

Effective Data Visualization for Scientific Researchers

VLAG PhD week
Baarlo, March 26th, 2024

Irene van den Broek, PhD

 @IrenevdBroek

 @JeBentWatJeMeet

 @IreneVDB

Hi there, I'm Irene!

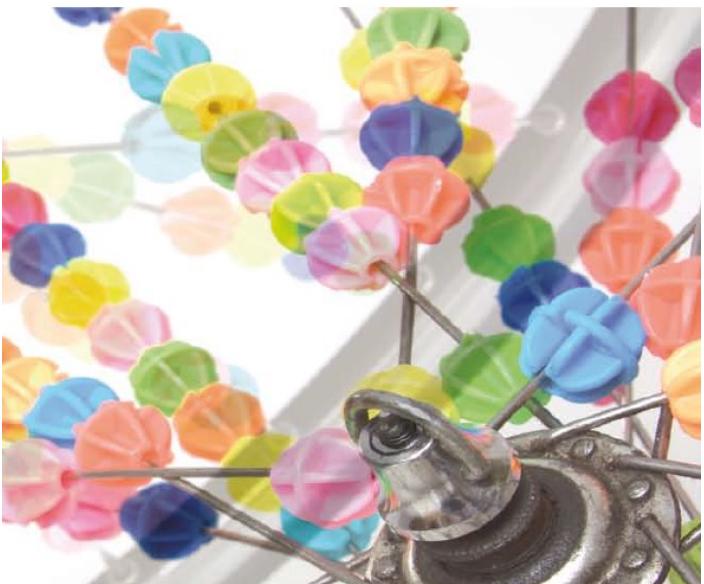


Irene van den Broek

irenevandenbroek@gmail.com

I have a background in biomarker research

Liquid chromatography coupled to tandem mass spectrometry for the quantitative bioanalysis of bioactive and potential biomarker peptides



Irene van den Broek 2010



2005-2010
Utrecht University

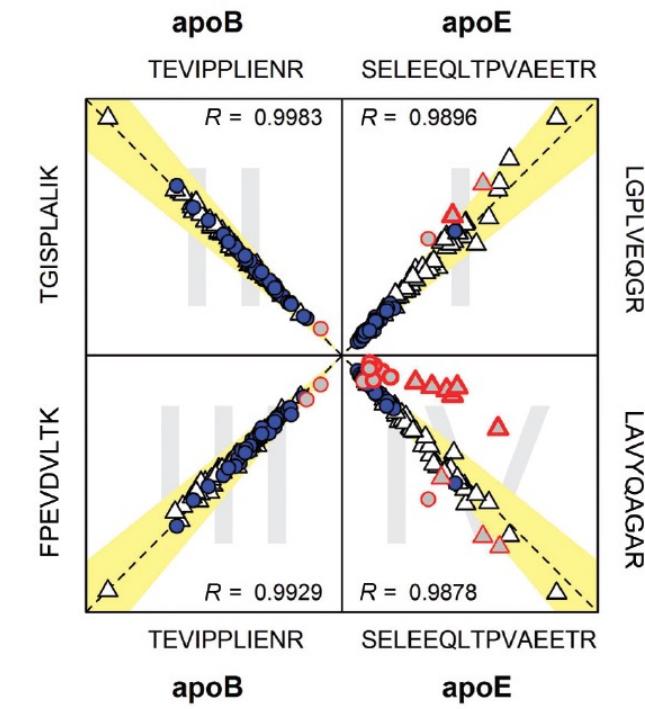
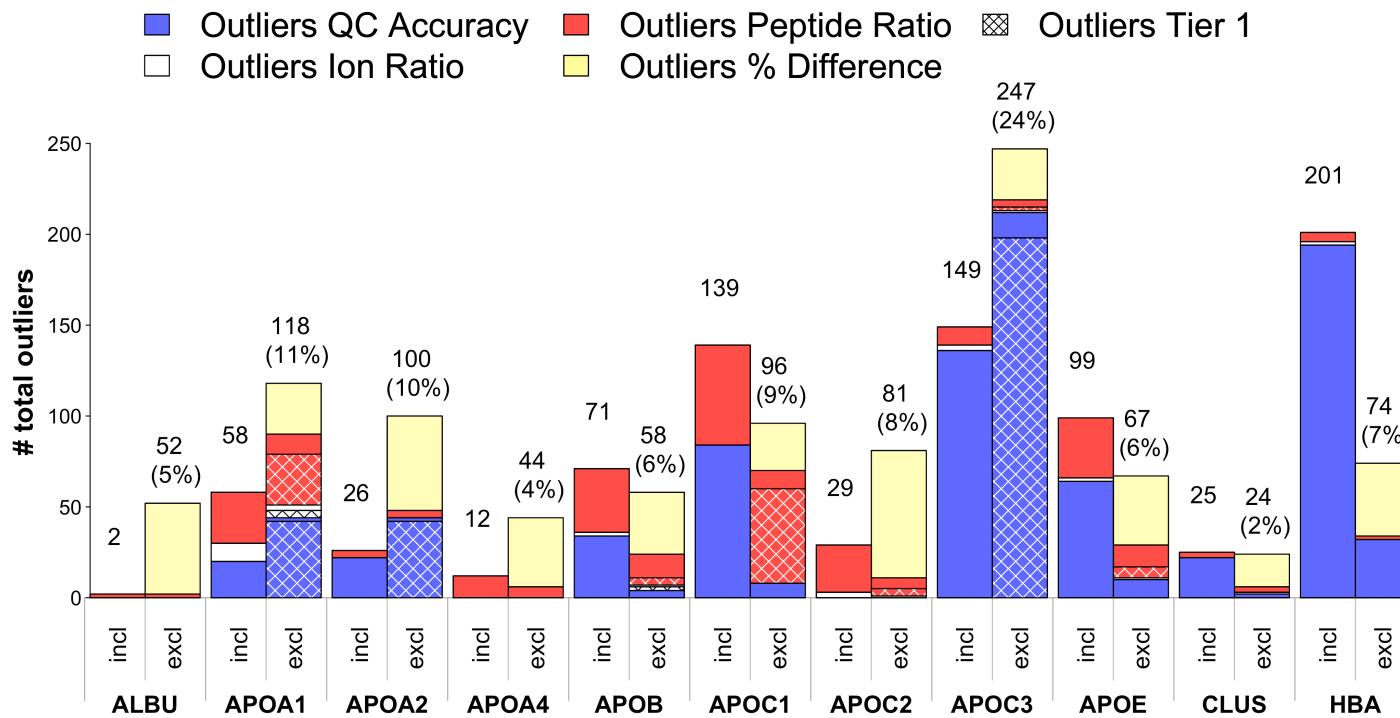


2013-2015
Leiden University
Medical Center

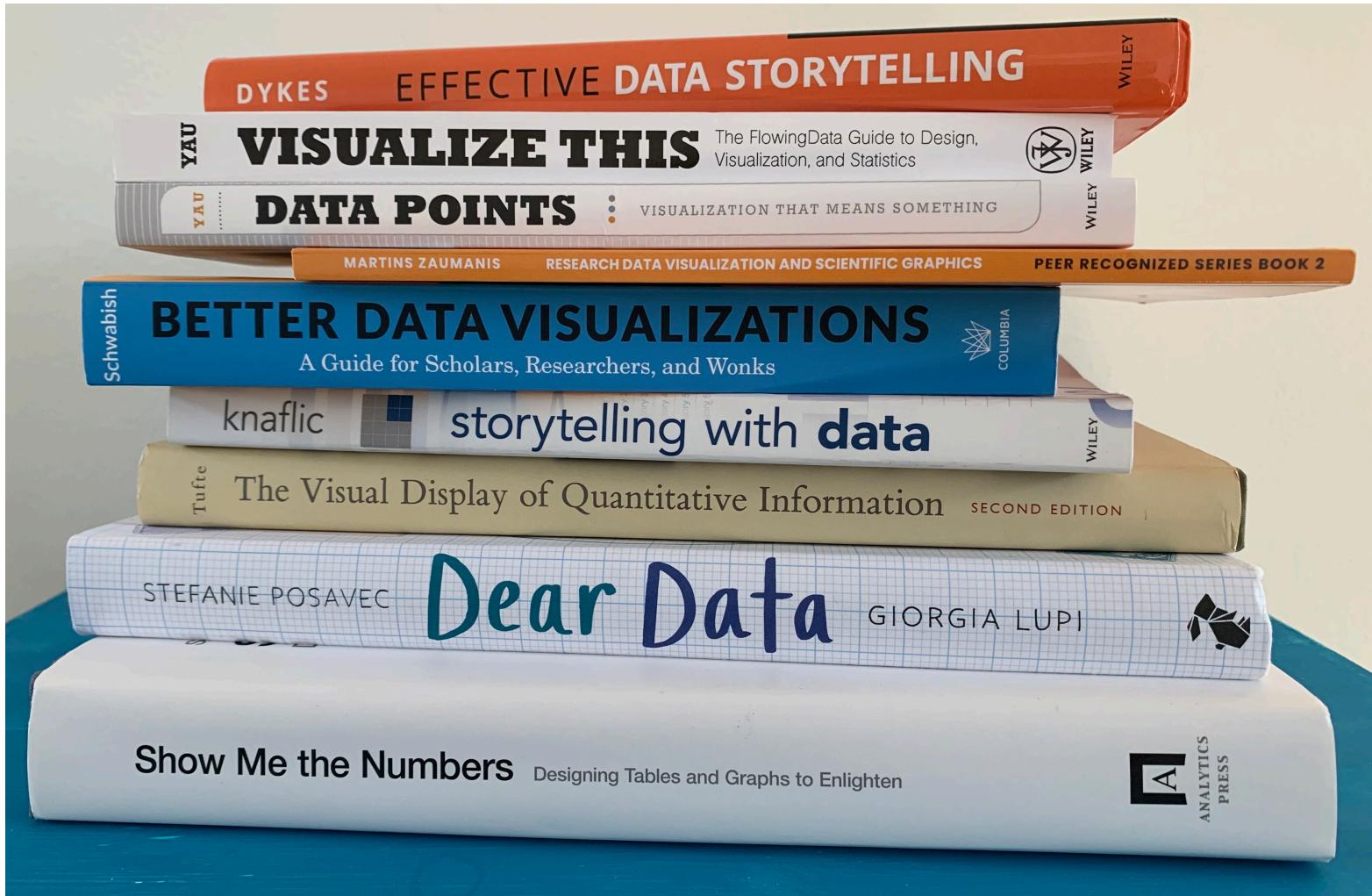


2015-2019
Cedars-Sinai
Medical Center

During my PhD and post-docs, I loved creating charts, preferably as complicated as possible...

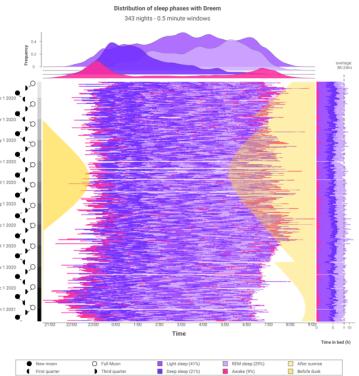


When I learned **Data Visualization** is a field on its own, I was hooked!

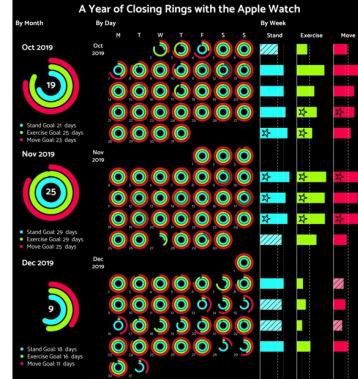


I started visualizing my Health and Habits.

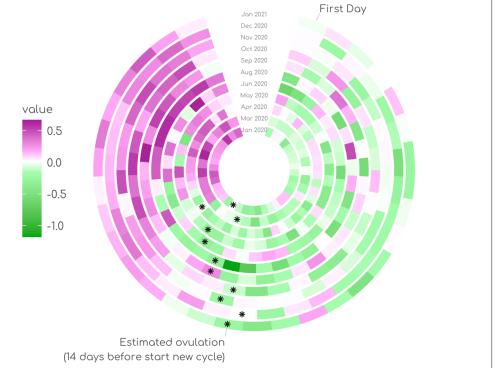
Sleep



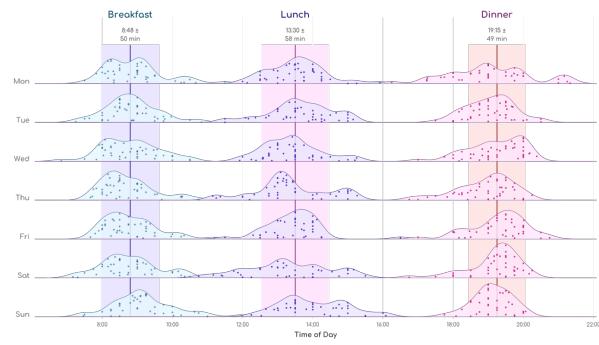
Activity



Body



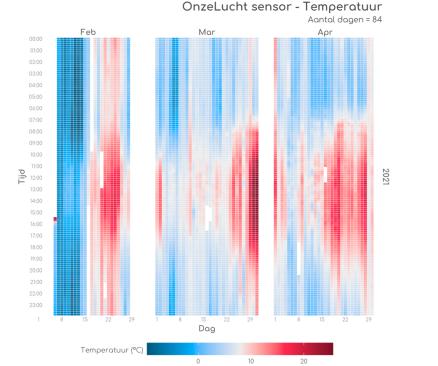
Food



Habits

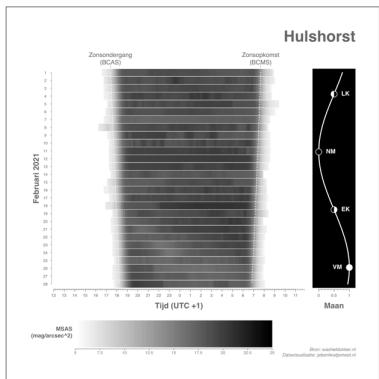


Environment



<https://www.jebentwatjemeet.nl>
<https://irenevdb.rbind.io>

And now combine my passions for teaching and data visualization



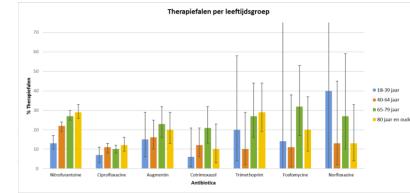
www.washetdonker.nl



www.onzelucht.nl



Figuur 1 Therapiefaalen voor verschillende antibiotische regimes per leeftijdsgroep

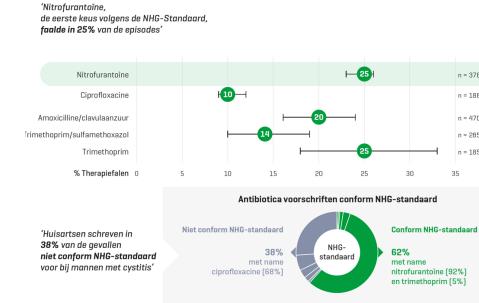


Tabel 1. AUC analyses van het basis- en final model, in vrouwen en mannen in totaal, en over etnische groepen.

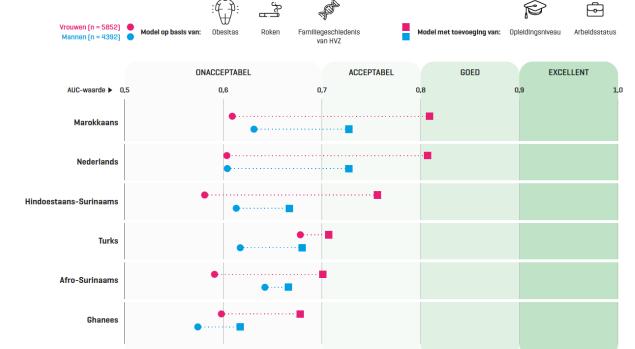
	Vrouwen (n=5852)		Mannen (n=4392)	
	AUC [95%CI]	AUC [95%CI]	AUC [95%CI]	AUC [95%CI]
Totalle populatie	.563 [.539, .584]	.682 [.664, .699]	.610 [.595, .627]	.664 [.644, .681]
Nederlands	.604 [.558, .640]	.807 [.772, .838]	.609 [.582, .638]	.721 [.691, .757]
Hindoestaans-Surinaams	.581 [.541, .623]	.756 [.711, .793]	.613 [.568, .646]	.667 [.627, .708]
Afro-Surinaams	.591 [.554, .633]	.701 [.669, .731]	.642 [.620, .665]	.666 [.633, .693]
Ghanees	.598 [.528, .642]	.678 [.631, .733]	.574 [.539, .613]	.617 [.580, .659]
Turks	.678 [.631, .733]	.707 [.650, .744]	.617 [.580, .659]	.680 [.644, .741]
Marokkaans	.609 [.568, .661]	.809 [.773, .836]	.631 [.584, .672]	.727 [.702, .754]

*Basis model: obesitas, roken, en een familiegeschiedenis van HVZ. **Final model: obesitas, roken, en een familiegeschiedenis van HVZ, opleidingsniveau en arbeidsstatus.

Voorschriften en faalpercentages van verschillende antibiotica bij mannen met cystitis



Bij zowel vrouwen als mannen droegen opleidingsniveau en arbeidsstatus bij aan de predictie van een verhoogd HVZ-risico
Toegevoegde voorspelende waarde [AUC] lijkt groter bij vrouwen dan bij mannen en varieerde tussen etnische groepen



Huisarts en Wetenschap

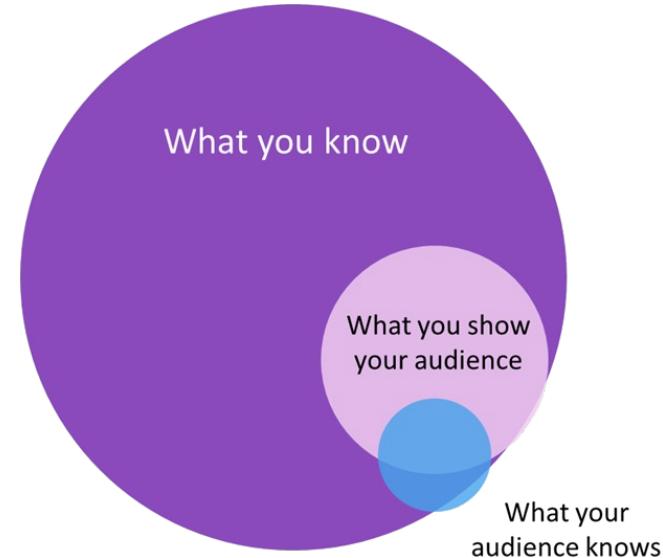
I'm excited to share with you what I wish I'd learned during my PhD!

Resist the urge to show everything!

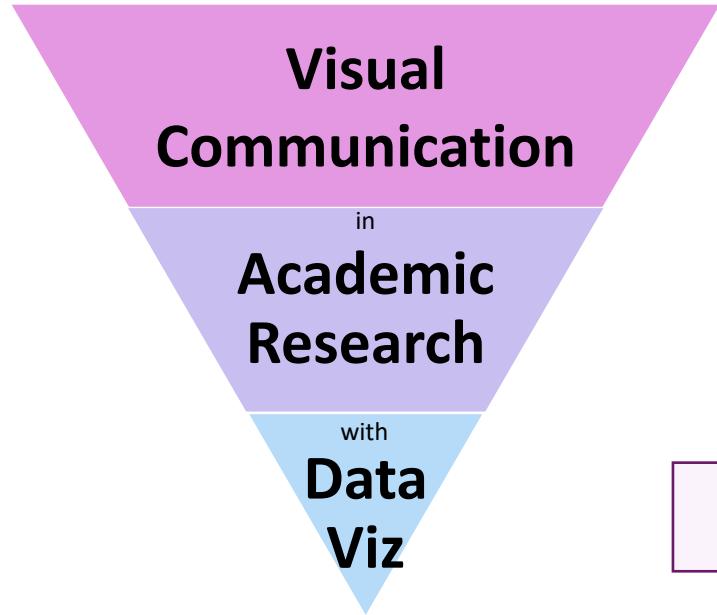


Don't underestimate how smart you are!

The curse of knowledge



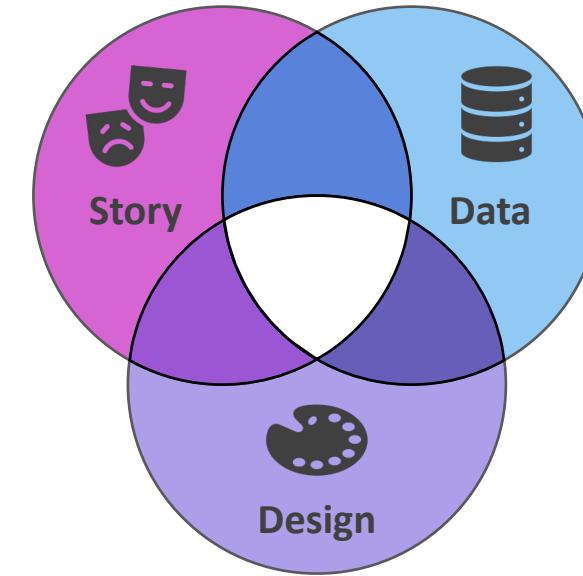
An overview for today:



WHY?

WHAT?

HOW?



Your turn!

A look at your work.

Nice to meet **YOU**!



Explain in 1 sentence:

- The **topic** of your PhD as explained to your **neighbor, friend, or family member**
- Your selected **visual**: (if applicable)
 - One thing you **like** or **dislike** about it

Warm-up!

And stand up

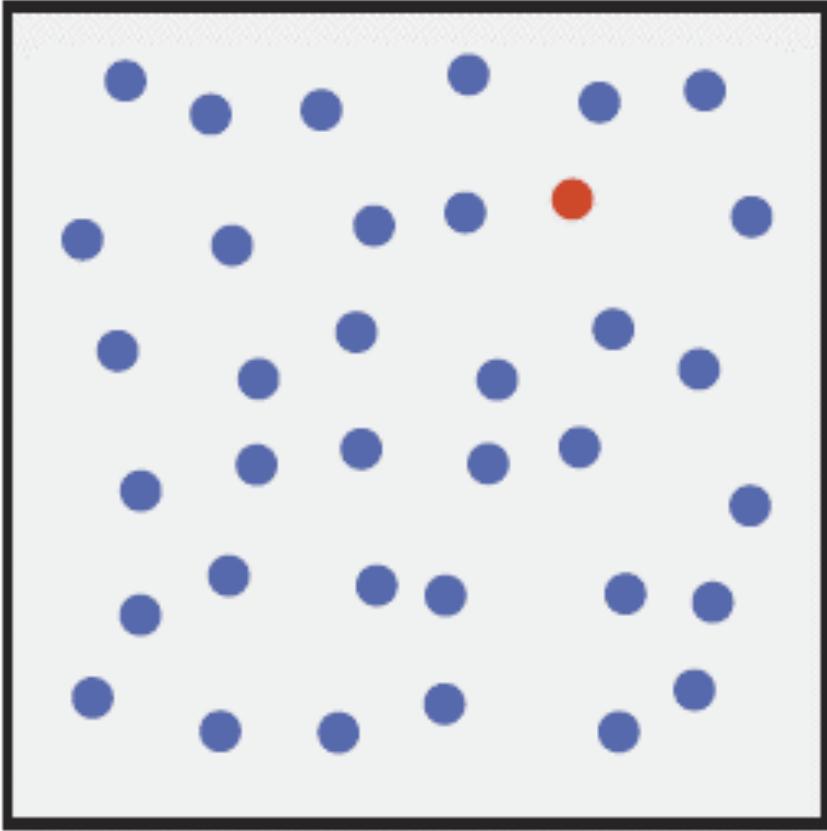
LEFT?

YES?

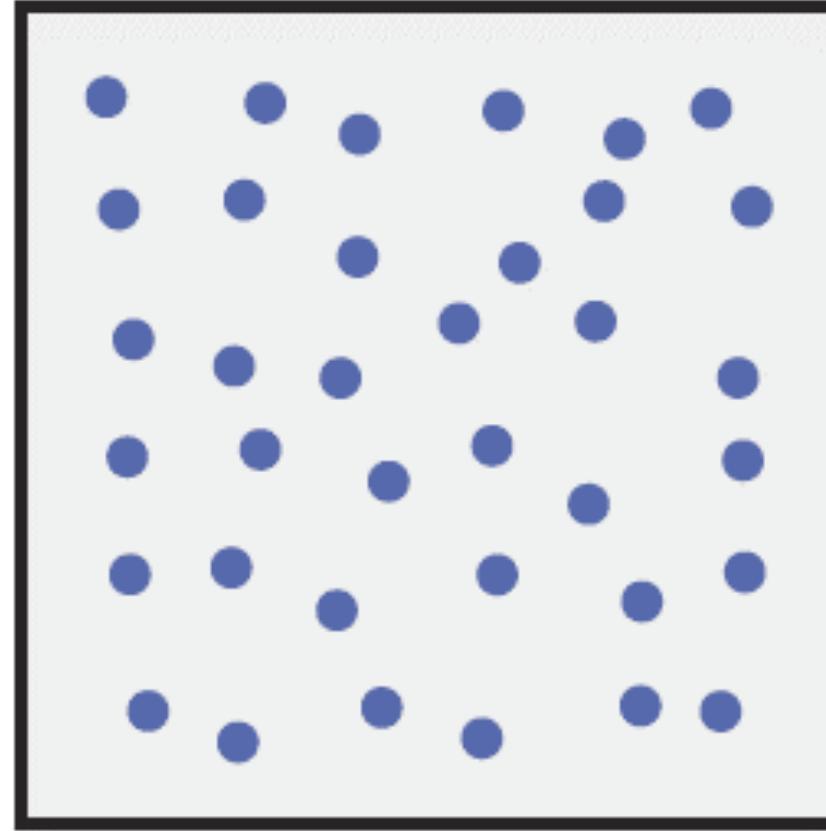


Which panel has a red dot?

A



B



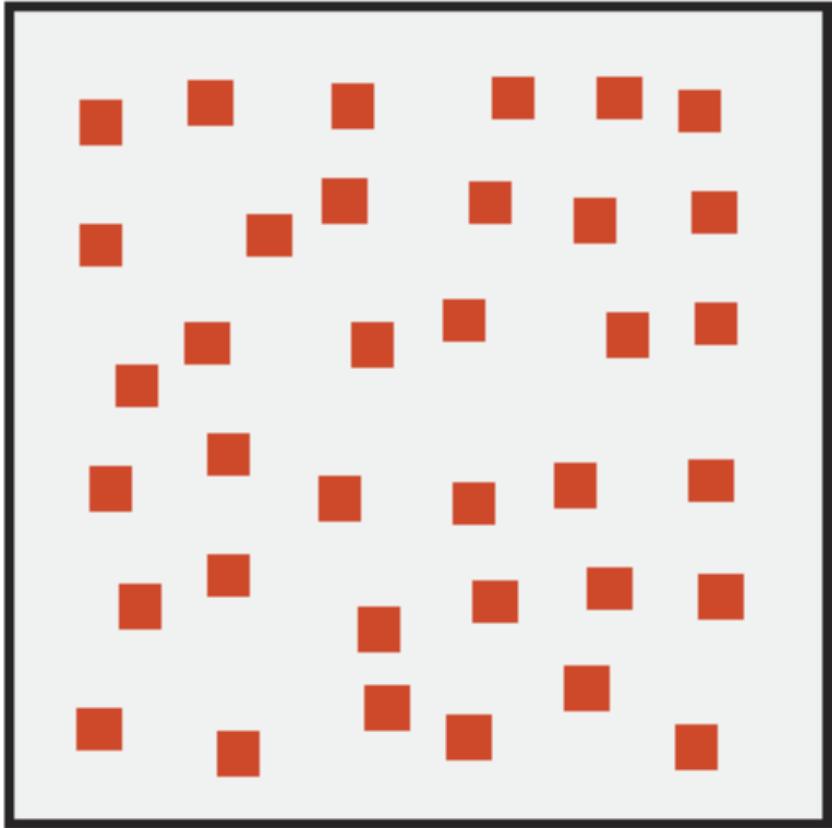
LEFT?

=

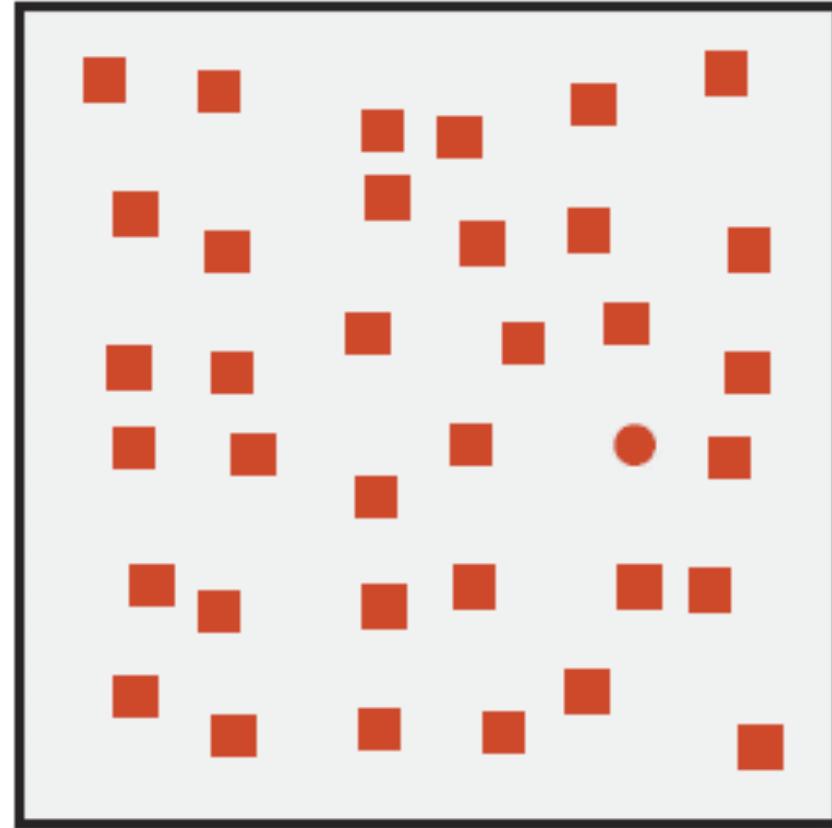
UP!

Which panel has a red dot?

A



B



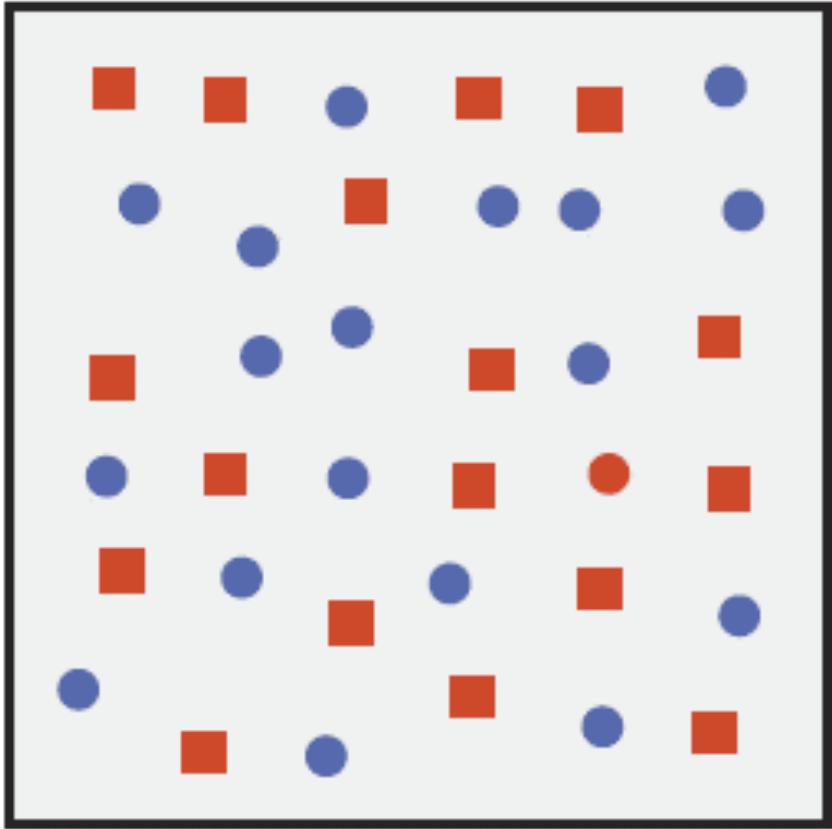
LEFT?

=

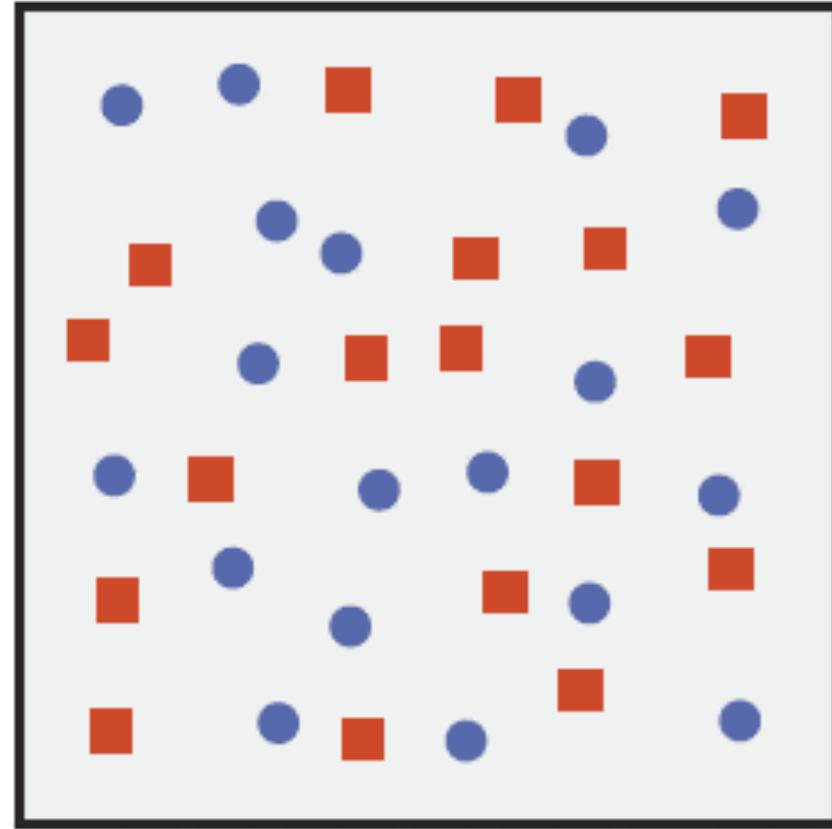
UP!

Which panel has a red dot?

A



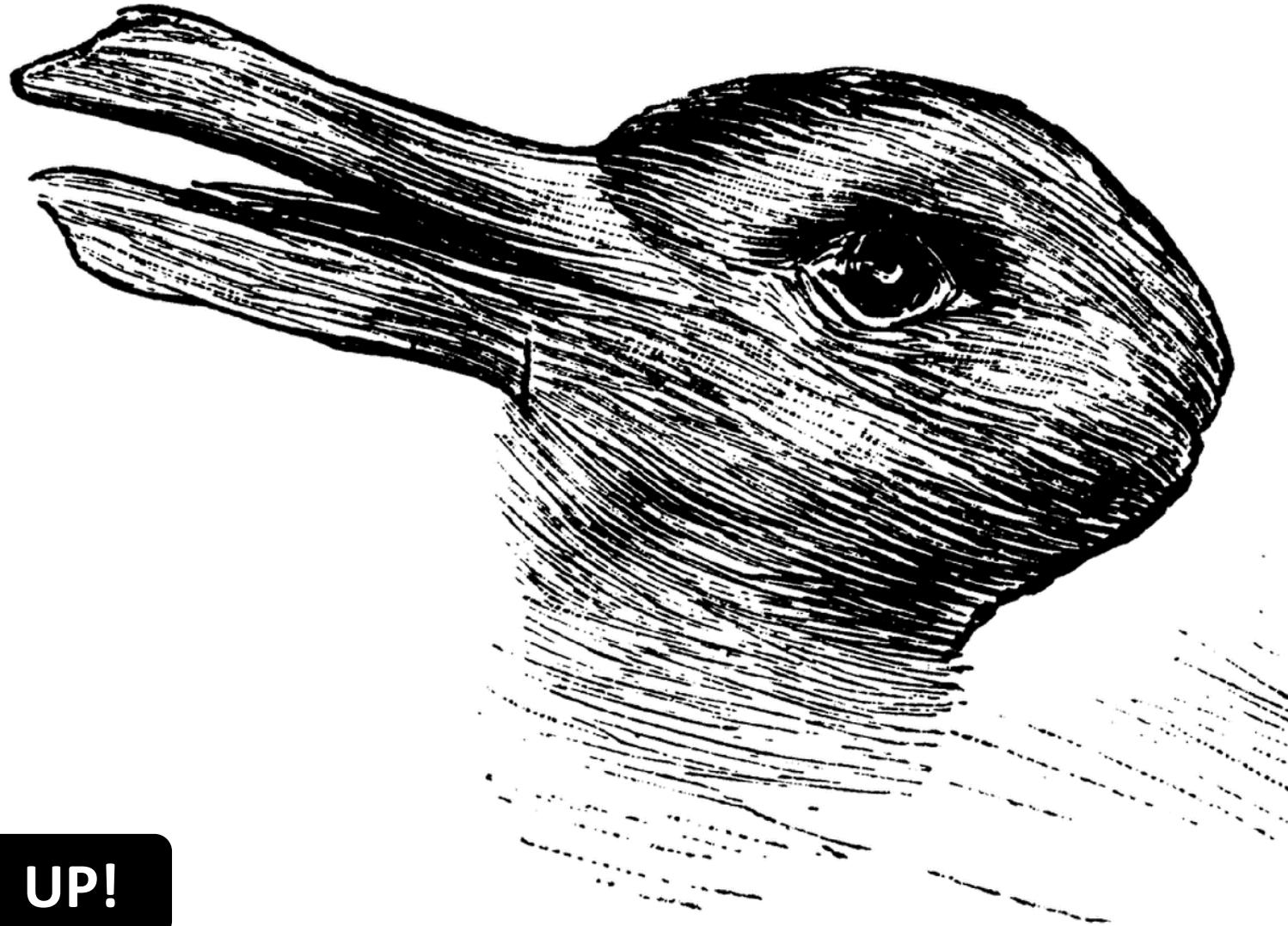
B



LEFT? =

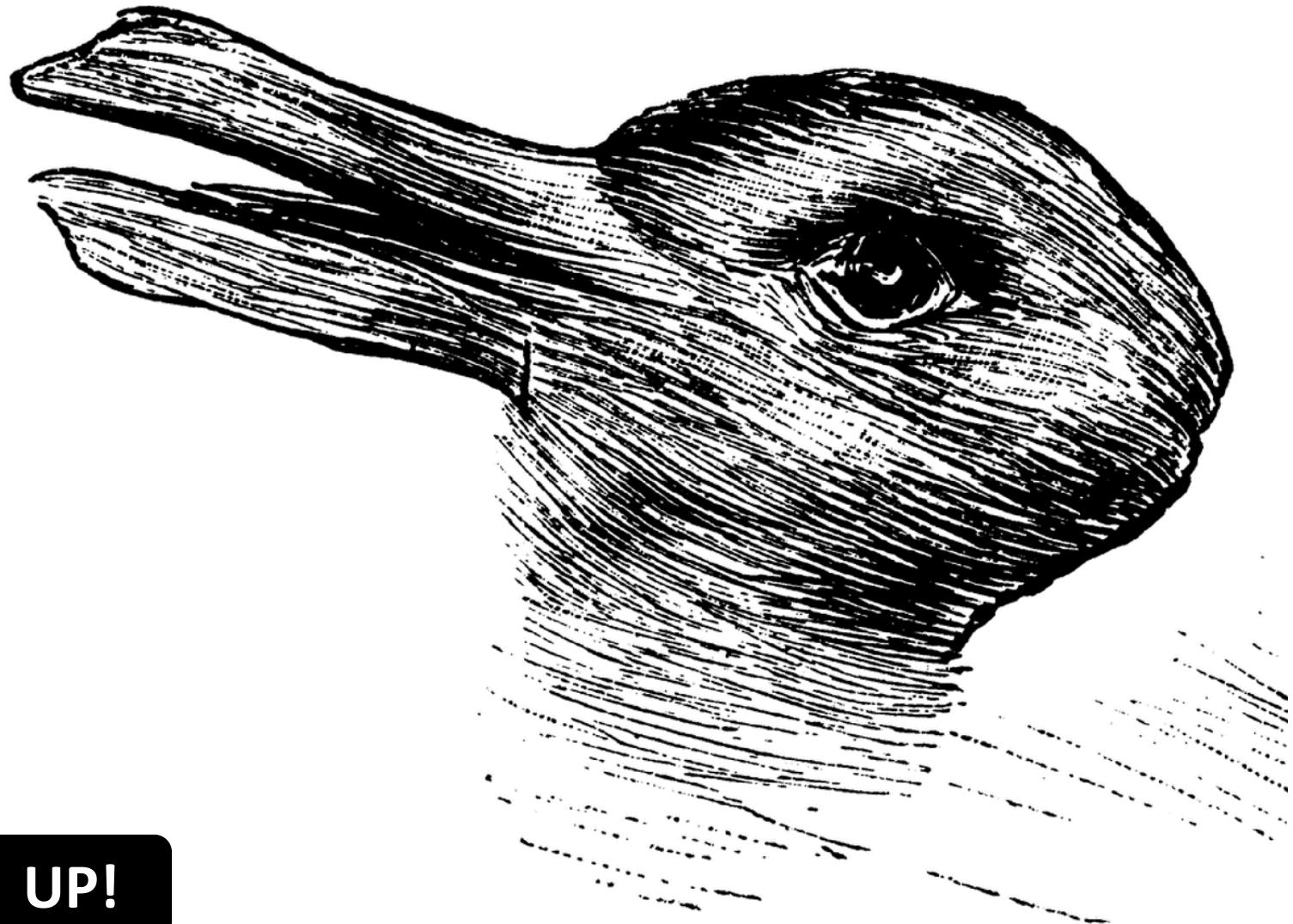
UP!

Do you see a Rabbit?



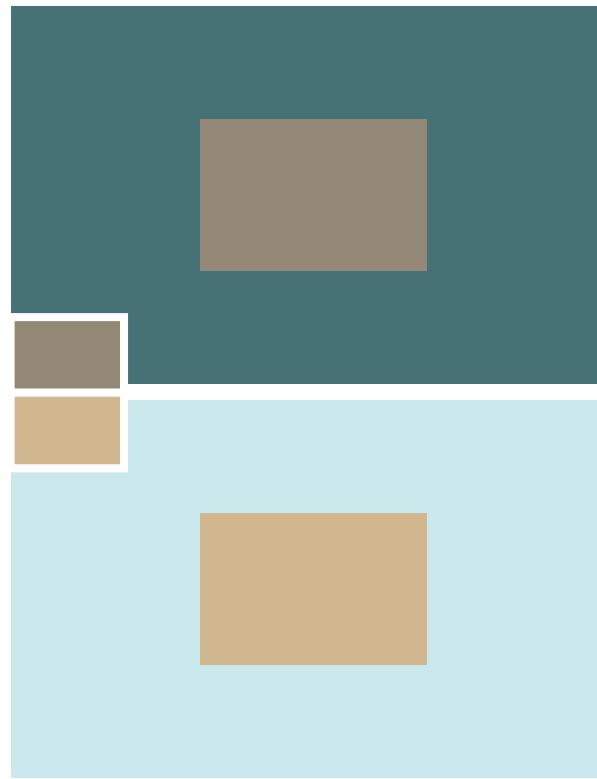
YES? = UP!

Do you see a Duck?



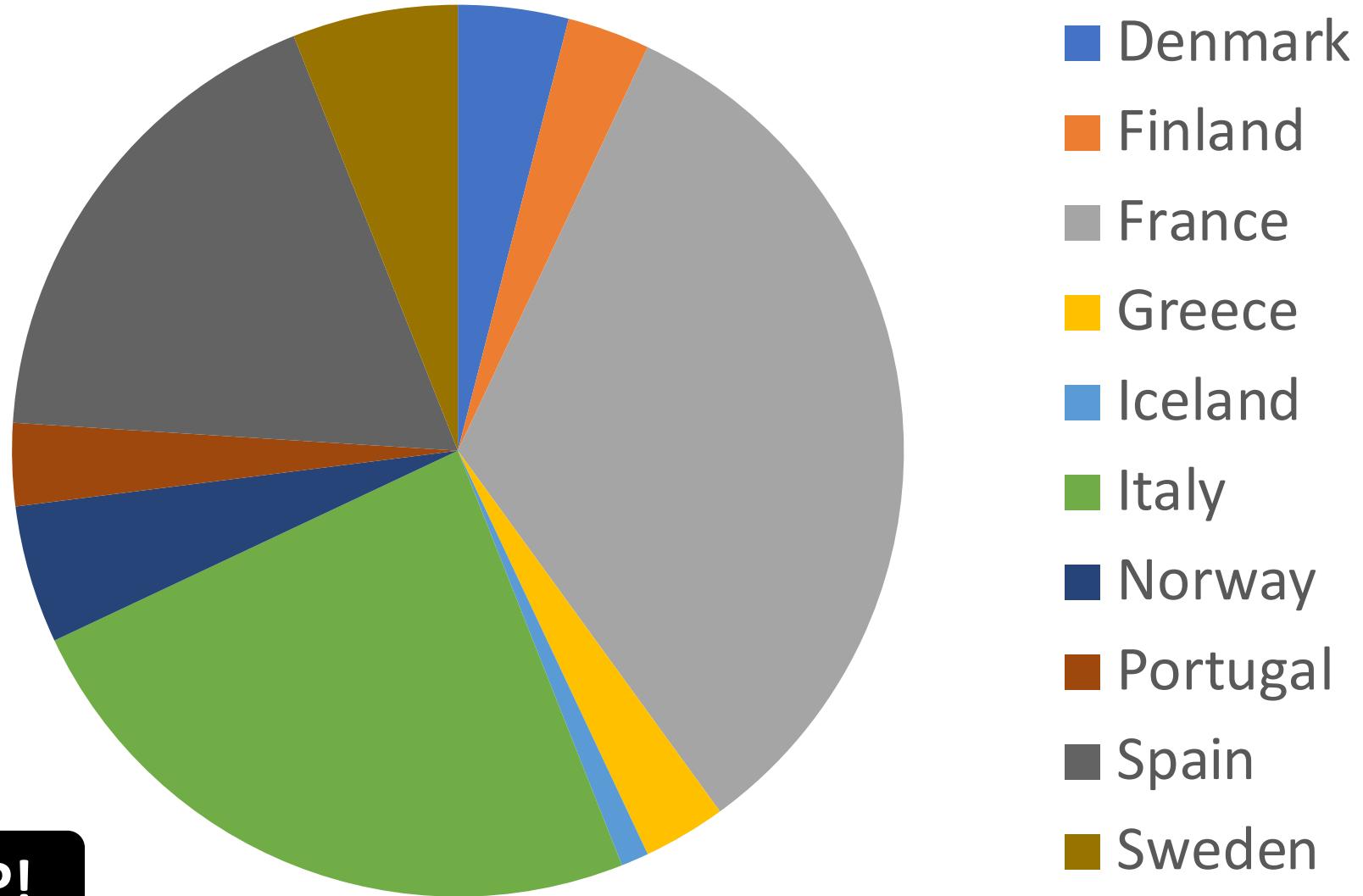
YES? = UP!

The inner squares have the same color



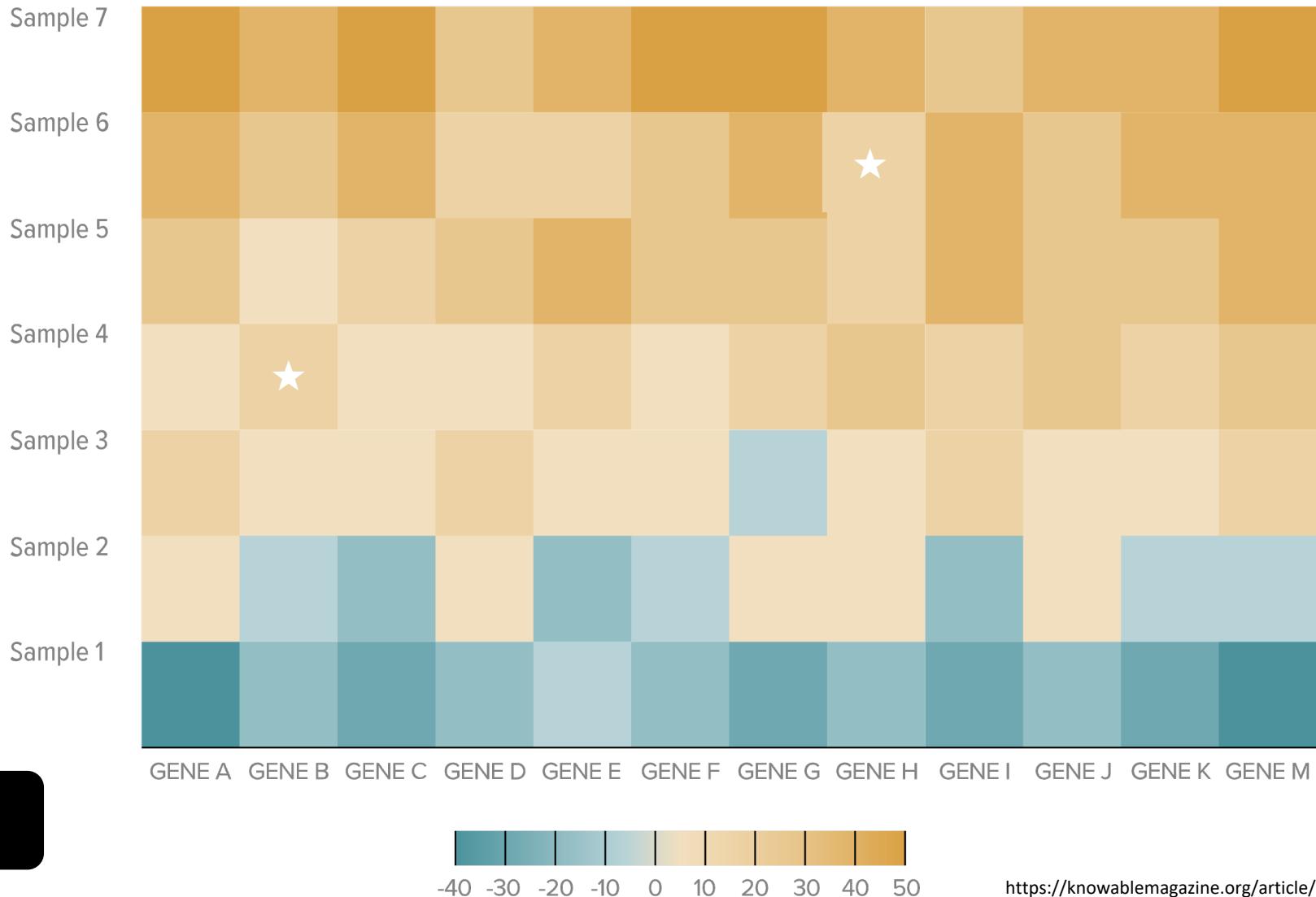
YES? = **UP!**

Norway has more widgets than Finland

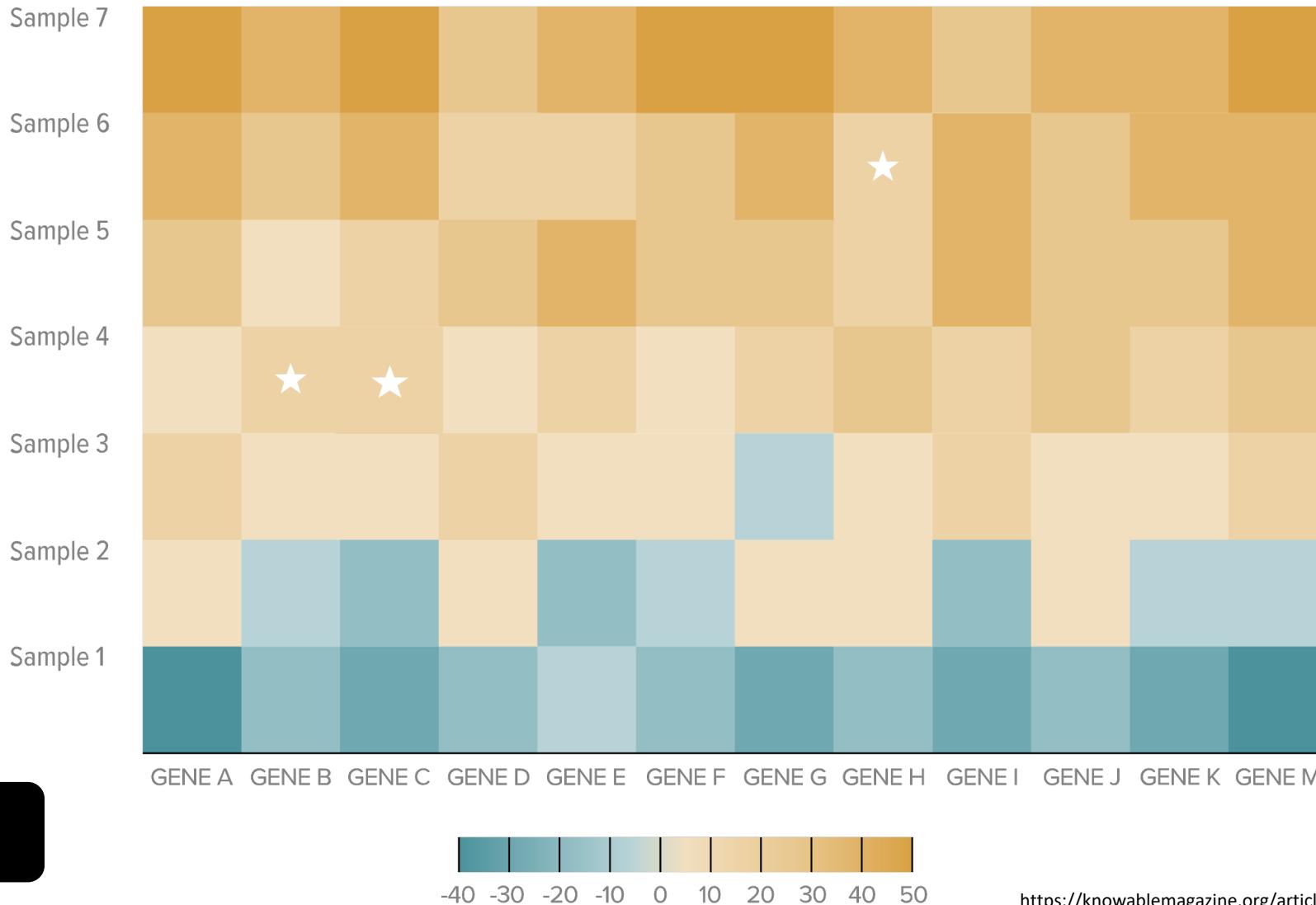


YES? = UP!

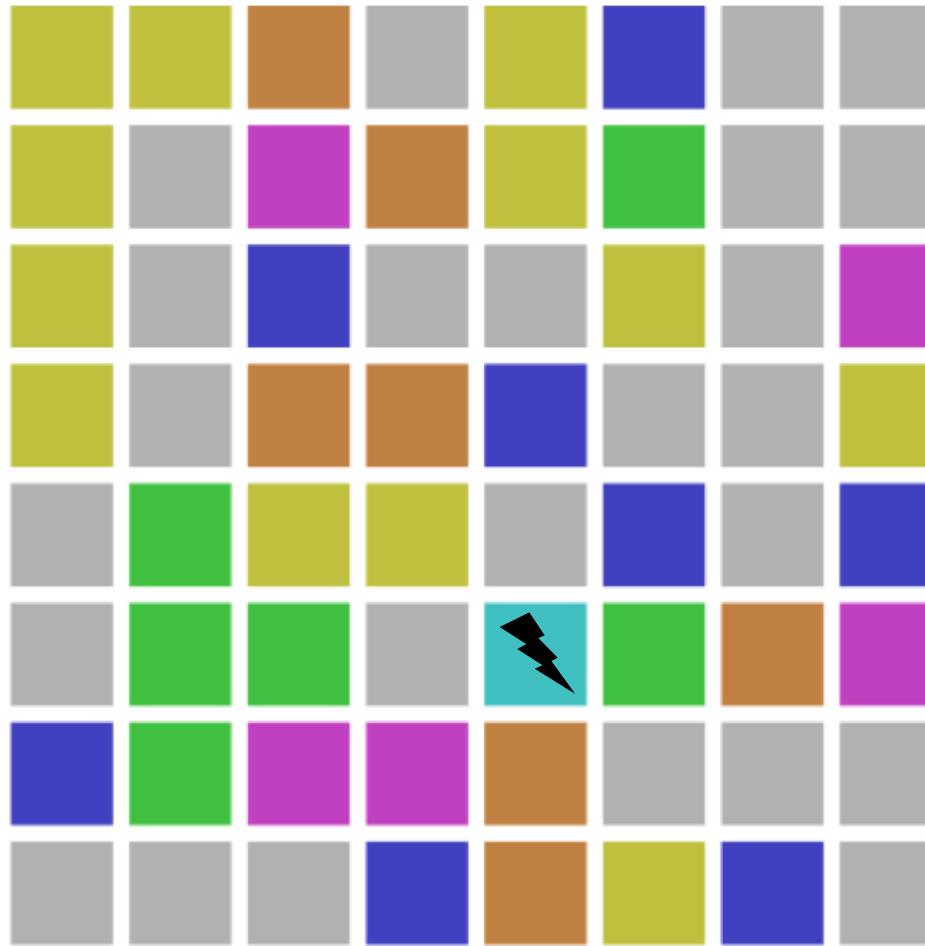
The areas with a star have the same color



The areas with a star have the same color

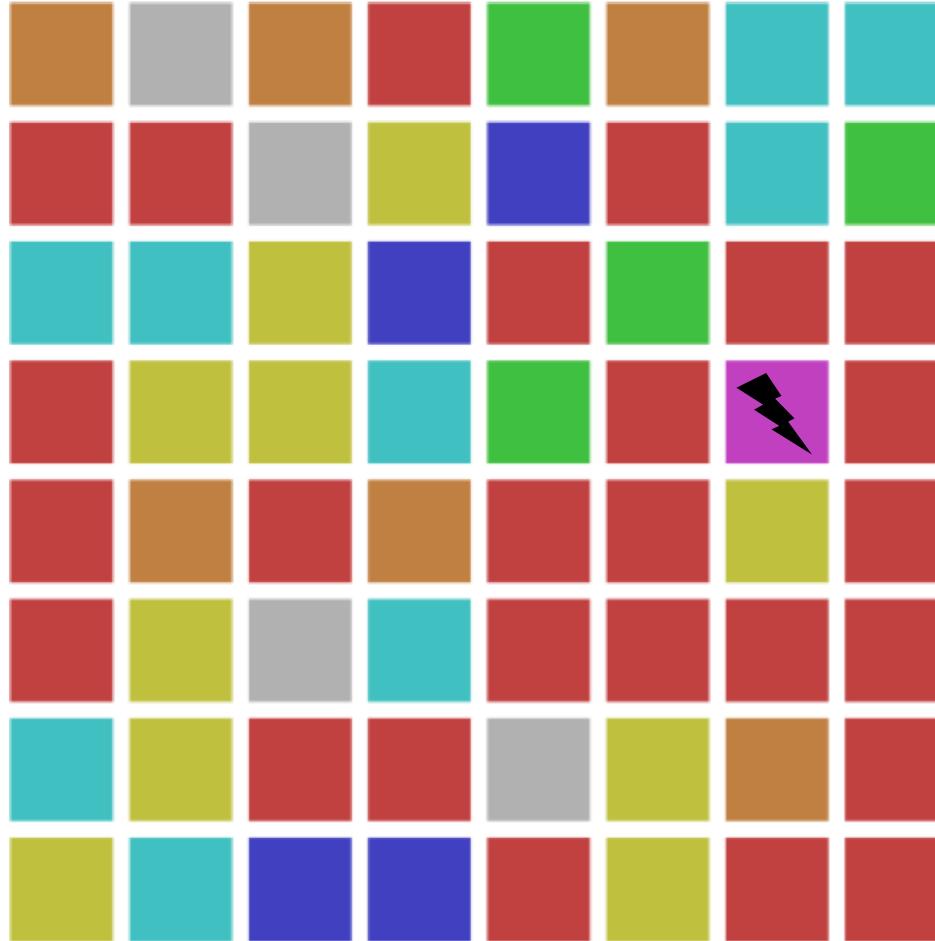


One square has a unique color



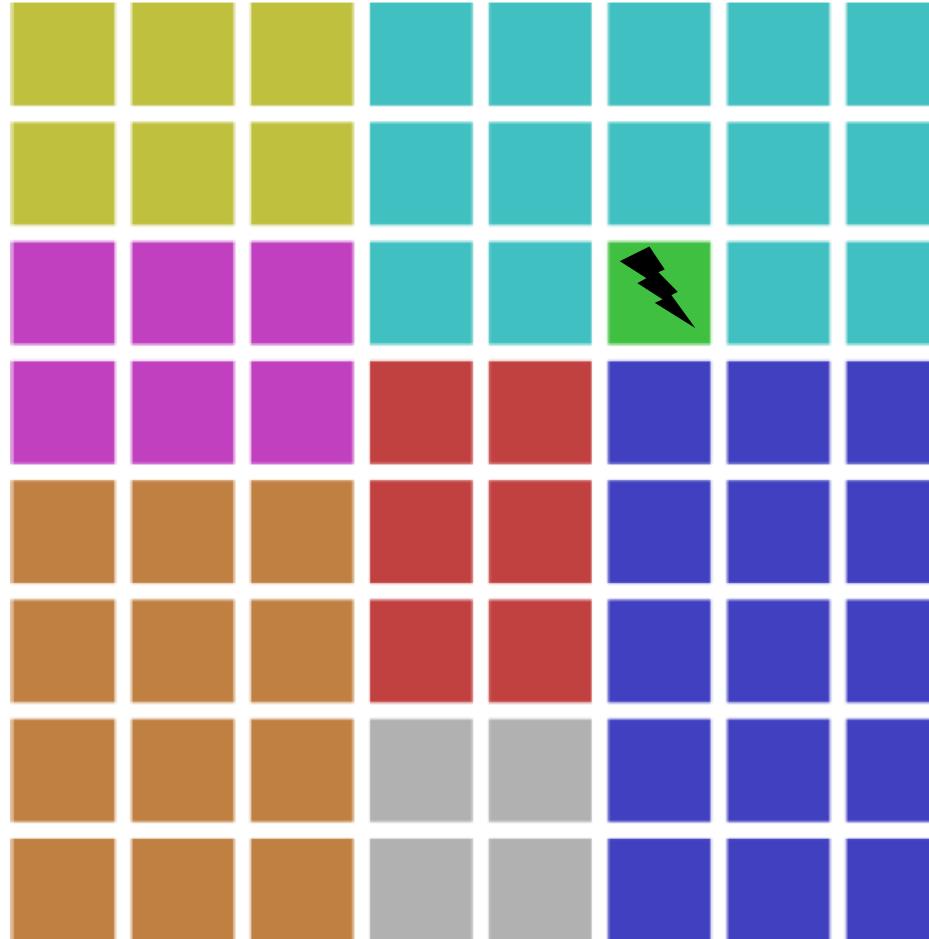
YES? = UP!

One square has a unique color



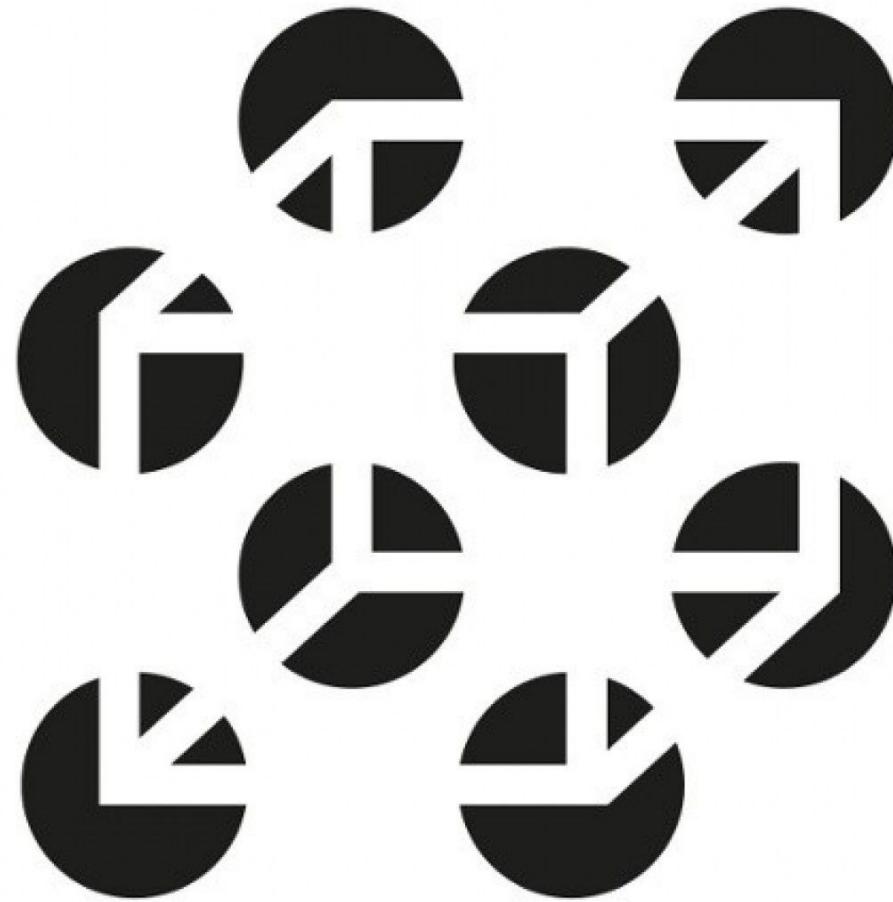
YES? = UP!

One square has a unique color



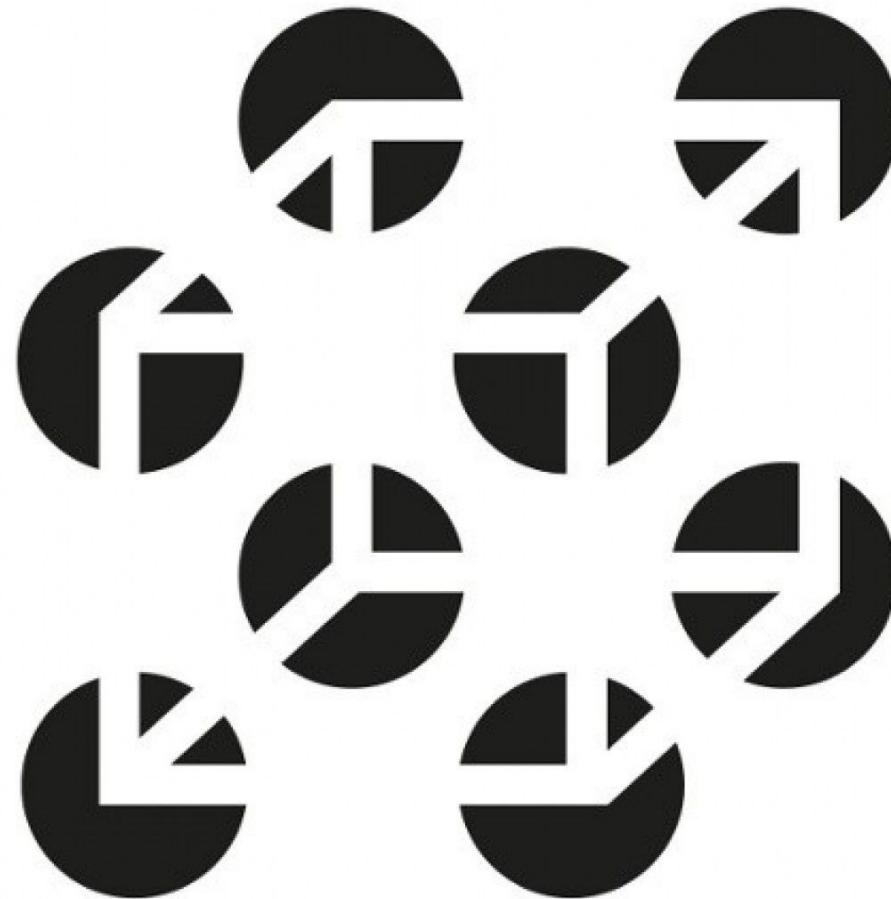
YES? = UP!

Do you *see* a cube?



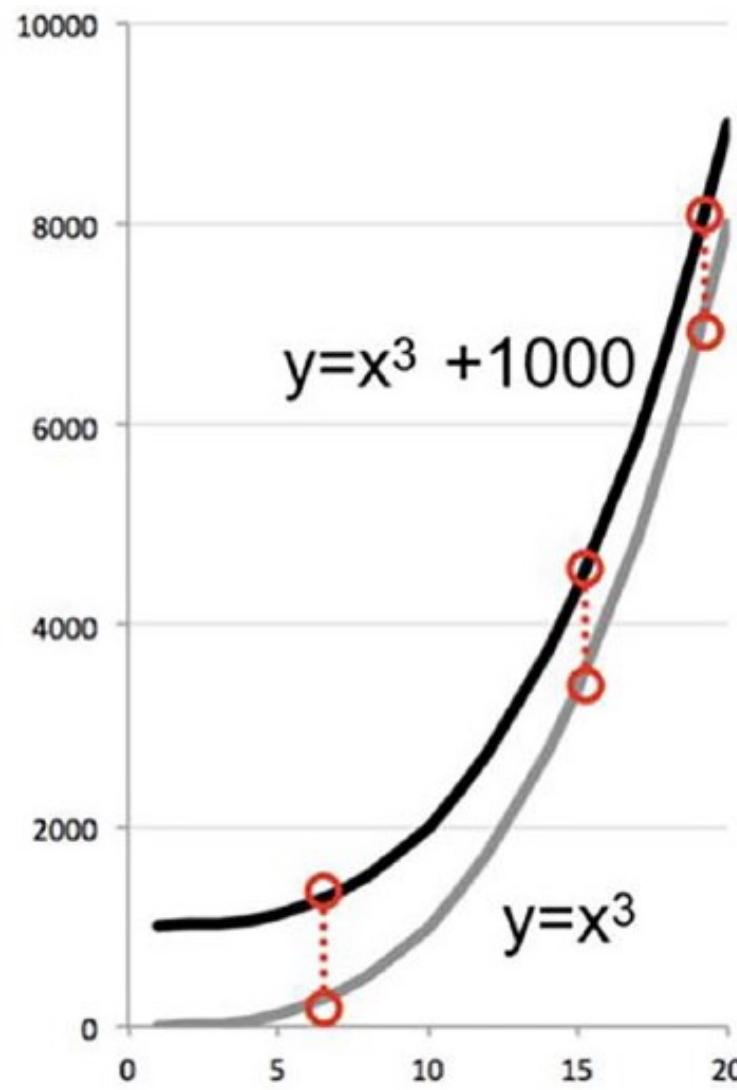
YES? = UP!

Is there a cube?



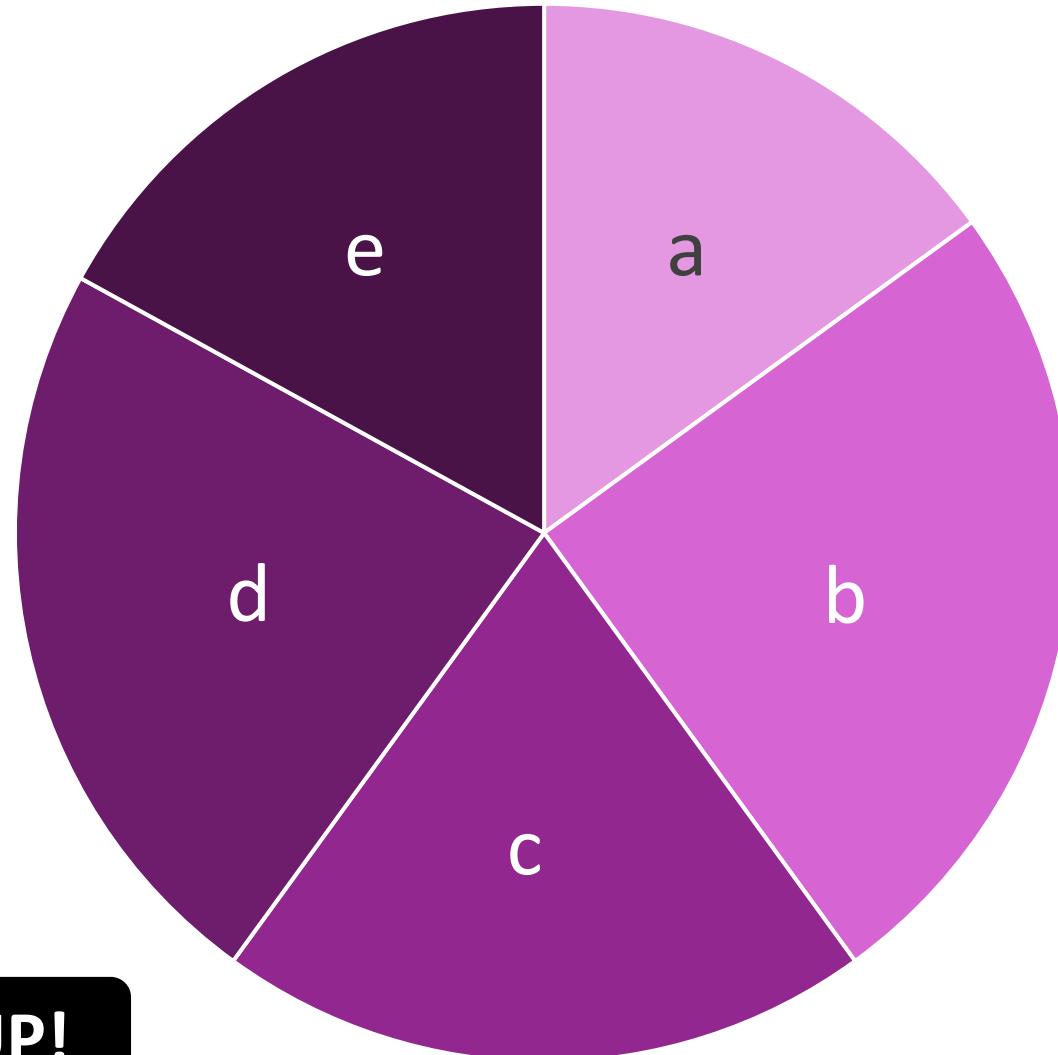
YES? = UP!

Where is the difference between the lines bigger? Left or right?



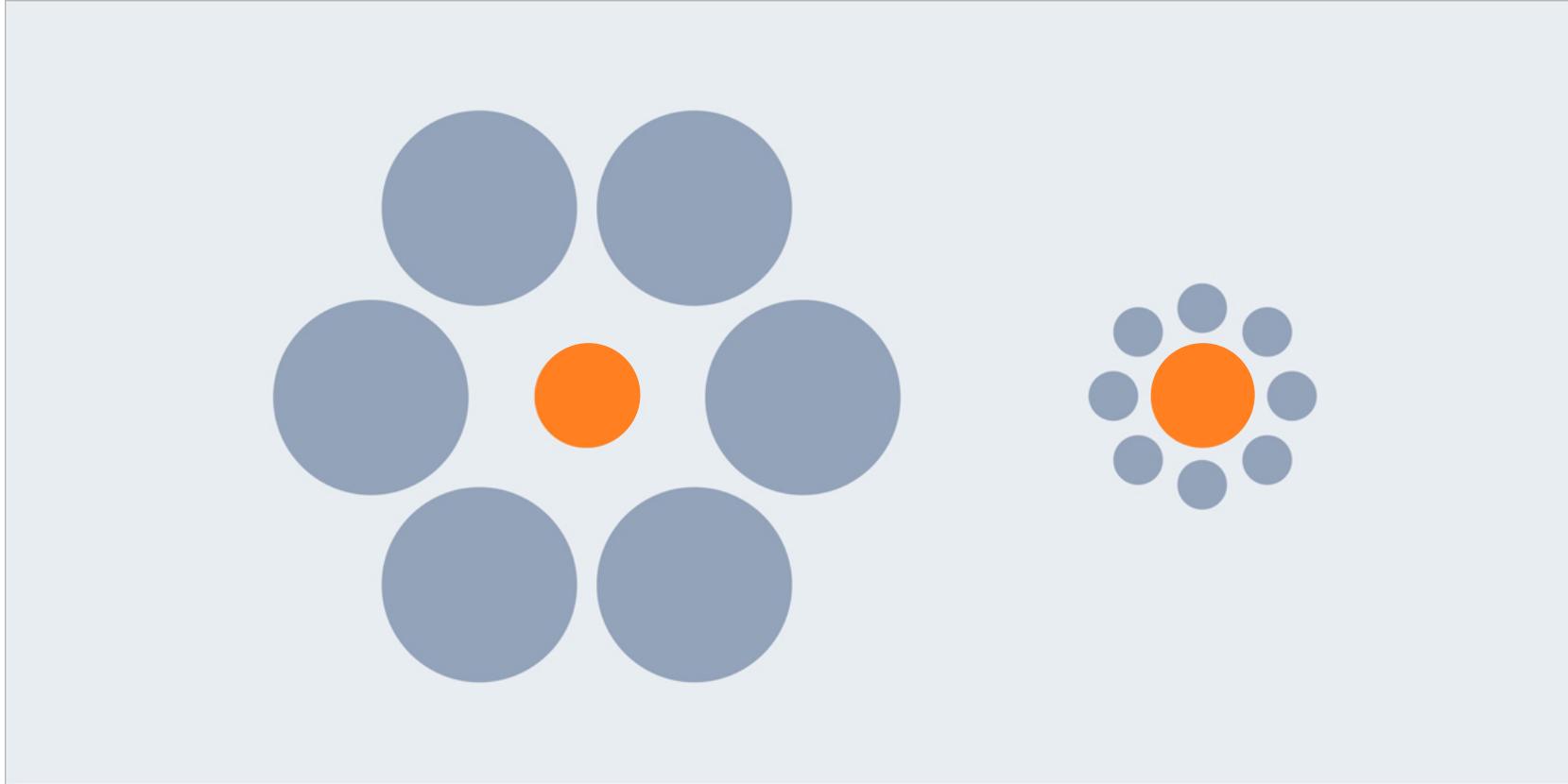
LEFT? = UP!

The order from high to low is b > d > c > e > a



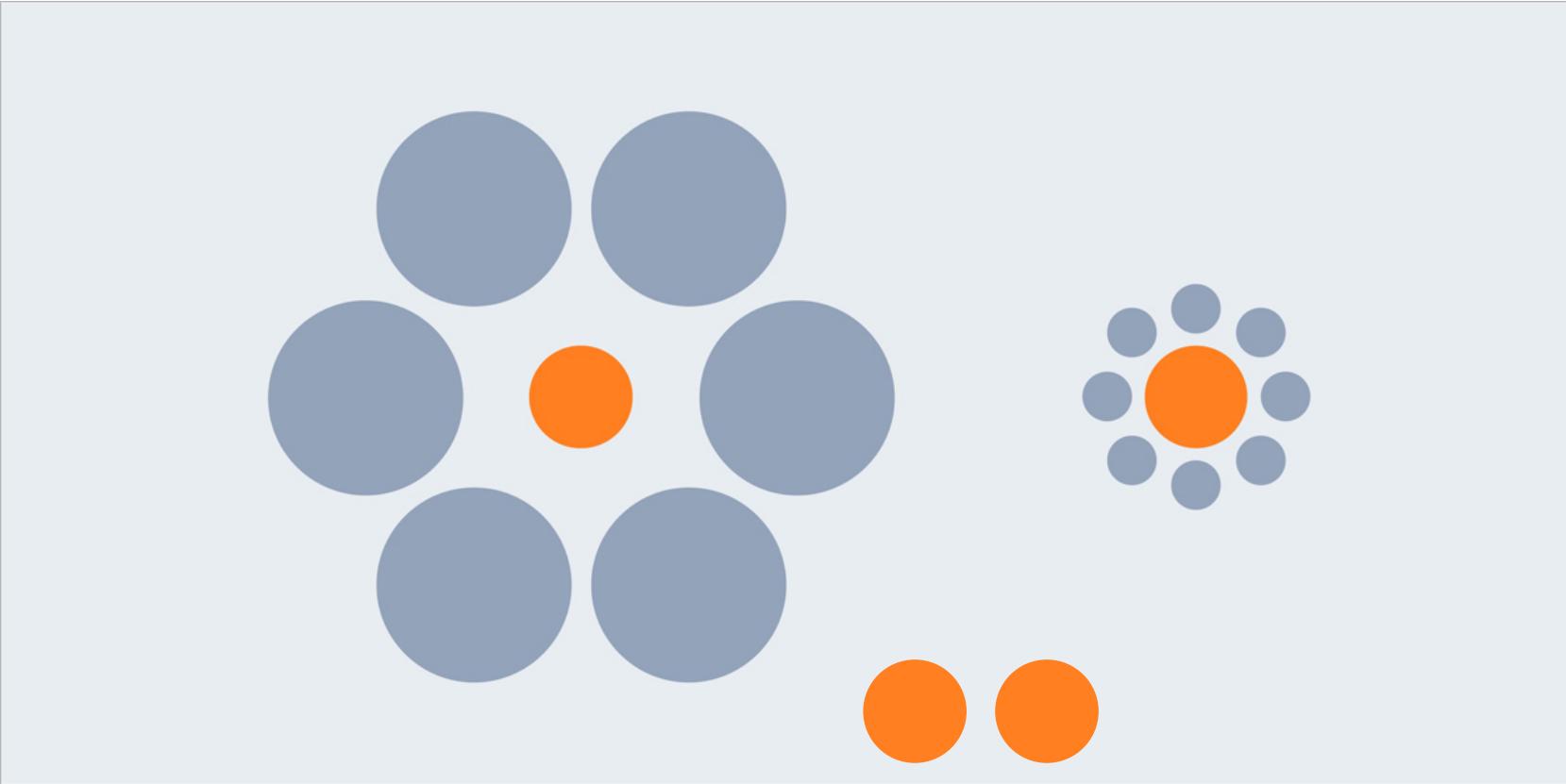
YES? = UP!

Which orange circle is smaller?



LEFT? = UP!

Which orange circle is smaller?



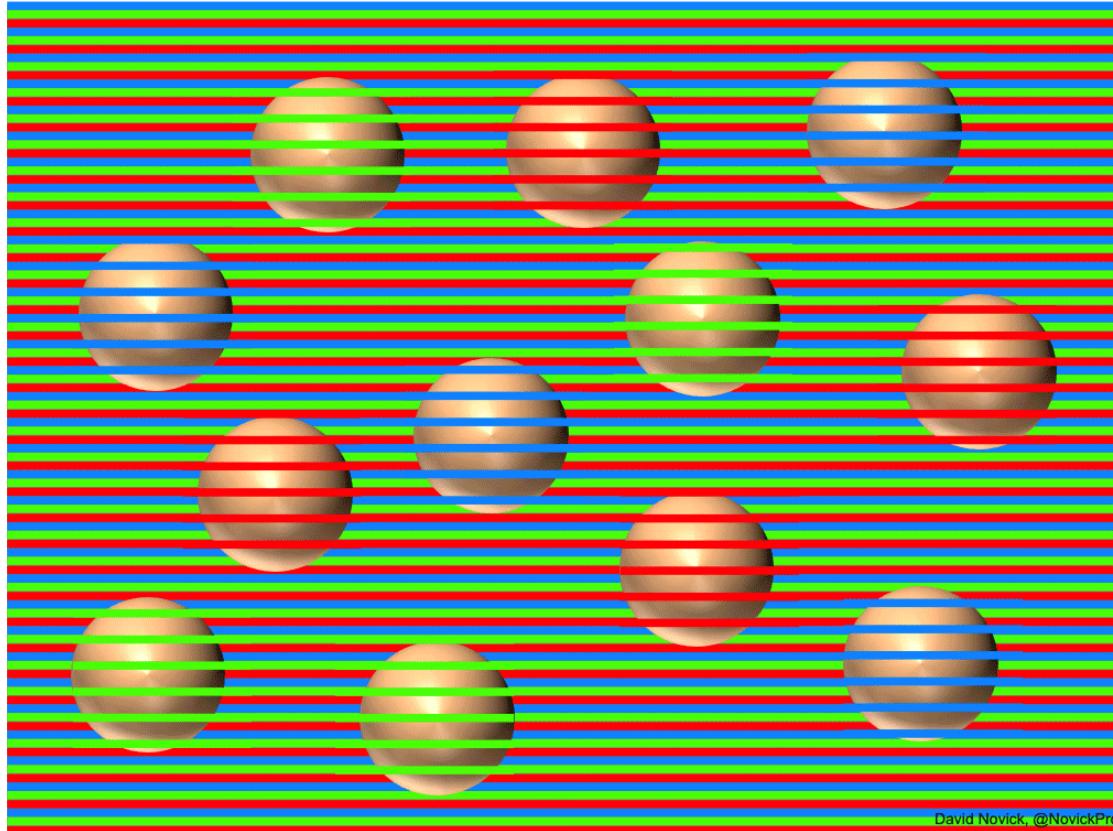
LEFT? = UP!

These spheres have the same color



YES? = UP!

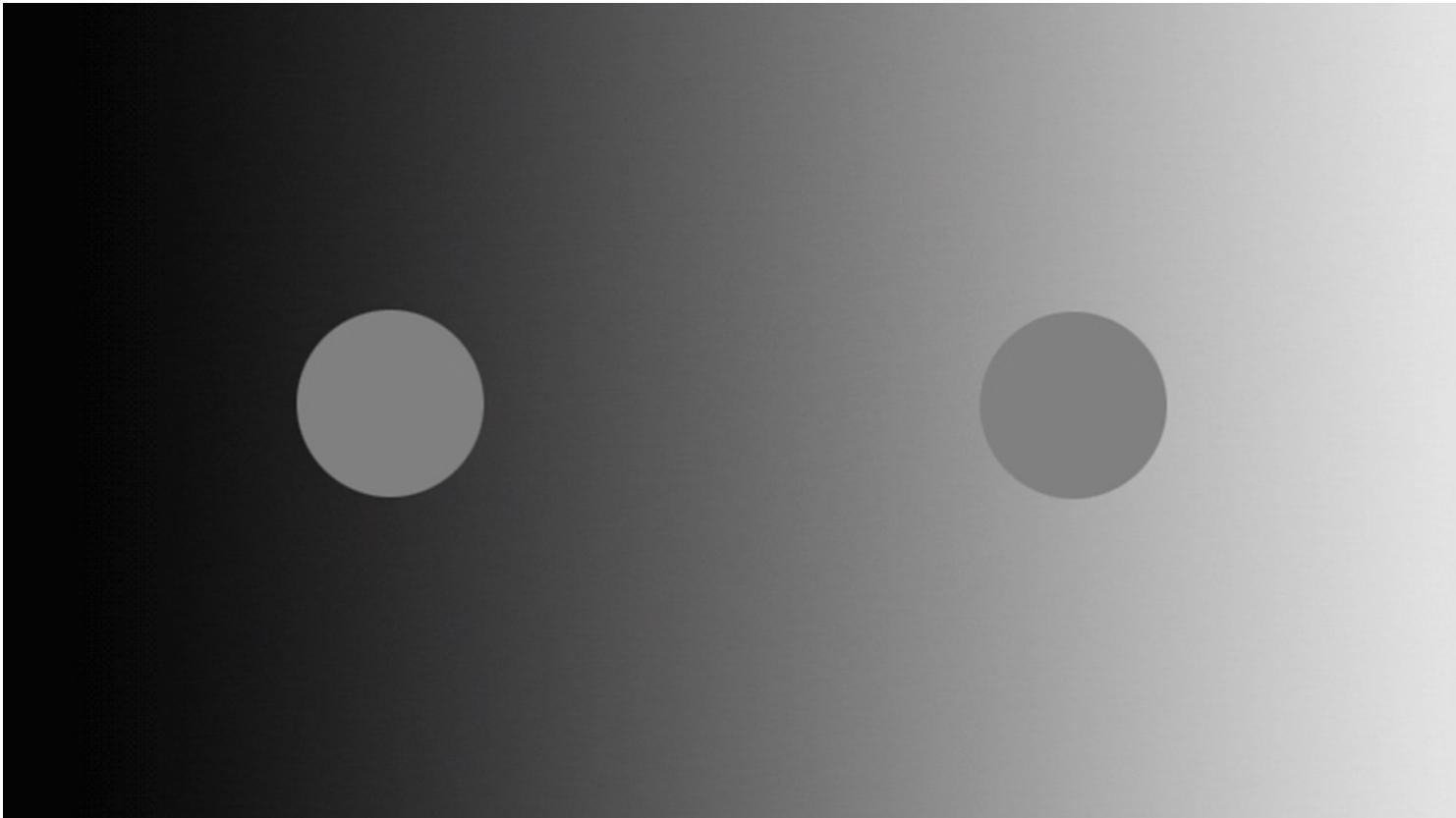
These spheres have the same color



David Novick, @NovickProf

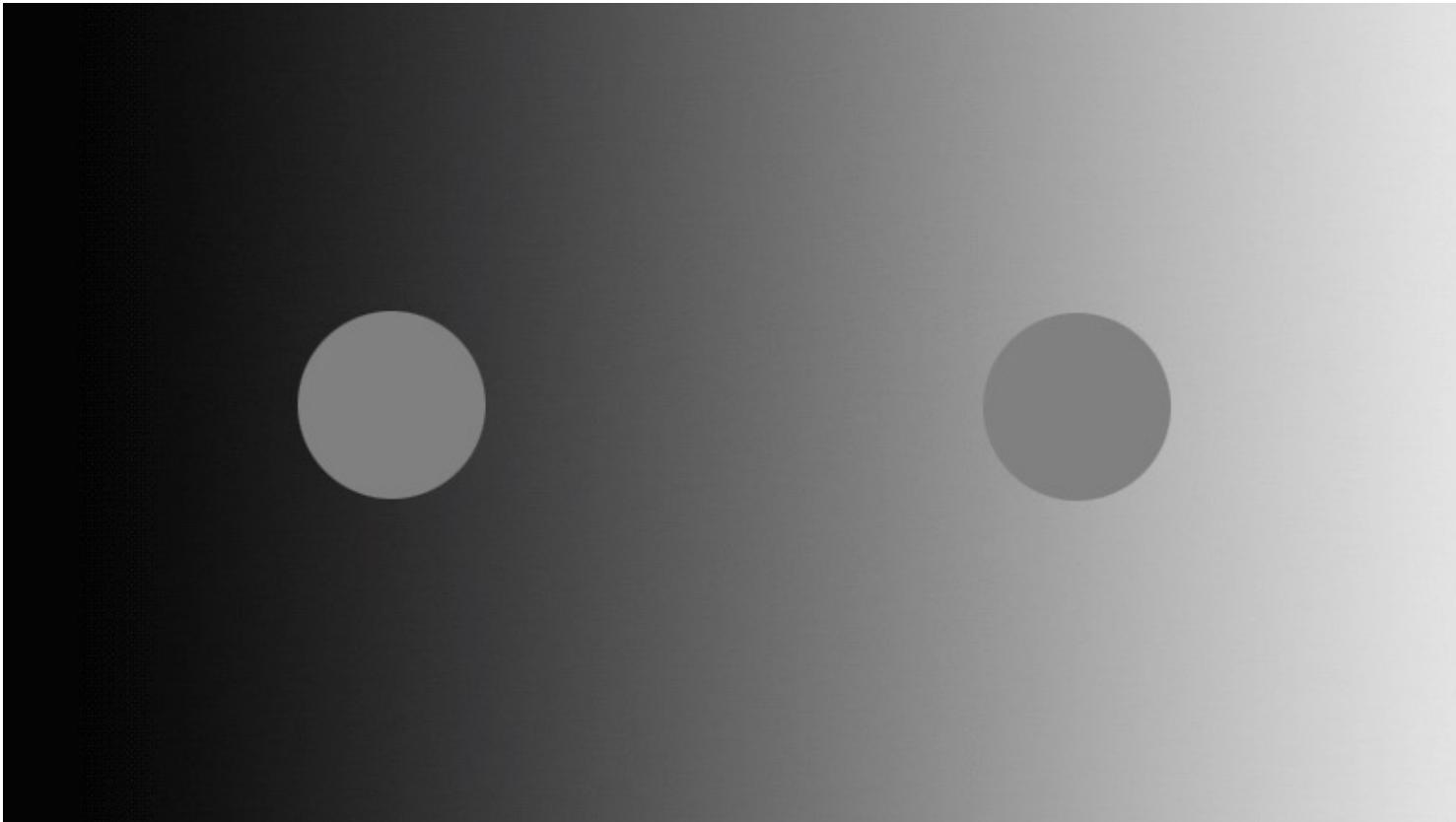
YES? = UP!

Which dot is darker?

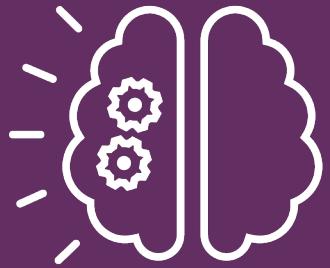


LEFT? = UP!

Are you sure...?



LEFT? = UP!

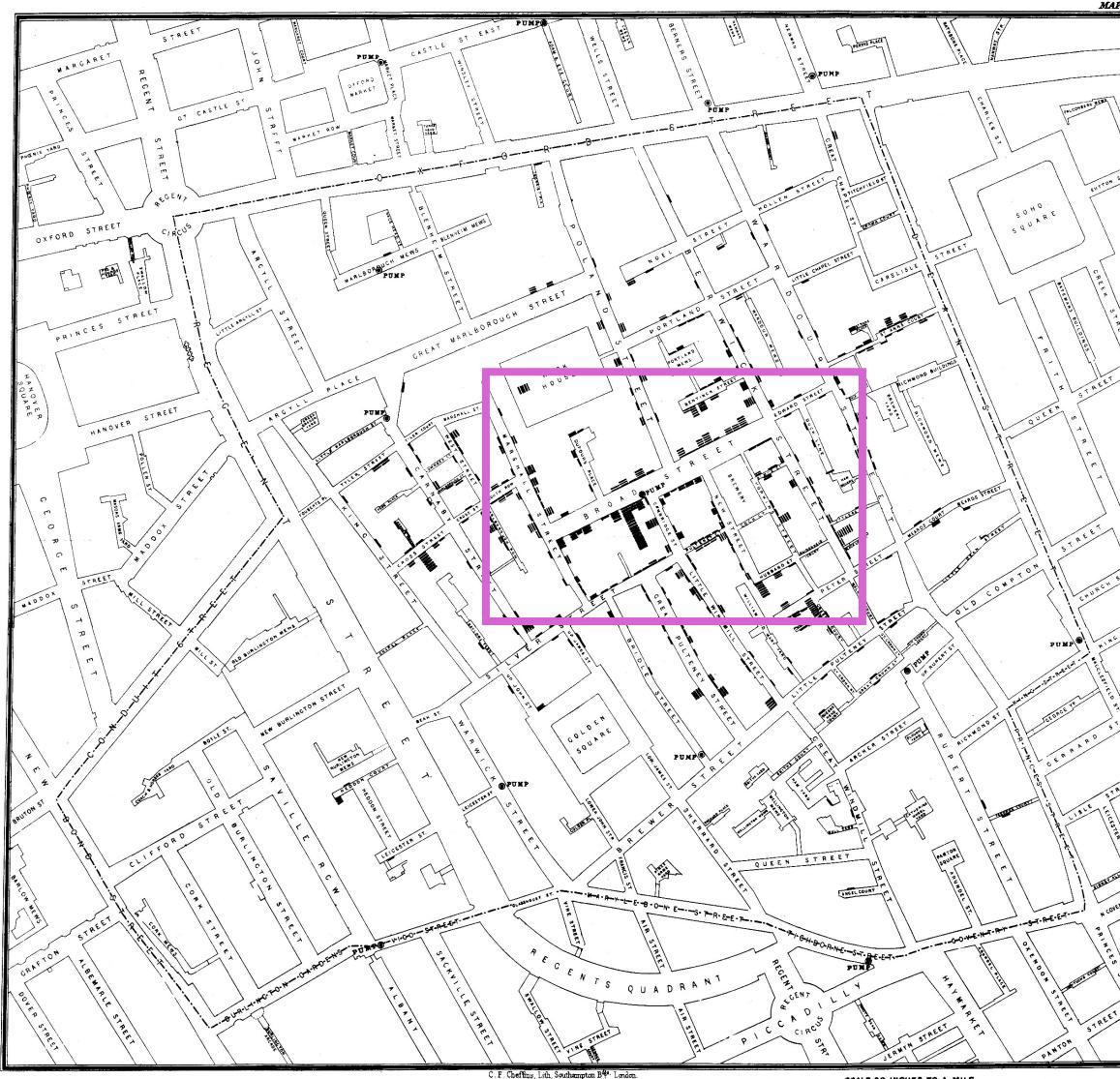


*“It’s not what you look at that
matters, it’s what you see”*

Henry David Thoreau

Why visual communication?

1854: The cholera map from John Snow



1854: The cholera map from John Snow



What can you see in these numbers?

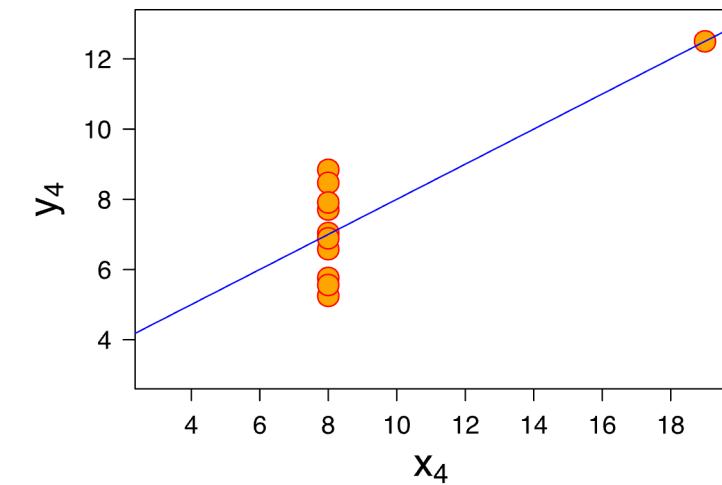
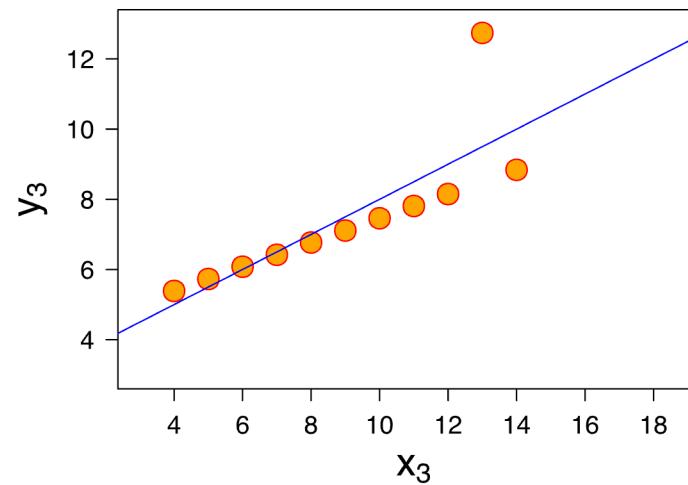
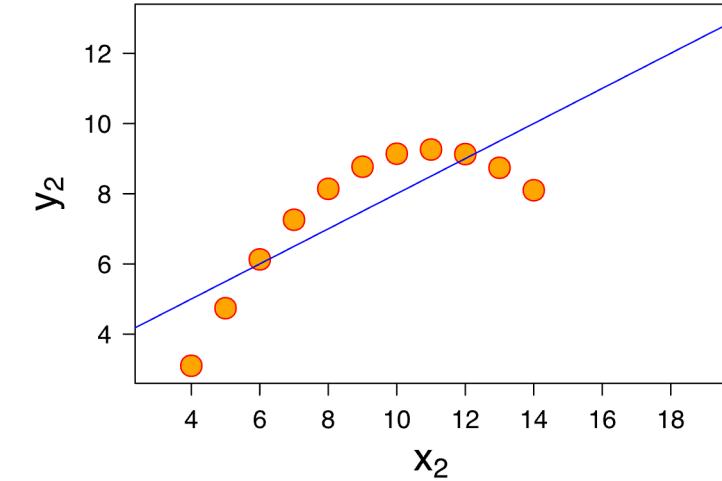
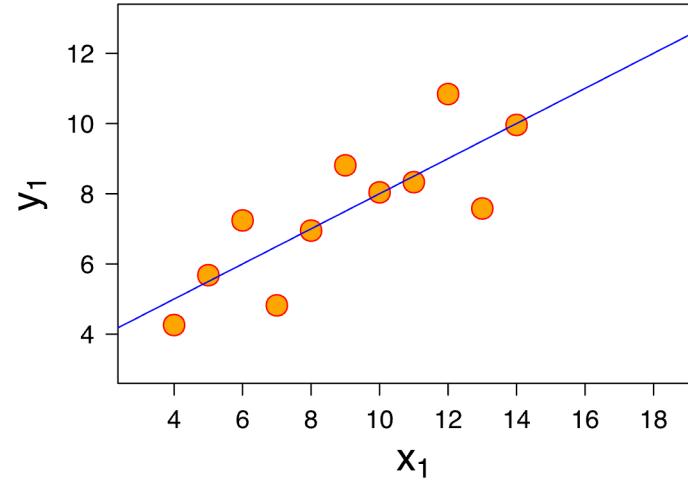
Anscombe's quartet:
4 datasets
11 x-values
11 y-values
Same total
Same mean
Same standard deviation

	I	II	III	IV				
	x	y	x	y	x	y	x	y
	10	8,04	10	9,14	10	7,46	8	6,58
	8	6,95	8	8,14	8	6,77	8	5,76
	13	7,58	13	8,74	13	12,74	8	7,71
	9	8,81	9	8,77	9	7,11	8	8,84
	11	8,33	11	9,26	11	7,81	8	8,47
	14	9,96	14	8,1	14	8,84	8	7,04
	6	7,24	6	6,13	6	6,08	8	5,25
	4	4,26	4	3,1	4	5,39	19	12,5
	12	10,84	12	9,13	12	8,15	8	5,56
	7	4,82	7	7,26	7	6,42	8	7,91
	5	5,68	5	4,74	5	5,73	8	6,89
SUM	99,00	82,51	99,00	82,51	99,00	82,50	99,00	82,51
AVG	9,00	7,50	9,00	7,50	9,00	7,50	9,00	7,50
STDEV	3,32	2,03	3,32	2,03	3,32	2,03	3,32	2,03

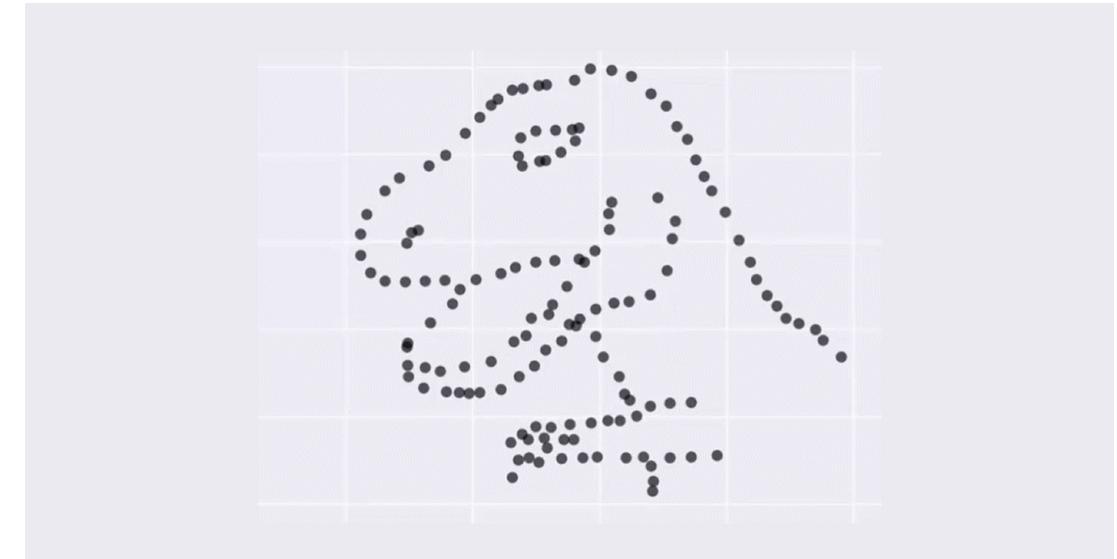
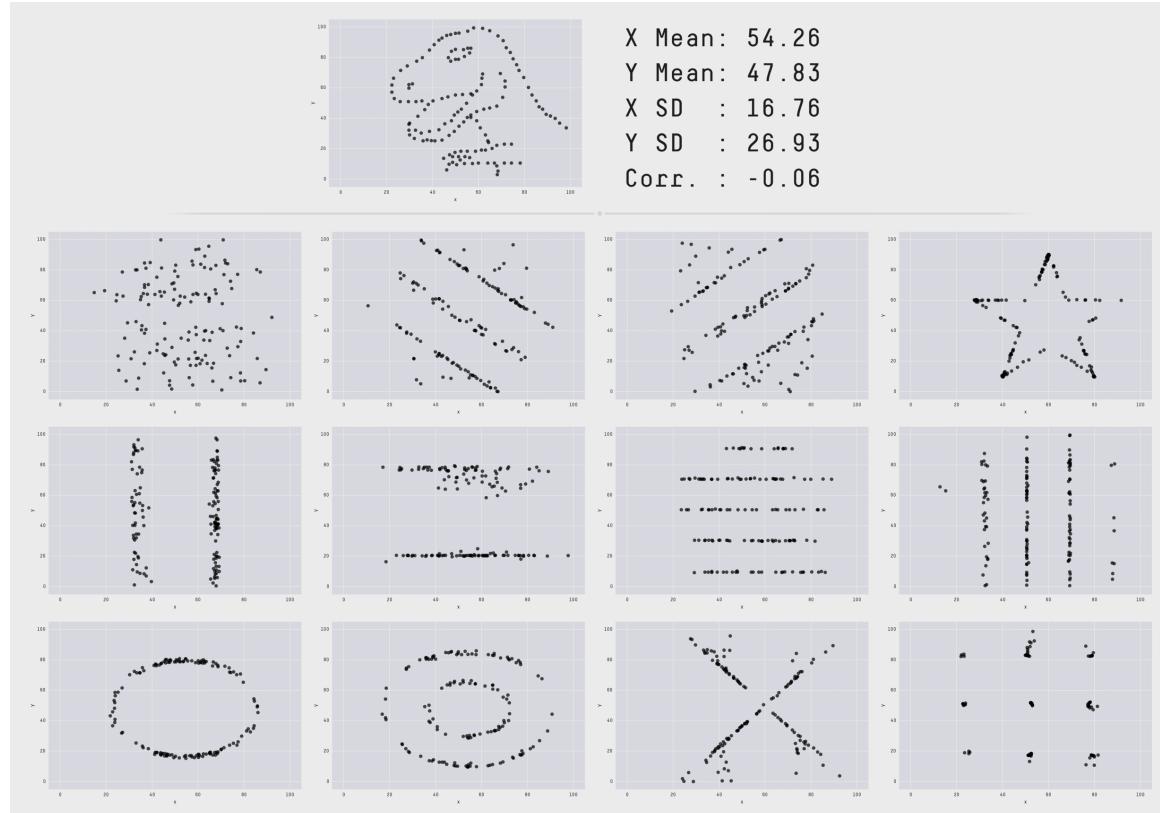
A picture is worth a thousand words!

Anscombe's quartet:

4 datasets
11 x-values
11 y-values
Same total
Same mean
Same standard deviation

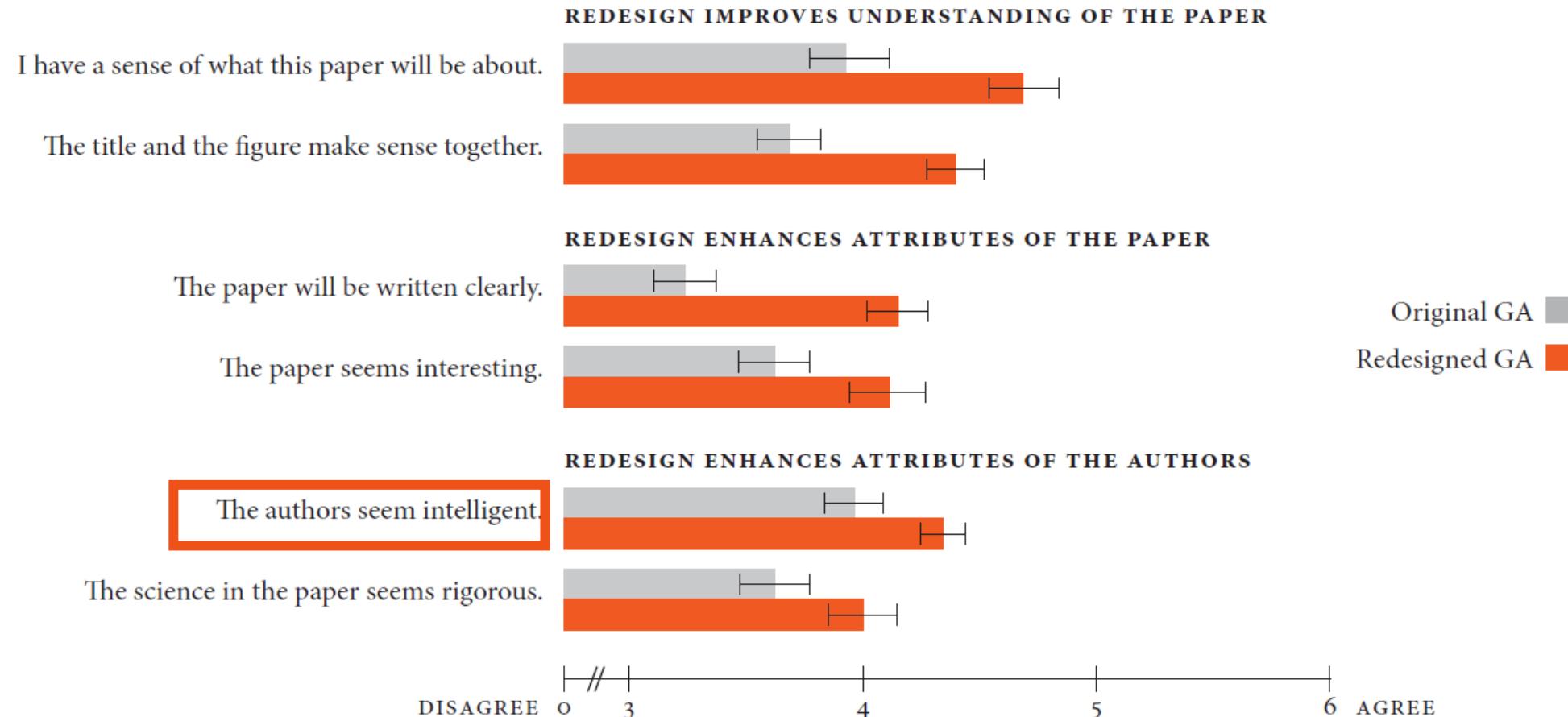


The Datasaurus Dozen 😊: Never trust summary statistics alone!



Matejka J & Fitzmaurice G (2017). *Same Stats, Different Graphs: Generating Datasets with Varied Appearance and Identical Statistics through Simulated Annealing*.
<https://www.autodeskresearch.com/publications/samestats>.

A good visual makes you (look) smarter!

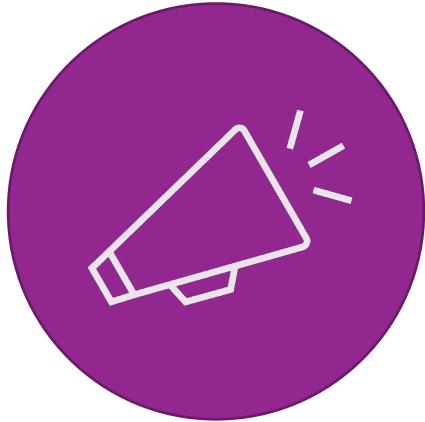


Why use visuals in academic research?



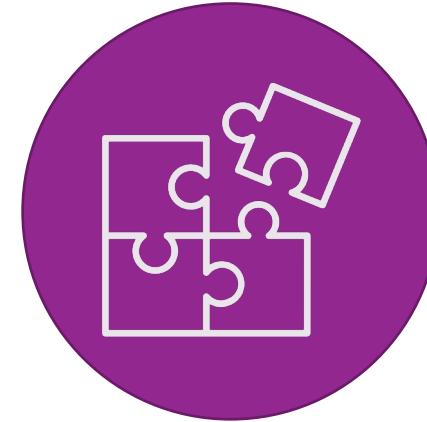
Provide **insight**

-
- Publications
 - Oral presentations
 - Poster presentations



Grab **attention**

-
- Graphical abstracts
 - Social media
 - General media



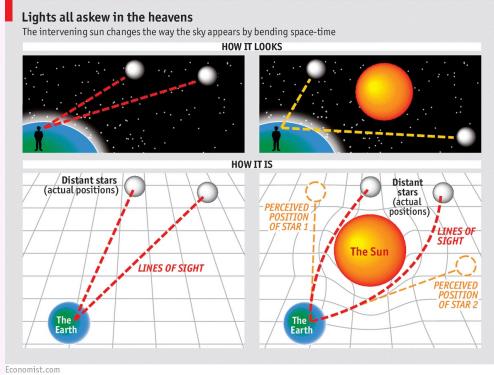
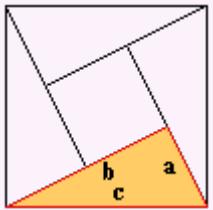
Show **competence**

-
- Grant applications
 - Portfolio / CV
 - Pitch

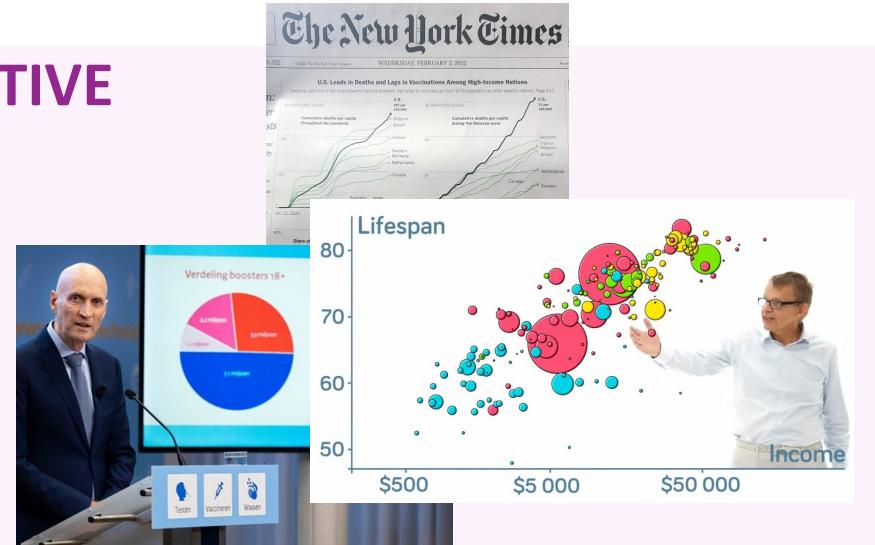
What is visual communication ?

Four types of visualizations

Idea illustration

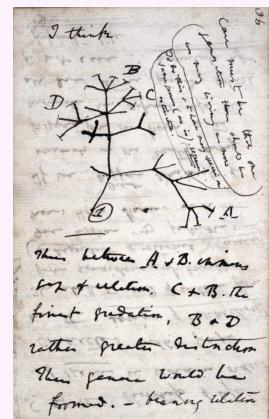
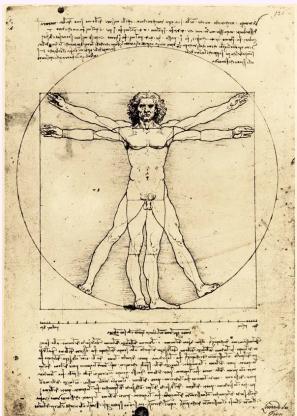


DECLARATIVE



'Everyday'
DataViz

Idea generation



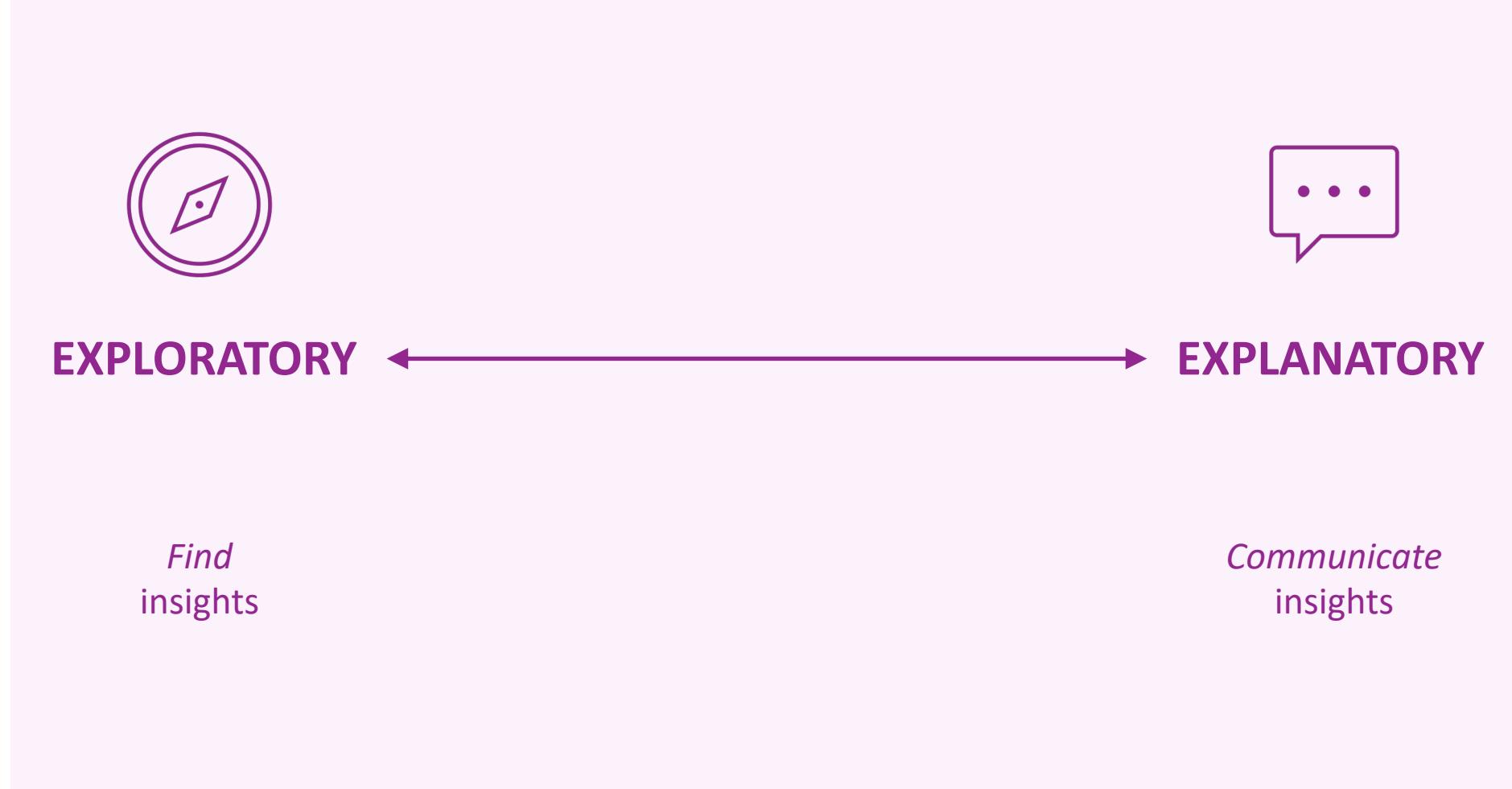
CONCEPTUAL

EXPLORATORY



Visual
discovery

Exploratory vs. explanatory data visualization



Exploratory vs. explanatory data visualization



EXPLORATORY

Understand

You



EXPLANATORY

Communicate

Other people

Less familiar (others)

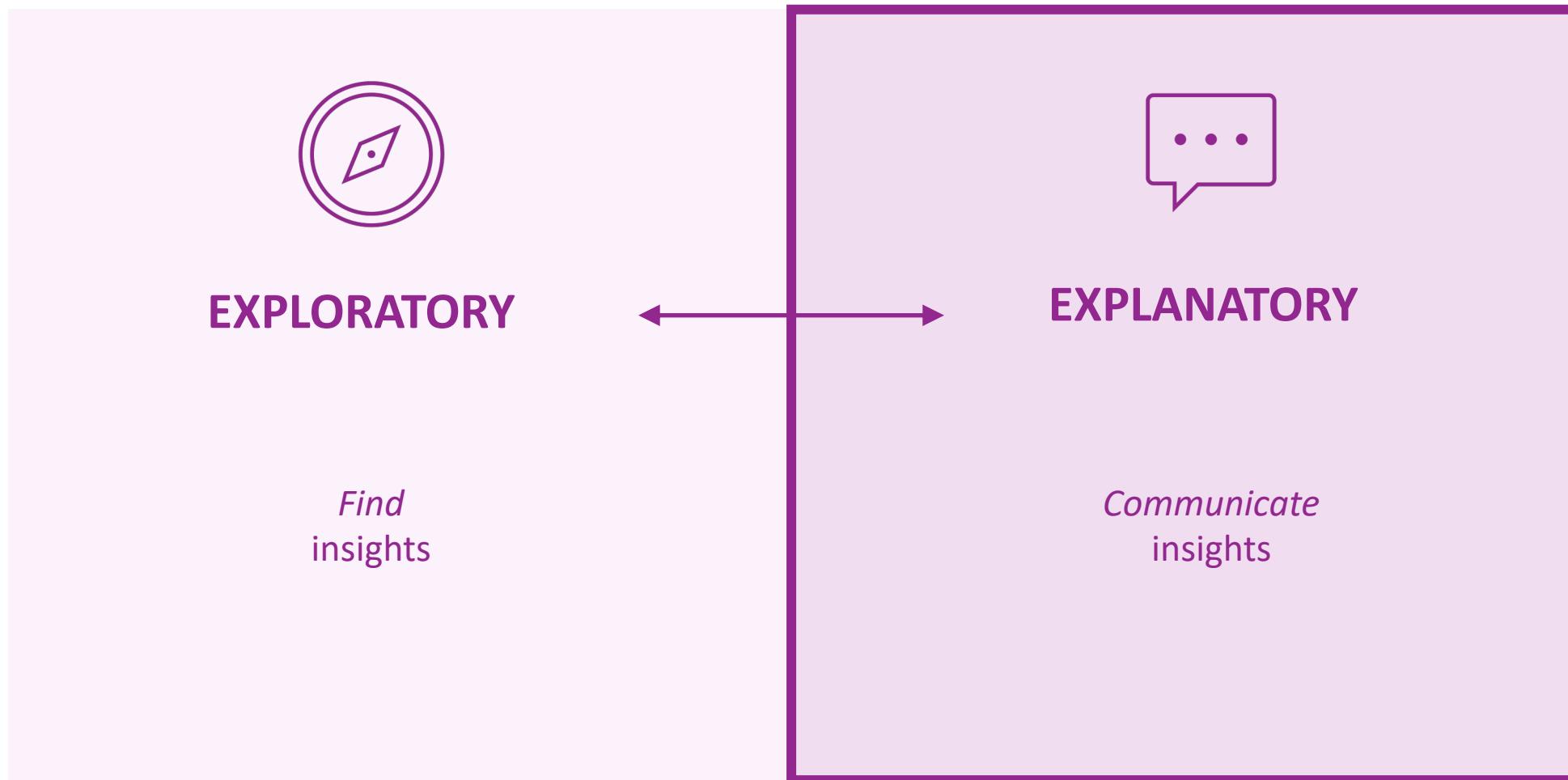
Simplicity, clarity, and cohesion

Known

Action

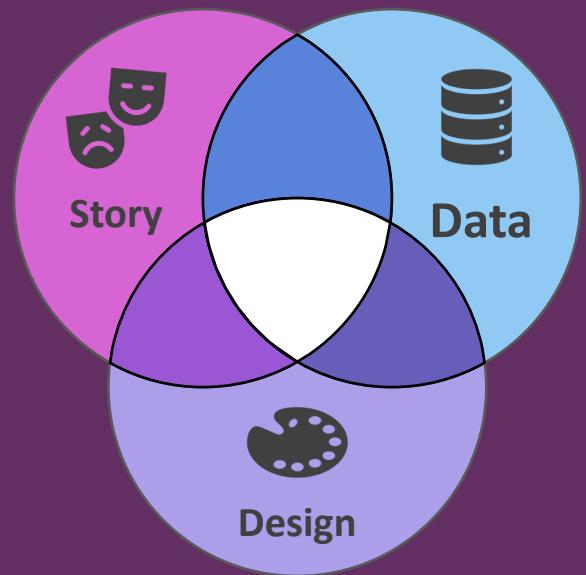
Goal:	Understand
Audience:	You
Data familiarity:	Very familiar (you)
Visualization focus:	Flexibility and speed
Narrative:	Unknown
Outcome:	Insight

We will focus on **explanatory** data visualization



HOW visual communication ?

Show the *right* data and show the data *right*.



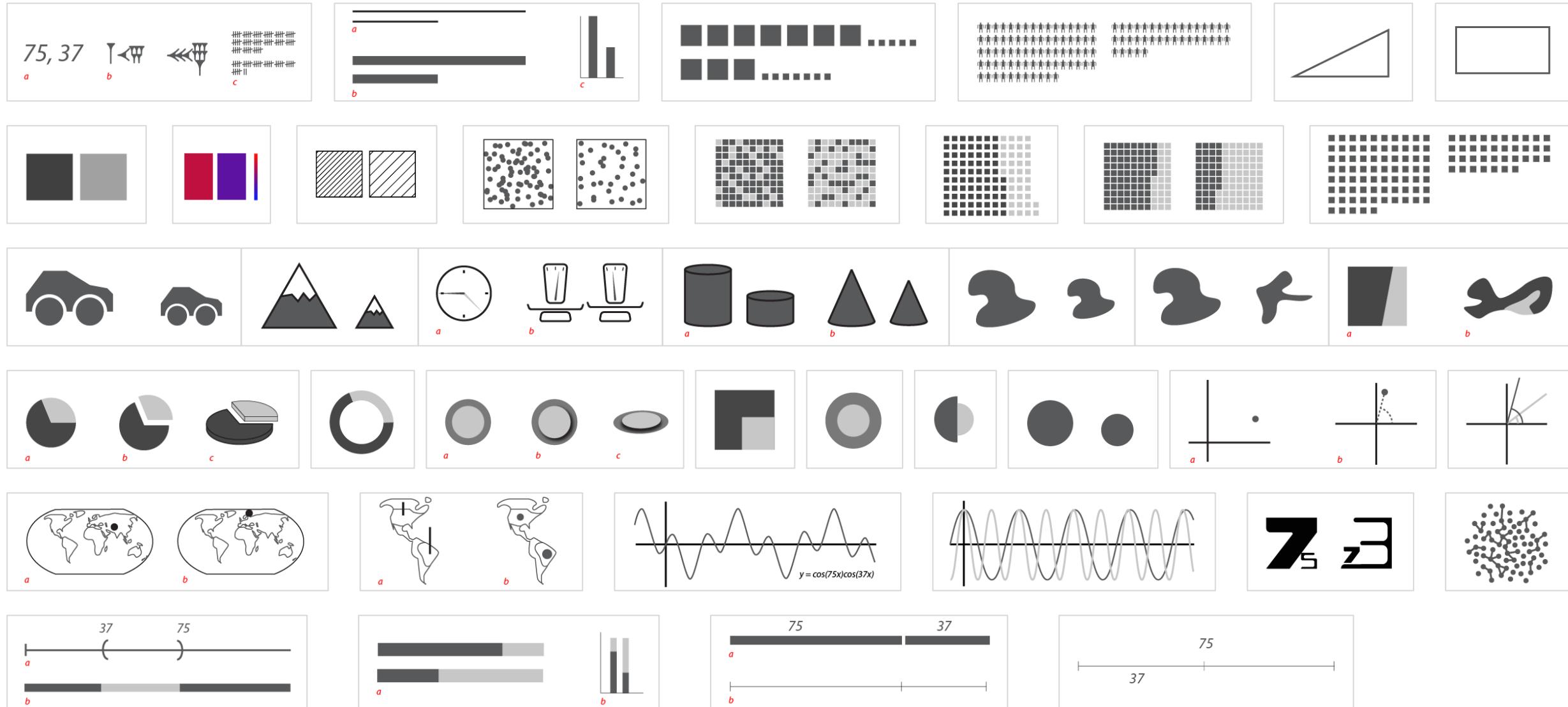
Exercise: In how many ways can you visualize two numbers?

75 and 37

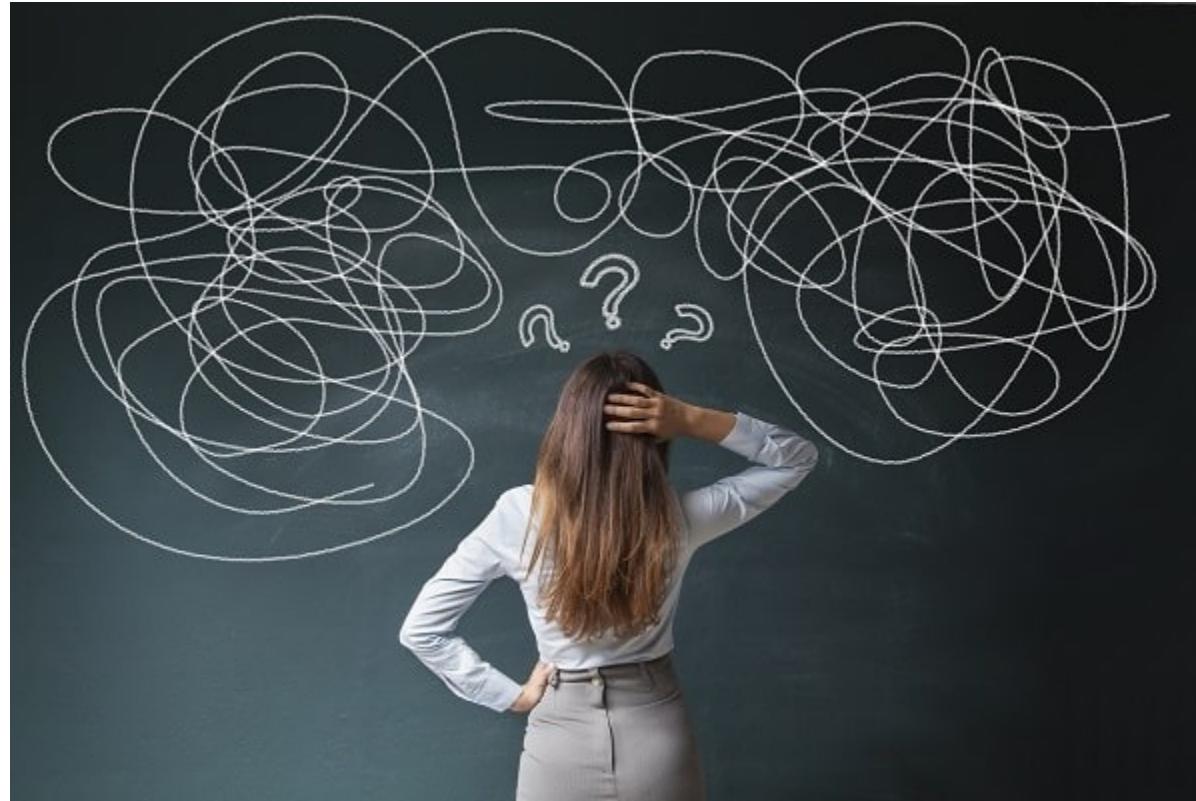


5 min

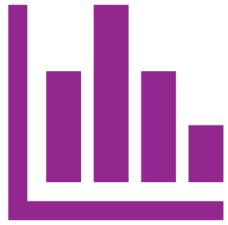
45 ways to communicate two quantities...



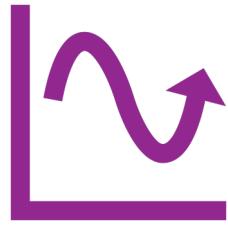
So many possibilities. How to choose?



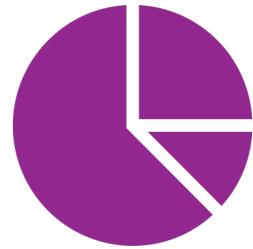
What do you want to show?



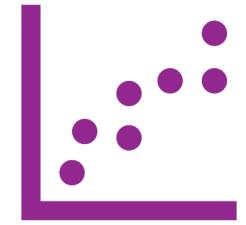
Comparison



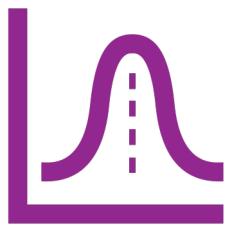
Trend



Part of a whole



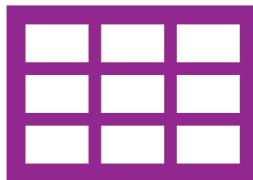
Relationship



Distribution



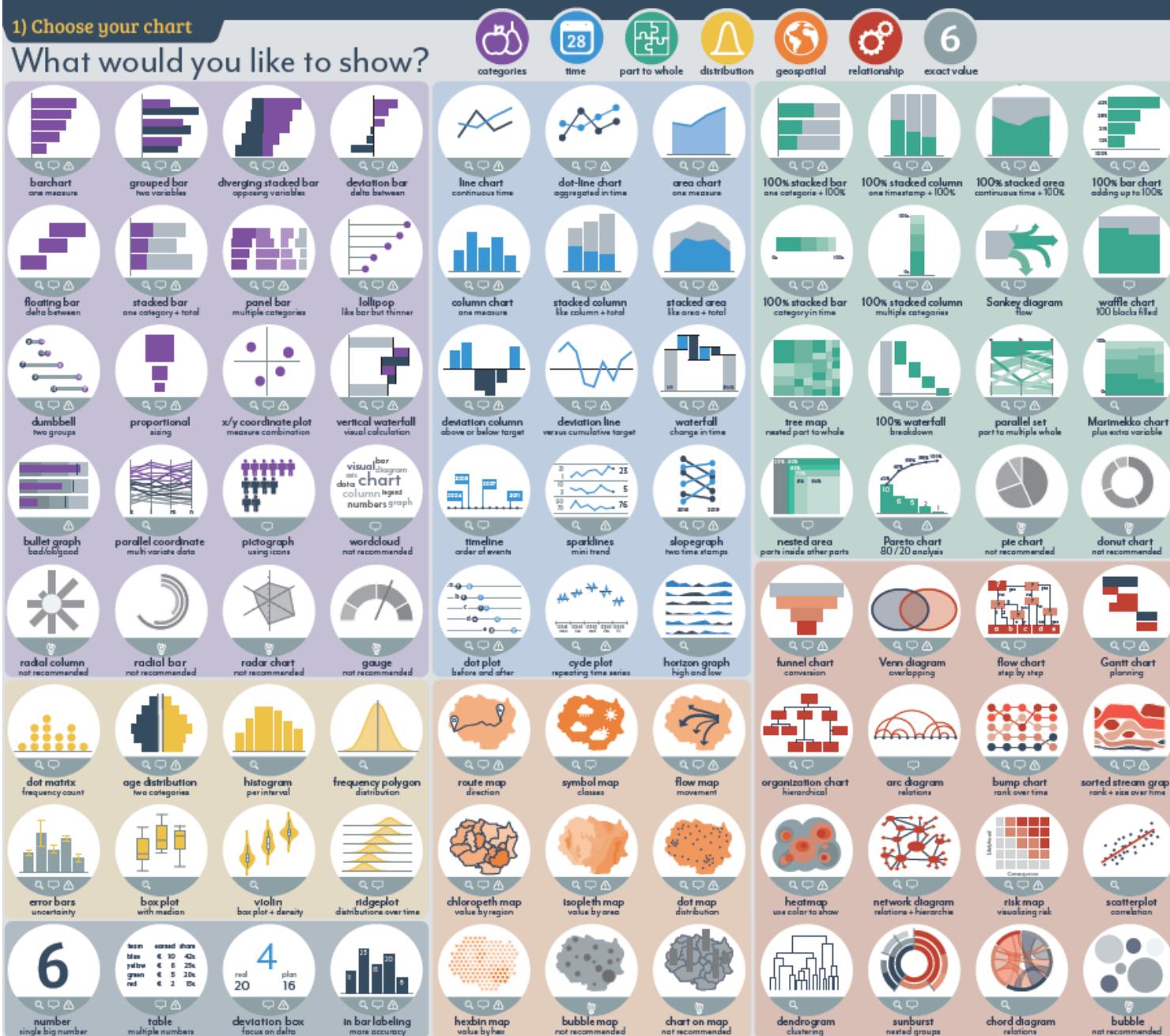
Location



Exact values

1) Choose your chart

What would you like to show?



Use this chart for: analysing, communicating, monitoring, confusing

Find more tips to choose and design your Perfect Chart at:

2) Design your chart

Let your data speak

do's

Show in context

relevant ranking

target or benchmark

Support easy comparison

small multiple

gridlines

Visual hierarchy

less is more

emphasize

Show and tell

descriptive title

annotation

don'ts

Misleading design

cutting of Y axes

multiple Y axis

Beauty over accuracy

3D effect

fluid lines

Too much

more than 4 series

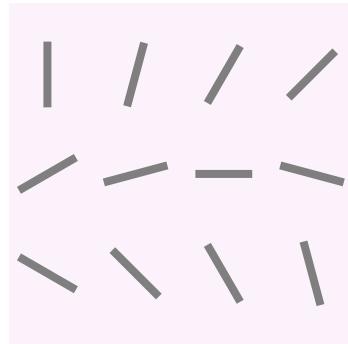
too much or meaningless color

Hard to read

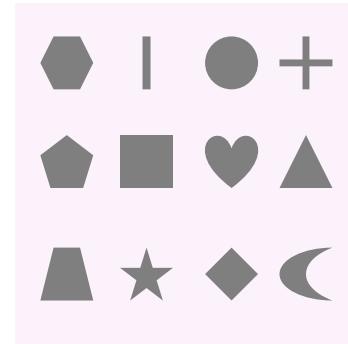
too much details

align text other than horizontally

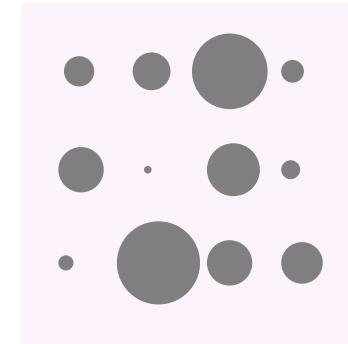
Visual attributes: from data to image



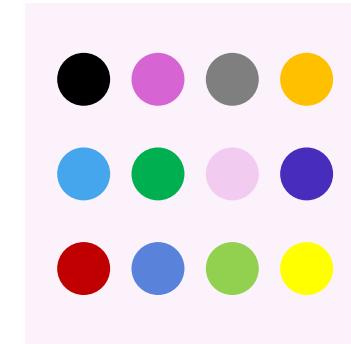
Oriëntatie



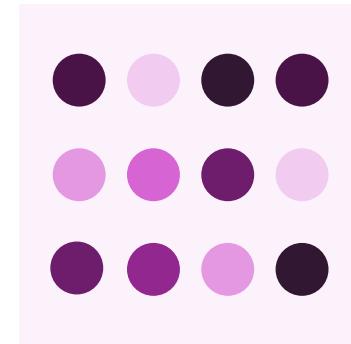
Vorm



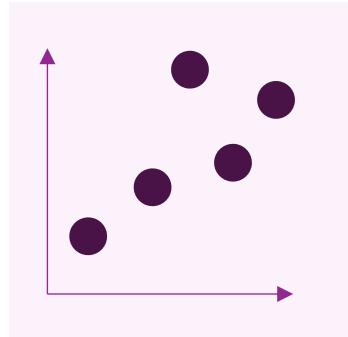
Grootte



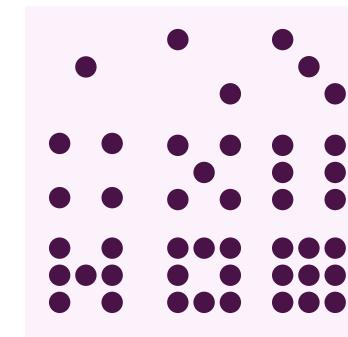
Kleur (hue)



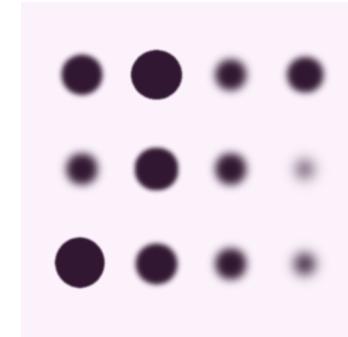
Kleur (helderheid)



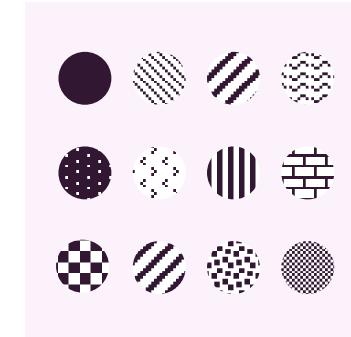
Positie



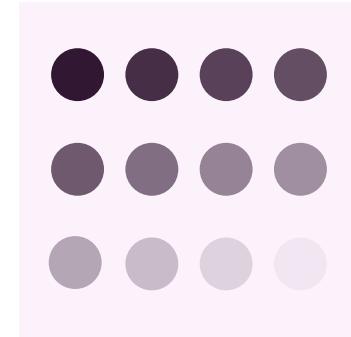
Aantal



Fuzziness



Textuur



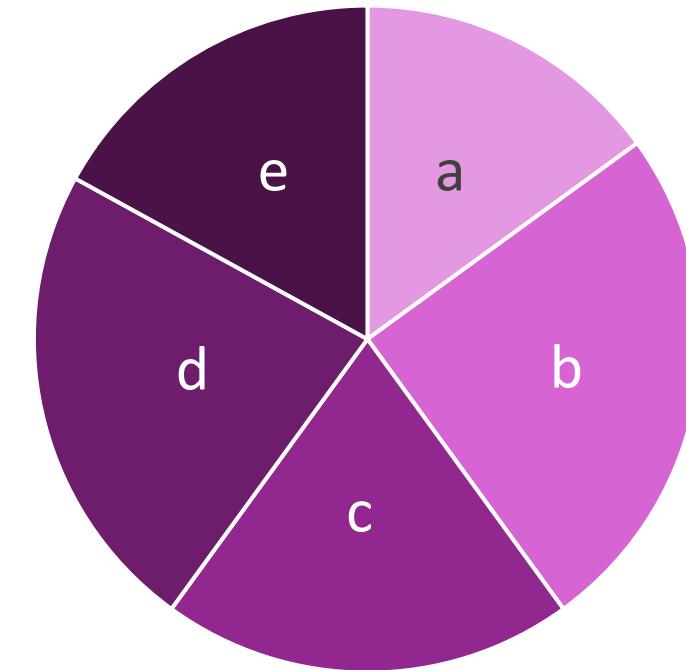
Transparantie

Some visual attributes are **more effective** than others

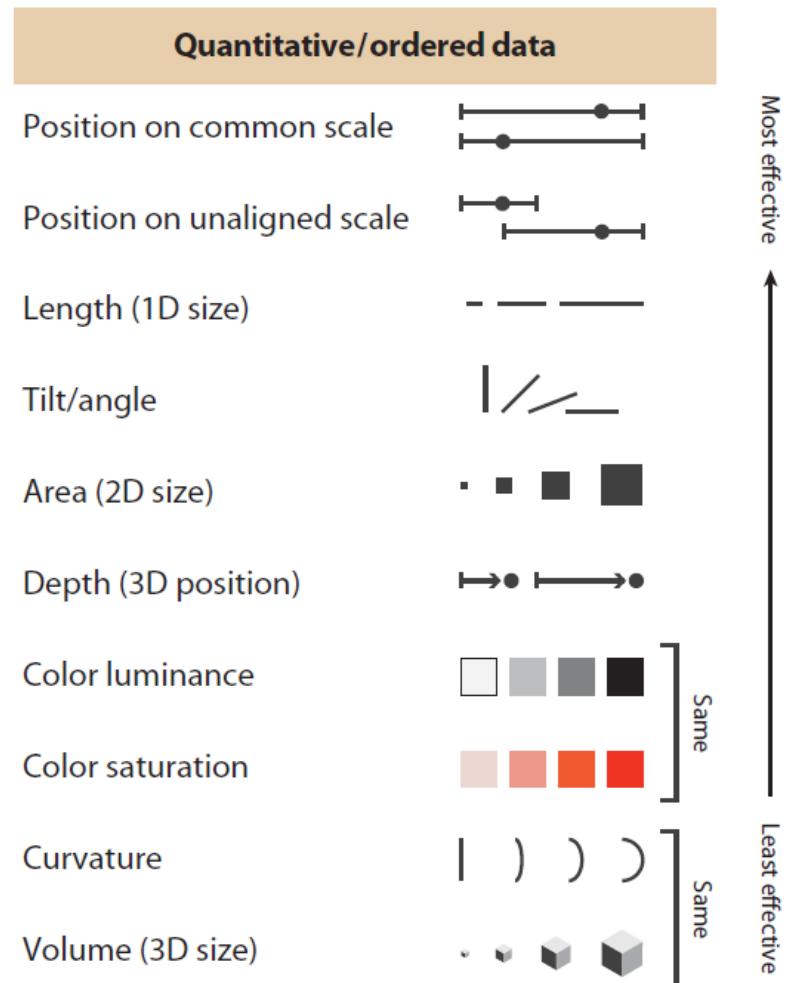
Which bar is highest?



Which slice is biggest?



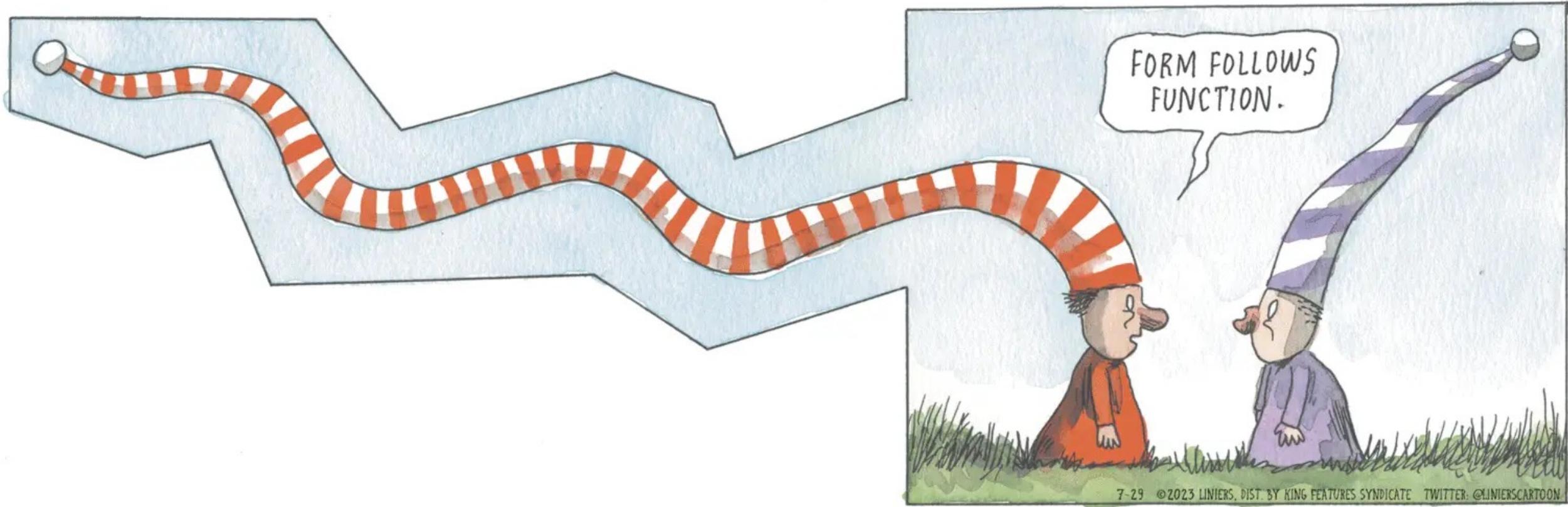
Some visual attributes are **more effective** than others



So many possibilities. How to choose?



Form follows function!

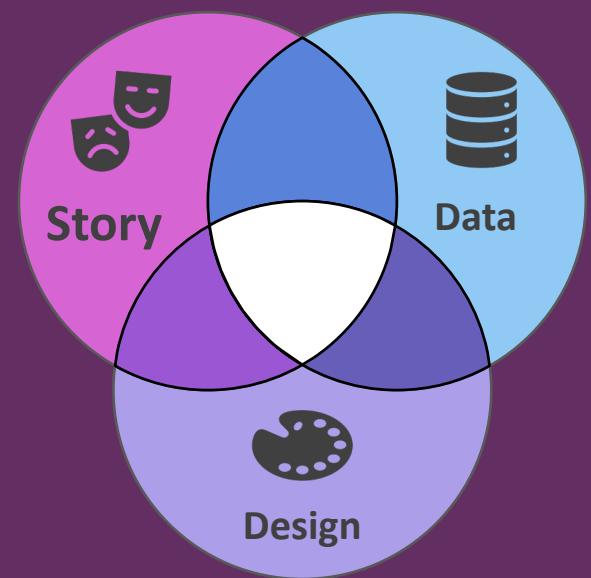


7-29 © 2023 LINIERS, DIST. BY KING FEATURES SYNDICATE TWITTER: @LINIERSCARTOON

<https://comicskingdom.com/macanudo/2023-07-29>

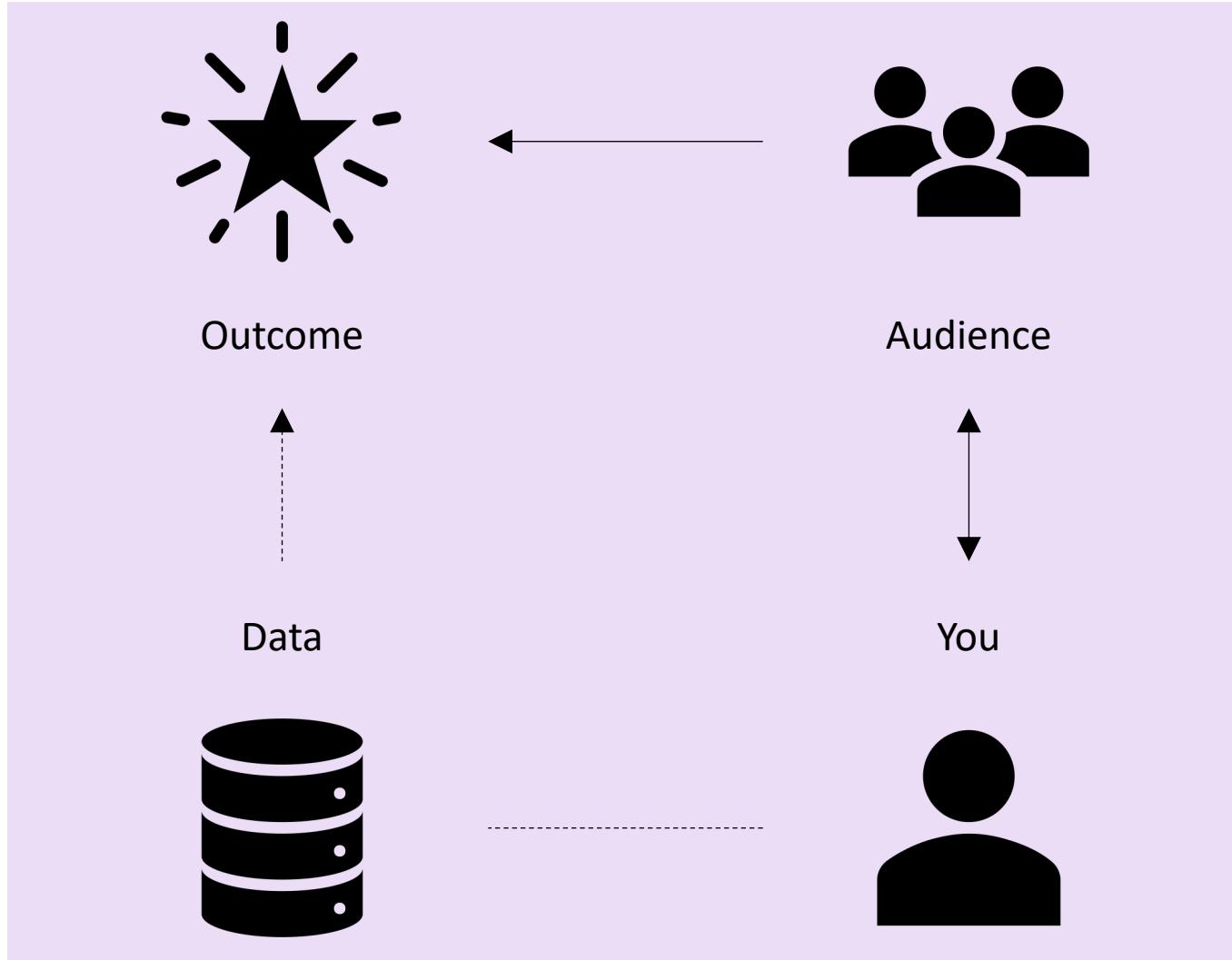
Know your context!

Start with the end in mind.



Start with the end in mind

Why?

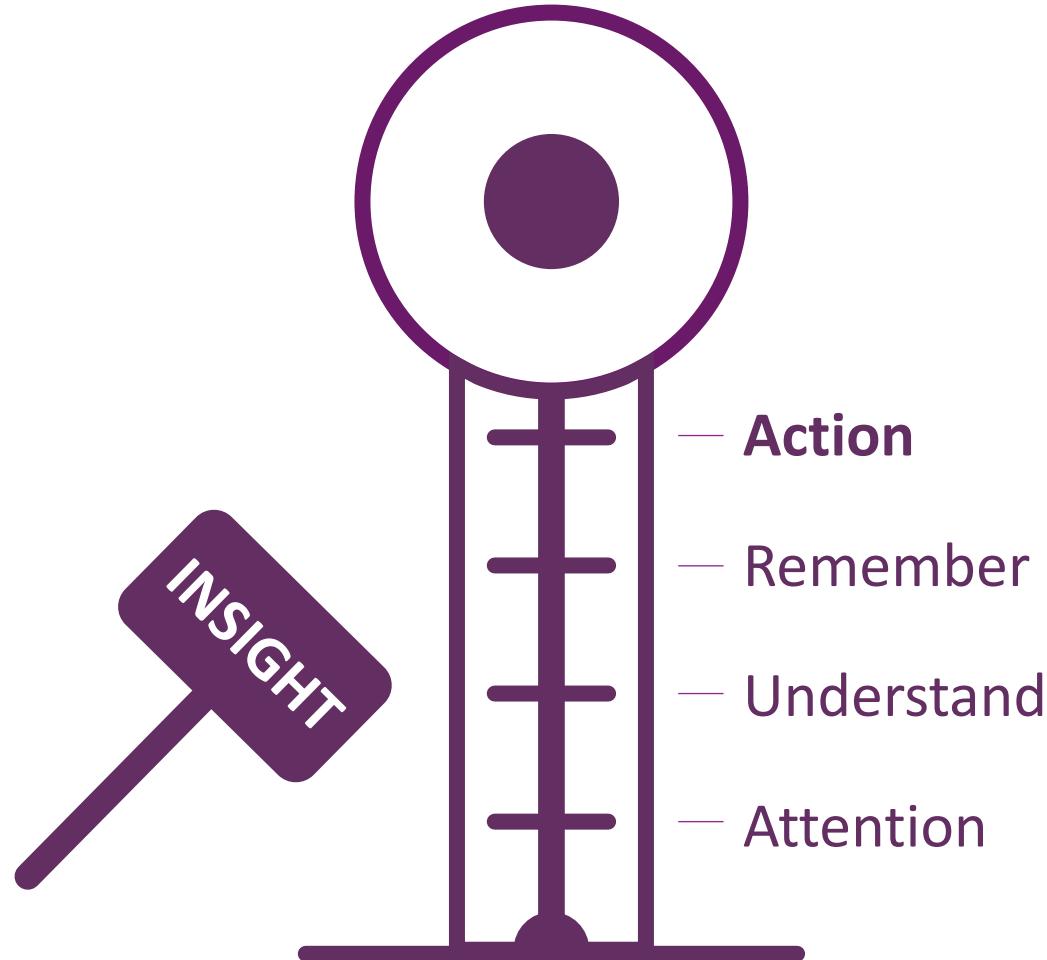


What?

Who?

Where?

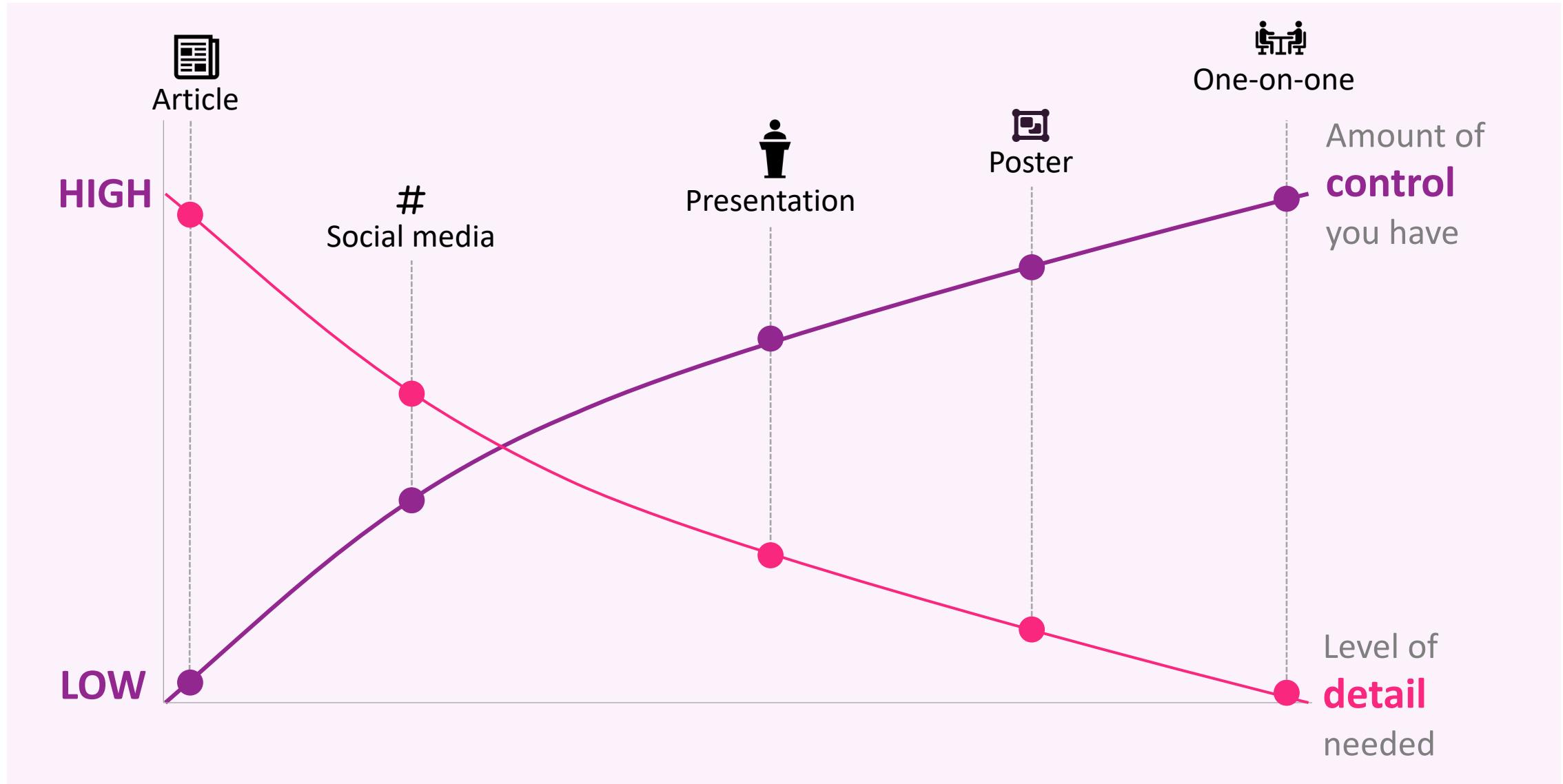
Why should your audience care?



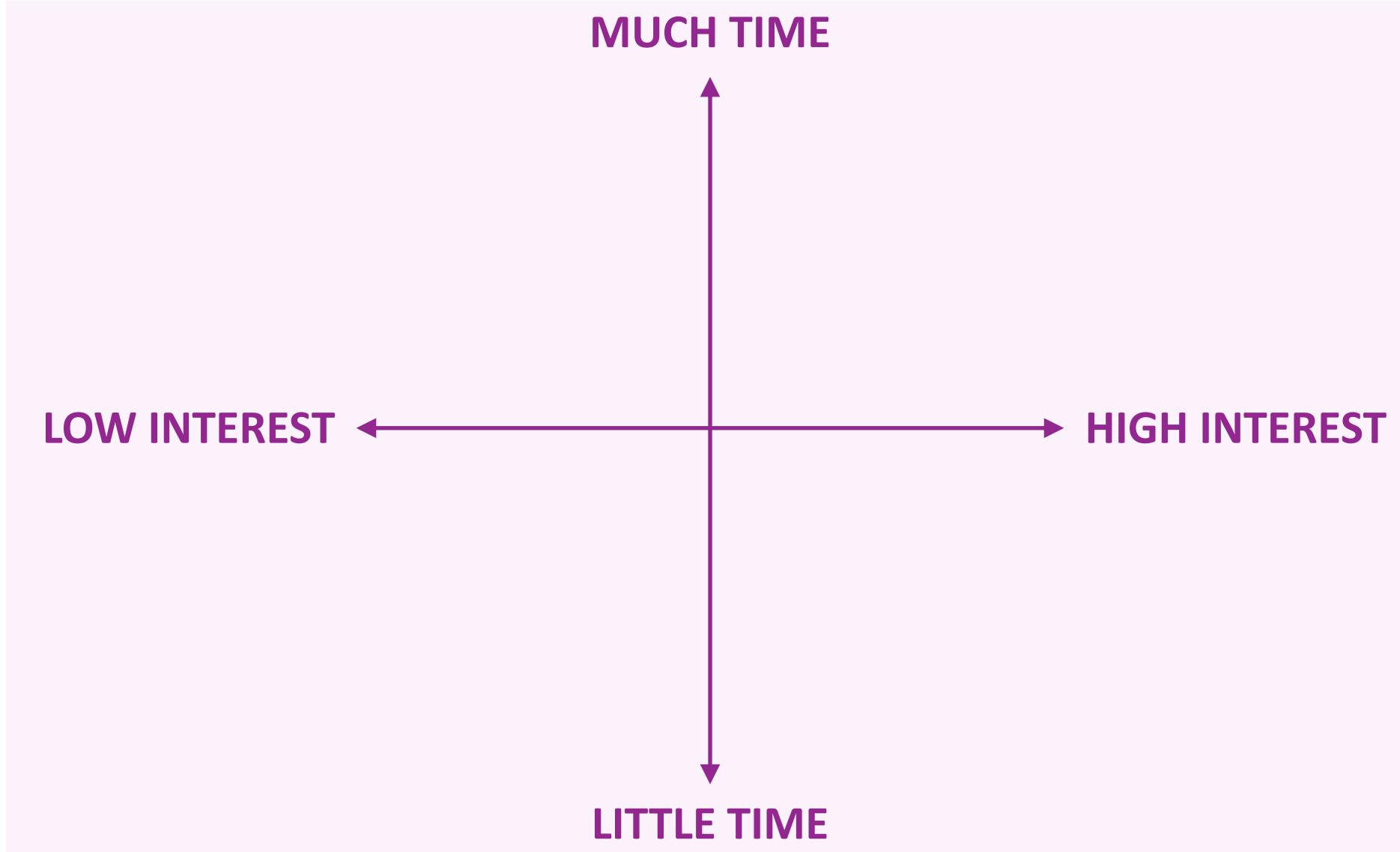
What is your **purpose**?
What **action** do you want your audience to take?

← **Why?**
← **Why?**
← **Why?**

Where you present defines *how* you present



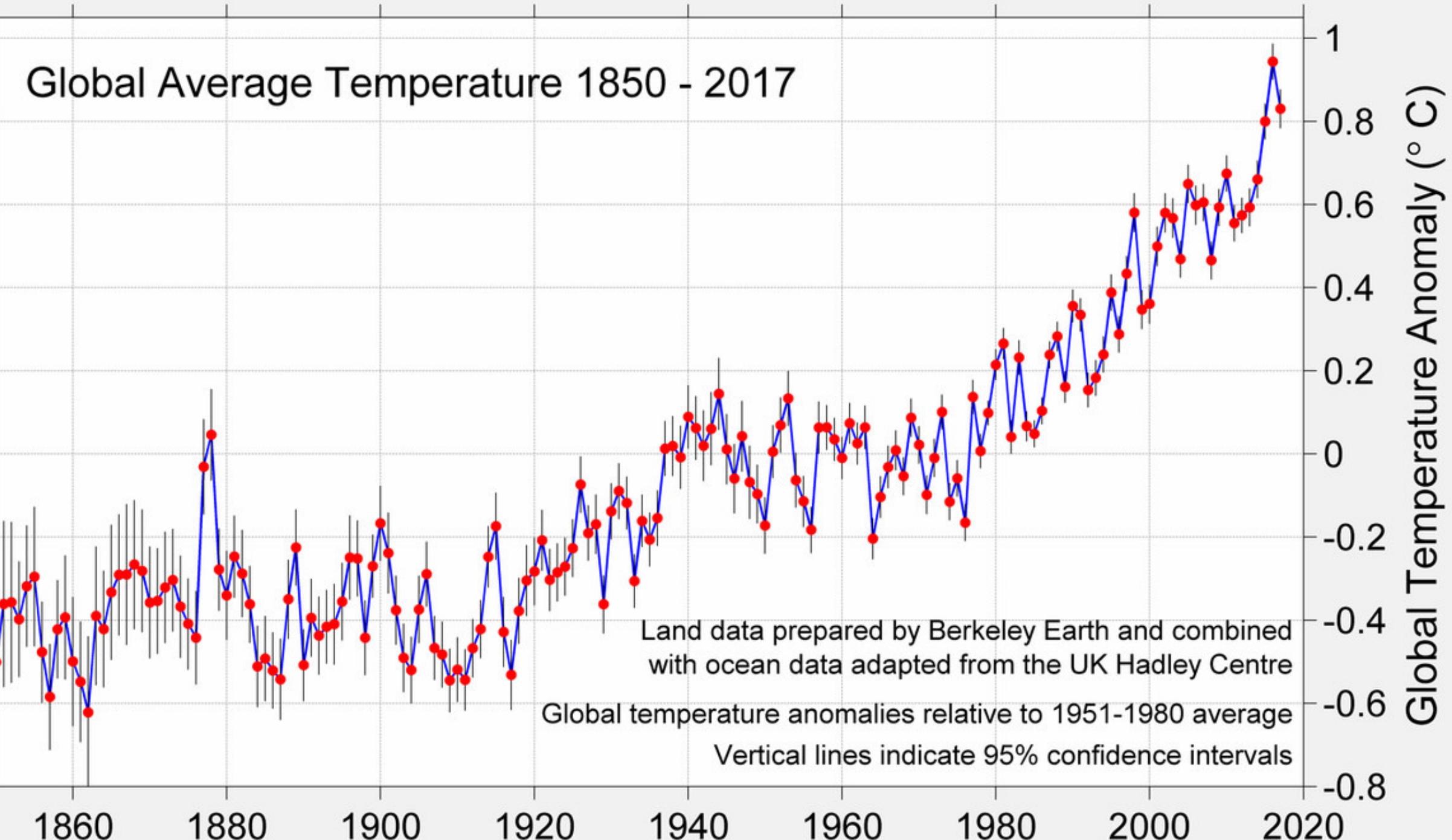
Who is your audience?



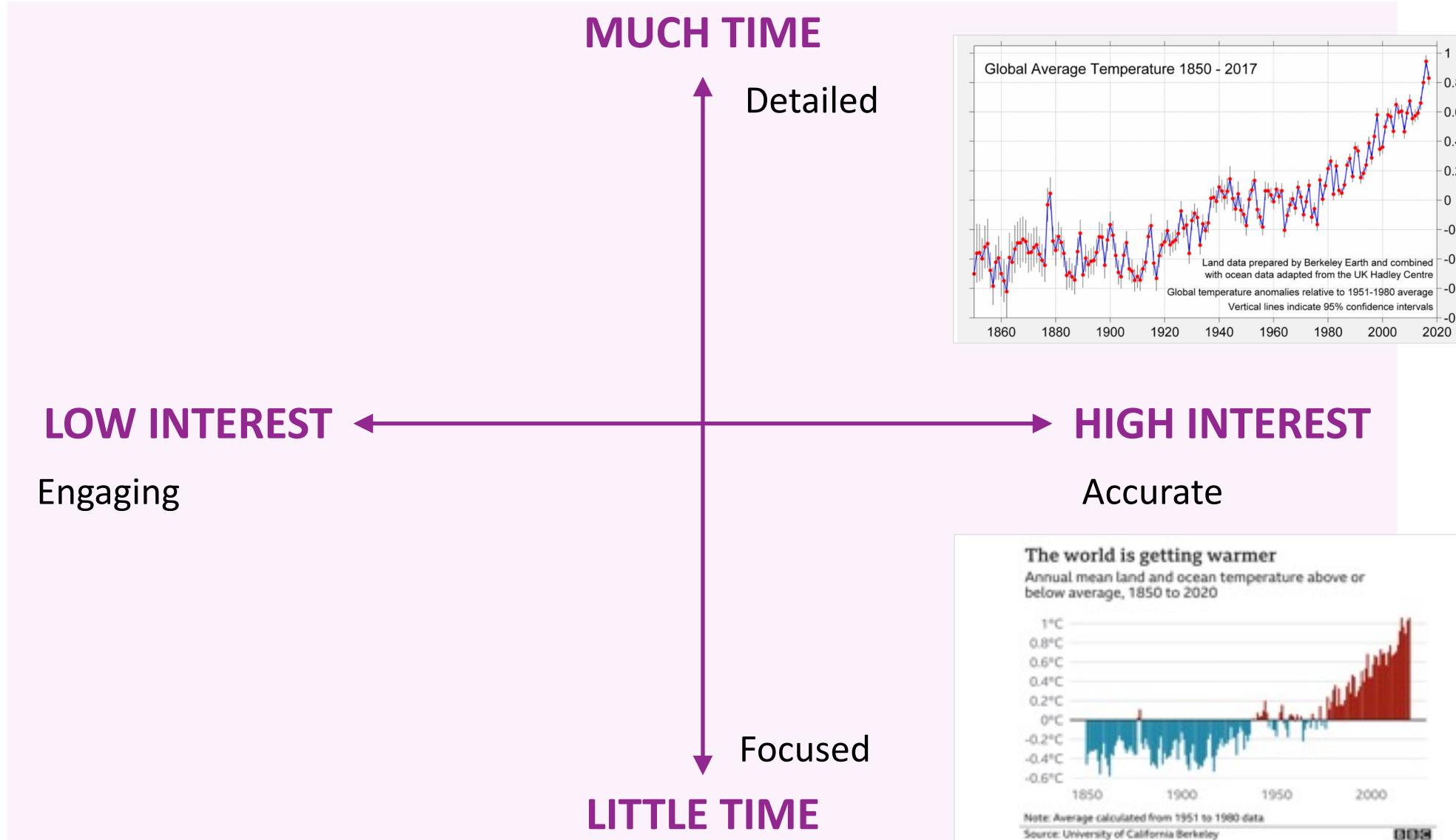
Who defines the level of detail and accuracy



Global Average Temperature 1850 - 2017

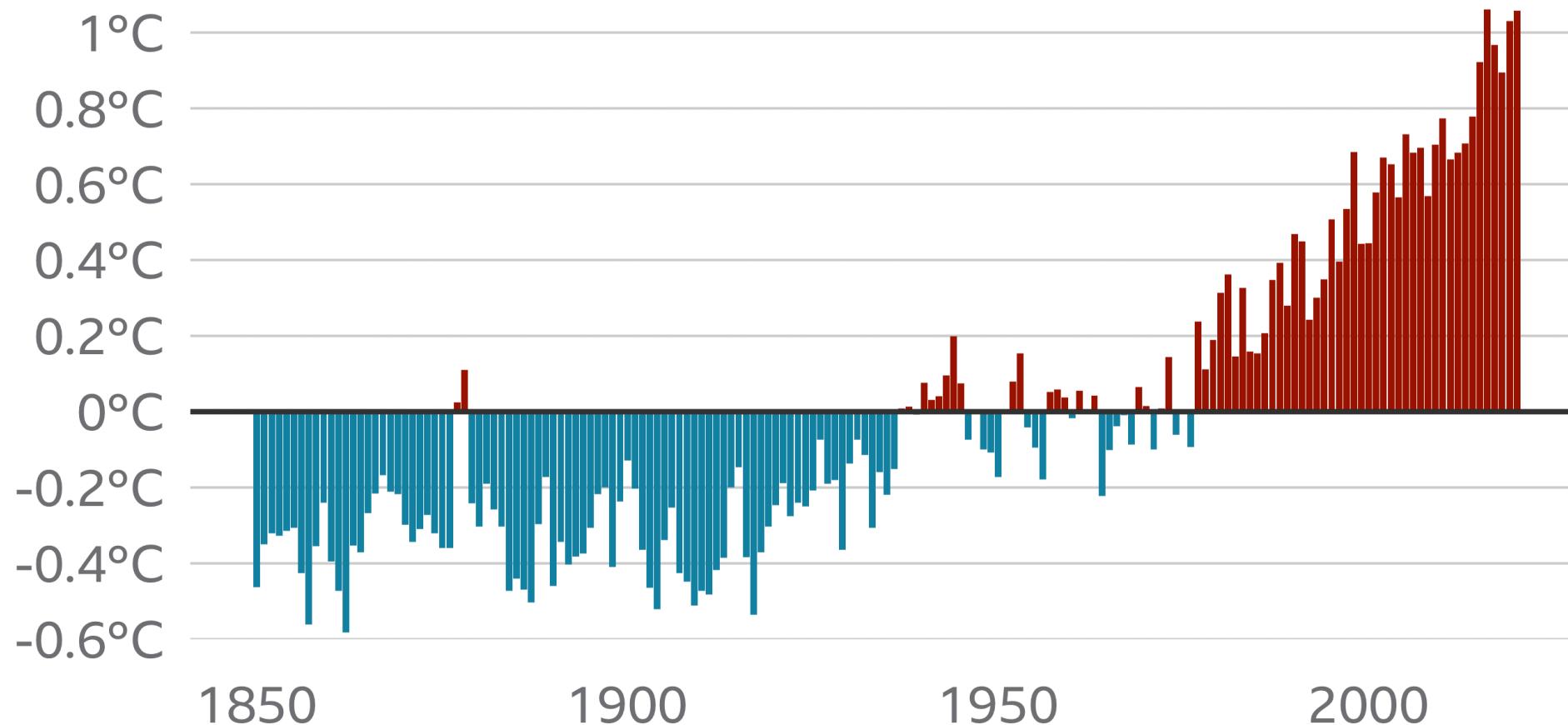


Who defines the level of detail and accuracy



The world is getting warmer

Annual mean land and ocean temperature above or below average, 1850 to 2020

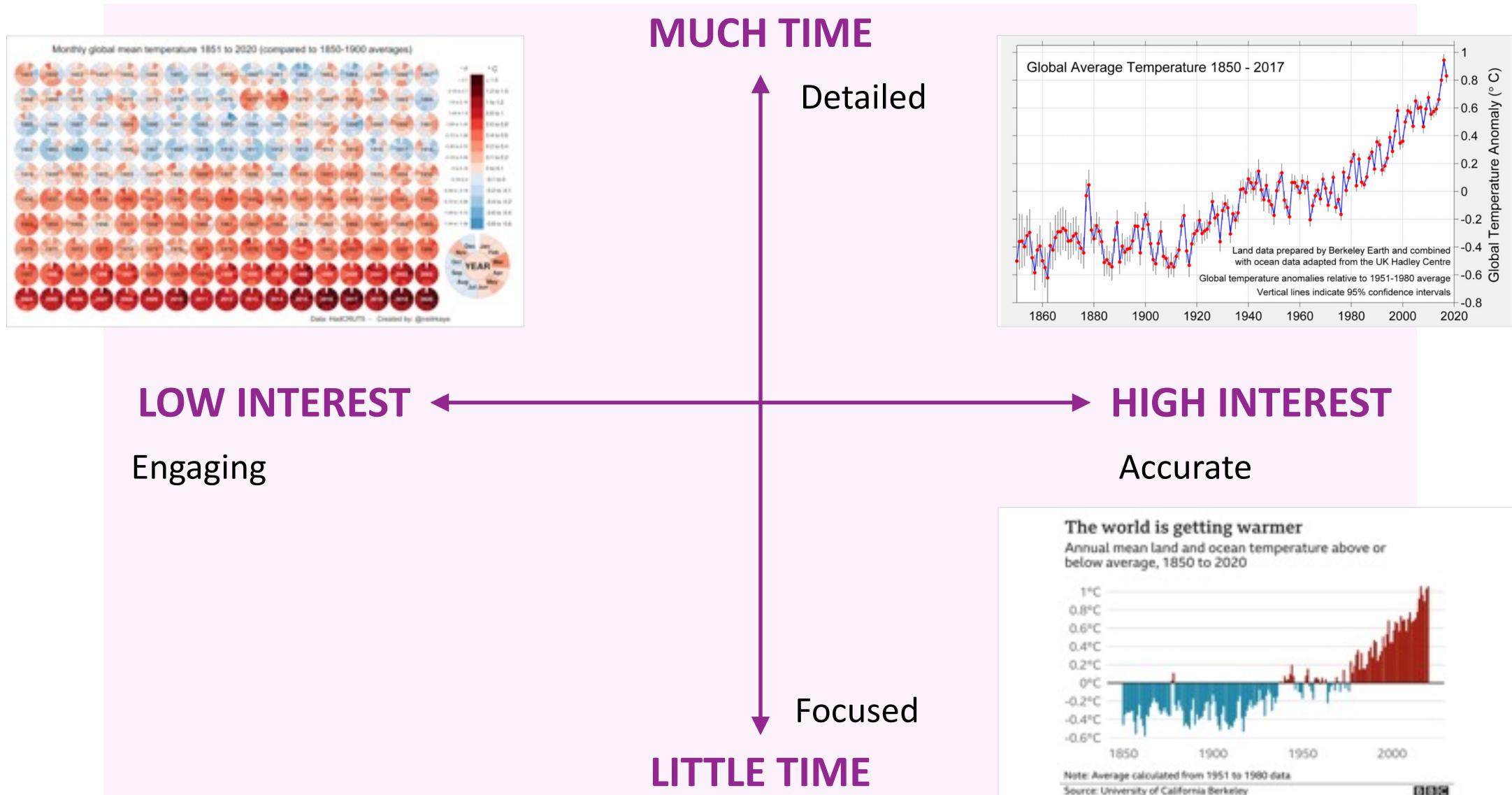


Note: Average calculated from 1951 to 1980 data

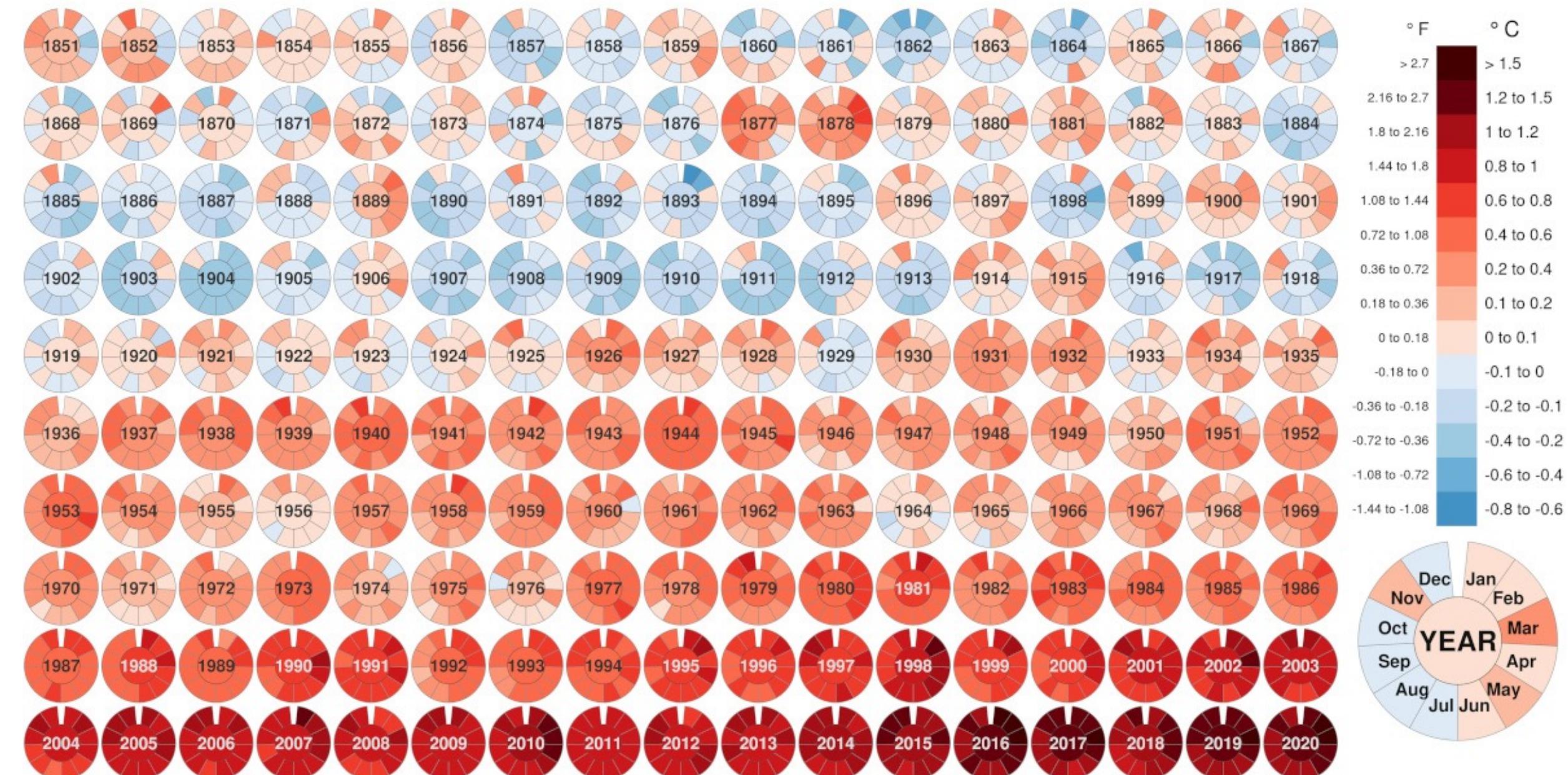
Source: University of California Berkeley

BBC

Who defines the level of detail and accuracy

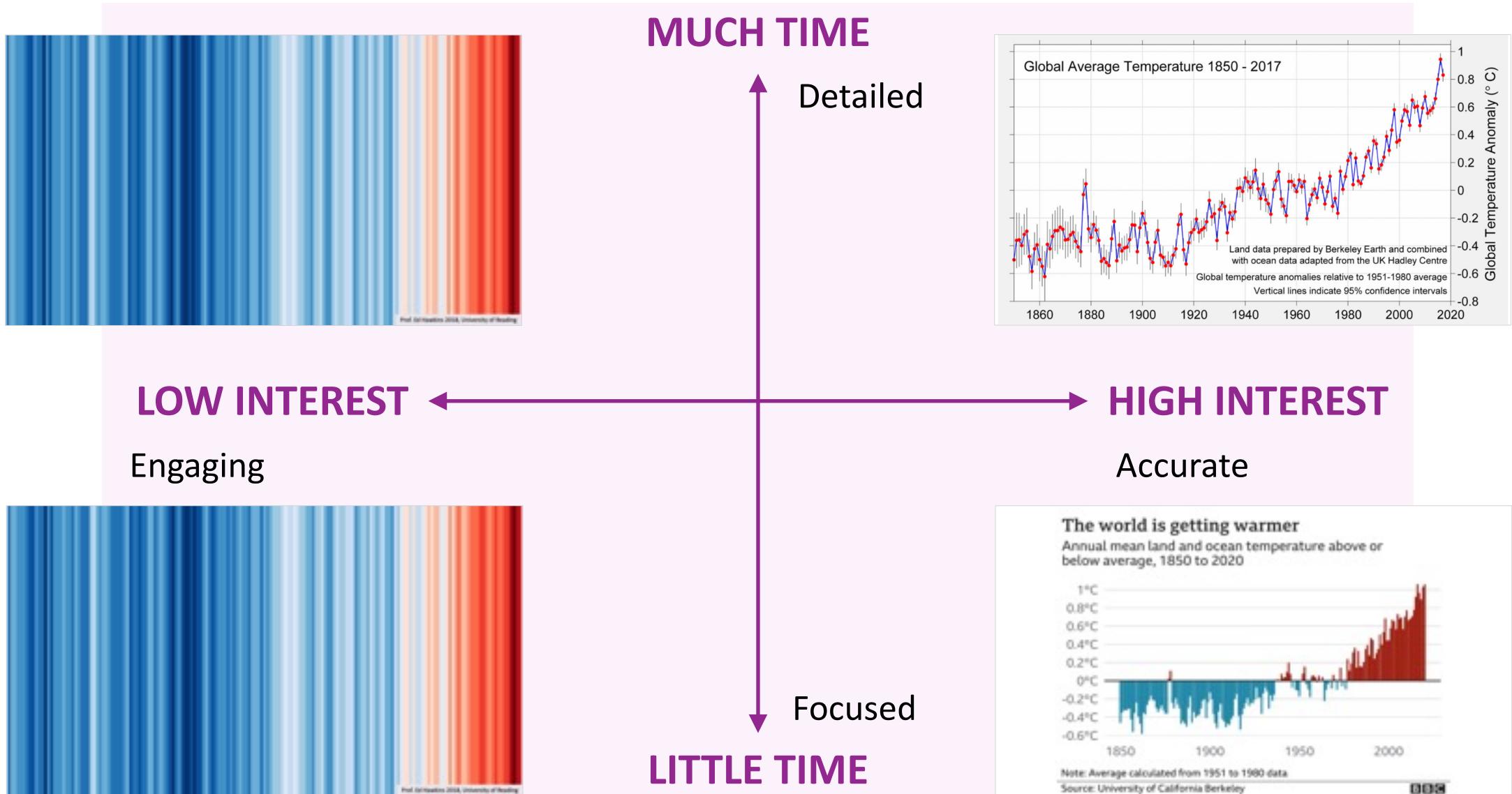


Monthly global mean temperature 1851 to 2020 (compared to 1850-1900 averages)



Data: HadCRUT5 - Created by: @neilrkaye

Who defines the level of detail and accuracy



Talking about reaching a broad public!



Prof. Ed Hawkins
#showyourstripes





Exercise



Exercise: One dataset, multiple stories

No. infections	City
250	Amsterdam
110	Rotterdam
125	Den Haag
23	Utrecht
125	Eindhoven
55	Groningen
155	Leeuwarden
85	Enschede
120	Maastricht
15	Wageningen

5 min



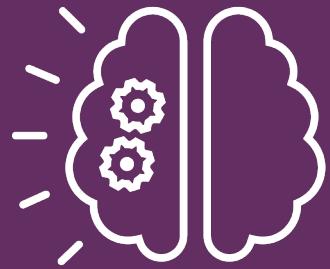
5 Scenarios:

The reader wants to know:

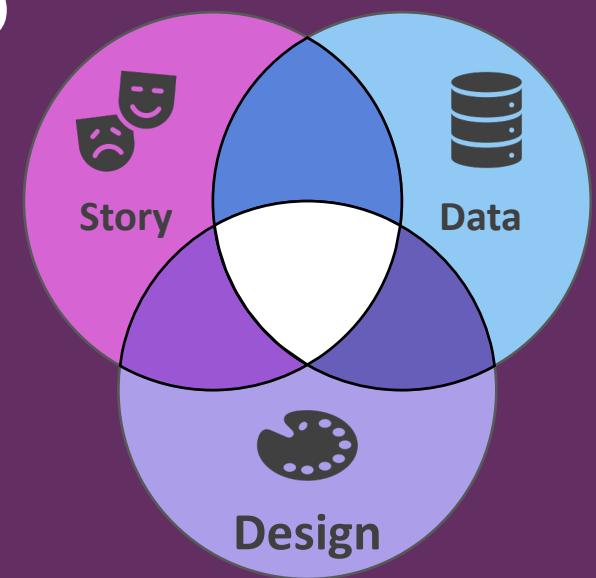
1. How many infections per city?
2. How does Maastricht rank?
3. How does the number of infections in Amsterdam relate to the other cities?
4. Which cities have more than 100 infections?
5. Does the distance between cities affect the number of infections?

- **1) Create a visual tailored to the reader's question**
- **2) How can you change the visual for another audience?**
 - More accurate / engaging
 - More focused / detailed

Use your imagination!



How does the brain perceive visual information?





The strengths of our brain

“The eyes only see what the mind is prepared to comprehend.” – Henri Bergson.

How many fives do you see?

321654643216465132168461321
646432136748651349687463123
668432616266984892536496874
651687964649843616984616957
465167412323161689312439873
421432875943869234987596387

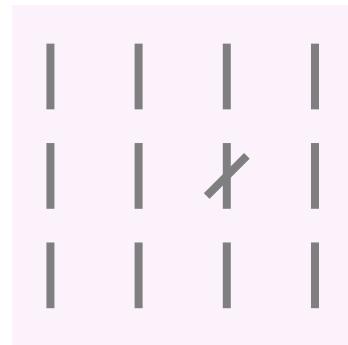
How many fives do you see?

321654643216465132168461321
646432136748651349687463123
668432616266984892536496874
651687964649843616984616957
465167412323161689312439873
421432875943869234987596387

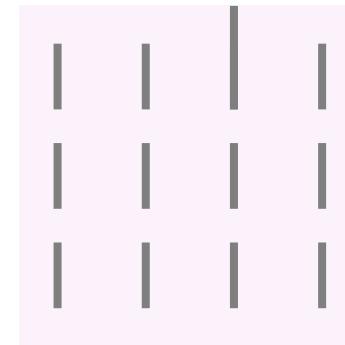
Pre-attentive attributes make your audience see what you want them to see before even seeing it!

321654643216465132168461321
646432136748651349687463123
668432616266984892536496874
651687964649843616984616957
465167412323161689312439873
421432875943869234987596387

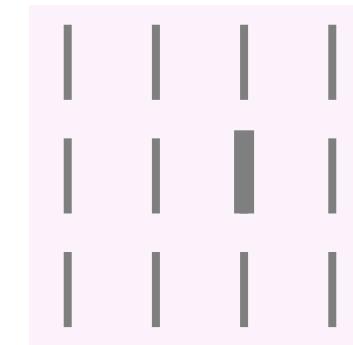
Pre-attentive attributes make your audience see what you want them to see before even seeing it!



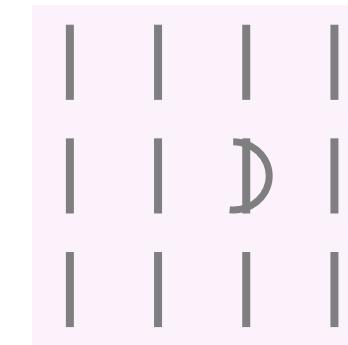
Orientation



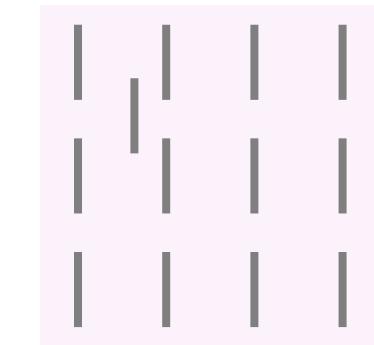
Length



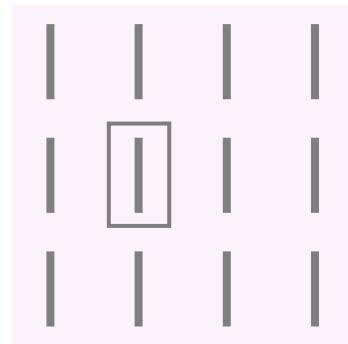
Width



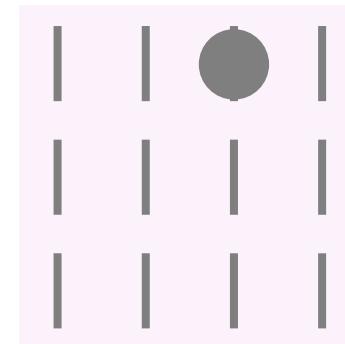
Curvature



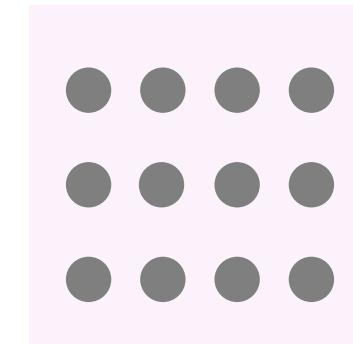
Position



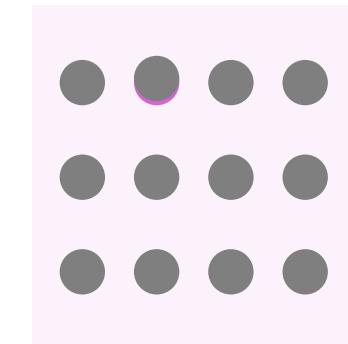
Enclosure



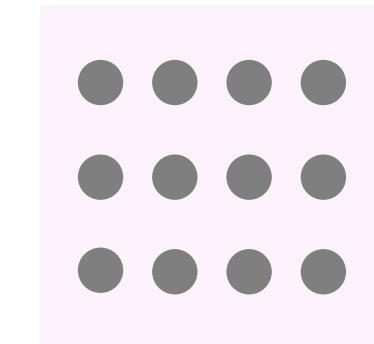
Shape



Size



Color



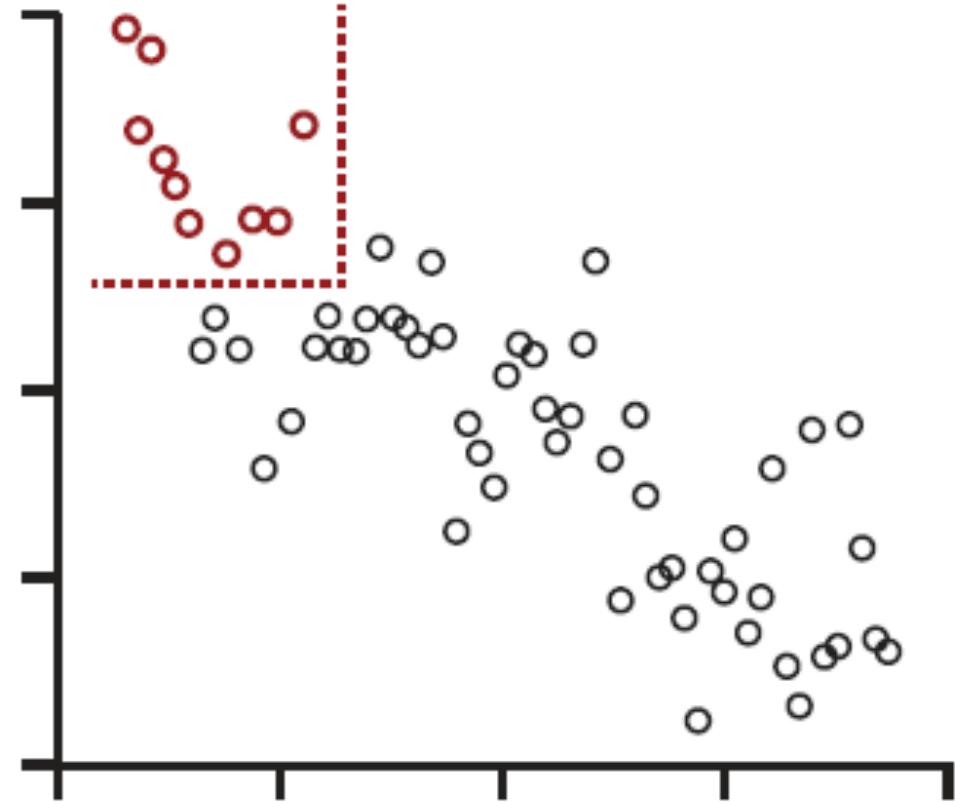
Motion

You can use pre-attentive attributes in **tables**

Color name	RGB (1-255)
Black	0, 0, 0
Orange	230, 159, 0
Sky blue	86, 180, 233
Bluish green	0, 158, 115
Blue	0, 114, 178
Vermillion	213, 94, 0

You can use pre-attentive attributes in tables and **charts**

Color name	RGB (1-255)
Black	0, 0, 0
Orange	230, 159, 0
Sky blue	86, 180, 233
Bluish green	0, 158, 115
Blue	0, 114, 178
Vermillion	213, 94, 0



You can also use pre-attentive attributes in text.

How can you leverage the use of pre-attentive attributes?

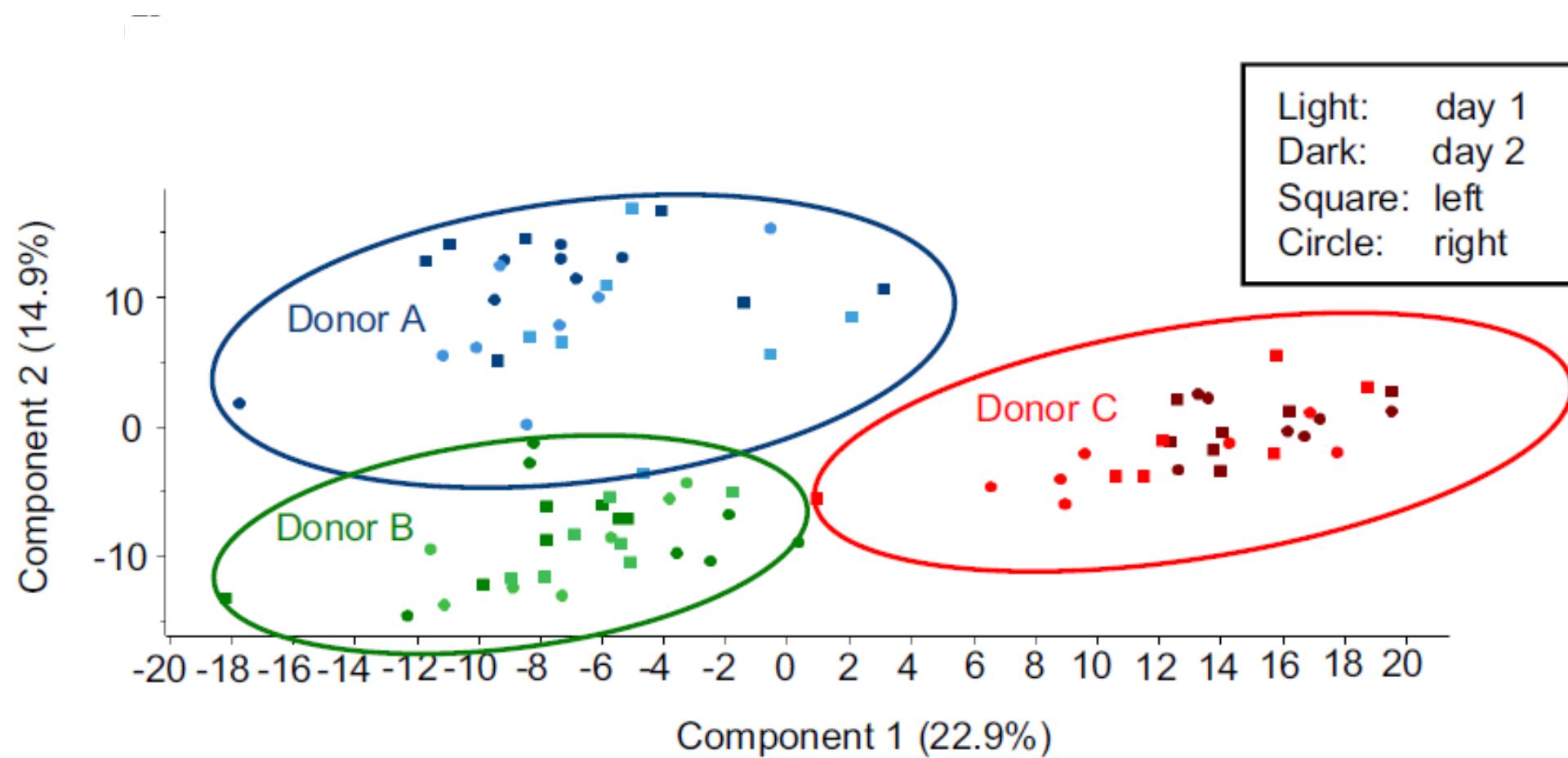
Without pre-attentive attributes you just have plain text. Or a plain figure. There is no guidance for the reader or viewer.

With pre-attentive attributes, you can:

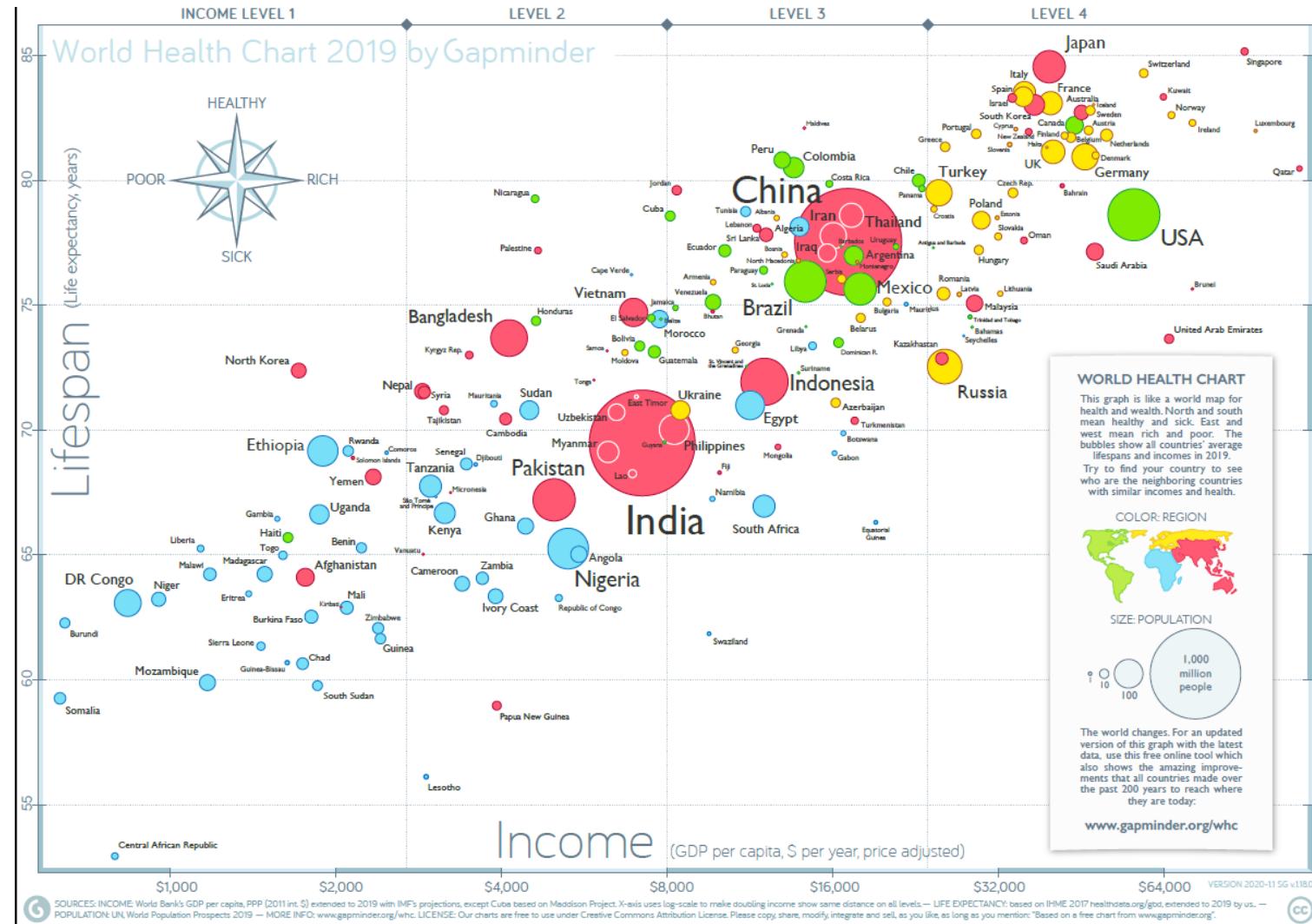
- (1) *Draw your audience attention to where you want them to look*, and
- (2) *Create a visual hierarchy of information*

This counts for **graphs** as well as **text**!

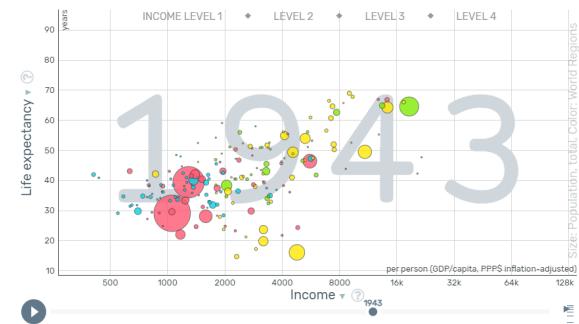
Pre-attentive attributes can create a visual hierarchy



Hans Rosling's Bubble chart



Positie
Grootte
Kleur
Beweging



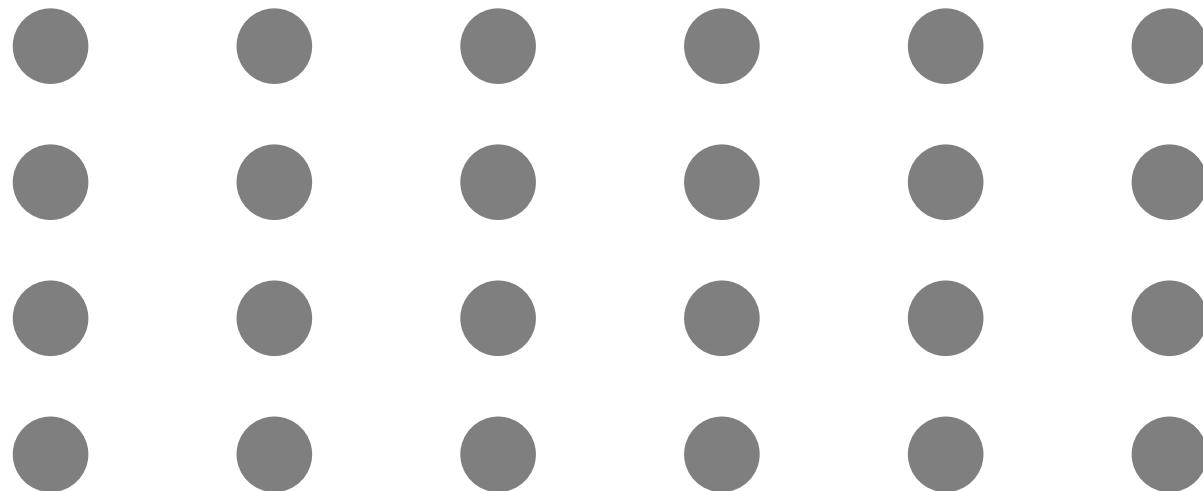
<https://www.gapminder.org/tools>

<https://www.youtube.com/watch?v=jbkSRLYSojo>

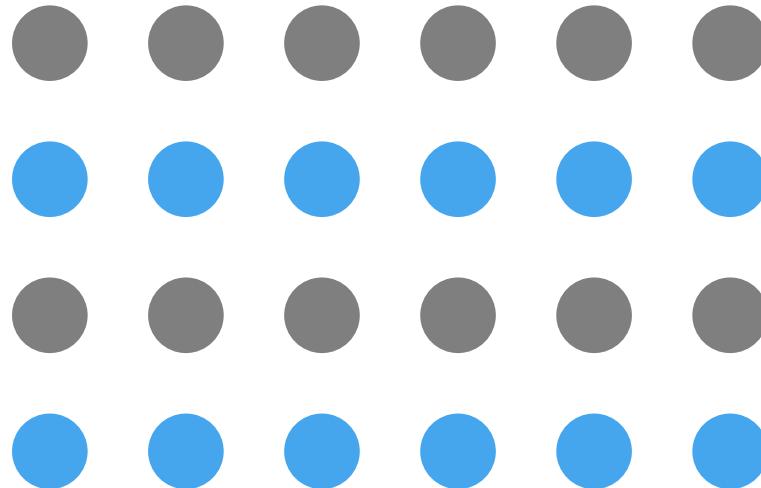
Do you see 4 rows or 6 columns?



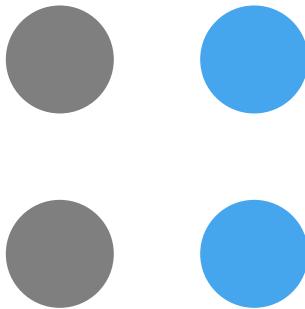
And now?



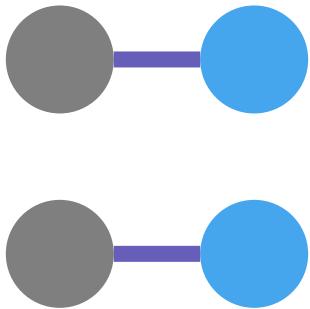
Do you see 4 rows or 6 columns?



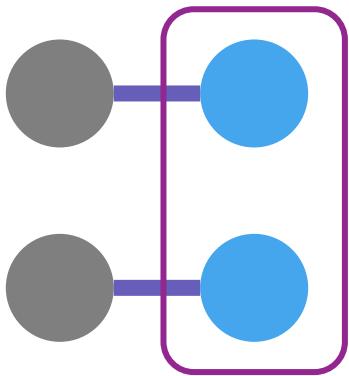
Which dots belong together?



And now...?



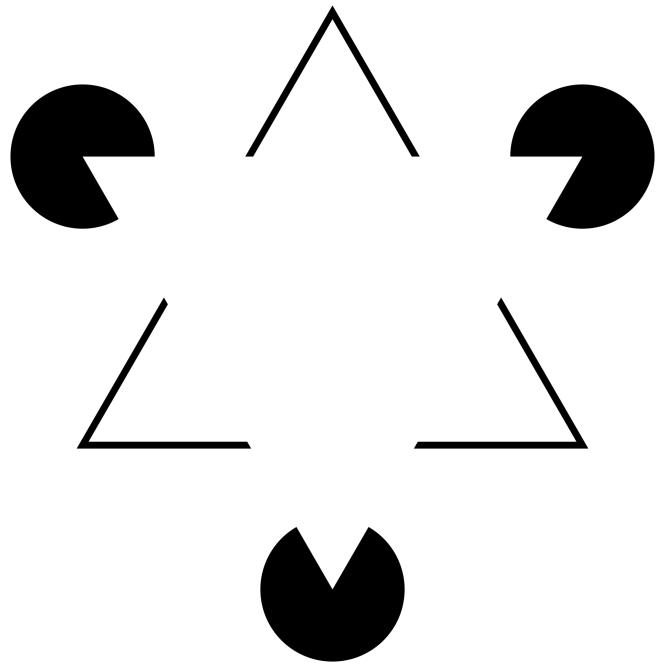
And now...?



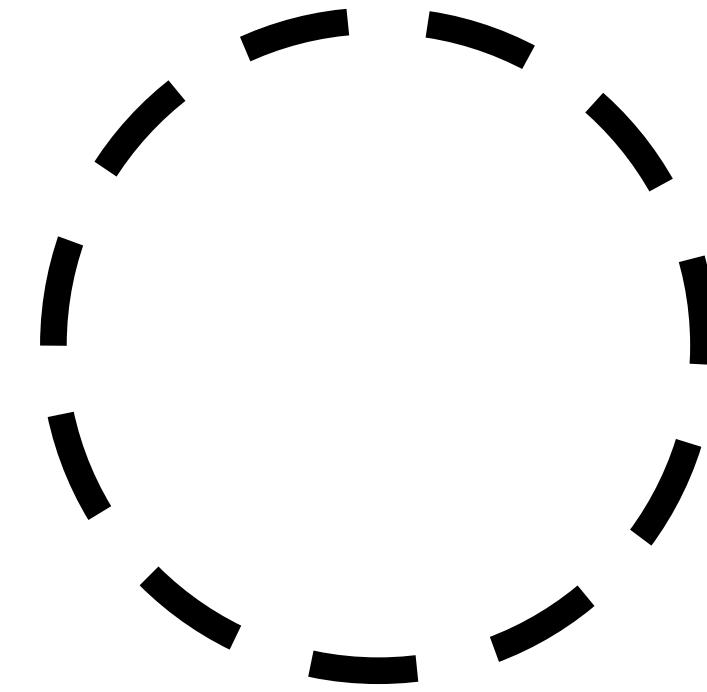
Can you read this?

Aoccdrnig to a rsceearh at Cmabrgide Uinervtisy, it deosn't
mttaer in what order the ltteers in a wrod are, the olny
iprmoatnt tnihg is taht the frsit and lsat ltteer be at the
rghit pclae. The rset can be a toatl mses and you can siltl
raed it wouthit porbelm. Tihs is bcuseae the huamn mnid
deos not raed ervey lteter by istlef, but the wrod as a
wlohe.

We're good at seeing things that may not explicitly exist!



Continuity



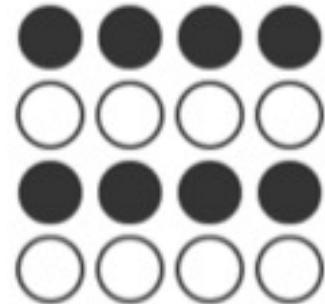
Closure

Gestalt principles: The whole is other than the sum of the parts.

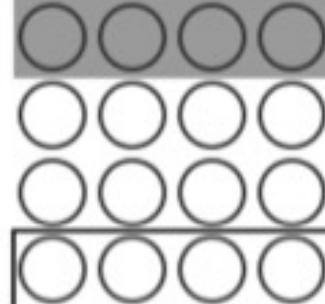
Proximity



Similarity



Enclosure



Symmetry

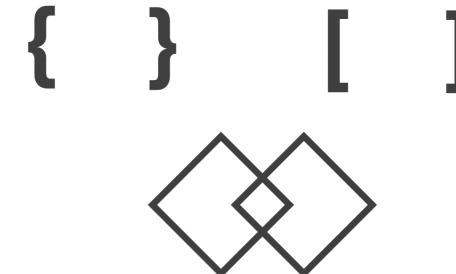
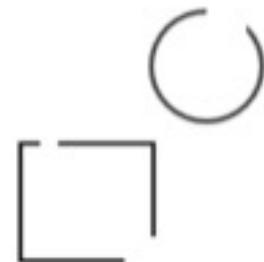


Figure-ground



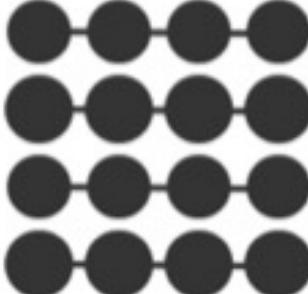
Closure



Continuity



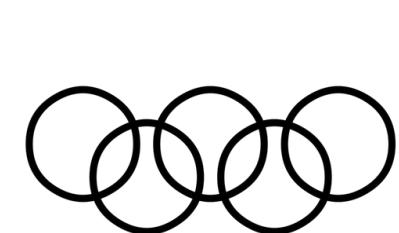
Connection



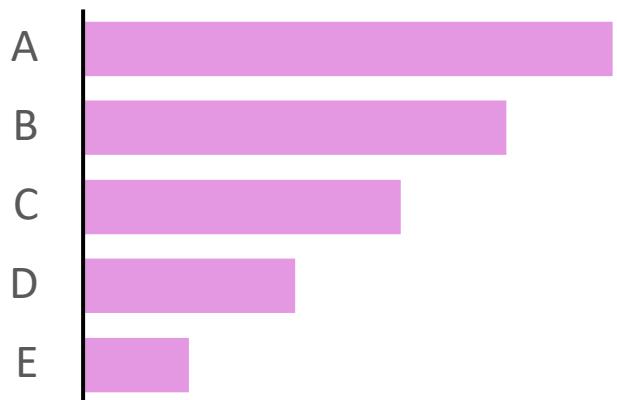
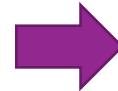
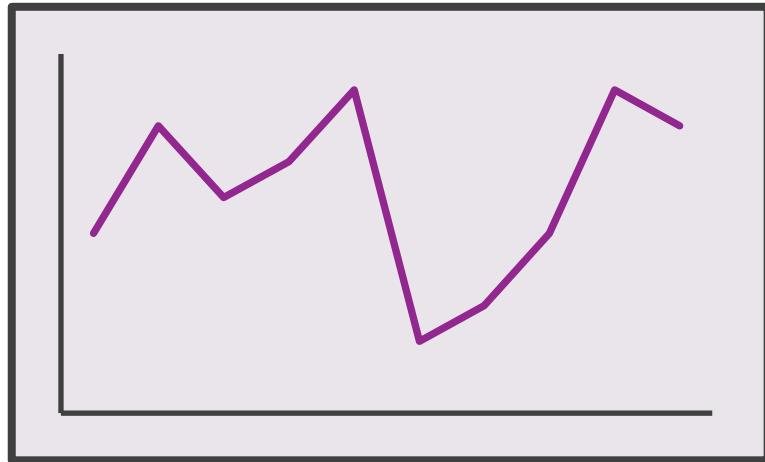
Common Fate



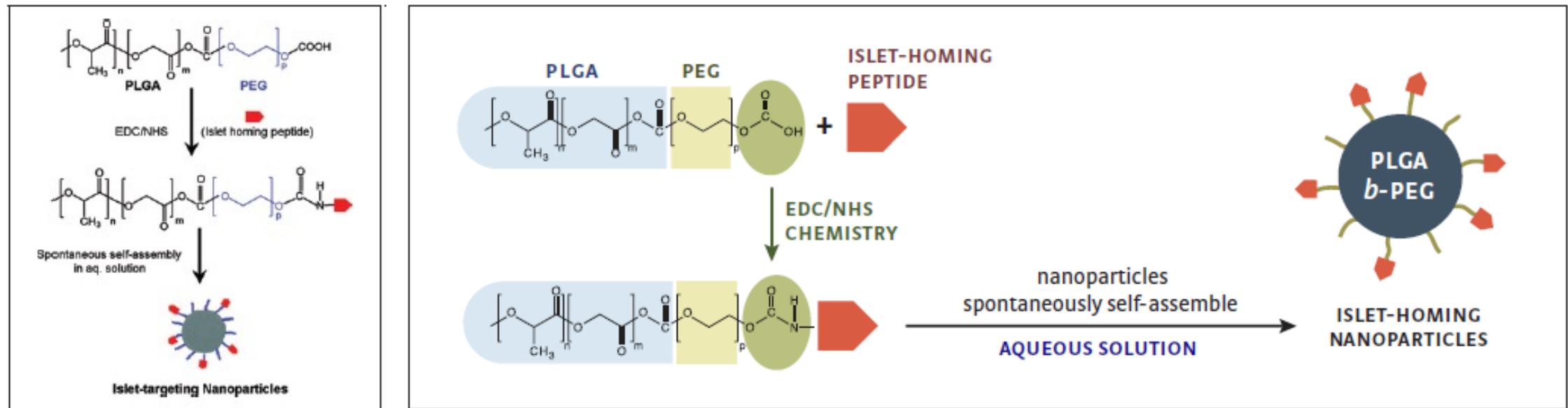
Simplicity



You can use the **Continuity** and **Closure** principle
to remove unnecessary elements in your chart



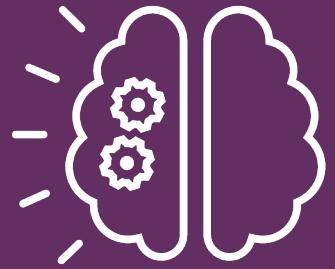
The Gestalt principles also apply to graphical abstracts



Shapes and colors used to identify similar structures.

But...

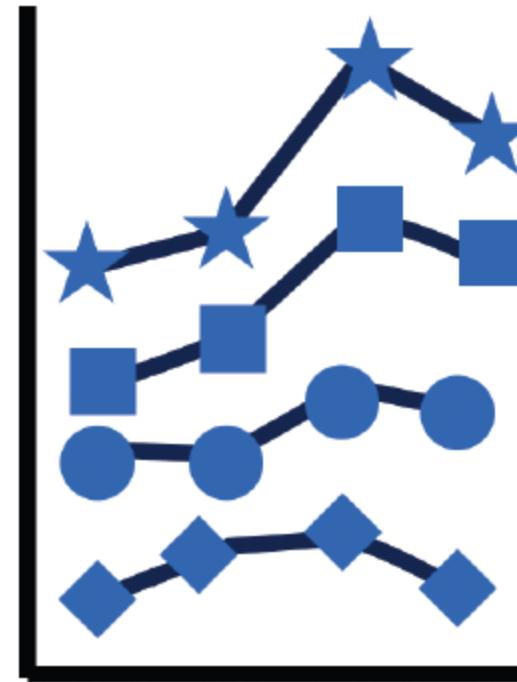
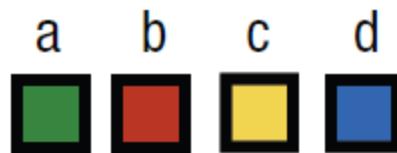
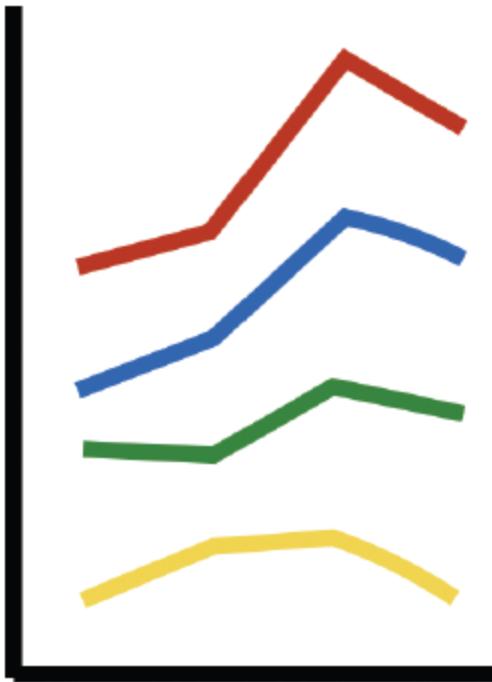
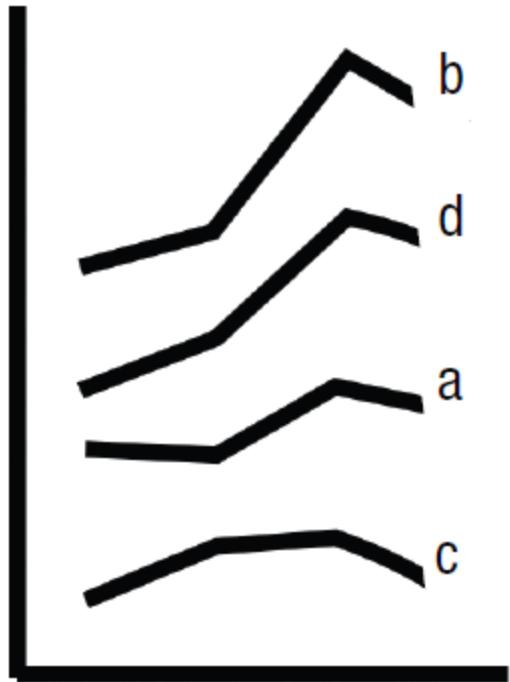




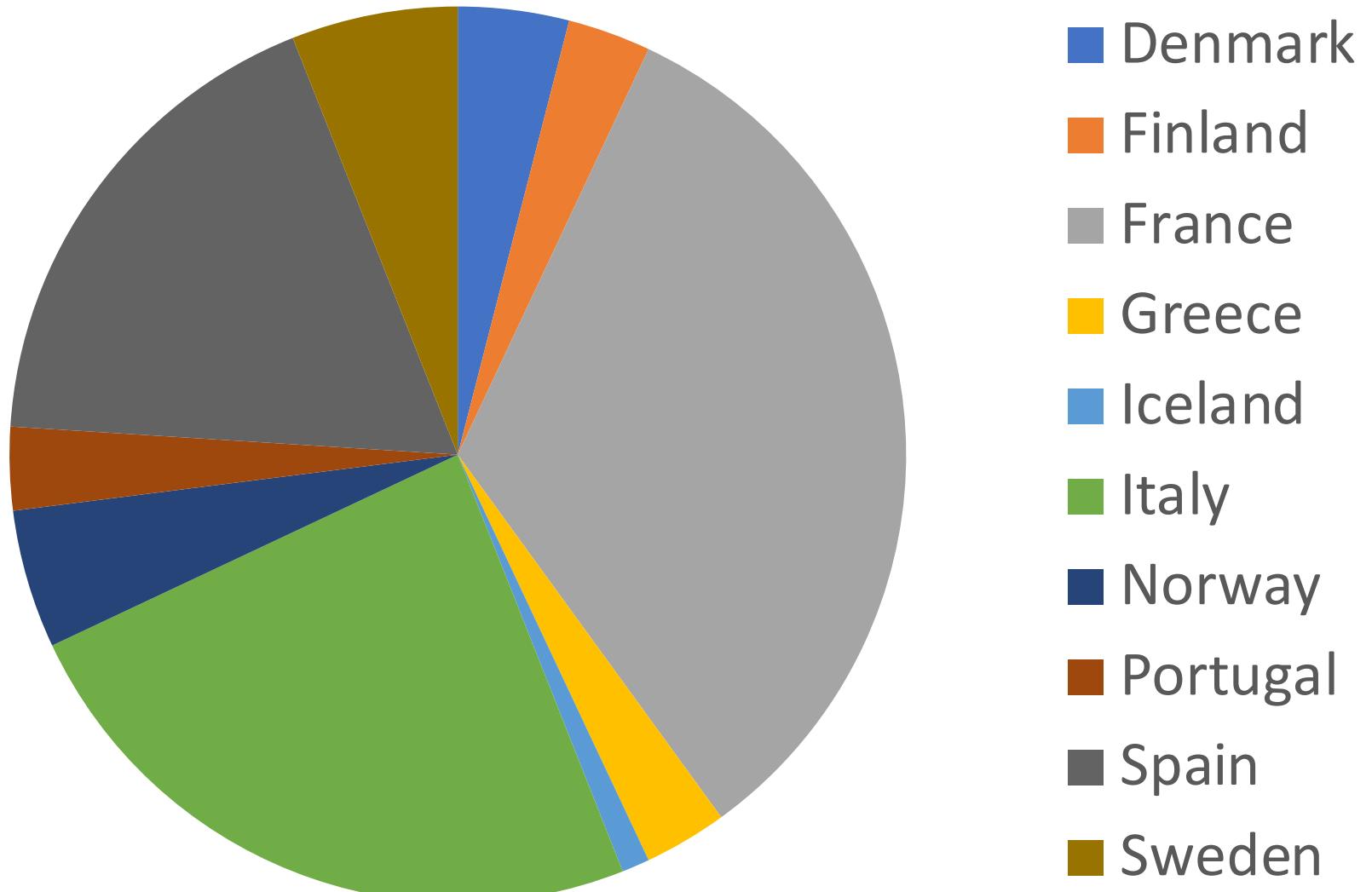
The weaknesses of our brain

“The eyes only see what the mind is prepared to comprehend.” – Henri Bergson.

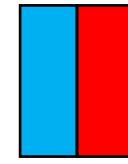
What is the order from top-to-bottom?



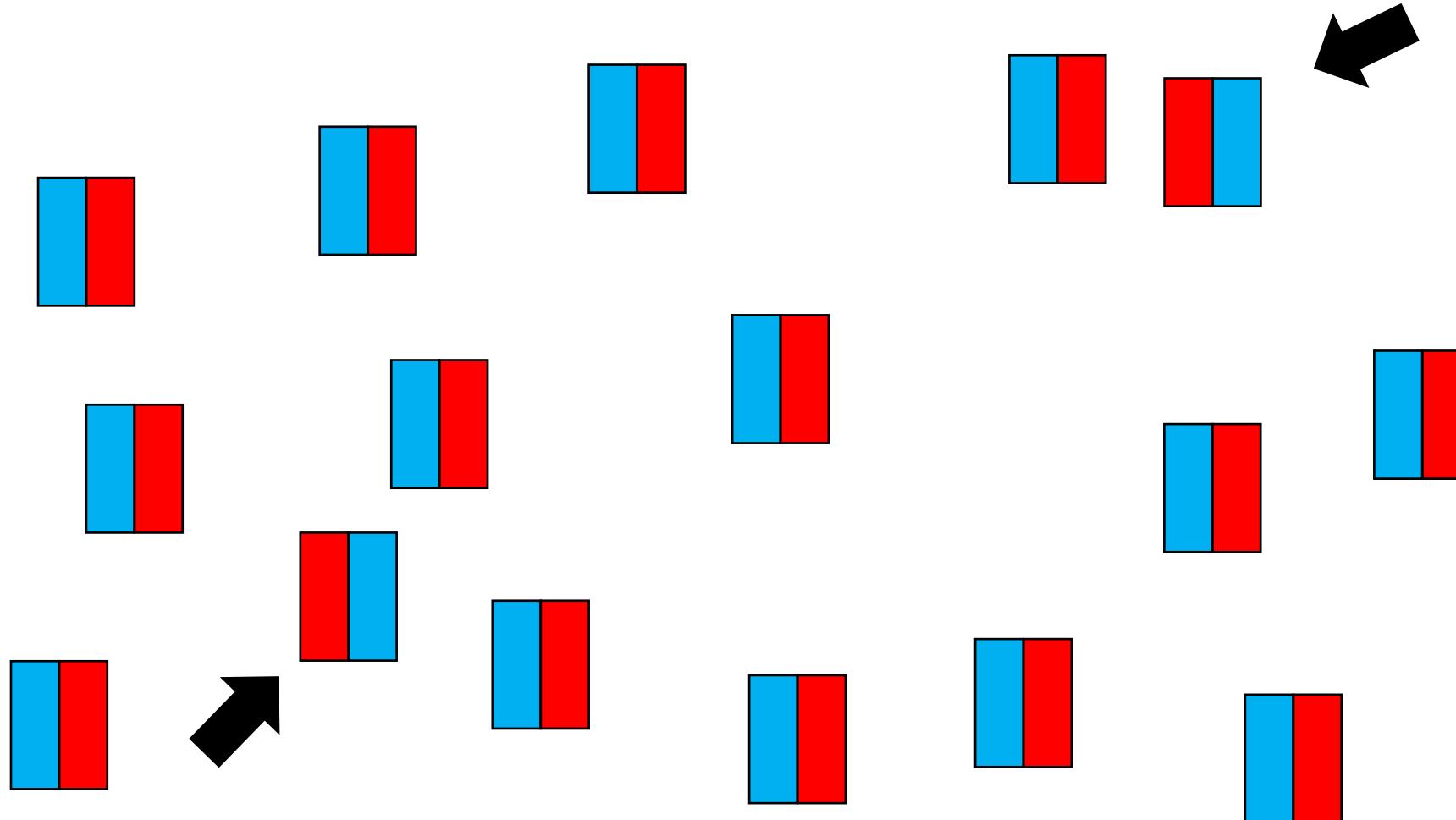
Norway has more widgets than Finland?



Comparing one set of colors is easy...



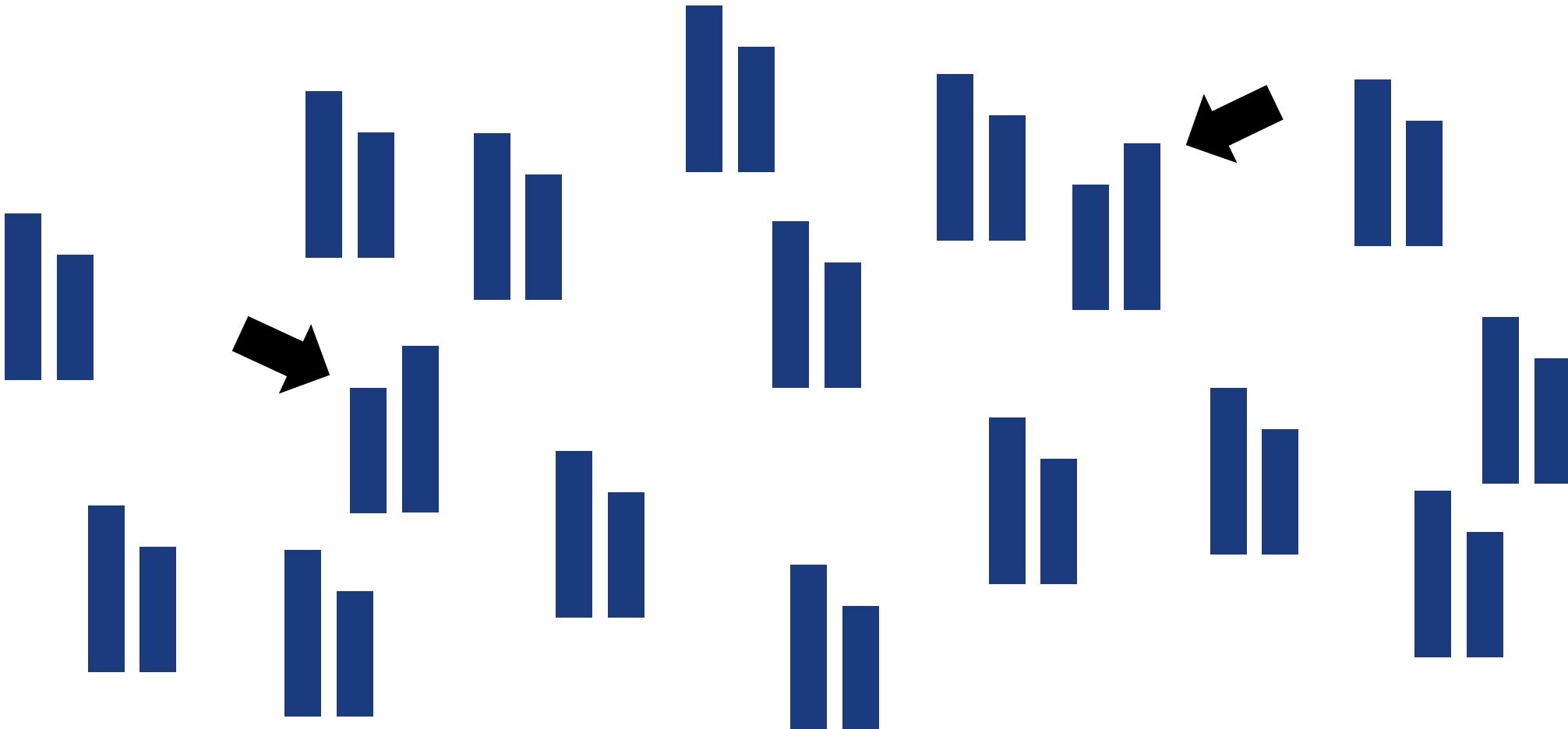
But: which one is not like the others?



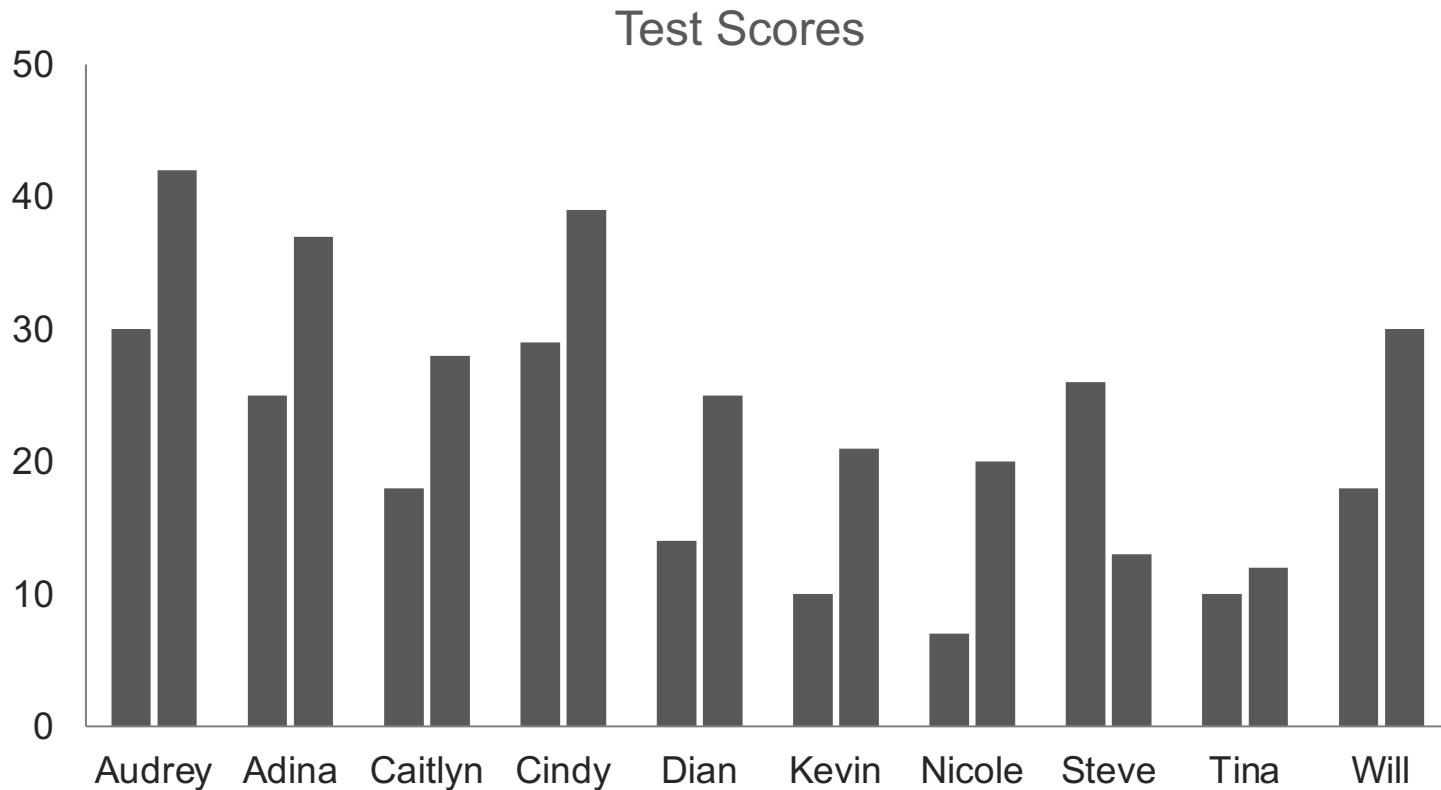
Do you see small-big or big-small?



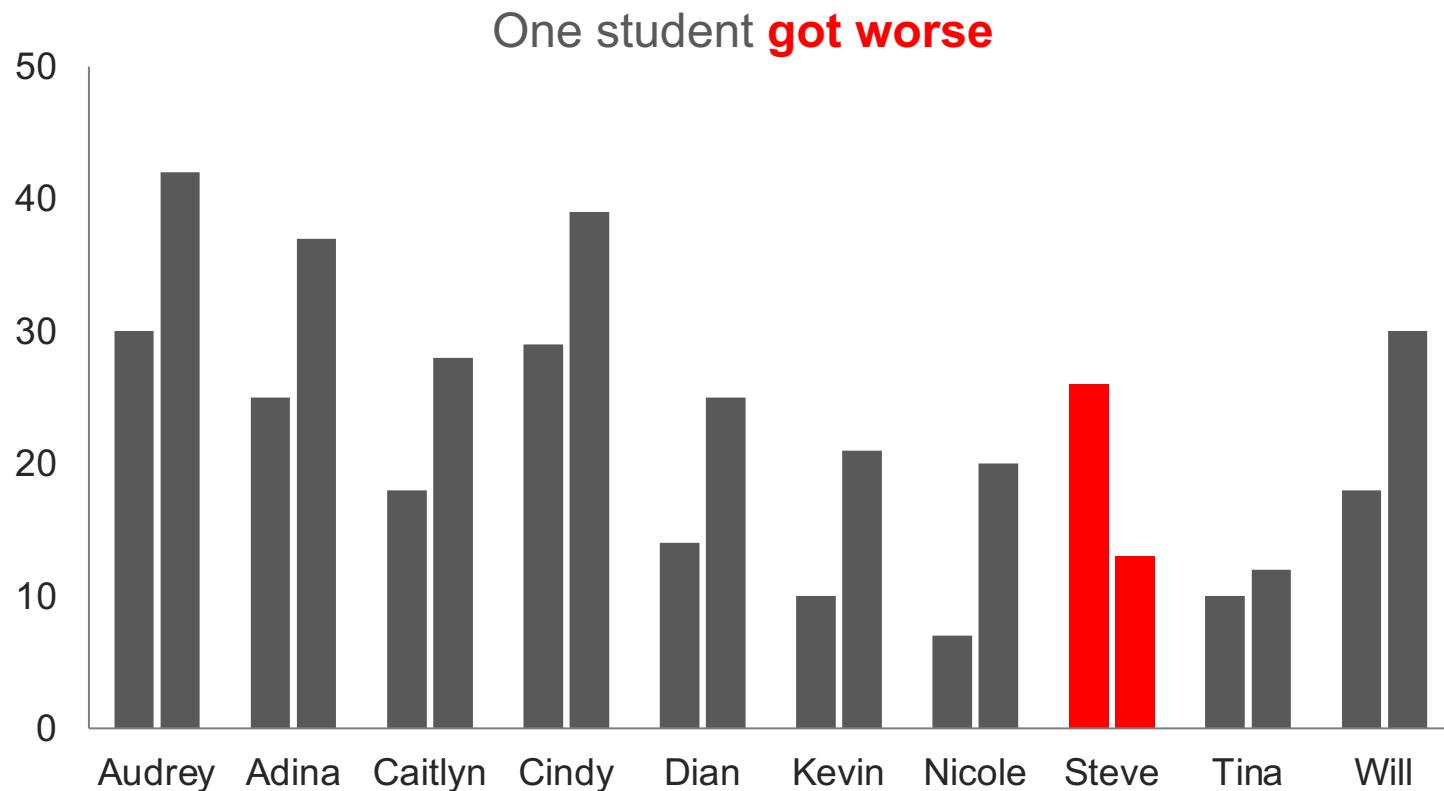
Which one is not like the others?



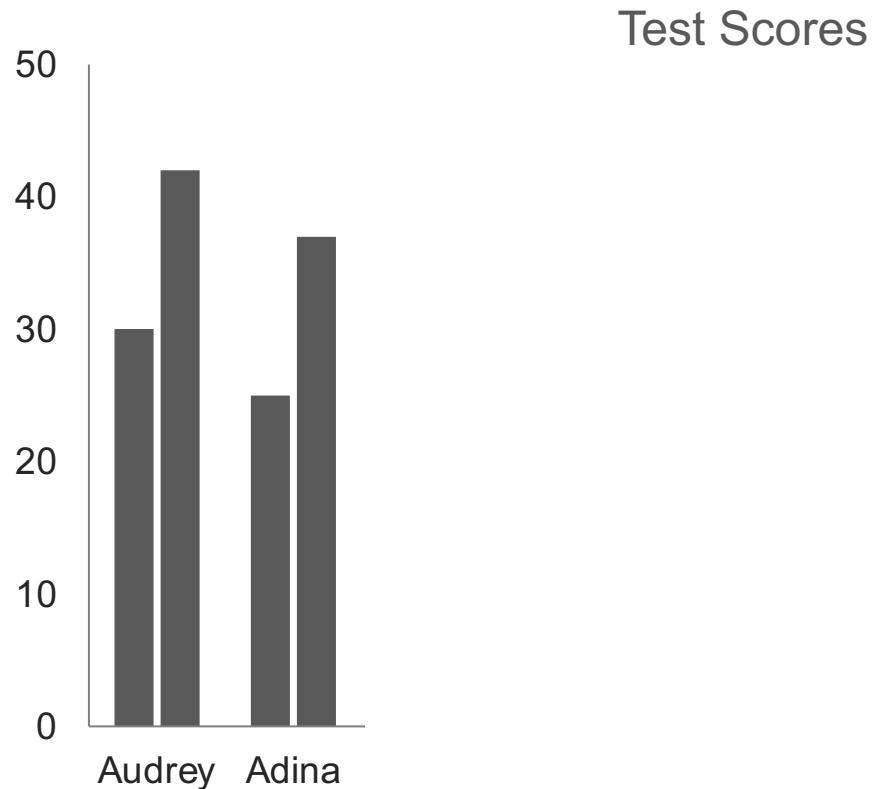
Which student got worse?



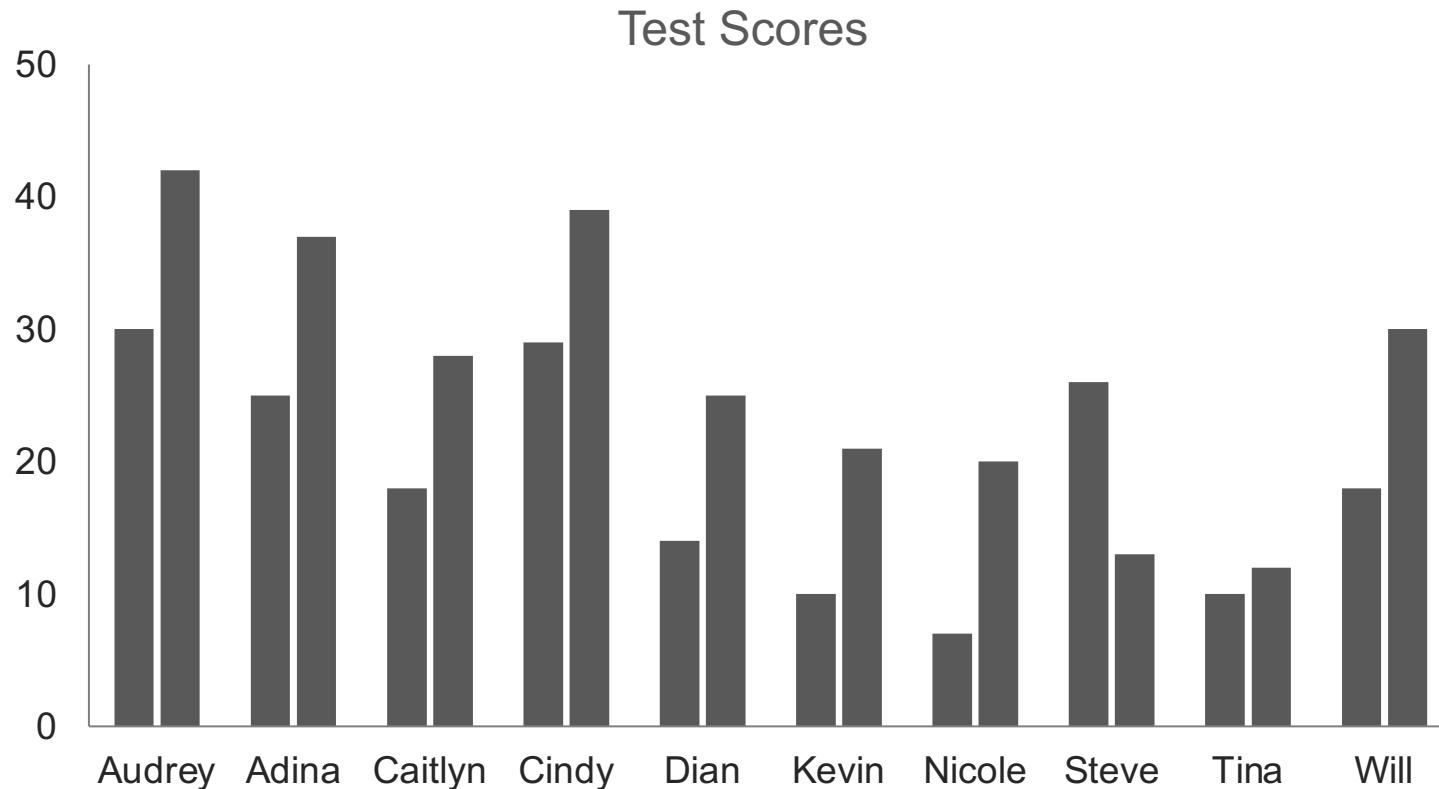
Which student got worse?



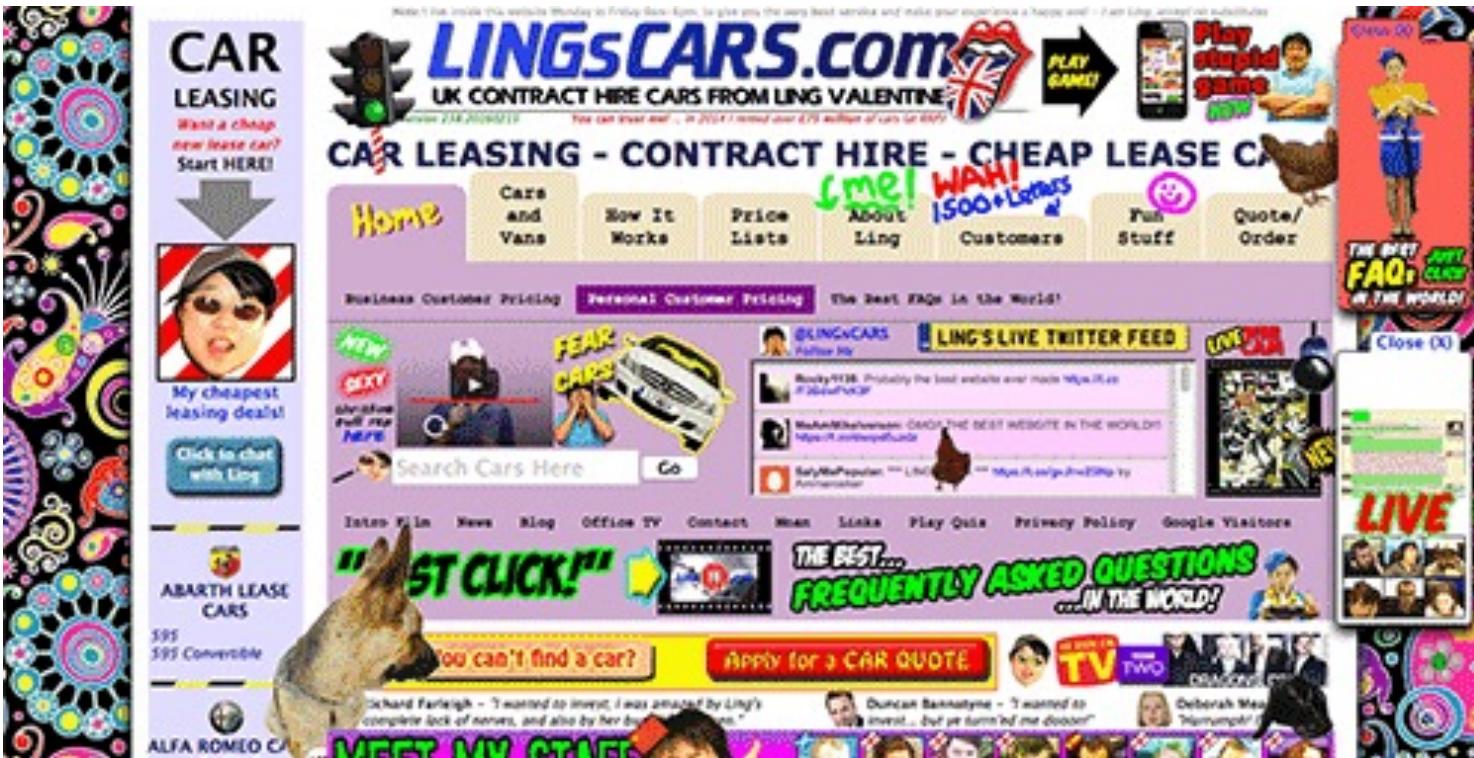
What is the average improvement?



What is the average improvement?



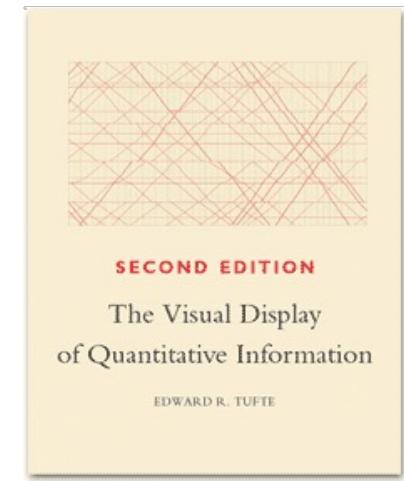
Where to look?



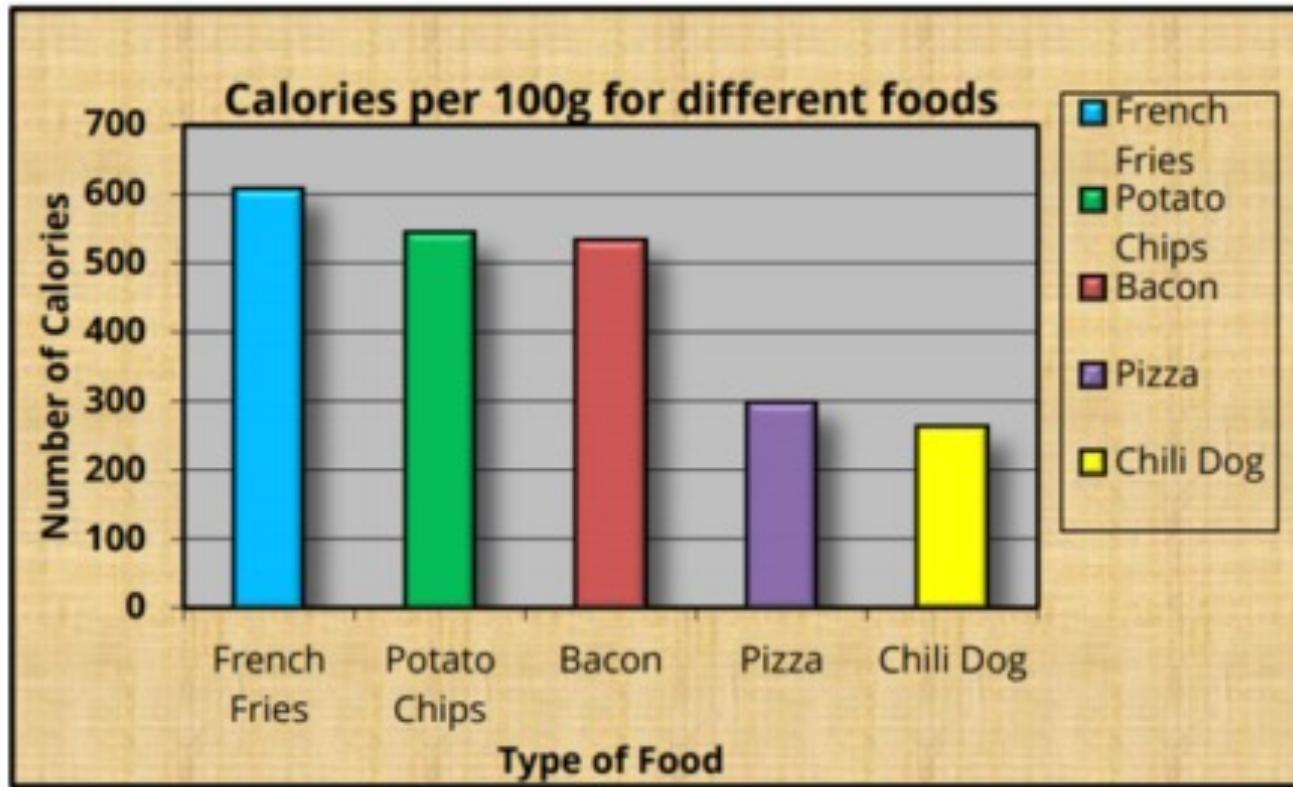
The data-ink ratio

Data-ink ratio =
$$\frac{\text{Data-ink}}{\text{Total ink used to print the graphic}}$$

- = proportion of a graphic's ink devoted to the non-redundant display of data-information
- = $1.0 - \text{proportion of a graphic that can be erased}$



Minimize distraction: maximize data-ink ratio



De data-ink ratio: remove to improve

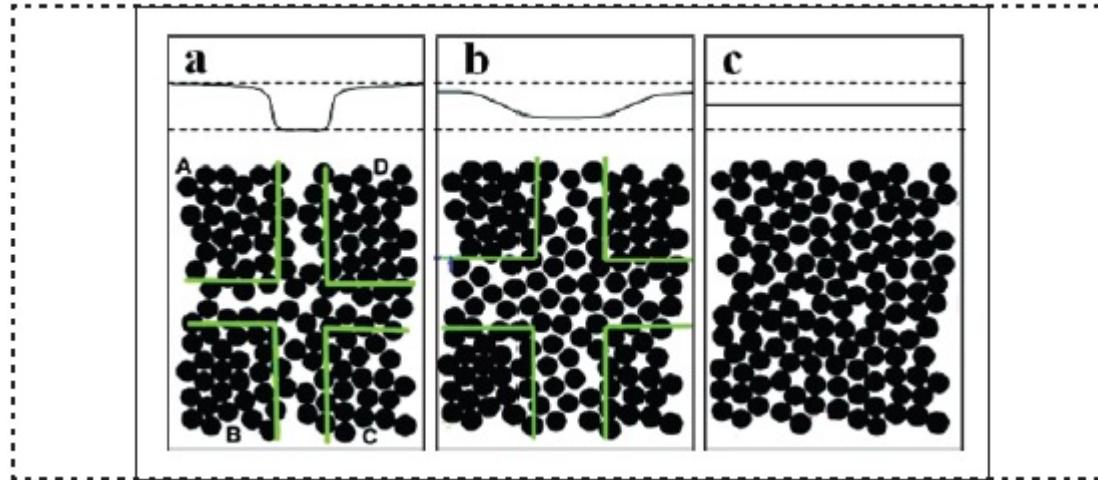
Remove
to improve
(the **data-ink** ratio)

Data-ink ratio also applies to tables

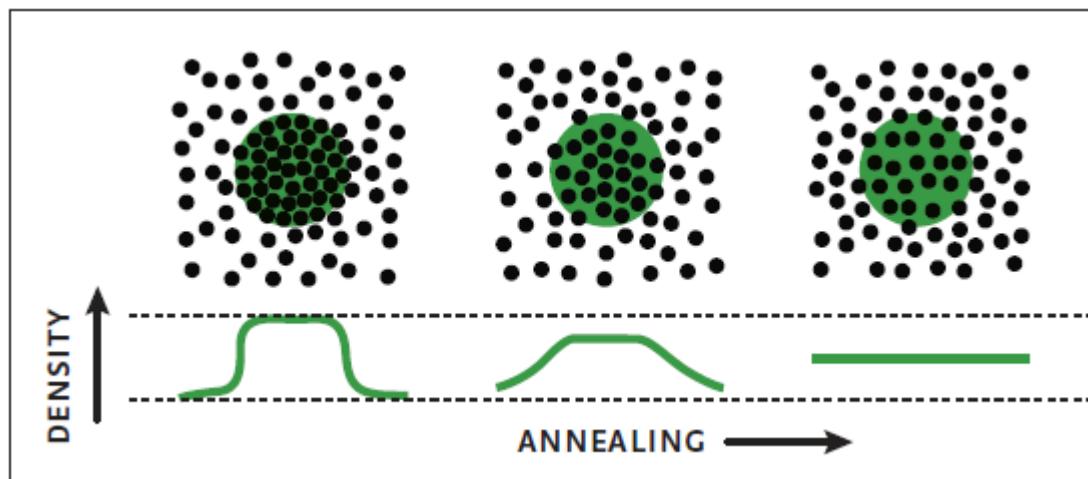
Student	Test1	Test2	Difference
Audrey	30.00	42.00	12.00 pts
Adina	25.00	37.00	12.00 pts
Caitlyn	18.00	28.00	10.00 pts
Cindy	29.00	39.00	10.00 pts
Dian	14.00	25.00	11.00 pts
Kevin	10.00	21.00	11.00 pts
Nicole	7.00	20.00	13.00 pts
Steve	26.00	13.00	-13.00 pts
Tina	10.00	12.00	2.00 pts
Will	18.00	30.00	12.00 pts

Student	Test1	Test2	Difference (pts)
Audrey	30	42	12
Adina	25	37	12
Caitlyn	18	28	10
Cindy	29	39	10
Dian	14	25	11
Kevin	10	21	11
Nicole	7	20	13
Steve	26	13	-13
Tina	10	12	2
Will	18	30	12

And to graphical abstracts



Too many interior boxes clutter the layout.



Boxes removed and arrows simplified.

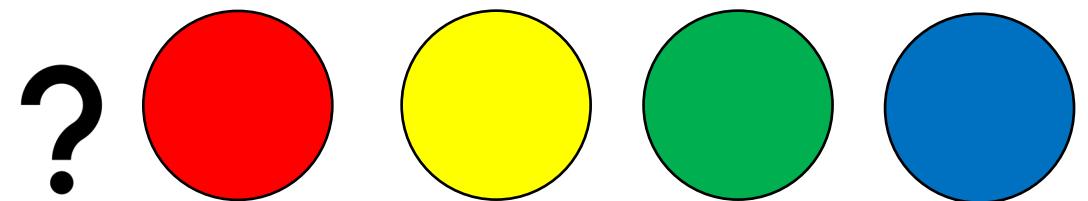
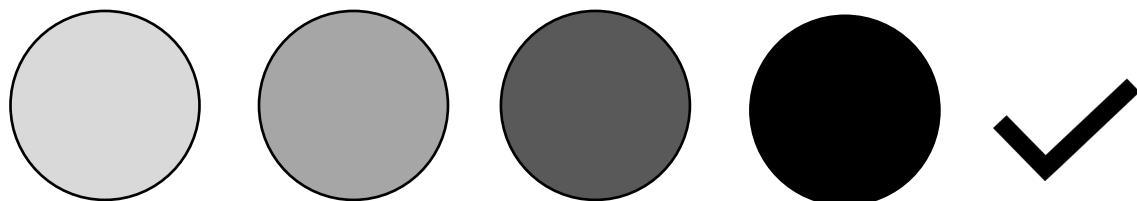
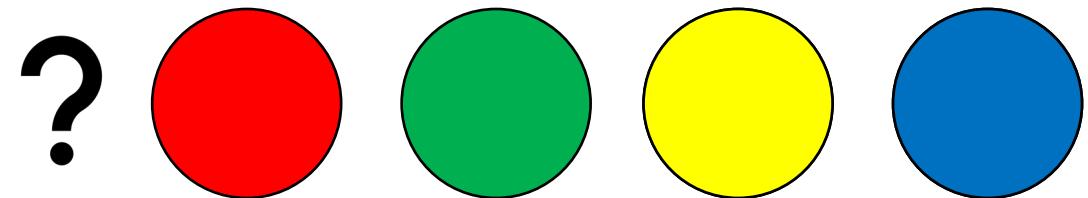
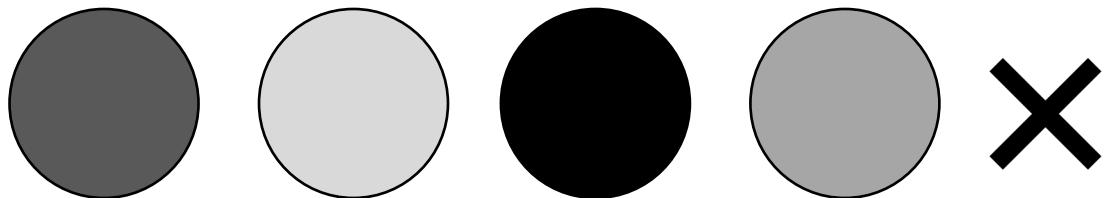
Color!



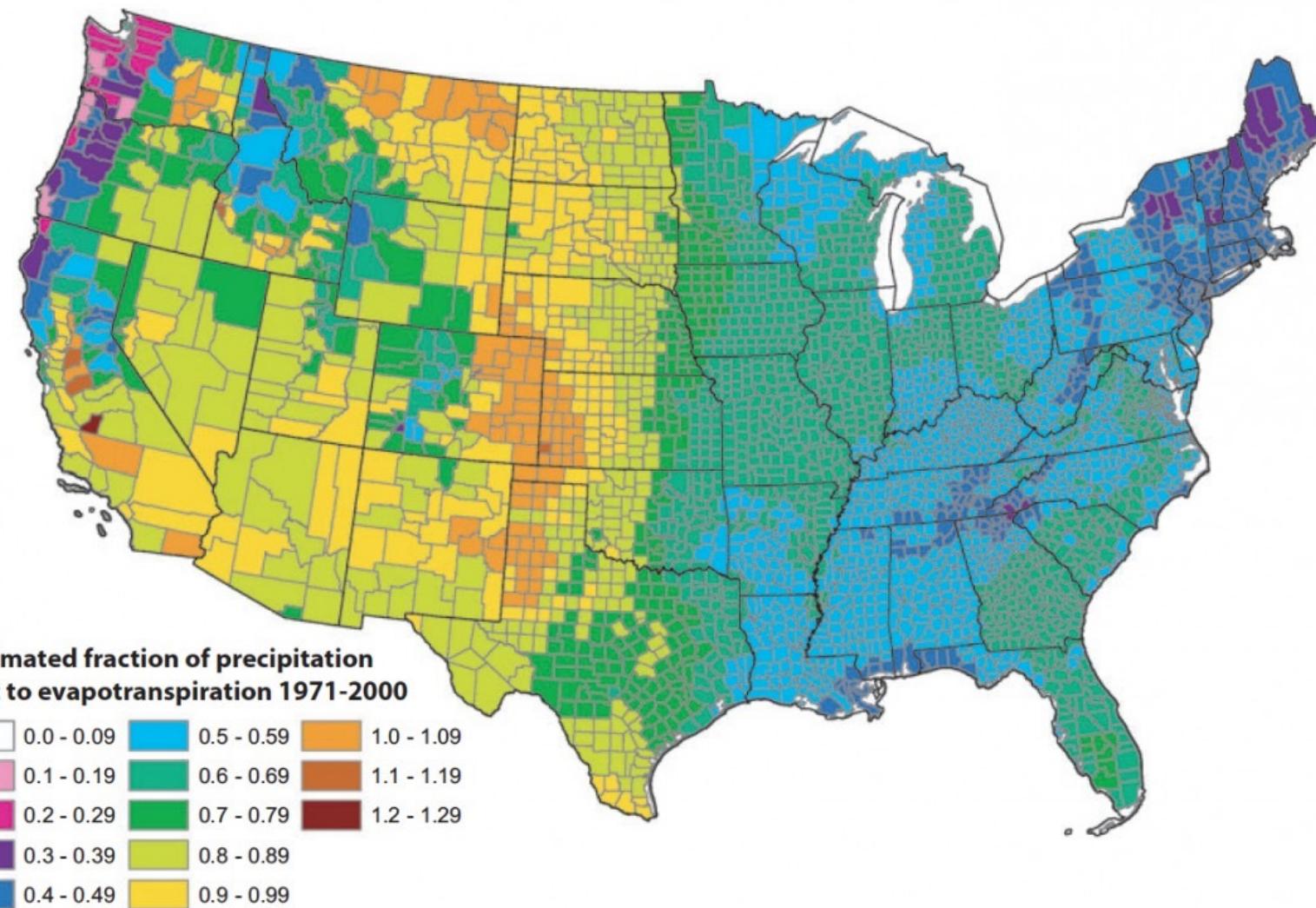
How to rank those circles from low to high?



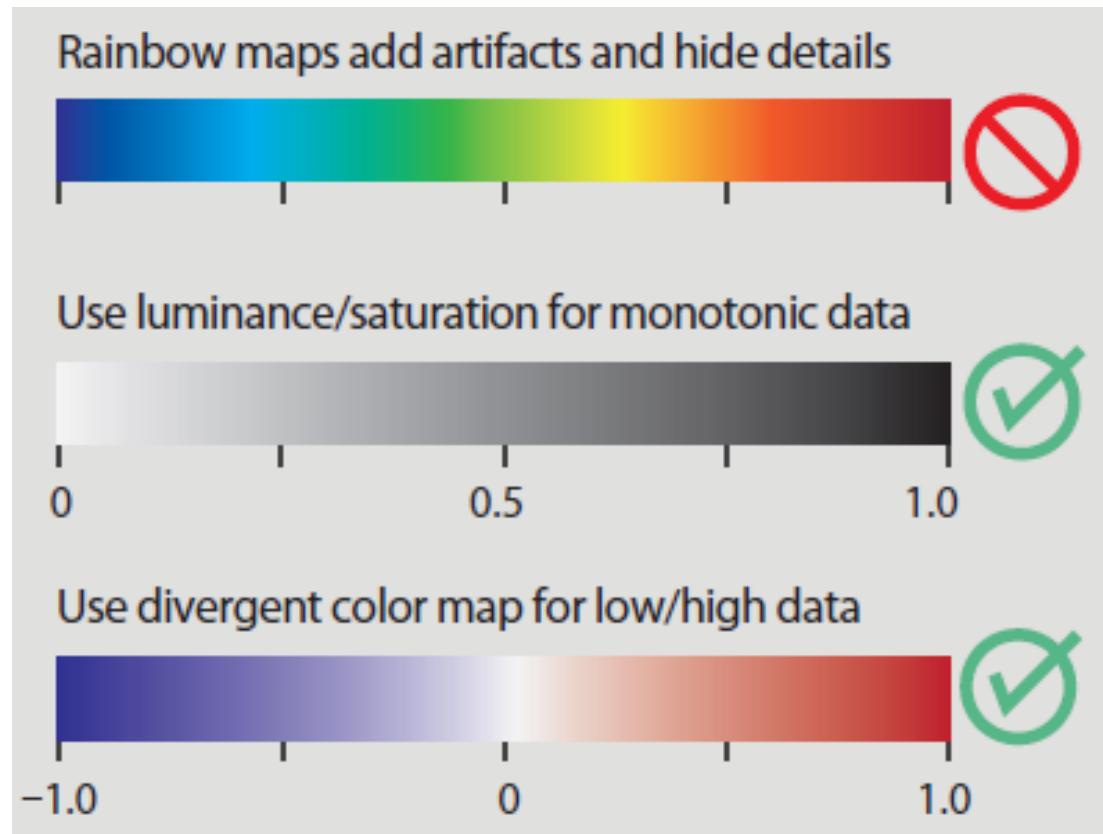
How to rank those circles from low to high?



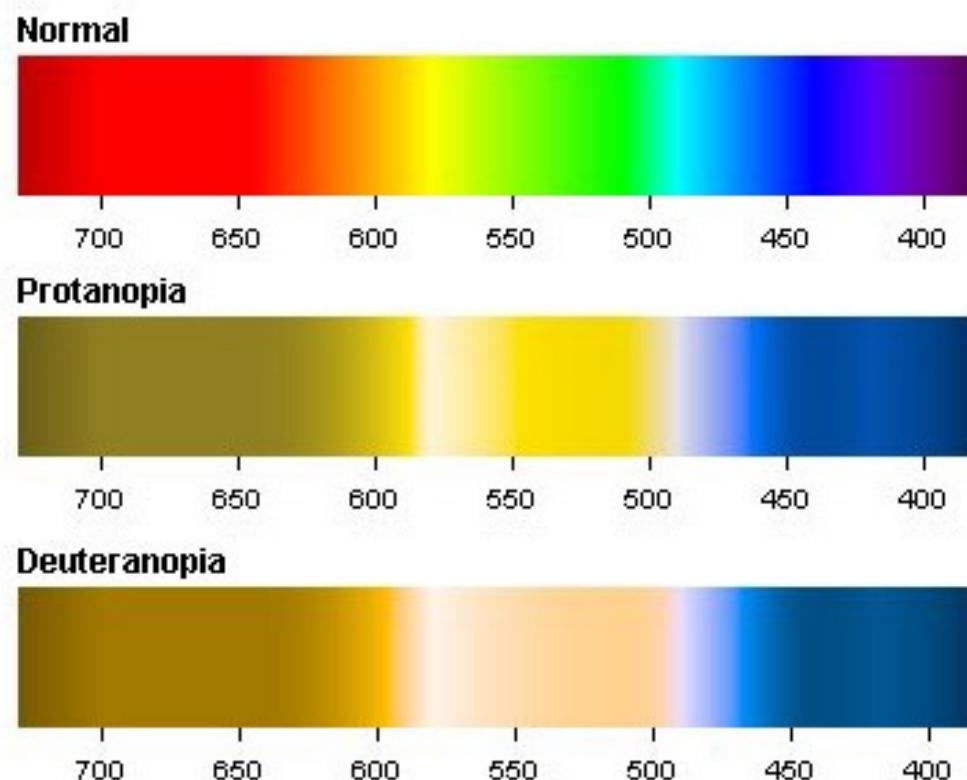
Avoid rainbow color maps for quantities!



Use a monochromatic or a diverging color scale instead



Another issue with color: color vision deficiency

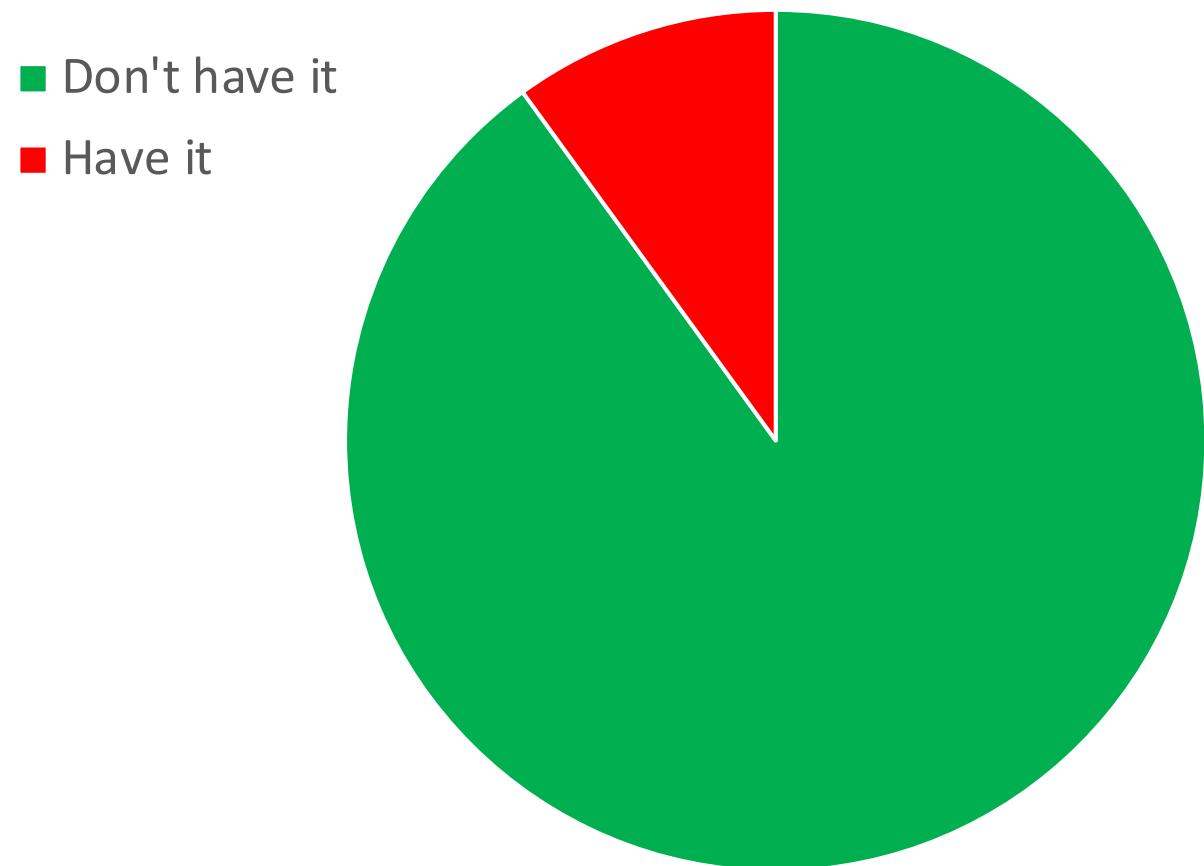


~2% male population

~6% male population

Avoid red-green color palettes

Red-green color blindness in men



Color issues are common in science communications!

Hydrol. Earth Syst. Sci.

797 papers from 2005-2020

Papers with color issues
(total % per journal)



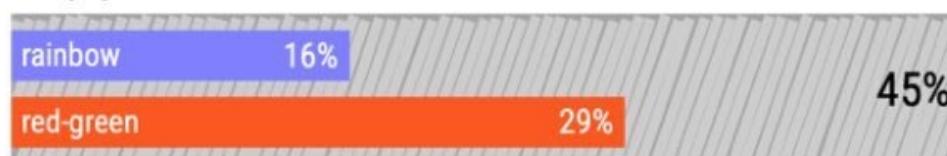
Nature Scientific Reports

Top 100 papers from 2019



Nature Communications

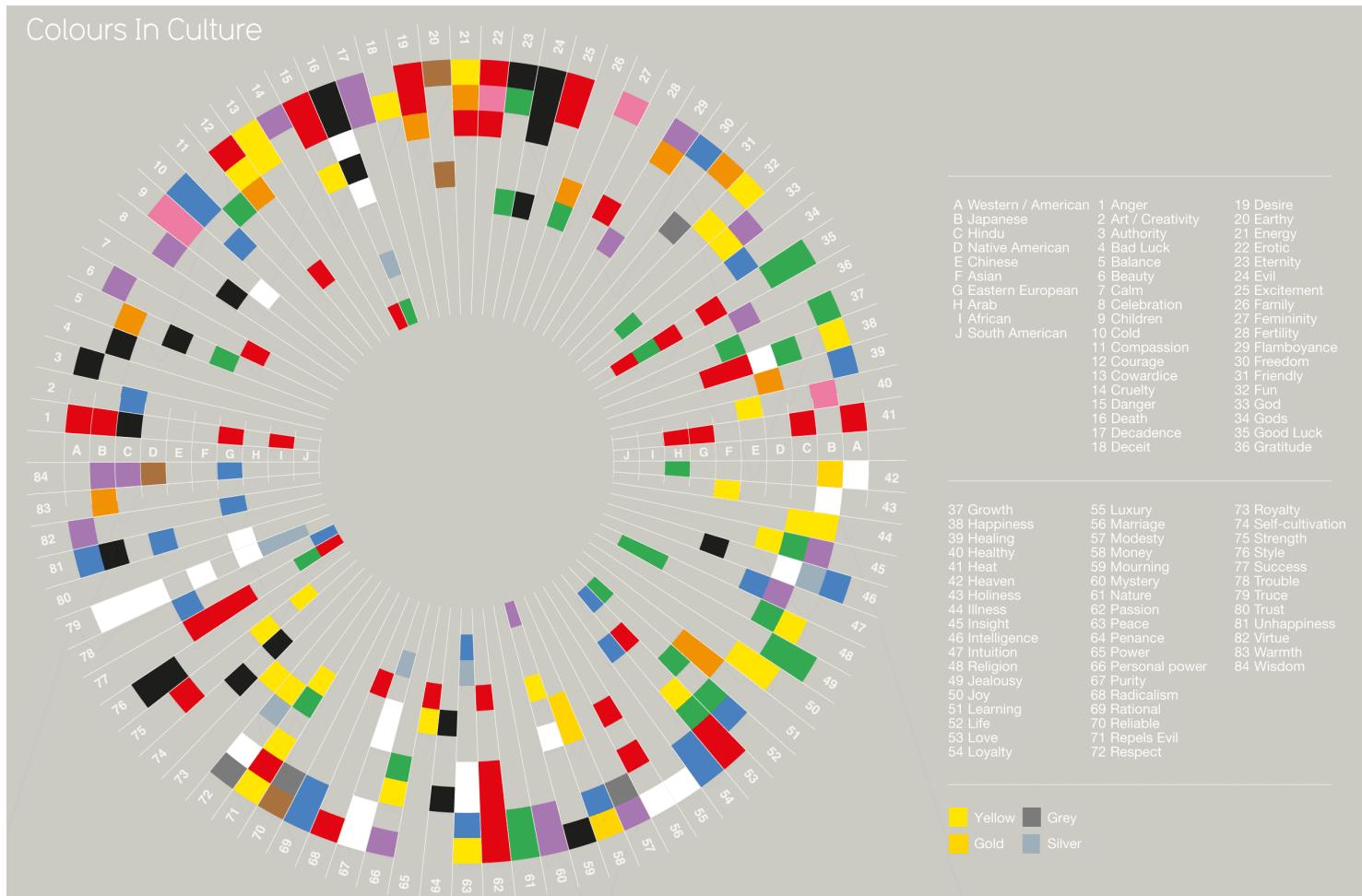
100 papers from 4-6 Nov 2020



Lastly, color is associated to feelings...

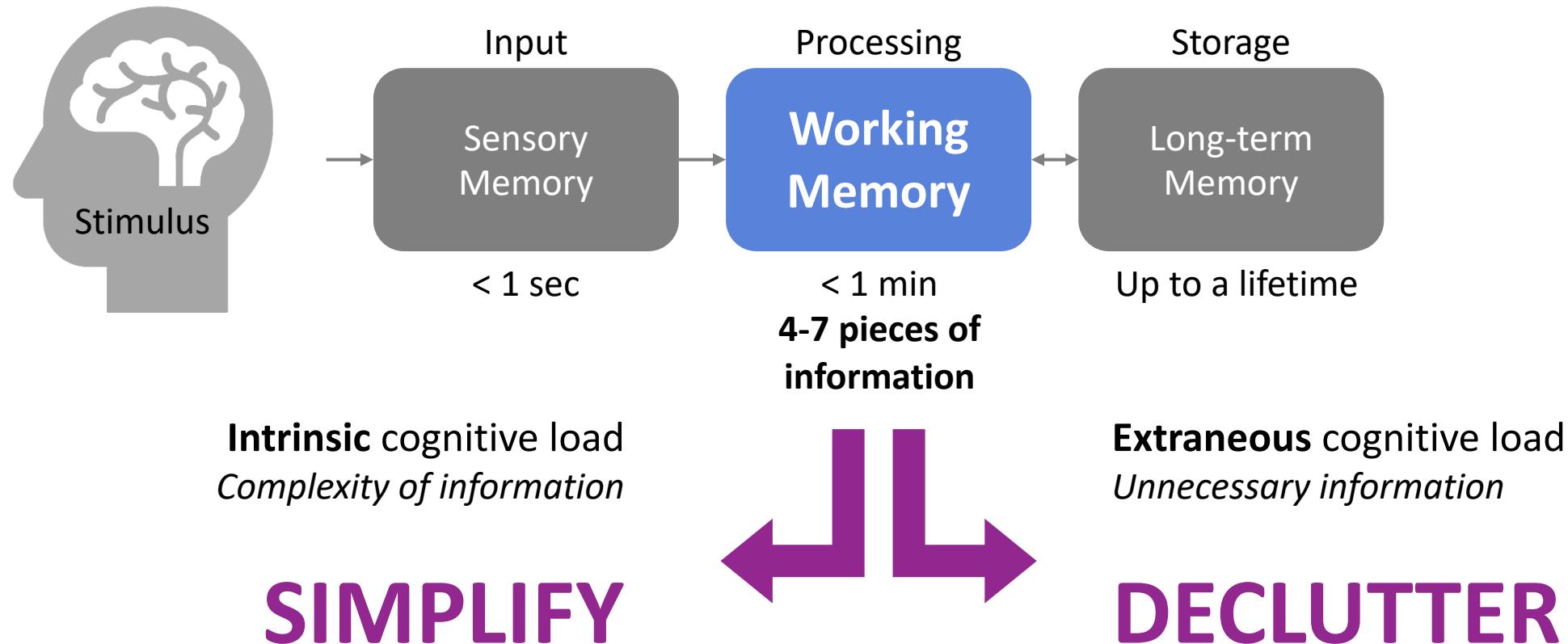


...and differs between cultures



Putting it all together

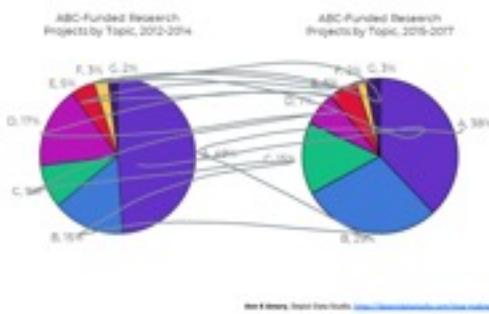
Optimize visual perception: minimize *intrinsic* and *extraneous cognitive load*



Putting it all together: Simplify, declutter, add focus



Simplify: Enable direct comparisons



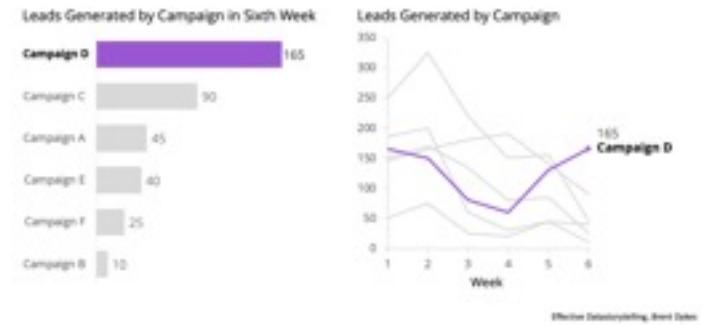
Declutter: Minimize distractions



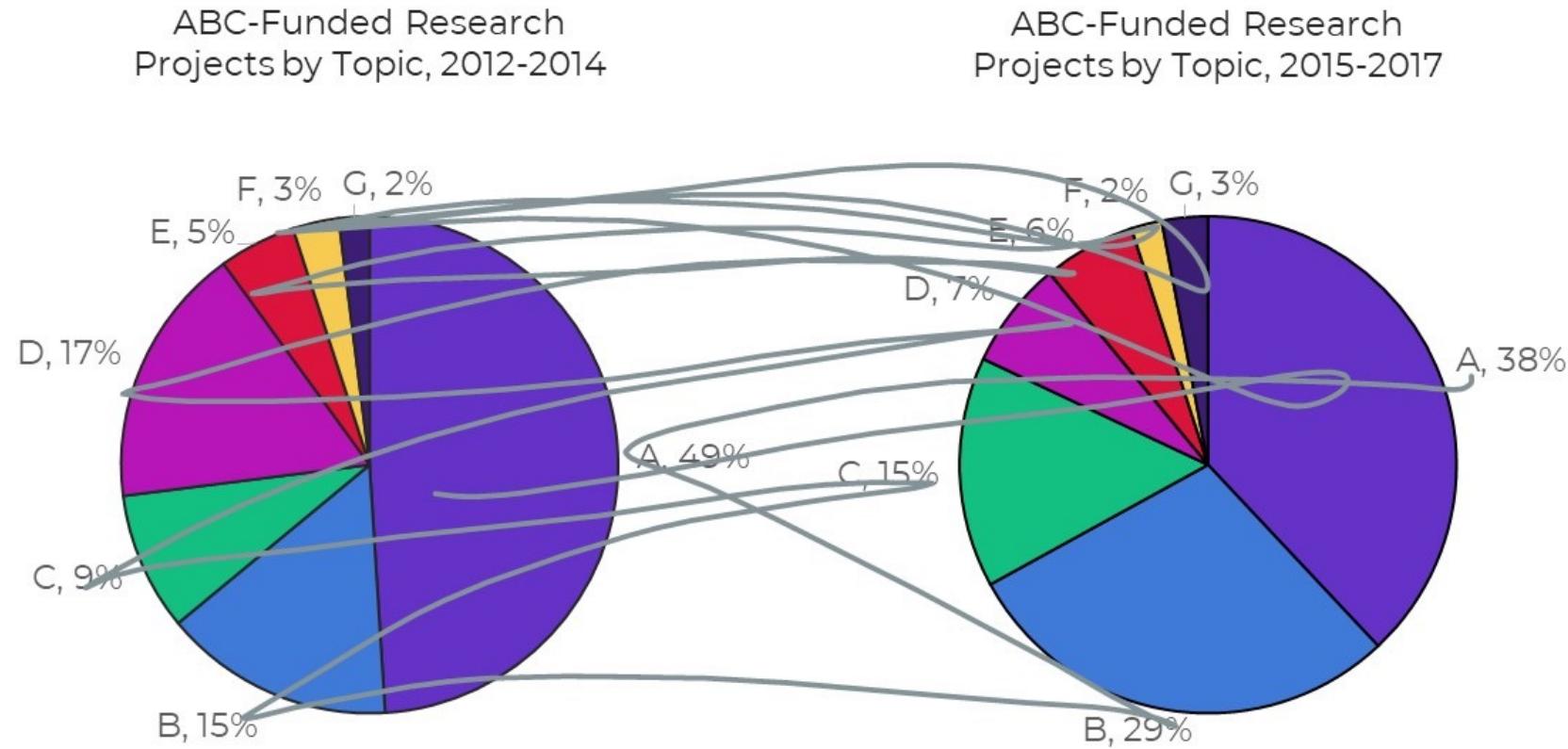
Karina Herpelová, The art of data visualization, a gift or a skill? Part 2: Isaca journal 2 (2010) 1-6.



Add focus: Highlight what's important



Simplify: Enable direct comparisons



Declutter: Minimize distractions



Effective. Not optimal.



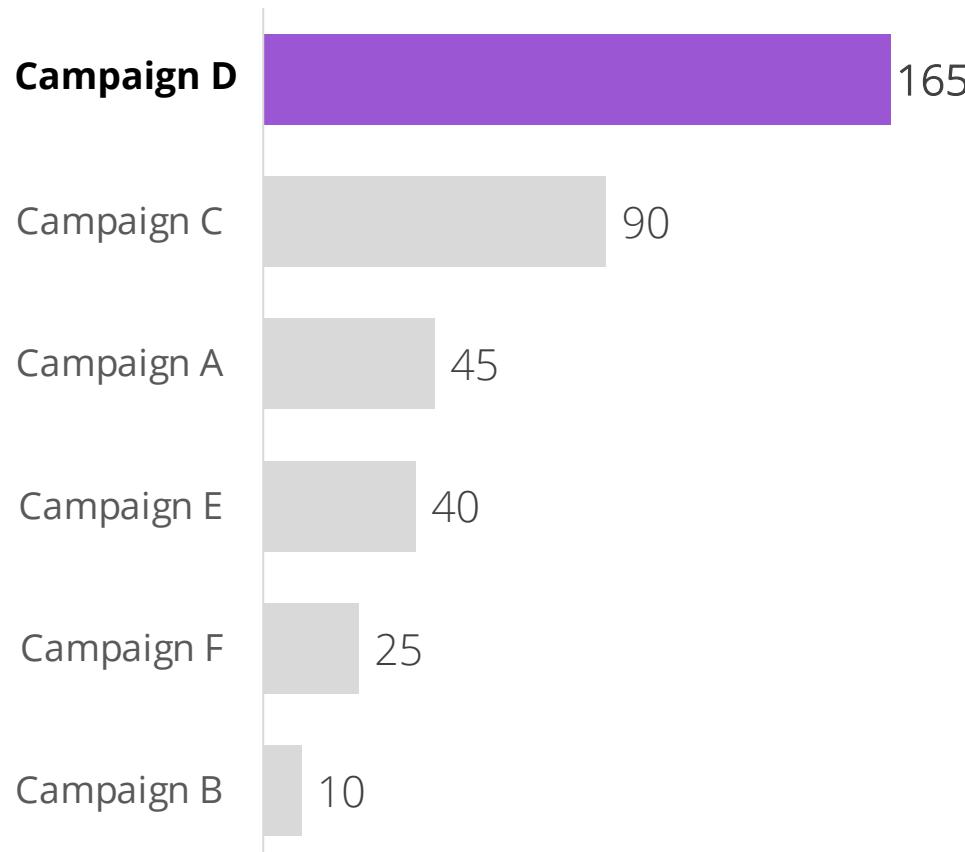
Simple, effective, optimal.



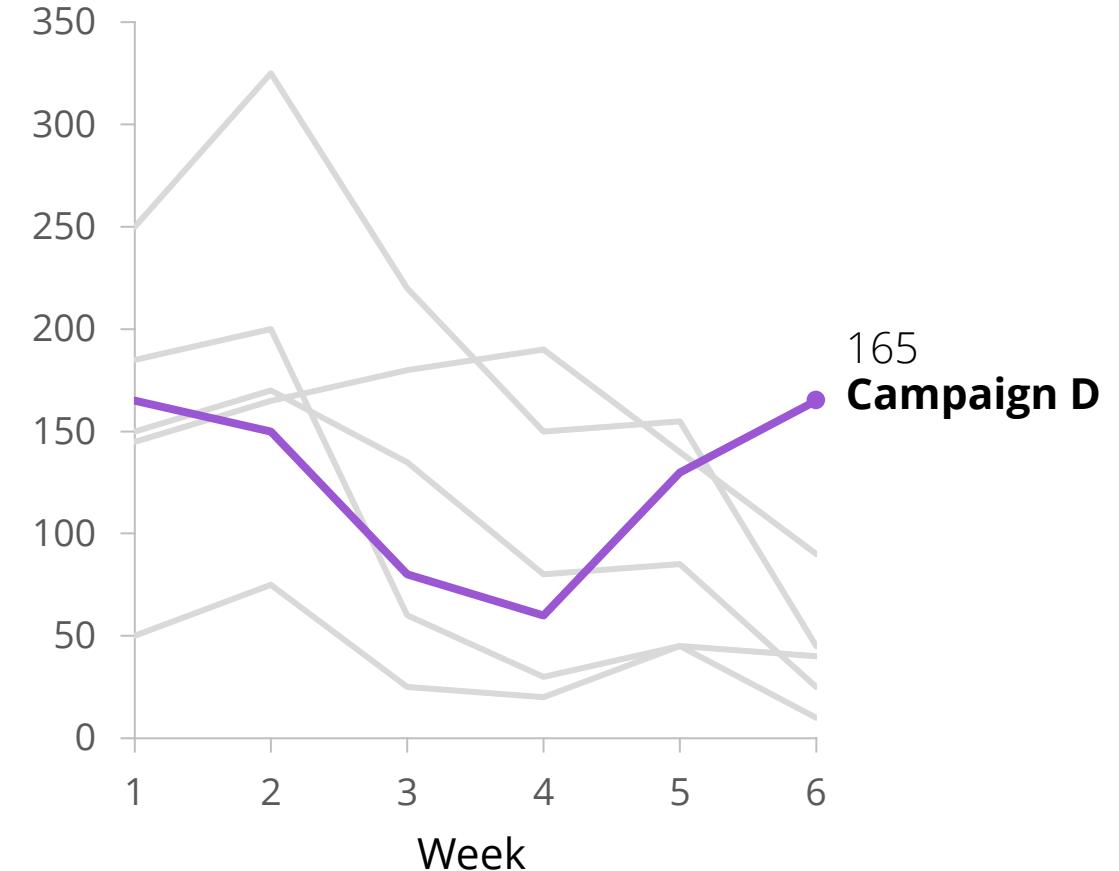
Bad.

Add focus: Highlight what's important

Leads Generated by Campaign in Sixth Week



Leads Generated by Campaign



Exercise

A look at your work.

Simplify and declutter.



Peer-feedback on your own work.

1.  **Simplify:** Enable direct (fast) comparisons

2.  **Declutter:** Eliminate irrelevant distractions

3.  **Add focus:** Draw attention to where you want it

- Is the most appropriate chart type used to present the data/message?
- What takes up most time to process? Could this process be simplified?
- Are there any unnecessary, redundant or distracting elements that can be removed/reduced?
- How could the message be more emphasized?
- Are all text and labels legible?

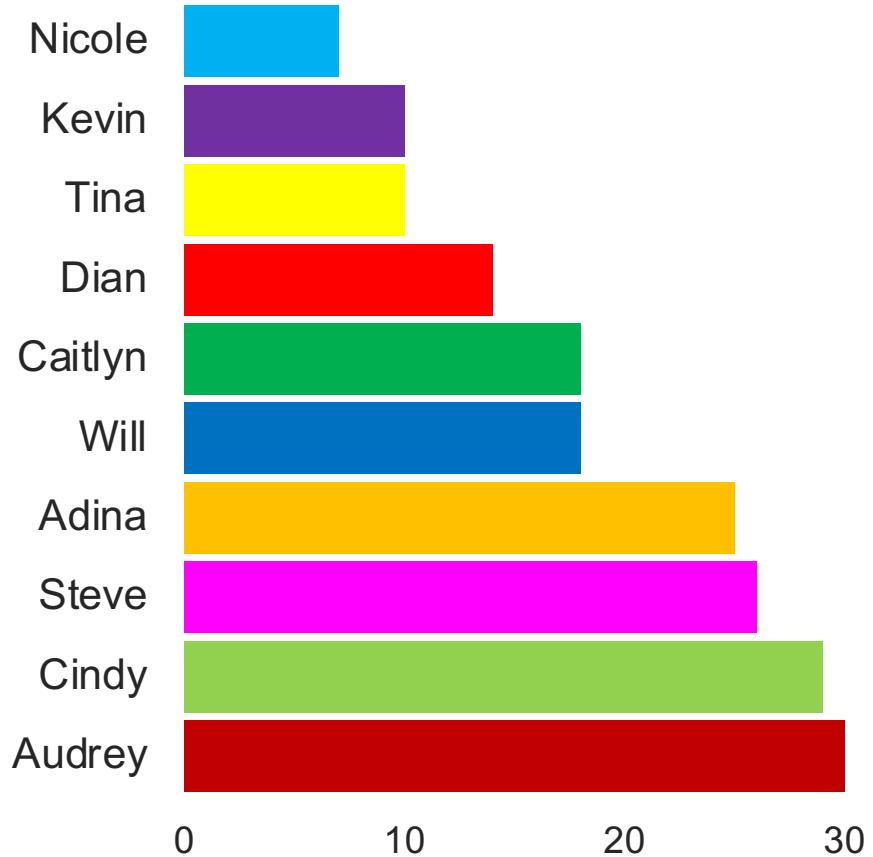


Do's and Don'ts

Show the *right* data, show the *data* right!

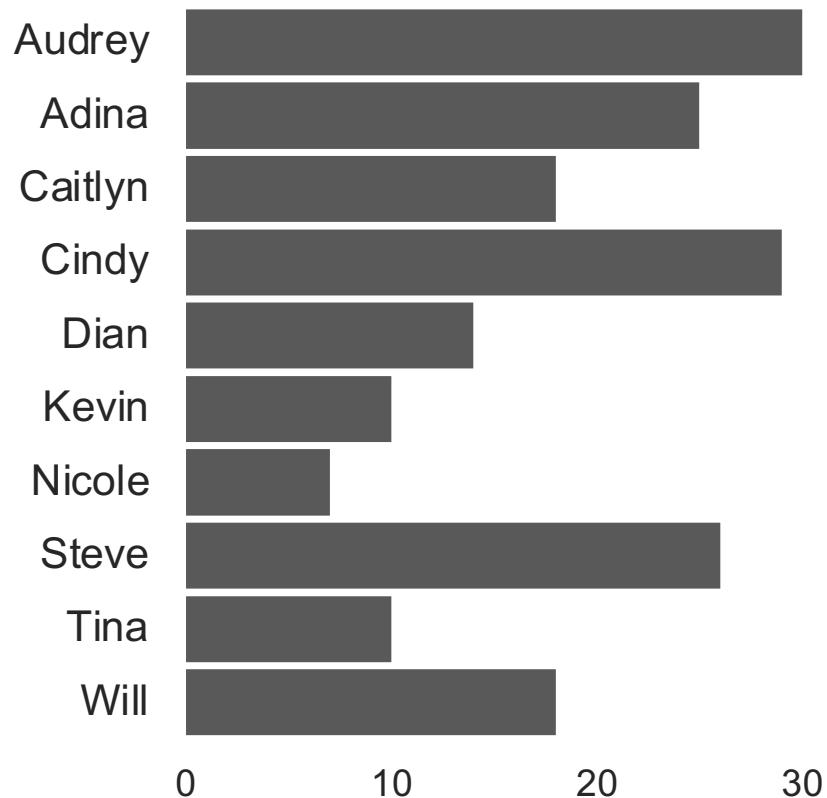


Don't: Use too many (useless) colors

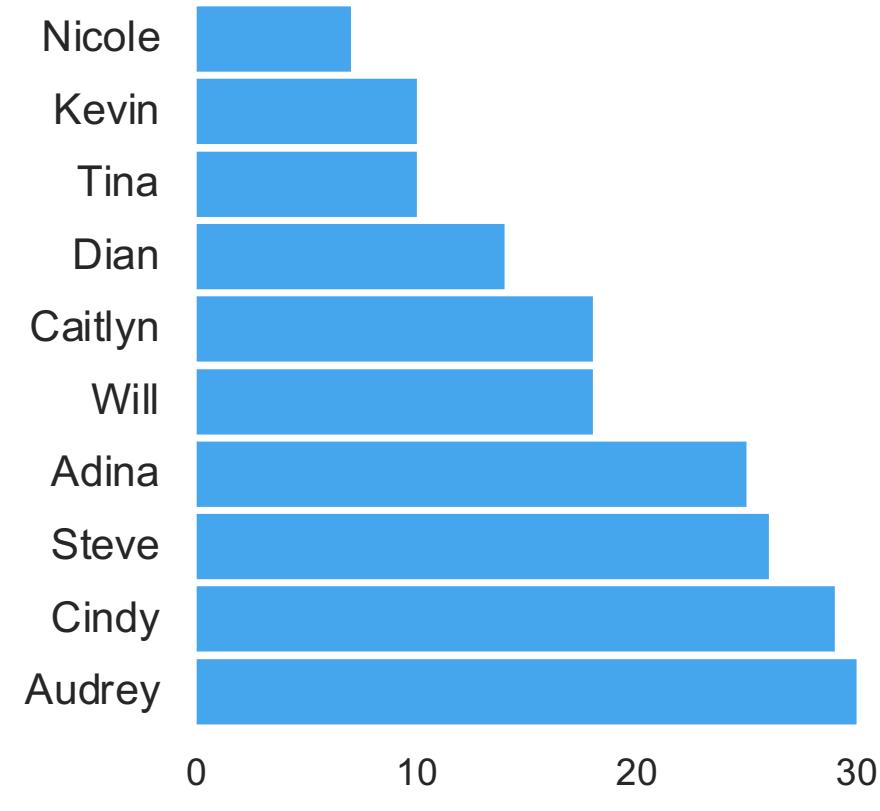


Do: Order your data logically, e.g., alphabetically or by number

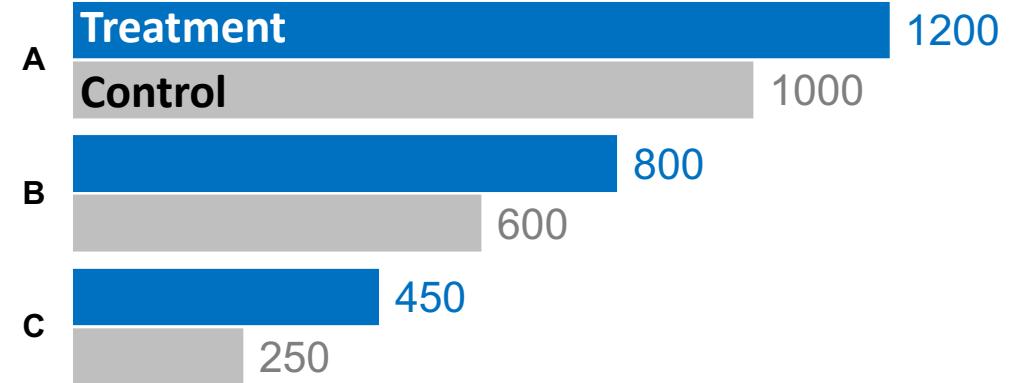
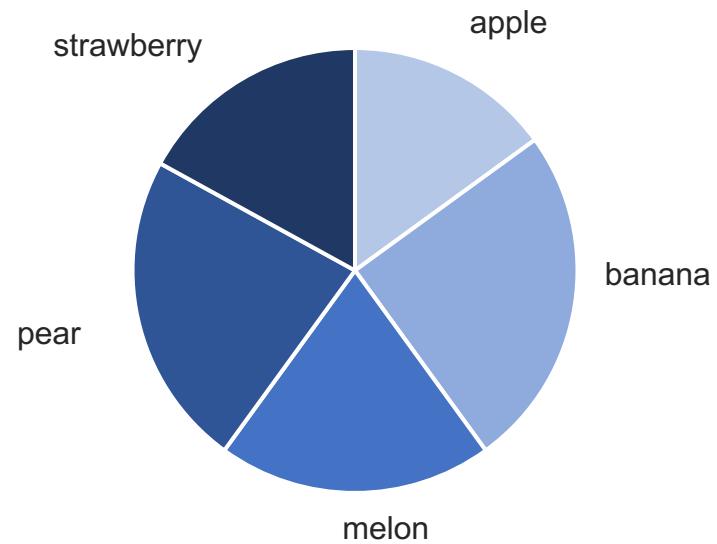
Student's scores for test 1



Student's scores for test 1

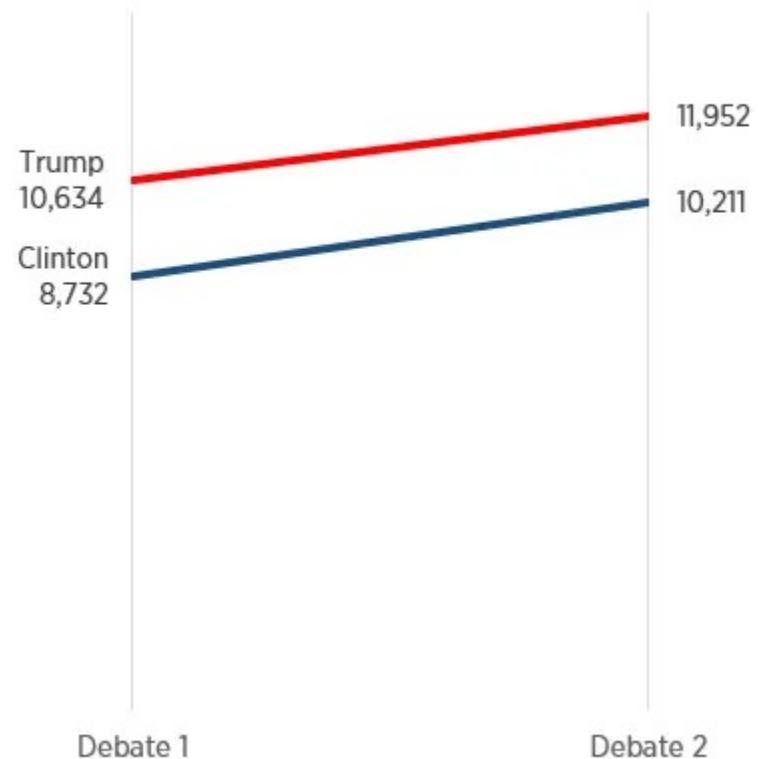


Do: Label your data directly

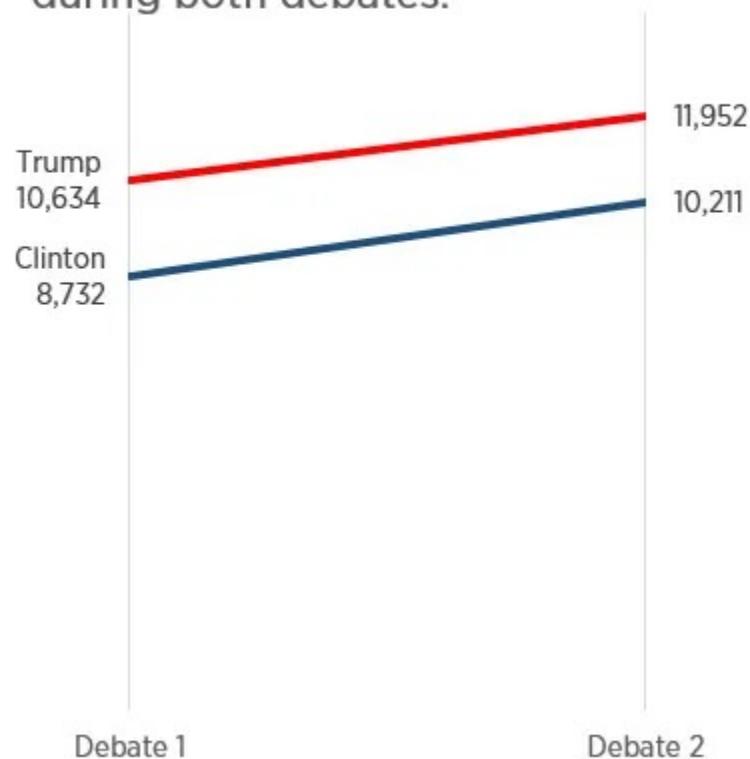


Do: Describe

Words Spoken at Debate

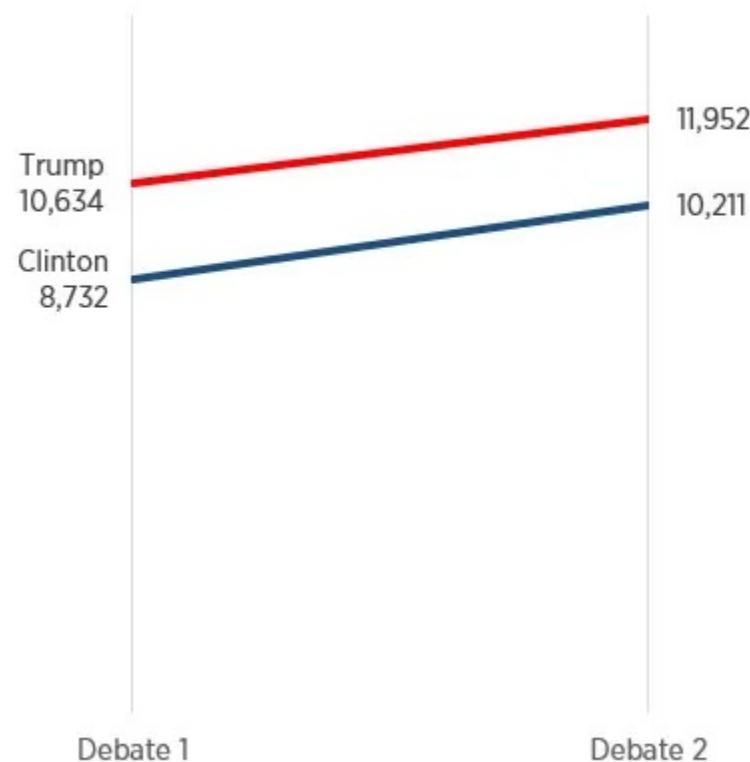


Trump spoke more words during both debates.

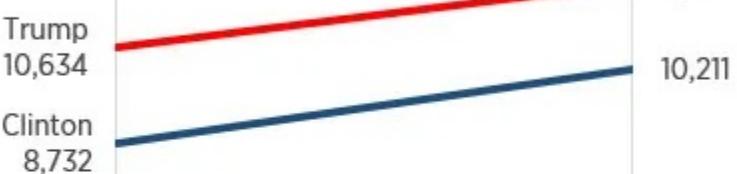


Don't: Judge

Words Spoken at Debate

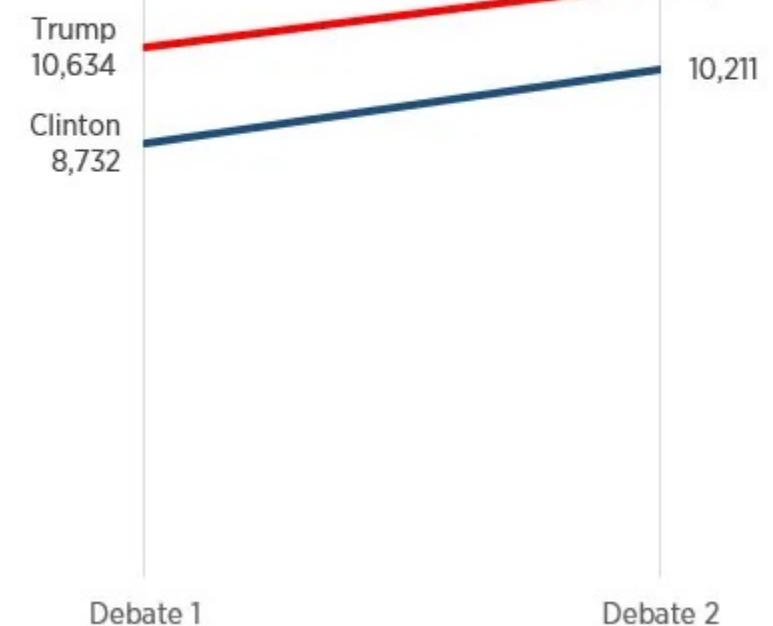


Trump spoke more words during both debates.



Trump spoke more words during both debates.

Therefore he deserves to be president.
Or maybe he's just a blowhard.

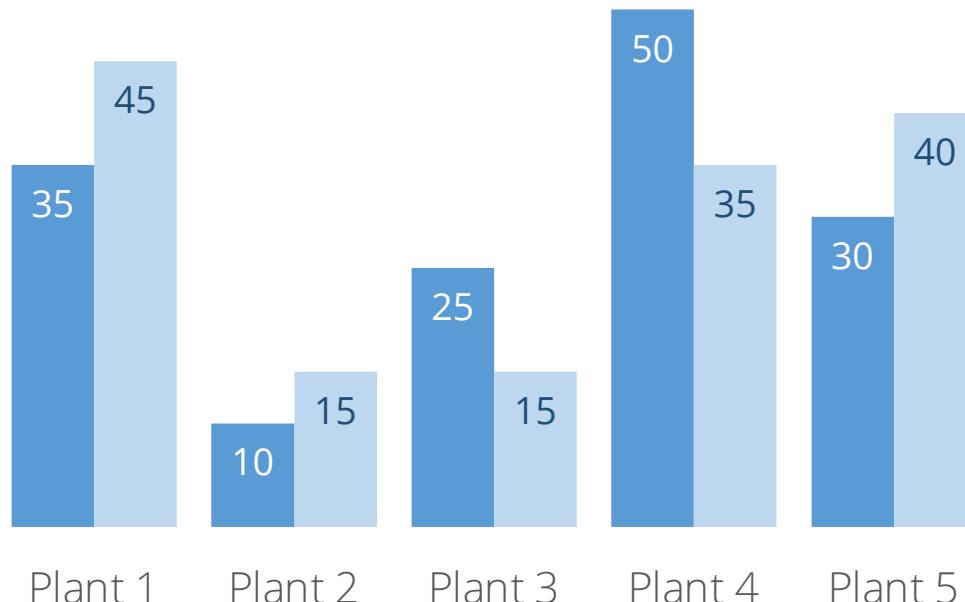


Don't: Let your audience do mental math

Safety Incidents by Plant

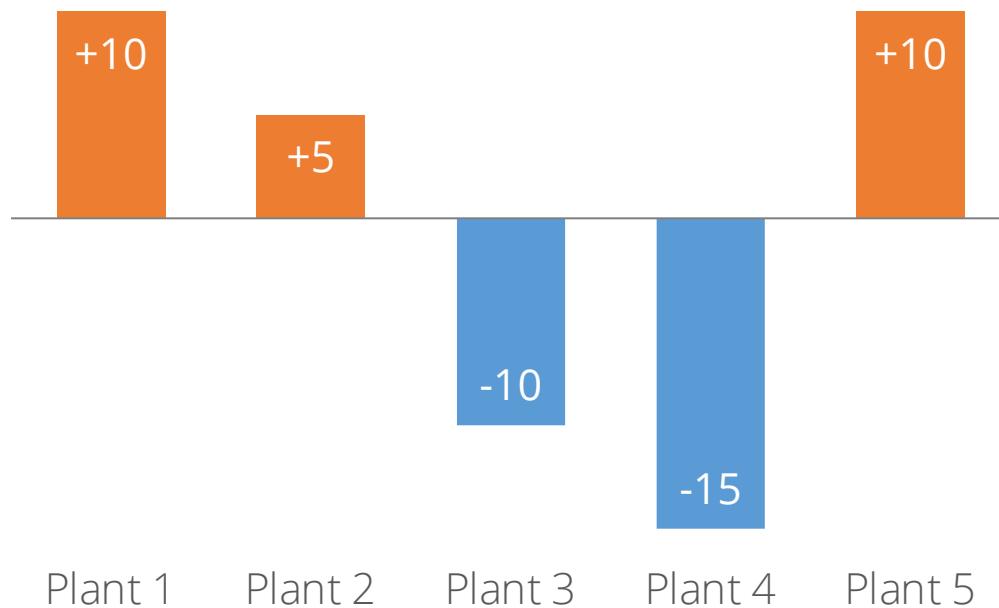
■ 2017 ■ 2018

*What's the mean difference
between 2017-2018?*



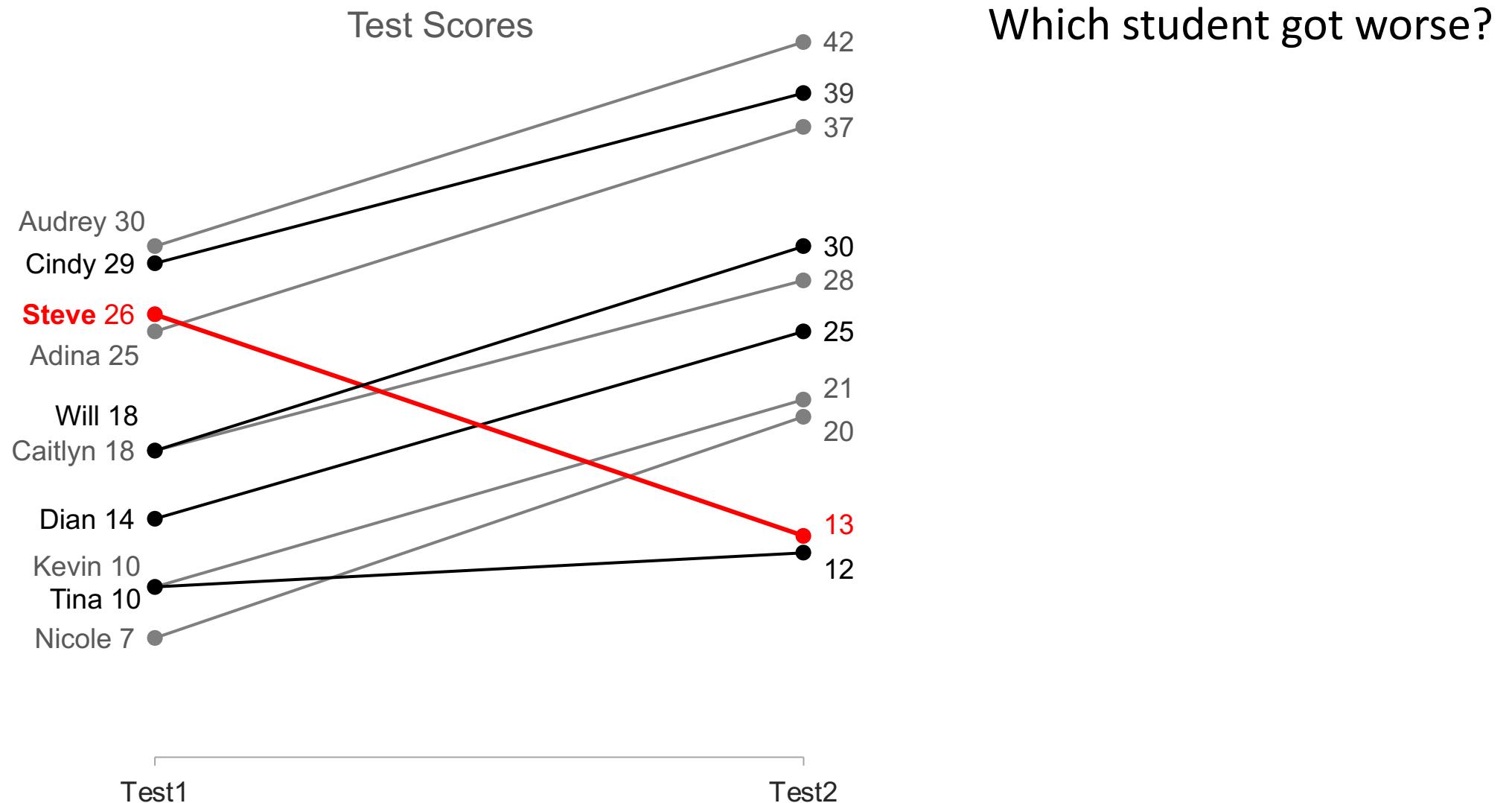
Do: Show differences directly

Year-to-Year Variance in Safety Incidents by Plant (2017-2018)

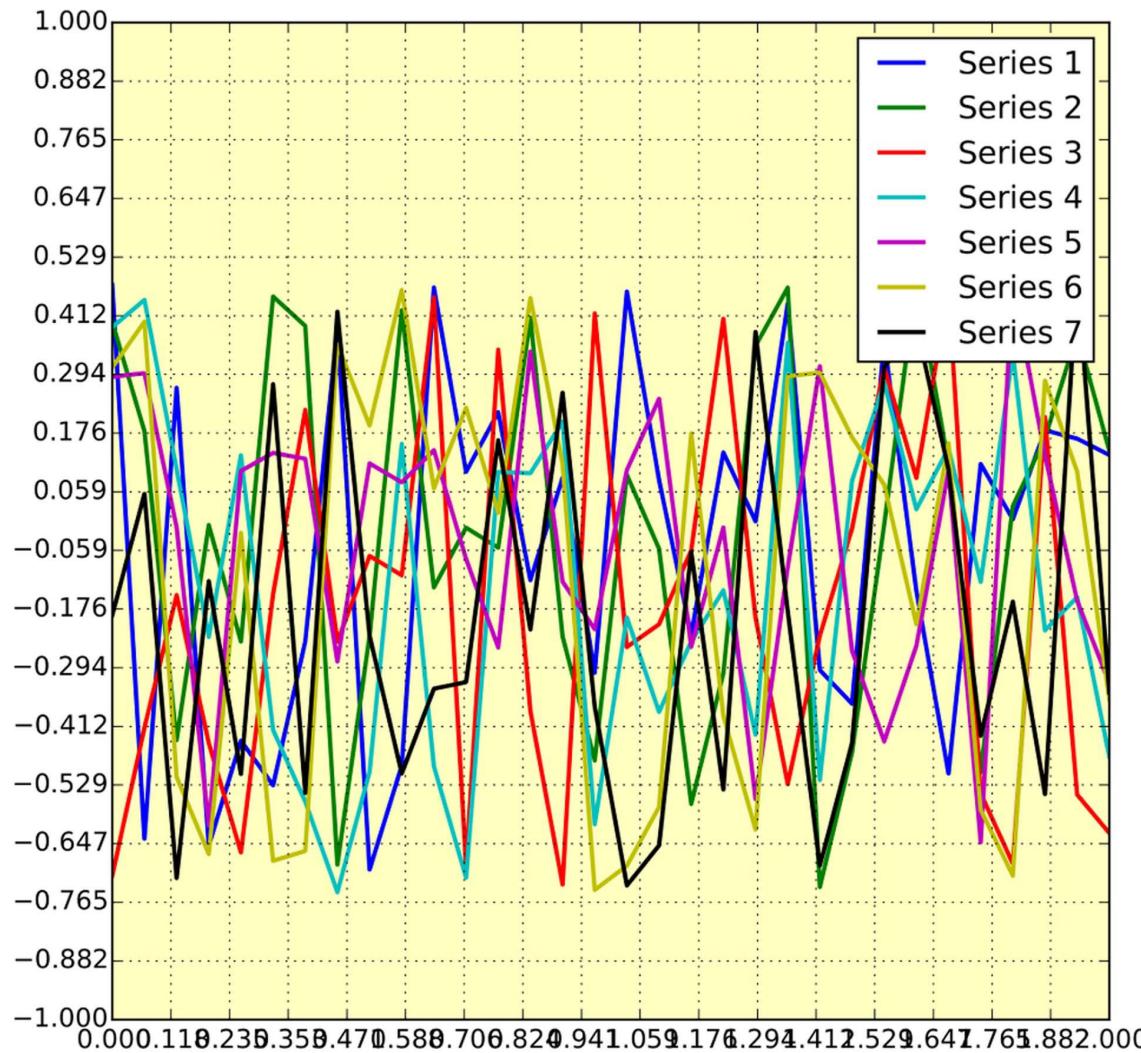


What's the mean difference between 2017-2018?

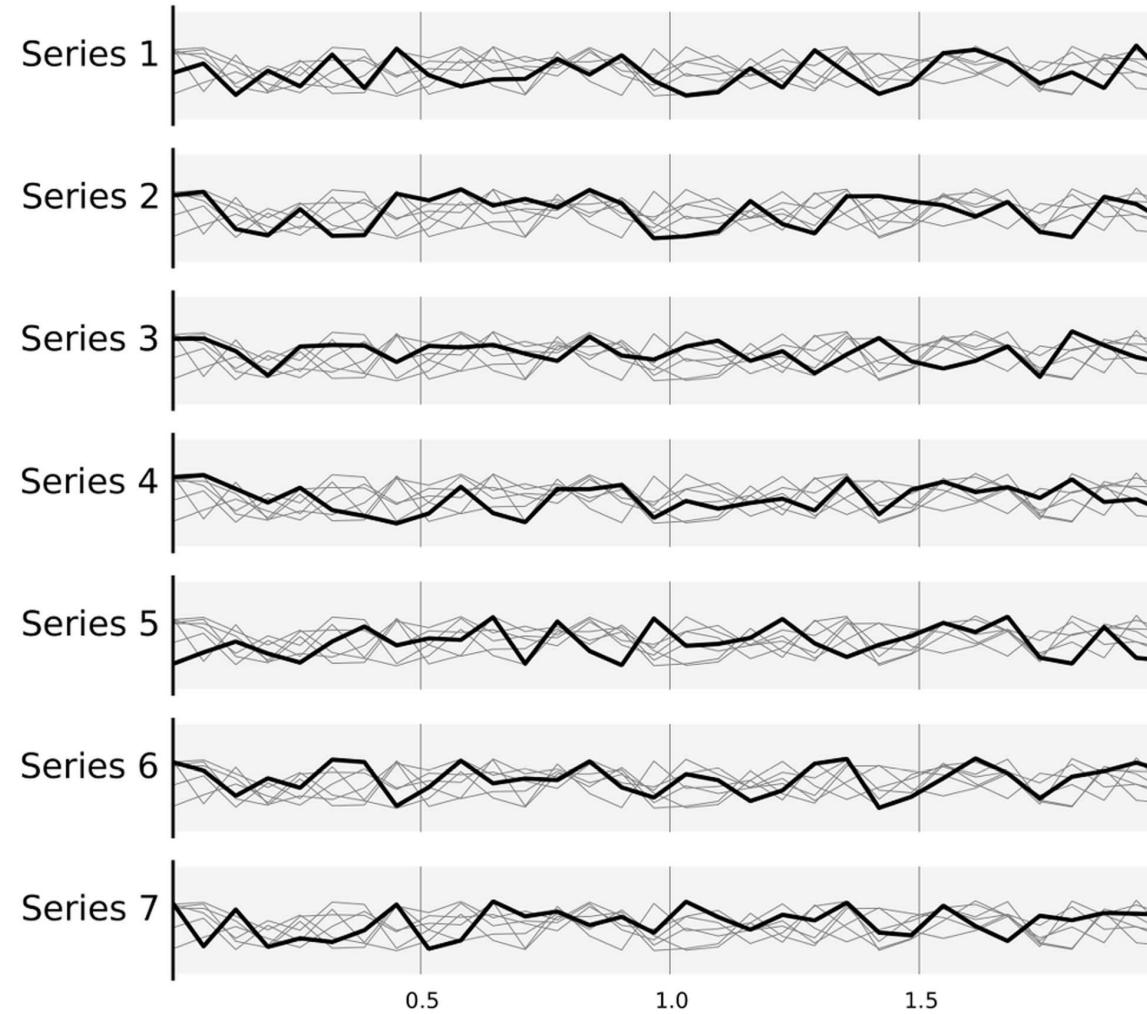
Do: Enable direct comparisons



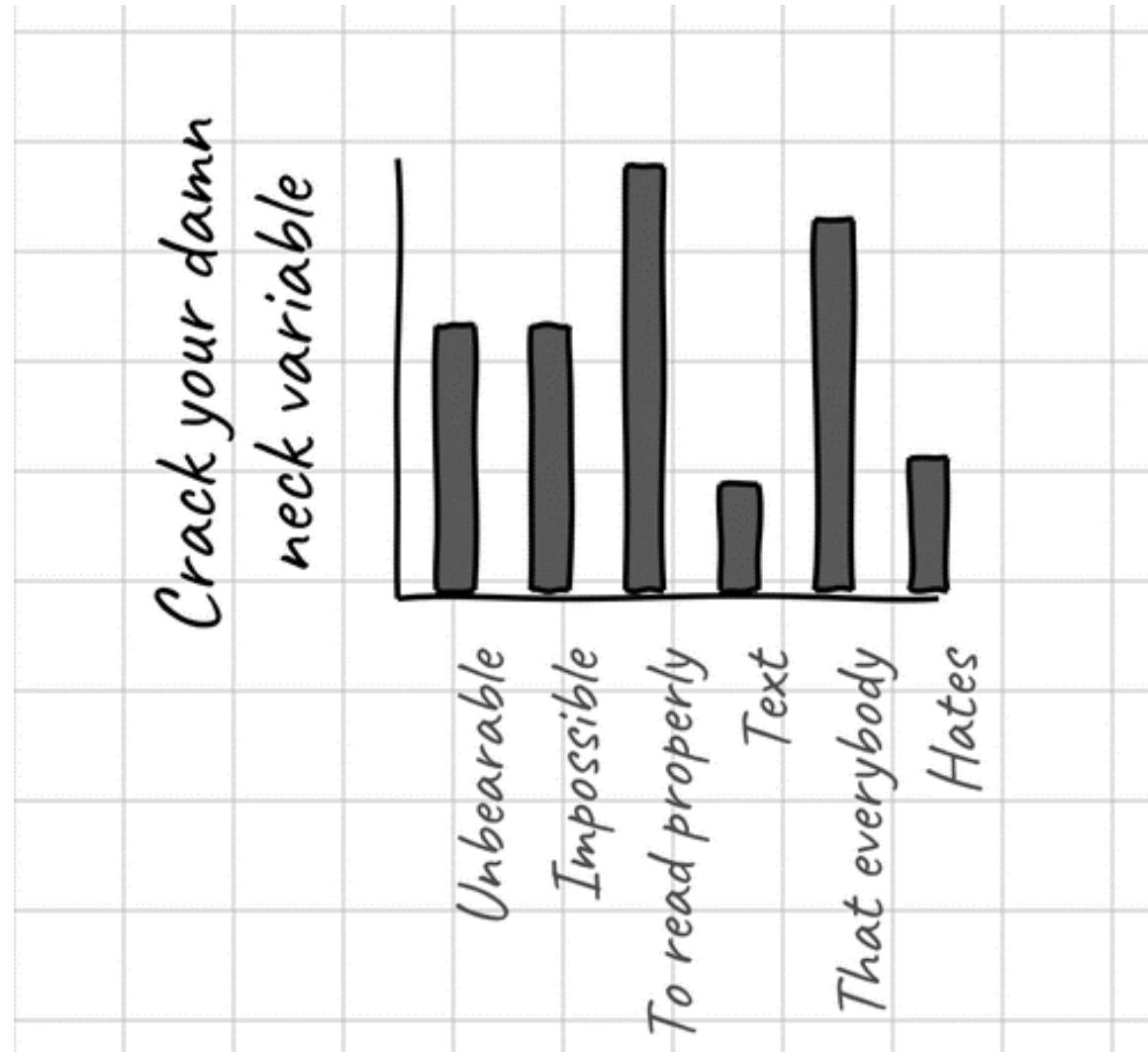
Don't: Use a spaghetti chart



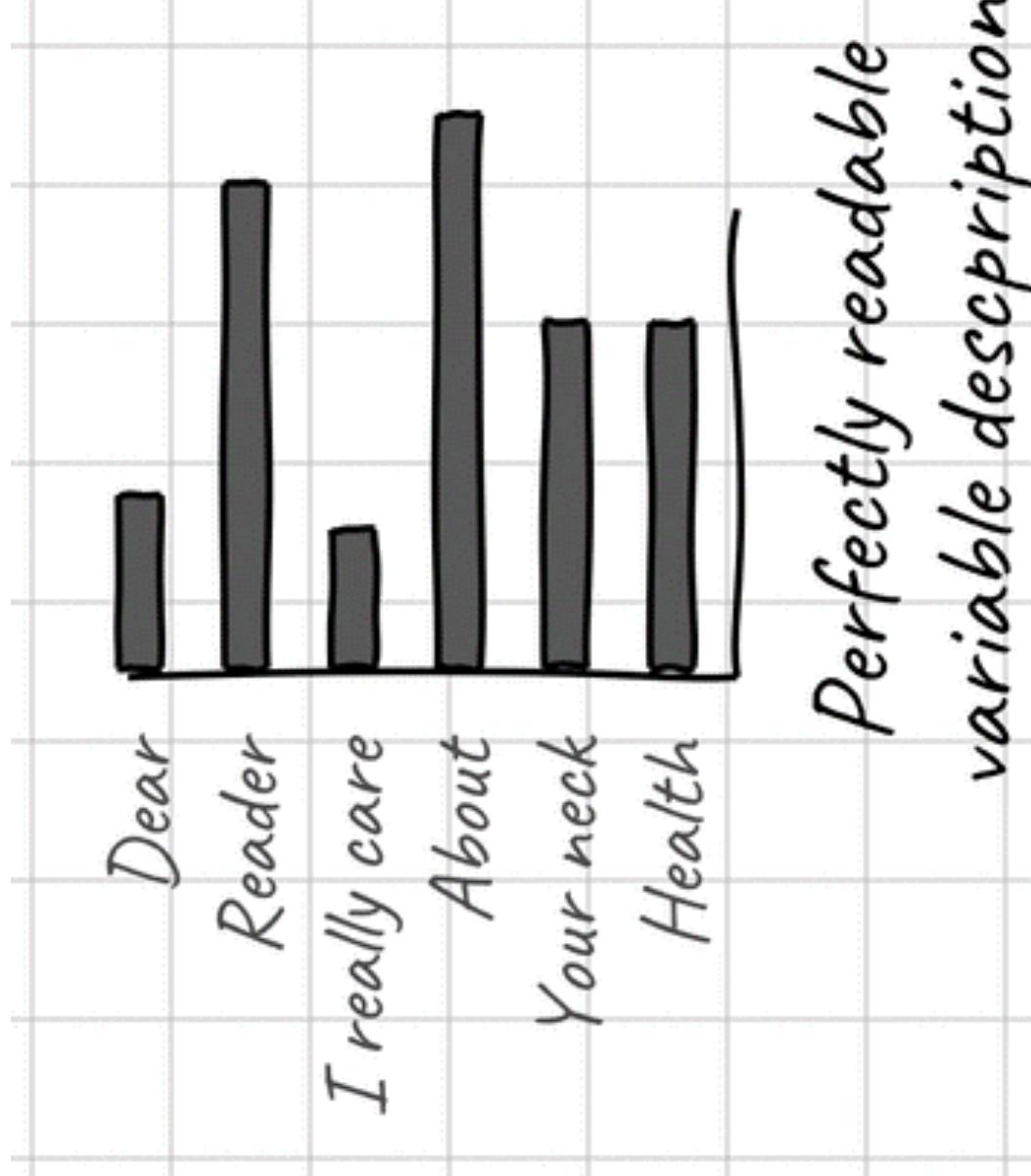
Do: Use small multiples instead



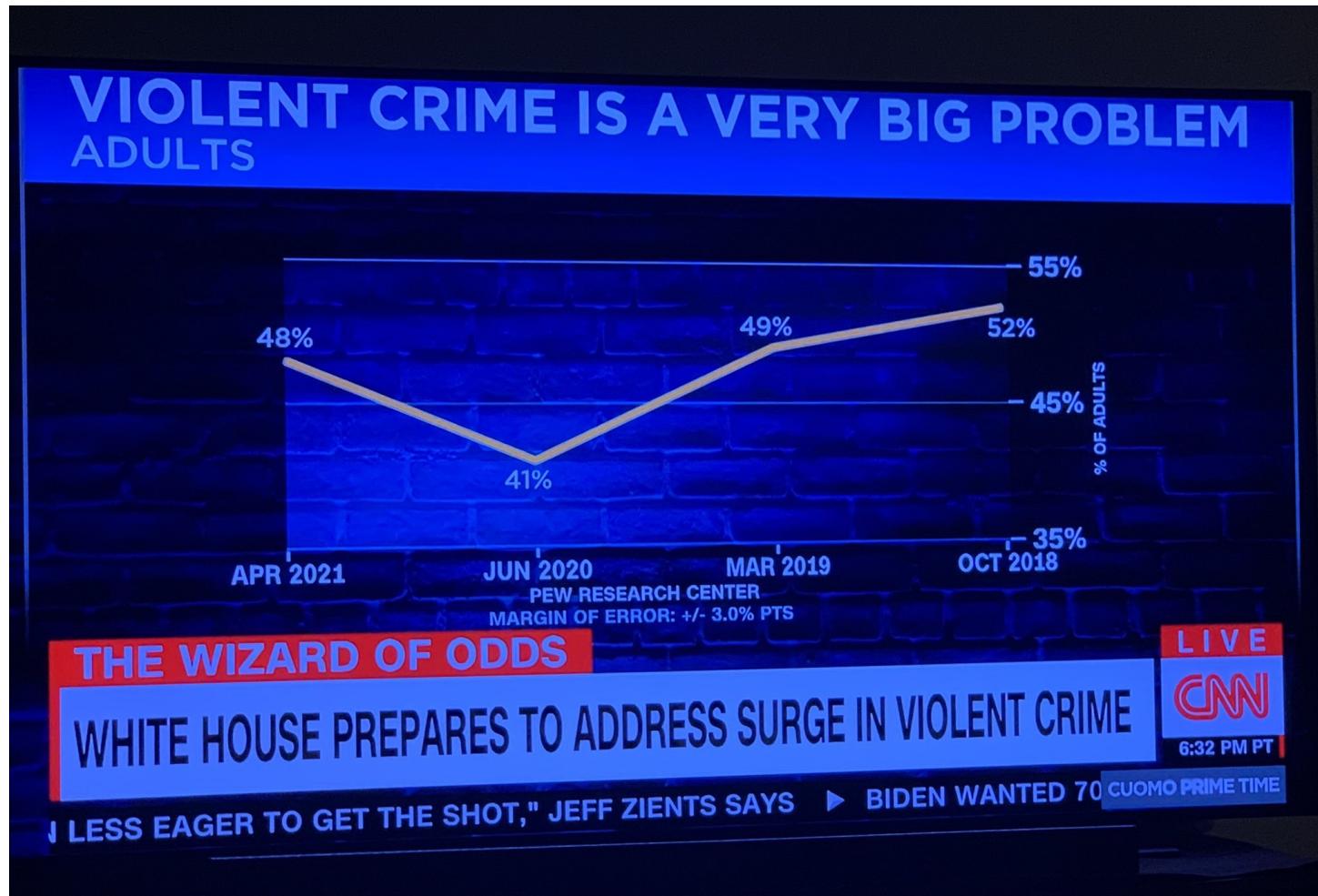
Don't: Make your audience crack their neck!



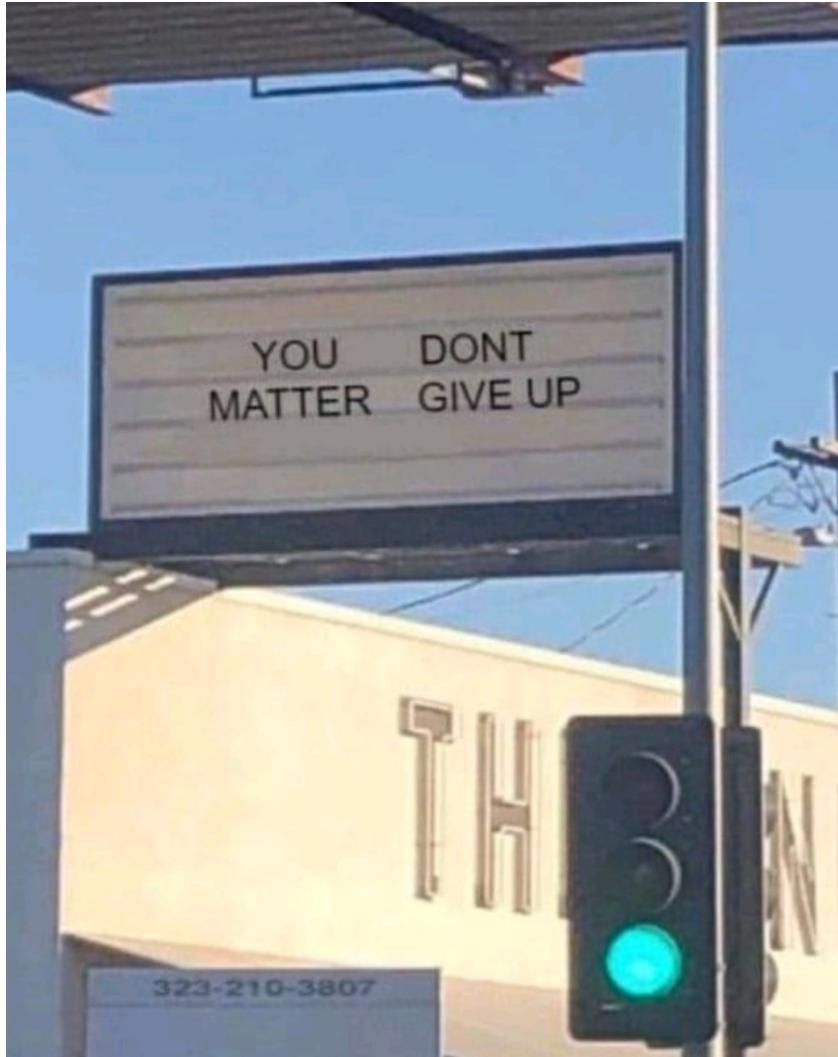
Do: Align text horizontal



Don't: Read from right-to-left



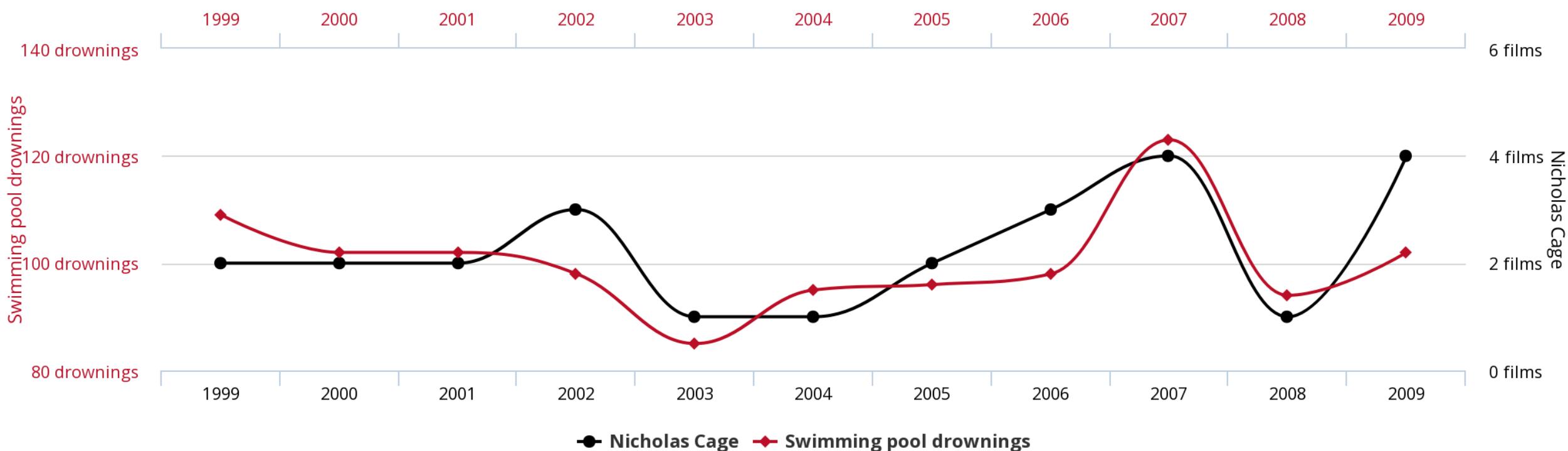
Do: Read from left-to-right...



..right?

Don't: use double axes

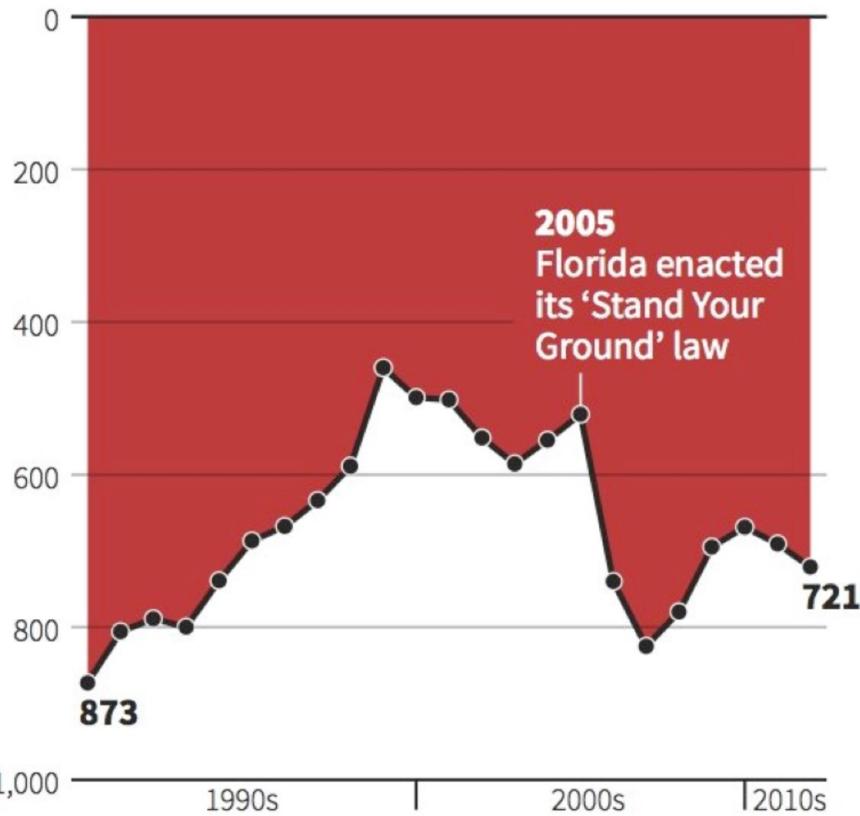
Number of people who drowned by falling into a pool
correlates with
Films Nicolas Cage appeared in



Don't: Flip the y-axis either

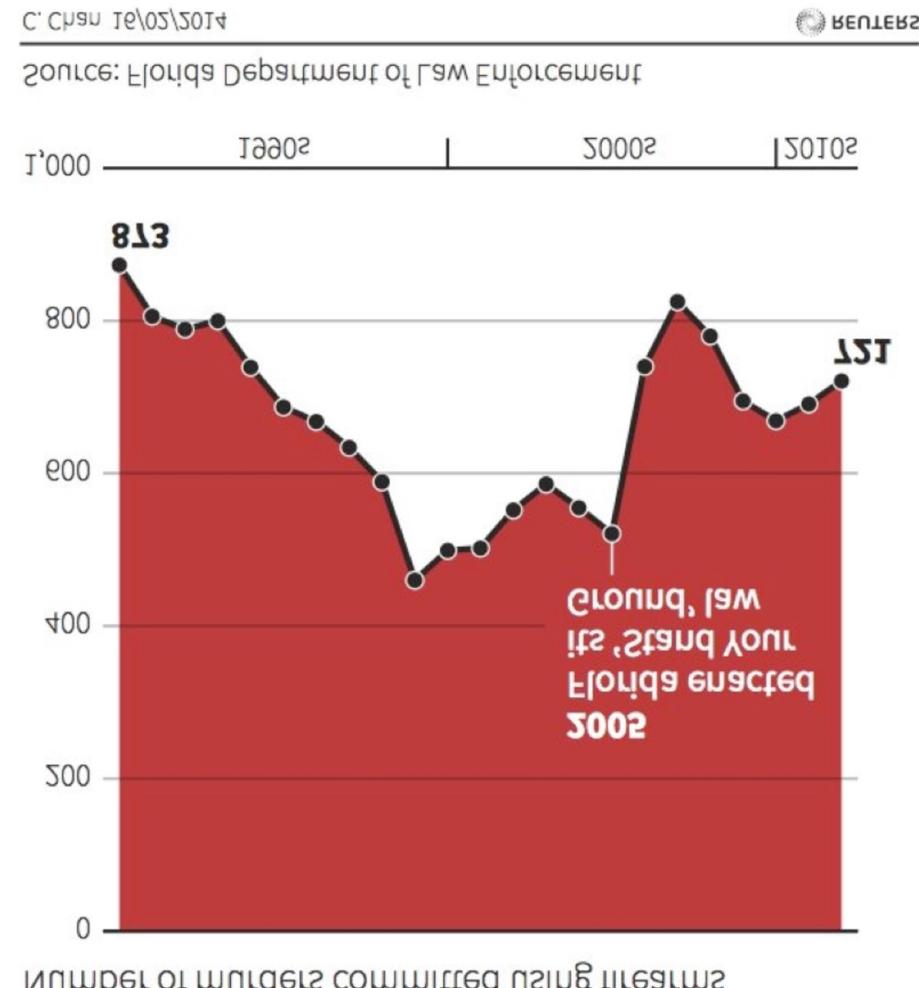
Gun deaths in Florida

Number of murders committed using firearms



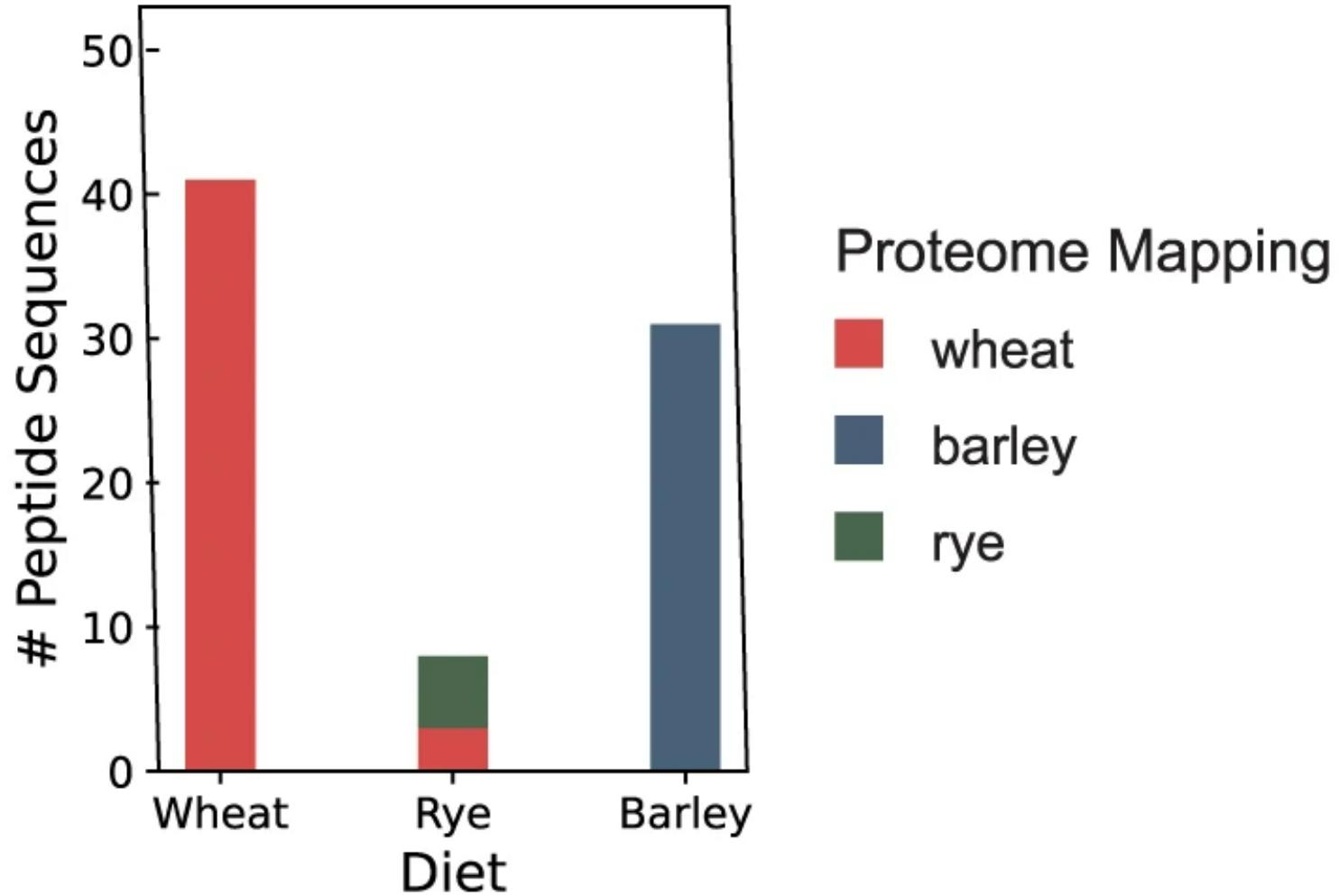
Source: Florida Department of Law Enforcement

Don't: Flip the y-axis either

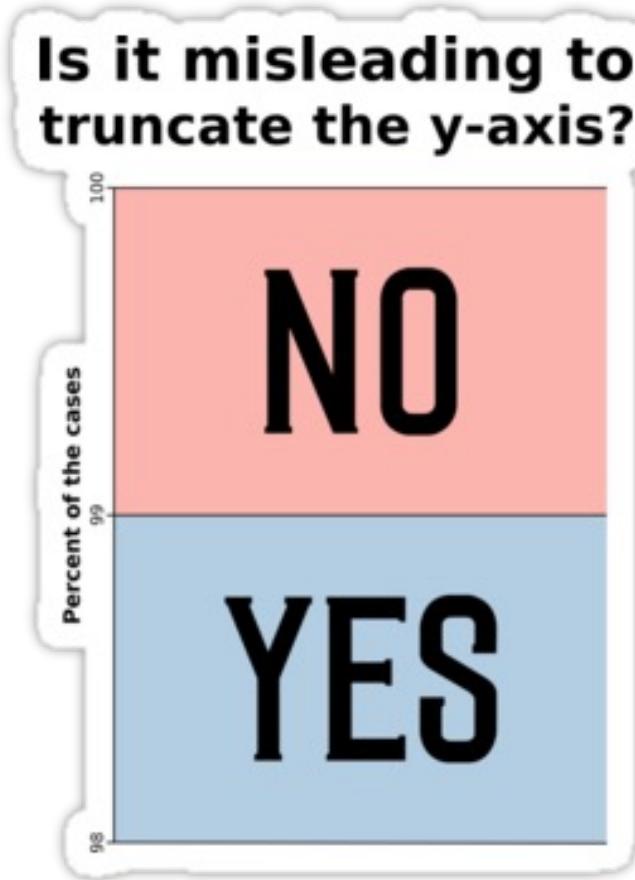


Serial Killers in Florida

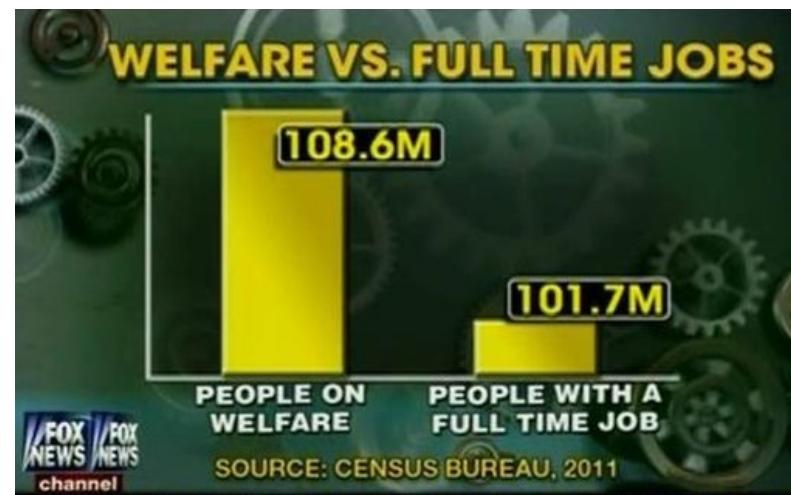
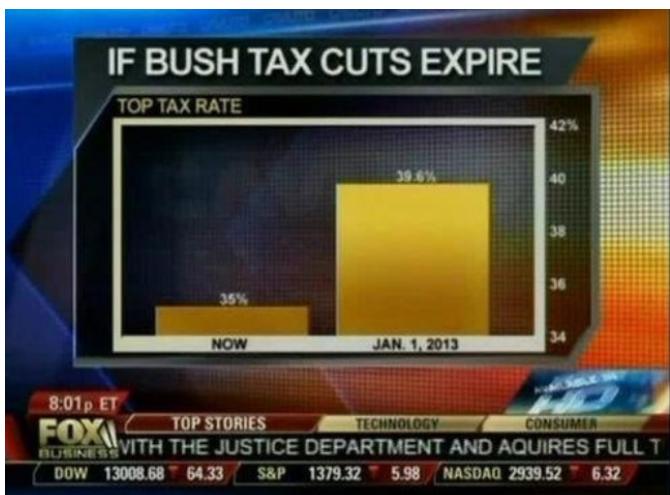
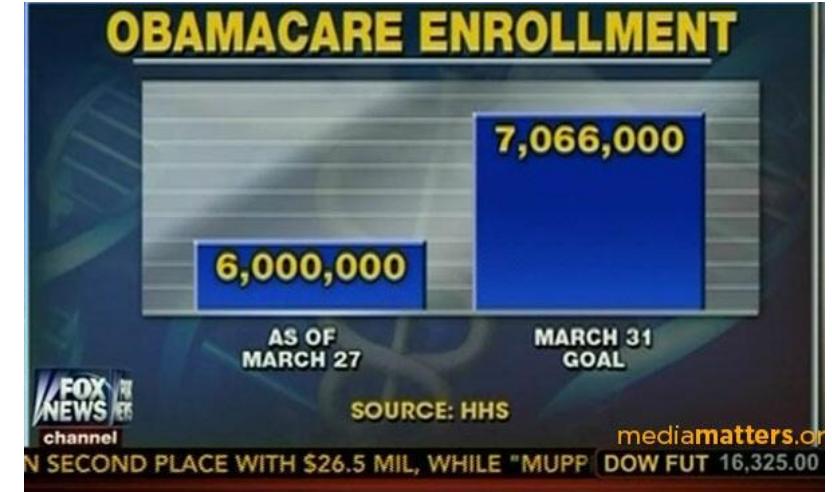
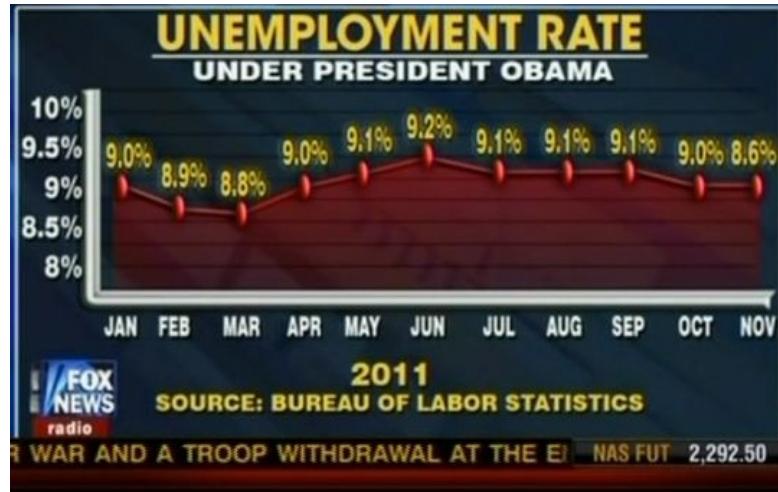
Don't: *Tilt* (?) the y-axis either



Don't: Truncate the y-axis

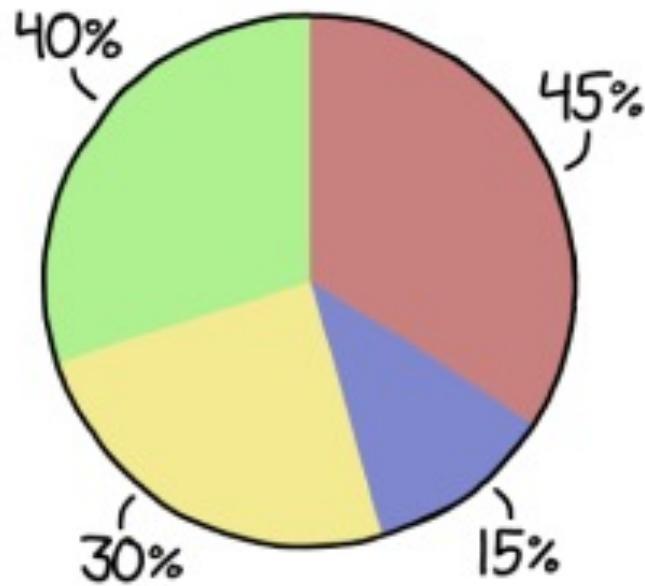


Who does that, you say?

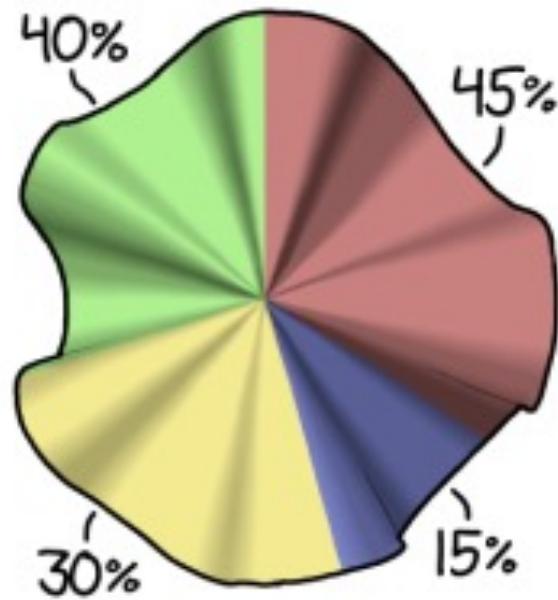


Don't: Use pie charts where the numbers don't add up

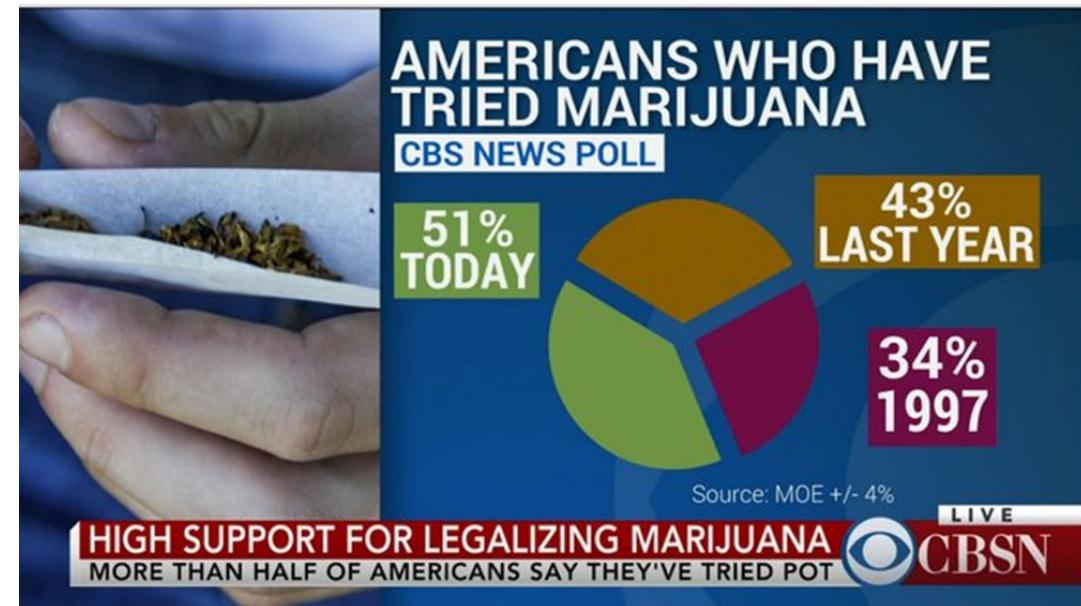
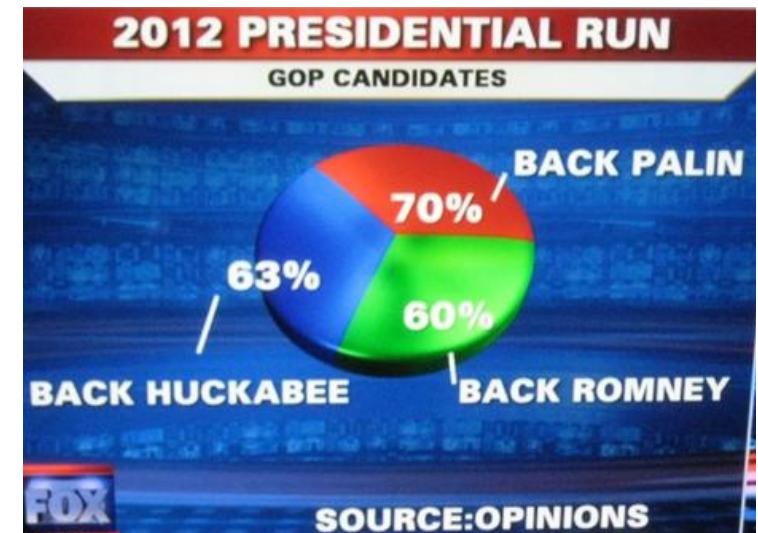
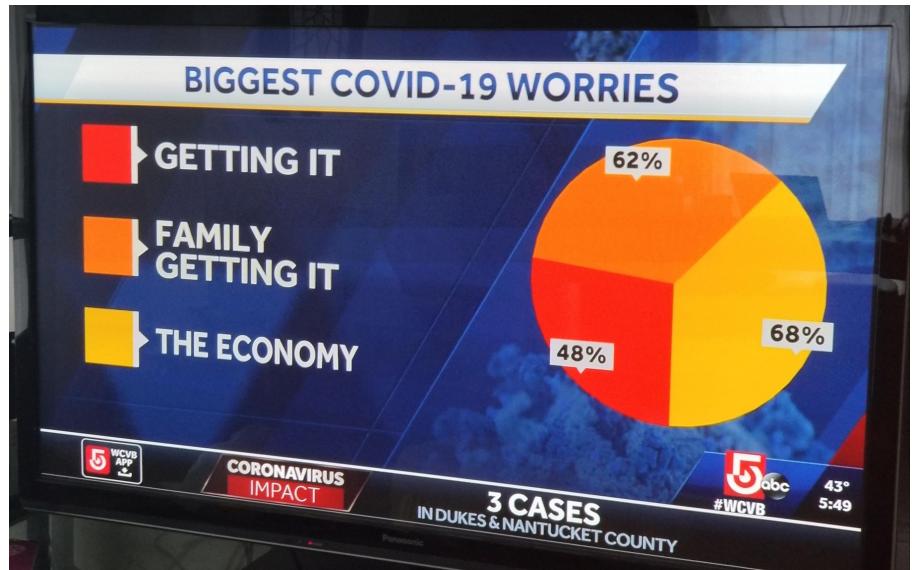
WRONG:



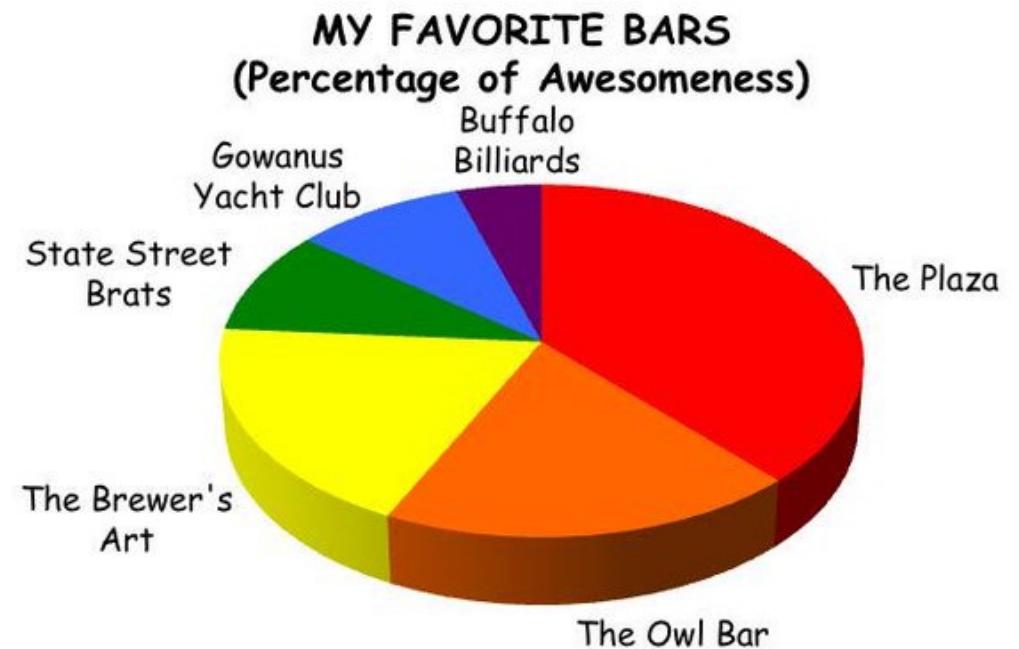
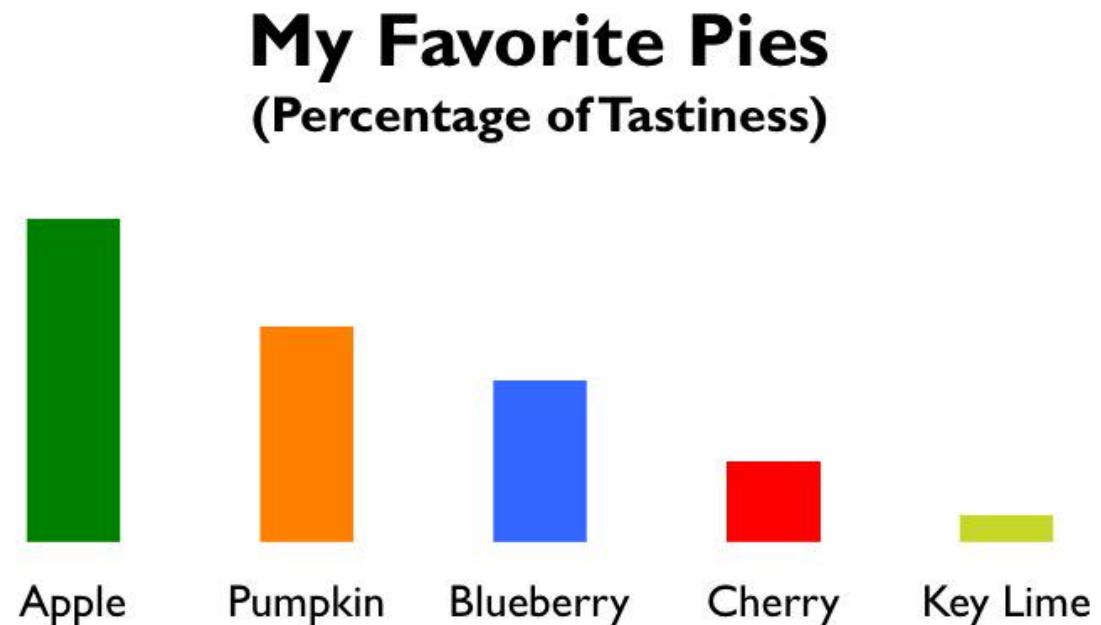
RIGHT:



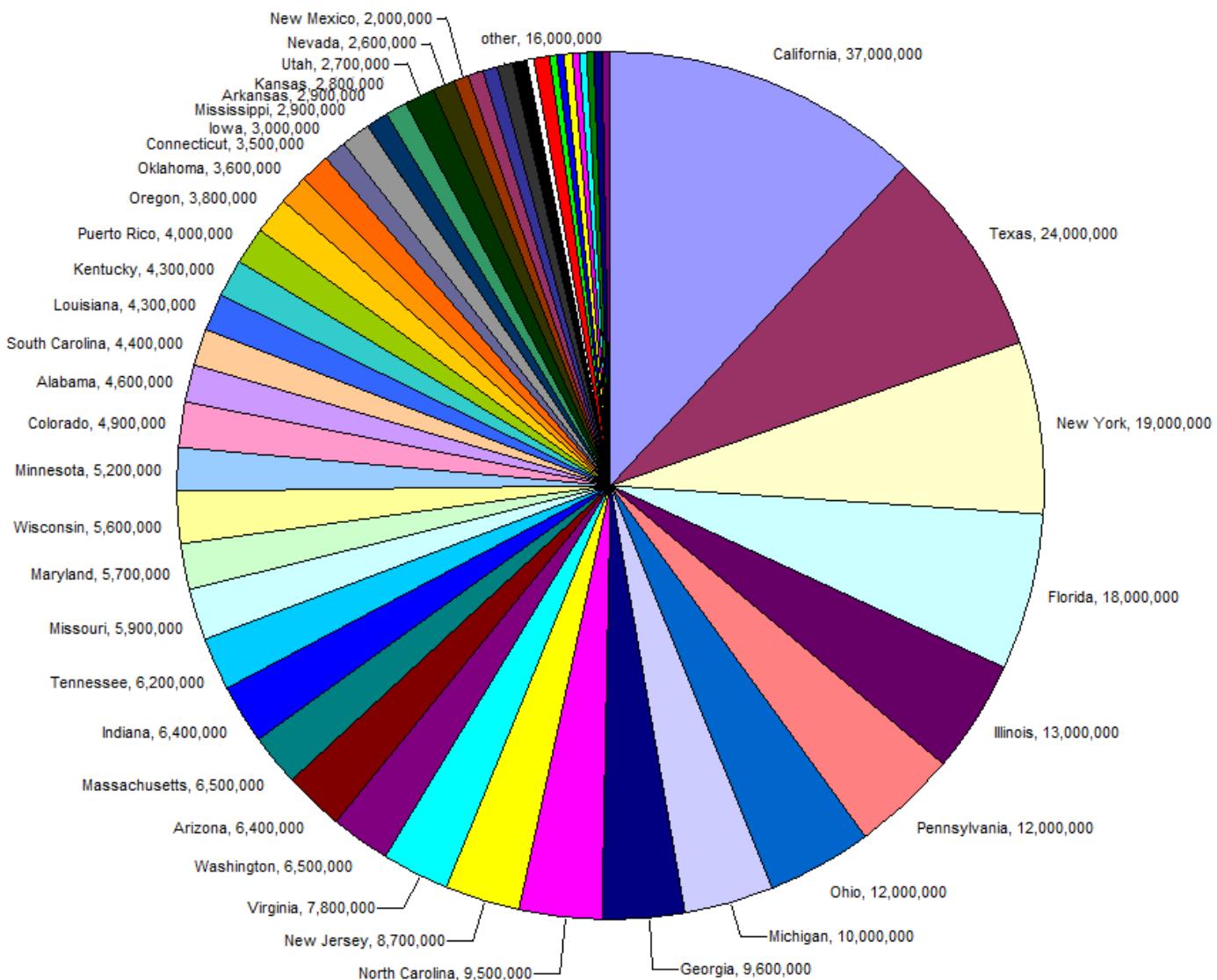
Who does that, you say?



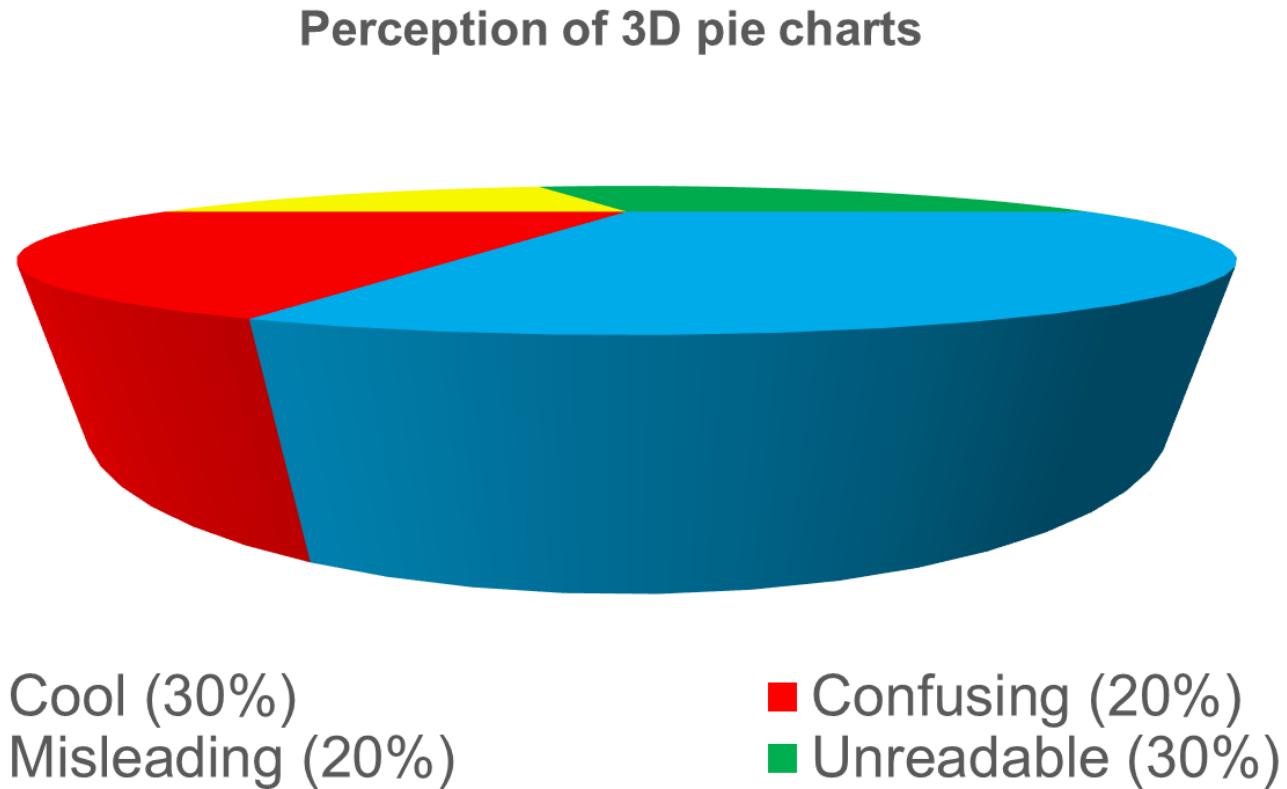
Do: Know when to choose for *bars* or *pies*



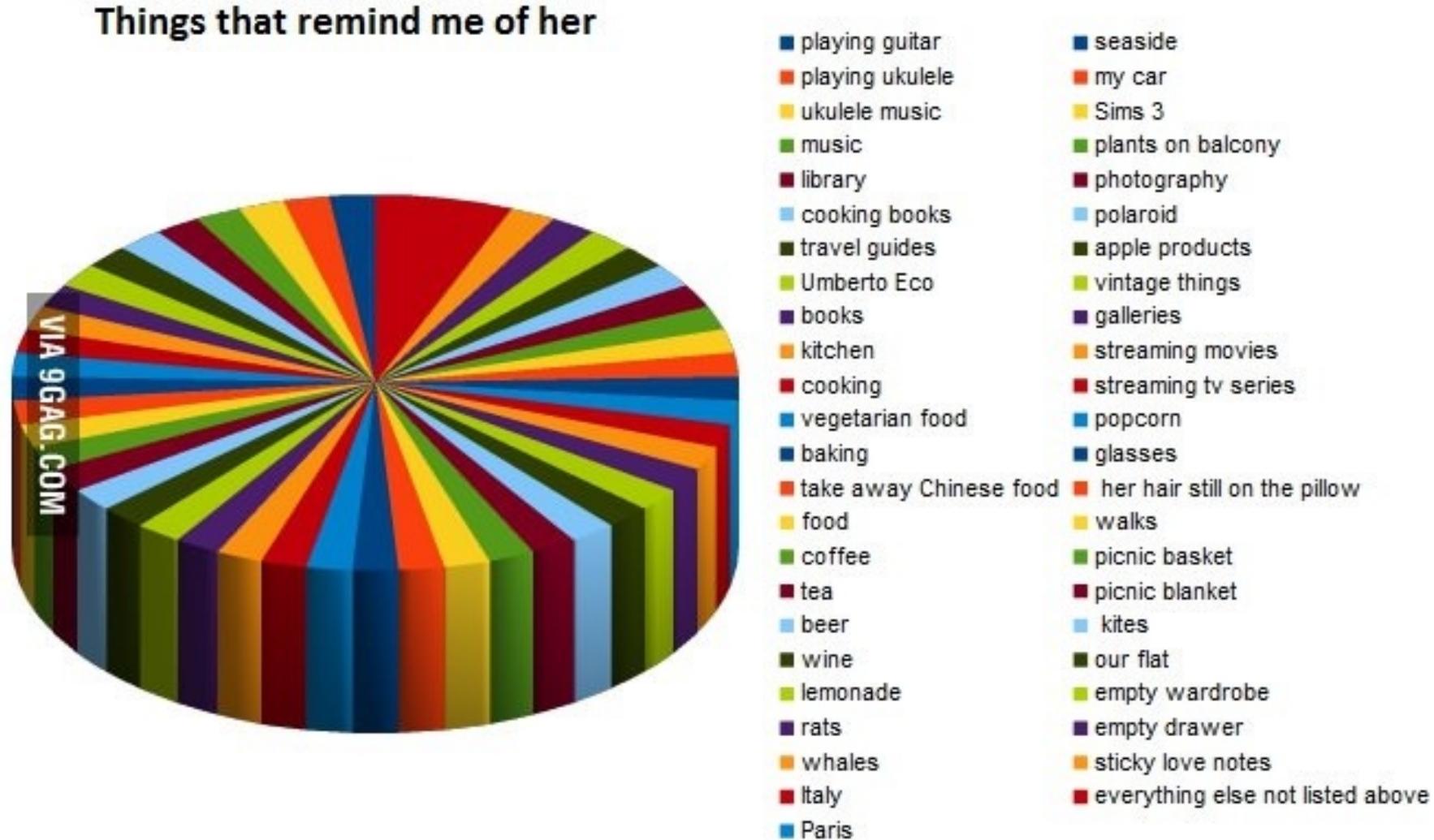
Don't: Use pie charts with >5 categories



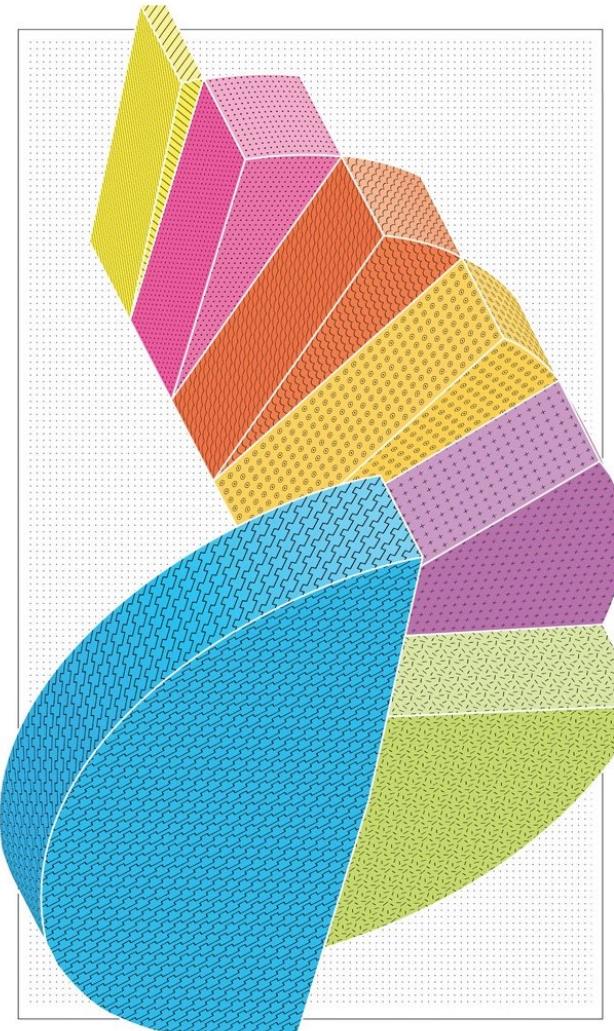
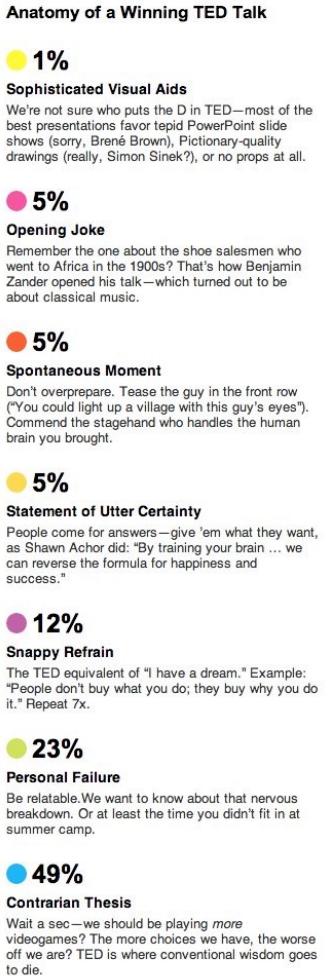
Don't: Use 3D pie charts



Don't: Use 3D pie charts with >5 categories



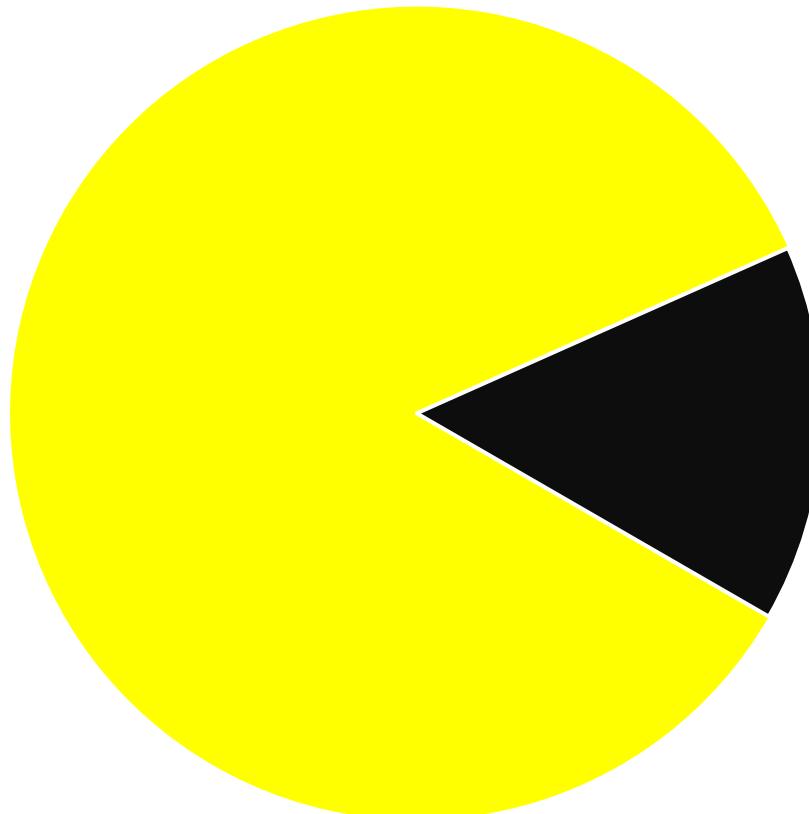
Don't: Use patterned 3D winding staircase lying on its side pie diagrams with >5 categories!



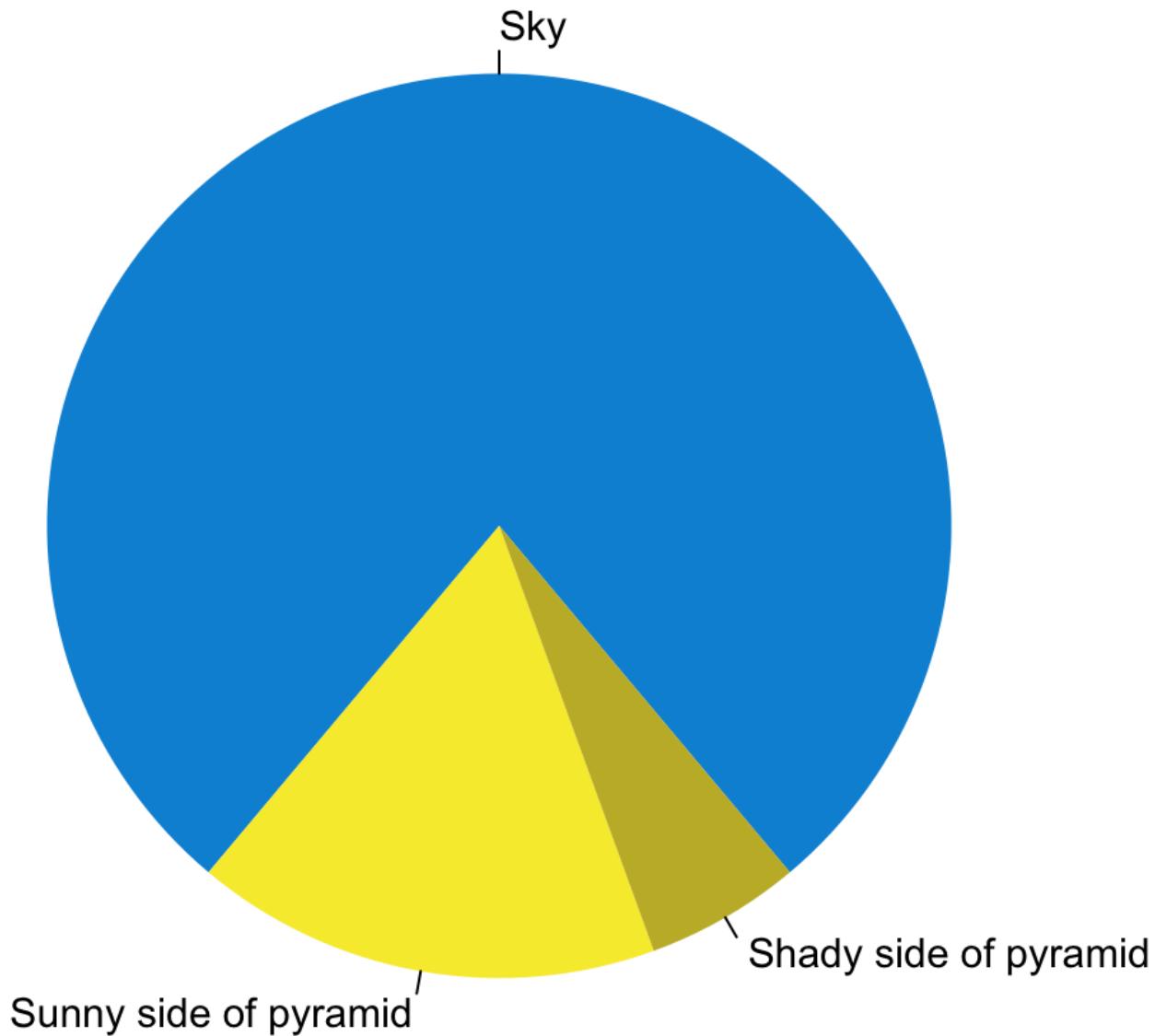
Do: Use pie charts to show the part-to-whole relation of 2 categories

Percentage of chart that looks like Pacman

- Pacman
- Not Pacman



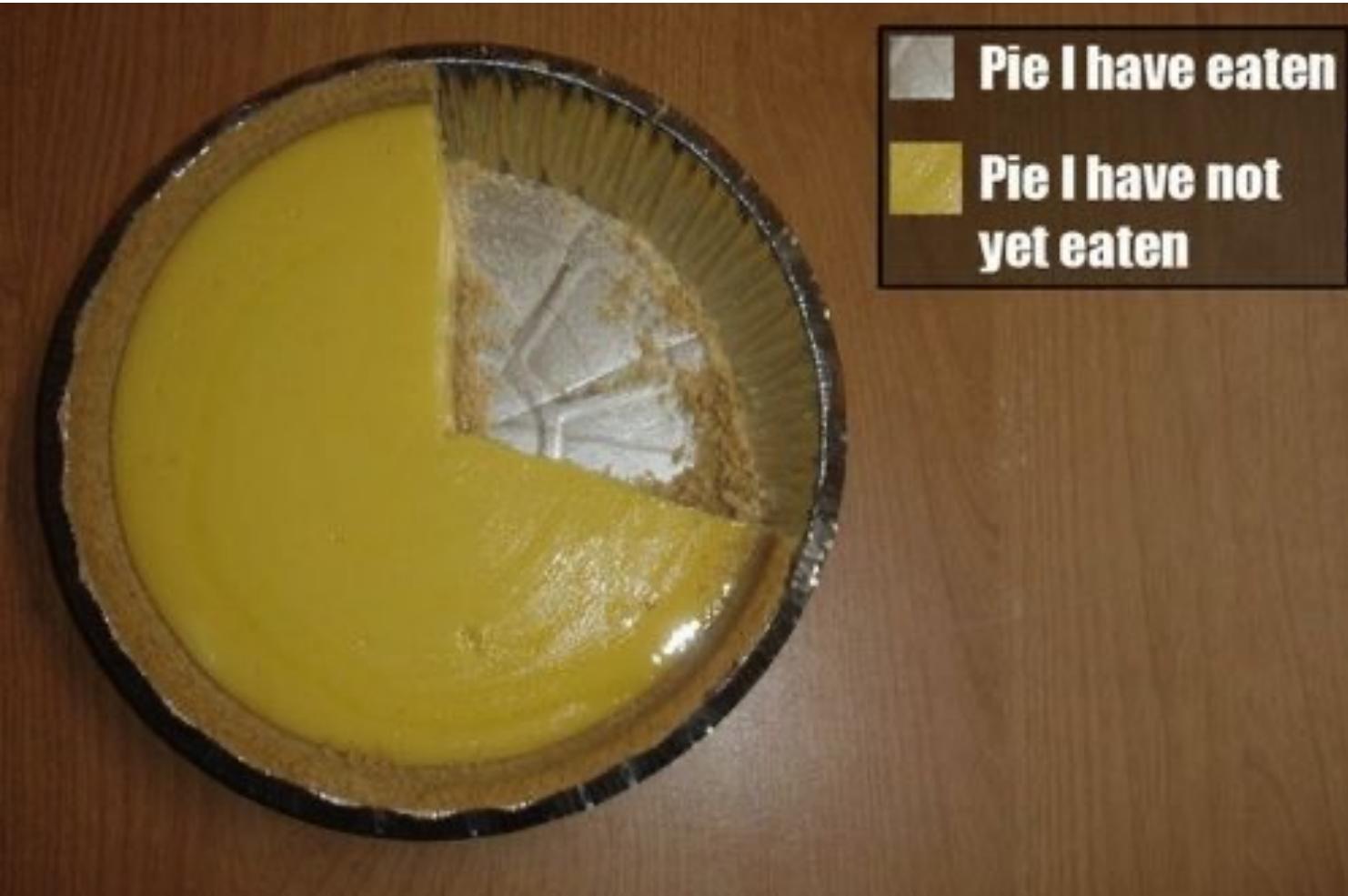
Do: Pie charts for 3 categories is okay too



Do: Sometimes >5 groups work ☺



Do: Know when pie charts are *the best!*



Thank you!



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Twitter icon @JeBentWatJeMeet

Happy Viz-ing!



<https://irenevdb.rbind.io>