STAT 209
Data Computing and Visualization

June 3rd, 2021

Colin Reimer Dawson

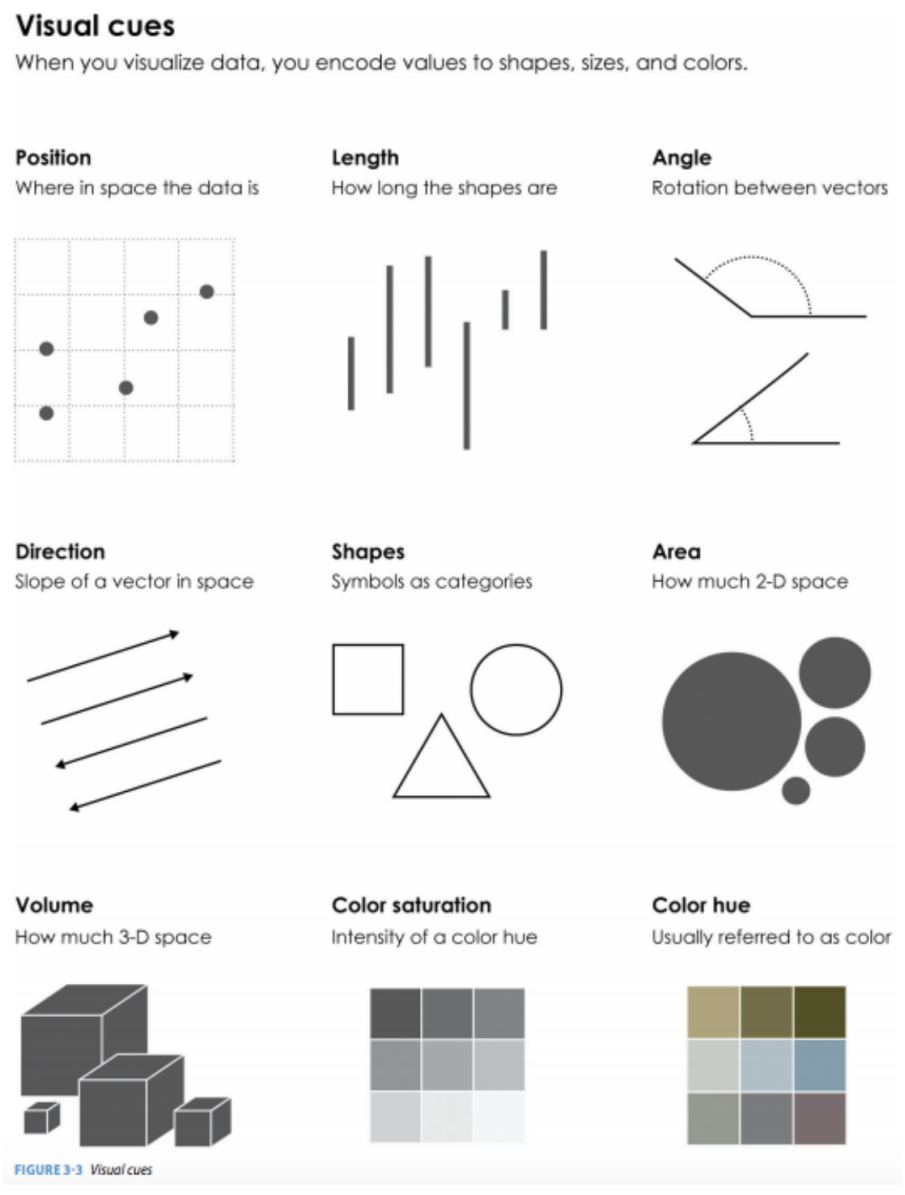
Outline

Elements of data graphics
- Graphical Elements
- Human-Sensitive Design

The Grammar of Graphics

Elements of data graphics

- Visual cues
  - position, size, color, etc.
- Coordinate system
  - how are data points organized?
- Scale
  - relationship between variable and distance in space
- Context
  - what in the world is the data about?
- Faceting
  - What are the sub-parts (facets) of the graph?



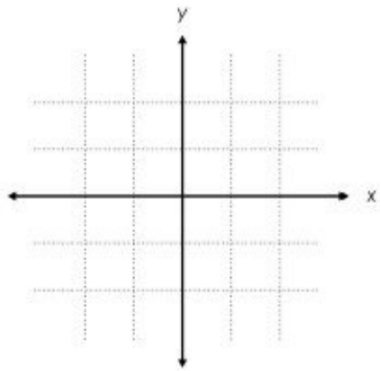
Source: Nathan Yau, *Data Points*

Coordinate systems

There are a variety of them, from cylindrical to spherical, but these three will cover most of your bases.

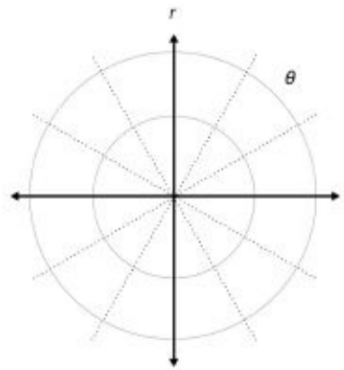
Cartesian

If you've ever made a graph, the x- and y-coordinate system will look familiar to you.



Polar

Pie charts use this system. Coordinates are placed based on radius *r* and angle *θ*.



Geographic

Latitude and longitude are used to identify locations in the world. Because the planet is round, there are multiple projections to display geographic data in two dimensions. This one is the Winkel tripel.

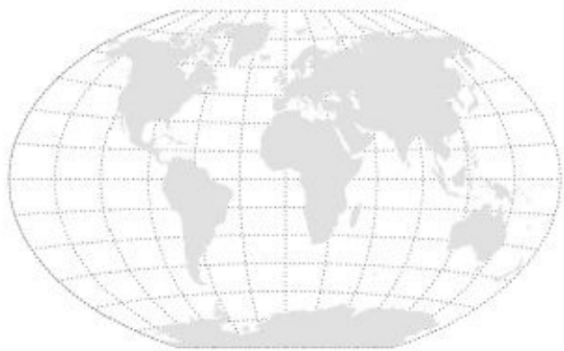


FIGURE 3-13 *Commonly used coordinate systems*

Source: Nathan Yau, *Data Points*

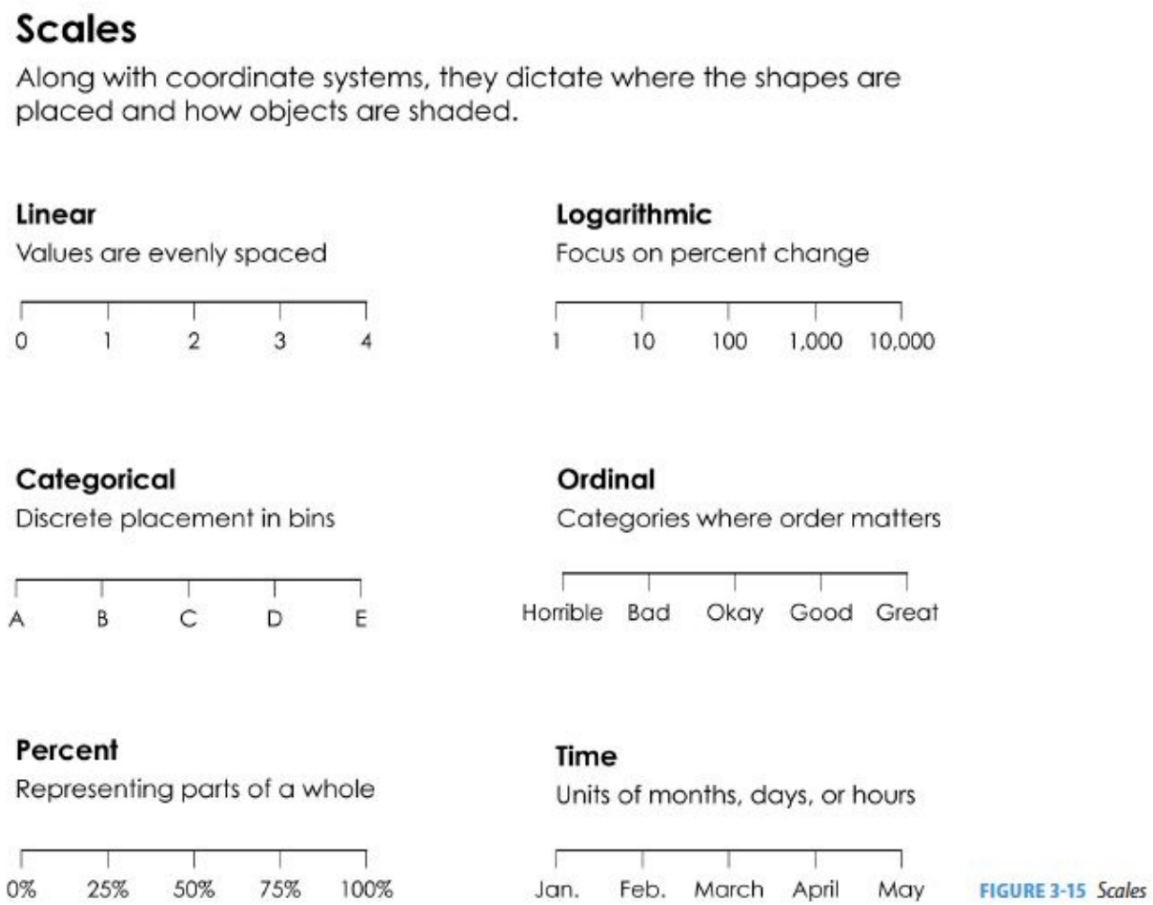
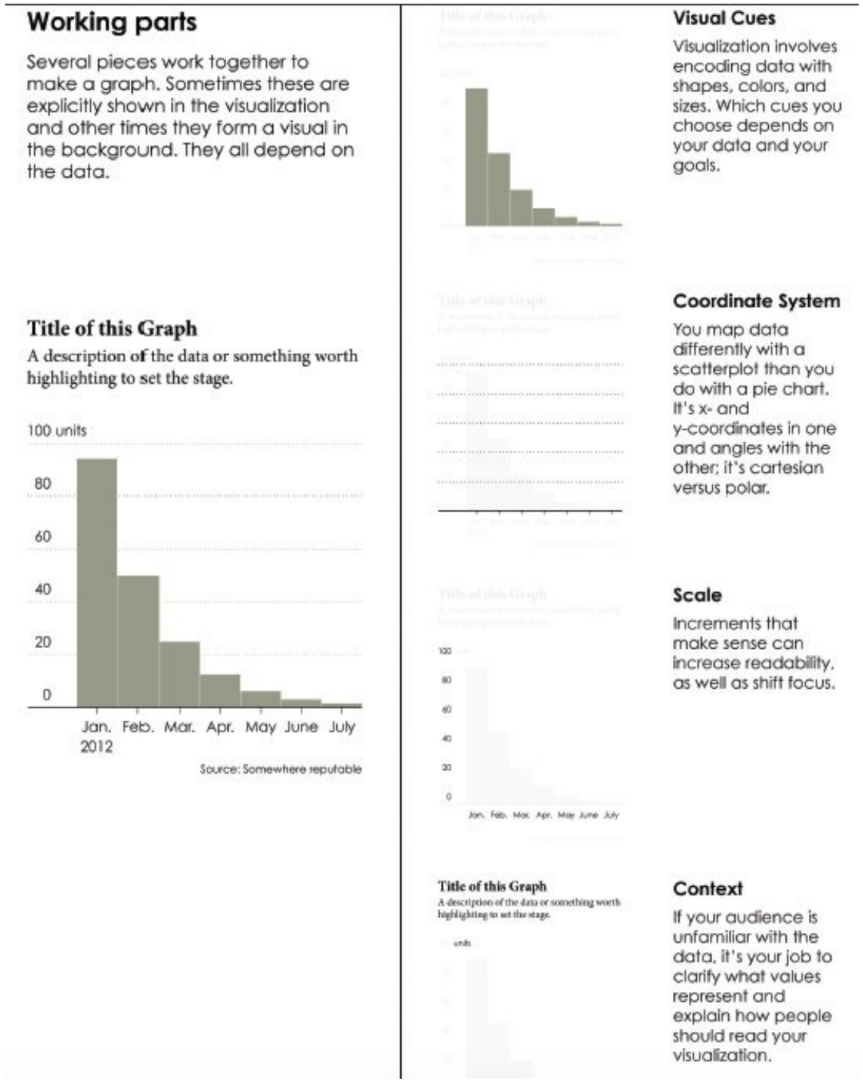


FIGURE 3-15 *Scales*

Source: Nathan Yau, *Data Points*



Source: Nathan Yau, *Data Points*

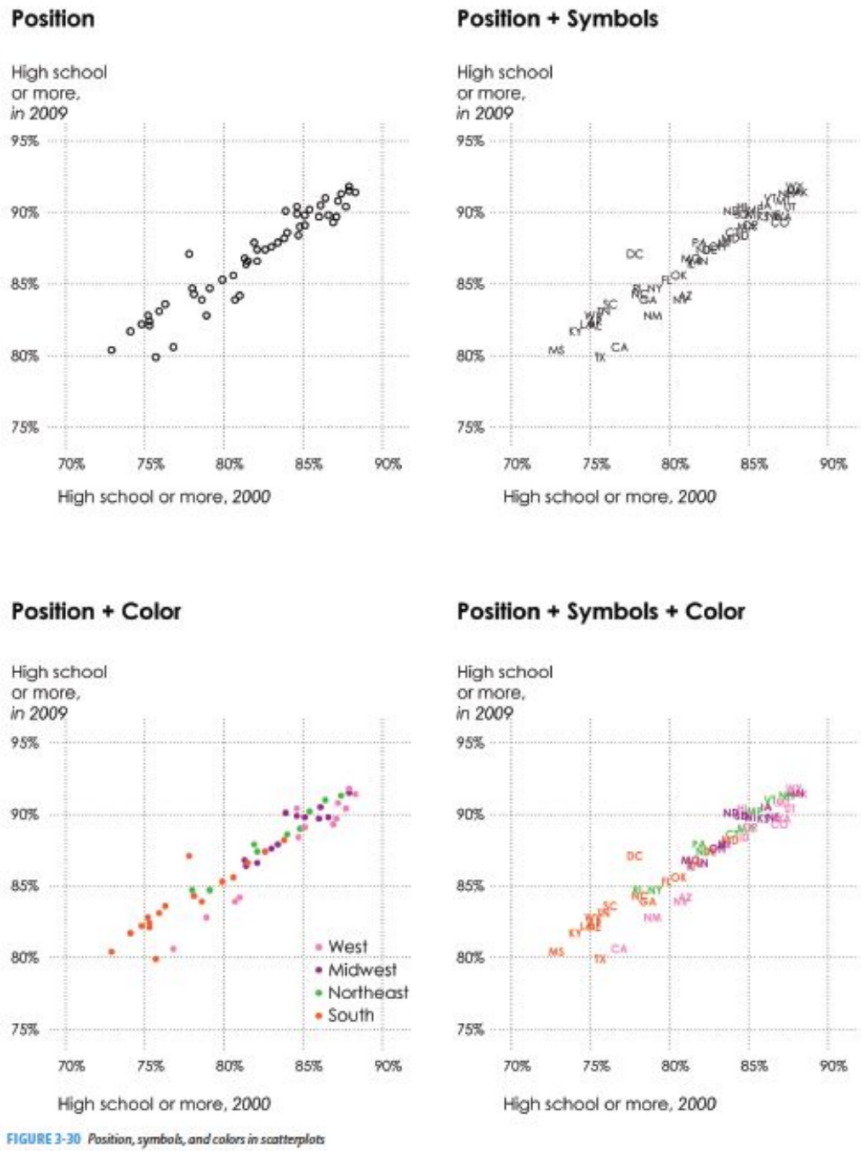
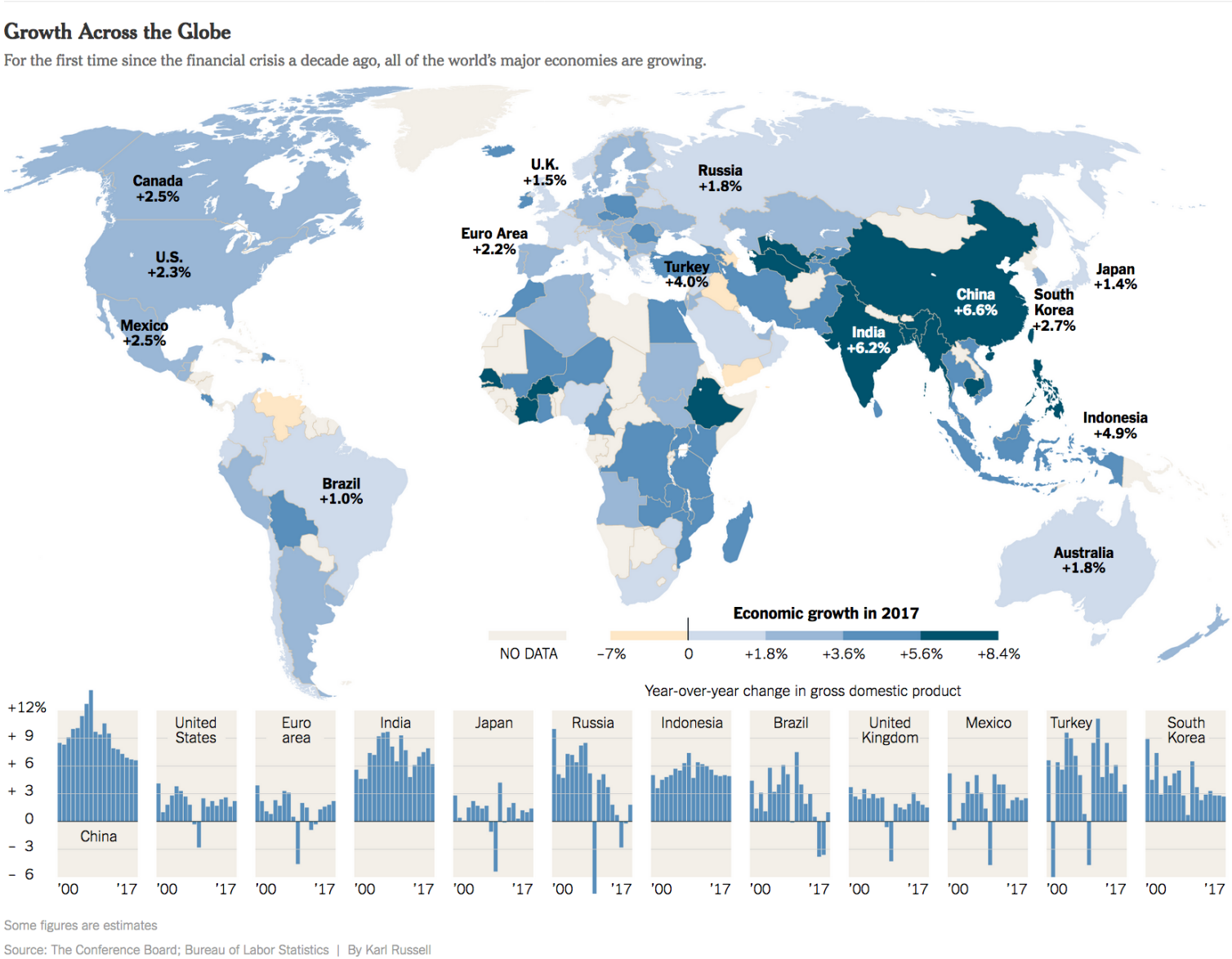


FIGURE 3-30 *Position, symbols, and colors in scatterplots*

Source: Nathan Yau, *Data Points*



Source: New York Times

A Perceptual Hierarchy

Cleveland and McGill (1985): people better at judging:

- position than size
- length than angle
- 1D differences than 2D differences
- 2D differences than 3D differences
- size than color

Dos and Don'ts

- Prefer length scale to color scale
- Never use pie charts
- ABC: Always Bring Context
- Above all else, *show the data* (Edward Tufte)

The Grammar of Graphics

- *The Grammar of Graphics* by Leland Wilkinson (1999, 2005) set out to define "parts of speech" and "grammar rules" of data visualization
- An "ontology of graphs"
- Implemented in R in `ggplot2` package (Hadley Wickham, 2010)
    - `ggplot` (or `ggplot1`) was sort of a beta version; not really used today

Graphical elements in ggplot2

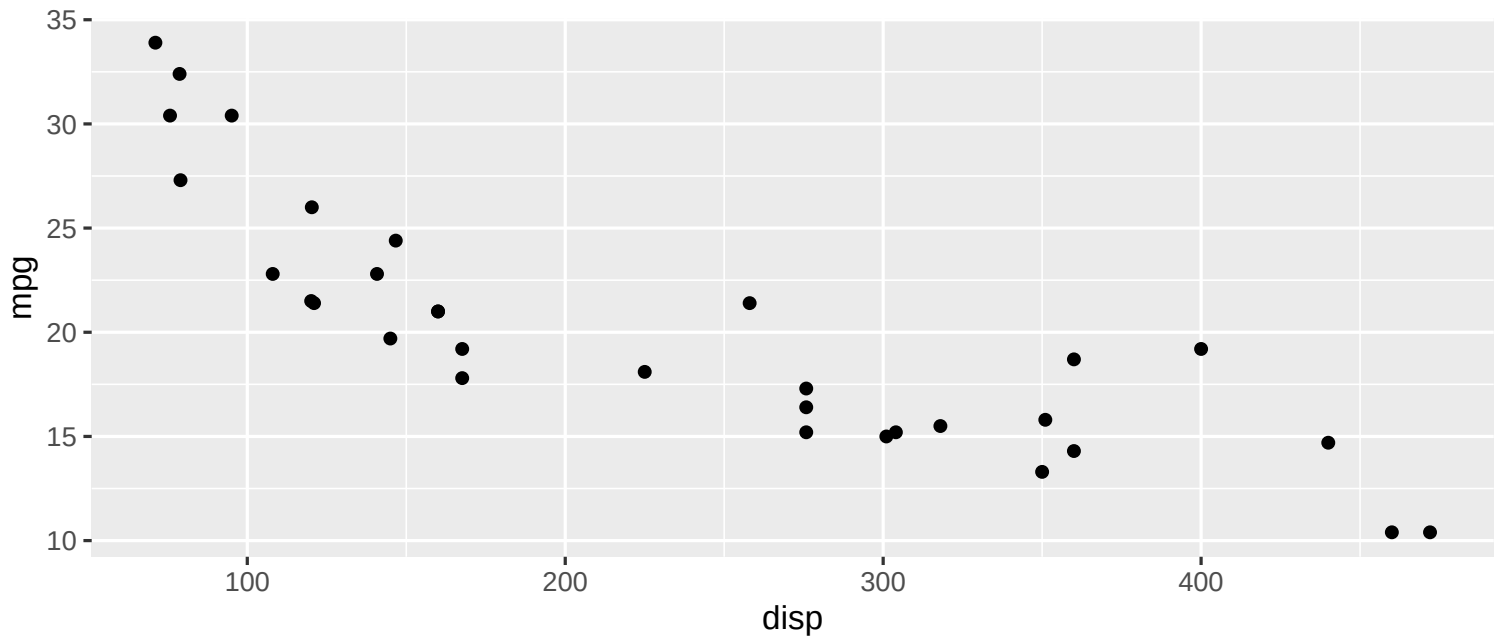
Graphical element	ggplot2 object(s)
The dataset	`data=` argument
Geometric objects	`geom_*()` functions
Mappings of variables to cues	`aes()` function
Scales	`scale_*()` functions
Faceting	`facet_wrap()`, `facet_grid()`

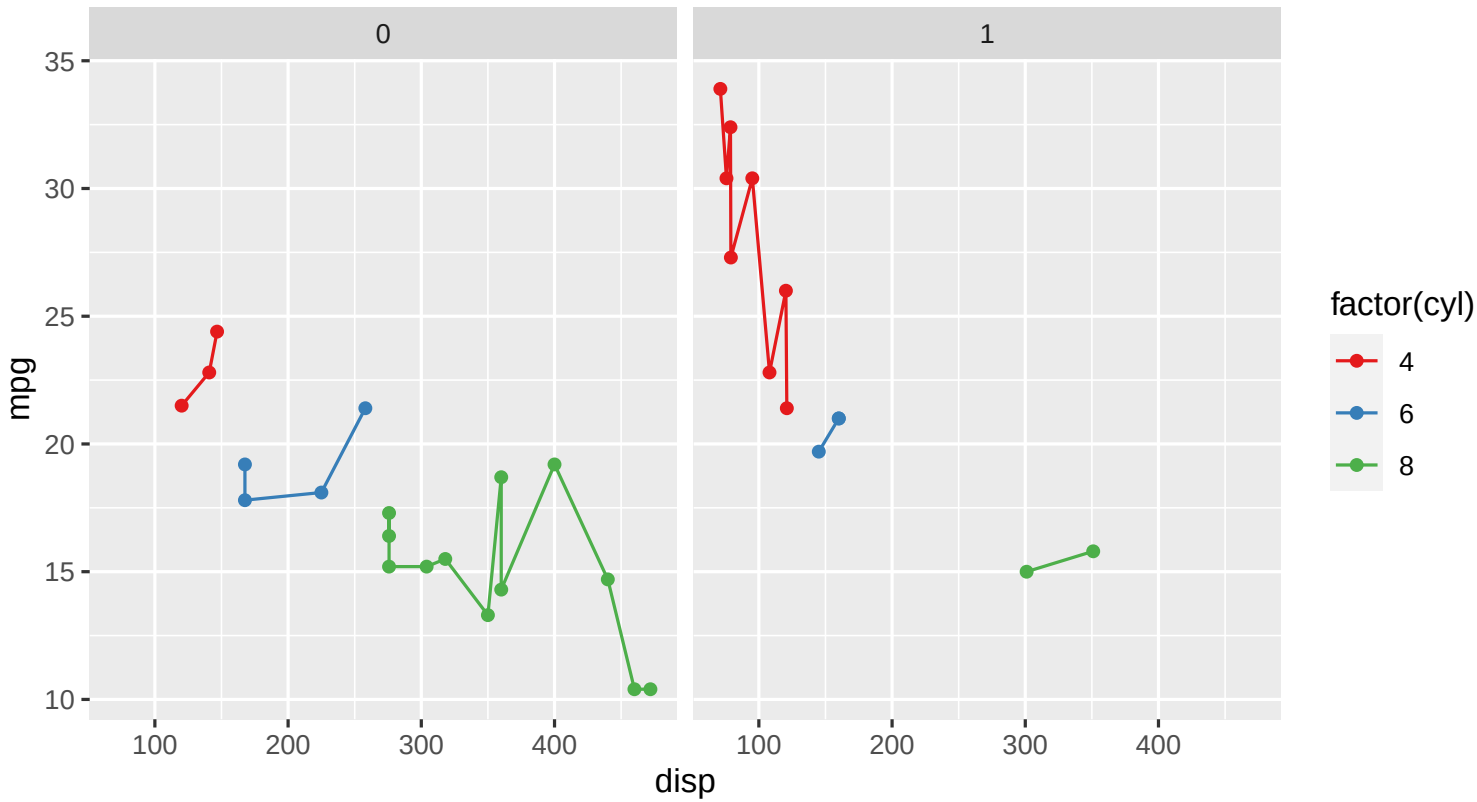
Combination elements via the '+' operator to produce a plot as an R *object* (can be assigned to things, operated on later, etc.)

The minimal template

Plots must at a minimum have data (`data=`), a mapping (`aes()`), and at least one geometry element (`geom_*()`)

```
library(tidyverse)
ggplot(data = mtcars, aes(x = disp, y = mpg)) +
  geom_point()
```



Something more complex

```
ggplot(data = mtcars, aes(x = disp, y = mpg, color = factor(cyl))) +
  geom_point() +
  geom_line() +
  facet_wrap(~am) +
  scale_color_brewer(palette = "Set1")
```