

Effective Data Visualization for Scientific Researchers

Rotterdam, June 10th, 2022

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

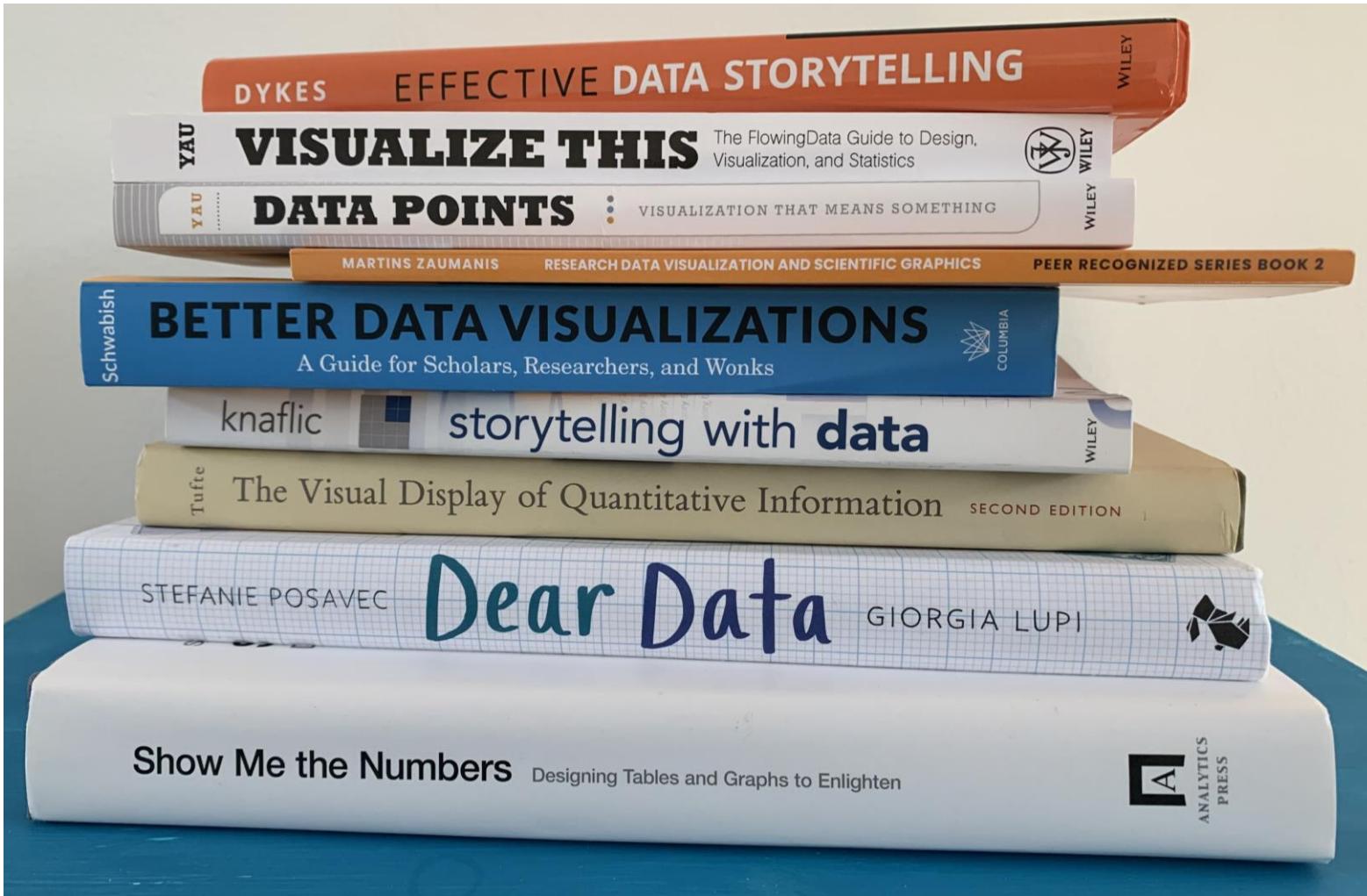


2013-2015
Leiden University
Medical Center



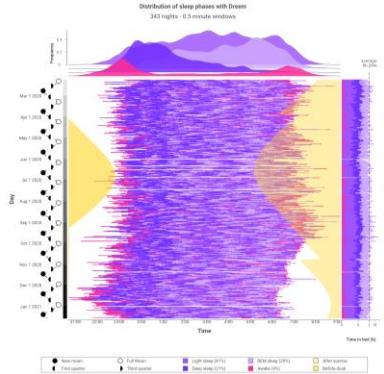
2015-2019
Cedars-Sinai
Medical Center

But when I learned Data Viz is a field on its own, I was hooked!

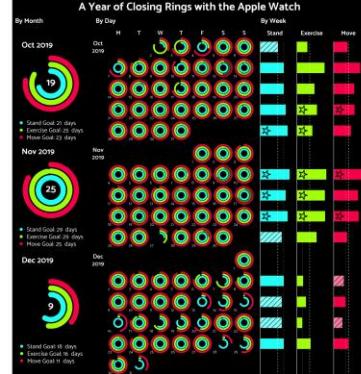


I started visualizing my Health and Habits.

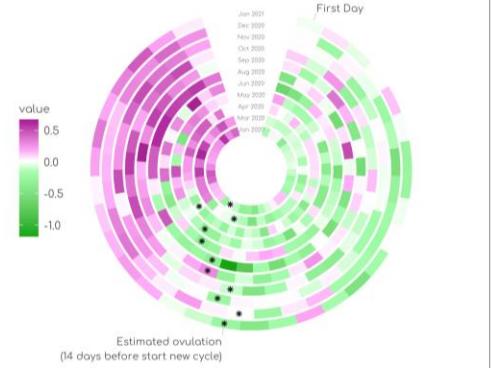
Sleep



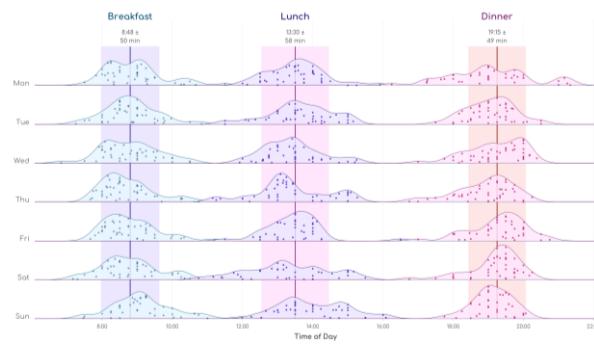
Activity



Body



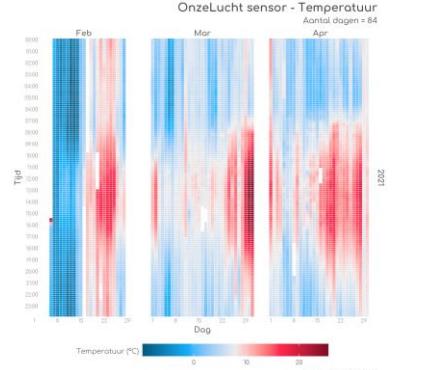
Food



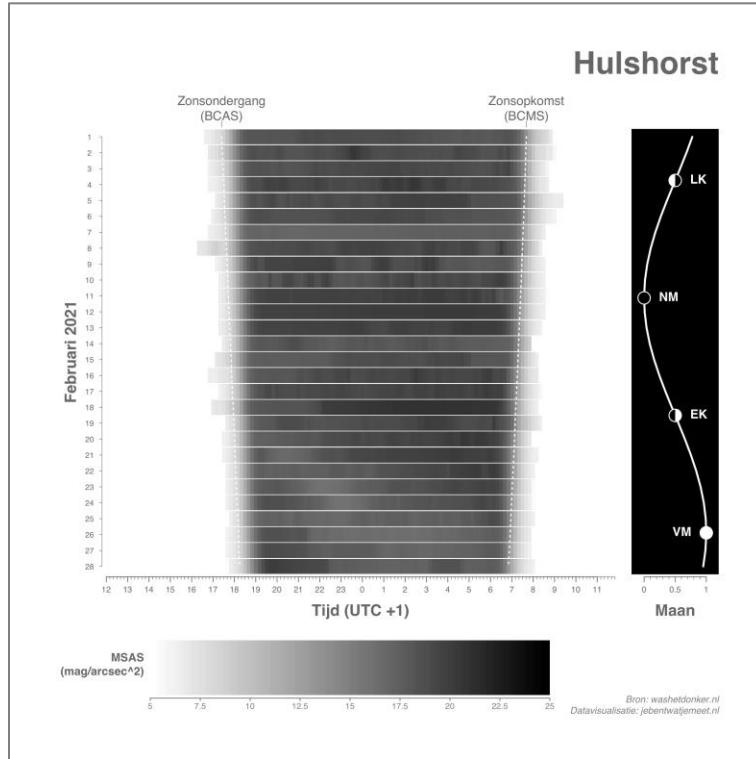
Habits



Environment



And now combine my passions for teaching and data visualization

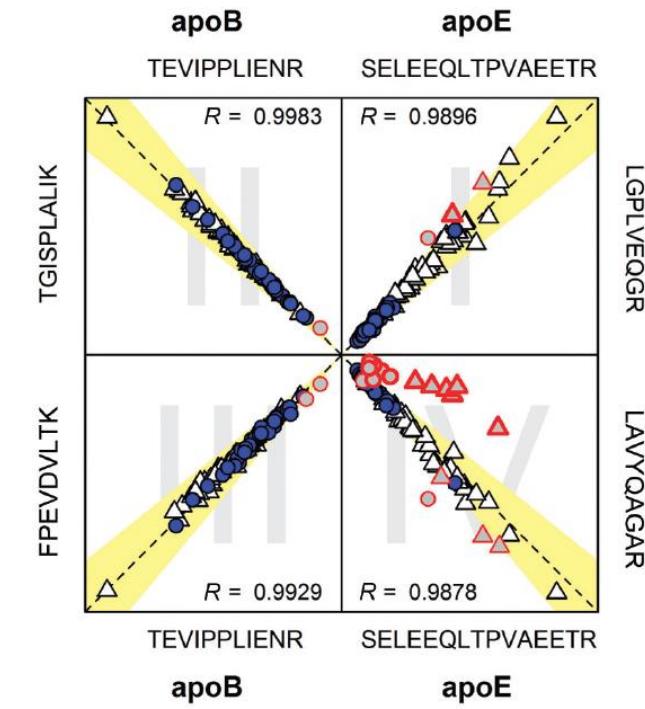
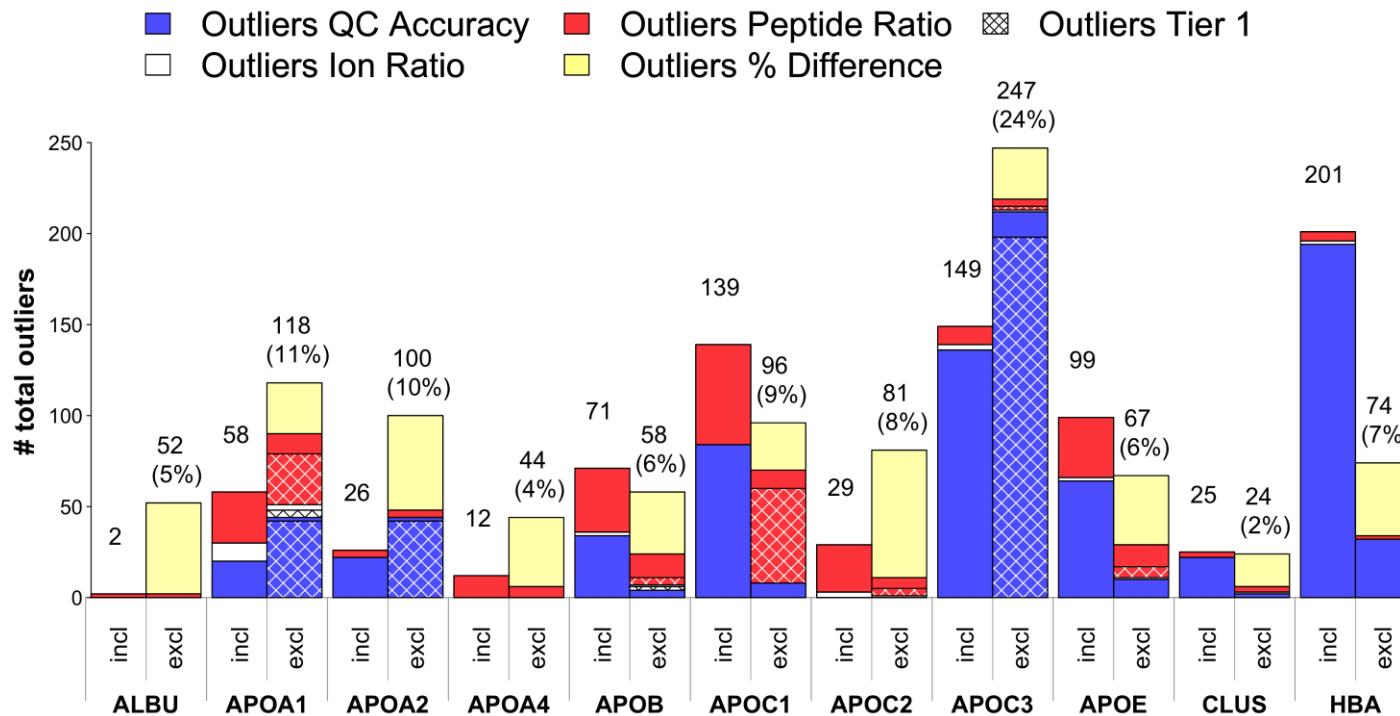


www.washetdonker.nl

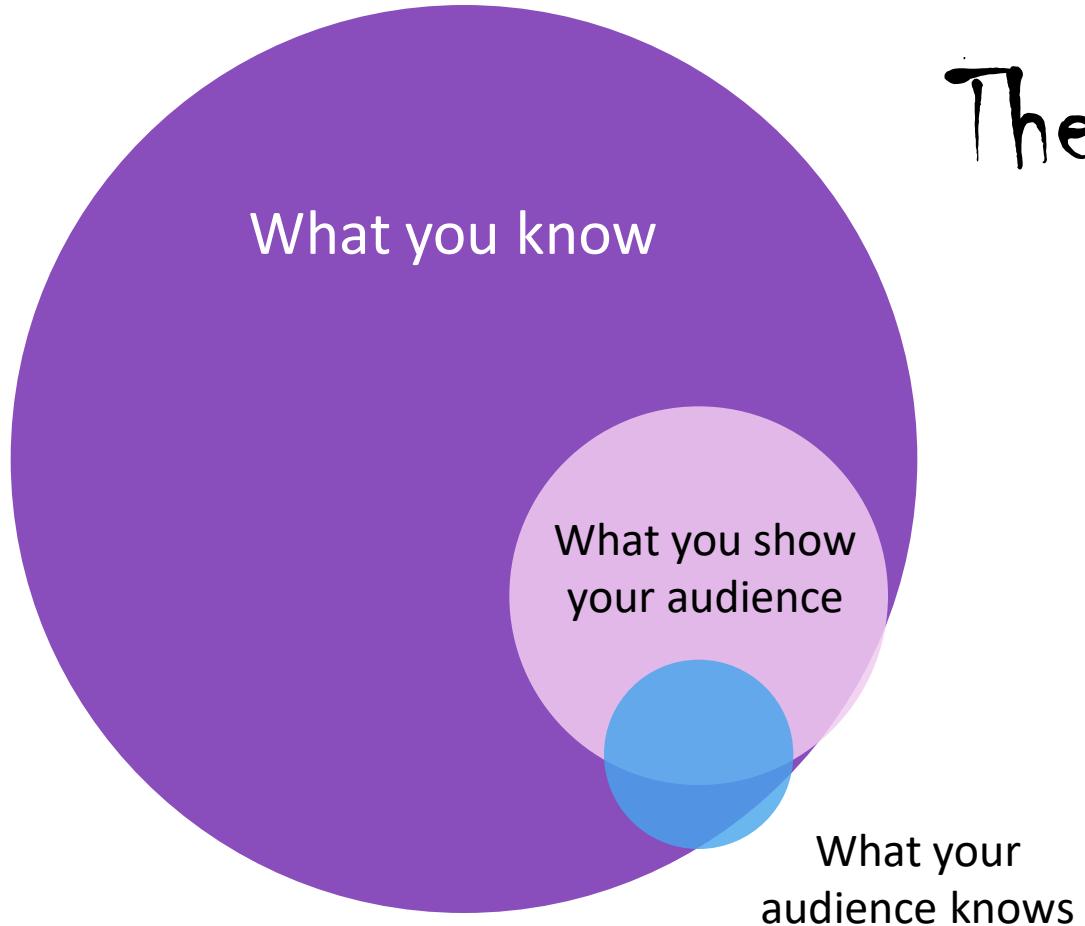


www.onzelucht.nl

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



Don't underestimate how smart you are!

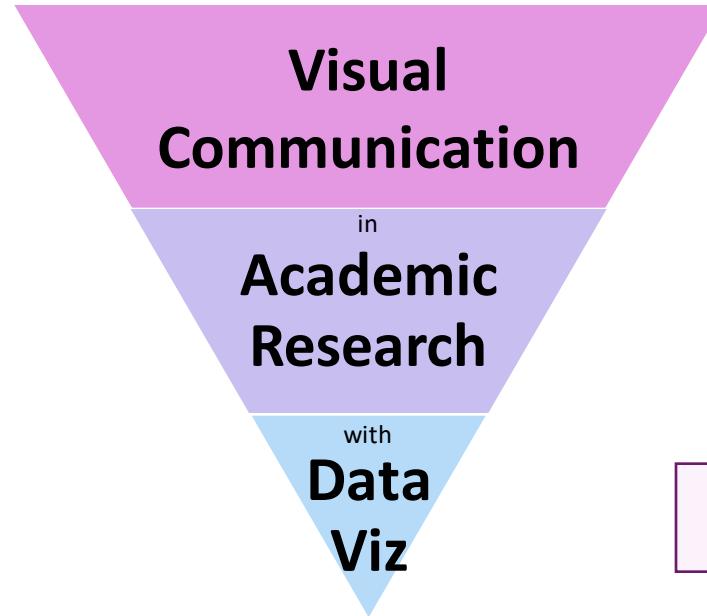


The curse of knowledge

Resist the urge to show *everything*!



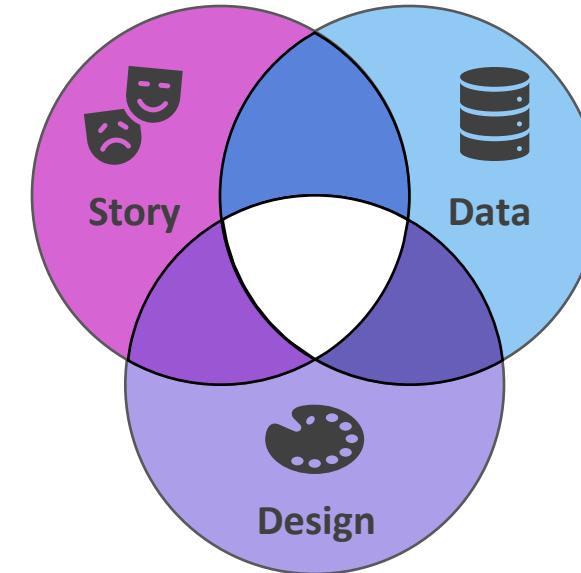
An overview for today:



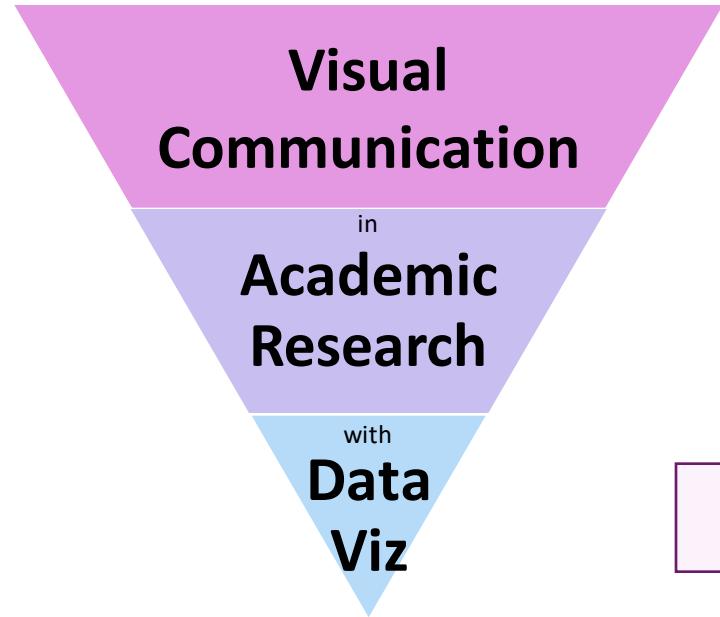
WHY?

WHAT?

HOW?



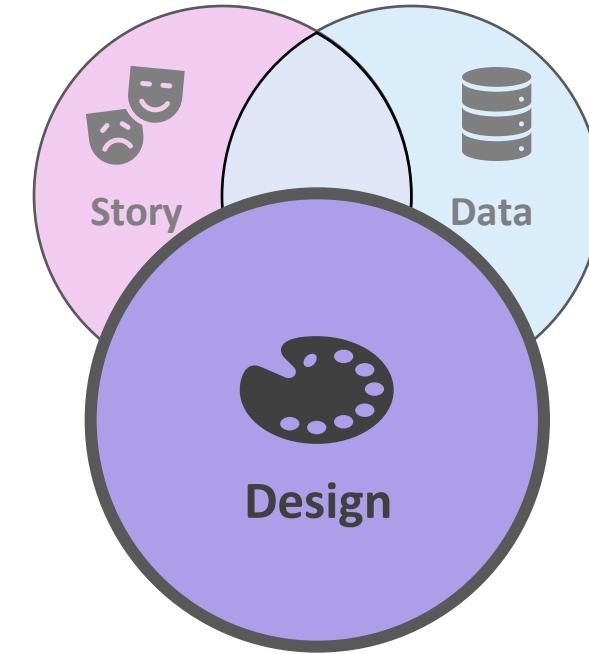
An overview for today:



WHY?

WHAT?

HOW?



Warm-up!

And stand up

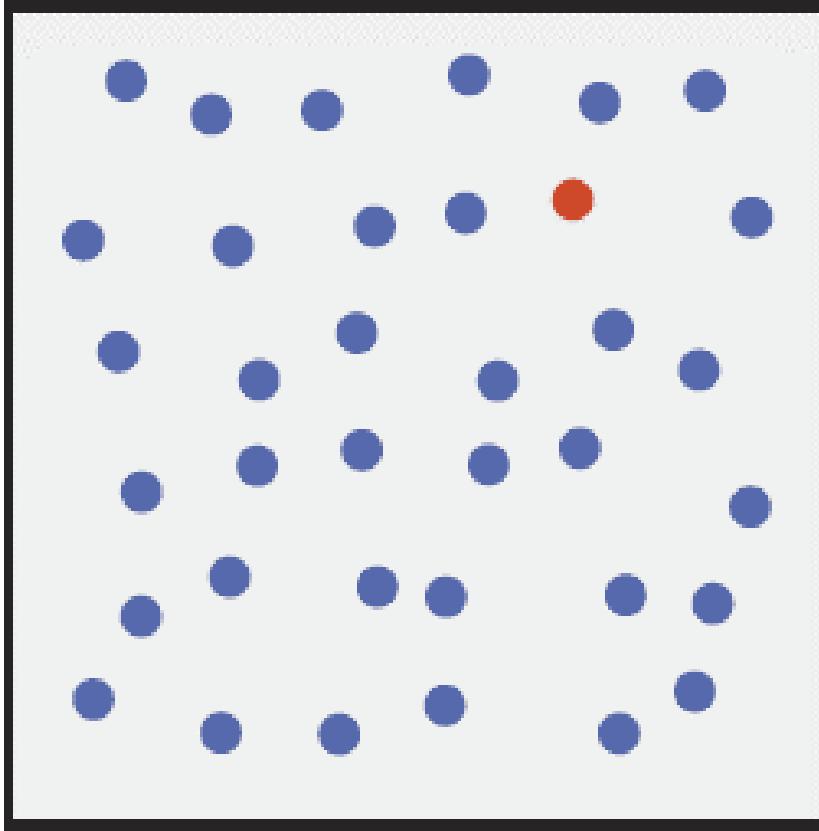
LEFT?

YES?

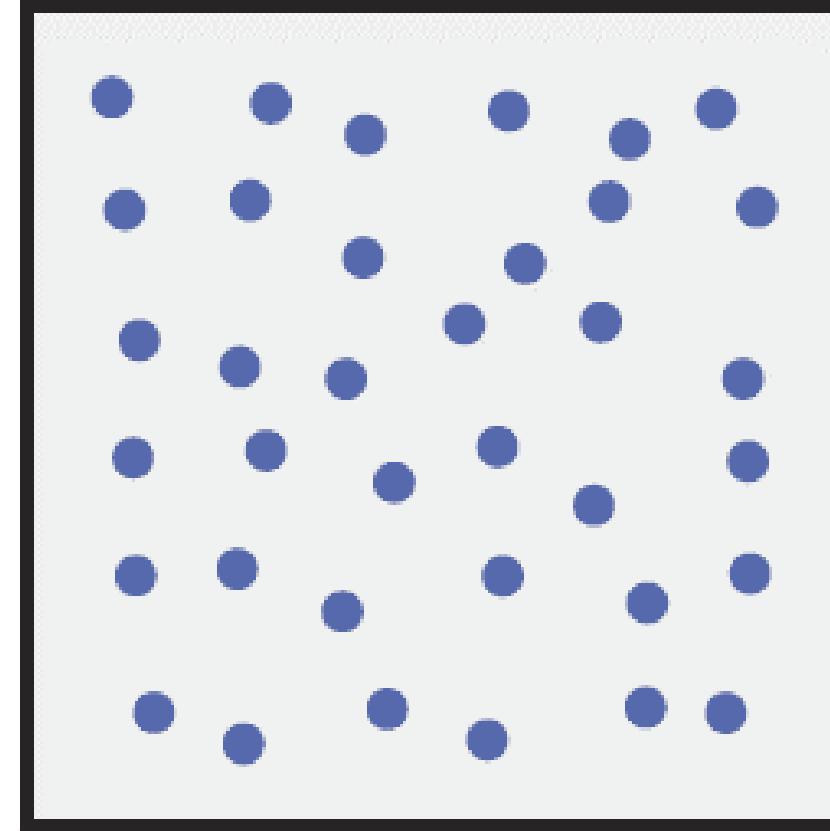


Which panel has a red dot?

A



B



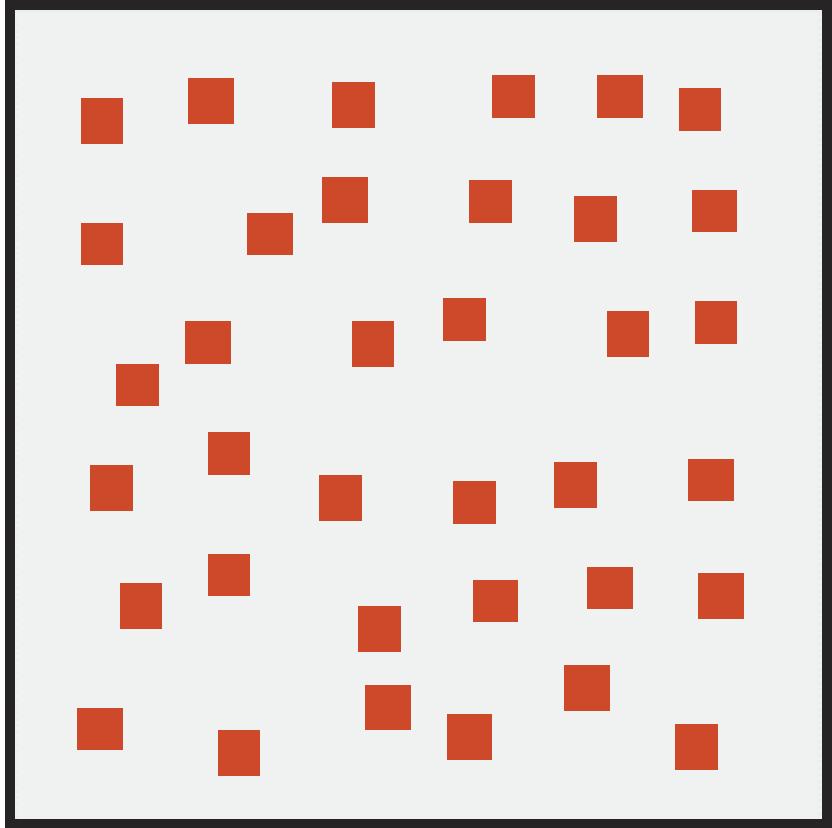
LEFT?

=

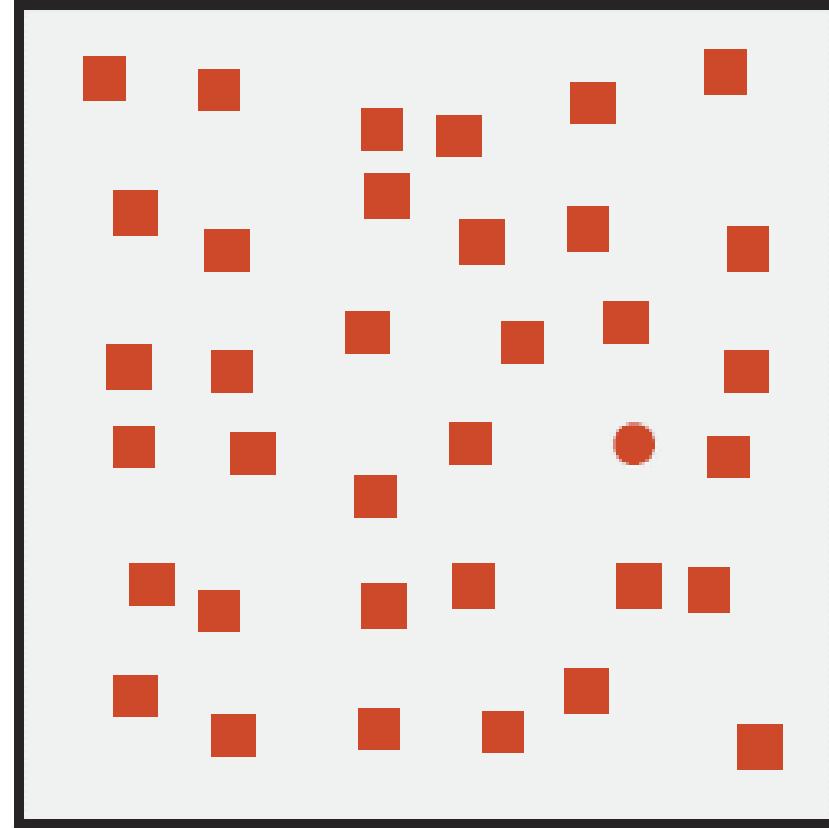
UP!

Which panel has a red dot?

A



B



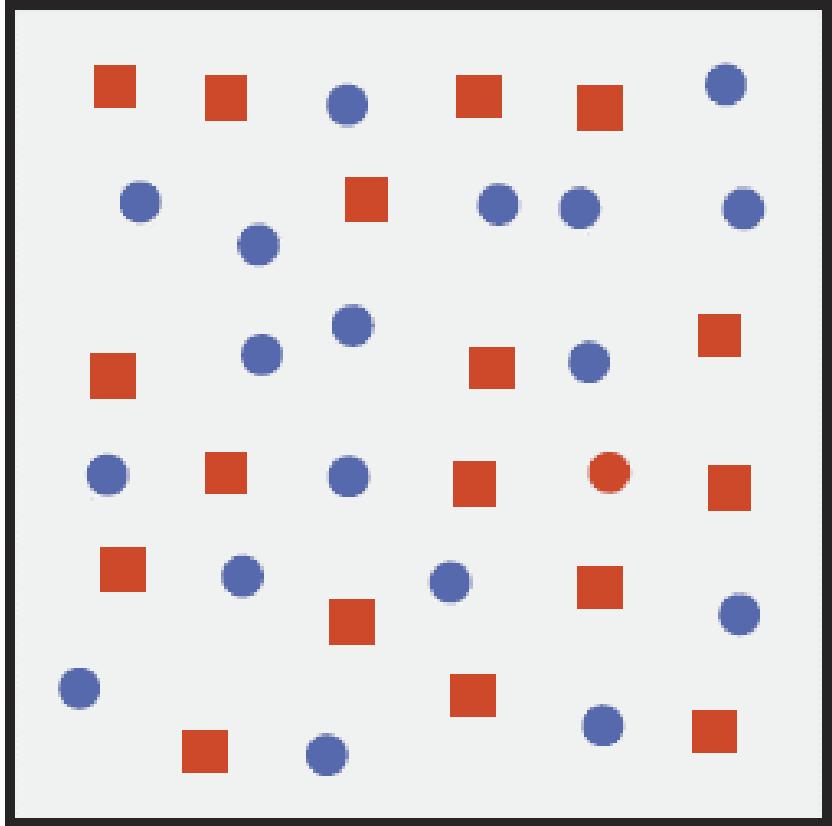
LEFT?

=

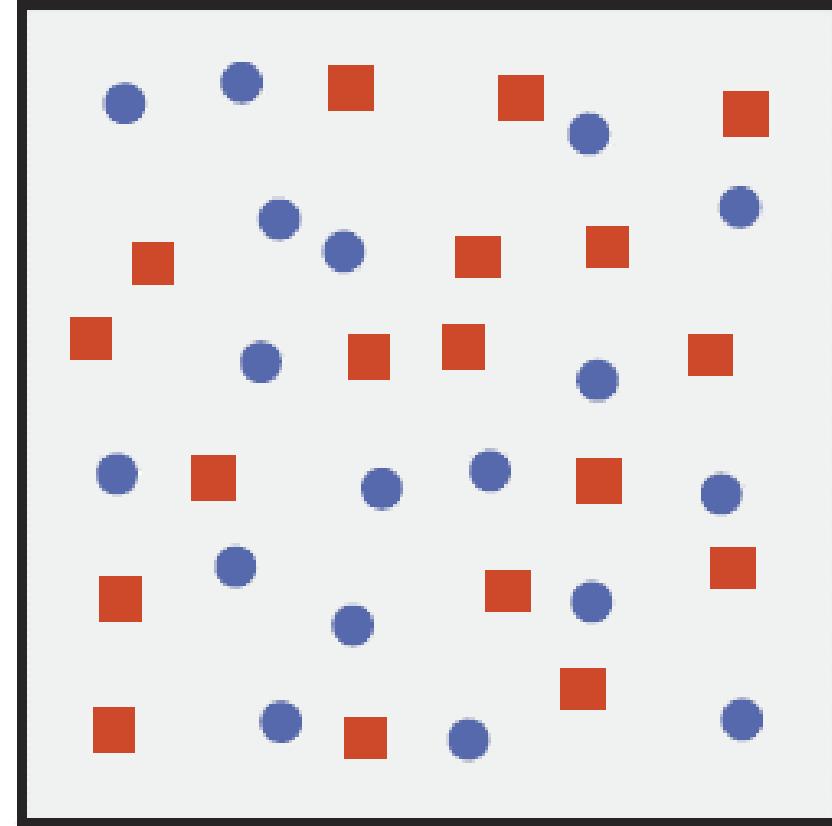
UP!

Which panel has a red dot?

A



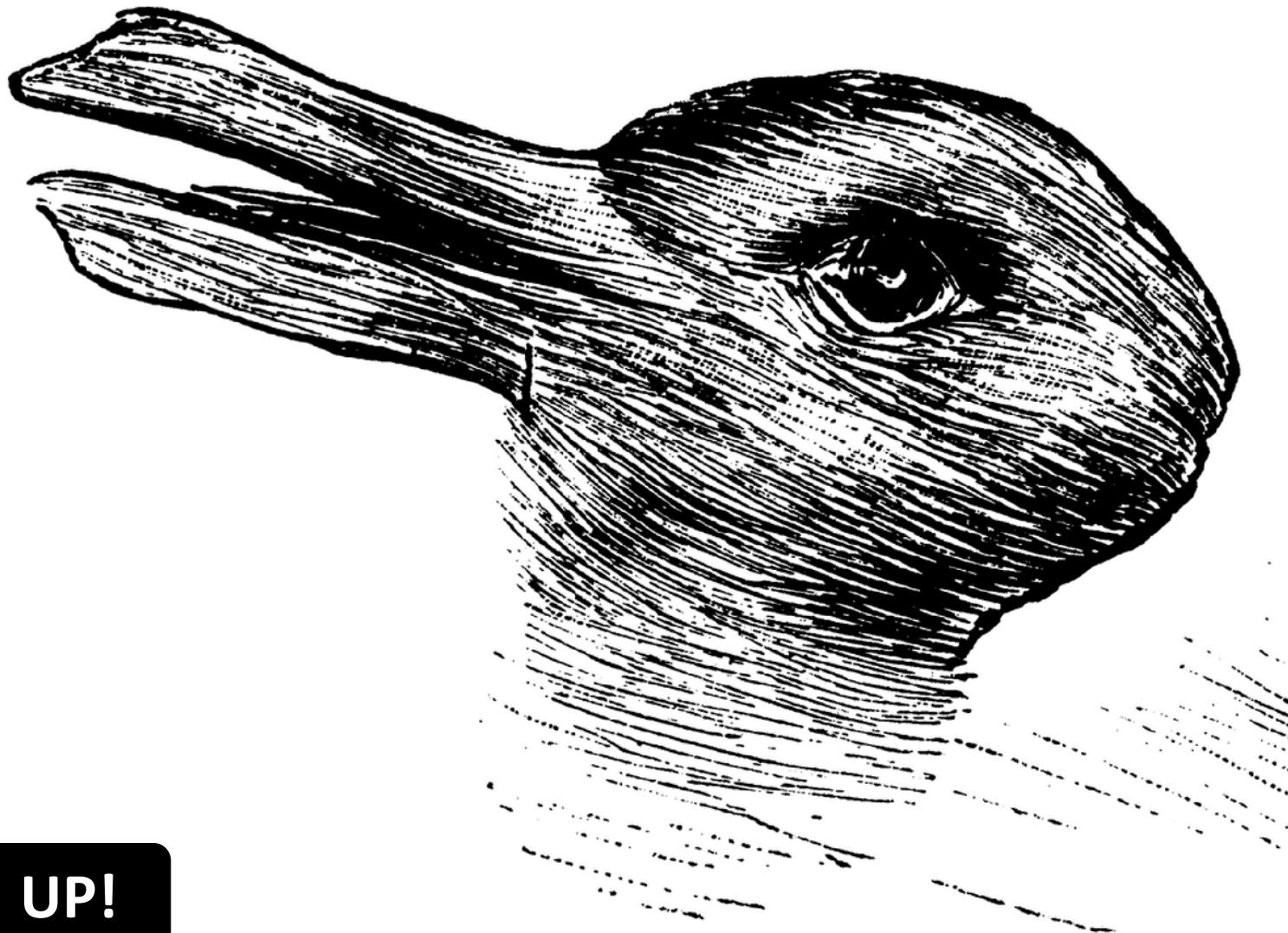
B



LEFT?

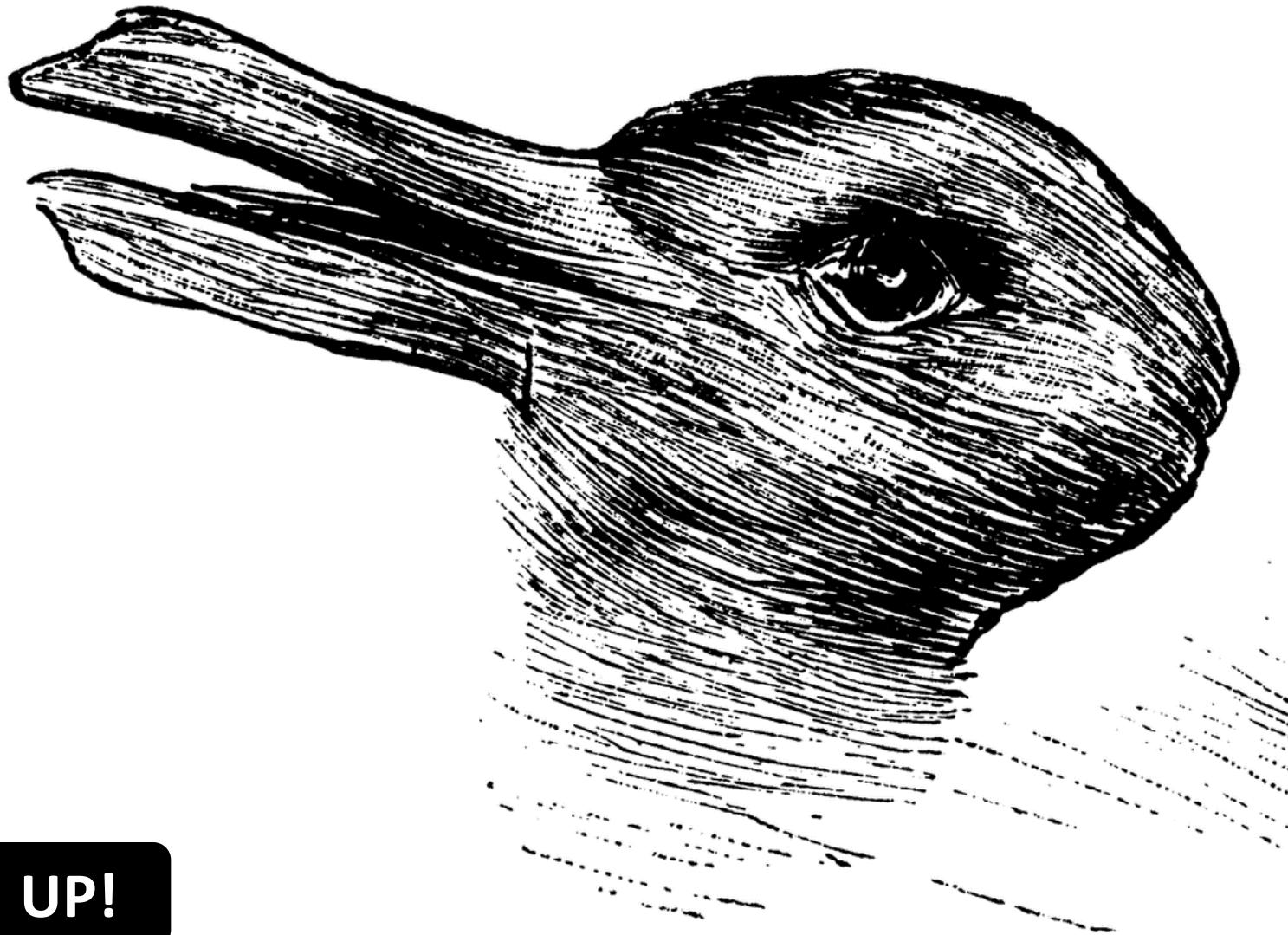
= UP!

Do you see a Rabbit?



YES? = UP!

Do you see a Duck?



YES? = UP!

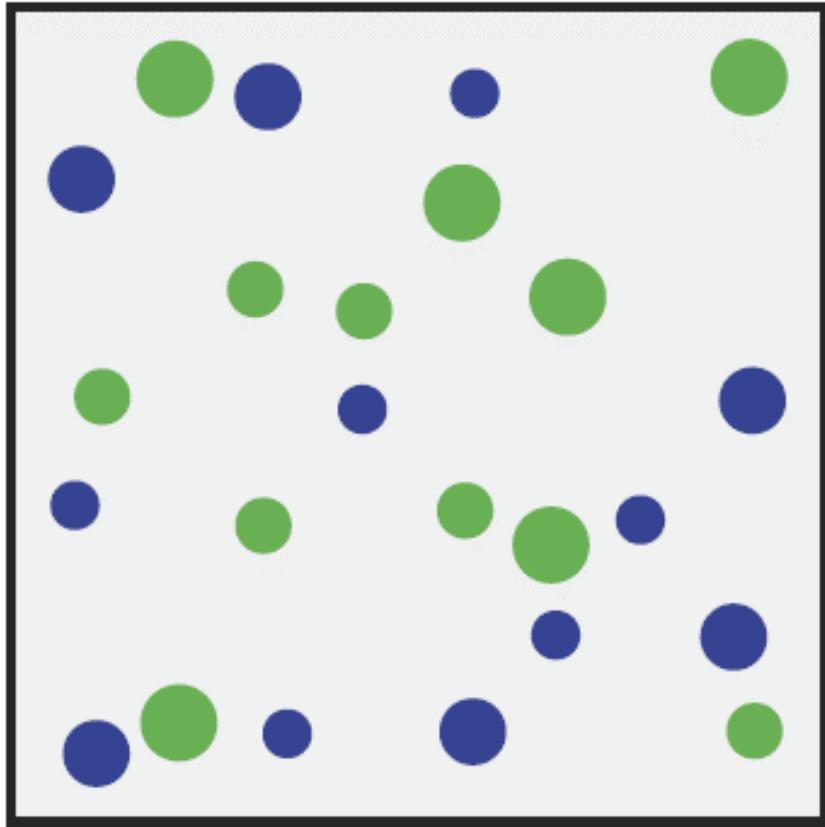
The inner squares have the same color



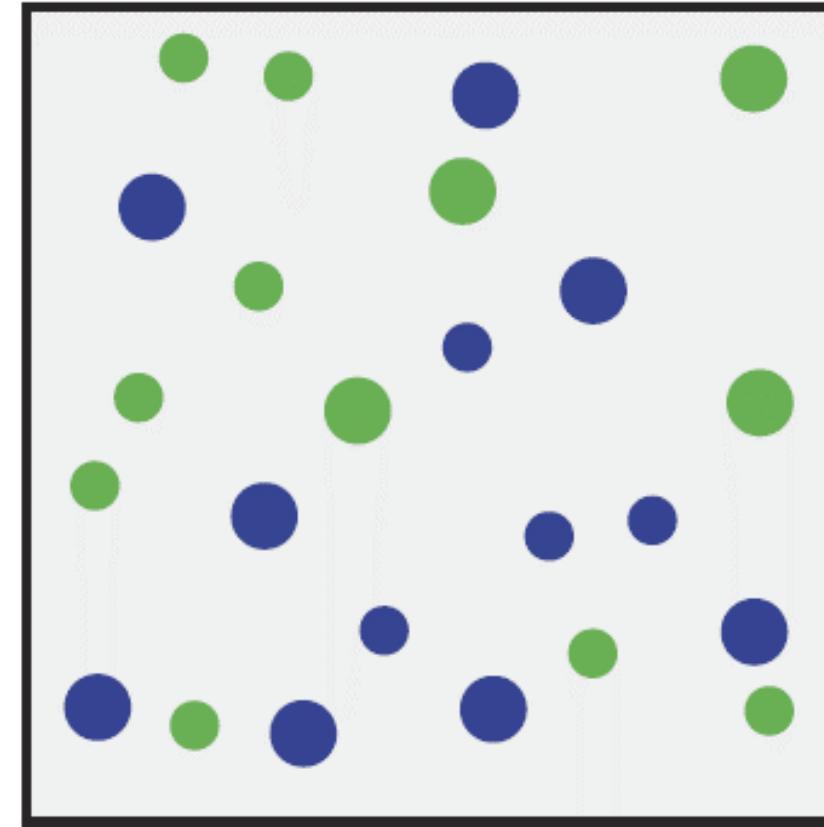
YES? = UP!

Which panel has the **biggest green** dots?

A



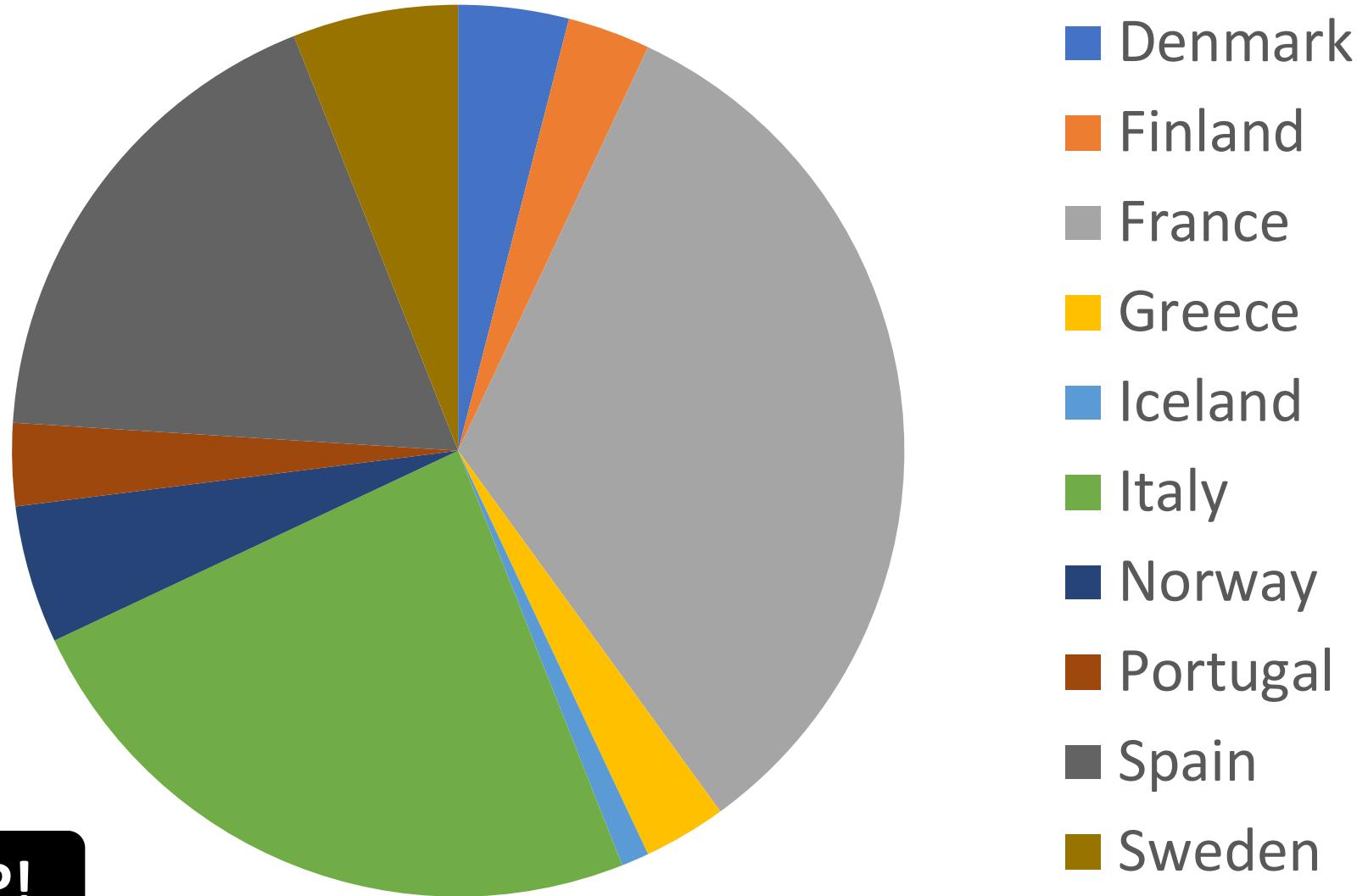
B



LEFT? =

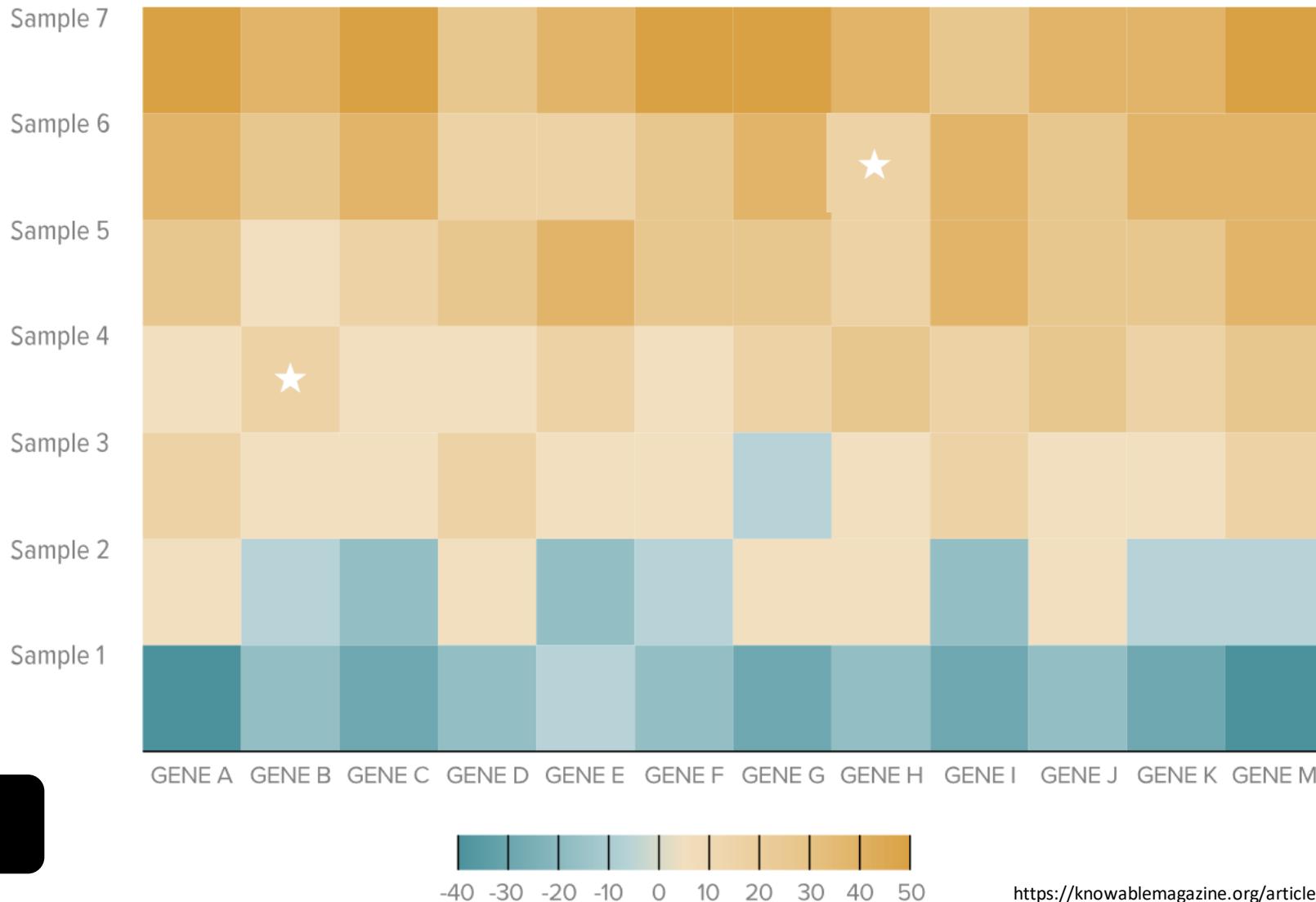
UP!

Norway has more widgets than Finland

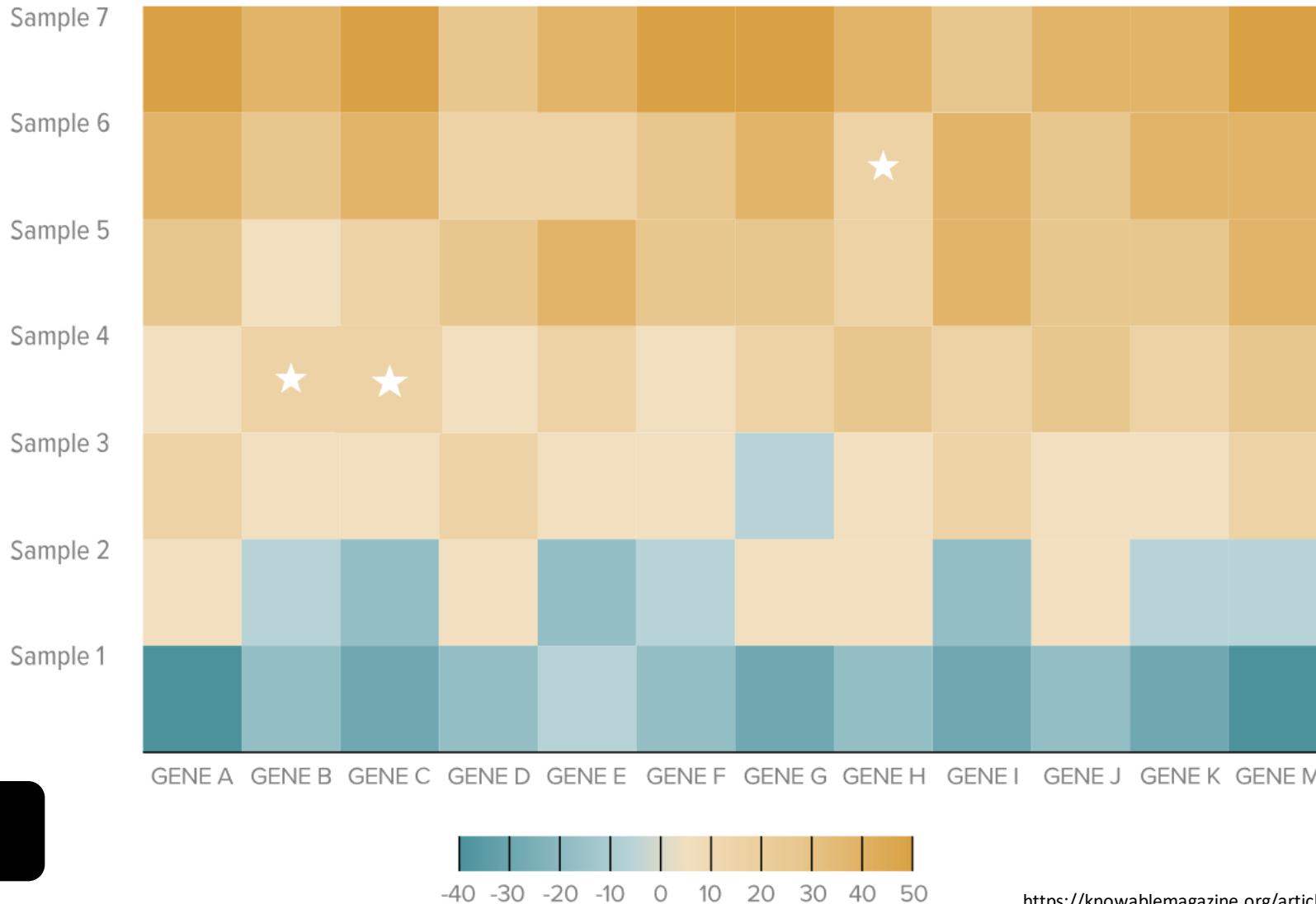


YES? = UP!

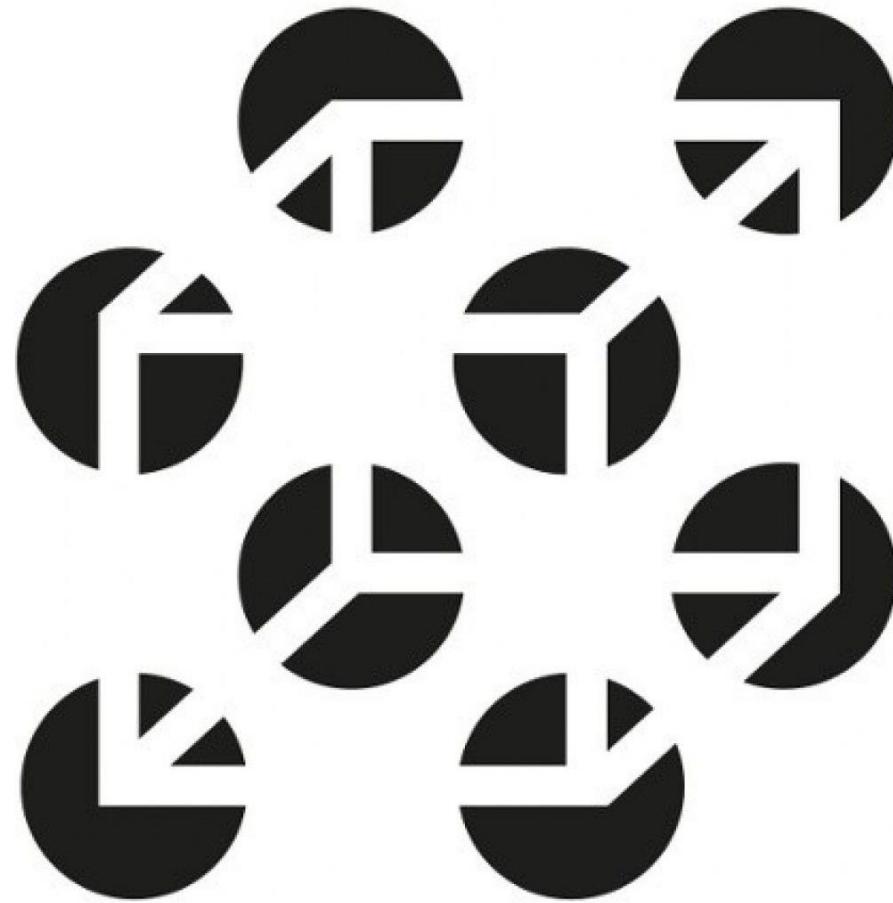
The areas with a star have the same color



The areas with a star have the same color

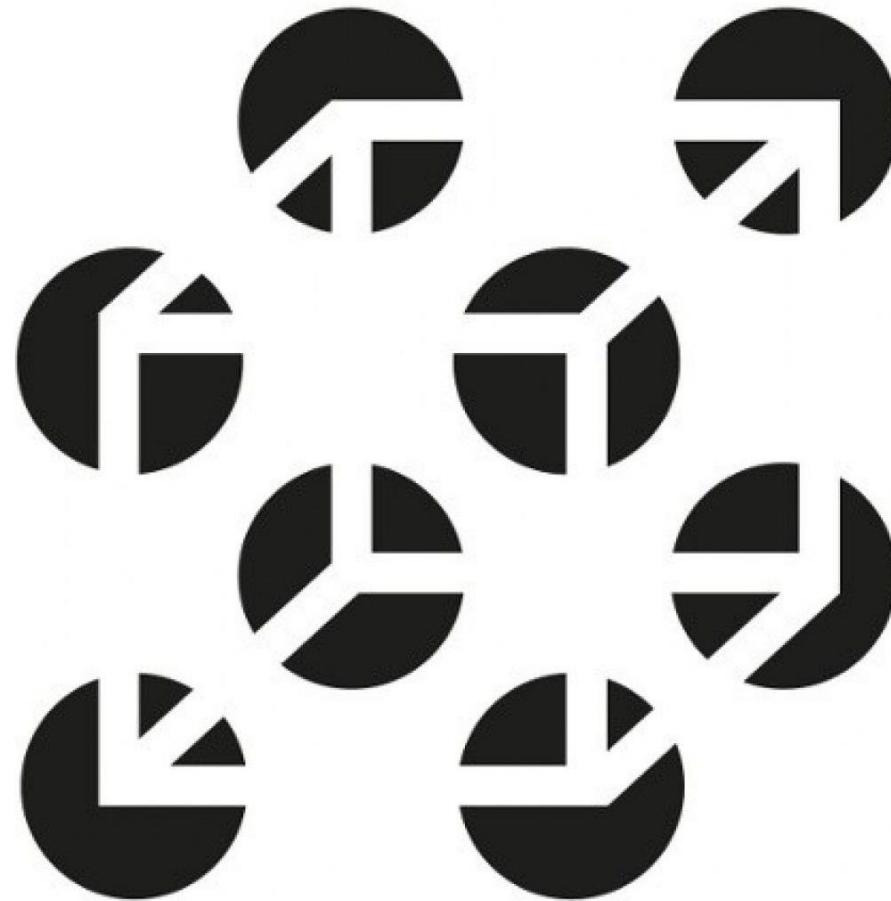


Do you *see* a cube?



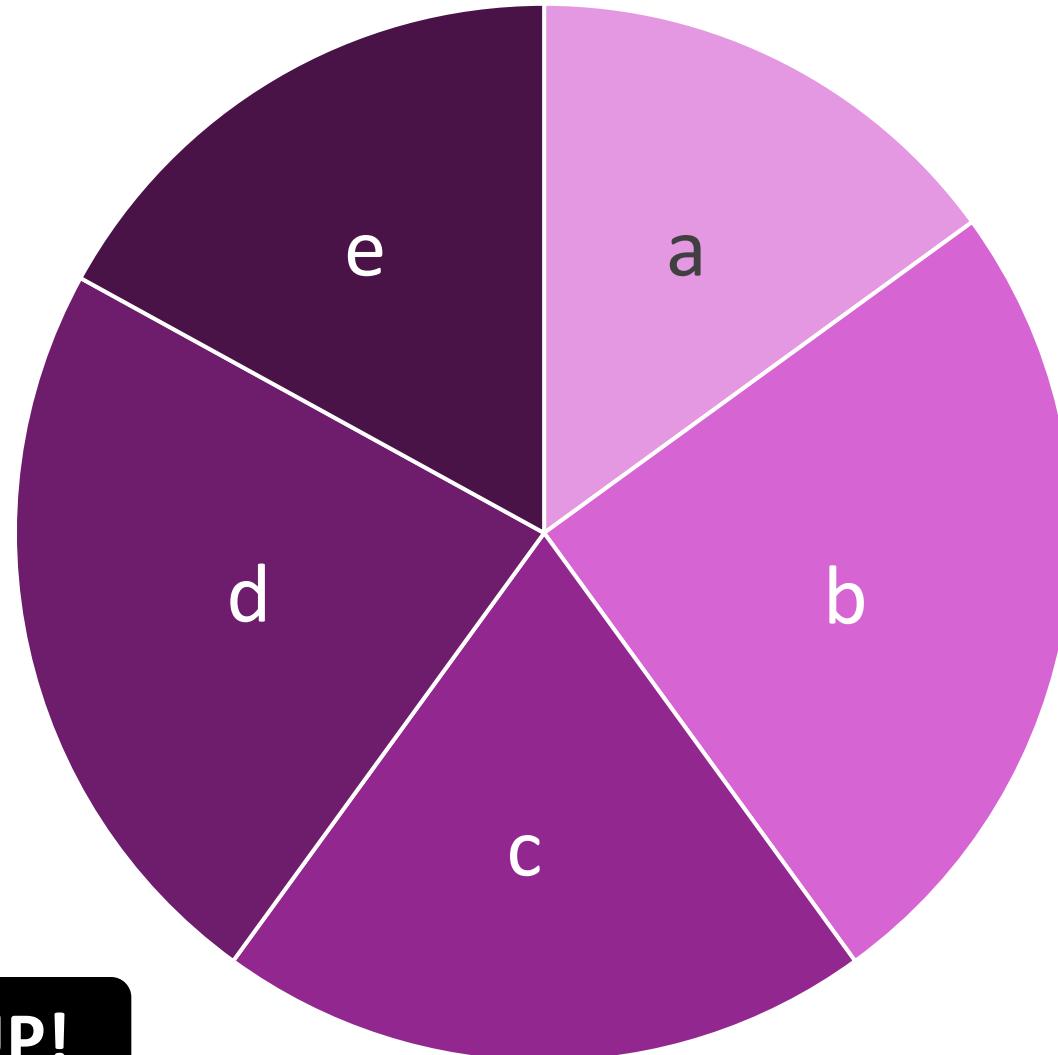
YES? = UP!

Is there a cube?



YES? = UP!

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



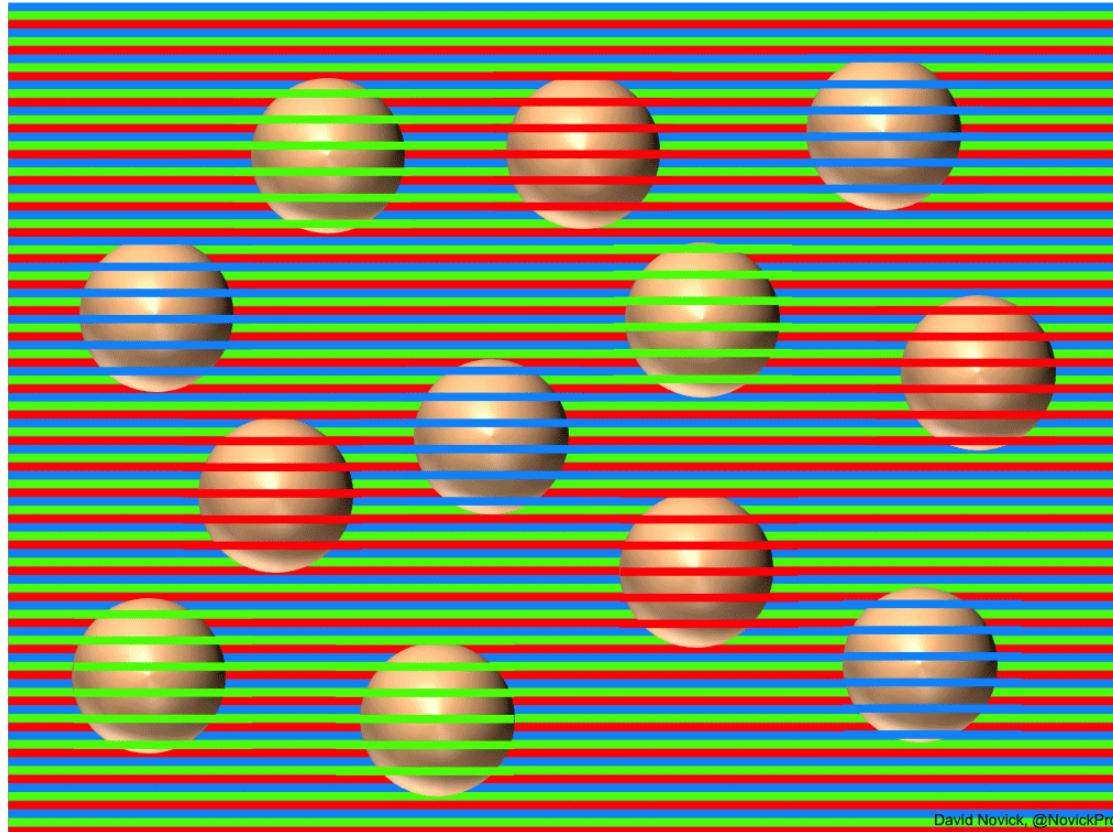
YES? = UP!

These spheres have the same color



YES? = **UP!**

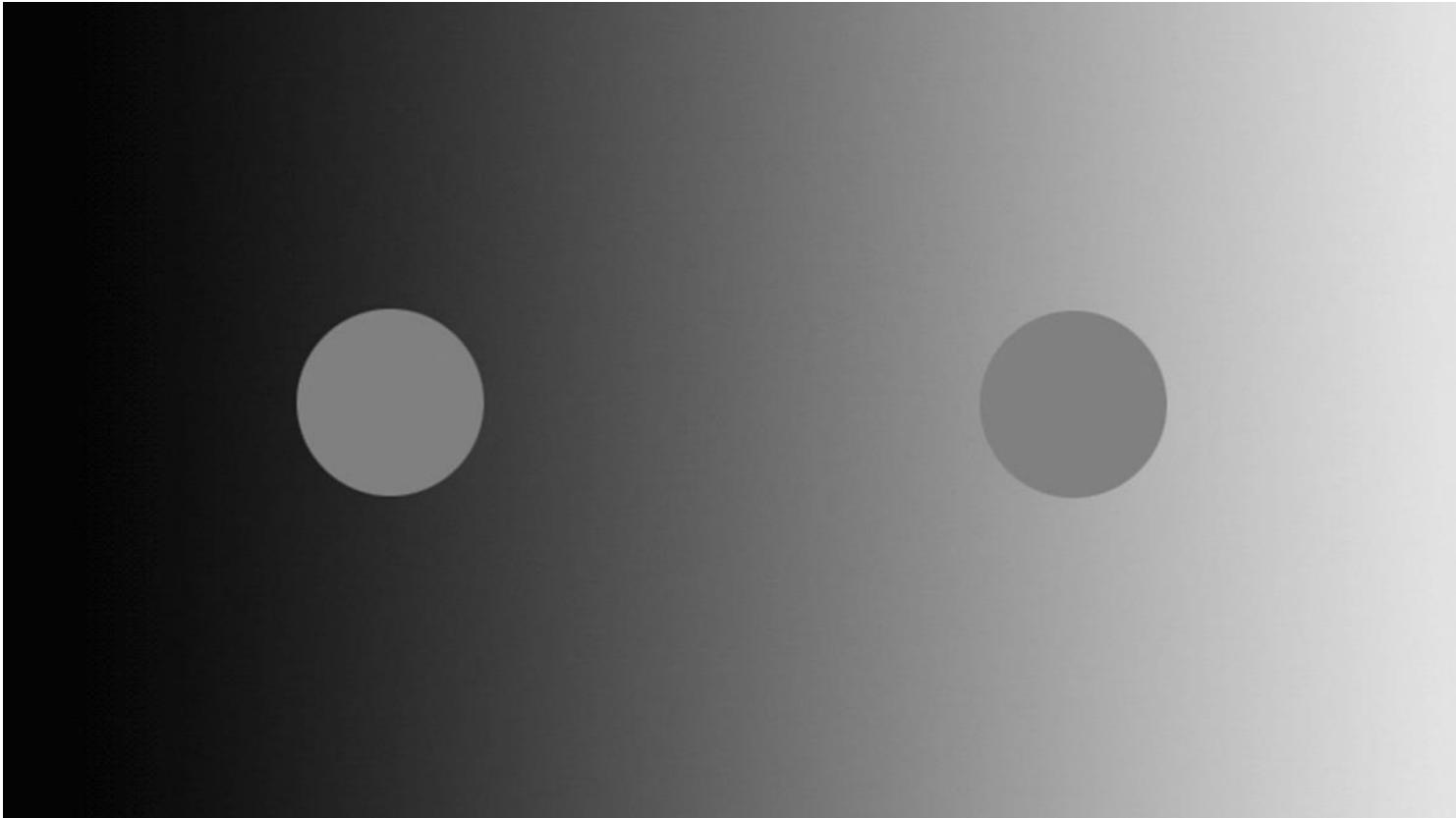
These spheres have the same color



David Novick, @NovickProf

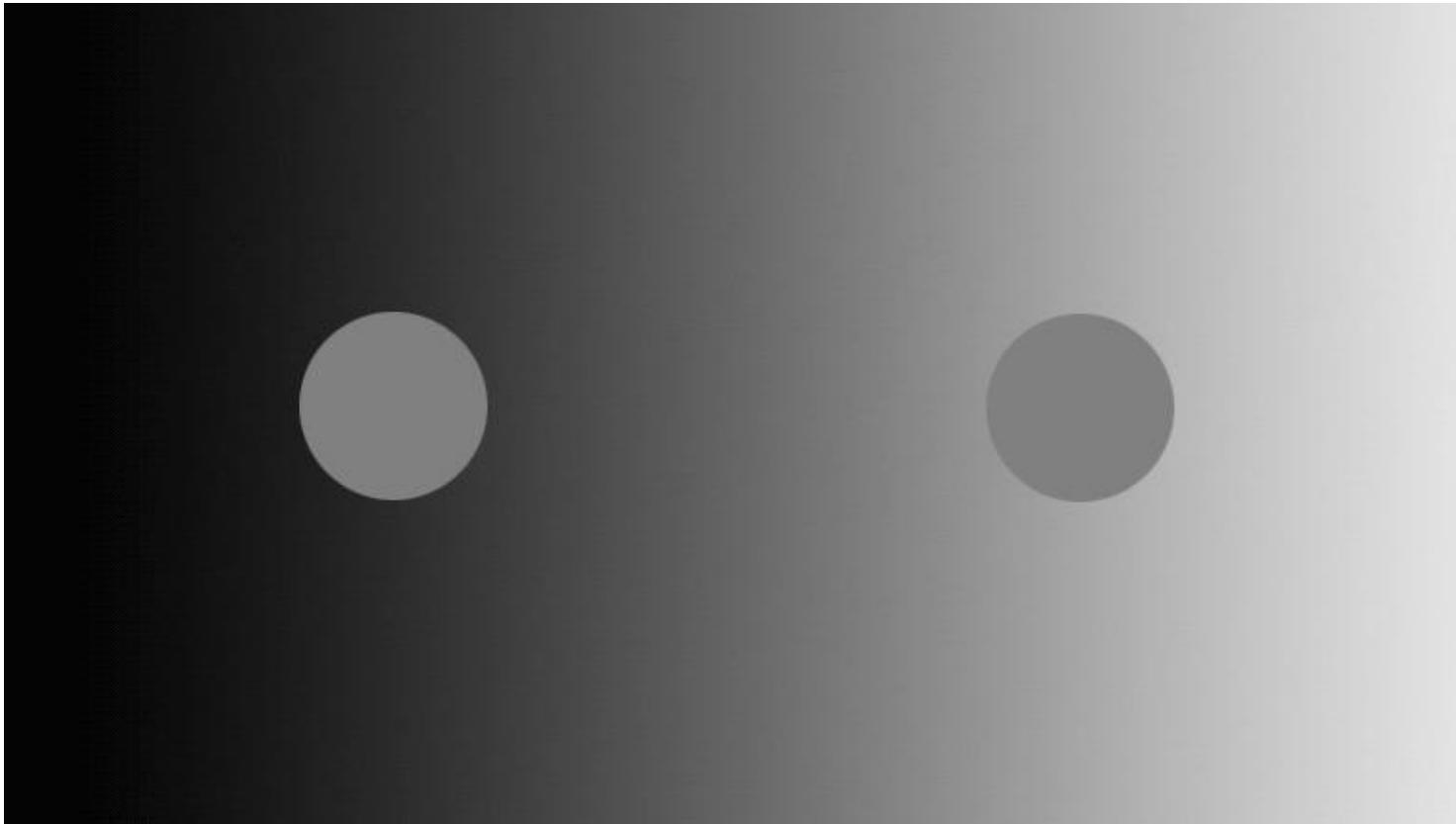
YES? = **UP!**

Which dot is darker?



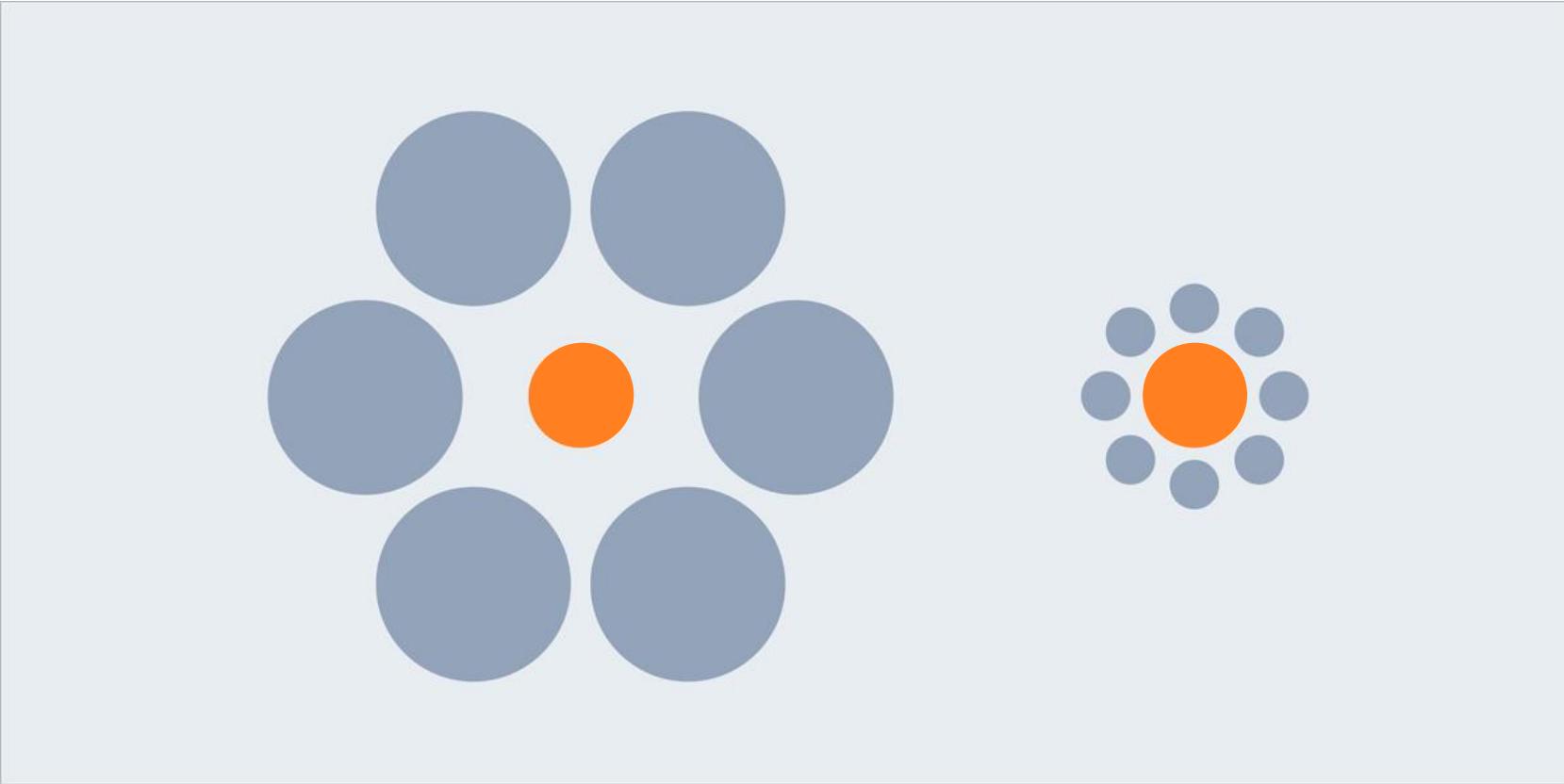
LEFT? = UP!

Are you sure...?



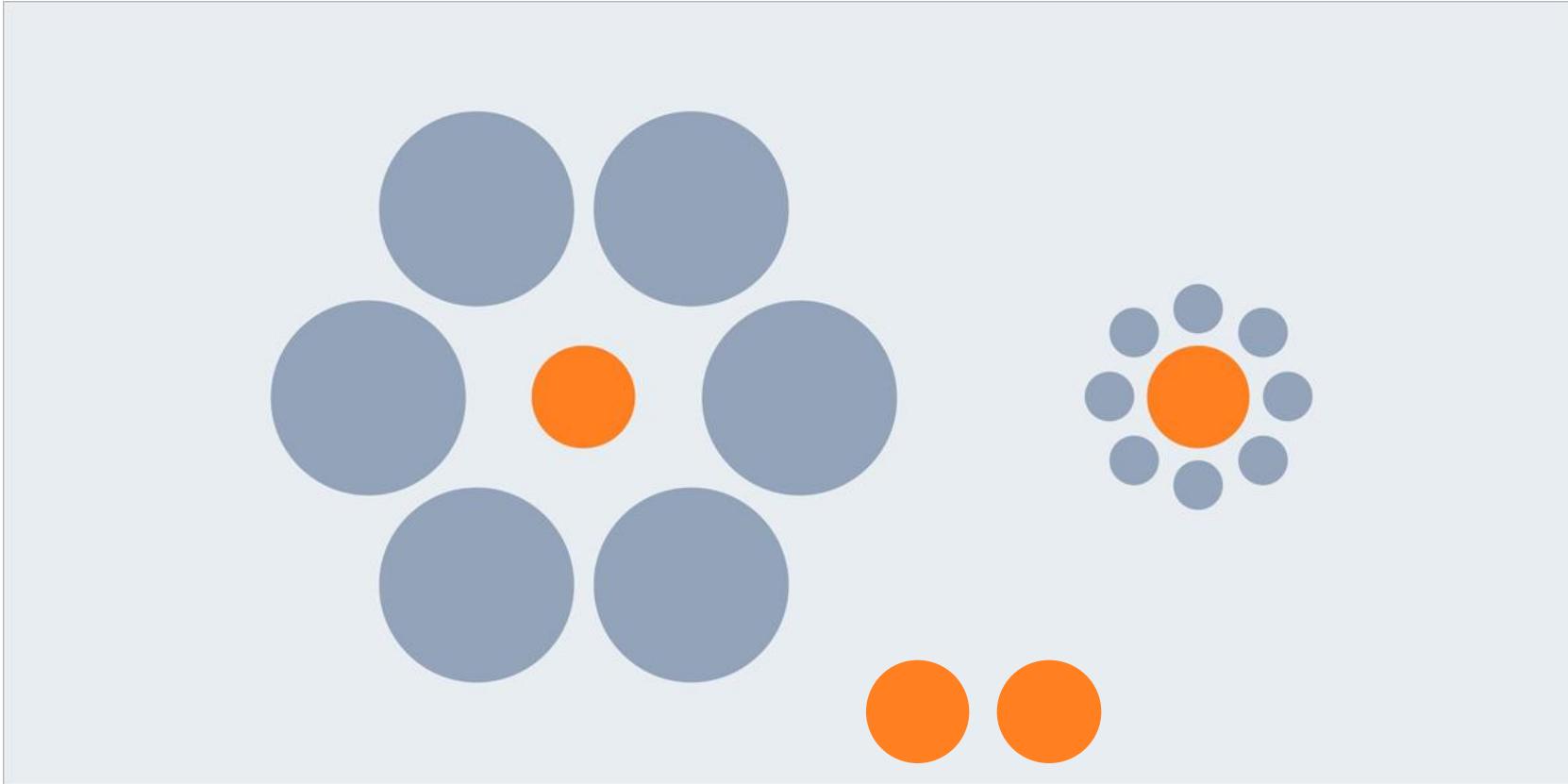
LEFT? = UP!

Which orange circle is smaller?

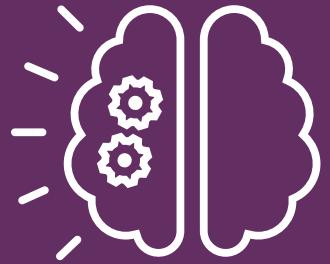


LEFT? = UP!

Which orange circle is smaller?



LEFT? = UP!



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

Henry David Thoreau

Why visual communication ?

What can you see in these numbers?

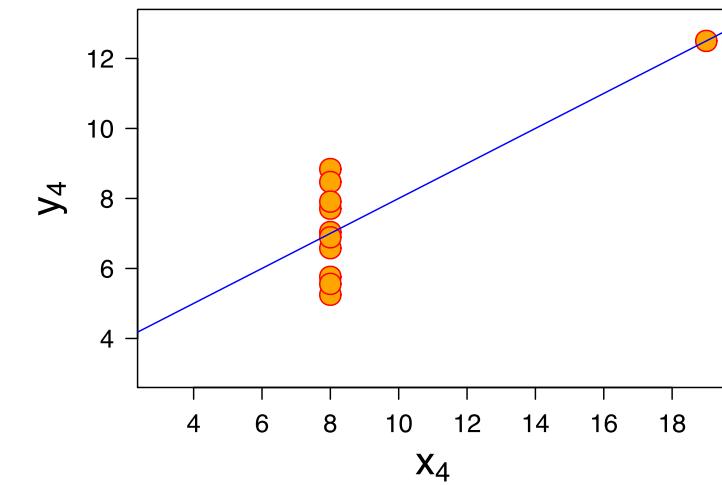
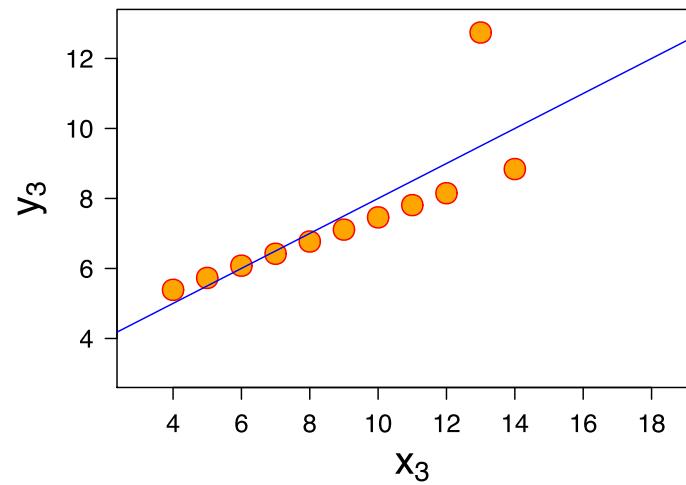
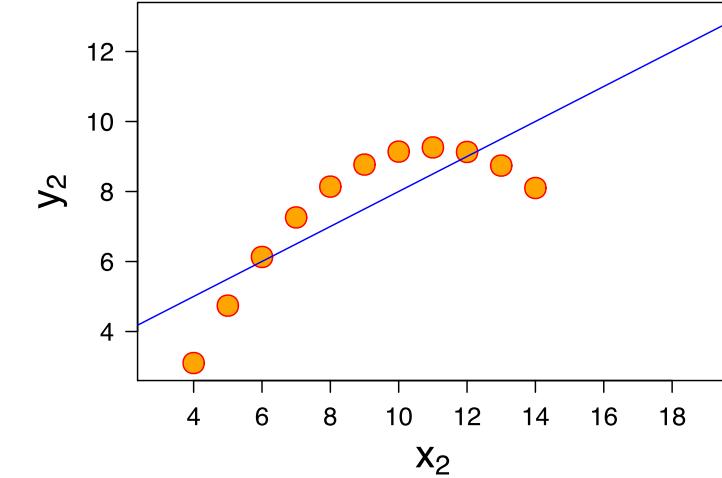
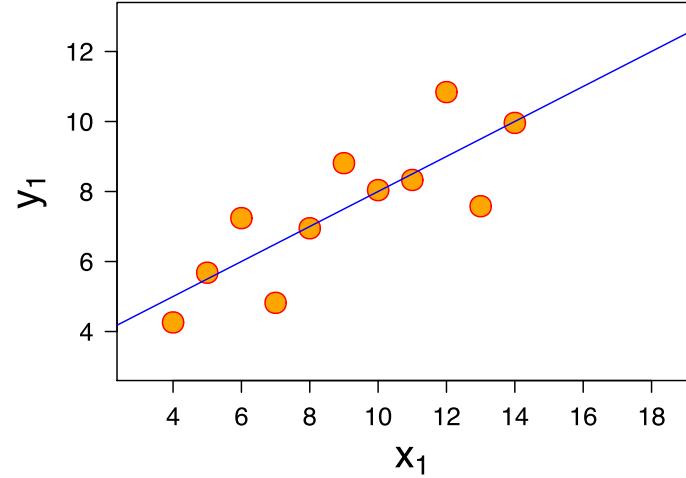
Anscombe's quartet:
4 datasets
11 x-values
11 y-values
Same total
Same mean
Same standard deviation

	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

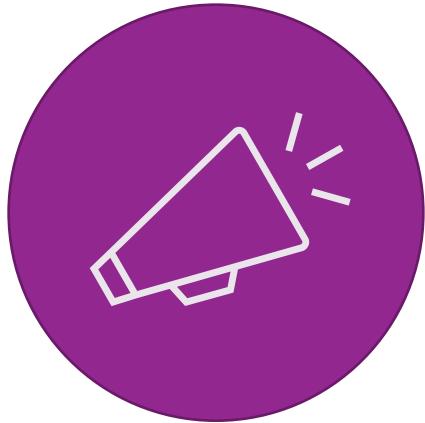


Why use visuals in academic research?



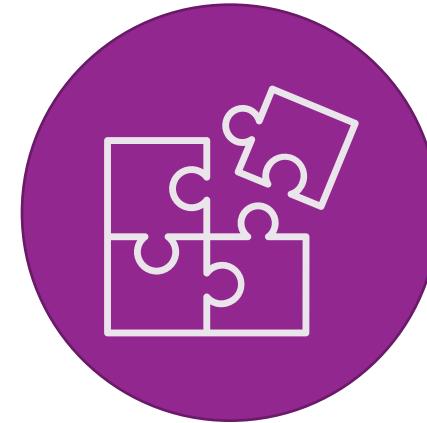
Provide **insight**

-
- Publications
 - Oral presentations
 - Poster presentations



Grab **attention**

-
- Graphical abstracts
 - Social media
 - General media



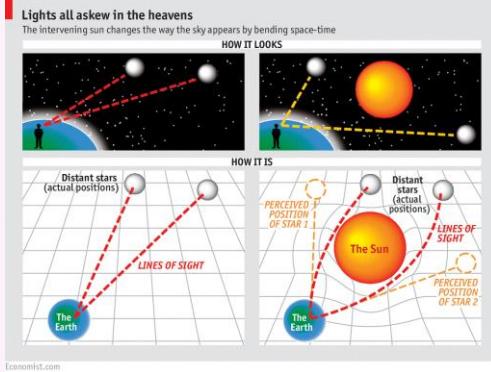
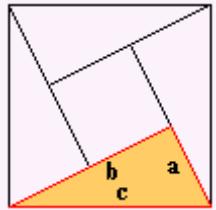
Show **competence**

-
- Grant applications
 - Portfolio / CV
 - Pitch

What is visual communication ?

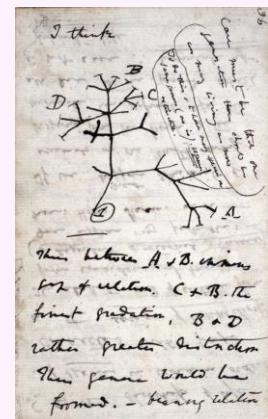
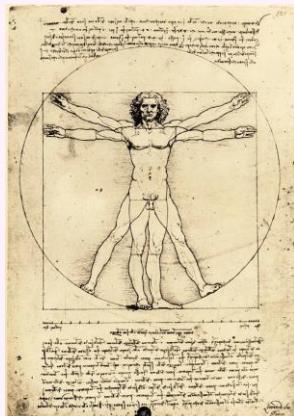
Four types of visualizations

Idea illustration

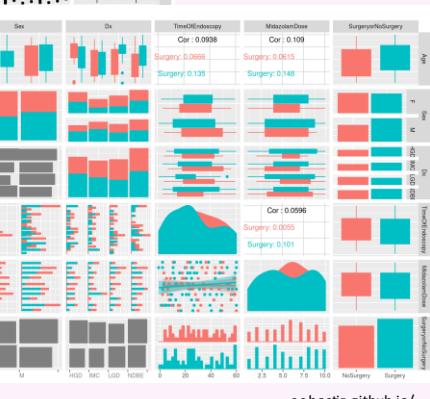
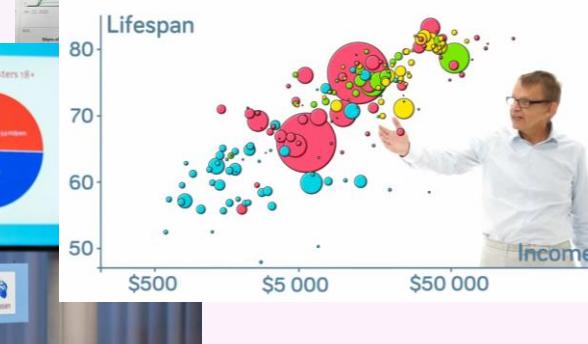


DECLARATIVE

Idea generation



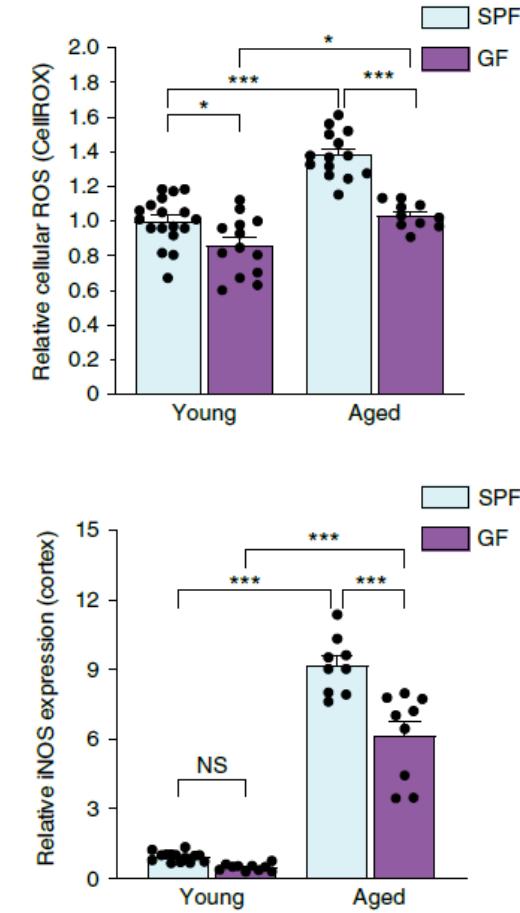
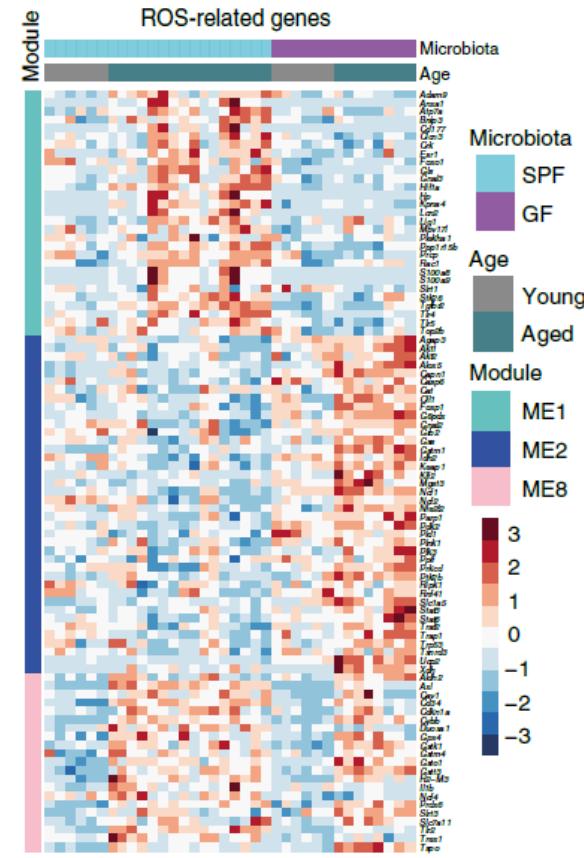
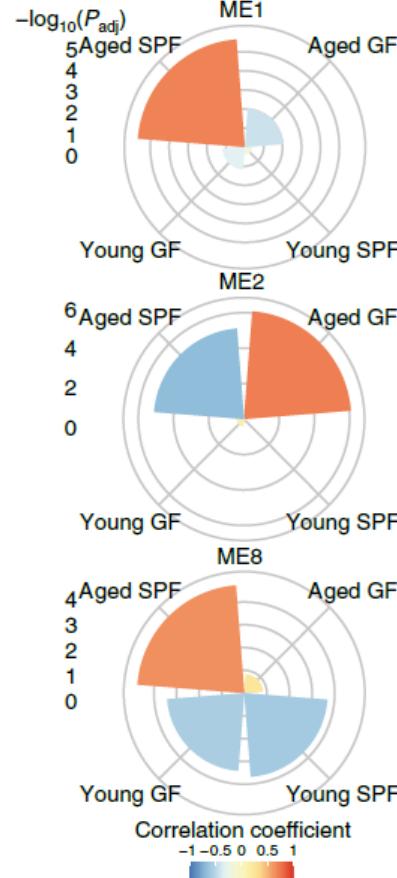
EXPLORATORY



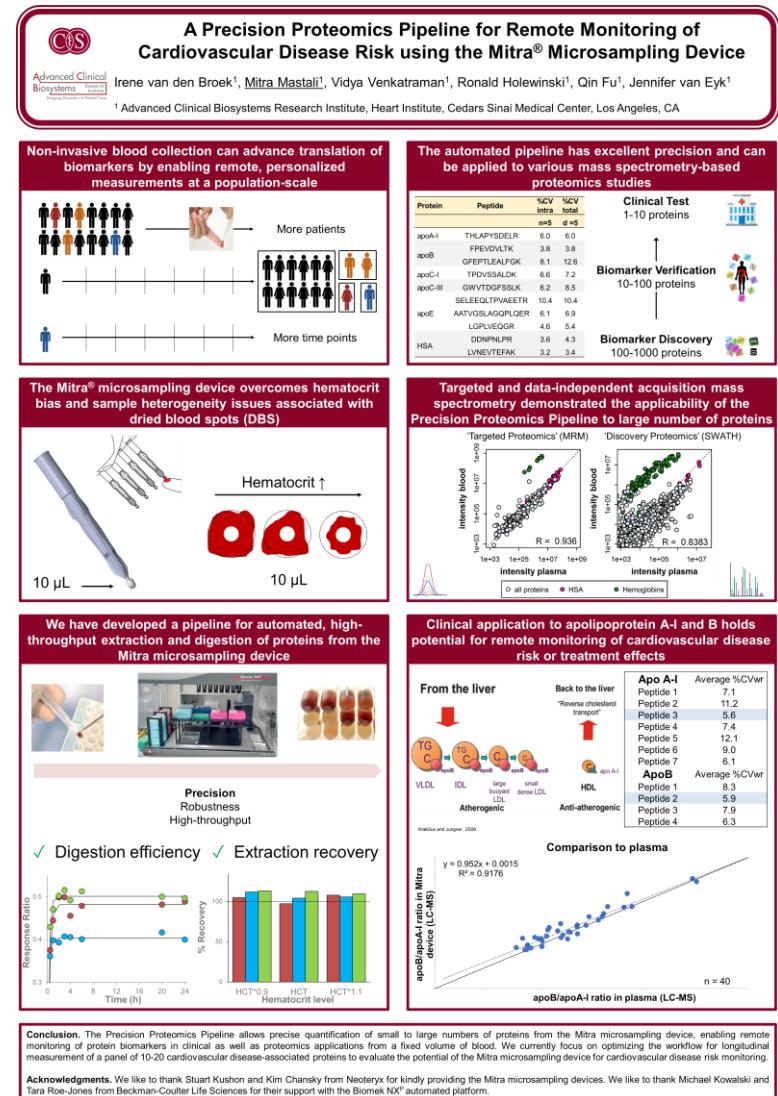
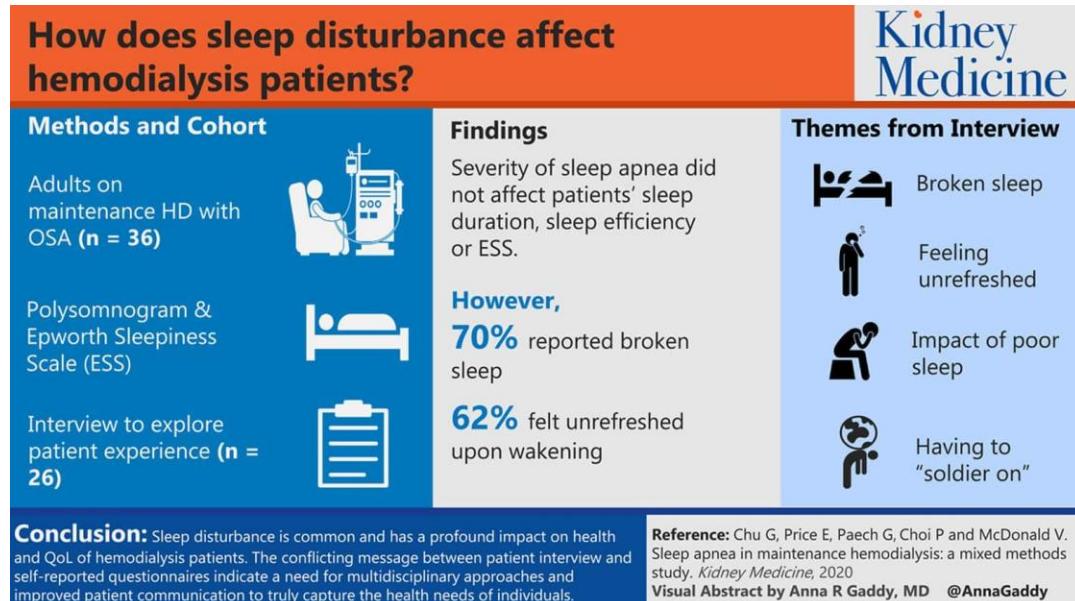
'Everyday'
DataViz

Visual
discovery

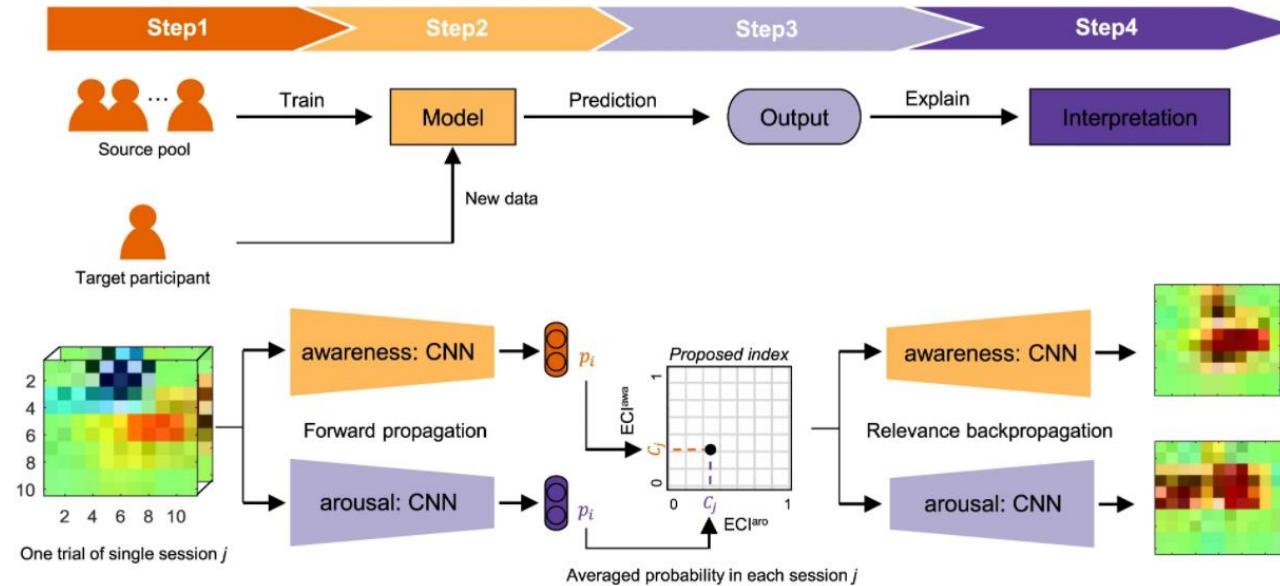
Visual communication in academic research is not *just* **data** charts...



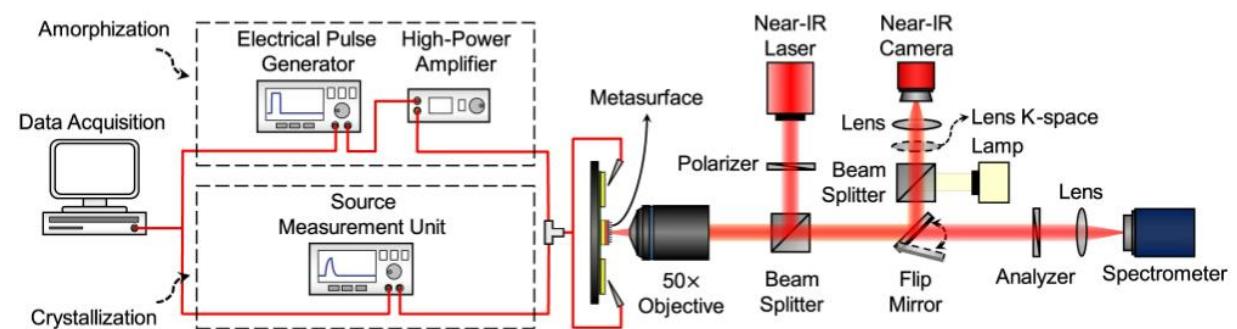
You can also think of graphical abstracts or posters...



Flow charts or schematics...

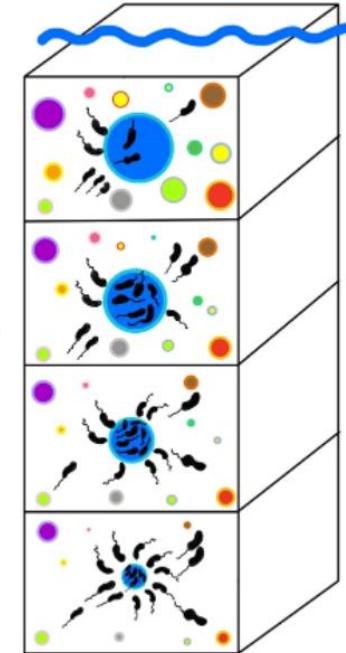
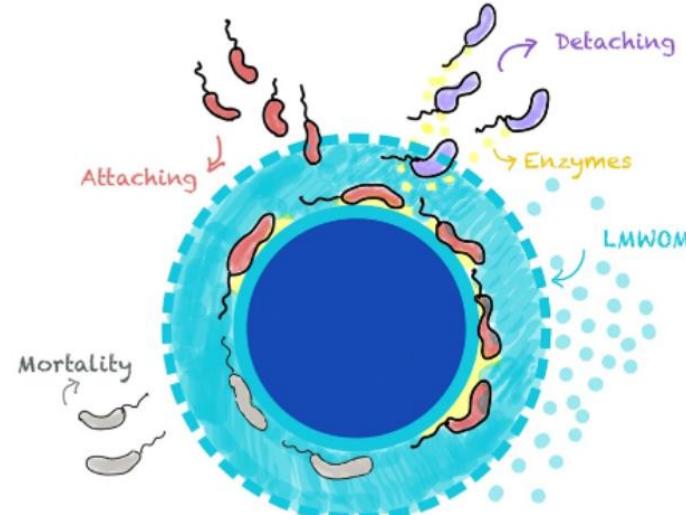
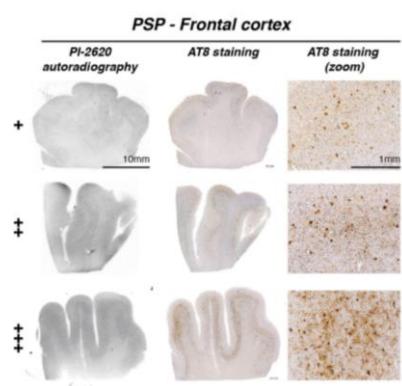
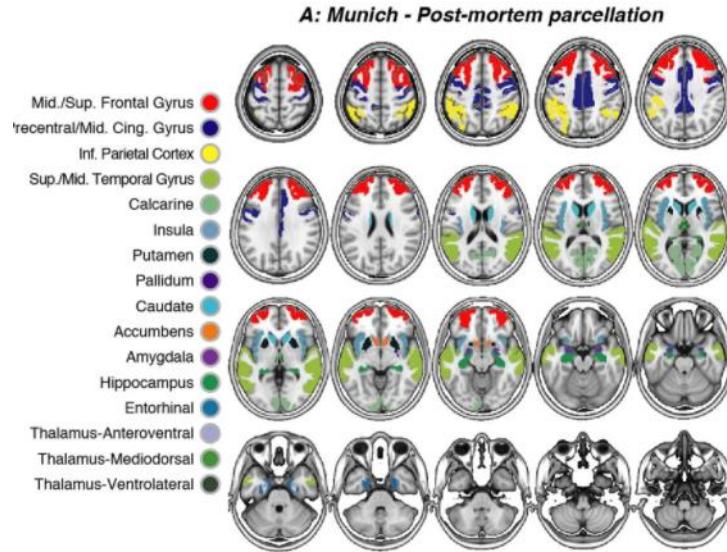


Lee M et al. (2022) Nat Commun **13**, 1064.



Abdollahramezani, S et al. Nat Commun **13**, 1696 (2022).

Illustrations, drawings, images...



Talking about reaching a broad public!



Prof. Ed Hawkins
#showyourstripes



HOW visual communication ?

1. Choose a chart

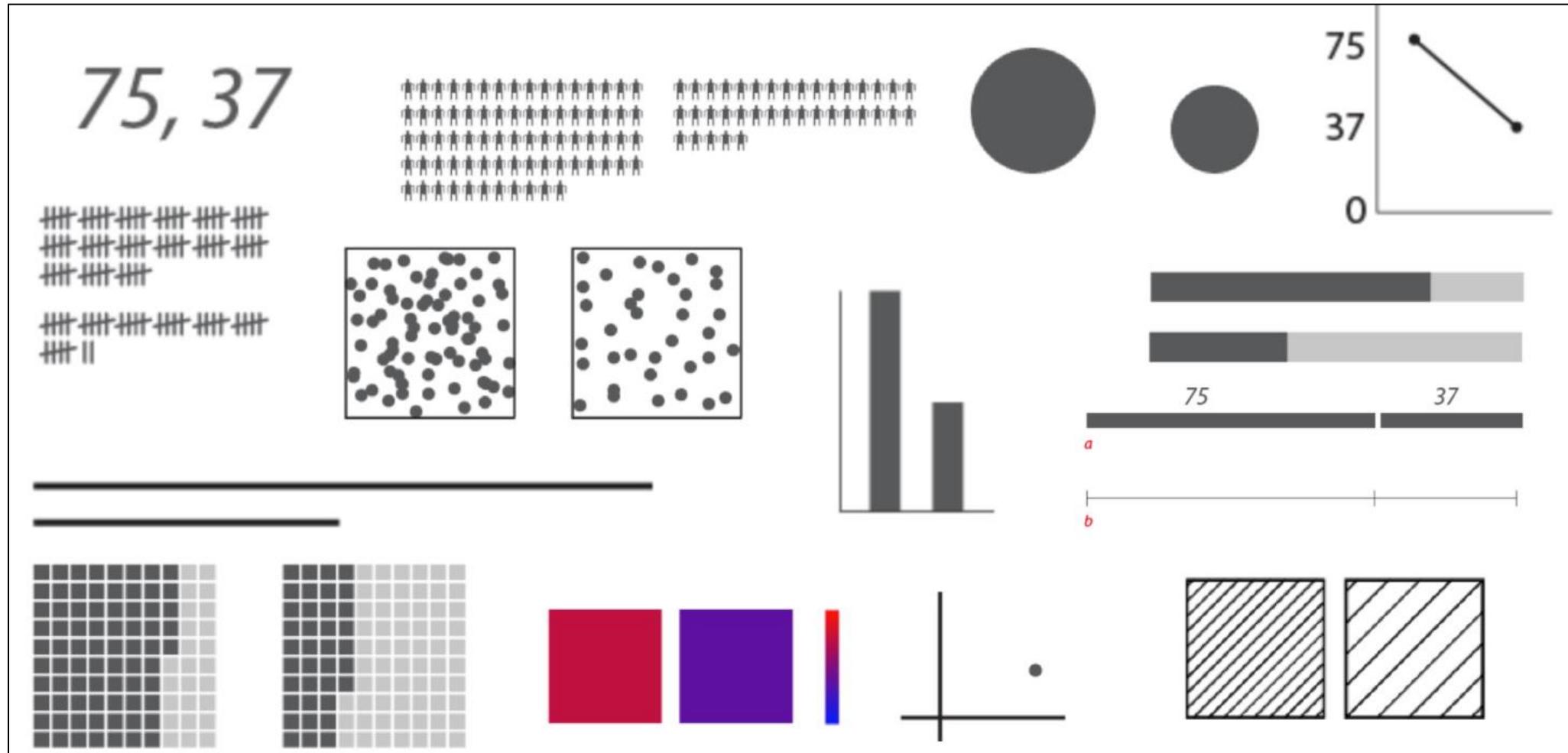
Exercise: In how many ways can you visualize two numbers?

75 and 37

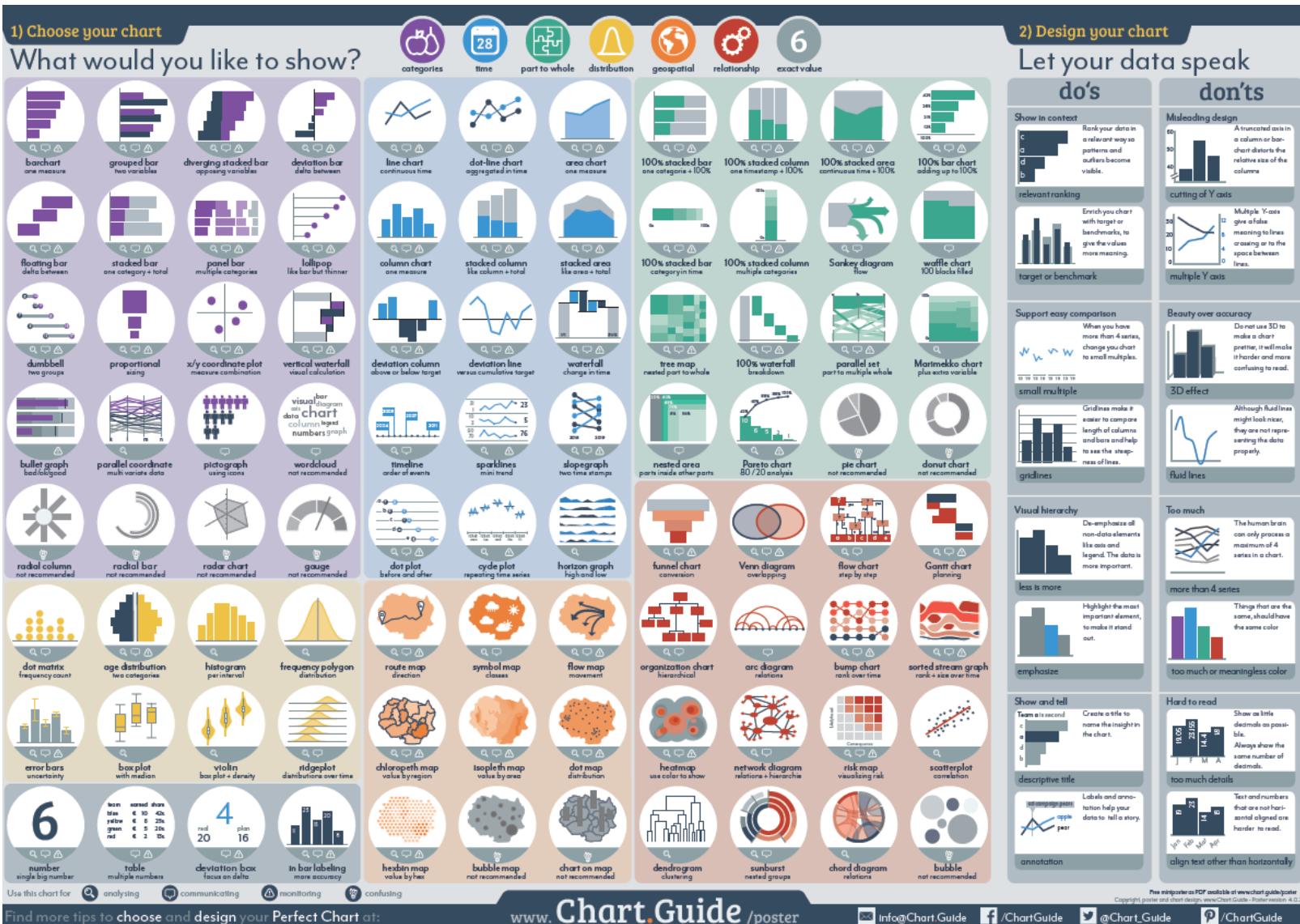


5 min

Some of 45 ways to communicate two quantities



So many ways: how to choose?



HOW visual communication ?

2. Improve visual perception



Visual perception

The strengths of our brain

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

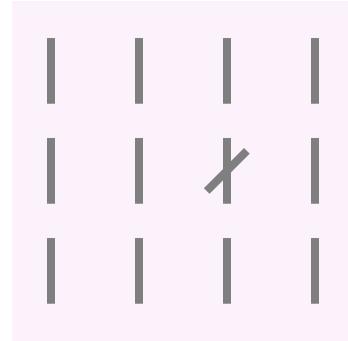
How many fives do you see?

321654643216465132168461321
646432136748651349687463123
668432616266984892536496874
651687964649843616984616957
465167412323161689312439873
421432875943869234987596387

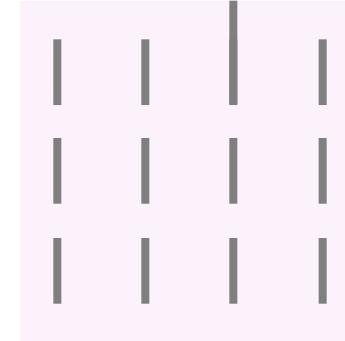
How many fives do you see?

321654643216465132168461321
646432136748651349687463123
668432616266984892536496874
651687964649843616984616957
465167412323161689312439873
421432875943869234987596387

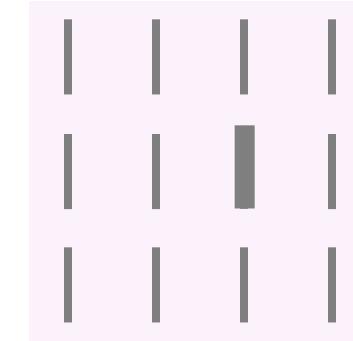
Pre-attentive attributes make your audience see what you want them to see before even seeing it!



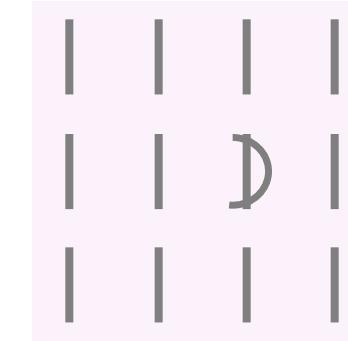
Orientation



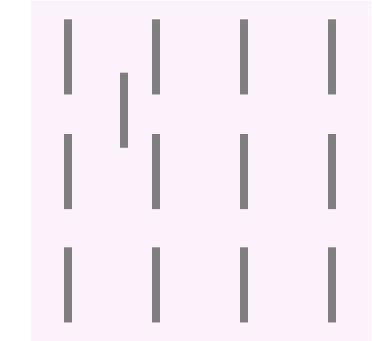
Length



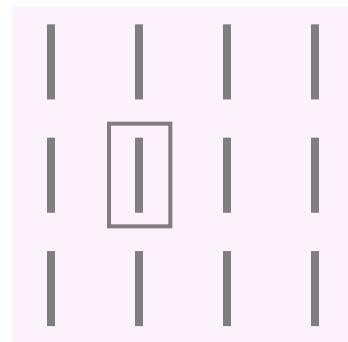
Width



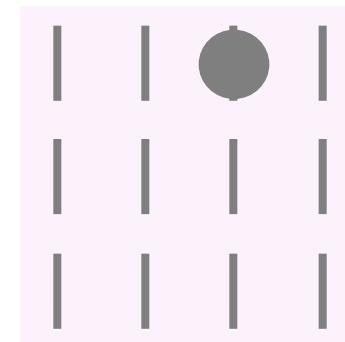
Curvature



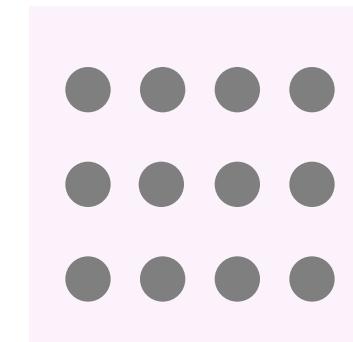
Position



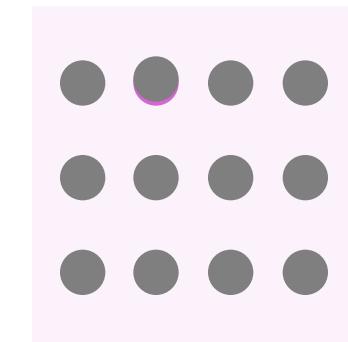
Enclosure



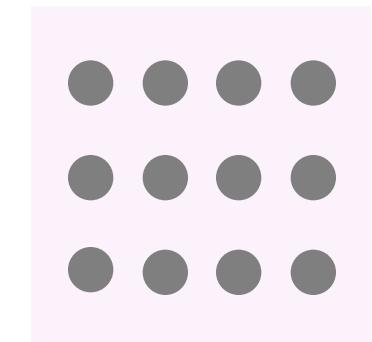
Shape



Size

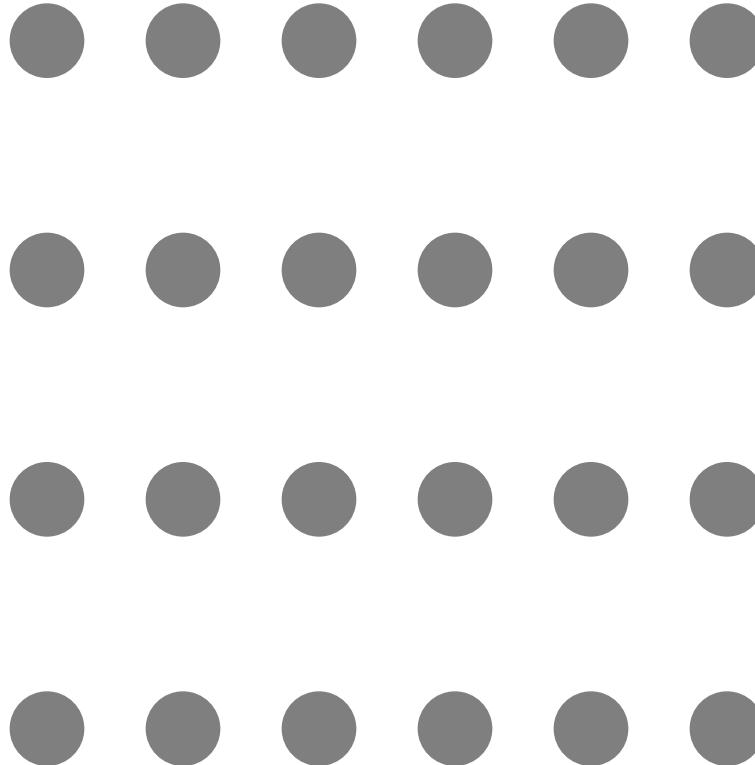


Color

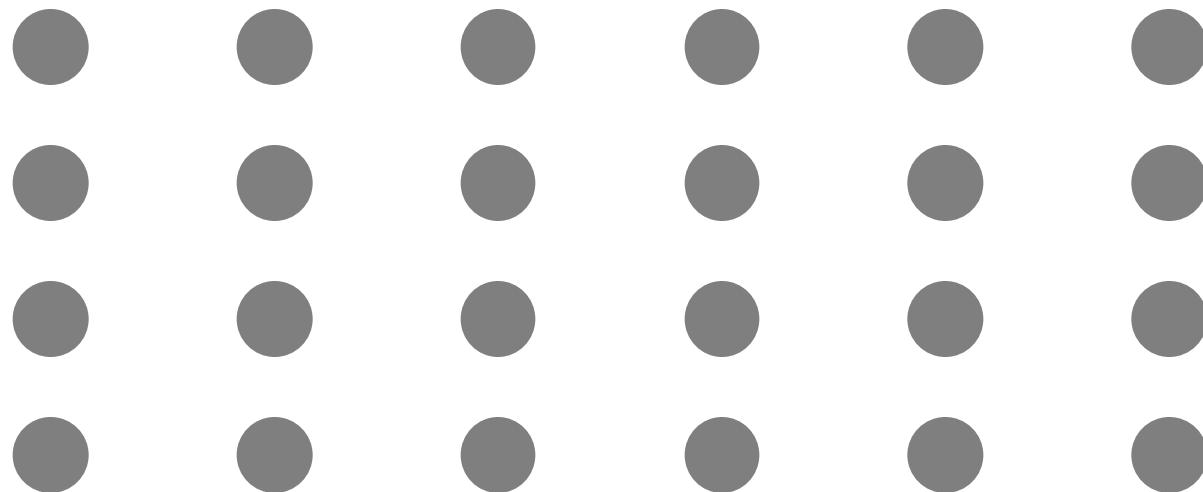


Motion

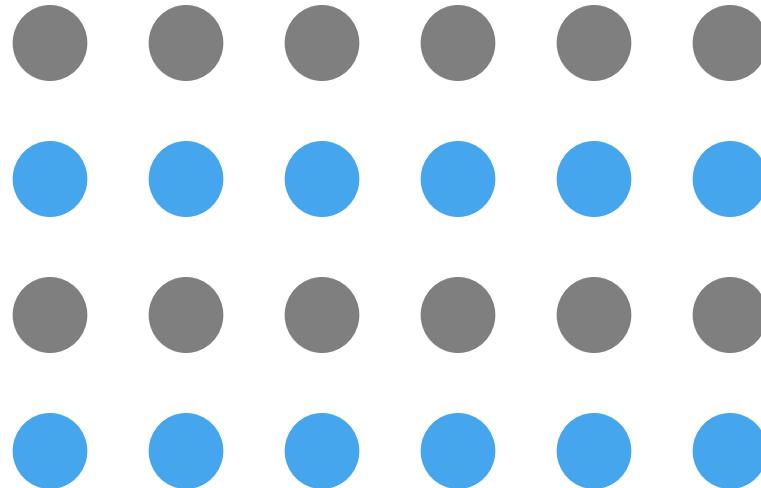
Do you see 4 rows or 6 columns?



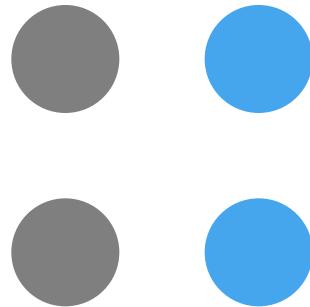
And now?



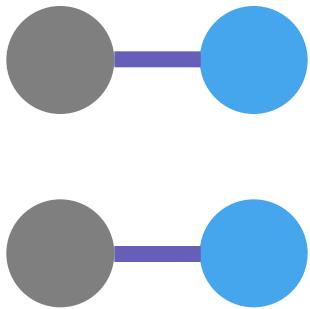
Do you see 4 rows or 6 columns?



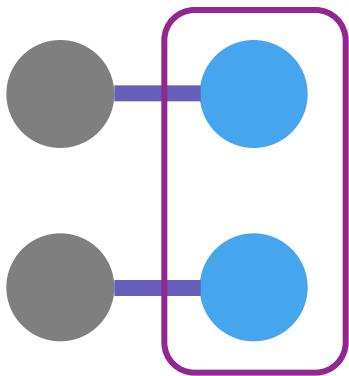
Which dots belong together?



And now...?



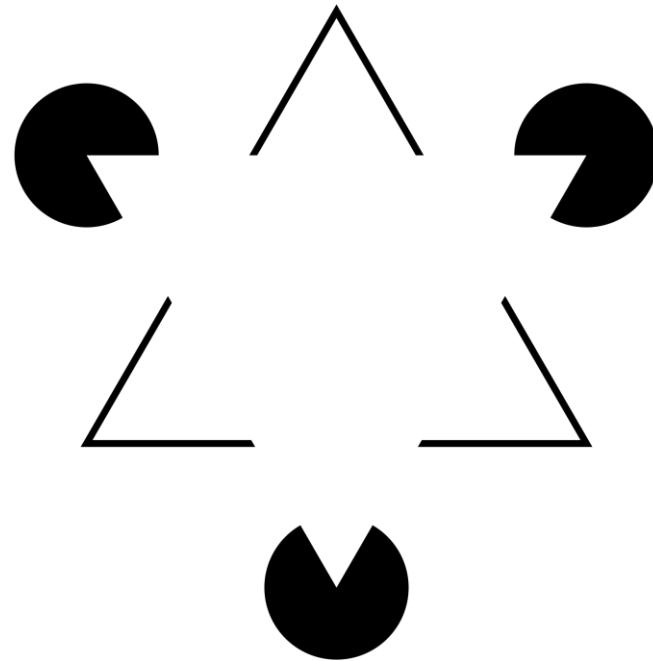
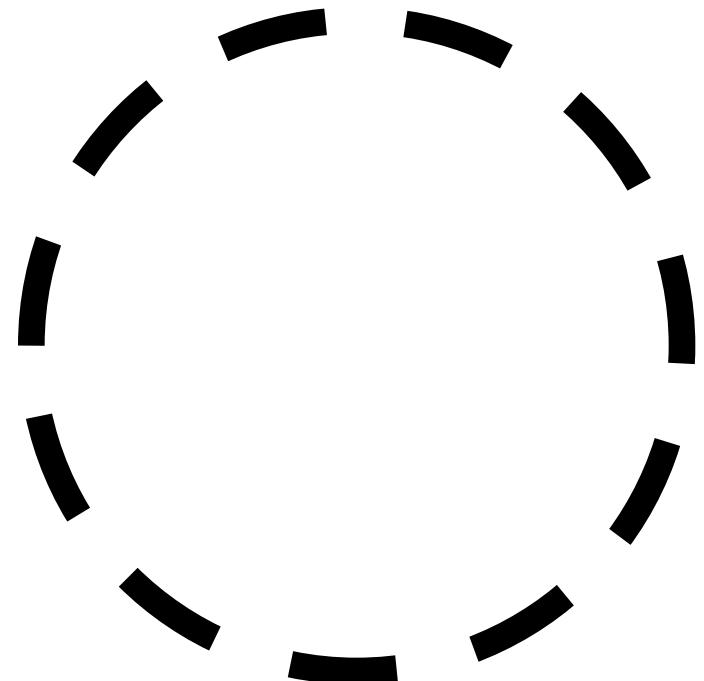
And now...?



Can you read this?

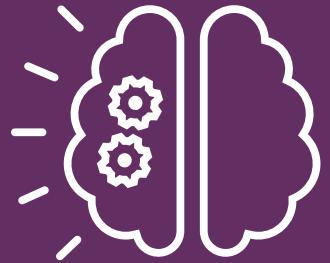
Aoccdrnig to a rsceearh at Cmabrgide Uinervtisy, it deosn't mttaer in what order the ltteers in a wrod are, the olny iprmoatnt tnihg is taht the frsit and lsat ltteer be at the rghit pclae. The rset can be a toatl mses and you can siltl raed it wouthit porbelm. Tihs is bcuseae the huamn mnid deos not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

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



But...



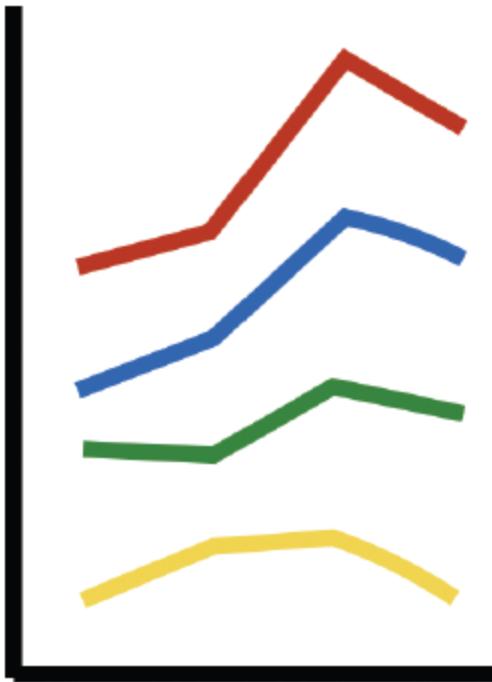
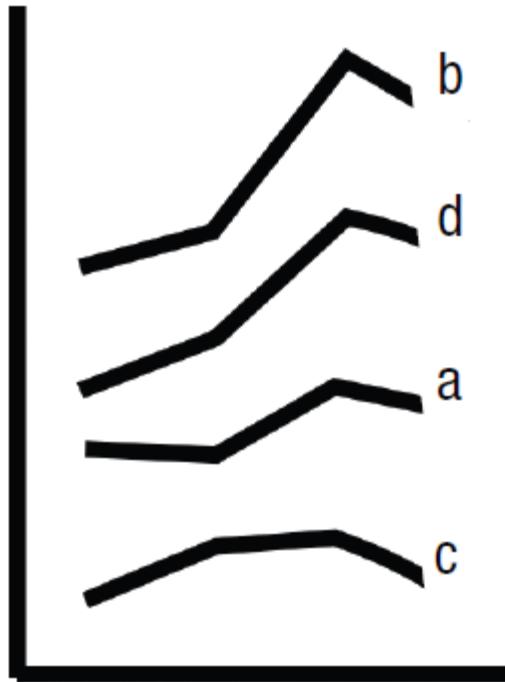


Visual perception

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?



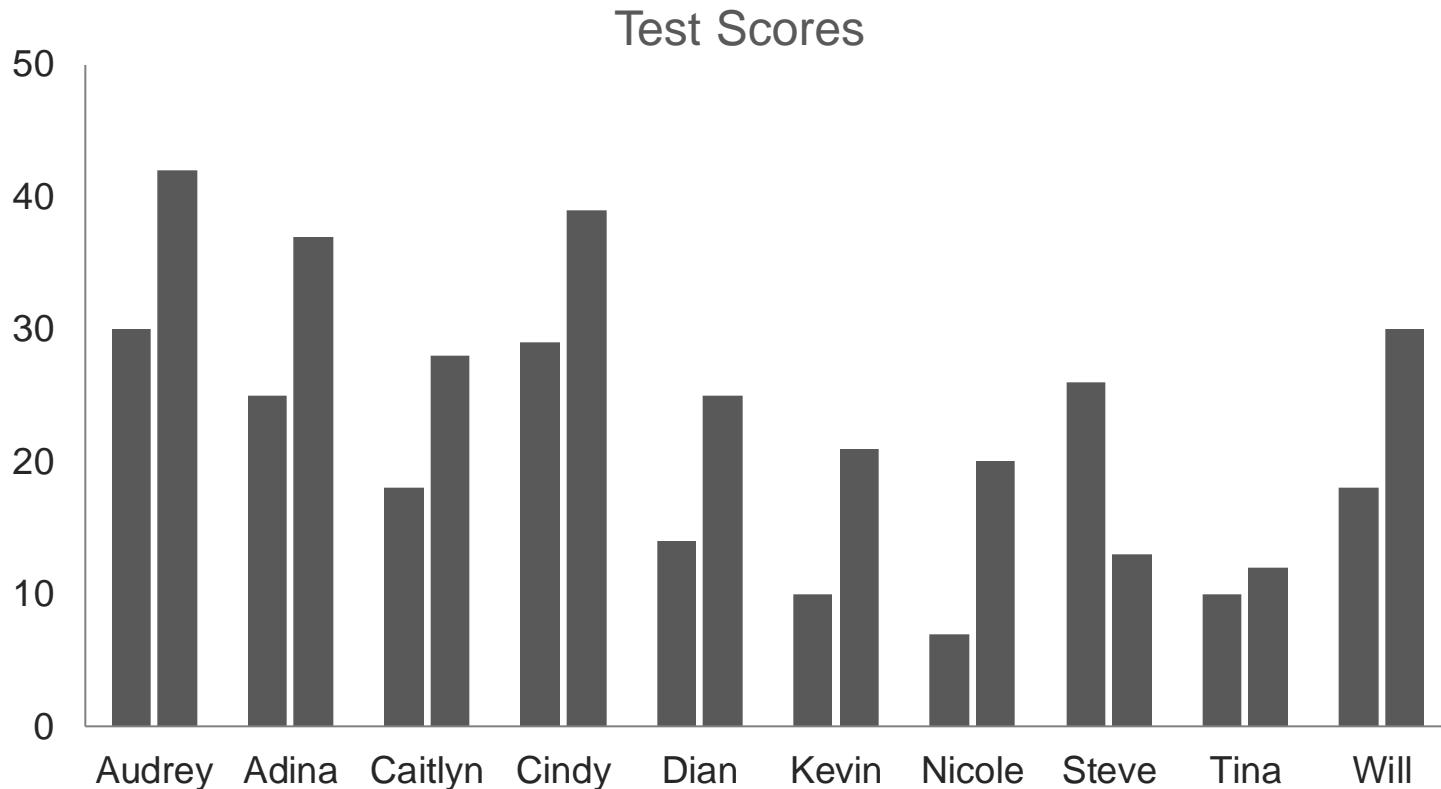
Do you see small-big or big-small?



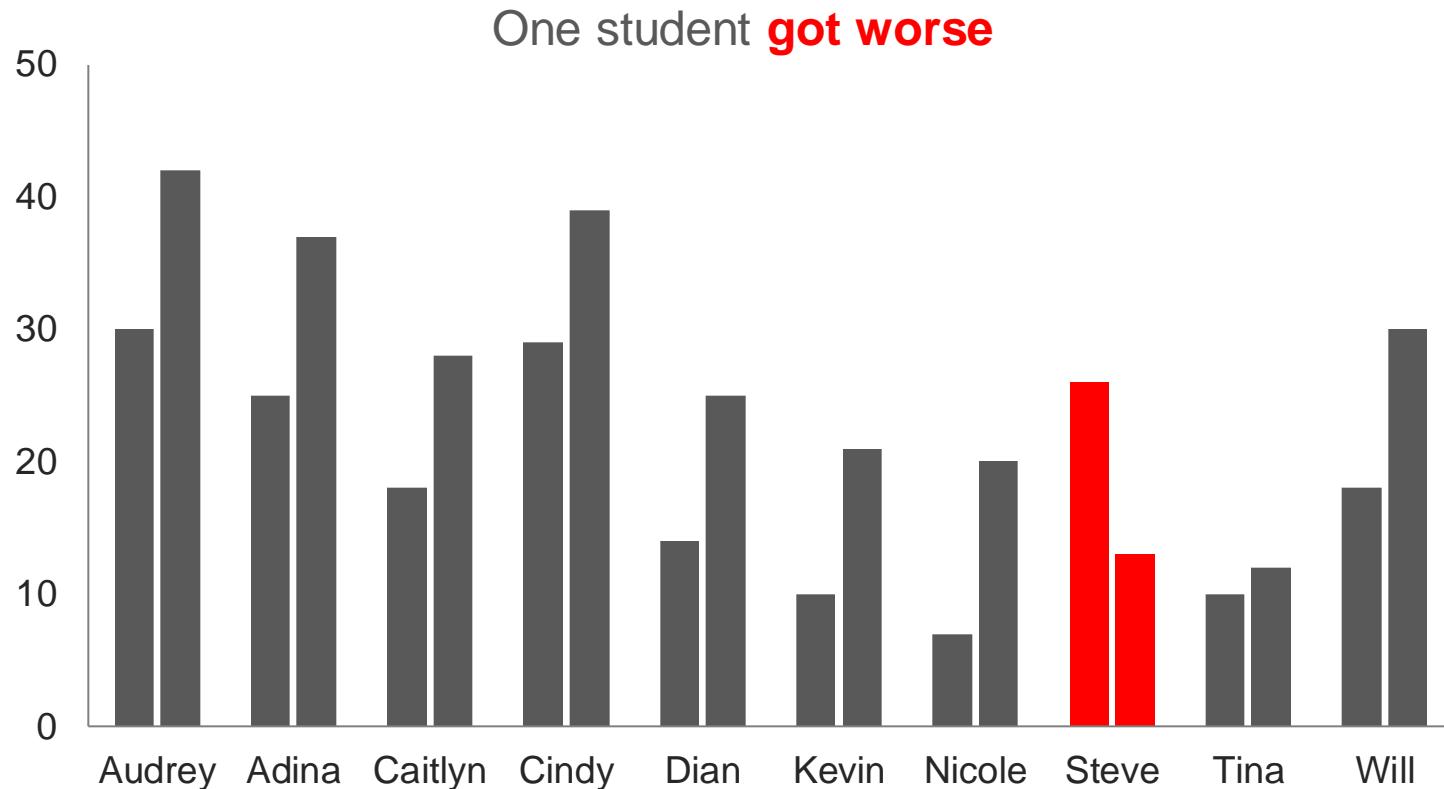
Which one is not like the others?



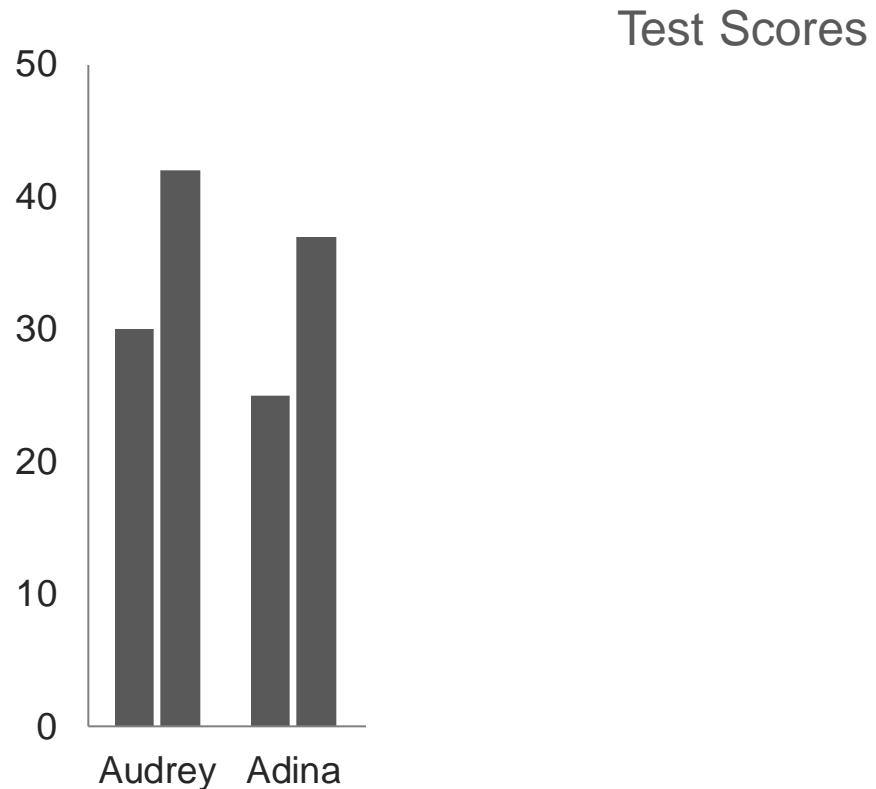
Which student got worse?



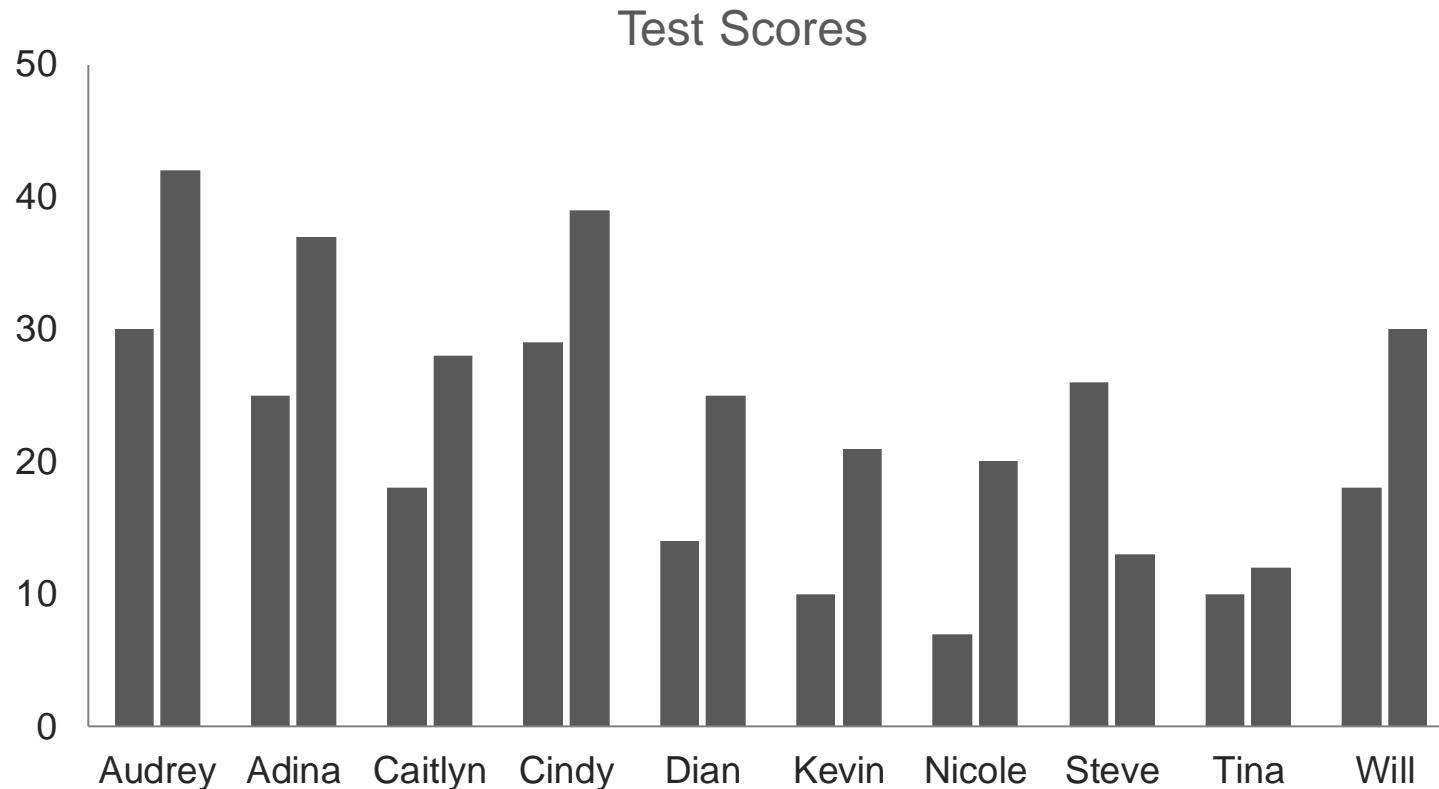
Which student got worse?



What is the average improvement?



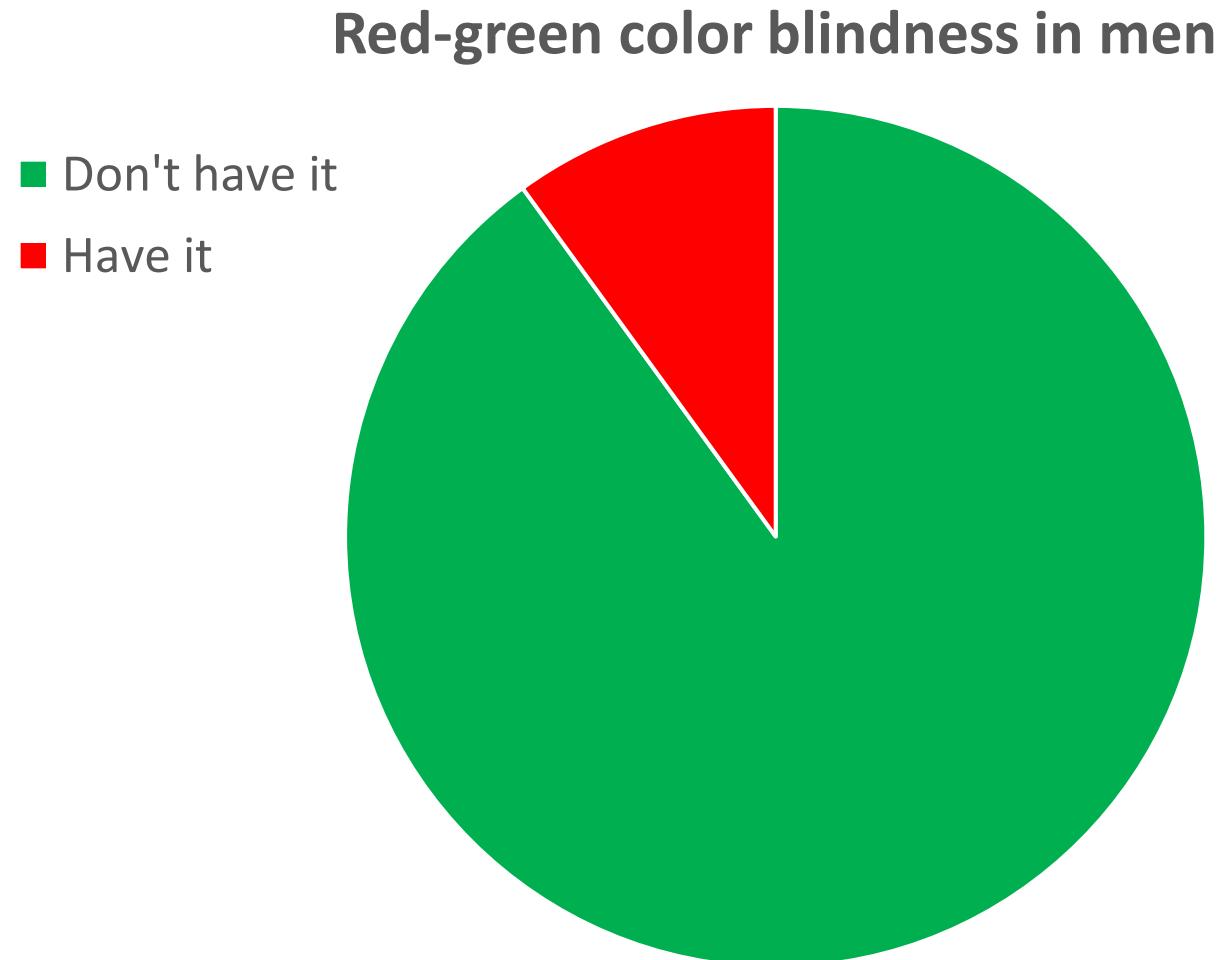
What is the average improvement?



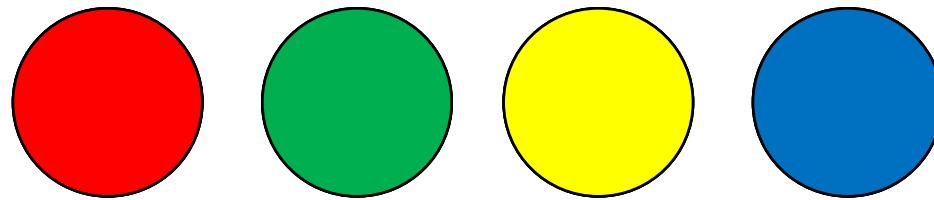
Where to look?



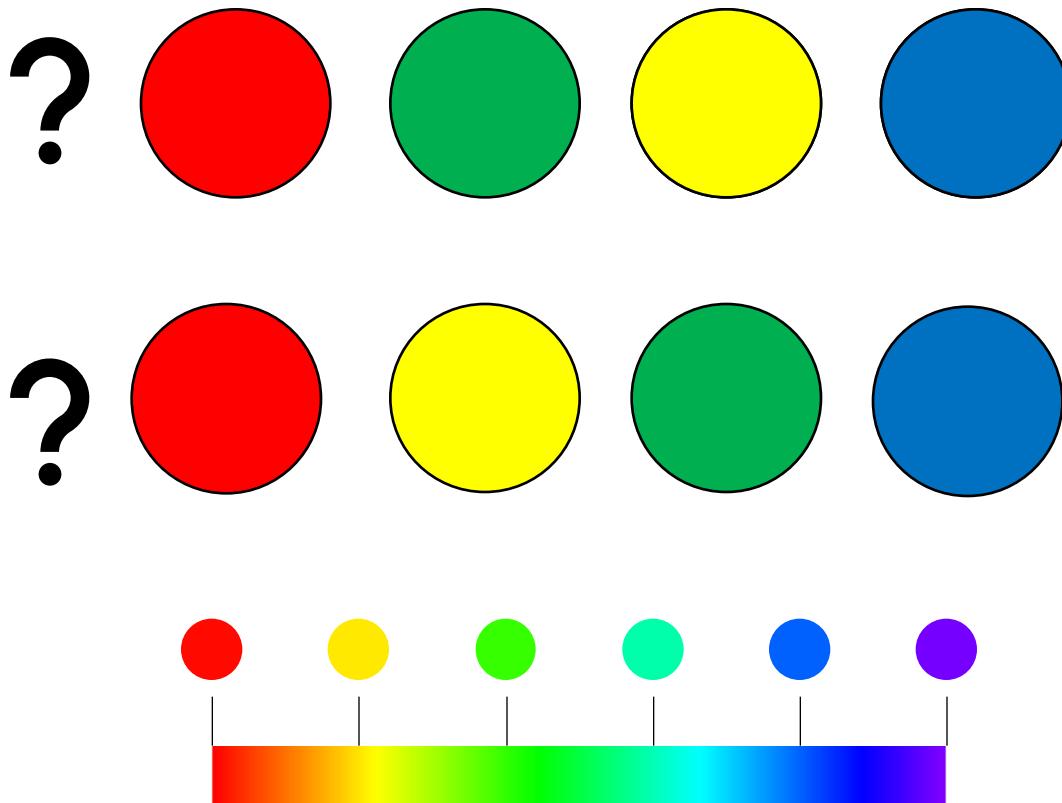
Who will (not) understand this chart?



How to order the dots from high to low?



How to order the dots from high to low?



Color issues are common in science communications!

Hydrol. Earth Syst. Sci.

797 papers from 2005-2020

Papers with color issues
(total % per journal)



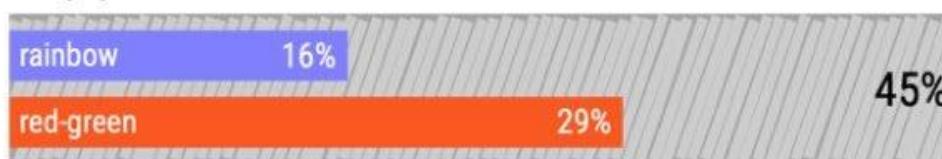
Nature Scientific Reports

Top 100 papers from 2019



Nature Communications

100 papers from 4-6 Nov 2020



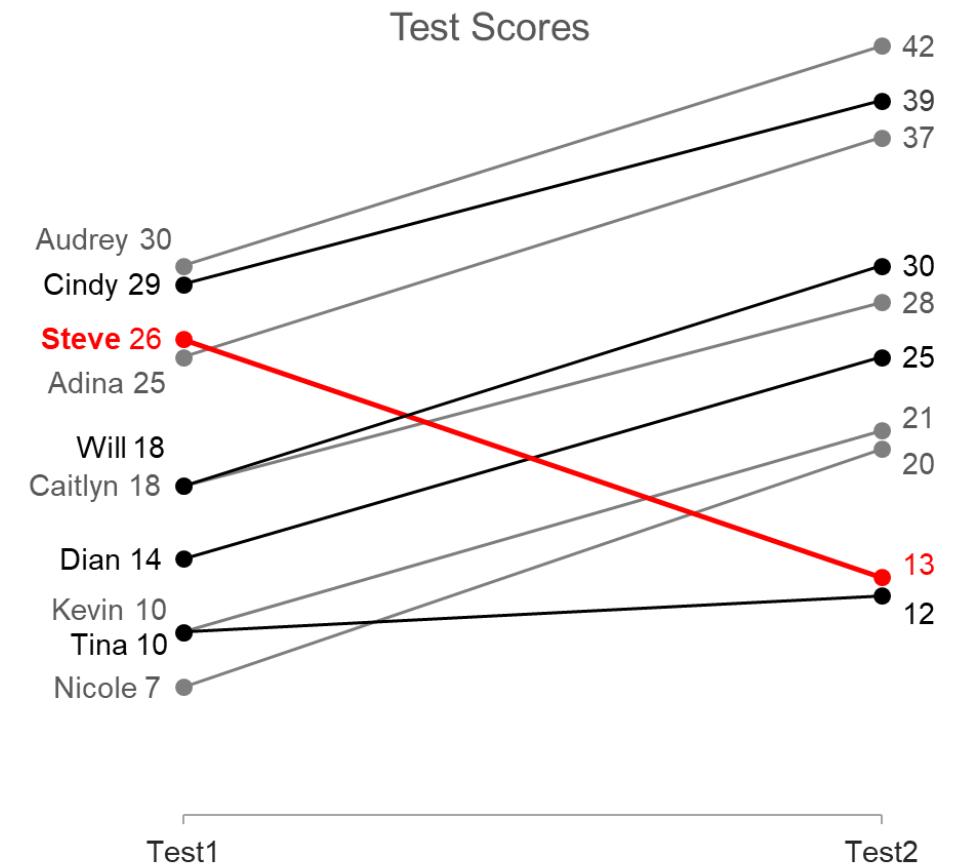
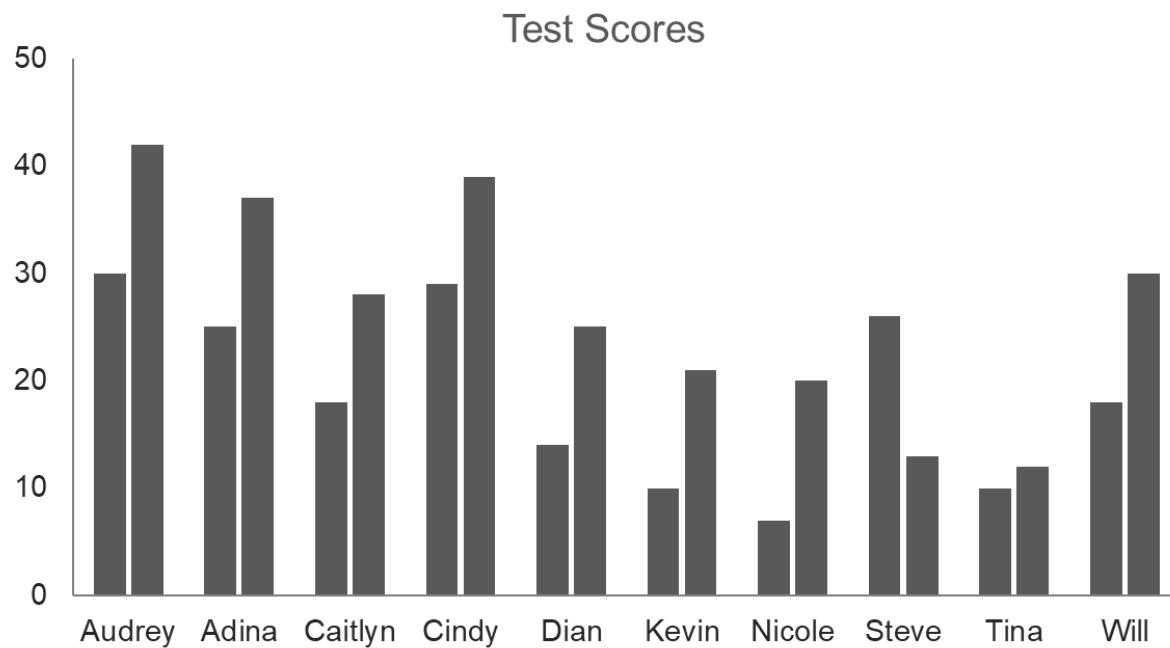
Pulling it all together

The 4 key steps in visual design

4 steps to optimize visual perception

1.  **Simplify:** Enable direct (fast) comparisons
2.  **Declutter:** Eliminate irrelevant distractions
3.  **Add focus:** Draw attention to where you want it
4.  **Ensure intuitive and accessible design:** Do the visual elements follow a natural flow?

Simplify: Enable direct comparisons

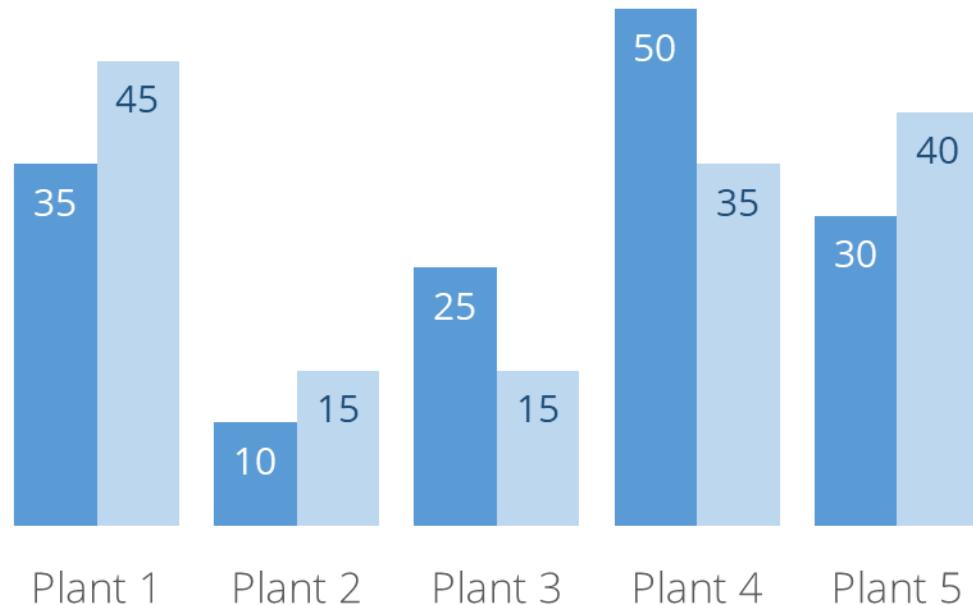


Simplify: Avoid mental math

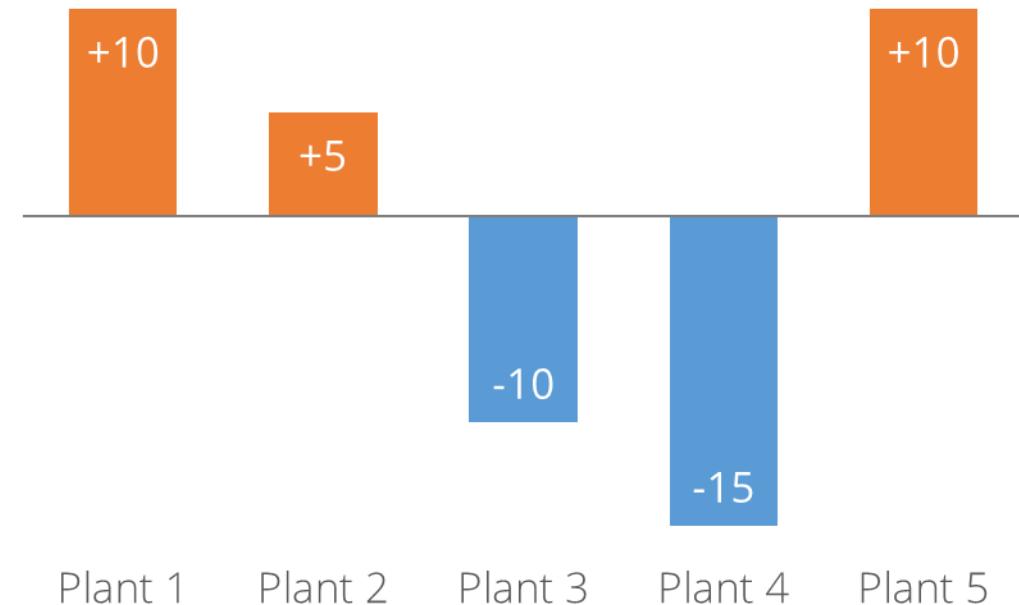
What is the mean difference?

Safety Incidents by Plant

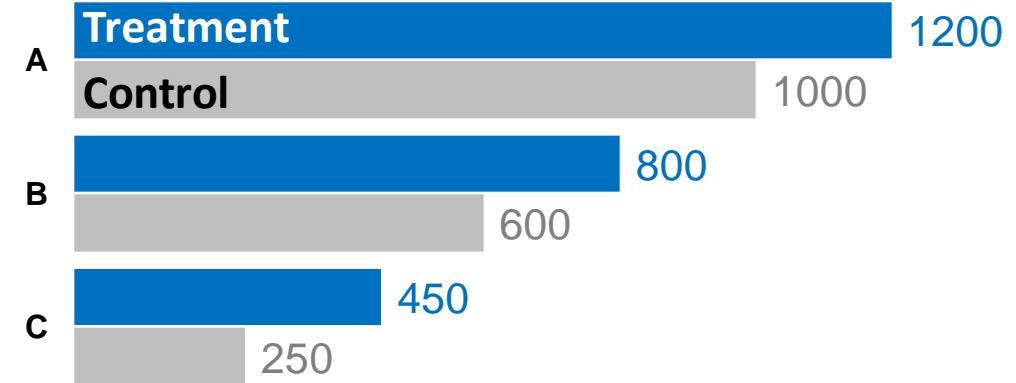
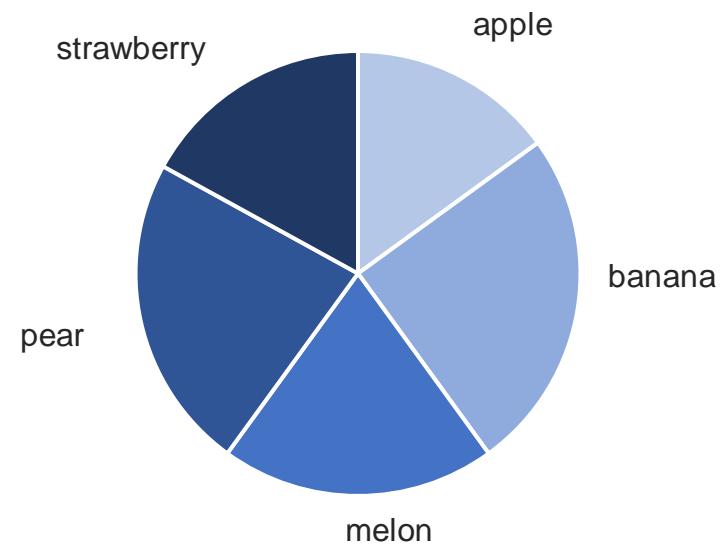
■ 2017 ■ 2018



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



Simplify: Label your data directly



Declutter: Minimize distractions



Effective. Not optimal.



Simple, effective, optimal.



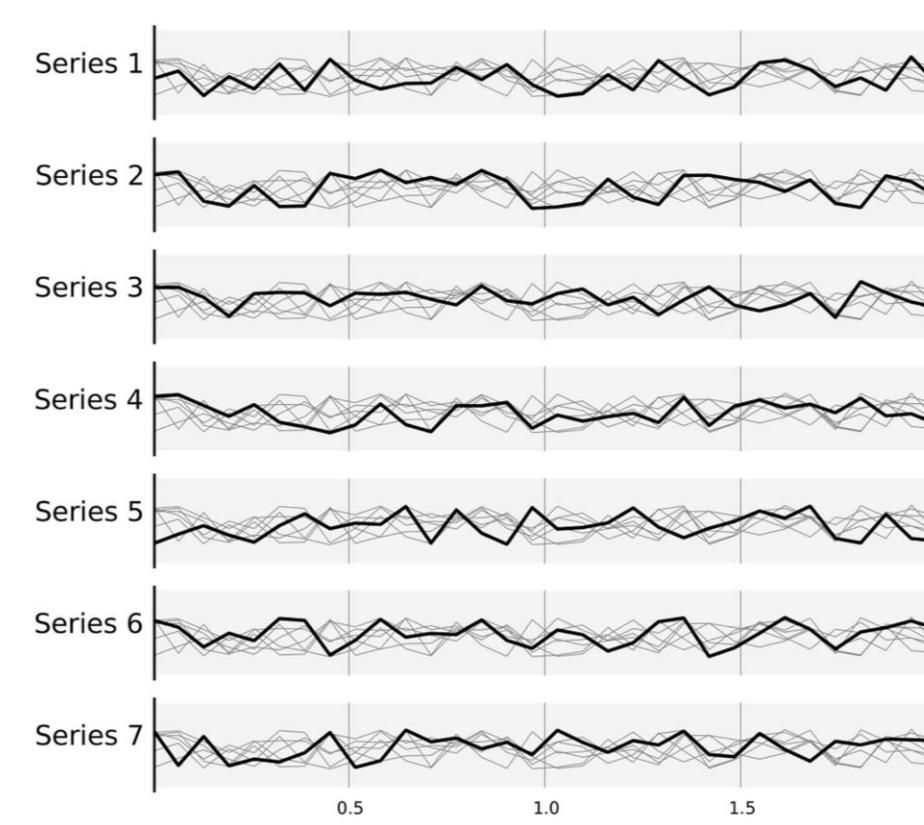
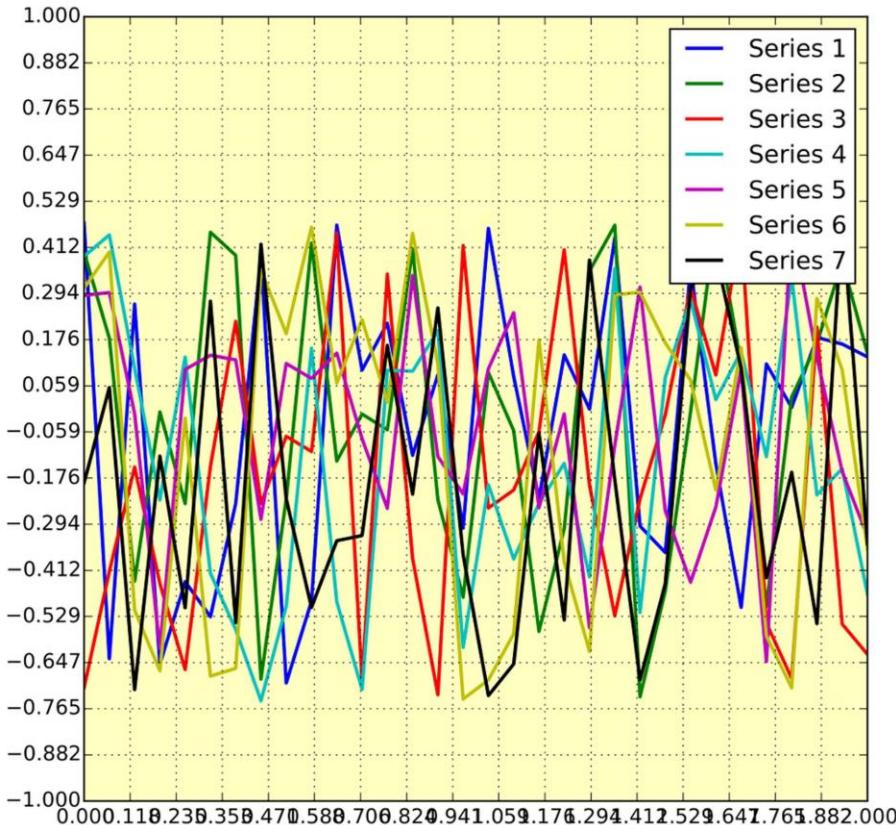
Bad.

Declutter: Remove unnecessary elements

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

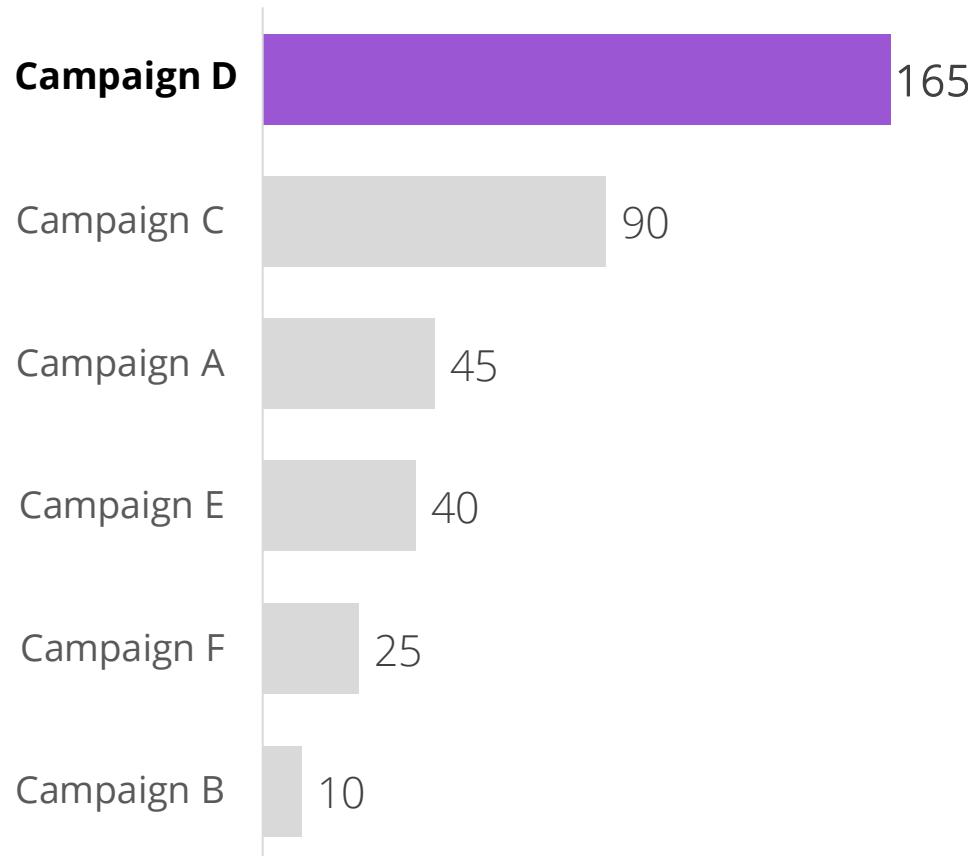
Student	Test1	Test2	Difference (pts)
Audrey	30	42	12
Adina	25	37	12
Caitlyn	18	28	10
Cindy	29	39	10
Dian	14	25	11
Kevin	10	21	11
Nicole	7	20	13
Steve	26	13	-13
Tina	10	12	2
Will	18	30	12

Declutter: Avoid the spaghetti chart

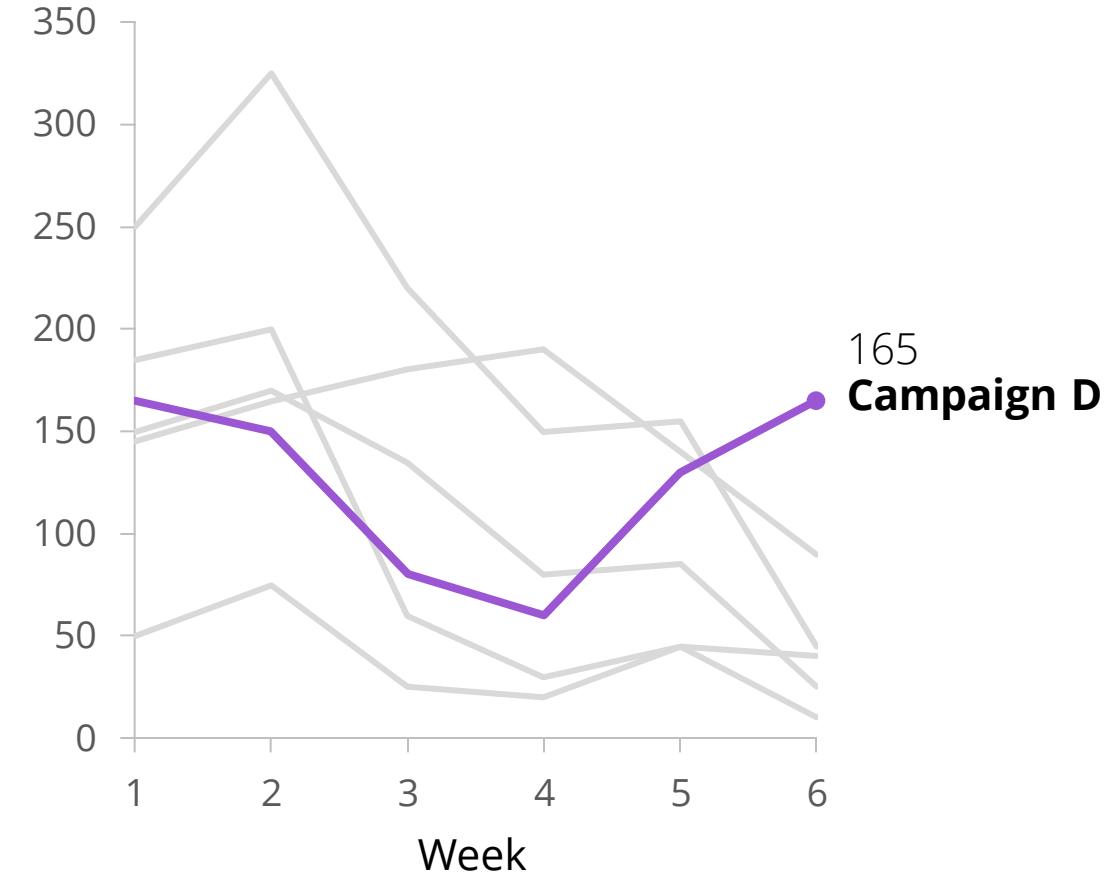


Add focus: Highlight what's important

Leads Generated by Campaign in Sixth Week



Leads Generated by Campaign

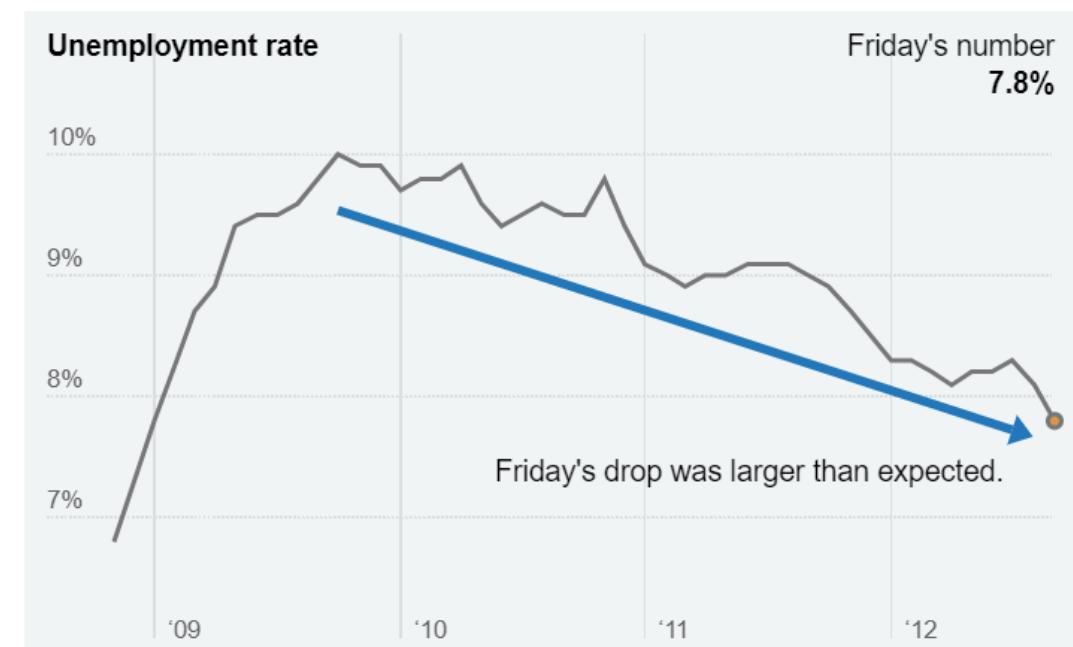


Add focus: Highlight what's important

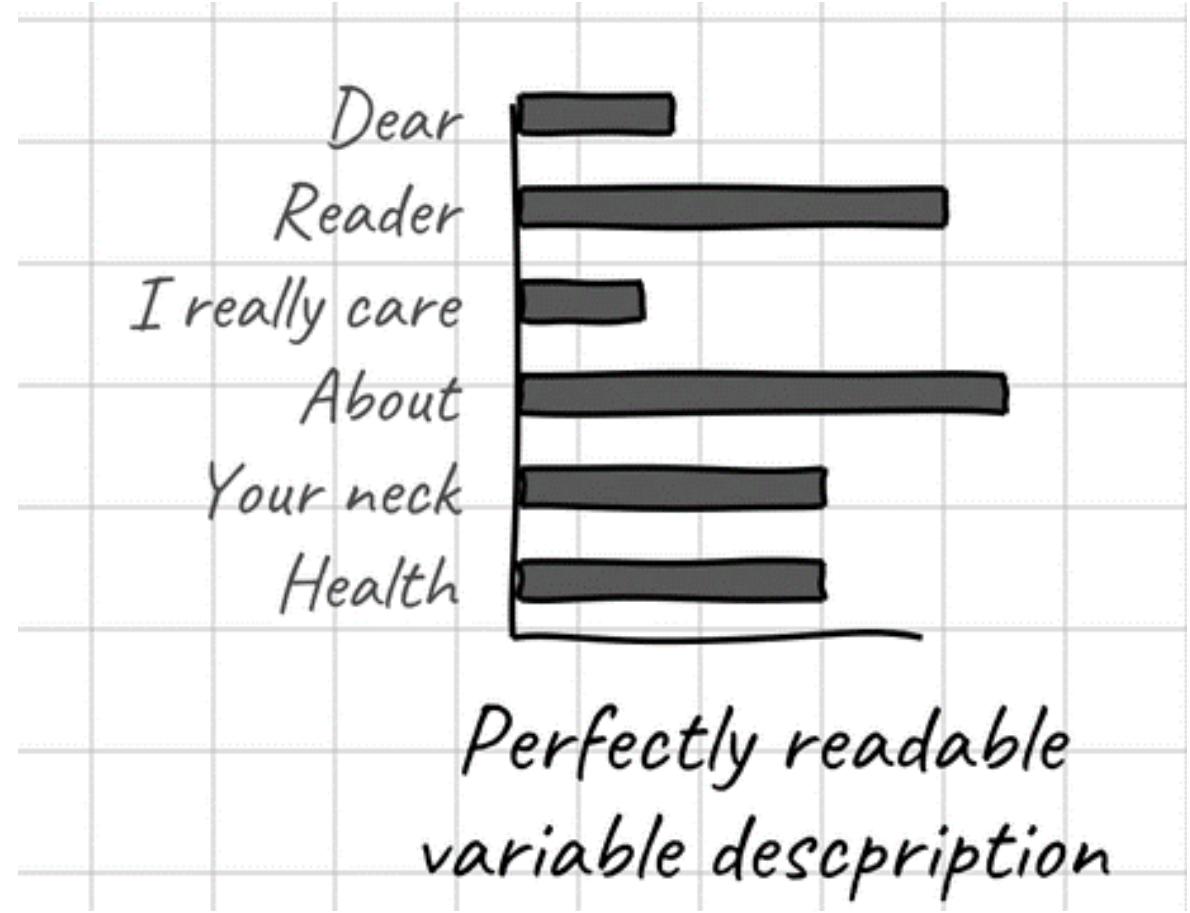
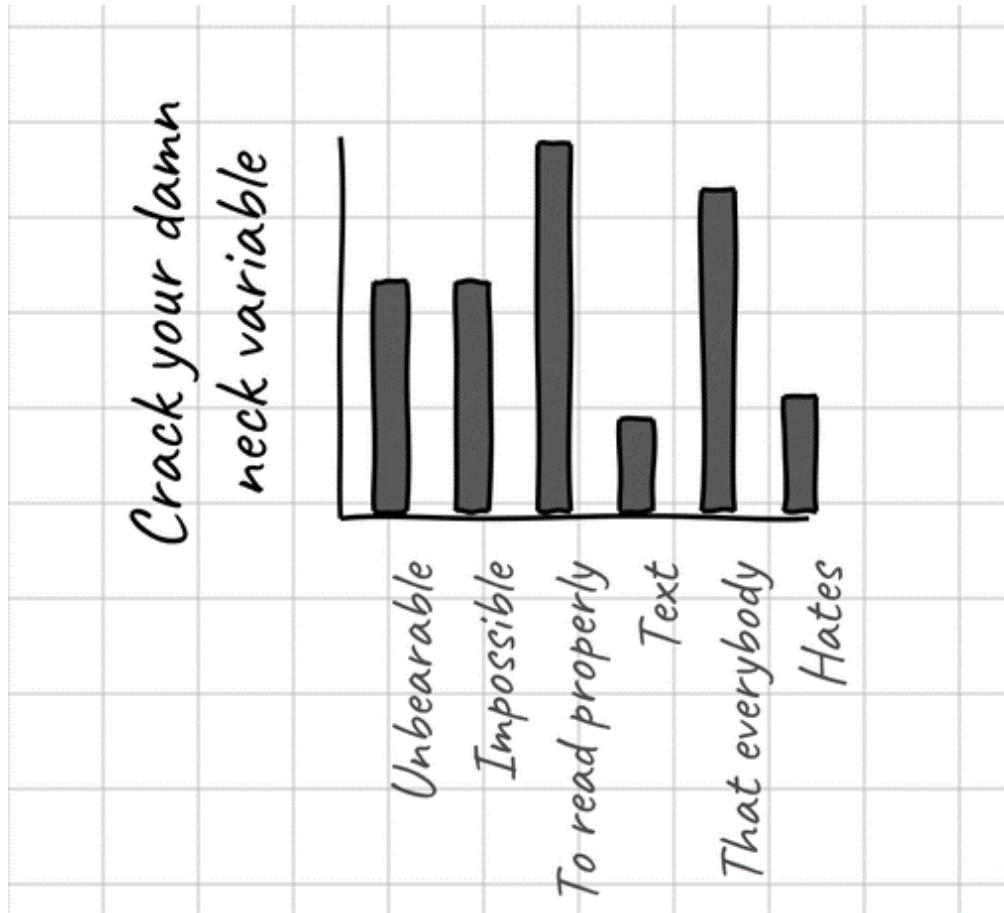
The rate was above 8 percent for 43 months.



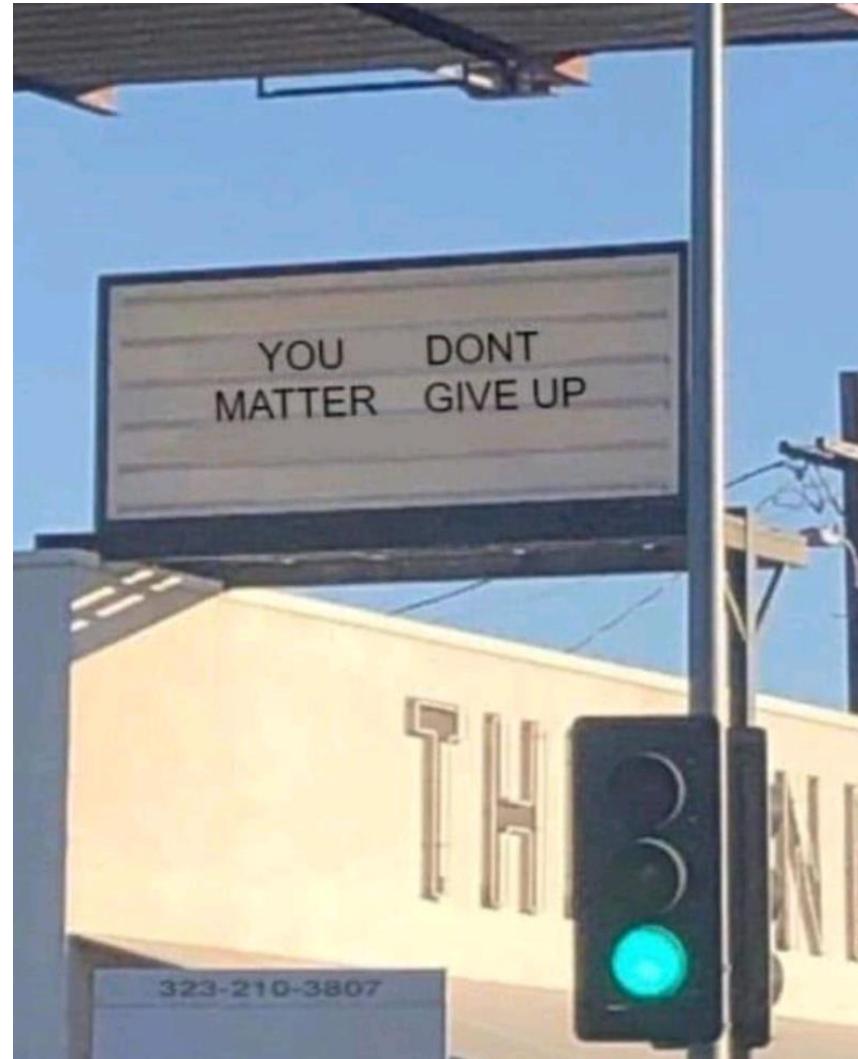
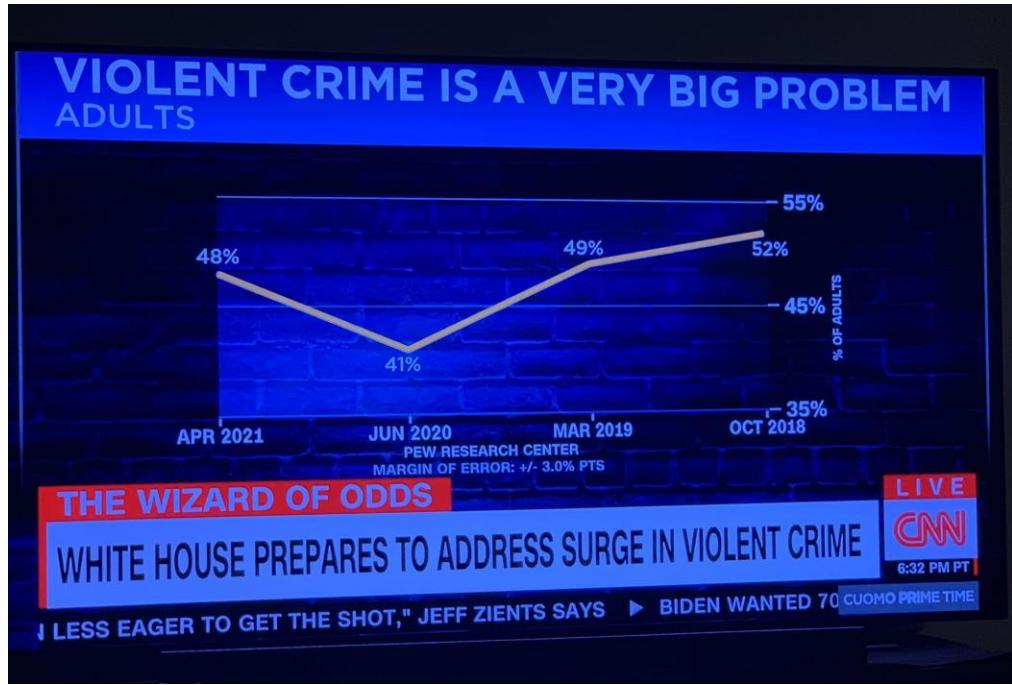
The rate has fallen more than 2 points since its recent peak.



Intuitive: Follow the reading direction



Intuitive: Read from left-to-right

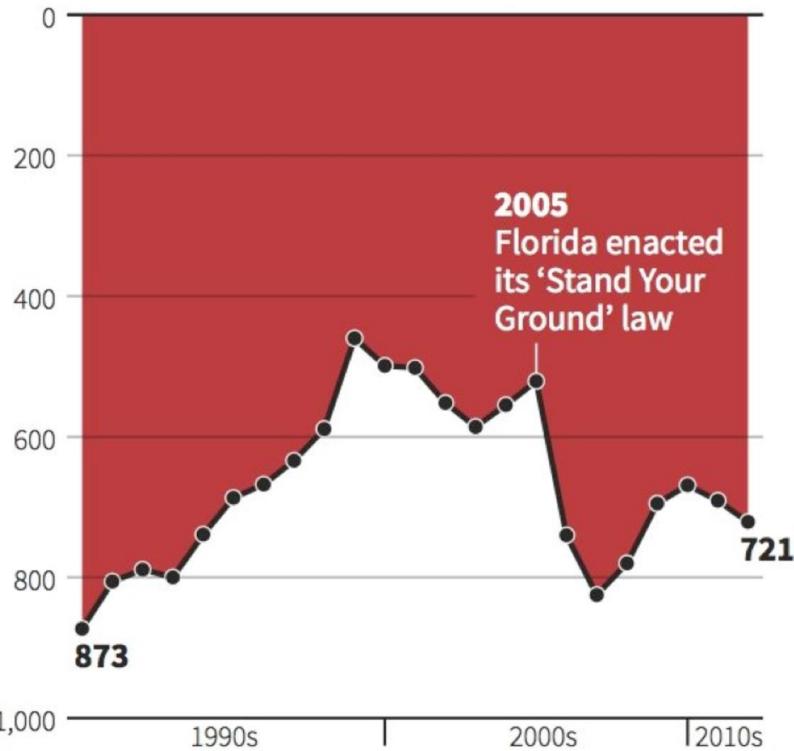


..right?

Intuitive: What goes up, goes up...

Gun deaths in Florida

Number of murders committed using firearms

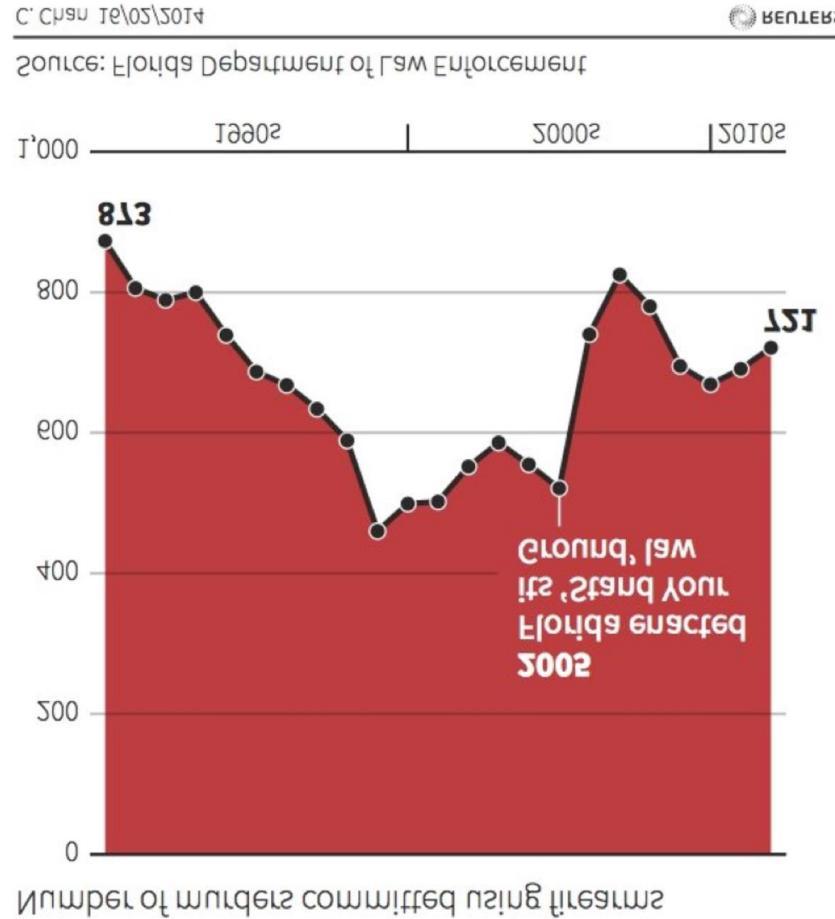


Source: Florida Department of Law Enforcement

C. Chan 16/02/2014

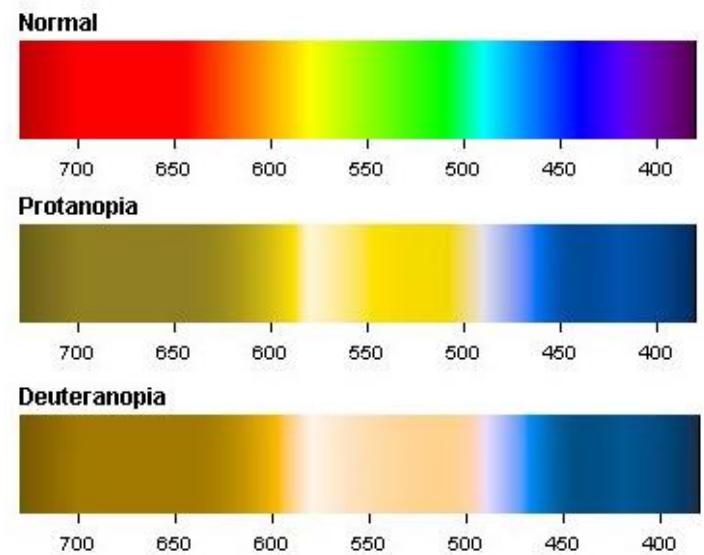
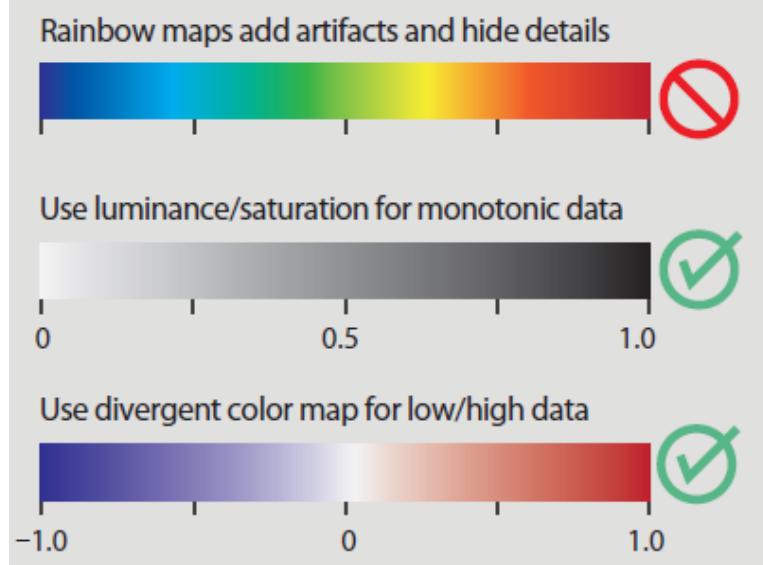
REUTERS

Intuitive: What goes up, goes up...



Can detect in Florida

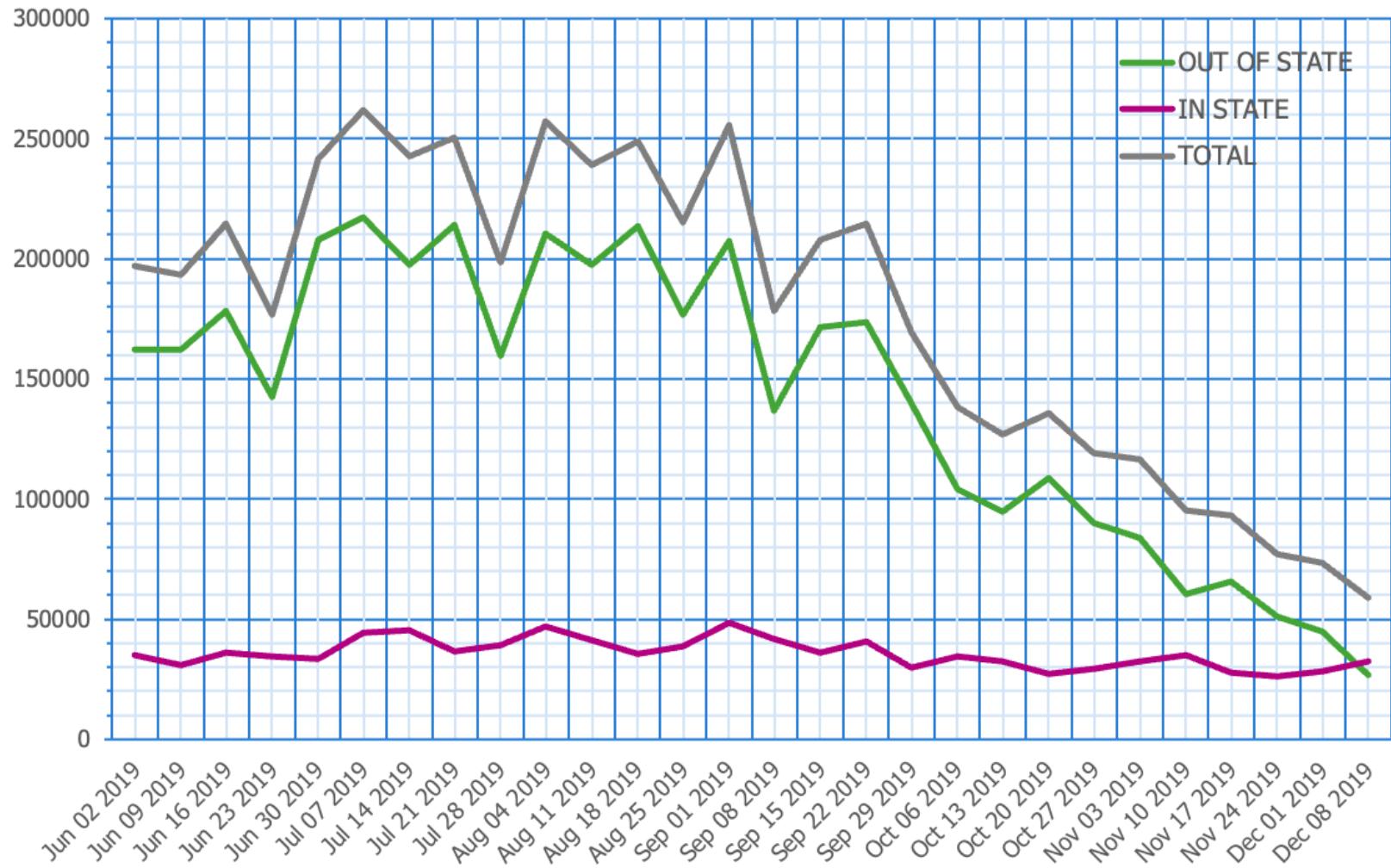
Accessible: Be mindful of your color choices



Make-over

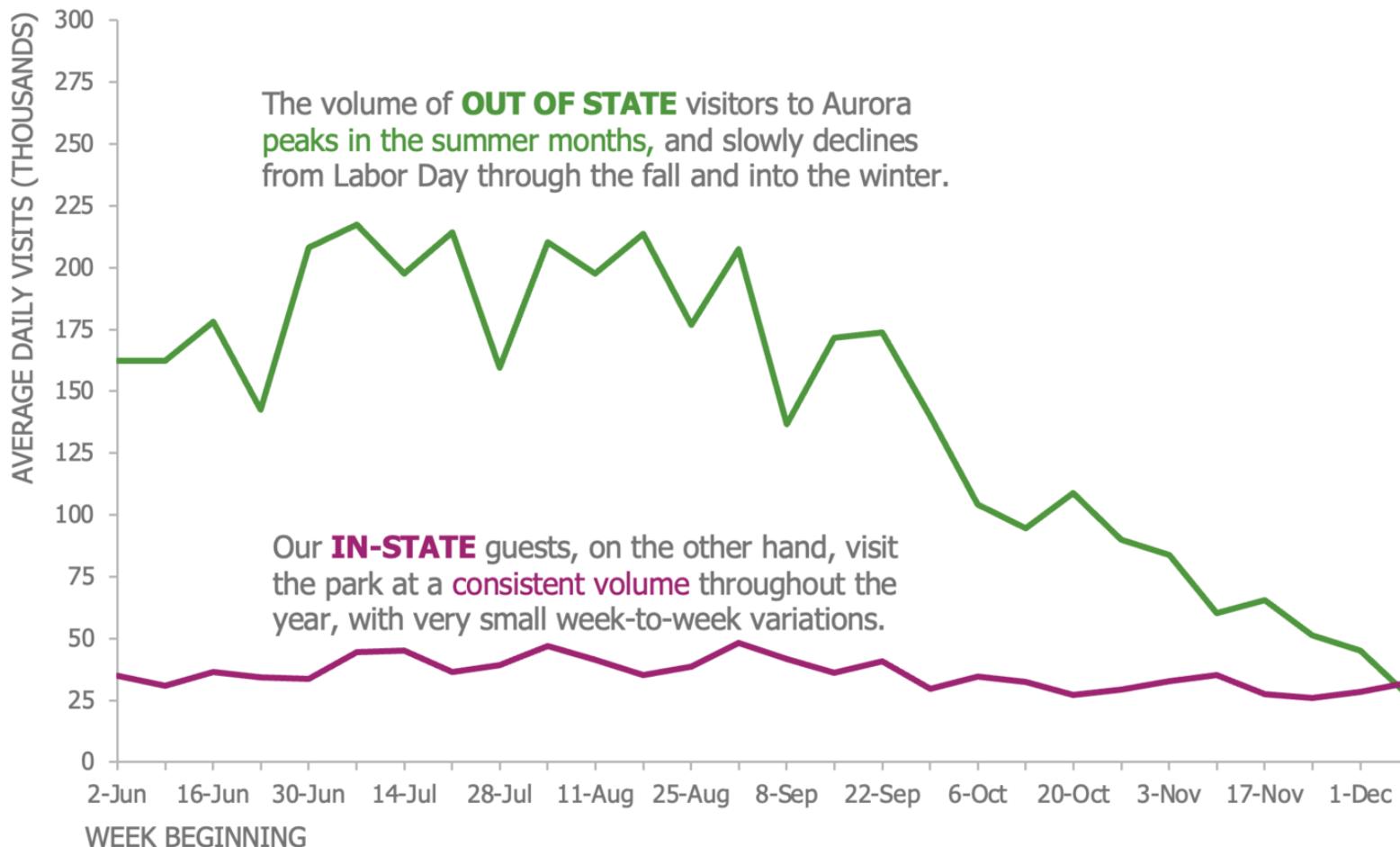
Notice, wonder, improve

Daily Average Park Visitors By Week



Daily visitors to Aurora Park in summer/fall 2019

VALUES ARE CALCULATED WEEKLY AS A 7-DAY AVERAGE



Thank you
and
Happy Viz-ing!



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Twitter icon @JeBentWatJeMeet



<https://www.jebentwatjemeet.nl>

<https://irenevdb.rbind.io>

Find the slides and resources here:

https://irenevdb.github.io/DataViz_yESHPM/Presentation.pdf

https://irenevdb.github.io/DataViz_yESHPM/ReferenceList.pdf