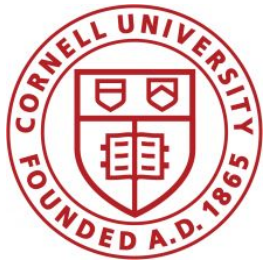


DSFA

Spring 2021

Lecture 18

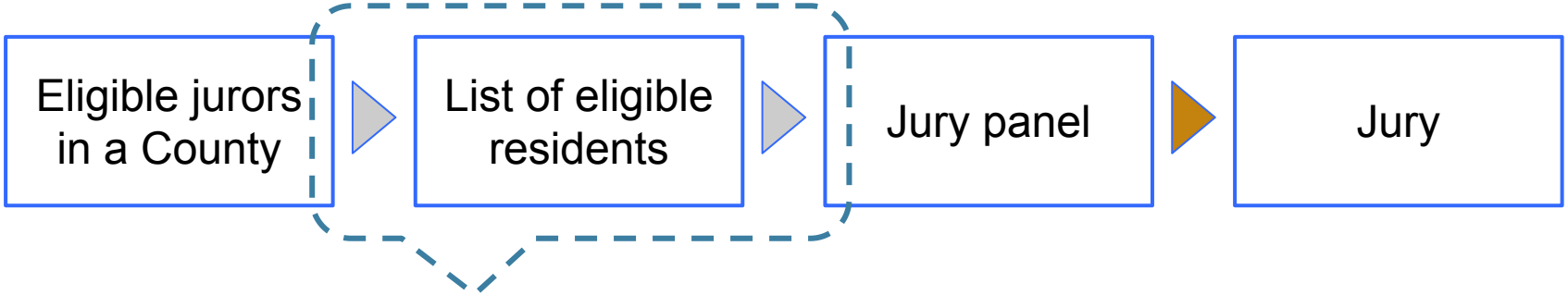
Hypothesis Testing

Announcements

- Project 1, part 2 due Friday 5:59PM
- Prelim 1
  - Can submit regrade requests until Monday 3/29, 5PM, via Gradescope
  - Look at posted solutions first

Jury Panels

Jury Panels



Section 197 of California's Code of Civil Procedure says, "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." (Demo)

Does this panel look like it was drawn at random from the population?

Yes

No

Statistics

A statistic is a number calculated from a sample

Total Variation Distance

Every distance has a computational recipe

Total Variation Distance (TVD):

- For each category, compute the difference in proportions between two distributions
- Take the absolute value of each difference
- Sum & divide by 2

(Demo)

Empirical Distributions

Distribution of a Statistic

Statistic: A quantity computed for a particular sample

Distribution: The chance of each outcome of sampling

Sampling distribution: Chance of each value of a statistic (computed from all possible samples)

Also known as the *probability distribution of the statistic*

Empirical distribution: Observations of a statistic (computed from some samples drawn at random)

Simulating a Statistic

Fix a sample size and choose your statistic.

- Simulate the statistic once:
  - Draw a random sample of the size you fixed.
  - Calculate the statistic and keep a record of the value
- Repeat previous step numerous times (as many times as you have patience for; thousands are good).
- You now have one value of the statistic for each repetition. Visualize the results.

(Demo)

Does it look like this panel was drawn randomly from the population?

Yes

No

The sample vs the distribution

To assess if sample was drawn randomly from distribution:

- Decide on a statistic that measures the distance between two distributions
- Compute the statistic from the sample; that is, the distance between distributions of sample and known population
- Sample at random and from the population and compute the statistic from the random sample; repeat numerous times
- Compare

Hypothesis Testing

Testing a Hypothesis

Step 1: The Hypotheses

- A test chooses between two views of how data were generated
- *Null hypothesis* proposes that data were generated at random
- *Alternative hypothesis* proposes some effect other than chance

Step 2: The Test Statistic

- A value that can be computed for the data and for samples

Step 3: The Sampling Distribution of the Test Statistic

- What the test statistic might be if the null hypothesis were true
- Approximate the sampling distribution by an empirical distribution

Conclusion of a Test

Resolve choice between null and alternative hypotheses

- Compare observed test statistic to its empirical distribution under the null hypothesis
- If the observed value is **consistent** with the distribution, then the test *does not* support the alternative hypothesis

Whether a value is consistent with a distribution:

- A visualization may be sufficient
- Convention: The observed significance level (P-value)

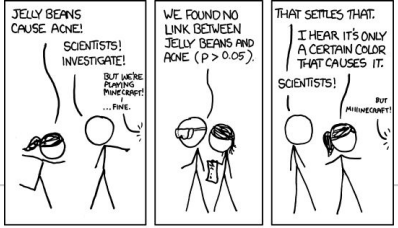
(Demo)

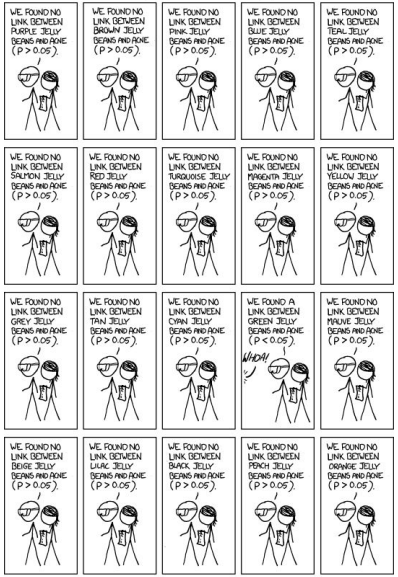
Observed Significance Level

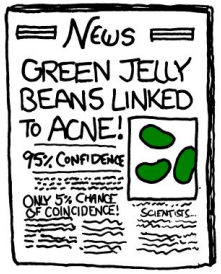
P-Value: The chance, under the null hypothesis,
that the test statistic is equal to the value that was observed
or is even further in the direction of the alternative.

Statistically Significant: The P-value is less than 5%

Highly Statistically Significant: The P-value is less than 1%


JELLY BEANS CAUSE ACNE!
SCIENTISTS! INVESTIGATE!
BUT WE'RE PLAYING MINECRAFT!
...FINE.
WE FOUND NO LINK BETWEEN JELLY BEANS AND ACNE (P > 0.05).
THAT SETTLES THAT.
I HEAR IT'S ONLY A CERTAIN COLOR THAT CAUSES IT.
SCIENTISTS!
BUT MINECRAFT!


WE FOUND NO LINK BETWEEN PURPLE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BROWN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN PINK JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BLUE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TEAL JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN SALMON JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN RED JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TURQUOISE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN MAGENTA JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN YELLOW JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN GREY JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TAN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN CYAN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND A LINK BETWEEN GREEN JELLY BEANS AND ACNE (P < 0.05).
WHOA!
WE FOUND NO LINK BETWEEN MAUVE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BEIGE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN LILAC JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BLACK JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN PEACH JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN ORANGE JELLY BEANS AND ACNE (P > 0.05).


NEWS
GREEN JELLY BEANS LINKED TO ACNE!
95% CONFIDENCE
ONLY 5% CHANCE OF COINCIDENCE!
SCIENTISTS