CompSci 190: Testing Hypotheses

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Sampling

- Probability: Compute what will happen when you run an experiment
- Statistics: Look at the outcome of the experiment and try to reason about the world
- Sampling: Take the outcome of an experiment and use the rules of probability to reason about how it might have come out differently

Estimation

Statistical Inference:

Making conclusions based on data in random samples

Example:

fixed

Use the data to guess the value of an unknown number

depends on the random sample

Create an **estimate** of the unknown quantity

Terminology

Parameter

A number associated with the population

Statistic

A number calculated from the sample

A statistic can be used as an **estimate** of a parameter

(Demo)

How do we test a hypothesis?

- Chocolate has no effect on cardiac disease.
- Yes, chocolate has some effect on cardiac disease.

- This jury panel was selected at random from eligible jurors.
- No, it has too many people with college degrees.

- Create a model for our set of assumptions about the data

How do we assess a model?

- Simulate data according to the assumptions of the model
  - Learn what the model predicts.

- Compare the predictions to the data that were observed.

- If the data and the model's predictions are not consistent, that is evidence against the model.

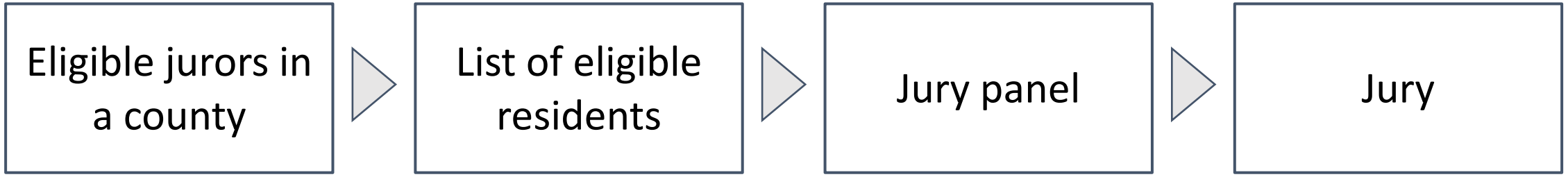
Robert Swain v. Alabama

1965 Supreme Court case about jury selection

- In Talladega, Alabama, 26% of residents were black
- In Swain's jury panel, 8 of 100 panelists were black
- All 8 were struck from the jury by the prosecution (using peremptory challenges)

Ruling: "The overall percentage disparity has been small and reflects no studied attempt to include or exclude a specified number of [black men]."

Jury Panels



Section 197 of California's Code of Civil Procedure: All persons selected for jury service shall be selected at random, from a source or sources inclusive of a representative cross section of the population of the area served by the court.

Sixth Amendment to the US Constitution: … the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the state and district wherein the crime shall have been committed.

Sampling from a Distribution

- Sample at random from a categorical distribution

```
sample_proportions(sample_size, pop_distribution)
```

- Samples at random from the population
  - Returns an array containing the distribution of the categories in the sample

Perfect information

- You want to know how many US voters support a particular policy.
- You could ask everyone. That works.
- But, sometimes we can't afford to do that. So, instead, we could ask some of them, and draw inferences about the general population.

A common scenario

- You have to make a decision based on incomplete information.
- The quality of your decision is affected by
  - the information that you have
  - the information that you don’t have

- So, before making the decision, it is worth examining why and how your information came to be incomplete.

Terminology

- **Population:** A collection of individuals
  - All United flights out of SFO in Summer 2015

- **Variable:** Something that varies in the population
  - airline *(categorical variable)*
  - amount of delay in departure *(quantitative variable)*

- **Sample:** A subset of the population

Why take a sample?

- You want to understand the variable in the population,

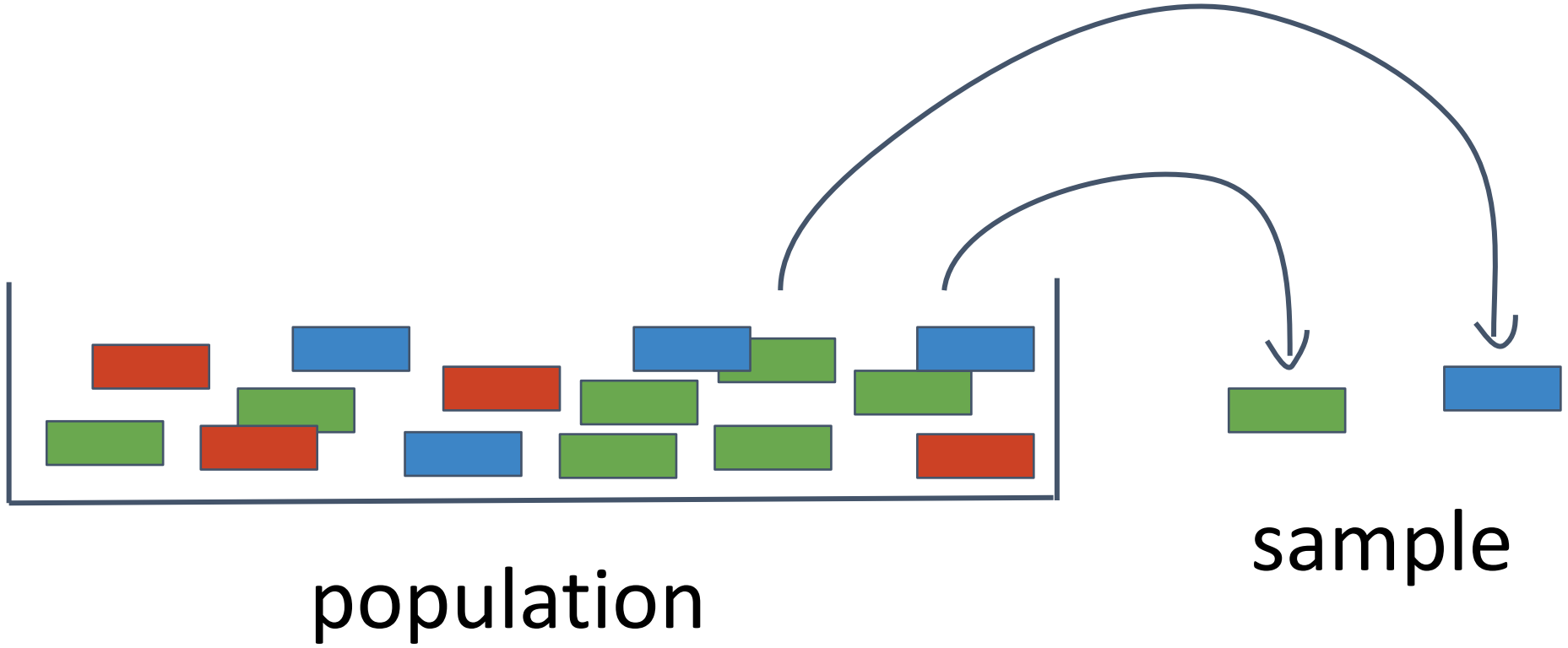
but

- you don't have the resources to measure the variable on all the individuals in the population,

so

- you just measure it on a subset of them.

“Tickets in a box”

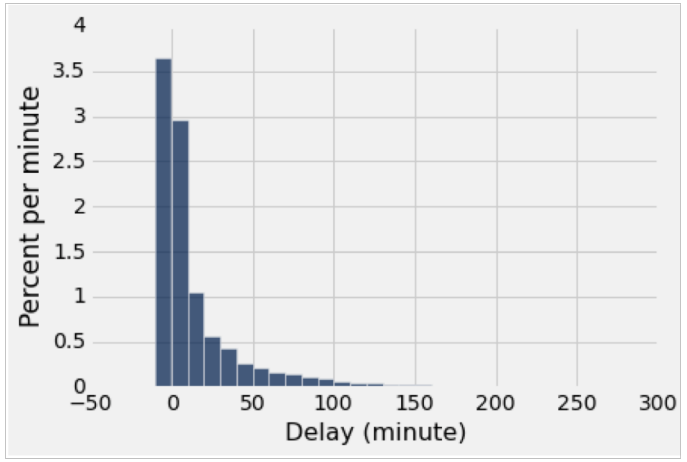


Best way to draw the sample

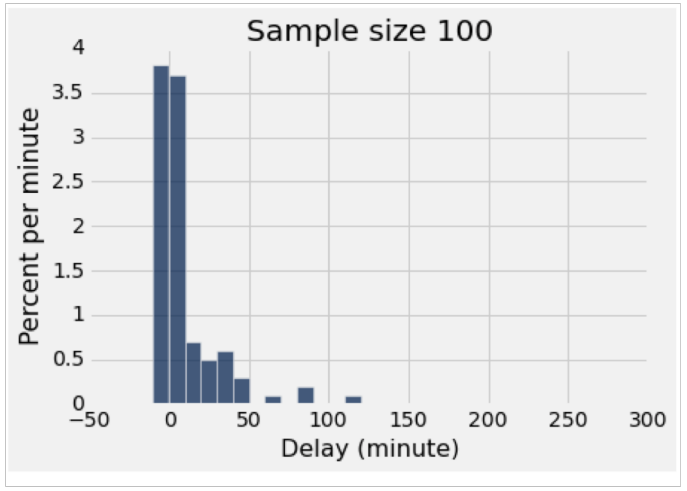
At random!

Two distributions

distribution of the population



empirical distribution of a sample



Why sample at random?

The empirical distribution
of a large random sample
is very likely to be close
to the distribution of the population.

That's why.

The effect of sample size

- Larger random samples are more likely to resemble the population than smaller ones.

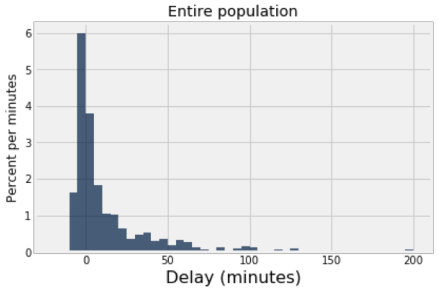
- However, if the method of sampling is not random, taking a larger sample isn't necessarily better.
  - You could just end up with a big bad sample.

More terminology

- **Parameter:** A number calculated using the values in the population
  - Median delay among all flights
  - Proportion of voters who are Republican

- **Statistic:** A number calculated using the values in a sample

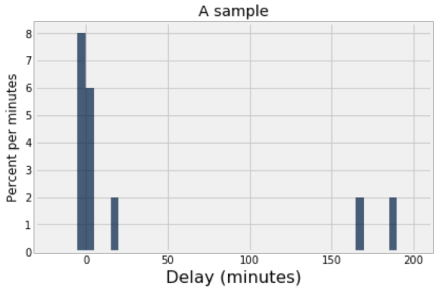
- A statistic can be used as an estimate of a parameter.

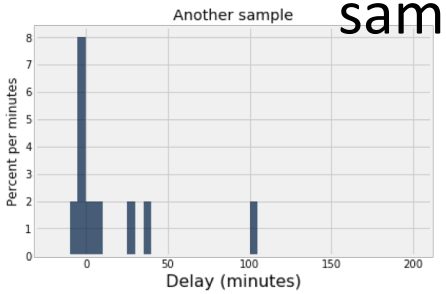


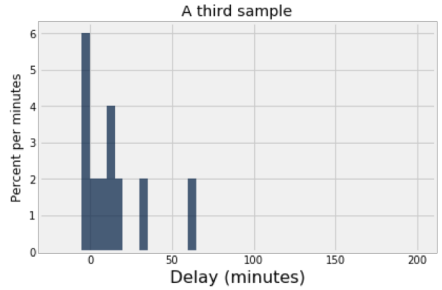
randomly sample

randomly sample

randomly sample



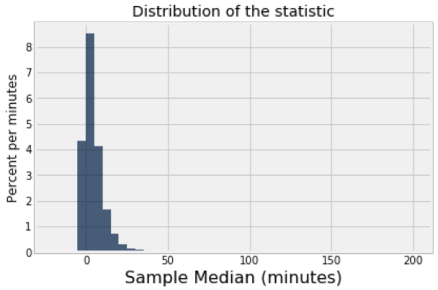




median = 2.0

median = -0.5

median = 9.5



HW5: Gary's Game

- Flip a fair (?) coin 10 times
  - If number of heads >= 5, we win
  - Else Gary wins

- Play the game once
  - There's one head
  - Was the game rigged?

http://bit.ly/FoDS-f18-1031

If you have the entire population...

- Formulate a question you want to answer (a parameter of the population).
- Visualize the data (the population).
- Compute the answer.
- Interpret the results, and explain them in language without statistical jargon.

If you don't...

- Formulate a question you want to answer (a parameter of the population).
- Select a method of inference.
- Visualize the data (the sample).
- Calculate the statistic on your sample, then apply the method to estimate the population parameter.
- Interpret the results, and explain them in language without statistical jargon.