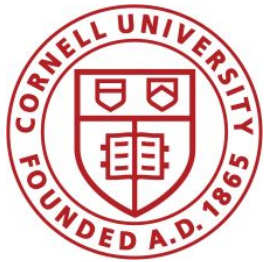


DSFA

Spring 2021

Lecture 21

The Bootstrap

Announcements

Percentiles

Computing Percentiles

The 80th percentile is the value in a set that is at least as large as 80% of the elements in the set

For `s = [1, 7, 3, 9, 5]`, `percentile(80, s)` is 7

The 80th percentile is ordered element 4: `(80/100) * 5`

Percentile

Size of set

For a percentile that does not exactly correspond to an element, take the next greater element instead.

The `percentile` Function

- The *p*th percentile is the value in a set that is at least as large as *p*% of the elements in the set
- Function in the `datascience` module:

```
percentile(p, values)
```

- **`p`** is between 0 and 100
- Returns the *p*th percentile of the array

What is percentile(20, s)?

1

3

5

7

9

What is percentile(10,s)?

1

3

5

7

9

What is percentile(50,s)?

1

3

5

7

9

What is percentile(50, x) if x=make_array(1,2,3,4,5,6)?

2

3

3.5

4

percentile(39,s) == percentile(40,s)?

(s=make_array(1,3,5,7,9))

True

False

percentile(40,s) == percentile(41,s)?

True

False

Estimation (Review)

Inference: Estimation

- How big is an unknown parameter?
- If you have a census (that is, the whole population):
  - Just calculate the parameter and you're done
- If you don't have a census:
  - Take a random sample from the population
  - Use a statistic as an **estimate** of the parameter

(Demo)

Variability of the Estimate

- One sample ➜ One estimate
- But the random sample could have come out differently
- And so the estimate could have been different
- Main question:
  - **How different could the estimate have been?**
- The variability of the estimate tells us something about how accurate the estimate is:

  estimate = parameter + error

(Demo)

Where to Get Another Sample?

- One sample ➜ One estimate
- To get many values of the estimate, we needed many random samples
- Can’t go back and sample again from the population:
  - No time, no money
- Stuck?

The Bootstrap

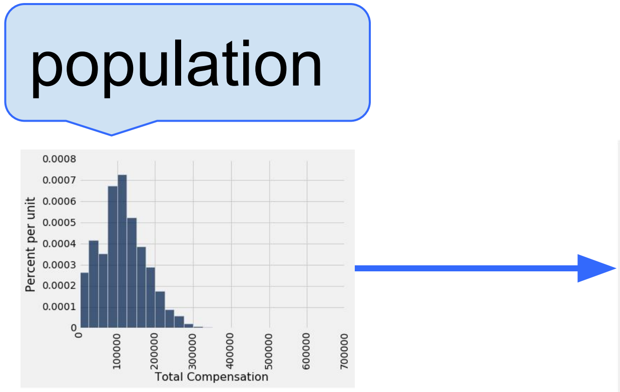
The Bootstrap

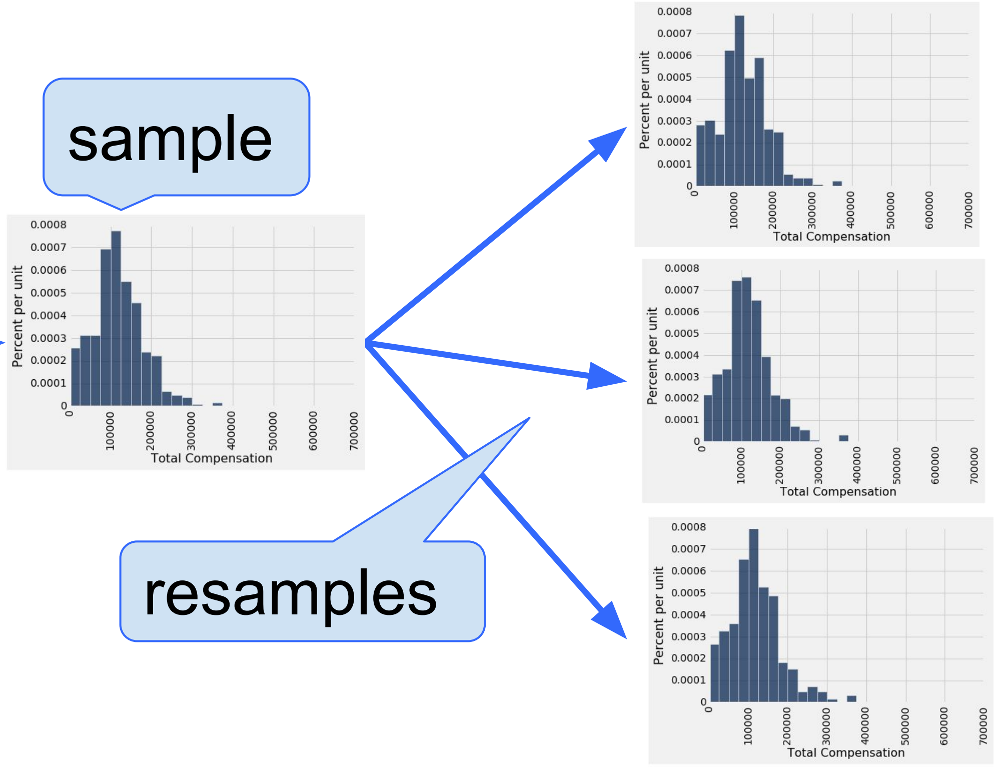
- A technique for simulating repeated random sampling

- All that we have is the original sample
  - … which is large and random
  - Therefore, it probably resembles the population

- So we sample at random from the original sample!

Why the Bootstrap Works





All of these look pretty similar, most likely.

Key to Resampling

- From the original sample,
  - draw at random
  - with replacement
  - as many values as the original sample contained

- The size of the new sample has to be the same as the original one, so that the two estimates are comparable

(Demo)