MassMutual DSDP / DEDP 2020:

VISUALIZATION TECHNIQUES

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Recall: deconstructing graphics

1. Find a data visualization you think is interesting
   - Some ideas: NYTimes, VisualisingData.com, Visual.ly
   - Remember to cite your source!

2. Identify the following:
   - What is the **data** that's being visualized? Where did it come from?
   - Which **data dimensions** are mapped to which **visual dimensions**?
   - How does this **shape your understanding** of the data?
   - If you **liked** the visualization: what is it doing **well**?
   - If you **disliked** the visualization: what would you **change**?

Discussion

What makes a **good** encoding?

Principle 1: expressiveness

- Encodes **all** the facts
- Example:

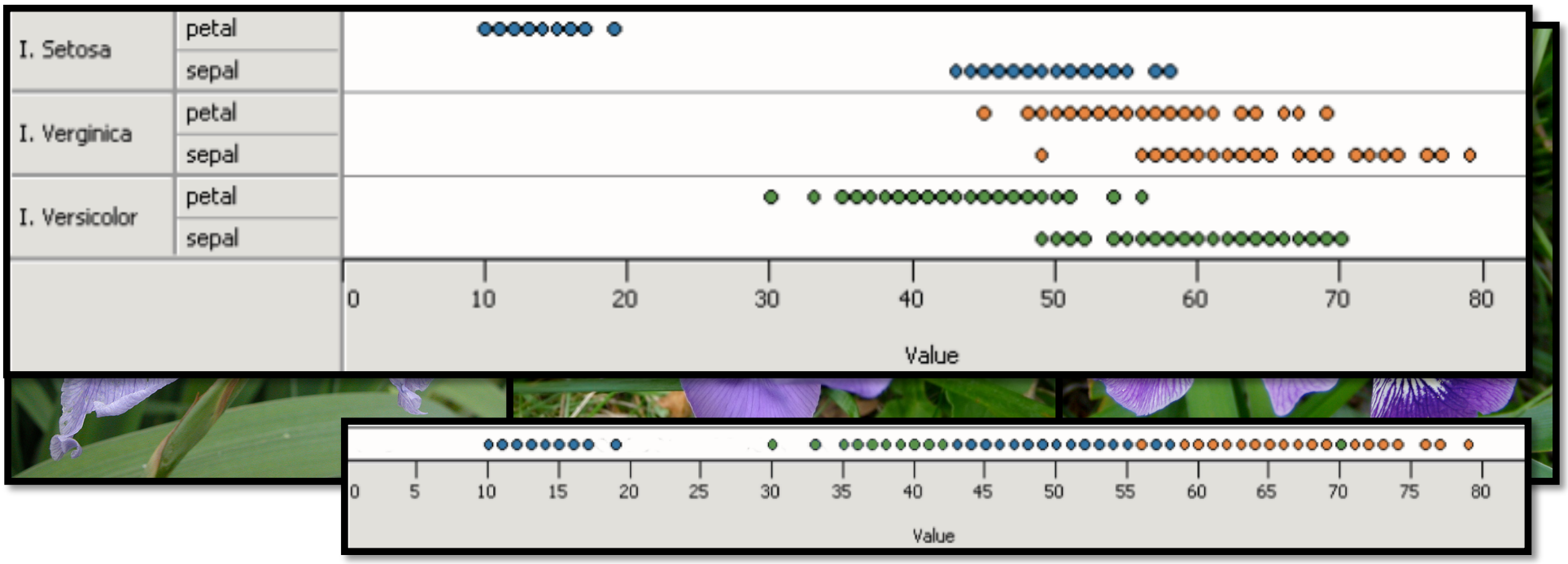
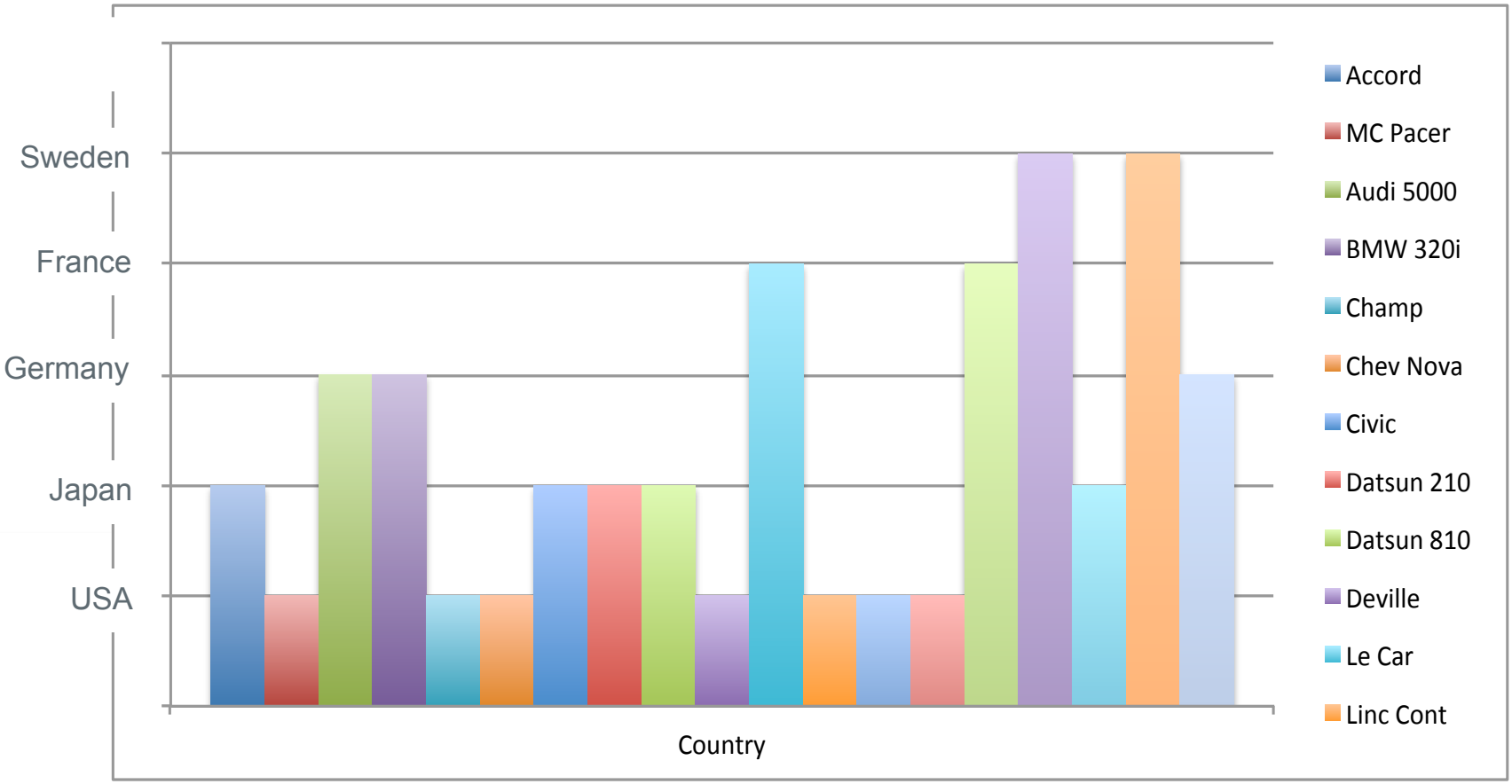


Fig. Courtesy of M Krzywinski

Principle 1: expressiveness

- Encodes **only** the facts
- Example:

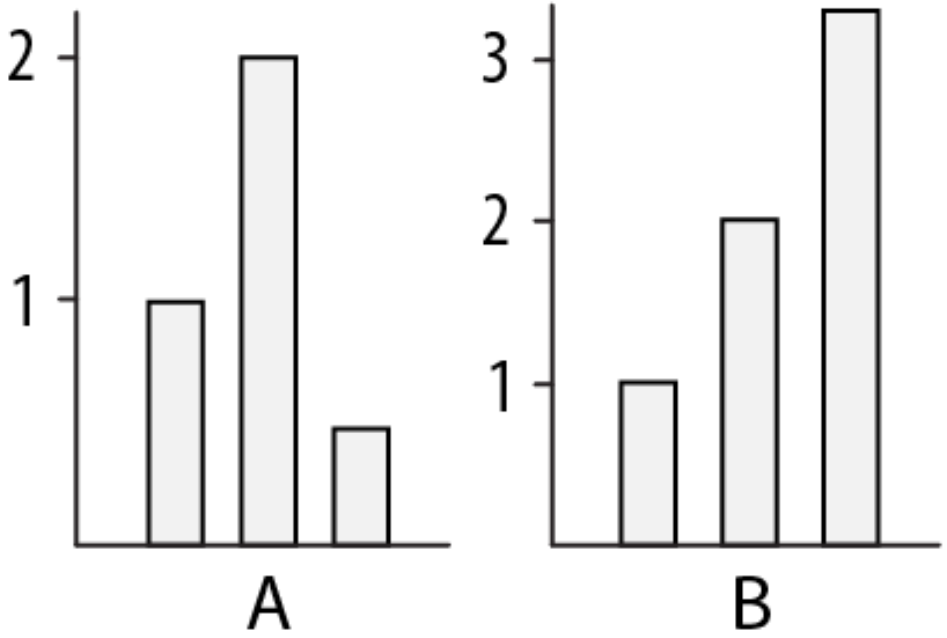


Adapted from Mackinlay J (1986) Automating the design of graphical presentations of relational information.

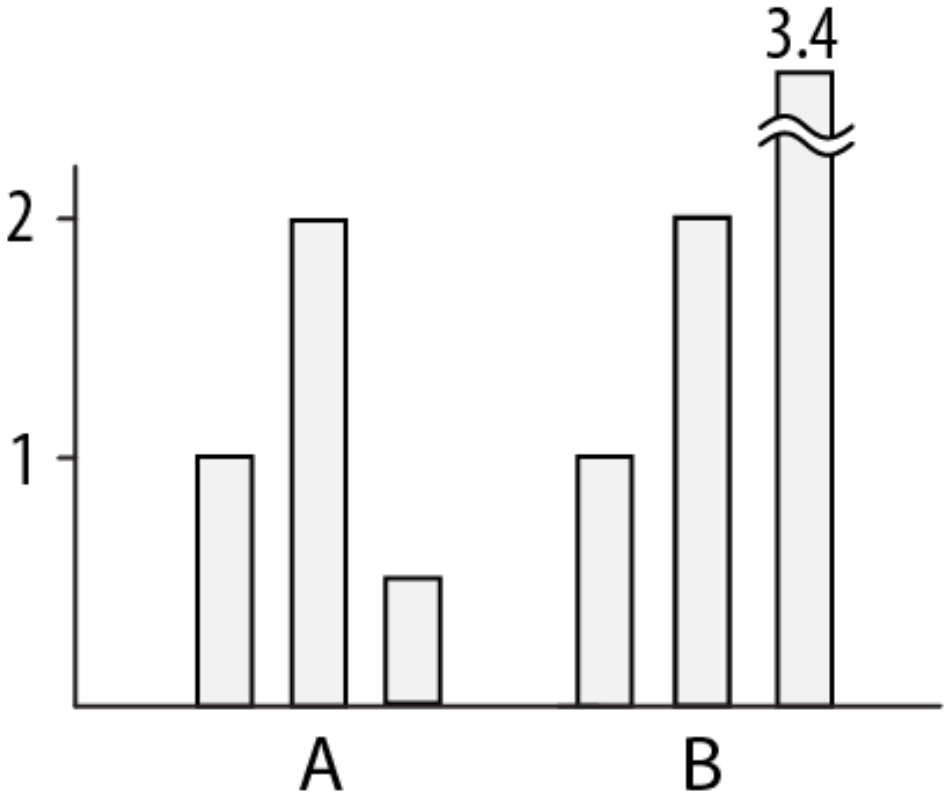
Principle 2: consistency

- Use **consistent axes** when comparing charts

misleading



improved

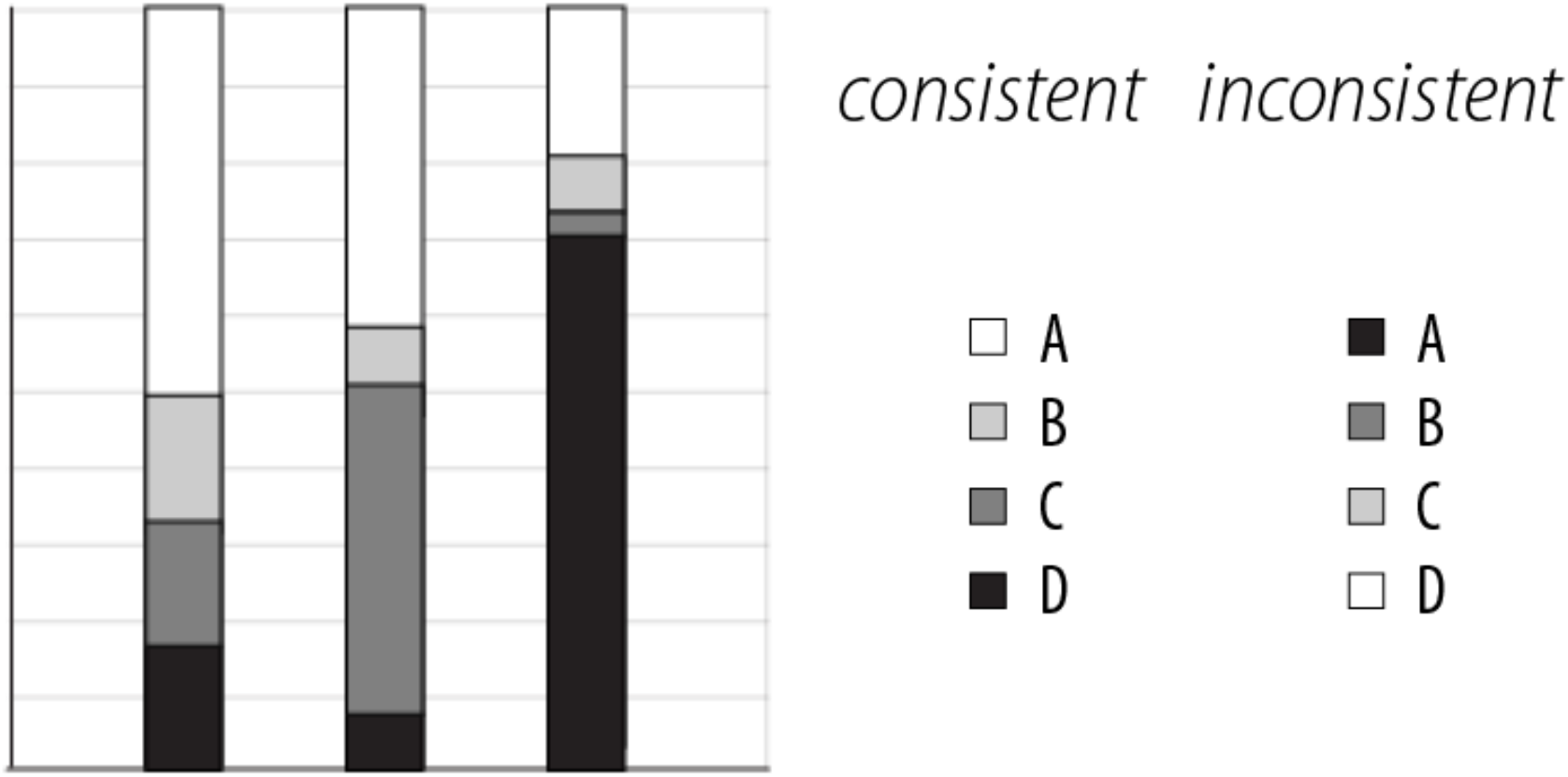


Raina SZ, et al. (2005) Evolution of base-substitution gradients in primate mitochondrial genomes. Genome Res 15: 665-673.

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

Principle 2: consistency

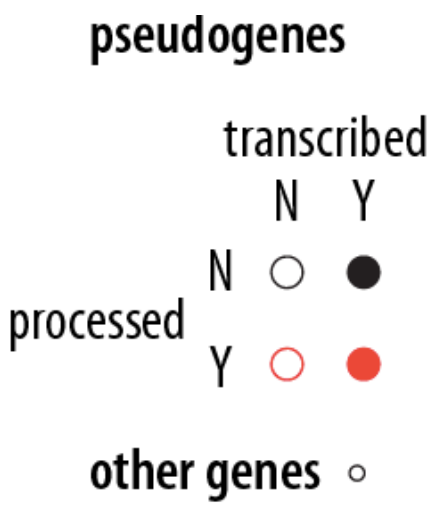
- A note on **legends**: order items according to appearance

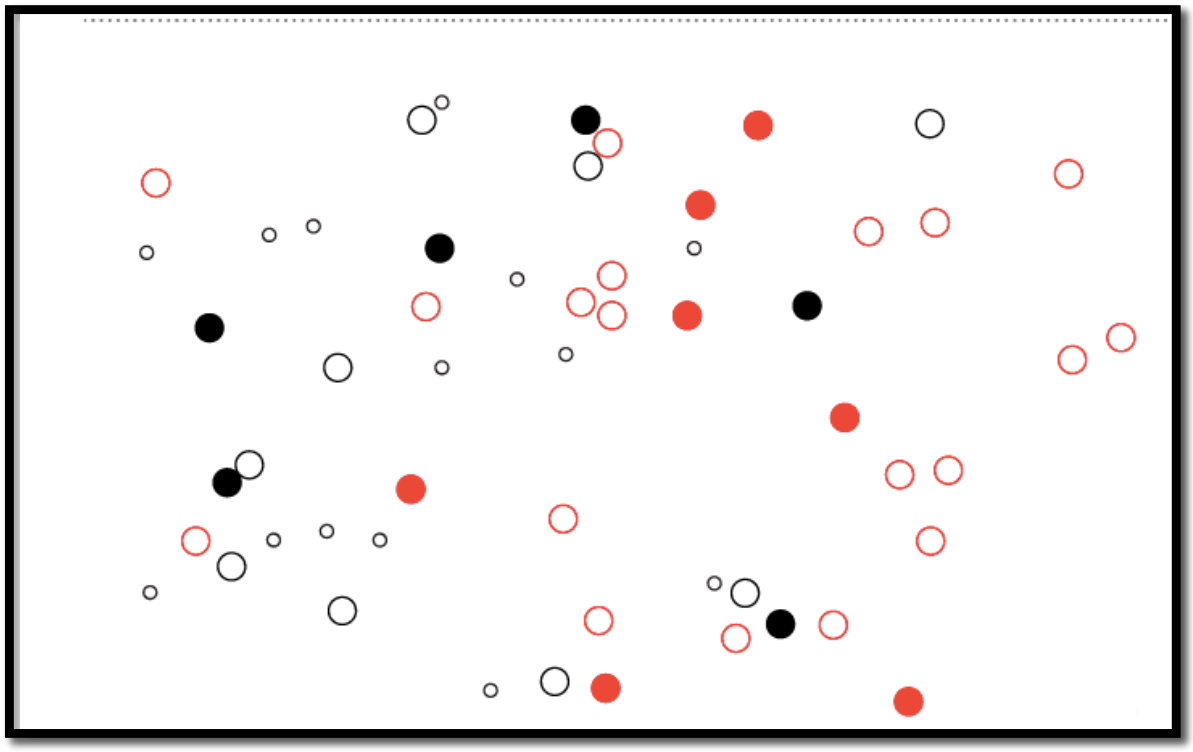


M. Krzwinski, behind every great visualization is a design principle, 2012

Principle 2: consistency

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





Principle 2: consistency

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

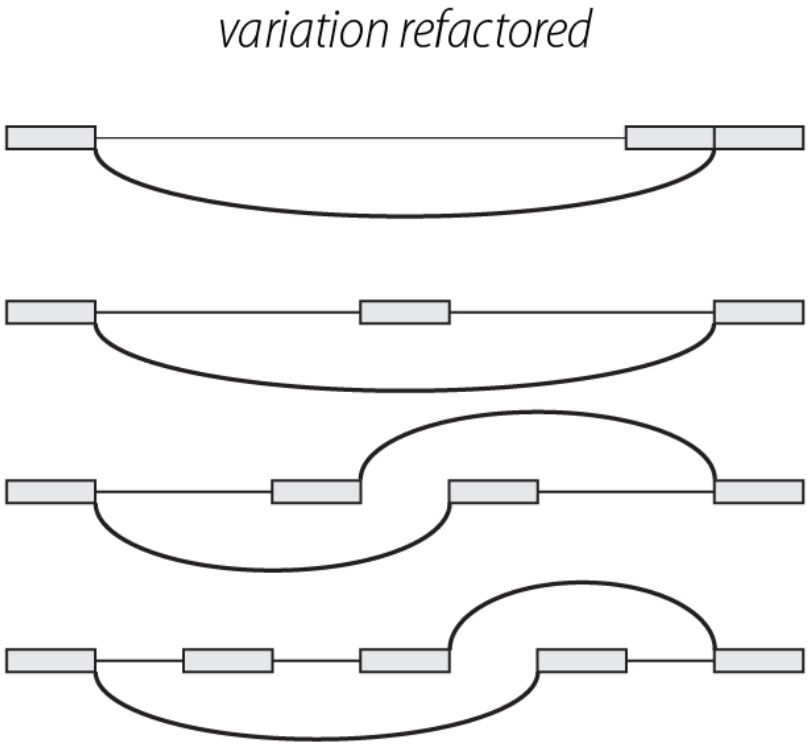
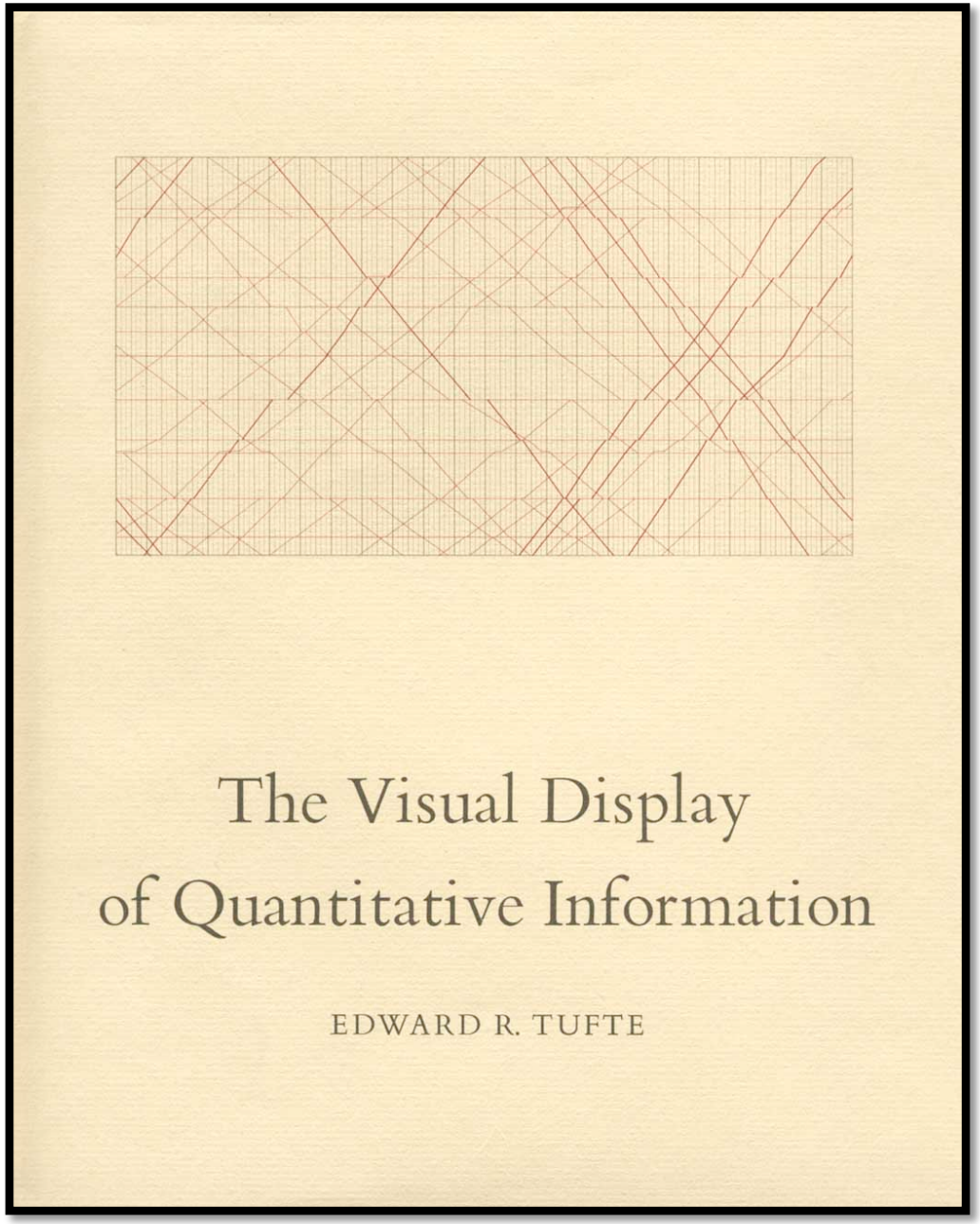


Fig. 1: Sharov AA et al. (2005) Genome-wide assembly and analysis of alternative transcripts in mouse. Genome Res 15: 748-754.
Fig. 2: M. Krzwinski, behind every great visualization is a design principle, 2012

Tufte, 1983

"Above all else, show the data."



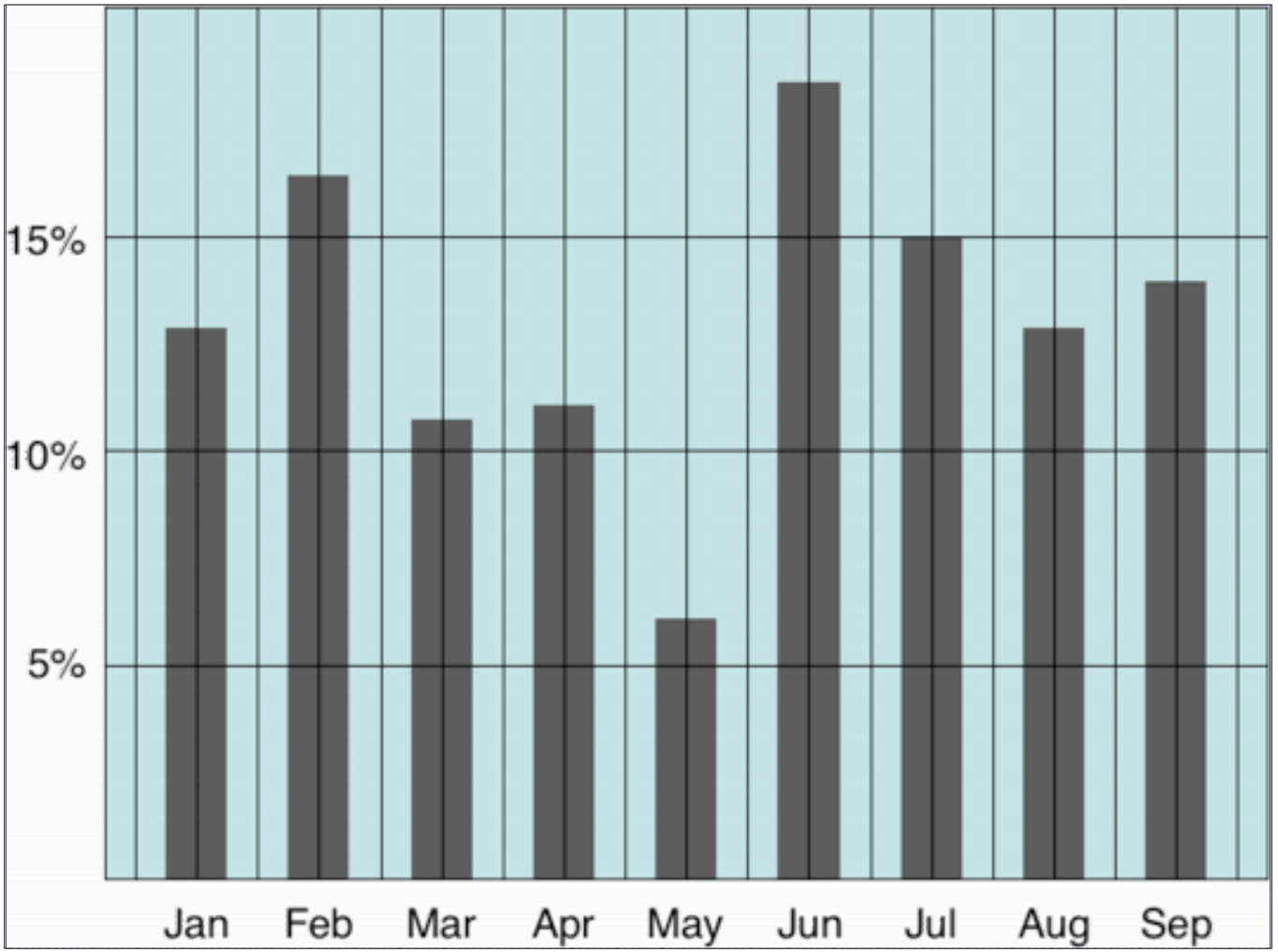
Tufte, 1983

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

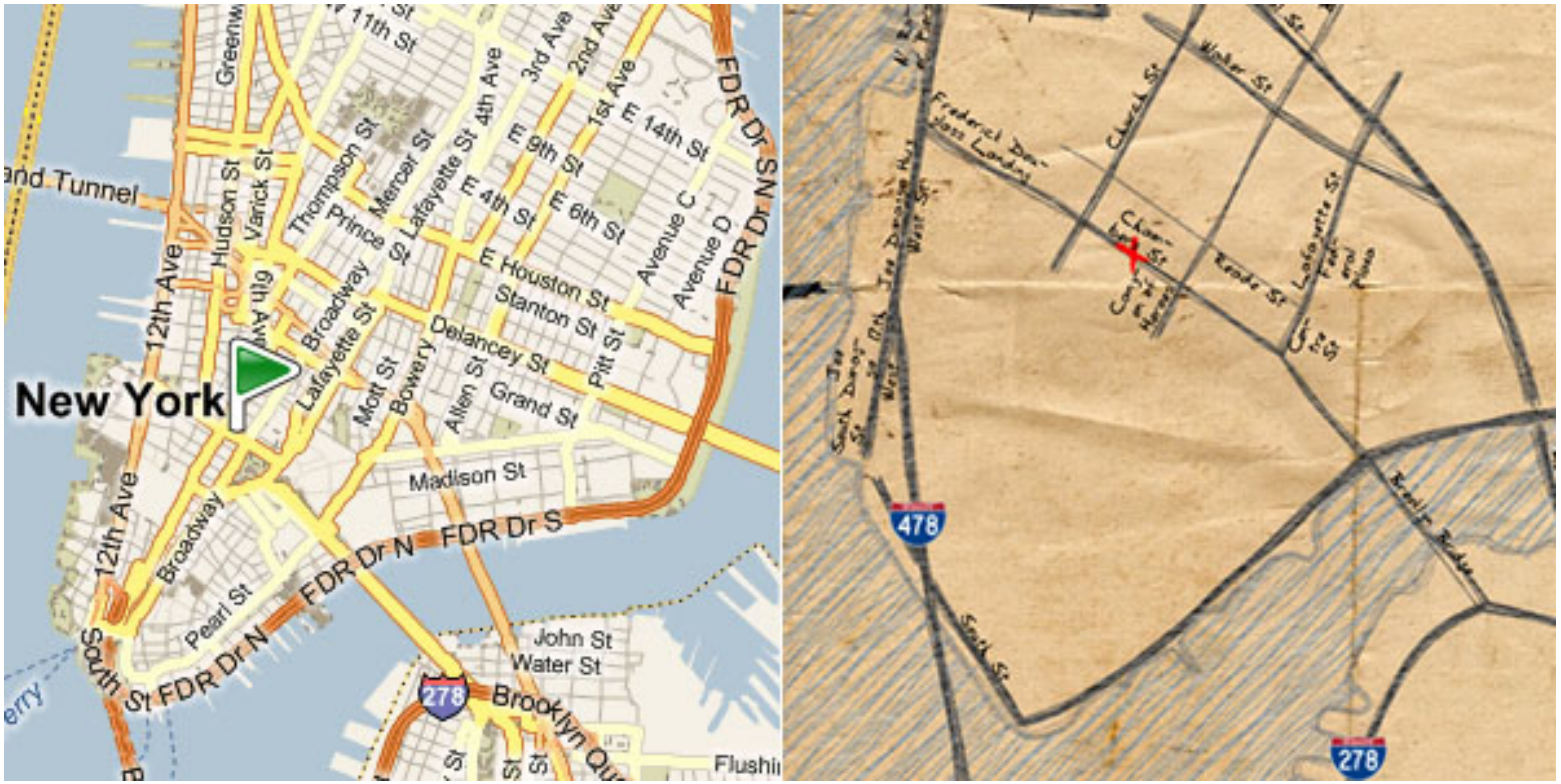
= proportion of a graphic's ink devoted to the non-redundant display of data-information

= 1 - proportion of a graphic that can be erased

Tufte: maximize the data-ink ratio



Familiar example

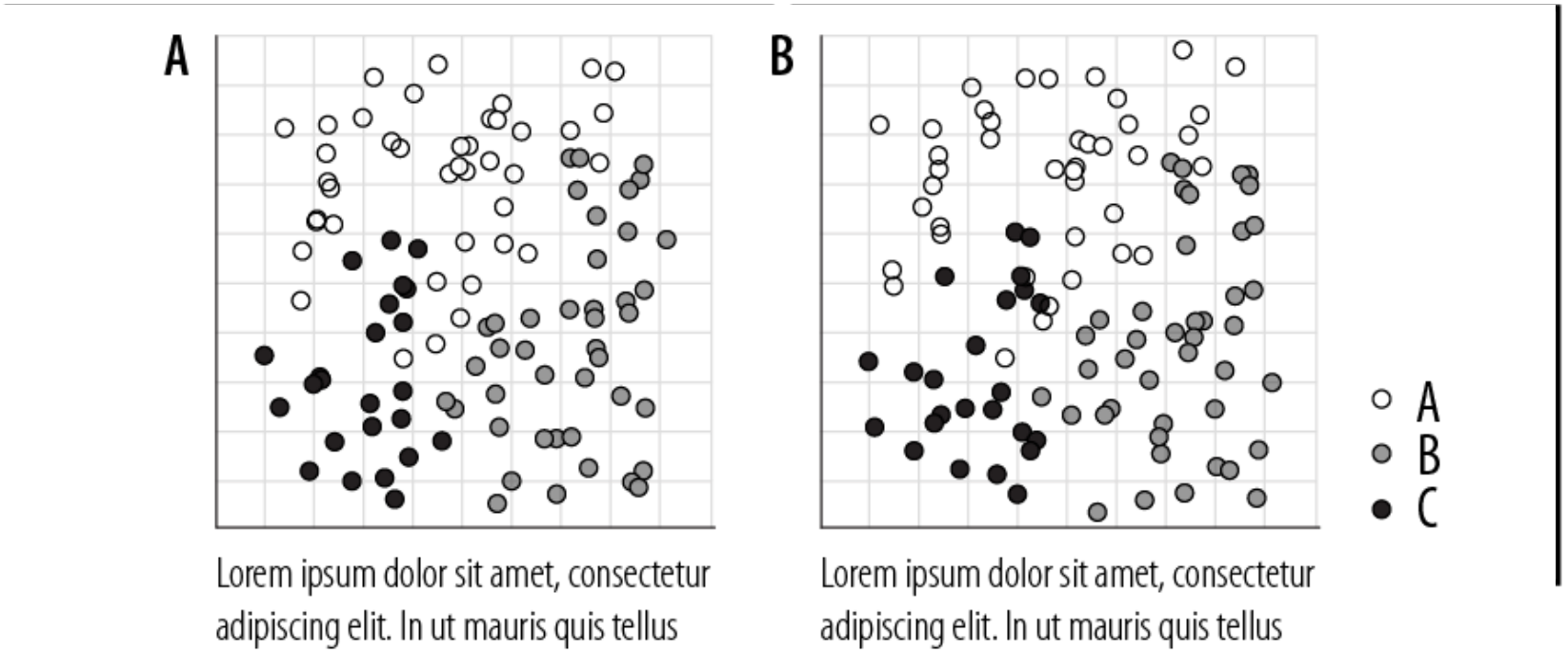


Discussion

- What do you think of the data-ink ratio?
- Consider ways to **maximize** it…

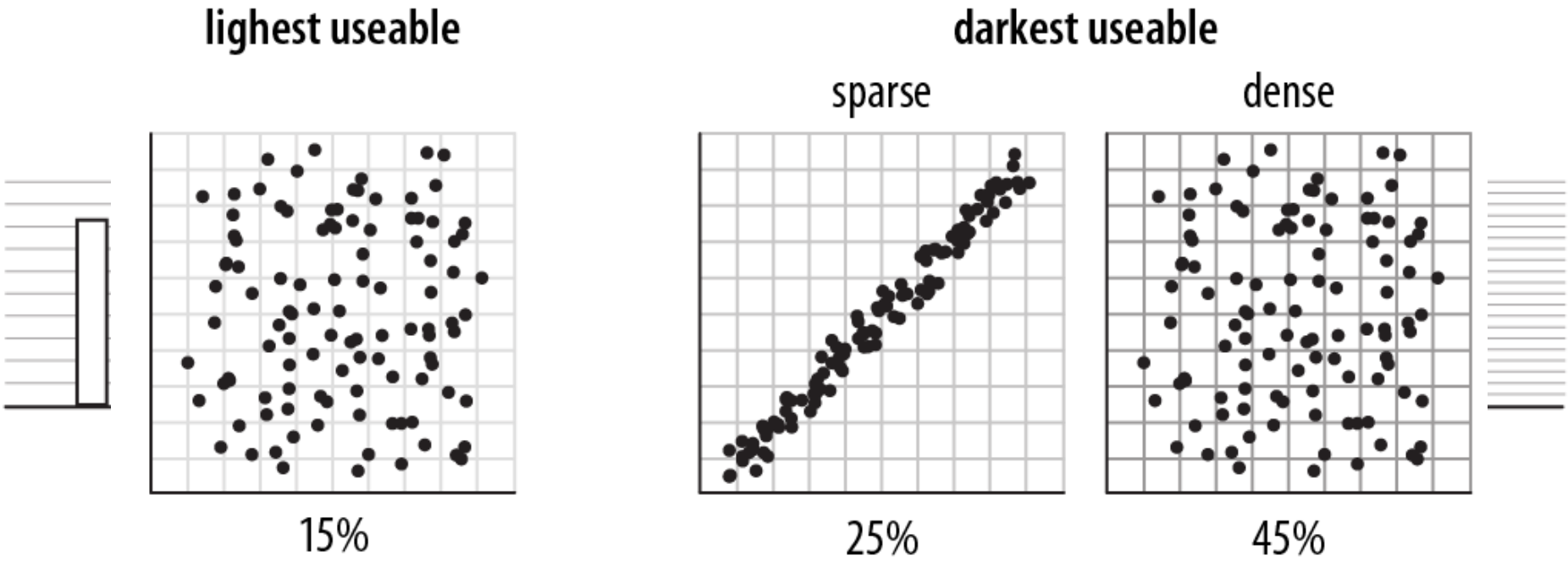
Principle 3: importance ordering

- Avoid unnecessary containment and repetition
- Example



Principle 3: importance ordering

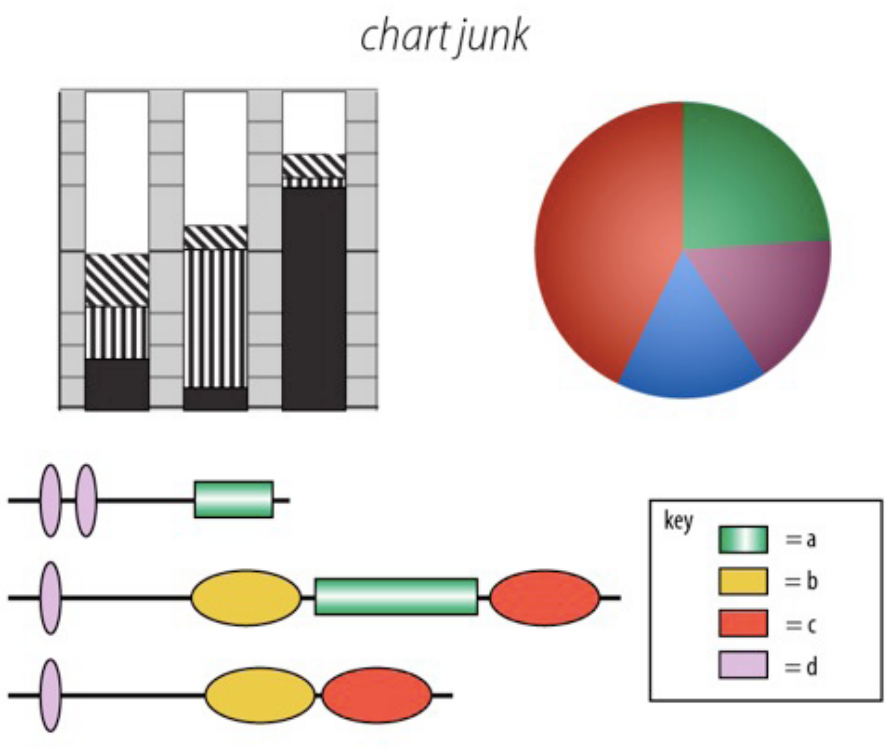
- Navigational aids shouldn't compete with data
- Avoid: heavy **axes**, **error bars** and **glyphs**

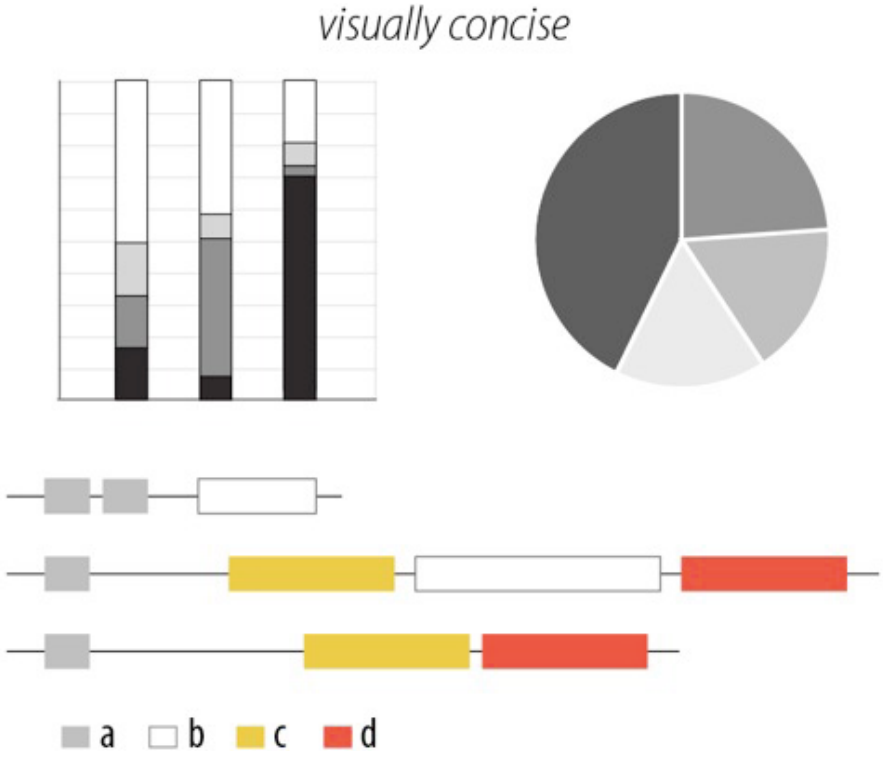


Heer J, Bostock M (2010) Crowdsourcing graphical perception: using mechanical turk to assess visualization design. Proceedings of the 28th international conference on Human factors in computing systems. Atlanta, Georgia, USA: ACM. pp. 203-212.

Principle 3: importance ordering

- Simplify, simplify, simplify…

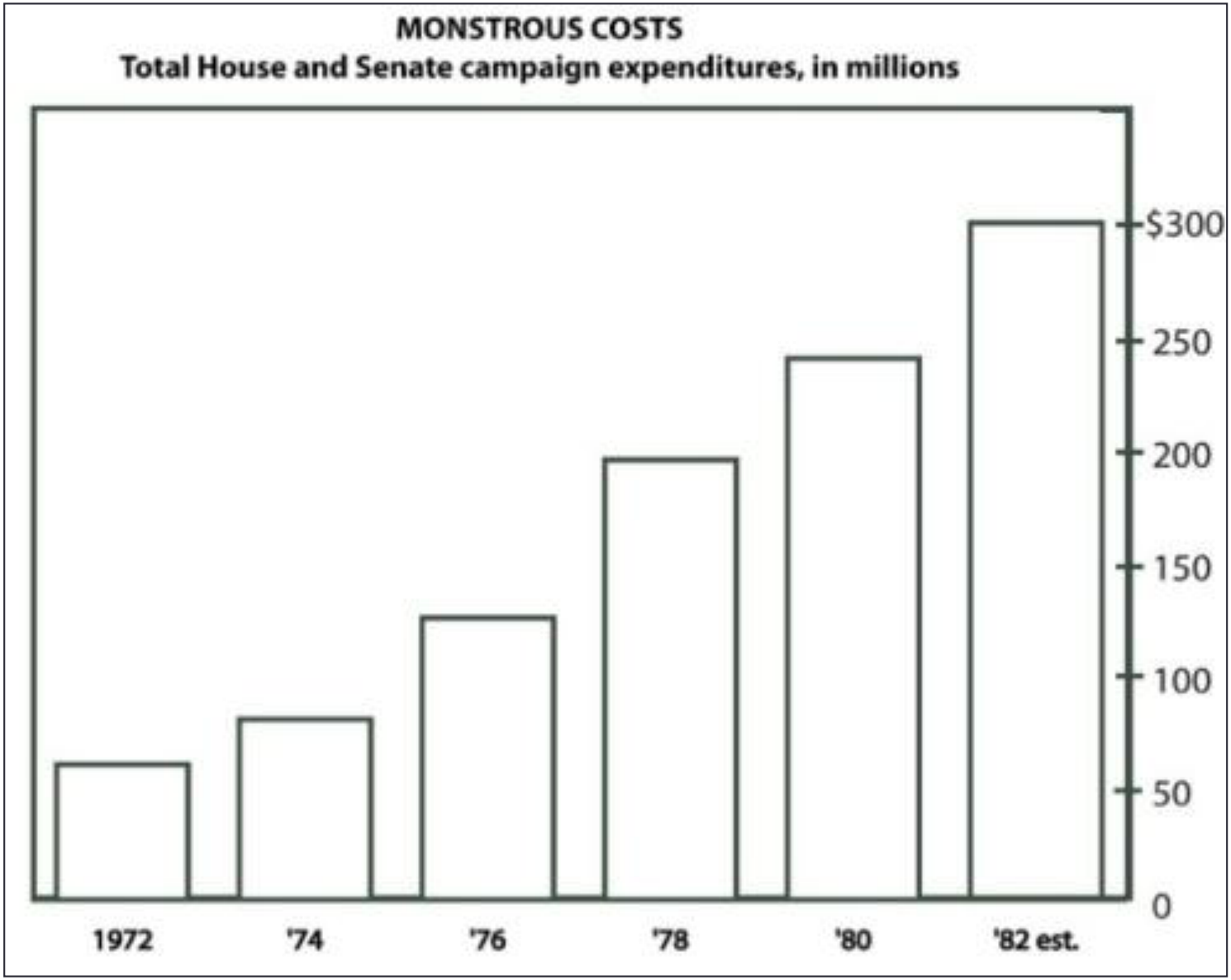




Sharov AA, et al (2006) Genome Res 16: 505-509.
Peterson J, et al. (2009) Genome Res 19: 2317-2323.
Thomson NR, et al. (2005) Genome Res 15: 629-640.
DB, Ko MS (2005) Genome Res 15: 748-754.

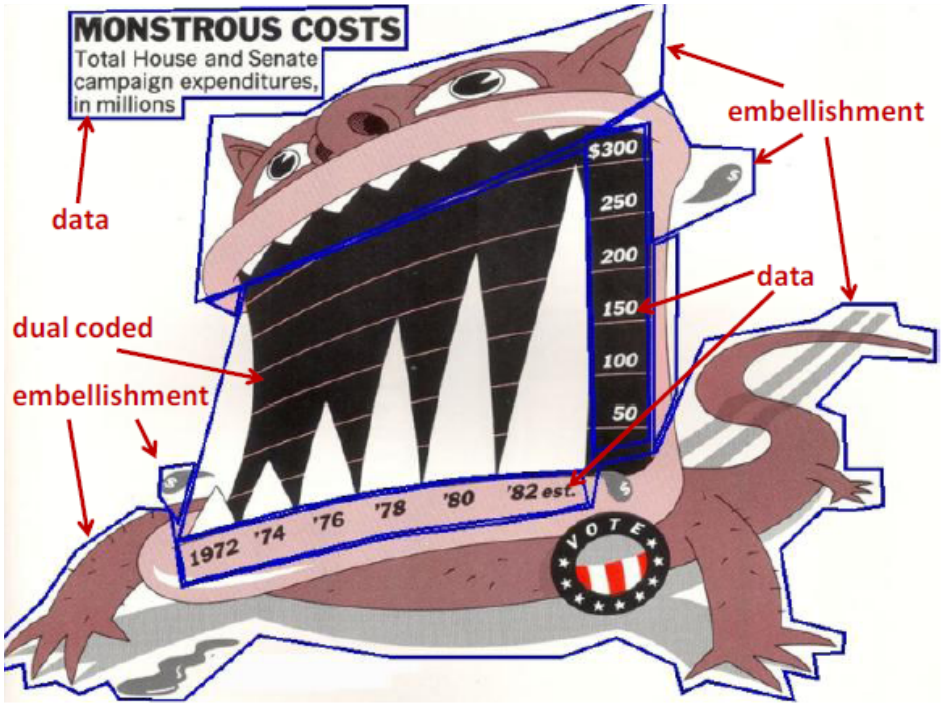
M. Krzwinski, behind every great visualization is a design principle, 2012

A caveat: “chart junk” and recall



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

Chart junk and eye gaze



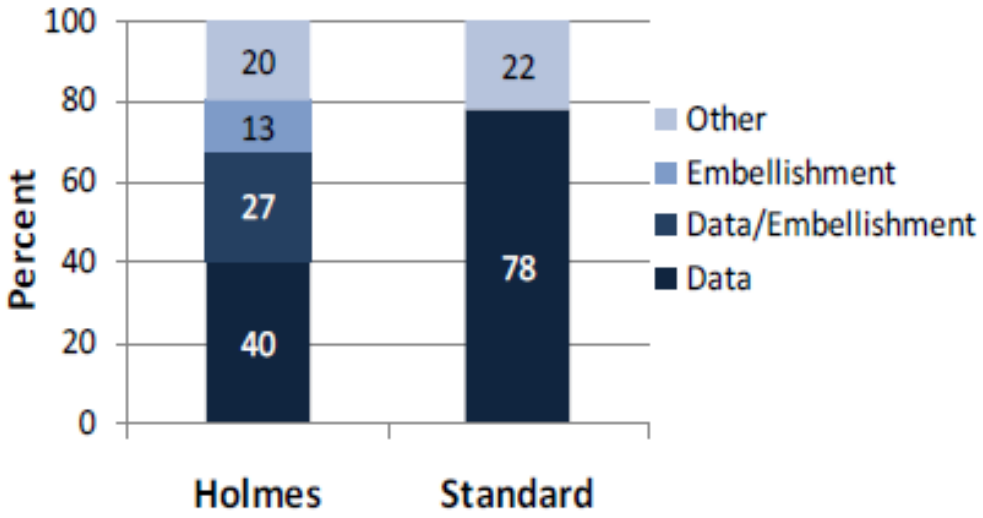
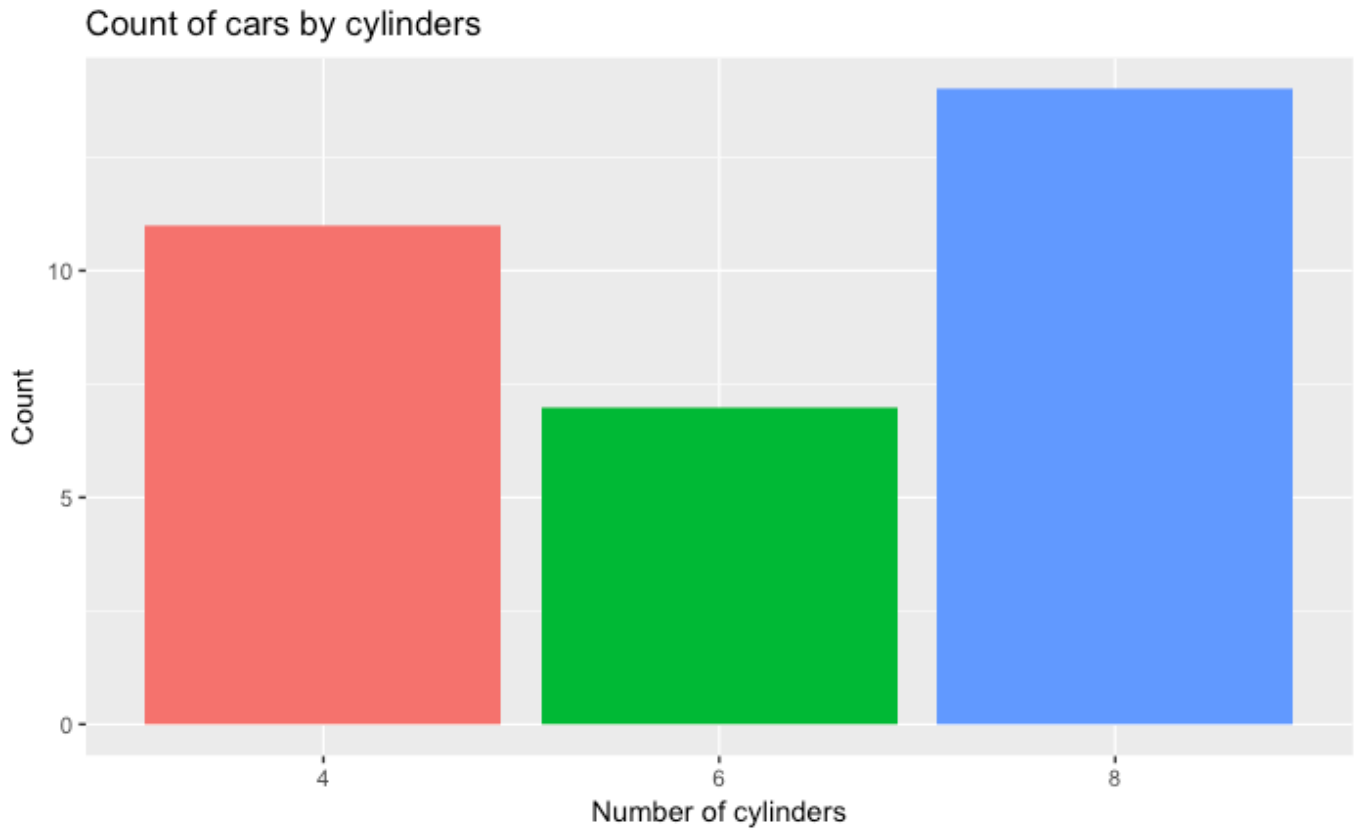


Figure 9. Percentage of on-screen time spent looking at different chart elements for Holmes and Plain charts.

What visualization techniques do you know?

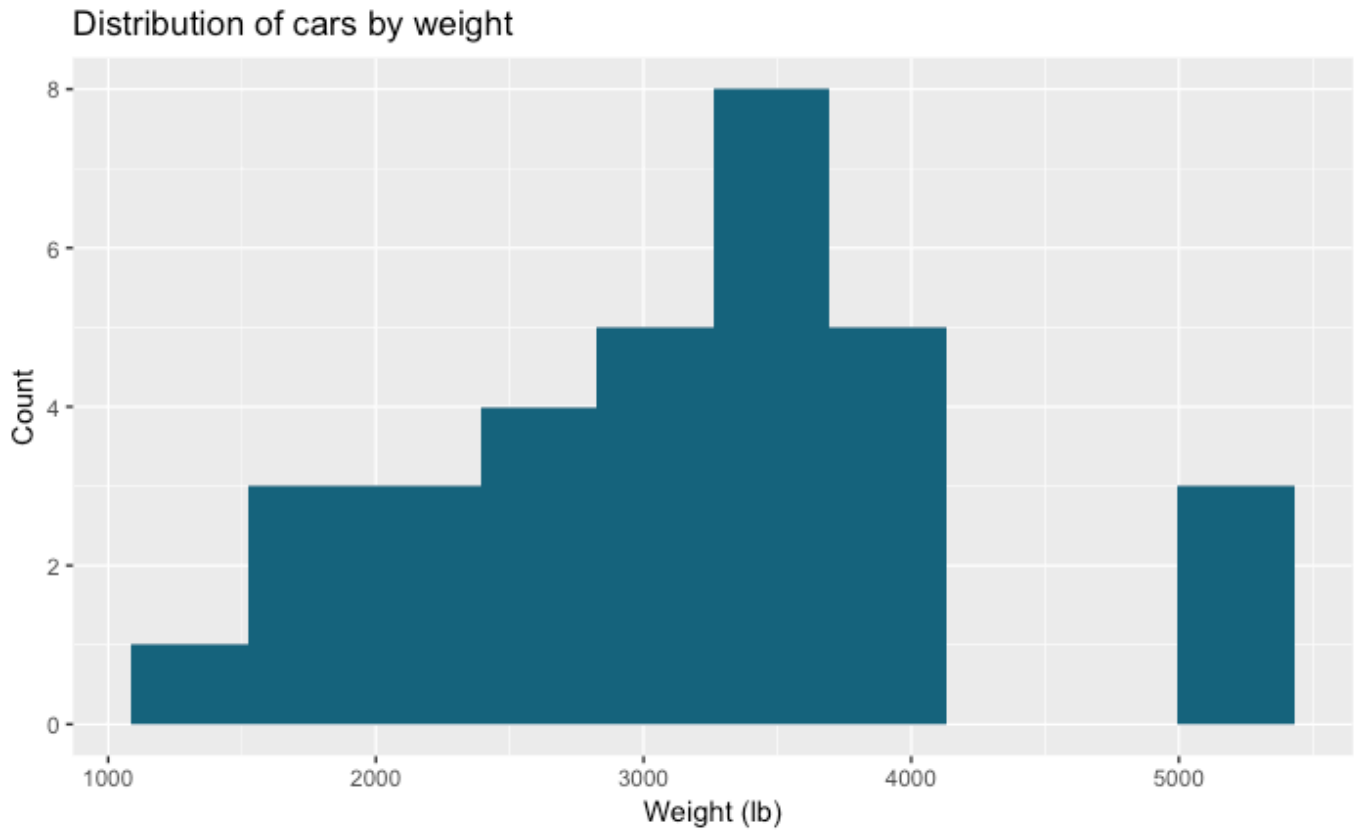
Bar chart

- Used for **comparable variables**
- Compares **quantitative** values for different categories
- Highlights **relative amounts**
- Grouped/stacked bars can break each **category** into sub-groups



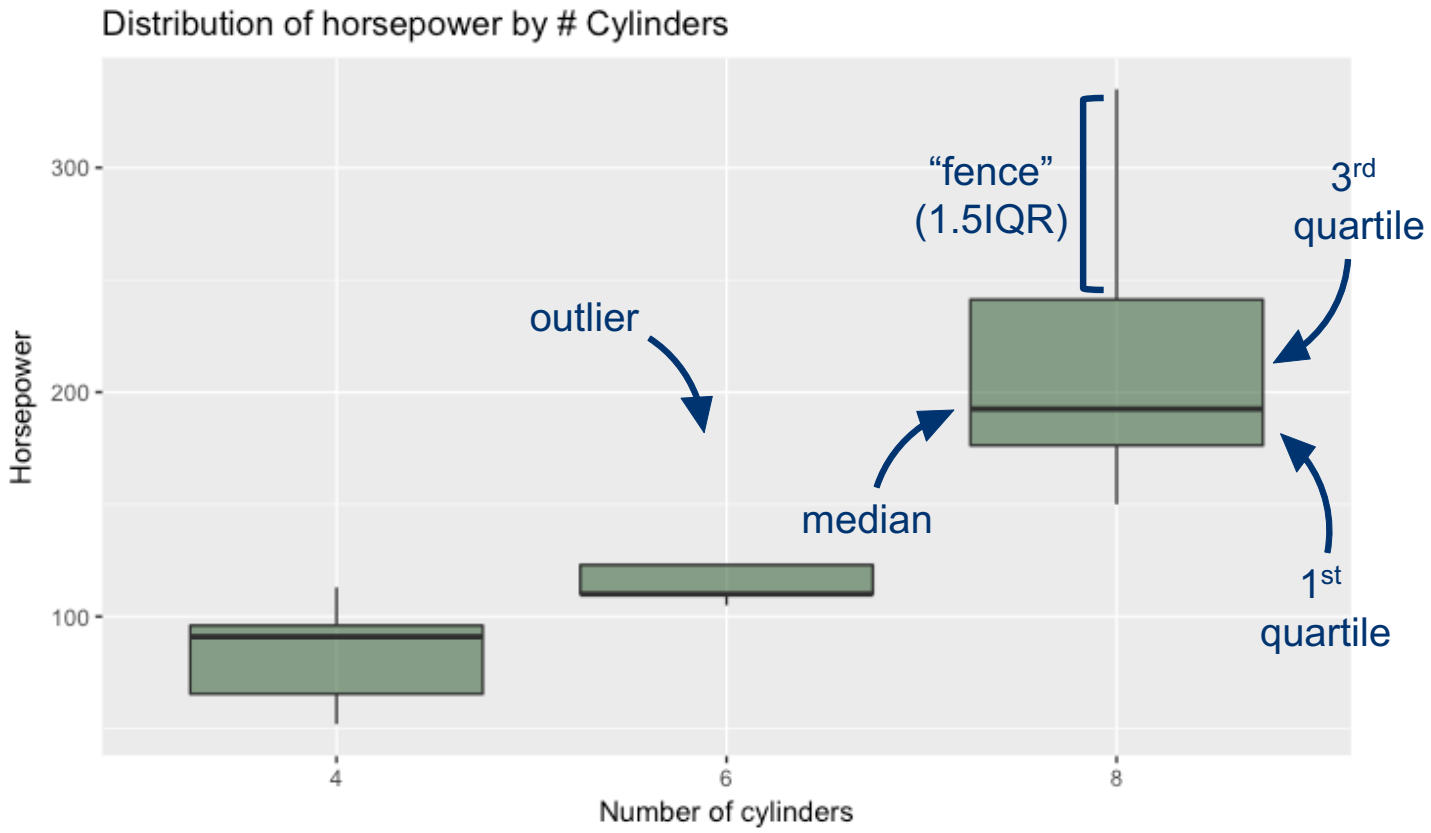
Histogram

- Looks like a bar chart… but the x-axis is **continuous**
- Y-axis shows count or relative frequency
- Highlights **distribution**
- Note: bin size makes a big difference!



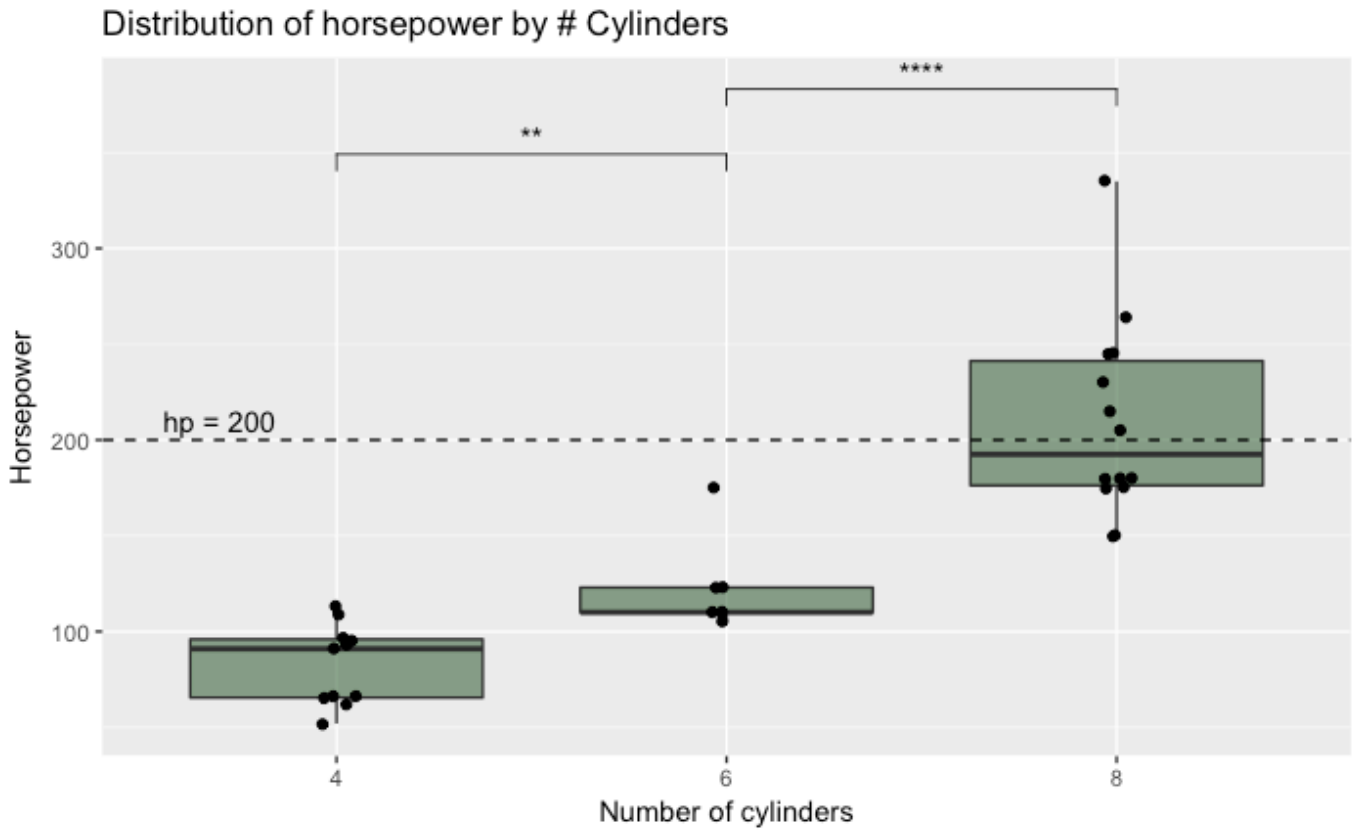
Boxplot

- Also useful for highlighting **distribution**
- Calls out key values:
  - median
  - 1st & 3rd quartiles
  - “fences”
  - outliers



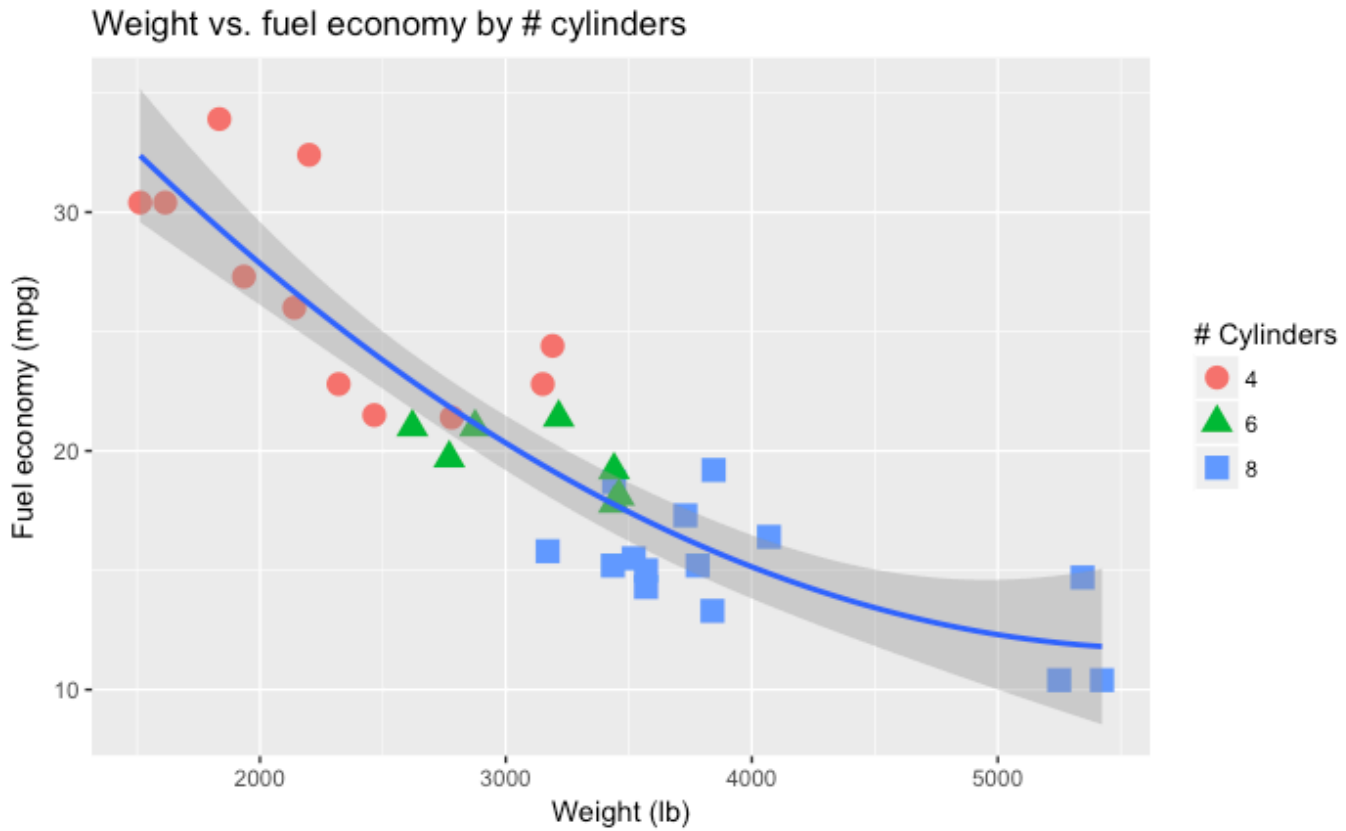
Boxplot add-ons

- Use “jitter” to show actual values
- Reference lines can help provide context
- Can use annotations to show statistical significance



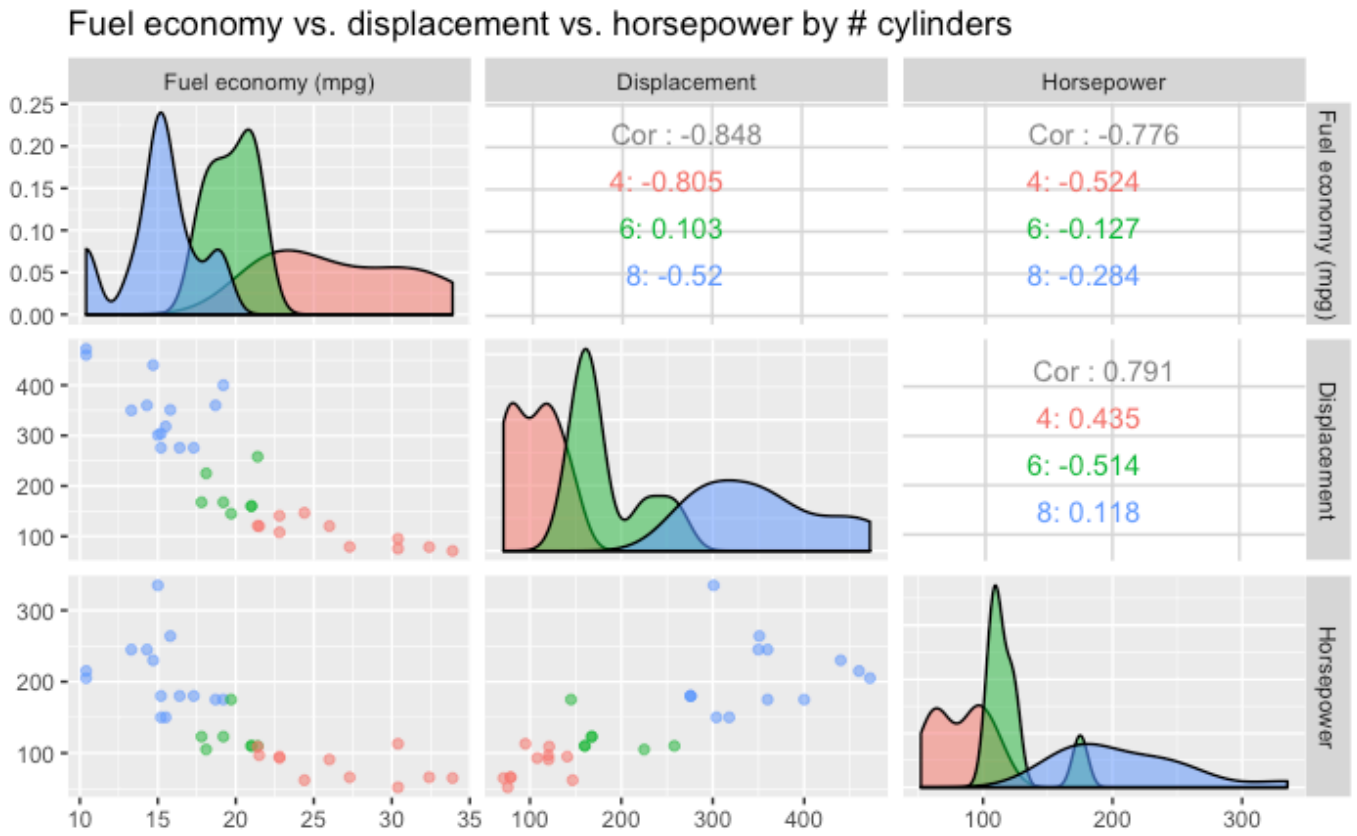
Scatterplot

- Shows the relationship between two **continuous variables**
- Each point in the plot represents an observation
- You can change color or symbol to **highlight groups**
- Sometimes useful to show a trend line (regression)



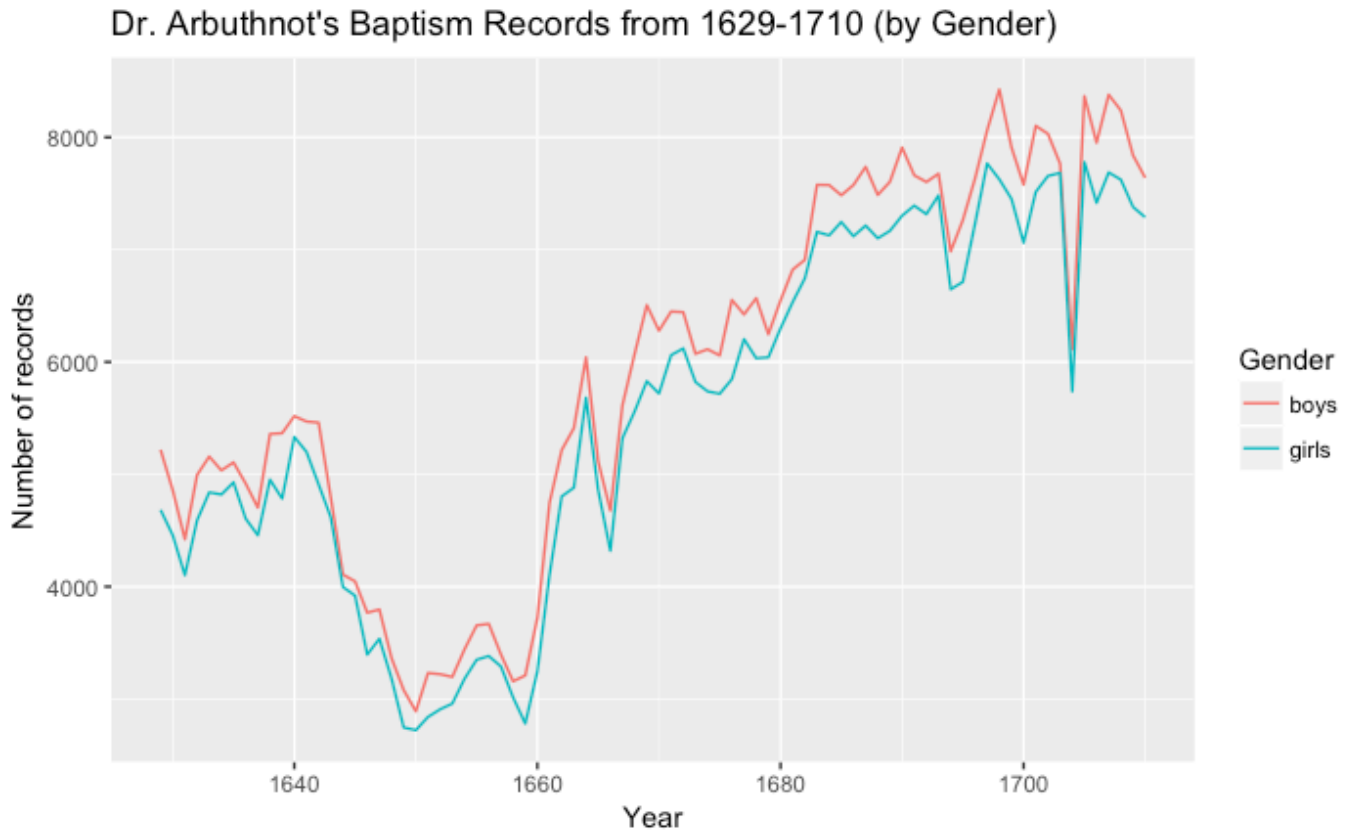
Scatterplot matrix (SPLOM)

- Scatterplots show the relationship between just two **continuous variables at a time**
- We can combine multiple scatterplots into a matrix to show additional relationships

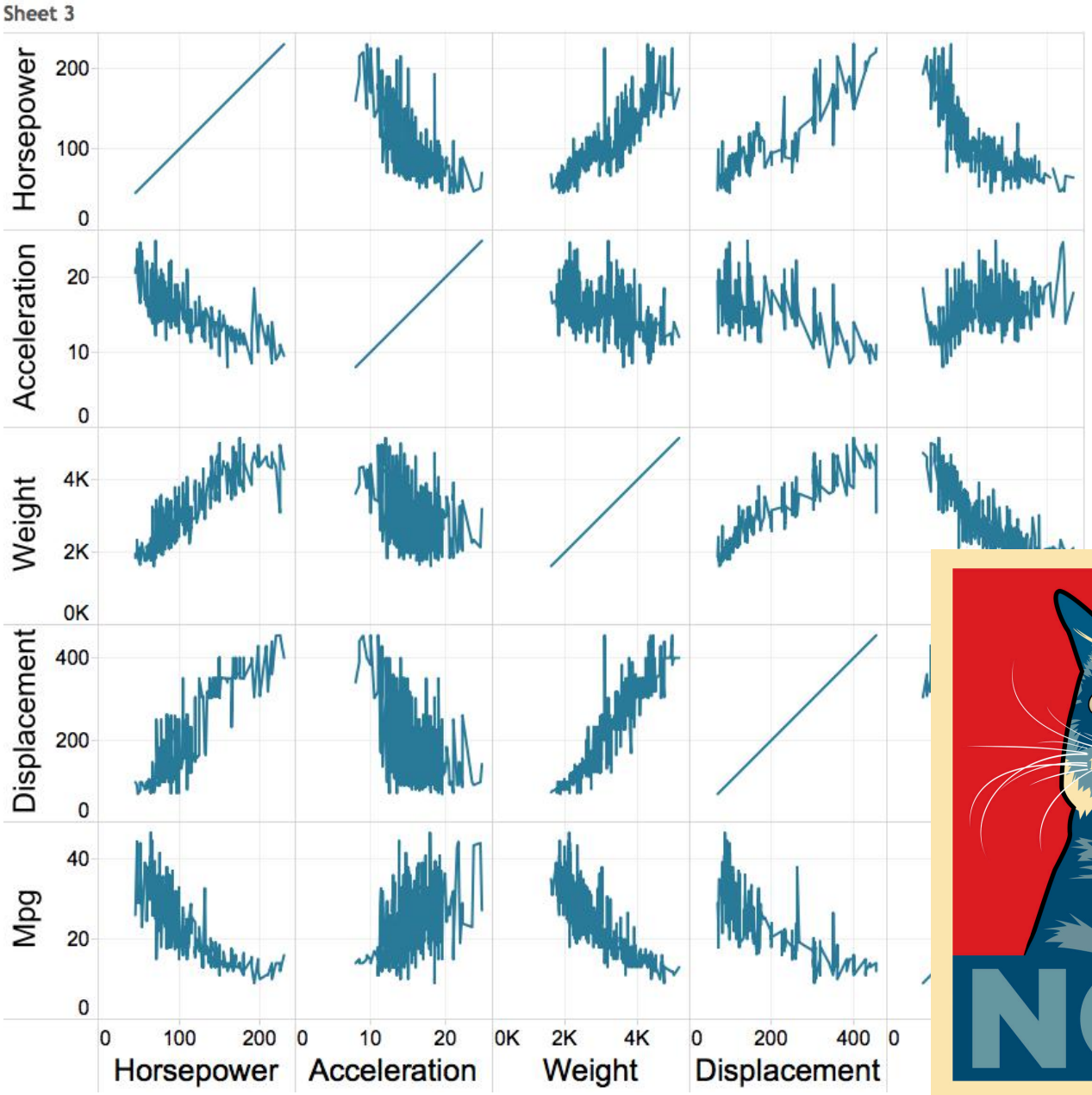


Line chart

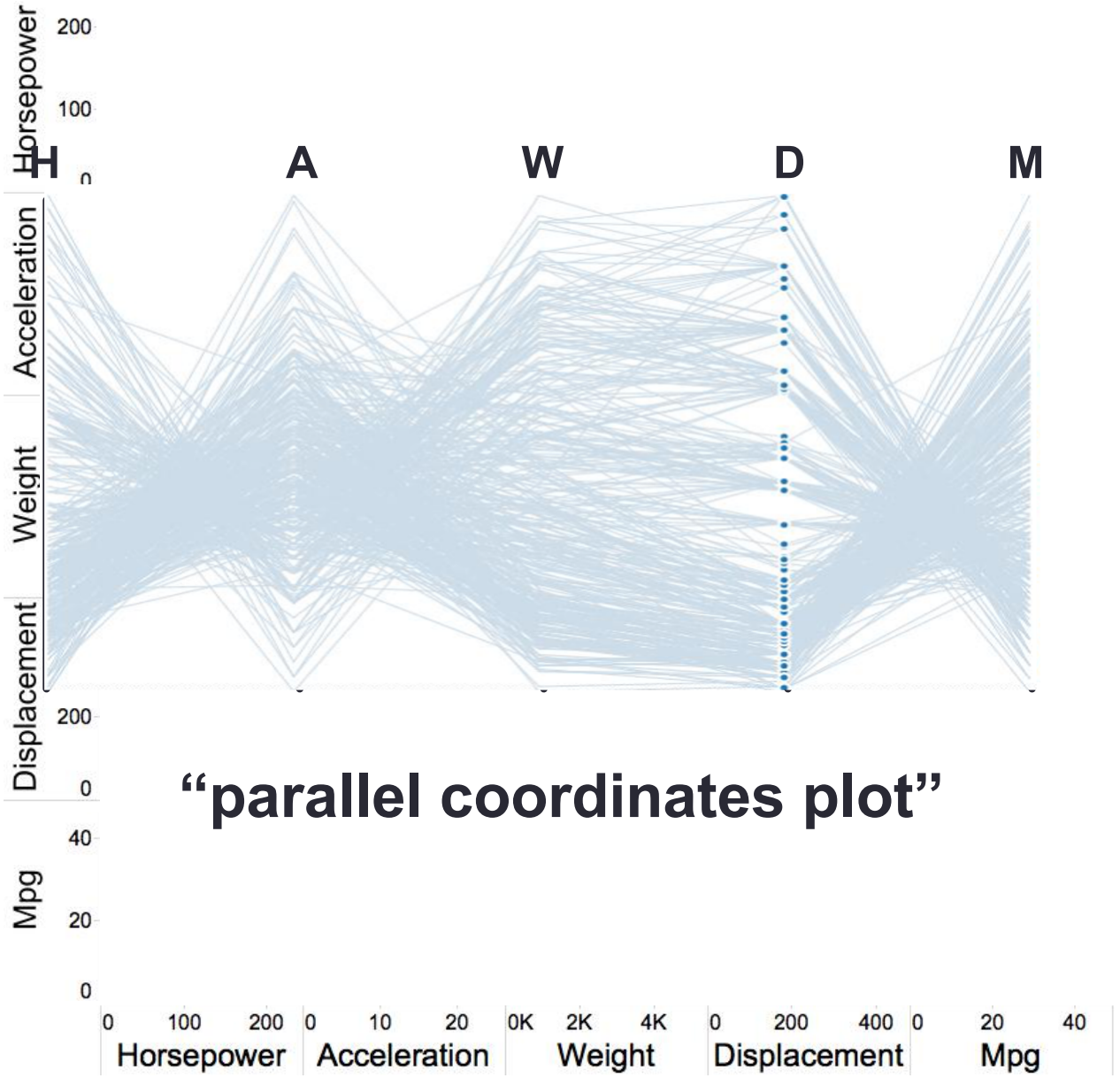
- Shows the trend in one variable, often **over time**
- Multiple lines can show multiple variables, or the same variable for multiple observations (must have the **same scale**!)
- Highlights “position switches”



Multiple variables: line chart matrix?

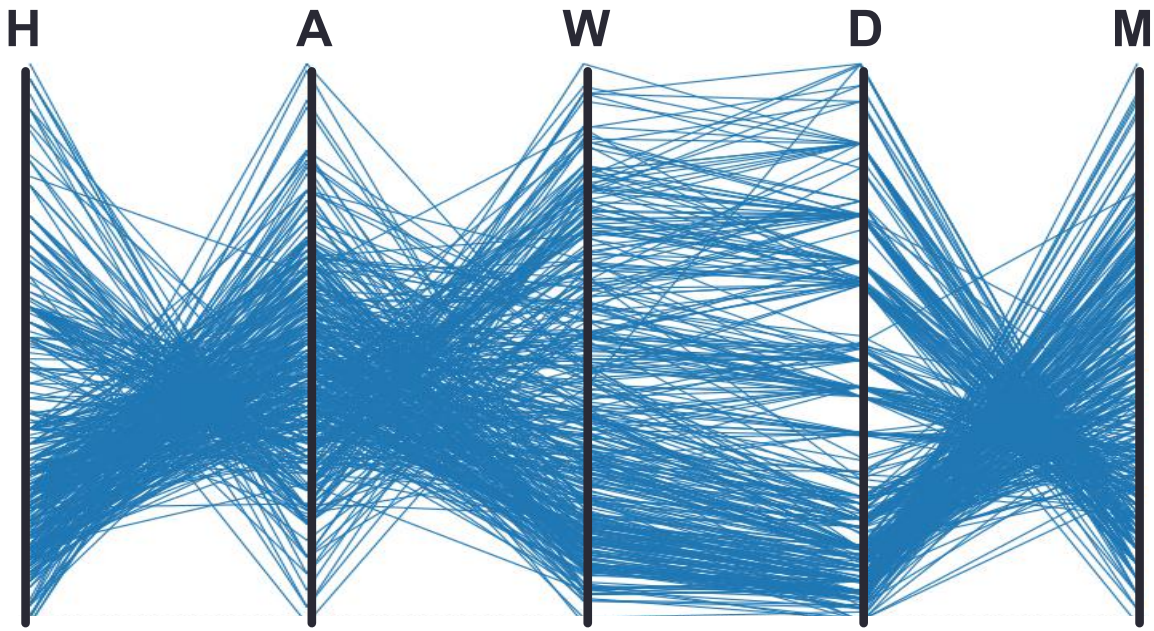


Weirder idea



“parallel coordinates plot”

Morning challenge



“parallel coordinates plot”

How would you build this using **`ggplot2`**?