

# Amounts and Proportions

## Session 4

PMAP 8921: Data Visualization with R  
Andrew Young School of Policy Studies  
May 2020

# Plan for today

**Reproducibility**

**Amounts**

**Proportions**

# Reproducibility

# Why am I making you learn R?

Pivot Tables do the same thing!

|    | A                          | B               | C    | D         | E      | F    | G            | H      | I    | J         | K           |
|----|----------------------------|-----------------|------|-----------|--------|------|--------------|--------|------|-----------|-------------|
| 1  |                            |                 |      |           |        |      |              |        |      |           |             |
| 2  |                            |                 |      |           |        |      |              |        |      |           |             |
| 3  | Total words                | Column Labels ▾ |      |           |        |      |              |        |      |           |             |
| 4  |                            | Elf             |      | Elf Total | Hobbit |      | Hobbit Total | Man    |      | Man Total | Grand Total |
| 5  | Row Labels ▾               | Female          | Male |           | Female | Male |              | Female | Male |           |             |
| 6  | The Fellowship Of The Ring | 1229            | 971  | 2200      | 14     | 3644 | 3658         | 0      | 1995 | 1995      | 7853        |
| 7  | The Return Of The King     | 183             | 510  | 693       | 2      | 2673 | 2675         | 268    | 2459 | 2727      | 6095        |
| 8  | The Two Towers             | 331             | 513  | 844       | 0      | 2463 | 2463         | 401    | 3589 | 3990      | 7297        |
| 9  | Grand Total                | 1743            | 1994 | 3737      | 16     | 8780 | 8796         | 669    | 8043 | 8712      | 21245       |
| 10 |                            |                 |      |           |        |      |              |        |      |           |             |
| 11 |                            |                 |      |           |        |      |              |        |      |           |             |
| 12 |                            |                 |      |           |        |      |              |        |      |           |             |
| 13 |                            |                 |      |           |        |      |              |        |      |           |             |
| 14 |                            |                 |      |           |        |      |              |        |      |           |             |
| 15 |                            |                 |      |           |        |      |              |        |      |           |             |
| 16 |                            |                 |      |           |        |      |              |        |      |           |             |
| 17 |                            |                 |      |           |        |      |              |        |      |           |             |

PivotTable Fields

FIELD NAME

☒ Film  
☒ Race  
☒ Gender  
☒ Words

Filters

Columns

: Race ⓘ  
: Gender ⓘ

Rows

: Film ⓘ

Values

: Total words ⓘ

# Why am I making you learn R?

**More powerful**

**Free and open source**

**Reproducibility**

# Austerity and Excel

Growth in a Time of Debt

Carmen M. Reinhart and Kenneth S. Rogoff

NBER Working Paper No. 15639

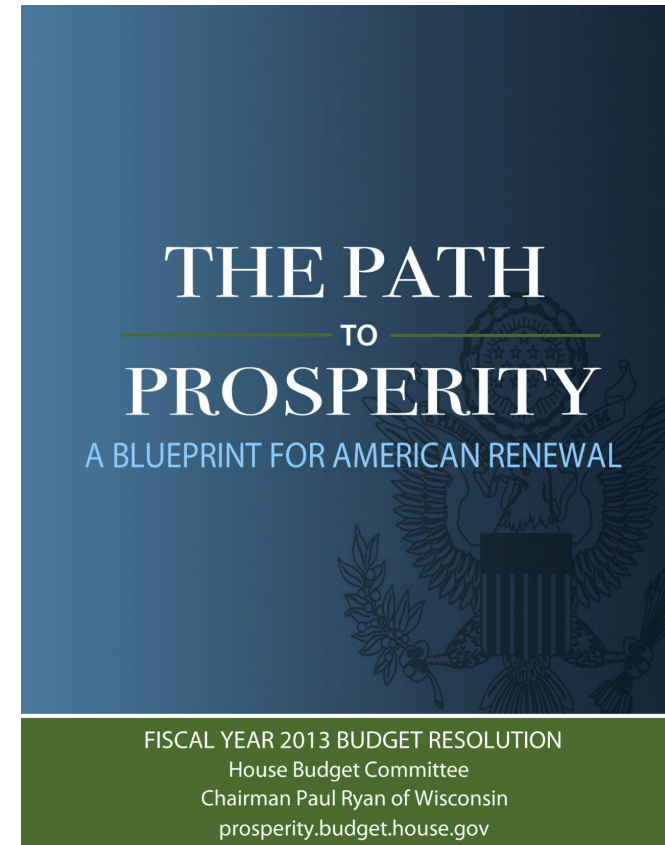
January 2010, Revised January 2010

JEL No. E2,E3,E6,F3,F4,N10

## ABSTRACT

We study economic growth and inflation at different levels of government and external debt. Our analysis is based on new data on forty-four countries spanning about two hundred years. The dataset incorporates over 3,700 annual observations covering a wide range of political systems, institutions, exchange rate arrangements, and historic circumstances. Our main findings are: First, the relationship between government debt and real GDP growth is weak for debt/GDP ratios below a threshold of 90 percent of GDP. Above 90 percent, median growth rates fall by one percent, and average growth falls considerably more. We find that the threshold for public debt is similar in advanced and emerging economies. Second, emerging markets face lower thresholds for external debt (public and private)—which is usually denominated in a foreign currency. When external debt reaches 60 percent of GDP, annual growth declines by about two percent; for higher levels, growth rates are roughly cut in half. Third, there is no apparent contemporaneous link between inflation and public debt levels for the advanced countries as a group (some countries, such as the United States, have experienced higher inflation when debt/GDP is high). The story is entirely different for emerging markets, where inflation rises sharply as debt increases.

**Debt:GDP ratio**  
**90%+ → -0.1% growth**



Paul Ryan's 2013 House budget resolution

# Austerity and Excel



Thomas Herndon

Over time, another problem emerged: Other researchers, using seemingly comparable data on debt and growth, couldn't replicate the Reinhart-Rogoff results. They typically found some correlation between high debt and slow growth — but nothing that looked like a tipping point at 90 percent or, indeed, any particular level of debt.

Finally, Ms. Reinhart and Mr. Rogoff allowed [researchers at the University of Massachusetts](#) to look at their original spreadsheet — and [the mystery of the irreproducible results was solved](#). First, they omitted some data; second, they used unusual and highly questionable statistical procedures; and finally, yes, they made an Excel coding error. Correct these oddities and errors, and you get what [other researchers have found](#): some correlation between high debt and slow growth, with no indication of which is causing which, but no sign at all of that 90 percent “threshold.”

From **Paul Krugman, "The Excel Depression"**

# Austerity and Excel

Table 1. Real GDP Growth as the Level of Government Debt Varies:  
Selected Advanced Economies, 1790-2009  
(annual percent change)

| Country                               | Period    | Central (Federal) government debt/ GDP |                  |                  |                      |
|---------------------------------------|-----------|--|------------------|------------------|----------------------|
|                                       |           | Below 30 percent                       | 30 to 60 percent | 60 to 90 percent | 90 percent and above |
| Australia                             | 1902-2009 | 3.1                                    | 4.1              | 2.3              | 4.6                  |
| Austria                               | 1880-2009 | 4.3                                    | 3.0              | 2.3              | n.a.                 |
| Belgium                               | 1835-2009 | 3.0                                    | 2.6              | 2.1              | 3.3                  |
| Canada                                | 1925-2009 | 2.0                                    | 4.5              | 3.0              | 2.2                  |
| Denmark                               | 1880-2009 | 3.1                                    | 1.7              | 2.4              | n.a.                 |
| Finland                               | 1913-2009 | 3.2                                    | 3.0              | 4.3              | 1.9                  |
| France                                | 1880-2009 | 4.9                                    | 2.7              | 2.8              | 2.3                  |
| Germany                               | 1880-2009 | 3.6                                    | 0.9              | n.a.             | n.a.                 |
| Greece                                | 1884-2009 | 4.0                                    | <b>0.3</b>       | <b>4.8</b>       | 2.5                  |
| Ireland                               | 1949-2009 | 4.4                                    | 4.5              | 4.0              | 2.4                  |
| Italy                                 | 1880-2009 | <b>5.4</b>                             | <b>4.9</b>       | 1.9              | 0.7                  |
| Japan                                 | 1885-2009 | 4.9                                    | 3.7              | 3.9              | 0.7                  |
| Netherlands                           | 1880-2009 | 4.0                                    | 2.8              | 2.4              | 2.0                  |
| New Zealand                           | 1932-2009 | 2.5                                    | 2.9              | 3.9              | <b>3.6</b>           |
| Norway                                | 1880-2009 | 2.9                                    | 4.4              | n.a.             | n.a.                 |
| Portugal                              | 1851-2009 | 4.8                                    | 2.5              | 1.4              | n.a.                 |
| Spain                                 | 1850-2009 | <b>1.6</b>                             | 3.3              | <b>1.3</b>       | 2.2                  |
| Sweden                                | 1880-2009 | 2.9                                    | 2.9              | 2.7              | n.a.                 |
| United Kingdom                        | 1830-2009 | 2.5                                    | 2.2              | 2.1              | 1.8                  |
| United States                         | 1790-2009 | 4.0                                    | 3.4              | 3.3              | <b>-1.8</b>          |
| Average                               |           | <b>3.7</b>                             | <b>3.0</b>       | <b>3.4</b>       | <b>1.7</b>           |
| Median                                |           | <b>3.9</b>                             | <b>3.1</b>       | <b>2.8</b>       | <b>1.9</b>           |
| Number of observations = <b>2,317</b> |           | 866                                    | 654              | 445              | 352                  |

**Debt:GDP ratio = 90%+ → 2.2% growth (!!)**



# Genes and Excel

Septin 2

Membrane-  
Associated Ring  
Finger (C3HC4) 1

2310009E13

|   | A            | B                        |
|---|--------------|--------------------------|
| 1 | Actual value | What Excel turns it into |
| 2 | SEPT2        | 2-Sep                    |
| 3 | MARCH1       | 1-Mar                    |
| 4 | 2310009E13   | 2.31E+19                 |

**20% of genetics papers between 2005–2015 (!!!)**

# General guidelines

**Don't touch the raw data**

**If you do, explain what you did!**

**Use self-documenting, reproducible code**

**R Markdown!**

**Use open formats**

**Use .csv, not .xlsx**

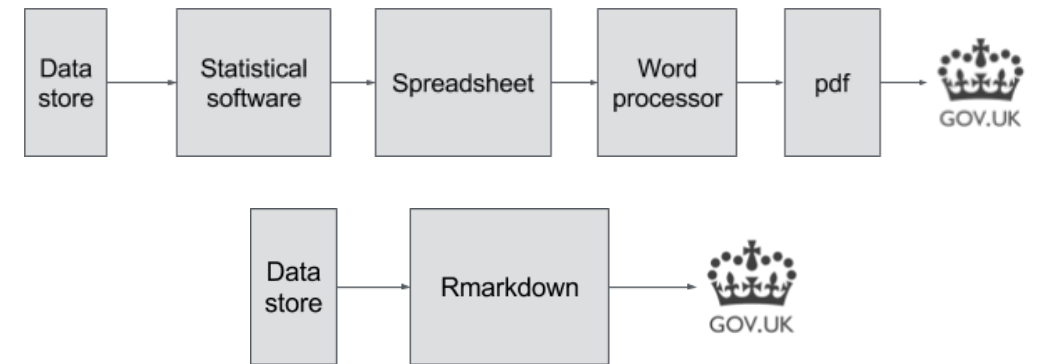
# R Markdown in real life

## 3.1.2 Data Visualization

We use `ggplot2` as our main package to create ad-hoc exploratory graphics as well as polished-looking customized visualizations. When combined with tools to clean and transform data, `ggplot2` allows analysts to quickly translate insights into high quality, compelling visualizations. In addition to the static graphics of `ggplot2`, we often make interactive visualizations or dashboards using R packages such as `plotly` (Sievert et al. 2017), `leaflet` (Cheng et al. 2017), `dygraphs` (Vanderkam et al. 2017), `DiagrammeR` (Sveidqvist et al. 2017), and `shiny` (Chang et al. 2017).

## 3.1.3 Reproducible Research

At Airbnb, all R analyses are documented in `rmarkdown`, where code and visualizations are combined within a single written report. Posts are carefully reviewed by experts in the content area and techniques used, both in terms of methodologies and code style, before publishing and sharing with the business partners. The peer review process is



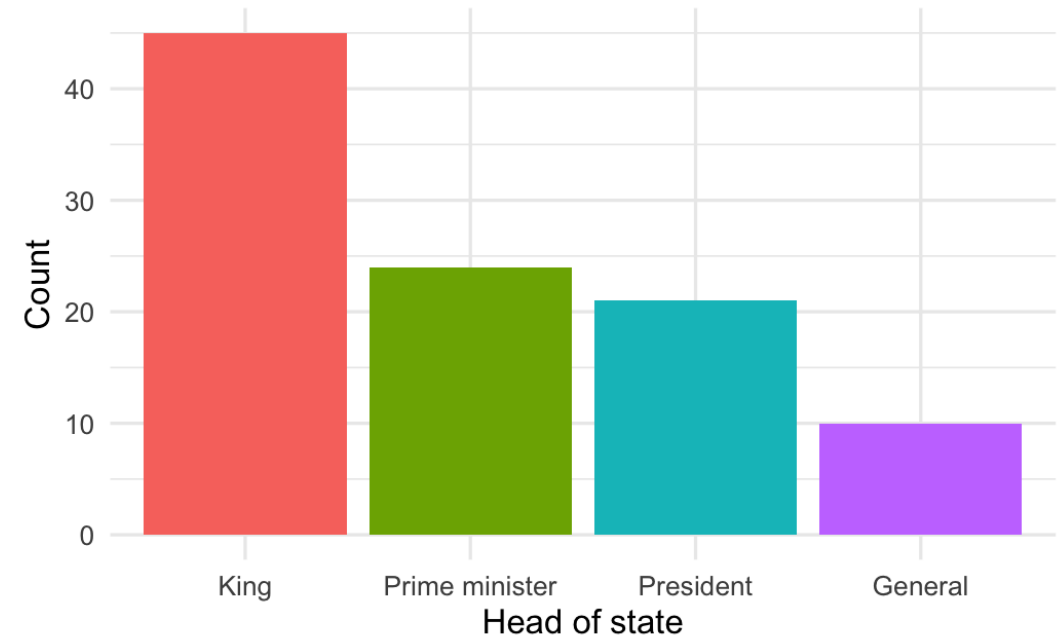
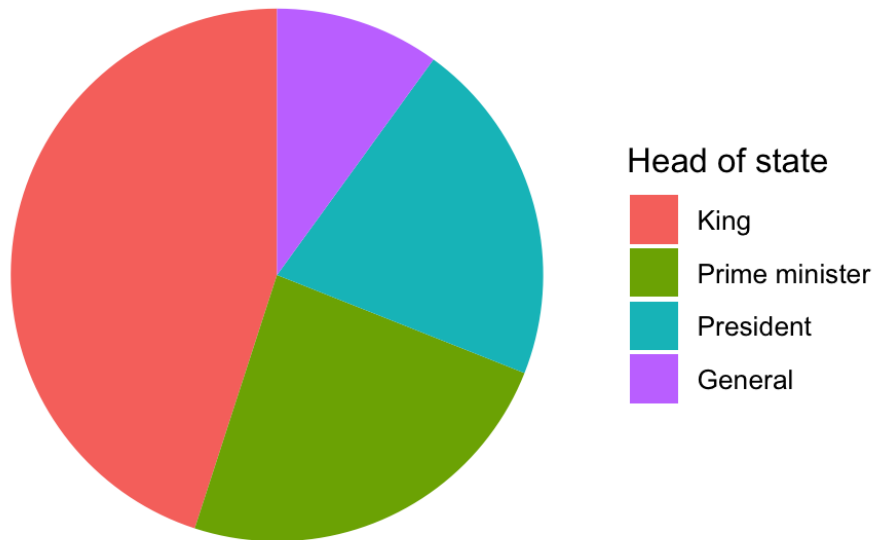
The UK's reproducible analysis pipeline

Airbnb, ggplot, and rmarkdown

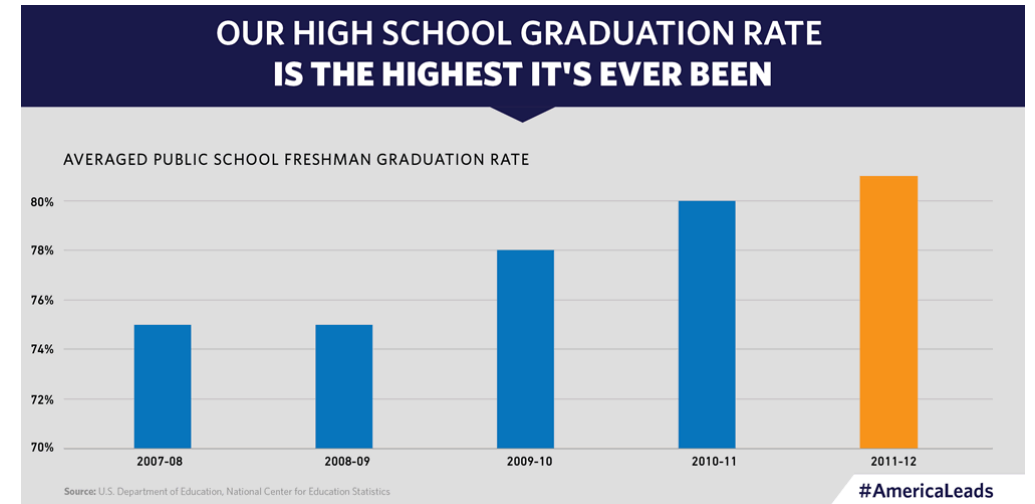
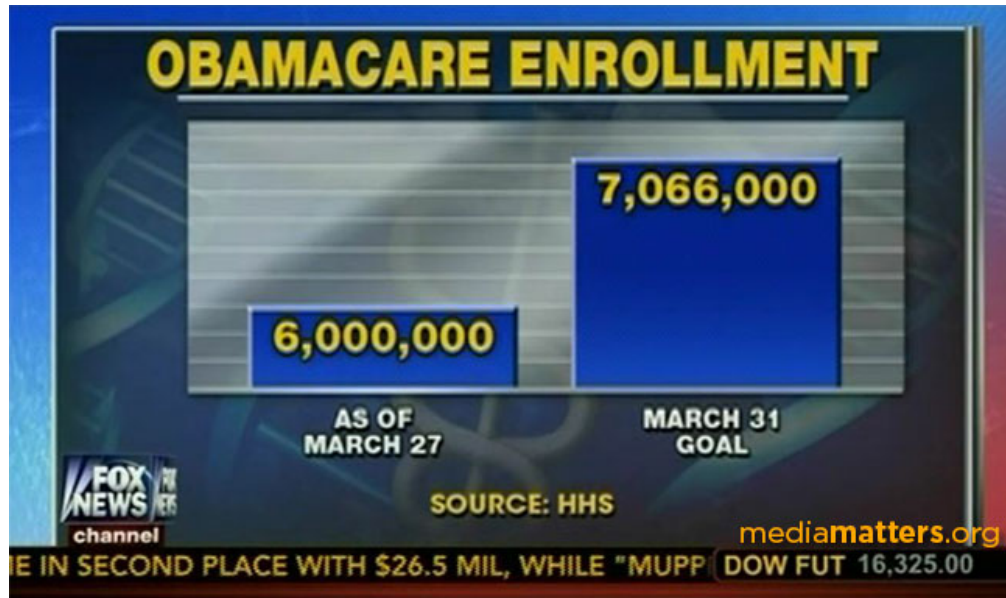
# Amounts

# Yay bar plots!

We are a lot better at visualizing line lengths than angles and areas



# Oh no bar plots!



# Start at zero

**The entire line length matters,  
so don't truncate it!**

**Always start at 0**

**(Or don't use bars)**

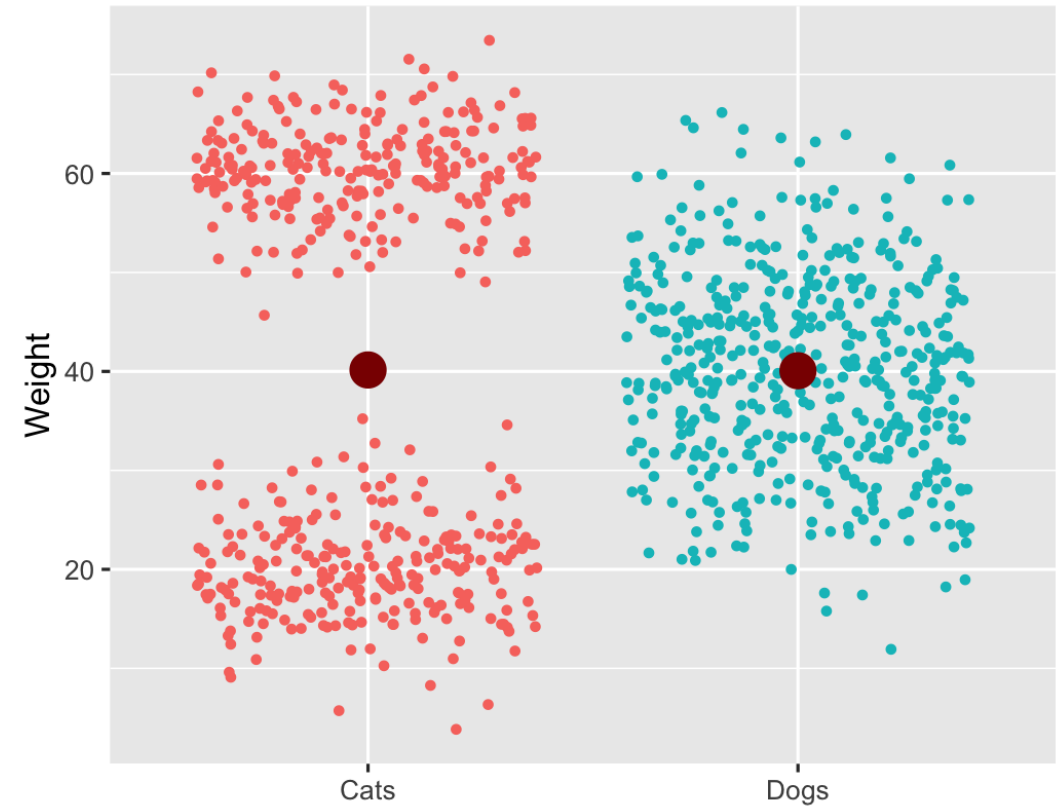
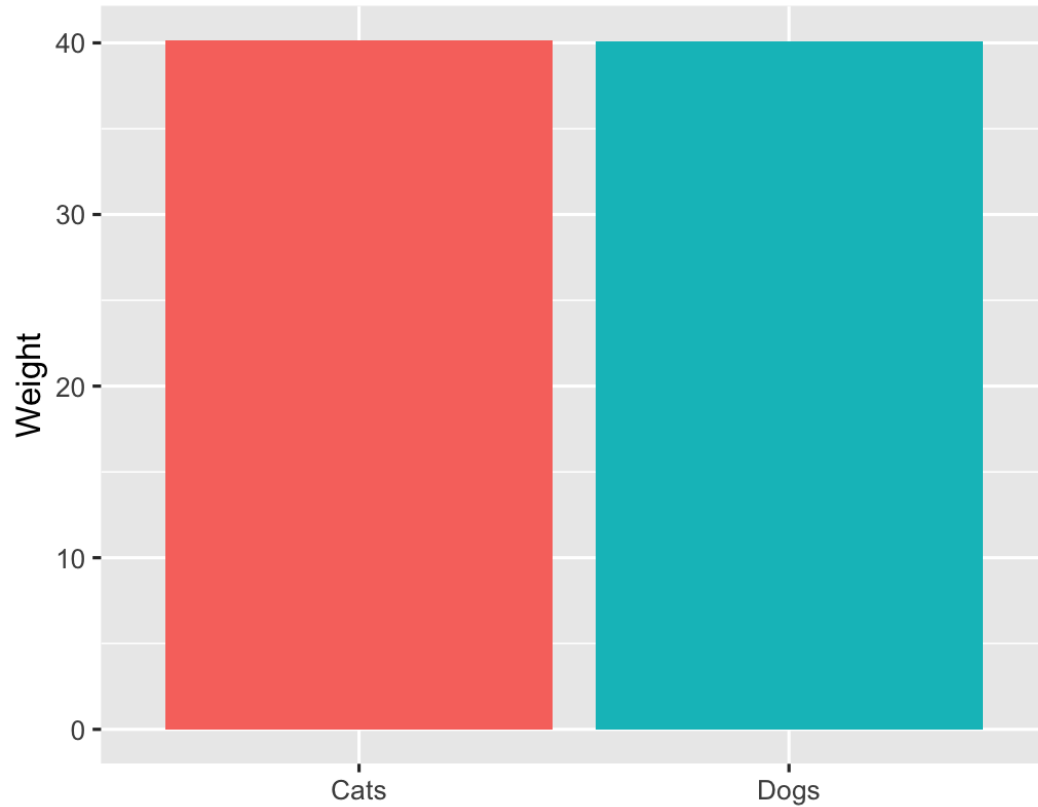
# Bar plots and summary statistics

**#barbarplots**



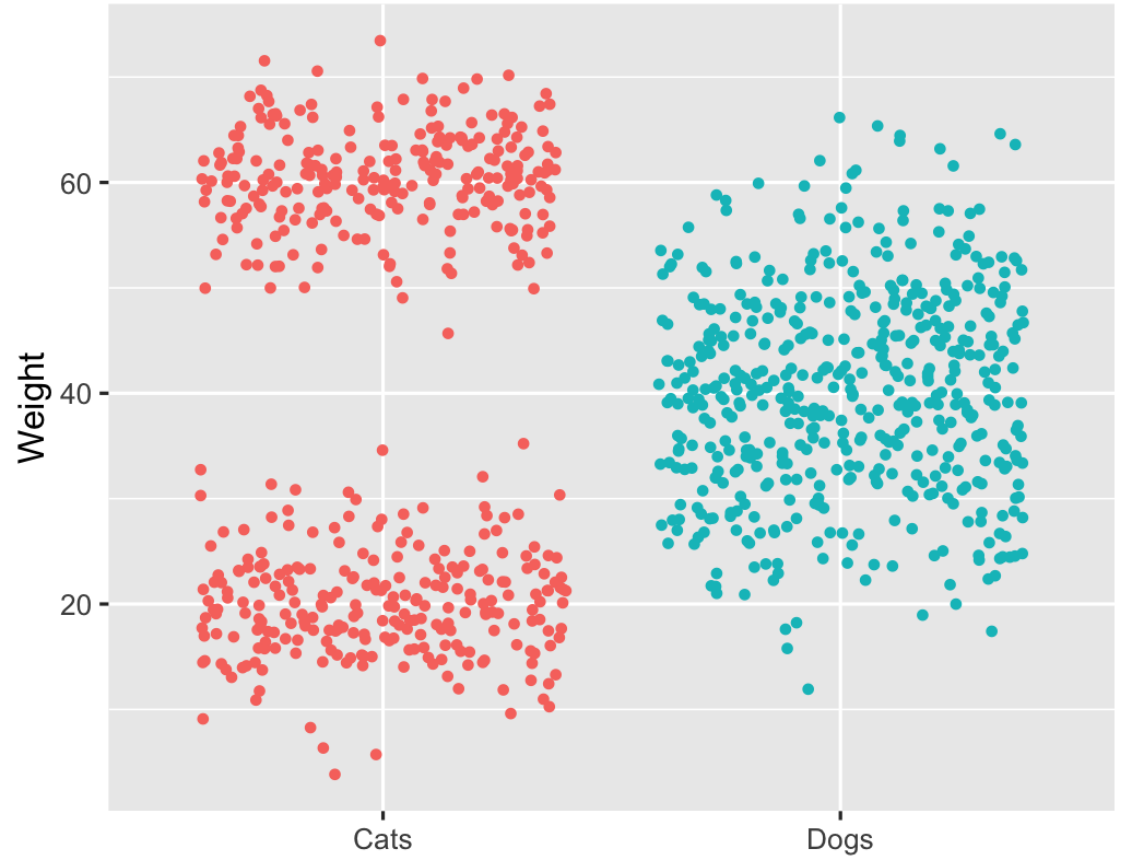


# Bar plots and summary statistics



# Show more data with strip plots

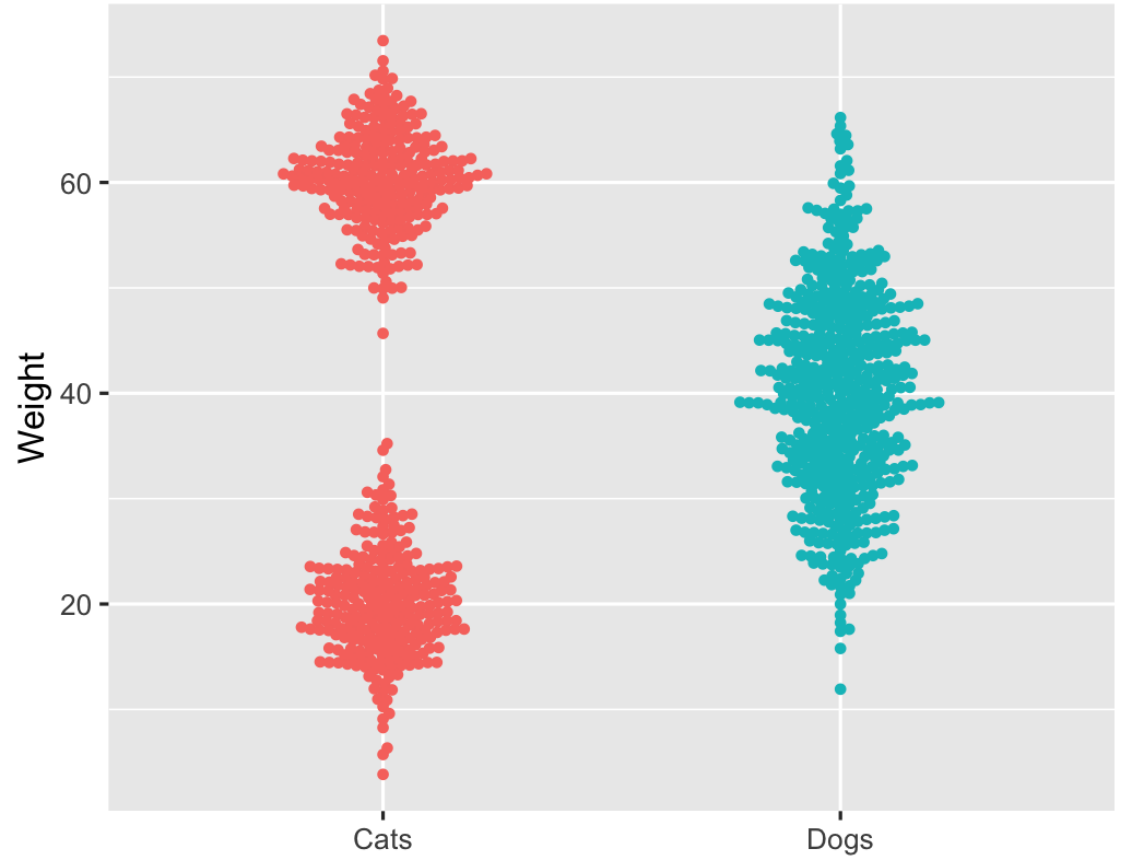
```
ggplot(animals,  
      aes(x = animal_type,  
          y = weight,  
          color = animal_type)) +  
  geom_point(position = position_jitter(height = 1),  
            size = 1) +  
  labs(x = NULL, y = "Weight") +  
  guides(color = FALSE)
```



# Show more data with beeswarm plots

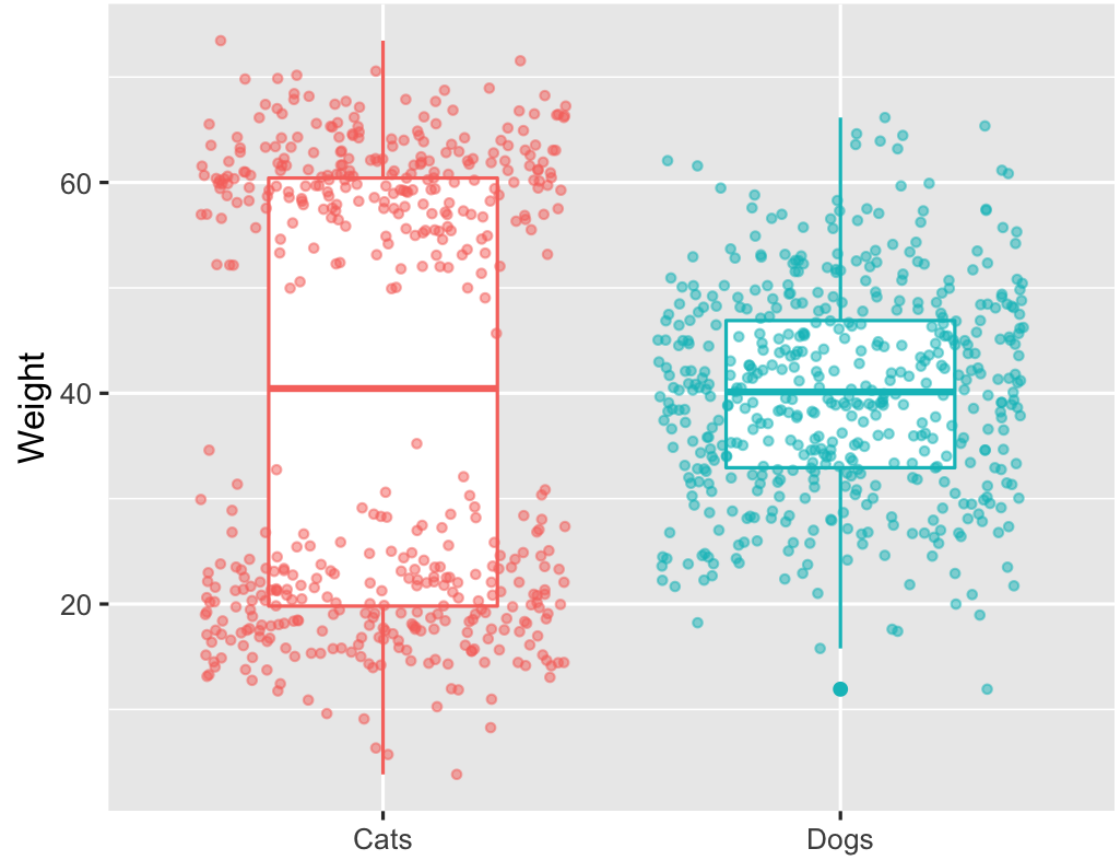
```
library(ggbeeswarm)

ggplot(animals, aes(x = animal_type,
                    y = weight,
                    color = animal_type)) +
  geom_beeswarm(size = 1) +
  # Or try this too:
  # geom_quasirandom() +
  labs(x = NULL, y = "Weight") +
  guides(color = FALSE)
```



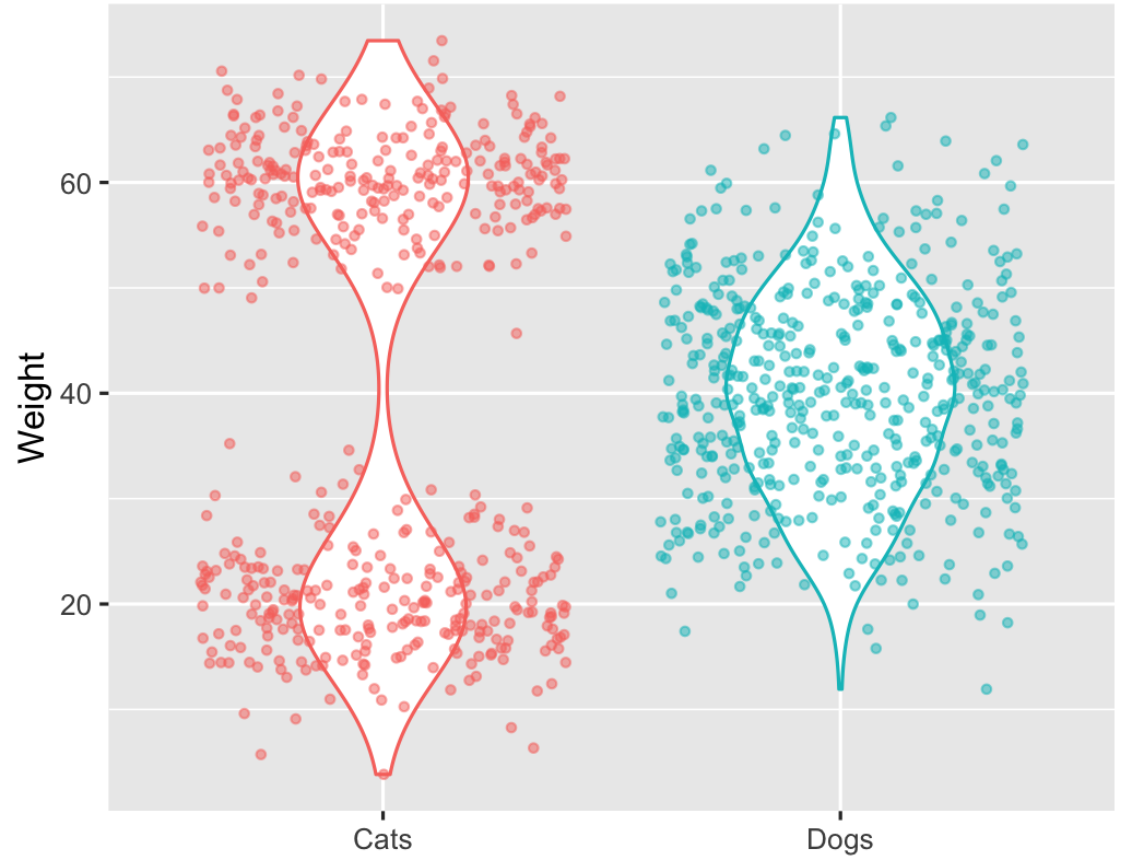
# Combine boxplots with points

```
ggplot(animals, aes(x = animal_type,  
                    y = weight,  
                    color = animal_type)) +  
  geom_boxplot(width = 0.5) +  
  geom_point(position = position_jitter(height = 1),  
            size = 1, alpha = 0.5) +  
  labs(x = NULL, y = "Weight") +  
  guides(color = FALSE)
```



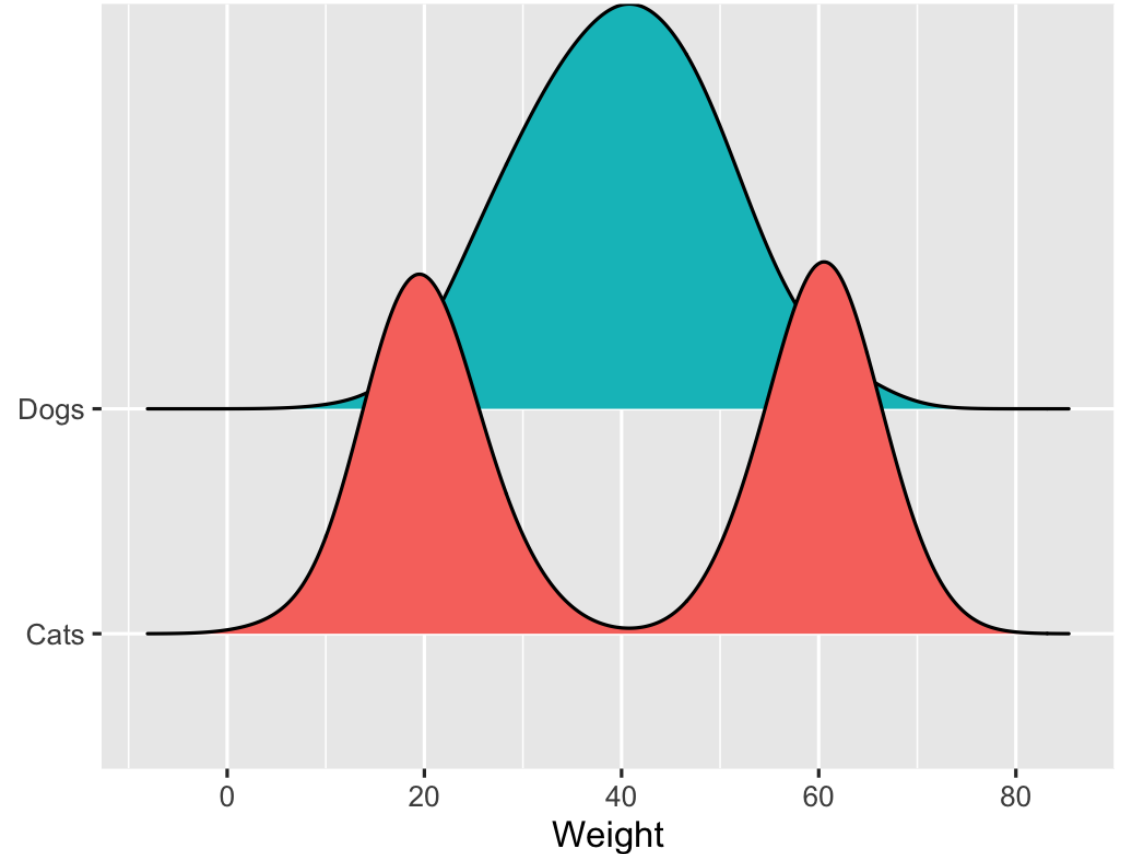
# Combine violins with points

```
ggplot(animals, aes(x = animal_type,  
                    y = weight,  
                    color = animal_type)) +  
  geom_violin(width = 0.5) +  
  geom_point(position = position_jitter(height =  
    size = 1, alpha = 0.5) +  
  labs(x = NULL, y = "Weight") +  
  guides(color = FALSE)
```



# Overlapping ridgeplots

```
library(ggribes)\n\nggplot(animals, aes(x = weight,\n                    y = animal_type,\n                    fill = animal_type)) +\n  geom_density_ridges() +\n  labs(x = "Weight", y = NULL) +\n  guides(fill = FALSE)
```



# General rules

**Bar charts always start at zero**

**Don't use bars for summary statistics.  
You throw away too much information.**

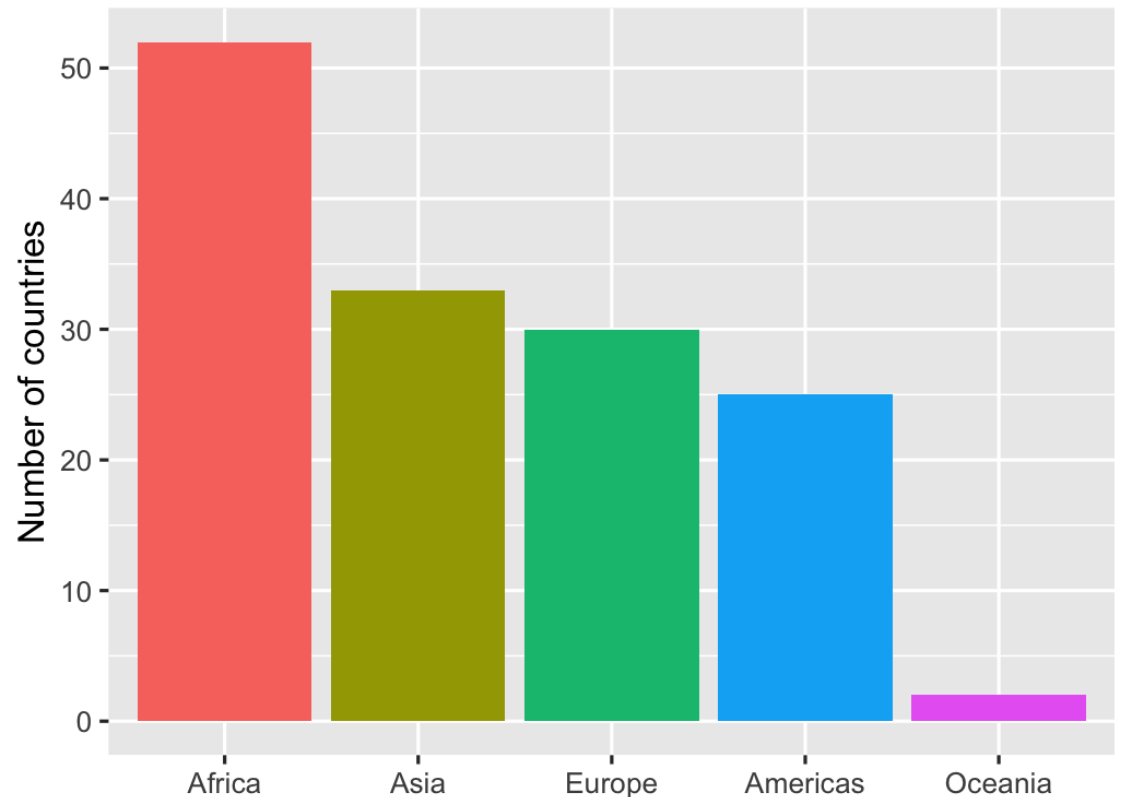
**The end of the bar is often all that matters**

# Lots of alternatives

We'll use a summarized version of the gapminder dataset as an example

```
library(gapminder)
gapminder_continents <- gapminder %>%
  filter(year == 2007) %>% # Only look at 2007
  count(continent) %>% # Get a count of countries
  arrange(desc(n)) %>% # Sort descendingly
  # Make continent into an ordered factor
  mutate(continent = fct_inorder(continent))

ggplot(gapminder_continents,
       aes(x = continent, y = n, fill = continent)) +
  geom_col() +
  guides(fill = FALSE) +
  labs(x = NULL, y = "Number of countries")
```

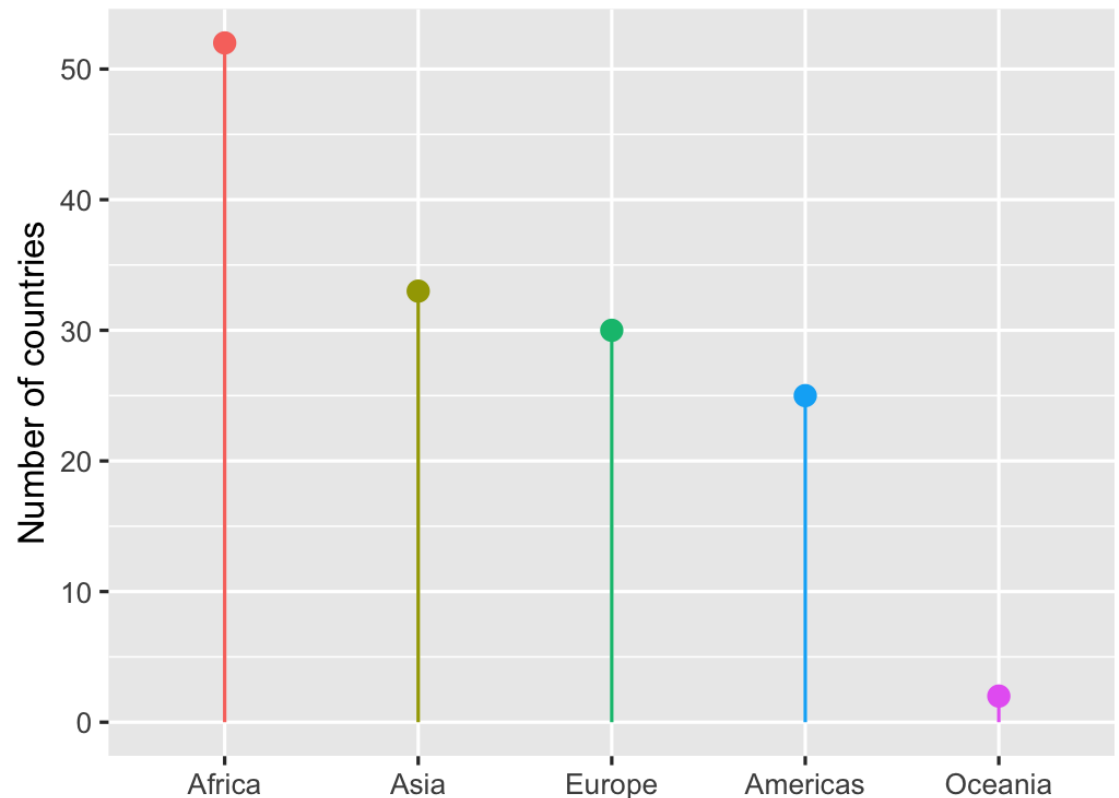




# Alternatives: Lollipop charts

Since the end of the bar is important, emphasize it the most

```
ggplot(gapminder_continents,  
       aes(x = continent, y = n,  
           color = continent)) +  
  geom_pointrange(aes(ymin = 0, ymax = n)) +  
  guides(color = FALSE) +  
  labs(x = NULL, y = "Number of countries")
```

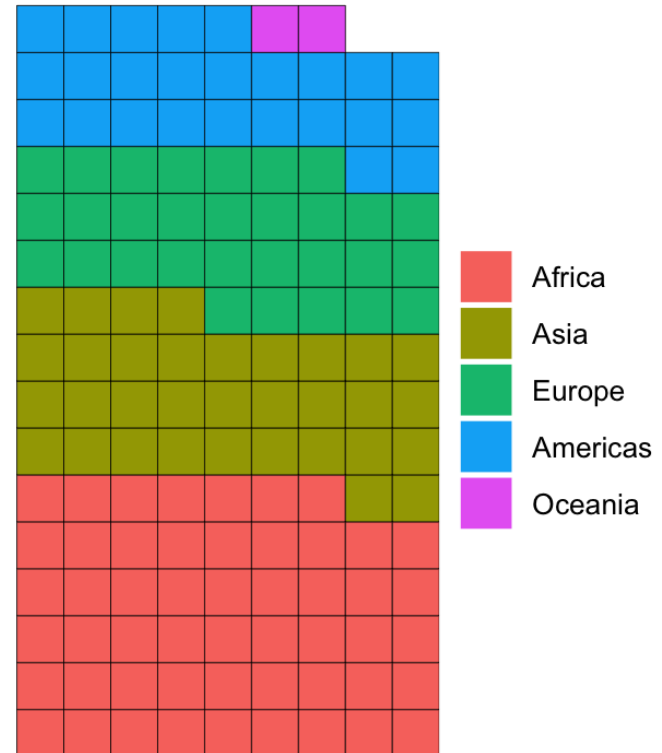


# Alternatives: Waffle charts

Show the individual observations as squares

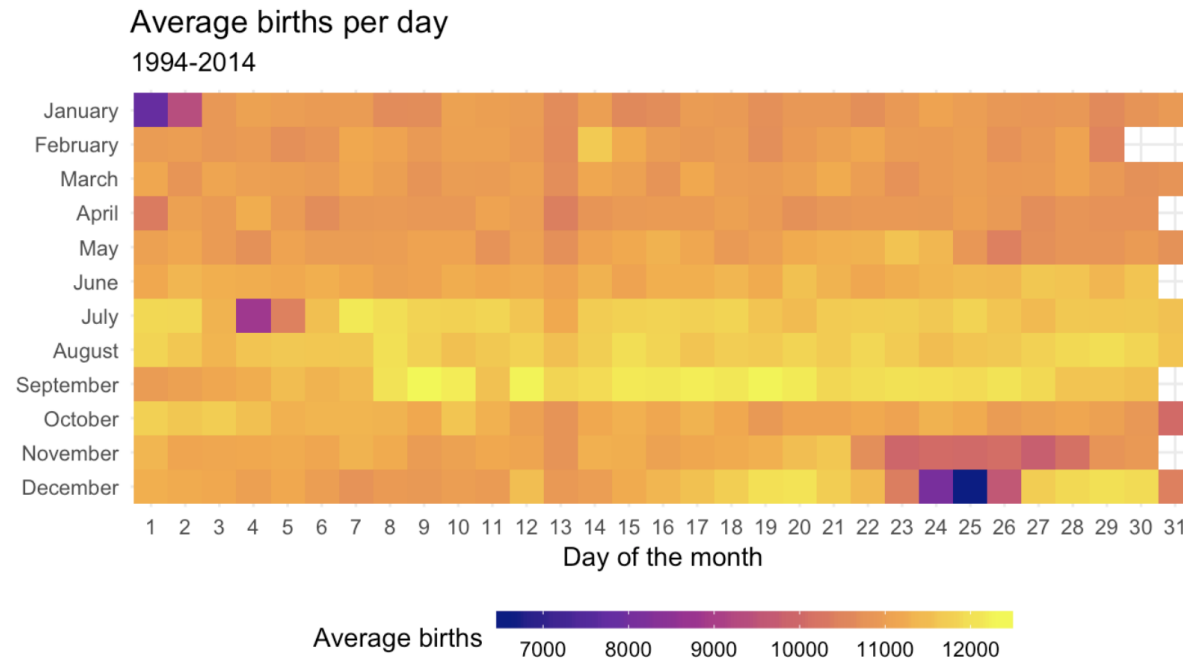
```
# This has to be installed in a special way--
# Run this in your console:
# devtools::install_github("hrbrmstr/waffle")
library(waffle)

ggplot(gapminder_continents,
       aes(x = continent, y = n,
           fill = continent)) +
  geom_waffle(aes(values = n), # geom_waffle
             n_rows = 9, # It has lots of
             flip = TRUE) +
  labs(fill = NULL) +
  coord_equal() + # Make all the squares square
  theme_void() # Use a completely empty theme
```



# Alternatives: Heatmaps

If exact counts are less important,  
try a heatmap with `geom_tile()`



# Proportions

# Why proportions?

Sometimes we want to compare values across a whole population instead of looking at raw counts

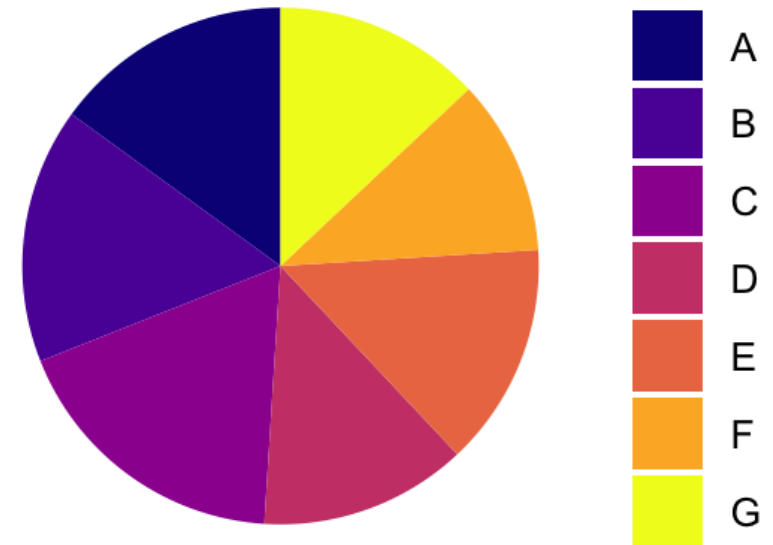
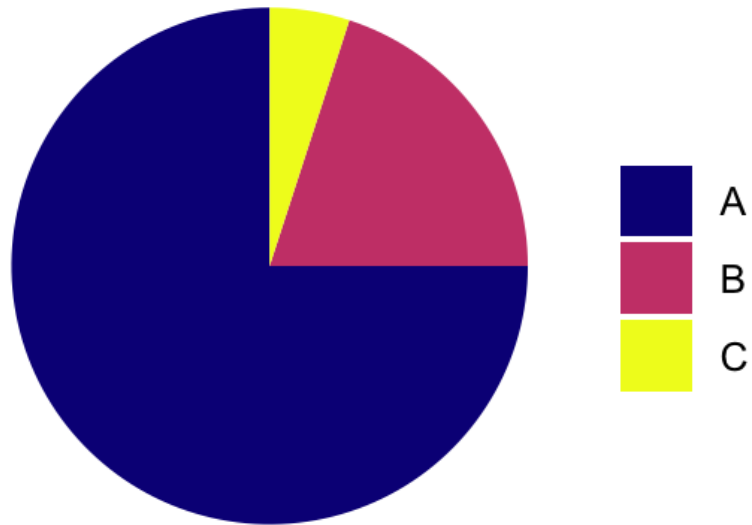
Only do this when it makes analytical sense!

**COVID-19 amounts vs. proportions**

# Pie charts

Perceptual issues with angle and fill space

Only okay(ish) if there are a few easily distinguishable categories



# Alternatives

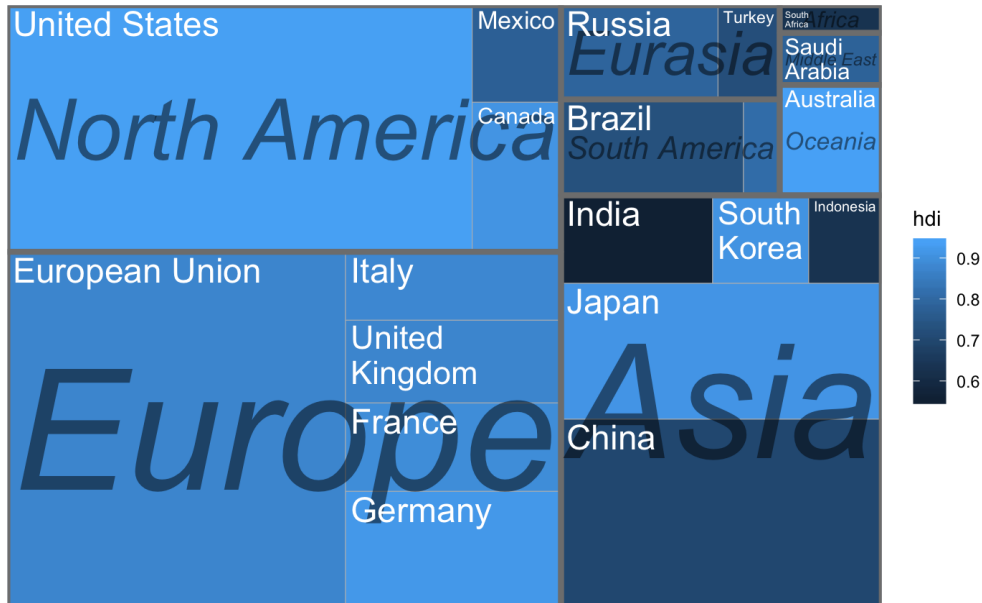
Bar plots

Any of the alternatives to bar plots

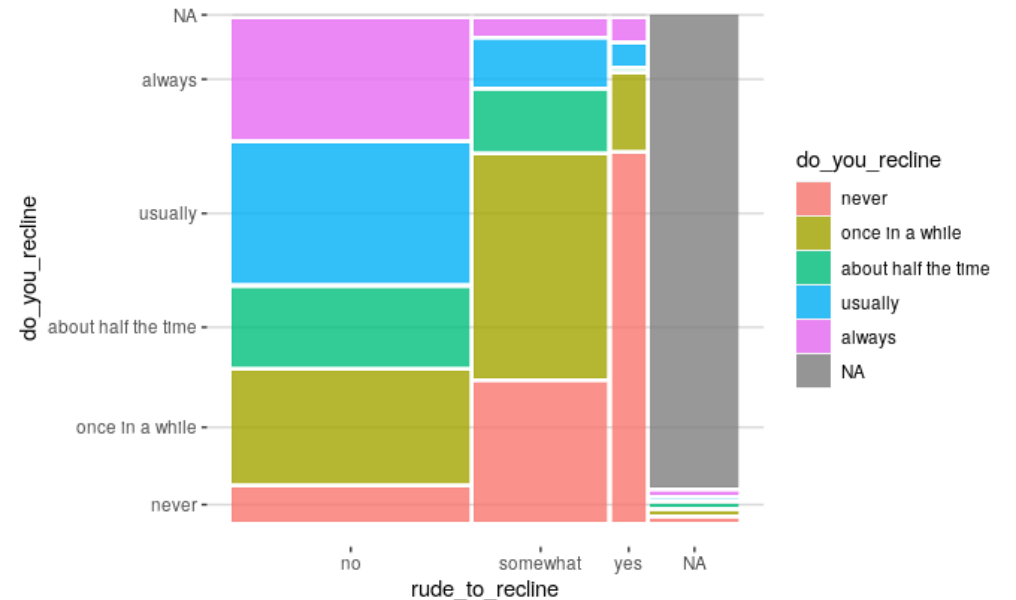
Treemaps and mosaic plots  
(but these can still be really hard to interpret)

# Treemaps and mosaic plots

## Treemaps with the **treemapify** package



## Mosaic plots with the **ggmosaic** package





# Alternatives

Bar plots

Any of the alternatives to bar plots

Treemaps and mosaic plots  
(but these can still be really hard to interpret)

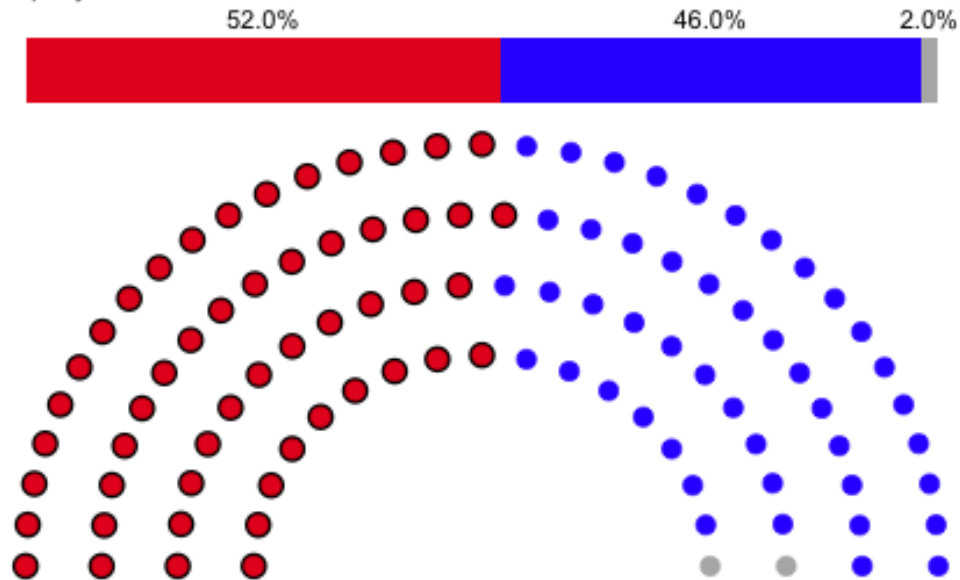
Specialized figures like parliament plots

# Parliament plots

## Parliament plots with the **ggparliament** package

United States Senate

The party that has control of the Senate is encircled in black.



UK parliament in 2017

