Communicating with Data – Choosing Visual Channels

Dr. Ab Mosca (they/them)

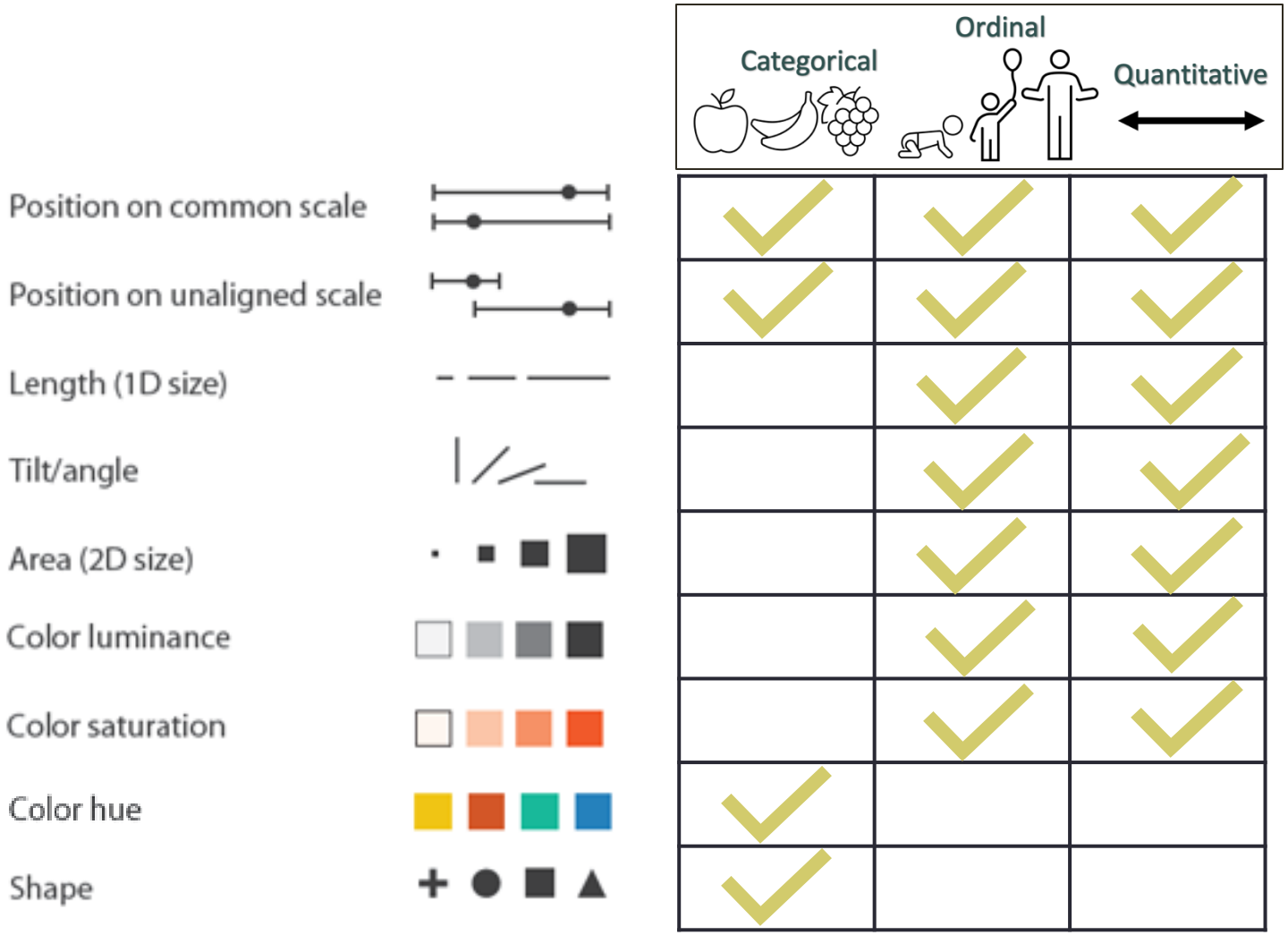
Slides based off slides courtesy of Jordan Crouser (https://jcrouser.github.io/)

Plan for Today

- Recap data-visual mapping
- Expressiveness & effectiveness of visual channels
- A sampling of visualization techniques

Recall: Data → Visuals

- Remember… **Big idea behind visualization**
  - **Map data dimensions to visual dimensions in a principled way**



Visual Encoding

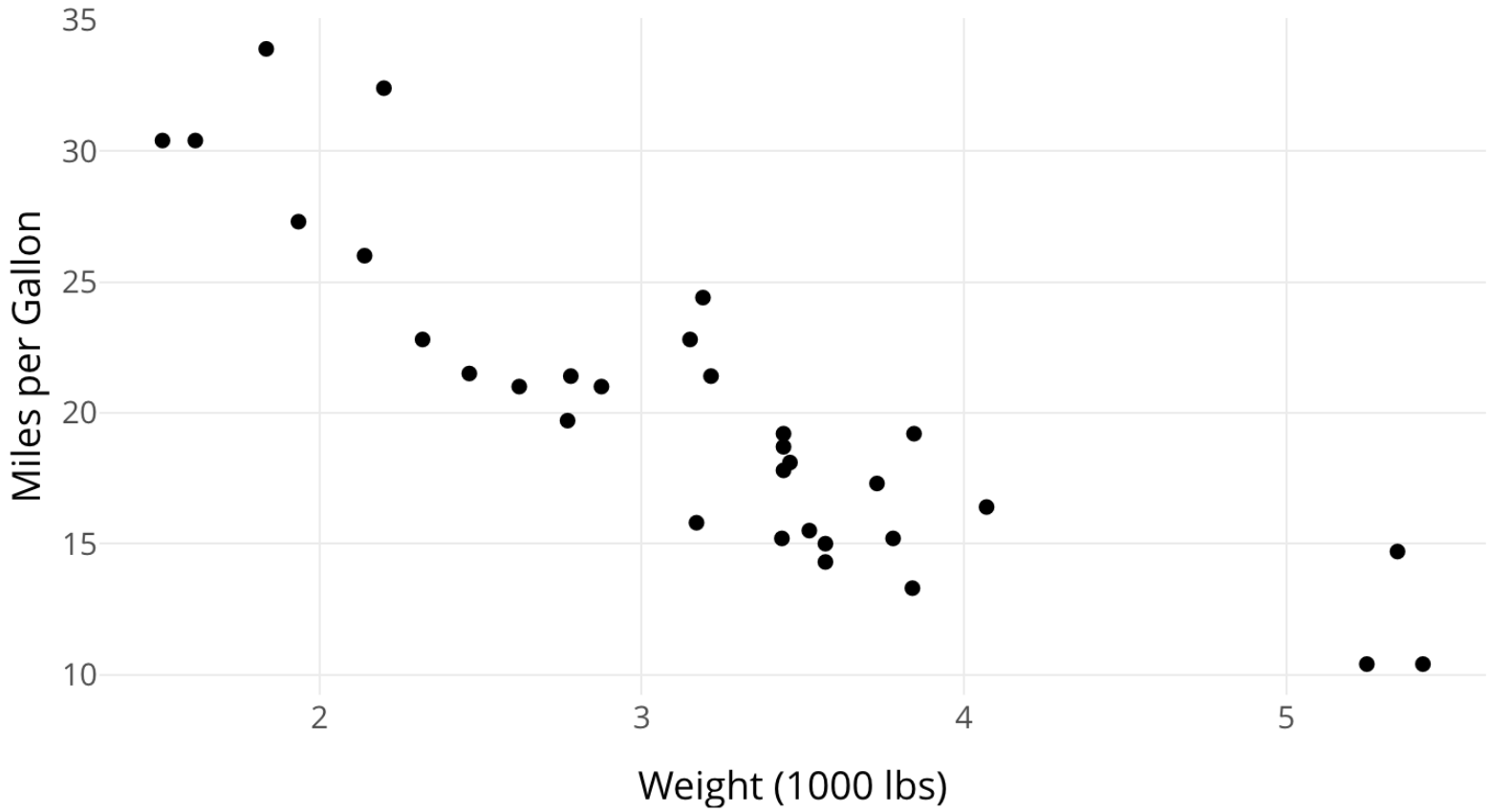
- Remember… **Big idea behind visualization**
  - **Map data dimensions to visual dimensions in a principled way**

- The process of representing variables via visual channels is called **encoding**
- **Visual encoding** is another term for a visualization

- One way we will often analyze visualizations is by inspecting their data-visual mapping (i.e. encoding)

Ex. Data-Visual Mapping

- What are the marks in this visualization?
- What variables are shown?
- What visual channel(s) encode(s) each variable?
- Based on data type and channel type, is the encoding appropriate?



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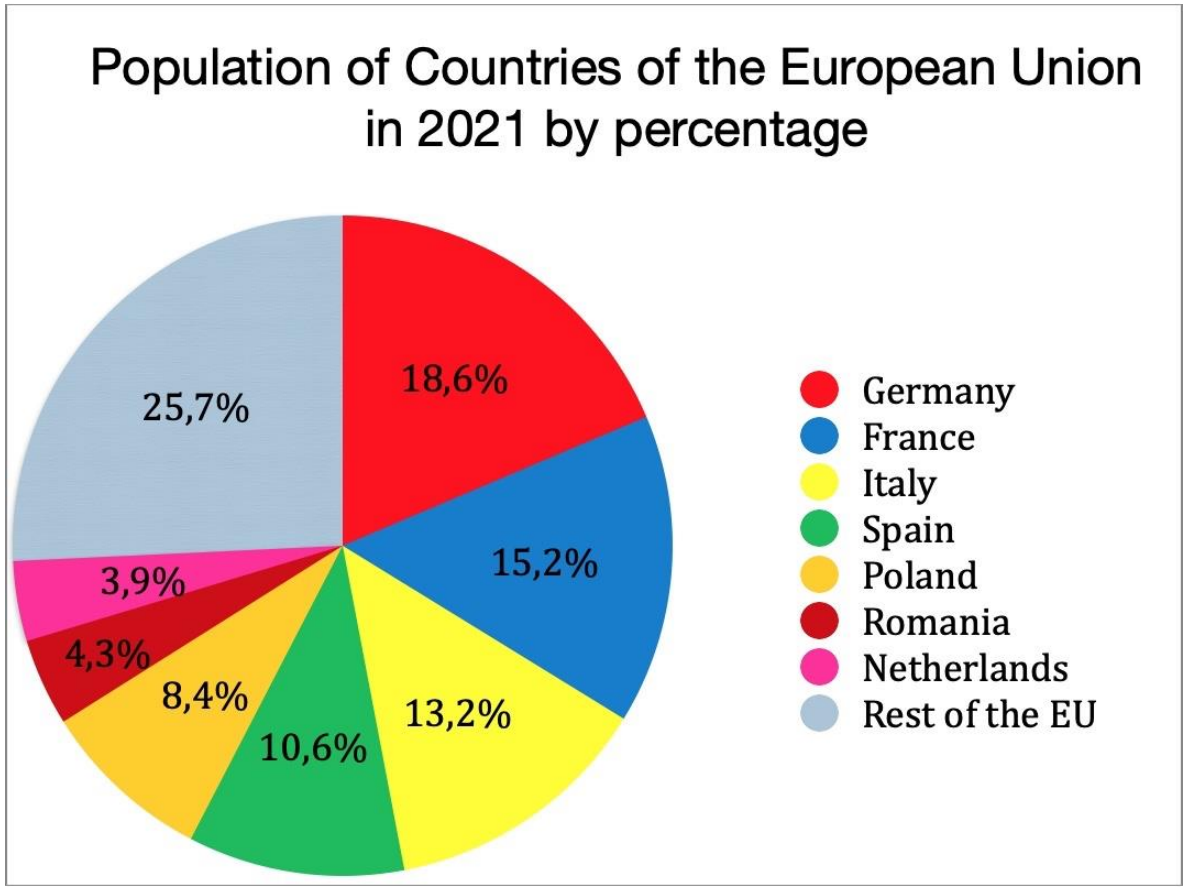

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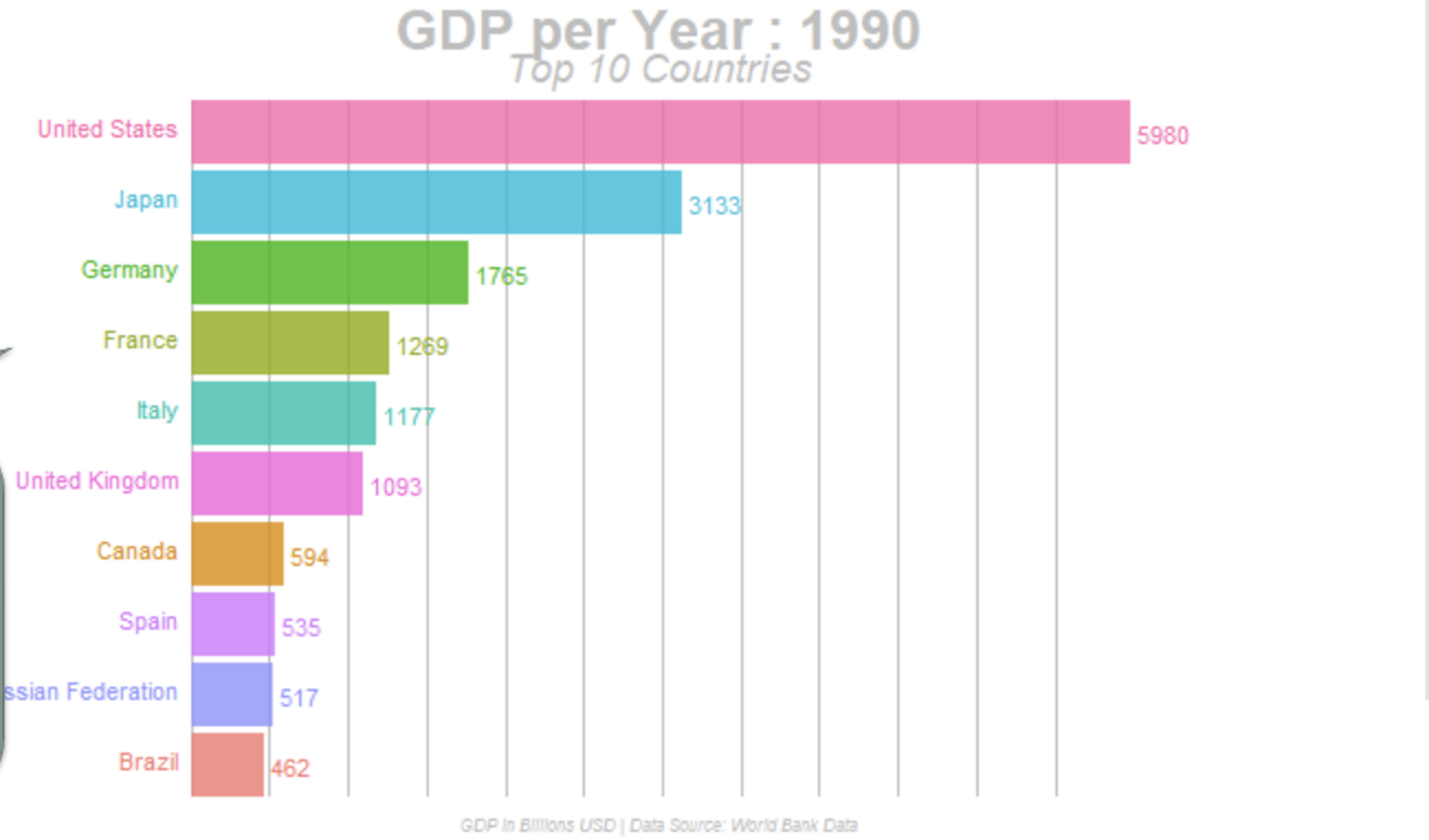
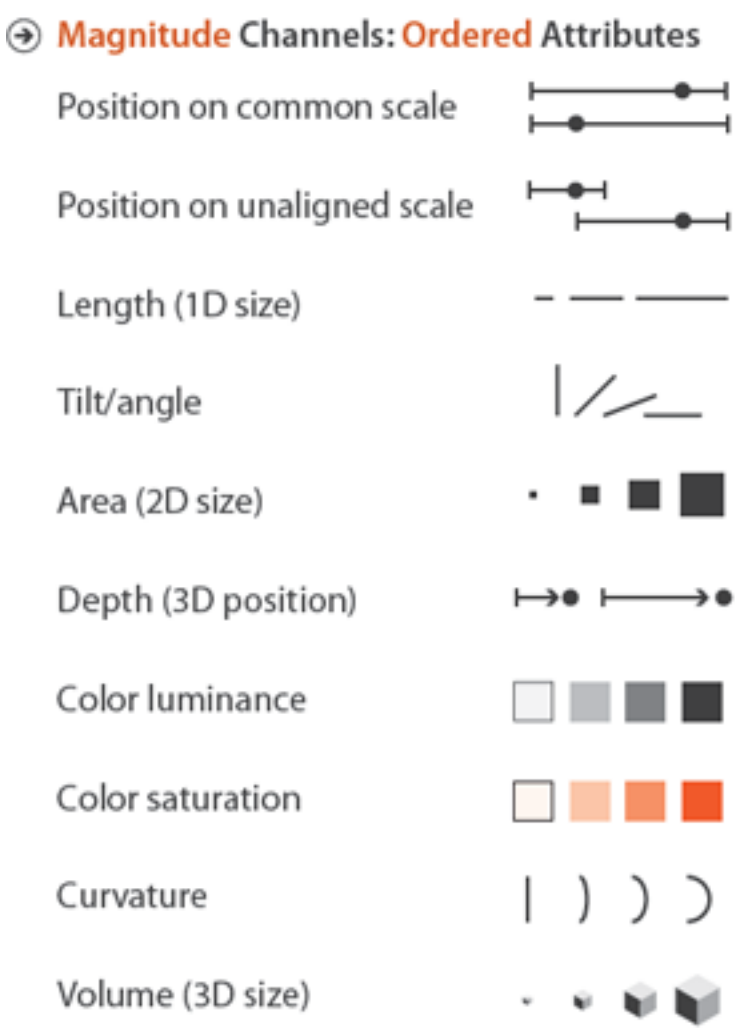
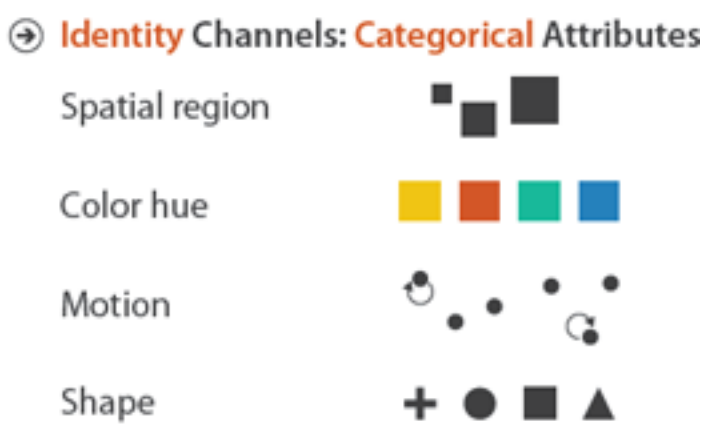


Dual (or double) encoding == encoding one variable via more than one channel

Ranking Visual Channels





- Using the correct visual channel type for the correct variable type is called **expressiveness**
- We also consider **effectiveness** to choose visual channels

Ranking Visual Channels

- The salience (noticeability) of channels used in the visual encoding should match the importance of attributes.
  - i.e. More important attributes should be encoded with more **effective** channels.

- **Effectiveness** refers to how well a channel supports:
  - Accuracy
  - Discriminability
  - Separability
  - Visual popout
  - Grouping

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

Accuracy

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How much longer is the second bar?

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much longer is the second bar?

2X

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second square?

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second square?

4X

Accuracy

Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second box?

Accuracy

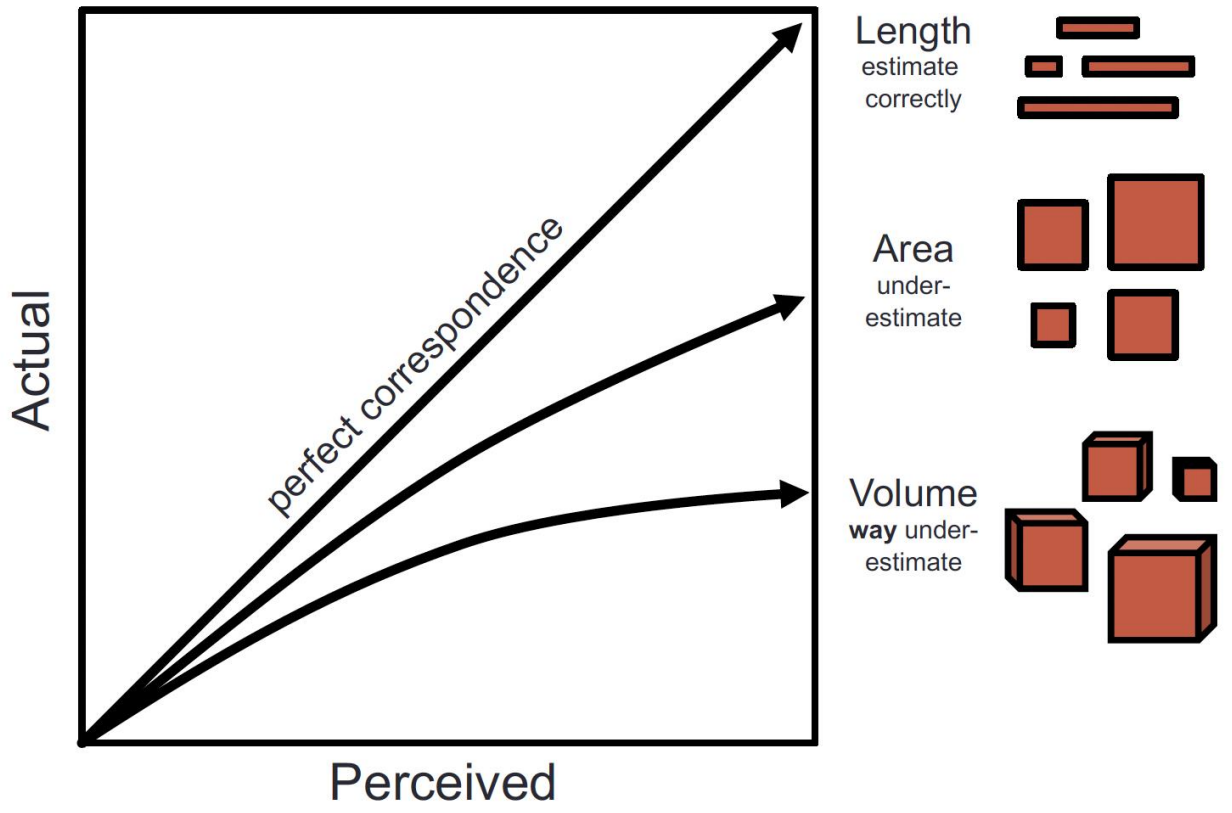
Definition: how close human perceptual judgement is to an objective measurement of the stimulus

How much bigger is the second box?

27X

Accuracy

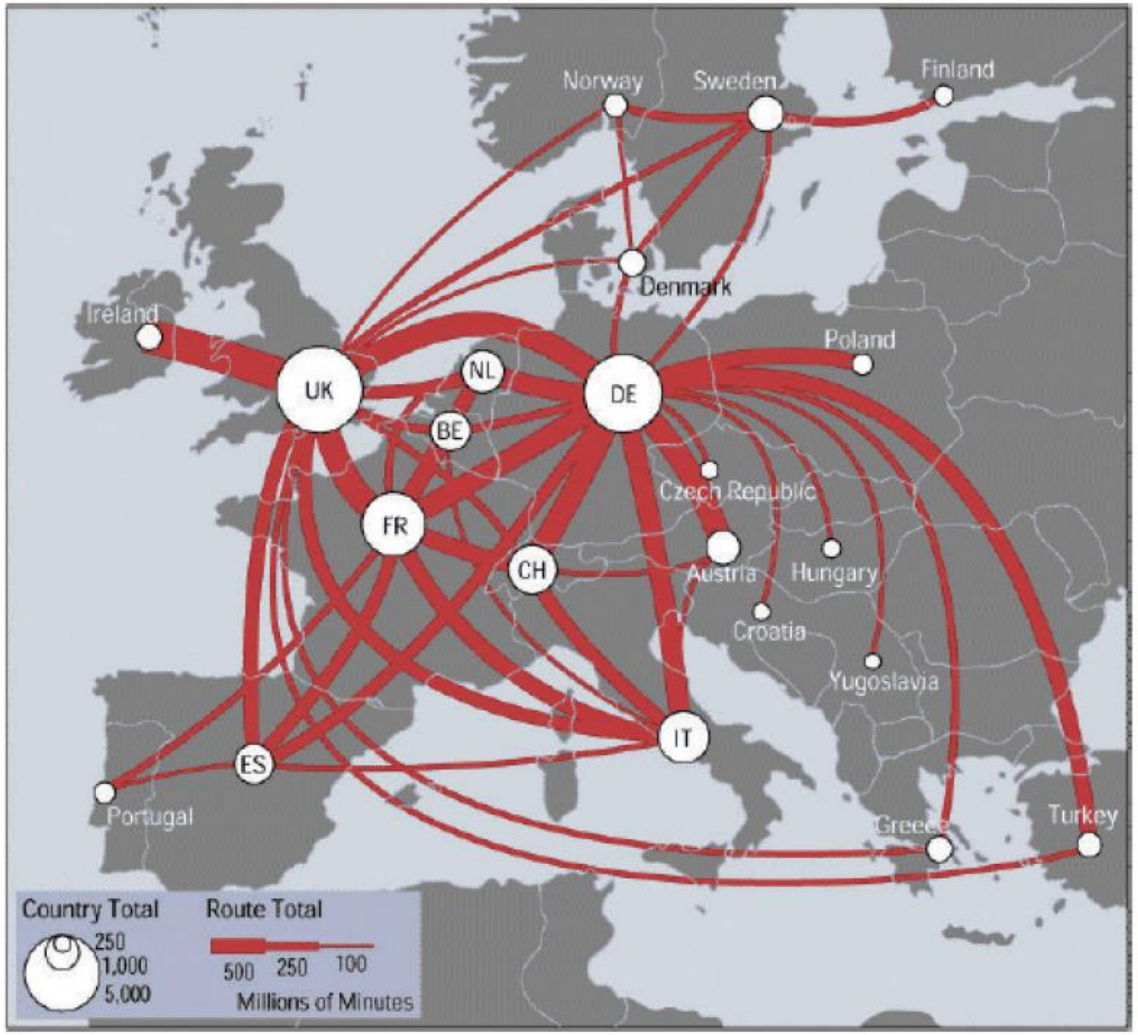
Definition: how close human perceptual judgement is to an objective measurement of the stimulus



http://makingmaps.net/2007/08/28/perceptual-scaling-of-map-symbols/

Discriminability

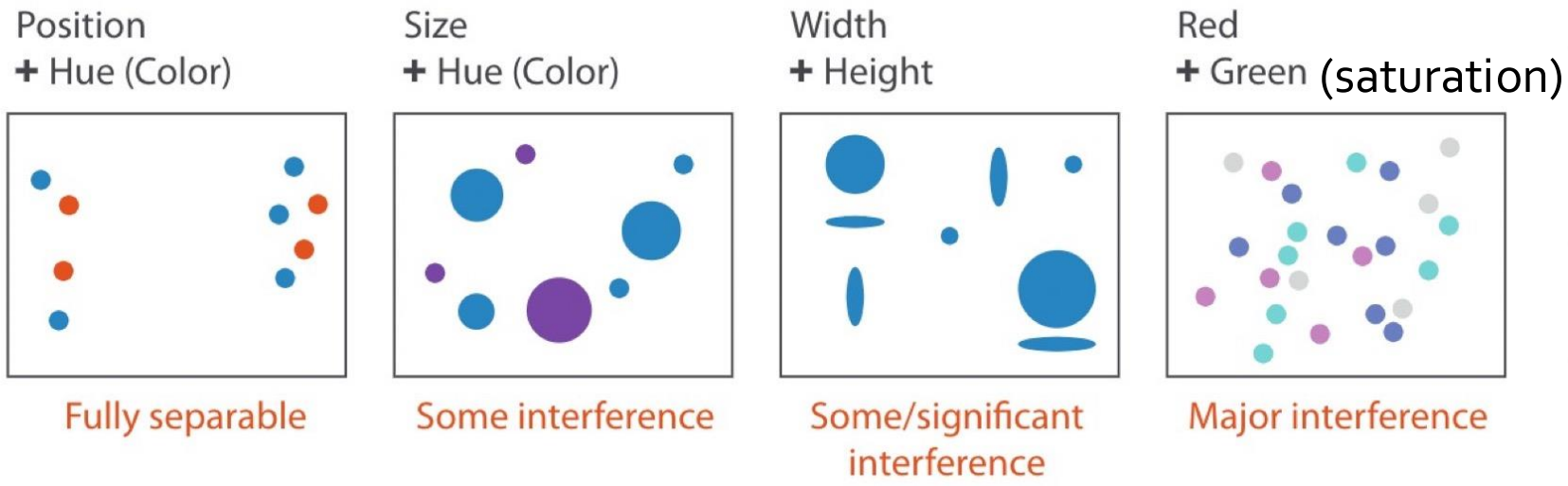
Definition: how differentiable levels of the channel are



https://web.cse.ohio-state.edu/~shen.94/Melbourne/Slides/TamaraChp5.pdf

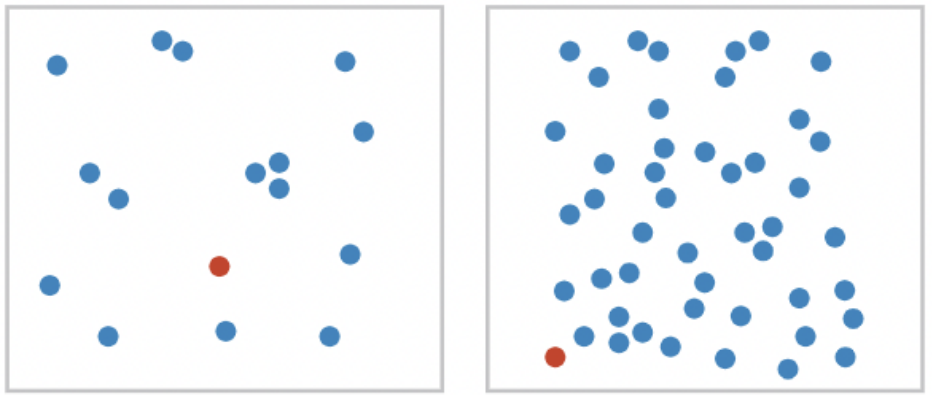
Separability

Definition: whether channels exist independently or integrally with others



Visual Popout

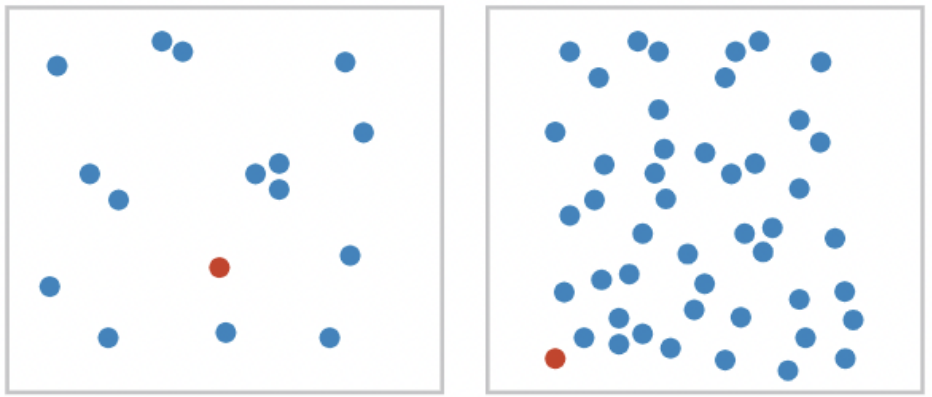
Definition: how well a distinct item stands out from others



(a) (b)

Visual Popout

Definition: how well a distinct item stands out from others

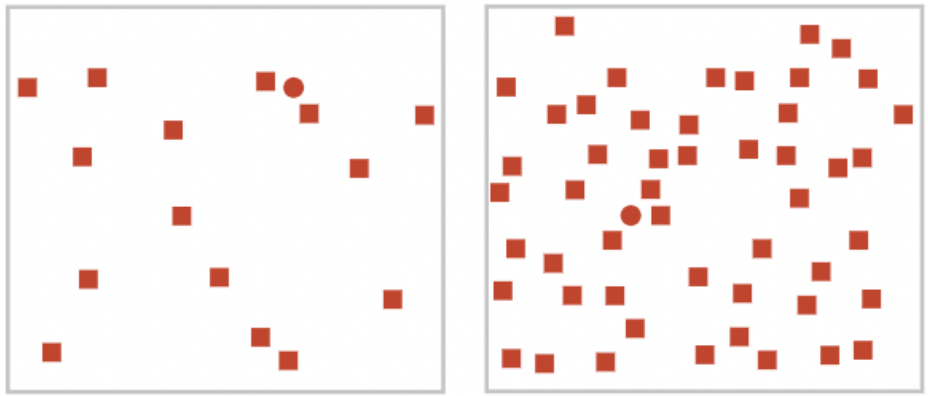


(a) (b)

Color is a good channel for this

Visual Popout

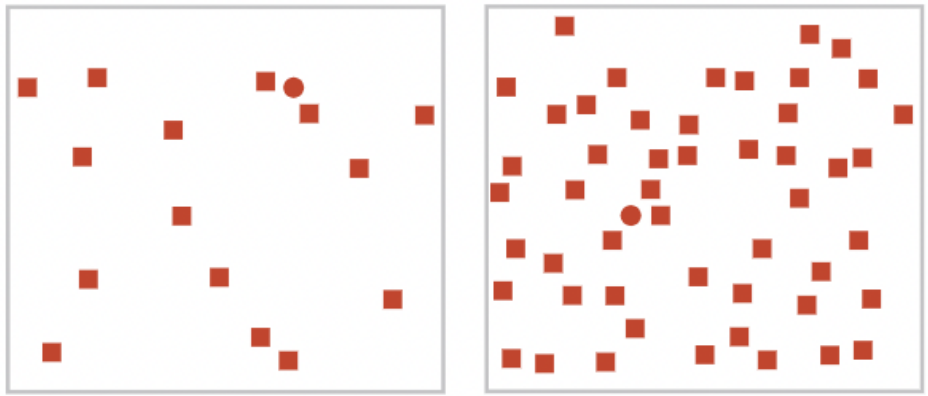
Definition: how well a distinct item stands out from others



(c) (d)

Visual Popout

Definition: how well a distinct item stands out from others

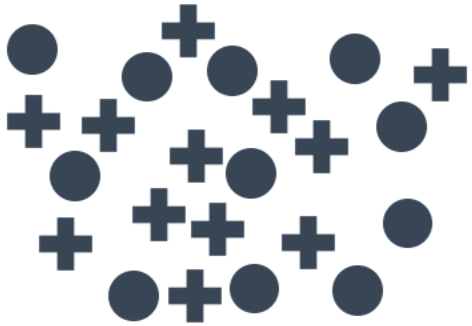


(c) (d)

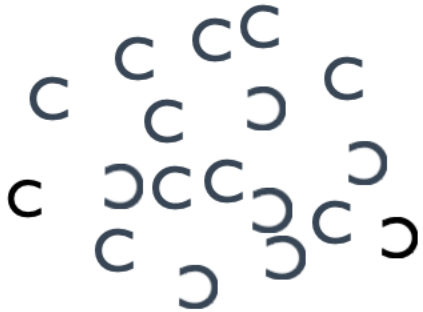
Shape is not as helpful

Grouping

Definition: how likely people are to infer differences as representing distinct groups



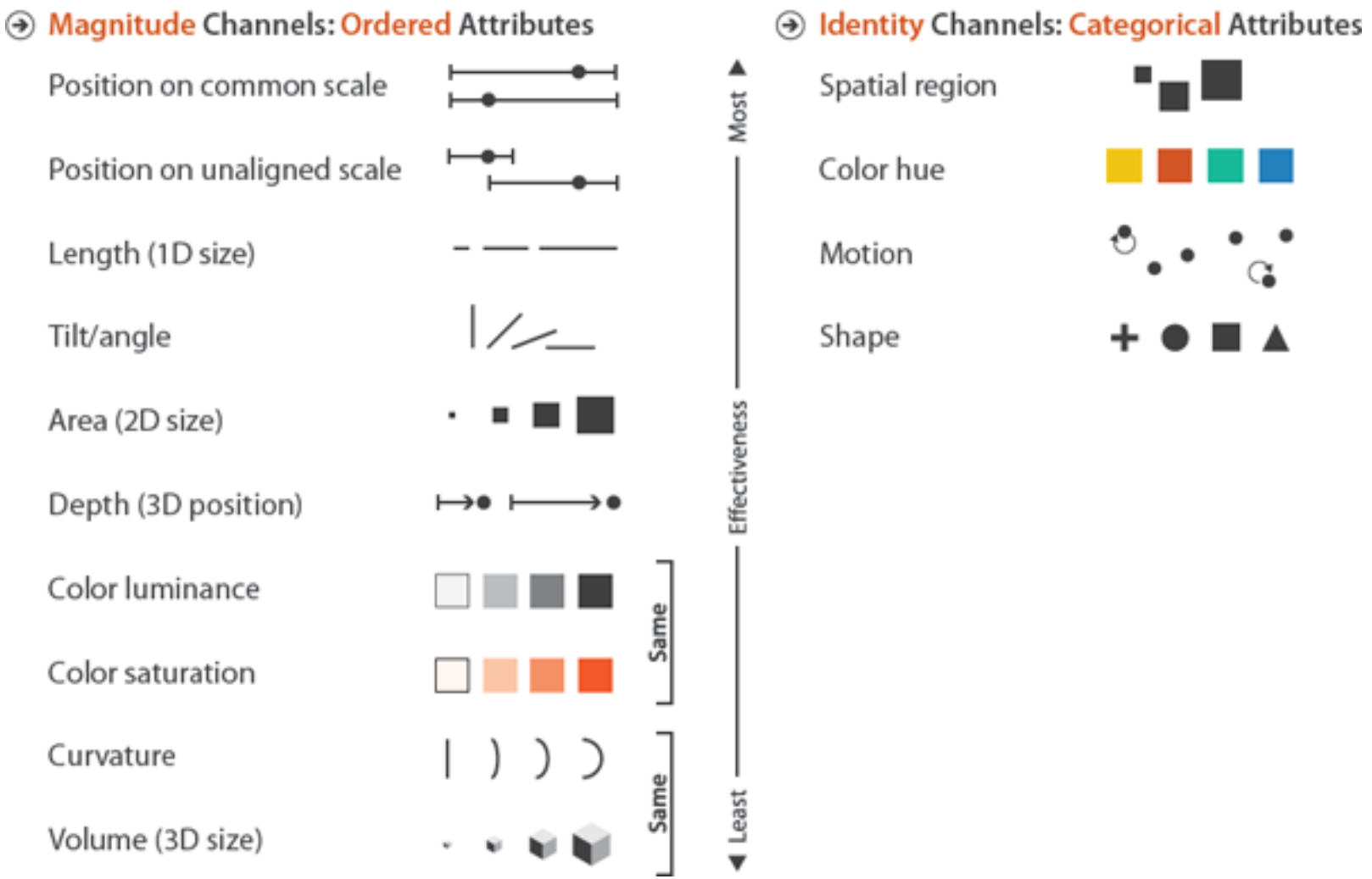
Circles and +’s



C’s and Ↄ’s

Ranking Visual Channels

- Design takeaway: Prioritize most effective channels for most important data



Your Turn!

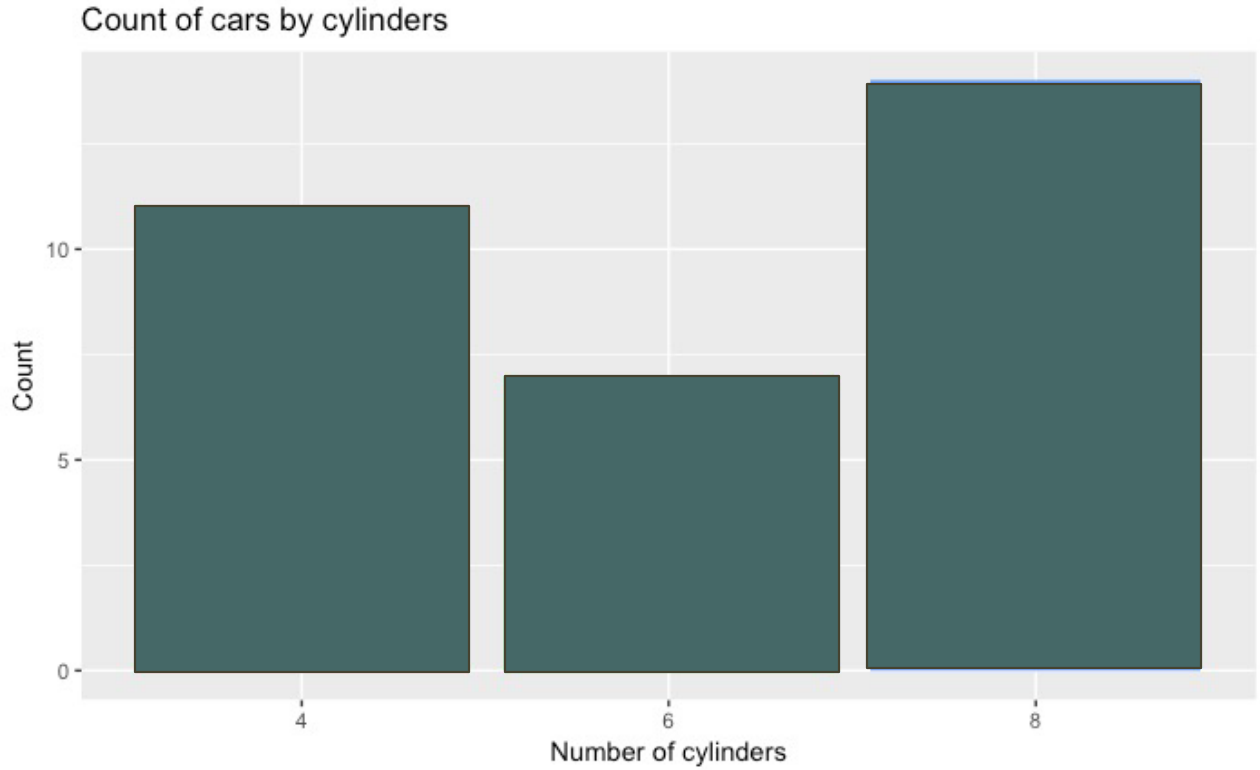
- Find someone (or two) to work with
- Choose a visualization from https://informationisbeautiful.net/

- What variables does the visualization show?
- What visual channel(s) encode each variable?
- Does the visualization follow the principles of effectiveness and expressiveness?

A sampling of visualization techniques

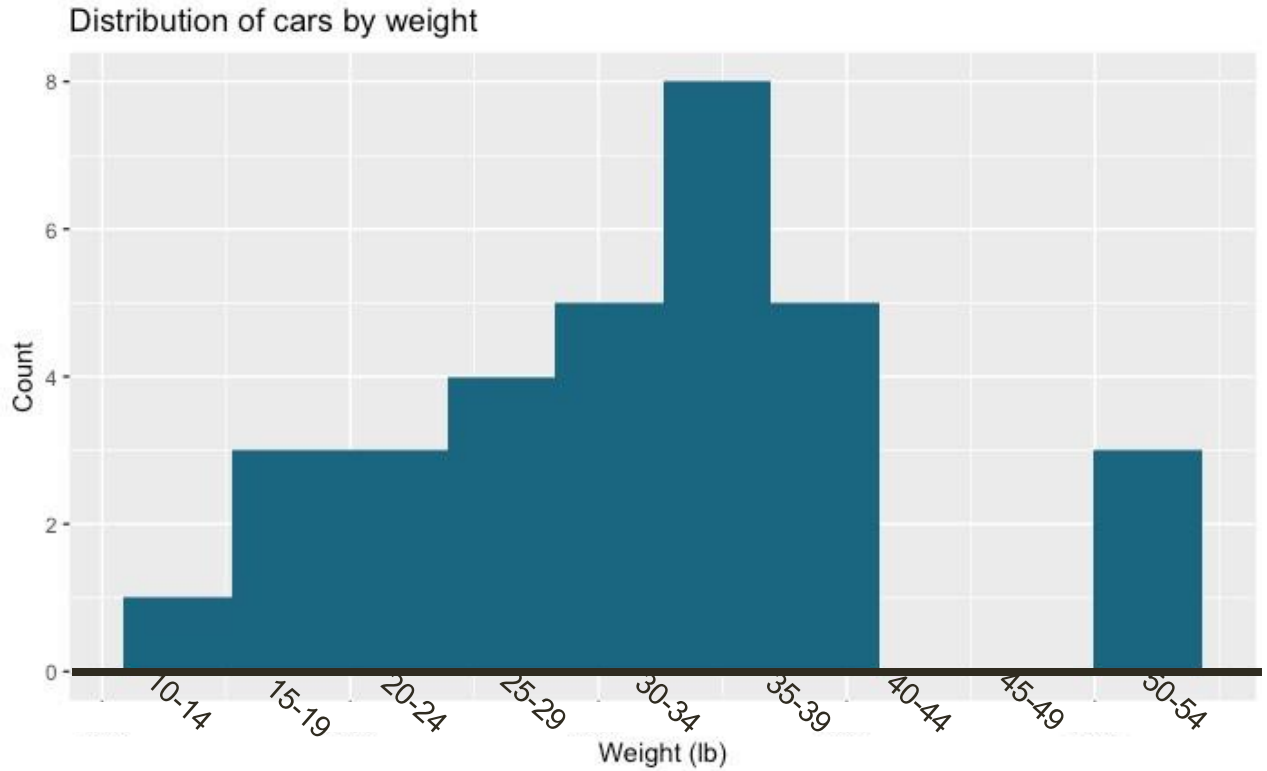
Bar chart

- Used to show **quantitative variable X categorical or ordinal variable**
- **Compares** quantitative values for different categories
- Highlights **relative amounts**
- Grouped/stacked bars can break each **category** into sub-groups



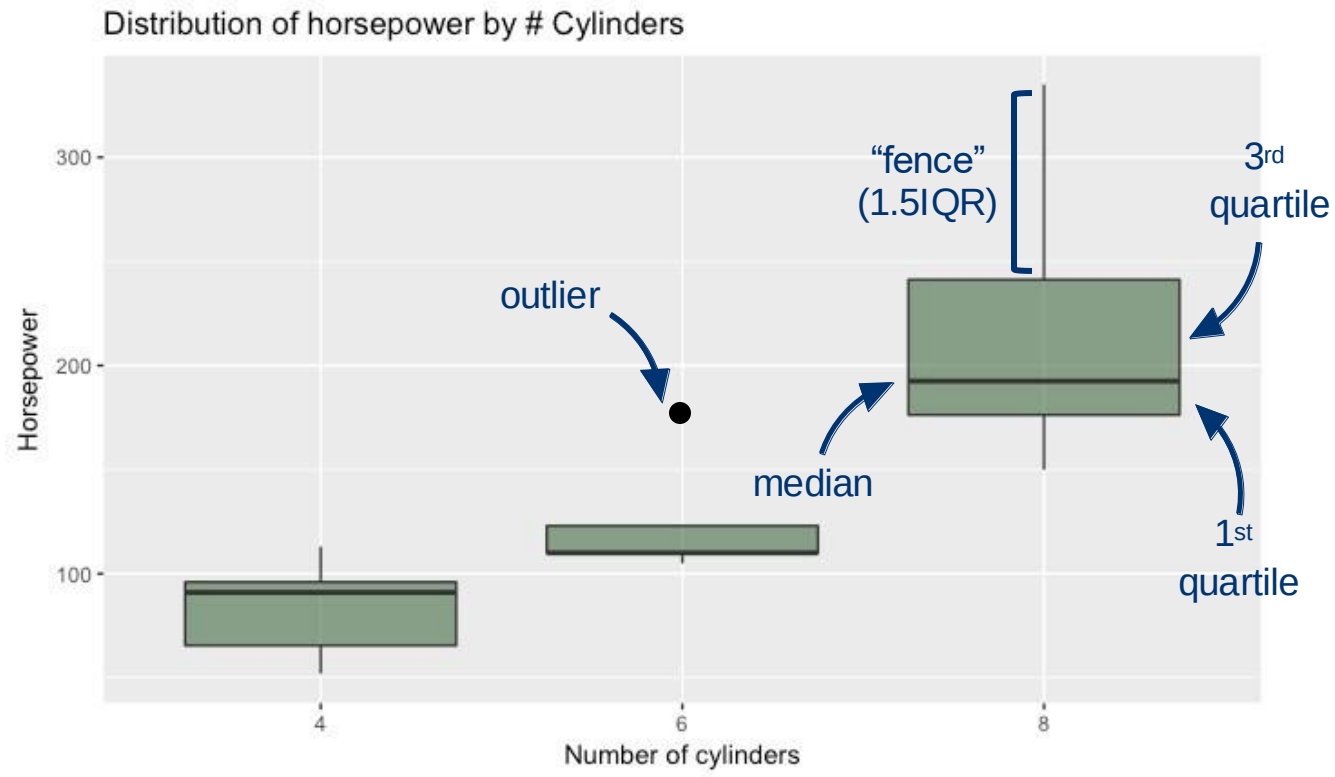
Histogram

- Used for **one quantitative variable**
- Looks like a bar chart… but the x-axis consists of equal size ranges (bins) for the quantitative variable
- Y-axis shows count or relative frequency
- Highlights **distribution**
- Note: bin size makes a big difference!



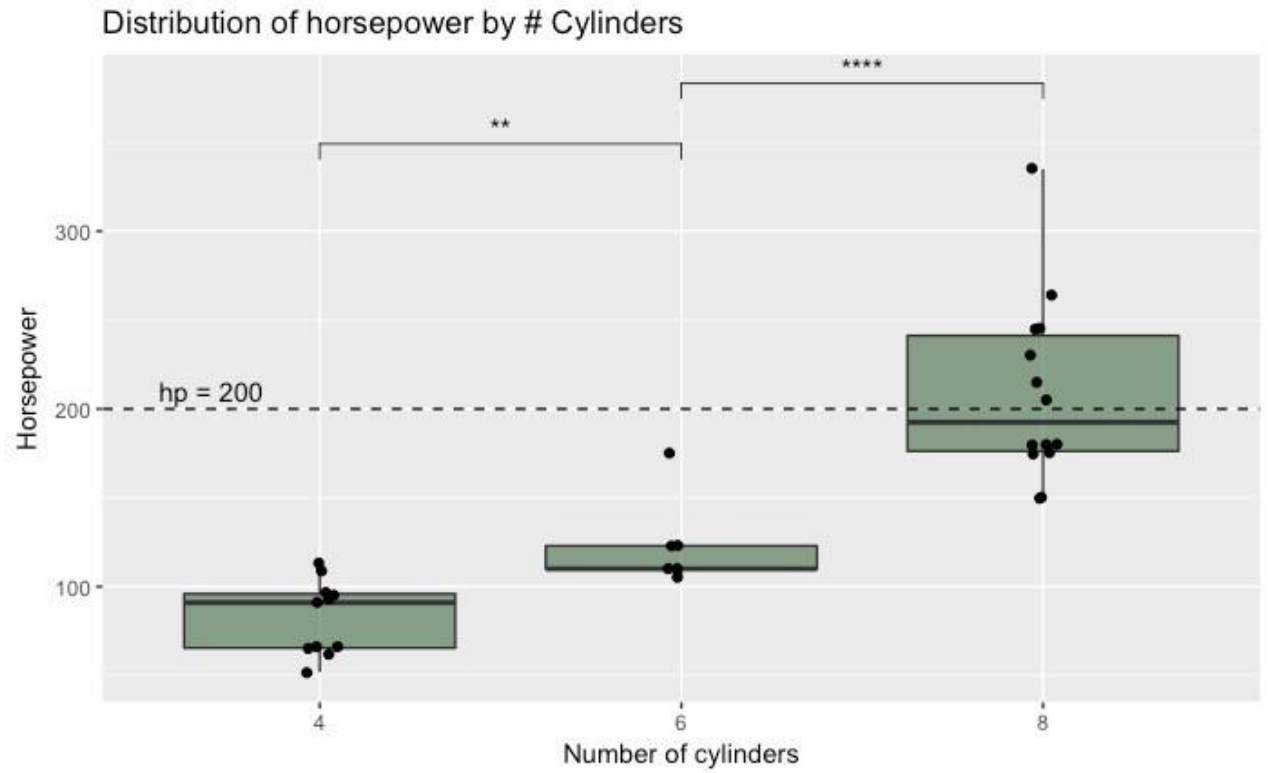
Boxplot

- Used for **one quantitative variable**
- Also useful for highlighting **distribution**
- Calls out key values:
  - median
  - 1st & 3rd quartiles
  - "fences"
  - outliers



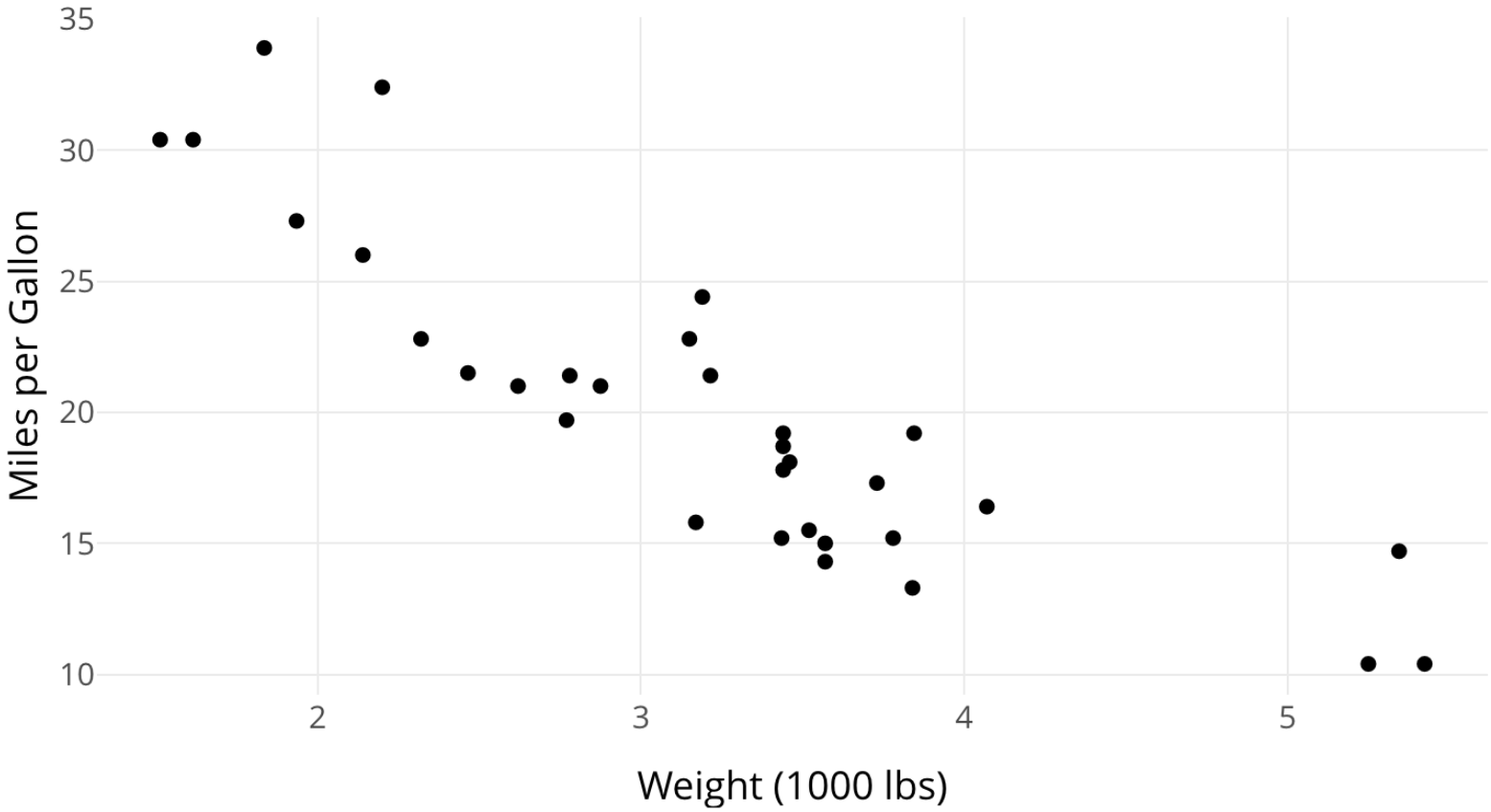
Boxplot

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



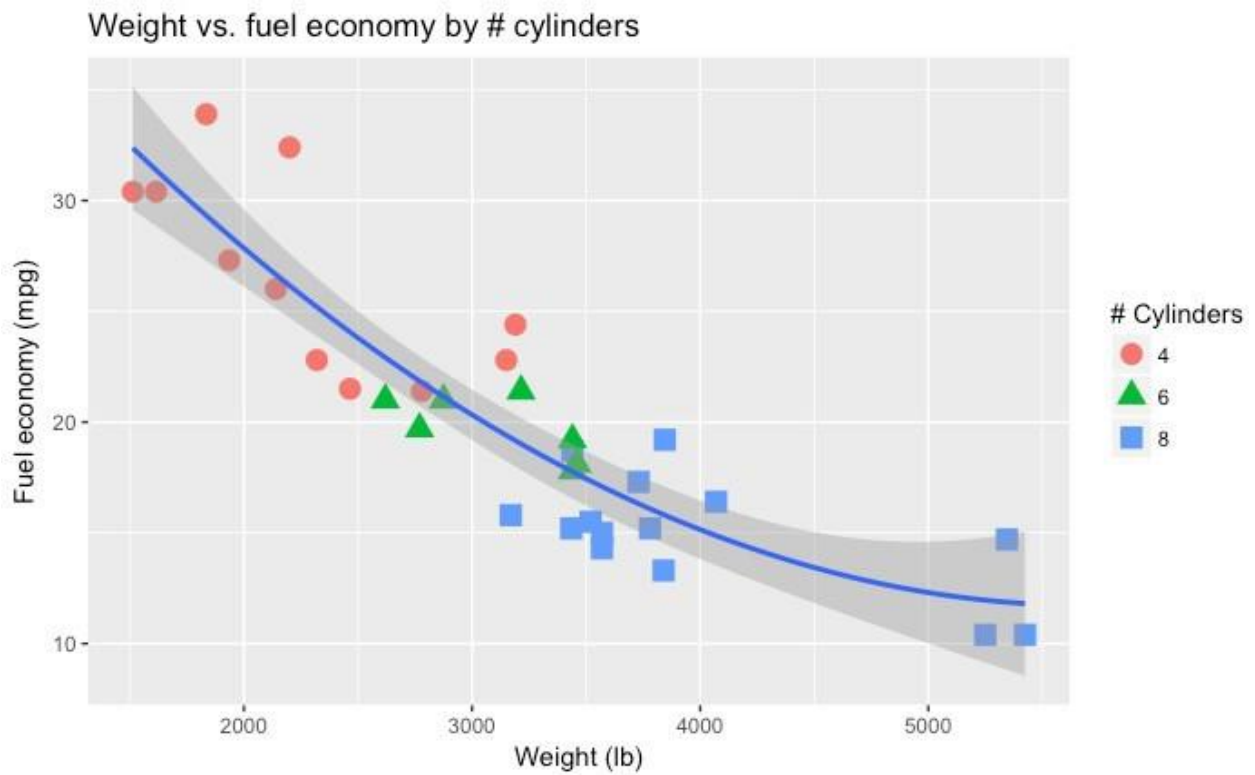
Scatterplot

- Used to show **one quantitative variable X one quantitative variable**
- Shows the **relationship** between the two variables
- Each point in the plot represents an observation



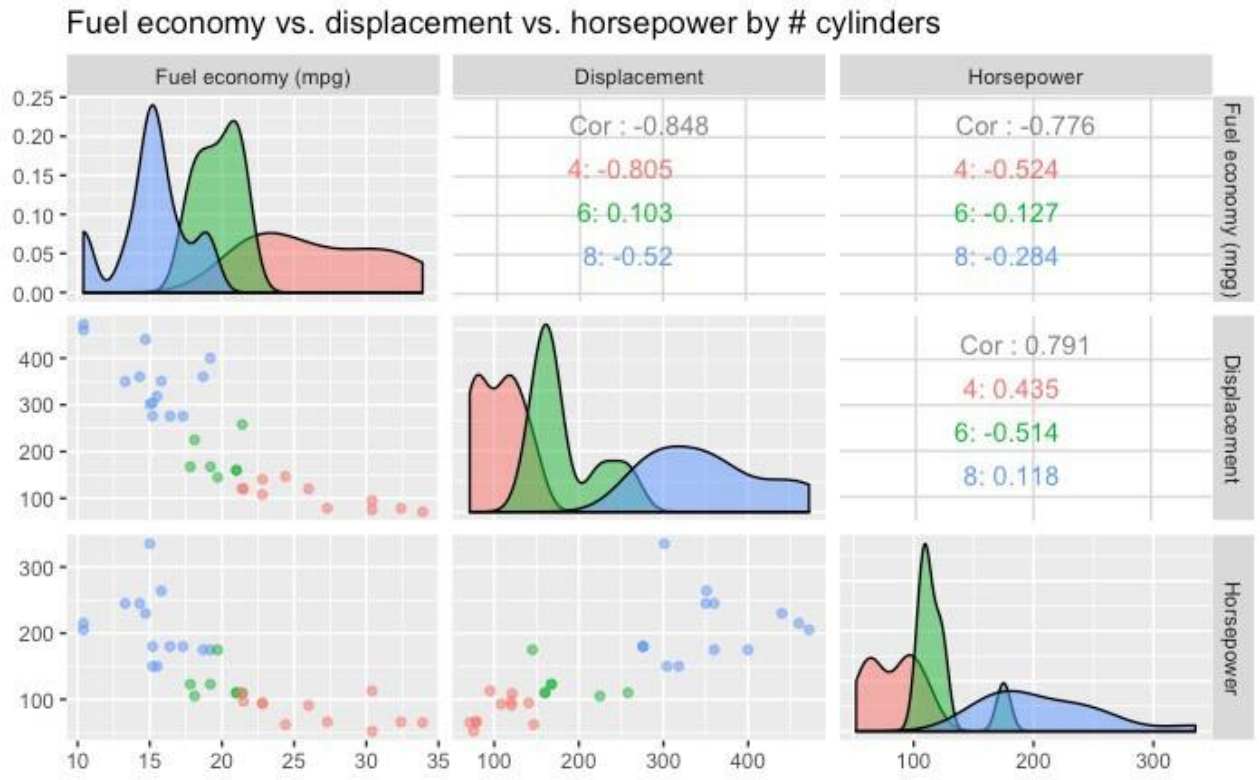
Scatterplot

- Can use color or symbol to show **one quantitative variable X one quantitative variable X one categorical variable**
- This highlights groups
- Sometimes useful to show a trend line (regression)



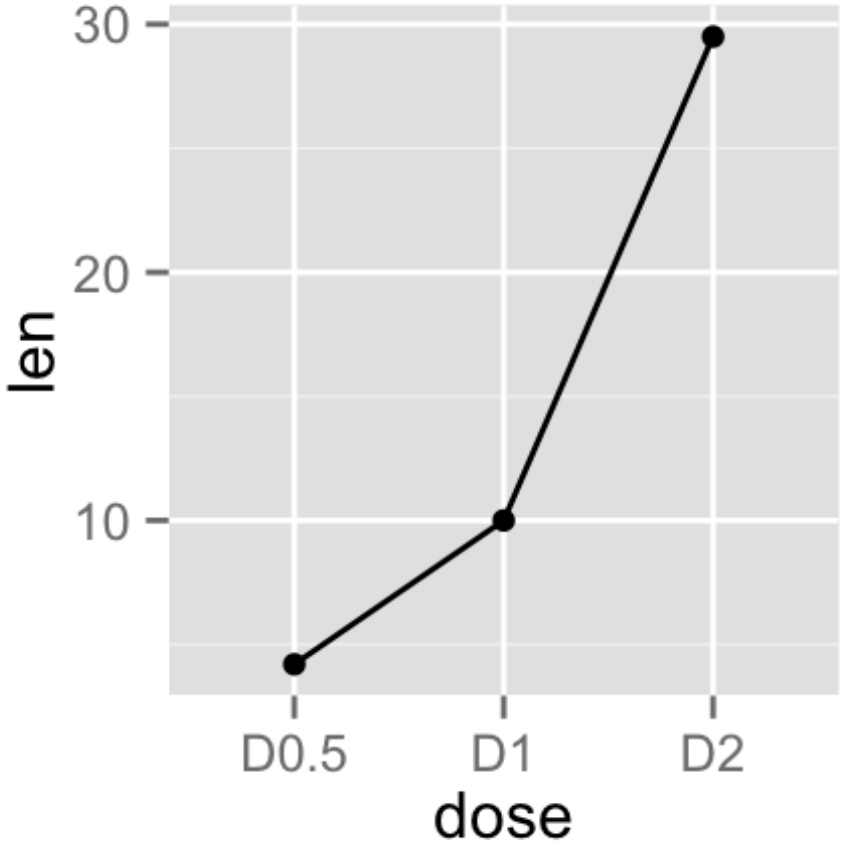
Scatterplot matrix (SPLOM)

- Can use to show **many combinations of one quantitative variable X one quantitative variable**
- Combines multiple scatterplots into a matrix to show **additional relationships**



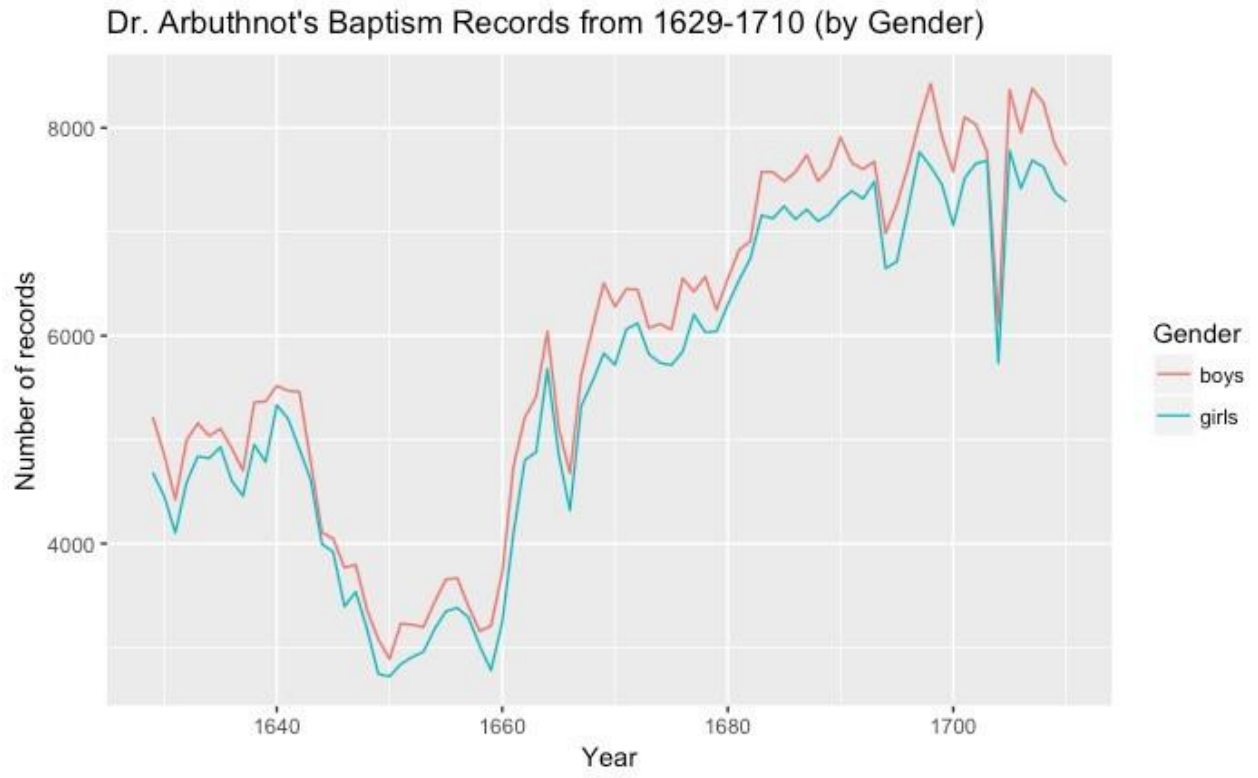
Line chart

- Shows the **trend of one quantitative variable**, often **over time**

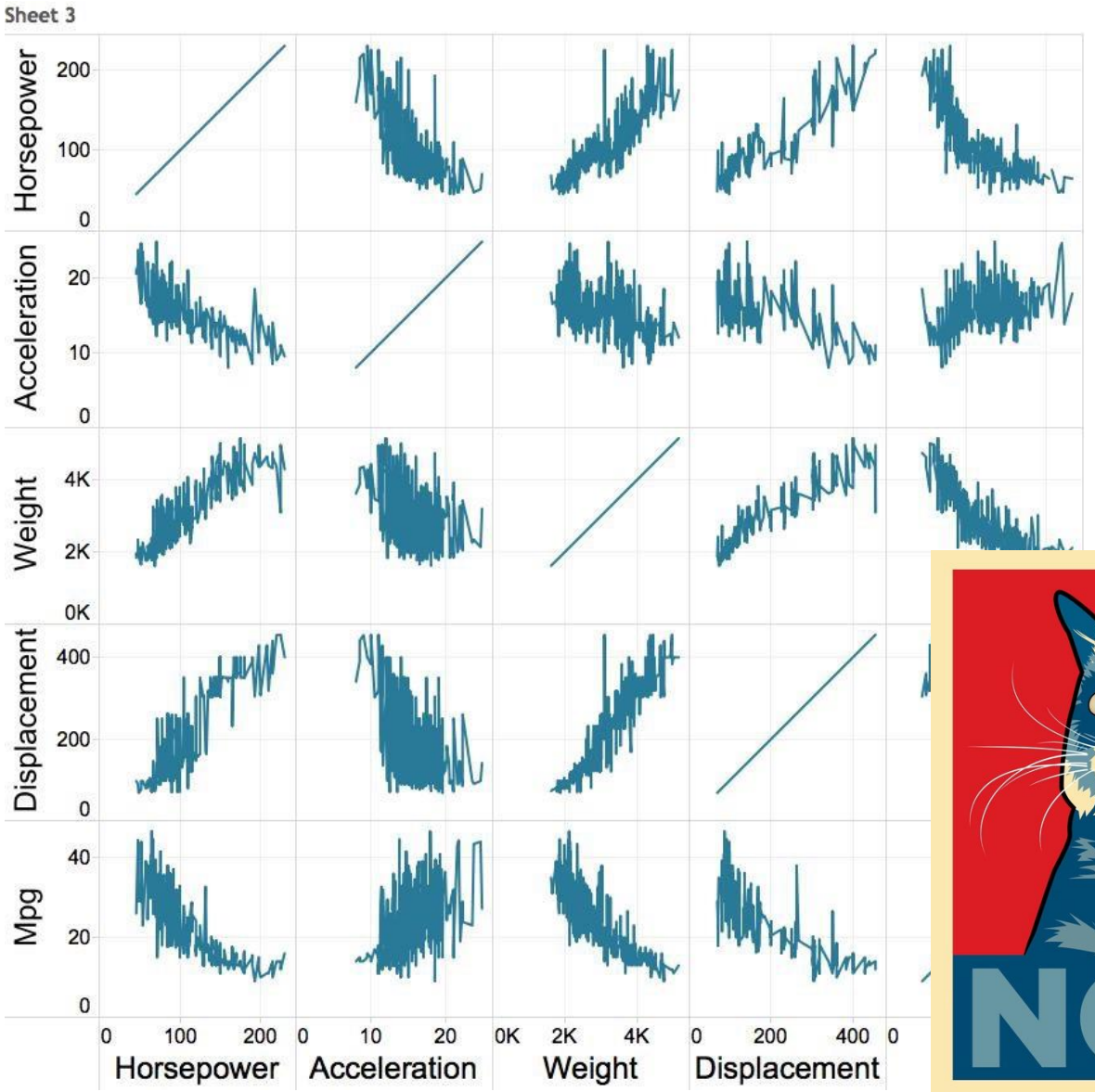


Line chart

- Multiple lines allow **comparison of trends**
- Can show one quantitative variable across groups, or multiple quantitative variables (if they have the same scale)
- Highlights "position switches"

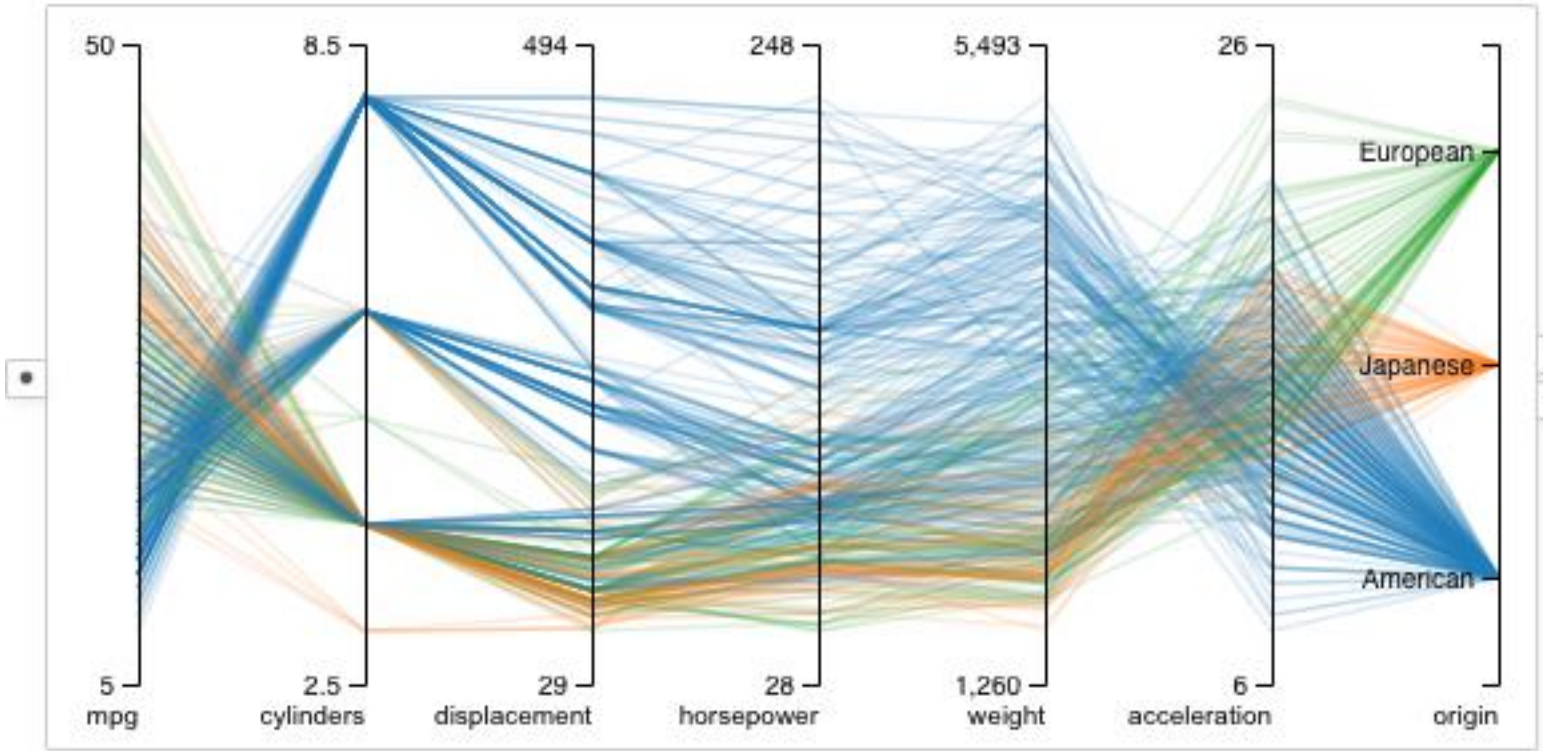


Multiple variables: line chart matrix?



Parallel Coordinates Plot

- Supports (pairwise) **comparison of a collection of quantitative variables**
- Each axis represents one variable
  - They may have different scales, typically you normalize them
- Each line represents one observation (connecting the associated values along each axis)
- Axis order matters!

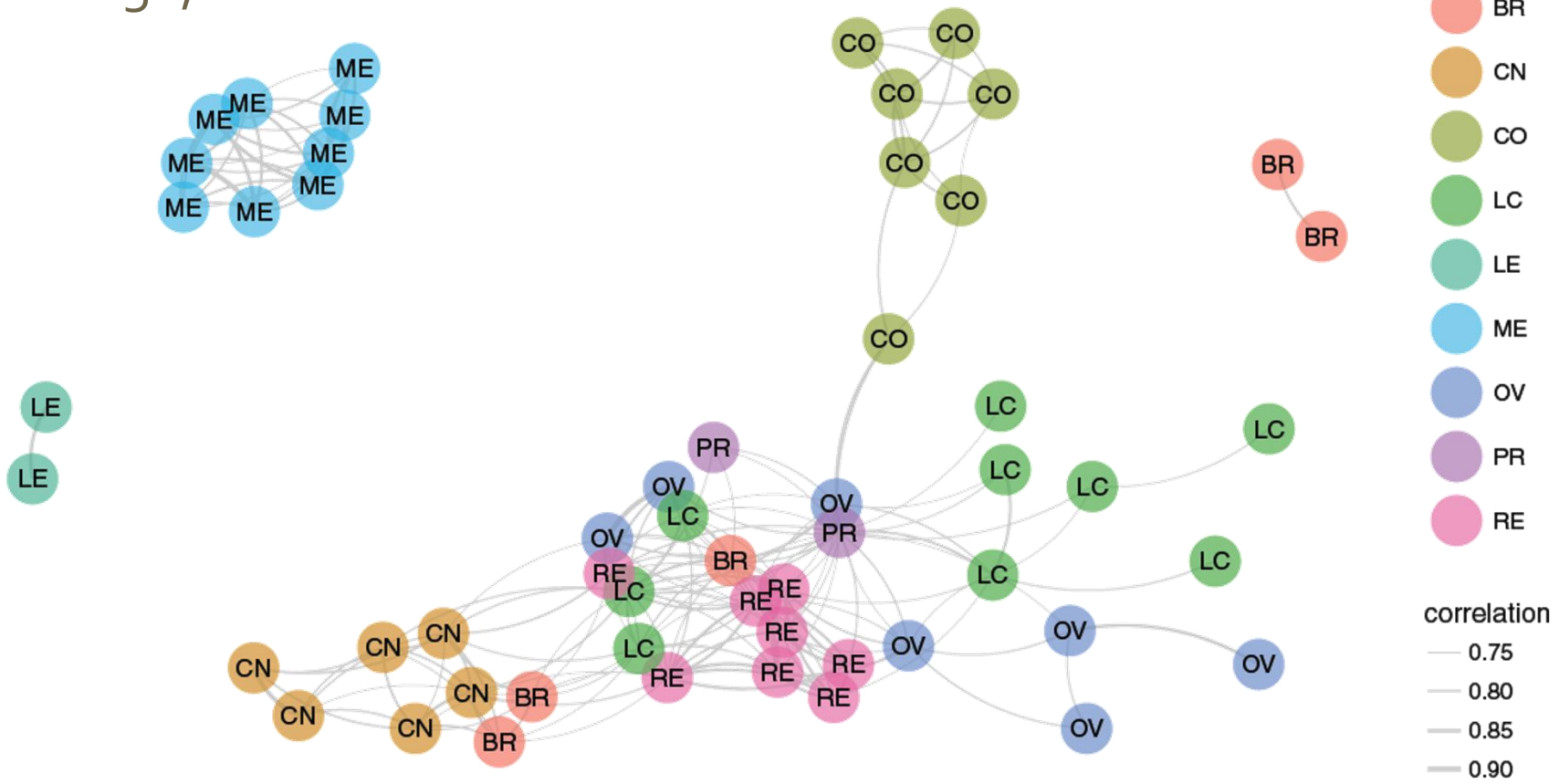


https://visflow.org/node/visualization/parallel-coordinates.html

ta-to-
parallel.html

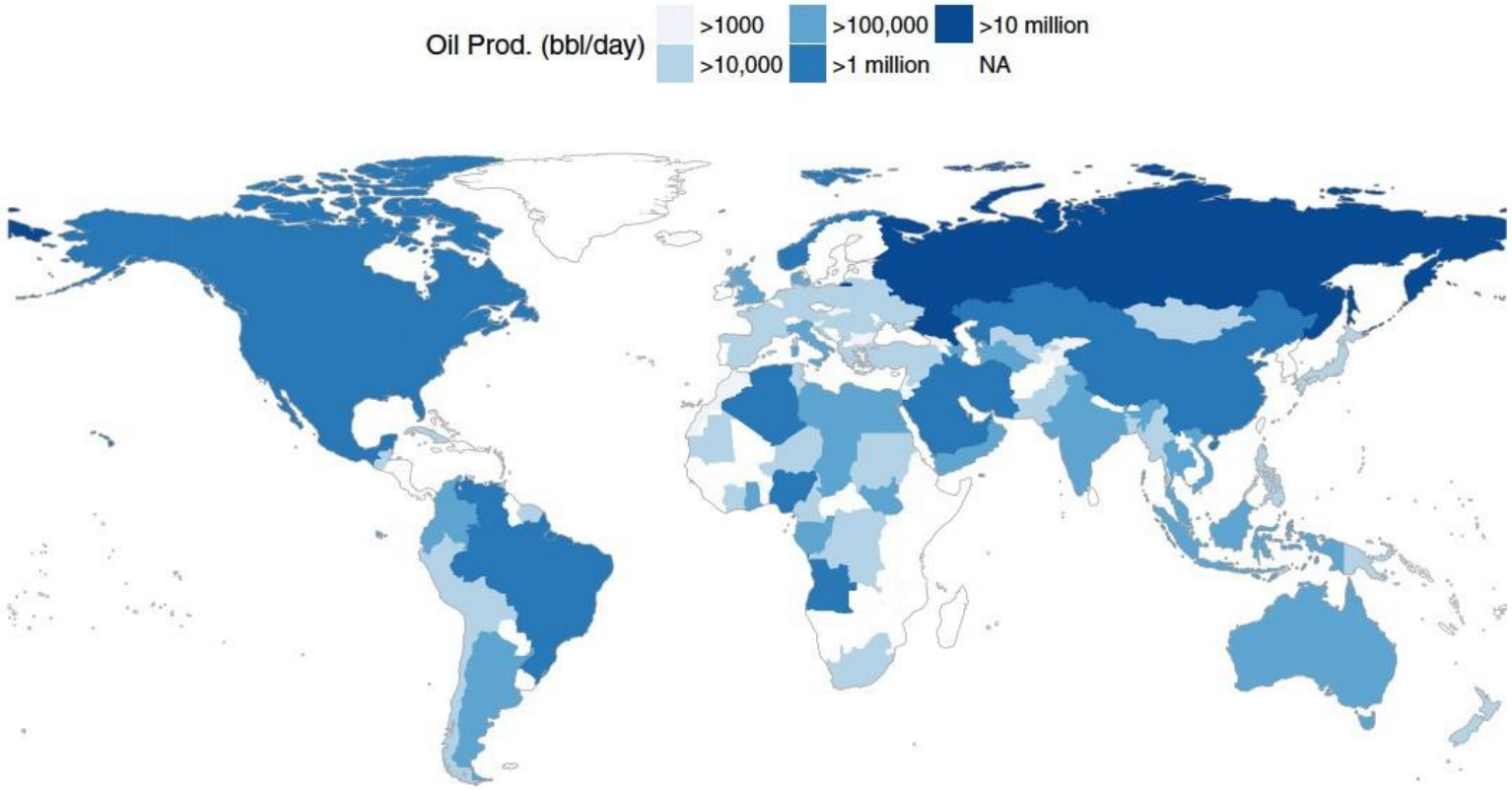
Network

- Shows **graph data**
- Useful for showing the **relationships between entities**
- Can use color, size, etc. to encode additional information
- Caveat: network diagrams quickly become hairballs for large, dense data



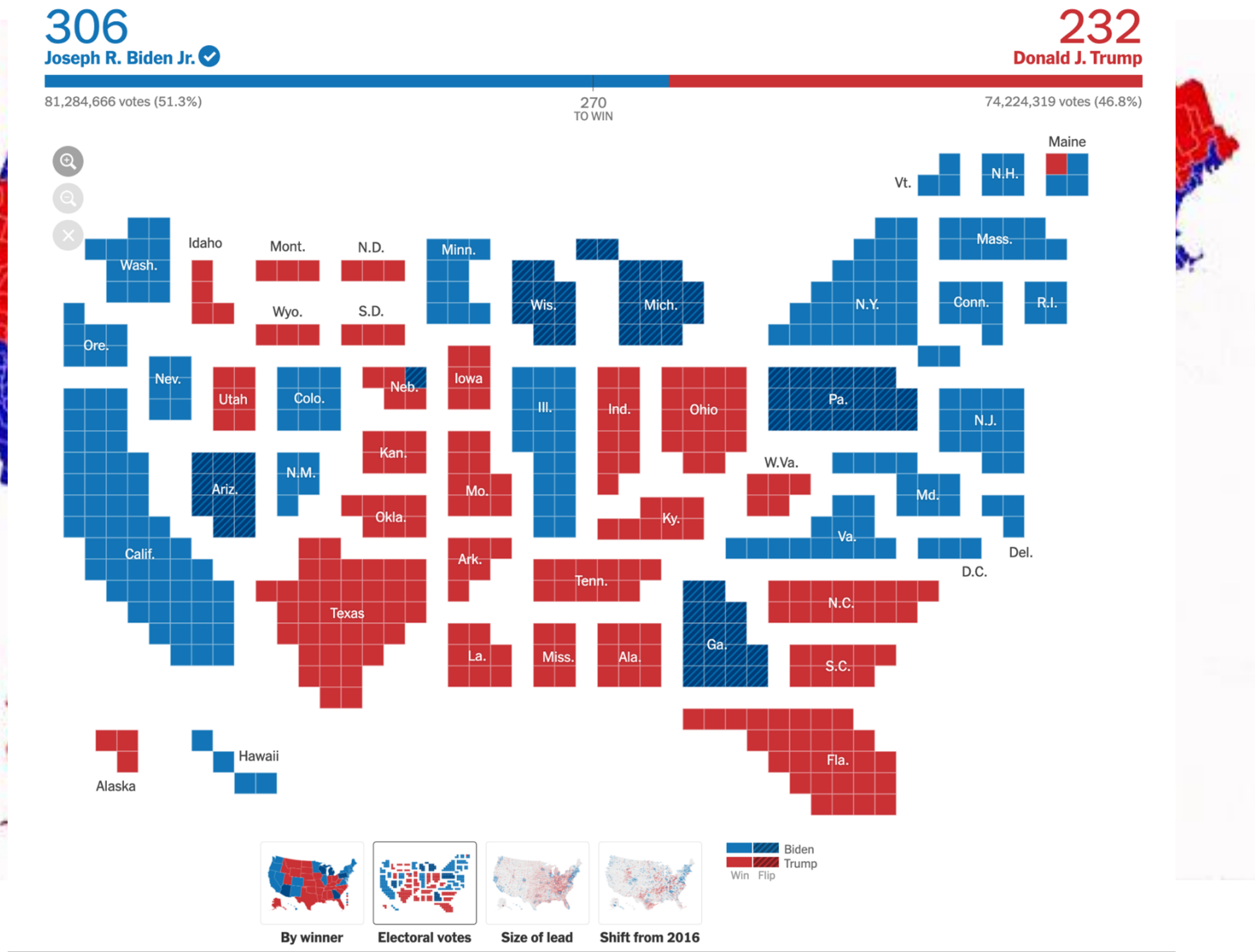
Map

- Shows **geographic (spatial) data**
- Useful for analysis with a strong geographic component
- Filled maps (choropleth) vs. points
- Remember: color scale comparisons are harder for humans than size comparisons!



Map

- Remember to map the correct data to your visual channels



Your Turn!

- Find someone (or two) to work with
- Choose a visual encoding from https://datavizproject.com/ that you ***have not previously encountered***
- What variable types is your visual encoding good for?
- What types of questions do you think this visual encoding would be good for answering?
- Find an example of the visual encoding with real data. What is one interesting thing the visualization shows?