Communicating with Data – Visualization Fundamentals Pt. 2

Dr. Ab Mosca (they/them)

Slides based off slides courtesy of Jordan Crouser (https://jcrouser.github.io/)

Plan for Today

- Refresher: mental models
- Putting marks together
- Group activity: what we draw vs. what we see
- Refresher: building blocks
- Choosing visual channels
- Group activity: does this follow the rules?

Mental Models

The "gestalt effect"

ge·stalt

/gəˈSHtält,-ˈSHtôlt/

noun PSYCHOLOGY

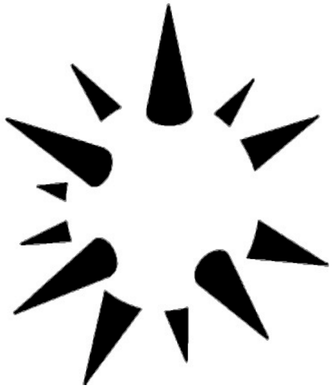
an organized whole that is perceived as more than the sum of its parts.

Translations, word origin, and more definitions

Our brain's ability to generate whole forms, instead of just collections of unrelated elements

Gestalt effects

Reification

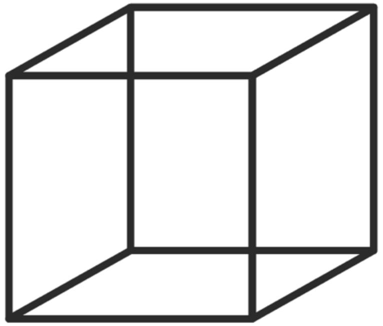


Demonstration of reification in perception from Lehar S. (2003) The World In Your Head, Lawrence Erlbaum, Mahwah, NJ. p. 52, Fig. 3.3

Emergence

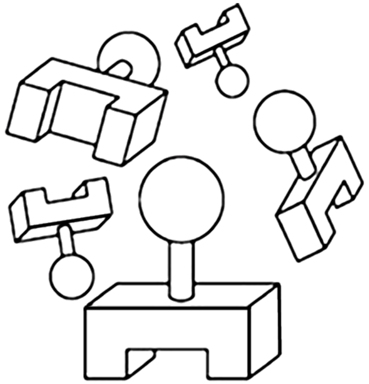
https://www.interaction-design.org/literature/topics/gestalt-principles#docs-internal-guid-f7074e47-7fff-b4dc-f0f5-966e09f6b4e7

Multistability



https://www.interaction-design.org/literature/topics/gestalt-principles#docs-internal-guid-f7074e47-7fff-b4dc-f0f5-966e09f6b4e7

Invariance



Demonstration of invariance in perception from Lehar S. (2003) The World In Your Head, Lawrence Erlbaum, Mahwah, NJ. p. 53, Fig. 3.5

What does this mean for visualization?

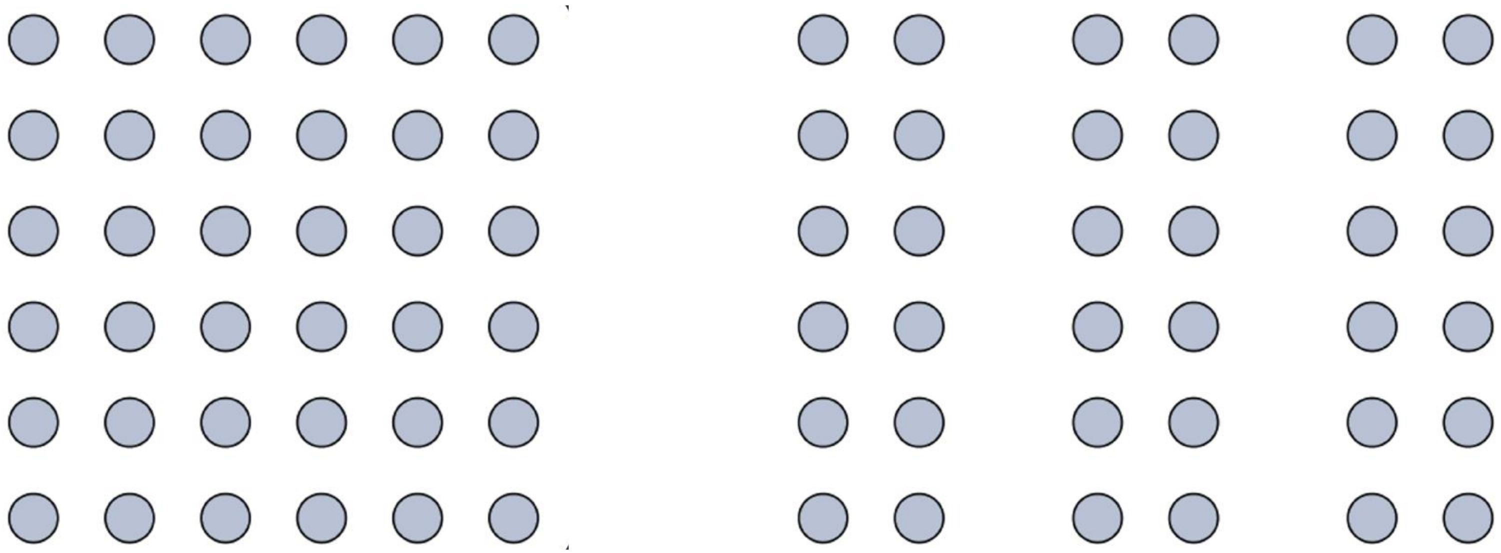
Question: what makes all this mental model stuff useful to us (designers and readers of data)?

Answer: in order to understand how people interpret and make sense of data, we need to know what **cues** they're picking up on – and how to situate those cues within a larger framework

→ 6 "Laws of Grouping"

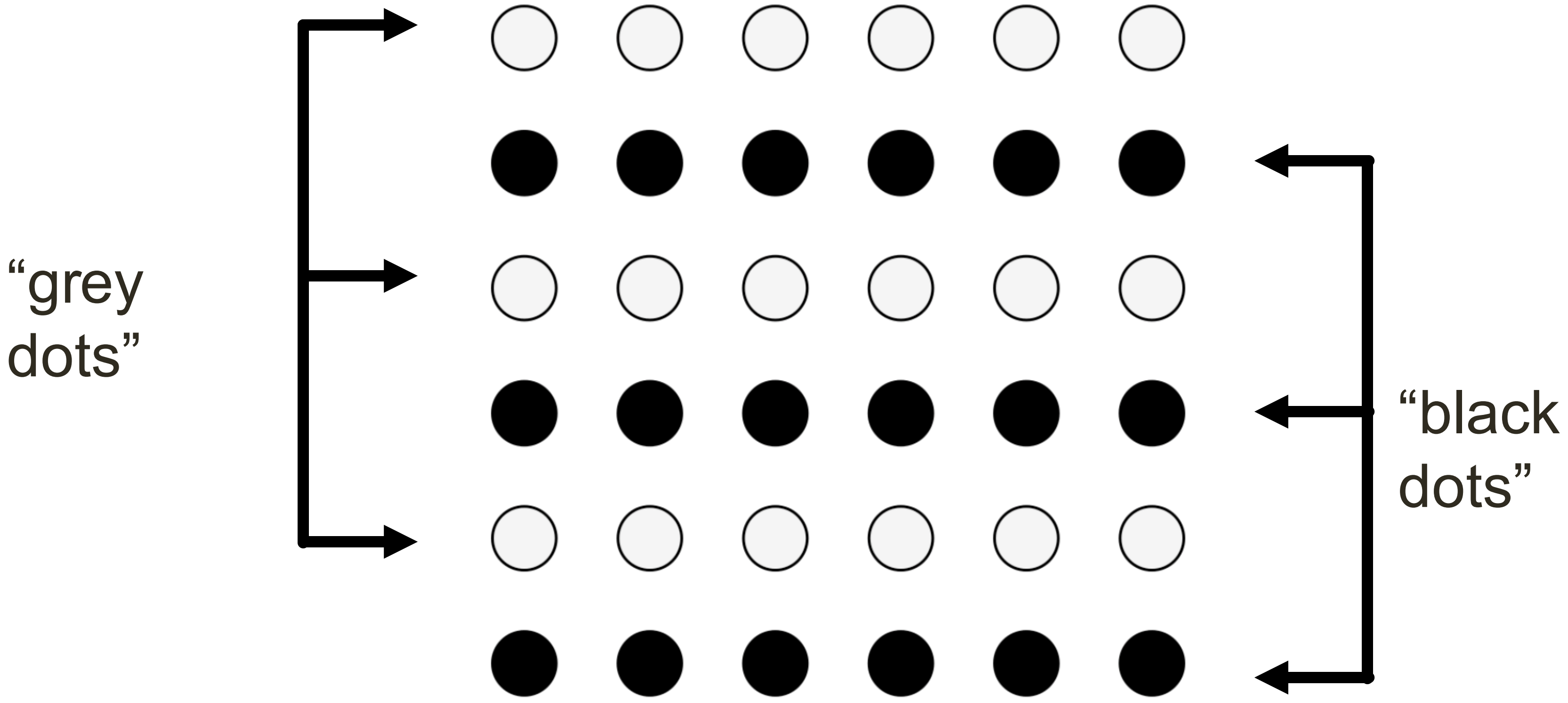
Law of Proximity

We interpret objects that are **close** to each other as a group



Law of Similarity

We interpret objects that are **visually similar** to each other as a group

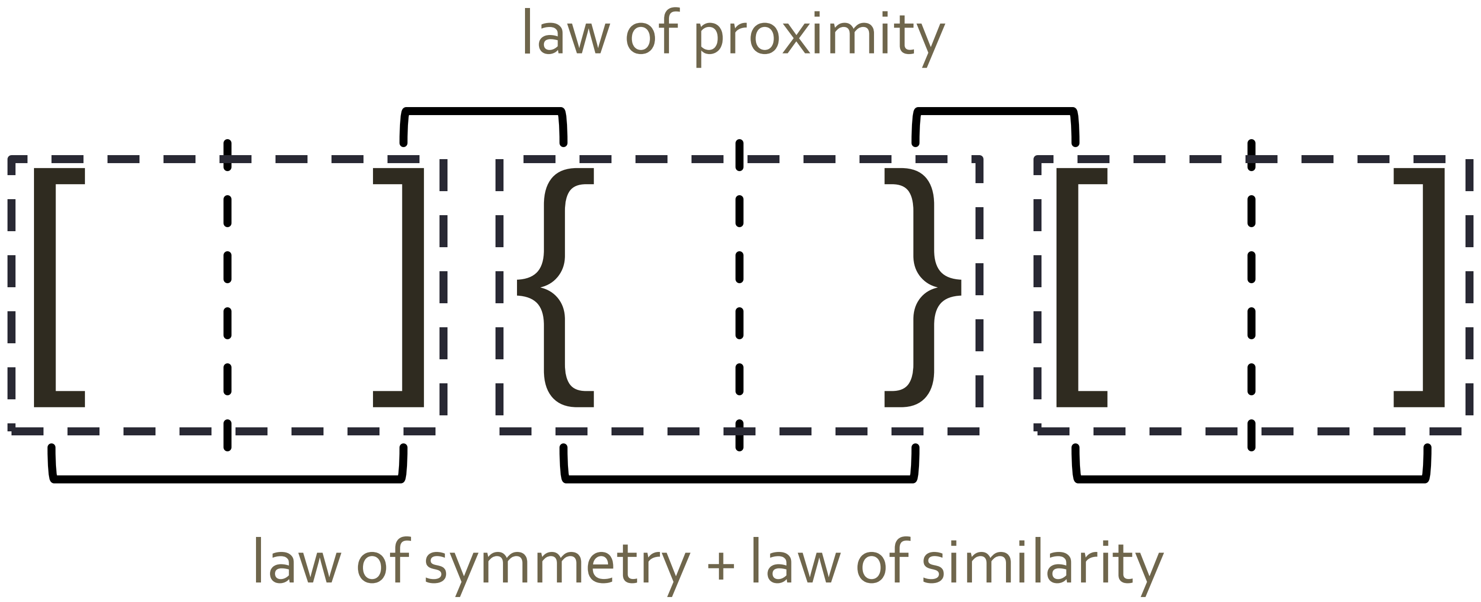


Law of Closure

When parts of a picture are missing, we fill in the visual gap

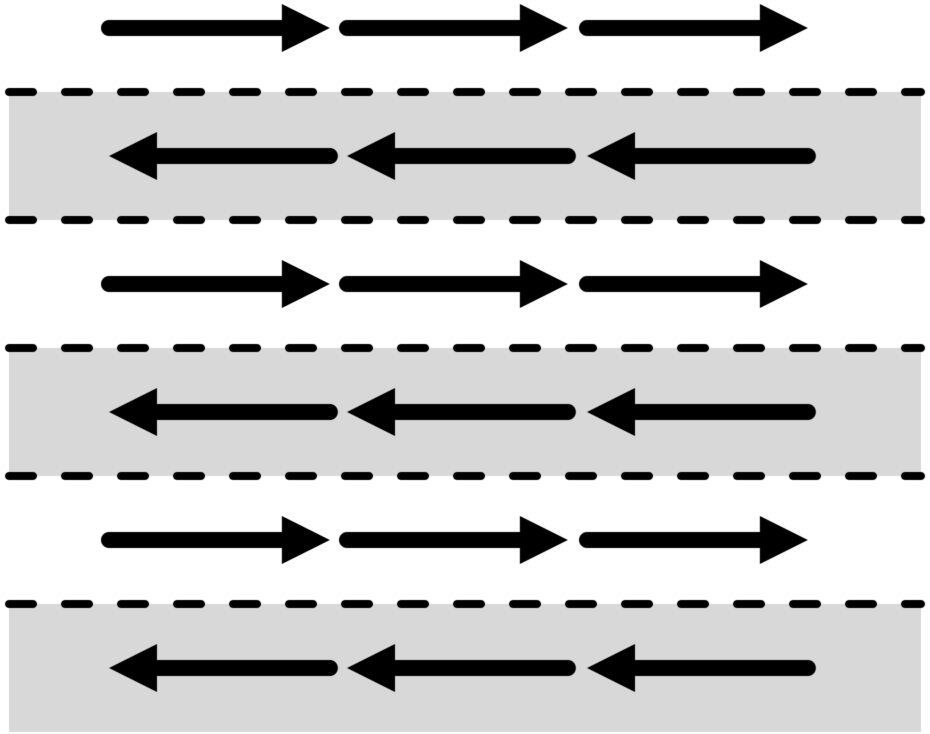
Law of Symmetry

We perceive objects as being symmetrical, arranged around a center point



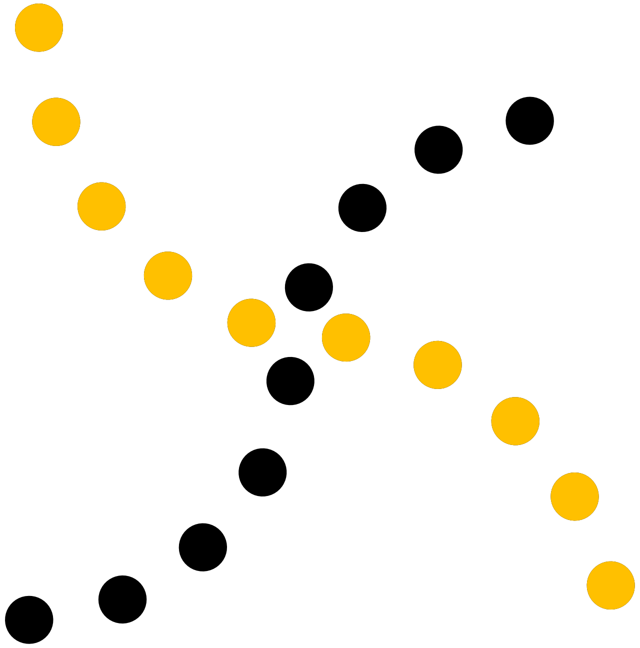
Law of Common Fate

We group objects that we perceive to be moving along the same path



Law of Continuity

We tend to group objects along the **smoothest path**

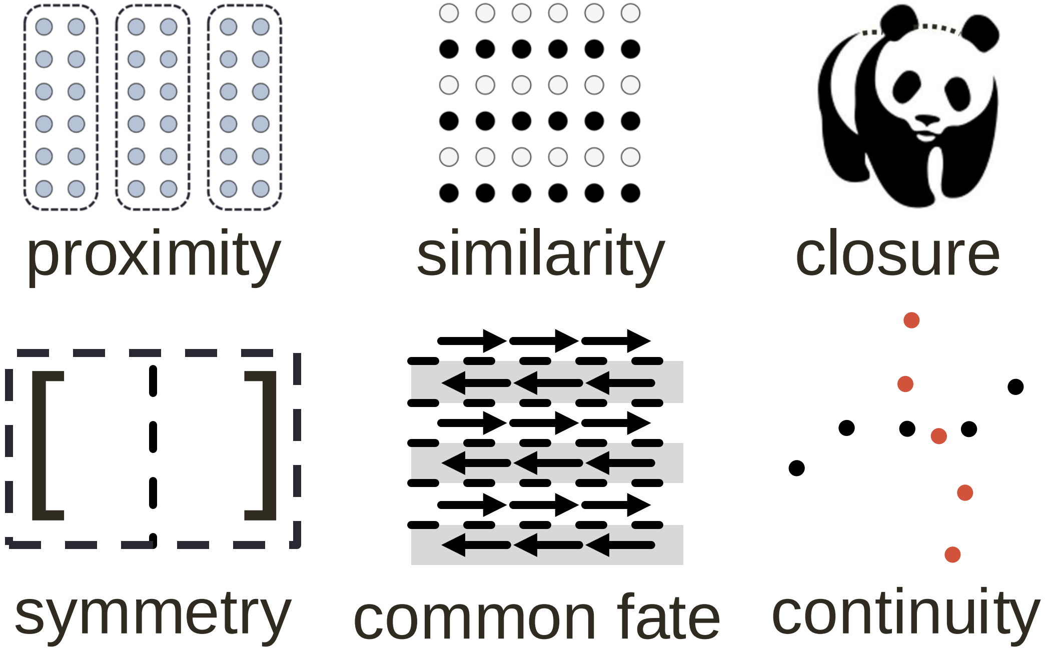


Let's Practice

- Break into teams of 3
- Choose a visualization from the Tableau Vis of the Day collection: https://public.tableau.com/app/discover/viz-of-the-day
- Write the title on the board so we don't get repeats!
- **Goal:** identify as many examples of the Laws of Grouping (Gestalt Principles) in action in your sample visualization as you can
- Be prepared to present your findings to the class

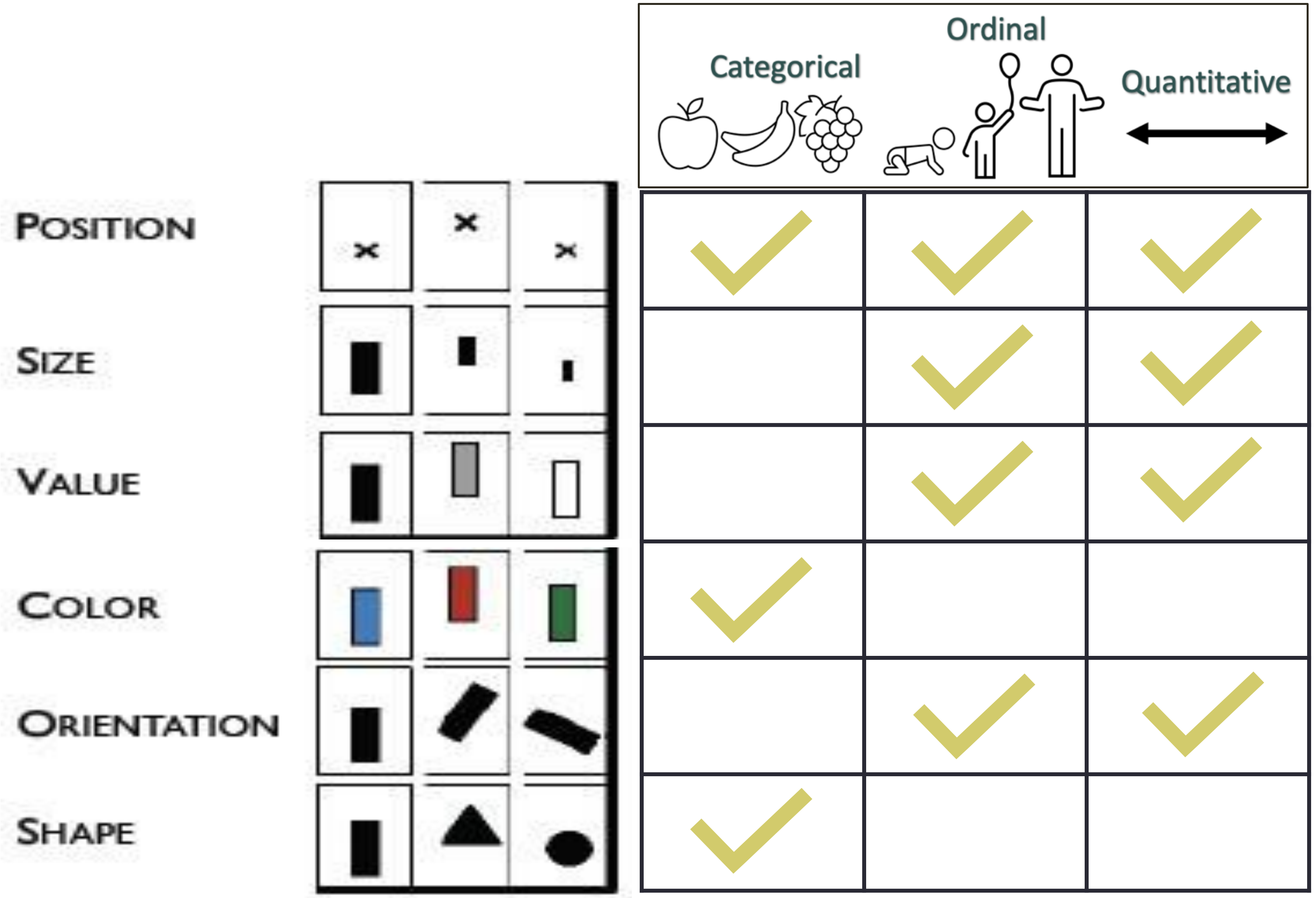
Let's Practice

Group activity: what we draw vs. what we see



Data → Visuals

- Remember… **Big idea behind visualization**
  - Map data dimensions to visual dimensions in a principled way
  - Not all visual dimensions can represent all data types



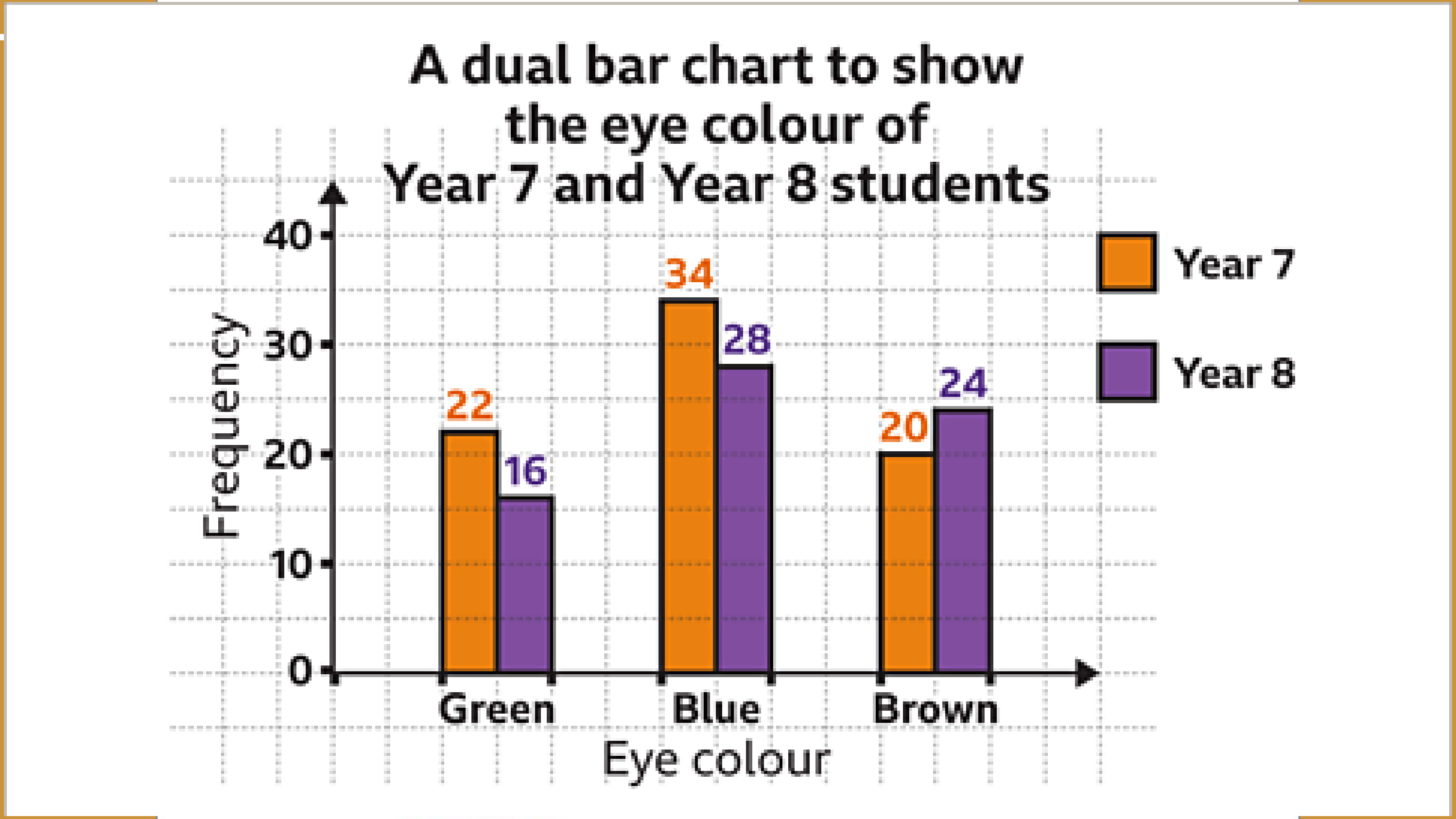
	Categorical	Ordinal	Quantitative
Position	✓	✓	✓
Size		✓	✓
Value		✓	✓
Color	✓		
Orientation		✓	✓
Shape	✓		

Jacques Bertin, *Semiologie Graphique* (Semiology of Graphics), 1967.

Data → Visuals

Data → Visual Mapping is the description of what data if represented by what visual channel.

Ex.



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Principle 1: expressiveness

Match Channel Type to Data Type

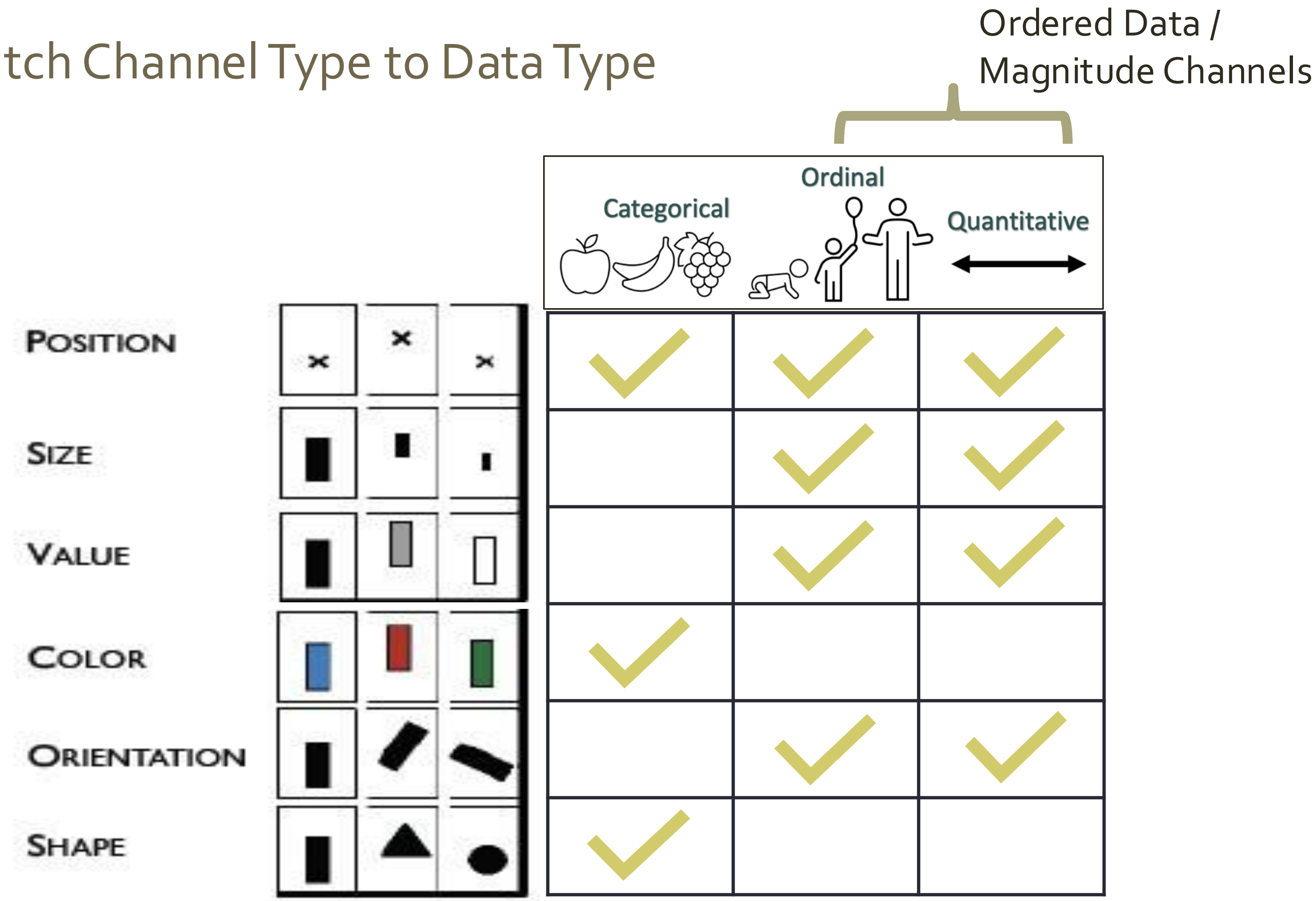
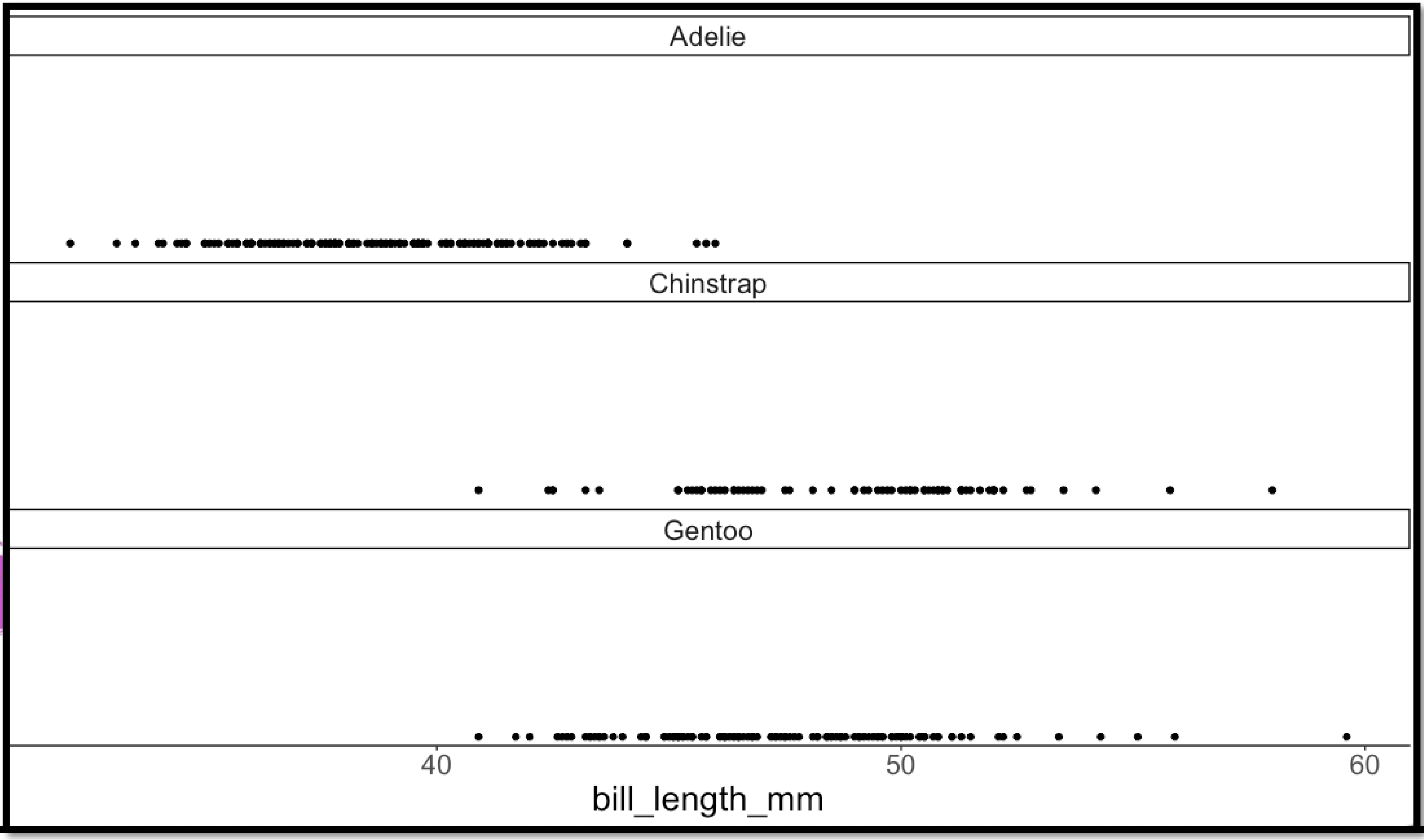
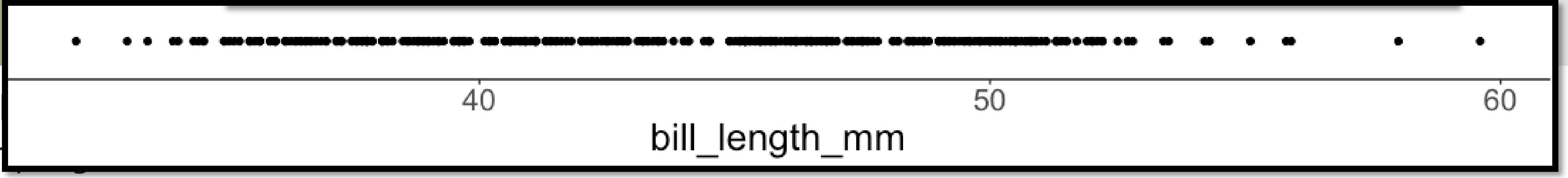


Fig. Courtesy of M Krzywinski

Principle 1: expressiveness

Encode **all** the facts

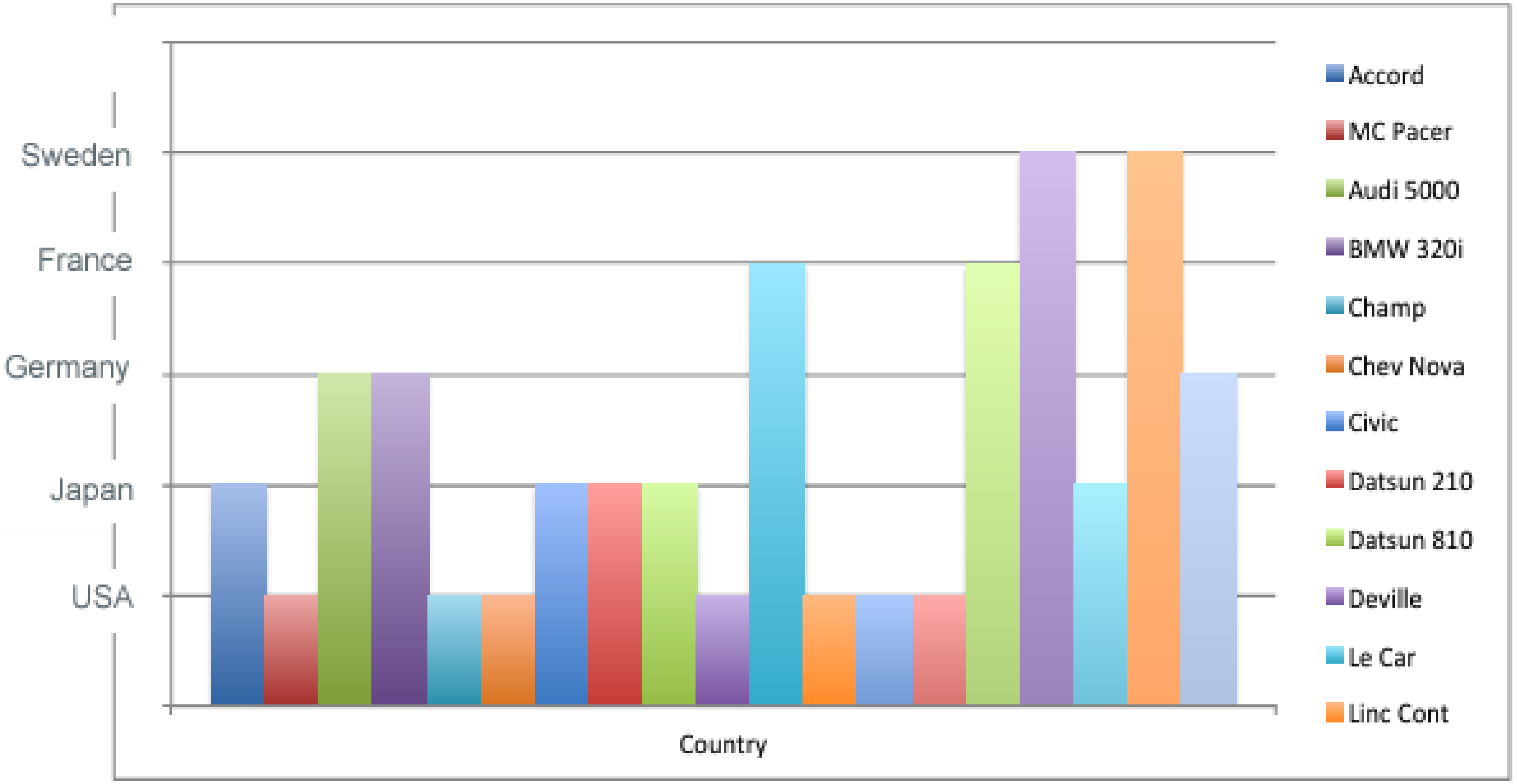




https://allisonhorst.githu
guins/#meet-the-palmer

Principle 1: expressiveness

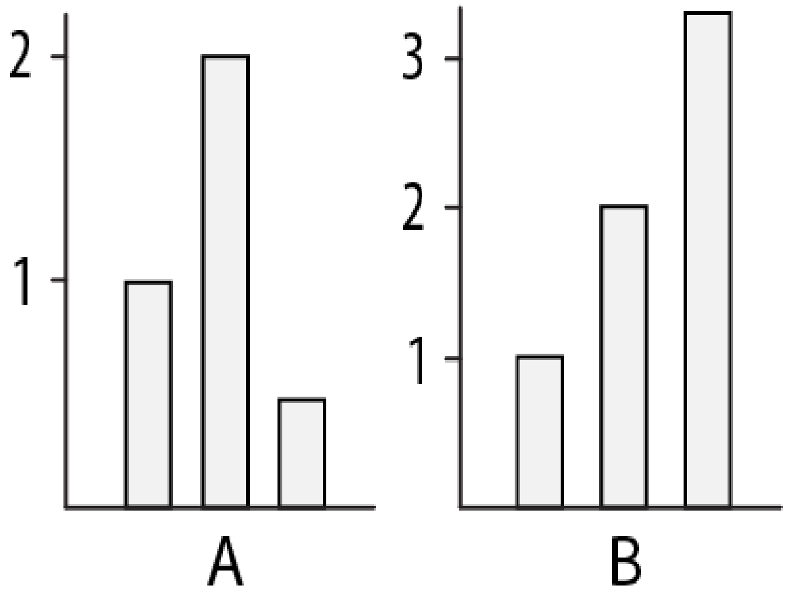
Only the facts



Adapted from Mackinlay J (1986) Automating the design of graphical presentations of relational information.

Principle 2: consistency

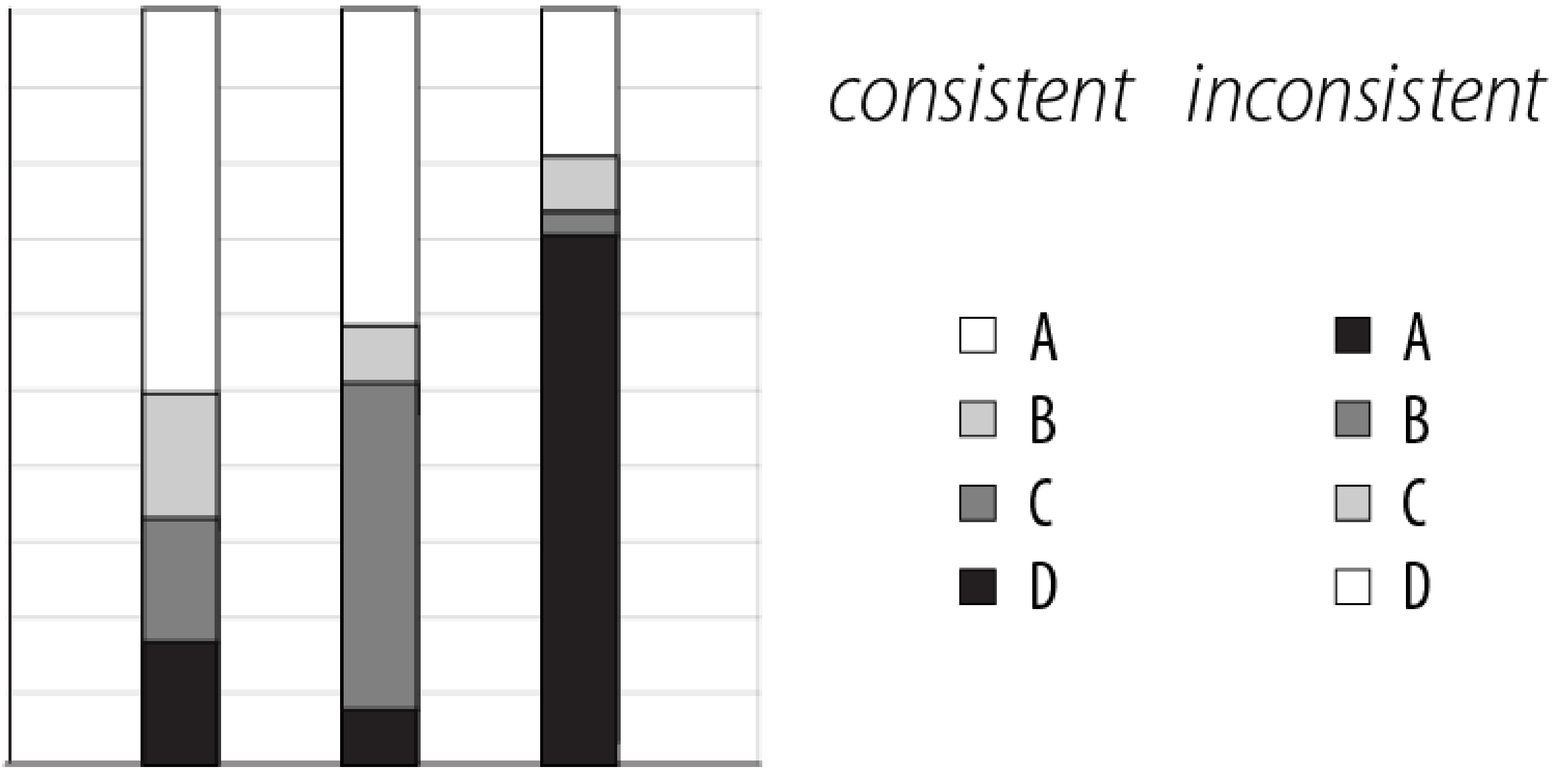
- Use **consistent axes** when comparing charts



Raina SZ, et al. (2005) Evolution of base-substitution gradients in primate mitochondrial genomes. Genome Res 15: 665-673.

Principle 2: consistency

- A note on legends: order items according to appearance



M. Krzwinski, behind every great visualization is a design principle, 2012

Principle 2: consistency

- Visual variation should reflect and enhance the underlying variation in the data
- Avoid visually similar encodings for independent variables
- Example:

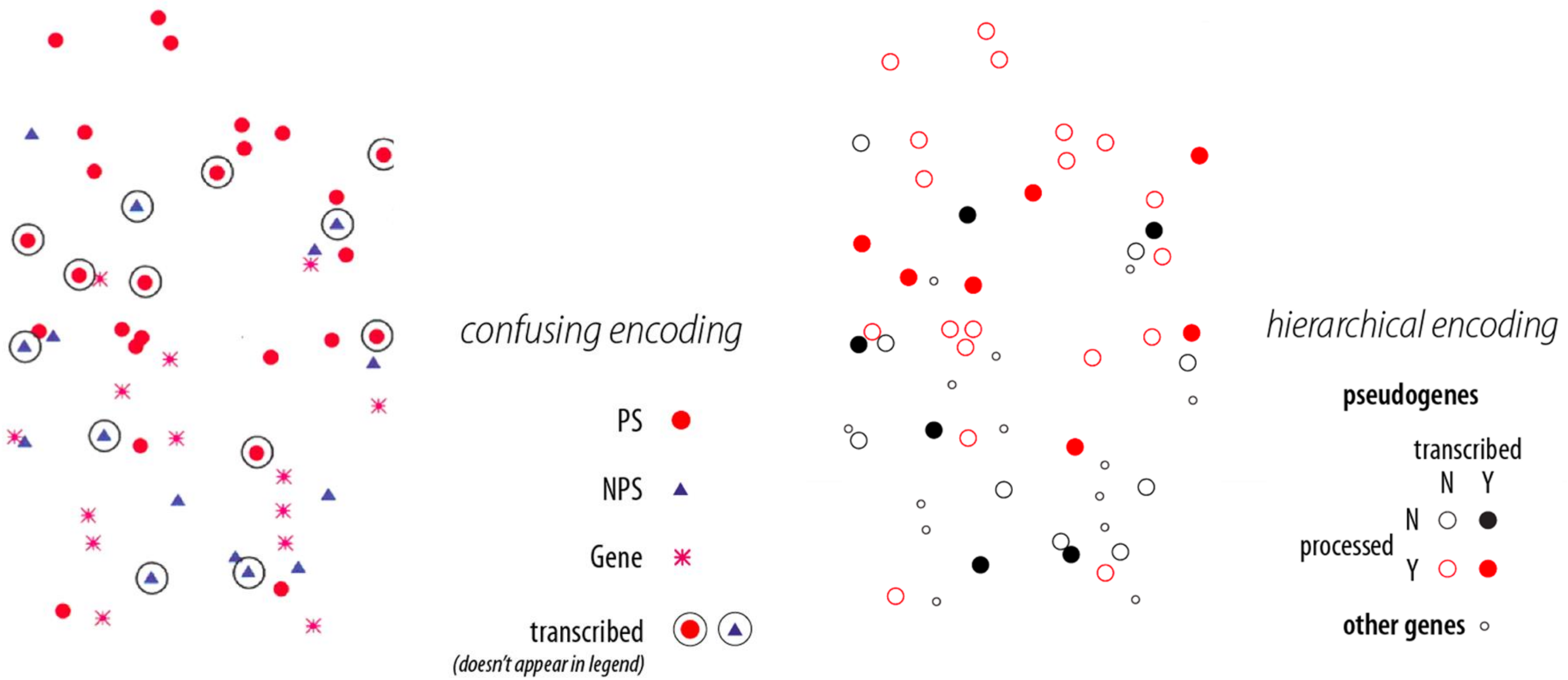


Fig. 2: M. Krzwinski, behind every great visualization is a design principle, 2012

Principle 2: consistency

- Uniform size and alignment reduces visual complexity and aids interpretation
- Example:

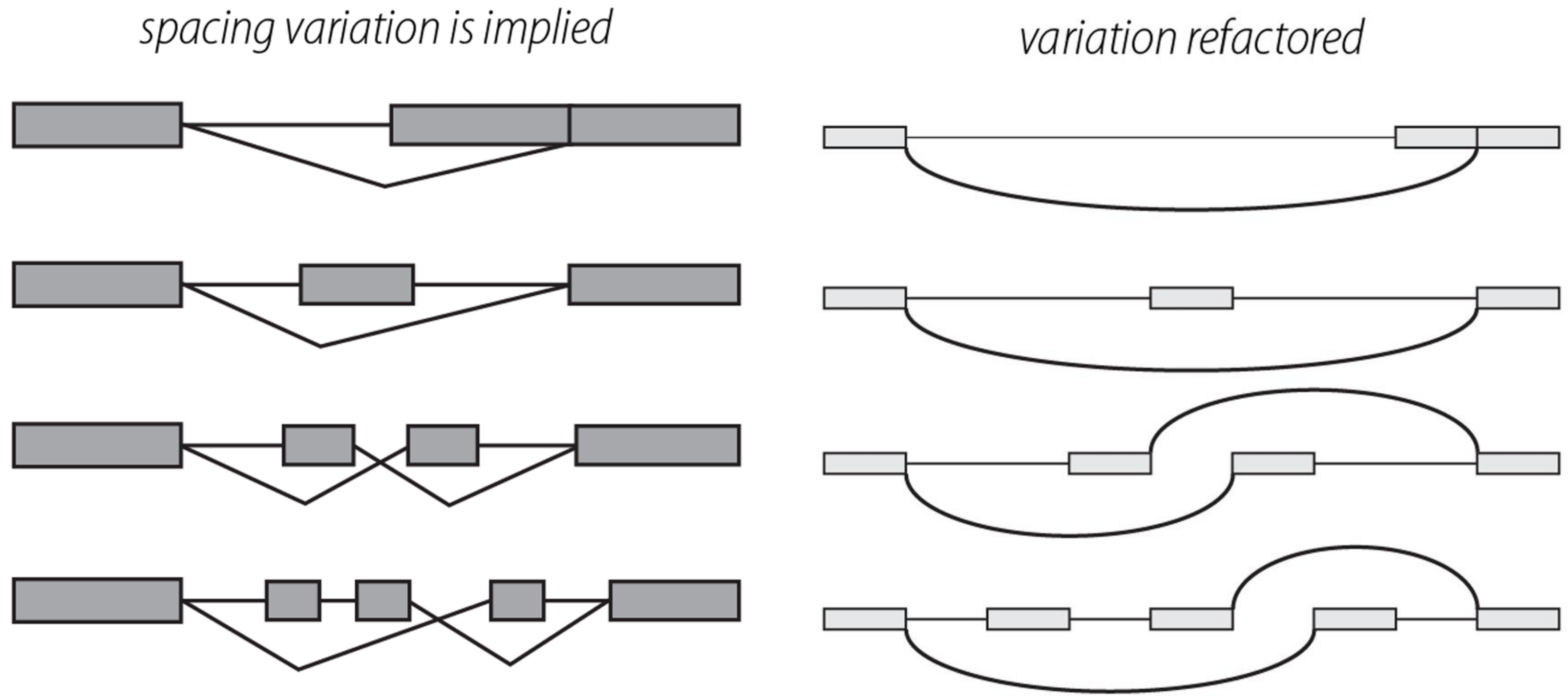
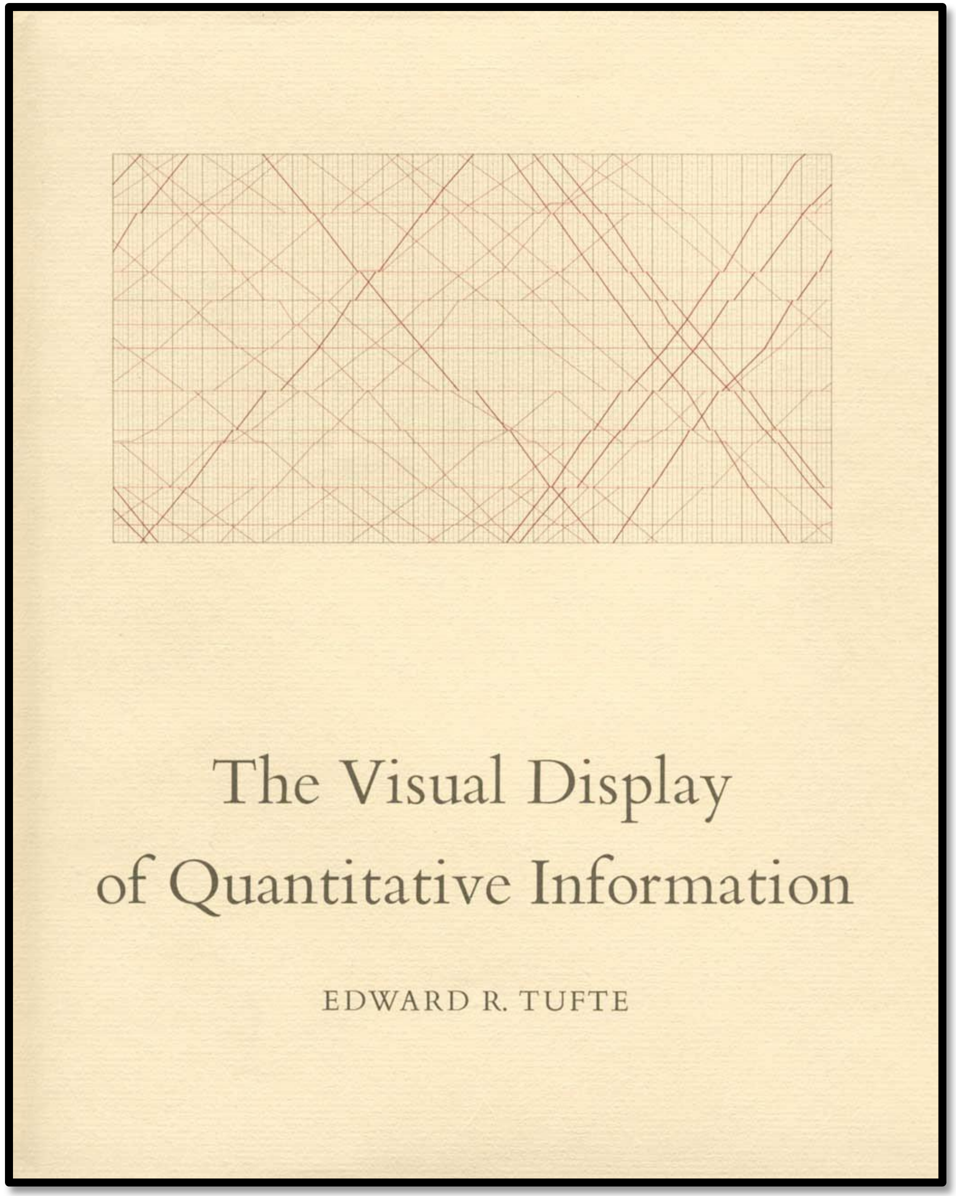


Fig. 1: Sharov AA et al. (2005) Genome-wide assembly and analysis of alternative transcripts in mouse. Genome Res 15: 748-754.
Fig. 2: M. Krzwinski, behind every great visualization is a design principle, 2012

Tufte, 1983

- "Above all else, show the data."



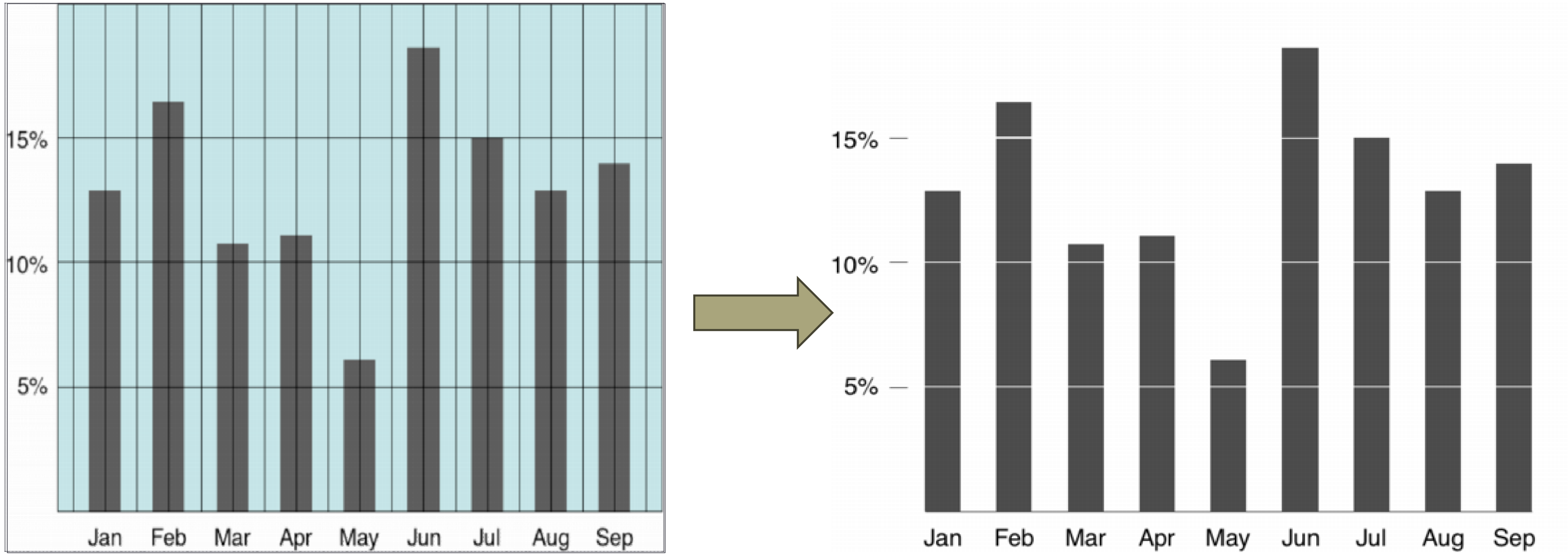
Tufte, 1983

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

= proportion of a graphic's ink devoted to the non-redundant display of data-information

= 1 - proportion of a graphic that can be erased

Tufte: maximize the data-ink ratio

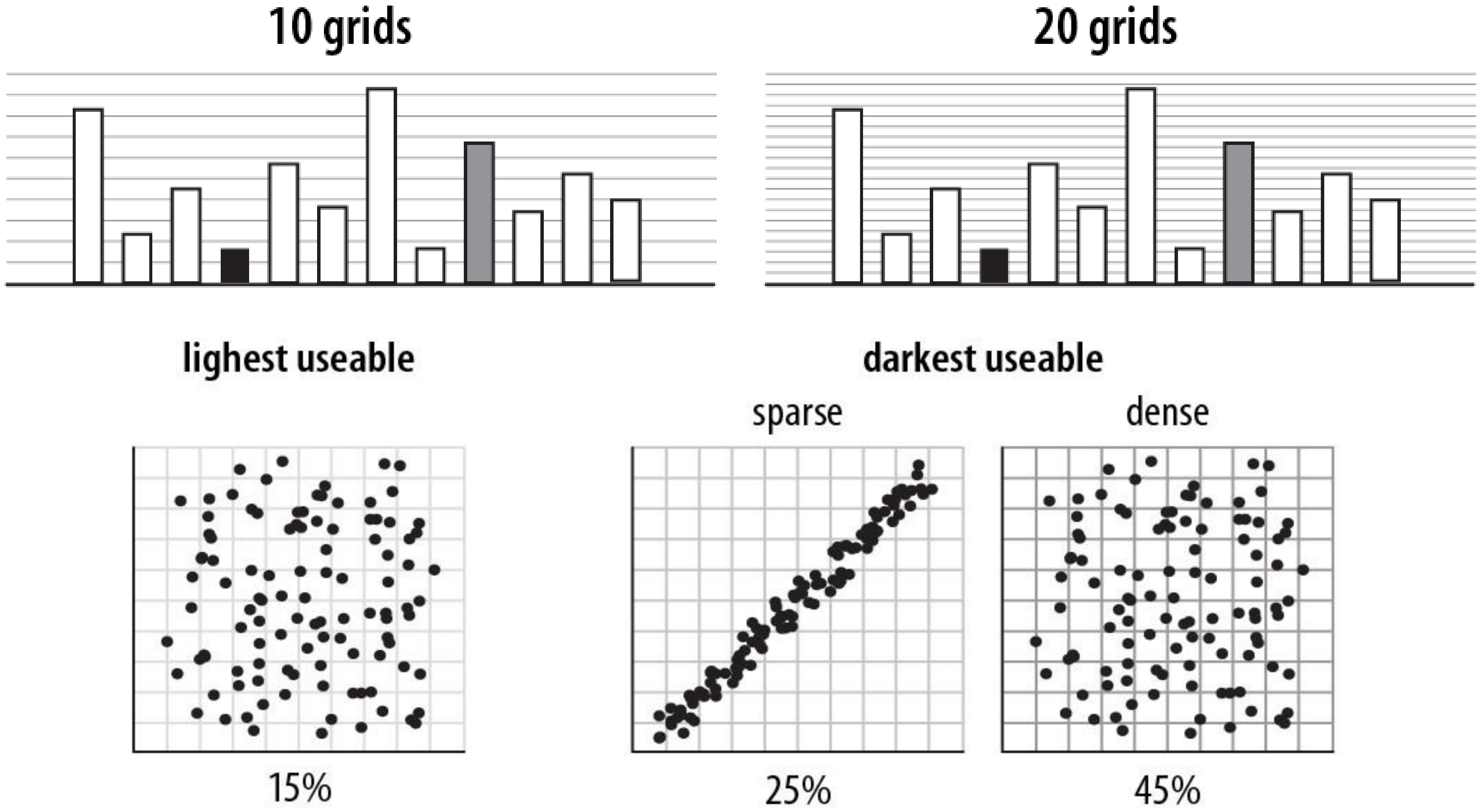


Discussion

- What do you think of the data-ink ratio?
- Think of 3 specific ways to maximize it
- Do you think there are limits or tradeoffs to this design approach?

Principle 3: importance ordering

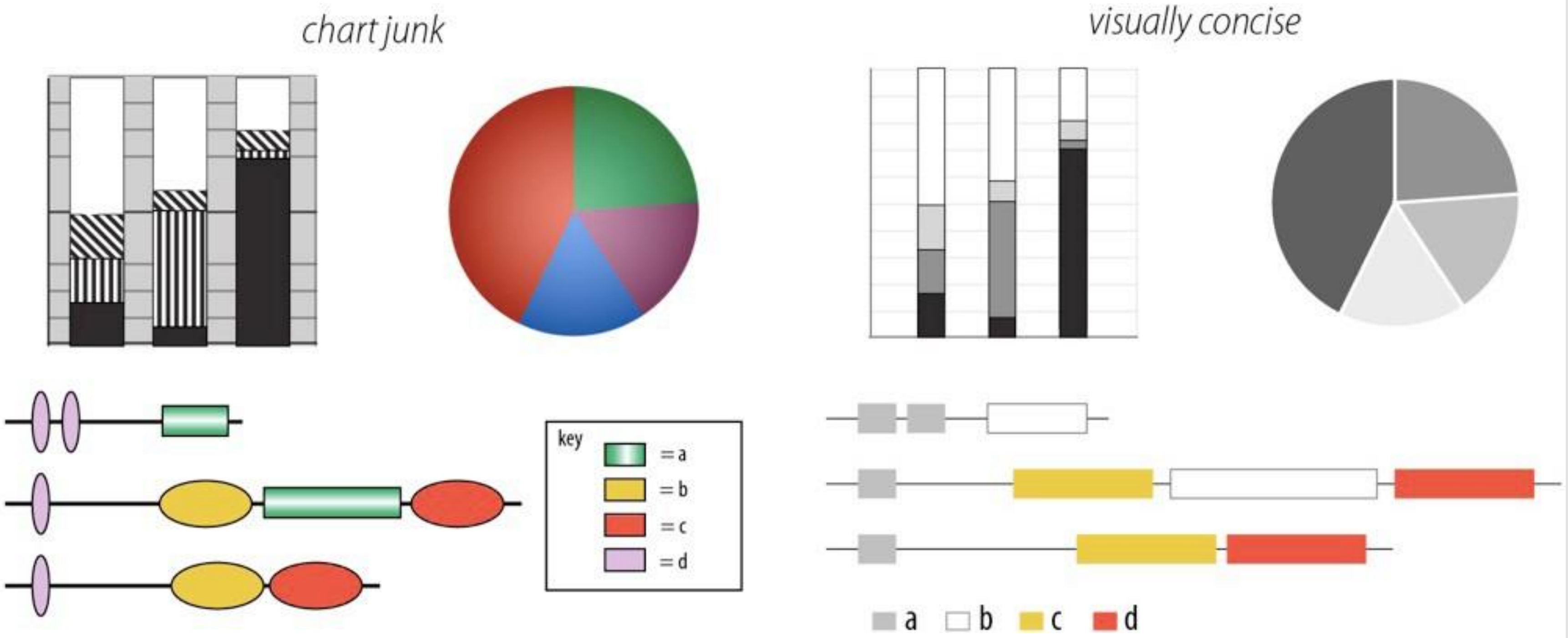
- Navigational aids shouldn't compete with data
- Avoid: heavy axes, error bars and glyphs



Heer J, Bostock M (2010) Crowdsourcing graphical perception: using mechanical turk to assess visualization design. Proceedings of the 28th international conference on Human factors in computing systems. Atlanta, Georgia, USA: ACM. pp. 203-212.

Principle 3: importance ordering

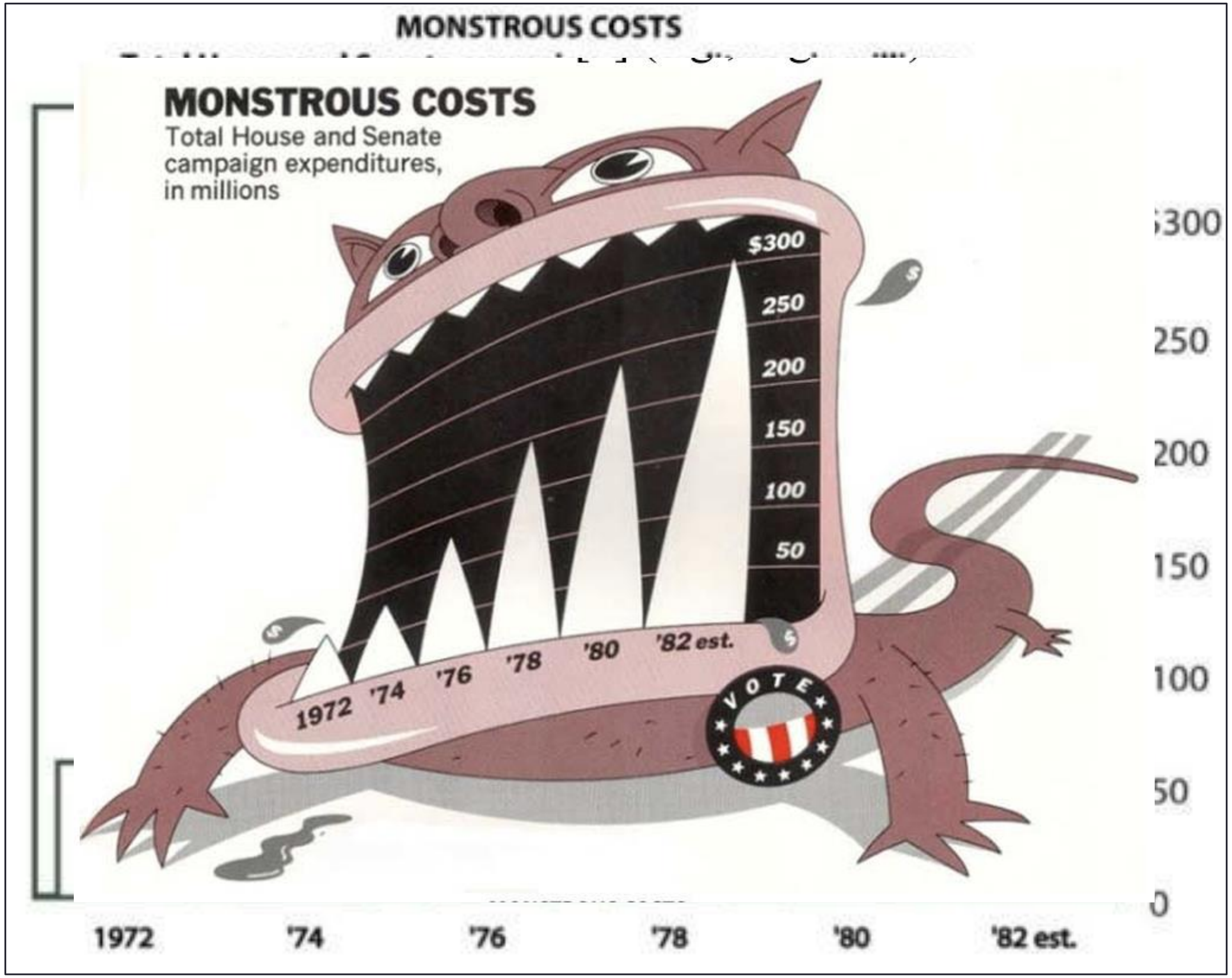
- Simplify, simplify, simplify…



Sharov AA, et al (2006) Genome Res 16: 505-509.
Peterson J, et al. (2009) Genome Res 19: 2317-2323.
Thomson NR, et al. (2005) Genome Res 15: 629-640.
DB, Ko MS (2005) Genome Res 15: 748-754.

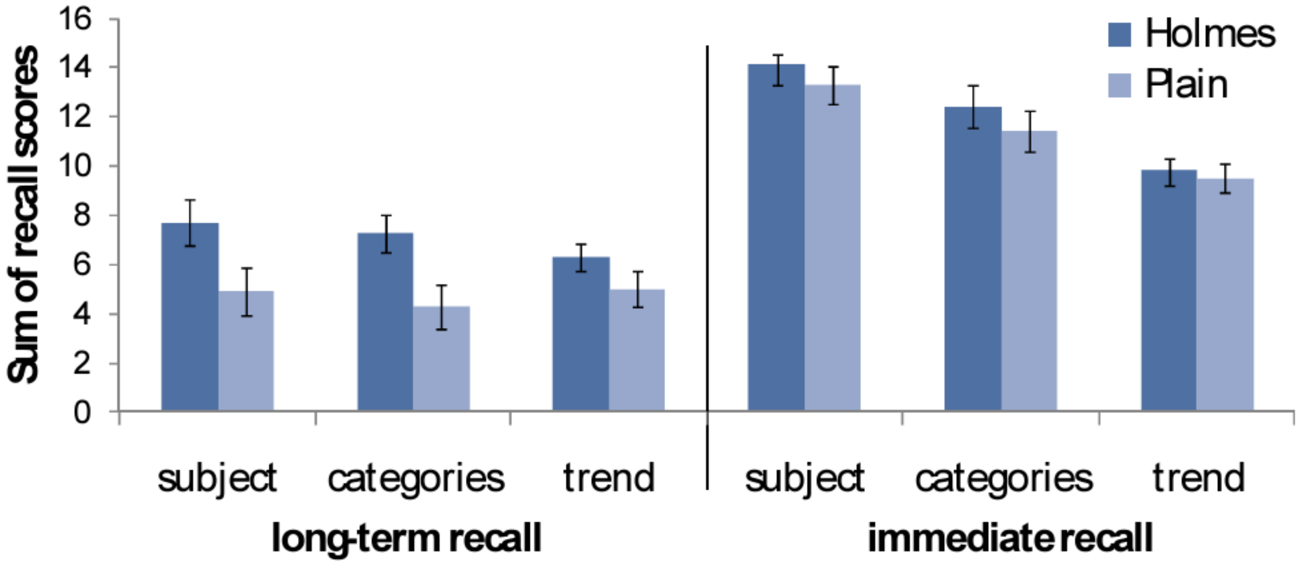
M. Krzwinski, behind every great visualization is a design principle, 2012

A caveat: “chart junk” and recall



Bateman et al. “Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts”, CHI 2010

A caveat: “chart junk” and recall



Bateman et al. “Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts”, CHI 2010

A caveat: “chart junk” and preference

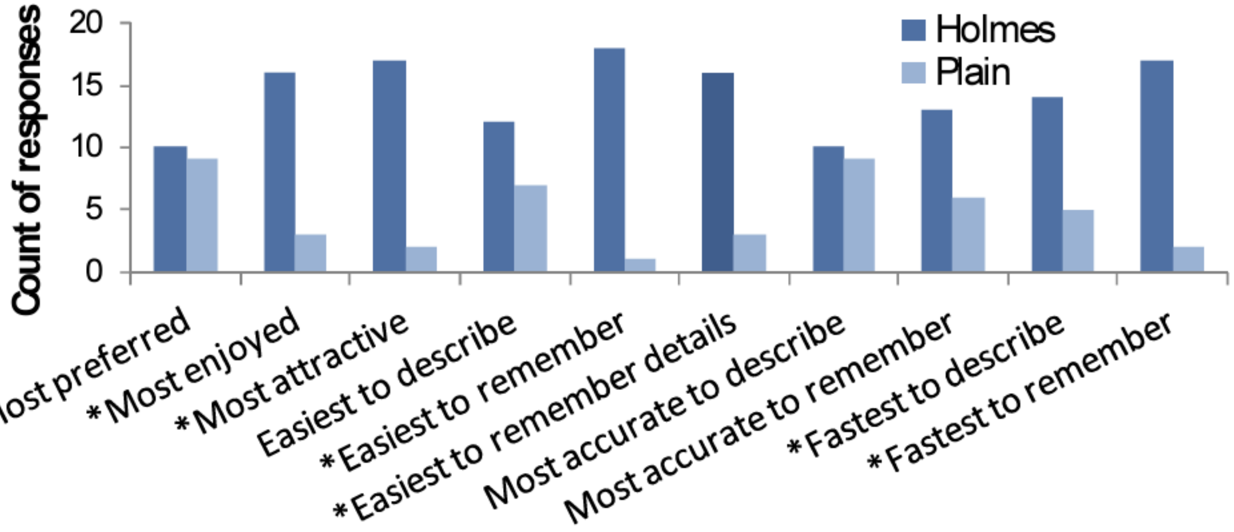
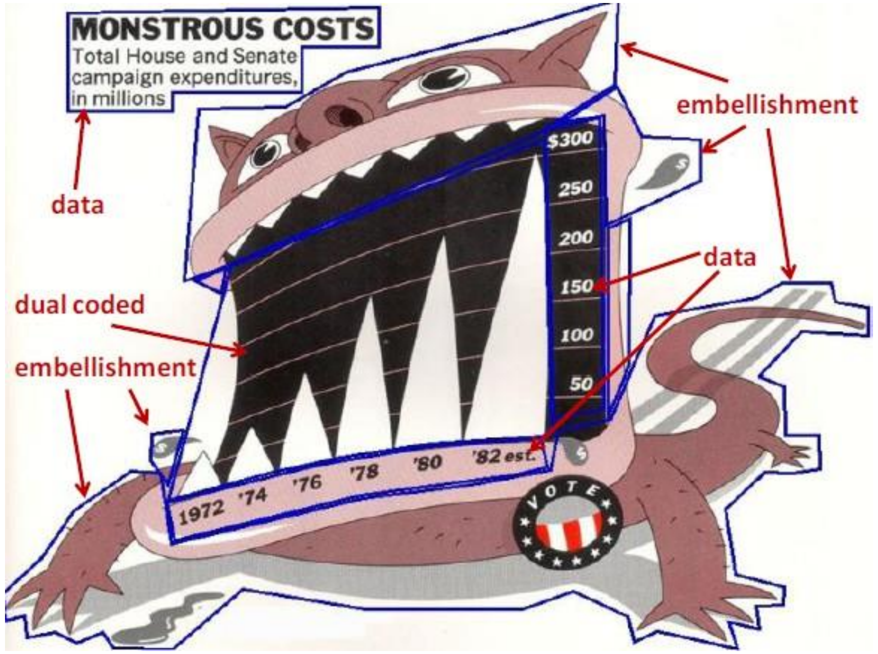


Figure 8. Count of user responses: *indicates significant difference between chart types from chi-squared test at α=0.05

Bateman et al. “Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts”, CHI 2010

Chart junk and eye gaze



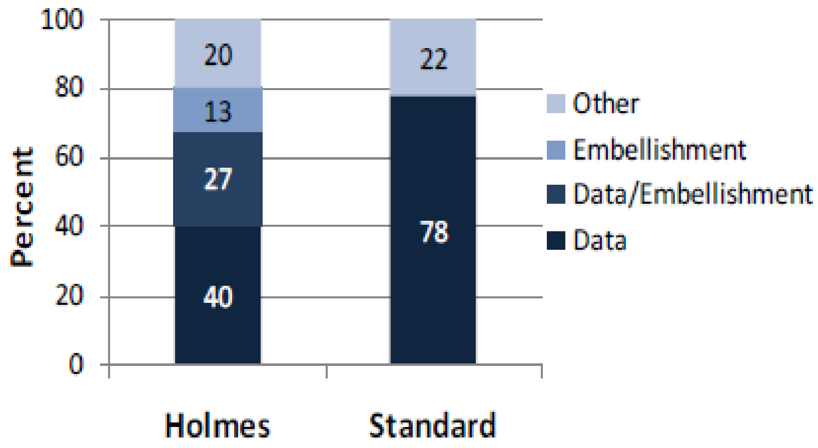


Figure 9. Percentage of on-screen time spent looking at different chart elements for Holmes and Plain charts.

Returning to the Marks and Channels Activity

- Work with 2 other people. Be prepared to share your work with the class.
- Find a data visualization you think is interesting
  - Some ideas: New sites, government sites, Tableau, massvis.mit.edu
  - Write down what you chose on the board so we don't get repeats!
- Answer:
  1. Why did you choose this specific visualization?
  2. Does the visualization follow all the design principles we just looked at?
     1. If not, which are violated and how?
  3. Do you think your answer to (2) impacted your answer to (1)?