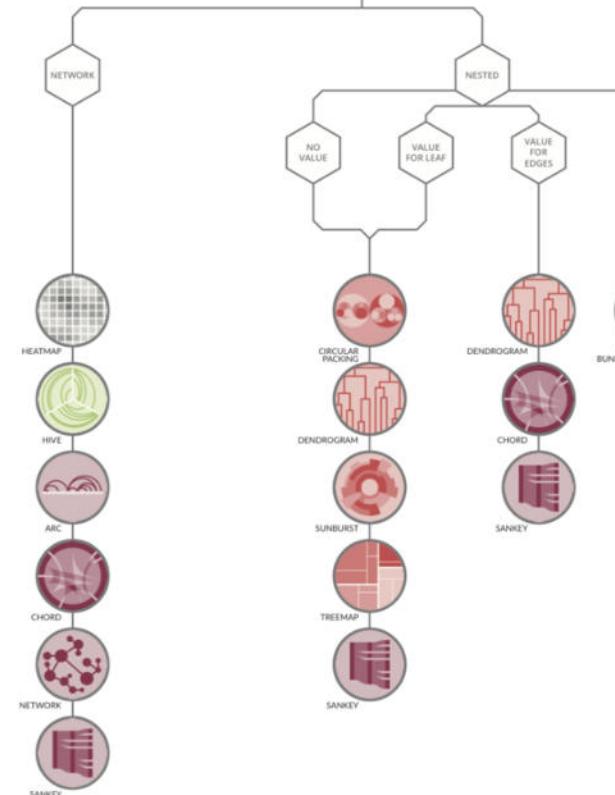
Dataviz is a world with endless possibilities and this project does not claim to be exhaustive. However it should provide you with a good starting point. For an interactive version and much more, visit:

[data-to-viz.com](http://data-to-viz.com)

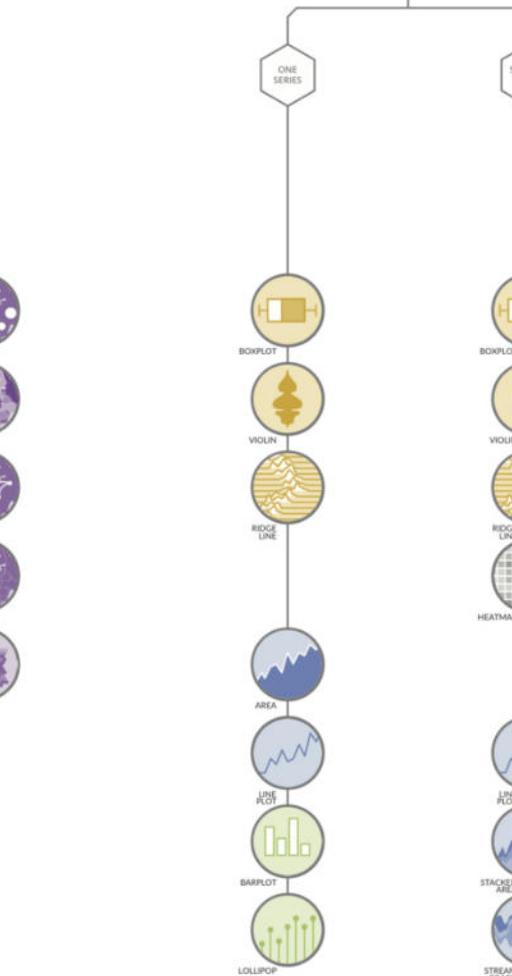
## CATEGORIC



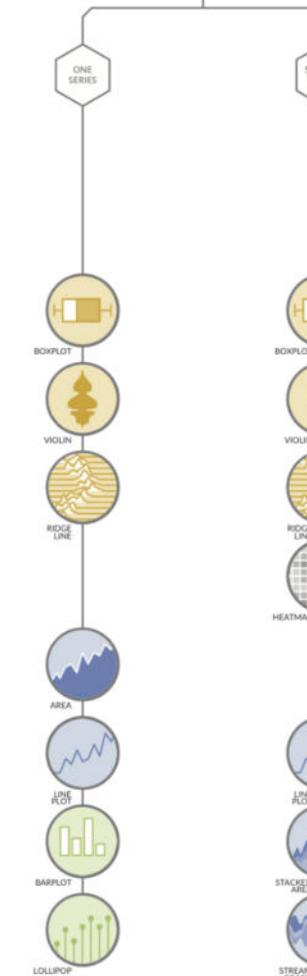
## RELATIONAL



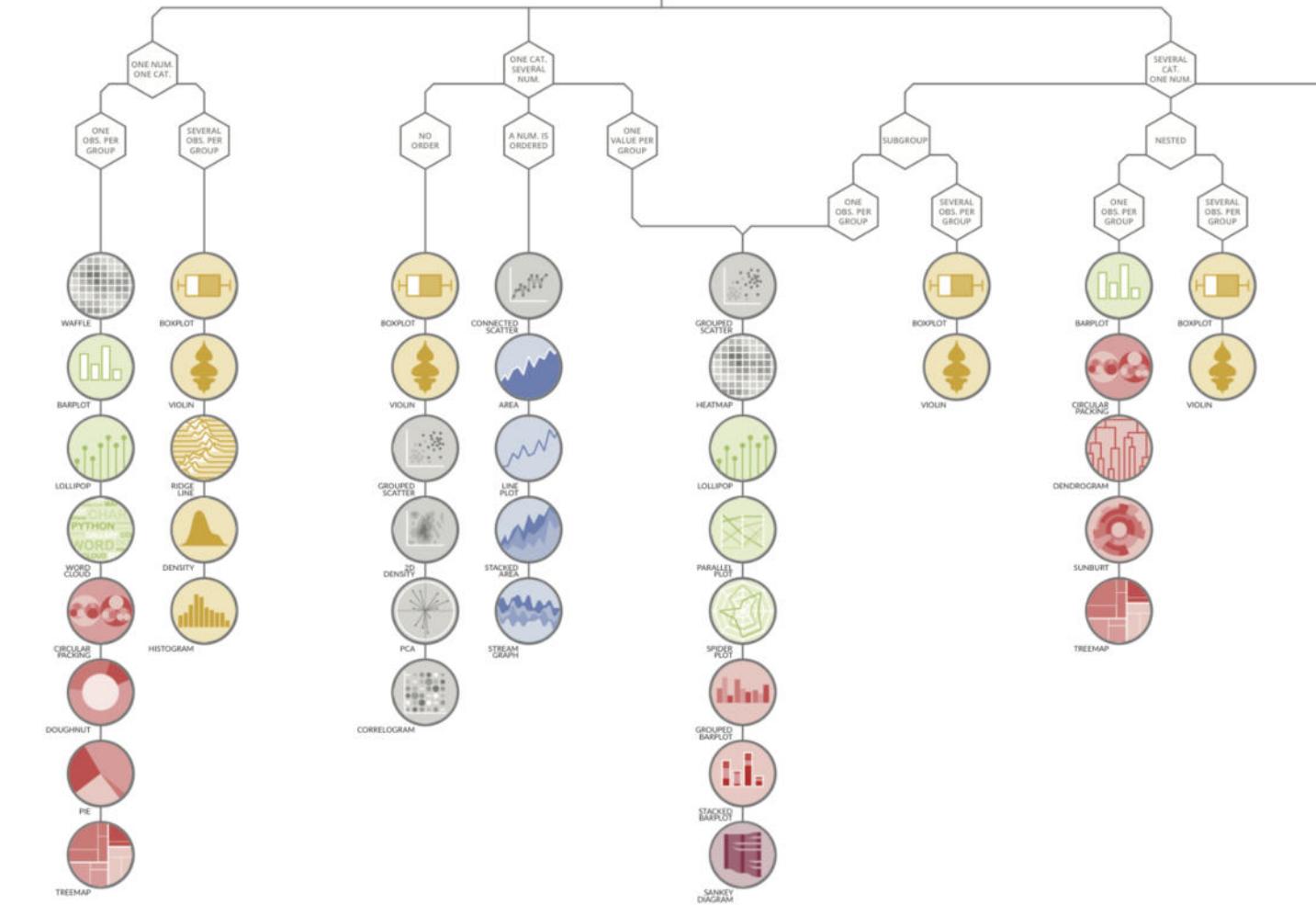
## MAP



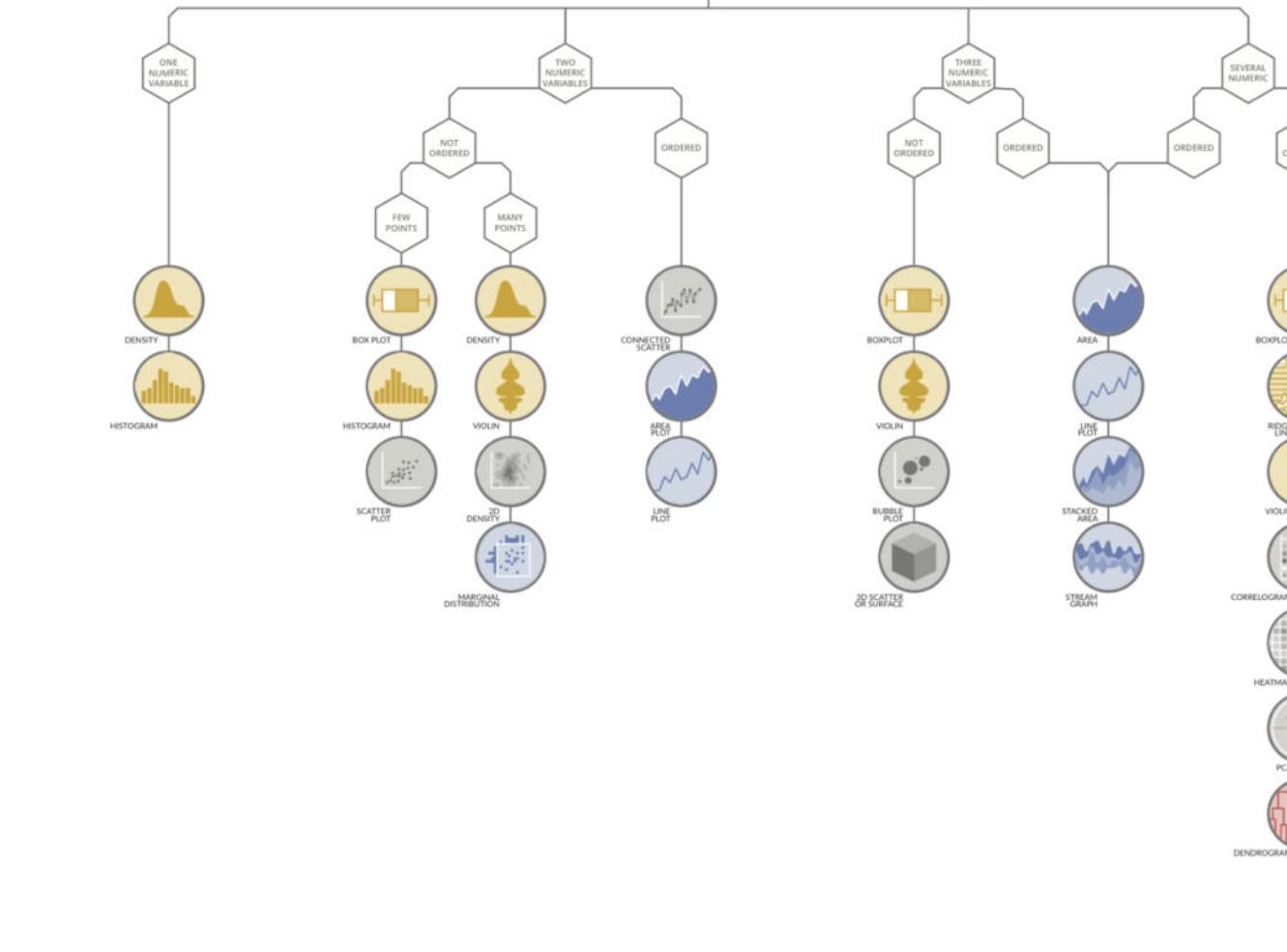
## TIME SERIES



## CATEGORIC AND NUMERIC



## NUMERIC



Source: [data-to-viz.com](http://data-to-viz.com)

The screenshot shows a modal window on the data-to-viz.com website. At the top left is a yellow circular icon containing a boxplot. To its right is a close button (X). Below the icon is the title "BOXPLOT". A subtitle "Summarize the distribution of numeric variables" follows. Underneath is a section titled "About" with a detailed description of what a boxplot is. Below this is a section titled "Common Mistakes" with a bulleted list of three items. Further down is a "Code" section with four buttons: "R graph gallery", "Python gallery", "D3js gallery", and "Flourish". At the bottom is a "Read More" section with a link to a dedicated page. The background of the modal is white, while the rest of the website has a dark grey background. On the right side of the dark grey area, there is a grid of 12 circular icons, each representing a different type of chart or visualization, such as Boxplot, Ridgeplot, Scatter, Connected scatter, Density 2d, Barplot, Lollipop, Circular Barplot, Treemap, Dendrogram, Circular packing, and Sunburst.

SSIBILITIES

presented in this website.

part of a whole Evolution Map Flow

Boxplot Ridgeplot Scatter

Connected scatter Density 2d Barplot

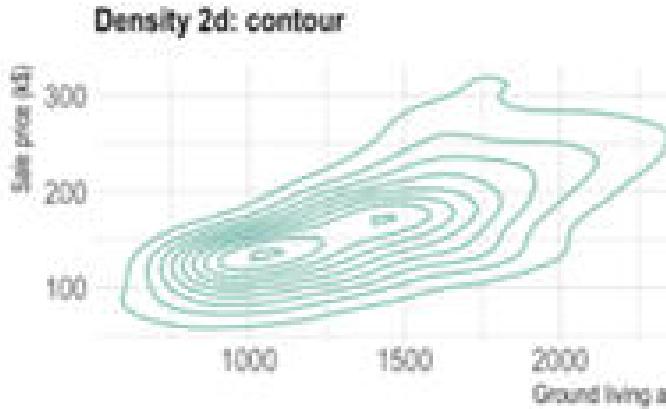
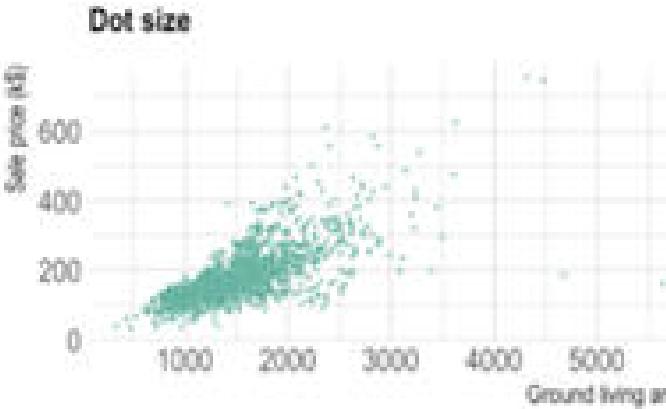
Lollipop Circular Barplot Treemap

Dendrogram Circular packing Sunburst

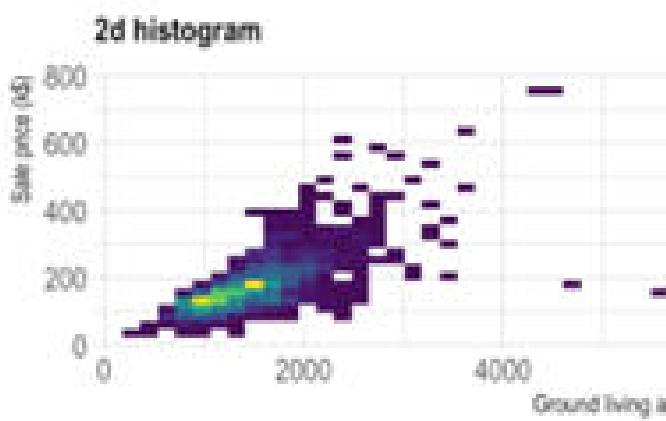
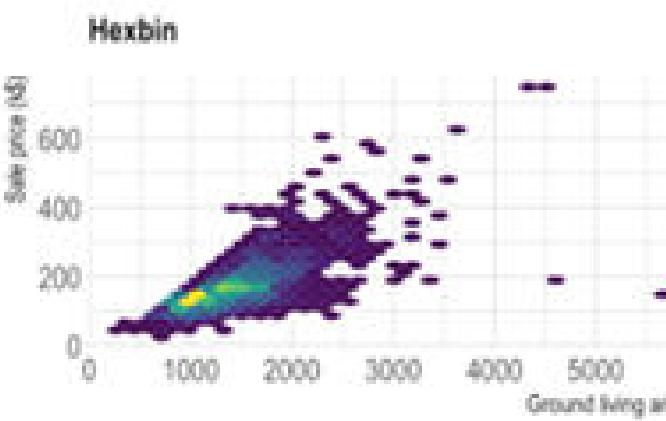
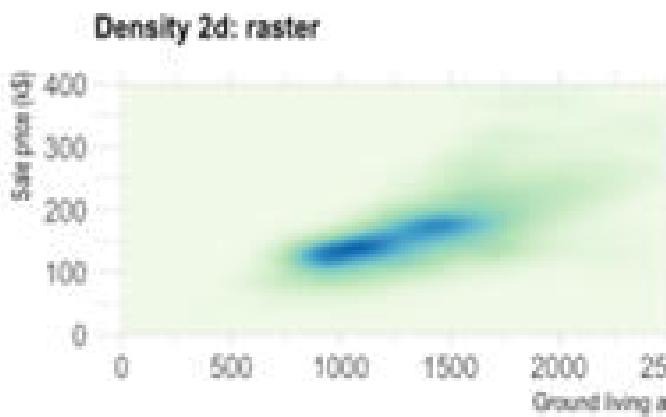
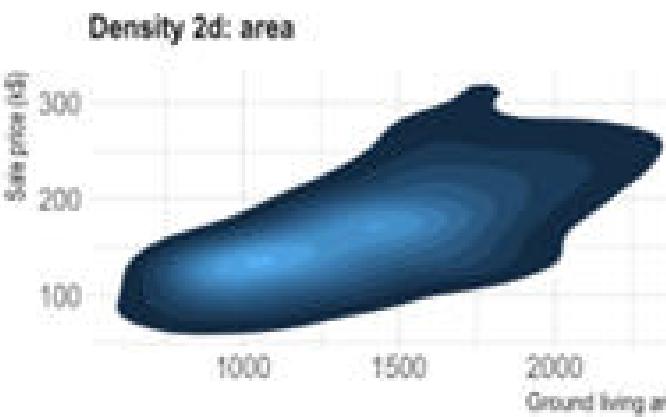
Source: [data-to-viz.com](http://data-to-viz.com)

# Overplotting

The most common pitfall with scatterplot is overplotting: when the sample size gets big, dots are plotted on top of each other what makes the chart unreadable. There are several work around to avoid this issue as describe in this [specific post](#). Here is a summary of the different offered techniques:



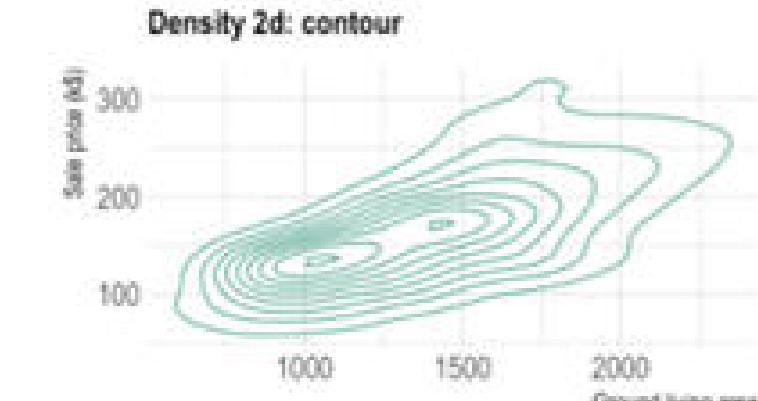
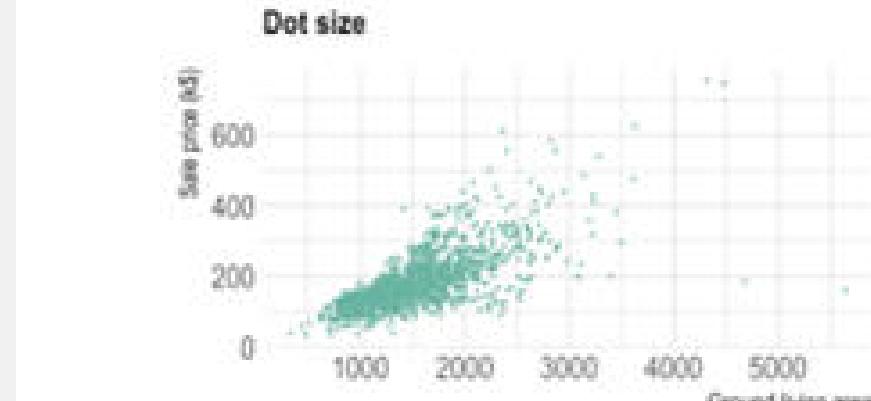
CODE



Going further

You can learn more about each type of graphic presented in this story in the dedicated

```
* code for all graphics:  
p <- data %>%  
  ggplot( aes(x=GroundArea, y=SalePrice/1000)) +  
  theme_ipsum() +  
  theme(  
    plot.title = element_text(size=12),  
  ) +  
  ylab('Sale price (k$)') +  
  xlab('Ground living area')  
  
# Reduce dot size  
p1 <- p + geom_point(color="#69b3a2", alpha=0.8, size=0.2) + ggtitle("Dot size")  
  
# Use density estimate  
p2 <- p + geom_density2d(color="#69b3a2") + ggtitle("Density 2d: contour")  
  
# Use density estimate (area)  
p3 <- p + stat_density_2d(aes(fill = ..level..), geom = "polygon") + ggtitle("Density 2d: area") + theme(legend.position = "none")  
  
# with raster  
p4 <- p +  
  stat_density_2d(aes(fill = ..density..), geom = "raster", contour = FALSE) +  
  scale_fill_distiller(palette=4, direction=1) +  
  scale_x_continuous(expand = c(0, 0)) +  
  scale_y_continuous(expand = c(0, 0)) +  
  theme(  
    legend.position = "none"  
  ) +  
  ggtitle("Density 2d: raster") +  
  xlim(0,2500) +  
  ylim(0,400)  
  
# Hexbin  
p5 <- p + geom_hex() +  
  scale_fill_viridis() +  
  theme(legend.position = "none") +  
  ggtitle("Hexbin")  
  
# 2d histogram  
p6 <- p + geom_bin2d() +  
  scale_fill_viridis() +  
  theme(legend.position = "none") +  
  ggtitle("2d histogram")  
  
p1 + p2 + p3 + p4 + p5 + p6 + plot_layout(ncol = 2)
```



Density 2d: area

Density 2d: raster

# Group Exercise

## Have a look at the “Chart o Charts” poster

- 👉 Fill one dot for each chart type you have used already to communicate your data

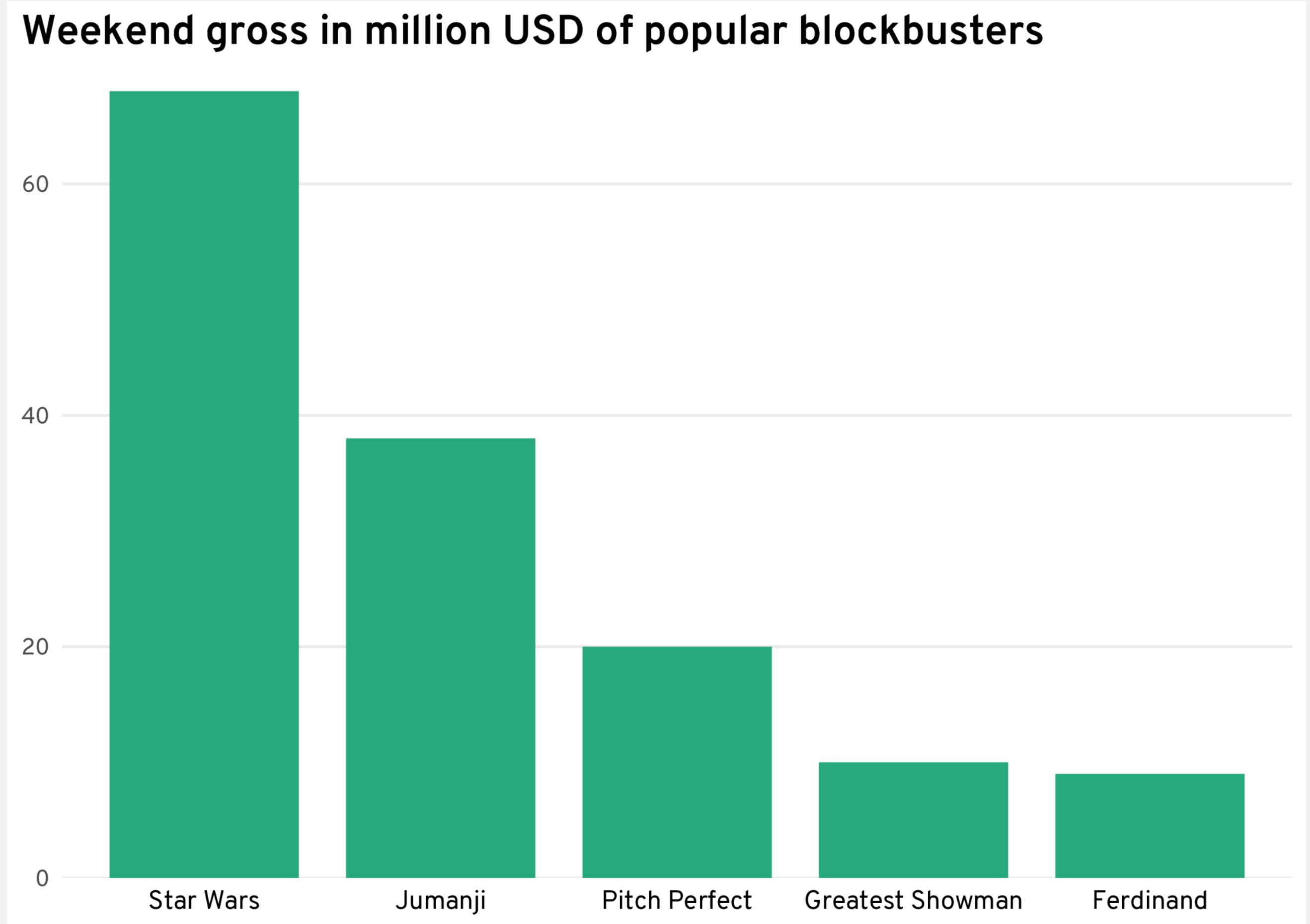
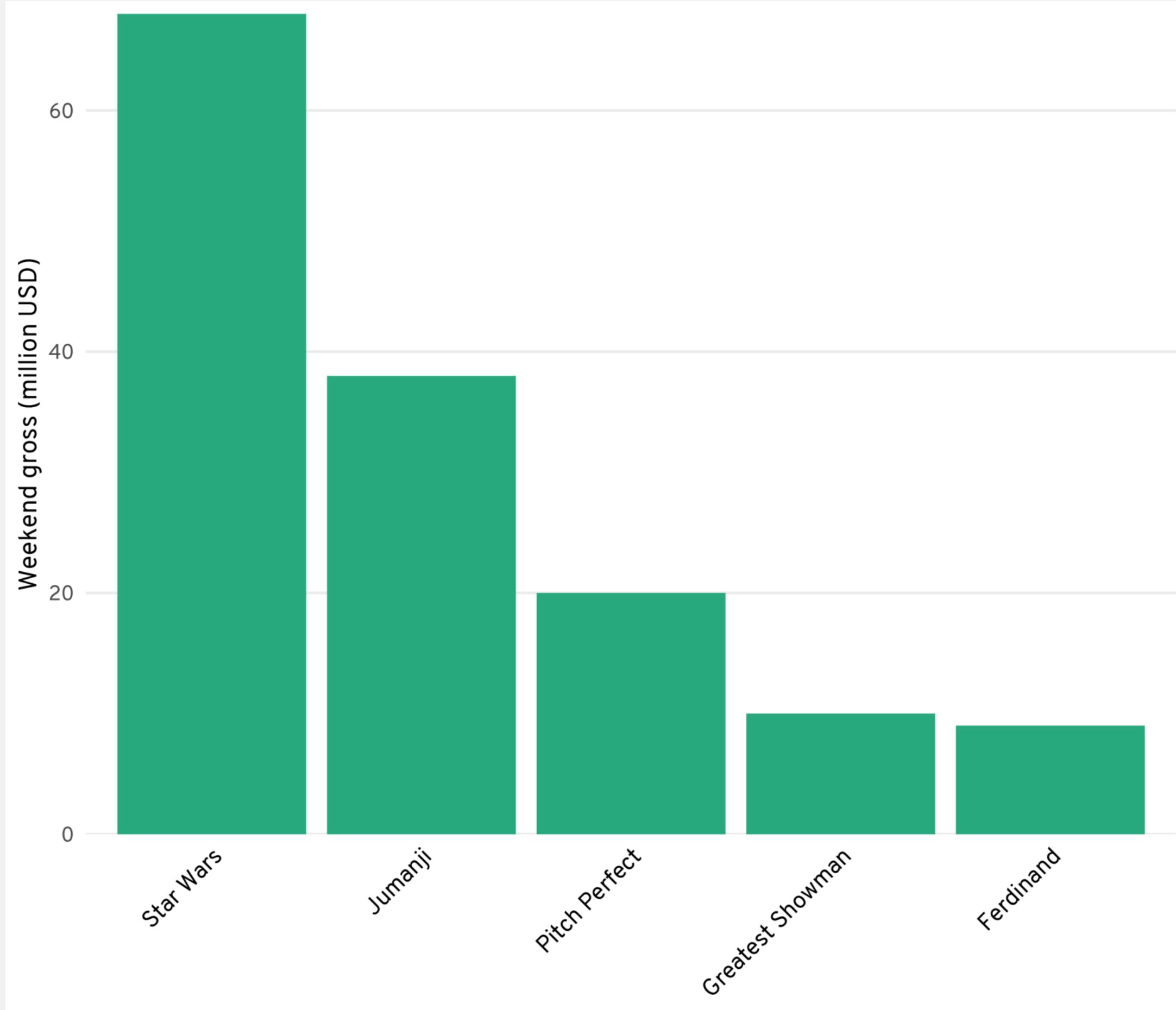
## Have a look at the “Chart Choice Helpers”

- 👉 Explore and discuss potential chart types for future data visualizaitons
- 👉 Look up the chart types on the poster you didn't know
- 👉 Are there chart types you find hard to read / understand?

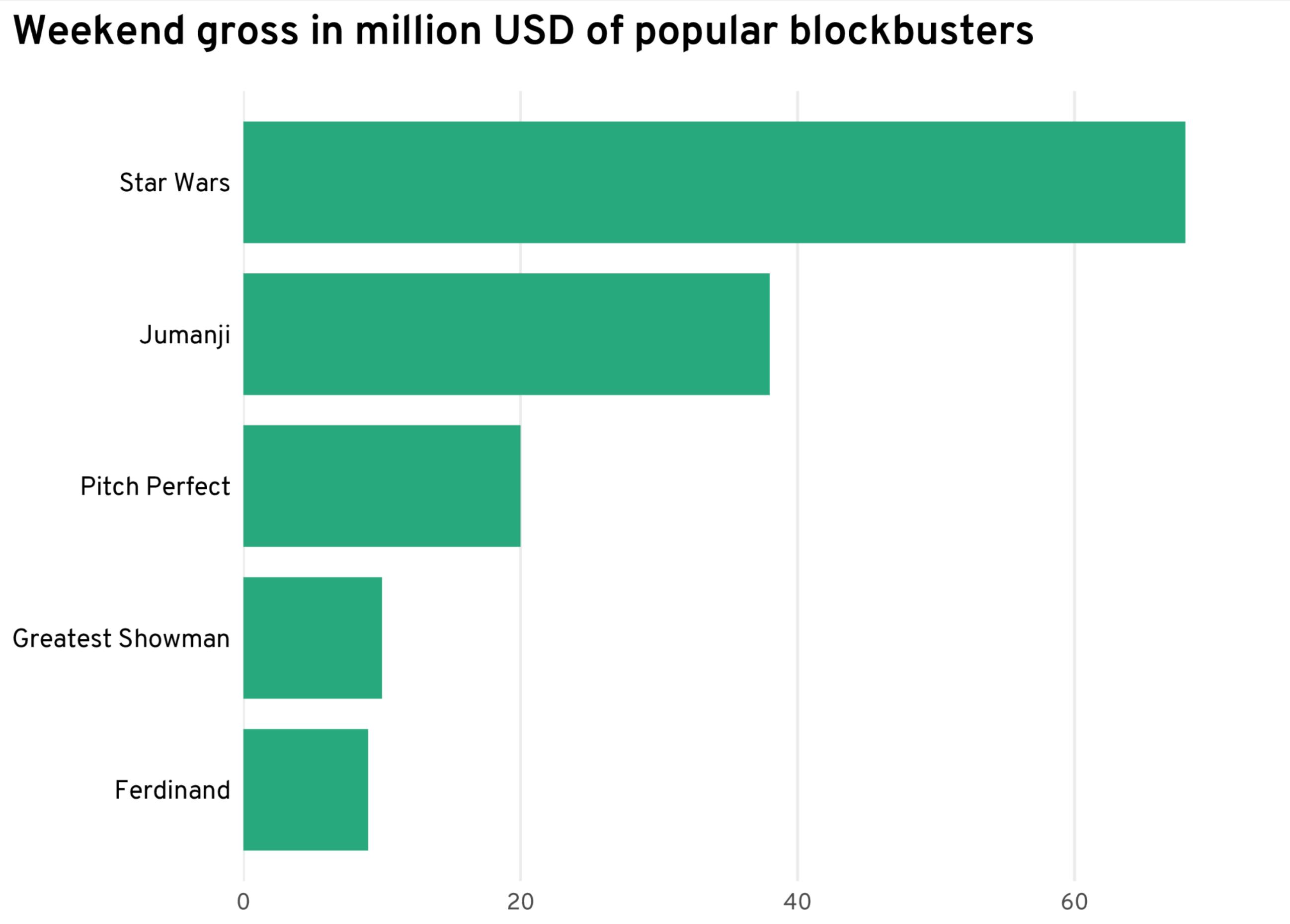
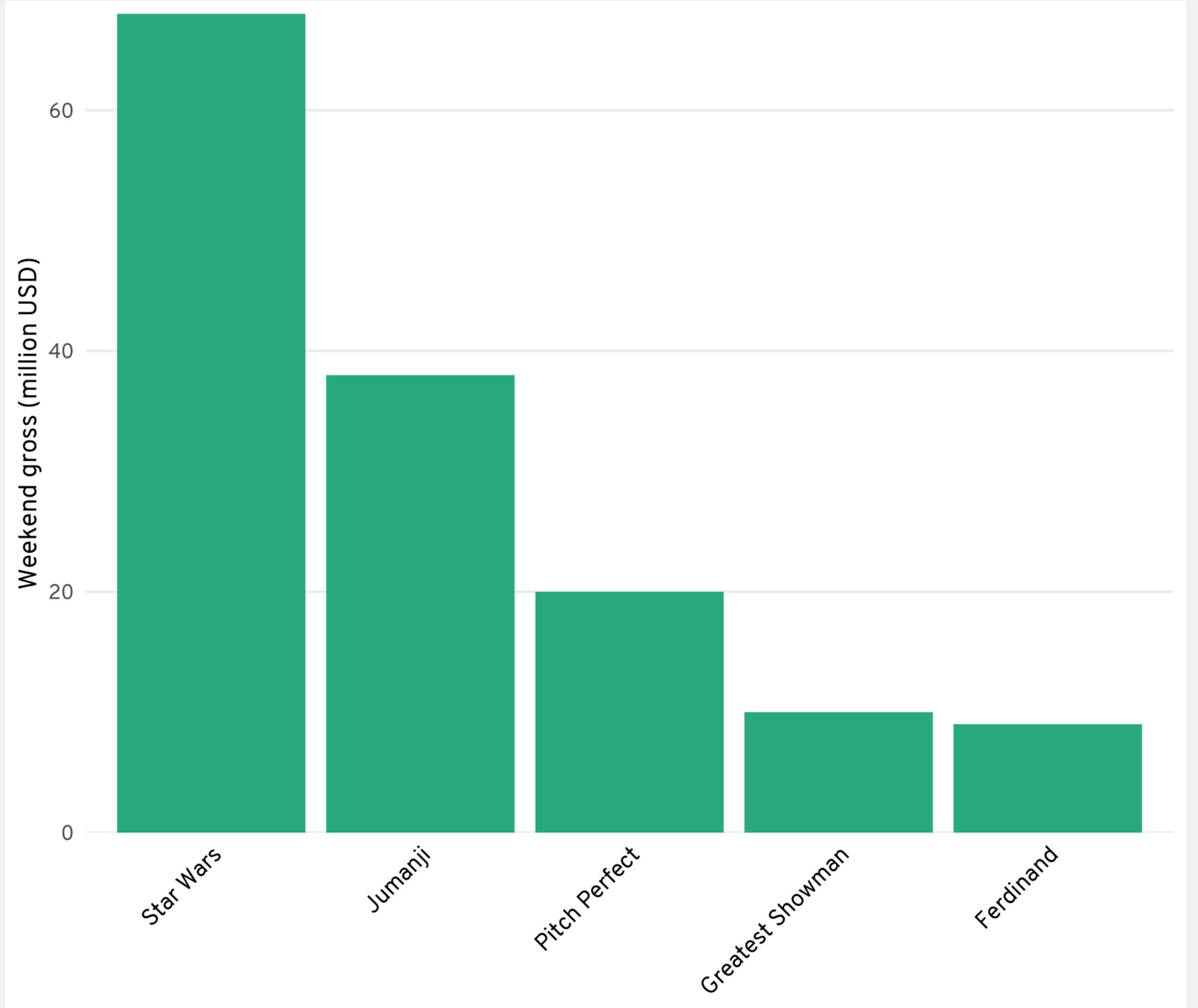
# DATAVIZ RULES

Recommendations

# Don't Tilt Labels

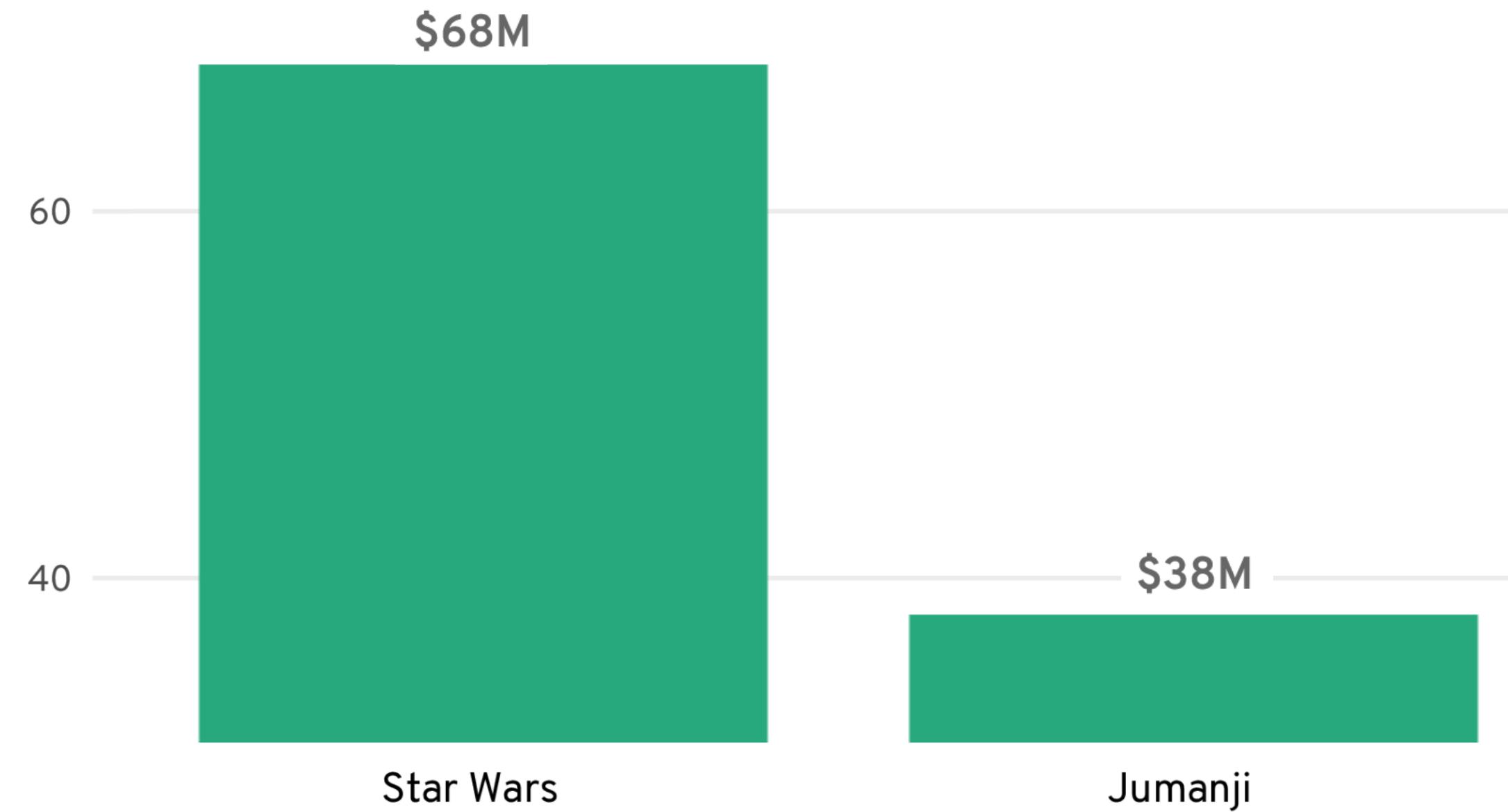


# Don't Tilt Labels

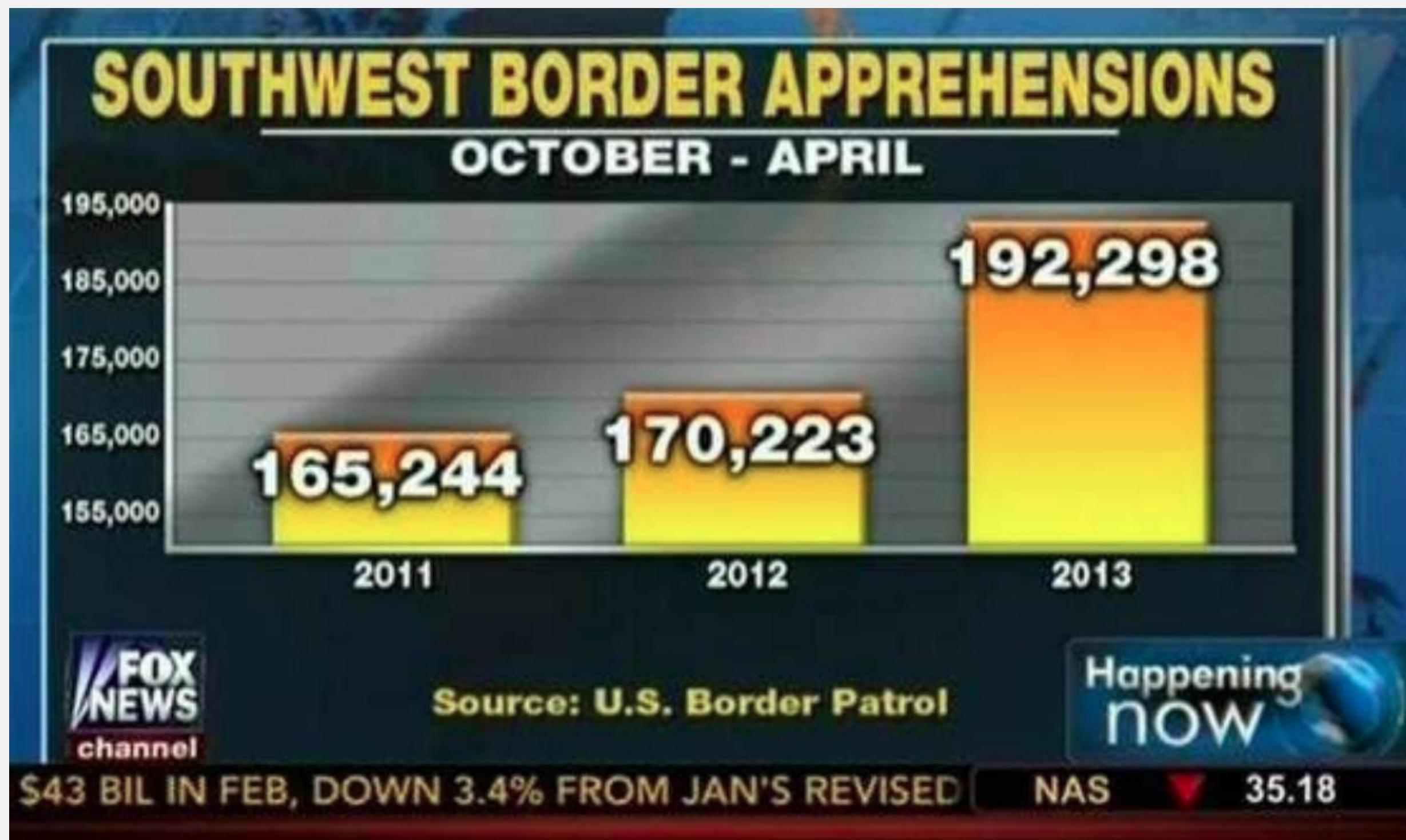


# Always Stat at Zero

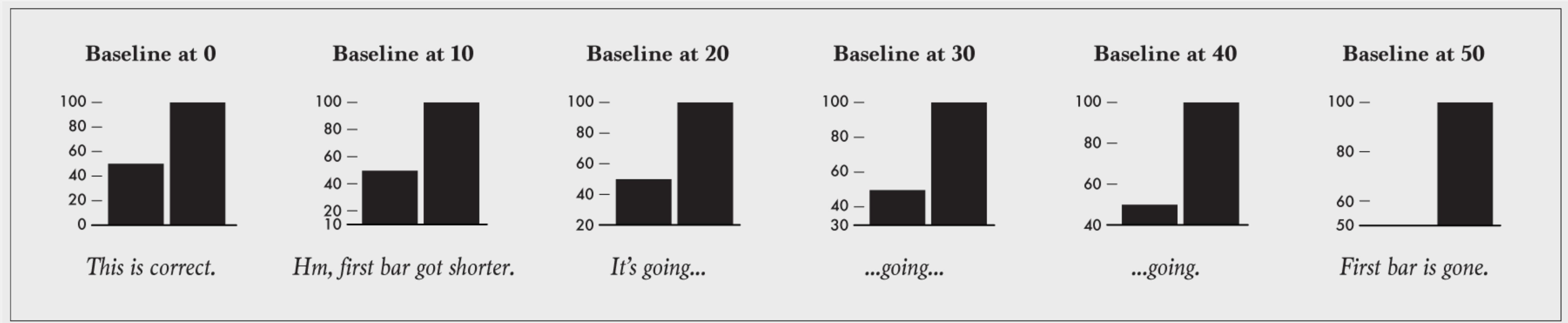
Weekend gross in million USD of popular blockbusters



# Always Stat at Zero

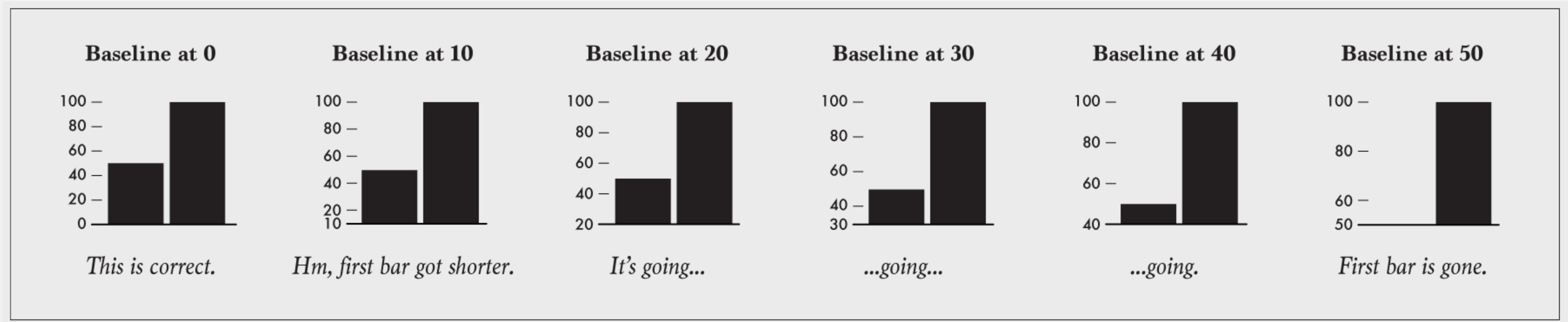


# Bar Graphs Should Start at Zero



Source: Nathan Yau ([flowingdata.com](http://flowingdata.com))

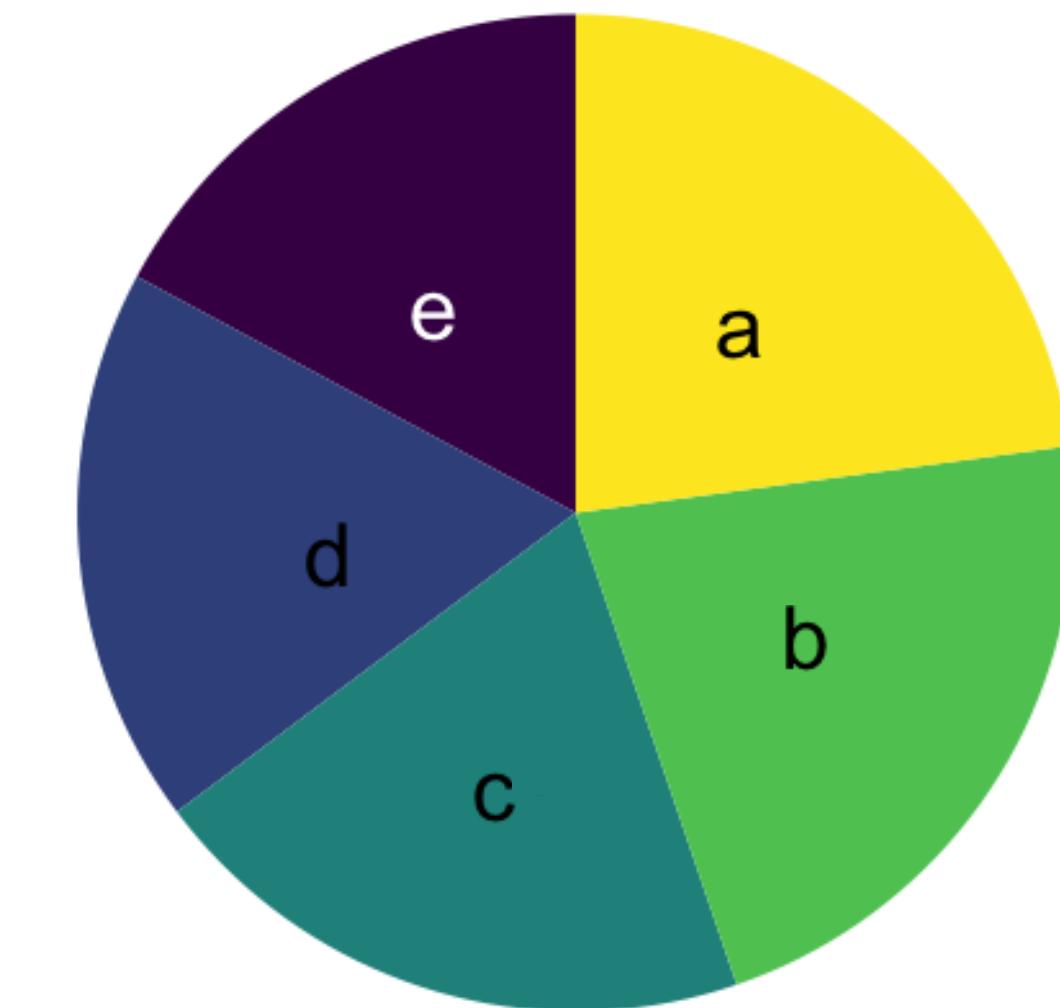
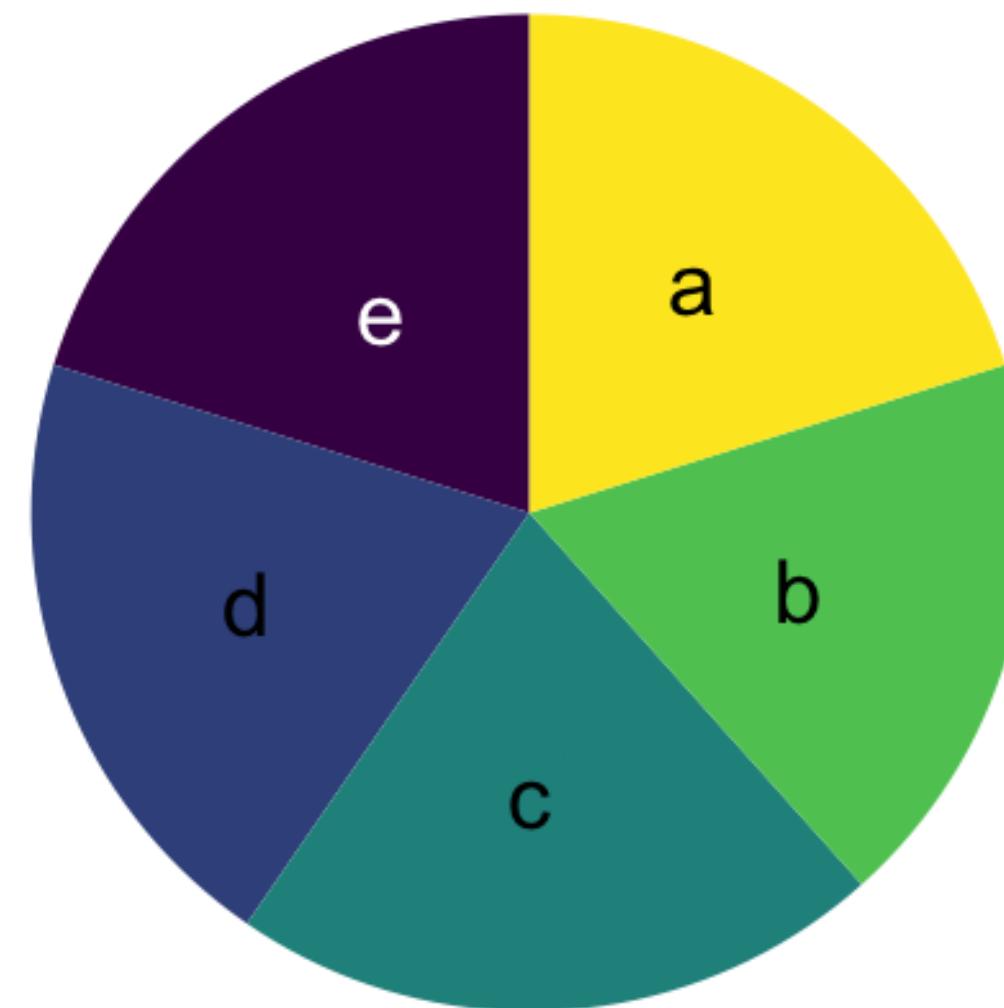
# Bar Graphs Should Start at Zero

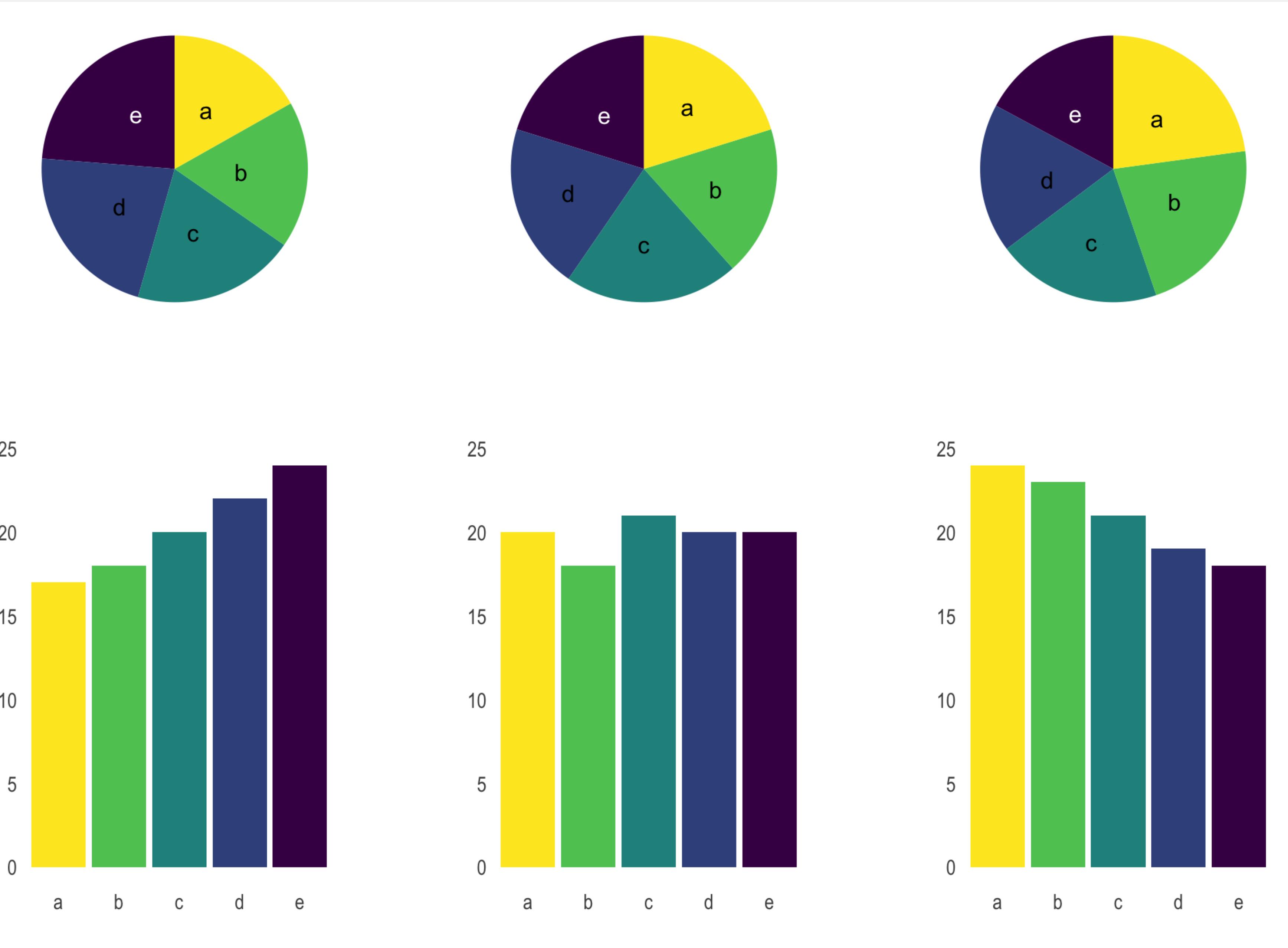


Source: Nathan Yau ([flowingdata.com](http://flowingdata.com))

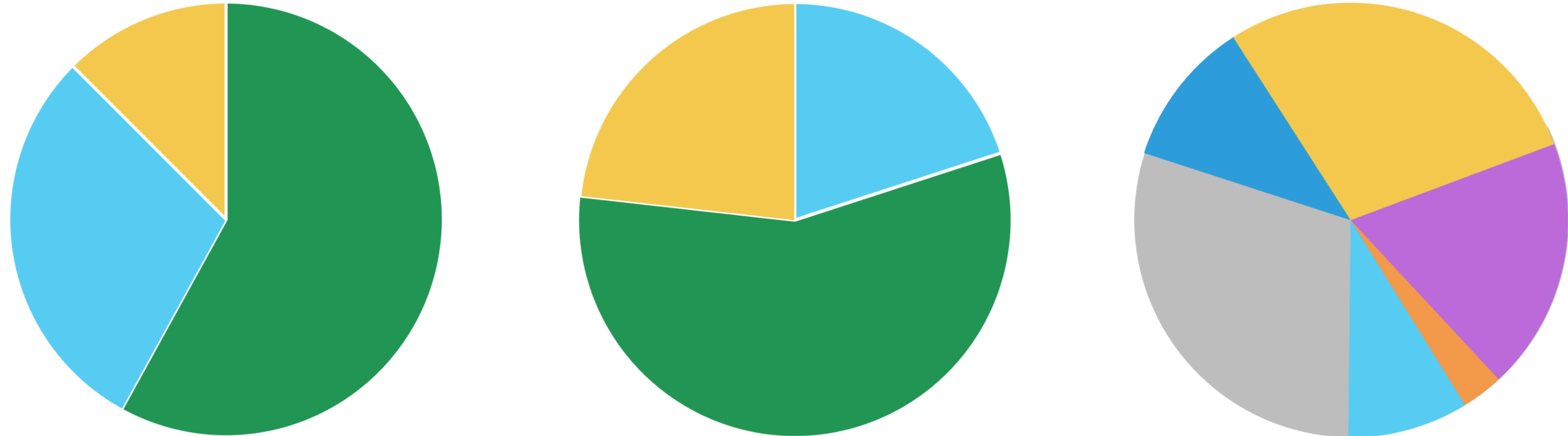


# Beware of Pie Charts



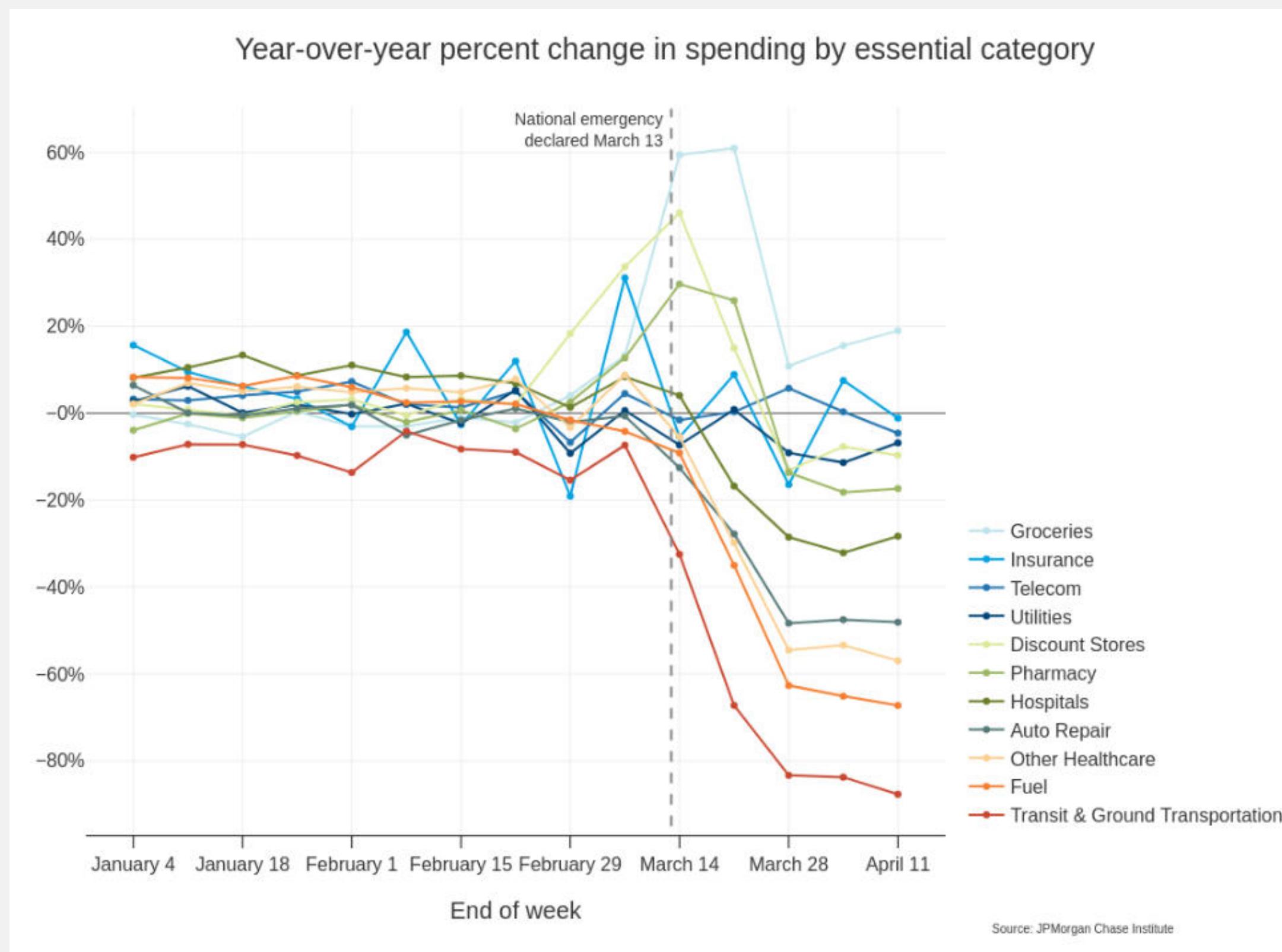


# Beware of Pie Charts

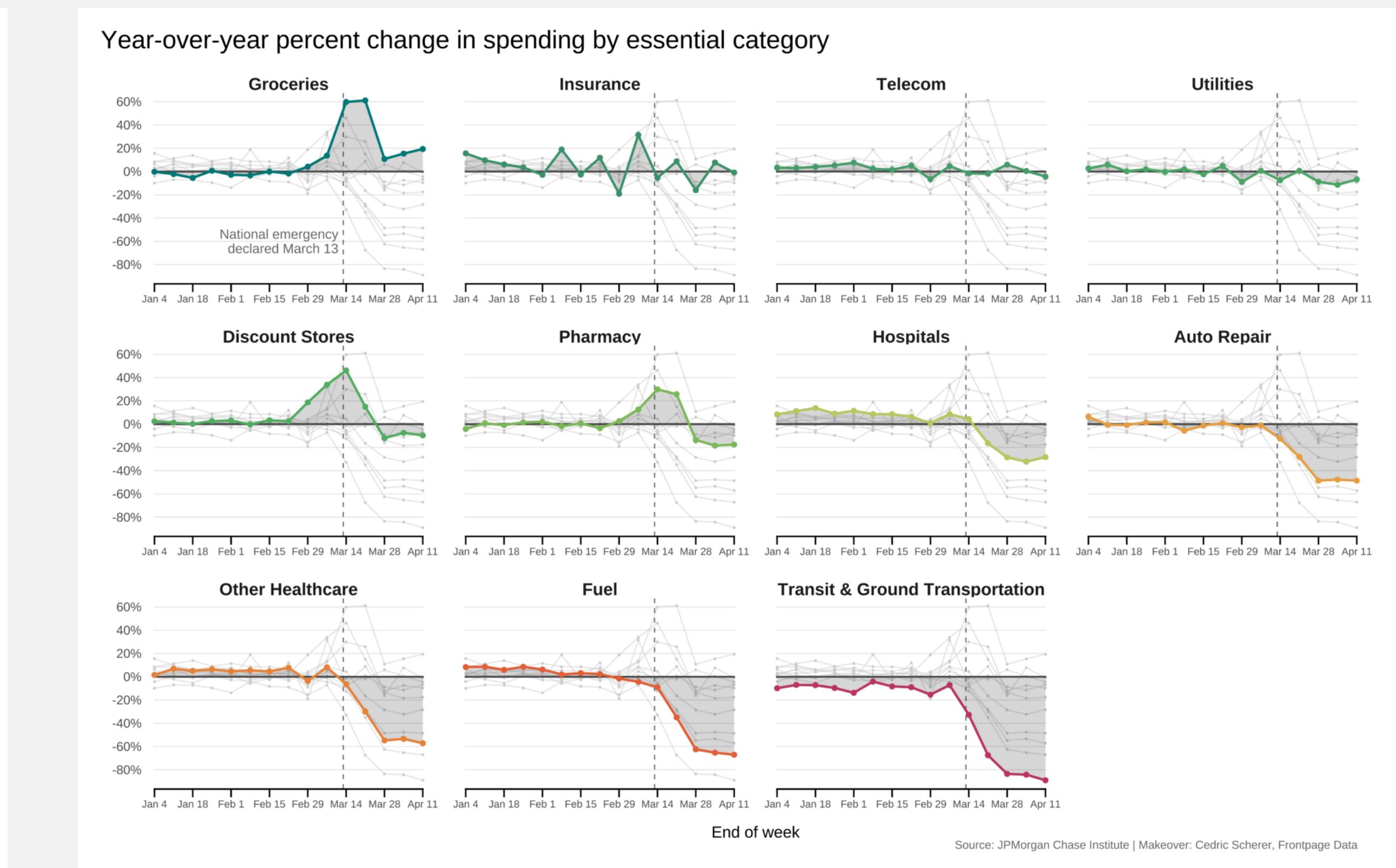


Source: “*Hands-On Data Visualization*” by Jack Dougherty & Ilya Ilyankou

# The Power of Small Multiples



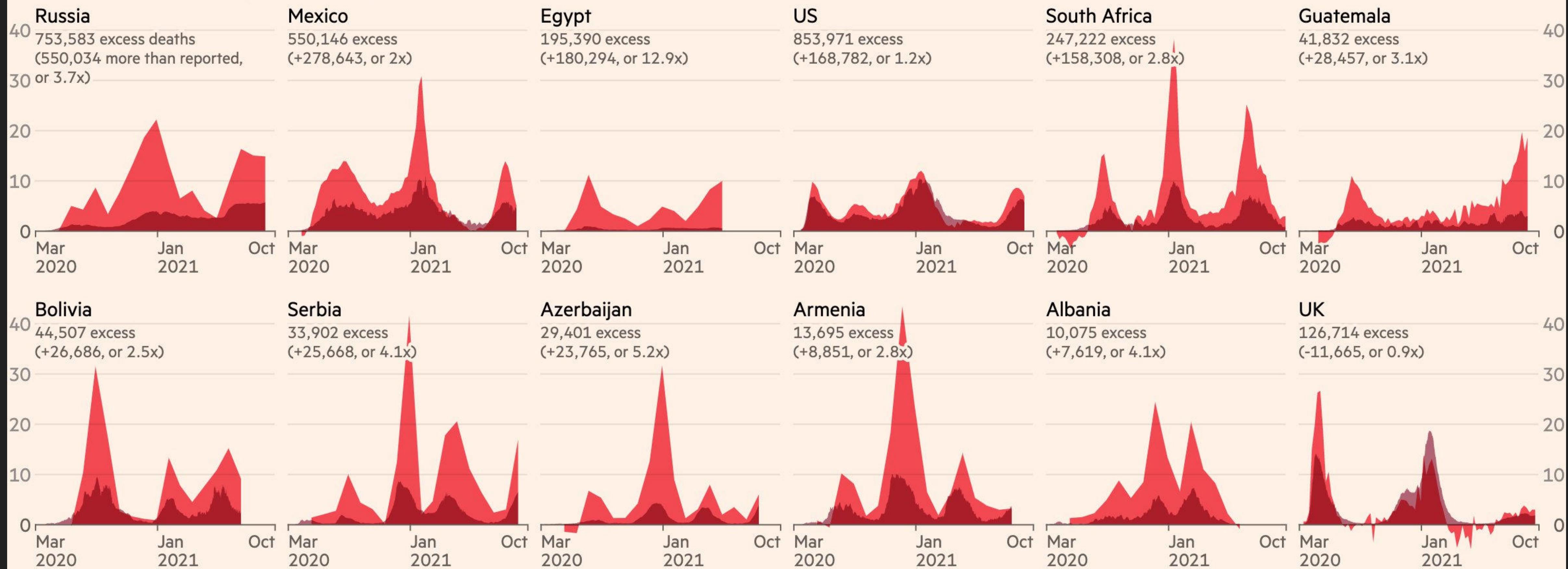
*Original graphic by JPMorgan Chase Institute*



# *Makeover using small multiples*

Russia has recorded more than 753,000 excess deaths during the pandemic, almost four times the official Covid death toll provided by state agencies

Daily **excess deaths** vs **reported deaths**, per million people



Source: Johns Hopkins CSSE; FT analysis of national mortality data and Karlinsky & Kobak's World Mortality Dataset

© FT

Source: *John Burn-Murdoch (Financial Times)*

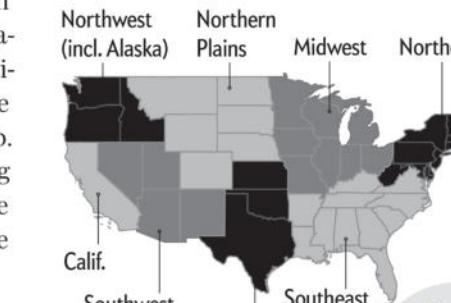
## GRAPHIC SCIENCE

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."



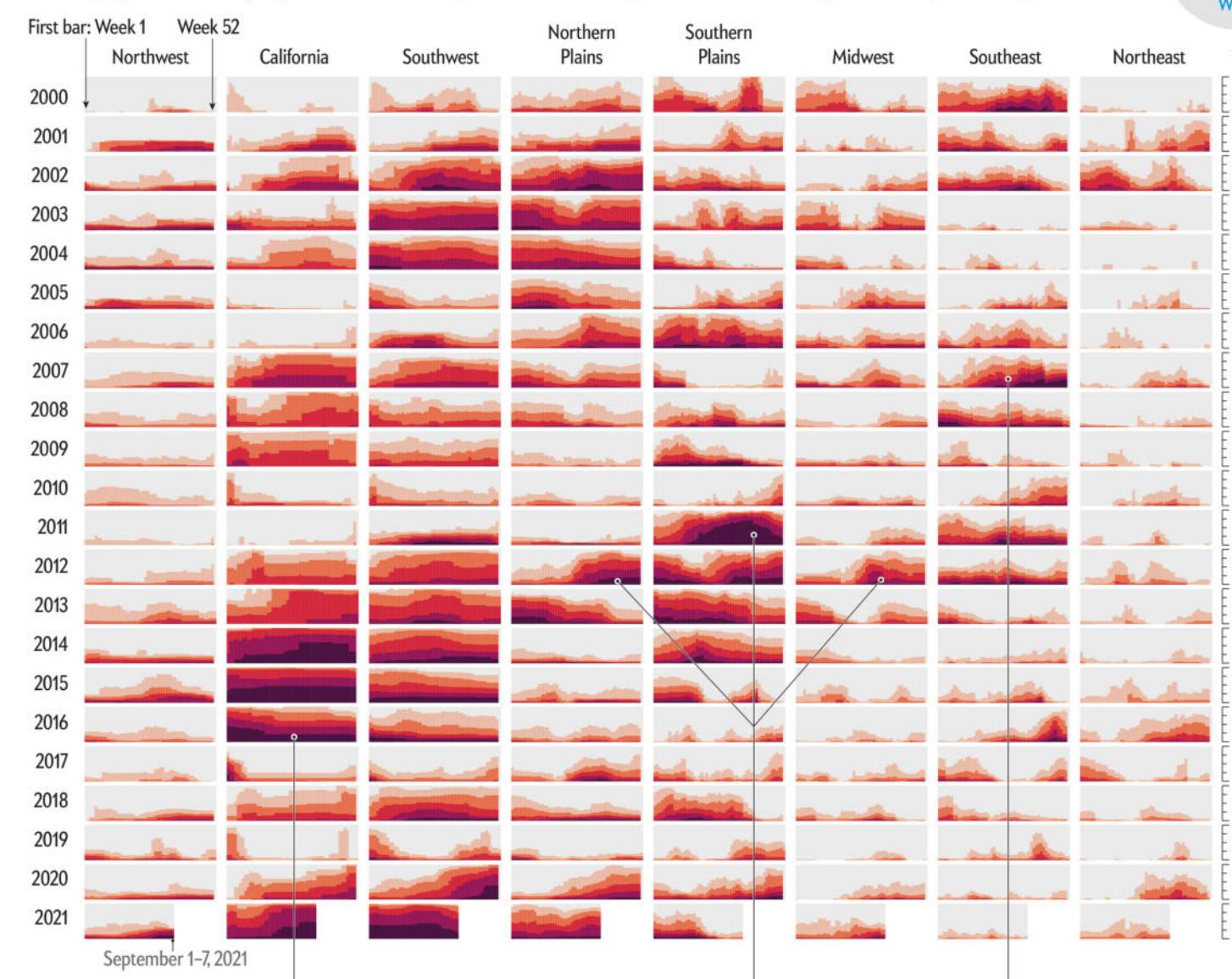
Percent of Region That Experienced Drought Each Week

100%

0%

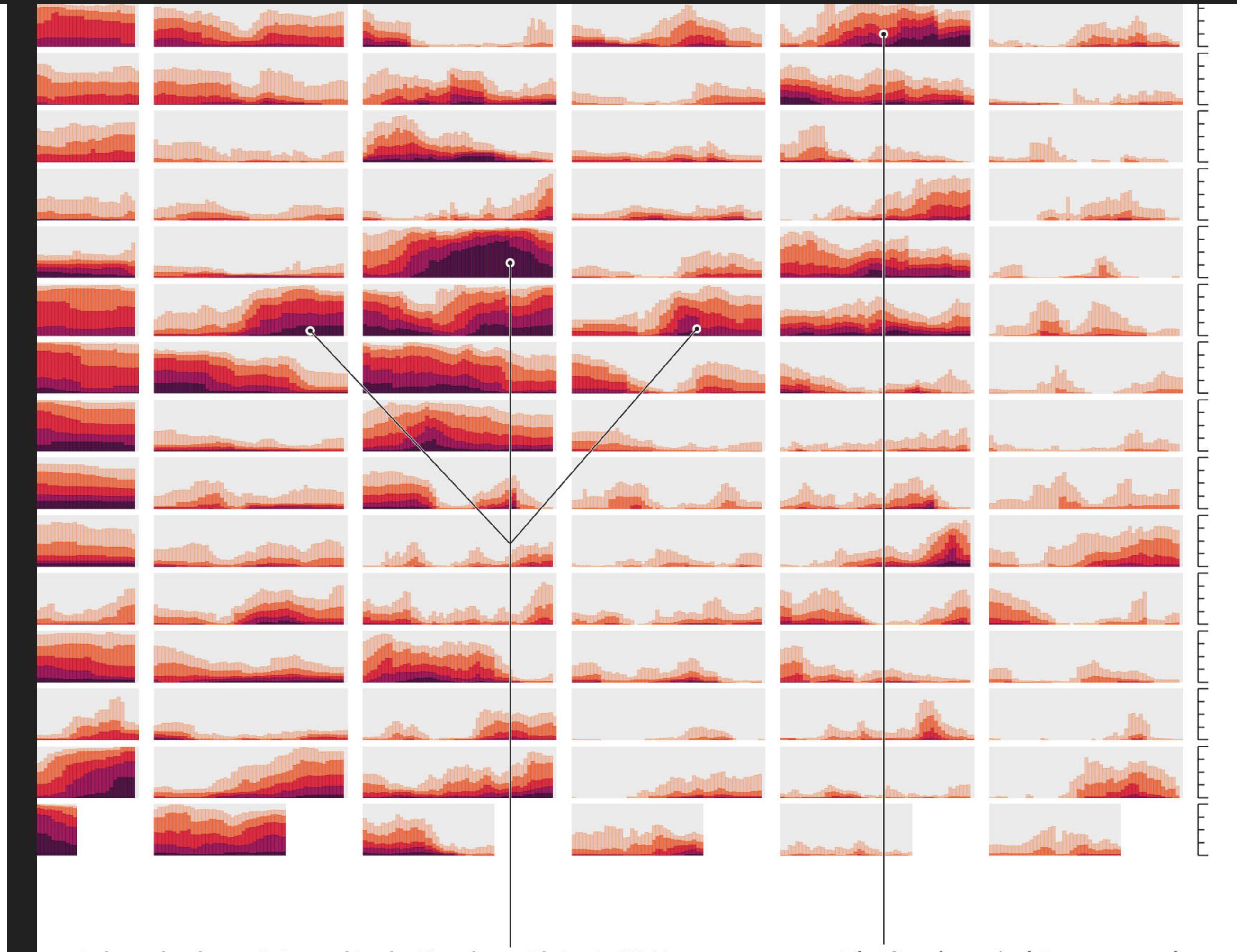
### Drought Extent and Intensity by Region over Time

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



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)

74 Scientific American, November 2021



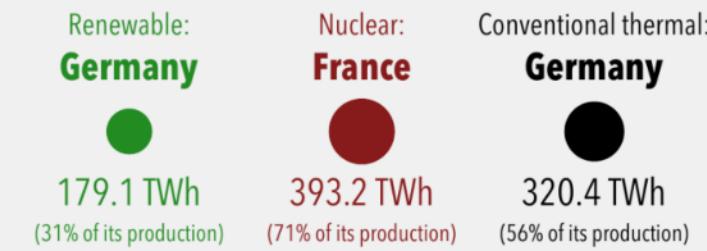
A drought that originated in the Southern Plains in 2011 eventually spread to the Midwest and Northern Plains when the moisture coming in from the Gulf of Mexico was absorbed by the parched South before it could reach the North.

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.

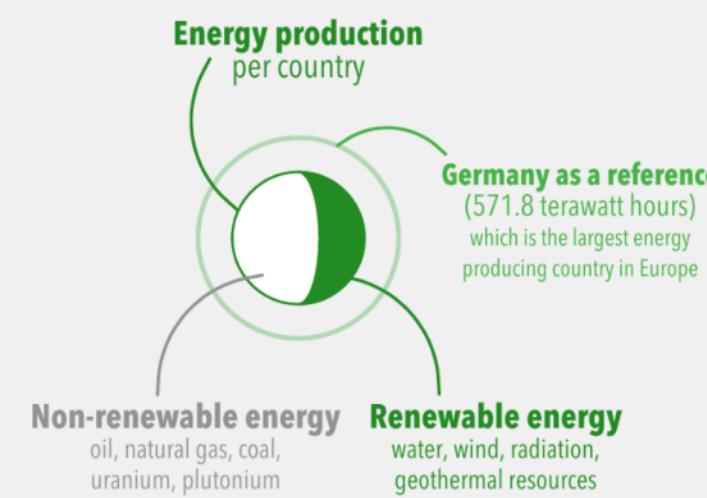
Source: “Escalating Drought”, together with Georgios Karamanis for Scientific American, Issue Nov 2021

## 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.

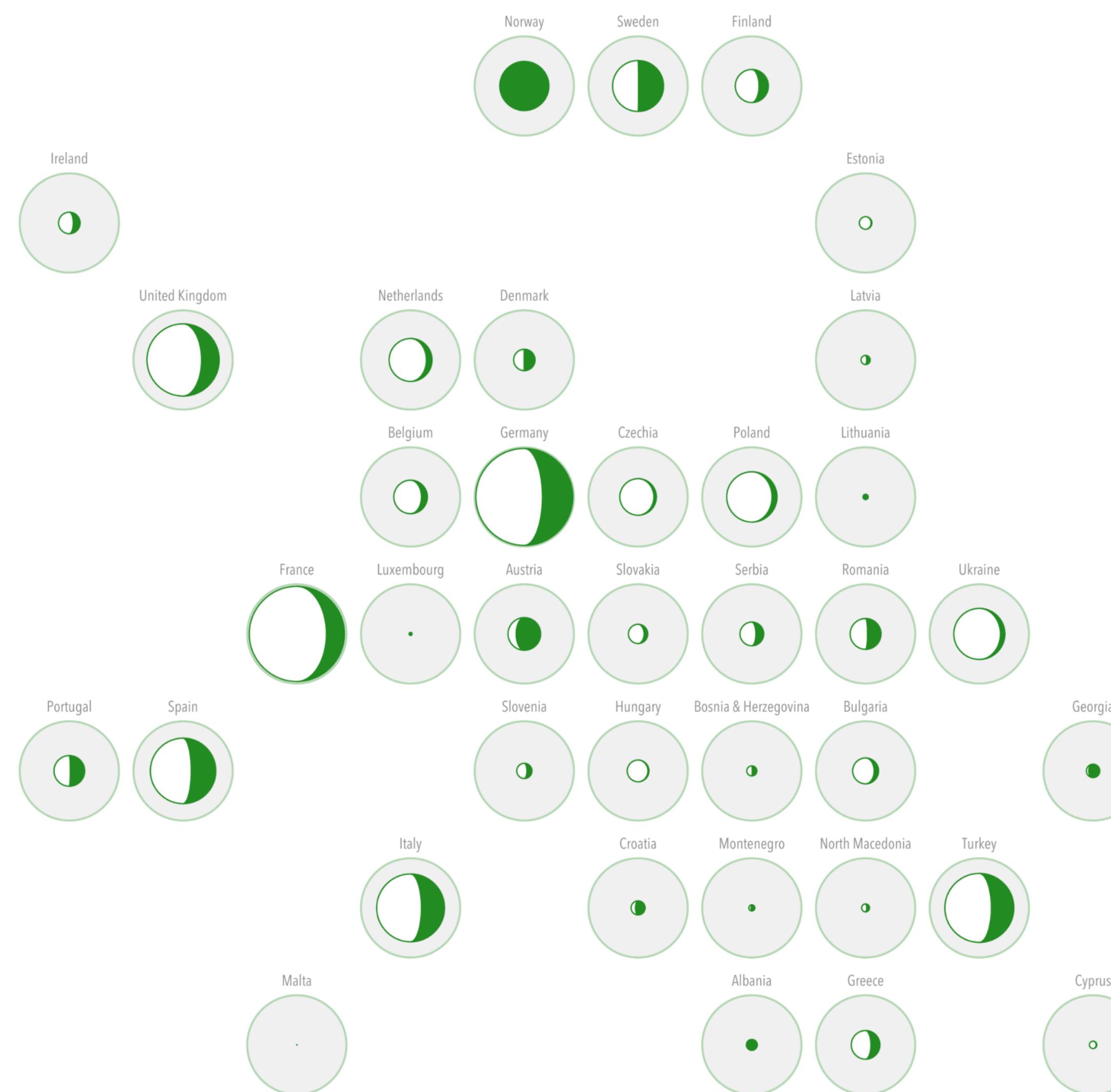


Renewable energy is energy that comes from resources that are naturally replenished such as sunlight, wind, water, and geothermal heat. Unlike fossil fuels, such as oil, natural gas and coal, or nuclear power sources such as uranium and plutonium, renewable energy regenerates naturally in a short period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

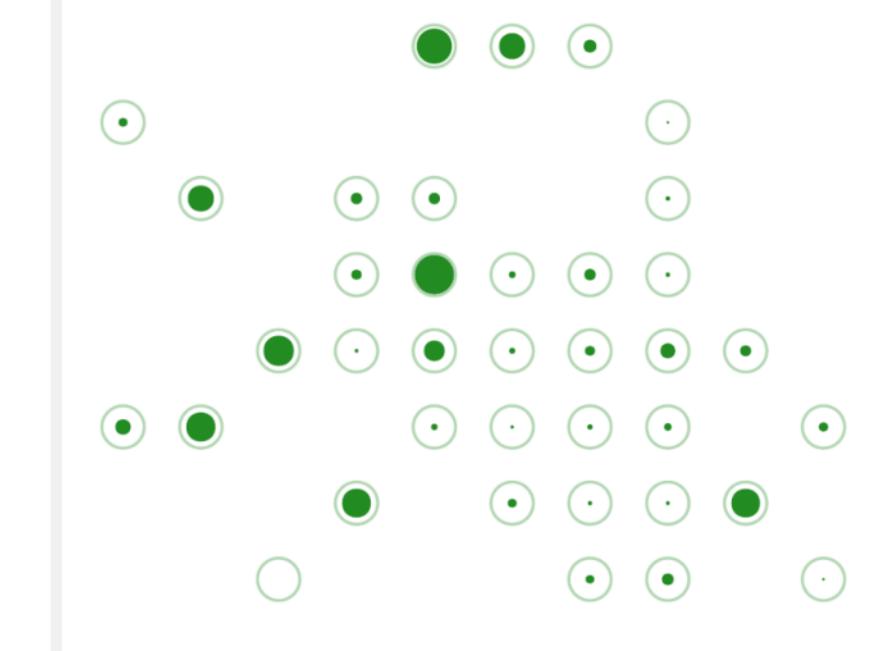


**Norway** had an electricity production almost entirely made up of renewable energy (98%). This makes Norway the second largest producer of this energy type in Europe. Interestingly, most of the renewable energy is produced by hydro power that take up 95% and only 3% by wind. In contrast, twelve European 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%).

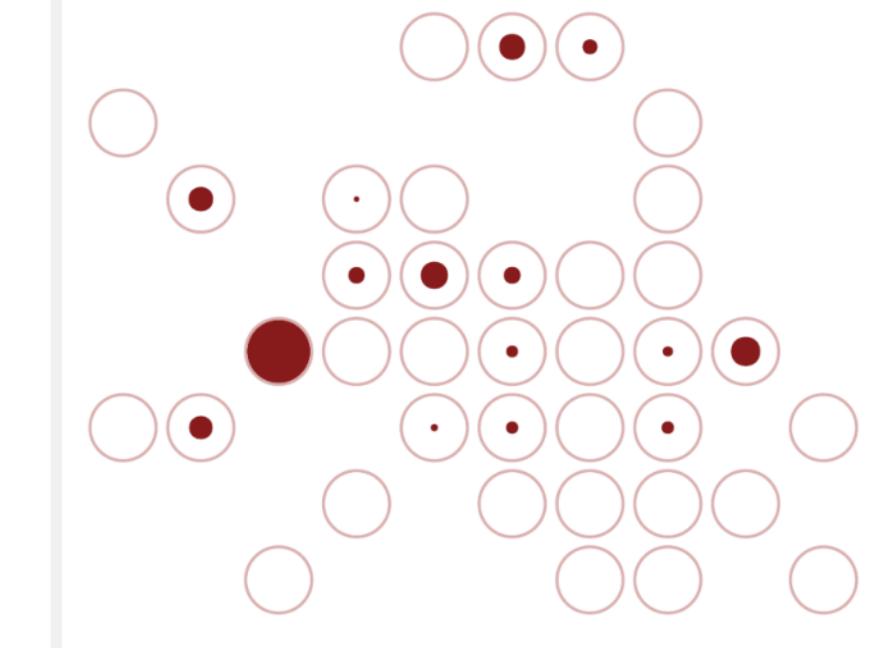
Note: Energy production is mapped to the area of the circles.  
Visualization by Cédric Scherer • Data by Eurostat



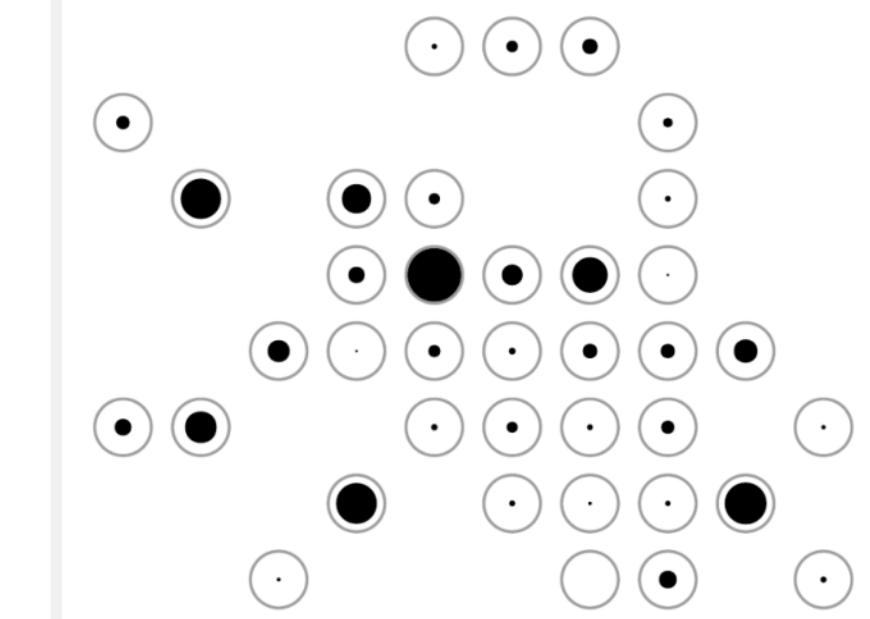
### Renewable energy



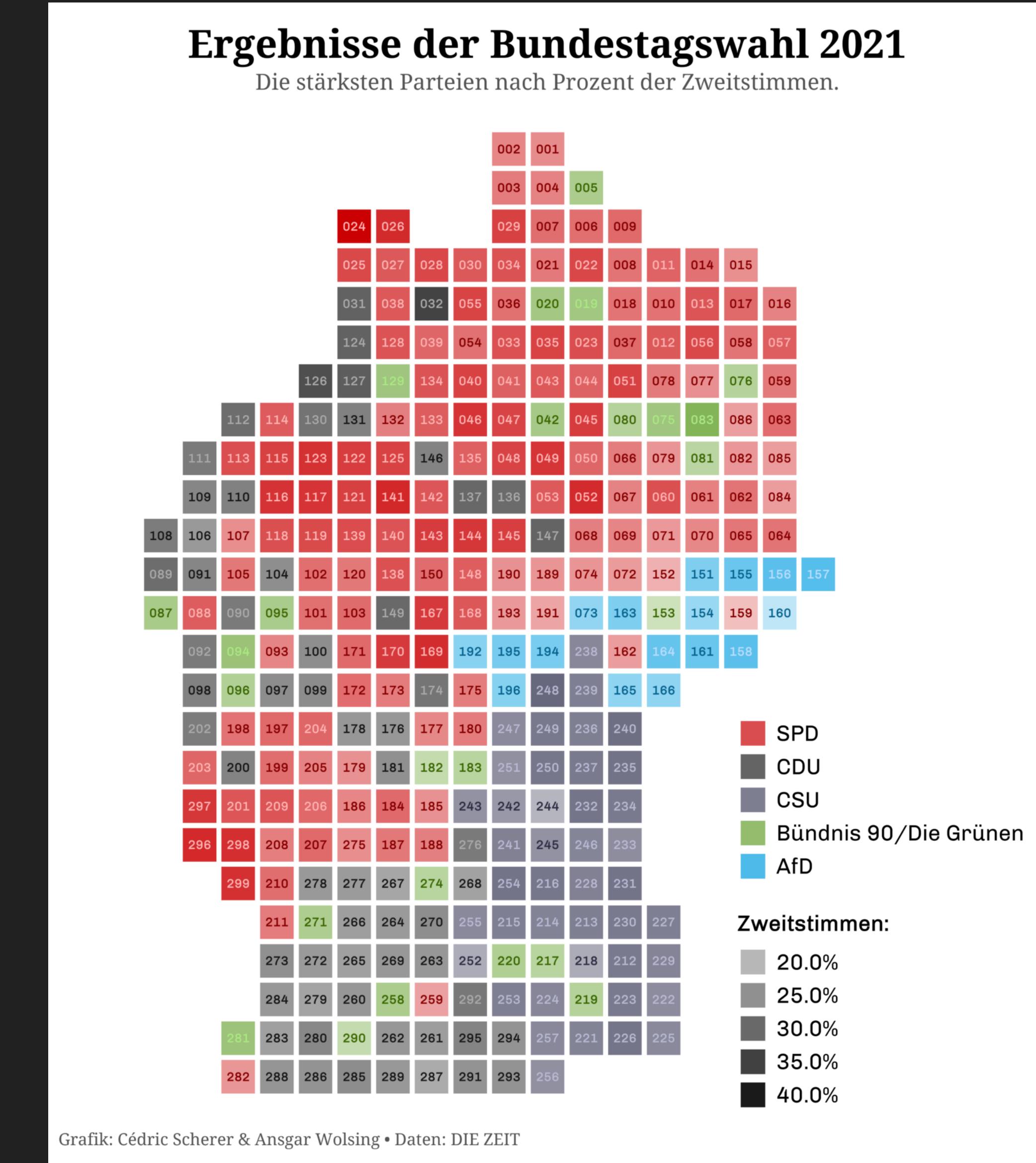
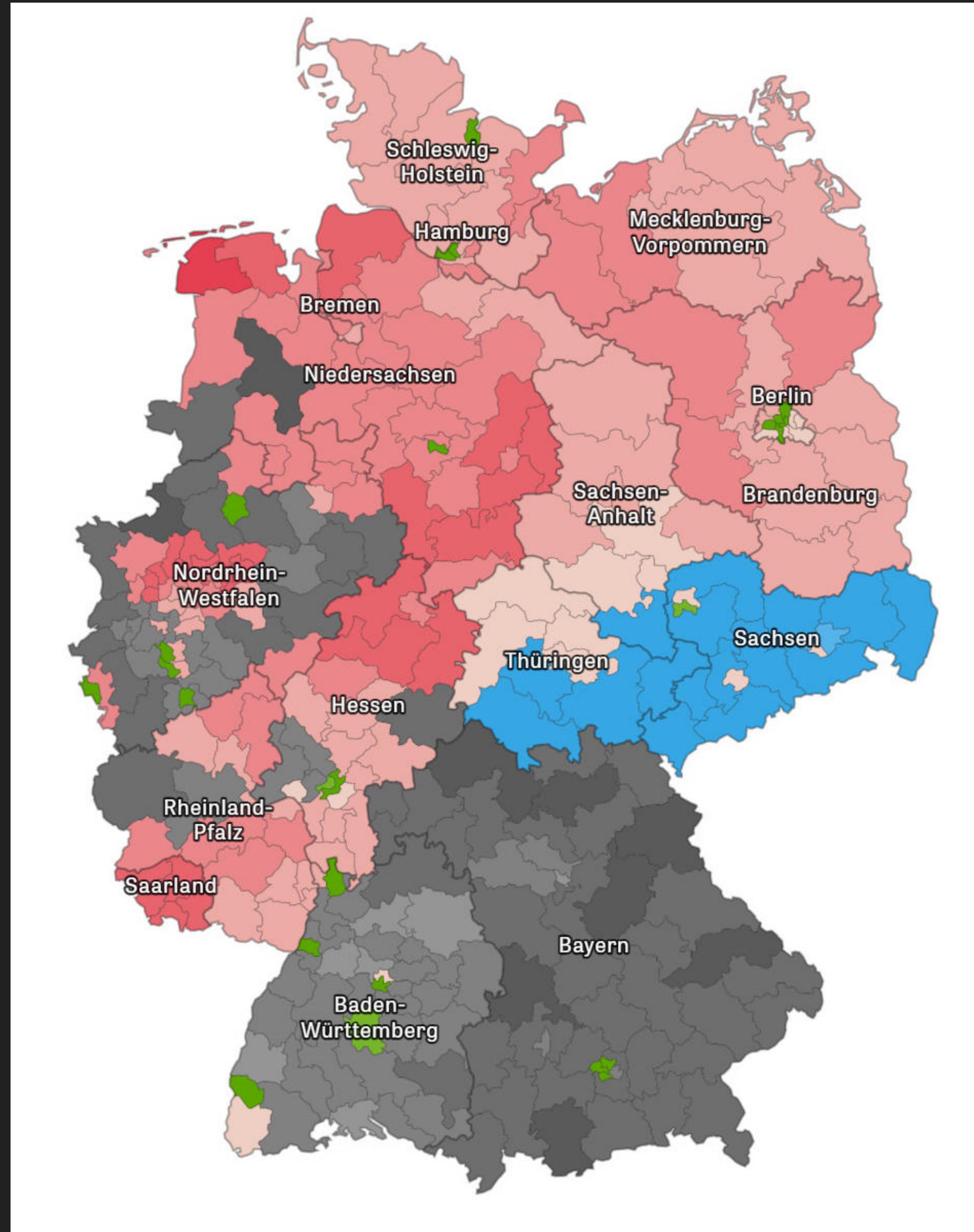
### Nuclear energy



### Conventional thermal energy



Source: “How European countries generated electricity in 2018”, #TidyTuesday Contribution



Source: Choropleth Map by Die Zeit (left) | Tile Grid Map by Cédric Scherer & Ansgar Wolsing (right)

# VISUAL FORM

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Present information in a logical, coherent way



cedricscherer.com

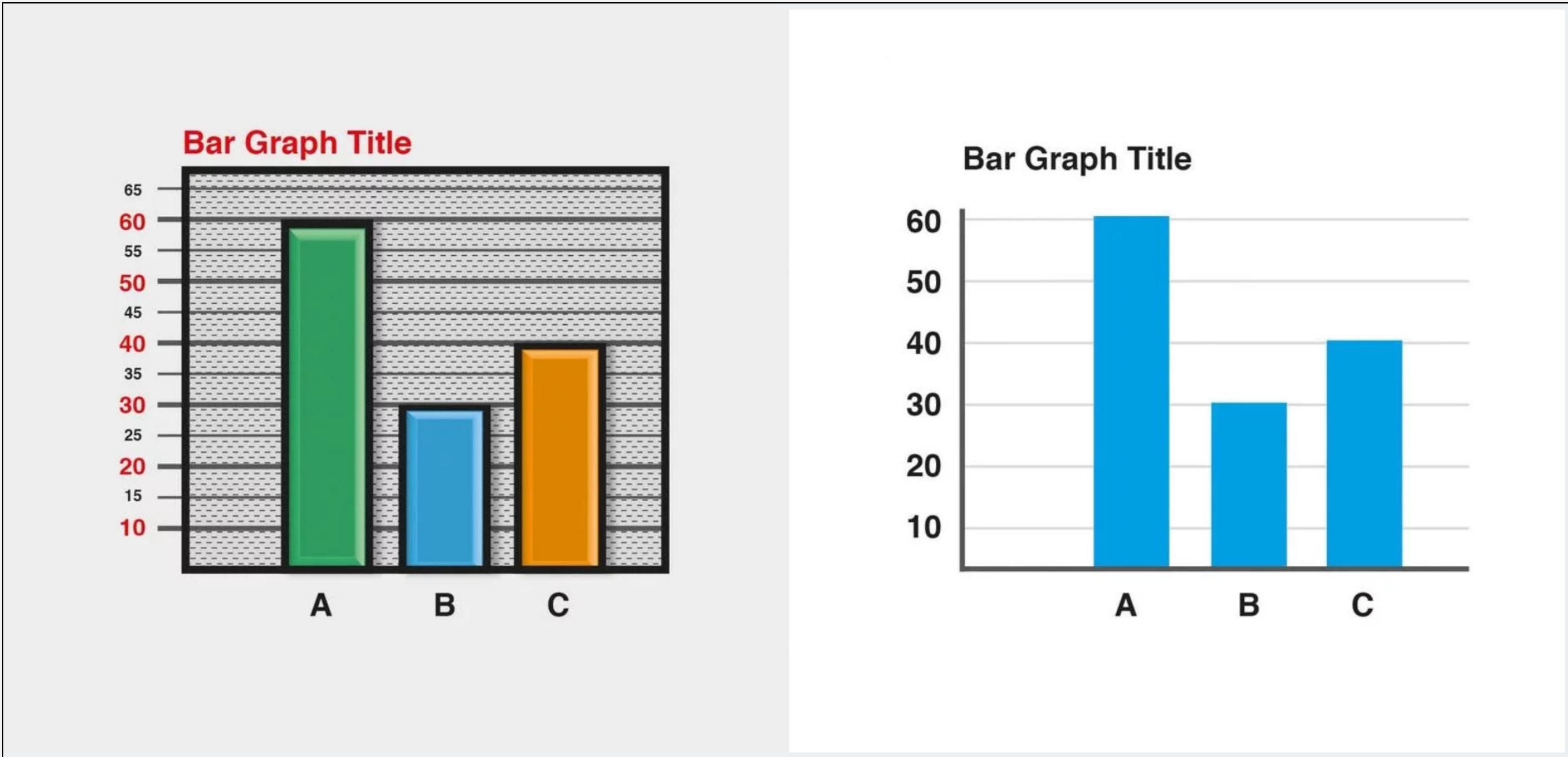


@CedScherer



z3tt

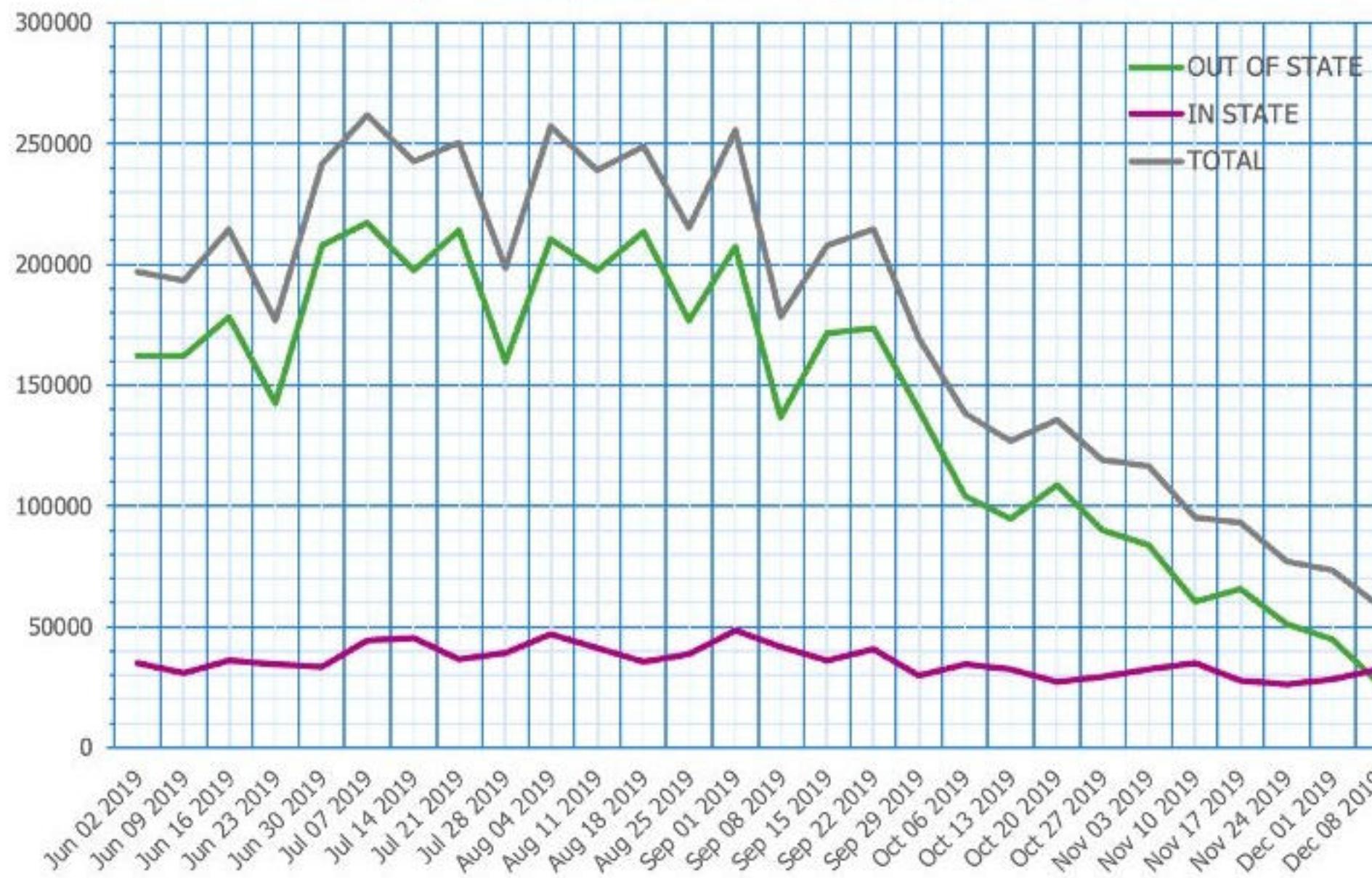
# Declutter Your Charts



Source: [canva.com](https://canva.com)

## BEFORE: SPOOKY SKELETON

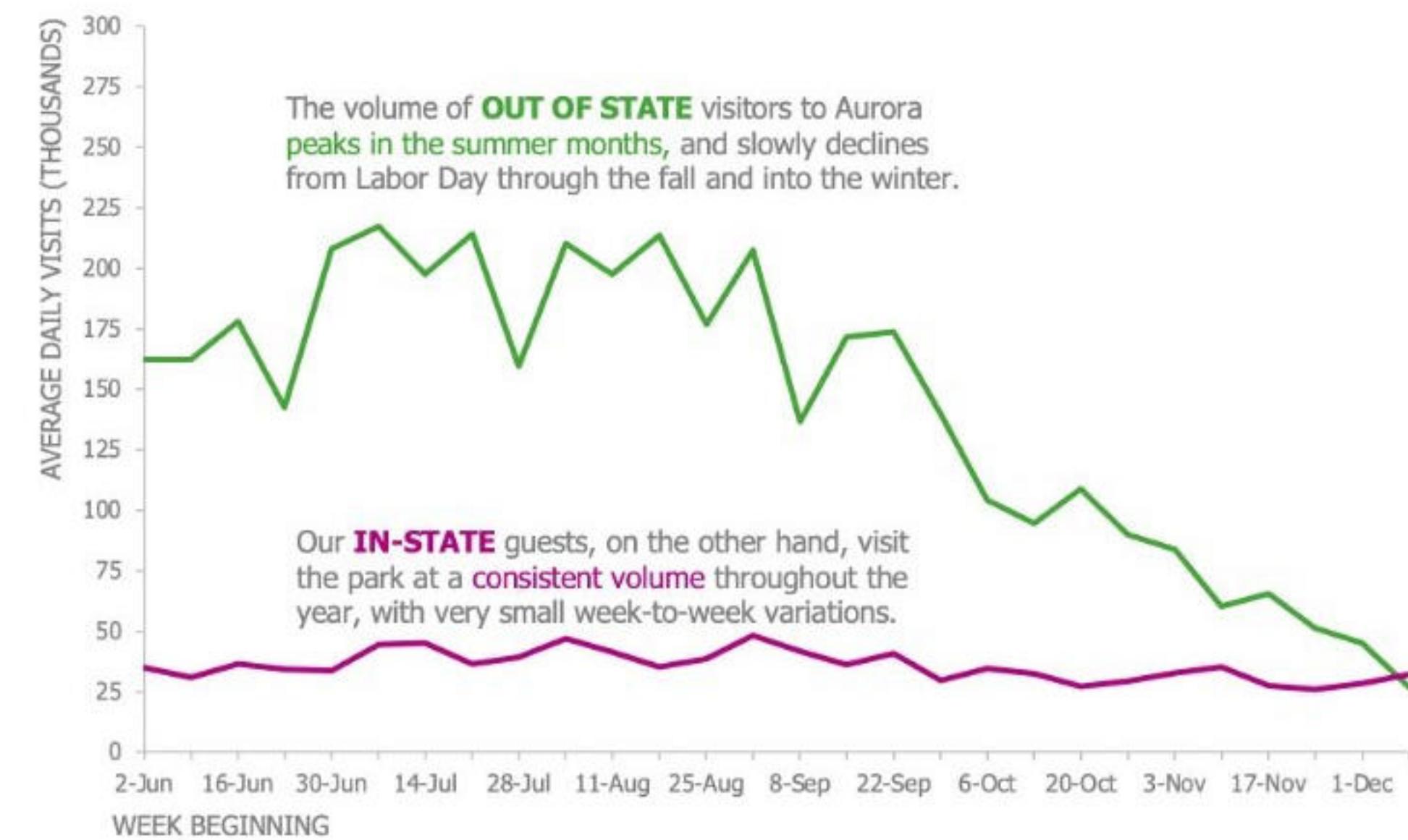
Daily Average Park Visitors By Week



## AFTER: GOOD BONES

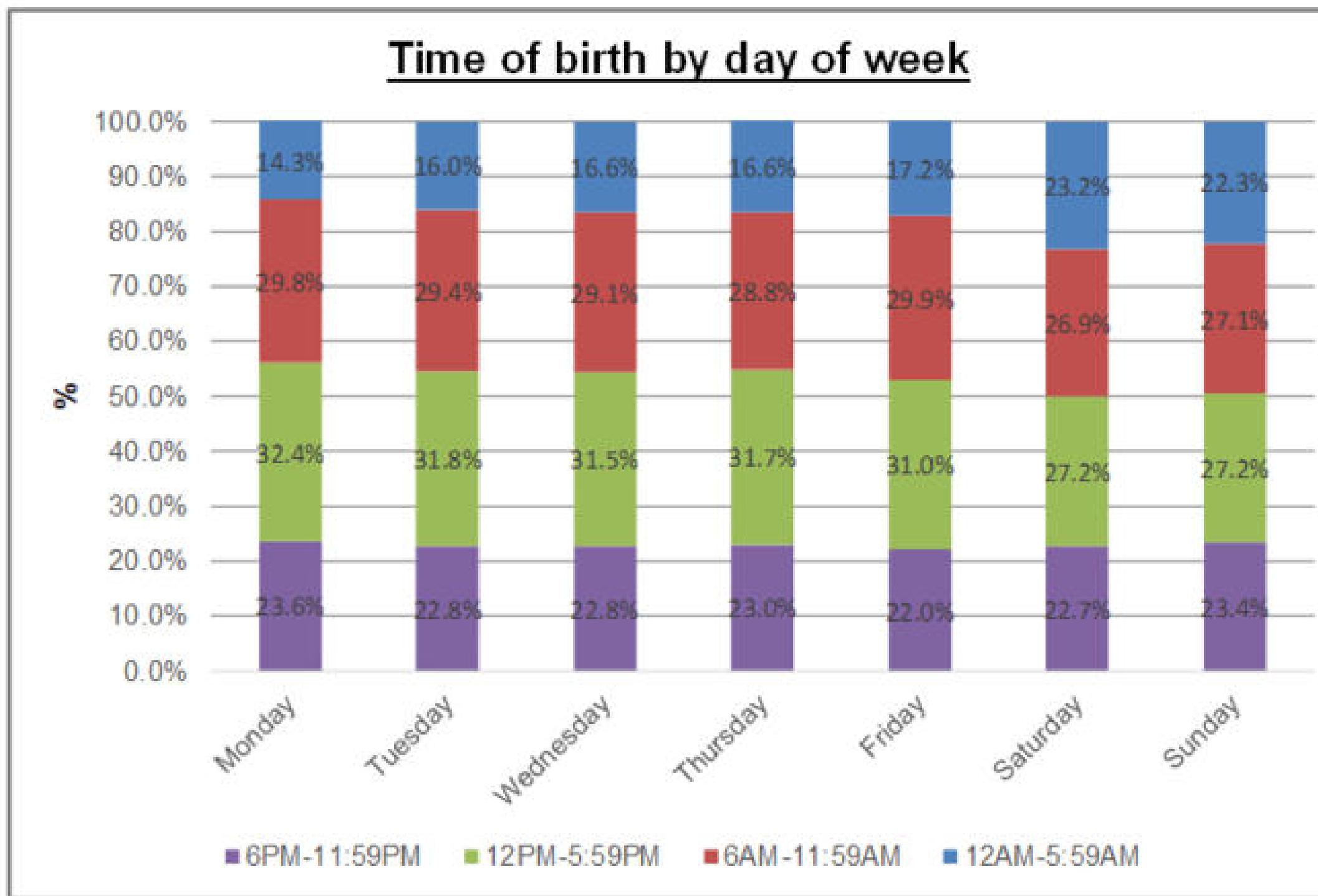
Daily visitors to Aurora Park in summer/fall 2019

VALUES ARE CALCULATED WEEKLY AS A 7-DAY AVERAGE

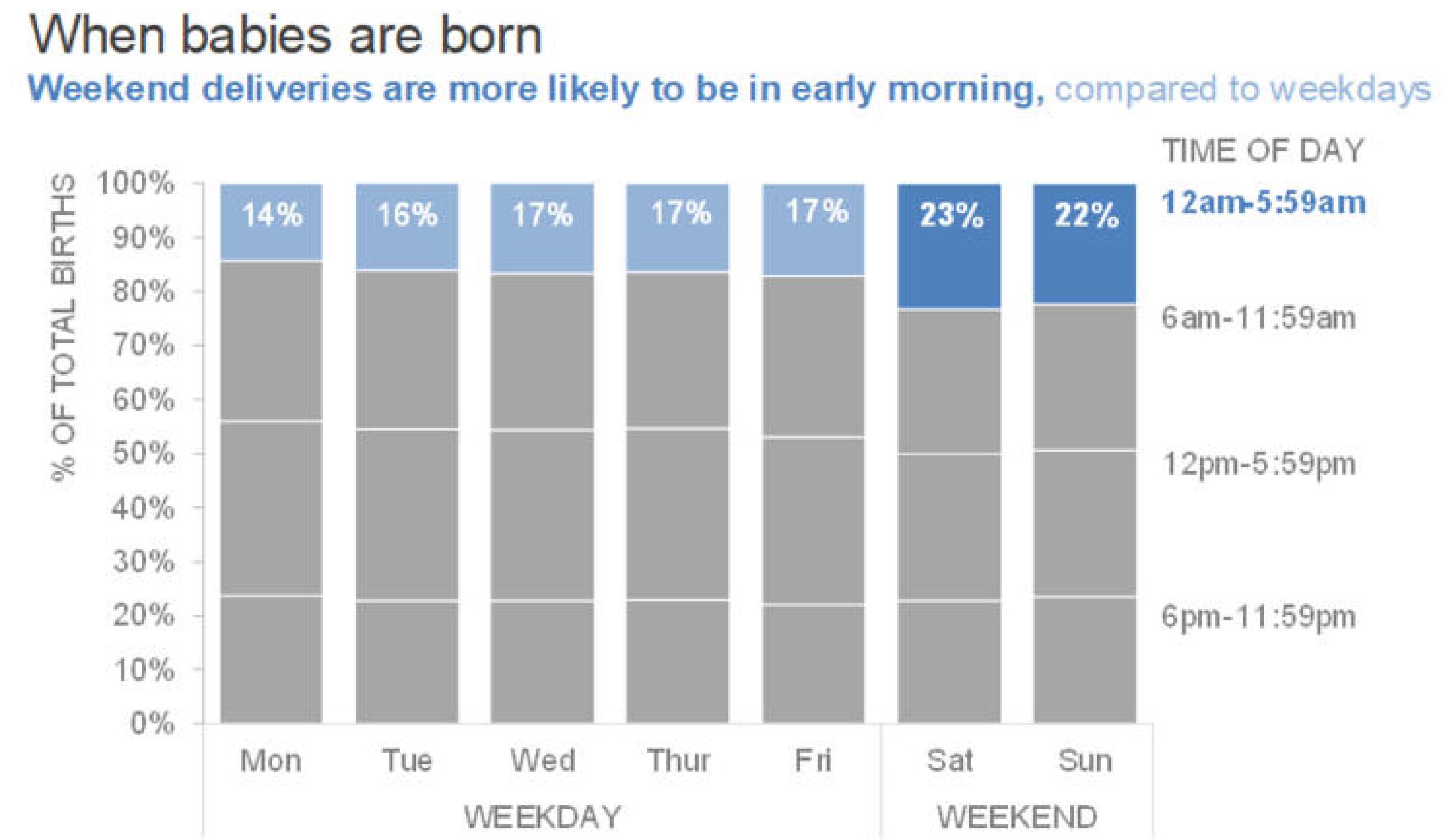


Source: “Your graph Skeleton Shouldn’t Be Scary” by Mike Cisneros (*Storytelling With Data*)

## BEFORE



## AFTER

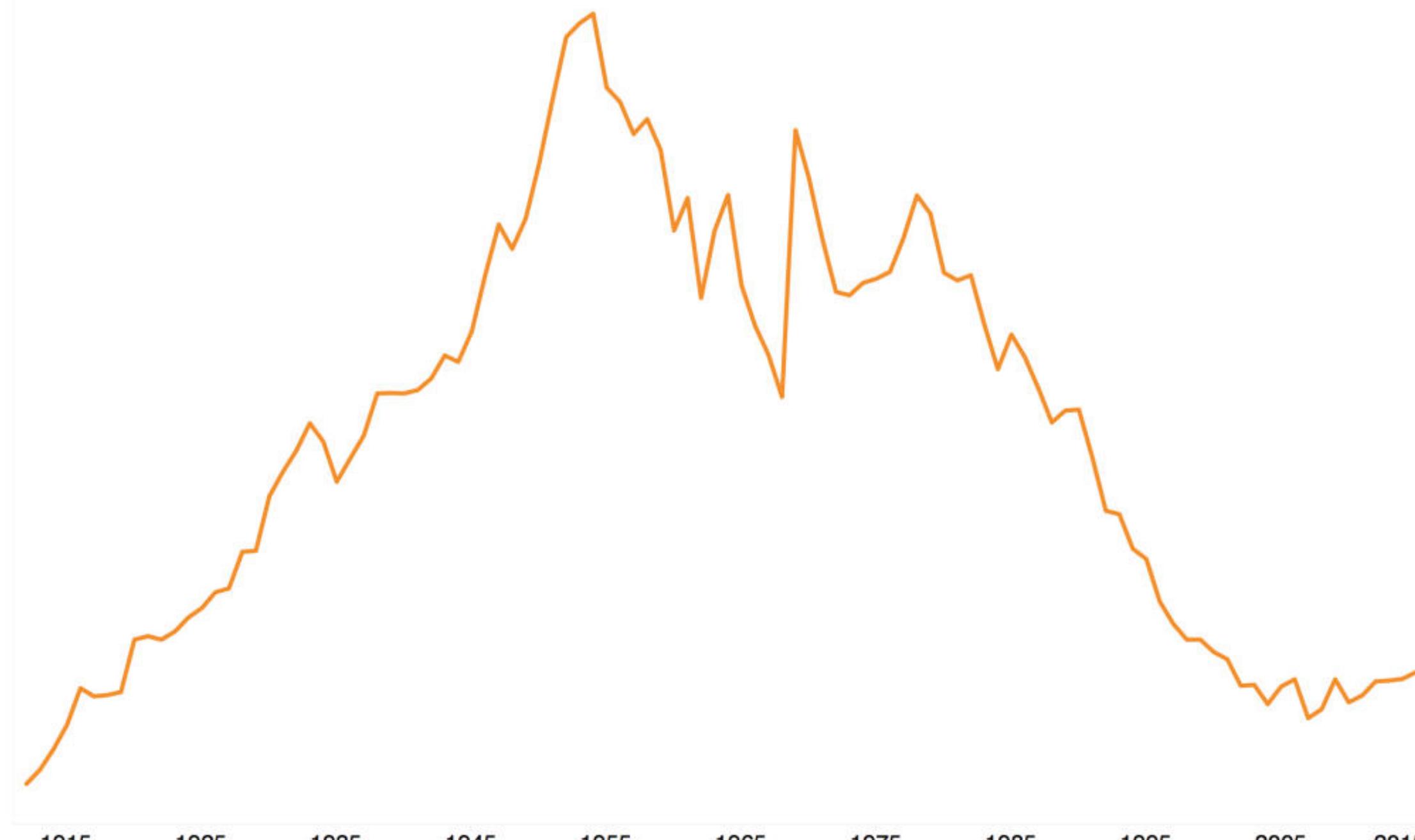


Source: “Declutter! (and Question Default Settings)” by Elizabeth Ricks (*Storytelling With Data*)

# The Power of Annotations

Rise and Fall of the name **Neil** in the USA  
Births 1912-2015

Source: data.gov



Visualisation: [@theneilrichards](#)

Source: ["Is white space always your friend?" by Neil Richards](#)

# The Power of Annotations

Rise and Fall of the name **Neil** in the USA  
Births 1912-2015

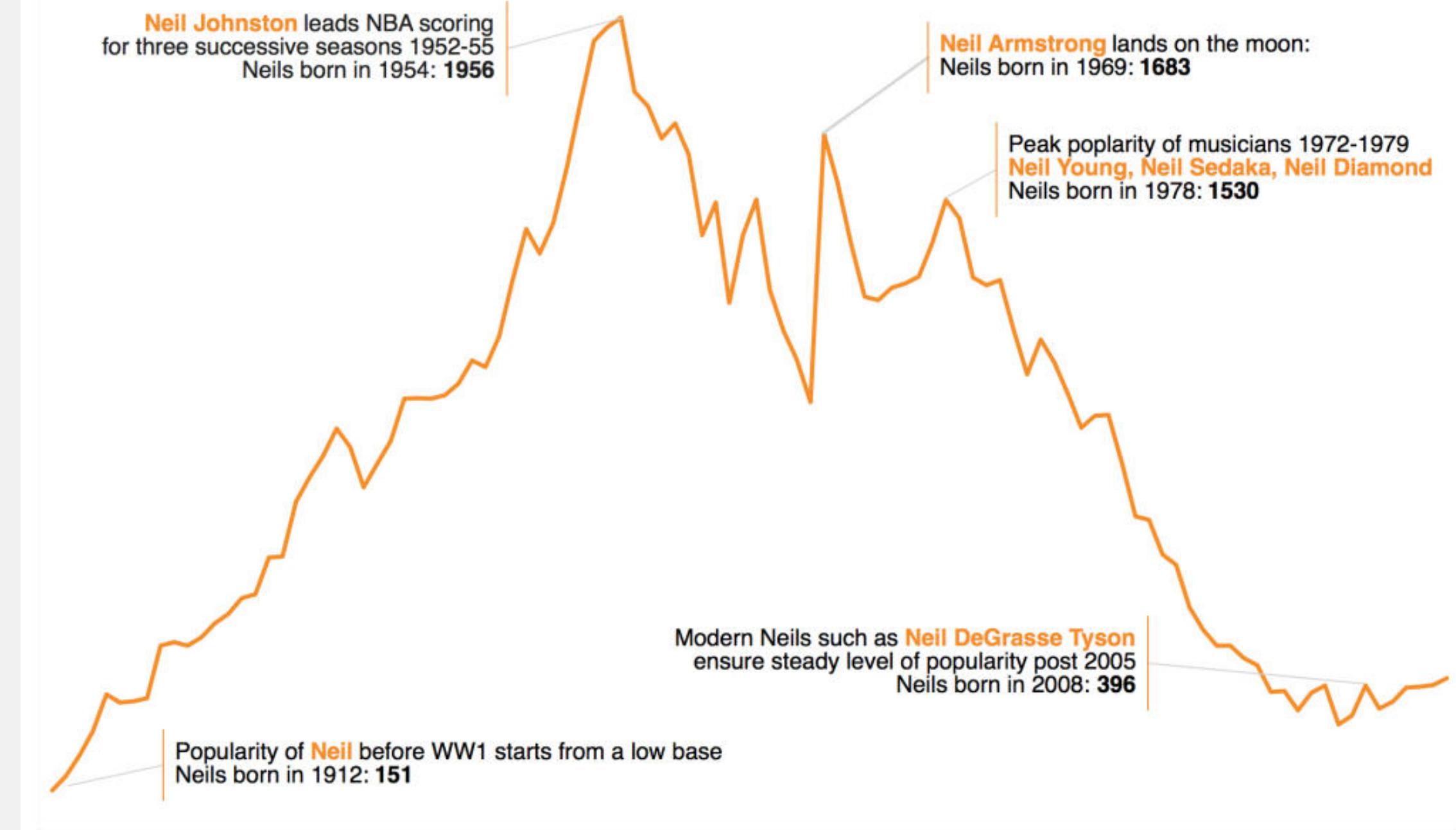
Source: data.gov



Visualisation: @theneilrichards

Rise and Fall of the name **Neil** in the USA  
Births 1912-2015

Source: data.gov



Visualisation: @theneilrichards

#SWDChallenge

Source: “Is white space always your friend?” by Neil Richards

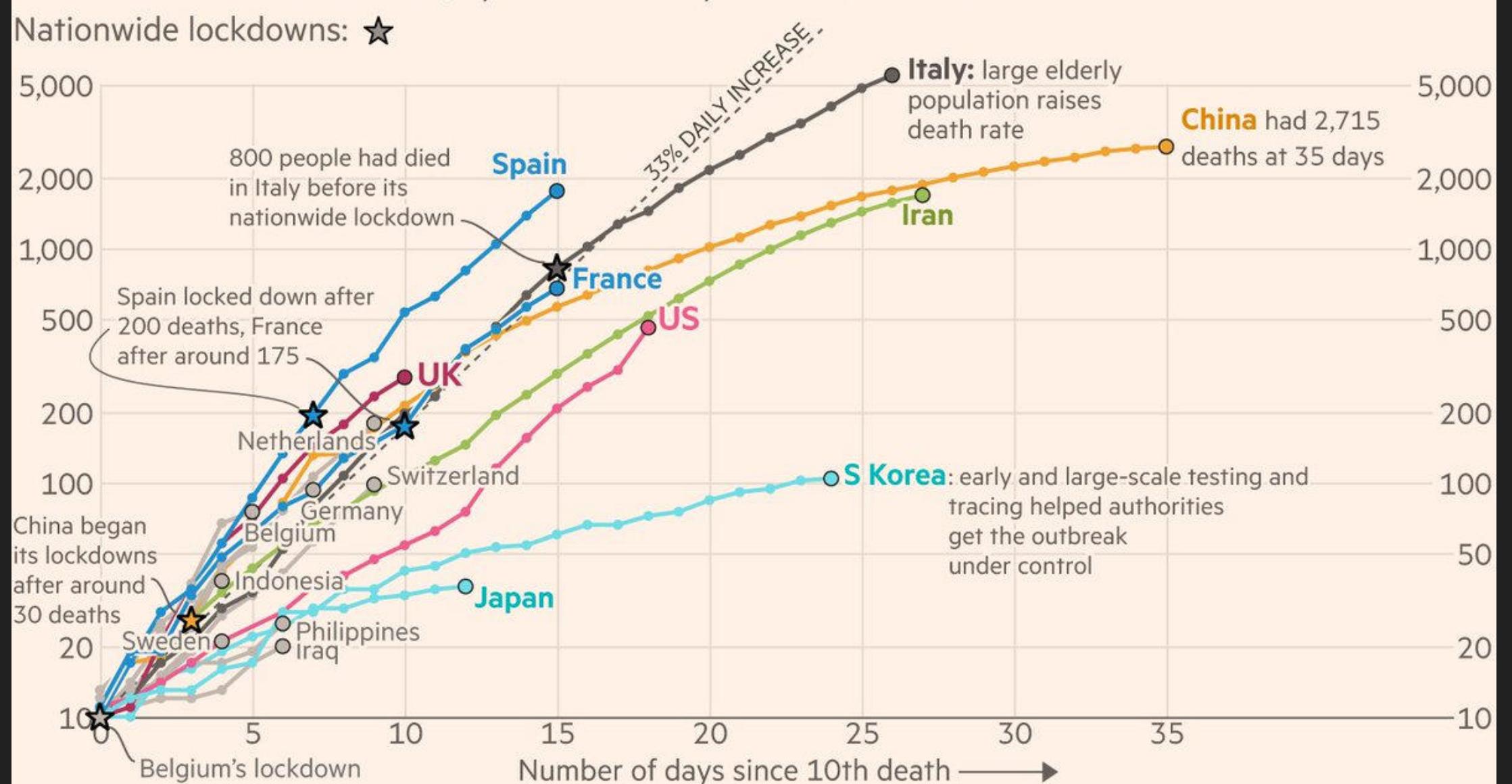
“The key thing we do is to add a title to the chart, as an entry point and to explain what is going on. **Text and other annotations add enormous value for non-chart people.**”

~ John Burn-Murdoch, Financial Times

Coronavirus deaths in Italy, Spain and the UK are increasing much more rapidly than they did in China

Cumulative number of deaths, by number of days since 10th death

Nationwide lockdowns: ★



FT graphic: John Burn-Murdoch / @jburnmurdoch

Source: FT analysis of Johns Hopkins University, CSSE; Worldometers; FT research. Data updated March 23, 09:00 GMT

© FT

Covid has grown gradually less lethal over the pandemic, mainly due to immunity, but it remains more dangerous than flu on average

Evolution of Covid-19's infection fatality ratio\* in England, relative to seasonal flu



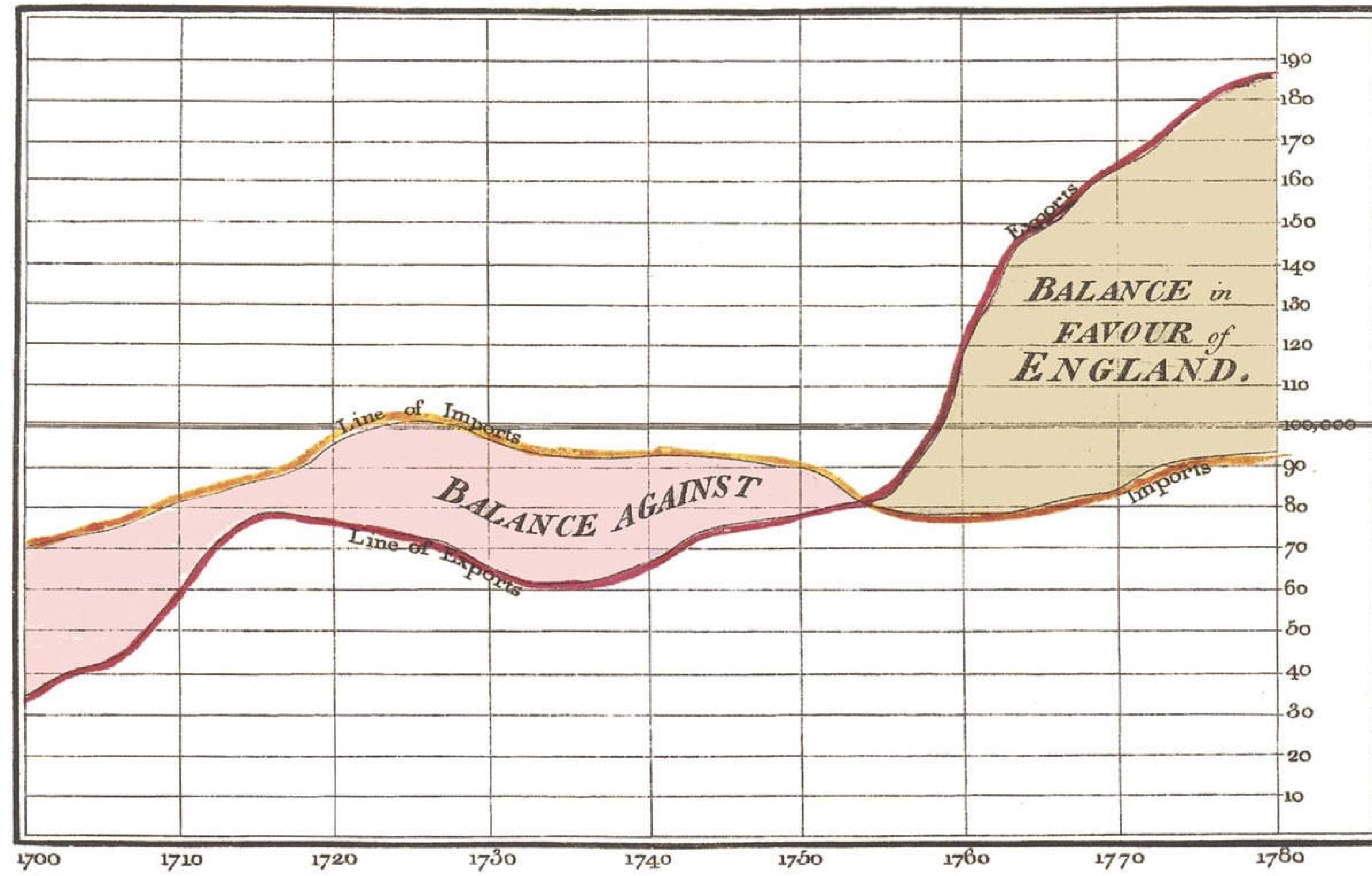
\*Covid IFR calculated using ONS death cert. mentions and ONS infection survey. \*\*IFR for seasonal flu as calculated for New Zealand in BMJ

Source: ONS. Based on prior work by Dan Howdon

FT graphic: John Burn-Murdoch / @jburnmurdoch

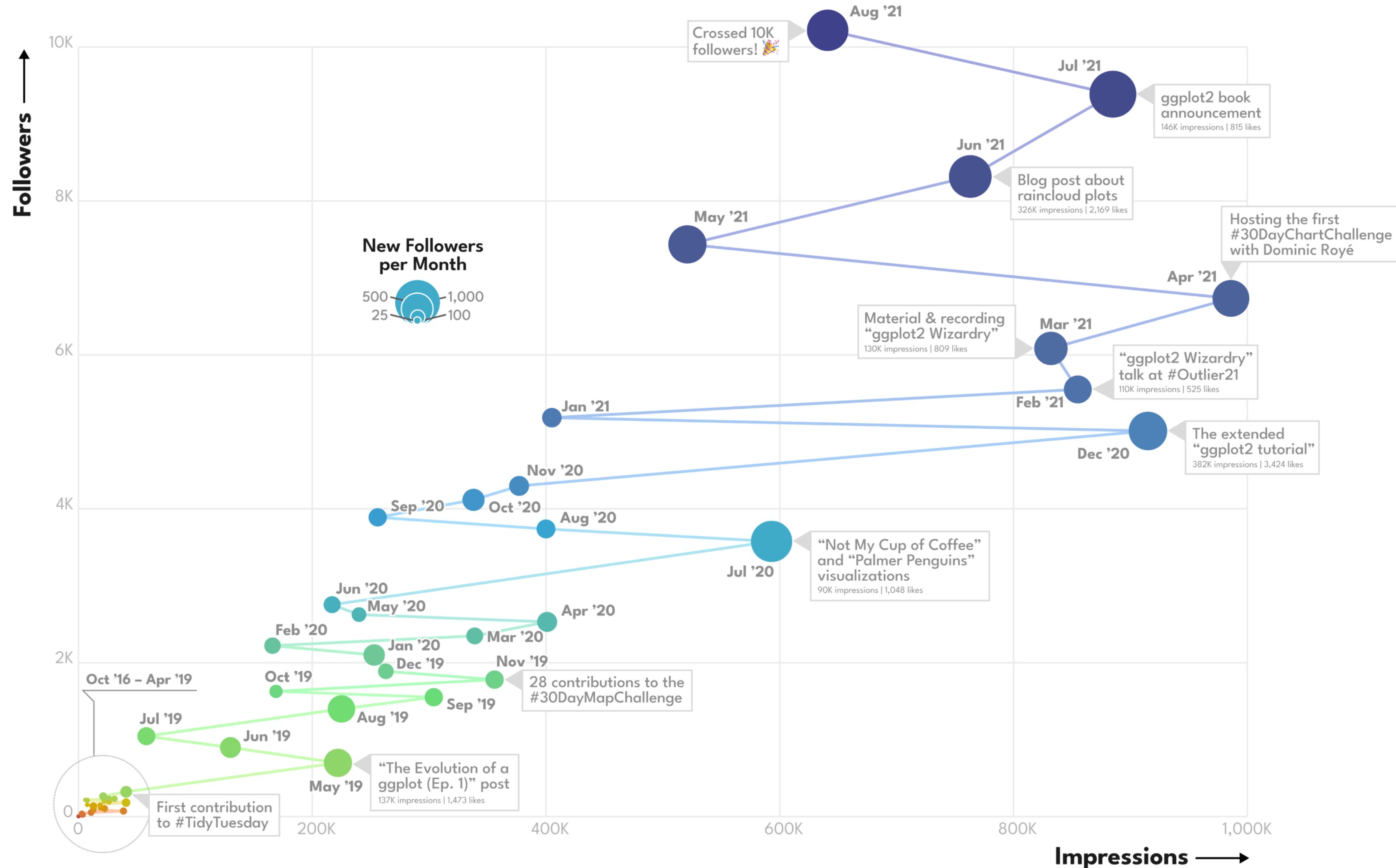
© FT

Exports and Imports to and from DENMARK & NORWAY from 1700 to 1780.



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

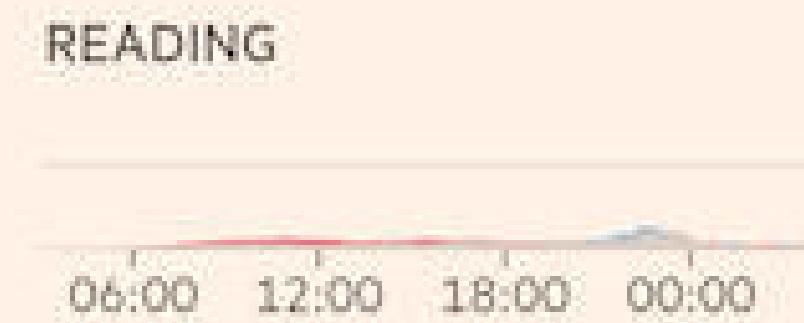
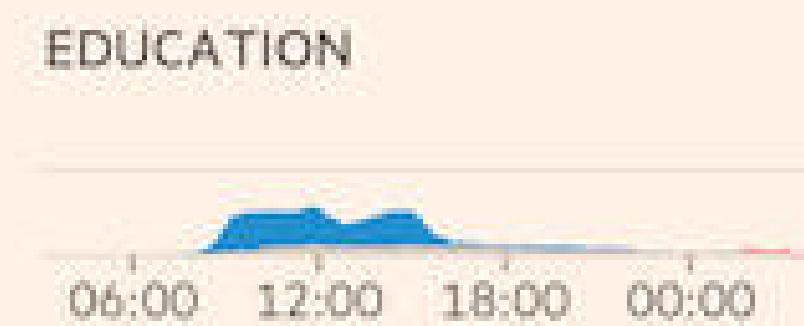
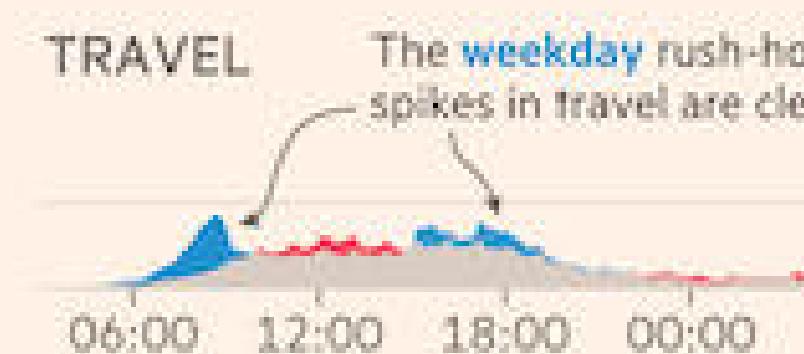
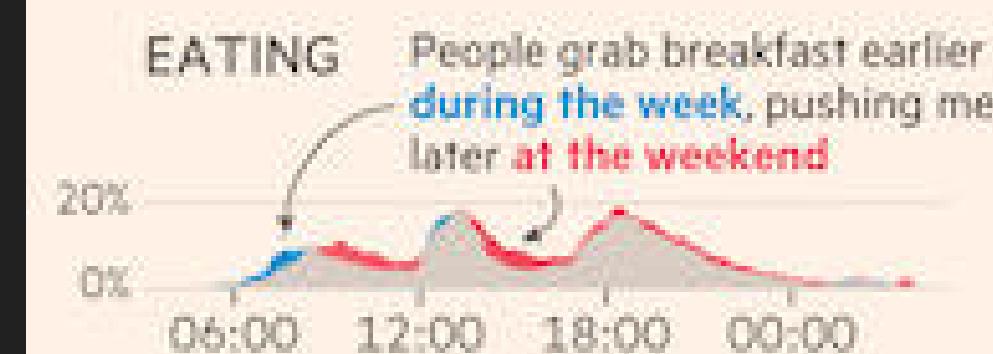
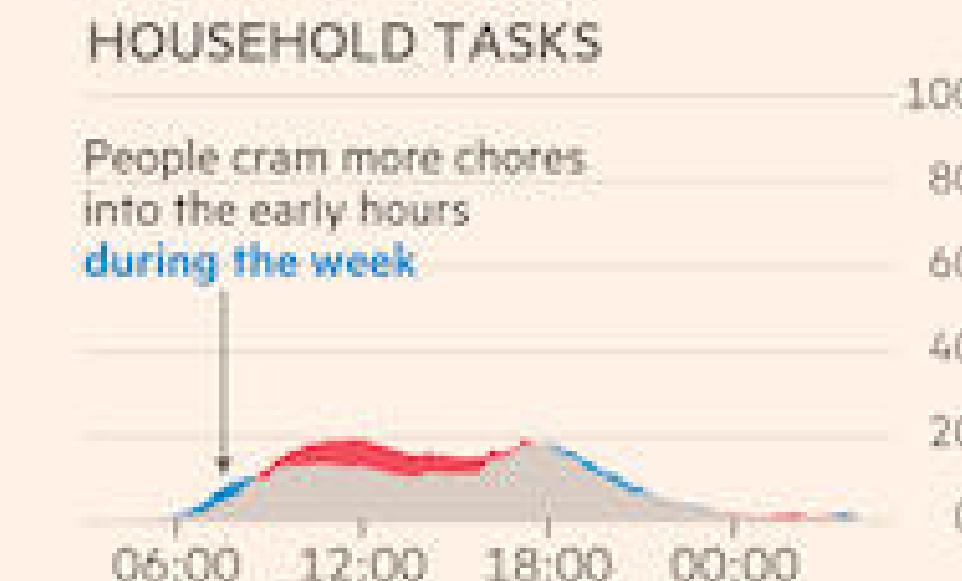
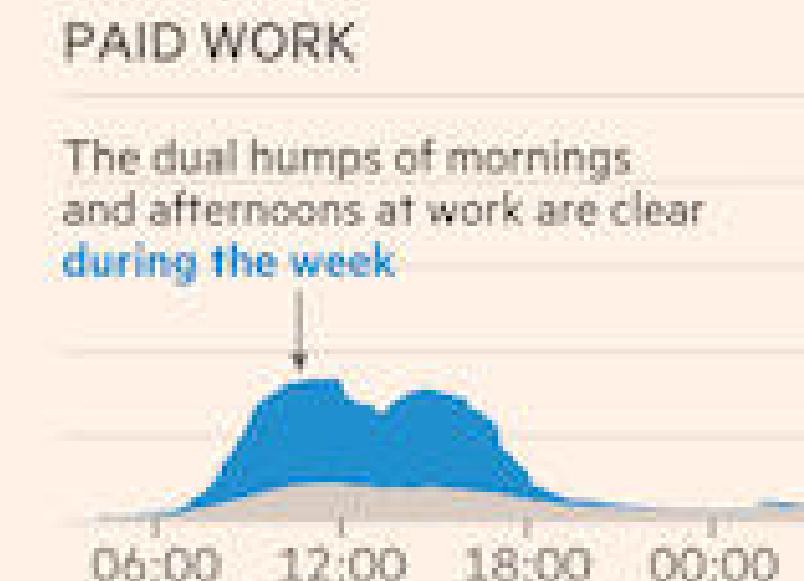
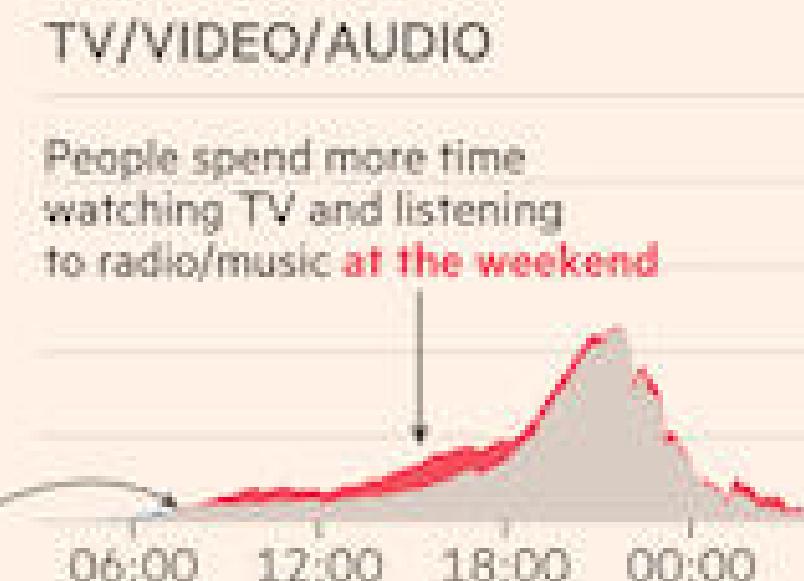
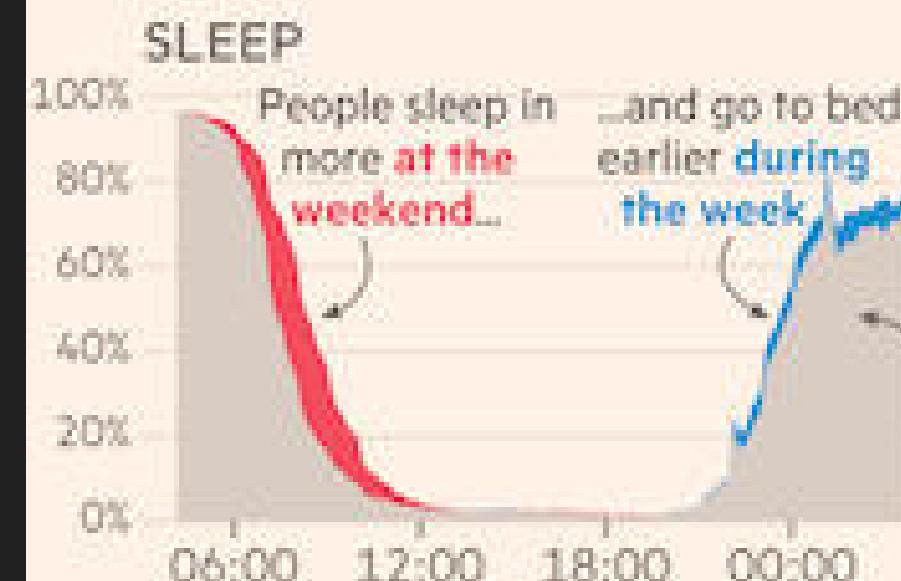
# My Road to 10K on Twitter – Thank You All for Following!



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

## How Britons spend their time at **weekends** vs **weekdays**

Share of people doing specific activities during **weekends** vs **weekdays**, by time of day (%)

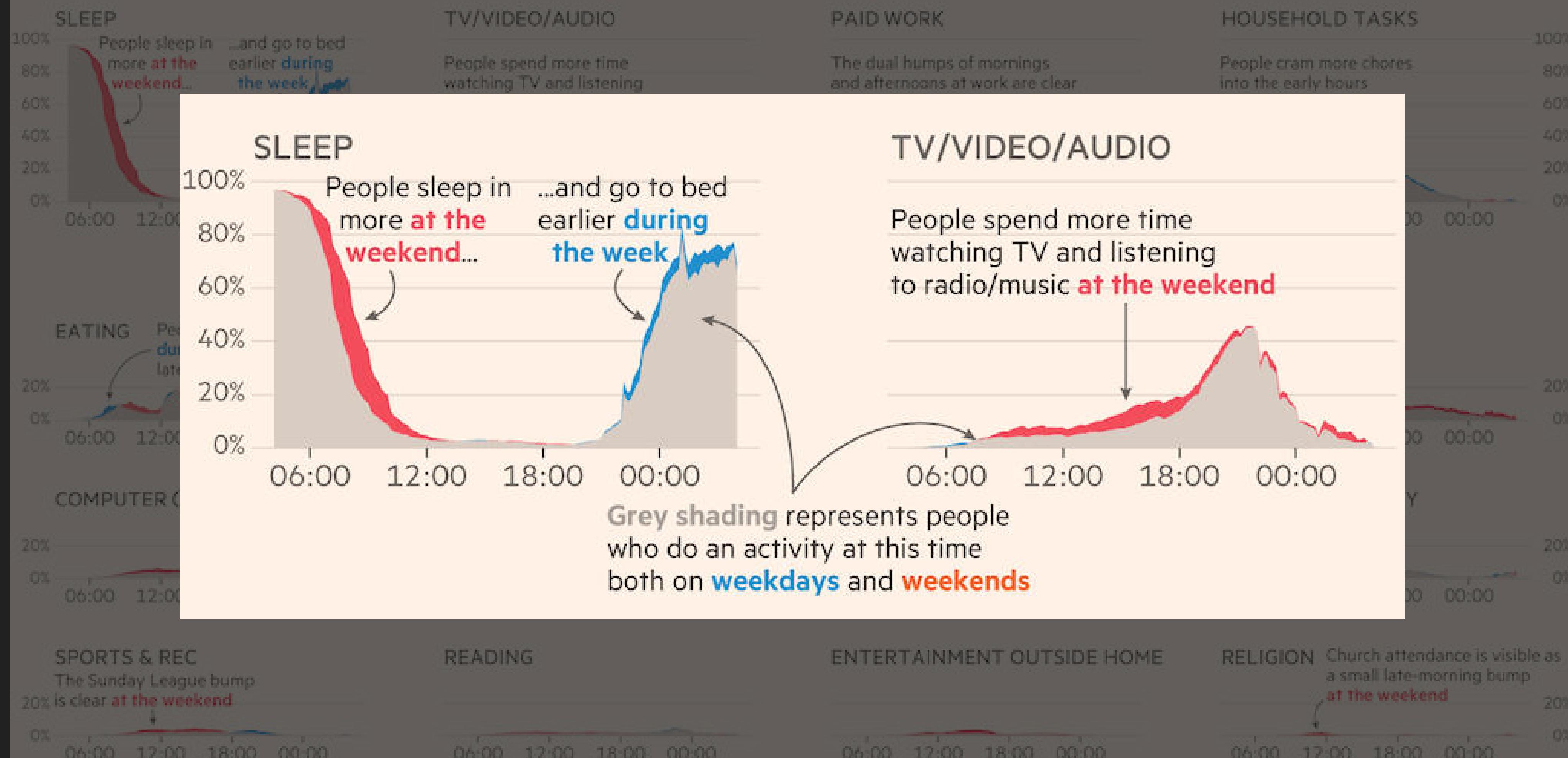


Source: FT analysis of UK Time Use Survey 2015

© FT

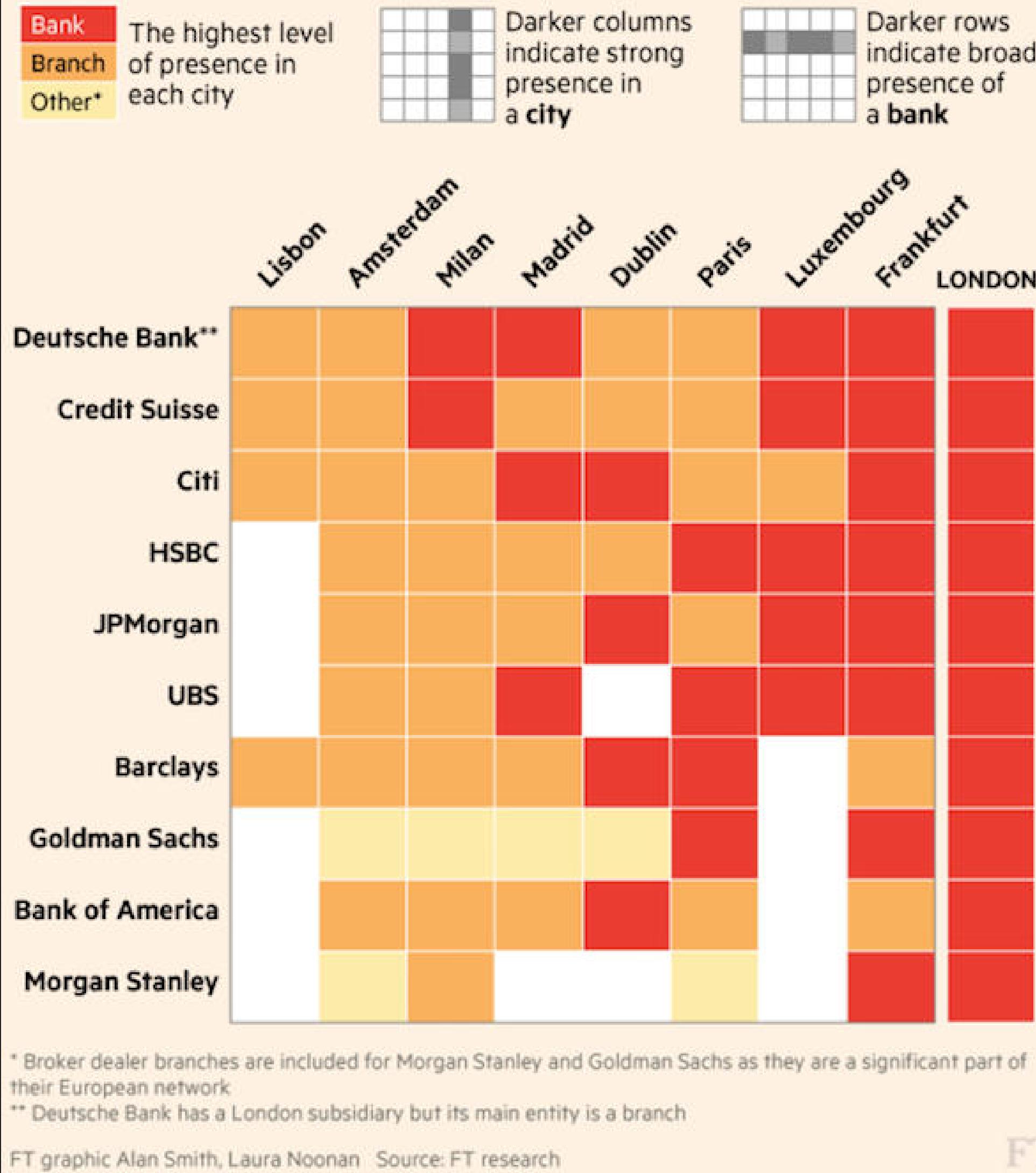
# How Britons spend their time at **weekends** vs **weekdays**

Share of people doing specific activities during **weekends** vs **weekdays**, by time of day (%)



Source: “*The Truth about Weekend Working*” by John-Burn Murdoch (Financial Times)

## The Brexit banking matrix: The contenders lining up for London's crown



Source: *“Frankfurt vies for UK banking jobs post-Brexit” by Alan Smith and Laura Noonan (Financial Times)*

# Supplementary supermarket shopping

1

People who do most of their food/grocery shopping at this supermarket...

2

...also regularly shop at this supermarket

So, for instance,  
27% of people  
who do most of  
their grocery  
shopping at Aldi  
also regularly  
shop at  
Morrisons.

	Aldi	Asda	Iceland	Lidl	Marks & Spencer	Morrisons	Sainsbury's	Tesco	The Co-operative	Waitrose
Aldi		36	26	34	17	33	23	28	22	16
Asda	38		34	32	19	29	20	27	20	11
Iceland	18	22		20	12	19	14	17	12	7
Lidl	25	24	26		13	24	20	24	21	17
Marks & Spencer	9	12	9	9		17	28	17	17	37
Morrisons	27	26	21	25	22		20	22	20	13
Sainsbury's	26	25	20	33	47	29		32	31	39
Tesco	45	39	42	44	43	37	42		42	40
The Co-operative	15	15	11	17	18	17	20	19		20
Waitrose	5	6	6	9	30	7	21	11	14	

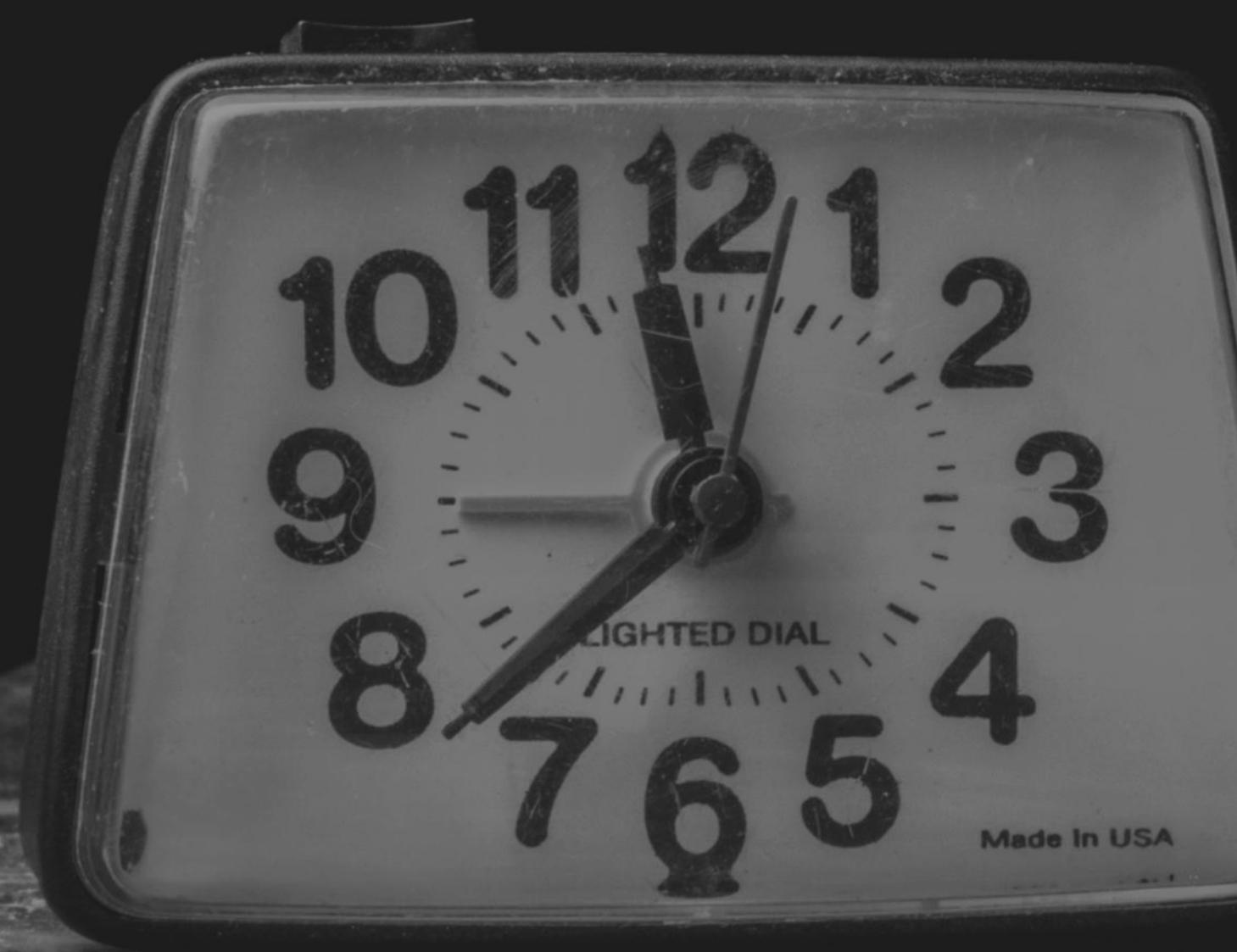
YouGov | [yougov.com](http://yougov.com)

YouGov Profiles December 2018

Source: “*Tesco is the nation’s primary AND secondary supermarket*” by Matthew Smith (YouGov)



*I'll be waiting for you!*



[cedricscherer.com](http://cedricscherer.com)



@CedScherer



z3tt

I'LL BE WAITING FOR YOU!



I'LL BE WAITING FOR YOU!

*I'll be waiting for you!*



Which would you prefer to wake up to?



cedricscherer.com



@CedScherer



z3tt

I'LL BE WAITING FOR YOU!

I'll be waiting for you !

# The Choice of the Typeface

- 👉 **Context matters:** font(s) should fit the topic and audience
- 👉 Use different sizes, weights and colors to **visualize hierarchy**
- 👉 Avoid using **ALL CAPS** and too many different styles
- 👉 Use **monospaced typefaces** for numbers

# The Choice of the Typeface

- 👉 **Context matters:** font(s) should fit the topic and audience
- 👉 Use different sizes, weights and colors to **visualize hierarchy**
- 👉 Avoid using **ALL CAPS** and too many different styles
- 👉 Use **tabular typefaces** for numbers
- 👉 **Consistency is key!**

# Visualize Hierarchy

I am important!

I am important, too.

Oh, hi there. Thanks for reading me...

But well, look at me!



# Visualize Hierarchy

**I am important!**

**I am important, too.**

Oh, hi there. Thanks for reading me...

**But well, look at me!**



# Visualize Hierarchy

I am important!

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# Visualize Hierarchy

I am important!

I am important, too.

Oh, hi there. Thanks for reading me...

But well, look at me!



# Keep it Simple

*Using a lot of fonts  
and different sizes  
makes your design look  
cluttered  
overcomplicated  
AND JUST NOT VERY NICE.*

*But if you just use  
a small selection of  
typefaces, styles and sizes  
you can keep your design  
cleaner, clearer  
and just much easier to digest.*



# Proportional Numbers

123.45  
678.90

# Tabular Numbers

123.45  
678.90

# The 1ll Test

1ll Calibri

1ll Open Sans

1ll Roboto

1ll Lato

1ll Oswald

1ll Cabinet Grotesk

1ll Cabin

1Il Monda

1Il Chivo

1ll Fira Sans

1Il Noto Sans

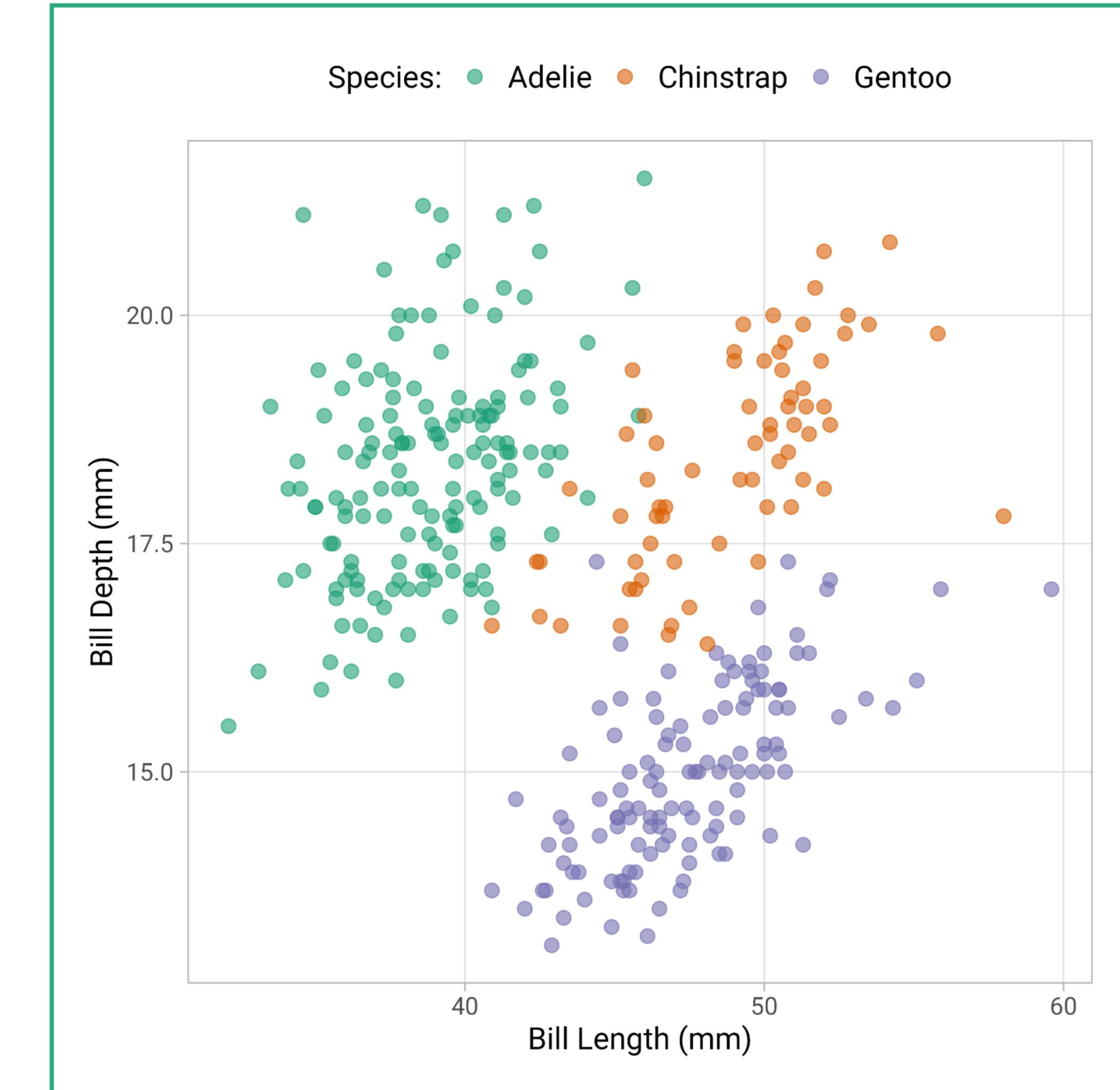
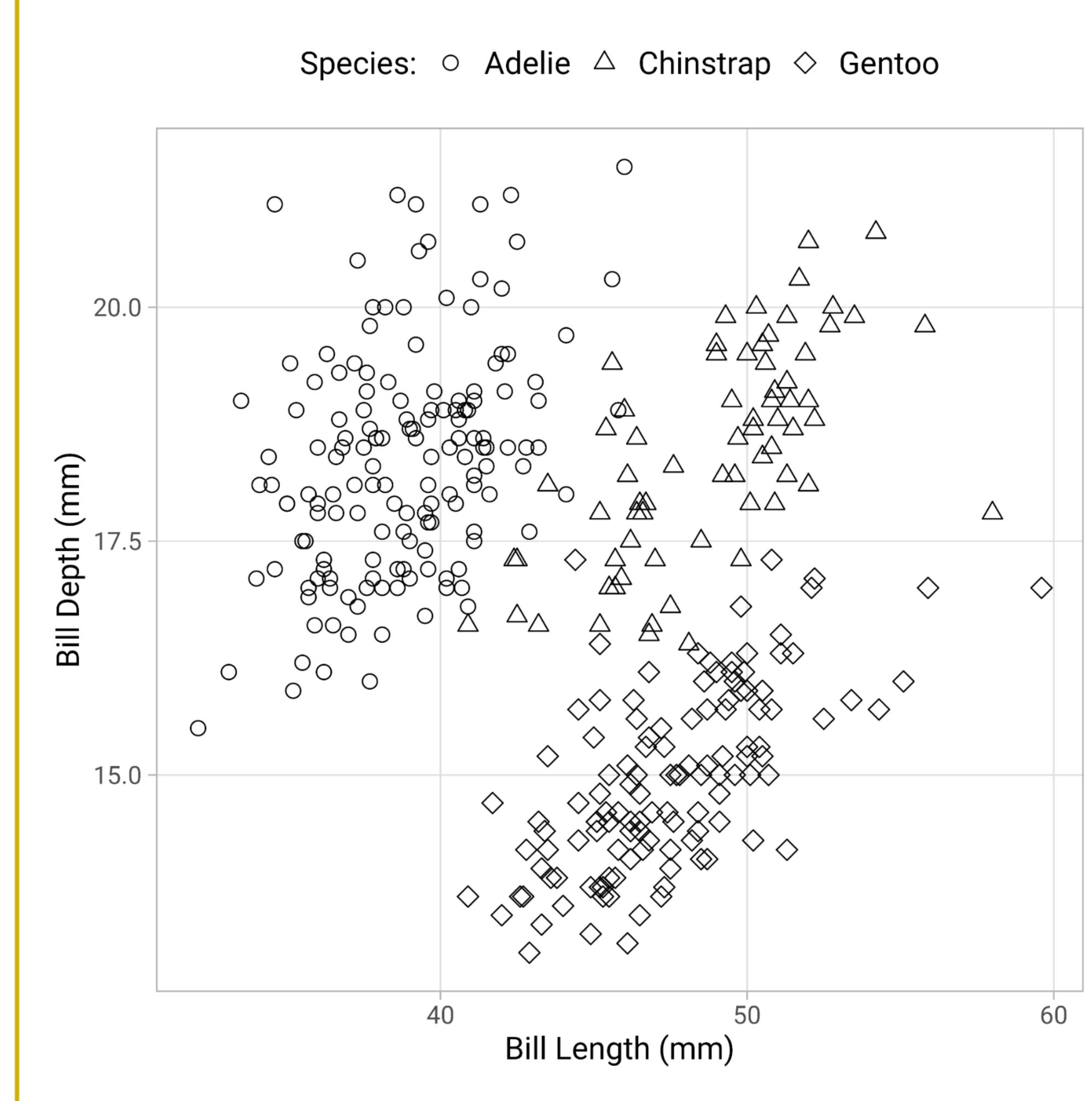
1ll Amulya



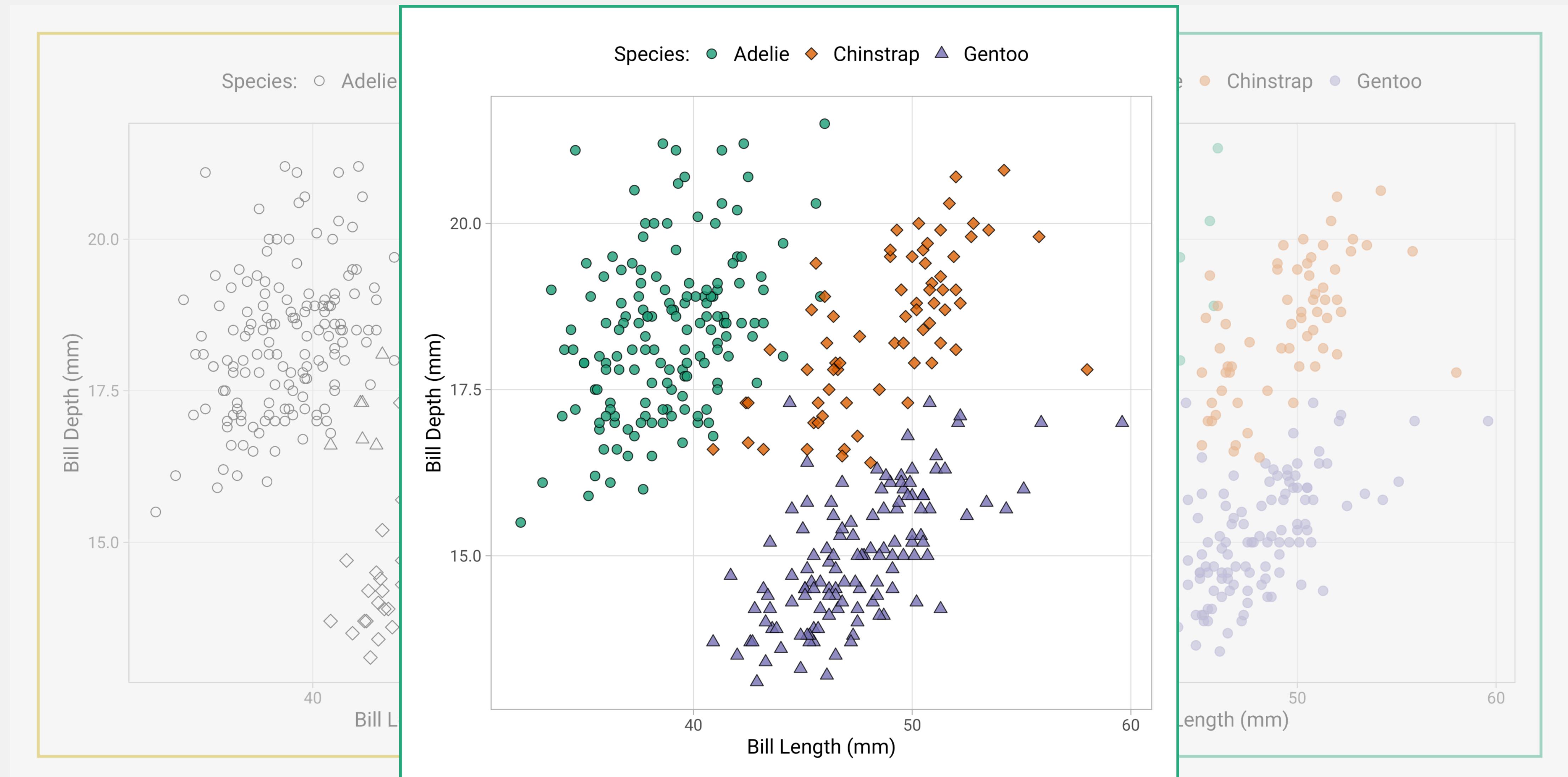
# COLORS

## and Pitfalls

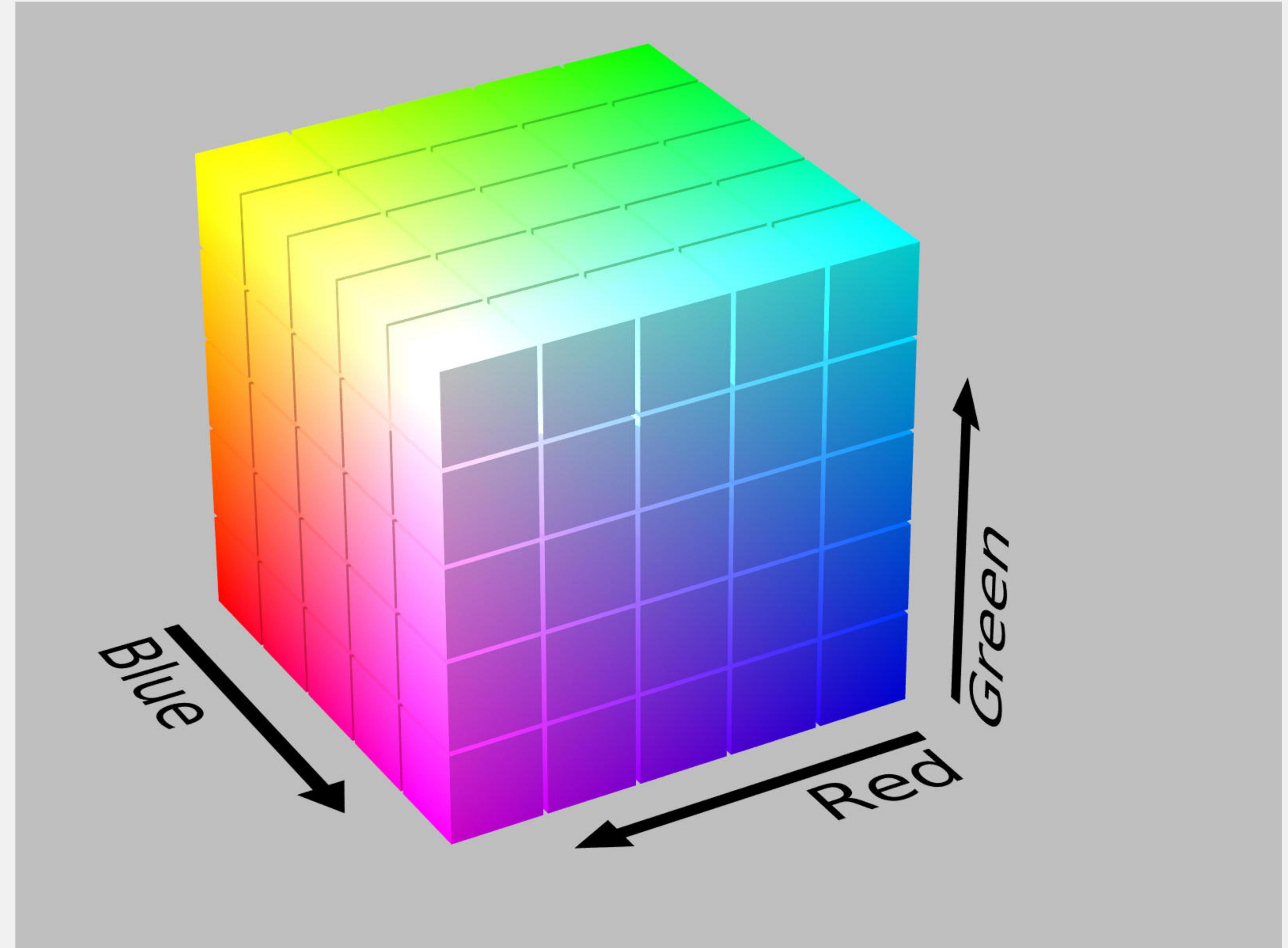
# Channels to Encode Information



# Use of Double Encoding

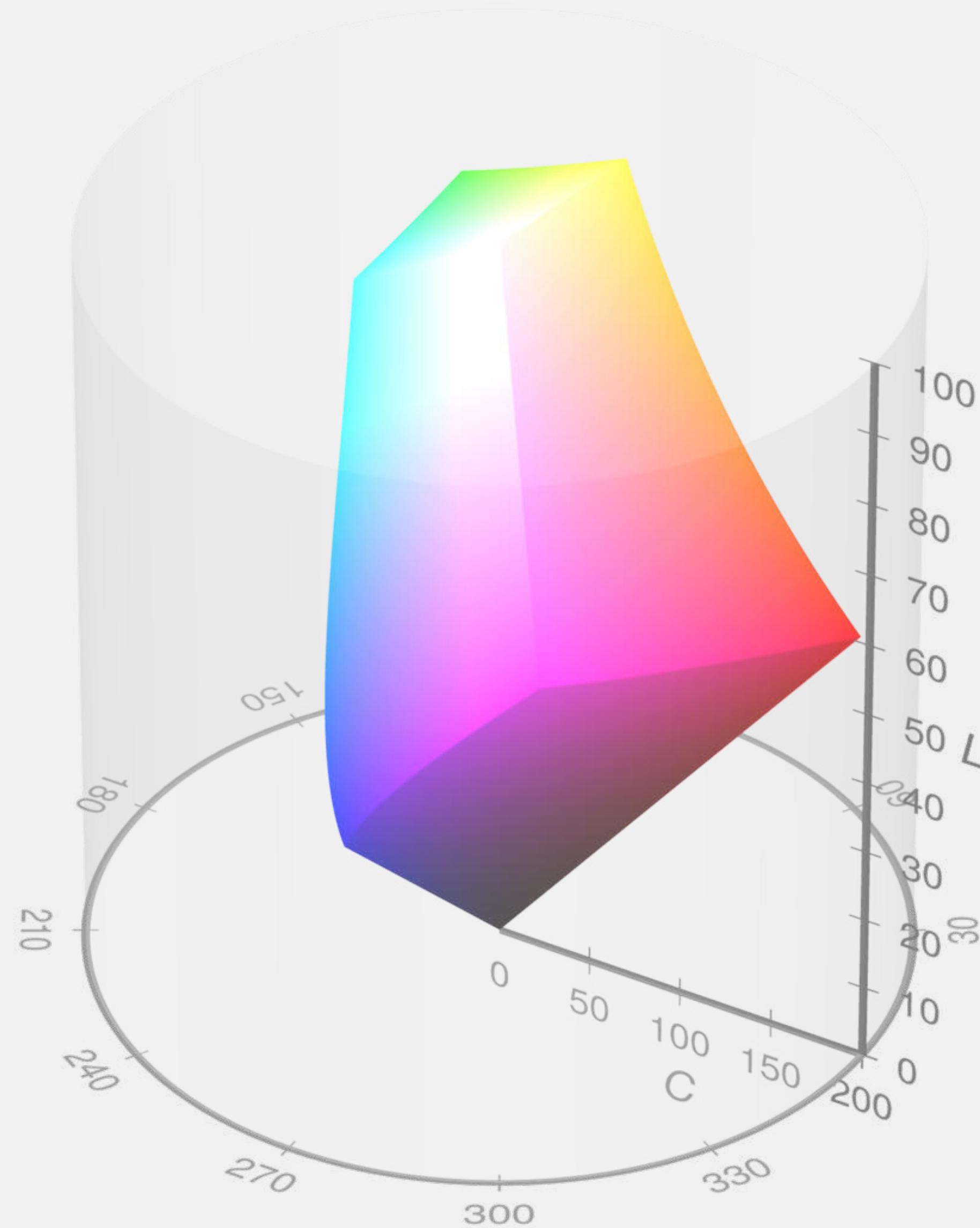


# The RGB Color Space



Michael Horvath

# The HCL Color Space



[Michael Horvath & Christoph Lipka](#)

# Hue

color family



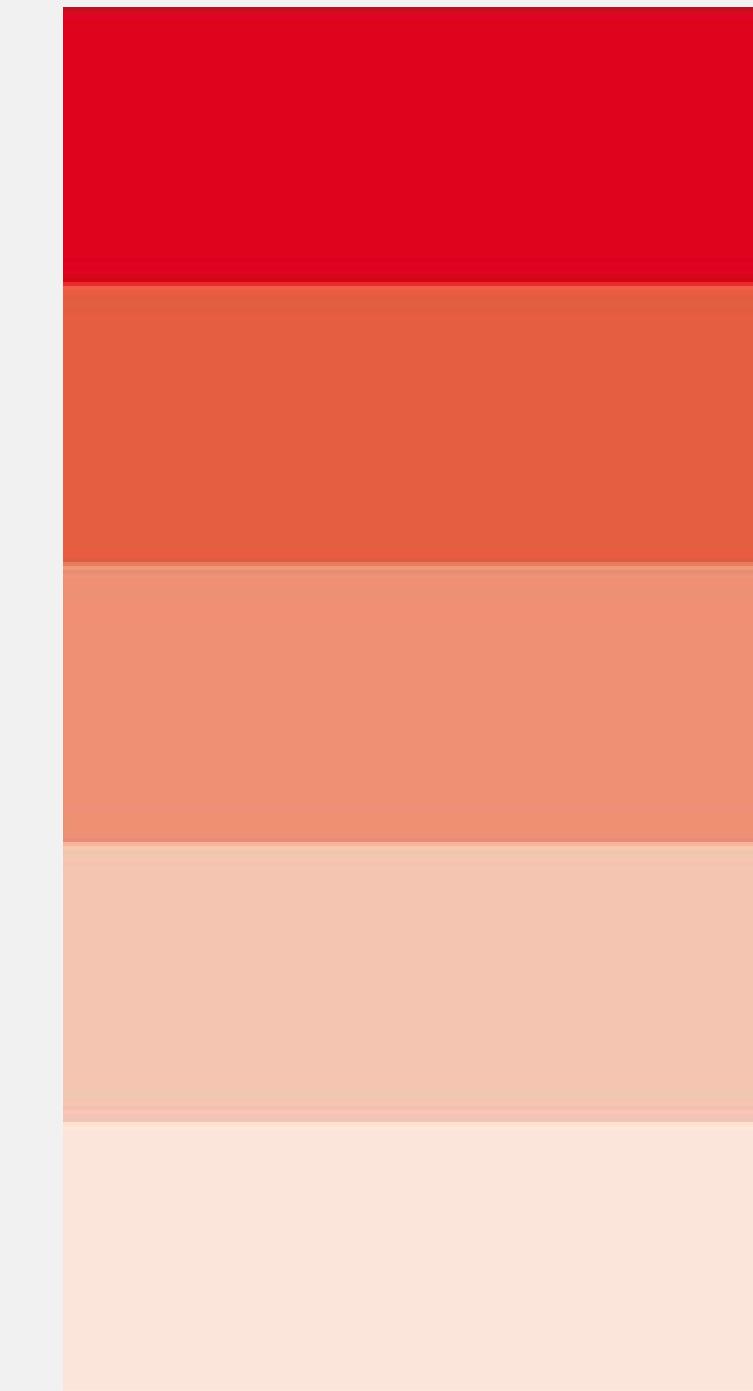
# Chroma

colorfulness



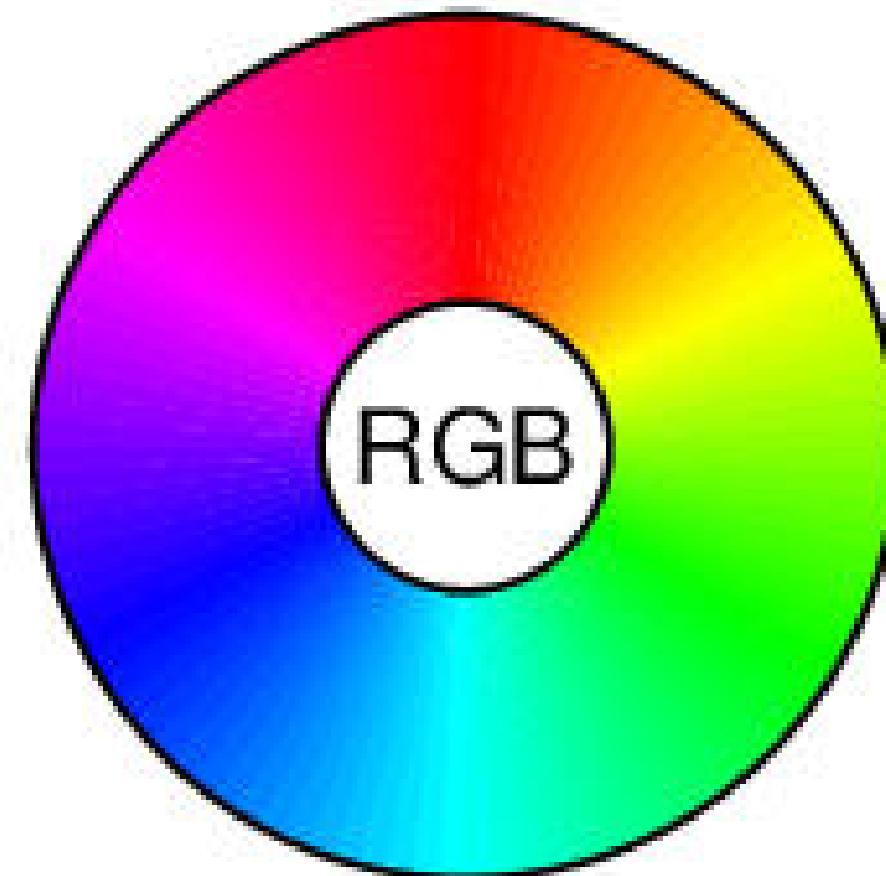
# Luminance

lightness / brightness

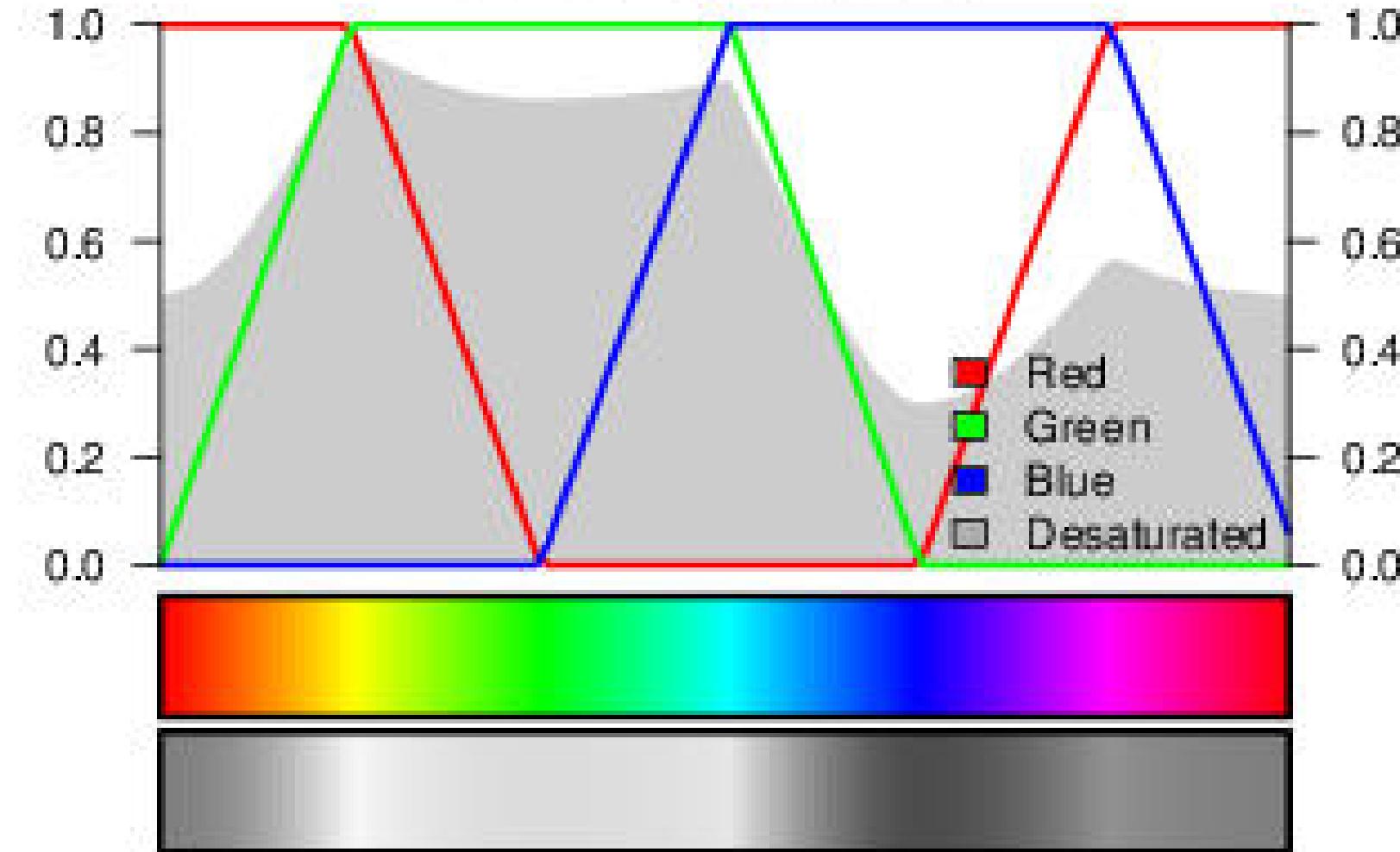


*Modified from [uxplanet.org](http://uxplanet.org)*

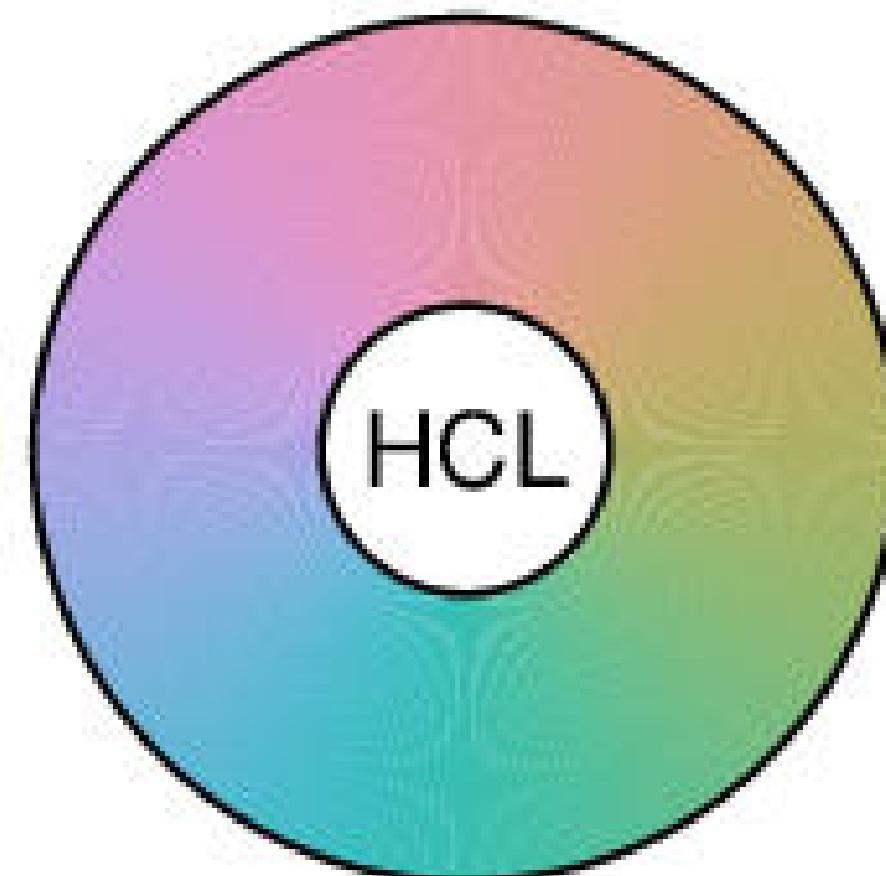
**RGB Rainbow**



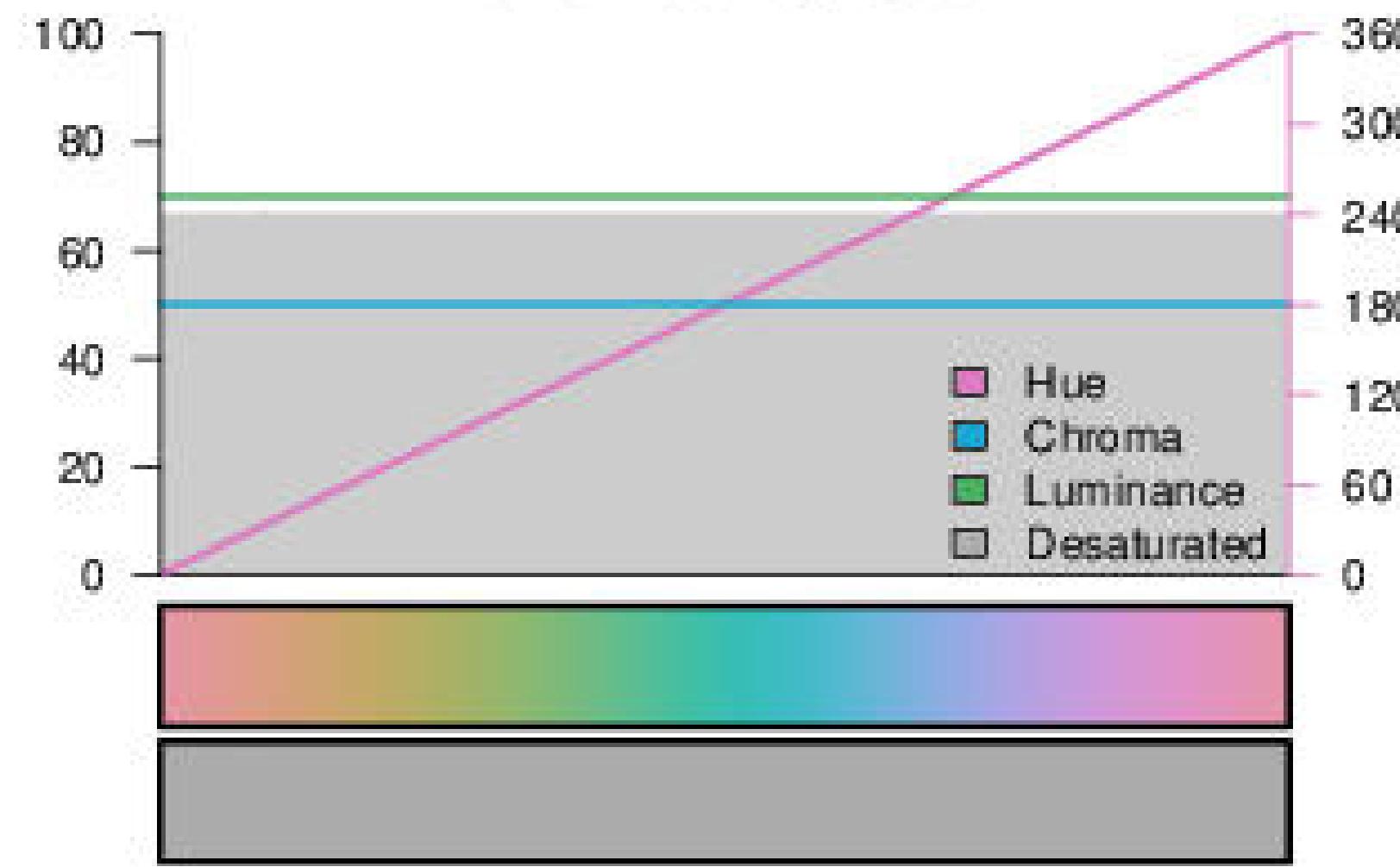
**RGB rainbow spectrum**



**A HCL Rainbow**



**HCL rainbow spectrum**

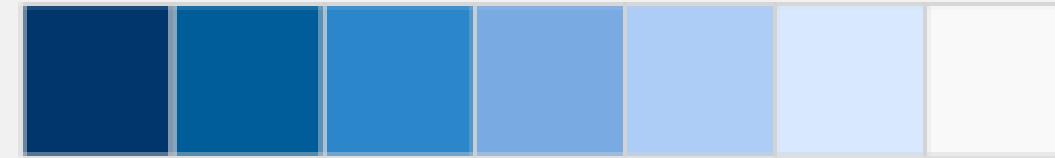


[hclwizard.org](http://hclwizard.org)

# Color Palette Choice

## Sequential

Palette



Desaturated



Use to encode  
***numerical information  
with order***

*use highest contrast for  
most important information*

*either single- or multi-hue*

*Modified from the `{colorspace}` R package vignette*

# Color Palette Choice

## Sequential



Use to encode  
***numerical information  
with order***

*use highest contrast for  
most important information*

*either single- or multi-hue*

## Diverging



Use to encode  
***numerical information  
with critical midpoint***

*ensure a meaningful midpoint value  
and use balanced extremes*

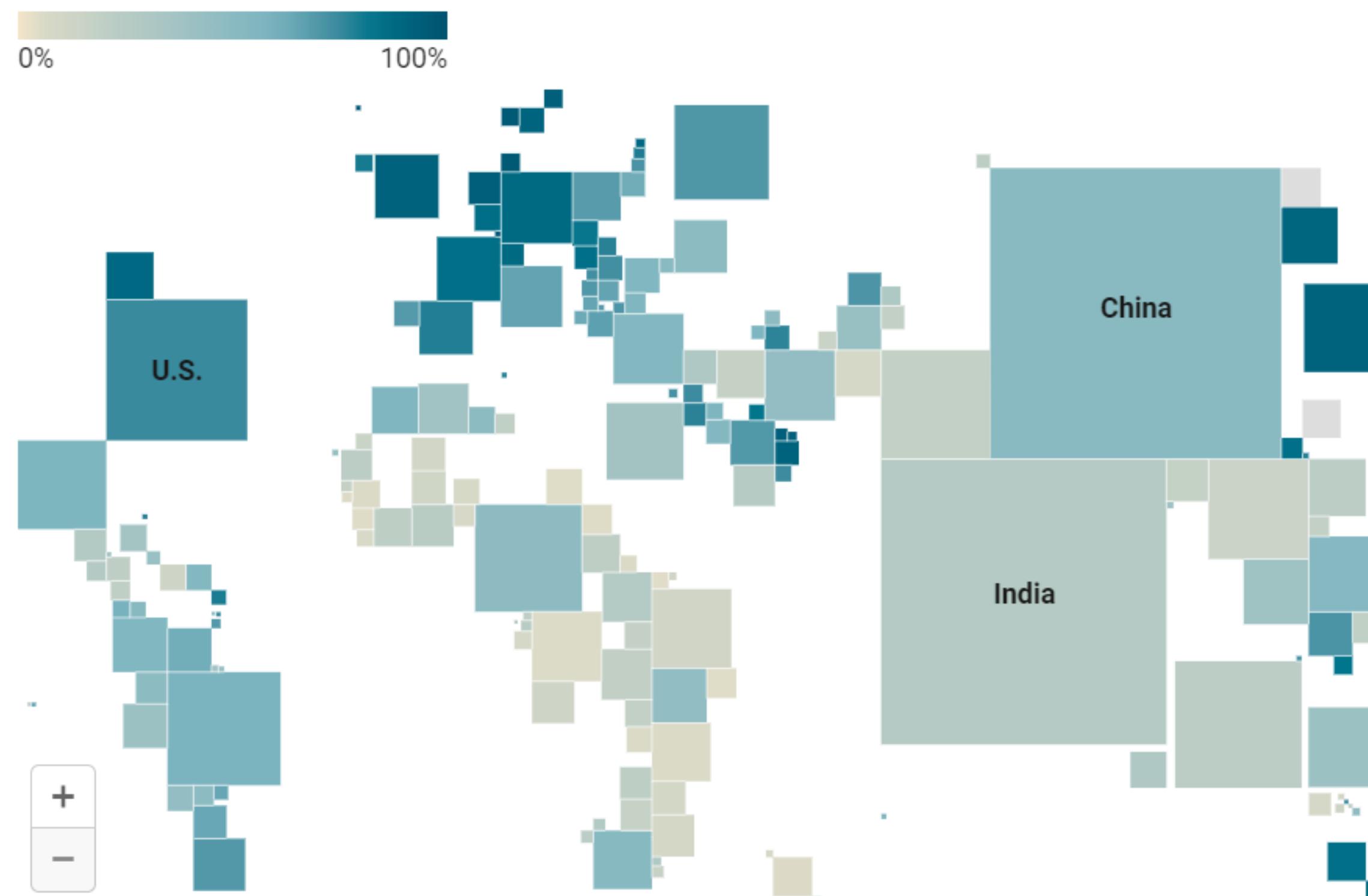
*combination of  
two sequential palettes*

*Modified from the `{colorspace}` R package vignette*

# Sequential versus Diverging Palettes

## The internet was mostly used by the Western World in 2015

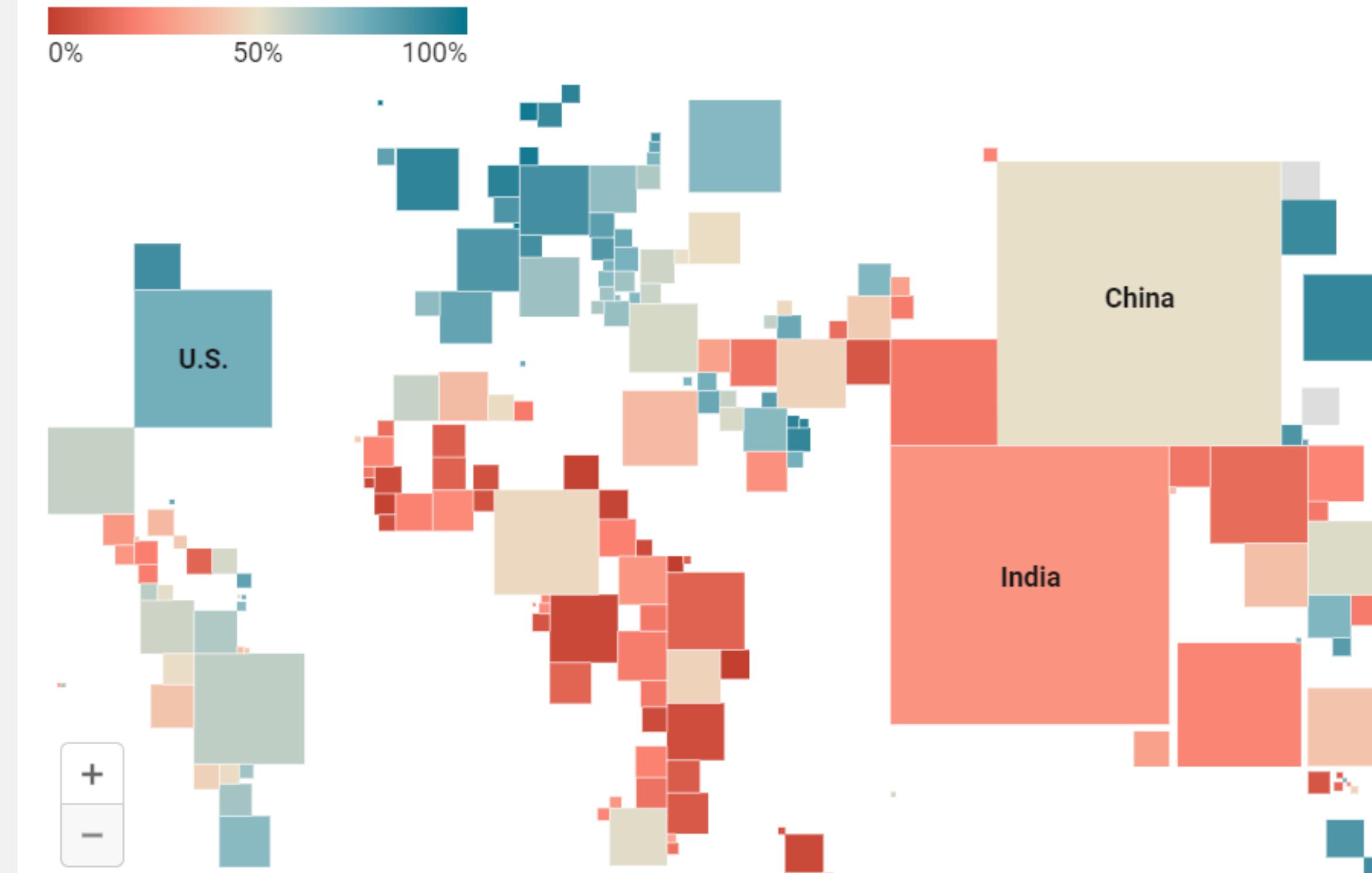
Share of individuals who have used the Internet in the last 3 months (via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.), in selected countries, 2015



Map: Lisa Charlotte Rost, Datawrapper • Source: Our World in Data • Get the data • Created with Datawrapper

In most African and Asian countries, less than half of the population was using the internet in 2015.

Share of individuals who have used the Internet in the last 3 months (via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.), in selected countries, 2015

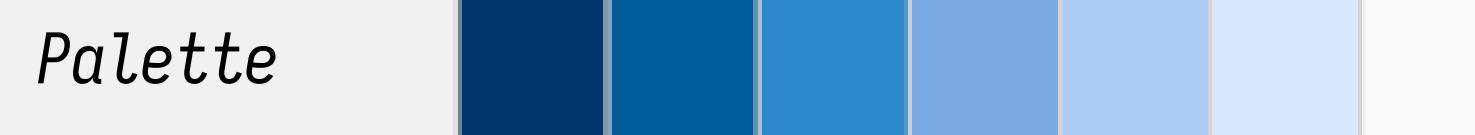


Map: Lisa Charlotte Rost, Datawrapper • Source: Our World in Data • Get the data • Created with Datawrapper

Source: “[When to use sequential and when to use diverging color scales](#)” by Lisa C. Muth / DataWrapper

# Color Palette Choice

## Sequential

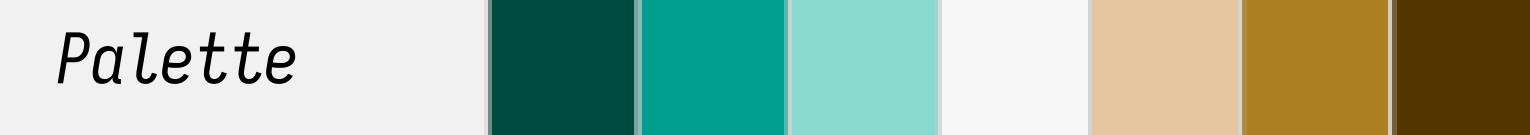


Use to encode  
***numerical information with order***

use highest contrast for  
most important information

either single- or multi-hue

## Diverging

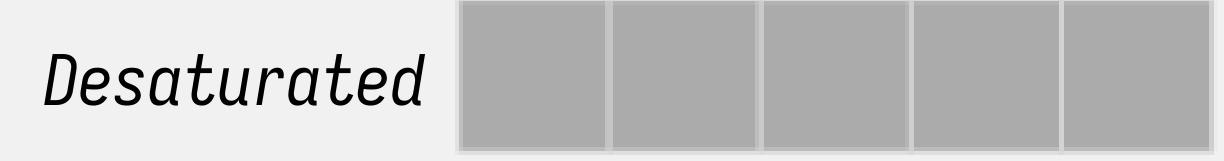


Use to encode  
***numerical information with critical midpoint***

ensure a meaningful midpoint value  
and use balanced extremes

combination of  
two sequential palettes

## Qualitative



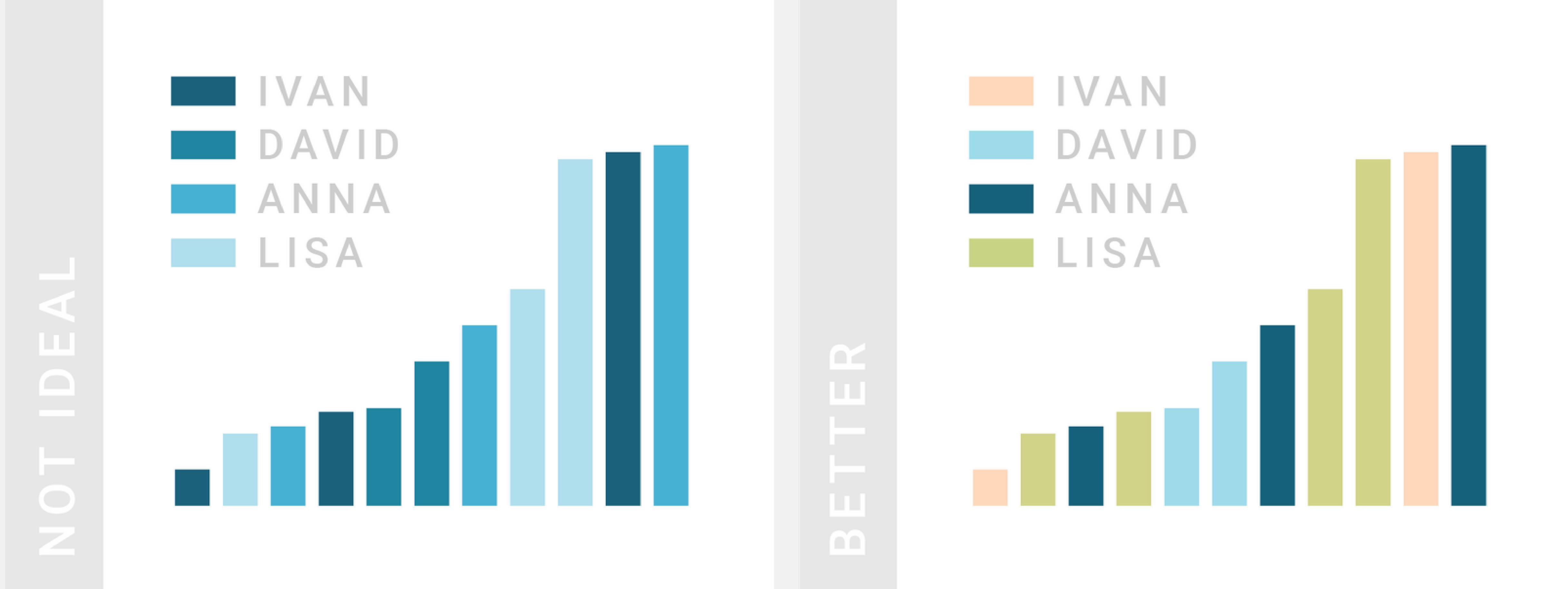
Use to encode  
***categorical information***

pick distinct colors with  
the same perceptual weight

limit categories to 6-8

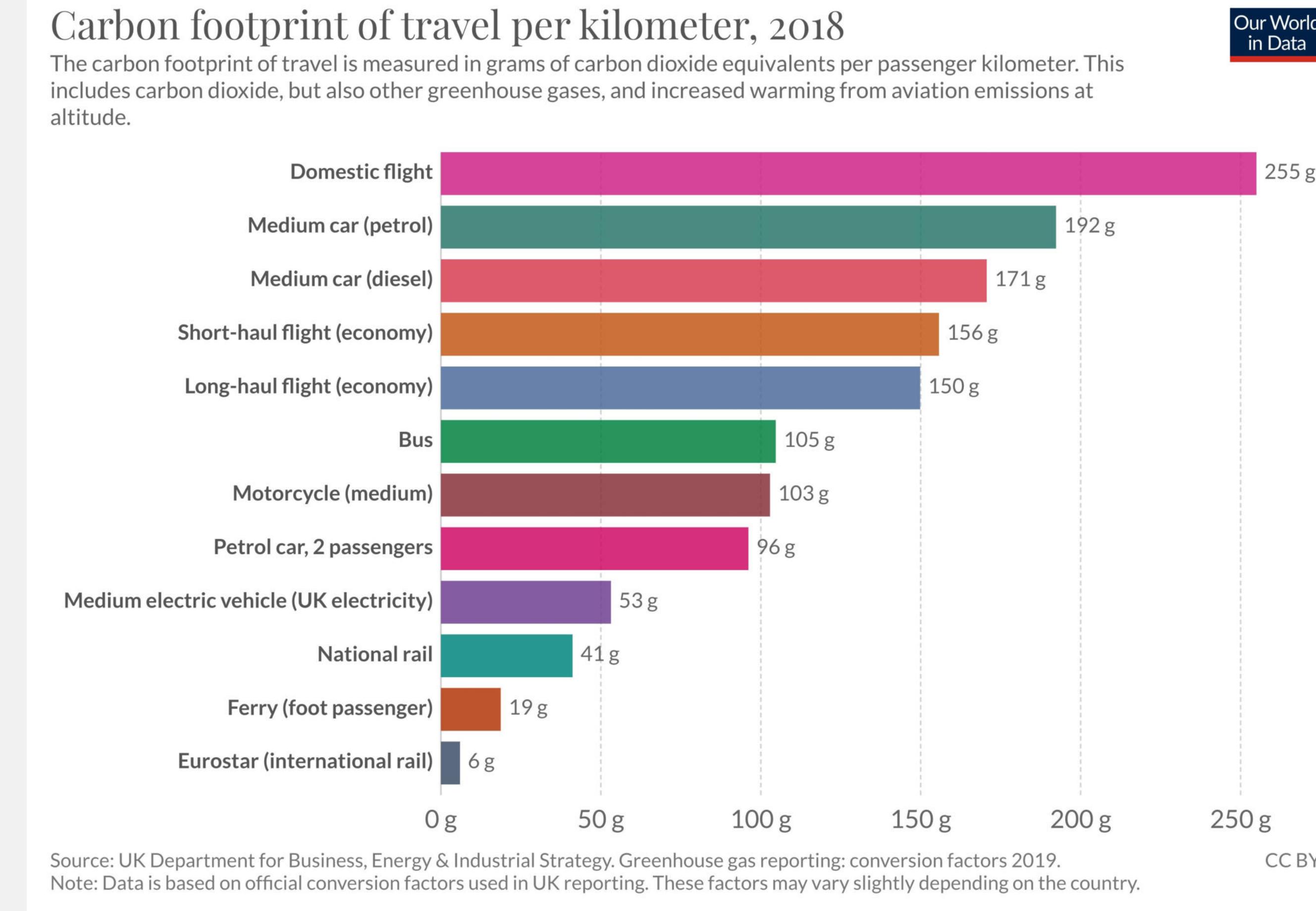
Modified from the `{colorspace}` R package vignette

# Sequential versus Qualitative Palettes



Source: “[When to use sequential and when to use diverging color scales](#)” by Lisa C. Muth / DataWrapper

# Use color wisely (and correctly)



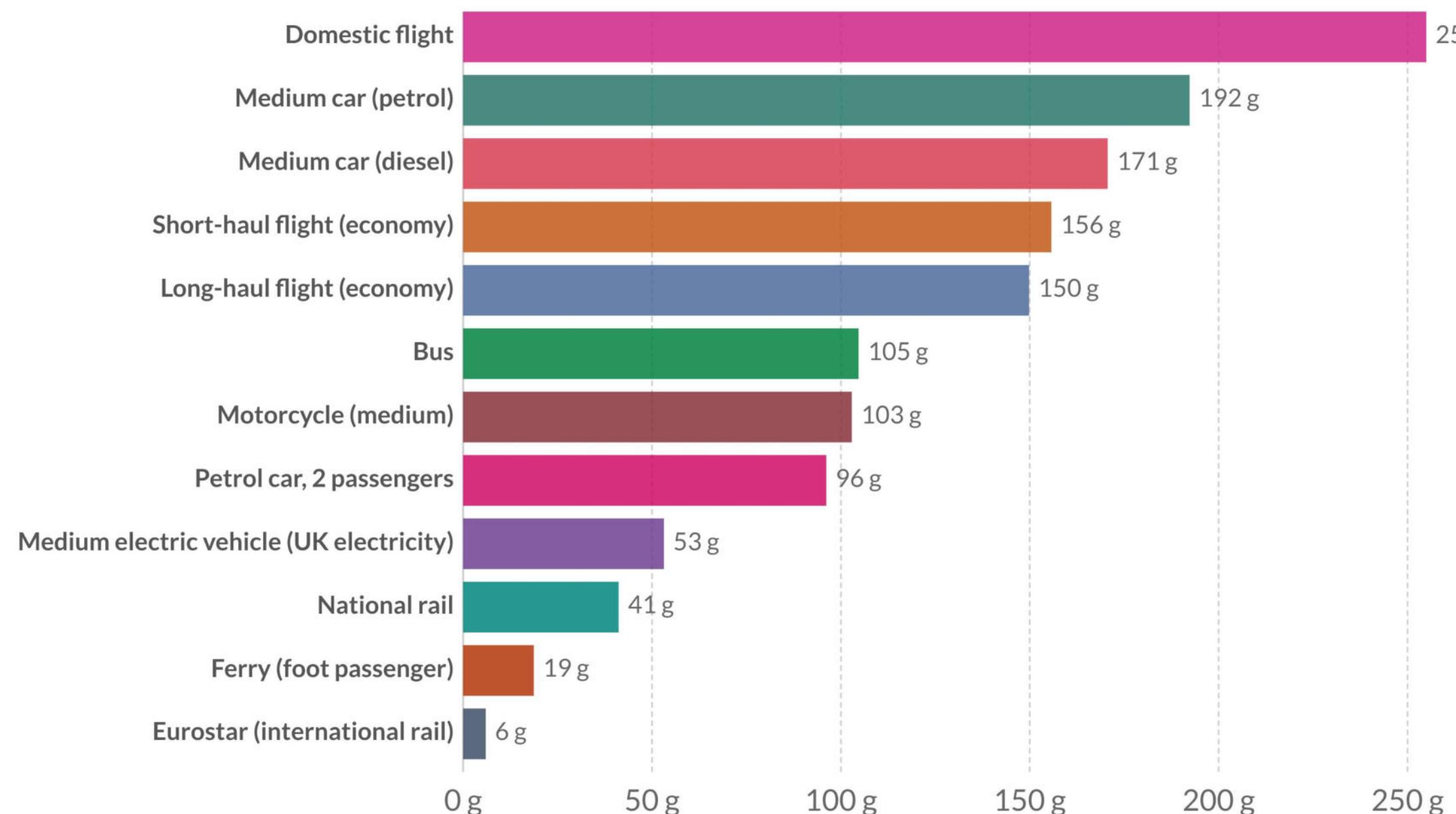
Original graphic with a random categorical palette

# Use color wisely (and correctly)

## Carbon footprint of travel per kilometer, 2018

The carbon footprint of travel is measured in grams of carbon dioxide equivalents per passenger kilometer. This includes carbon dioxide, but also other greenhouse gases, and increased warming from aviation emissions at altitude.

Our World  
in Data



Source: UK Department for Business, Energy & Industrial Strategy. Greenhouse gas reporting: conversion factors 2019.  
Note: Data is based on official conversion factors used in UK reporting. These factors may vary slightly depending on the country.

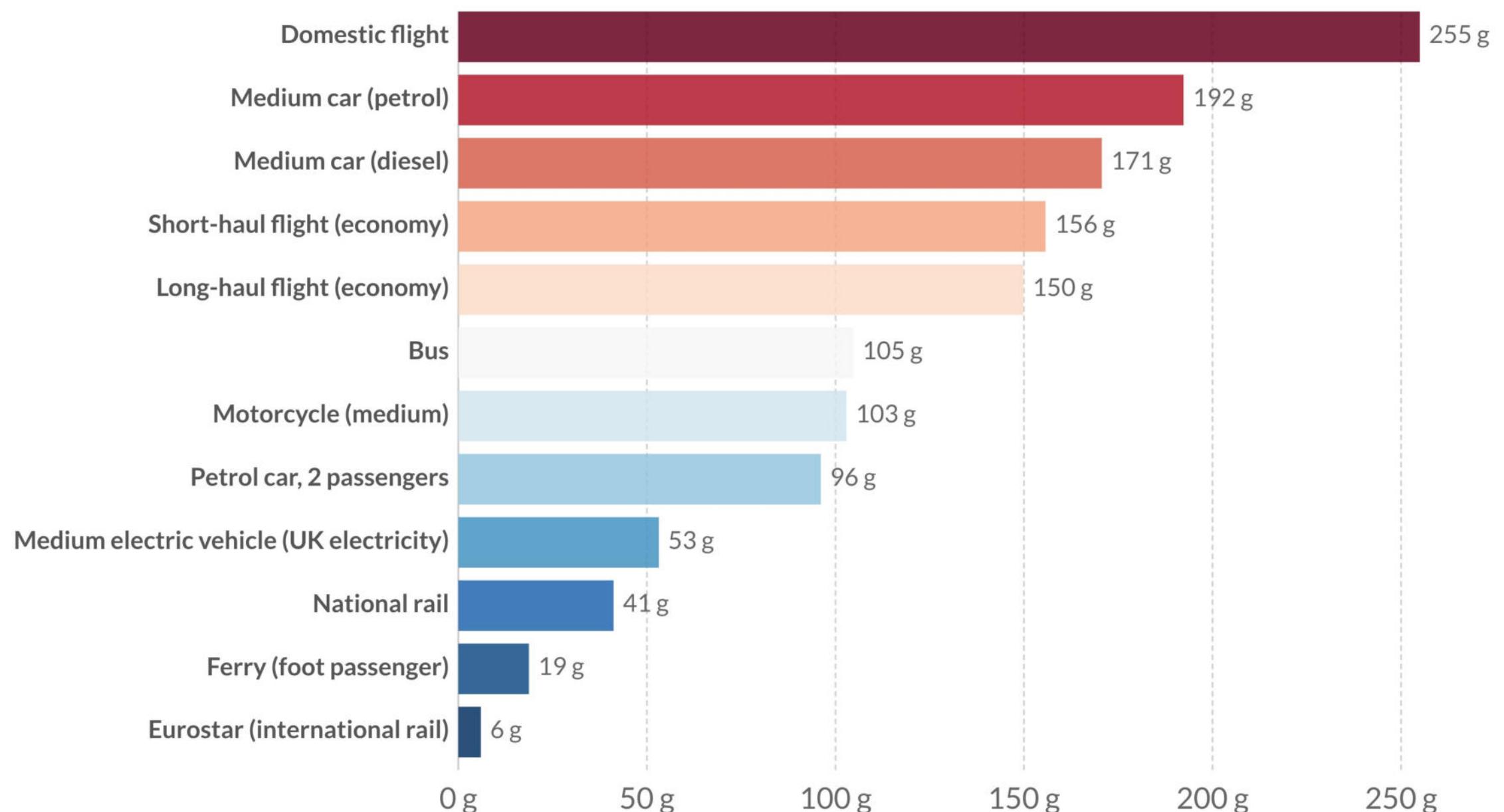
CC BY

Original graphic with a random categorical palette

## Carbon footprint of travel per kilometer, 2018

The carbon footprint of travel is measured in grams of carbon dioxide equivalents per passenger kilometer. This includes carbon dioxide, but also other greenhouse gases, and increased warming from aviation emissions at altitude.

Our World  
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Source: UK Department for Business, Energy & Industrial Strategy. Greenhouse gas reporting: conversion factors 2019.  
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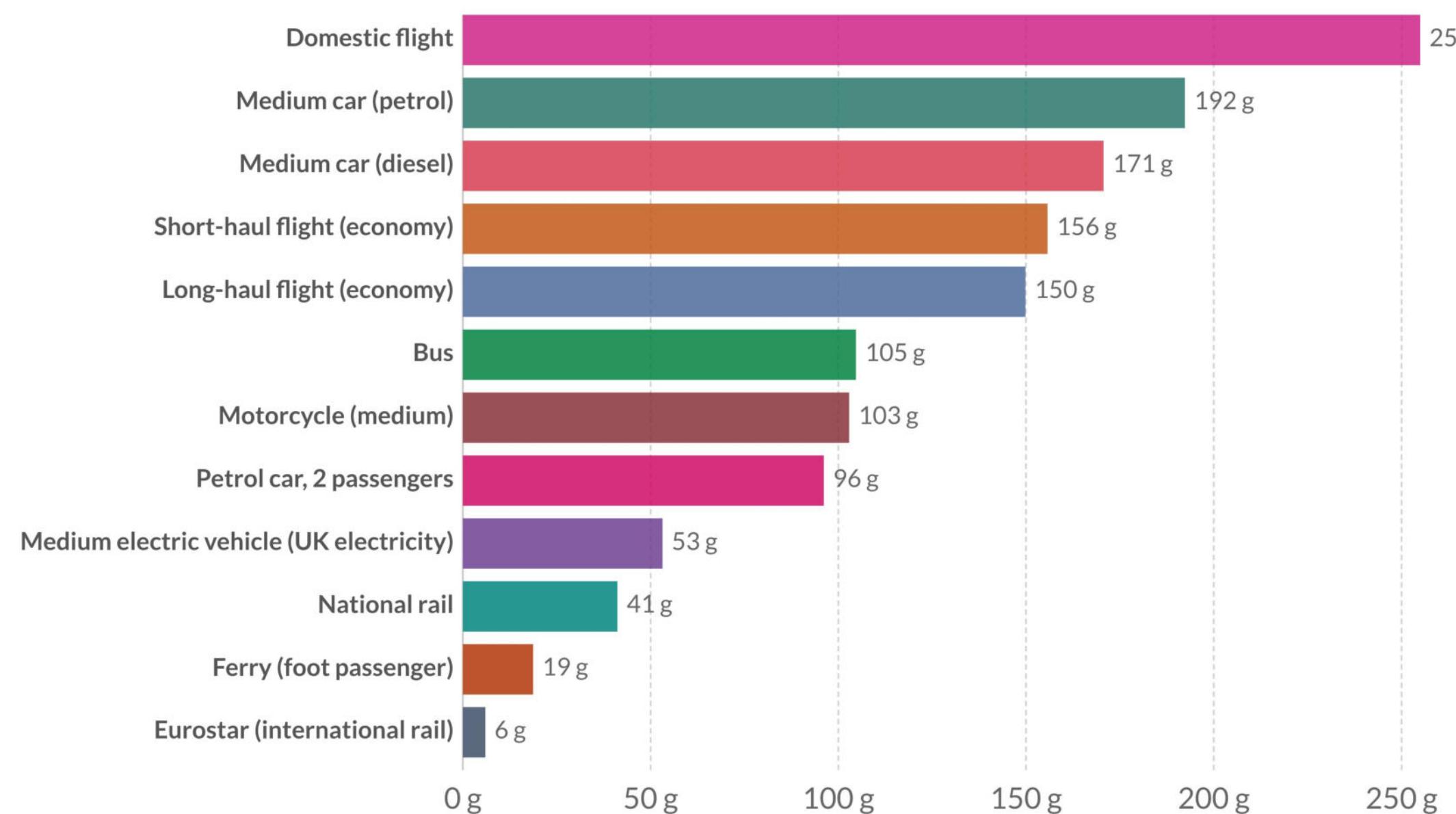
CC BY

Reworked graphic using a diverging palette

# Use color wisely (and correctly)

## Carbon footprint of travel per kilometer, 2018

The carbon footprint of travel is measured in grams of carbon dioxide equivalents per passenger kilometer. This includes carbon dioxide, but also other greenhouse gases, and increased warming from aviation emissions at altitude.



Source: UK Department for Business, Energy & Industrial Strategy. Greenhouse gas reporting: conversion factors 2019.

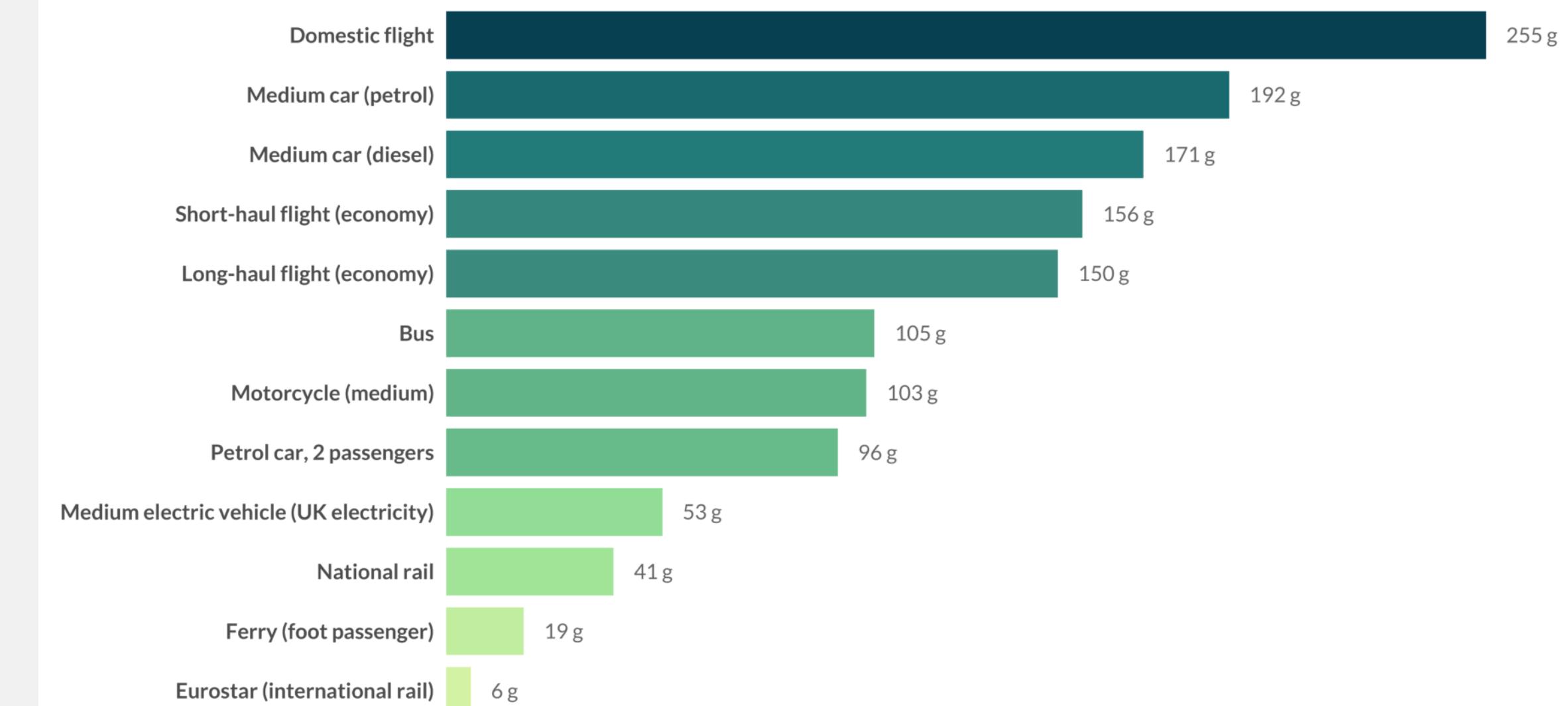
Note: Data is based on official conversion factors used in UK reporting. These factors may vary slightly depending on the country.

Our World  
in Data

CC BY

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The carbon footprint of travel is measured in grams of carbon dioxide equivalents per passenger kilometer. This includes carbon dioxide, but also other greenhouse gases, and increased warming from aviation emissions at altitude.



Source: UK Department for Business, Energy & Industrial Grenhouse gas reporting: conversion factors 2019.

Note: Data is based on official conversion factors used in UK reporting. These factors may vary slightly depending on the country.

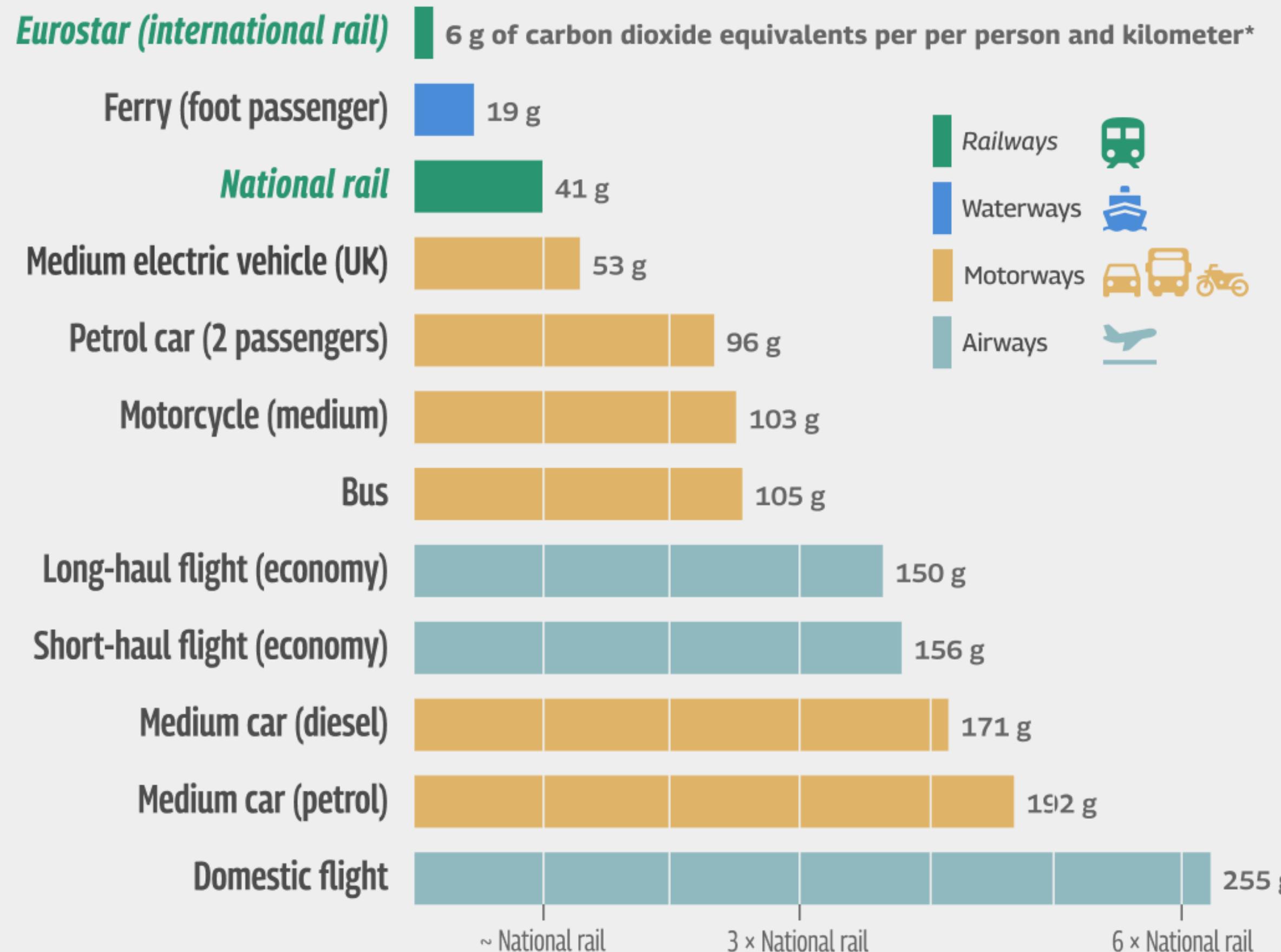
Original visualization by Hannah Ritchie, OurWorldInData.org | Makeover by Cédric Scherer

Original graphic with a random categorical palette

Makeover using a continuous palette

# Reduce your Carbon Footprint: *Take the Train*

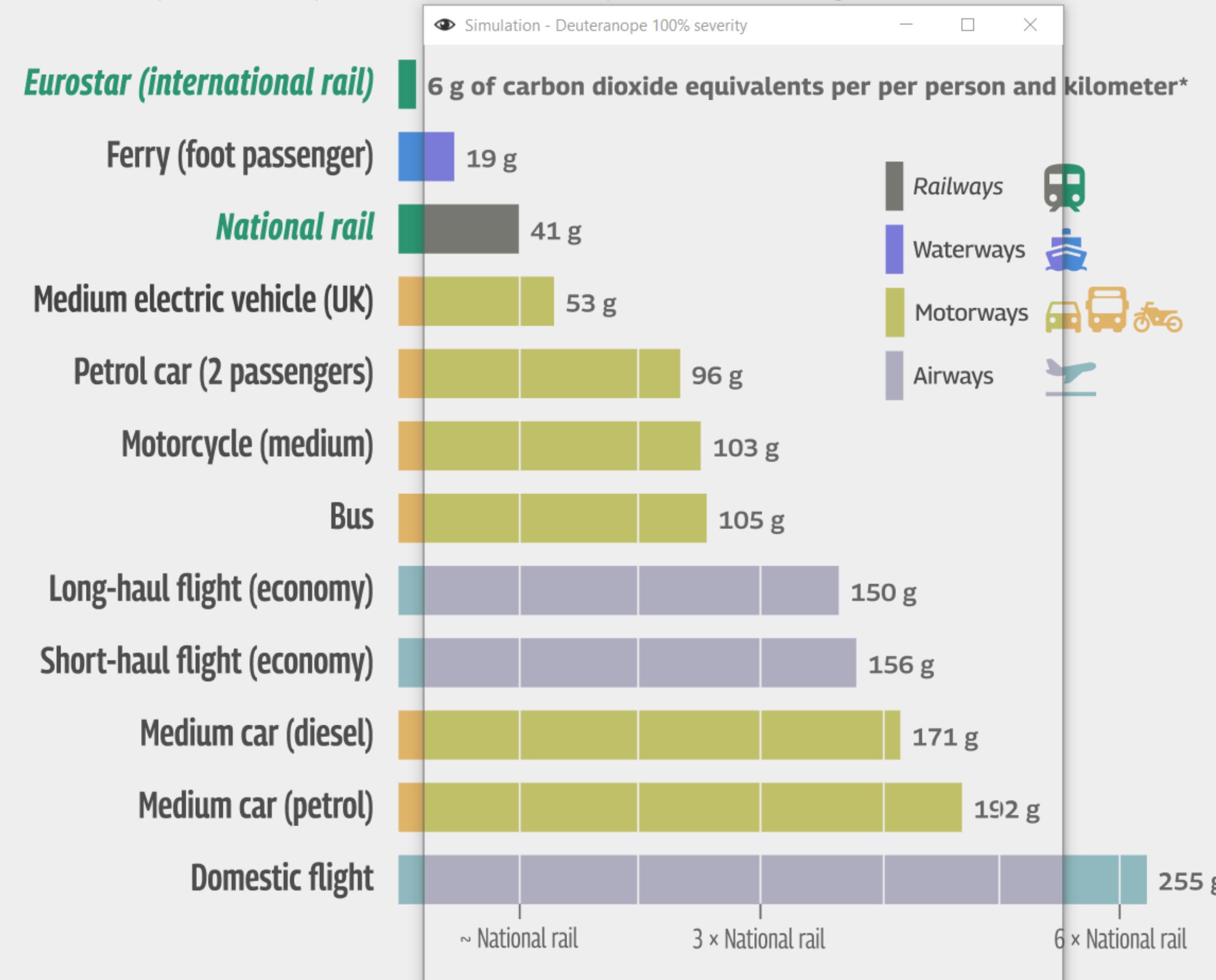
It's too far to walk or go by bike? Trains are nearly always the winning option over other moderate-to-long distance transportation modes. Taking a train instead of a car for medium-length distances would cut your emissions by ~80% and by ~84% if the train ride replaces a domestic flight.



Reworked graphic as contribution to the #30DayChartChallenge 2022

## Reduce your Carbon Footprint: *Take the Train*

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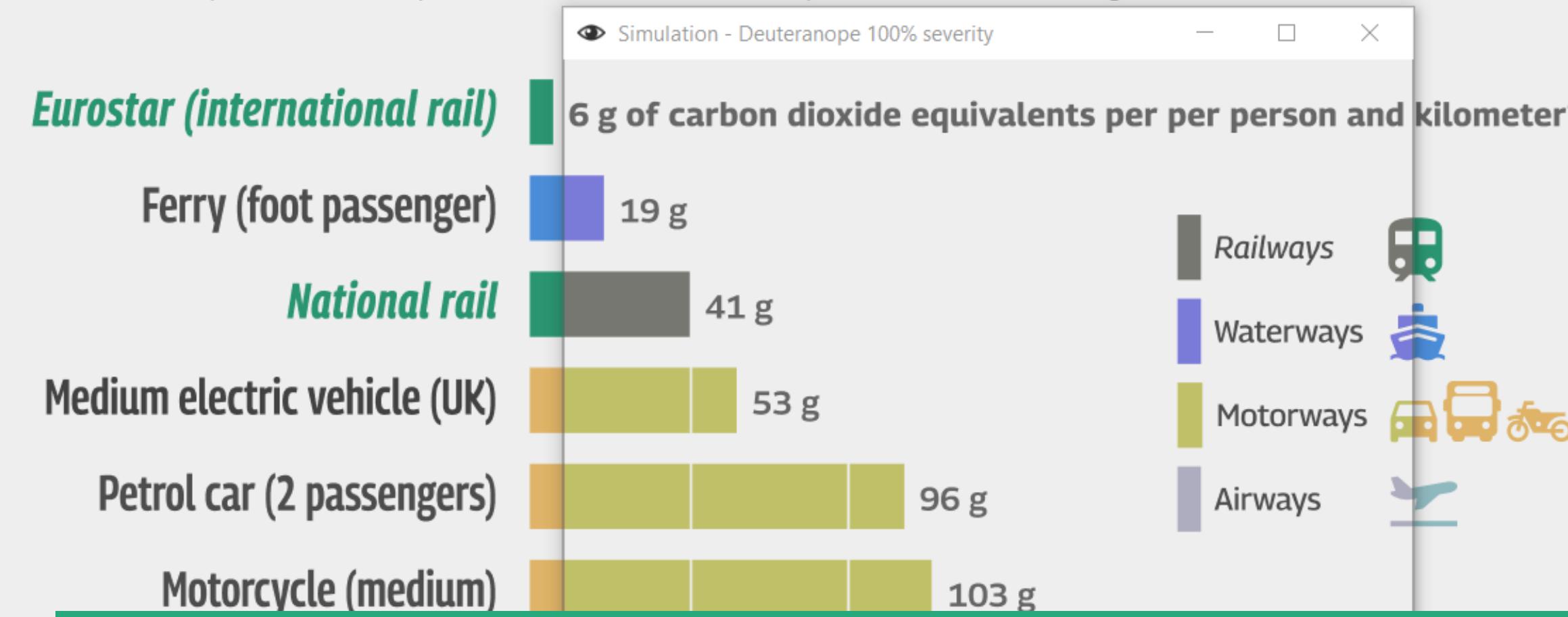


Don't trust  
color palettes  
— test them!

Reworked graphic as contribution to the #30DayChartChallenge 2022

## Reduce your Carbon Footprint: *Take the Train*

It's too far to walk or go by bike? Trains are nearly always the winning option over other moderate-to-long distance transportation modes. Taking a train instead of a car for medium-length distances would cut your emissions by ~80% and by ~84% if the train ride replaces a domestic flight.



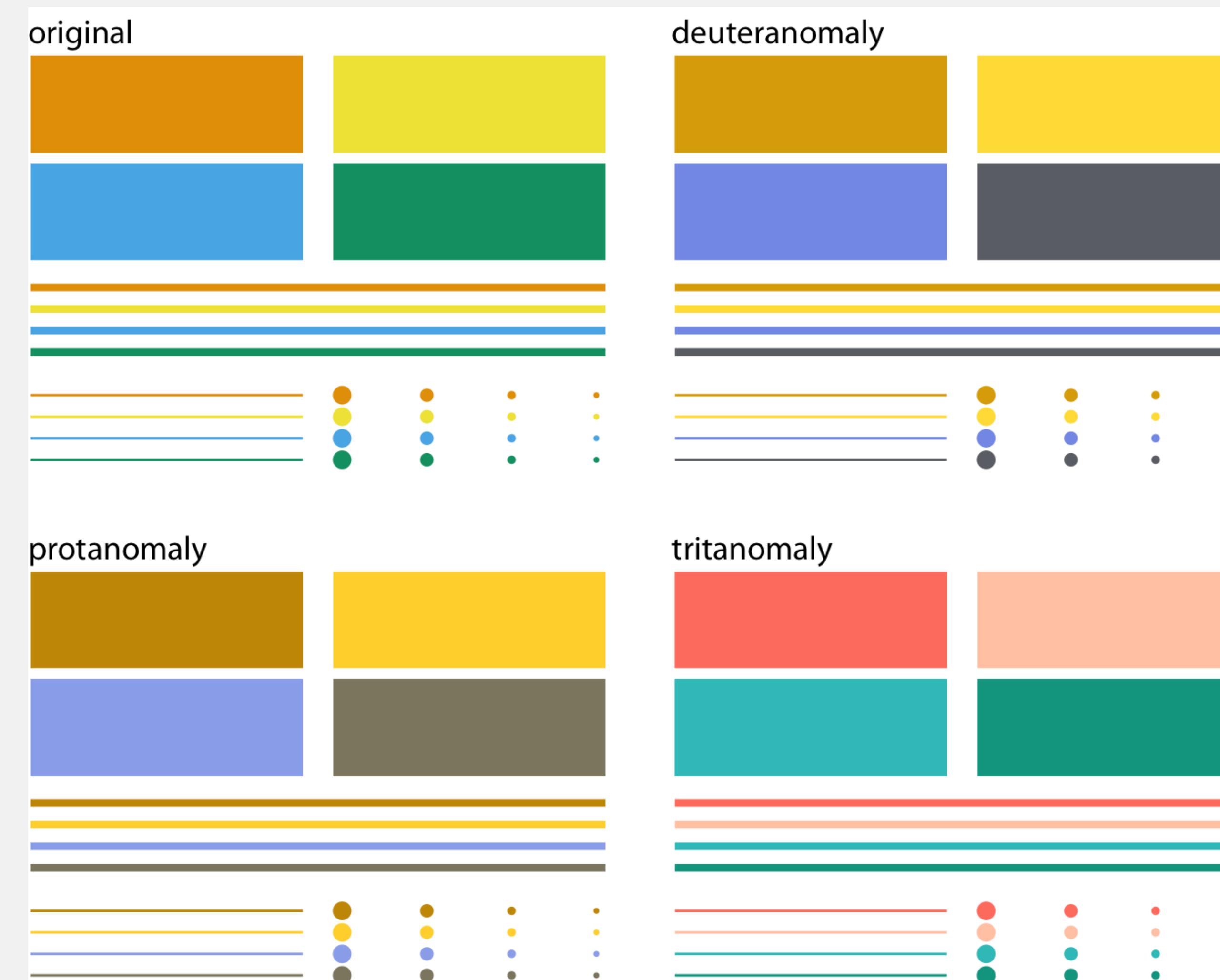
Don't trust  
color palettes  
— test them!

ColourSimulations  
SimDaltonims (Mac only)  
ColorFilter (for URLs)

Graphic: Cédric Scherer | Source: UK Department for Business, Energy & Industrial Strategy via OurWorldInData  
\* Data is based on official conversion factors used in UK reporting, measured as GHG Emissions (GCO2E/KM) 2018

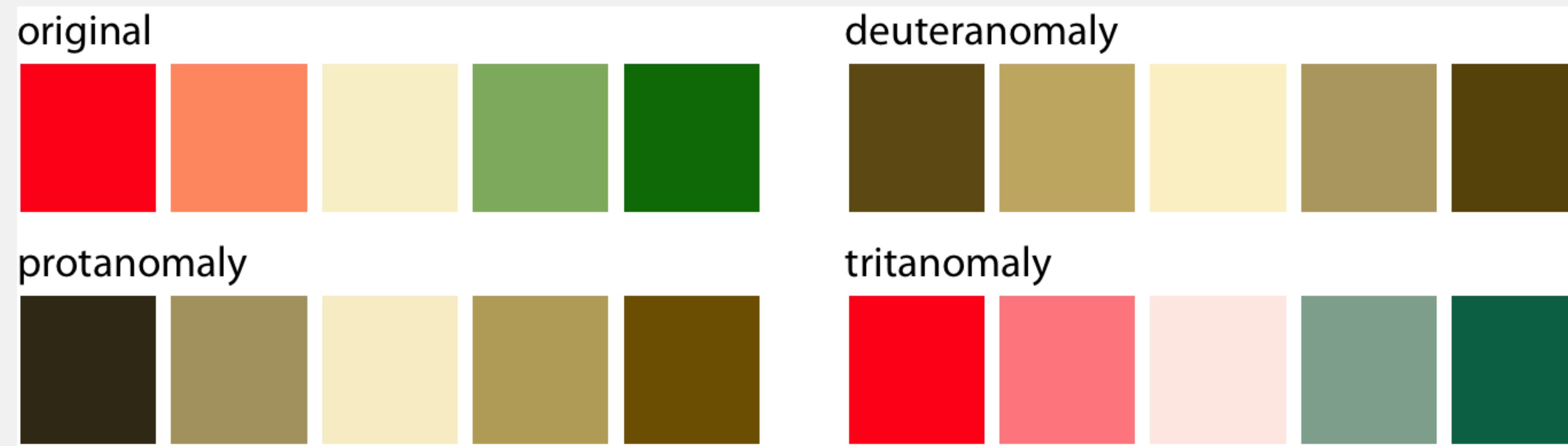
Reworked graphic as contribution to the #30DayChartChallenge 2022

# Ensure Readability for Color-Blind Persons



Source: “*Fundamentals of Data Visualization*” by Claus O. Wilke

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# Ensure Readability for Color-Blind Persons



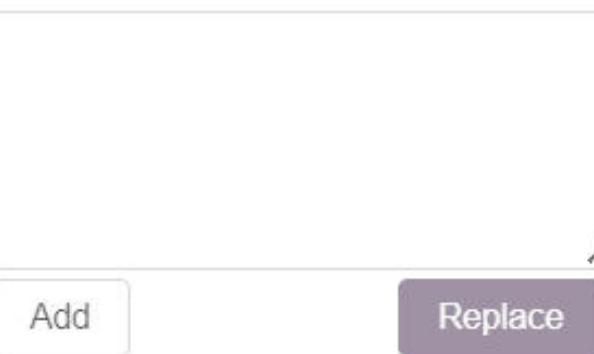
Source: ["Fundamentals of Data Visualization"](#) by Claus O. Wilke

# VIZ PALETTE

By: Elijah Meeks  
& Susie Lu

## PICK

Use Chroma.js



Use Colorgorical

Use ColorBrewer

## EDIT

- ≡ 1 ● #2a9571 [🔗](#) ×
- ≡ 2 ● #8fb9bf [🔗](#) ×
- 4 Colors      ≡ 3 ● #dfb468 [🔗](#) ×
- ≡ 4 ● #4b8cd8 [🔗](#) ×

#hex  rgb

hsl

## GET

#hex  rgb

hsl

String quotes  
 Object with metadata

```
[ "#2a9571",
  "#8fb9bf",
  "#dfb468",
  "#4b8cd8" ]
```

# COLORS IN ACTION

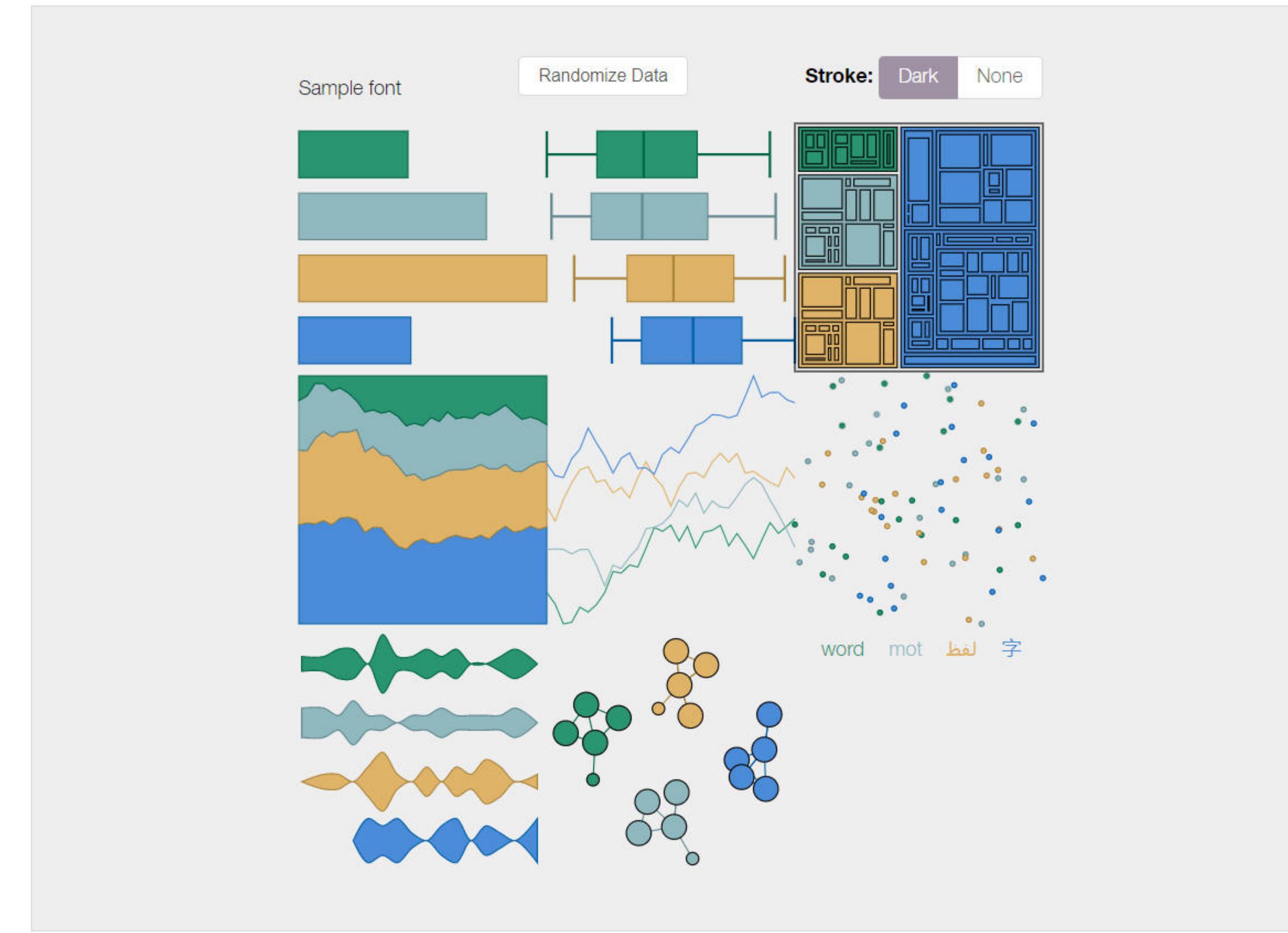
Background color:  #eeeeee [🔗](#)

Font color: ● #212121 [🔗](#)

Charts made with [Semiotic](#)

### Color Population:

No Color Deficiency - 96% Deuteranomaly - 2.7% Protanomaly - 0.66% Protanopia - 0.59% Deuteranopia - 0.56% Greyscale



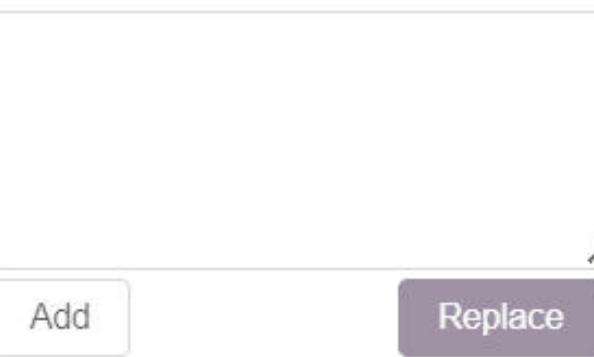
[Viz Palette](#) displaying the “colors in action” without color deficiency

# VIZ PALETTE

By: Elijah Meeks  
& Susie Lu

## PICK

Use Chroma.js



Use Colorgorical

Use ColorBrewer

## EDIT

- ≡ 1 ● #2a9571 [🔗](#) ×
- ≡ 2 ● #8fb9bf [🔗](#) ×
- ≡ 3 ● #dfb468 [🔗](#) ×
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#hex  rgb

hsl

## GET

#hex  rgb

hsl

String quotes  
 Object with metadata

```
[ "#2a9571",
  "#8fb9bf",
  "#dfb468",
  "#4b8cd8" ]
```

# COLORS IN ACTION

Background color:  #eeeeee [🔗](#)

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Viz Palette displaying the “colors in action” without color deficiency

# VIZ PALETTE

By: Elijah Meeks  
& Susie Lu

## PICK

Use Chroma.js



Add

Replace

Use Colorgorical

Use ColorBrewer

## EDIT

≡ 1 ● #2a9571 ↗

×

≡ 2 ● #8fb9bf ↗

×

4 Colors

≡ 3 ● #dfb468 ↗

×

≡ 4 ● #4b8cd8 ↗

×

Add

● #hex ○ rgb

○ hsl

## GET

String quotes  
 Object with metadata

```
[ "#2a9571",
  "#8fb9bf",
  "#dfb468",
  "#4b8cd8" ]
```

● #hex ○ rgb

○ hsl

# COLORS IN ACTION

Background color: ● #eeeeee ↗

Font color: ● #212121 ↗

Charts made with [Semiotic](#)

### Color Population:

No Color Deficiency - 96%

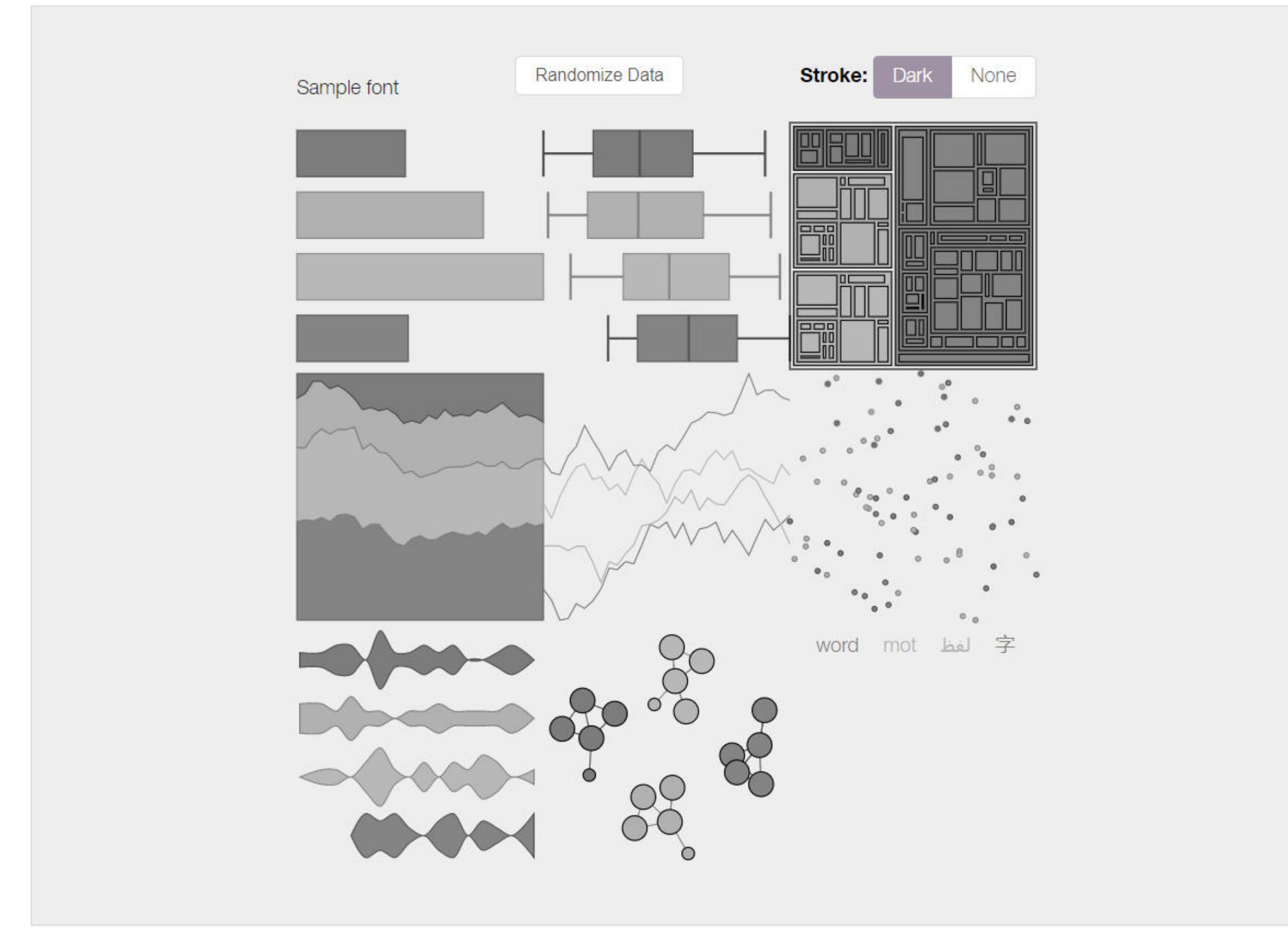
Deuteranomaly - 2.7%

Protanomaly - 0.66%

Protanopia - 0.59%

Deuteranopia - 0.56%

Greyscale



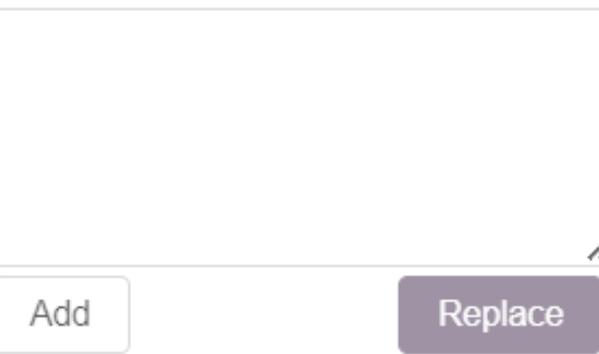
[Viz Palette](#) displaying the “colors in action” without color deficiency

# VIZ PALETTE

By: Elijah Meeks  
& Susie Lu

## PICK

Use Chroma.js



Add

Replace

Use Colorgorical

Use ColorBrewer

## EDIT

≡ 1 ● #2a9571 ↗

×

≡ 2 ● #8fb9bf ↗

×

4 Colors

≡ 3 ● #dfb468 ↗

×

≡ 4 ● #4b8cd8 ↗

×

#hex  rgb

hsl

## GET

String quotes  
 Object with metadata

```
[ "#2a9571",
  "#8fb9bf",
  "#dfb468",
  "#4b8cd8" ]
```

#hex  rgb

hsl

# COLORS IN ACTION

Background color: ● #505050 ↗

Font color: #fefefe ↗

Charts made with [Semiotic](#)

### Color Population:

No Color Deficiency - 96%

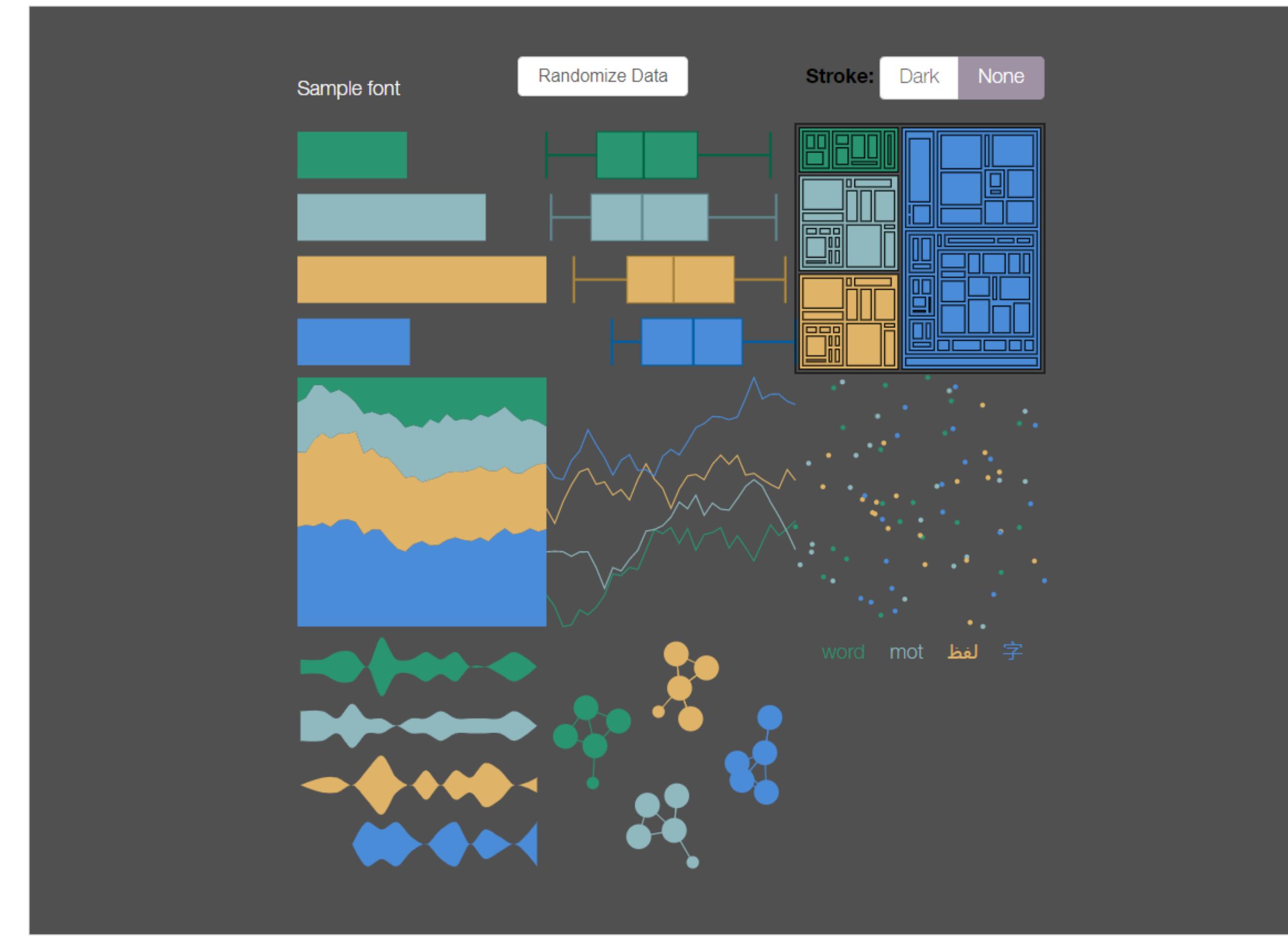
Deuteranomaly - 2.7%

Protanomaly - 0.66%

Protanopia - 0.59%

Deuteranopia - 0.56%

Greyscale



[Viz Palette](#) displaying the “colors in action” without color deficiency

# APCA CONTRAST CALCULATOR



TEXT COLOR

212121

#212121 • rgb(33,33,33)

APCA  
CONTRAST  
**Lc 93.0**

CLICK TO SWAP

BACKGROUND

eeeeeee

#eeeeee • rgb(238,238,238)



All Font Sizes are in CSS px · Fonts Under 80px Shown With Colors at Actual Size & Weight

LEVEL

200

300 • Light

400 • Normal

500

600

700 • Bold



29px  
Sample

21px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

15px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

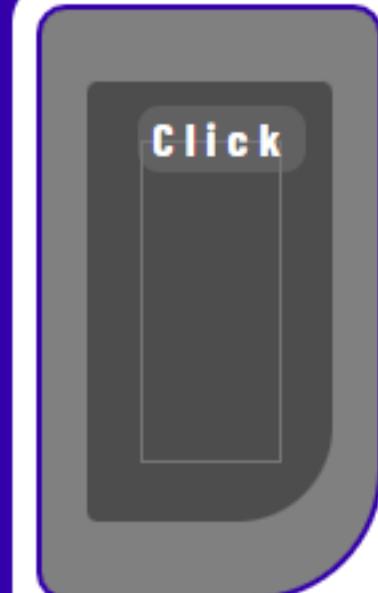
14.5px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

14px MIN  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

14px MINIMUM SIZE  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

The [Myndex APCA Contrast Calculator](#) displays modern contrast ratios for various combinations of text size and font weight

# APCA CONTRAST CALCULATOR



TEXT COLOR

4d4d4d

#4d4d4d • rgb(77,77,77)

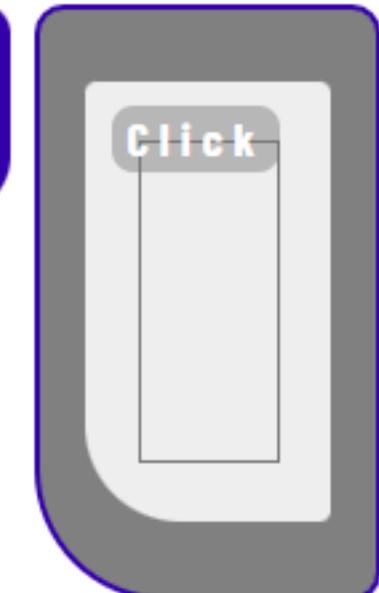
APCA  
CONTRAST  
**Lc 79.0**

CLICK TO SWAP

BACKGROUND

eeeeeee

#eee • rgb(238,238,238)



All Font Sizes are in CSS px · Fonts Under 80px Shown With Colors at Actual Size & Weight

LEVEL

200

300 • Light

400 • Normal

500

600

700 • Bold



34px  
Samp

23.5px  
the lazy grey dog sl  
frisky fox frolicked  
field of grass witho

17.5px  
the lazy grey dog sl  
frisky fox frolicked  
field of grass witho

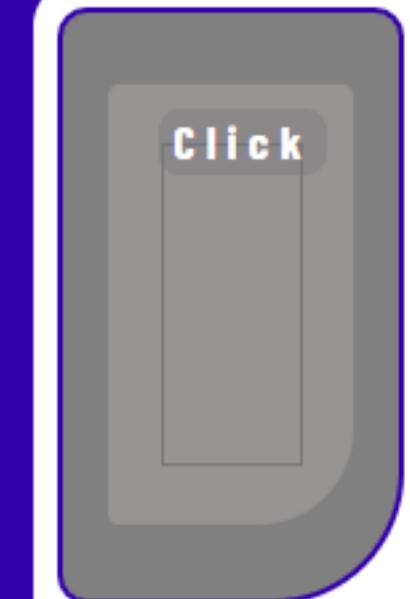
16.5px  
the lazy grey dog sl  
frisky fox frolicked  
field of grass witho

15px  
the lazy grey dog sl  
frisky fox frolicked  
field of grass witho

14px  
the lazy grey dog sl  
frisky fox frolicked  
field of grass witho

The [Myndex APCA Contrast Calculator](#) displays modern contrast ratios for various combinations of text size and font weight

# APCA CONTRAST CALCULATOR



TEXT COLOR

979494

#979494 • rgb(151,148,148)

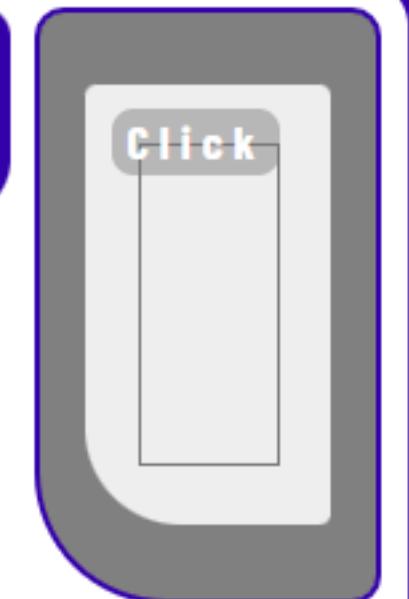
APCA  
CONTRAST  
**Lc 46.7**

CLICK TO SWAP

BACKGROUND

eeeeeee

#eee • rgb(238,238,238)



All Font Sizes are in CSS px · Fonts Under 80px Shown With Colors at Actual Size & Weight

LEVEL

200

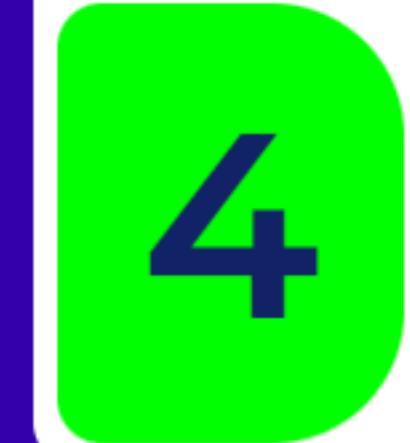
300 • Light

400 • Normal

500

600

700 • Bold



67px

48px  
Sample T

34px  
Sample Text

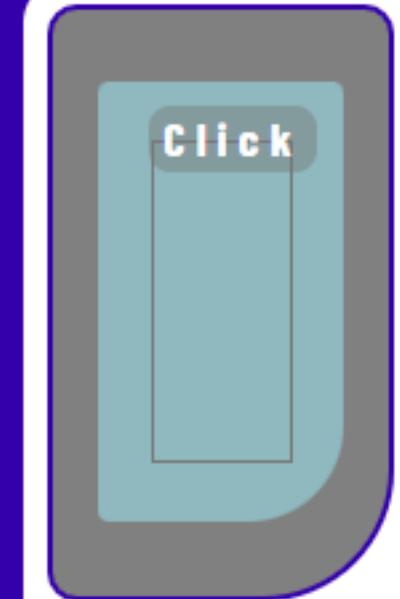
27px  
Sample

23px  
the lazy  
frisky fo

19.5px  
the lazy grey dog sleep  
frisky fox frolicked free  
field of grass without

The [Myndex APCA Contrast Calculator](#) displays modern contrast ratios for various combinations of text size and font weight

# APCA CONTRAST CALCULATOR



TEXT COLOR

8fb9bf

#8fb9bf • rgb(143,185,191)

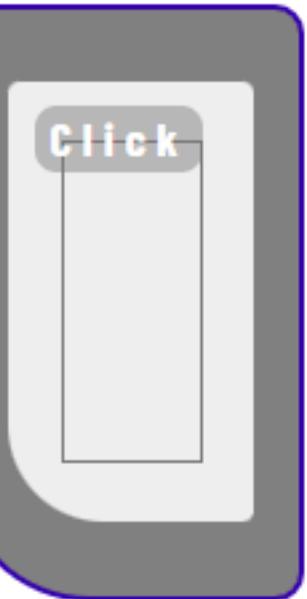
APCA  
CONTRAST  
**Lc 31.7**

CLICK TO SWAP

BACKGROUND

eeeeeee

#eee • rgb(238,238,238)



All Font Sizes are in CSS px · Fonts Under 80px Shown With Colors at Actual Size & Weight

LEVEL

200

300 • Light

400 • Normal

500

600

700 • Bold

4

N

111

86px

61p

52p

43px  
Sample Te

The [Myndex APCA Contrast Calculator](#) displays modern contrast ratios for various combinations of text size and font weight

# APCA CONTRAST CALCULATOR



TEXT COLOR

212121

#212121 • rgb(33,33,33)

APCA  
CONTRAST  
**Lc 93.0**

CLICK TO SWAP

BACKGROUND

eeeeeee

#eeeeee • rgb(238,238,238)



All Font Sizes are in CSS px · Fonts Under 80px Shown With Colors at Actual Size & Weight

LEVEL

200

300 • Light

400 • Normal

500

600

700 • Bold



29px  
Sample

21px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

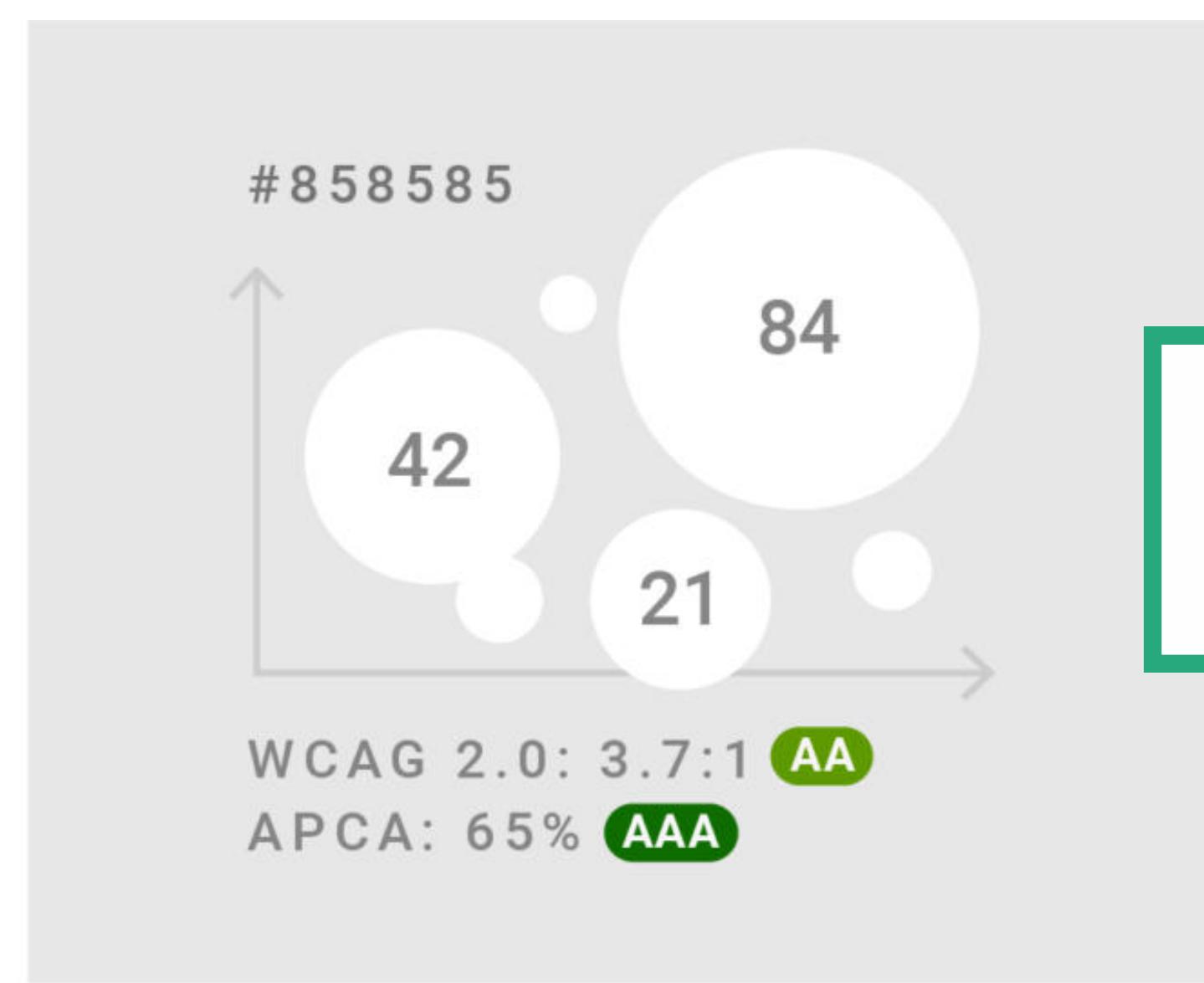
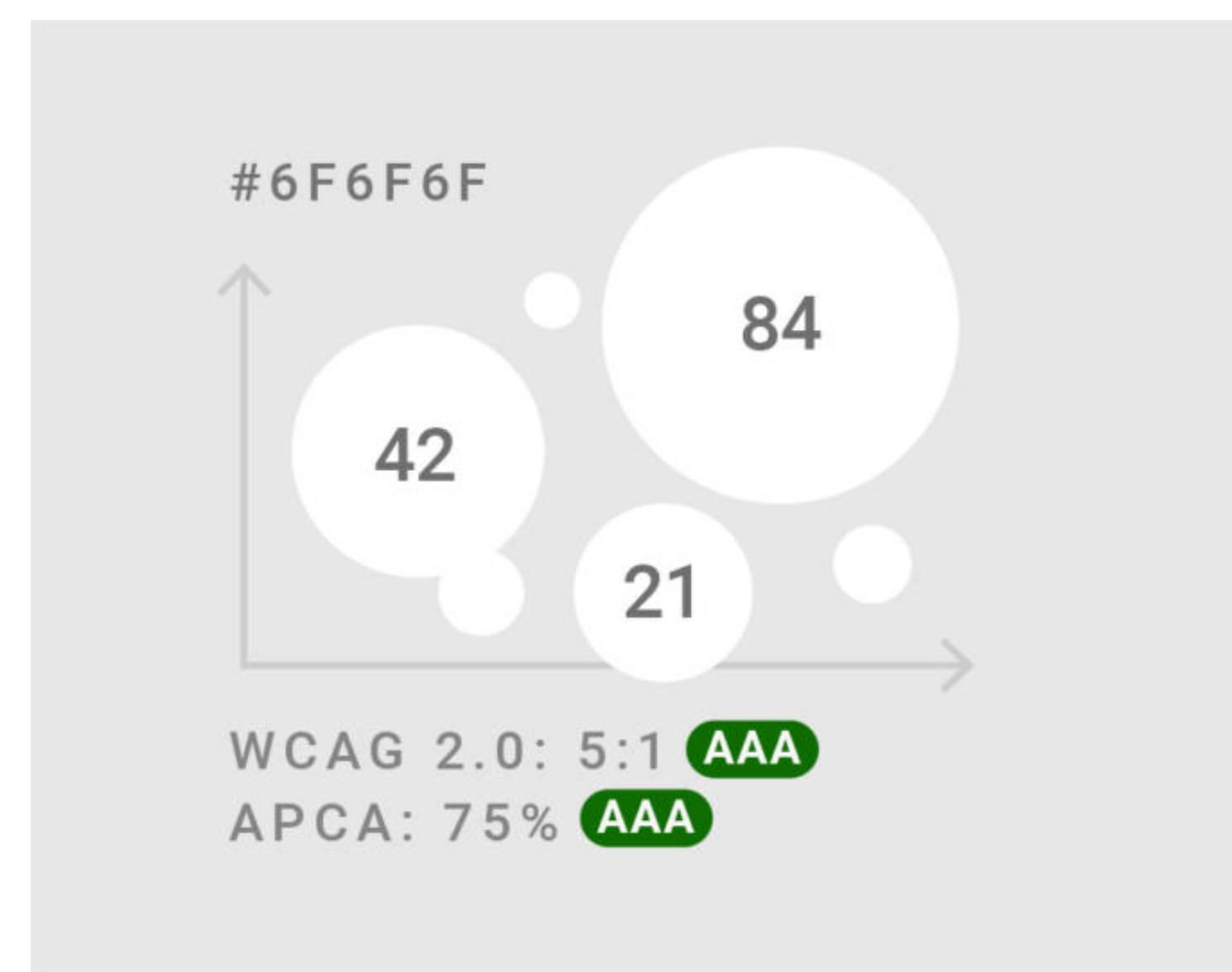
15px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

14.5px  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

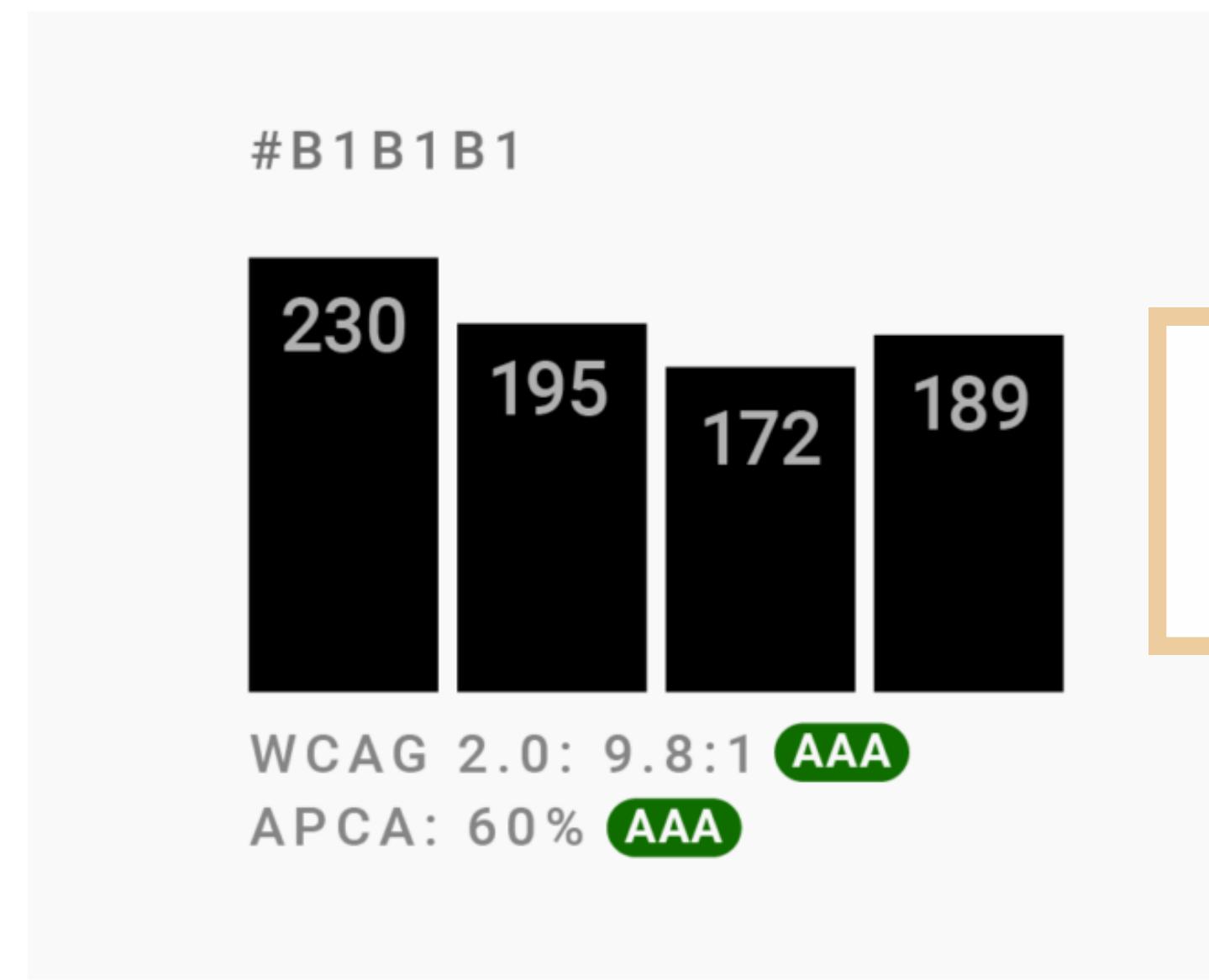
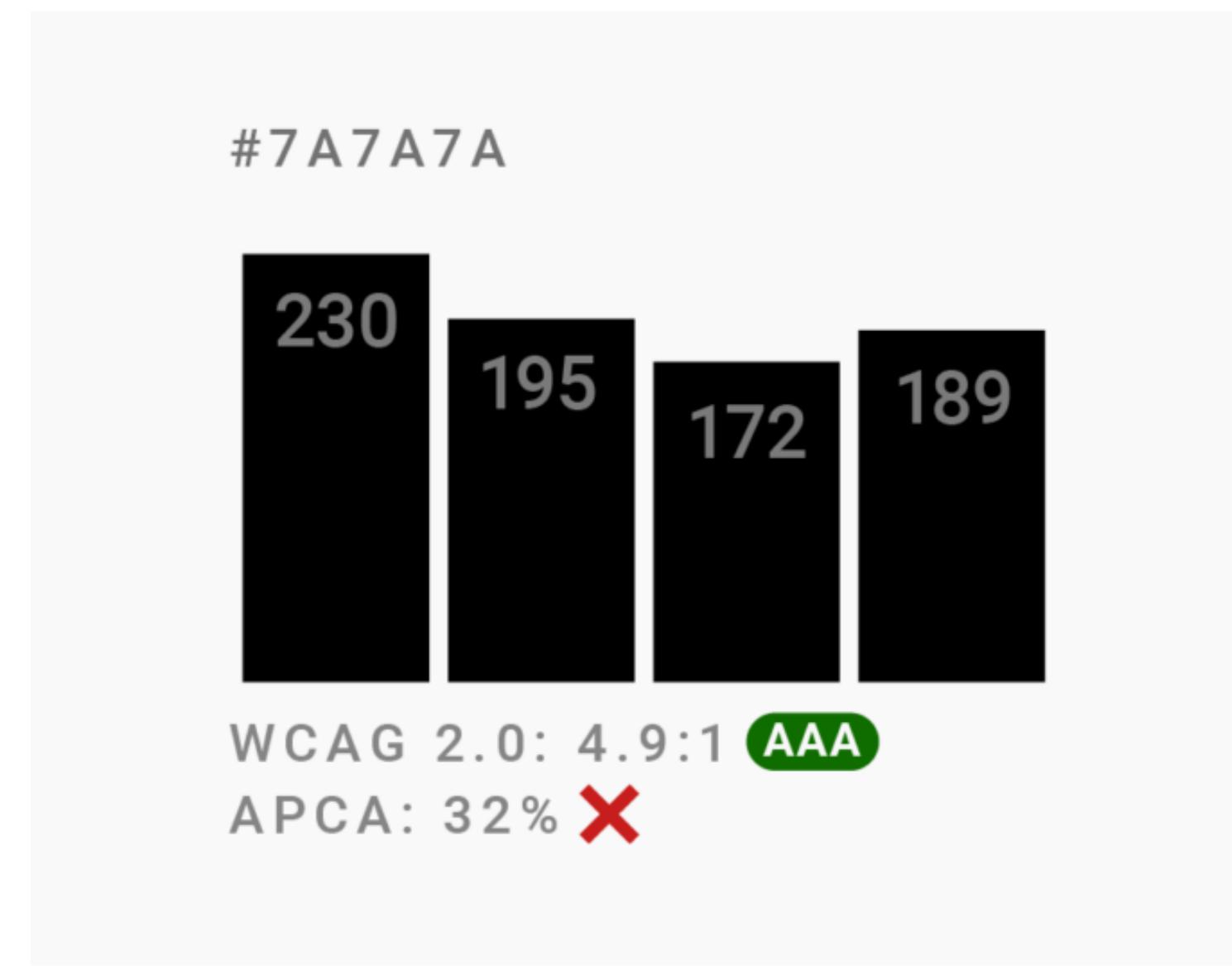
14px MIN  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

14px MINIMUM SIZE  
the lazy grey dog slept as the  
frisky fox frolicked freely in the  
field of grass without a care in  
the world, wondering if the dog  
would ever wake up so they could

The [Myndex APCA Contrast Calculator](#) displays modern contrast ratios for various combinations of text size and font weight



APCA allows for lighter grey on light backgrounds...



... but also requests lighter grey on dark backgrounds

*“It’s time for a more sophisticated color contrast check for data visualizations” by Lisa C. Muth / DataWrapper*

[Med Phys.](#) 2015 Jun; 42(6): 2942–2954. Published online 2015 May 20. doi: [10.1118/1.4921125](https://doi.org/10.1118/1.4921125)

PMCID: PMC5148121 | PMID: [26127048](https://pubmed.ncbi.nlm.nih.gov/26127048/)

## Effect of color visualization and display hardware on the visual assessment of pseudocolor medical images

Silvina Zabala-Travers, Mina Choi, Wei-Chung Cheng, and Aldo Badano<sup>a)</sup>

10 March 2017

## Interpretation of the rainbow color scale for quantitative medical imaging: perceptually linear color calibration (CSDF) versus DICOM GSDF

[Frédérique Chesterman](#), [Hannah Manssens](#), [Céline Morel](#), [Guillaume Serrell](#), [Bastian Piepers](#), [Tom Kimpe](#)

[Author Affiliations +](#)

[Proceedings Volume 10136, Medical Imaging 2017: Image Perception, Observer Performance, and Technology Assessment; 101360R \(2017\)](#) <https://doi.org/10.1117/12.2253885>

Event: [SPIE Medical Imaging](#), 2017, Orlando, Florida, United States

*IEEE Computer Graphics and Applications*

## Rainbow Color Map (Still) Considered Harmful

March/April 2007, pp. 14-17, vol. 27

DOI Bookmark: [10.1109/MCG.2007.46](https://doi.org/10.1109/MCG.2007.46)

Authors

David Borland, University of North Carolina at Chapel Hill

Russell M. Taylor II, University of North Carolina at Chapel Hill

Education and communication

Rainbow color map distorts and misleads research in hydrology – guidance for better visualizations and science communication

Michael Stoelze<sup>1</sup> and Lina Stein<sup>2</sup>

<sup>1</sup>Faculty of Environment and Natural Resources, University of Freiburg, Freiburg, Germany

<sup>2</sup>Department of Civil Engineering, University of Bristol, Bristol, UK

[Med Phys.](#) 2015 Jun; 42(6): 2942–2954. Published online 2015 May 20. doi: [10.1118/1.4921125](https://doi.org/10.1118/1.4921125)

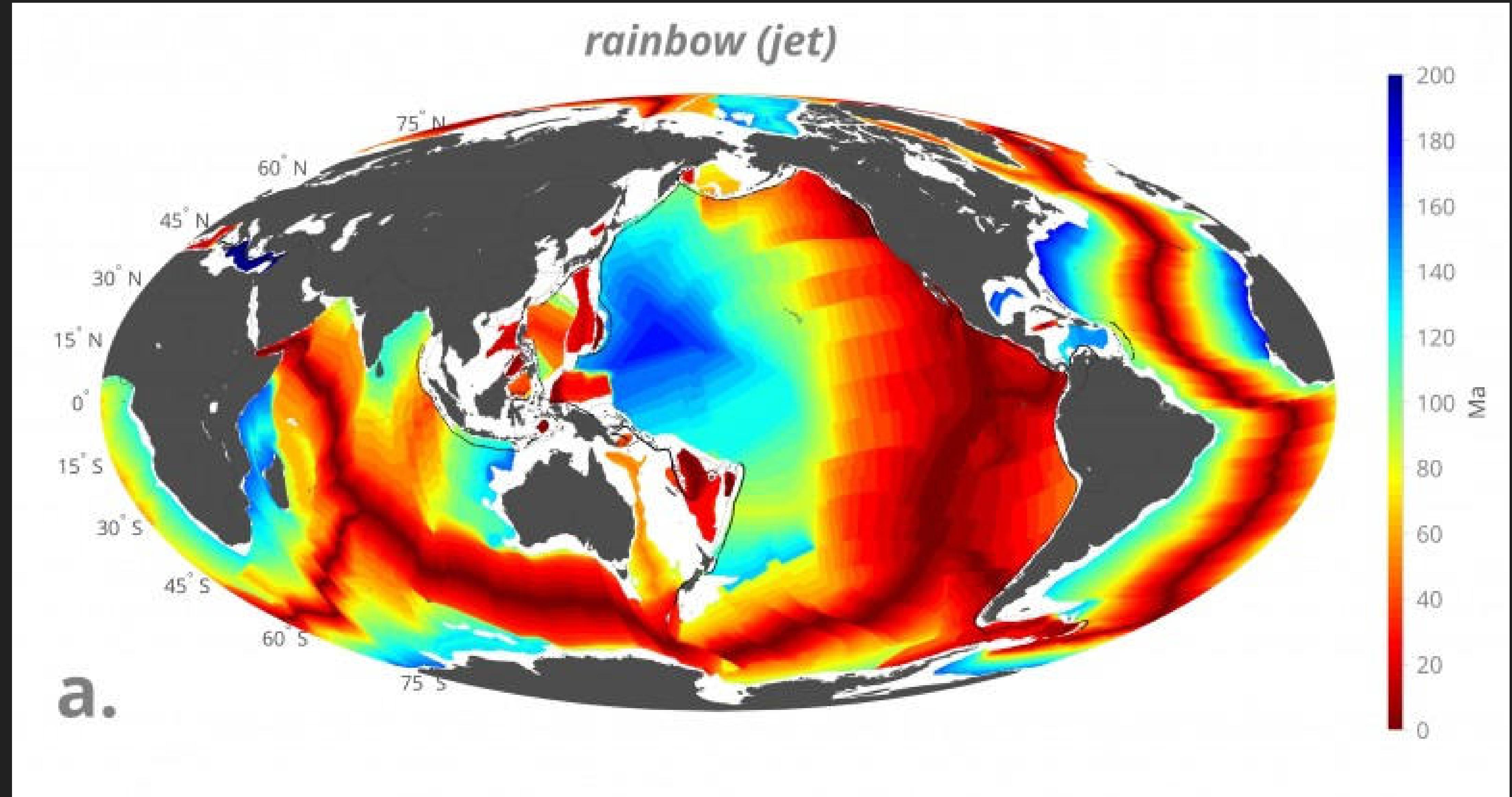
PMCID: PMC5148121 | PMID: [26127048](#)

Effect of color visualization and display hardware on the visual assessment of pseudocolor medical images

[Silvina Zabala-Travers](#), [Mina Choi](#), [Wei-Chung Cheng](#), and [Aldo Badano<sup>a\)</sup>](#)

**“The ad hoc manner in which color is handled and the lack of standard approaches have been associated with suboptimal and inconsistent diagnostic decisions with a negative impact on patient treatment and prognosis.”**

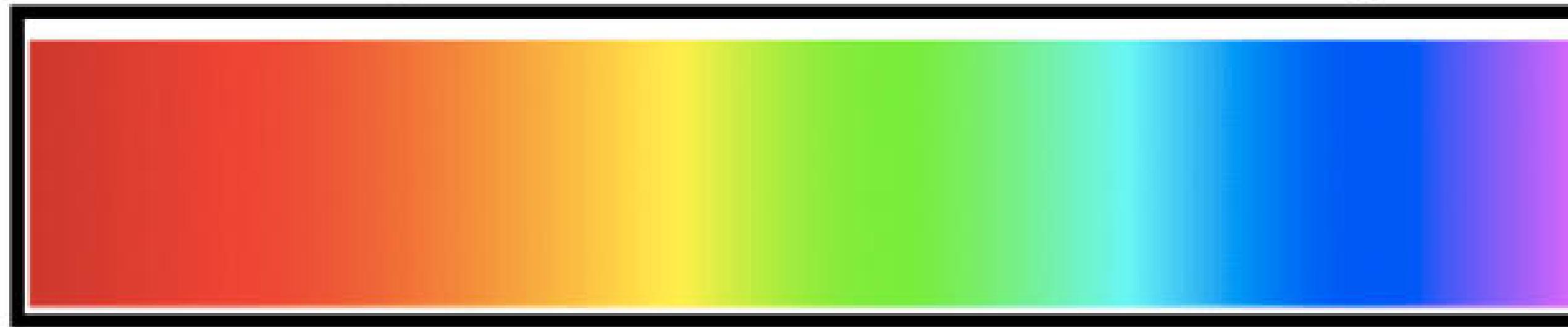
*Zabala-Travers, Choi, Cheng & Badano 2015 Med Phys.*



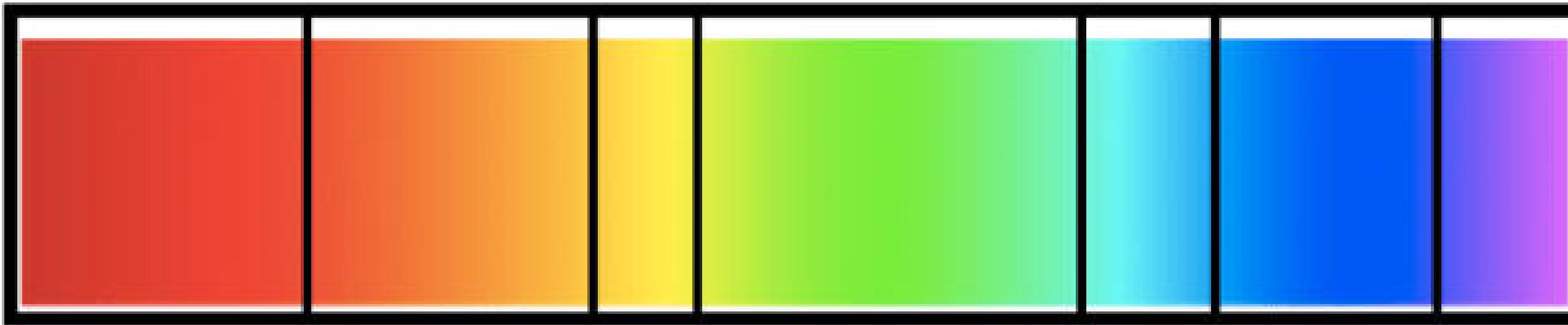
Source: "The Rainbow Colour Map (repeatedly) considered harmful", EGU Blogs

# Non-Uniform Distances between Hues in the Newton Rainbow Colormap

Red      Orange      Yellow      Green      Blue      Indigo      Purple



Typical Rainbow Colormap

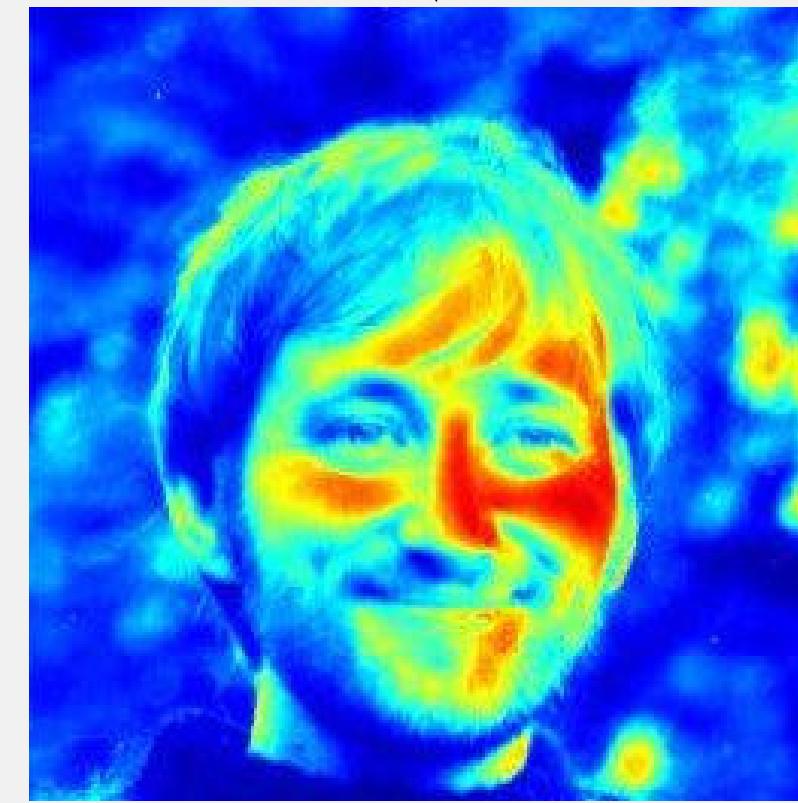


Non-Uniform Distances between Hues.

*Modified from [Fabio Cramer](#)*



**true-color Phil**



**rainbow Phil**



**batlow Phil**

*Modified from Fabio Crameri*



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Twitter



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Beamer



z3tt

# Summary

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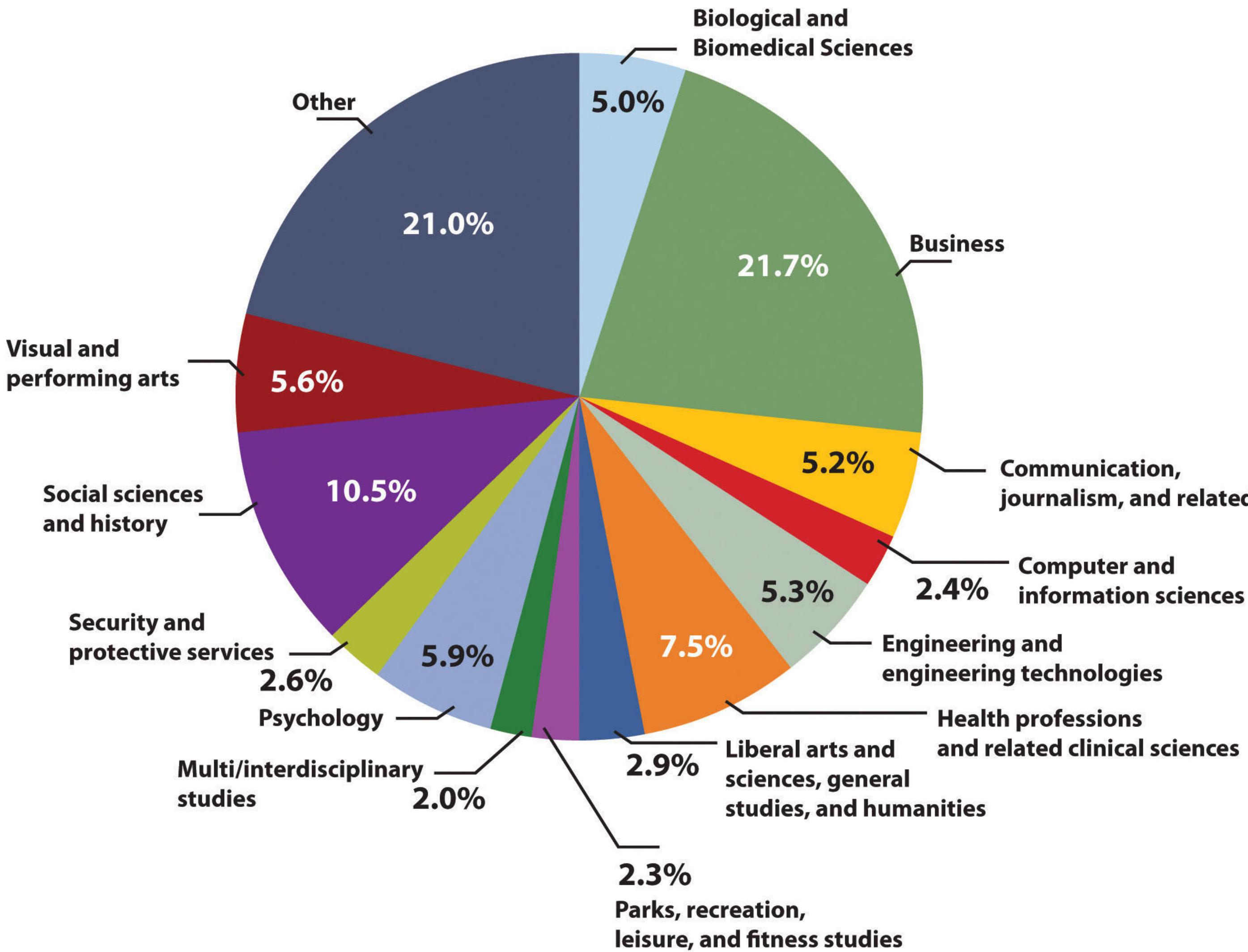
z3tt

## Panel (a)

Field of Study	Percentage of Bachelor's Degrees
Biological and biomedical sciences	5.0%
Business	21.7%
Communication, journalism, and related	5.2%
Engineering and engineering technologies	5.3%
Health professions and related clinical sciences	7.5%
Liberal arts and sciences, general studies, and humanities	2.9%
Psychology	5.9%
Social sciences and history	10.5%
Visual and performing arts	5.6%
Security and protective services	2.6%
Computer and information sciences	2.4%
Multi/interdisciplinary studies	2.3%
Parks, recreation, leisure, and fitness studies	2.0%
Other	21.0%

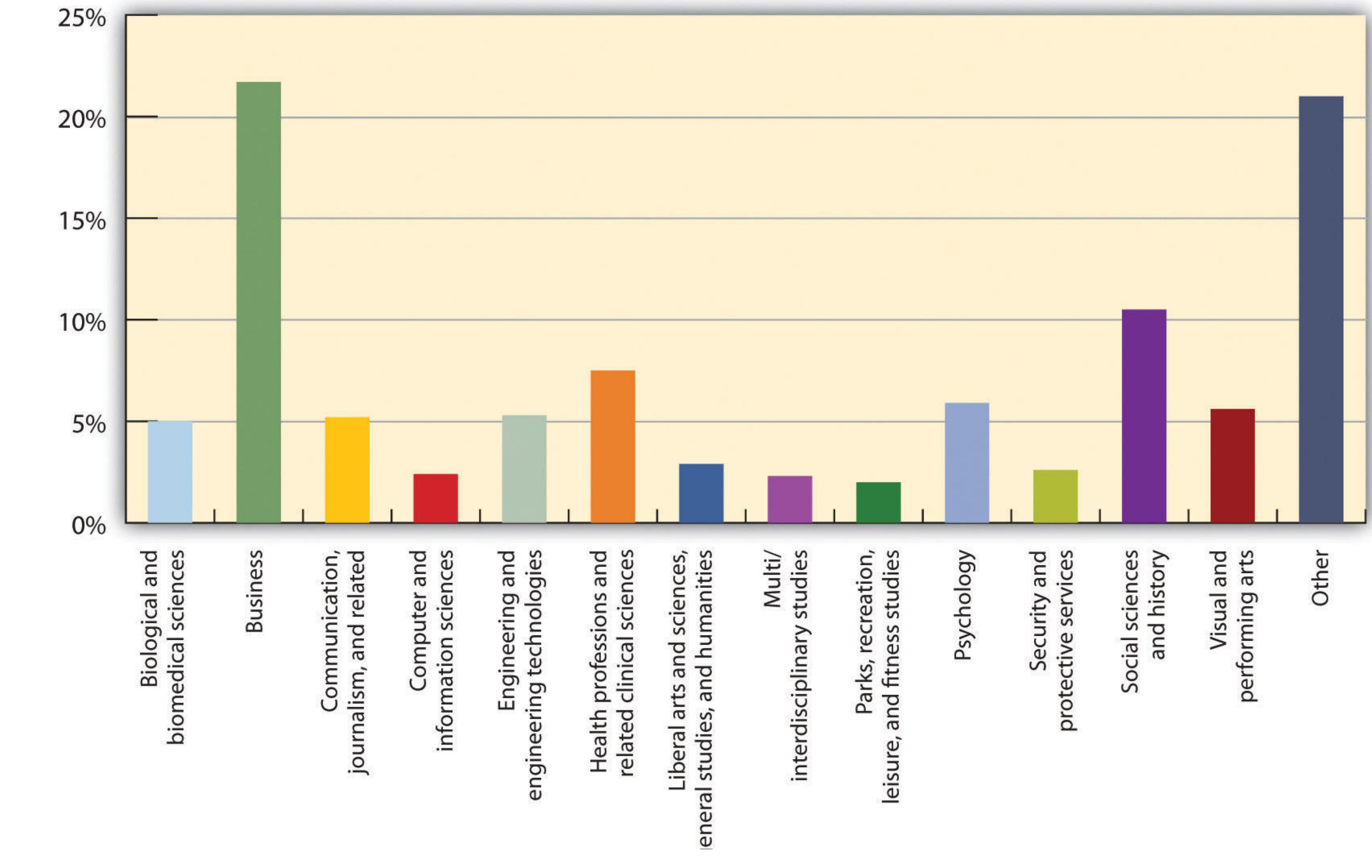
Source: [saylordotorg.github.io/text\\_principles-of-economics-v2.0](https://saylordotorg.github.io/text_principles-of-economics-v2.0)

Panel (b)



Source: [saylordotorg.github.io/text\\_principles-of-economics-v2.0](https://saylordotorg.github.io/text_principles-of-economics-v2.0)

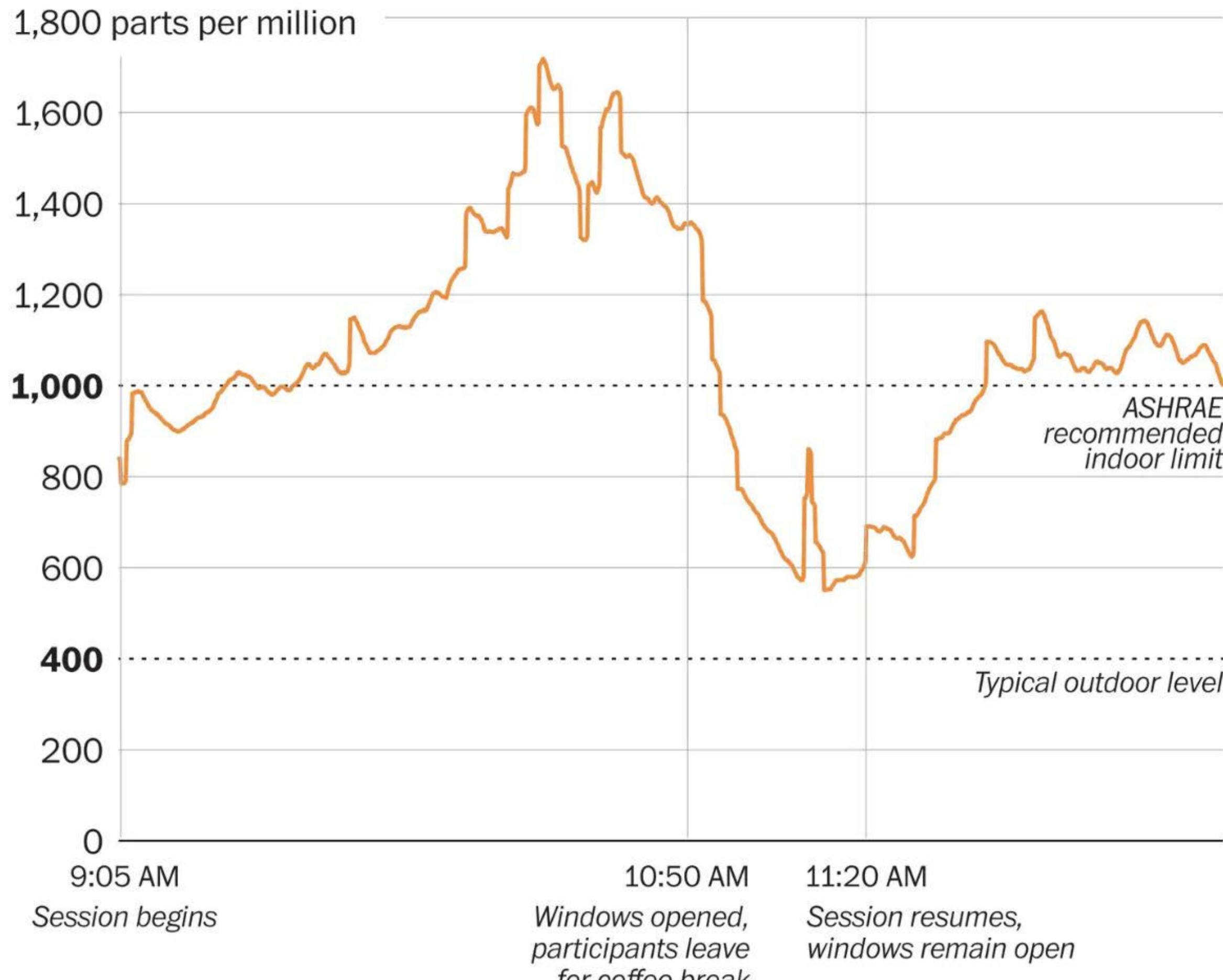
Panel (c)



Source: [saylordotorg.github.io/text\\_principles-of-economics-v2.0](https://saylordotorg.github.io/text_principles-of-economics-v2.0)

# Clearing the air

CO<sub>2</sub> levels in an occupied conference room on June 4, 2019



Source: Adam Ginsburg

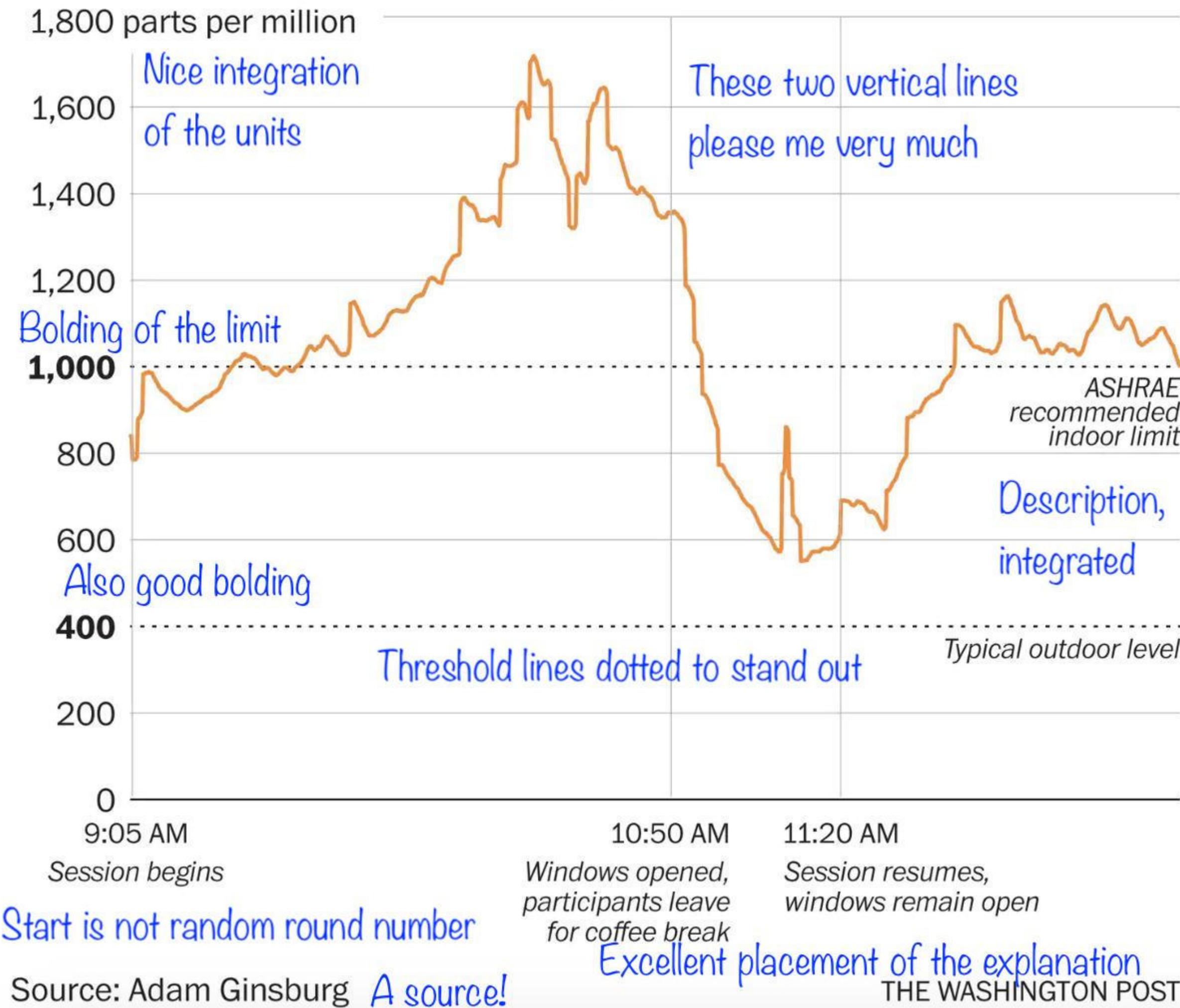
THE WASHINGTON POST

Source: ["Clearin the Air"](#) by Adam Ginsburg (Washington Post)

# Clearing the air

Fun and helpful title

CO<sub>2</sub> levels in an occupied conference room on June 4, 2019  
Units and metho in a subtitle, NOT in vertical text on the side



Notes by Francis Gagnon (Voilà)

# 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 .....

Present information in a logical, coherent way.

# Group Exercise

## Have a look at one of the example data visualizations

👉 Fill one dot for each chart type you have used already to communicate your data

## Have a look at the “Chart Choice Helpers”

- 👉 Explore and discuss potential chart types for future data visualizaitons
- 👉 Look up the chart types on the poster you didn't know
- 👉 Are there chart types you find hard to read / understand?

# Wrap~Up

---



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# Design for your audience.

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

# Design for your audience.

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

# Be honest.

- Check your data carefully, via summary statistics and visualizations.
- Show the distribution of the raw data if possible.
- Don't truncate bar charts, add spacing to truncated axes.

# Design for your audience.

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

# Be honest.

- Check your data carefully, via summary statistics and visualizations.
- Show the distribution of the raw data if possible.
- Don't truncate bar charts, add spacing to truncated axes.

# 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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