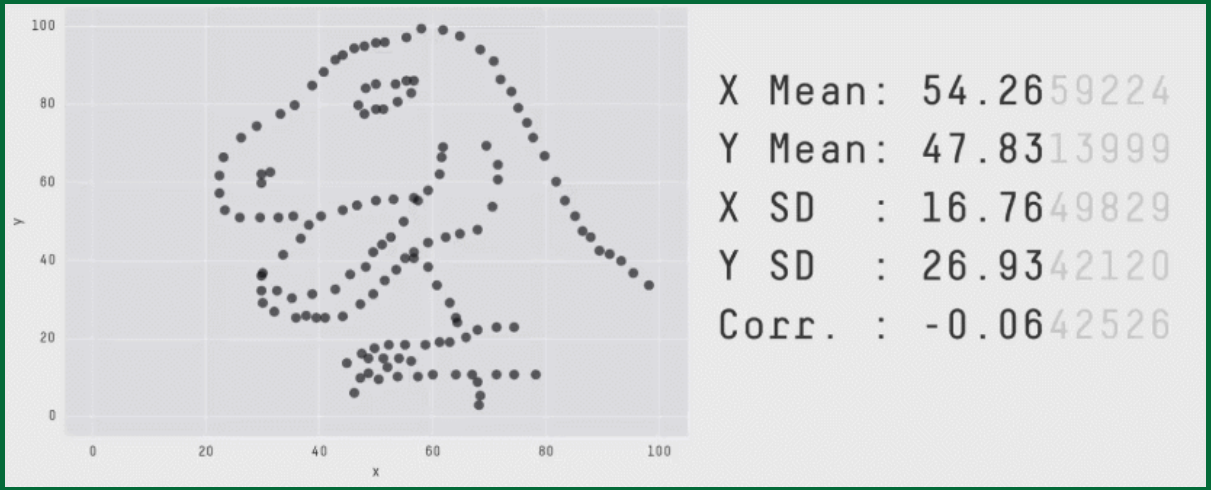
DSBA 5122: Visual Analytics

Class 5: Distributions and Uncertainty

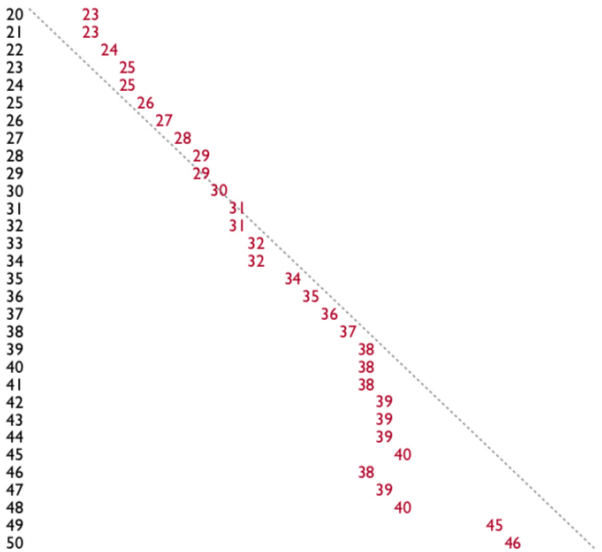
Ryan Wesslen

September 23, 2019

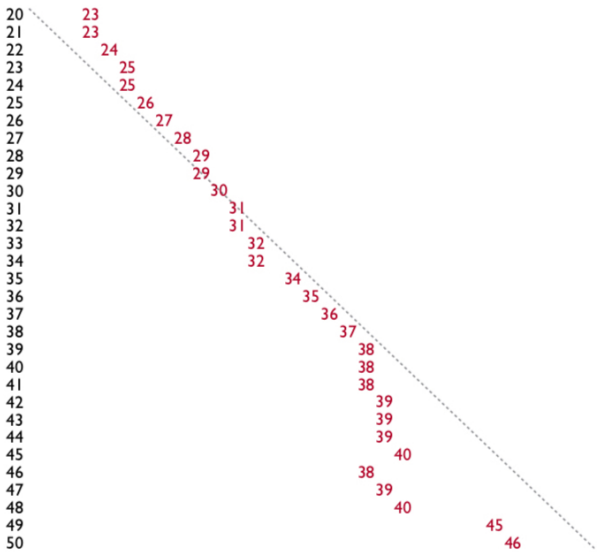
Why view Distributions? Cairo Ch. 7 & Wilke Ch. 7 - 9



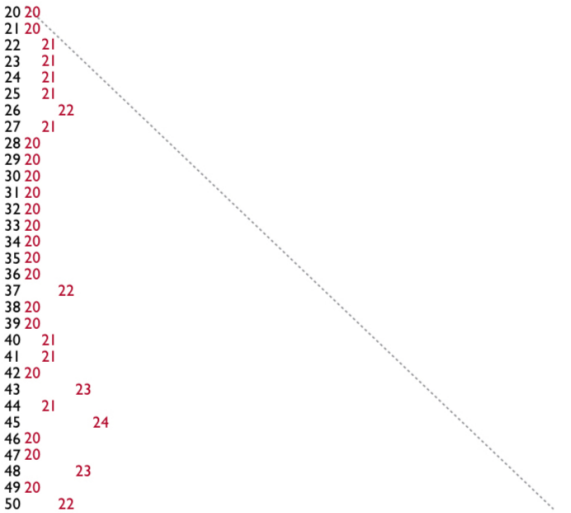
a woman's age *vs. the age of the men who look best to her*



a woman's age *vs. the age of the men who look best to her*



a man's age *vs. the age of the women who look best to him*



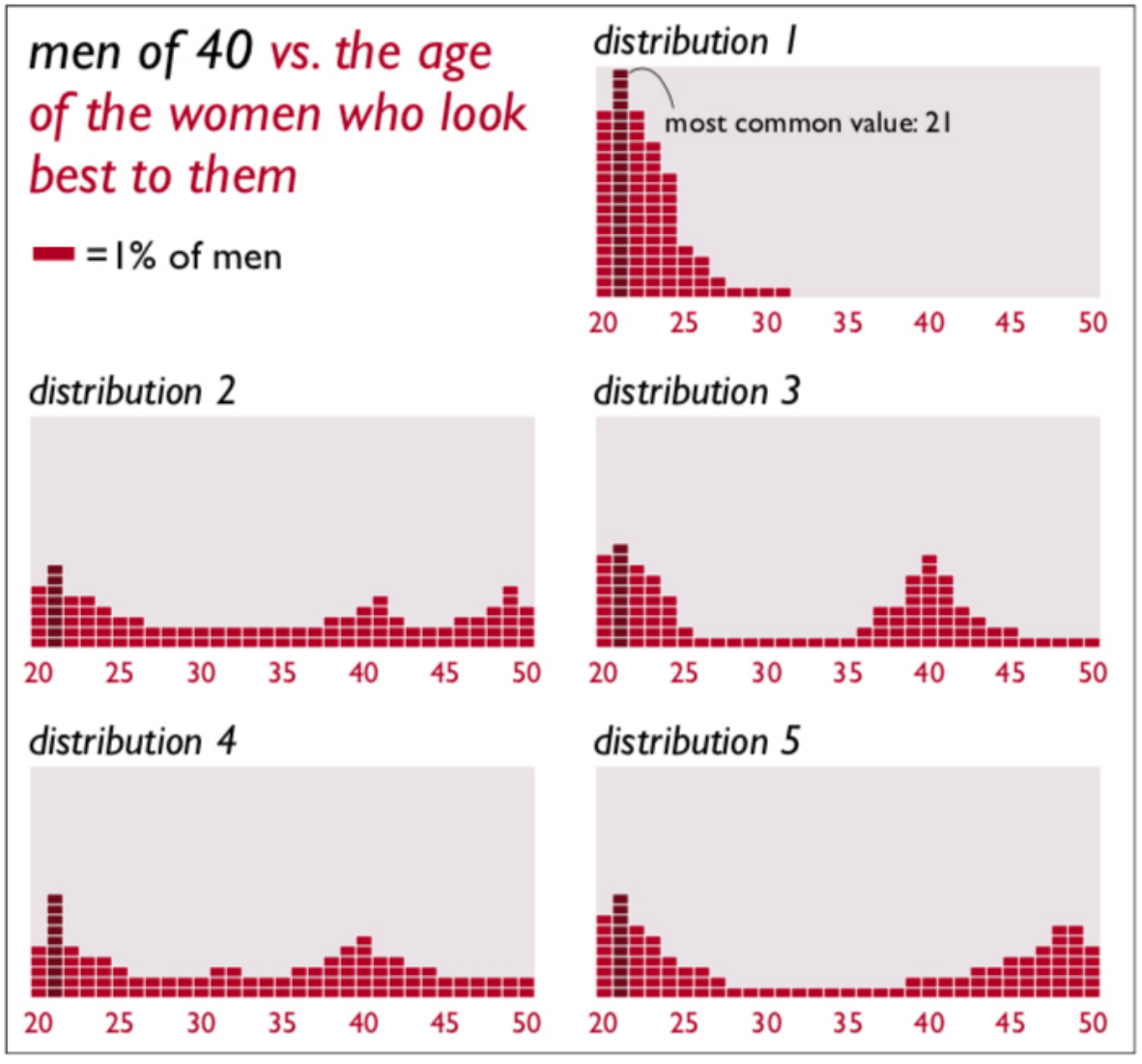
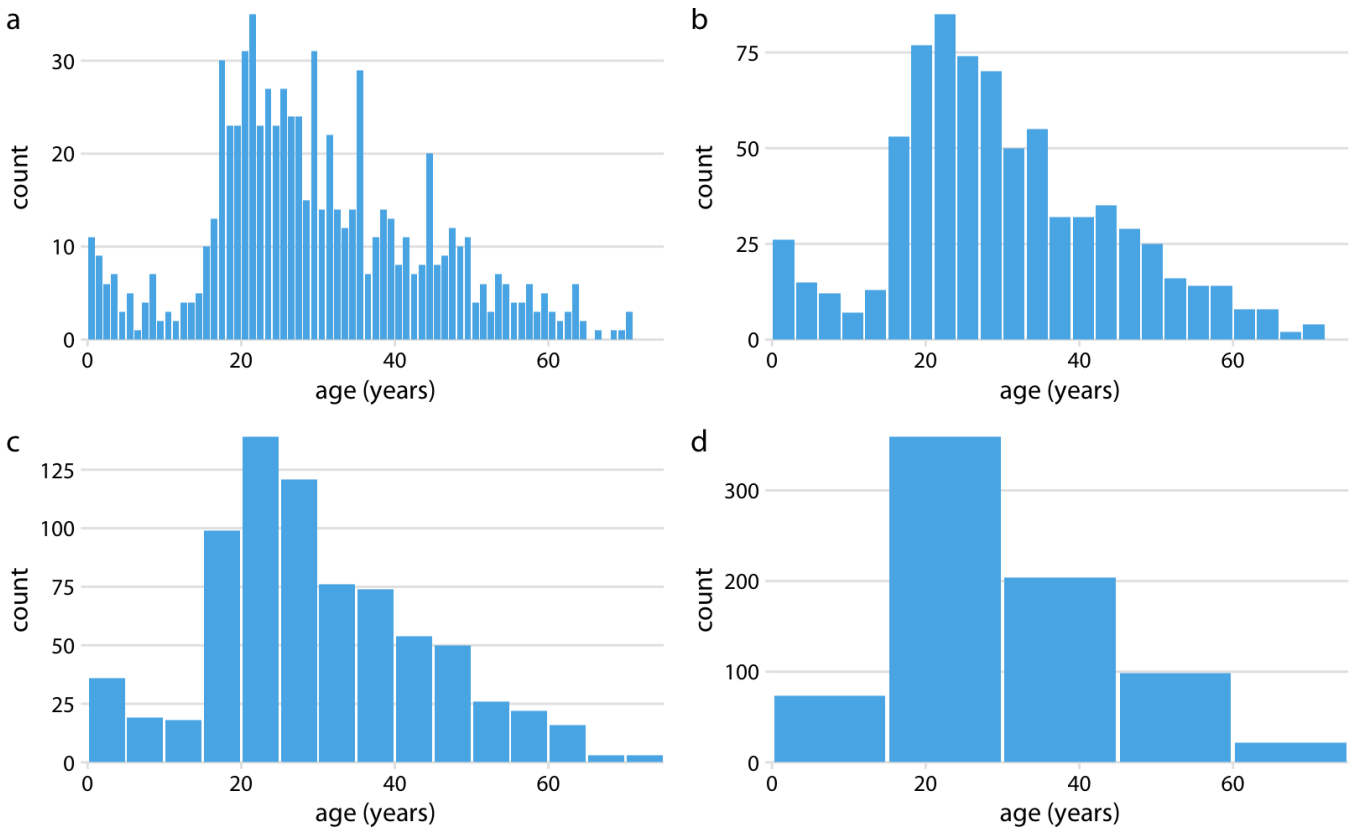
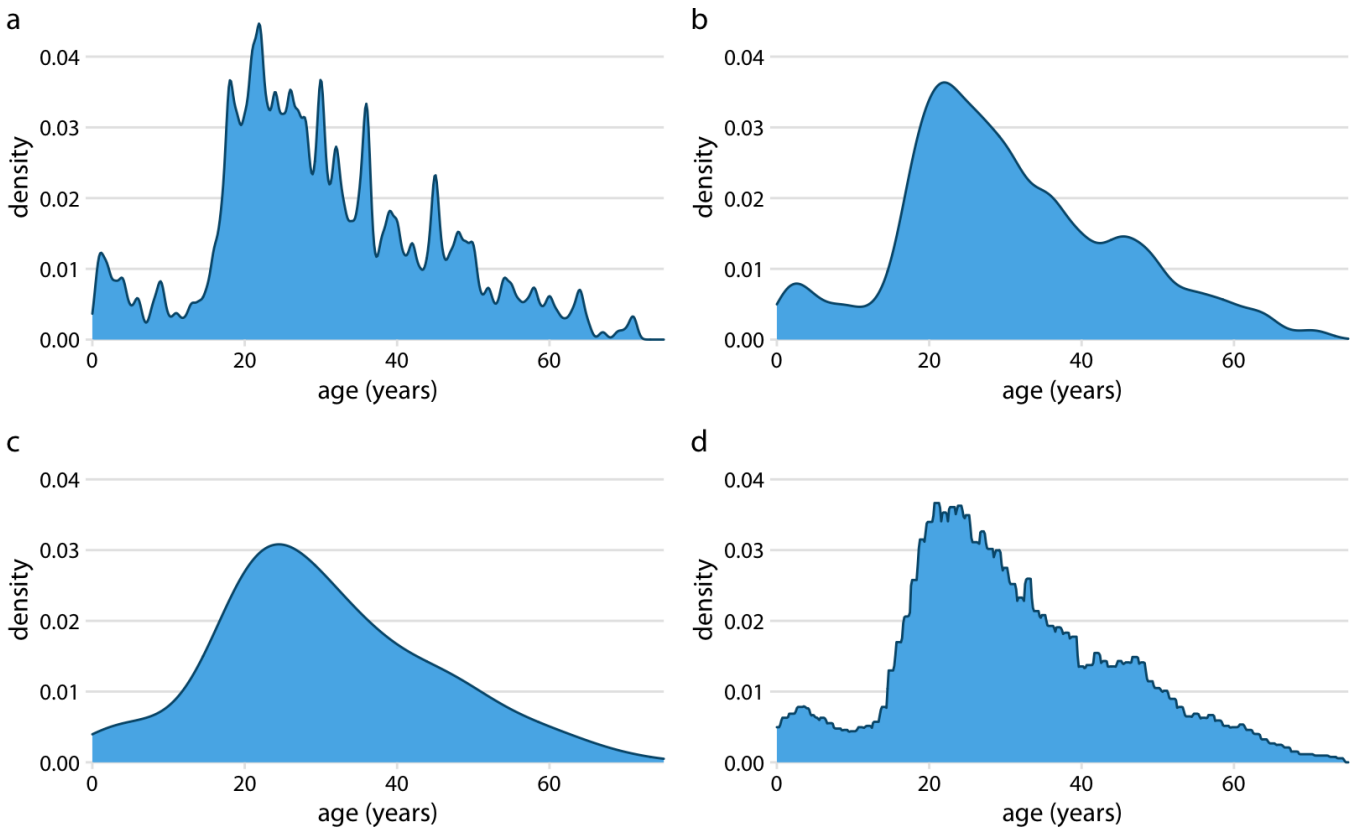
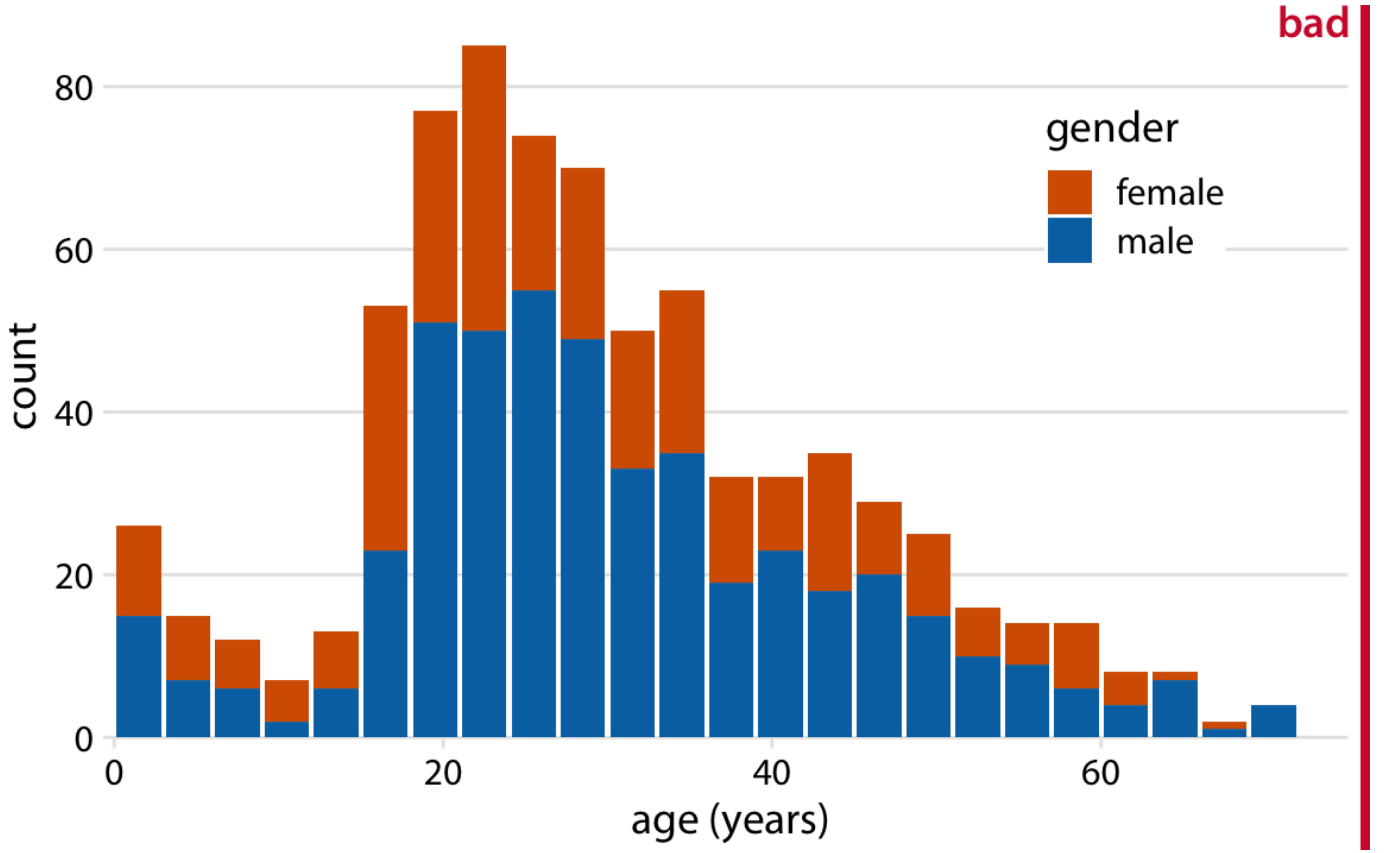
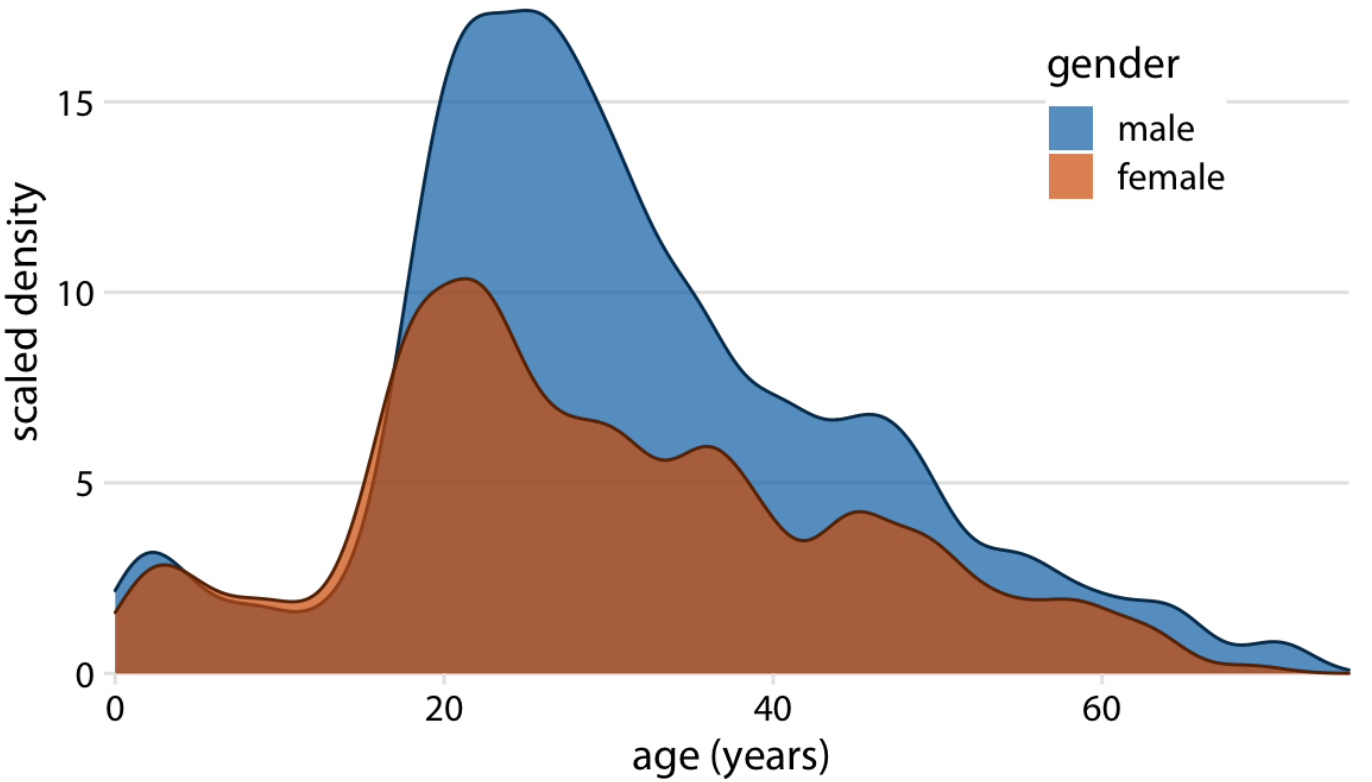


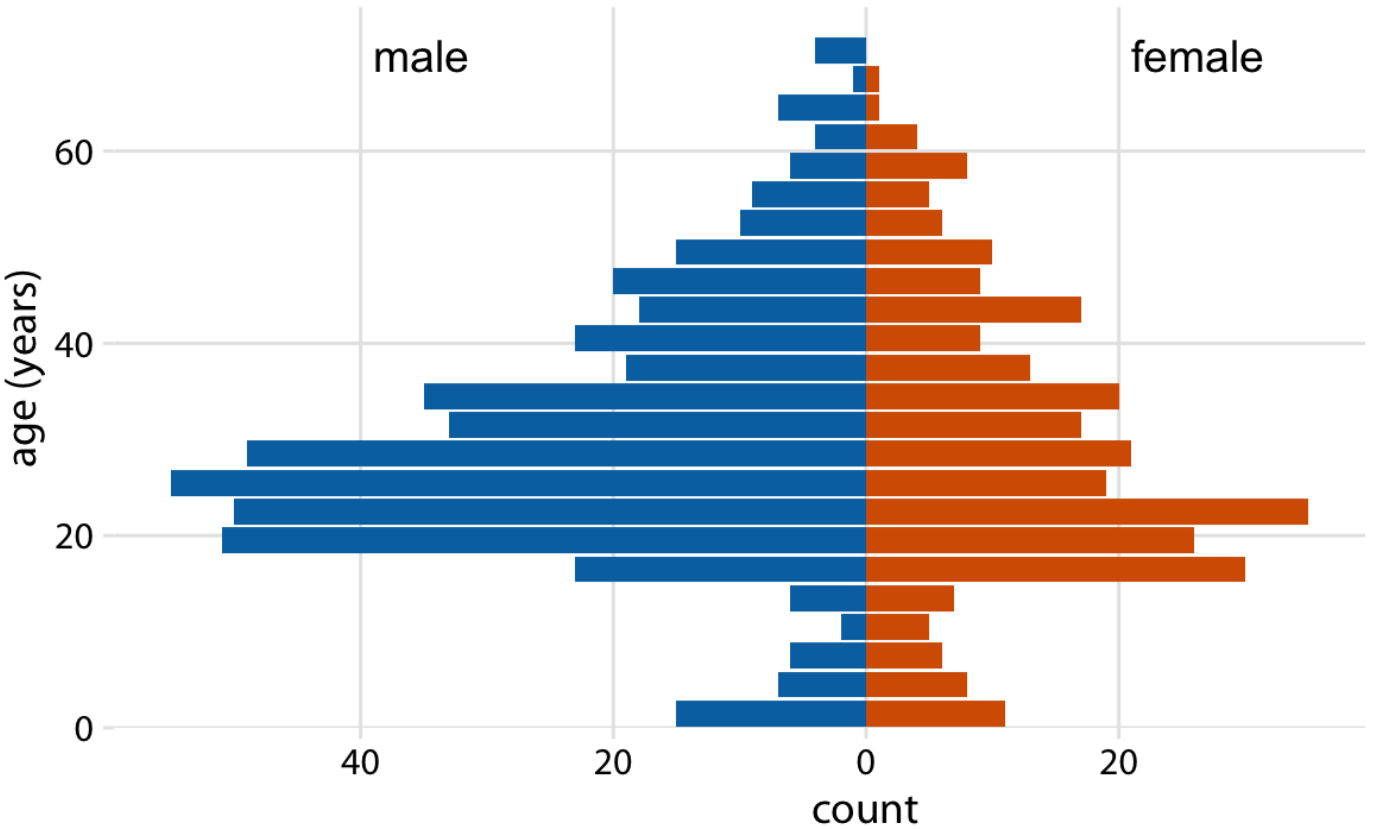
Figure 7.2 Five possible (and fictitious) distributions for the data corresponding to the preferences of men of 40. All of them have the same mode: 21.

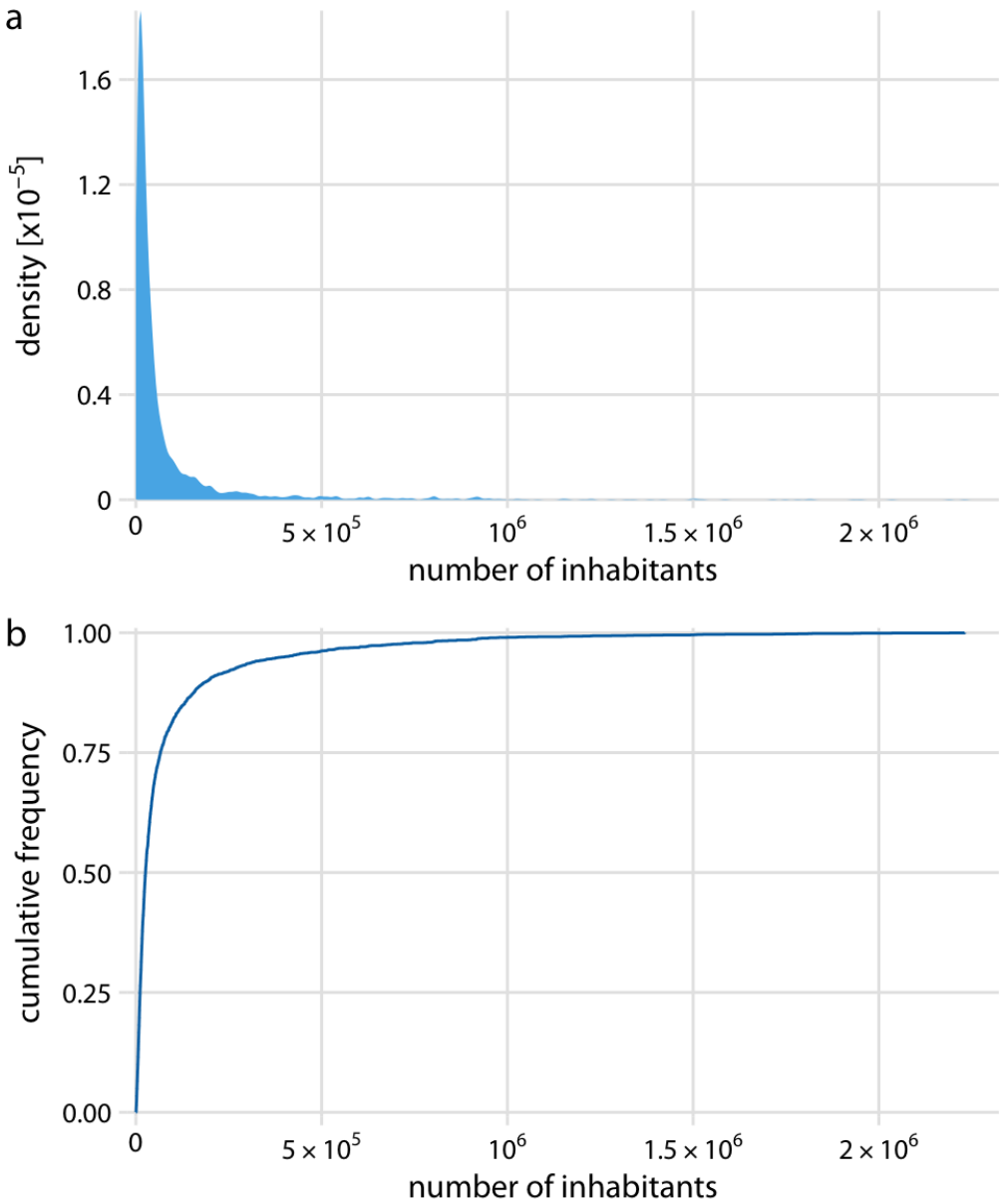

a
count
30
20
10
0
0
20
40
60
age (years)
b
count
75
50
25
0
0
20
40
60
age (years)
c
count
125
100
75
50
25
0
0
20
40
60
age (years)
d
count
300
200
100
0
0
20
40
60
age (years)

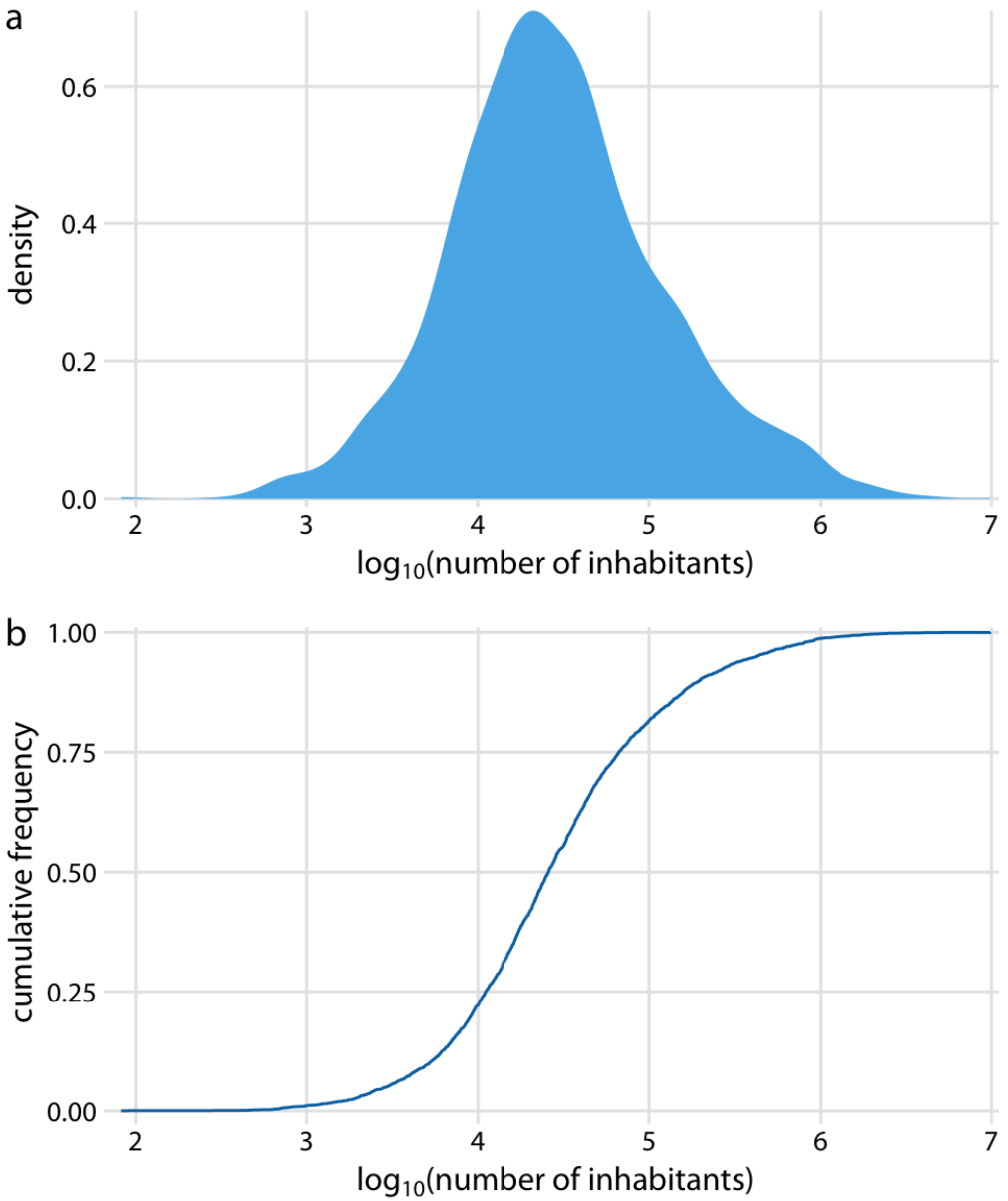

a
b
c
d
density
0.00
0.01
0.02
0.03
0.04
0
20
40
60
age (years)


bad
gender
female
male
count
80
60
40
20
0
0
20
40
60
age (years)

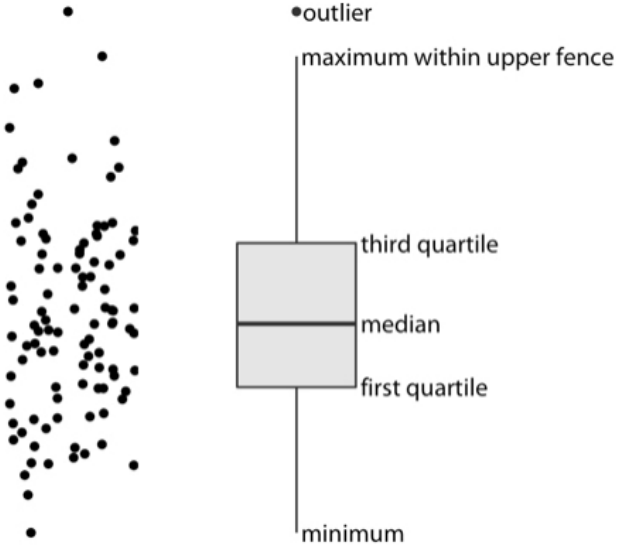

gender
male
female
scaled density
15
10
5
0
0
20
40
60
age (years)


male
female
60
40
20
0
age (years)
40
20
0
20
count

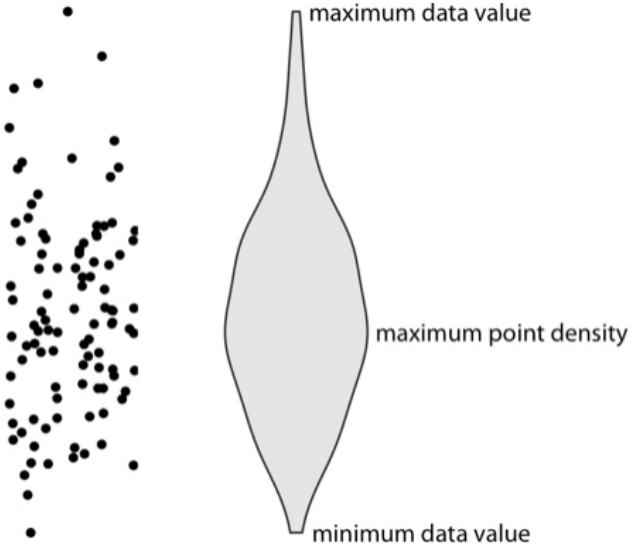

a
density [x10^{-5}]
1.6
1.2
0.8
0.4
0
0
5×10^5
10^6
1.5×10^6
2×10^6
number of inhabitants
b
cumulative frequency
1.00
0.75
0.50
0.25
0.00
0
5×10^5
10^6
1.5×10^6
2×10^6
number of inhabitants

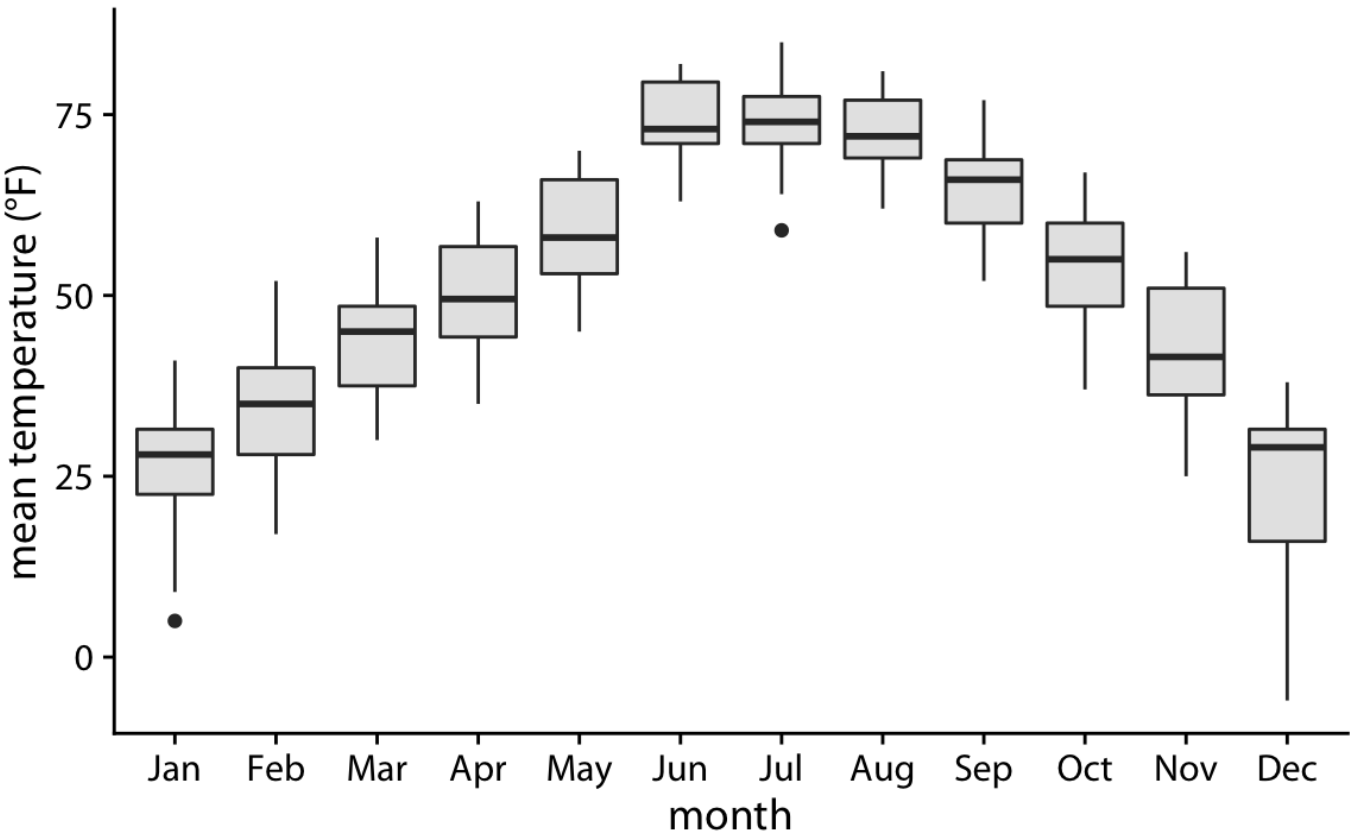

a
density
0.6
0.4
0.2
0.0
2
3
4
5
6
7
log10(number of inhabitants)
b
cumulative frequency
1.00
0.75
0.50
0.25
0.00
2
3
4
5
6
7
log10(number of inhabitants)

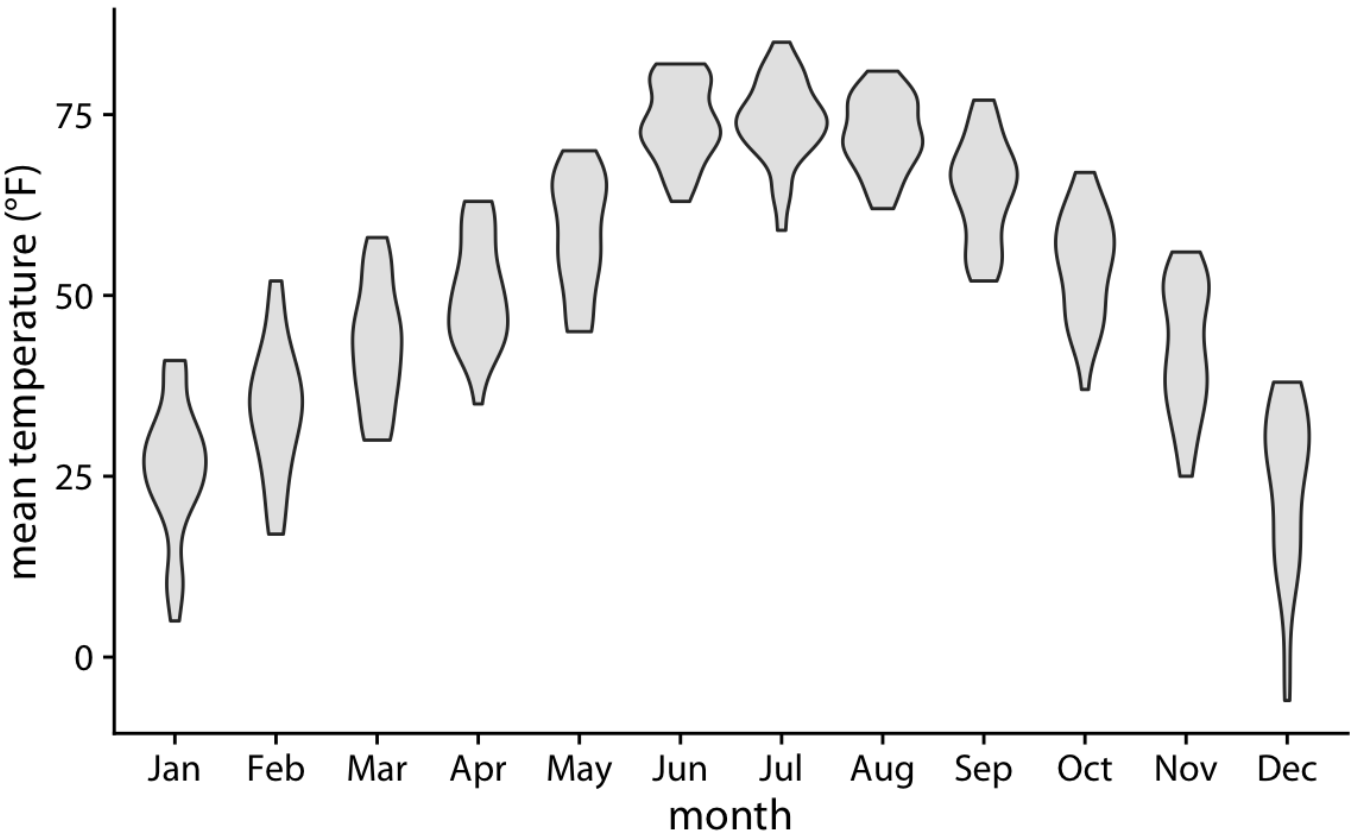
```
ggplot(df, aes(x, y)) + geom_boxplot()
```

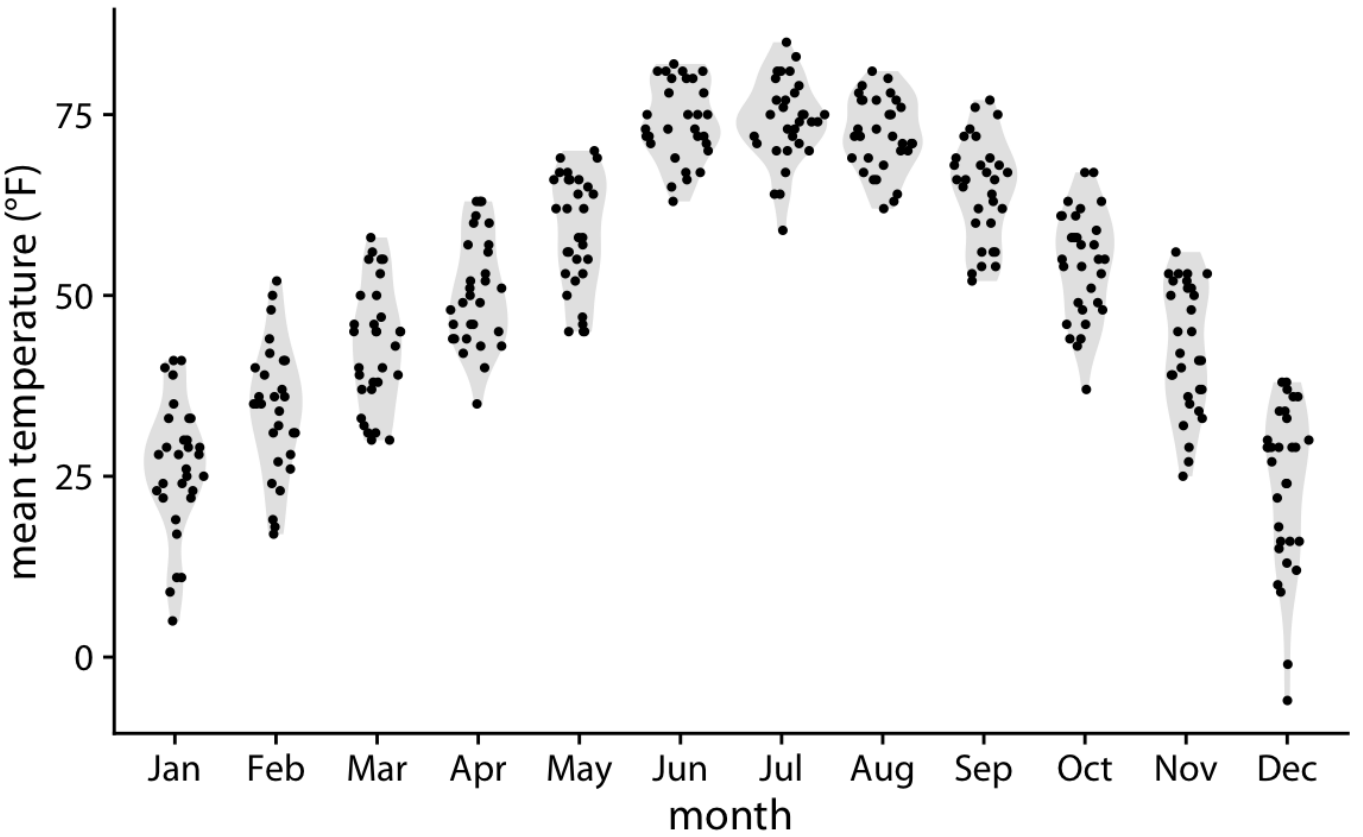


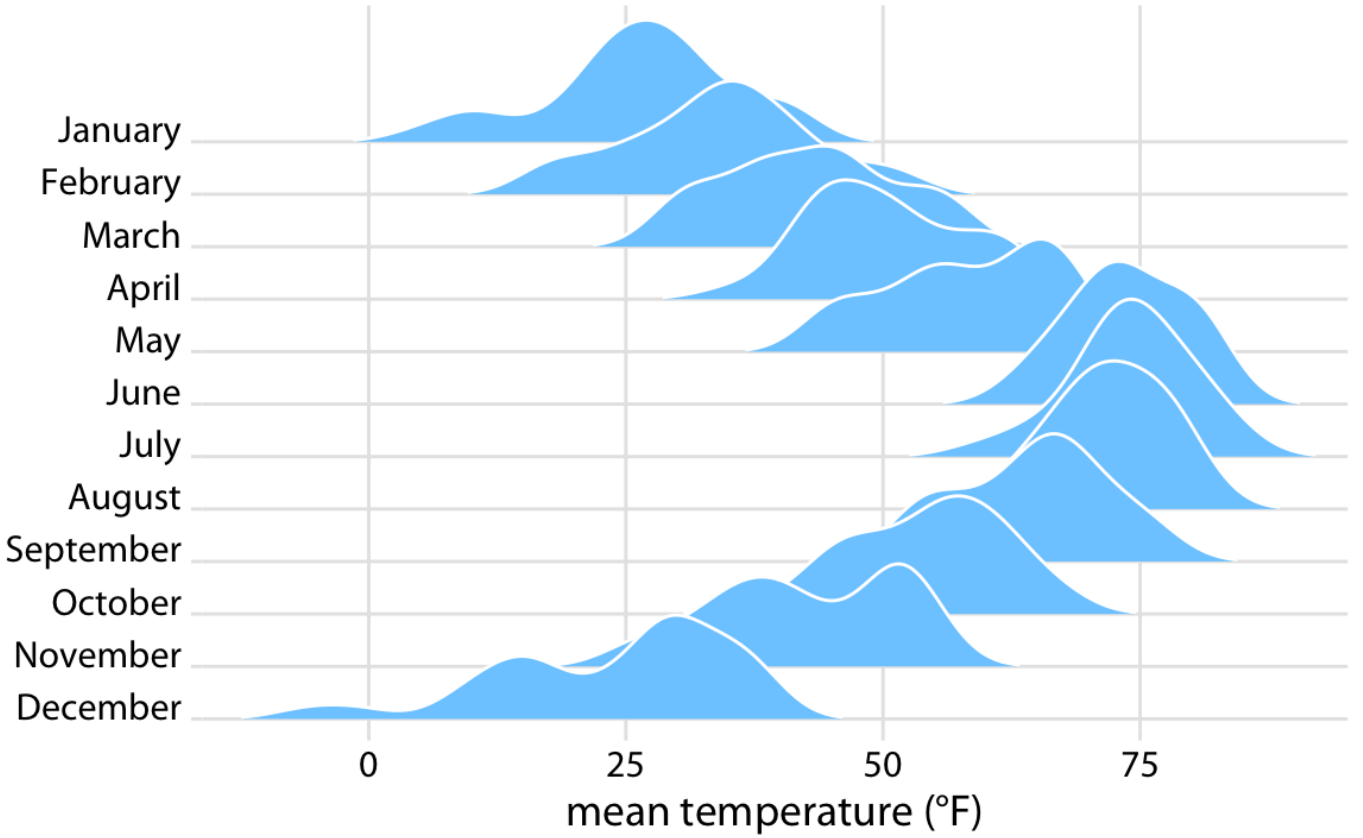

```
ggplot(df, aes(x, y)) + geom_violin()
```

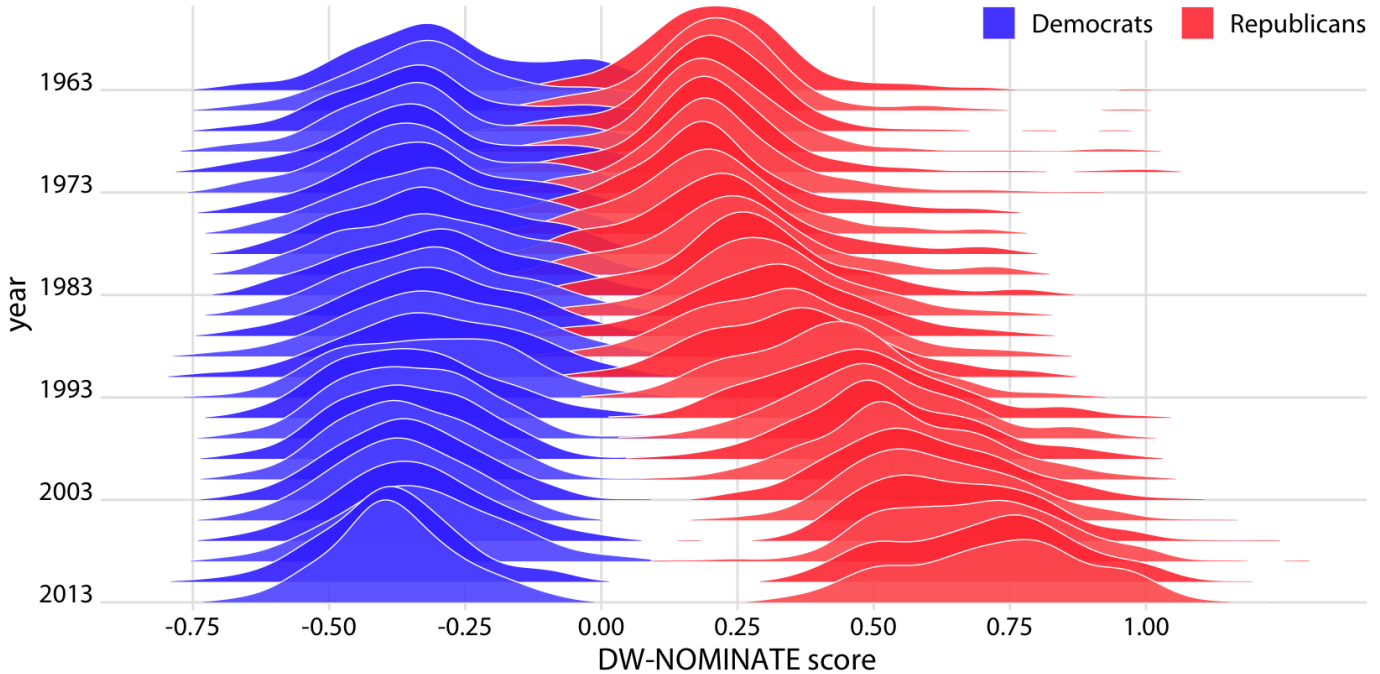



mean temperature (°F)
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
month

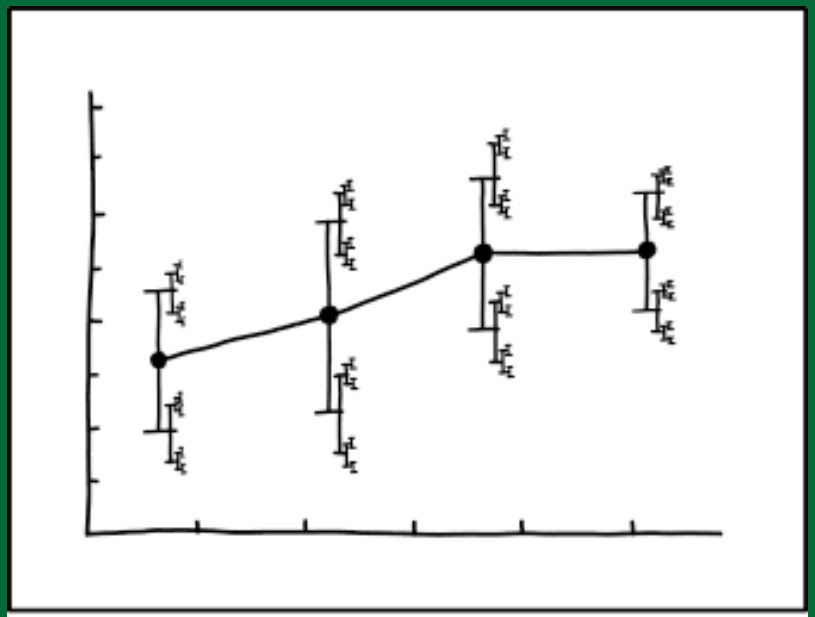

mean temperature (°F)
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
month


mean temperature (°F)
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
month


January
February
March
April
May
June
July
August
September
October
November
December
0
25
50
75
mean temperature (°F)


Democrats
Republicans
year
1963
1973
1983
1993
2003
2013
-0.75
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
DW-NOMINATE score

Uncertainty: Cairo Ch. 10 & Wilke Ch. 16



xkcd

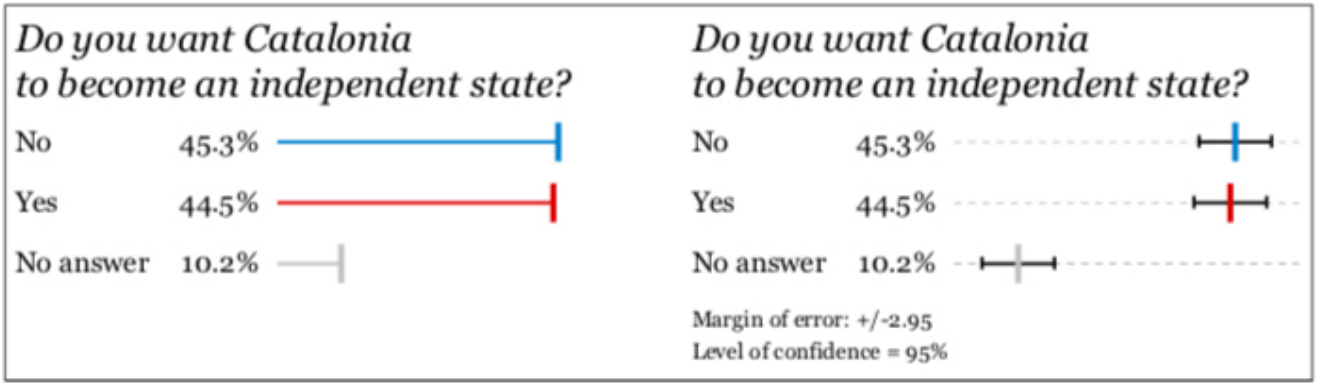


Figure 11.1 Displaying the margin of error can change your view of the data.

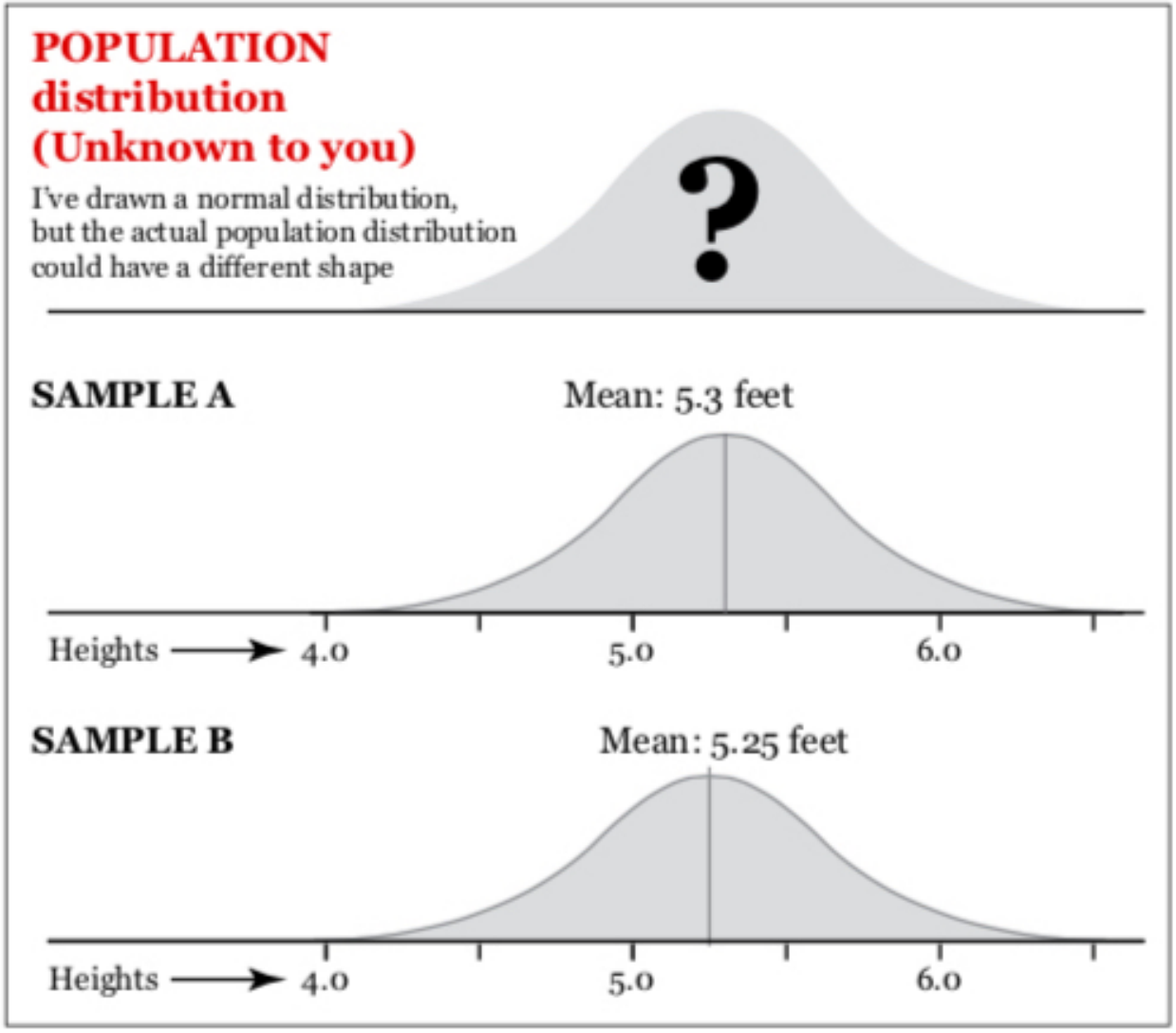


Figure 11.2 Population and samples.

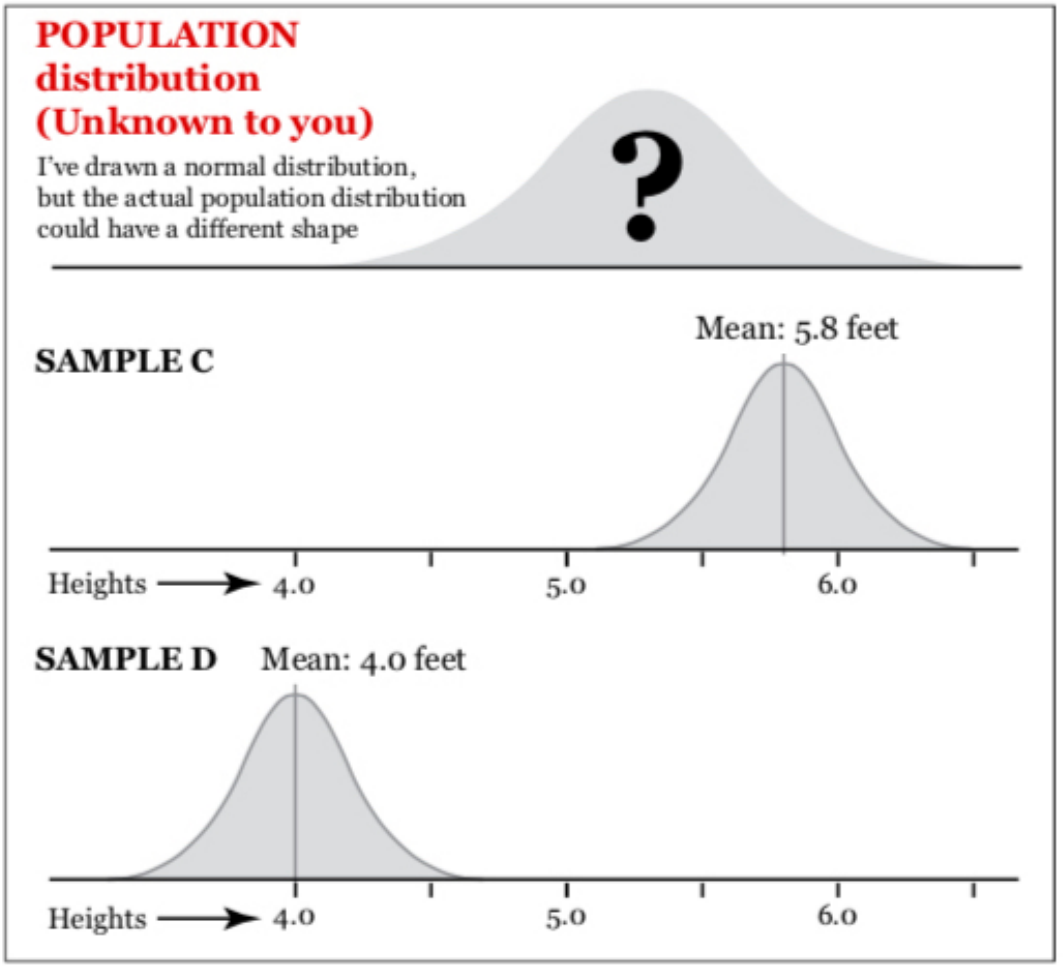


Figure 11.3 When drawing many samples from a population, it is possible to obtain a few with means that greatly differ from the population mean.

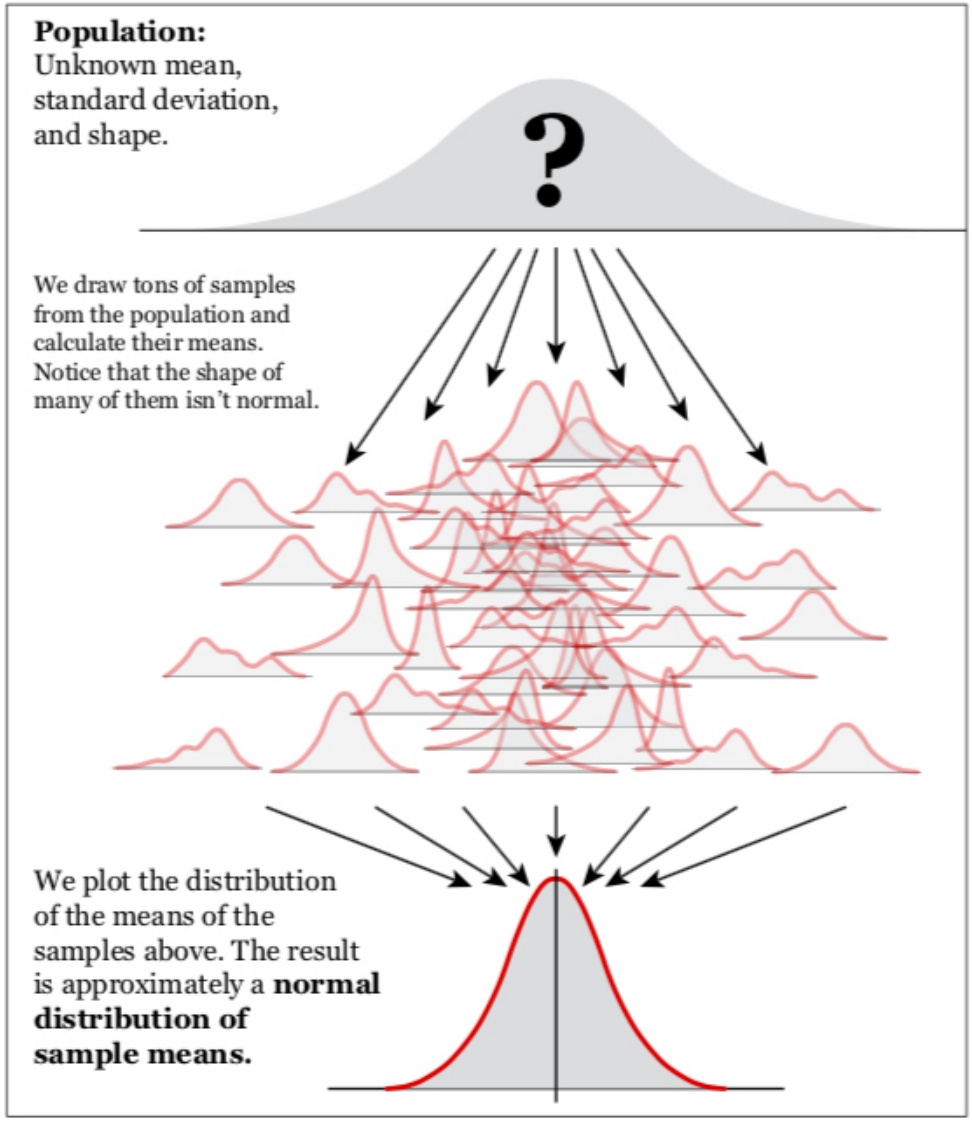
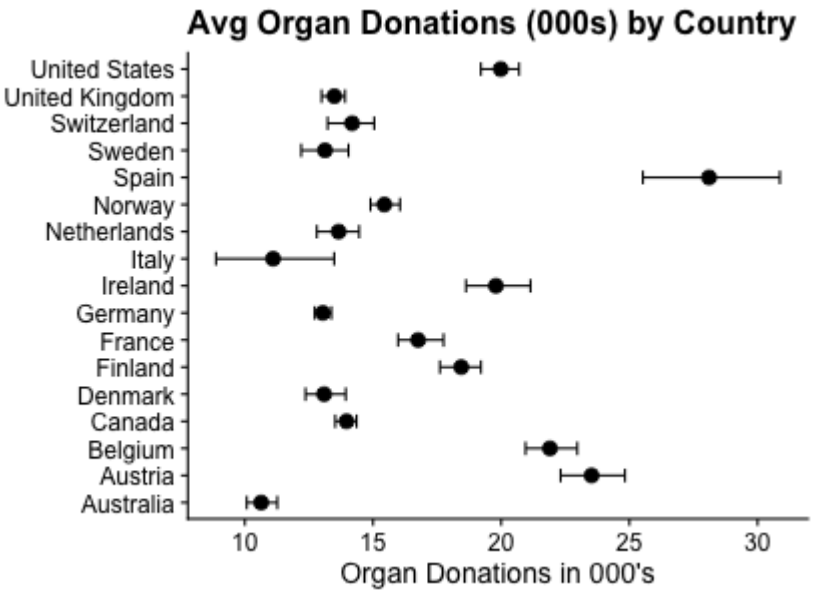


Figure 11.5 The distribution of (imaginary) sample means.

Bootstrapping: Within ggplot2

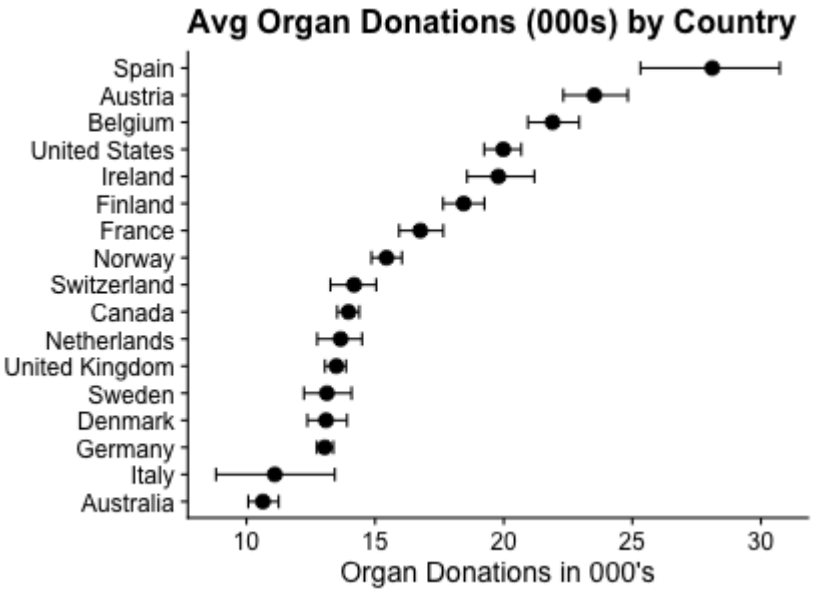
```
organdata %>%
  ggplot(aes(x = country, y = donors)) +
  stat_summary(fun.y = mean, geom = "point", size = 3) +
  stat_summary(fun.data = mean_cl_boot, geom = "errorbar", width = 0.5) +
  coord_flip() +
  cowplot::theme_cowplot() +
  labs(x = " ",
       y = "Organ Donations in 000's",
       title = "Avg Organ Donations (000s) by Country")
```



https://rstudio.cloud/spaces/22733/project/527500

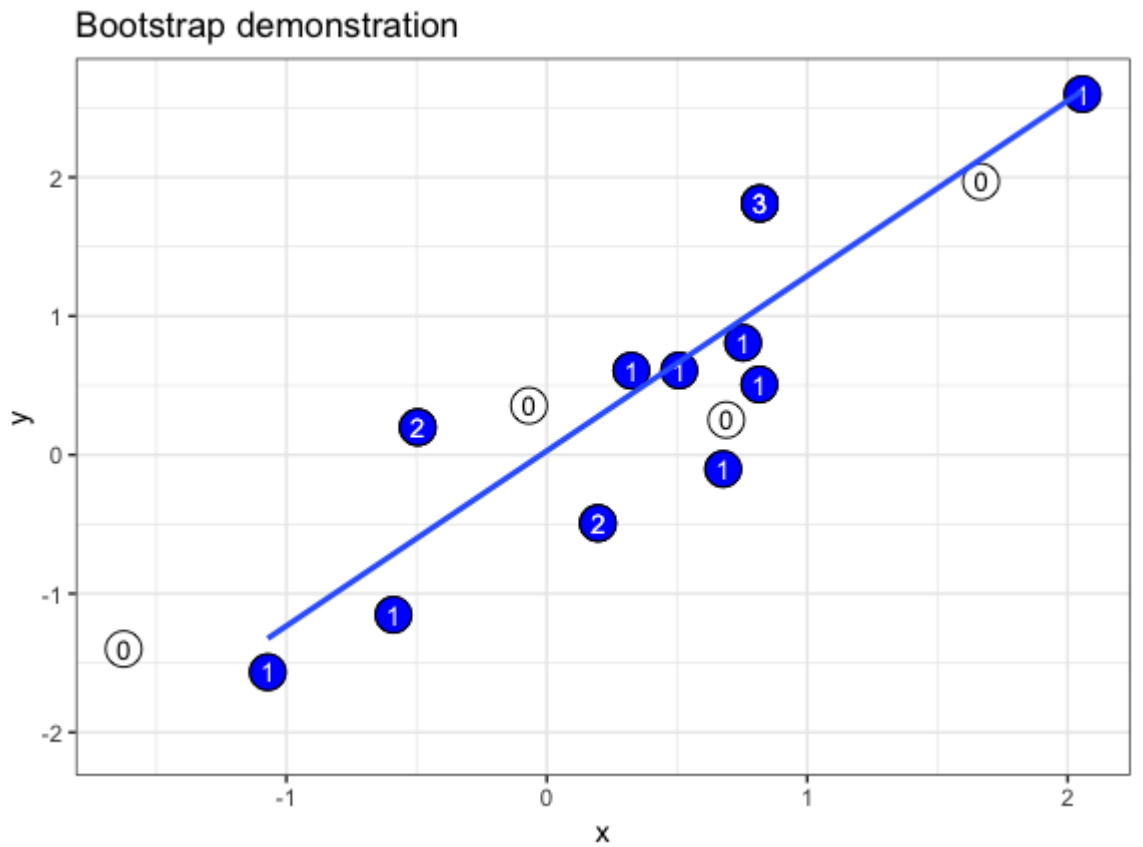
Bootstrapping: Outside ggplot2

```
organdata %>%
  group_by(country) %>%
  do(as_tibble(bind_rows(Hmisc::smean.cl.boot(.$donors)))) %>%
  ggplot(aes(x = reorder(country, Mean), y = Mean)) +
  geom_point(size = 3) +
  geom_errorbar(aes(ymin = Lower, ymax = Upper), width = 0.5) +
  coord_flip() +
  cowplot::theme_cowplot() +
  labs(x = " ", y = "Organ Donations in 000's", title = "Avg Organ Donations (000s) by Country")
```



https://rstudio.cloud/spaces/22733/project/527500

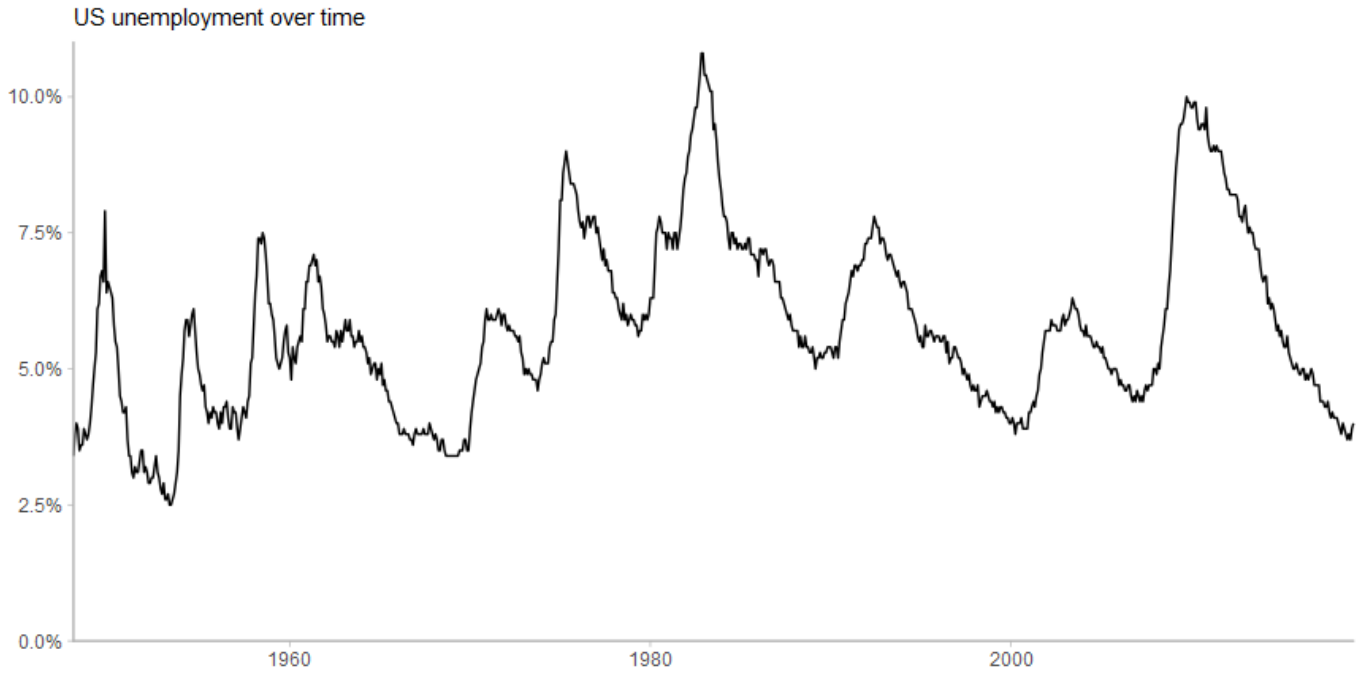
Bootstrapping with HOPs + gganimate



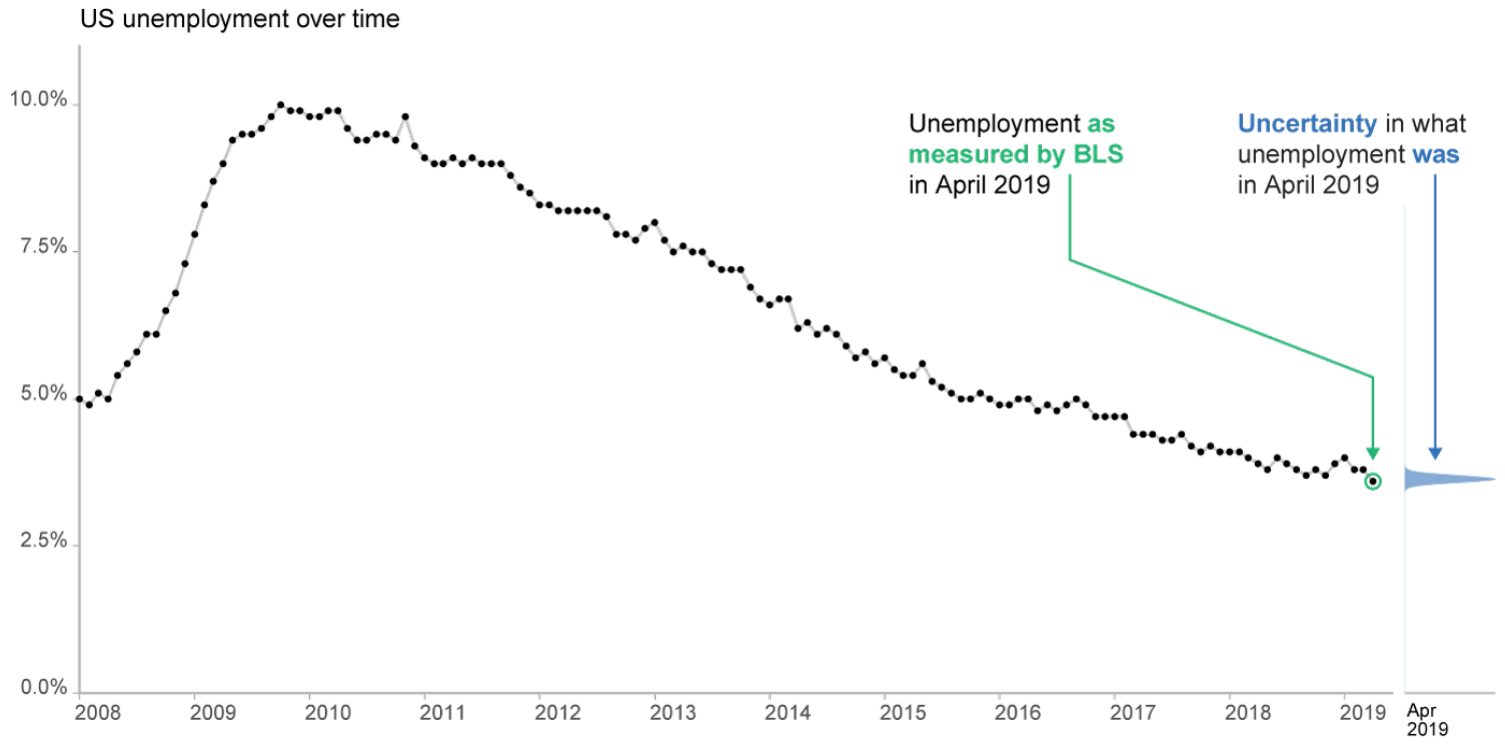
ungeviz package by Claus Wilke

Unemployment Rate

```
df %>%
  ggplot(aes(x = date, y = unemployment)) +
  geom_line() +
  coord_cartesian(ylim = c(0, .11), expand = FALSE),
  scale_y_continuous(labels = scales::percent) +
  labs(x = NULL, y = NULL, subtitle = "US unemployment over time")
```

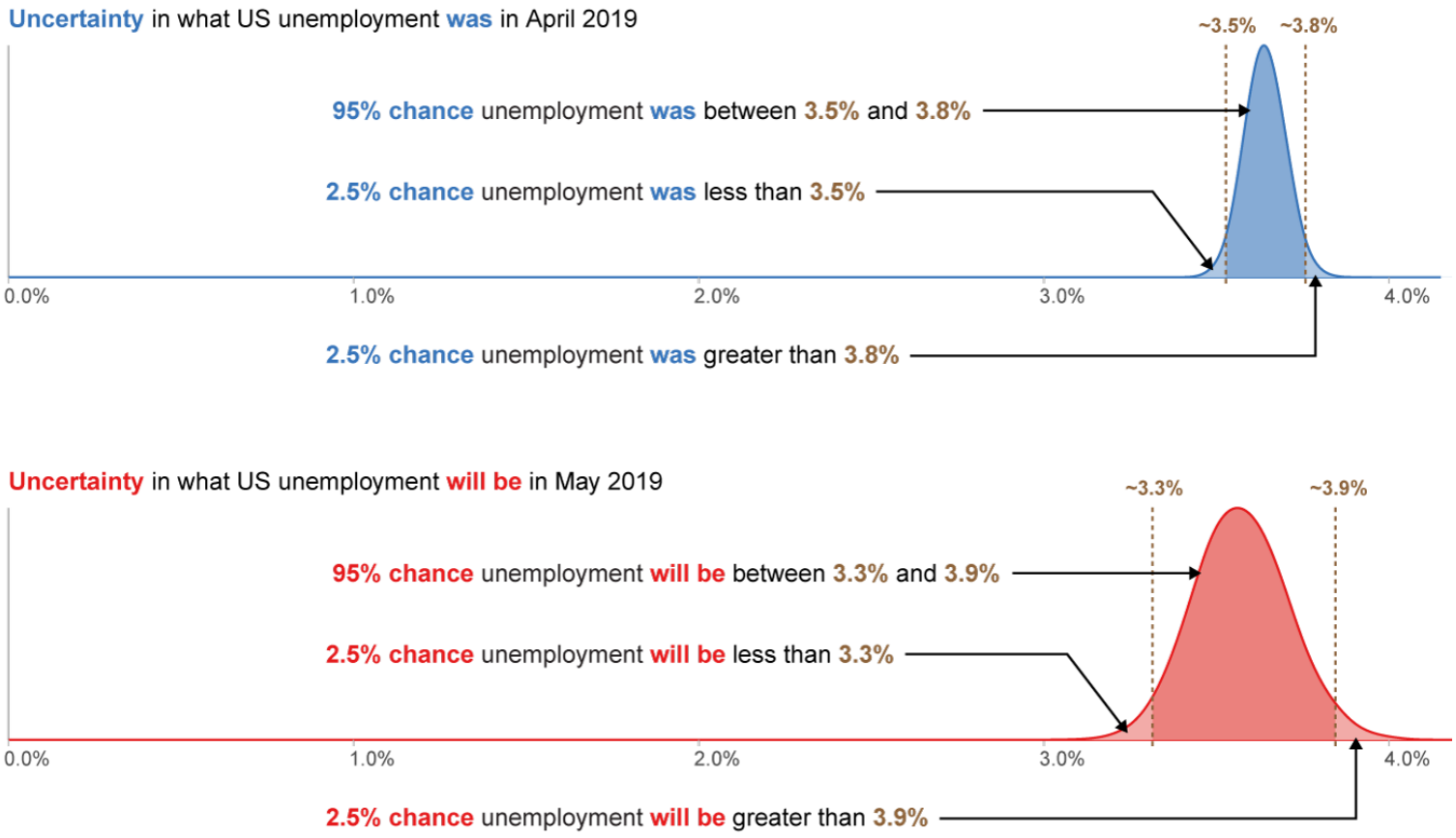


Unemployment Rate



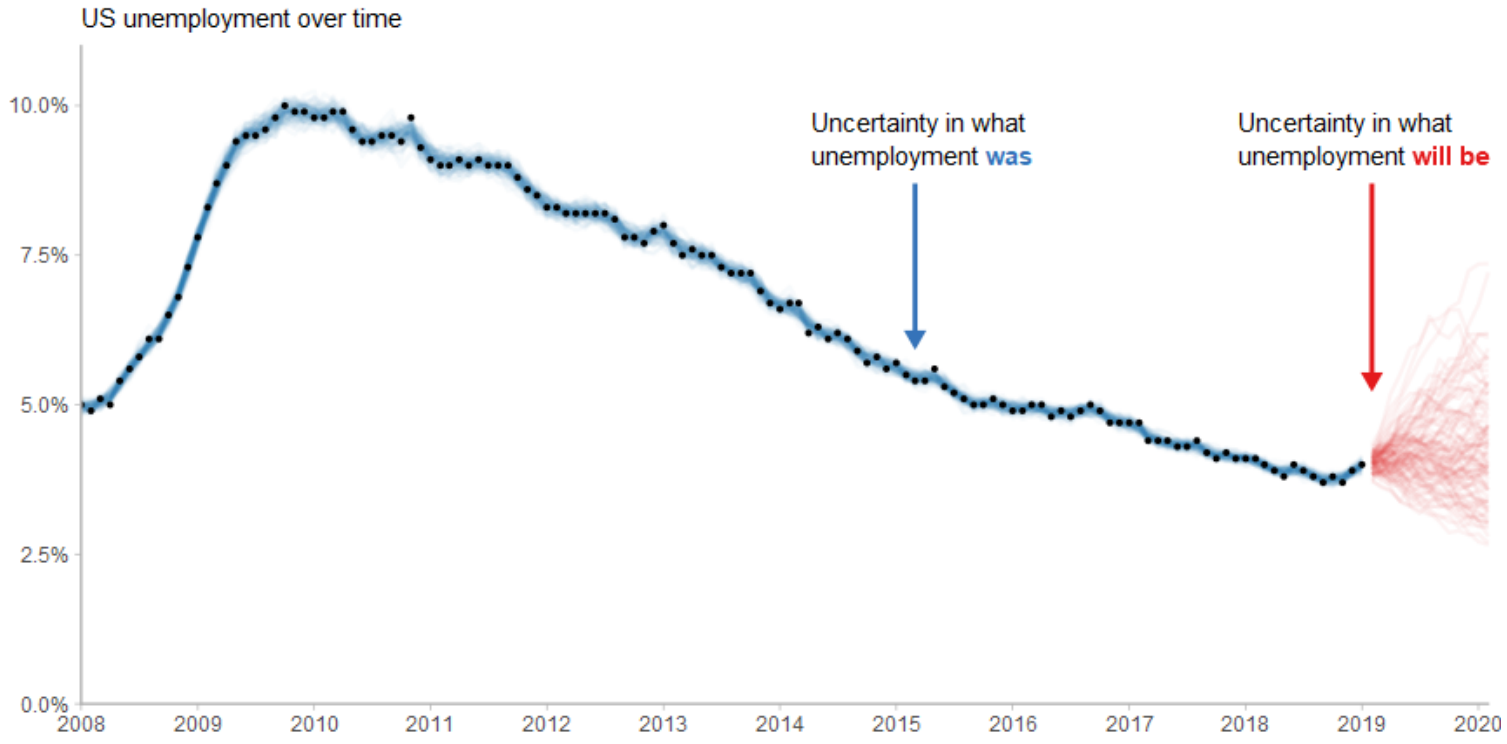
Kay and Hullman Multiple Views Blog 1

Unemployment Rate



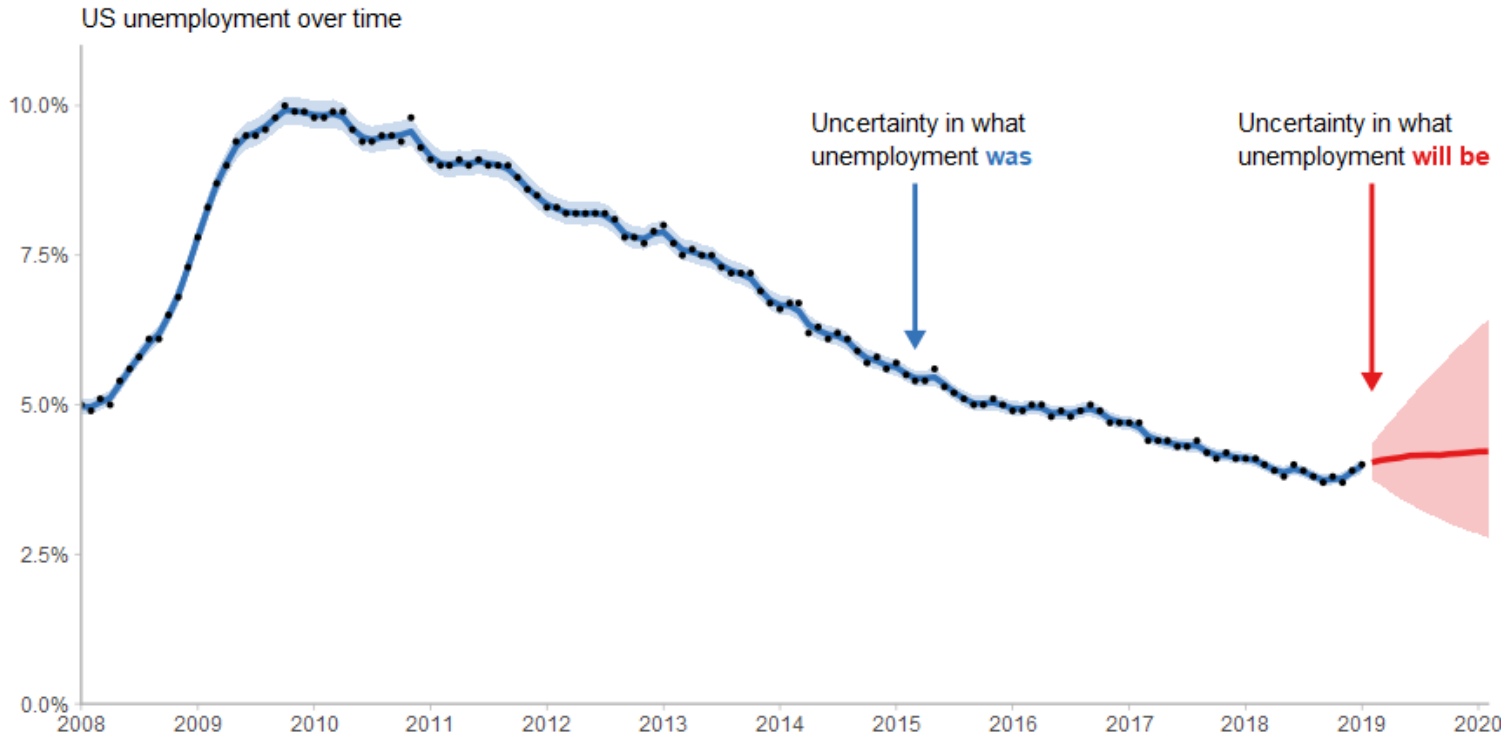
Kay and Hullman Multiple Views Blog 1

Unemployment Rate



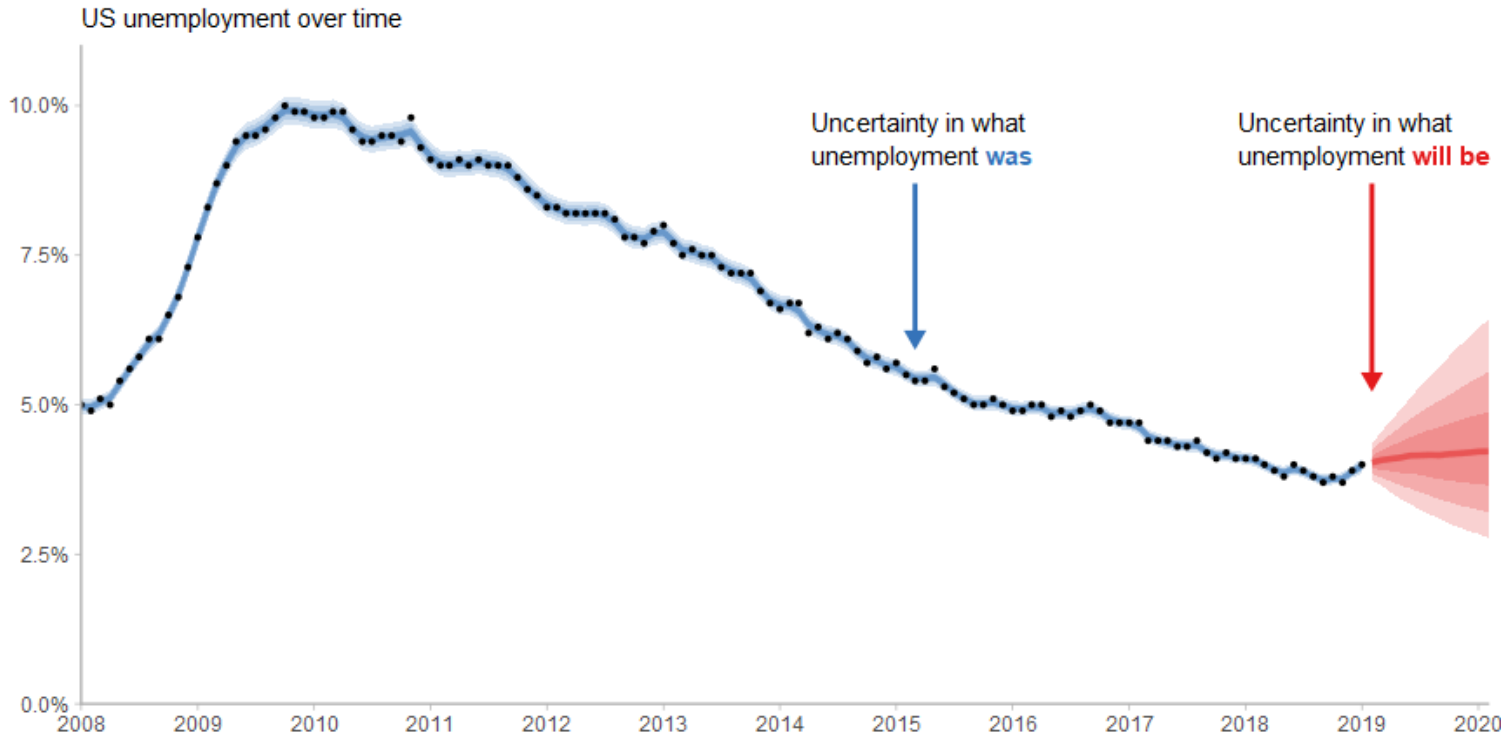
Source: Matthew Kay

Unemployment Rate



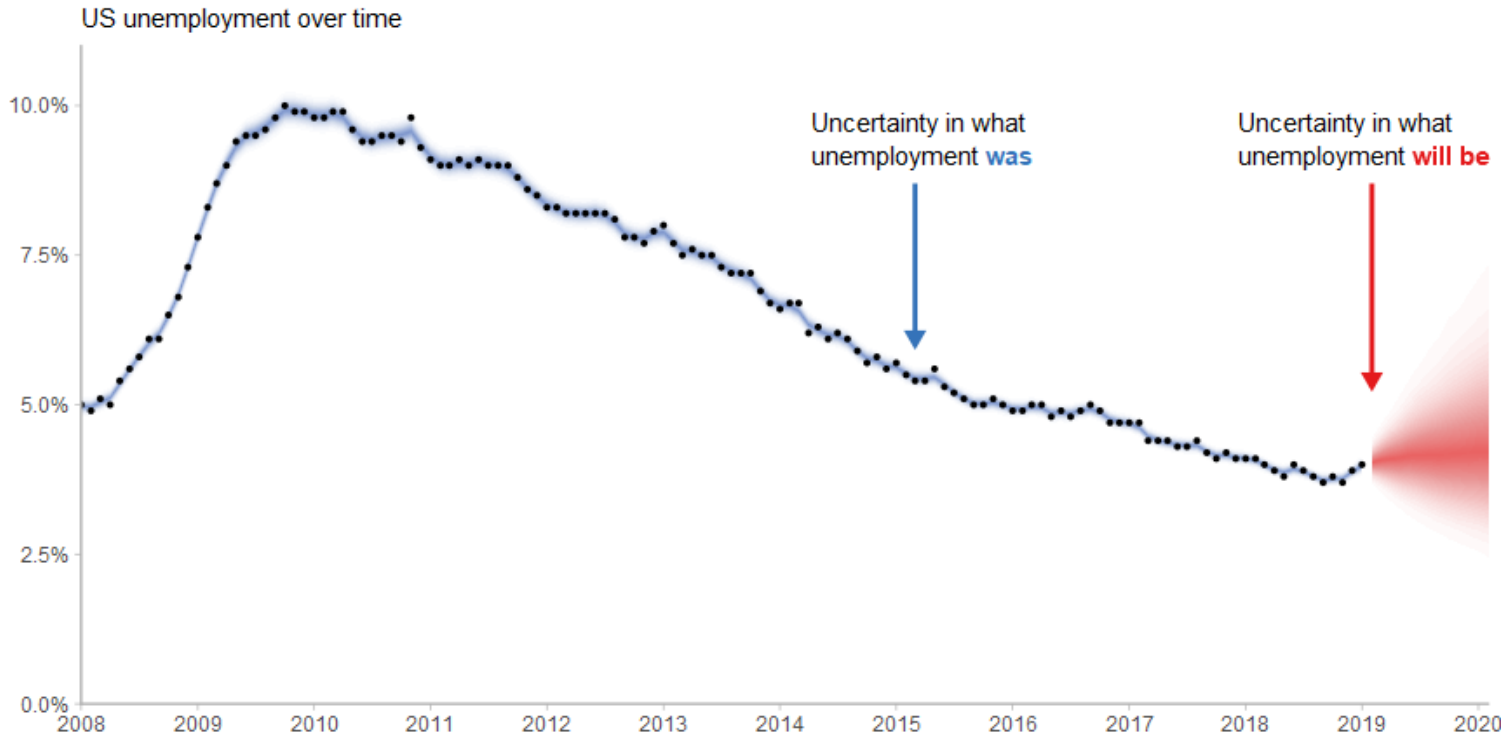
Source: Matthew Kay

Unemployment Rate



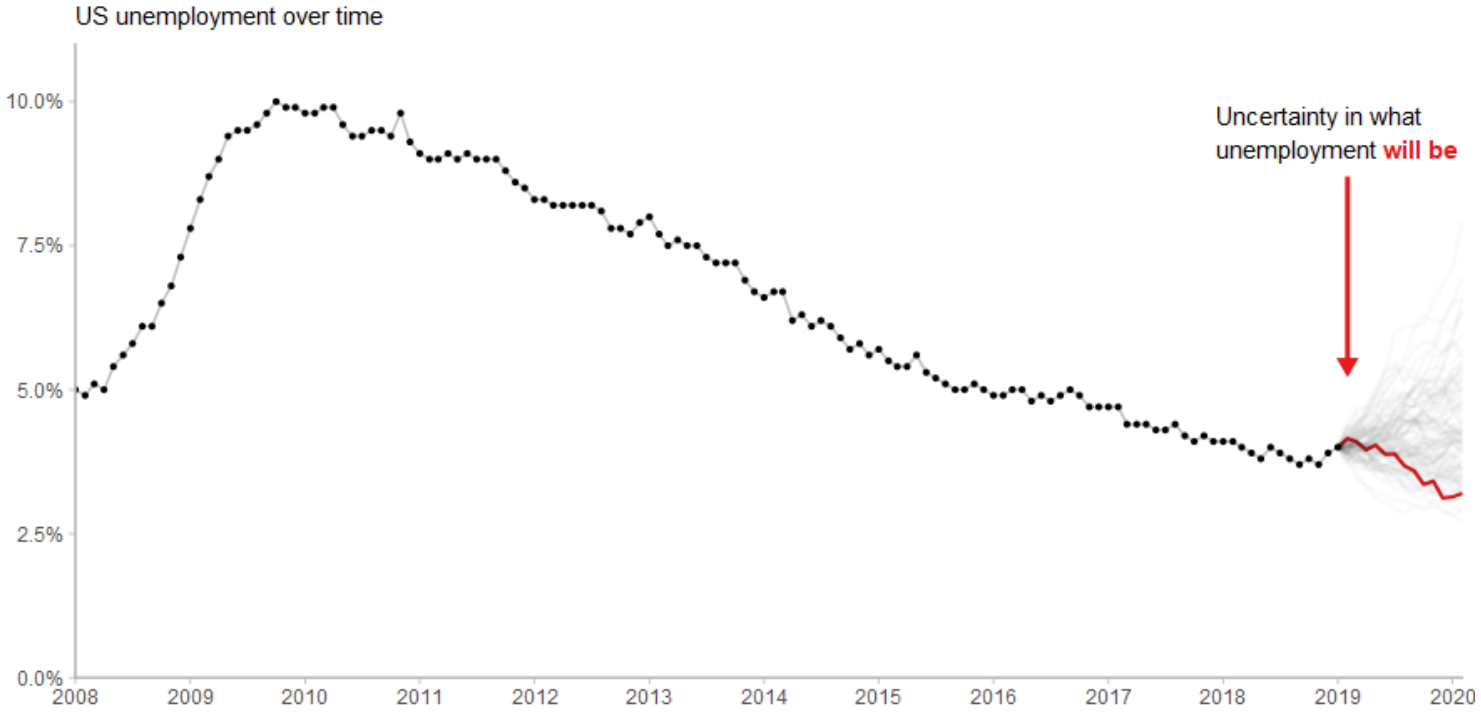
Source: Matthew Kay

Unemployment Rate



Source: Matthew Kay

Unemployment Rate



Hypothetical Outcome Plots (HOP): `tidybayes` & `gganimate`

Why is visualizing uncertainty hard?

- Efficient encodings for uncertainty can be hard to find.
- Make sure people understand encodings (what does the plot mean?).
- Perceptual models of probability (e.g., quantile dot plot, HOP).
- Decisions under uncertainty (e.g., Gigerenzer et al or Monty Hall problem).
- Findings may not apply in all contexts.
- Plus, you still have to actually build it!

Matthew Kay