

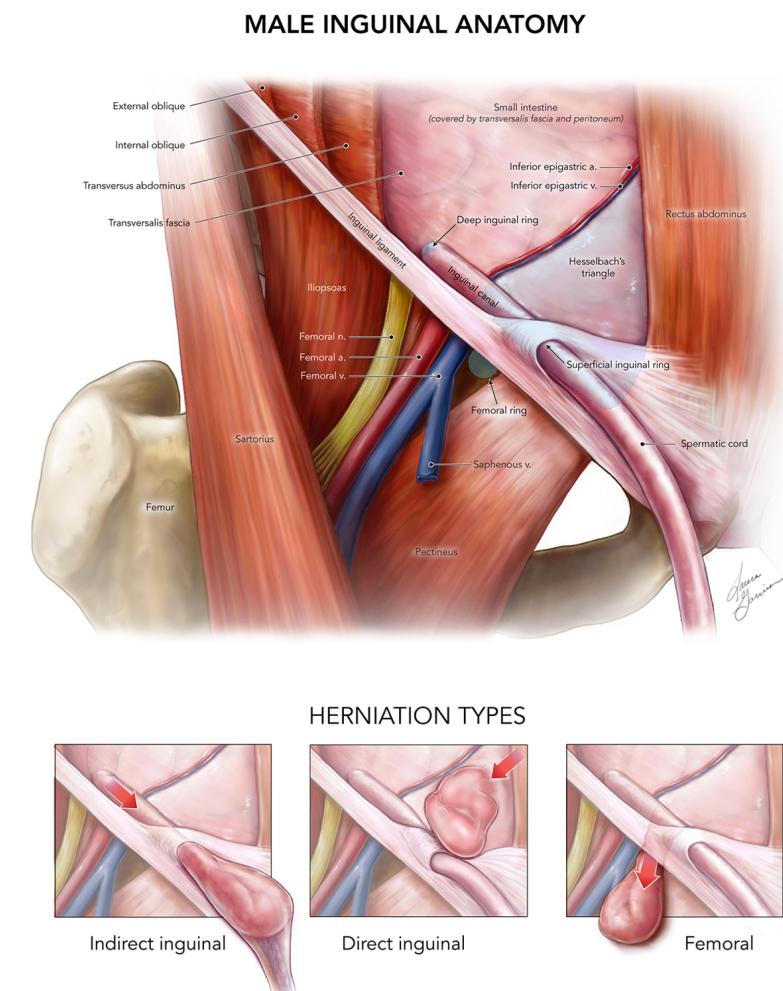


A Visualization Primer

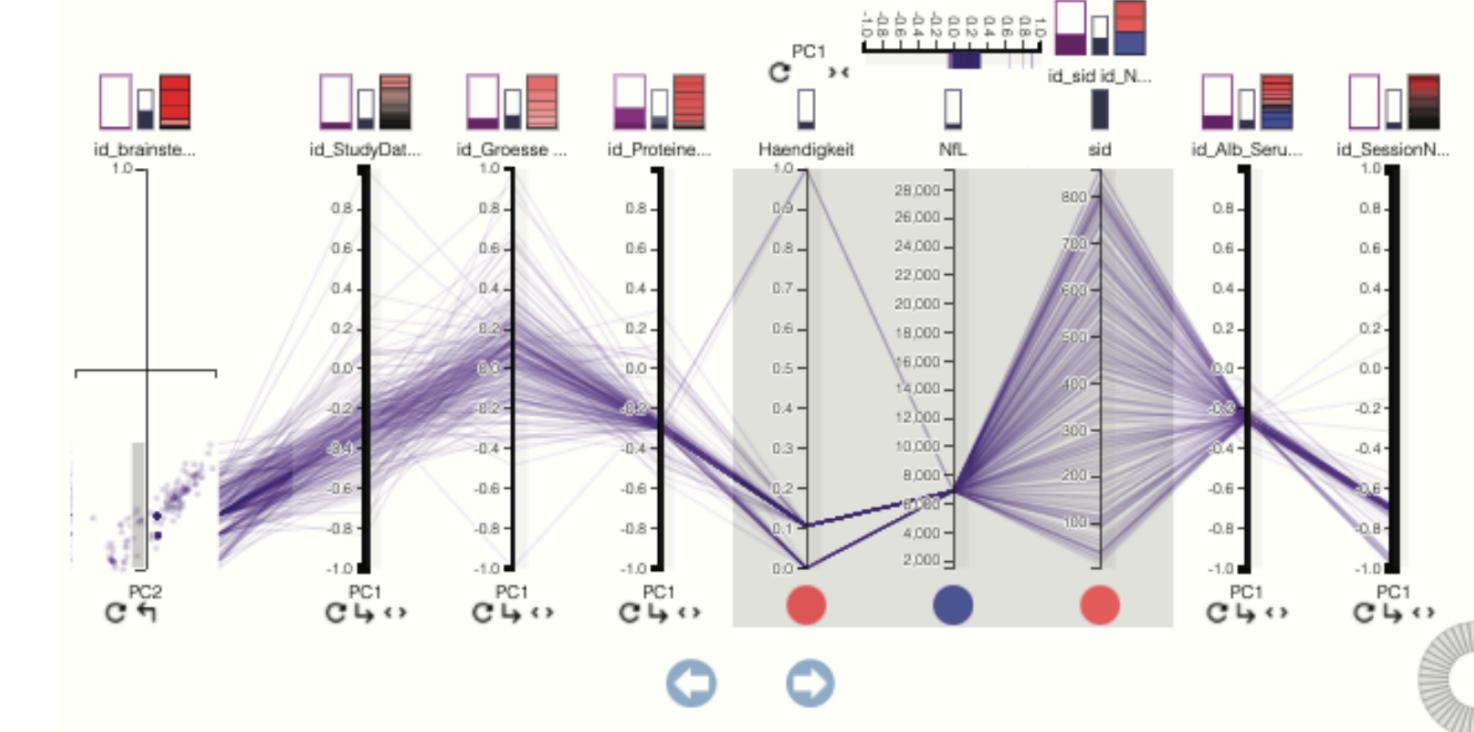
Laura Garrison, Associate Professor in Visualization
 Dept of Informatics, UiB
laura.garrison@uib.no

Bjerknes Data Visualization Workshop, 4-6 Dec 2023

Credit: [The Oatmeal](#)



MS Biomedical Visualization
(UIC, 2012)

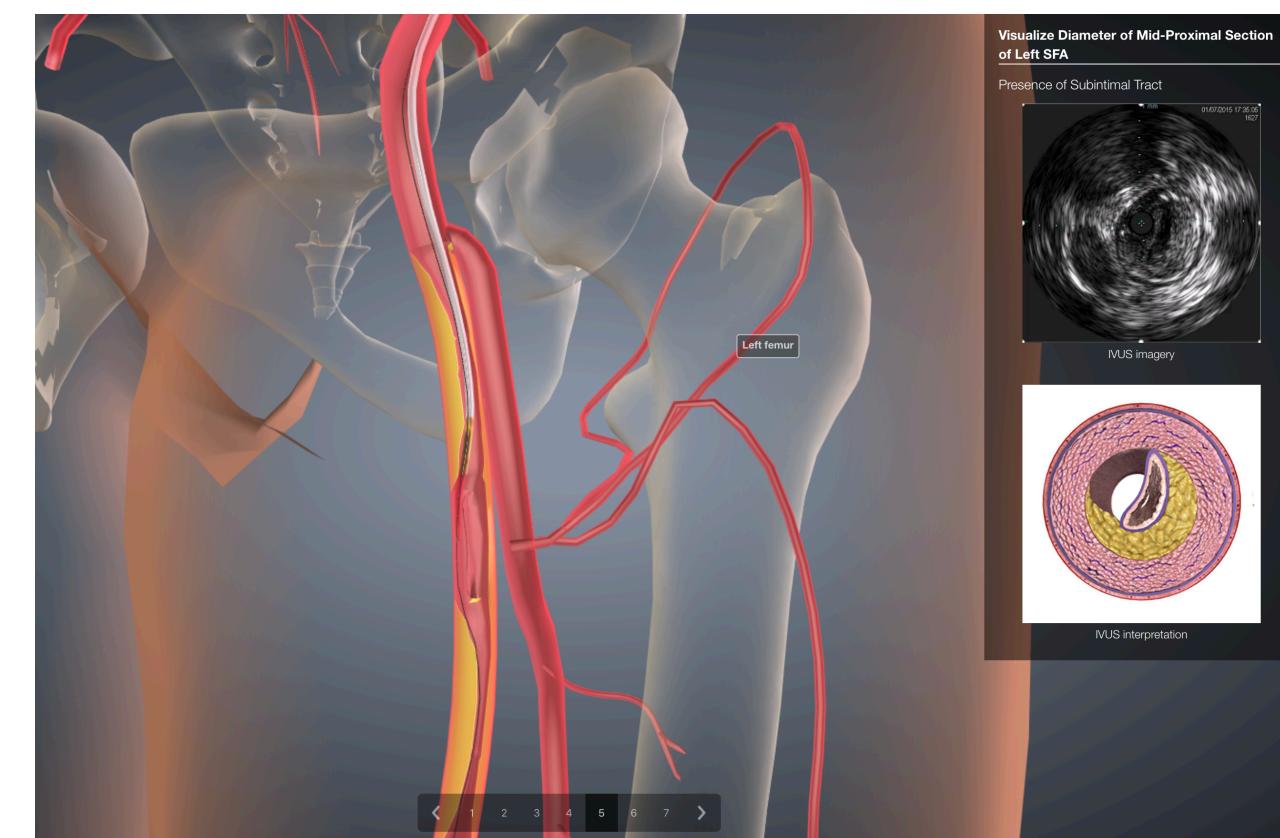


PhD Visualization
(UiB, 2022)



Assoc. Prof.
in Visualization
(UiB, 2023-)

BA Anatomy &
Physiology
Minors in Art,
Chemistry
(NMU, 2009)



Medical & Health Tech Start-ups (2012-18)

bouvet

MMIV

(2023)

Some administrative things

- Would you like to be a participant in our study?
 - If so, please review and sign one of the *Informed Consent* forms if so!
- Software:
 - Everyone has Figma installed?
 - Python?

PARTICIPATION IN RESEARCH PROJECT: INFORMED CONSENT

Understanding barriers to visualizing scientific research data

Thank you for participating in our study on data visualization practices by domain scientists!

About the project

In spite of a wealth of guidelines that are available for researchers and practitioners to create effective, informative visualizations, many continue to struggle with creating data visualizations. This qualitative research study takes an ethnographic approach to characterize the aspects of the visualization process that researchers from diverse domains struggle with when creating visualizations to communicate their science to their peers and to the broader public, and explores possible strategies to alleviate these pain points.

Specifically, with this project we are interested in investigating:

- Where are domain scientists becoming stuck, overwhelmed, or confused in the process of visualizing their data?
- How much training in visualization does a domain scientist typically receive? How much of this training is ad-hoc?
- What are the standard tools/languages/packages that domain scientists use, and what are the pain points they experience through the use of these tools?

Participation

Your participation in this study will consist of

1. Allowing us to refer to your pre-workshop survey responses to understand where you are coming from and what role visualization plays in your research.
2. Your permission to include two visualizations of your research that you have created.
3. Participation in a post-workshop follow up survey to assess how the workshop activities and lessons have impacted your thoughts on data visualization concepts and tools moving forward.

Voluntary participation and study withdrawal

Your participation in this study is completely voluntary and dependent on your consent. You can, at any time and without giving a reason, choose to withdraw your consent to participating in our study without repercussions.

What we will cover

- **Day 1**
 - Primer on data visualization
 - Hands on: Figma
- **Day 2**
 - Tasks & chart types
 - Hands on: Vega-Altair
 - Color with hands-on color tool exploration
- **Day 3**
 - Visual interaction and design tips
 - Visualization redesign + feedback

**Let's warm up with
some *bad* visualizations**



VOTELINE

SATURDAY'S RESULT

Can Julia Gillard win
the next federal election?

TODAY'S QUESTION

Do you like the plan to remove
a car lane of the Princes Bridge
for sole use by cyclists?

YES

1900 956 434

NO

1900 956 435

Calls cost 38.5c including GST. You

can also have your say at

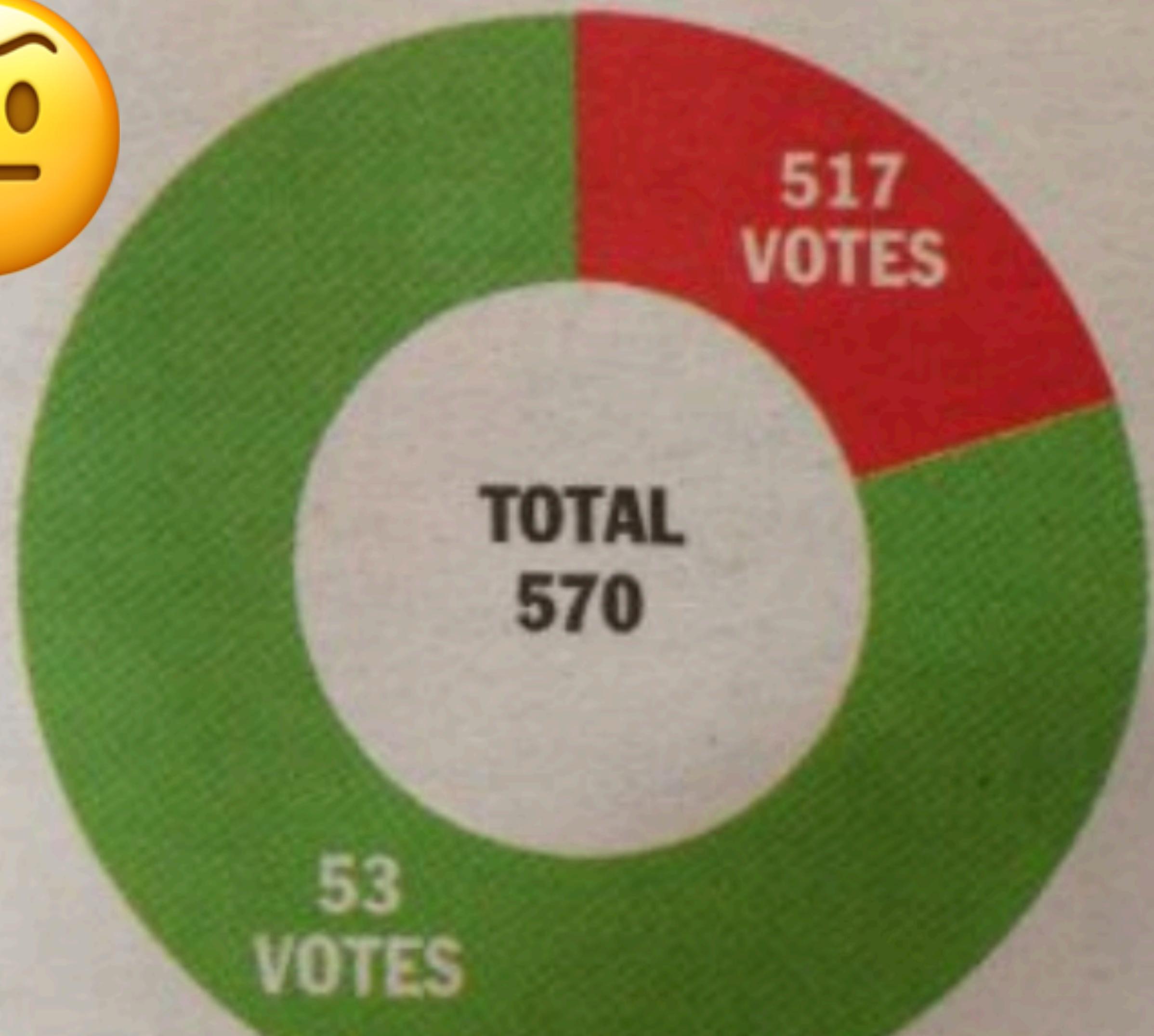
<https://viz.wtf/>

10%

YES

90%

NO



VOTELINE

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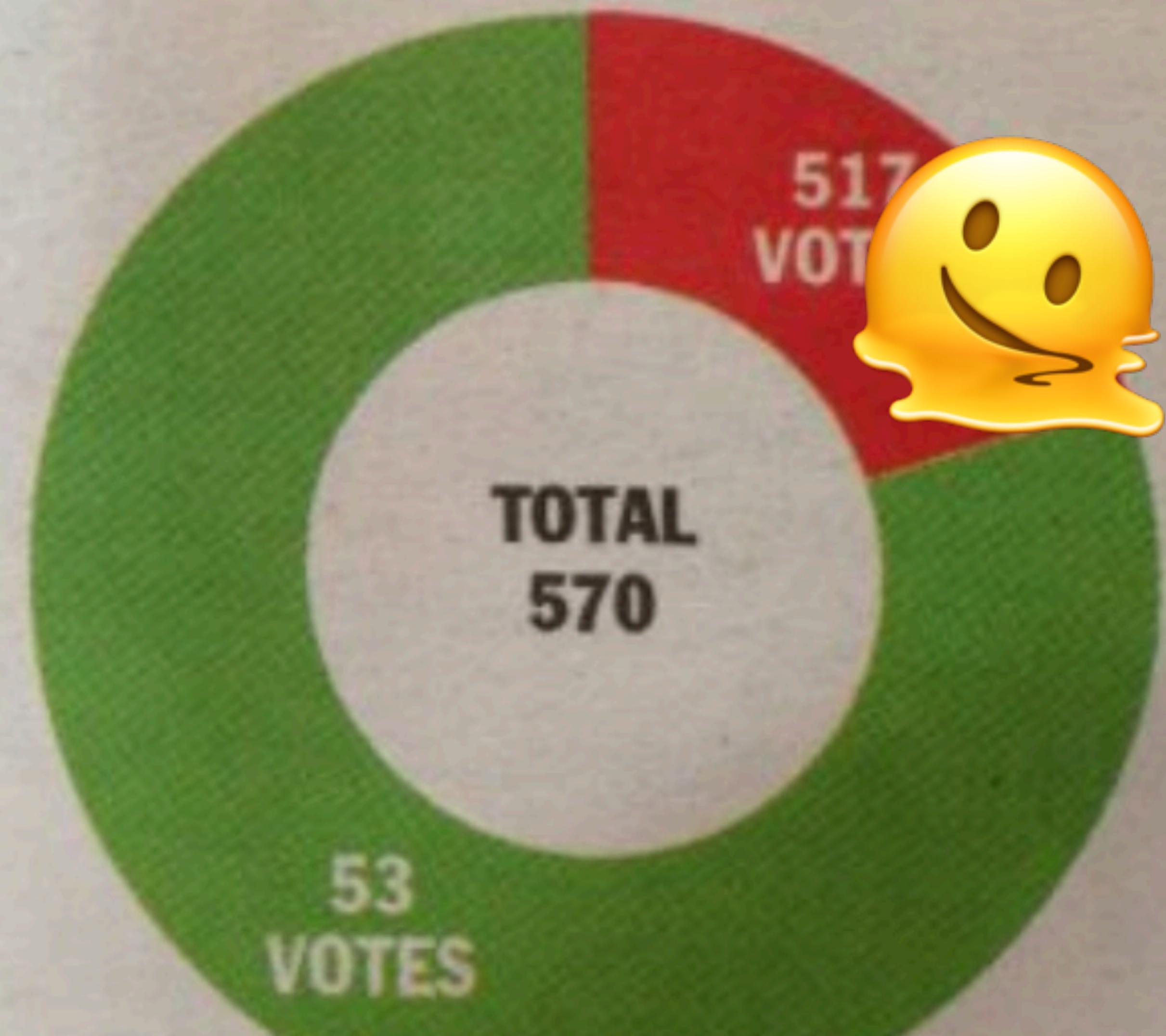
90%

NO

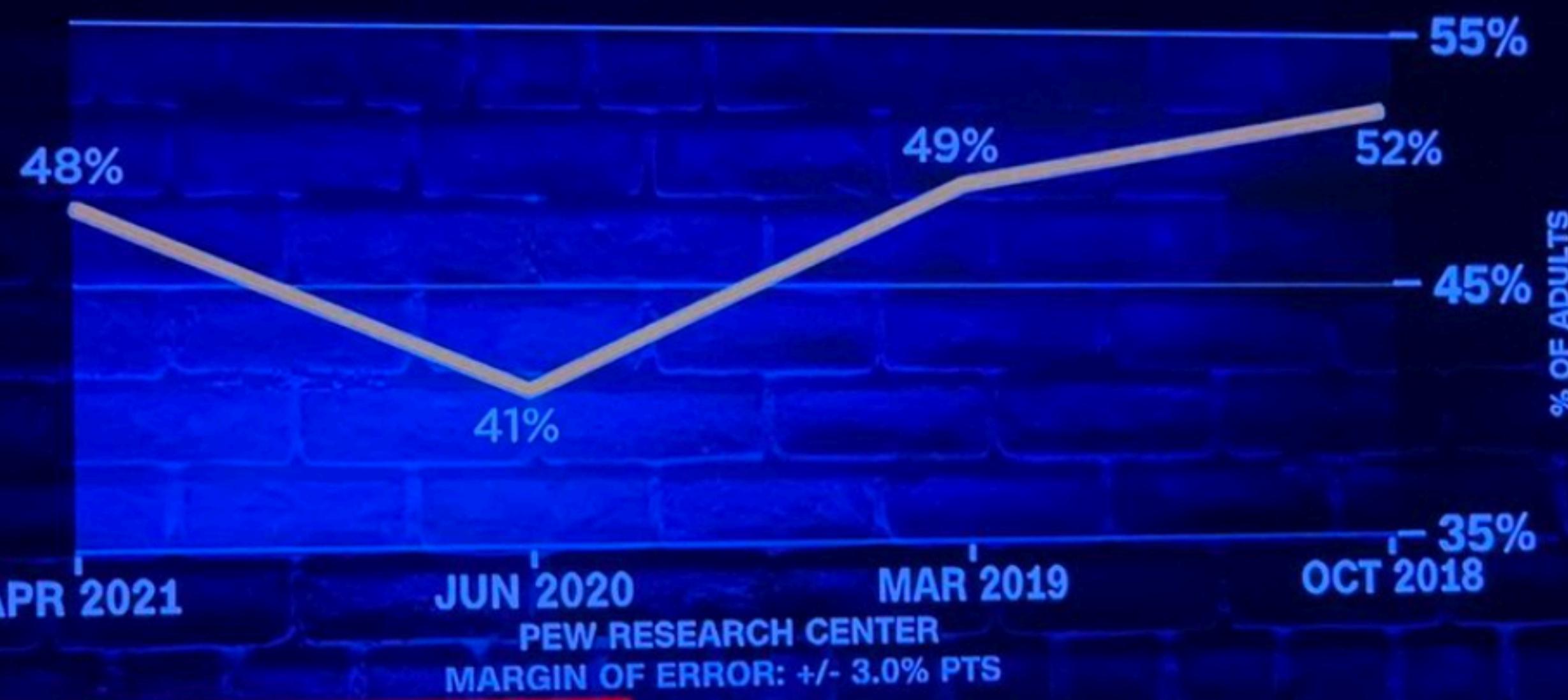
517
VOTES

TOTAL
570

53
VOTES



VIOLENT CRIME IS A VERY BIG PROBLEM ADULTS



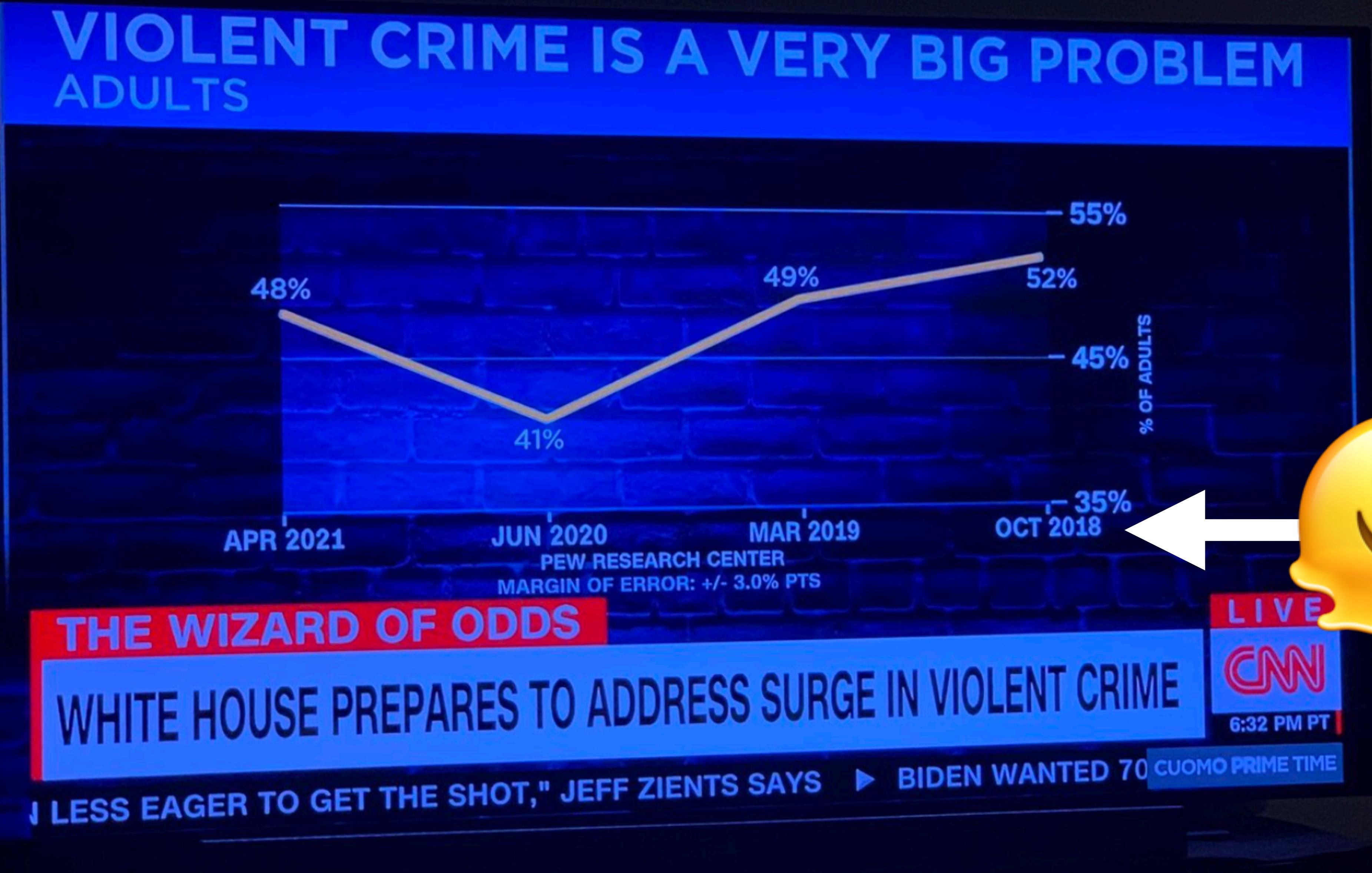
THE WIZARD OF ODDS

WHITE HOUSE PREPARES TO ADDRESS SURGE IN VIOLENT CRIME

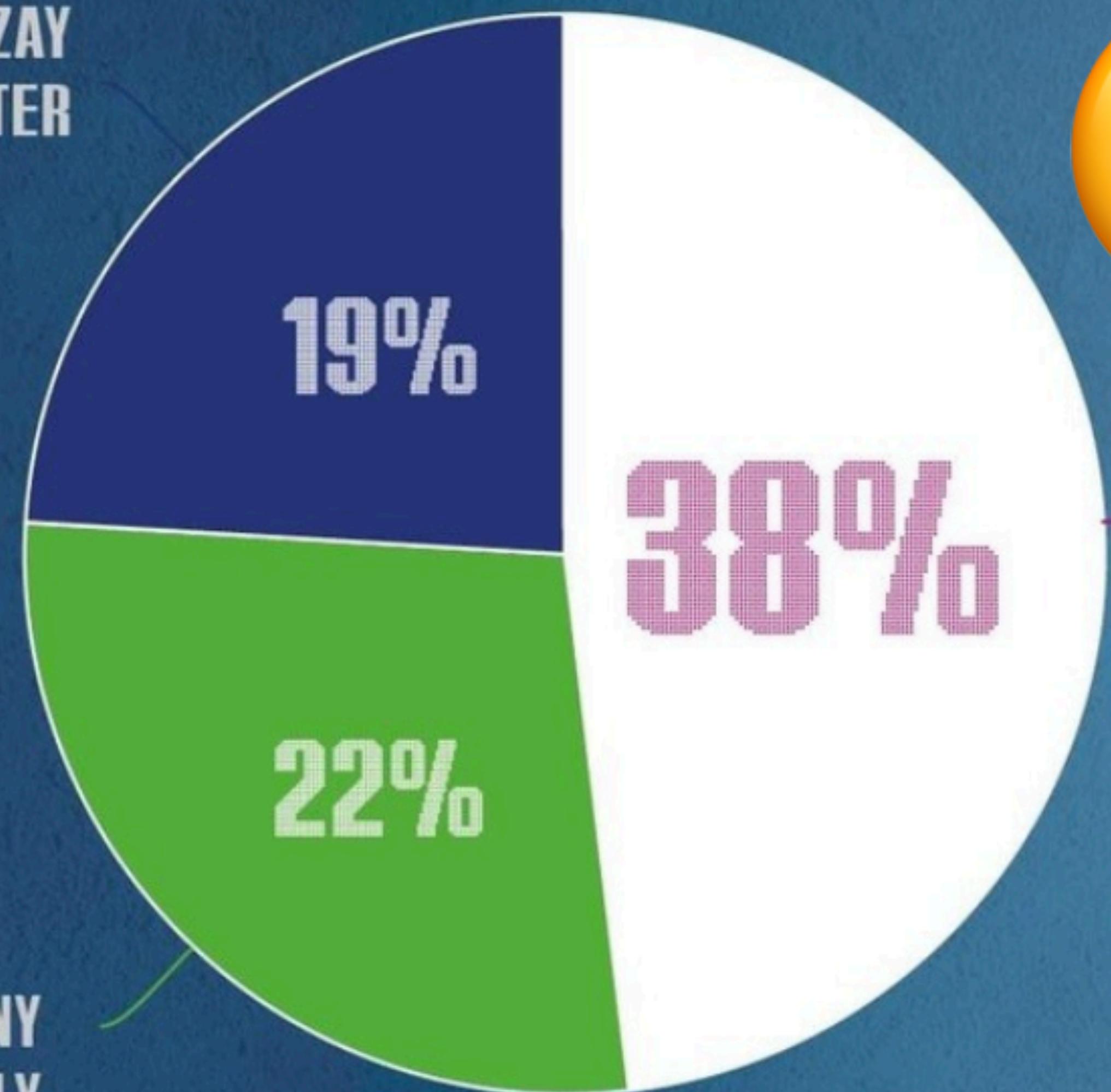
"I LESS EAGER TO GET THE SHOT," JEFF ZIENTS SAYS ► BIDEN WANTED 70 CUOMO PRIME TIME

LIVE
CNN
6:32 PM PT



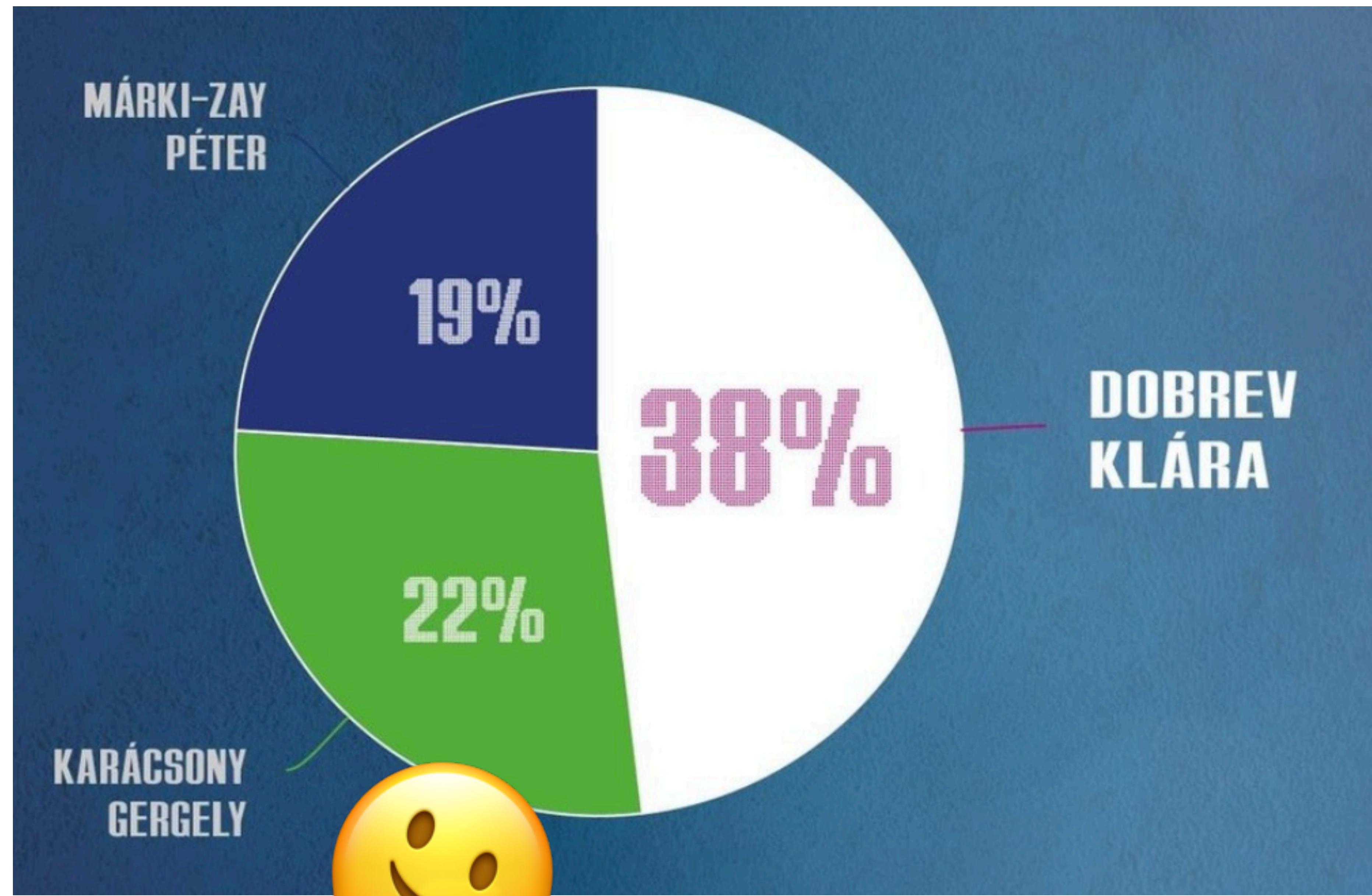


MÁRKI-ZAY
PÉTER



DOBREV
KLÁRA

OBBAINT NEM LEHET LEGYŐZNI BUDAPESTRŐL!



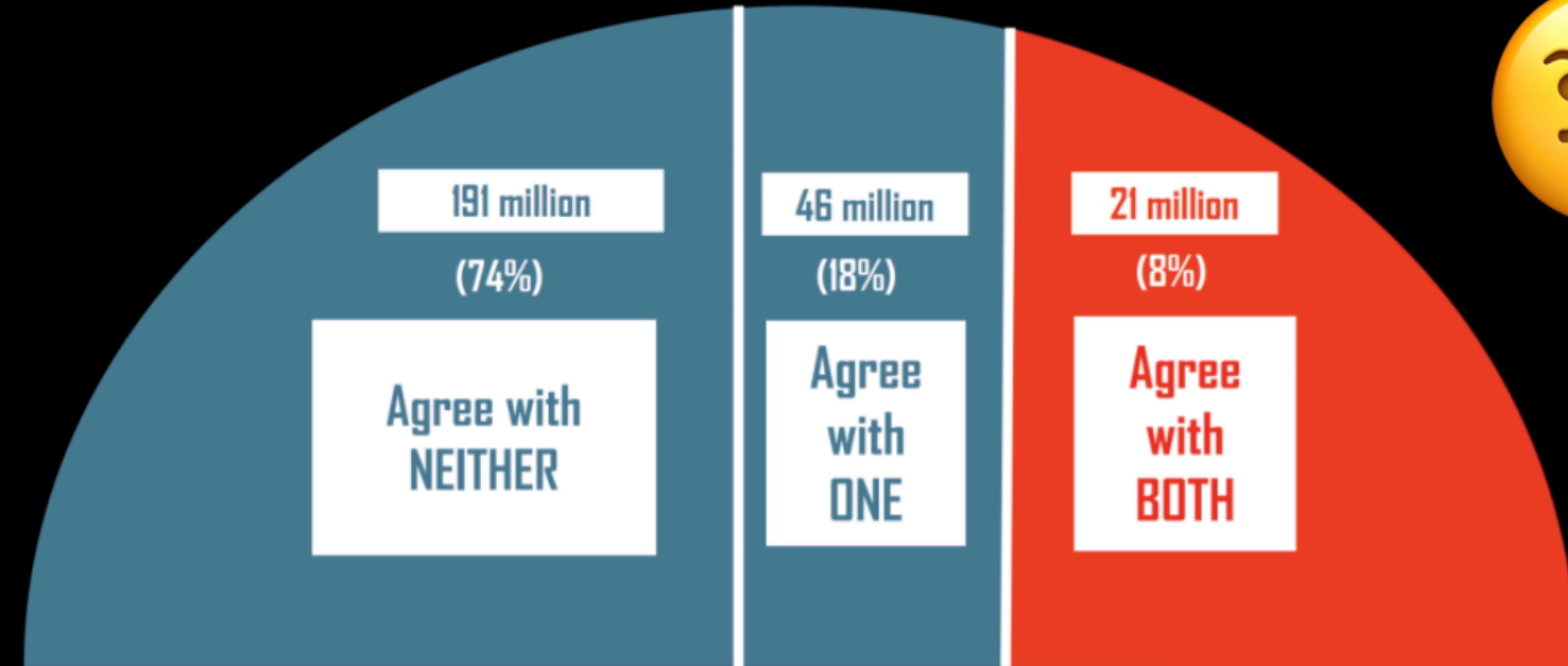
$$38 + 19 + 22 = \dots$$



WHAT IS THE MOVEMENT?

21 Million Americans Believe both:

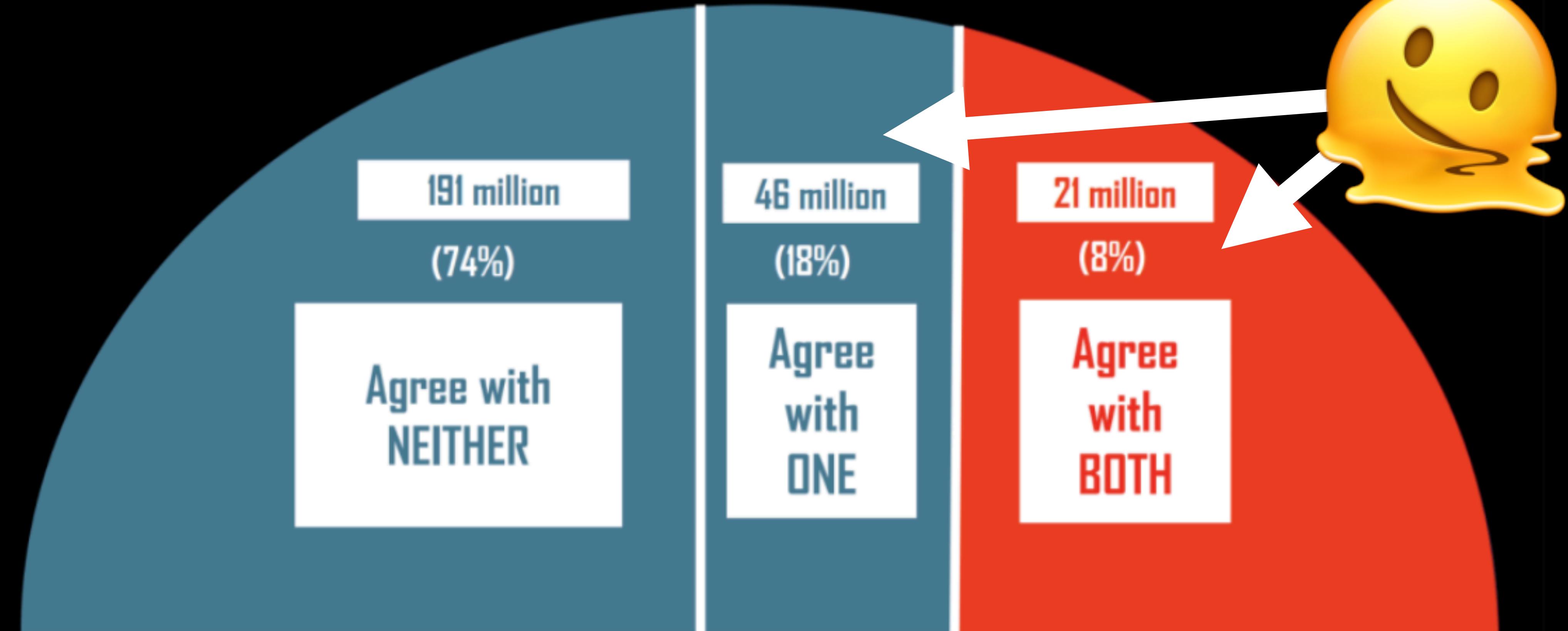
Biden Illegitimate + force justified to Restore Trump



CPOST/NORC SEPT 2021, based on US Census population estimate of 258 million US adults. Don't know/Did not answer < 1%
cpost.uchicago.edu

WHAT IS THE MOVEMENT?

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CPOST/NORC SEPT 2021, based on US Census population estimate of 258 million US adults. Don't know/Did not answer < 1%
cpost.uchicago.edu

**If Bush
tax cuts
expire**

Top tax rate:

35%



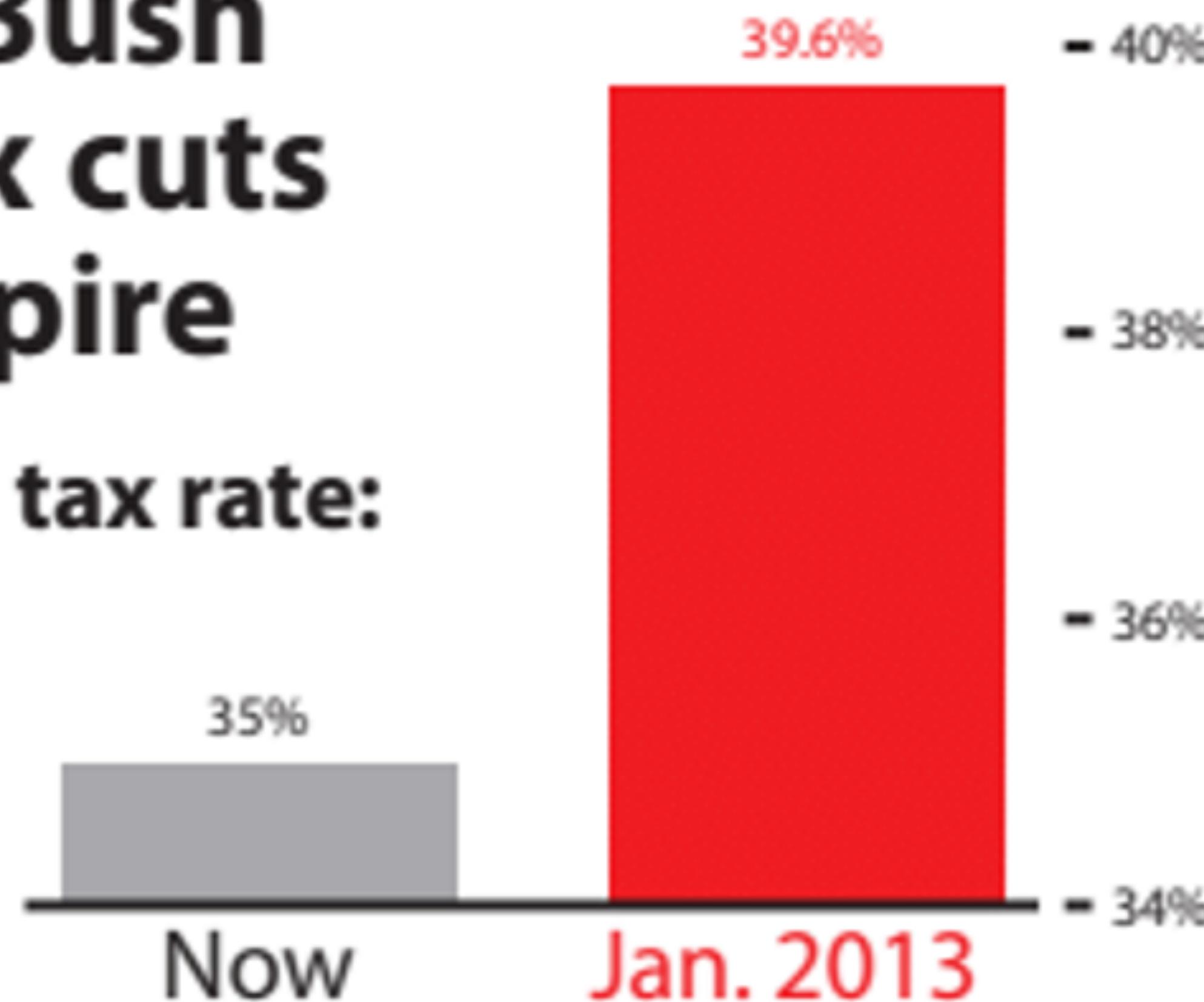
Now

Jan. 2013

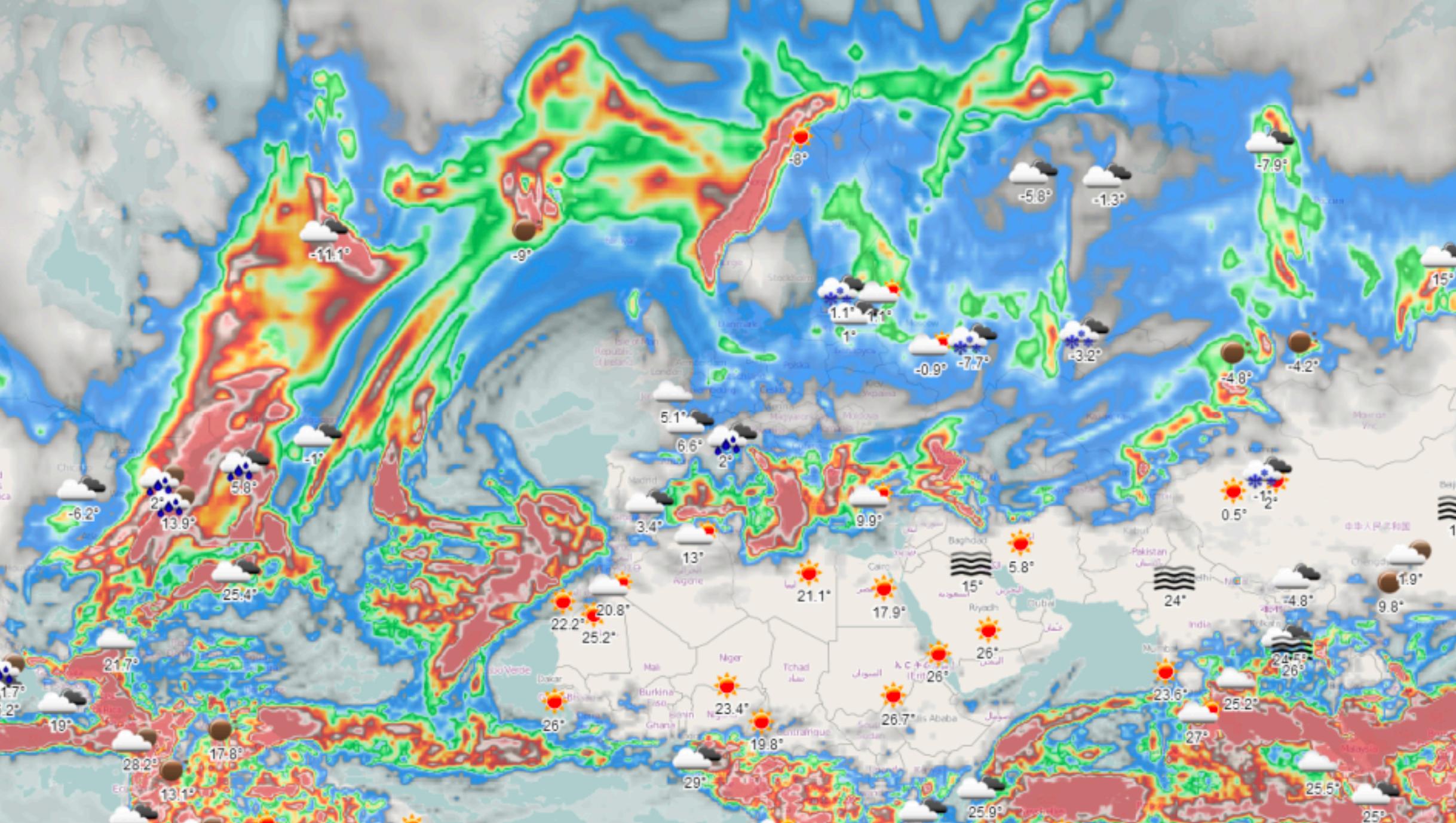


If Bush tax cuts expire

Top tax rate:



**What can we do to make
a *good* visualization?**



Data Science

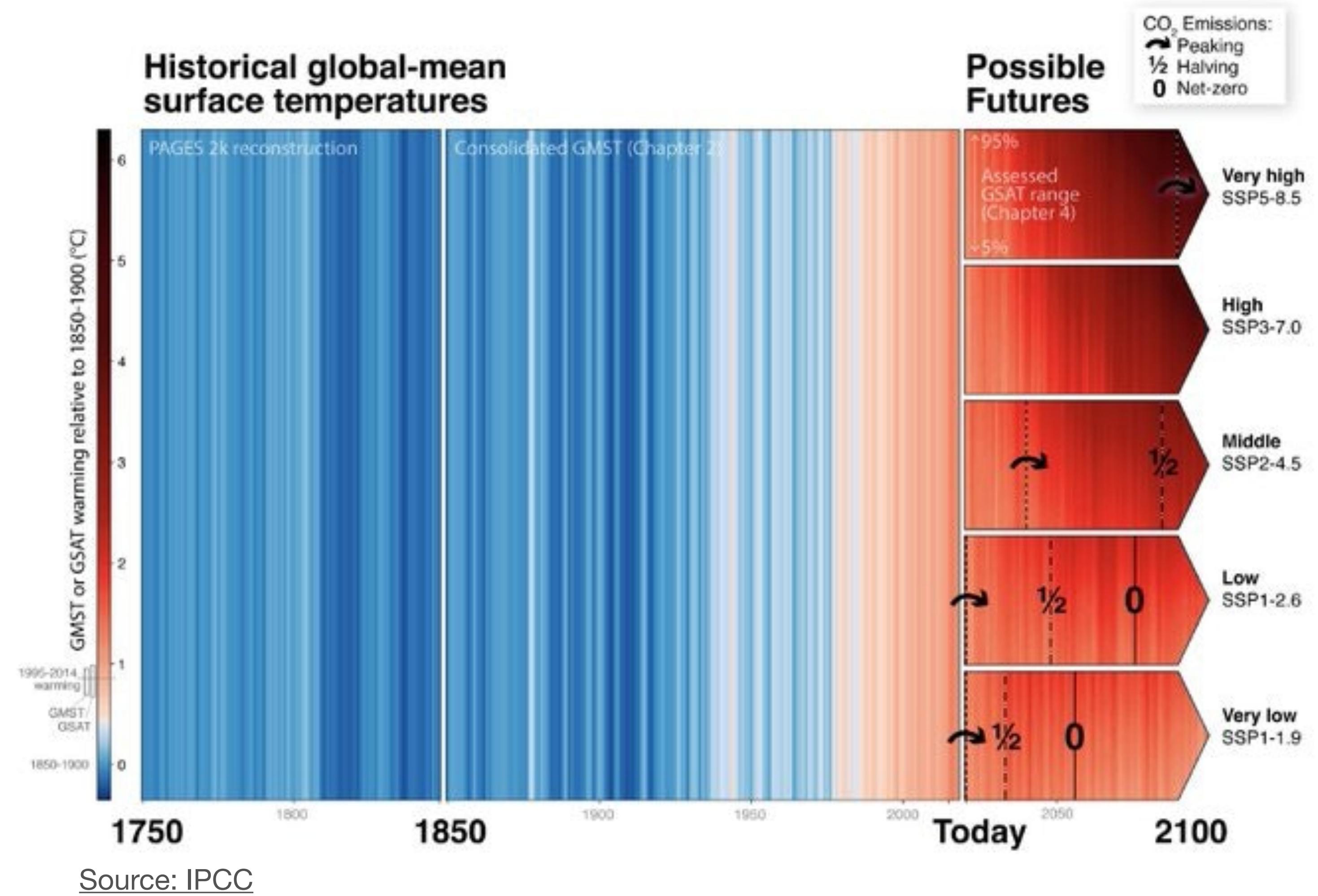
- Extract knowledge and insights from data, often using advanced analytics methods from:
 - Mathematics
 - Statistics
 - Algorithms
 - Machine learning



Src: Kiranshastry - Flaticon

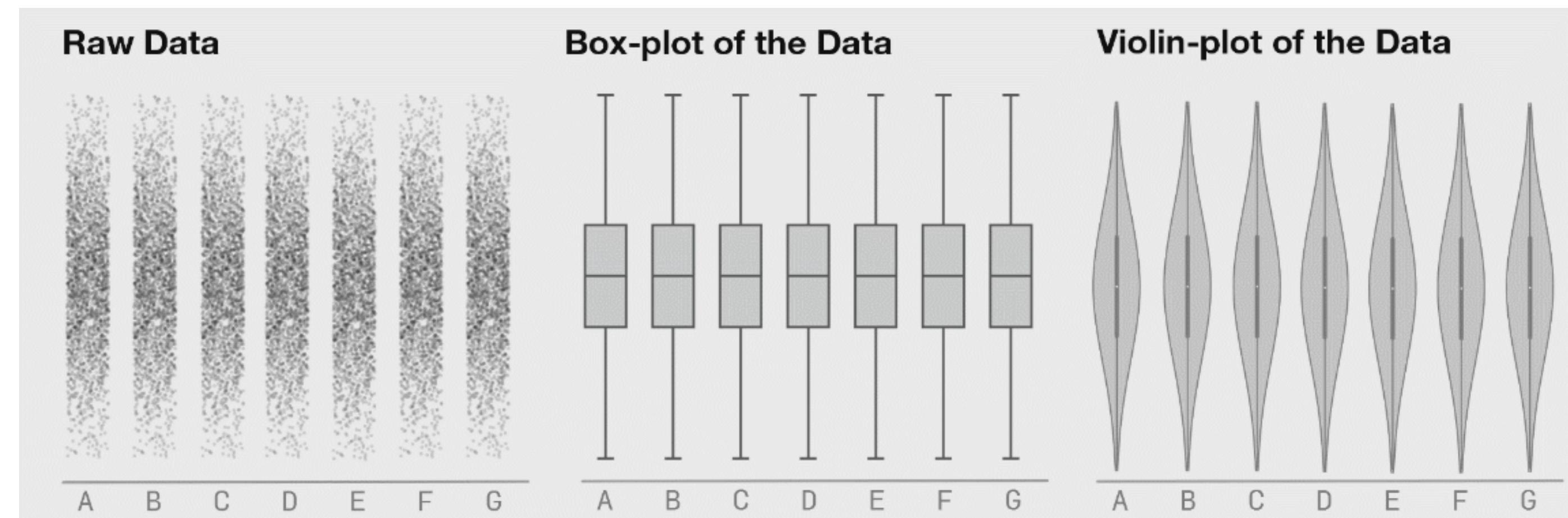
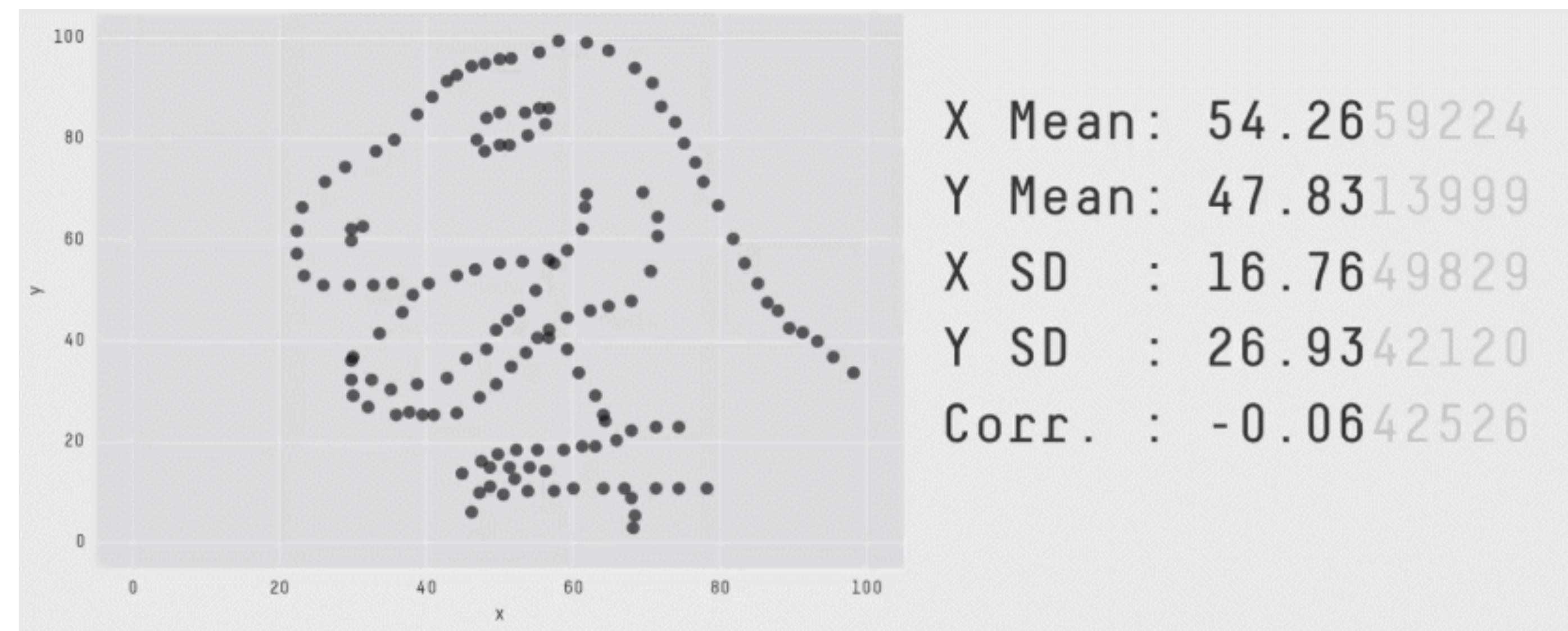
Visualization

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.



Why visualize?

- “visual representation”
 - replace cognition with perception
- “representations of datasets”
 - details matter, summaries can lose information

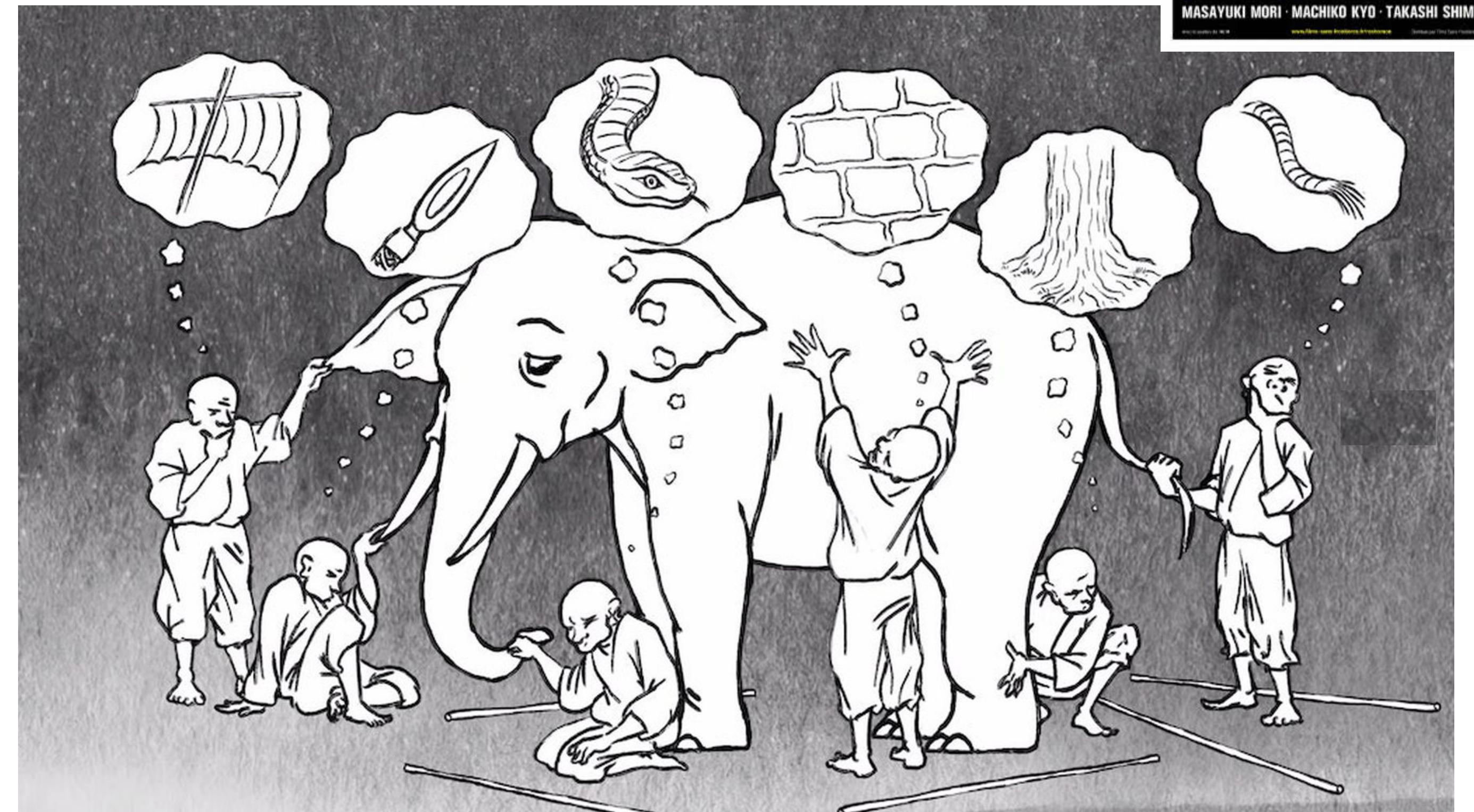


Matejka, J., & Fitzmaurice, G. (2017). Same stats, different graphs: generating datasets with varied appearance and identical statistics through simulated annealing. In Proceedings of the 2017 CHI conference on human factors in computing systems (pp. 1290-1294).



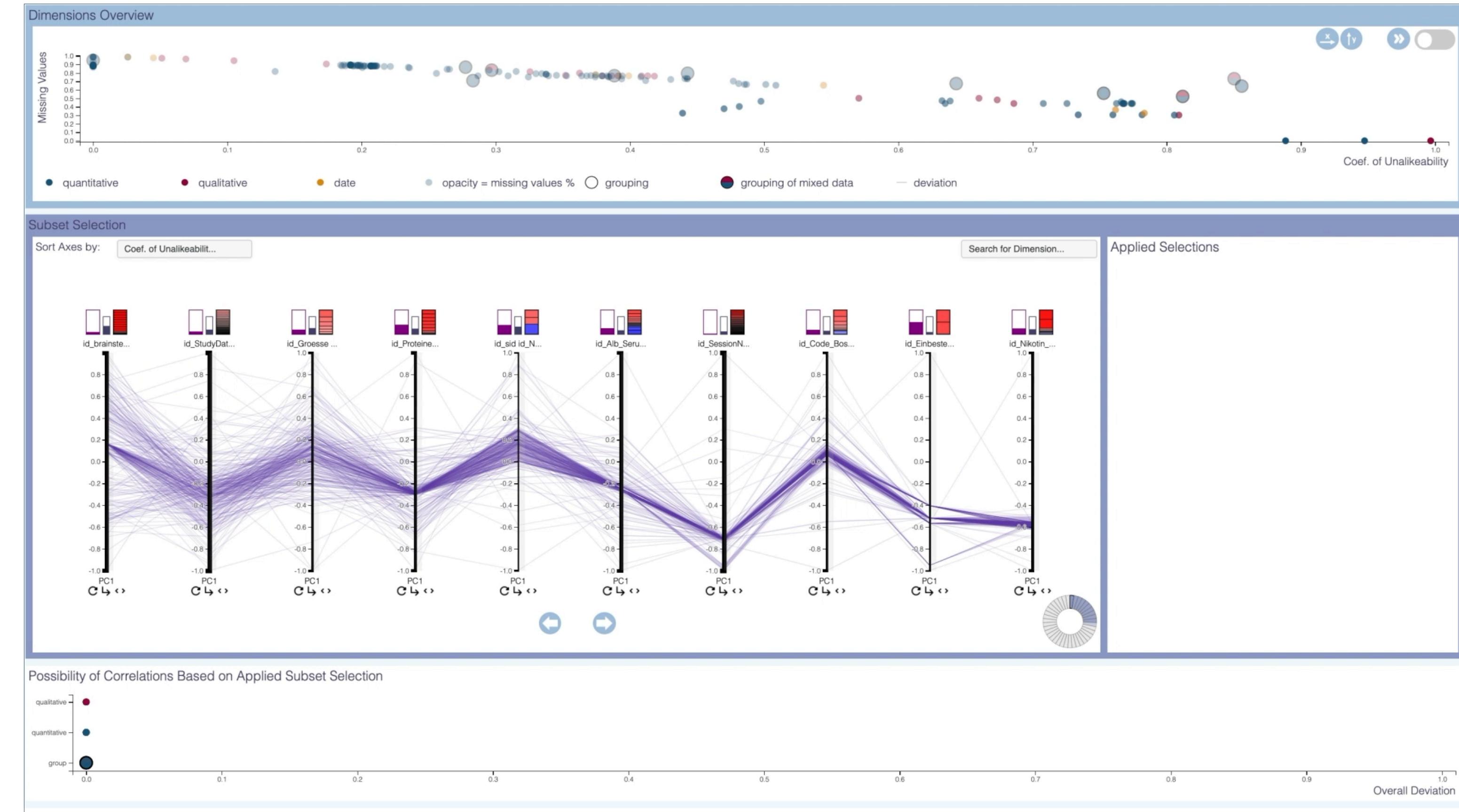
Why visualize?

- Rashomon Effect
 - Different models, parameters, representations, etc. can tell different stories
- Visualization can help us spot and understand reasons for these differences



Why visualize?

- Visualization is not necessary if there is a trustworthy automatic solution
- Augment human capabilities, not replace
- Many analysis problems are **ill-specified**

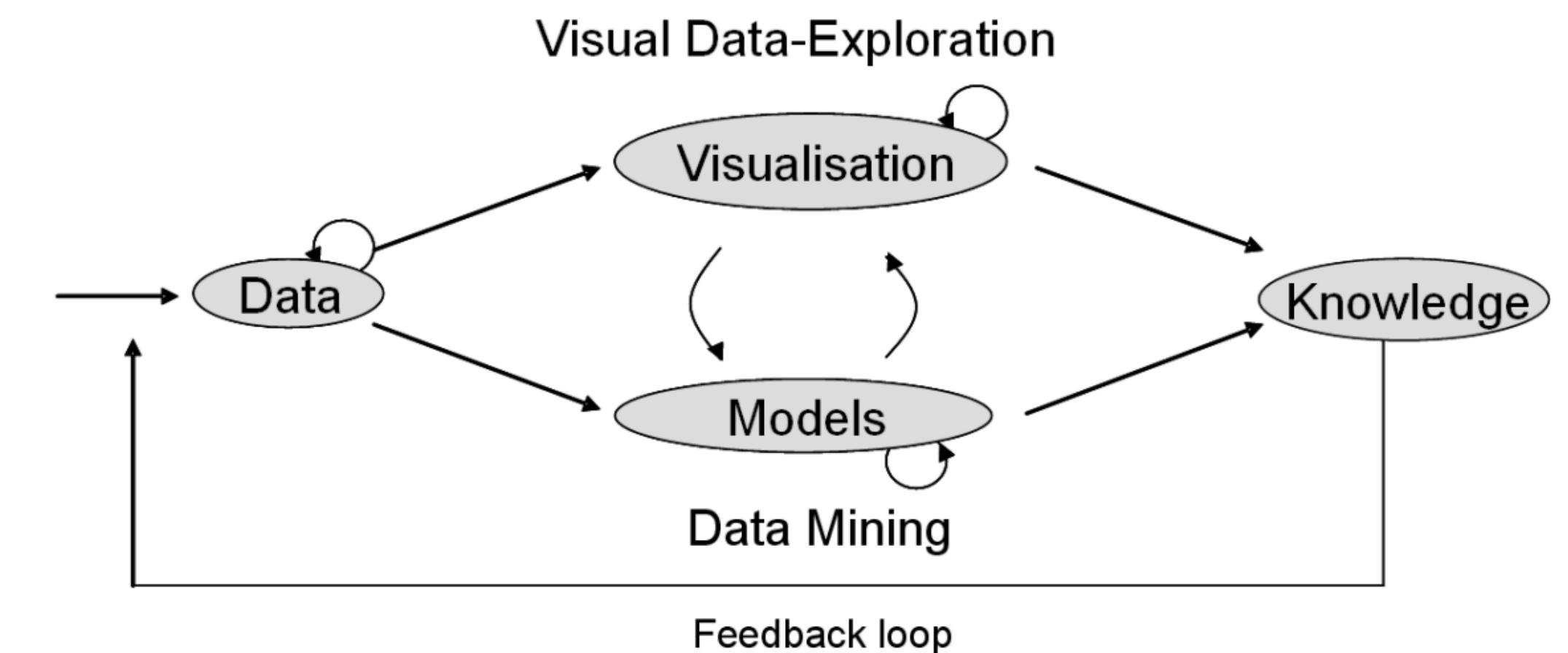


Munzner, T. (2014). Visualization analysis and design. AK Peters Visualization Series, CRC Press, Visualization Series. Chp 1

Garrison, L., Müller, J., Schreiber, S., Oeltze-Jafra, S., Hauser, H., & Bruckner, S. (2021). Dimlift: Interactive hierarchical data exploration through dimensional bundling. IEEE Transactions on Visualization and Computer Graphics, 27(6), 2908-2922.

Why visualize?

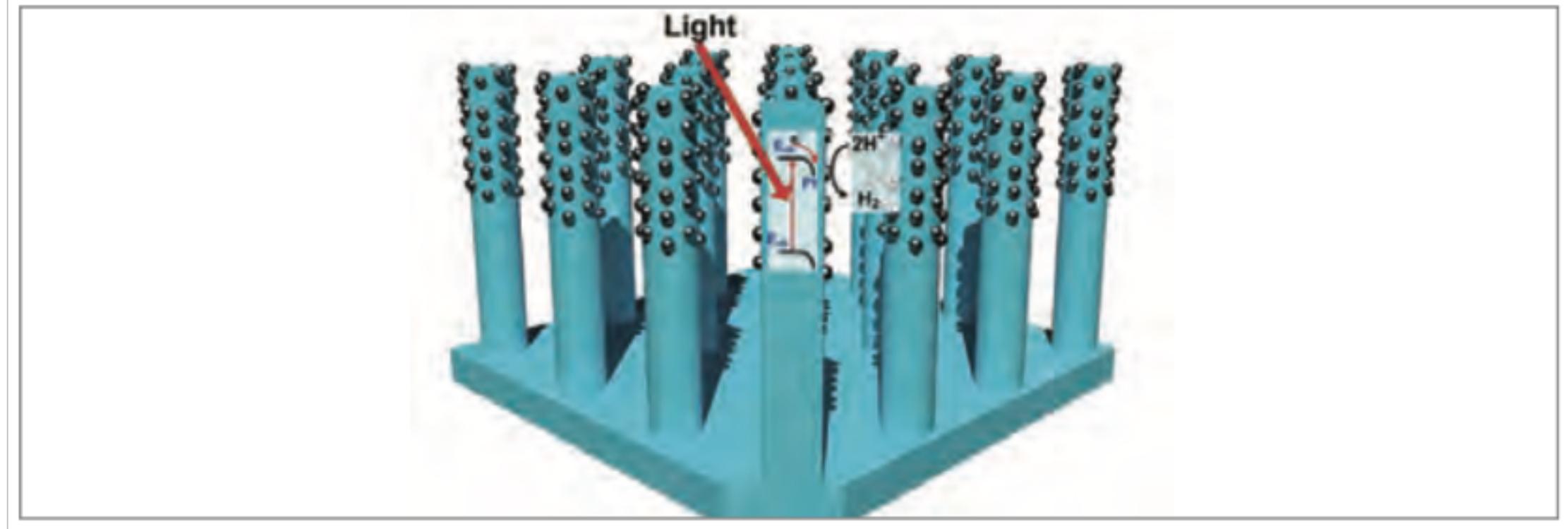
- Visualization integral **throughout** analysis pipeline to help steer a path of inquiry
- Help answer and form new questions:
 - *What do my data look like?*
 - *What are the requirements for developing a more complex model?*
 - *What if I remove/adjust this parameter?*
 - *Do I trust/can I verify the data/model?*



Visuals are powerful.

- High-quality visualizations are perceived as “more interesting, clearly written, and more scientifically rigorous” [1]
- Highly-cited papers tend to have more diagrams/schematics per page [2]

Before redesign:



After redesign:

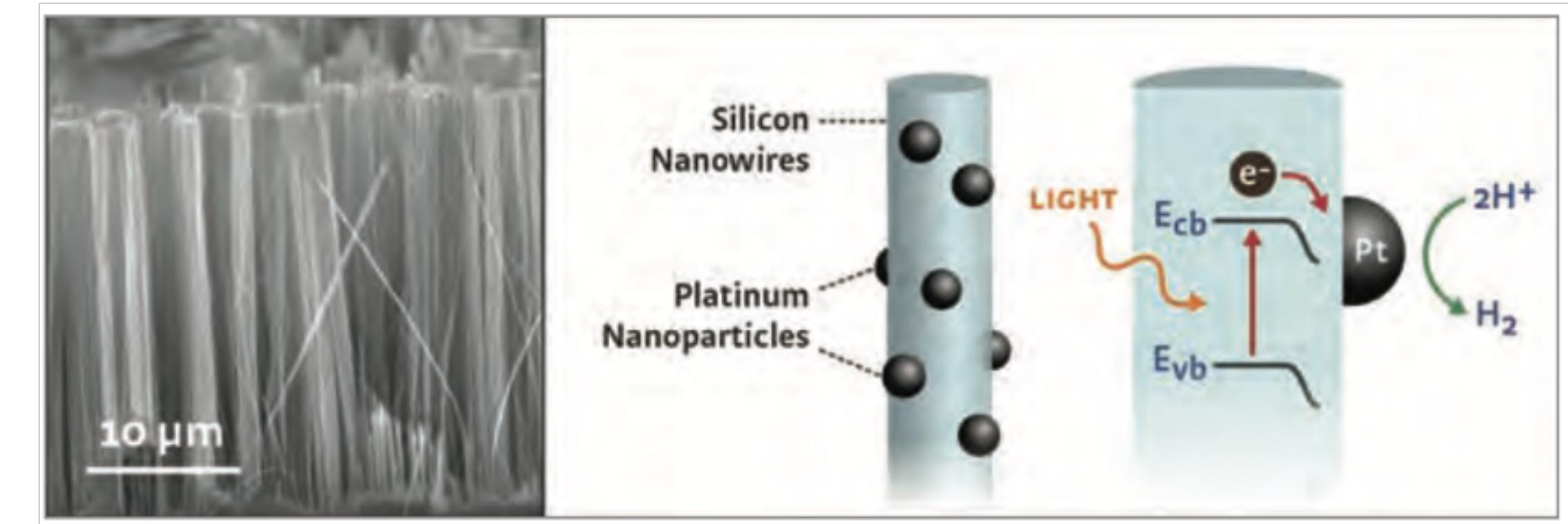


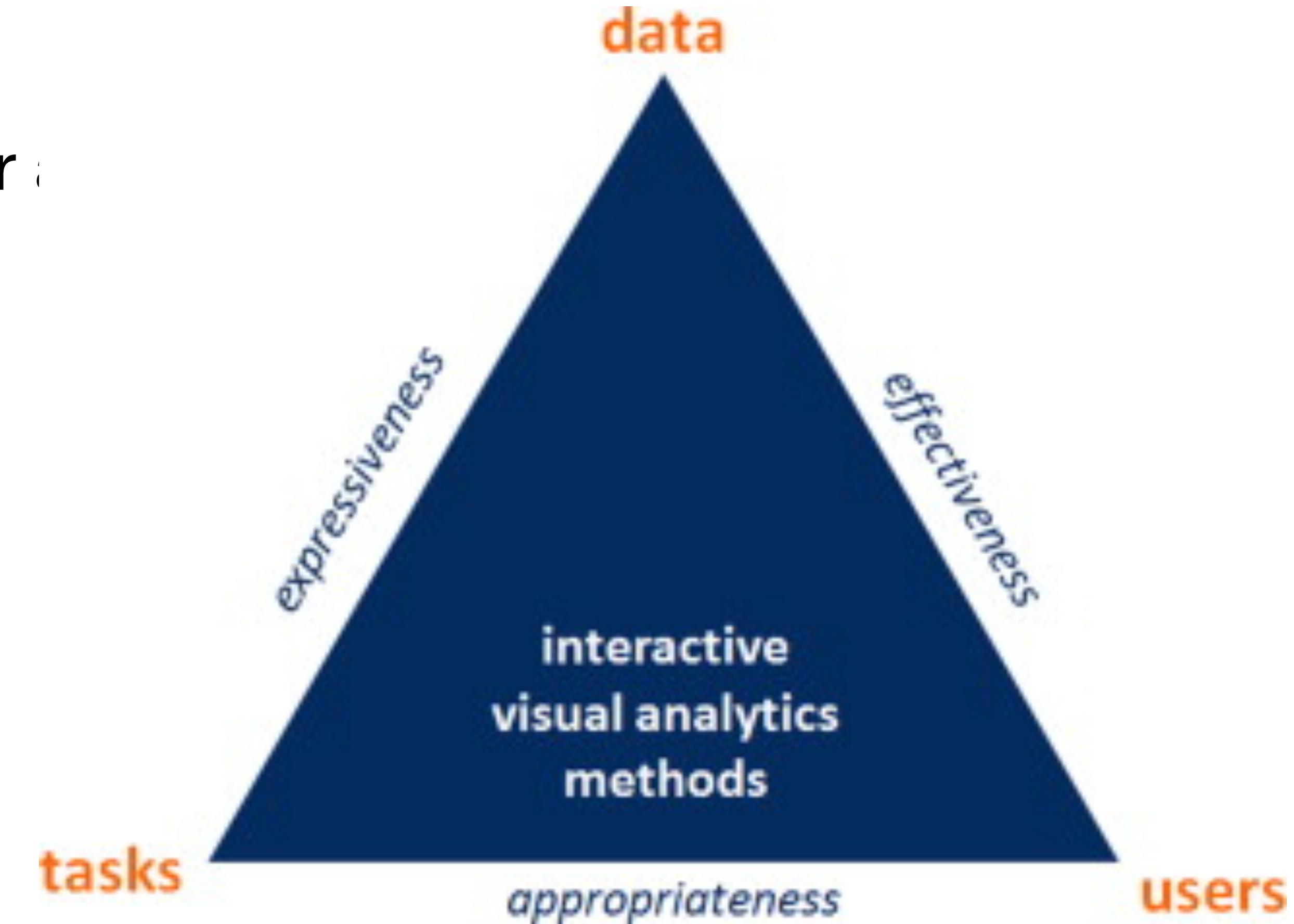
Image Credit: Jen Christiansen, Building Science Graphics (CRC Press 2023), p28

[1] K. Cheng et al., “Proving the Value of Visual Design in Scientific Communication,” *Information Design Journal*, Vol. 23, 2017.

[2] P. Lee, J. D. West, and B. Howe, “Viziometrics: Analyzing Visual Information in the Scientific Literature,” *IEEE Transactions on Big Data* Vol. 4, 2018.

Visualization in YOUR workflow

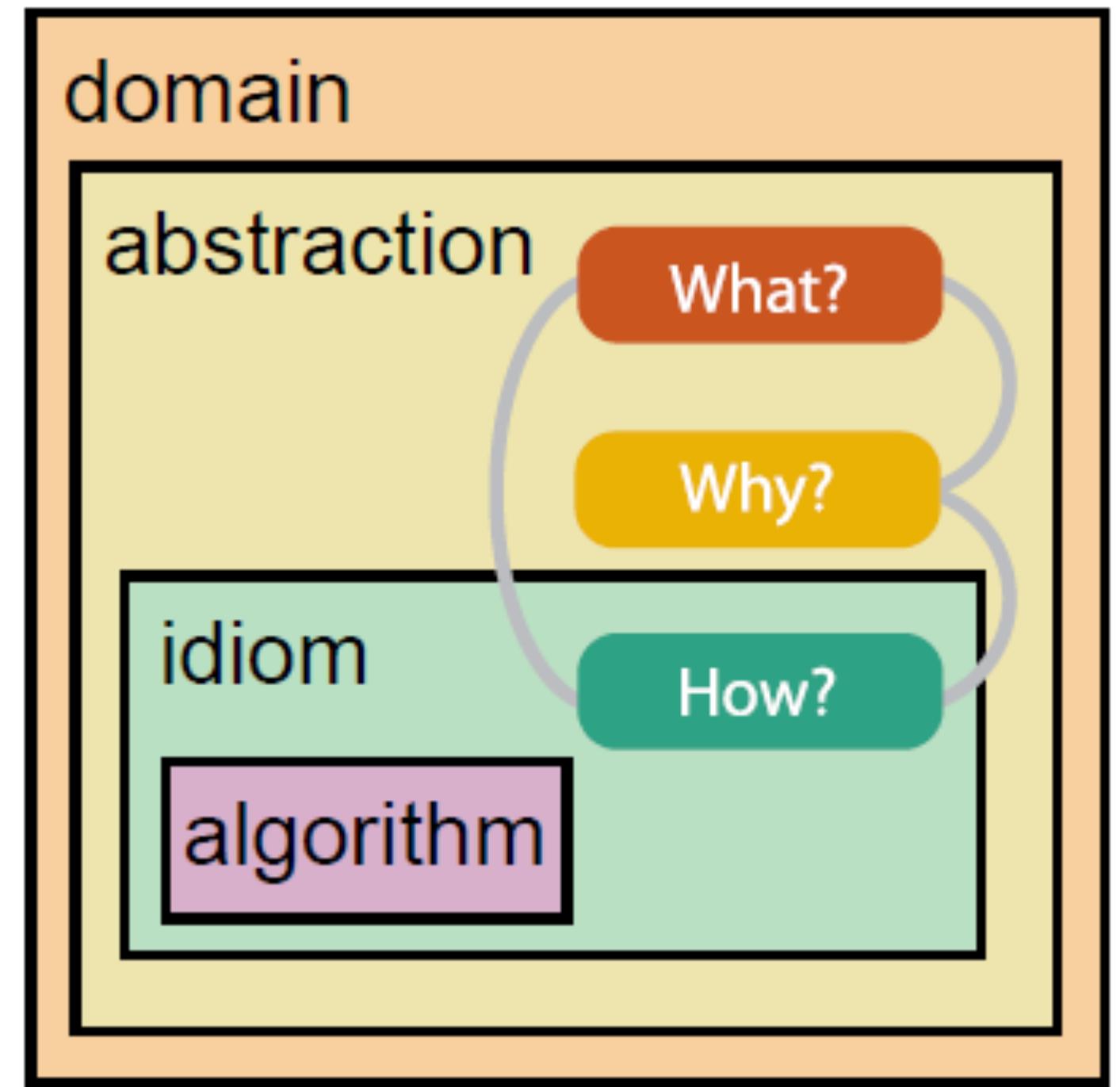
- Good visualization is possible for everyone!
- Consider:
 - Data
 - User(s)
 - Task(s)



Miksch, Silvia, and Wolfgang Aigner. "A matter of time: Applying a data–users–tasks design triangle to visual analytics of time-oriented data." *Computers & Graphics* 38 (2014): 286-290.

Visual Analysis Framework

- Domain
 - **Who** are you visualizing for? Yourself?
- Abstraction
 - **What** is shown (data abstraction)
 - **Why** showing (task abstraction)
- Idiom
 - **How** is it being shown
 - visual encoding idiom (how do you draw the picture)
 - interaction idiom (how do you manipulate the picture)
- Algorithm
 - efficient computation to show the picture

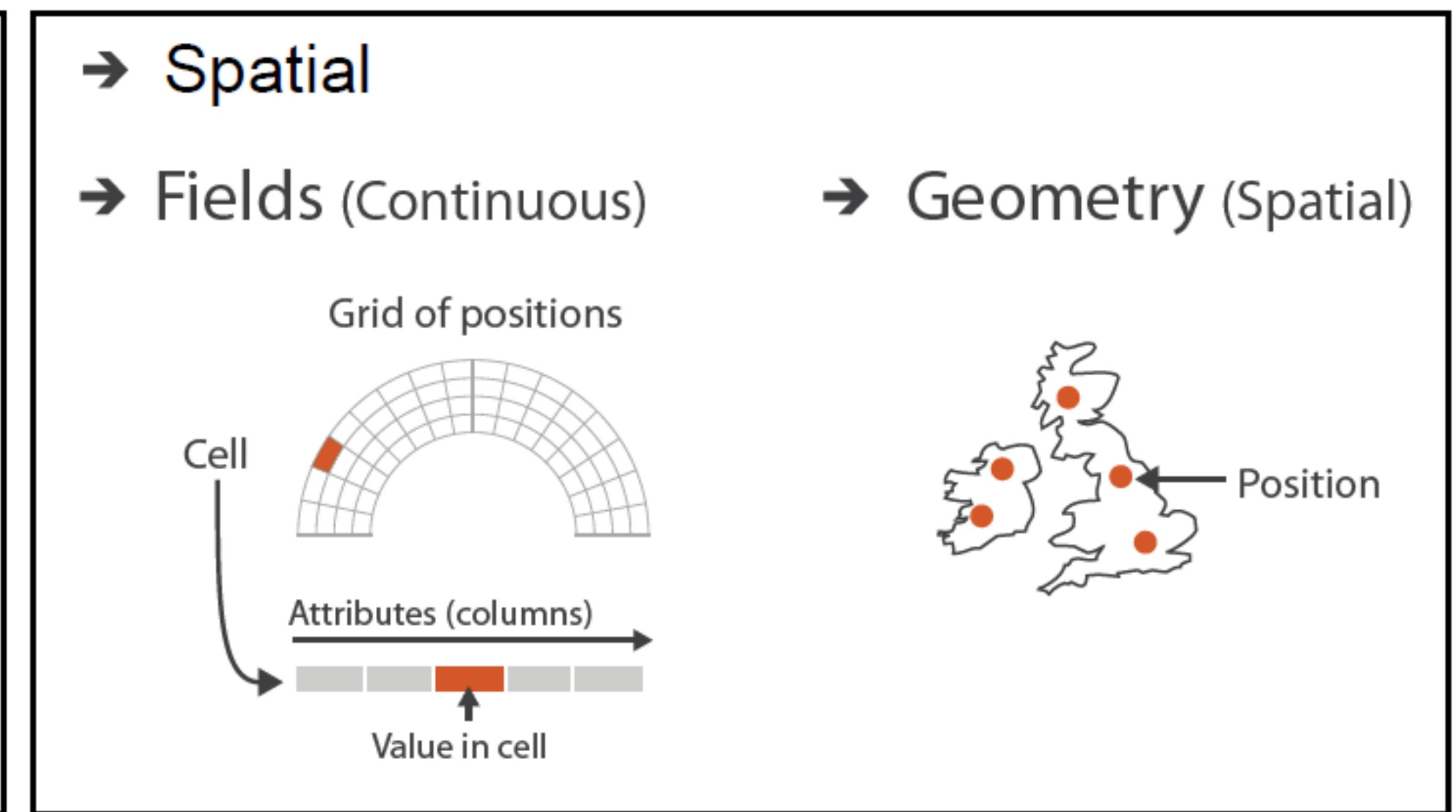
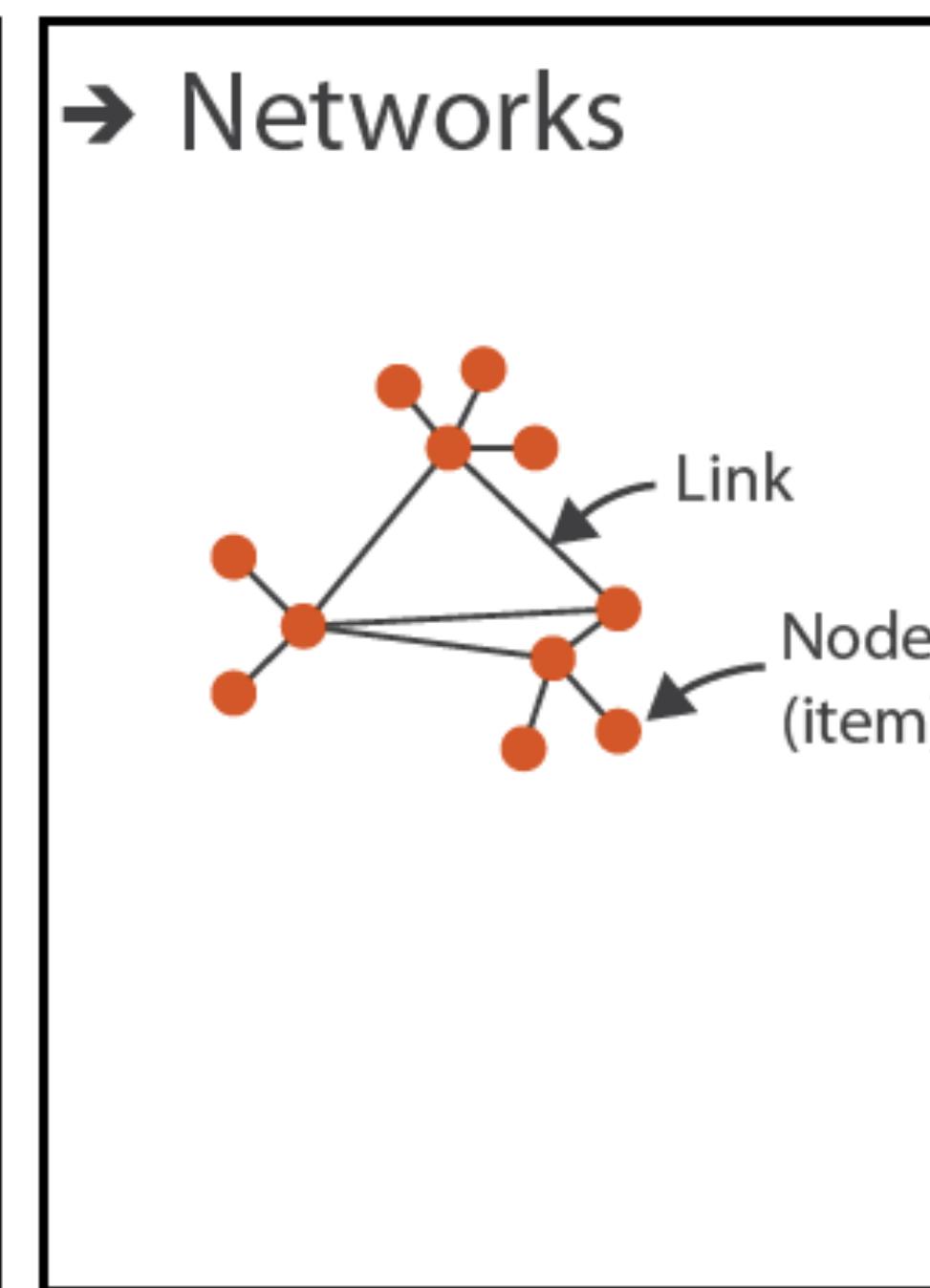
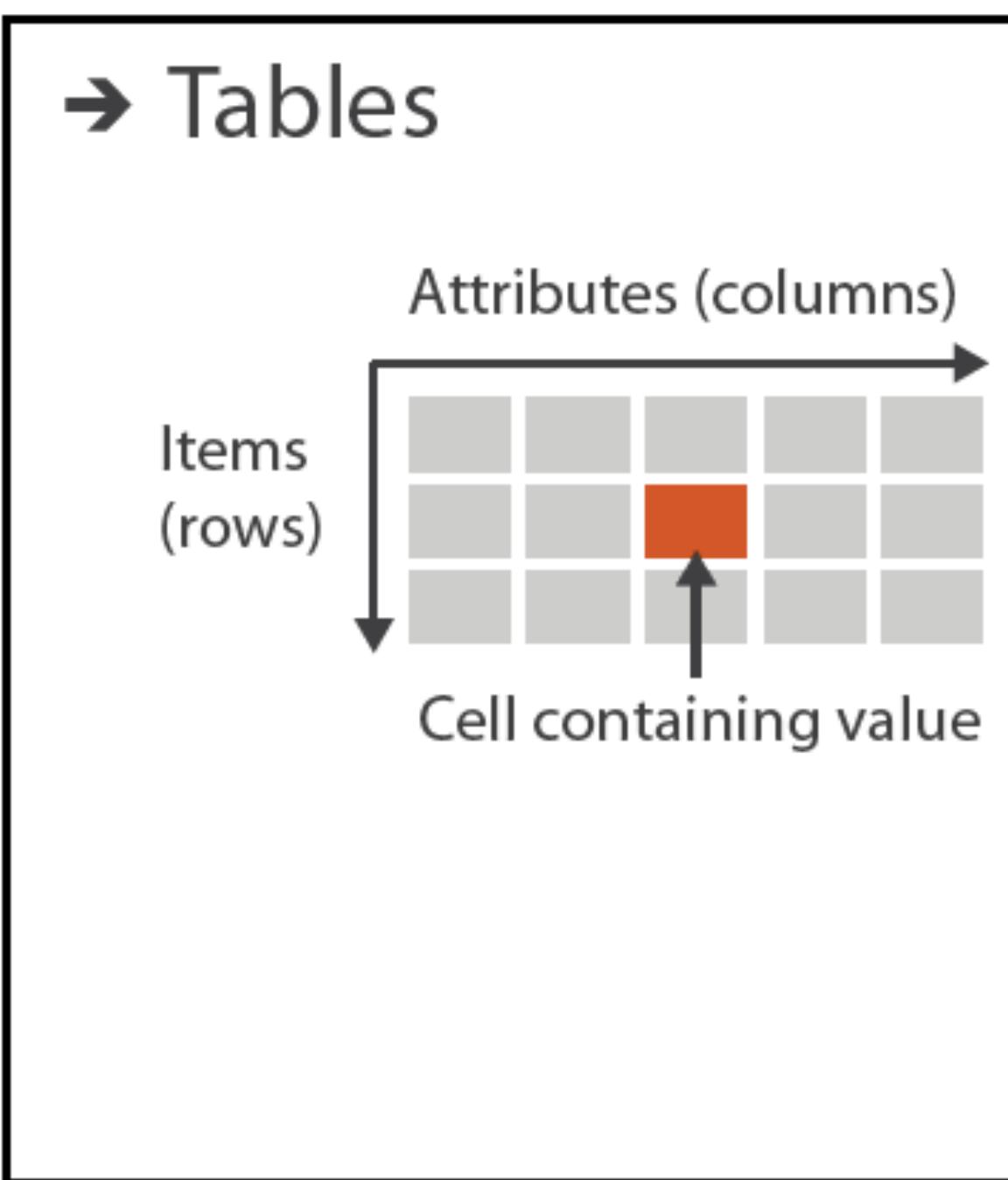


The visualization process

What, why, & how

What data do you have?

→ Dataset Types



What attribute types/ordering do you have?

➔ Attribute Types

➔ Categorical

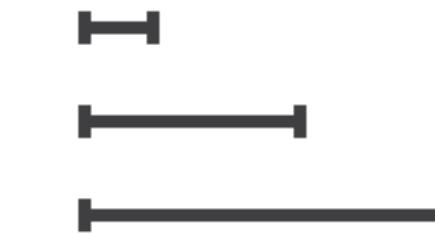


➔ Ordered

➔ *Ordinal*



➔ *Quantitative*



➔ Ordering Direction

➔ Sequential



➔ Diverging



➔ Cyclic



Why are you visualizing the data (actions)?

→ Analyze

→ Consume

→ *Discover*



→ *Present*



→ *Enjoy*



→ Produce

→ *Annotate*



→ *Record*



→ *Derive*



→ Search

	Target known	Target unknown
Location known	•..• <i>Lookup</i>	•..• <i>Browse</i>
Location unknown	<•○•> <i>Locate</i>	<•○•> <i>Explore</i>

→ Query

→ *Identify*



→ *Compare*



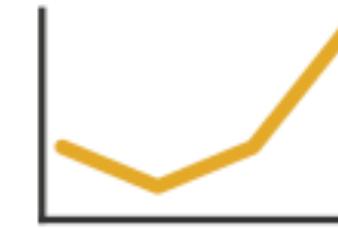
→ *Summarize*



Why are you visualizing the data (targets)?

→ All Data

→ Trends



→ Outliers



→ Features



→ Network Data

→ Topology



→ Paths



→ Attributes

→ One

→ Distribution



→ Extremes

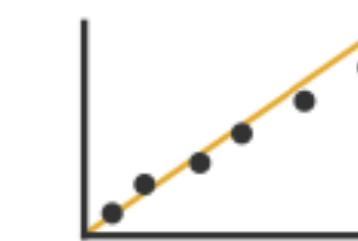


→ Many

→ Dependency



→ Correlation



→ Similarity



→ Spatial Data

→ Shape



How are you visualizing the data (encode)?

④ Arrange

→ Express



→ Order



→ Use



→ Separate



→ Align



④ Map

from categorical and ordered attributes

→ Color



→ Size, Angle, Curvature, ...



→ Shape



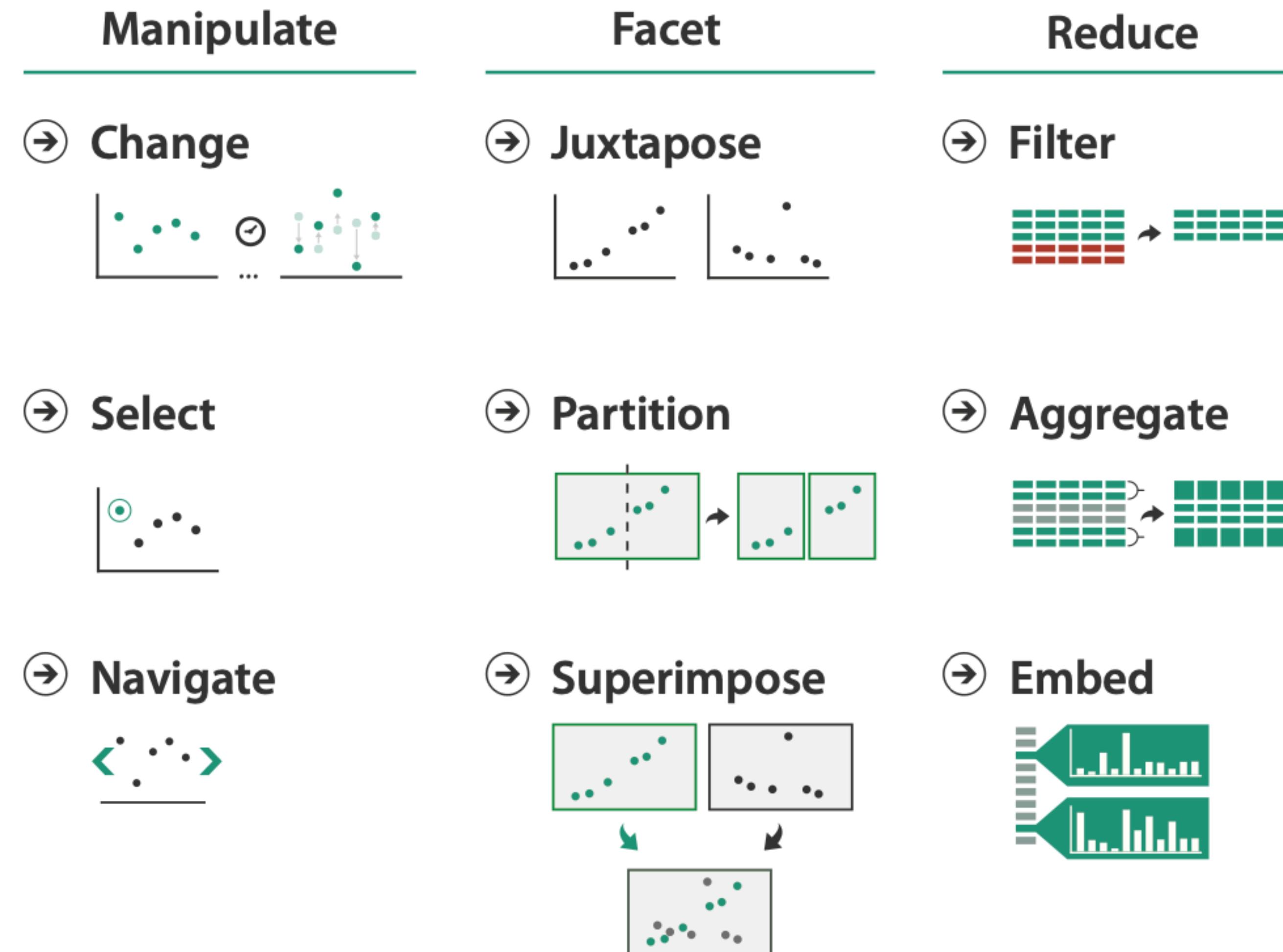
→ Motion

Direction, Rate, Frequency, ...



Munzner, T. (2014). Visualization analysis and design. AK Peters Visualization Series, CRC Press.

How are you visualizing the data (interact)?



The “how” impacts interpretation

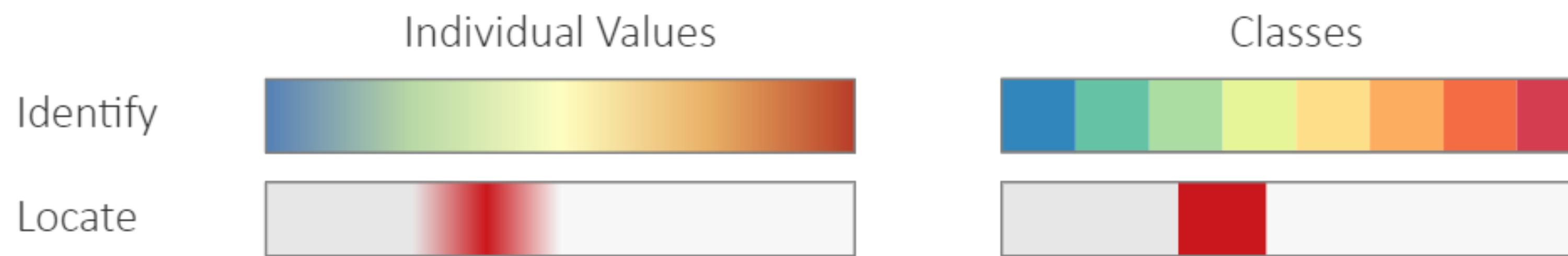


Figure 3.4 Color maps for identifying and locating values and classes.

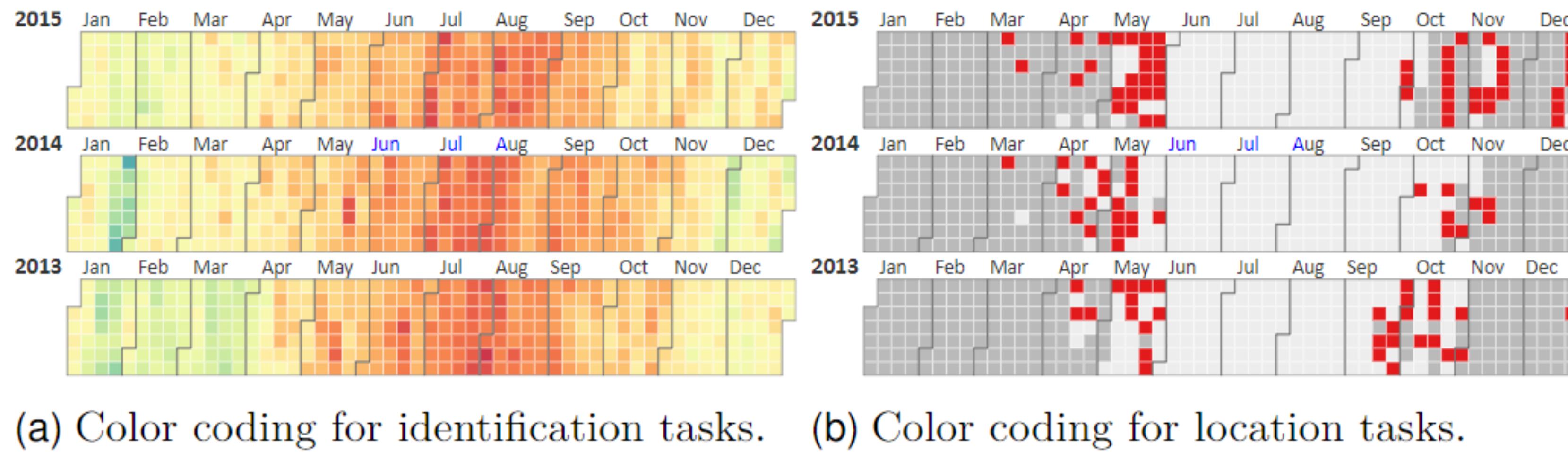
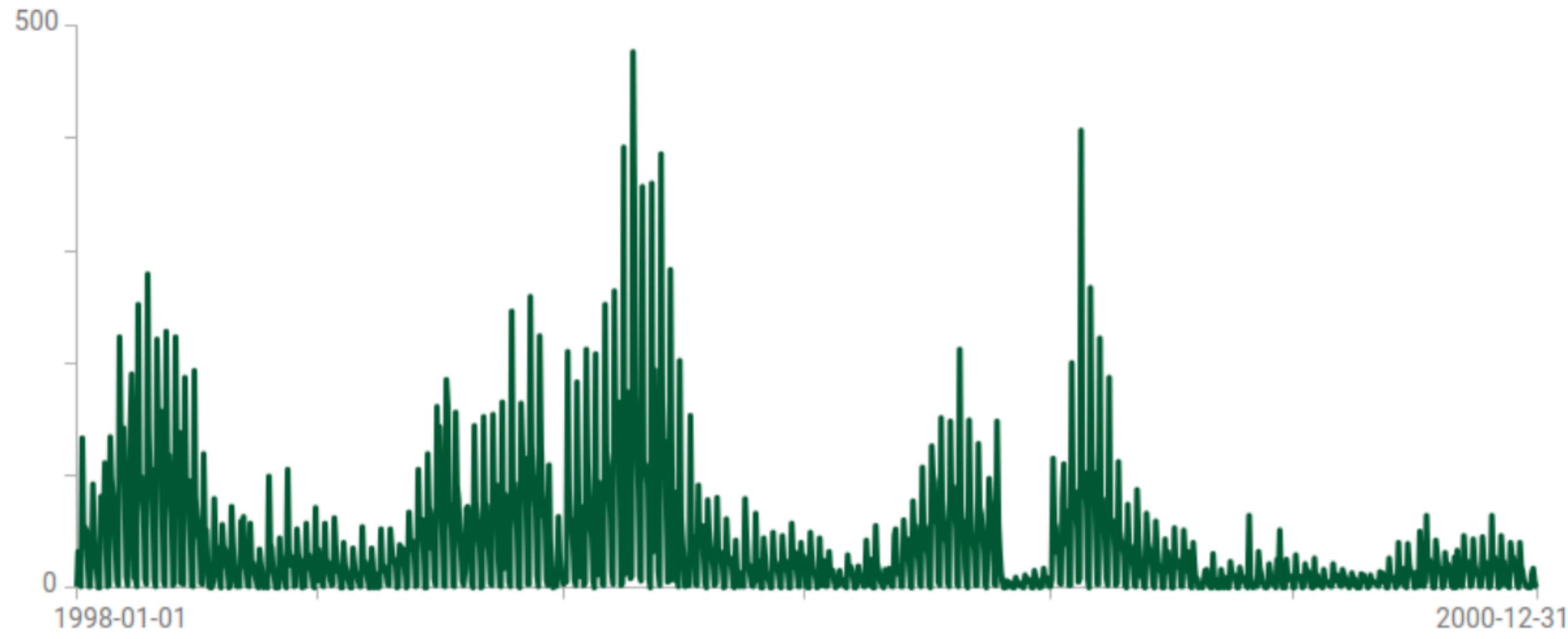
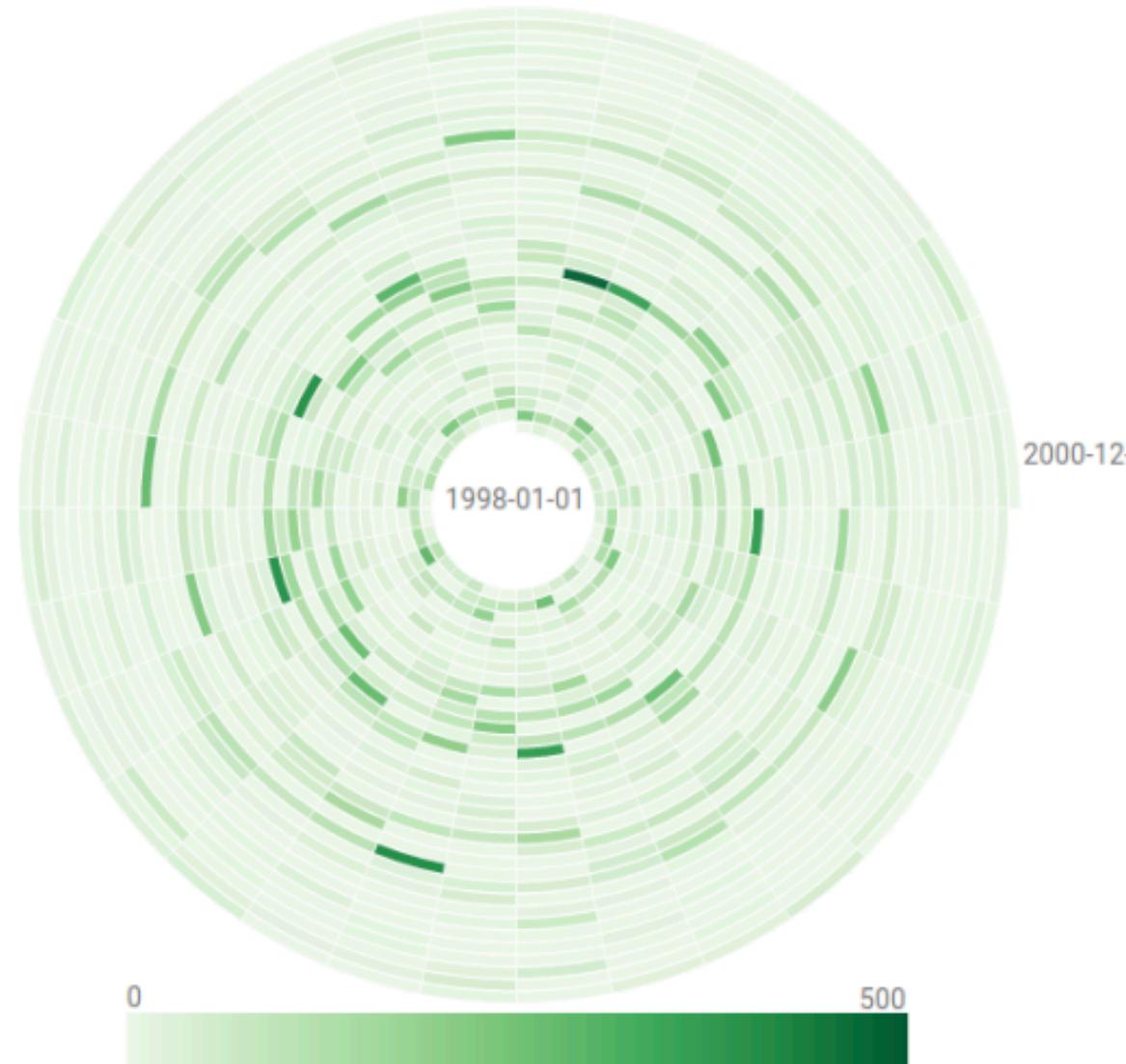


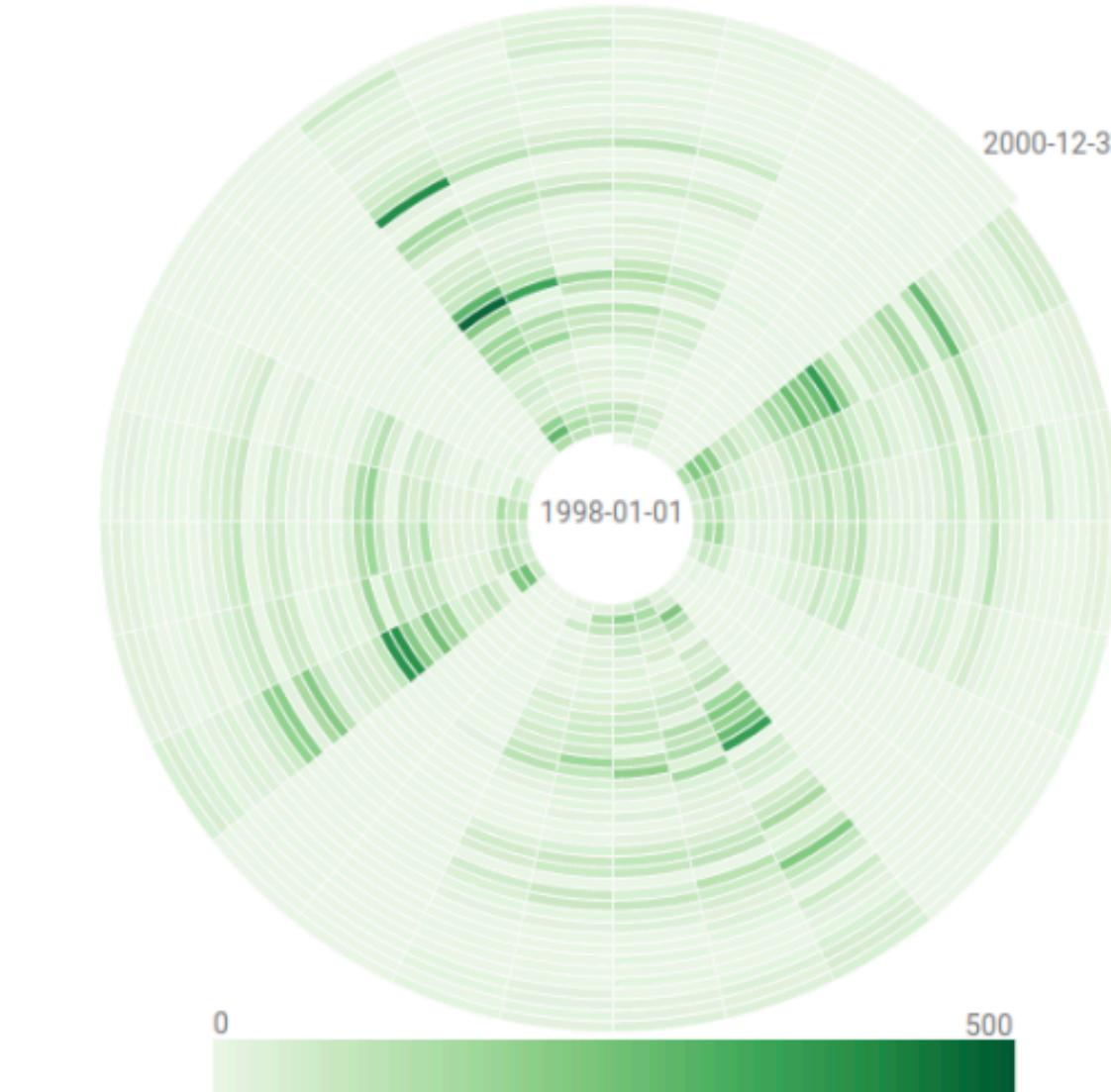
Figure 3.5 Applying the color maps from Figure 3.4 to temperature data.
Adapted from bl.ocks.org/mbostock/4063318.



(a) Line plot.



(b) Spiral plot (cycle length 32 days).



(c) Spiral plot (cycle length 28 days).

The language of visualization

Marks – represent data items or links

→ Points



→ Lines

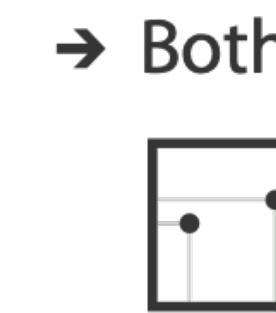


→ Interlocking Areas



Channels - how marks appear onscreen

→ Position



→ Color



→ Shape



→ Tilt



→ Size

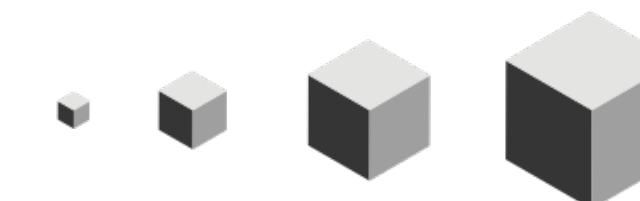
→ Length



→ Area

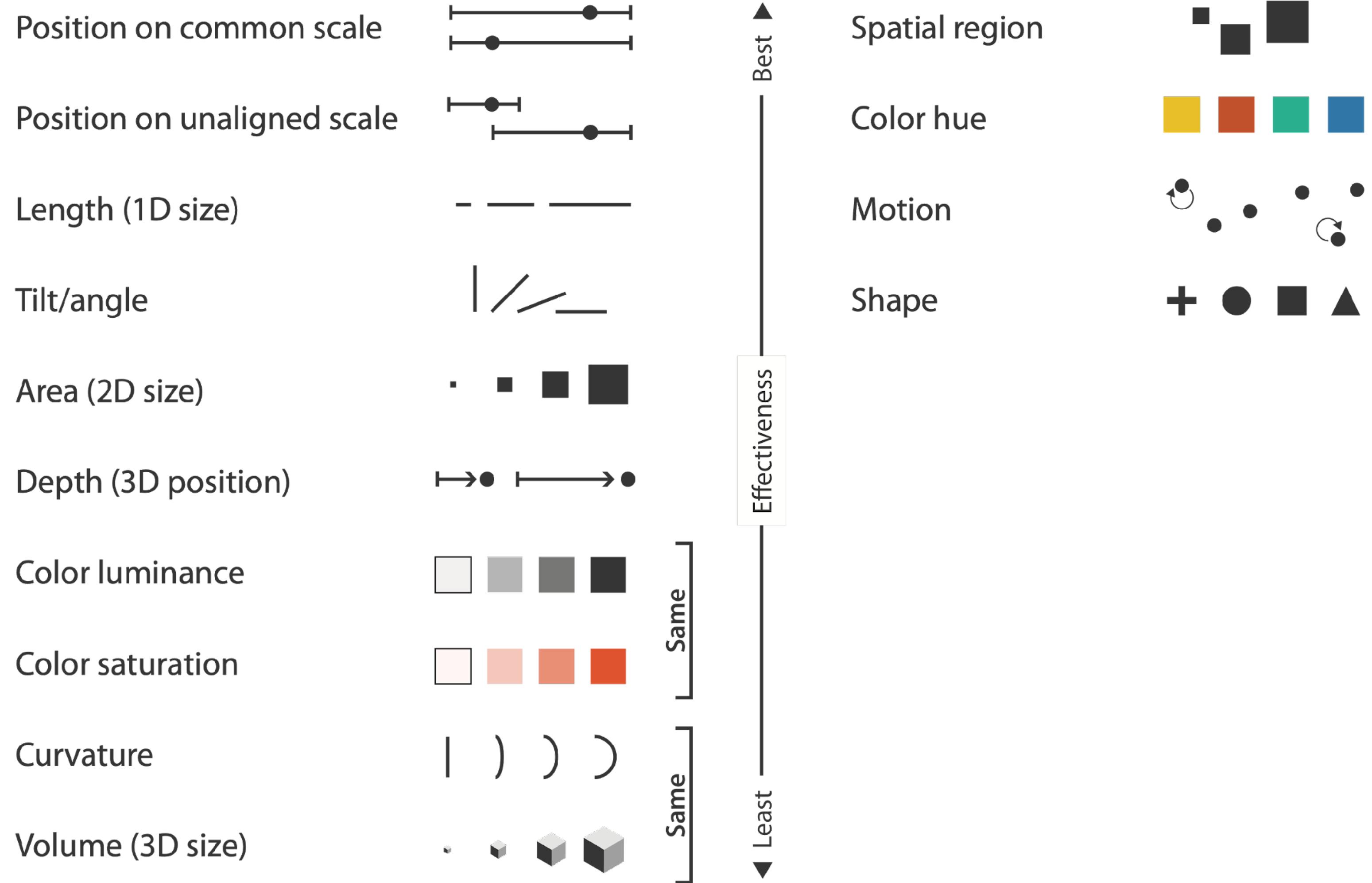


→ Volume



Channels

- Effectiveness rankings
 - Perceptual accuracy
 - Speed



Channels

- Expressiveness
 - Magnitude
 - Identity

→ **Magnitude Channels: Ordered Attributes**

Position on common scale



Position on unaligned scale



Length (1D size)



Tilt/angle



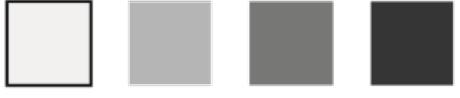
Area (2D size)



Depth (3D position)



Color luminance



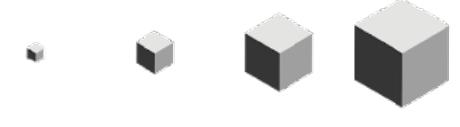
Color saturation



Curvature



Volume (3D size)



→ **Identity Channels: Categorical Attributes**

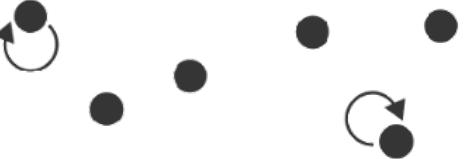
Spatial region



Color hue



Motion



Shape



Best ▲

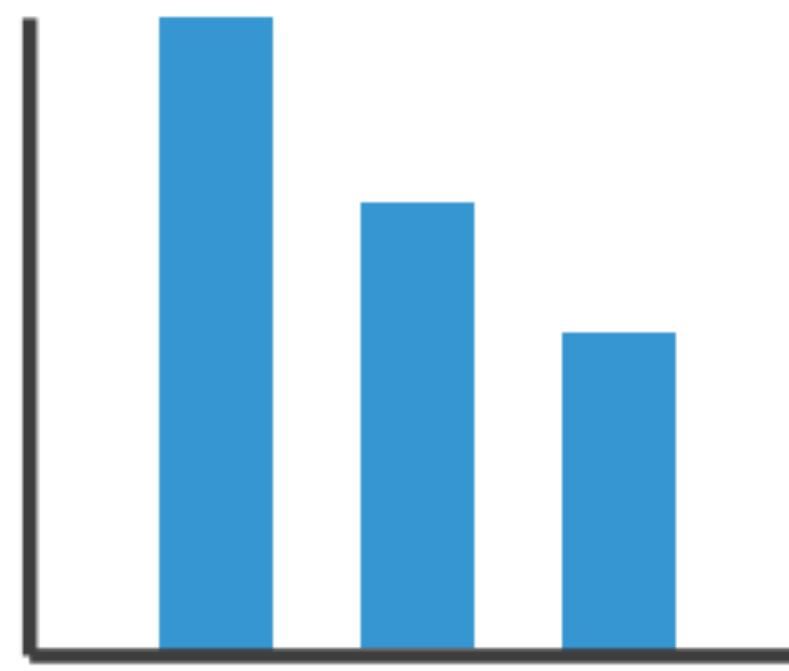
Effectiveness

Same]

Same]

Least ▼

Charts = Mark+Channel Combinations



④ Magnitude Channels: Ordered Attributes	
Position on common scale	
Position on unaligned scale	
Length (1D size)	
Tilt/angle	
Area (2D size)	
Depth (3D position)	
Color luminance	
Color saturation	
Curvature	
Volume (3D size)	

④ Identity Channels: Categorical Attributes	
Spatial region	
Color hue	
Motion	
Shape	

Effectiveness

Best ↑

Same

Least ↓

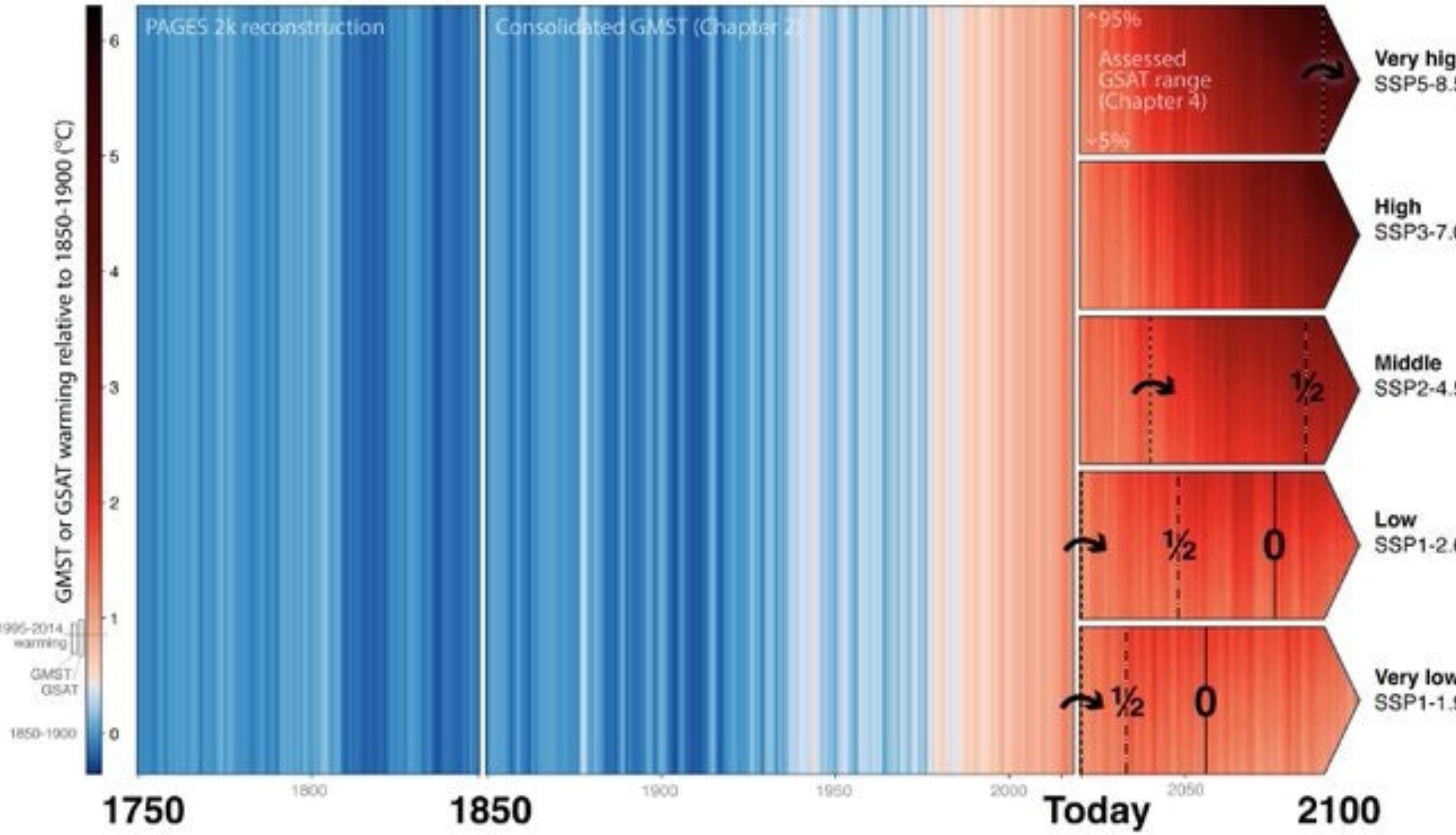
④ **Magnitude Channels: Ordered Attributes**

Position on common scale	
Position on unaligned scale	
Length (1D size)	
Tilt/angle	
Area (2D size)	
Depth (3D position)	
Color luminance	
Color saturation	
Curvature	
Volume (3D size)	

④ **Identity Channels: Categorical Attributes**

Spatial region	
Color hue	
Motion	
Shape	

Historical global-mean surface temperatures



Source: IPCC

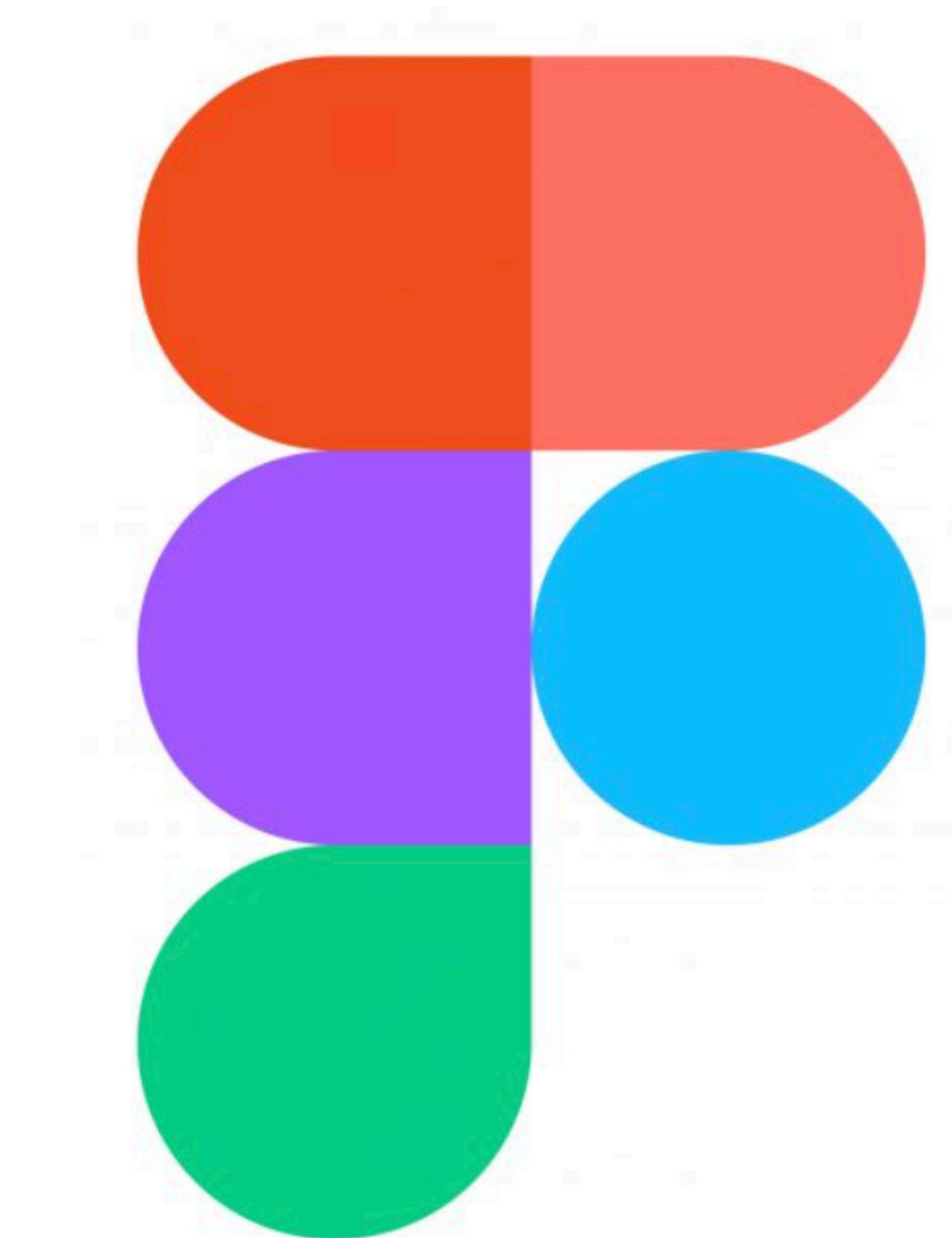
Want more?

Further reading

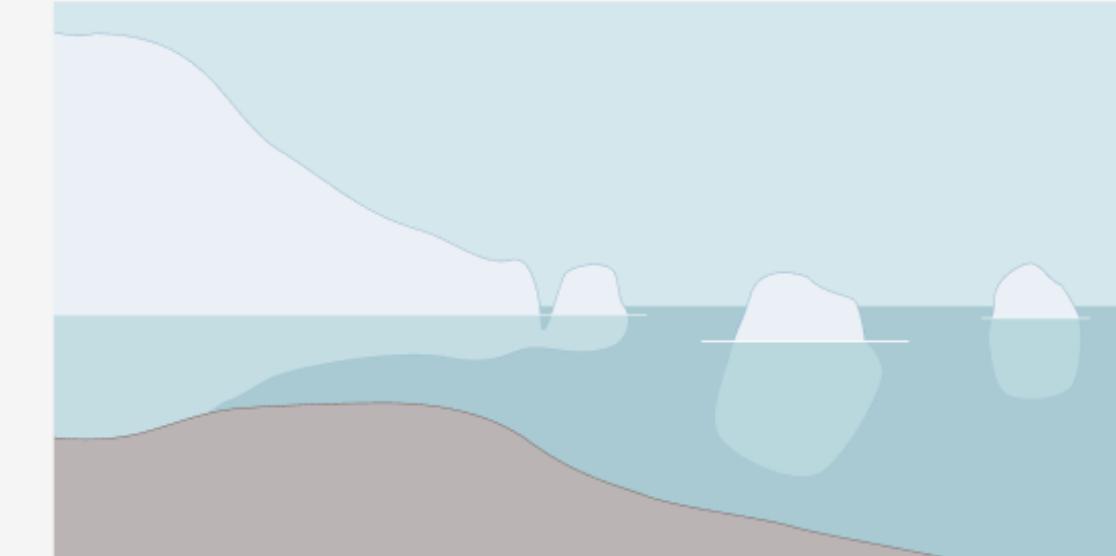
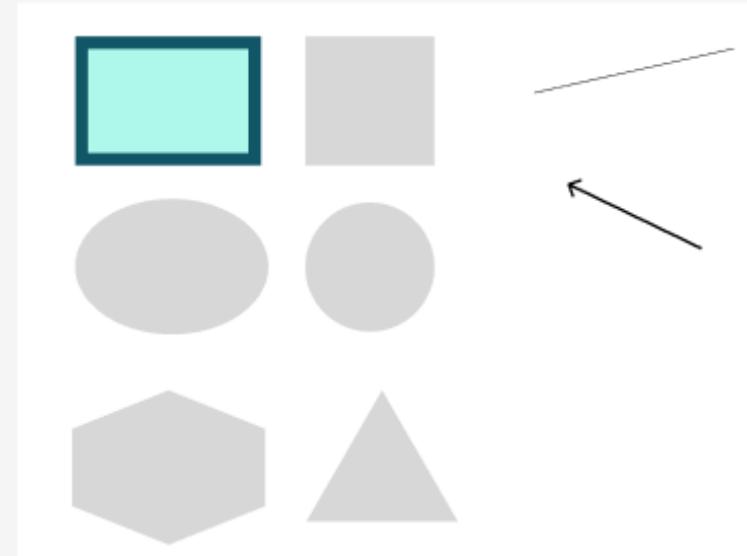
- Christiansen, J., 2022. Building Science Graphics: An Illustrated Guide to Communicating Science Through Diagrams and Visualizations. CRC Press.
- Franconeri, S.L., Padilla, L.M., Shah, P., Zacks, J.M. and Hullman, J., 2021. The science of visual data communication: What works. *Psychological Science in the public interest*, 22(3), pp.110-161.
- Gleicher M. Considerations for visualizing comparison. *IEEE transactions on visualization and computer graphics*. 2017 Aug 29;24(1):413-23.
- Nature Points of View: Data visualization article collection (<https://blogs.nature.com/methagora/2013/07/data-visualization-points-of-view.html>)
- Rogowitz, B.E., Treinish, L.A. and Bryson, S., 1996. How not to lie with visualization. *Computers in physics*, 10(3), pp.268-273.
- Schwabish J. Better data visualizations: A guide for scholars, researchers, and wonks. Columbia University Press; 2021 Dec 31

Break for 20 min

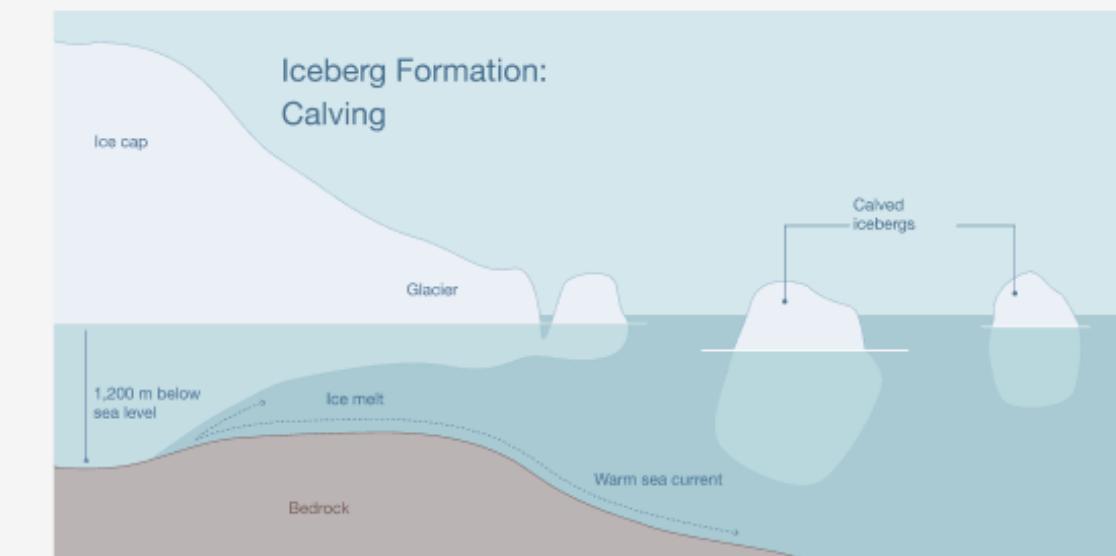
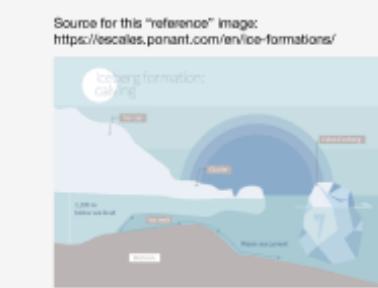
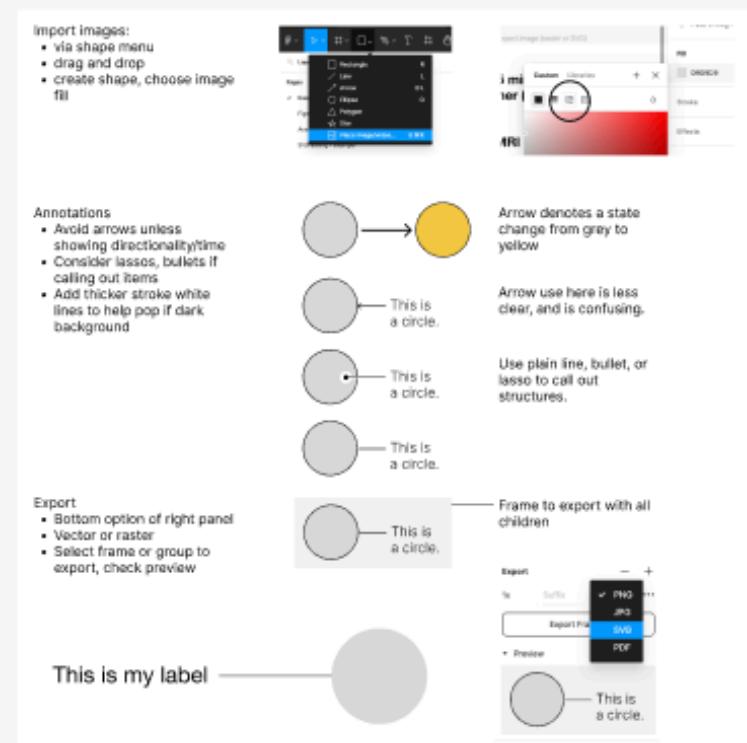
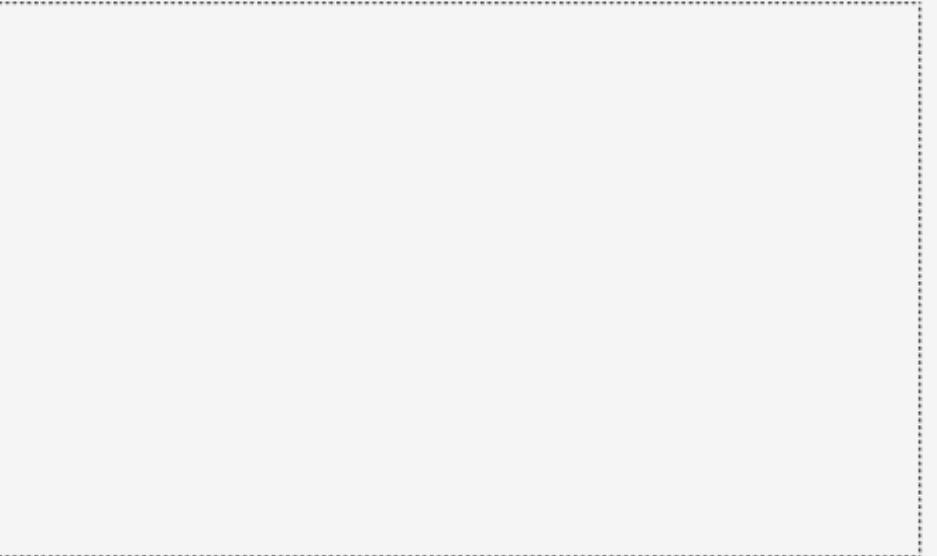
Next up: Figma



<https://www.figma.com/community/file/1313258653815696070/bjerknes-visualization-workshop-4-6-dec>



- Task 1 - Your turn!
- Create Figma account
 - Create frame title
 - Make simple graphic shapes:
 - Directional lines
 - Basic shapes
 - Organic shapes
 - Stroke/color-opacity
 - Delete objects/frames



- Task 2 - Your turn!
- TASK #2 (15 min)
- (1) Import an image file using any (or all) of the three ways that we discussed

