

# Uncertainty

## Session 6

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

# Plan for today

Communicating uncertainty

Visualizing uncertainty

# Communicating uncertainty

# The Bay of Pigs



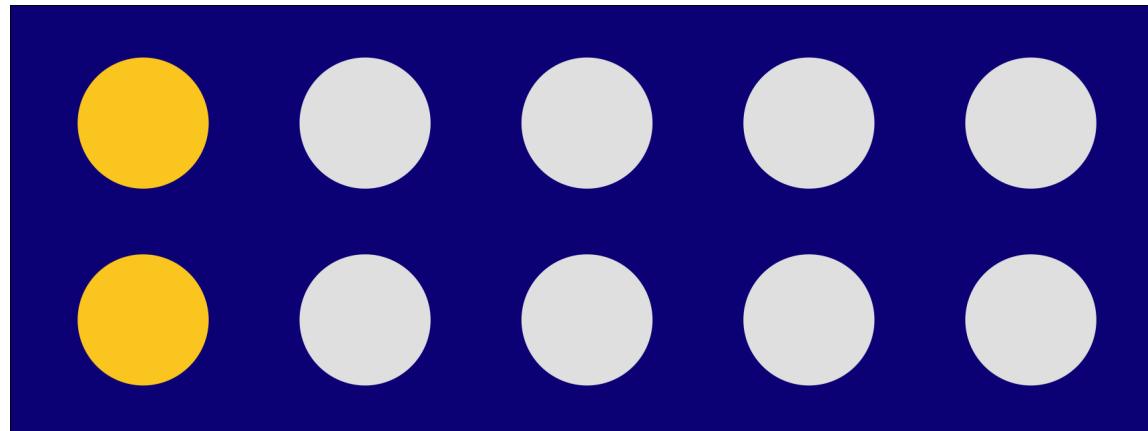
Joint Chiefs said  
"fair chance of  
success"

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

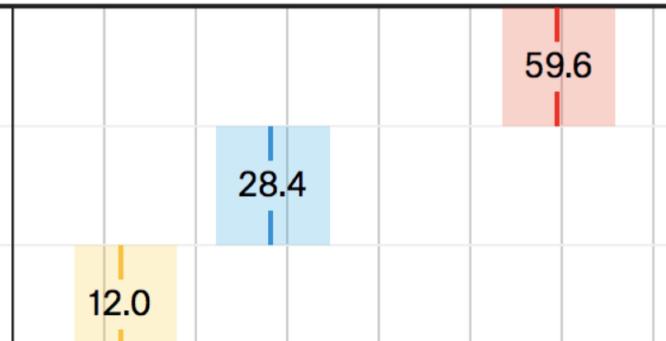
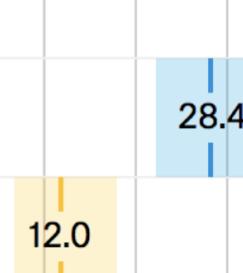


**<1 in 100**

Chance the Democrat wins (<0.1%)

**>99 in 100**

Chance the Republican wins (>99.9%)

Candidate	Forecasted vote share	Chance of winning
Mitt Romney (R)	 59.6	<b>&gt;99 in 100</b> (>99.9%)
Jenny Wilson (D)	 28.4	<b>&lt;1 in 100</b> (<0.1%)
Other candidates	 12.0	<b>&lt;1 in 100</b> (<0.1%)

# Misperceptions of probability

Texas LEAN R

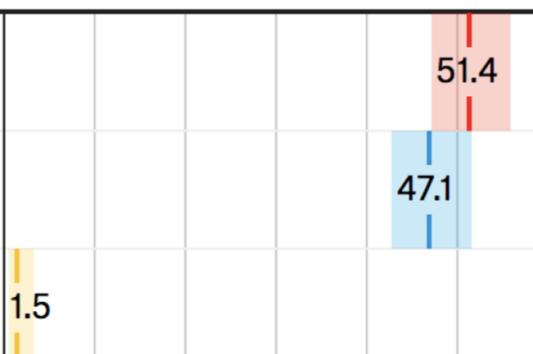
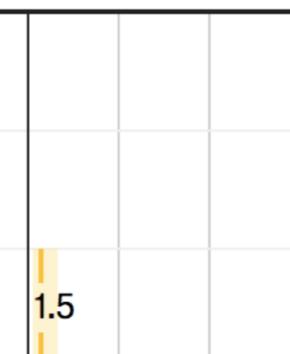


**1 in 4**

Chance the Democrat wins (25.5%)

**3 in 4**

Chance the Republican wins (74.5%)

Candidate	Forecasted vote share	Chance of winning
Ted Cruz (R) Incumbent	 51.4	<b>3 in 4</b> (74.5%)
Beto O'Rourke (D)	 47.1	<b>1 in 4</b> (25.5%)
Neal M. Dikeman (Lib.)	 1.5	<b>&lt;1 in 100</b> (<0.1%)

# Misperceptions of probability

**Chance of rain = Probability × Area**



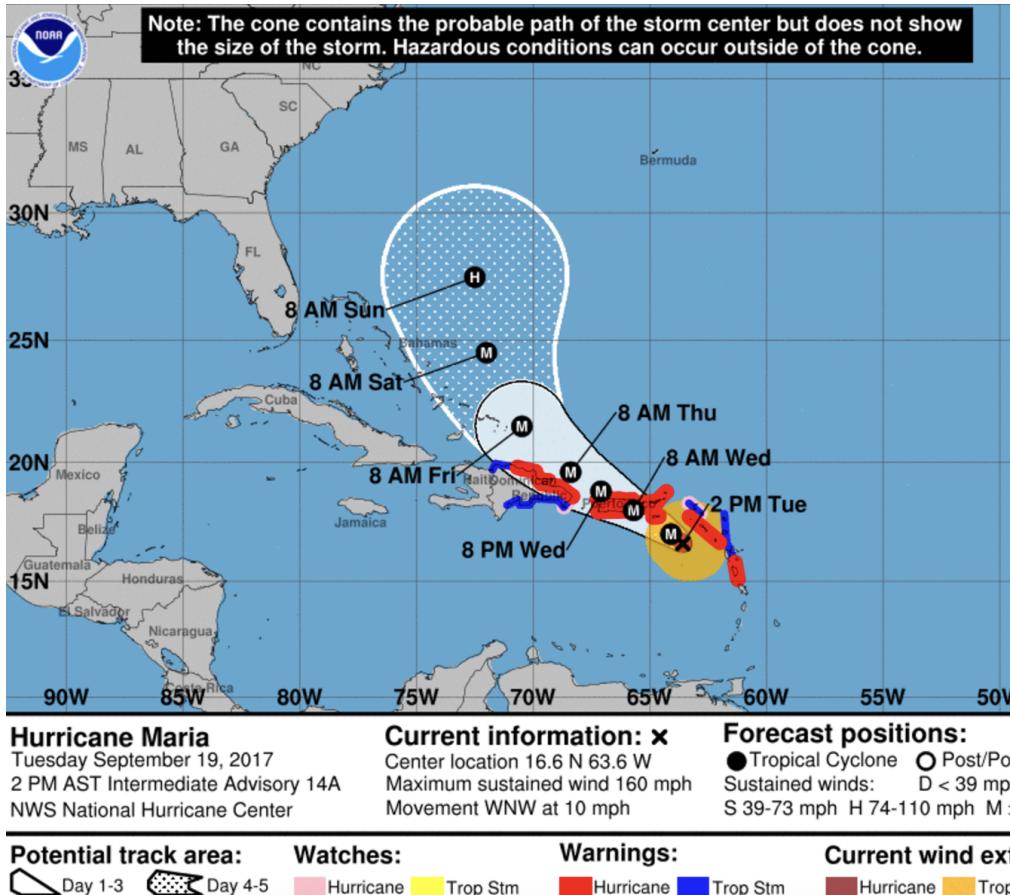
**100% chance in  
1/3 of the city**

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

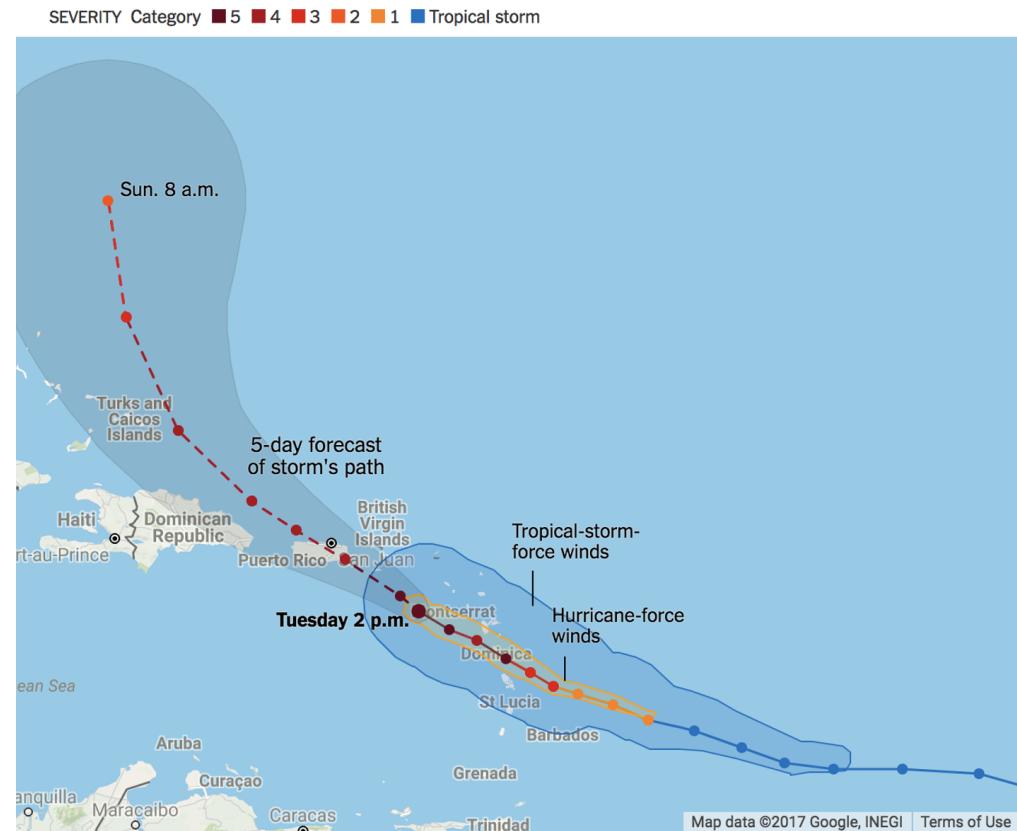
**Chance of rain  
for city = 33%**

# Misperceptions of probability

# Misperceptions of probability

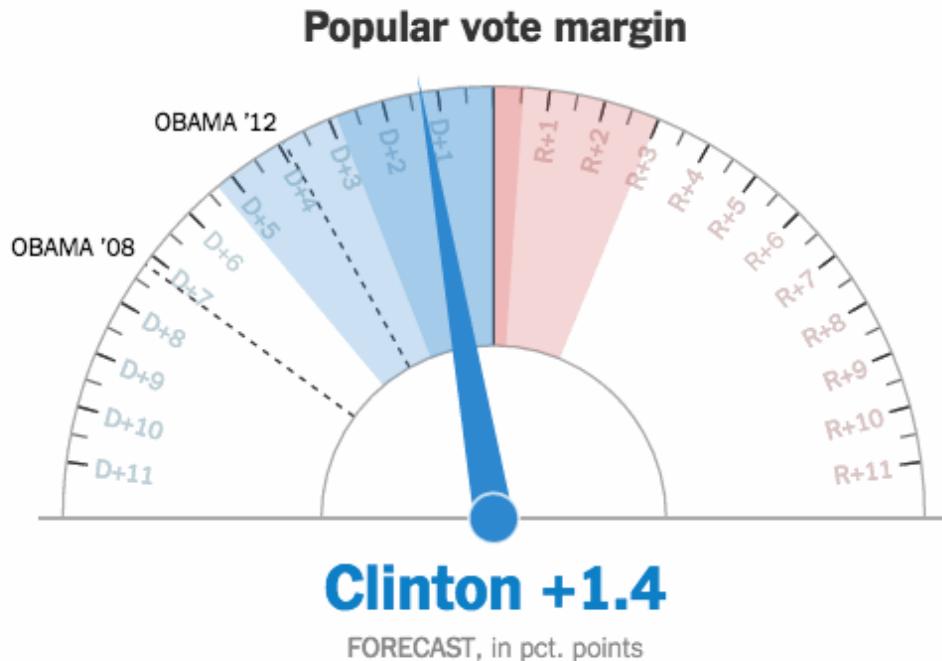


Hurricane Maria map, NOAA



Hurricane Maria map, New York Times

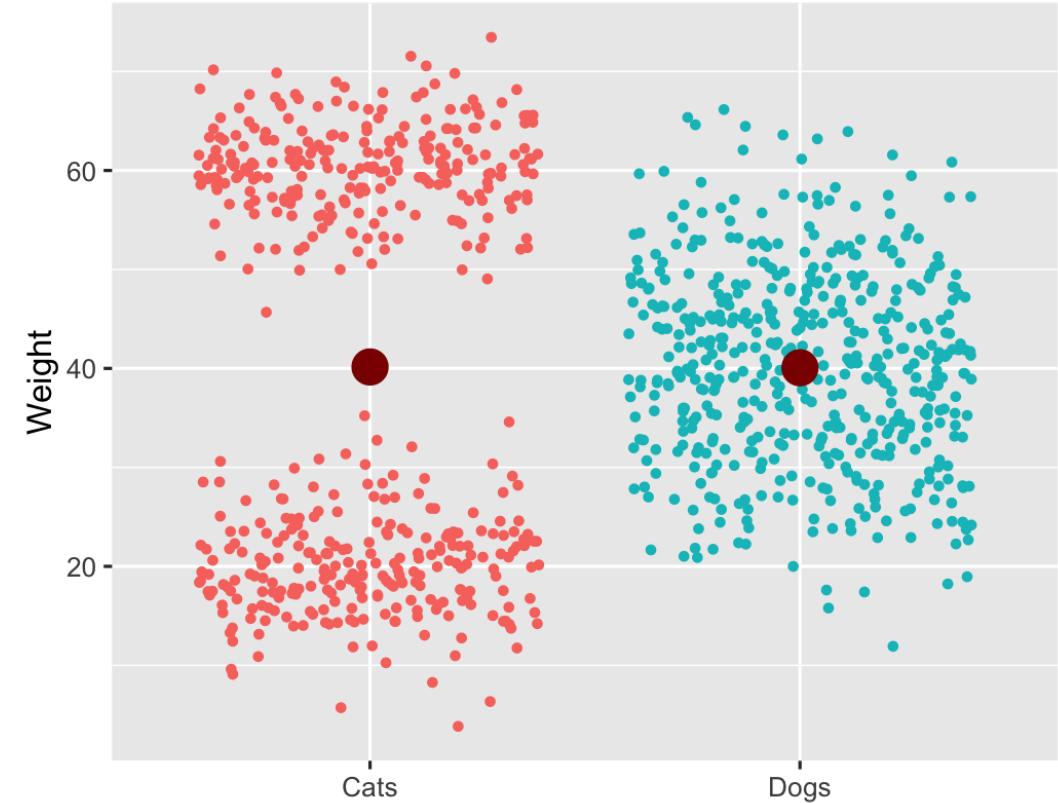
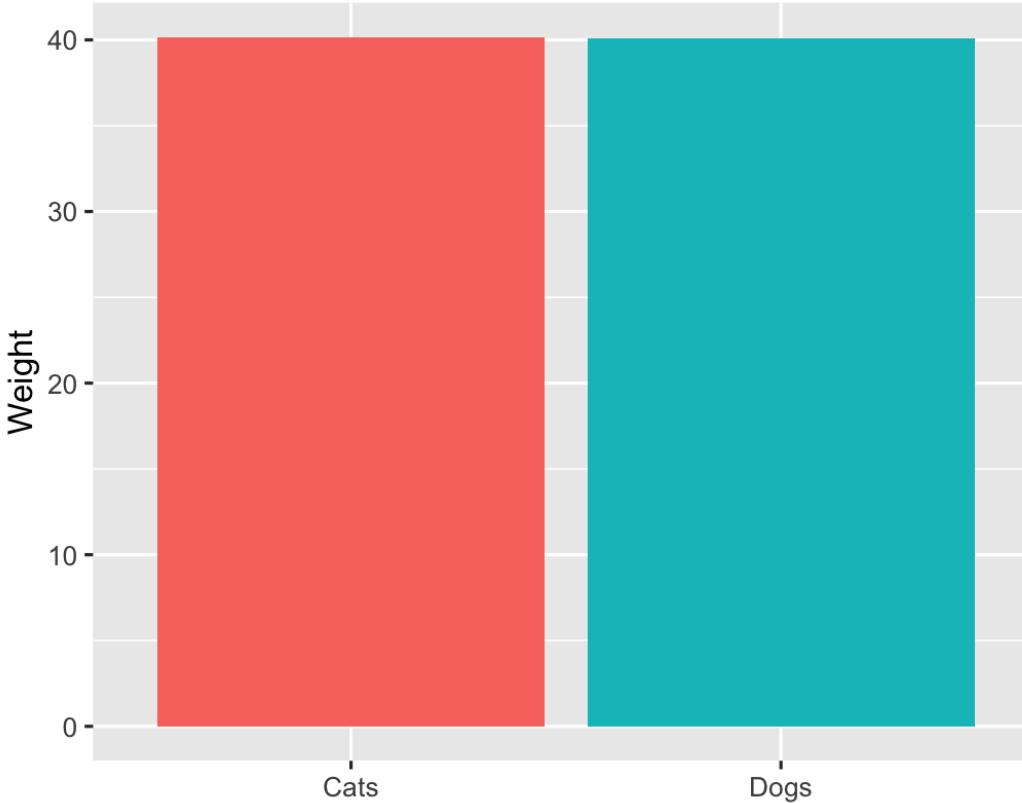
# The needle



# The needle

# 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

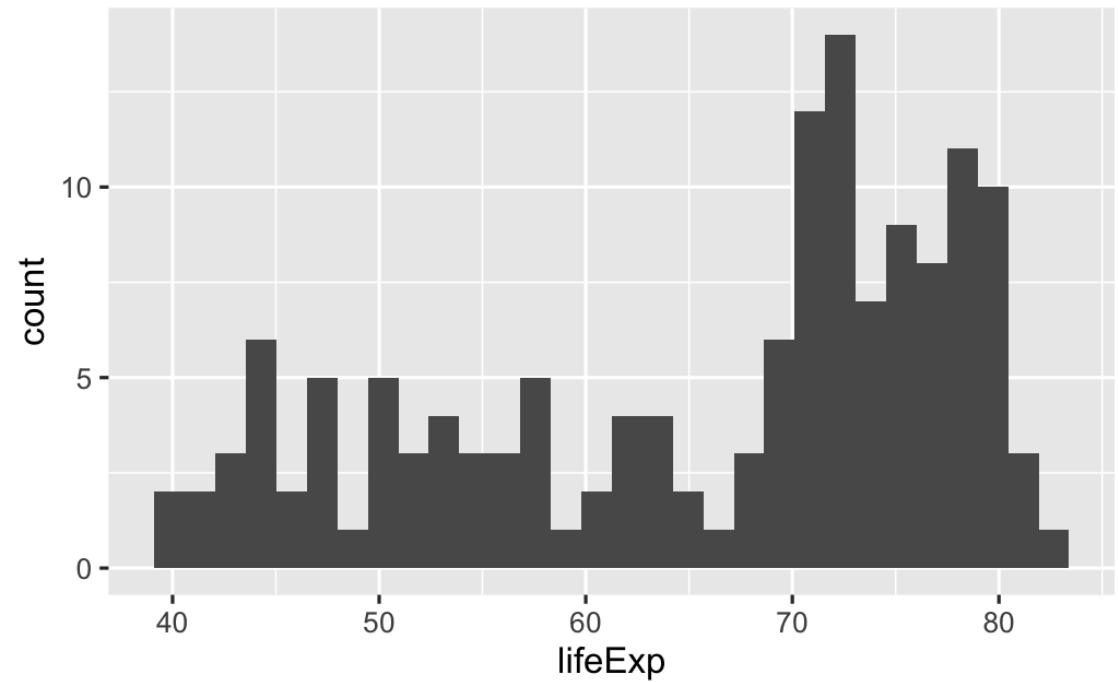
# Histograms

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

```
library(gapminder)

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

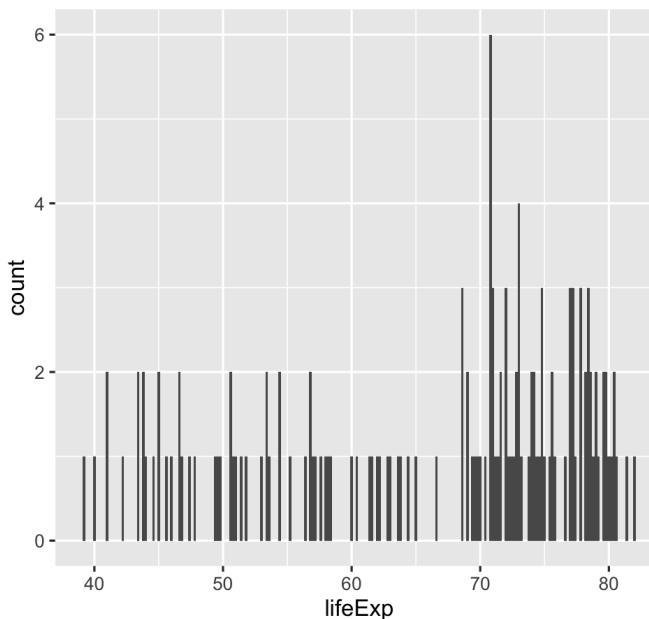
ggplot(gapminder_2002,
       aes(x = lifeExp)) +
  geom_histogram()
```



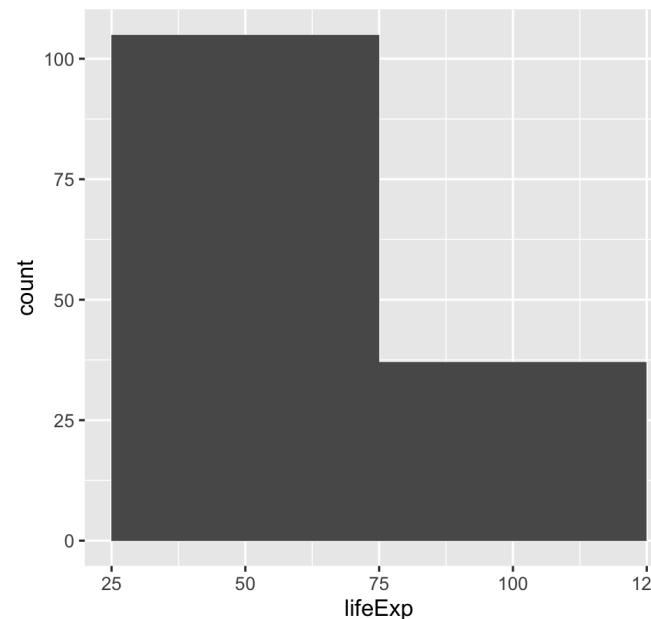
# Histograms: Bin width

No official rule for what makes a good bin width

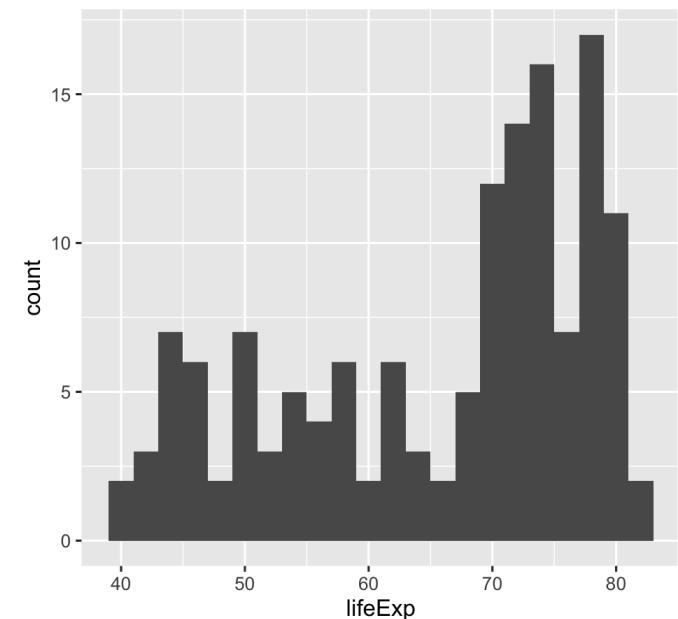
Too narrow:  
`binwidth = 0.2`



Too wide:  
`binwidth = 50`



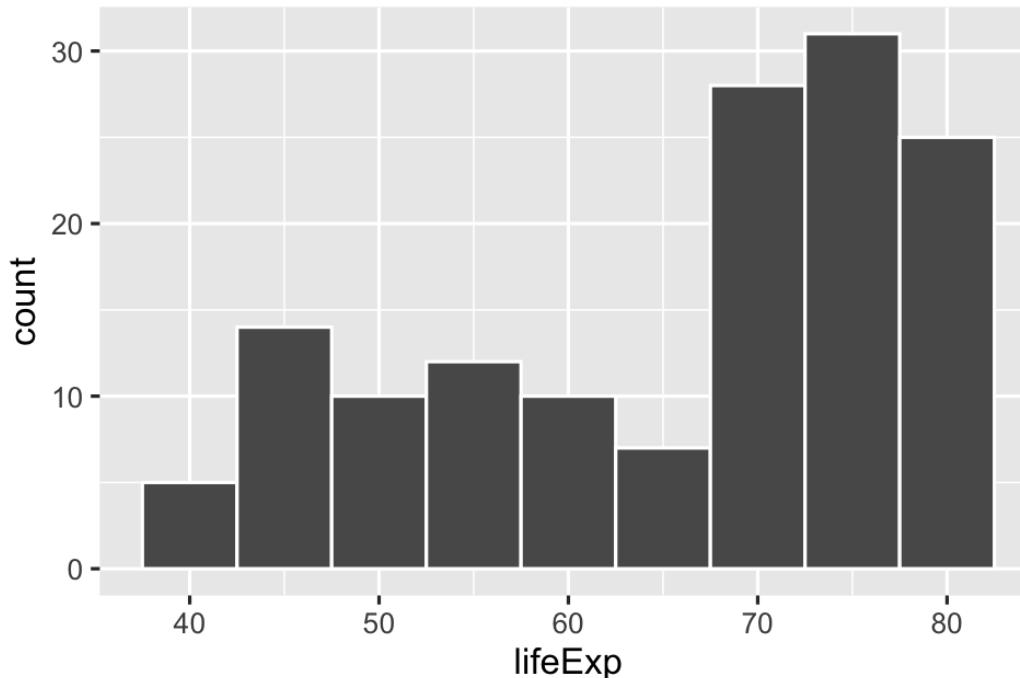
(One type of) just right:  
`binwidth = 2`



# Histogram tips

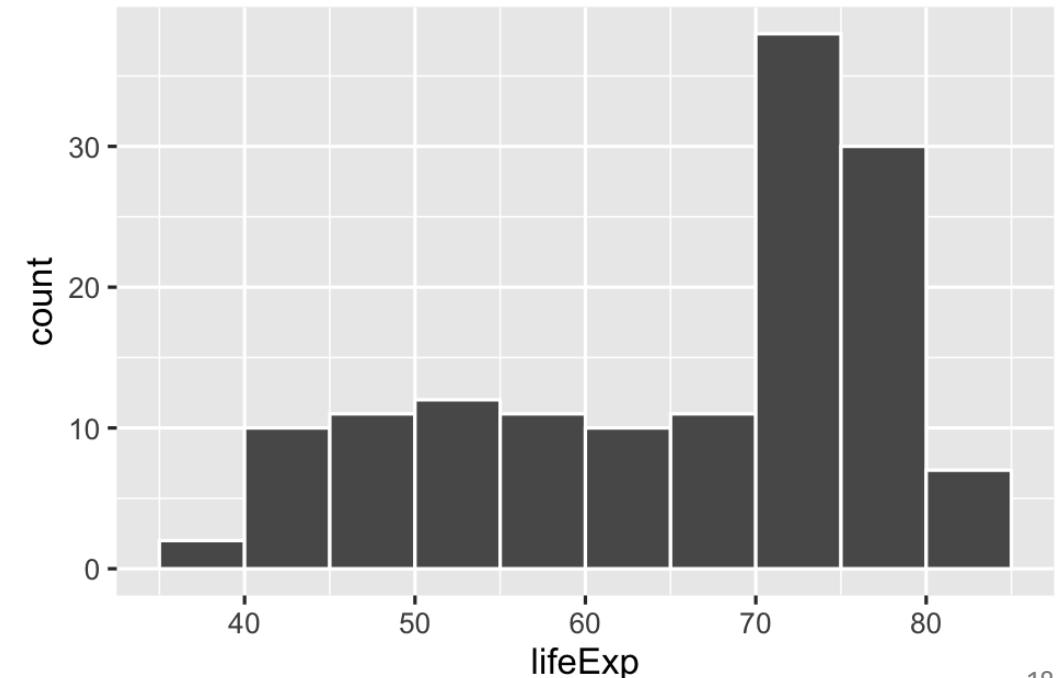
Add a border to the bars  
for readability

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



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

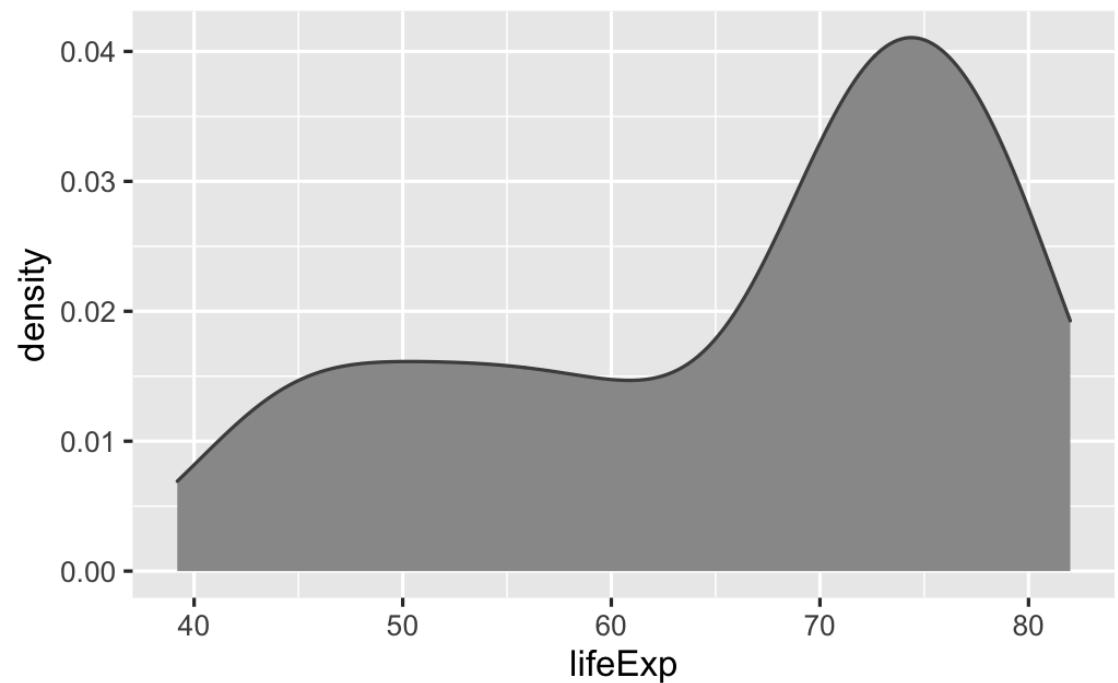
```
geom_histogram(..., boundary = 50)
```



# Density plots

Use calculus to find the probability of each x value

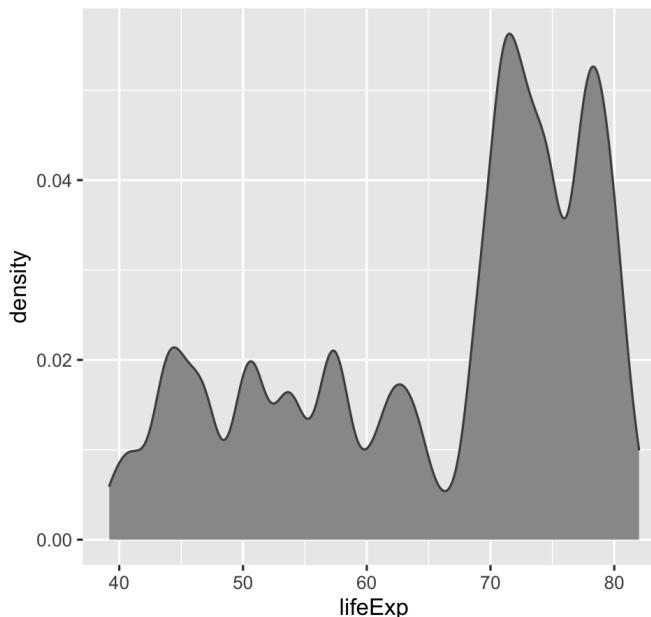
```
ggplot(gapminder_2002,  
       aes(x = lifeExp)) +  
  geom_density(fill = "grey60",  
              color = "grey30")
```



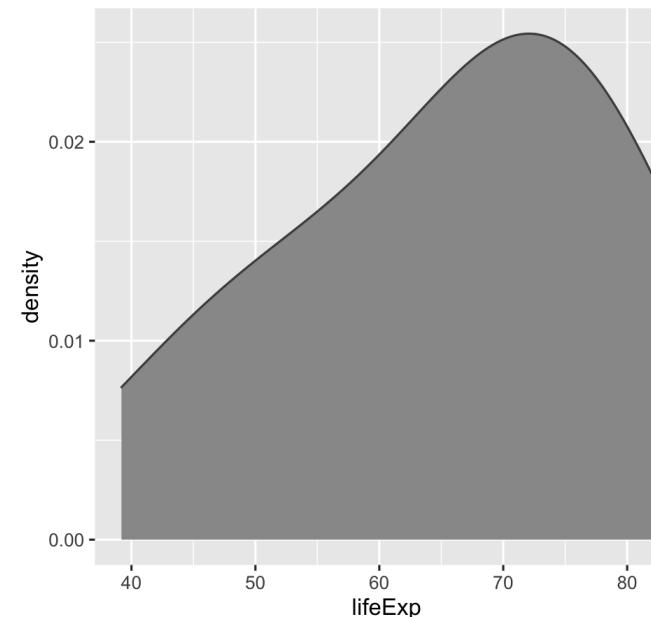
# Density plots: Kernels and bandwidths

Different options for calculus change the plot shape

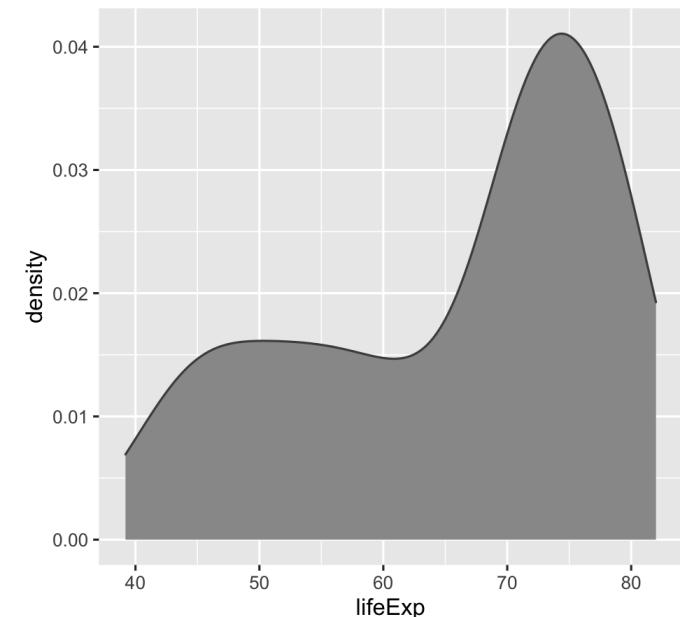
**bw = 1**



**bw = 10**



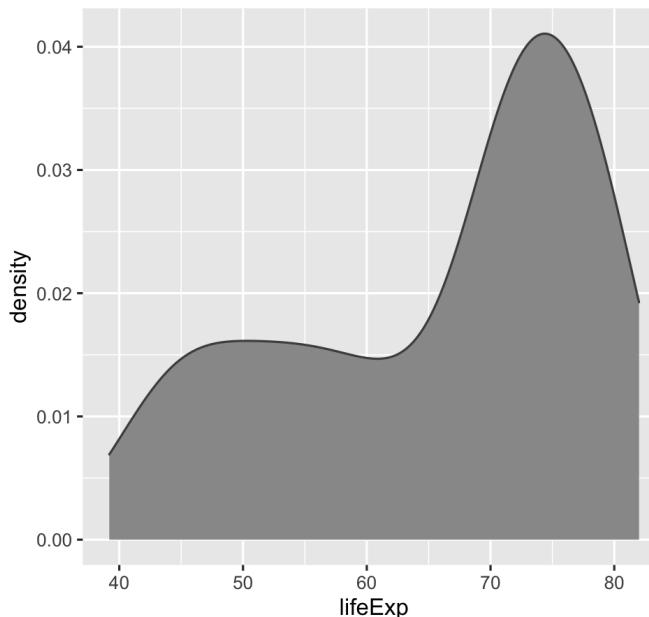
**bw = "nrd0"(default)**



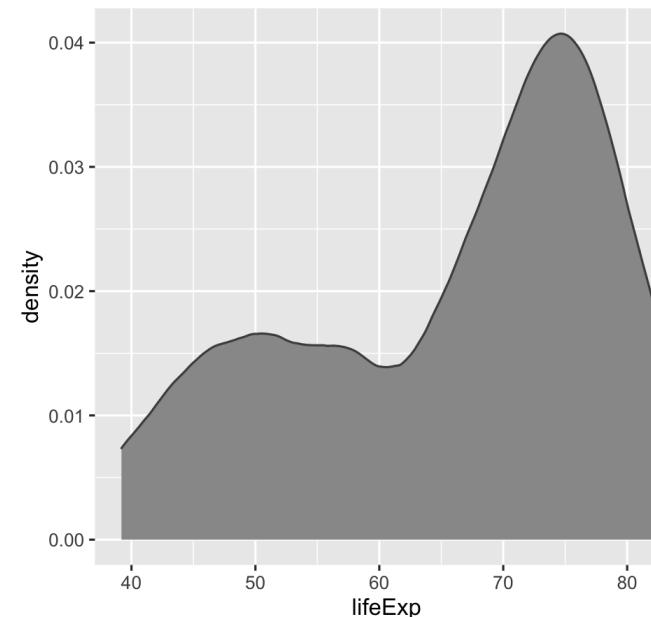
# Density plots: Kernels and bandwidths

Different options for calculus change the plot shape

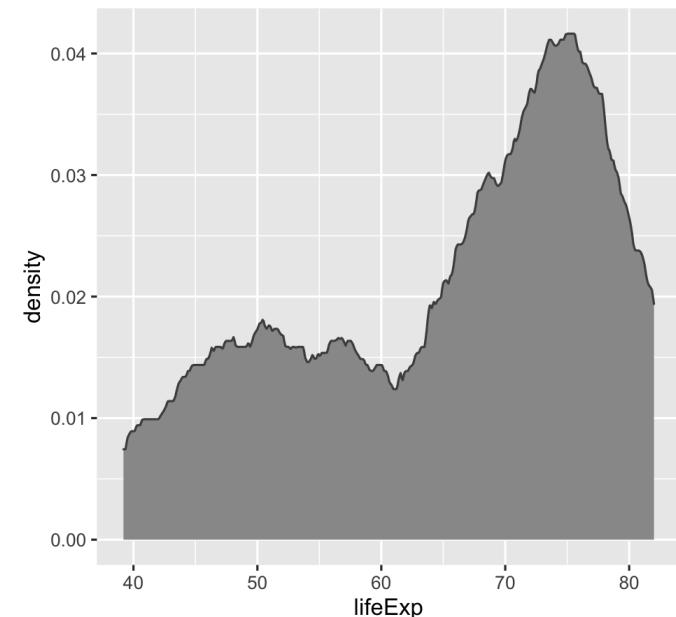
`kernel = "gaussian"`



`"epanechnikov"`



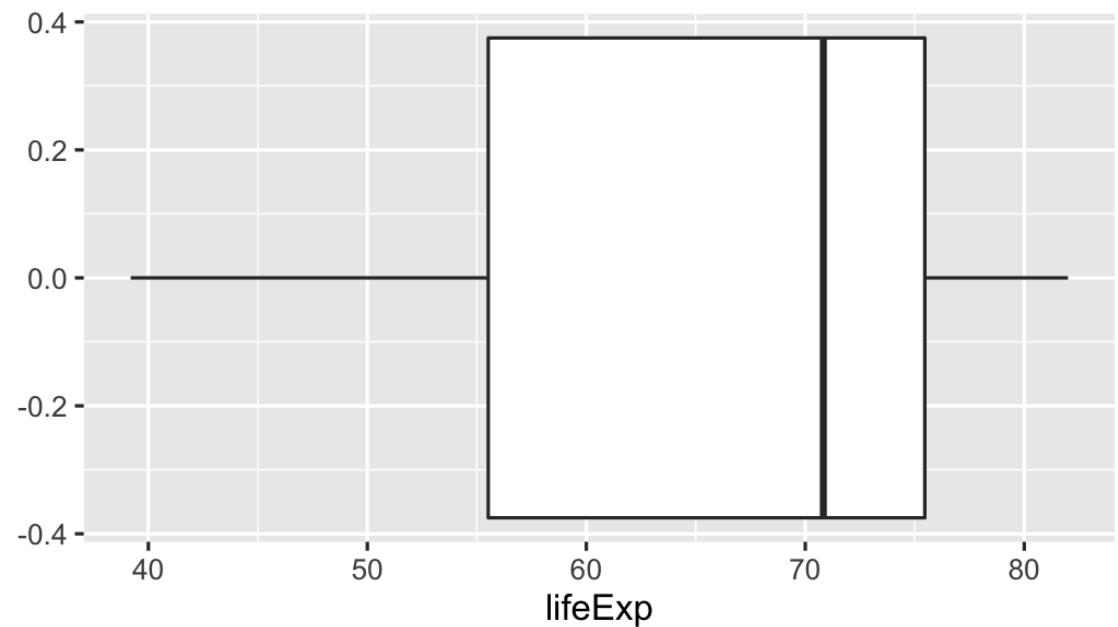
`"rectangular"`



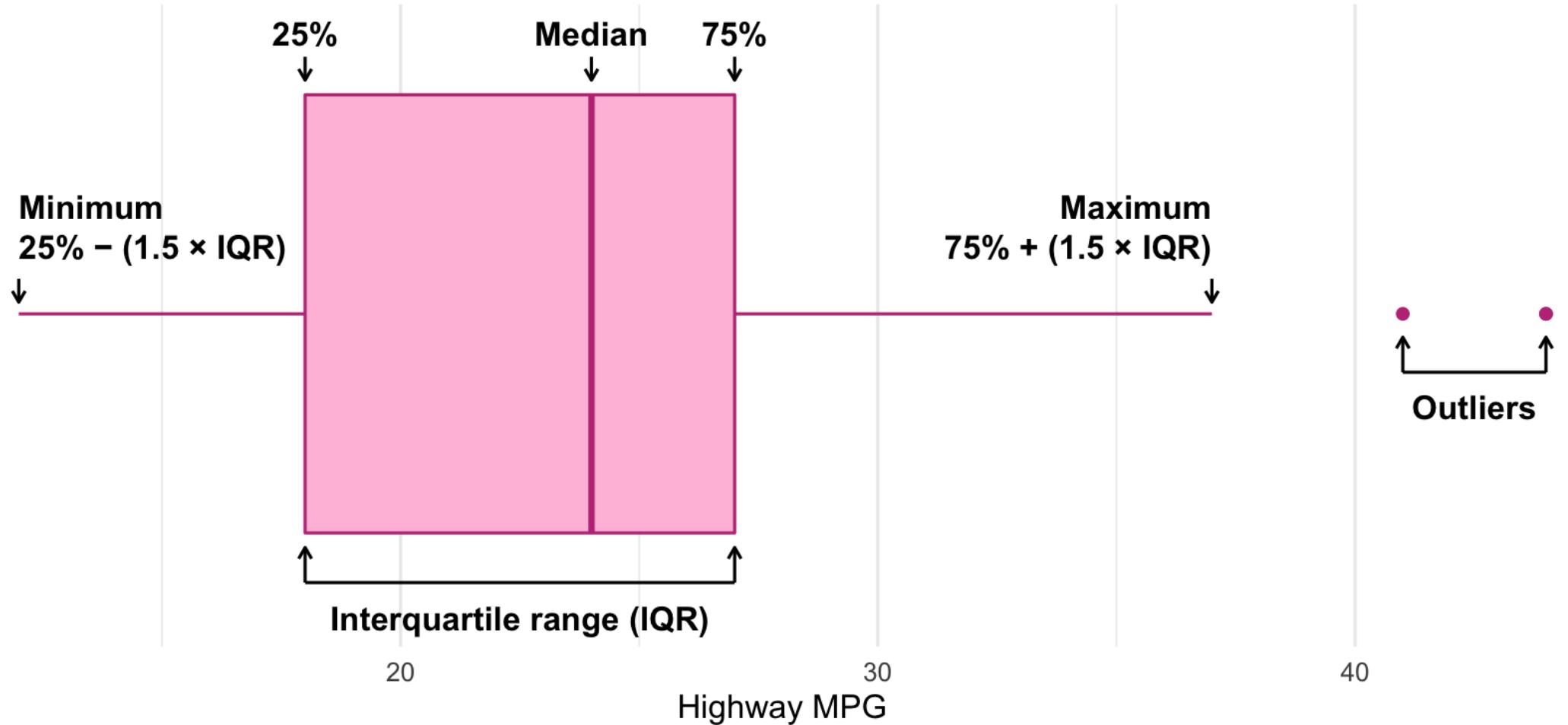
# Box plots

Show specific distributional numbers

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



# Box plots

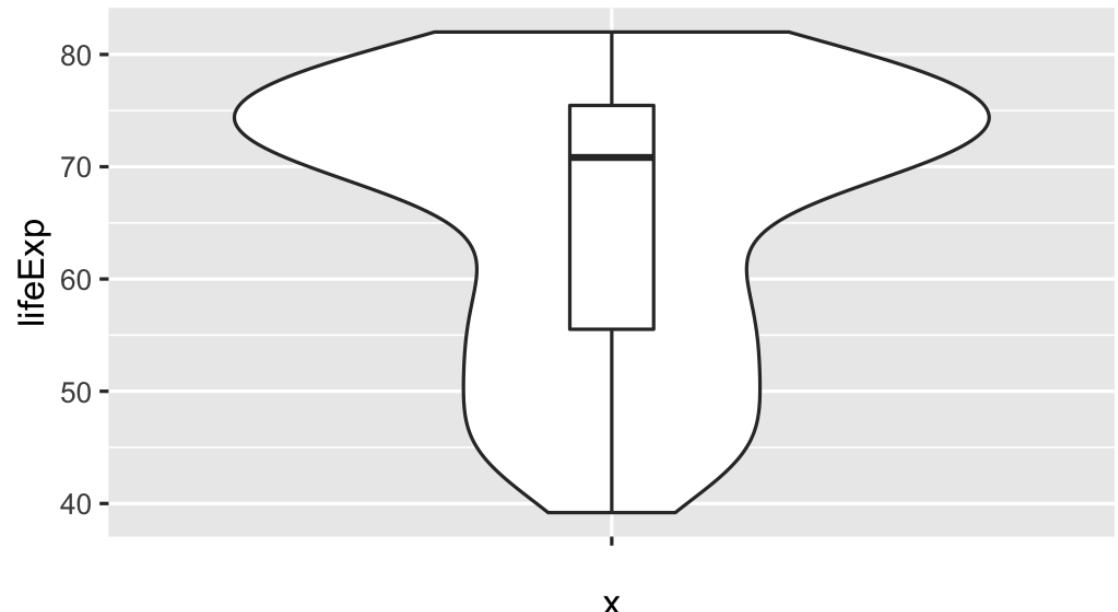


# Violin plots

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

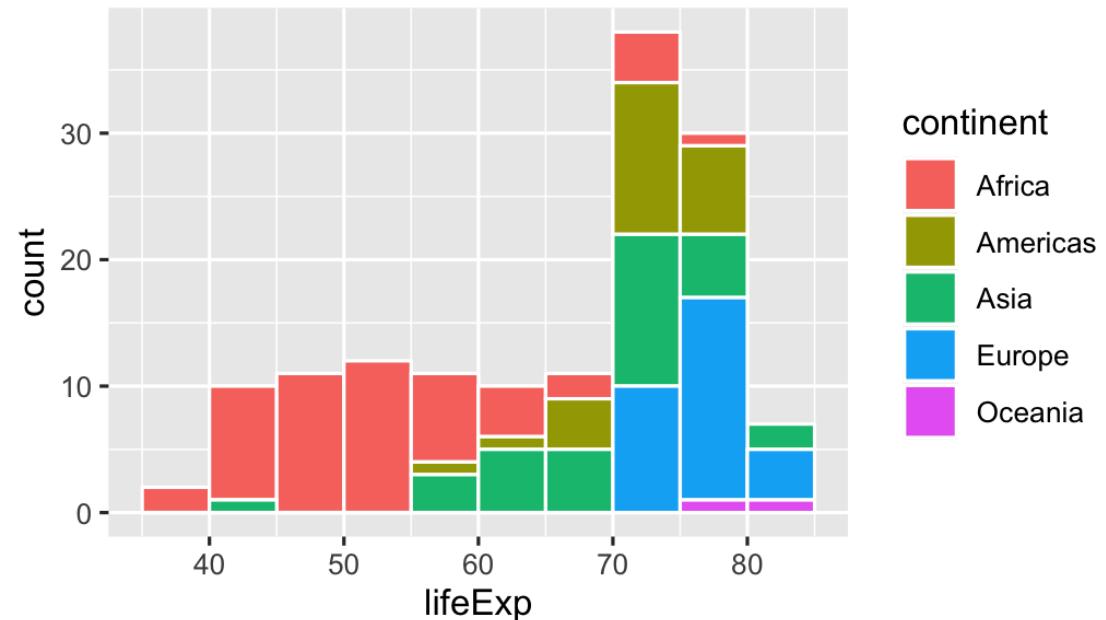
Add a `fill` aesthetic or use faceting!

# Multiple histograms

Fill with a different variable

This is bad and really hard to read though

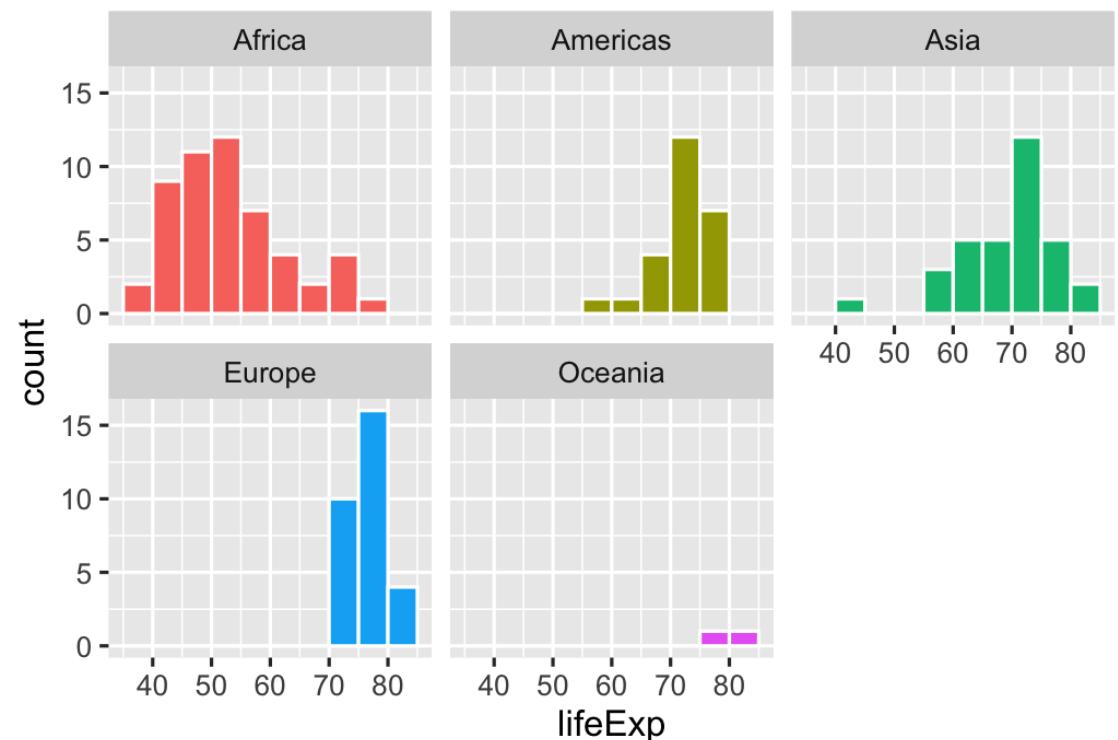
```
ggplot(gapminder_2002,  
       aes(x = lifeExp,  
            fill = continent)) +  
  geom_histogram(binwidth = 5,  
                 color = "white",  
                 boundary = 50)
```



# Multiple histograms

## Facet with a different variable

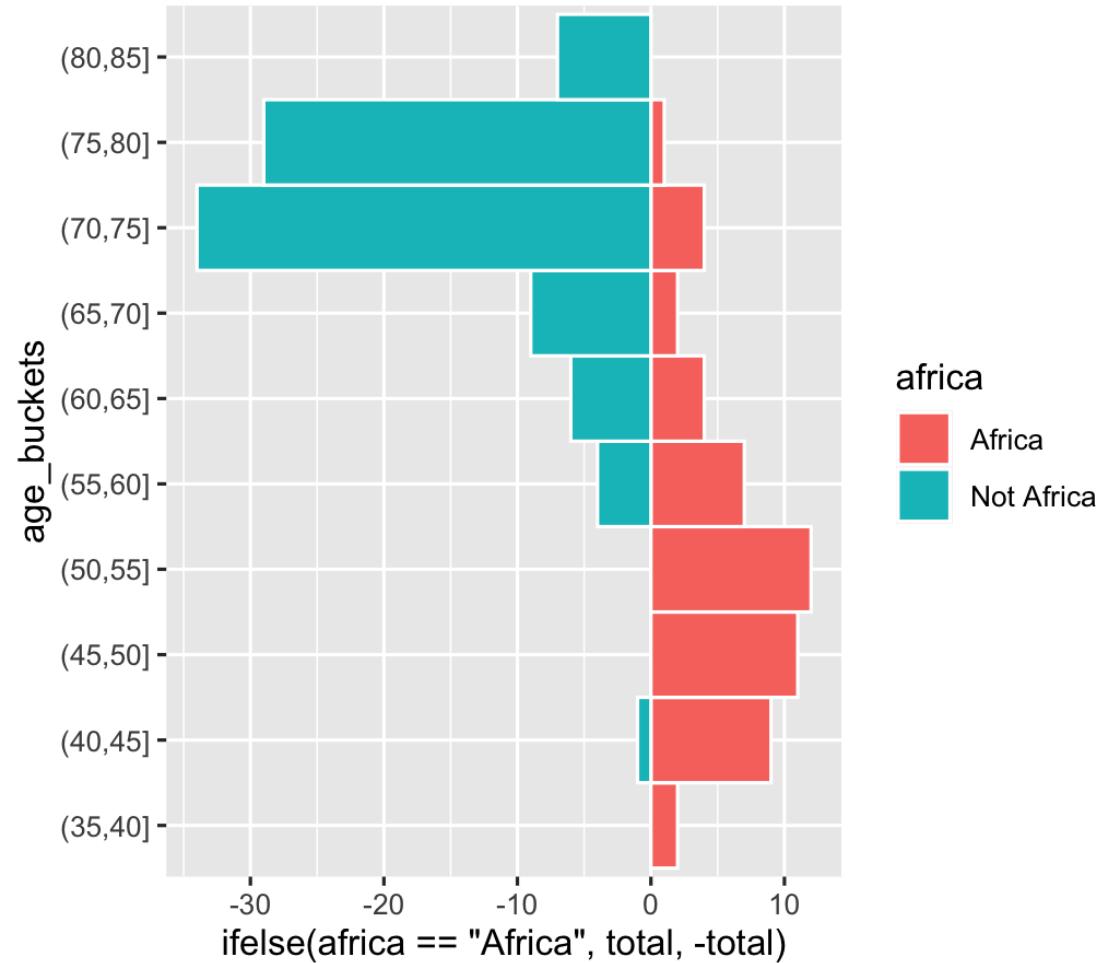
```
ggplot(gapminder_2002,  
       aes(x = lifeExp,  
            fill = continent)) +  
  geom_histogram(binwidth = 5,  
                 color = "white",  
                 boundary = 50) +  
  guides(fill = FALSE) +  
  facet_wrap(vars(continent))
```



# Pyramid histograms

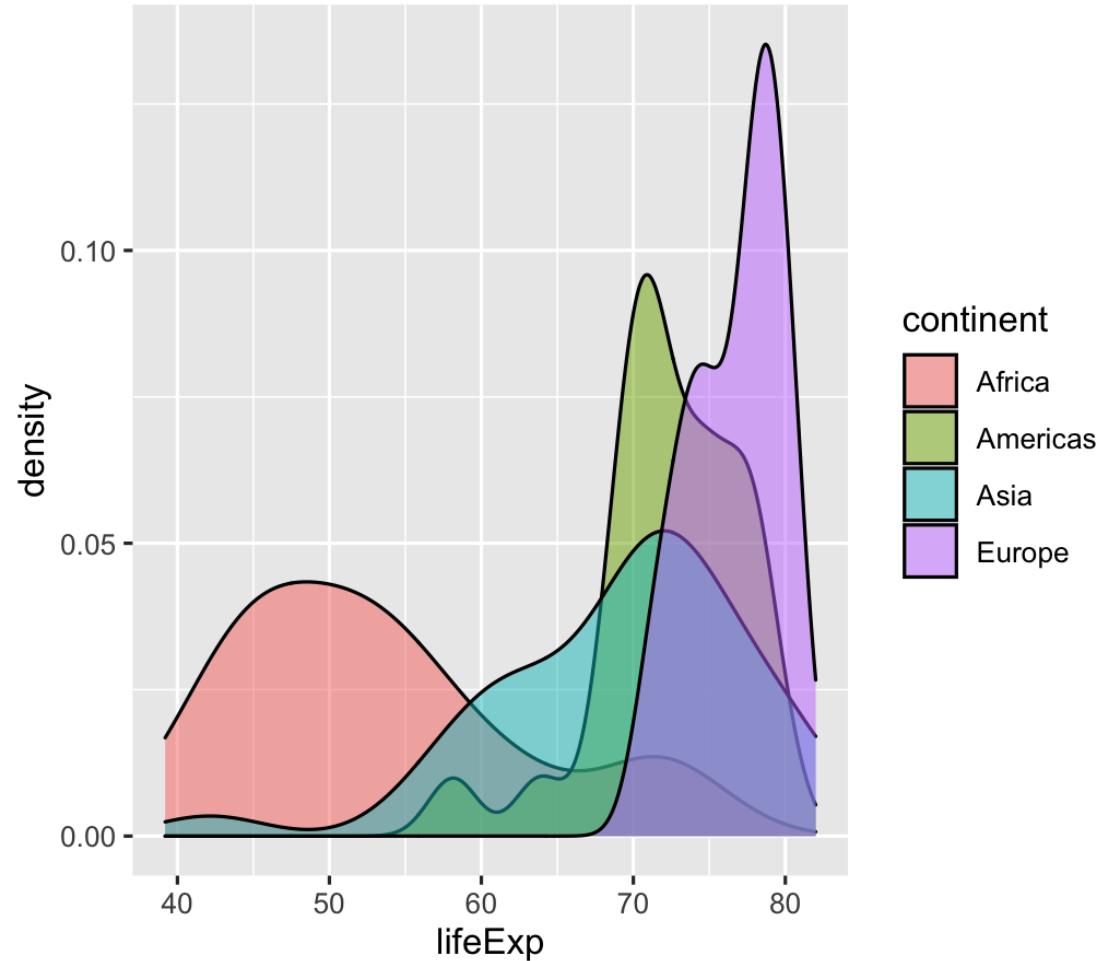
```
gapminder_intervals <- gapminder %>%
  filter(year == 2002) %>%
  mutate(africa =
    ifelse(continent == "Africa",
           "Africa",
           "Not Africa")) %>%
  mutate(age_buckets =
    cut(lifeExp,
        breaks = seq(30, 90, by = 5)))
group_by(africa, age_buckets) %>%
summarize(total =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

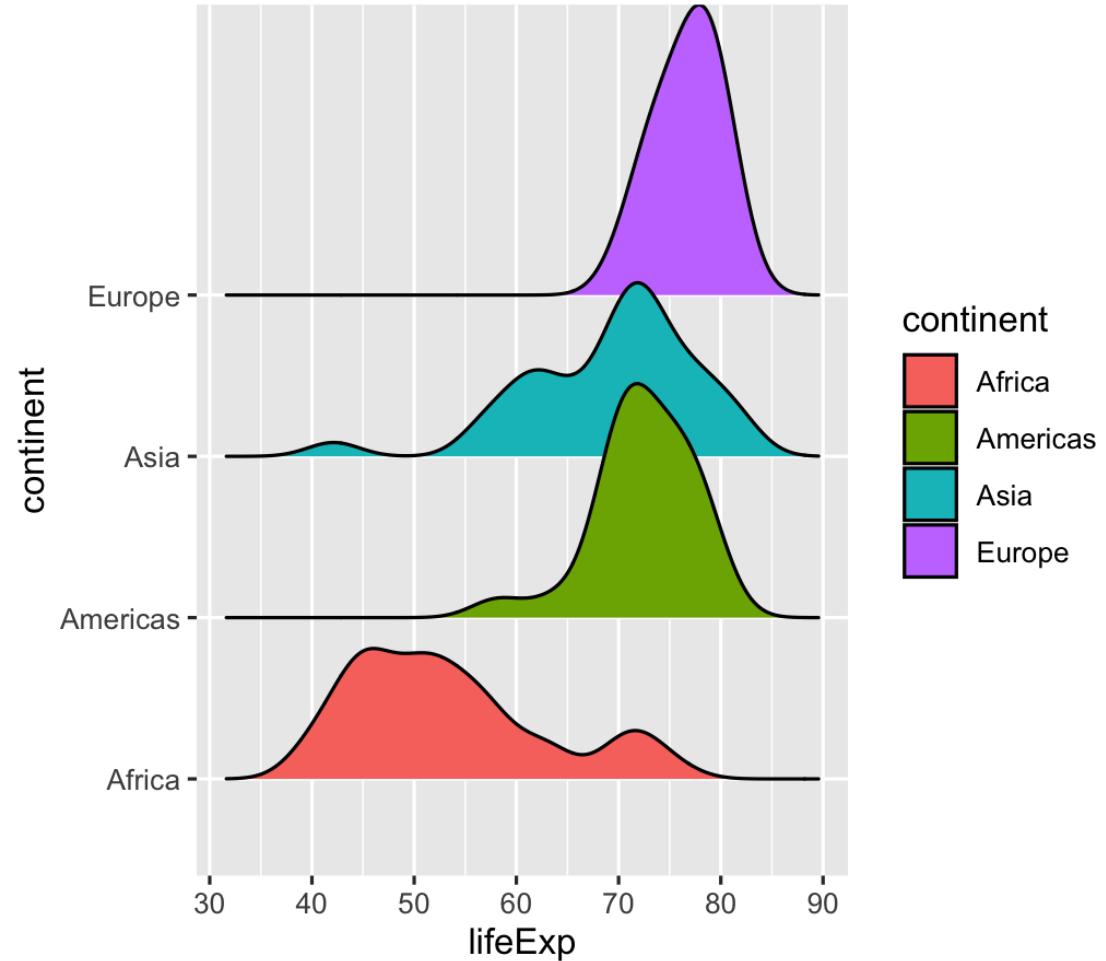
```
ggplot(filter(gapminder_2002,  
             continent != "Oceania"),  
       aes(x = lifeExp,  
            fill = continent)) +  
  geom_density(alpha = 0.5)
```



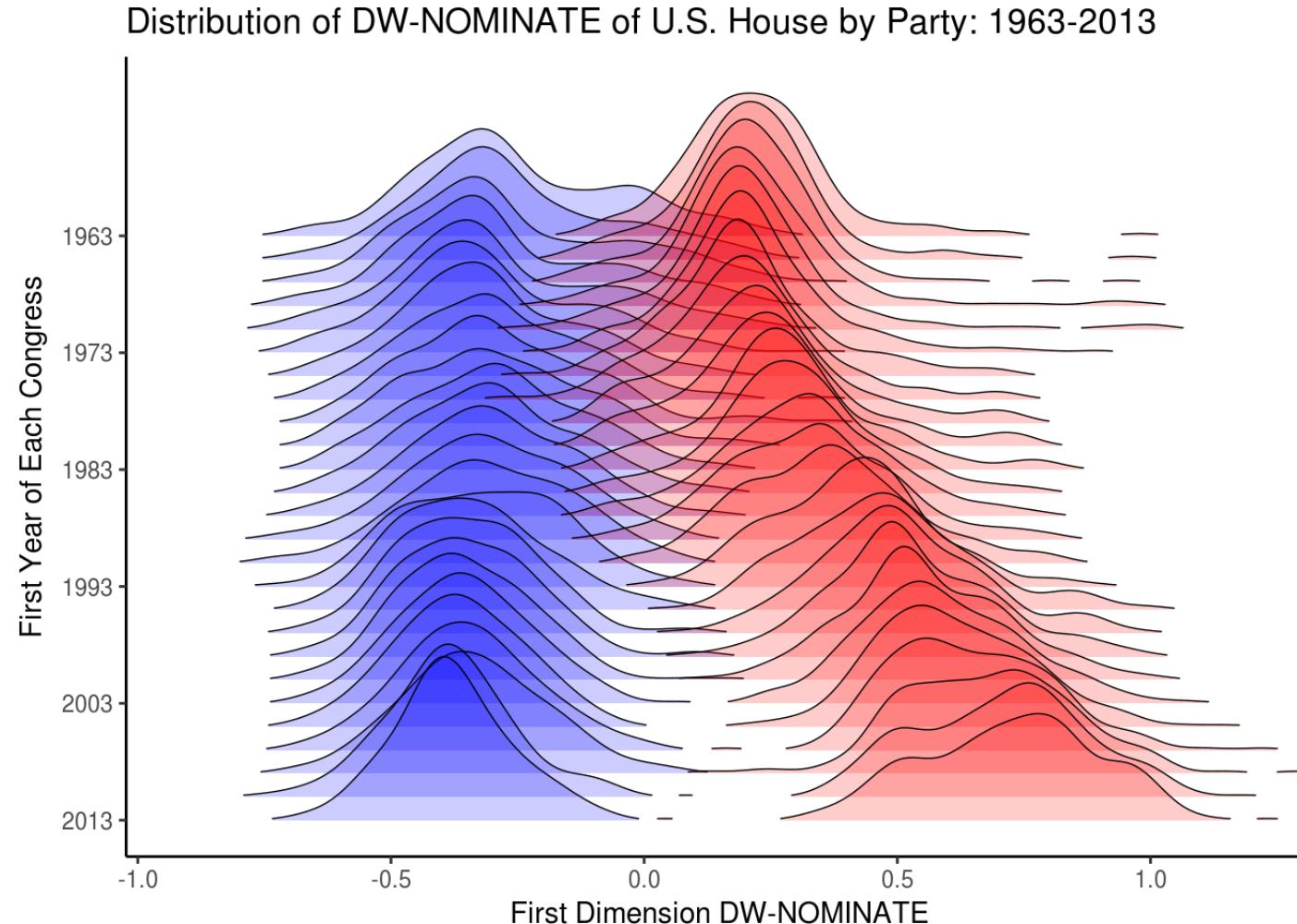
# Multiple densities: Ridge plots

```
library(ggridges)

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



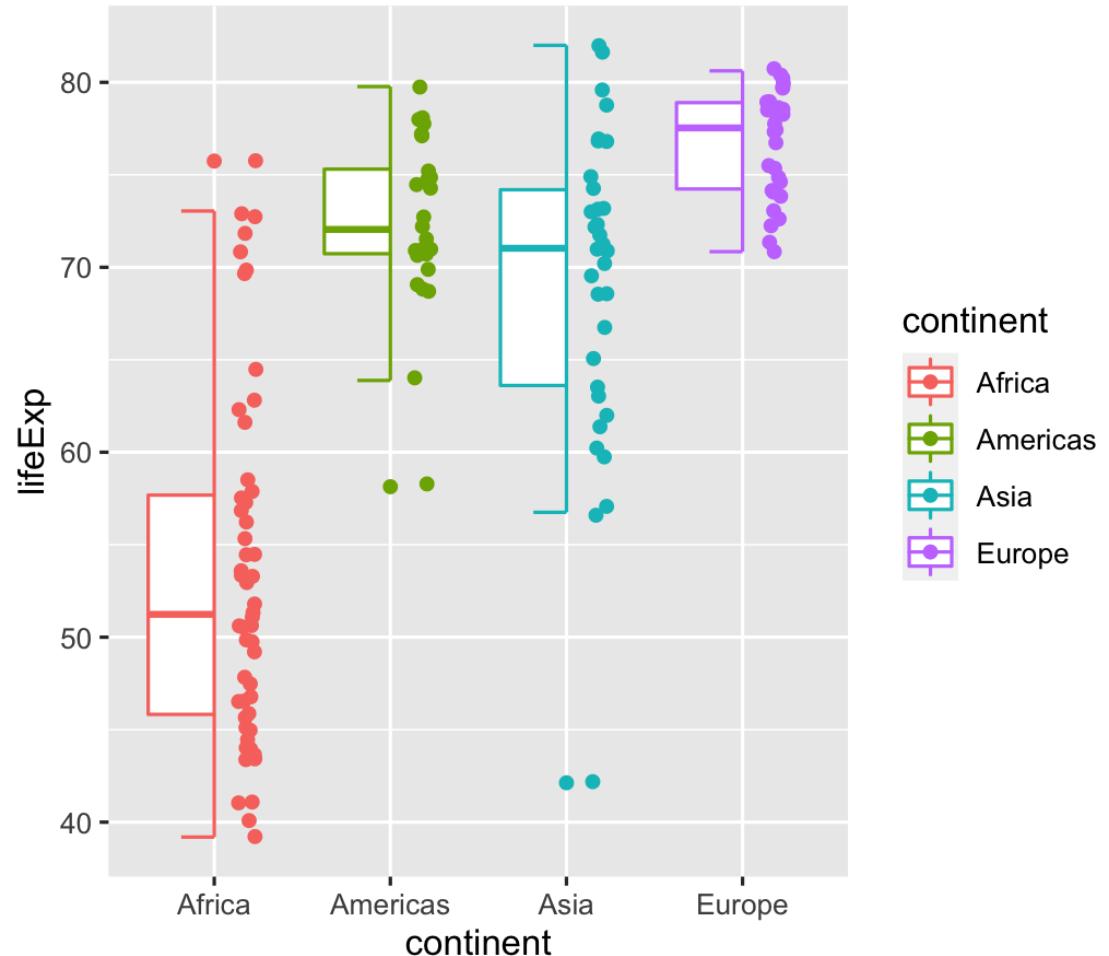
# Multiple densities: Ridge plots



# Multiple geoms: gghalves

```
library(gghalves)

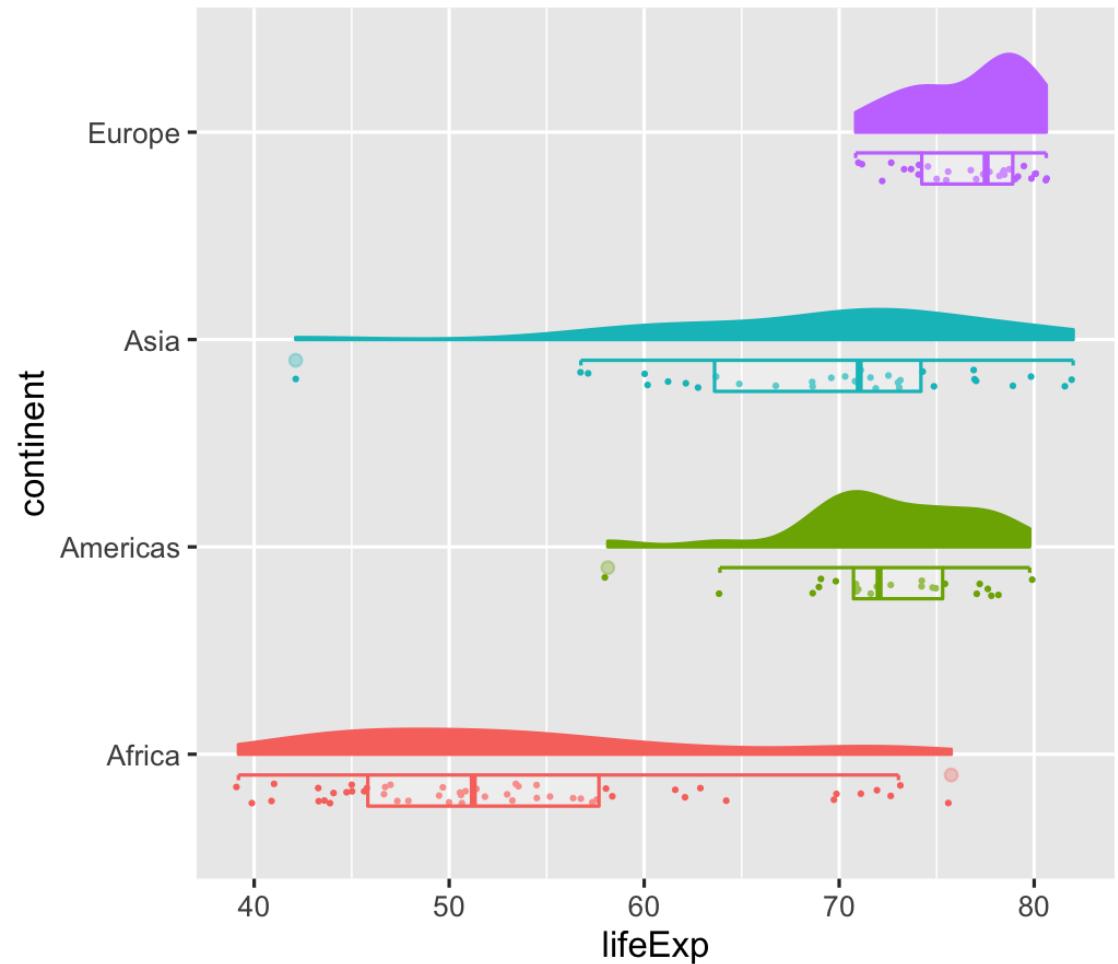
ggplot(filter(gapminder_2002,
              continent != "Oceania"),
       aes(y = lifeExp,
           x = continent,
           color = continent)) +
  geom_half_boxplot(side = "l") +
  geom_half_point(side = "r")
```



# Multiple geoms: Raincloud plots

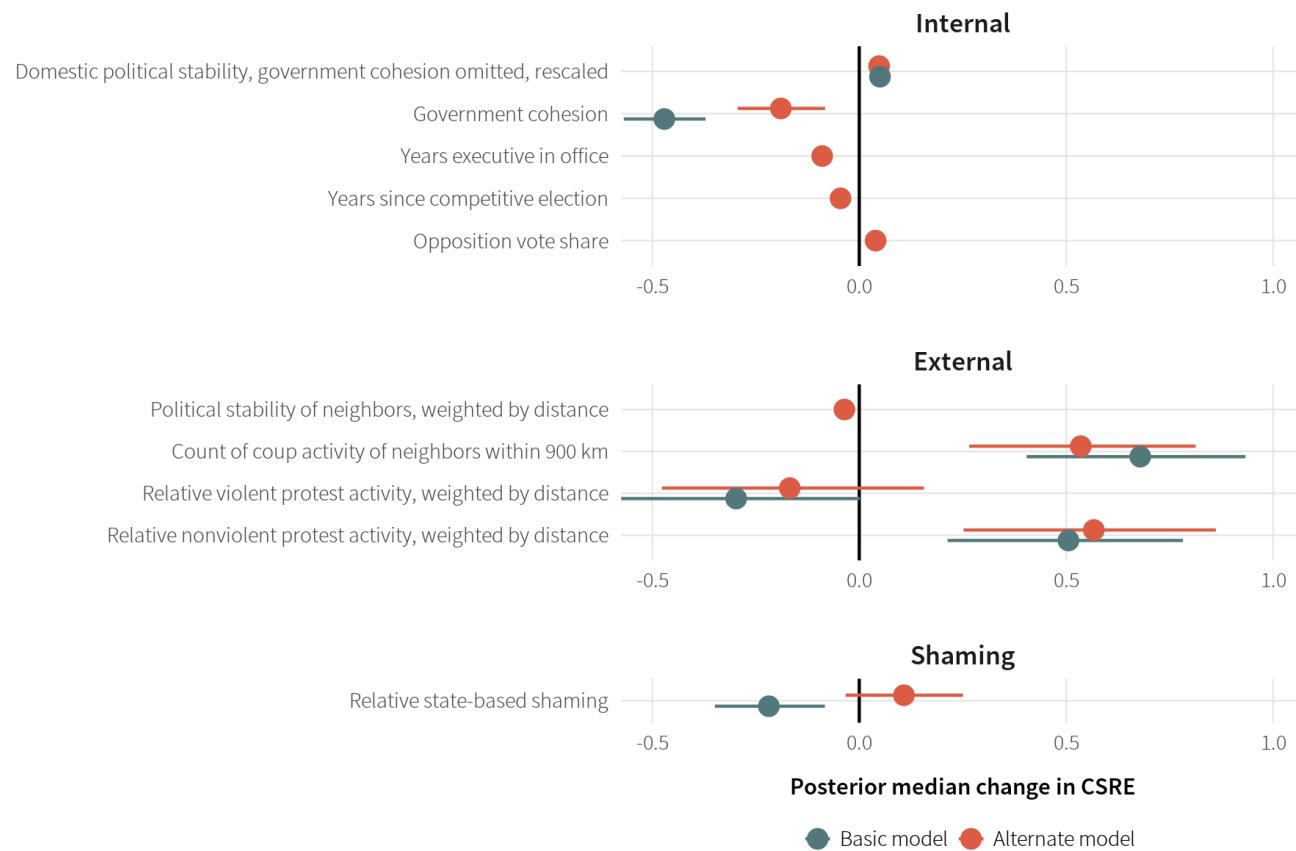
```
library(gghalves)

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 = FALSE, color = FALSE) +
  coord_flip()
```

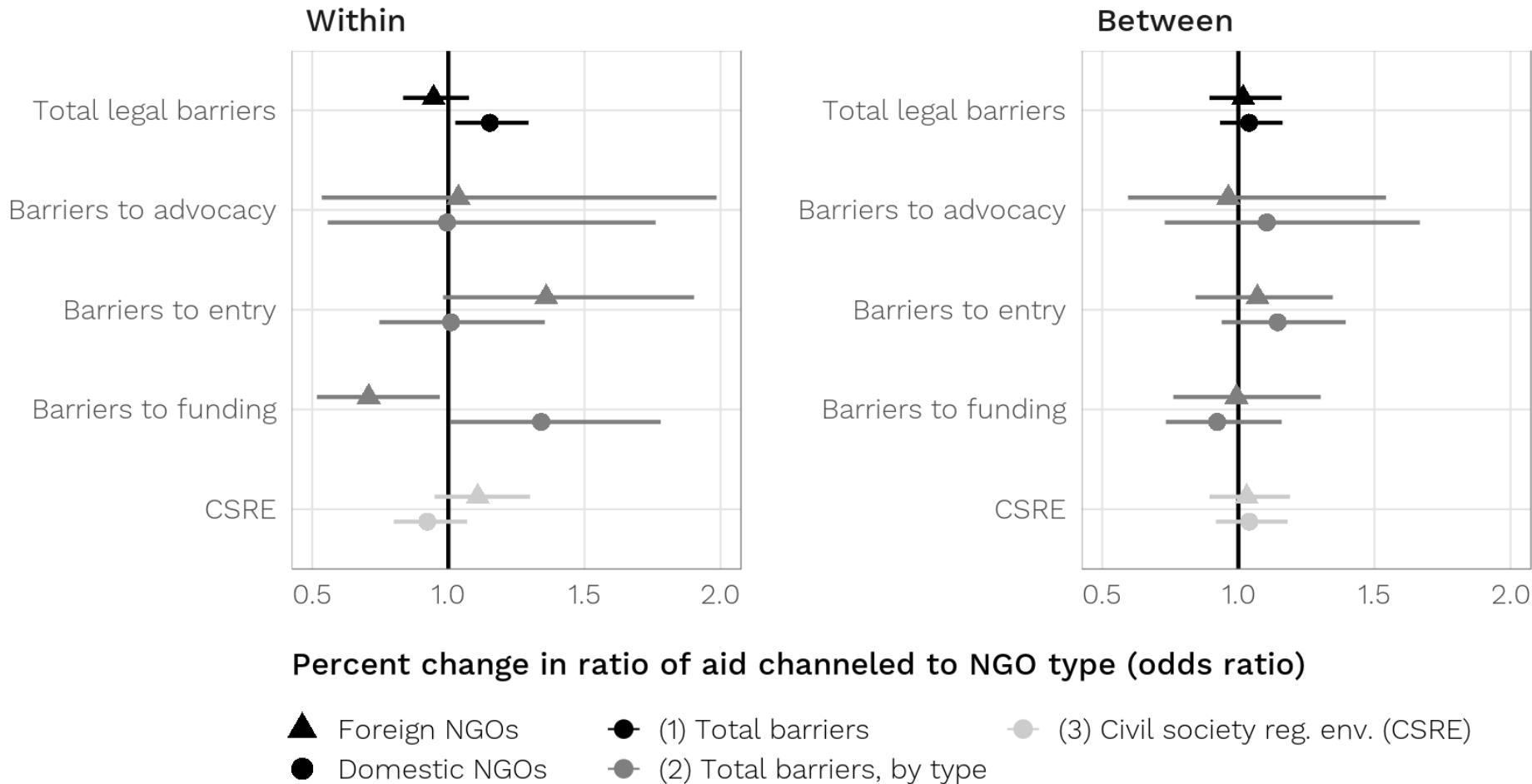


# Uncertainty in model estimates

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



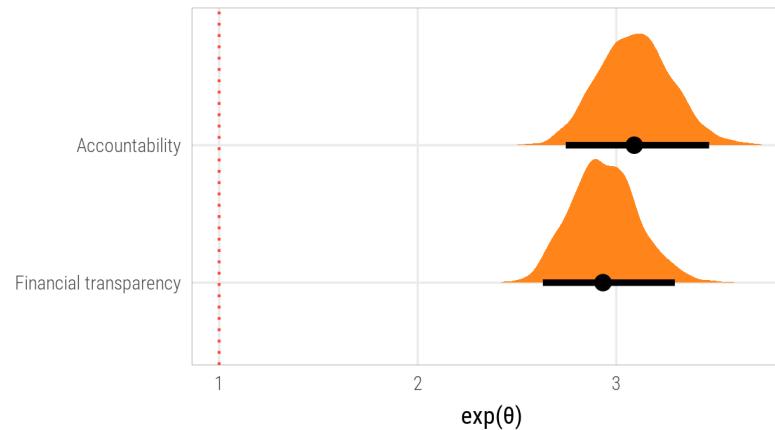
# Uncertainty in model estimates



# Uncertainty in model estimates

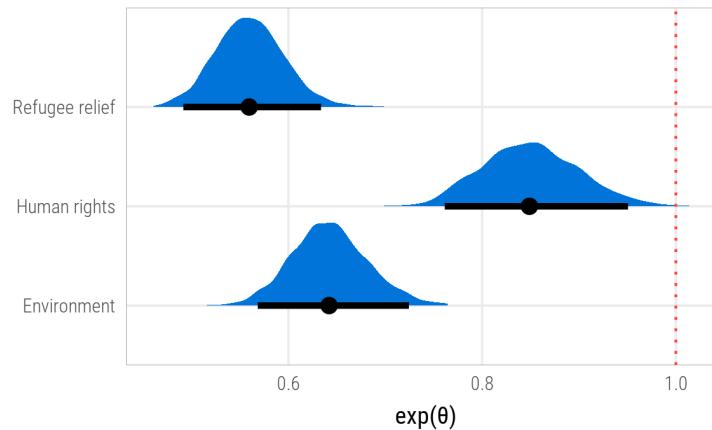
## Organizational practices

Reference groups = no accountability; no transparency



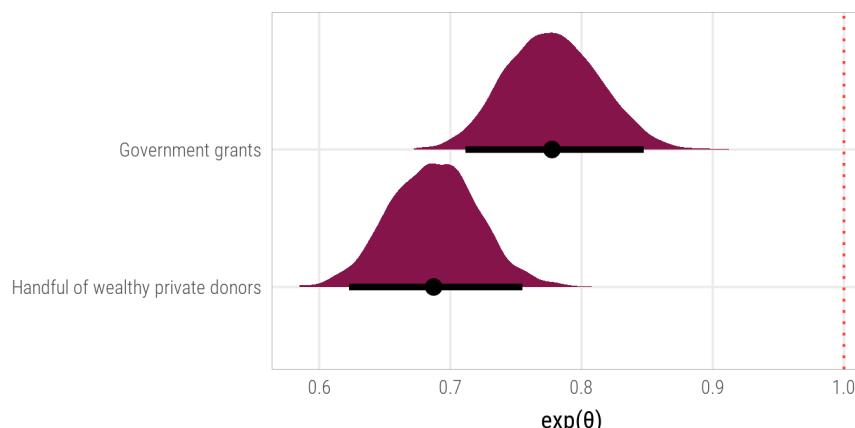
## Issue area

Reference group = emergency response



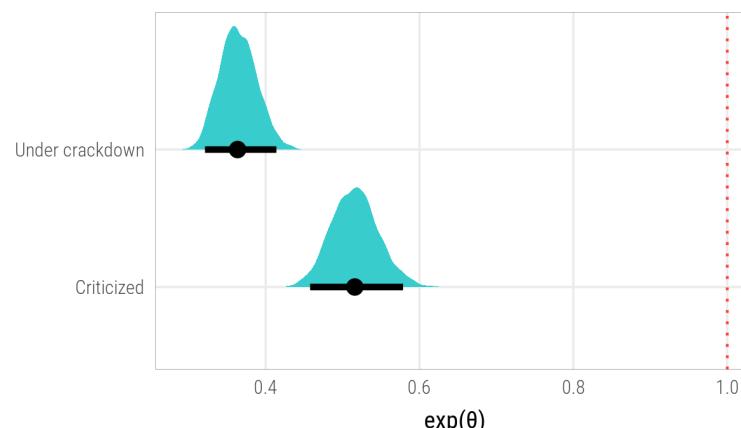
## Funding sources

Reference group = many small private donations



## Relationship with host government

Reference group = friendly relationship with government



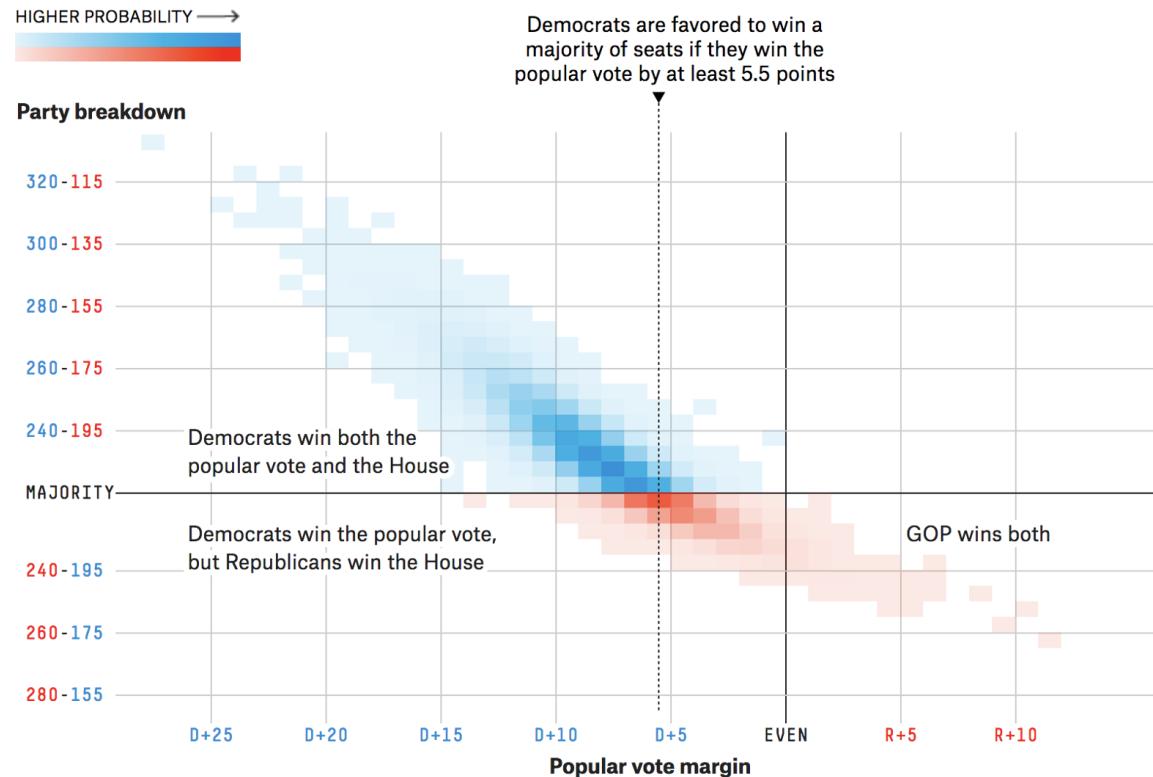
# Uncertainty in model effects

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

# 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