

YData: An Introduction to Data Science

Lecture 21: Examples

Jessi Cisewski-Kehe
Statistics & Data Science, Yale University
Spring 2020

Credit: data8.org

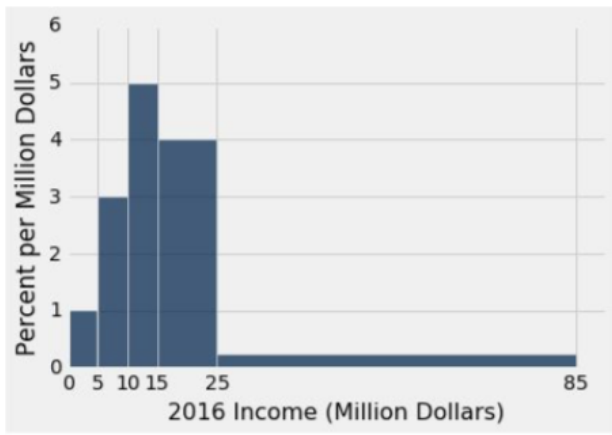


Announcements

Histograms

Using the Density Scale

- (a) Which bin has more people: $[10, 15)$ or $[15, 25)$?
- (b) What percent of incomes are in the $[25, 85)$ bin?
- (c) If you draw one bar over $[10, 25)$, how tall will it be?
- (d) Find (or give bounds for) the median income.



Answers

- (a) $[15, 25)$
- (b) 15%
- (c) 4.33 percent per million dollars
- (d) At least 15 and less than 25

Probability

Exercise 1

I pick one of the 12 months at random. Independently, you pick one of the 12 months at random.

What is the chance that we both pick the same month?

(i) $(1/12) * (1/12)$ (ii) $(1/12) + (1/12)$ (iii) $1/12$

(iii) $= (12/12) * (1/12)$ Also $(iii) = 12 * (i)$

Exercise 2

Marbles: G, G, G, G, R, R, R, B, B, Y. Draw 4 at random.

$$P(\text{no G}) = ?$$

$$P(\text{all G}) = ?$$

If with replacement:

$$(6/10) * (6/10) * (6/10) * (6/10)$$

If with replacement:

$$(4/10) * (4/10) * (4/10) * (4/10)$$

If without replacement:

$$(6/10) * (5/9) * (4/8) * (3/7)$$

If without replacement:

$$(4/10) * (3/9) * (2/8) * (1/7)$$

Exercise 3

Marbles: G, G, G, G, R, R, R, B, B, Y.

Draw 4 times at random with replacement.

$$1 - (6/10)*(6/10)*(6/10)*(6/10)$$

is the chance of: at least one G

$$(4/10)**4 + (3/10)**4 + (2/10)**4 + (1/10)**4$$

is the chance of: all four are the same color

Testing Hypotheses

Before You Compute Anything

- Figure out the viewpoint the question wants to test, and formulate:
 - Null hypothesis: Completely specified chance model under which you can simulate data
 - Alternative hypothesis: Viewpoint comes from the question
 - Test statistic: to help you choose one viewpoint
- Say what kind of values of the statistic will make you lean towards each alternative

Categorical Data

Null Hypothesis

The sample is drawn at random from a specified categorical distribution.

- Swain's jury panel was drawn at random from a population that had 26% black men
- Each pea plant has 75% chance of being purple flowering, regardless of other plants
- The Alameda County jury panels were drawn at random from the specified distribution of eligible jurors

Swain v. Alabama

- **Null:** Swain's jury panel was drawn at random from a population that had 26% black men
- **Alternative:** There were too few black men on the panel for it to look like a random sample
- **Test statistic:**
Number of black men in panel
P-value direction: to the left

Mendel's Model

- **Null:** Each pea plant has 75% chance of being purple flowering, regardless of other plants
- **Alternative:** The model isn't good.
- **Test statistic:**
|percent purple in sample - 75|
P-value direction: to the right
Could also have used TVD; direction is still to the right
$$\text{TVD} = (|\text{prop. purple} - 0.75| + |\text{prop. white} - 0.25|)/2$$

Alameda County Jury Panels

- **Null:** The Alameda County jury panels were drawn at random from the specified distribution of eligible jurors
- **Alternative:** The panels were not drawn at random from the specified distribution.
- **Test statistic:**
TVD
P-value direction: to the right

Numerical Data

GSI's Defense

- **Null:** Section 3 scores are like a sample drawn at random without replacement from the whole class.
- **Alternative:** The Section 3 average is too low for the section to be a random sample from the class.
- **Test statistic:**
Section 3 average
P-value direction: to the left

Comparing Two Samples

Birthweights

- **Null:** In the population, the distributions of the birth weights of the babies in the two groups are the same.
- **Alternative:** In the population, the babies of the mothers who didn't smoke (B) were heavier, on average, than the babies of the smokers (A).
- **Test statistic:**
Group B sample average - Group A sample average
P-value direction: to the right

Deflategate

- **Null:** Each group is like a sample drawn at random without replacement from all 15 footballs.
- **Alternative:** The Patriots' drop in ball pressures were too high for them to look like a random sample from the 15 balls.
- **Test statistic:**
Colts' average - Patriots' average
P-value direction: to the left

- **Null:** The distribution of all the potential control scores is the same as the distribution of all the potential treatment scores.
- **Alternative:** The distribution of all the potential control scores is different from the distribution of all the potential treatment scores.
- **Test statistic:**
| control group average - treatment group average |
P-value direction: to the right