

Uncertainty

Session 6

PMAP 8921: Data Visualization with R
Andrew Young School of Policy Studies
Spring 2025

Plan for today

Communicating uncertainty

Visualizing uncertainty

Communicating uncertainty

The Bay of Pigs



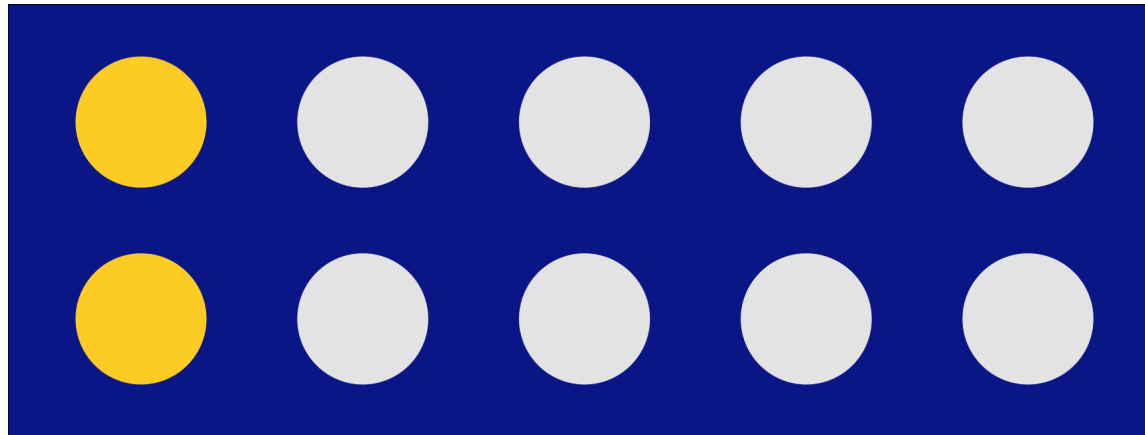
**Joint Chiefs said
"fair chance of
success"**

**In Pentagon-speak,
that meant 3:1 odds
of failure**

**25% chance of
success!**

Misperceptions of probability

1 in 5 vs. 20%



Misperceptions of probability

Utah **SOLID R**

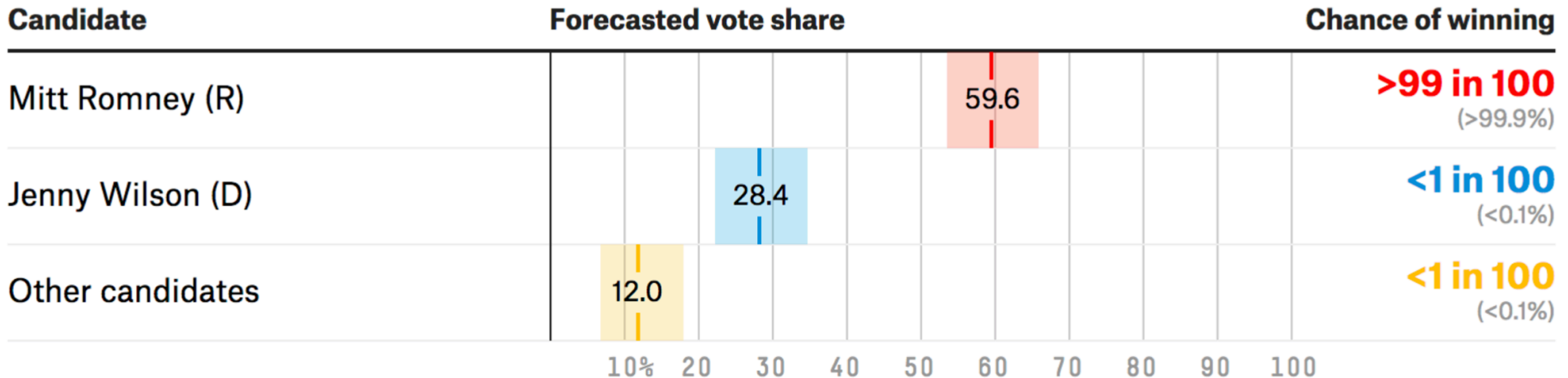


<1 in 100

Chance the Democrat wins (<0.1%)

>99 in 100

Chance the Republican wins (>99.9%)



Misperceptions of probability

Texas LEAN R

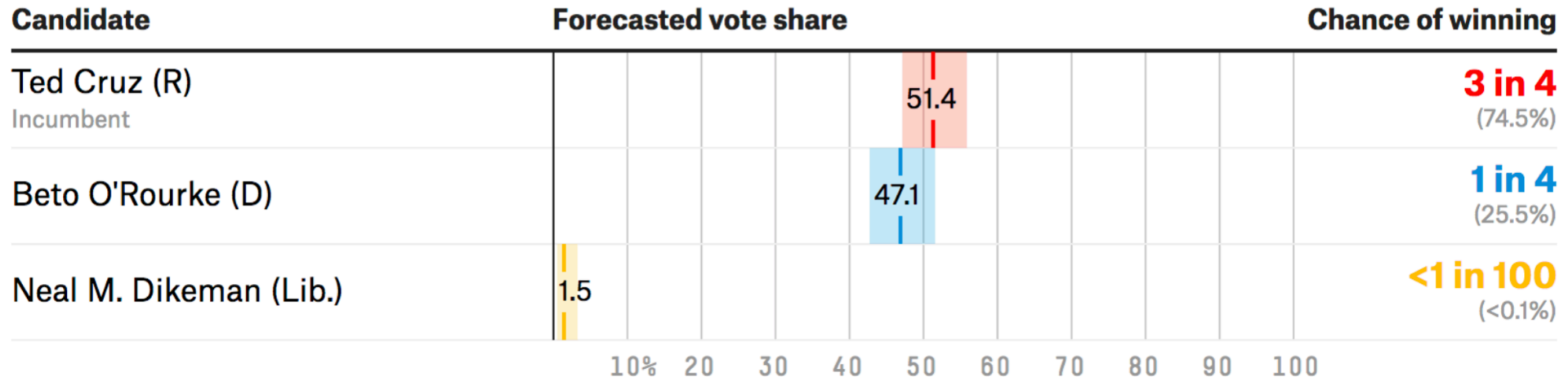


1 in 4

Chance the Democrat wins (25.5%)

3 in 4

Chance the Republican wins (74.5%)



Misperceptions of probability

Chance of rain = Probability × Area



**100% chance in
1/3 of the city**

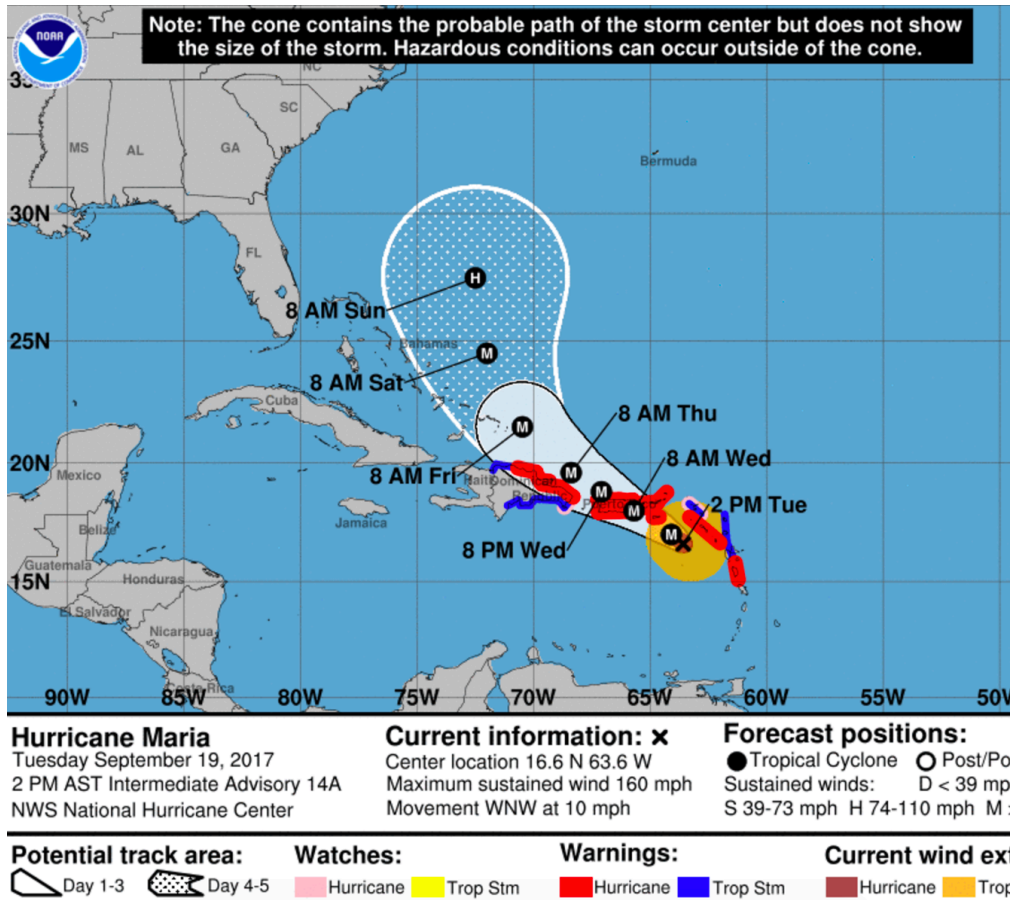
**0% chance in
2/3 of the city**

**Chance of rain
for city = 33%**

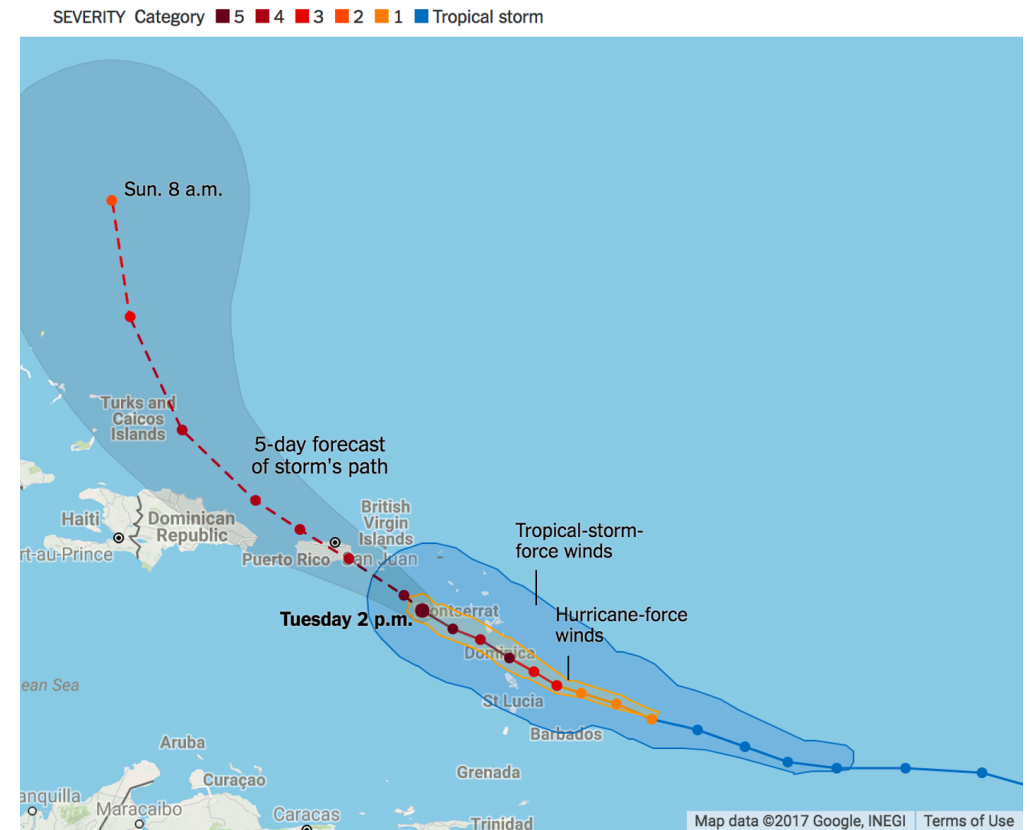
Misperceptions of probability



Misperceptions of probability

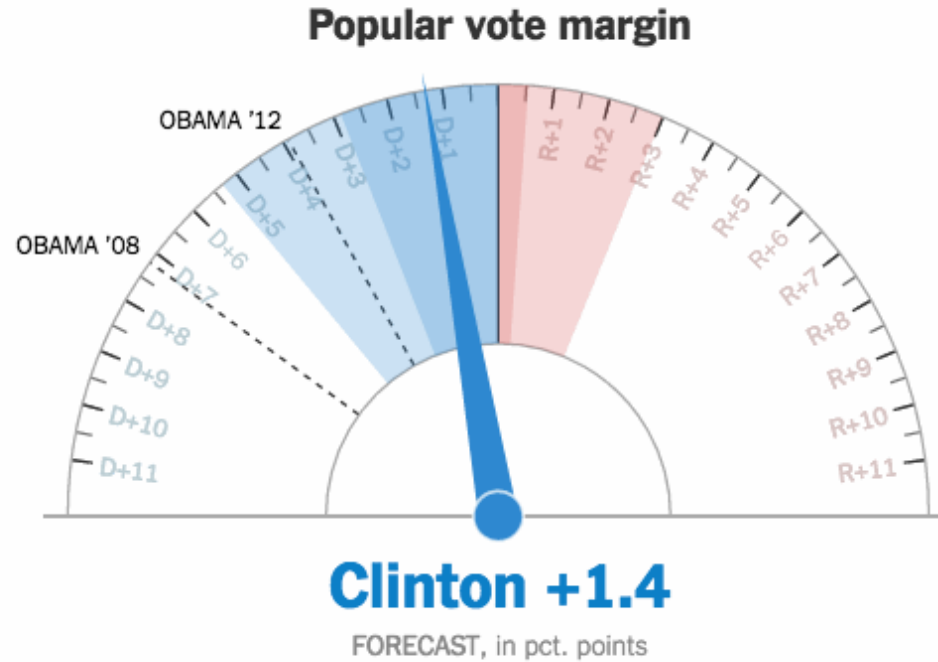


Hurricane Maria map, NOAA



Hurricane Maria map, New York Times

The needle



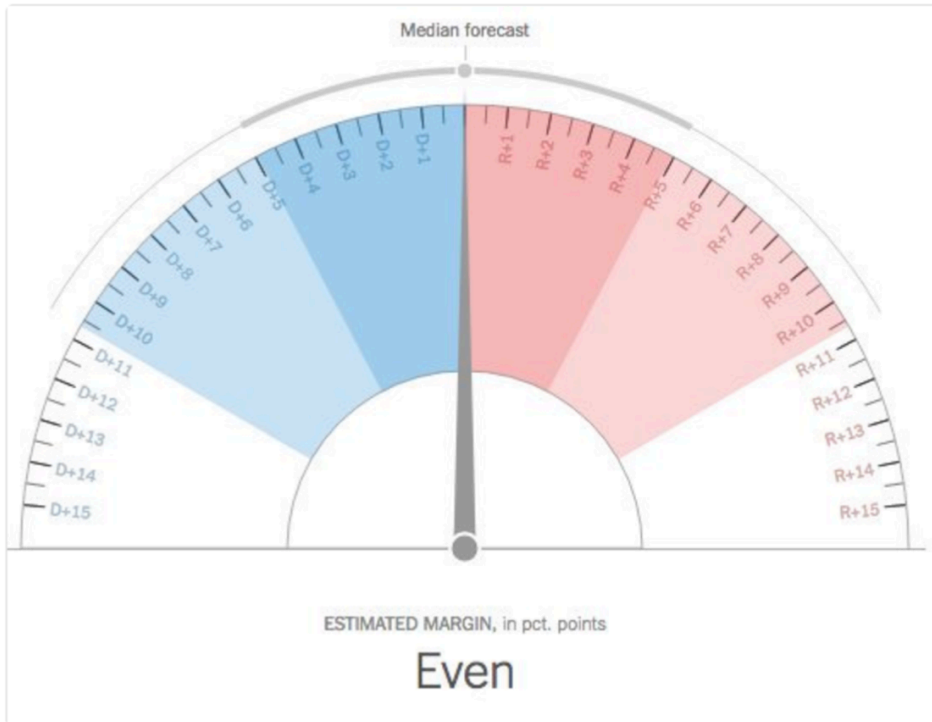
The needle



Nate Cohn ✓
@Nate_Cohn

Following

The GA-6 live model is live.
nytimes.com/elections/resu ...



Virgil Texas ✓ @virgiltexas · Jun 20

Replying to @Nate_Cohn

Nate



Alp Ozelik ✓ @alpicable · Jun 20

Replying to @Nate_Cohn

DO NOT DO THIS TO ME AGAIN



Sarcasmorator @Sarcasmorator · Jun 20

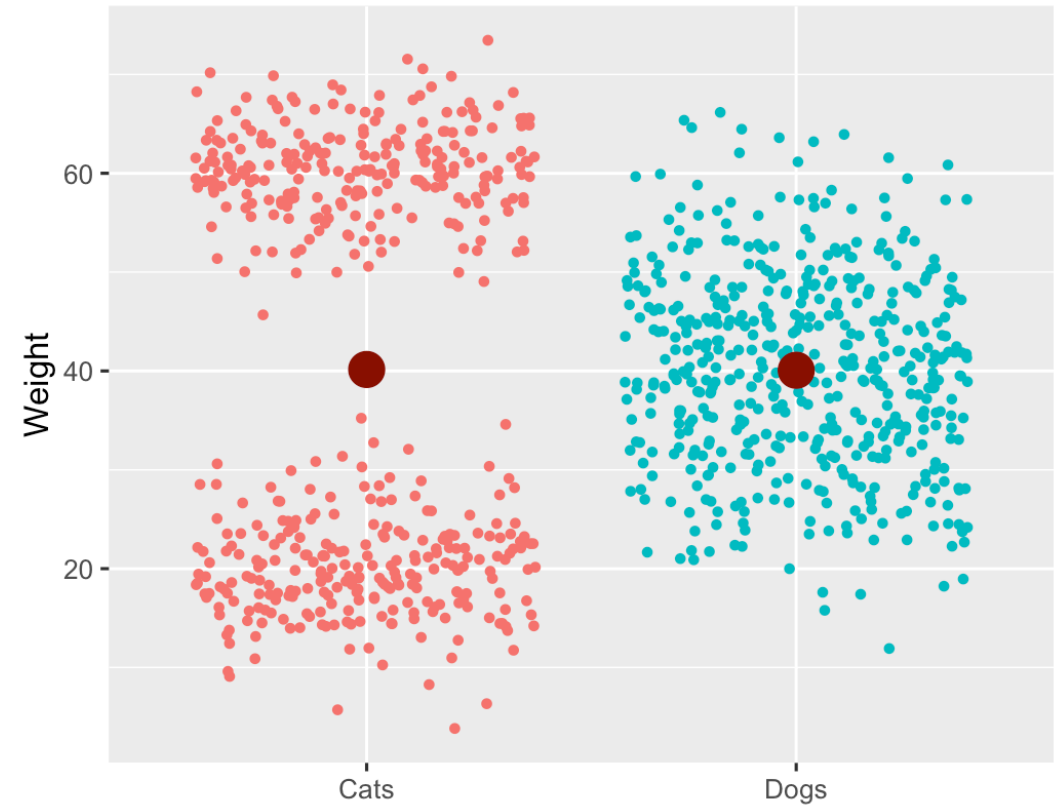
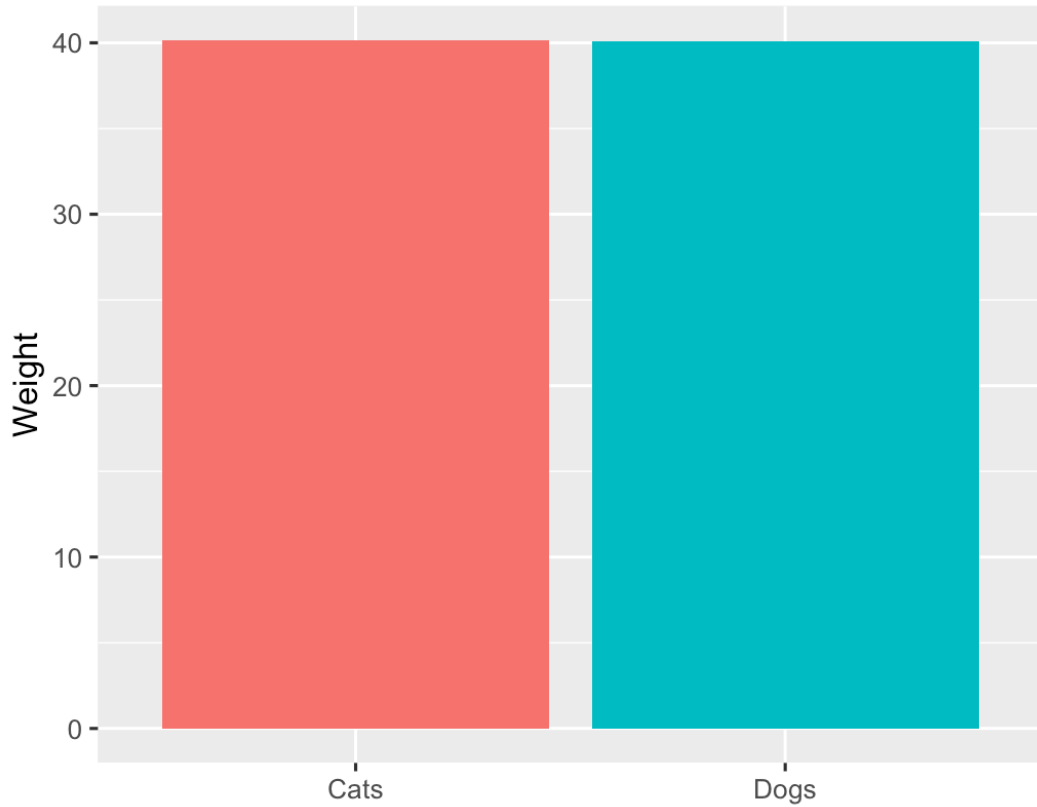
Replying to @Nate_Cohn @jacquicollins_

ah, yes, the election stress-o-meter



Visualizing uncertainty

Problems with single numbers



More information is always better

Avoid visualizing single numbers when you have a whole range or distribution of numbers

Uncertainty in single variables

Uncertainty across multiple variables

Uncertainty in models and simulations

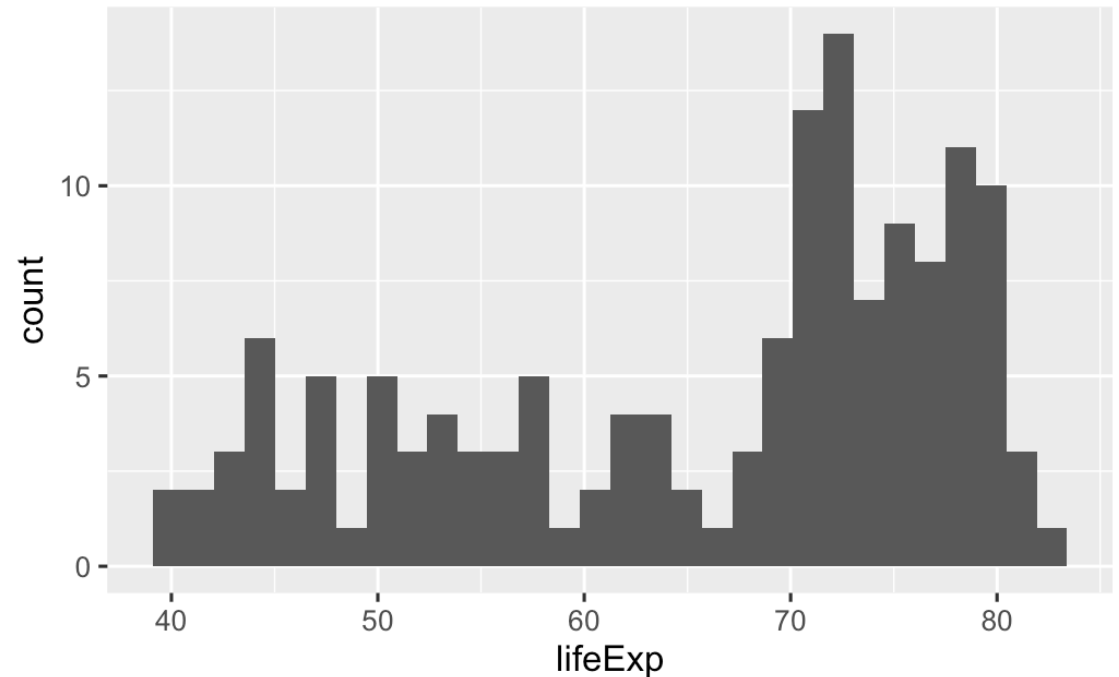
Histograms

Put data into equally spaced buckets (or bins),
plot how many rows are in each bucket

```
library(gapminder)

gapminder_2002 <- gapminder |>
  filter(year == 2002)

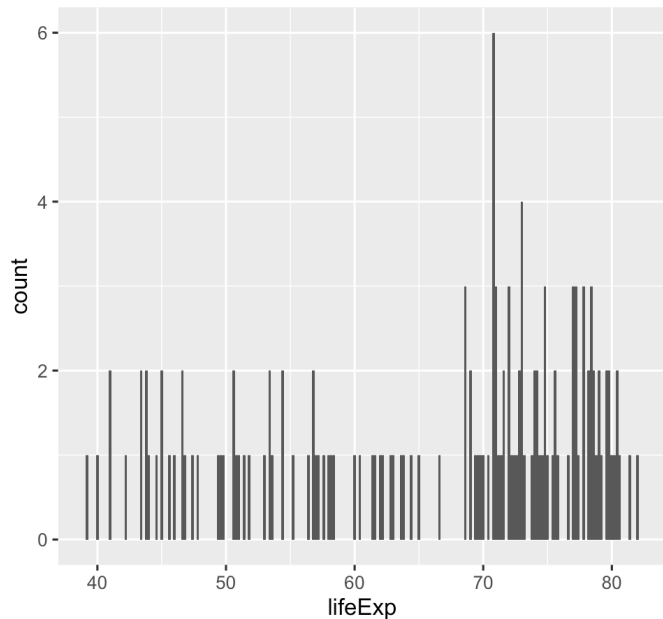
ggplot(gapminder_2002,
       aes(x = lifeExp)) +
  geom_histogram()
```



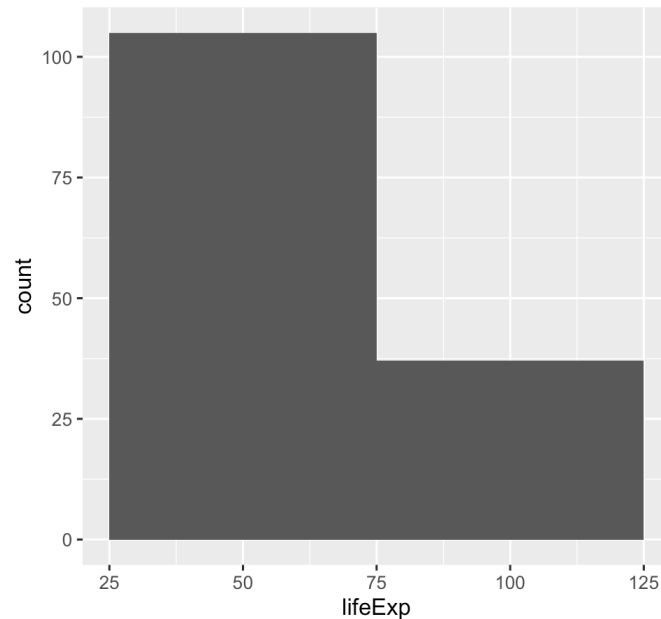
Histograms: Bin width

No official rule for what makes a good bin width

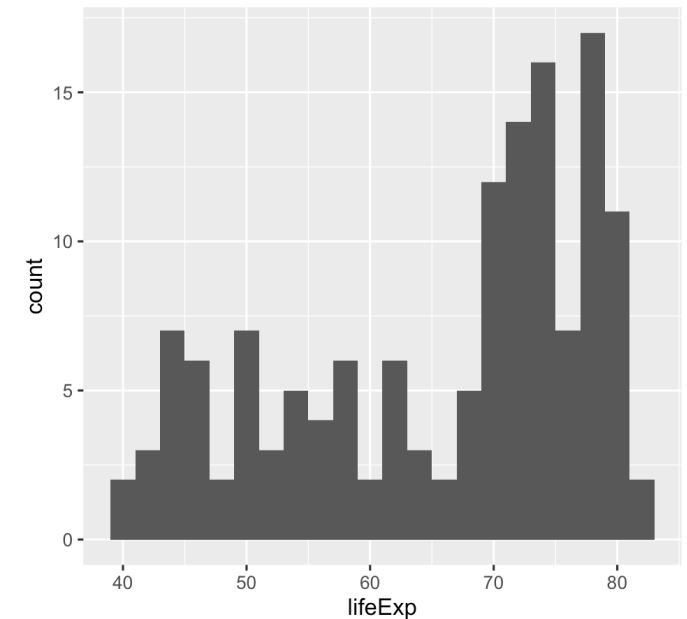
Too narrow:
binwidth = 0.2



Too wide:
binwidth = 50



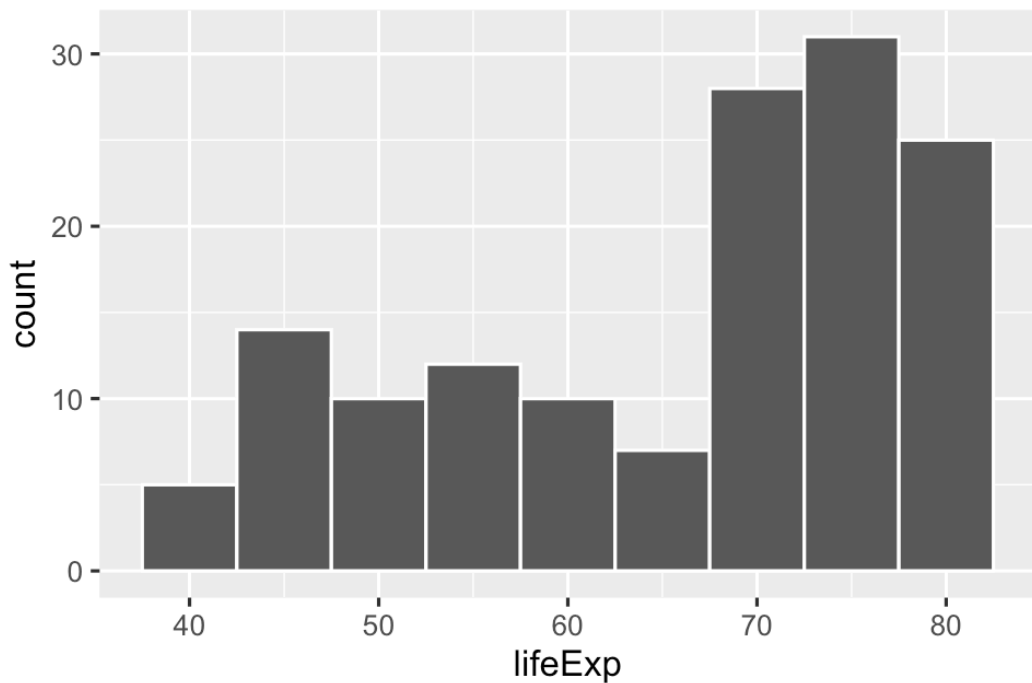
(One type of) just right:
binwidth = 2



Histogram tips

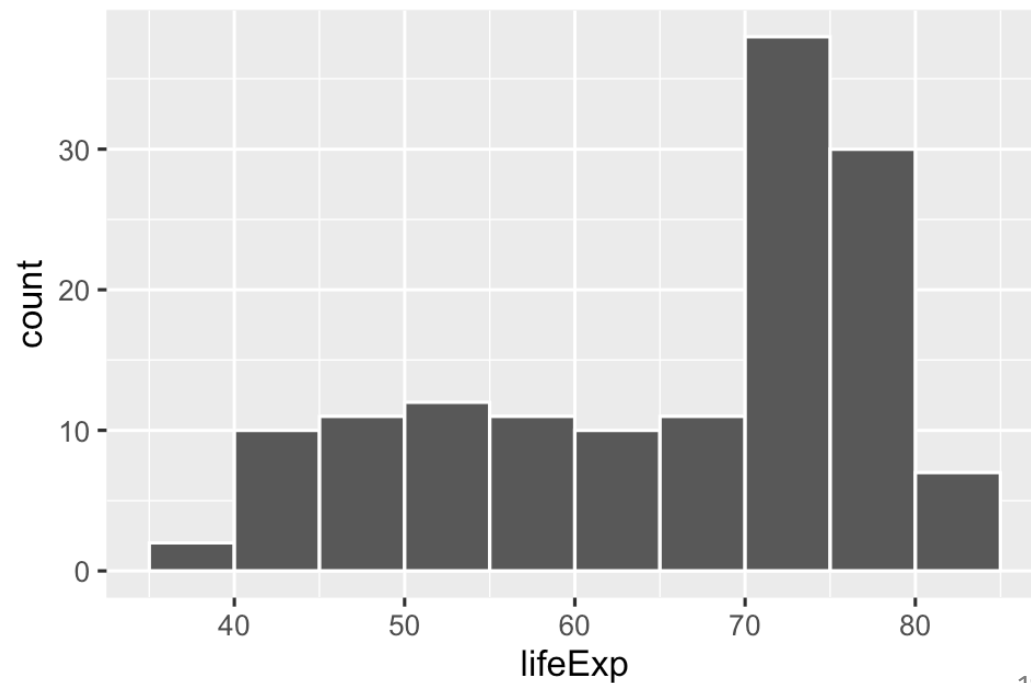
Add a border to the bars
for readability

```
geom_histogram(..., color = "white")
```



Set the boundary;
bucket now 50–55, not 47.5–52.5

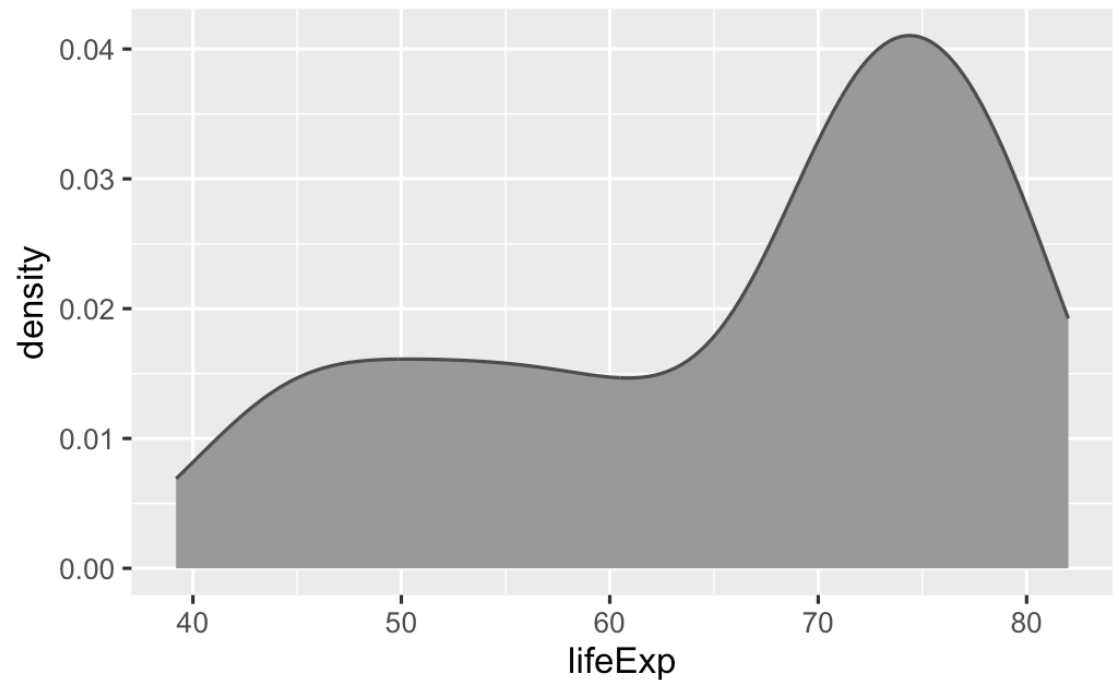
```
geom_histogram(..., boundary = 50)
```



Density plots

Use calculus to find the probability of each x value

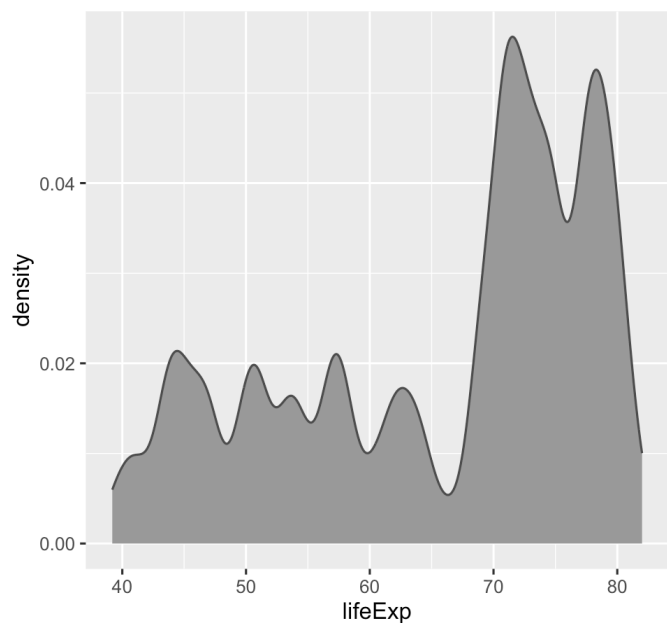
```
ggplot(gapminder_2002,  
       aes(x = lifeExp)) +  
  geom_density(fill = "grey60",  
              color = "grey30")
```



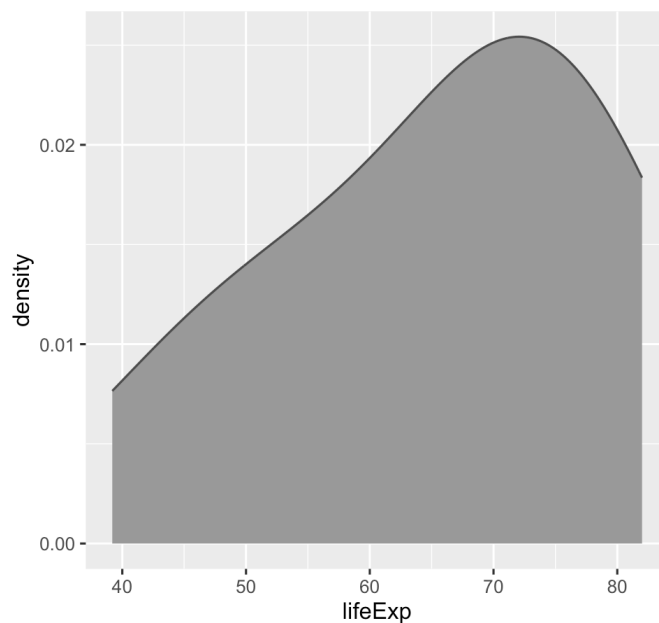
Density plots: Kernels and bandwidths

Different options for calculus change the plot shape

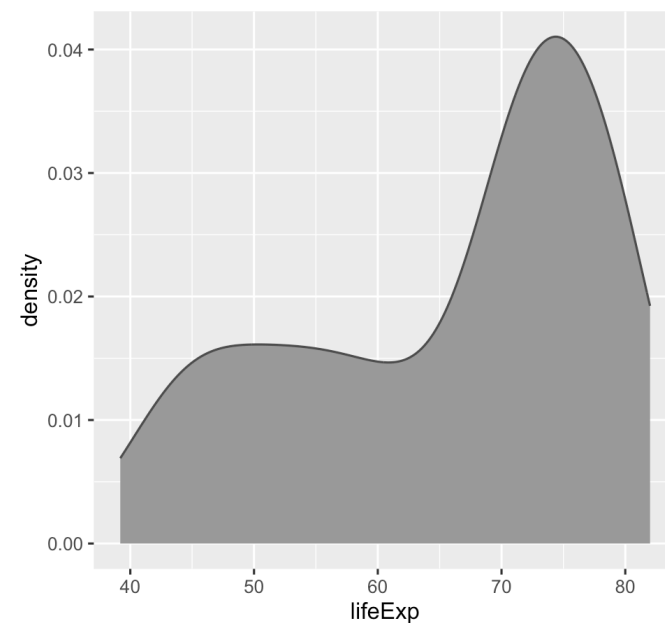
bw = 1



bw = 10



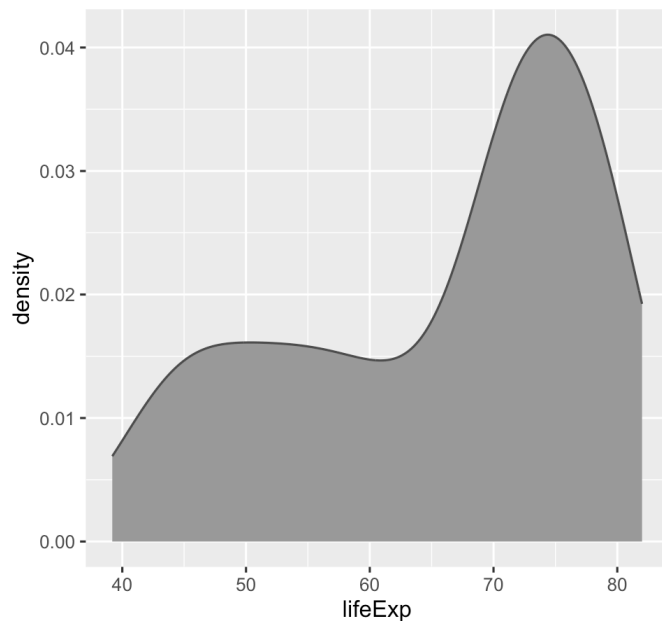
bw = "nrd0"(default)



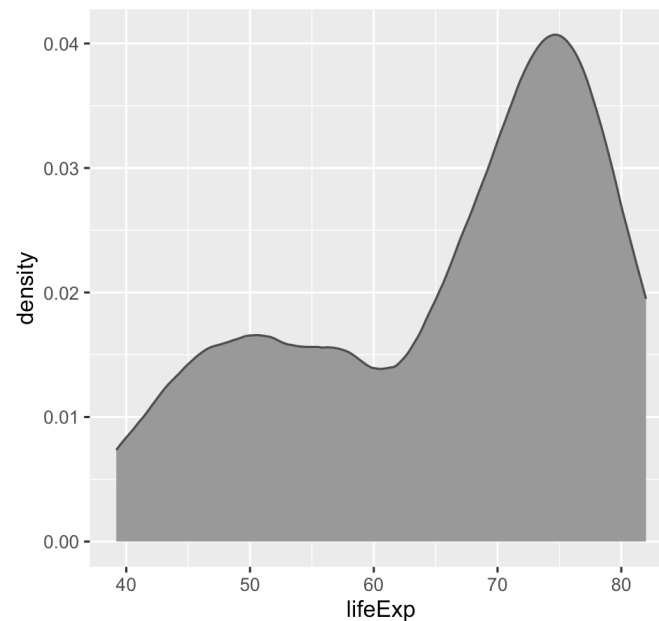
Density plots: Kernels and bandwidths

Different options for calculus change the plot shape

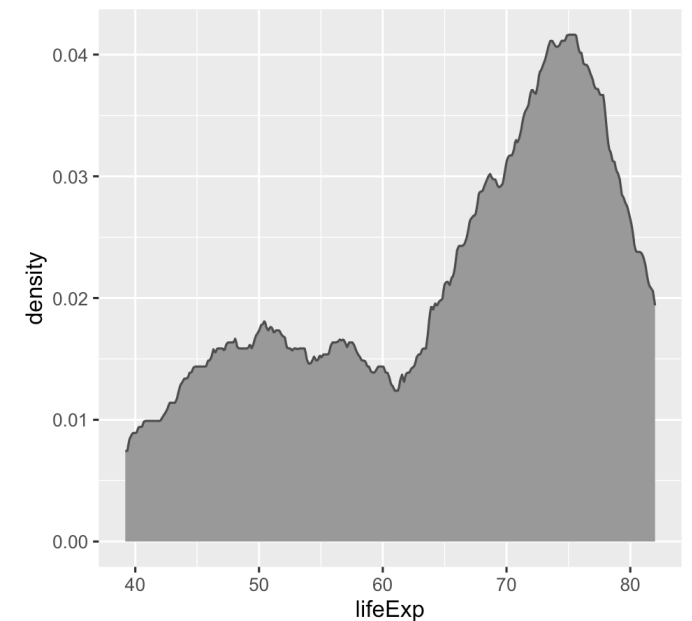
kernel = "gaussian"



"epanechnikov"



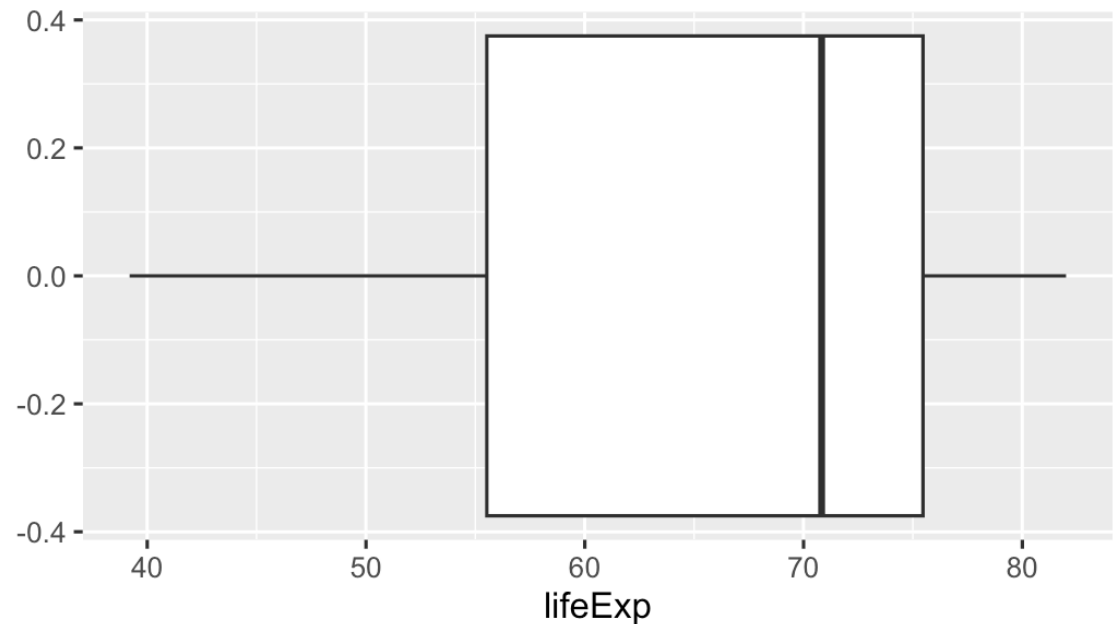
"rectangular"



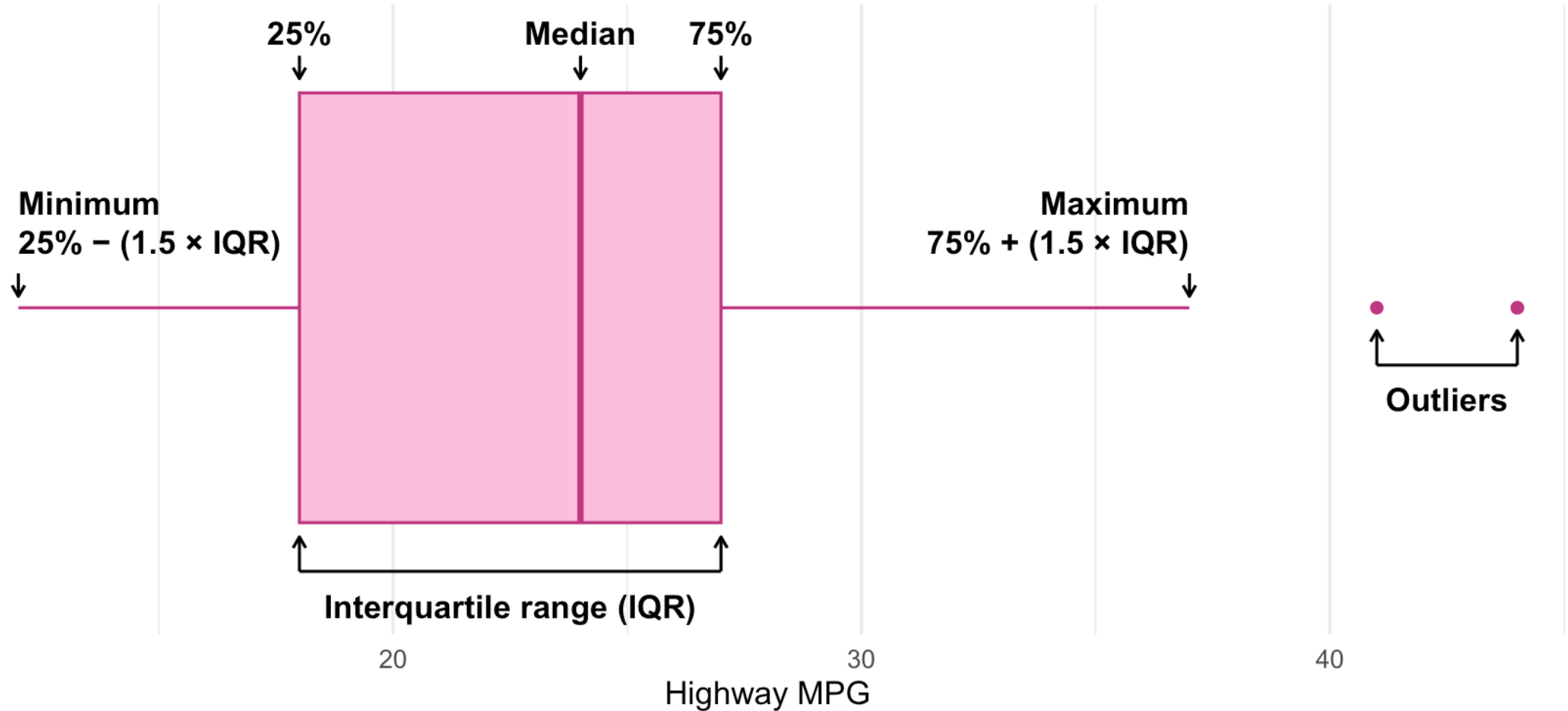
Box plots

Show specific distributional numbers

```
ggplot(gapminder_2002,  
       aes(x = lifeExp)) +  
  geom_boxplot()
```



Box plots

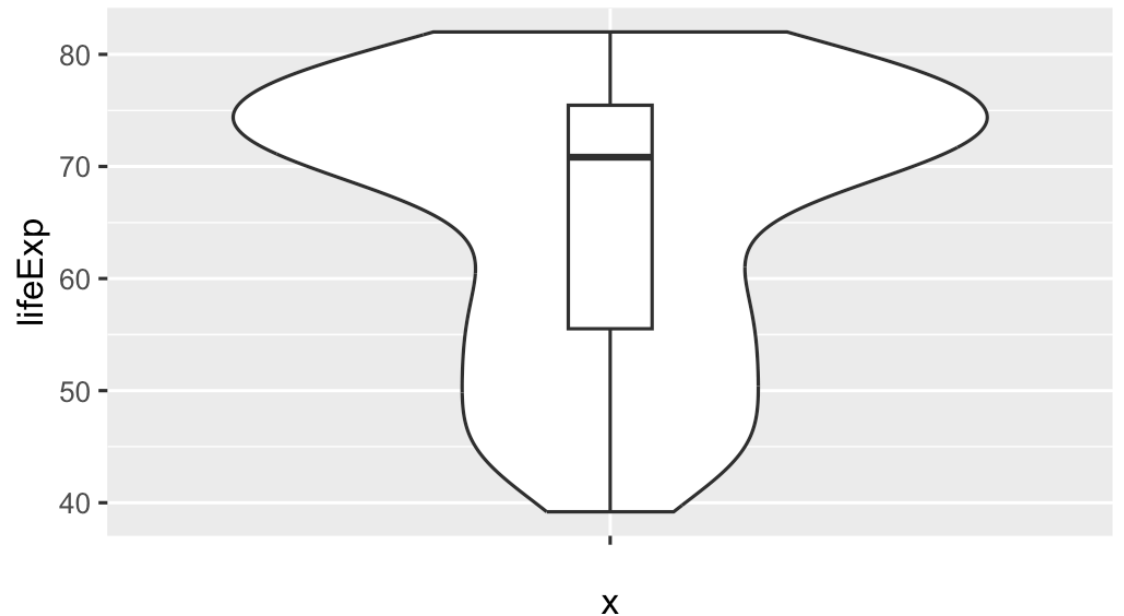


Violin plots

Mirror density plot and flip

Often helpful to overlay other things on it

```
ggplot(gapminder_2002,  
       aes(x = "",  
           y = lifeExp)) +  
  geom_violin() +  
  geom_boxplot(width = 0.1)
```



Uncertainty across multiple variables

Visualize the distribution of a single variable across groups

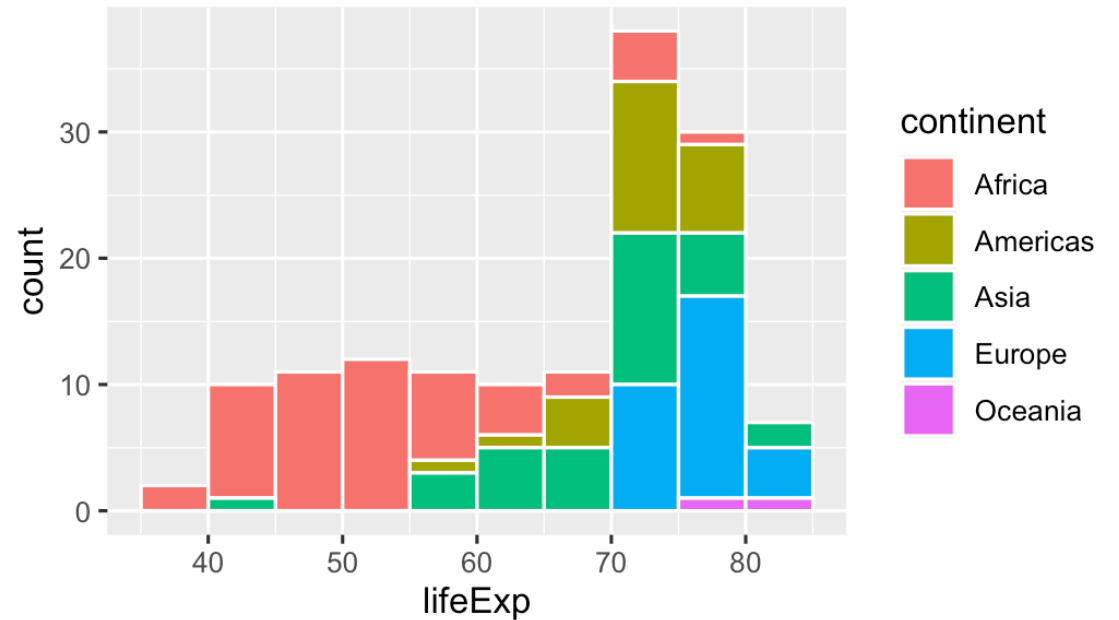
Add a `fill` aesthetic or use faceting!

Multiple histograms

Fill with a different variable

This is bad and really hard to read though

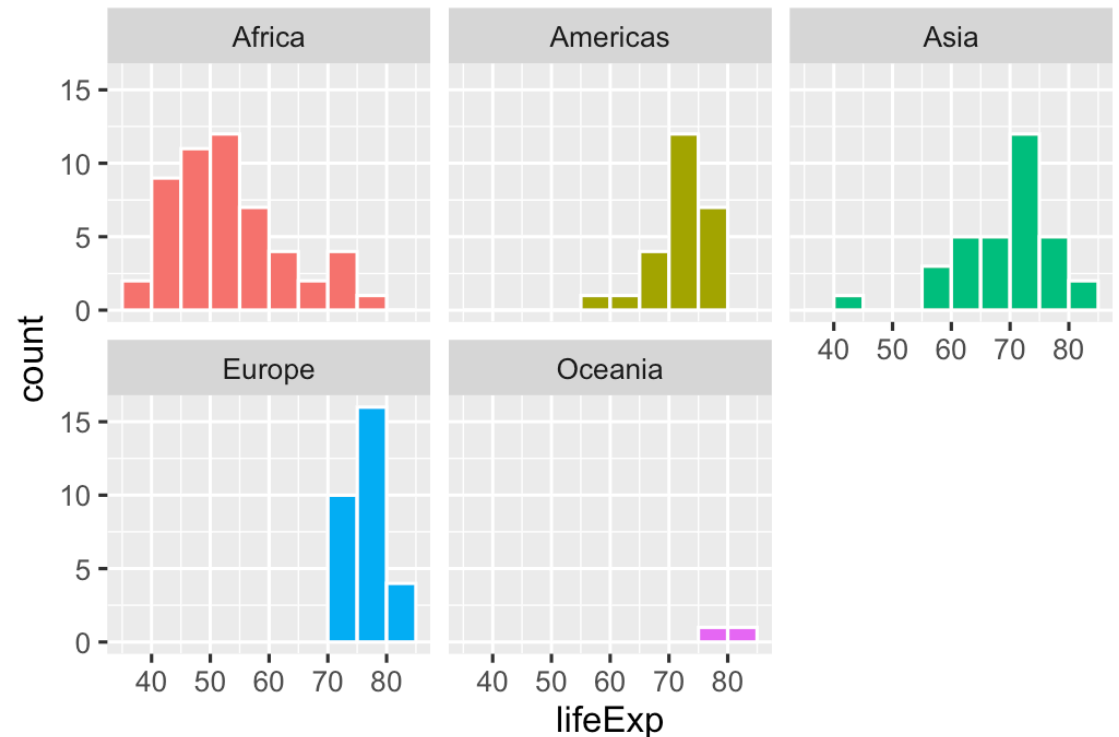
```
ggplot(gapminder_2002,  
       aes(x = lifeExp,  
           fill = continent)) +  
  geom_histogram(binwidth = 5,  
                color = "white",  
                boundary = 50)
```



Multiple histograms

Facet with a different variable

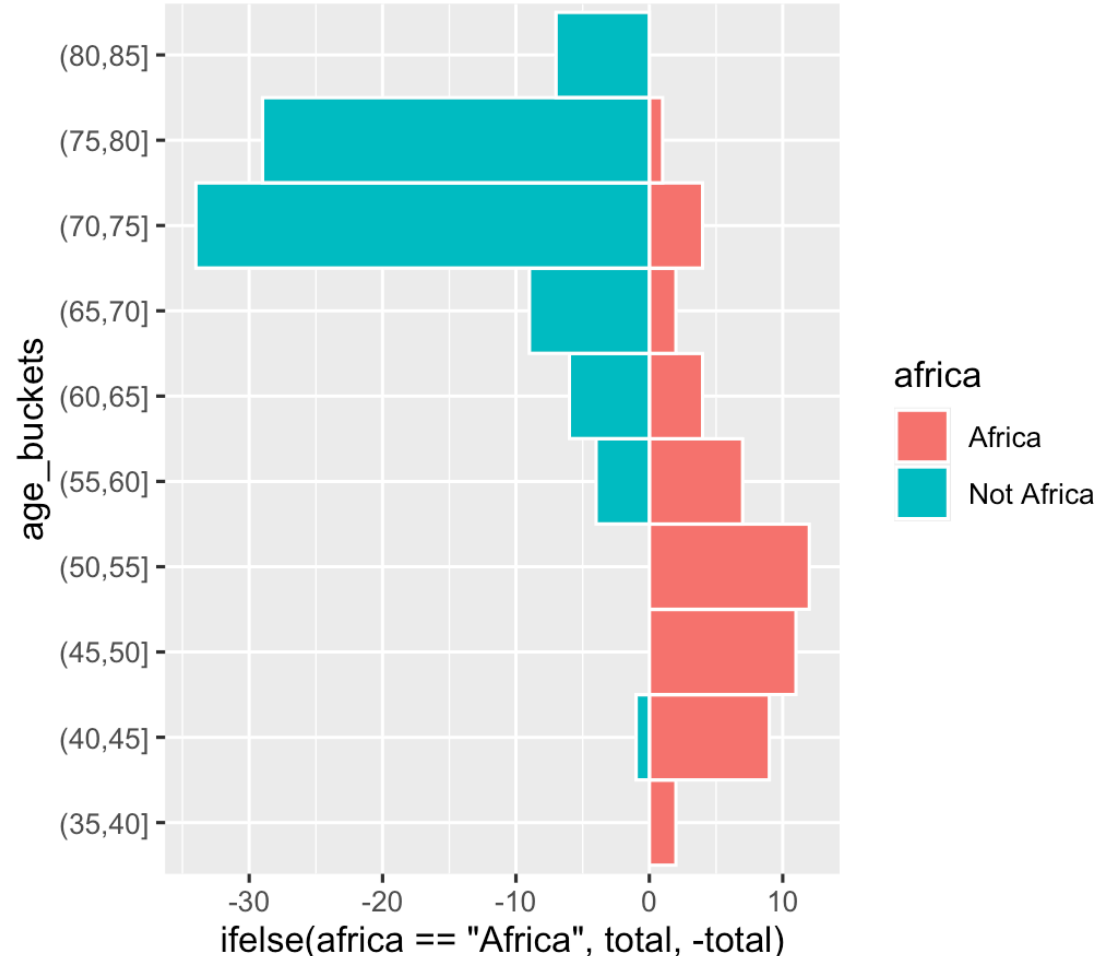
```
ggplot(gapminder_2002,  
       aes(x = lifeExp,  
           fill = continent)) +  
  geom_histogram(binwidth = 5,  
                color = "white",  
                boundary = 50) +  
  guides(fill = "none") +  
  facet_wrap(vars(continent))
```



Pyramid histograms

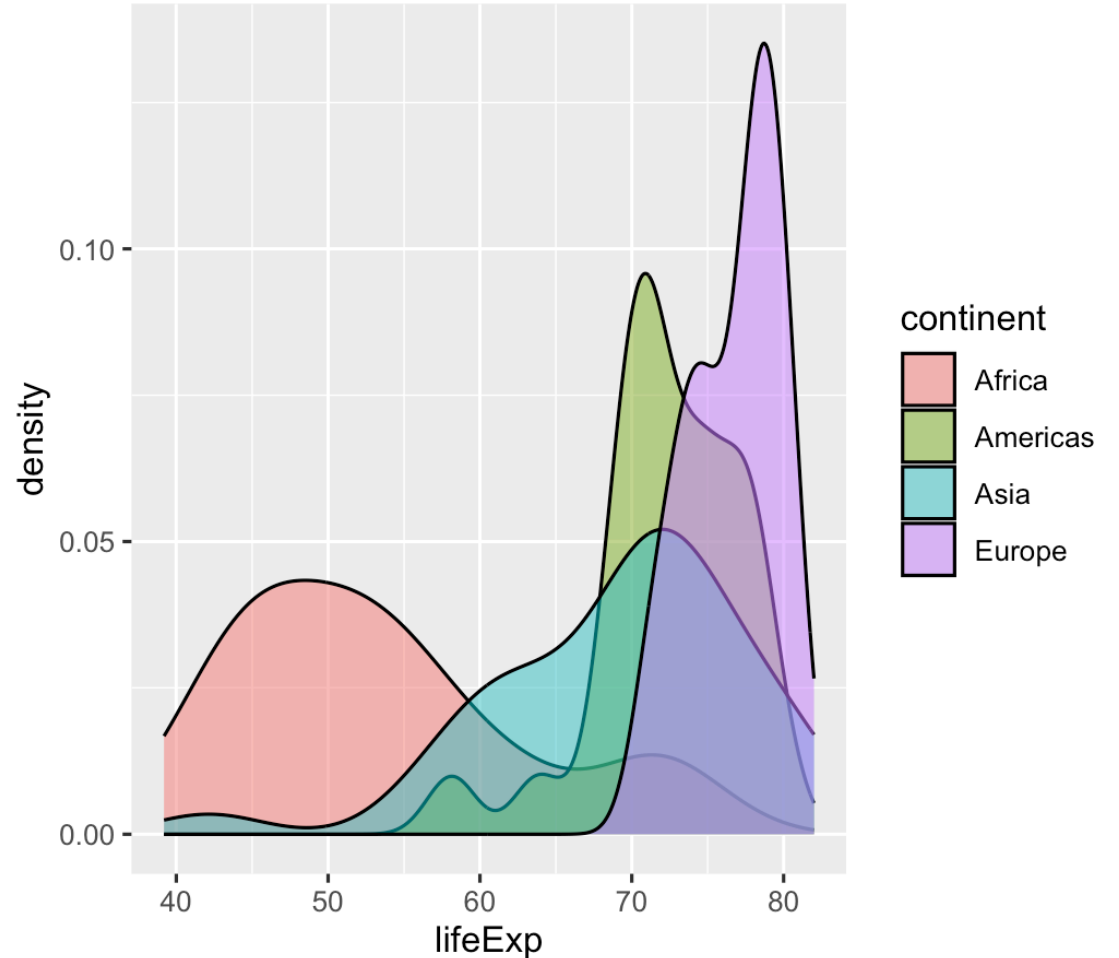
```
gapminder_intervals <- gapminder |>
  filter(year == 2002) |>
  mutate(africa =
    ifelse(continent == "Africa",
           "Africa",
           "Not Africa")) |>
  mutate(age_buckets =
    cut(lifeExp,
        breaks = seq(30, 90, by = 5)))
group_by(africa, age_buckets) |>
  summarize(total = n())

ggplot(gapminder_intervals,
  aes(y = age_buckets,
      x = ifelse(africa == "Africa",
                 total, -total),
      fill = africa)) +
  geom_col(width = 1, color = "white")
```



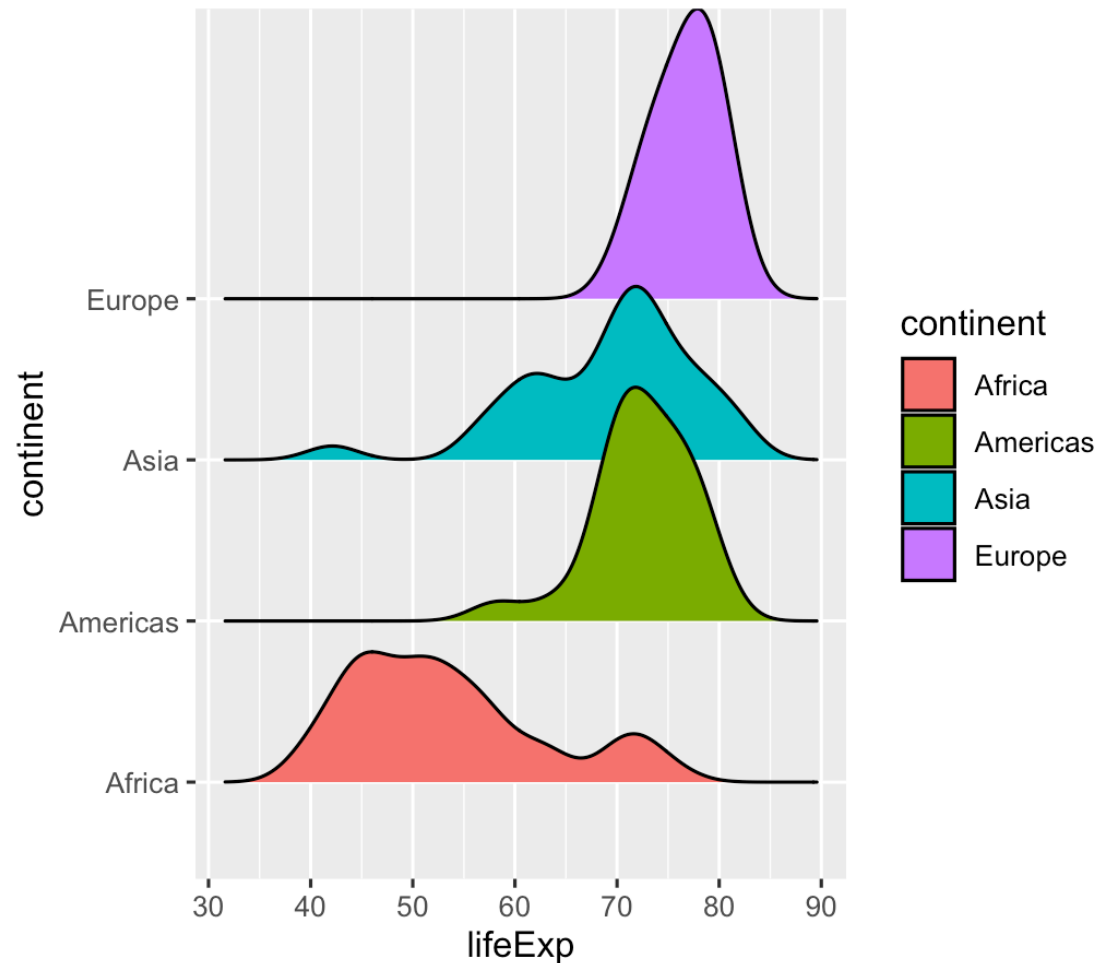
Multiple densities: Transparency

```
ggplot(filter(gapminder_2002,  
            continent != "Oceania"),  
       aes(x = lifeExp,  
           fill = continent)) +  
  geom_density(alpha = 0.5)
```

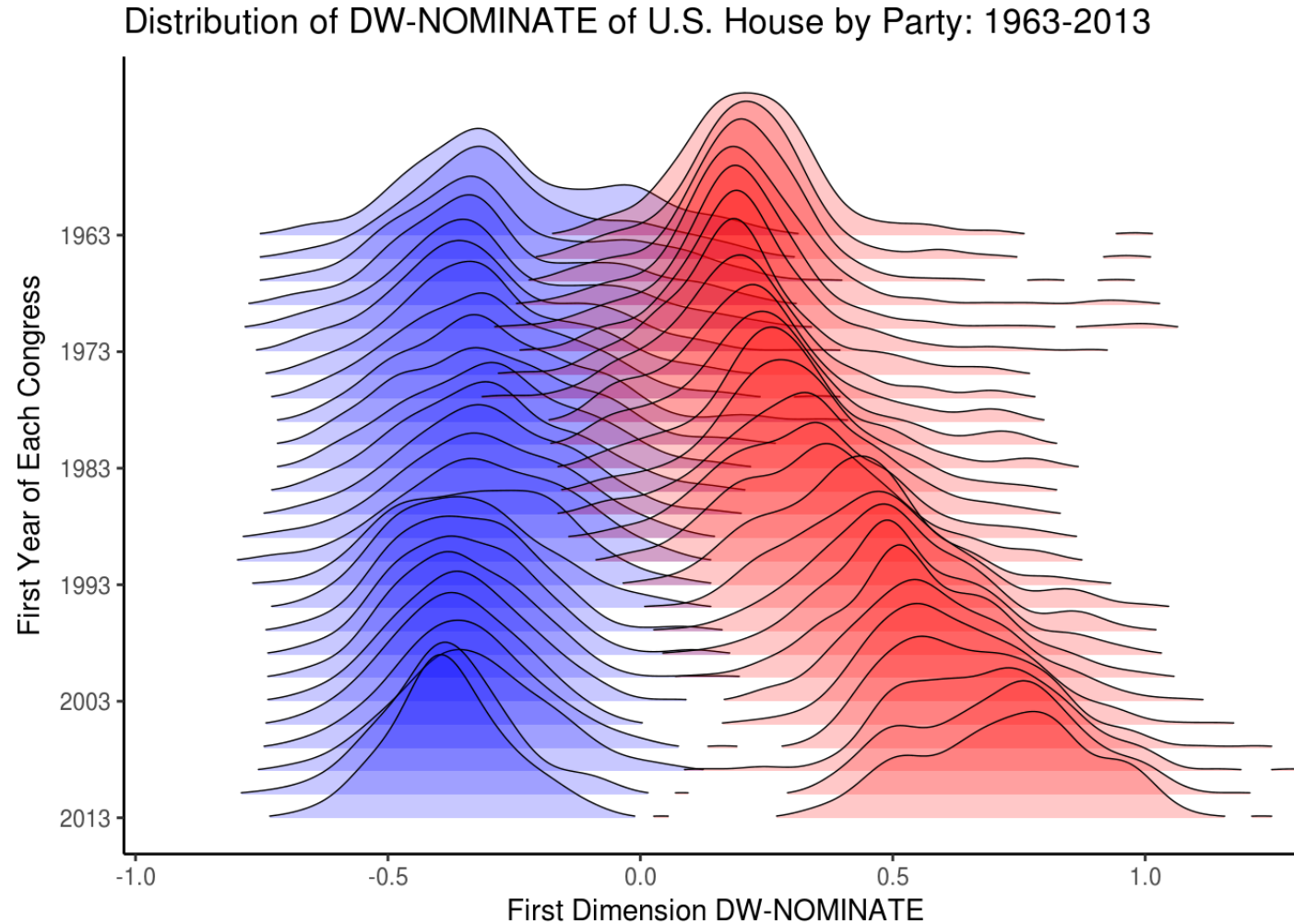


Multiple densities: Ridge plots

```
library(ggribes)  
  
ggplot(filter(gapminder_2002,  
             continent != "Oceania"),  
       aes(x = lifeExp,  
           fill = continent,  
           y = continent)) +  
  geom_density_ridges()
```



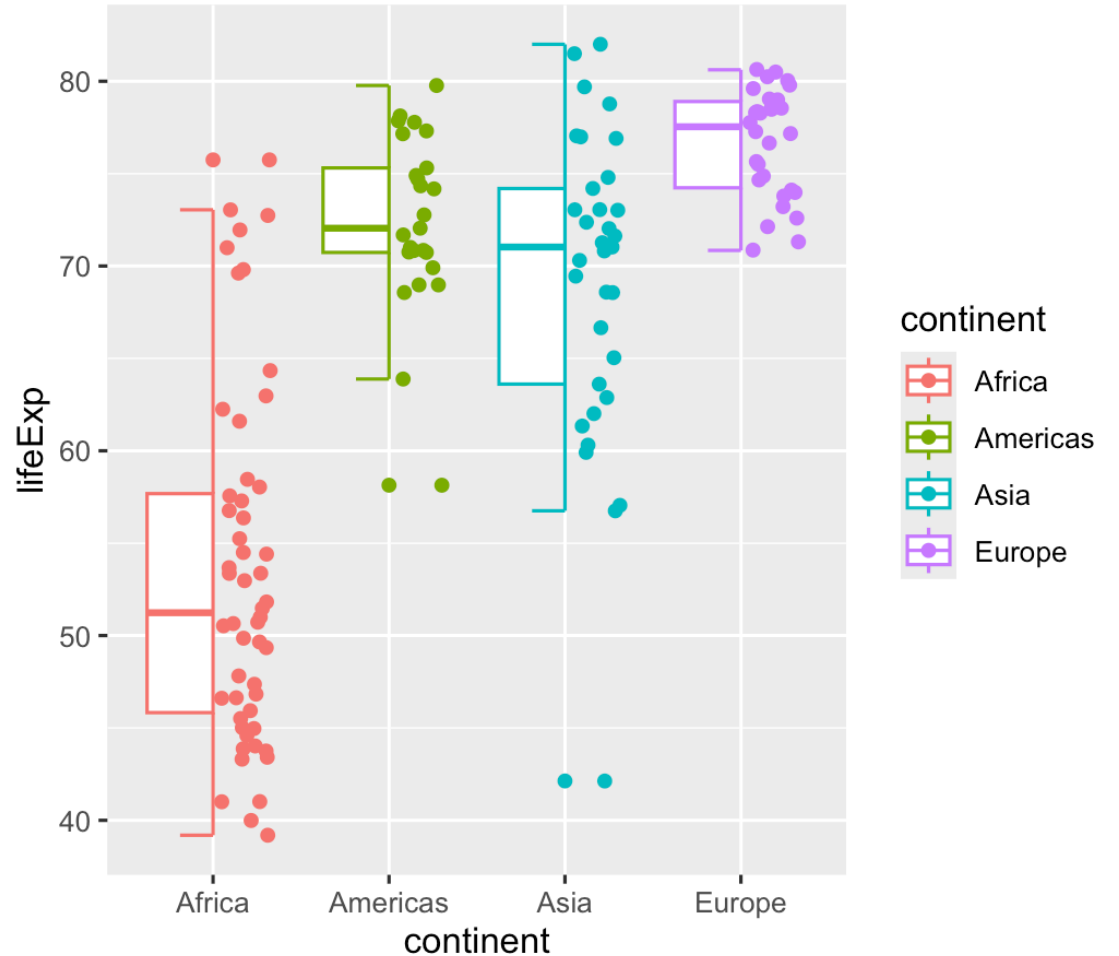
Multiple densities: Ridge plots



Multiple geoms: gghalves

```
library(gghalves)

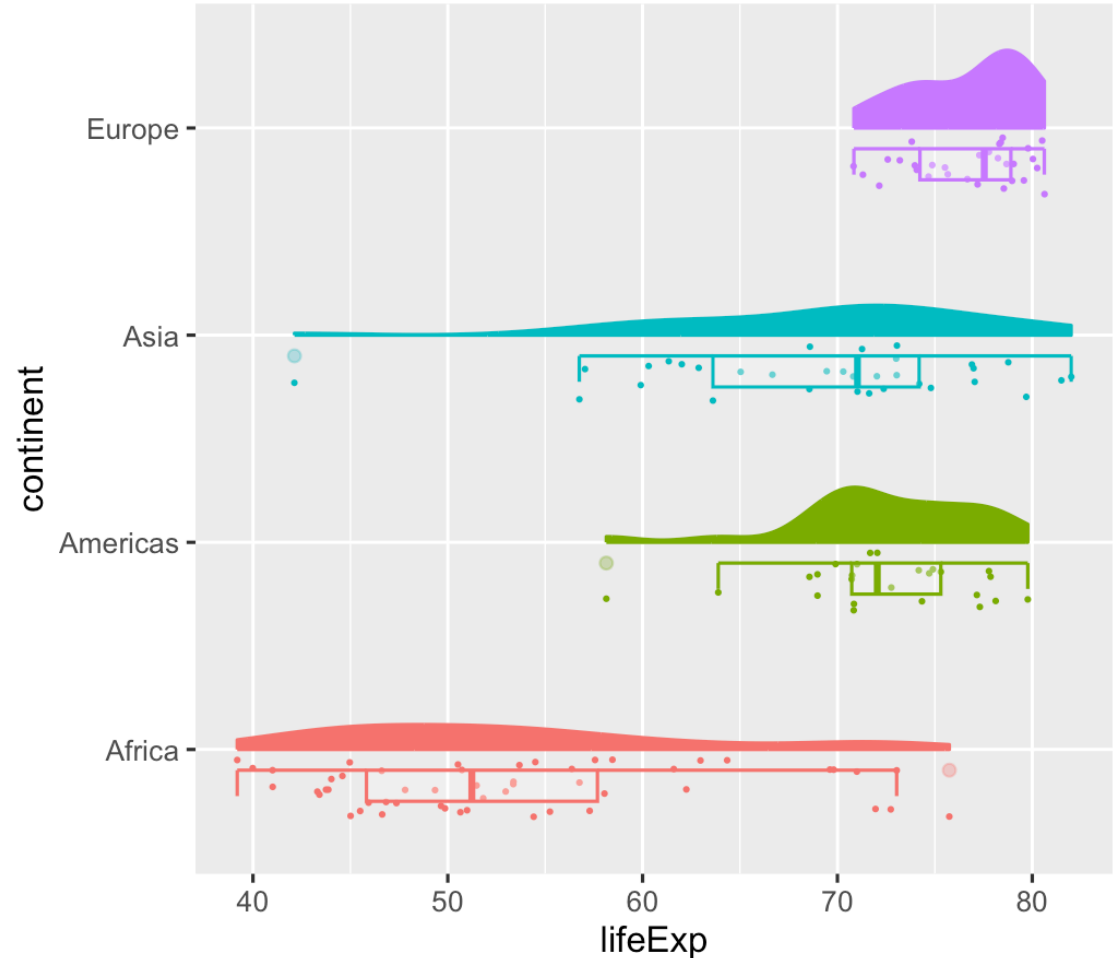
ggplot(filter(gapminder_2002,
             continent != "Oceania"),
       aes(y = lifeExp,
           x = continent,
           color = continent)) +
  geom_half_boxplot(side = "l") +
  geom_half_point(side = "r")
```



Multiple geoms: Raincloud plots

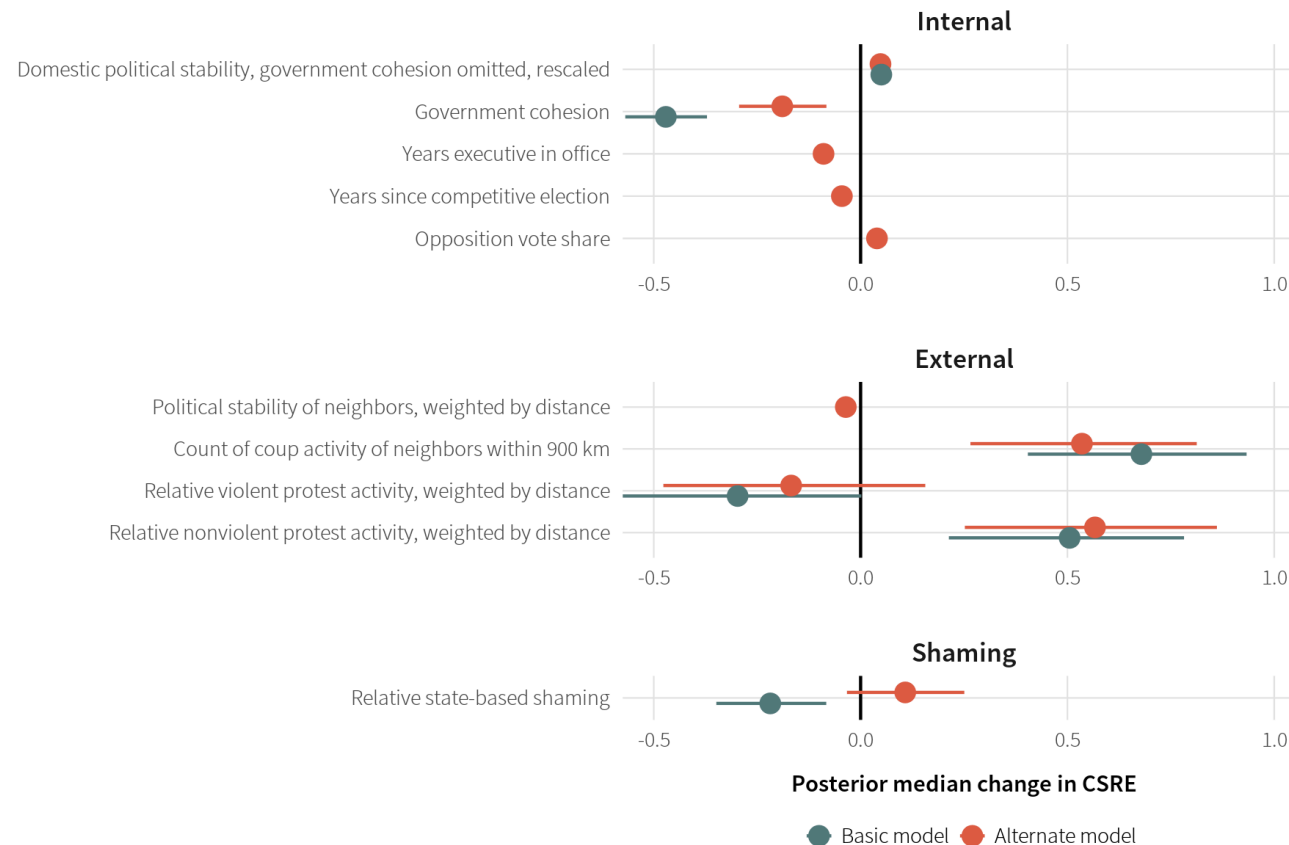
```
library(ggthemes)

ggplot(filter(gapminder_2002,
             continent != "Oceania"),
       aes(y = lifeExp,
           x = continent,
           color = continent)) +
  geom_half_point(side = "l", size = 0.3) +
  geom_half_boxplot(side = "l", width = 0.5,
                  alpha = 0.3, nudge = 0.1) +
  geom_half_violin(aes(fill = continent),
                  side = "r") +
  guides(fill = "none", color = "none") +
  coord_flip()
```

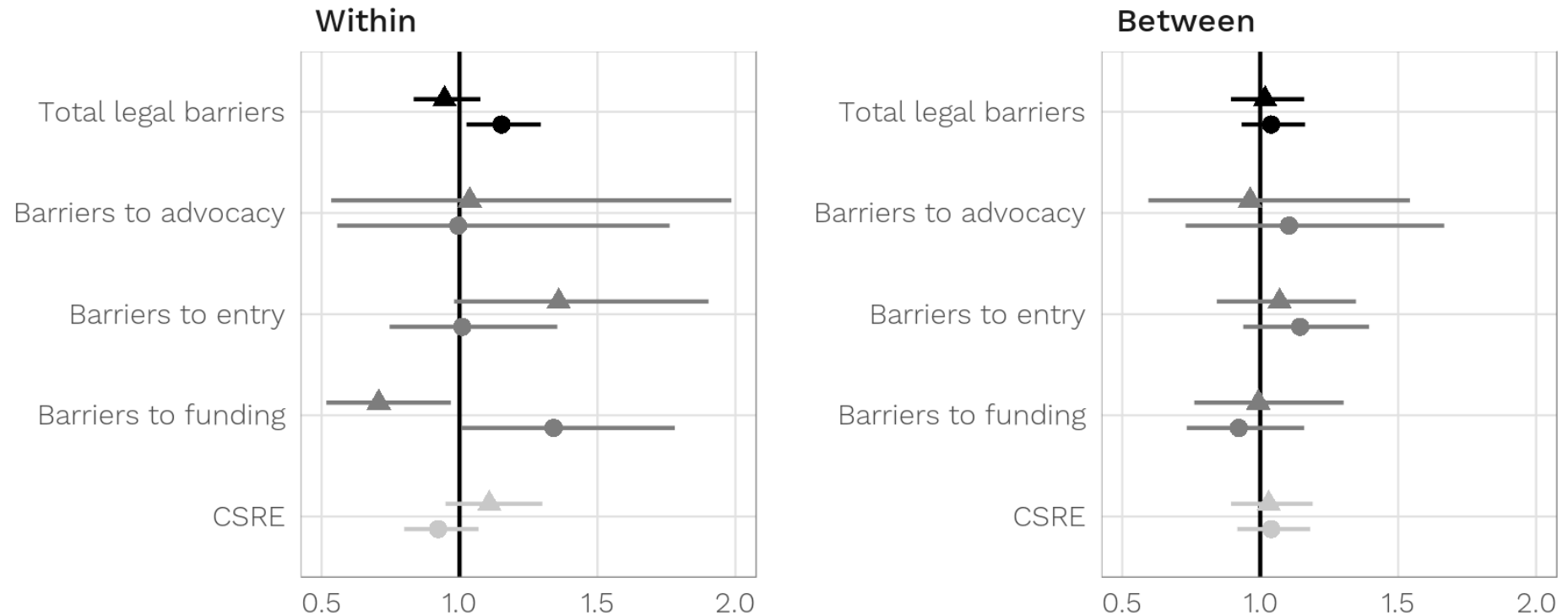


Uncertainty in model estimates

(You'll learn how to make these in the next session)



Uncertainty in model estimates



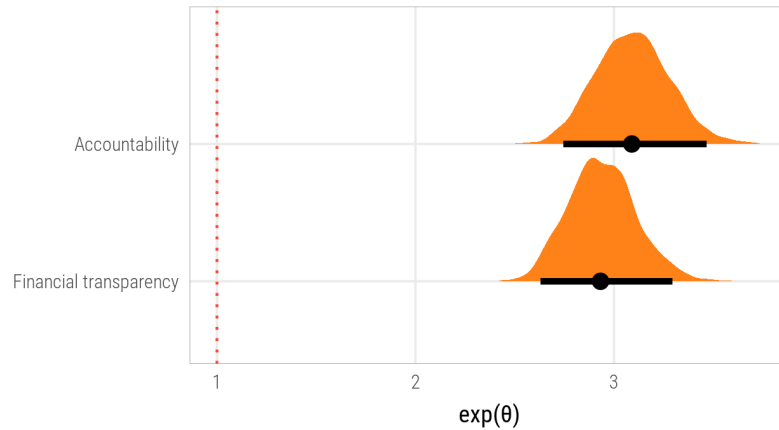
Percent change in ratio of aid channeled to NGO type (odds ratio)

- ▲ Foreign NGOs
- Domestic NGOs
- (1) Total barriers
- (2) Total barriers, by type
- (3) Civil society reg. env. (CSRE)

Uncertainty in model estimates

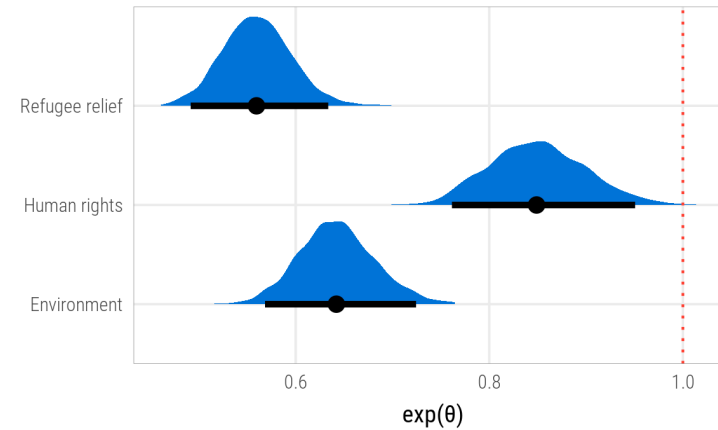
Organizational practices

Reference groups = no accountability; no transparency



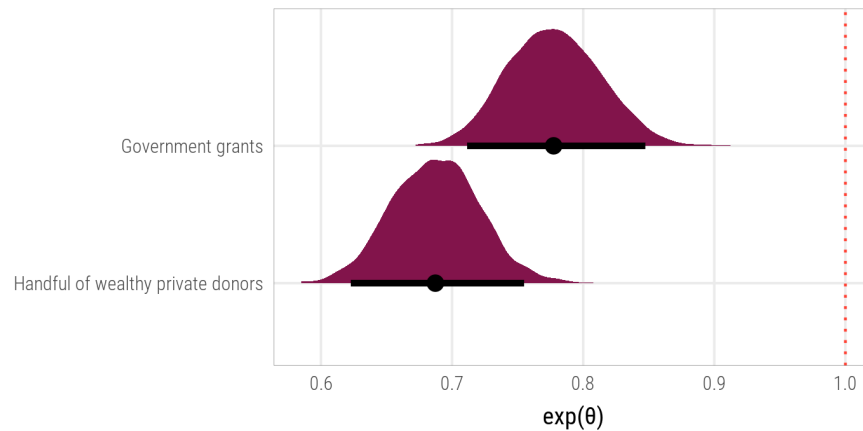
Issue area

Reference group = emergency response



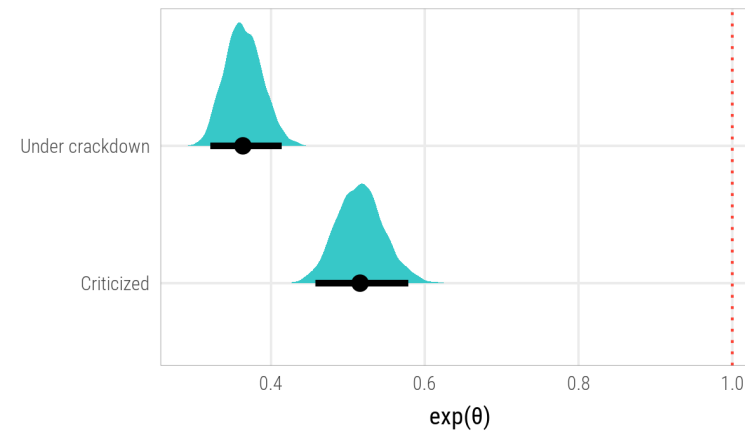
Funding sources

Reference group = many small private donations



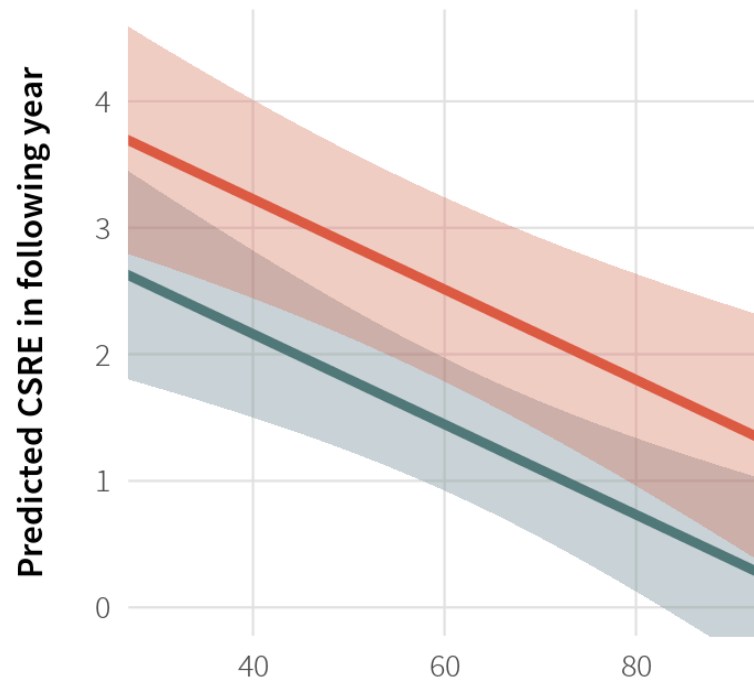
Relationship with host government

Reference group = friendly relationship with government



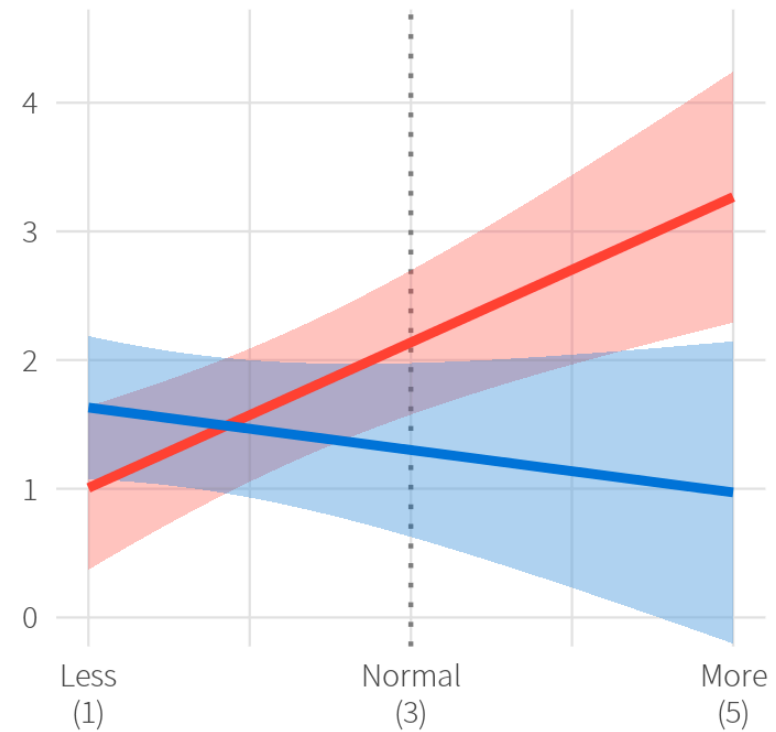
Uncertainty in model effects

(You'll learn how to make these in the next session)



Political stability of neighbors

- No coups in neighboring countries
- Coup activity in neighboring countries



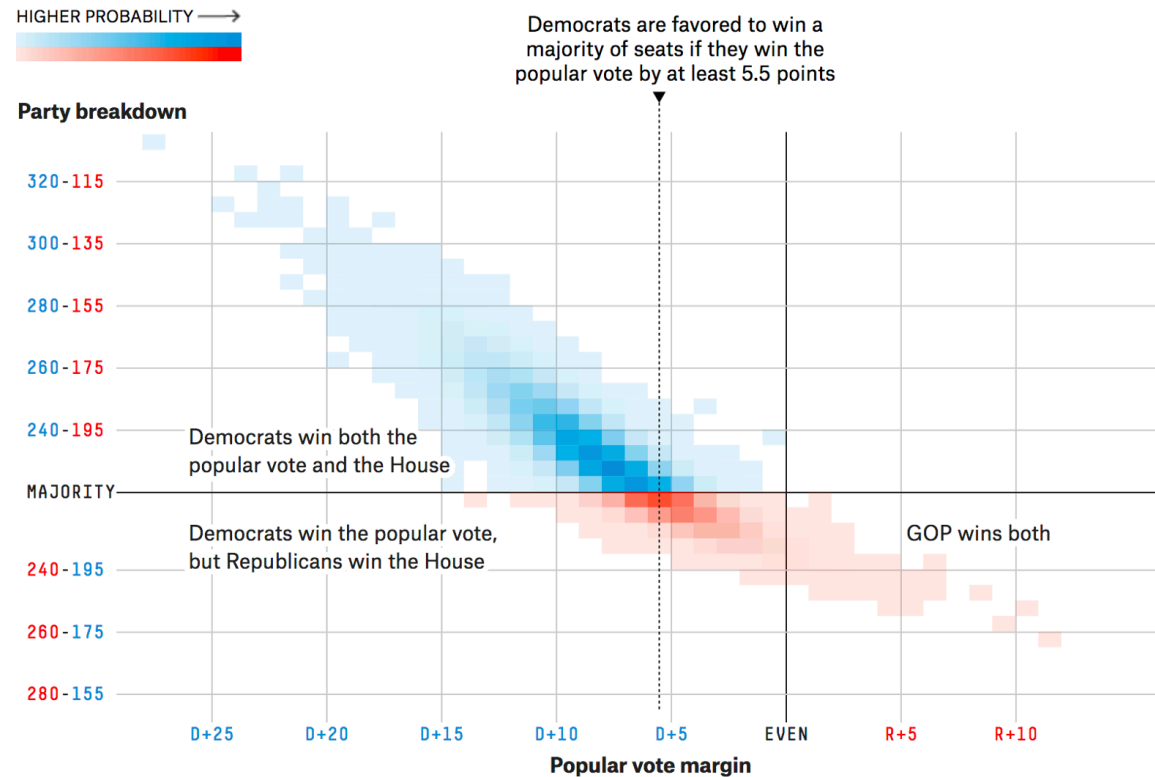
Relative protest activity

- Nonviolent
- Violent

Uncertainty in model outcomes

How the popular vote for the House translates into seats

How various breakdowns in the national popular vote correspond to the most likely distributions of House seats by party, according to our forecast



FiveThirtyEight's 2018 midterms model outcomes plot