Unit 1: Introduction to data

4. Introduction to statistical inference

GOVT 3990 - Spring 2017

Cornell University

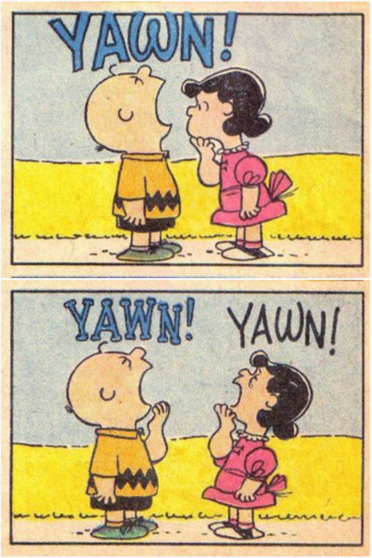
Outline

Announcements

- Problem set (PS) 1 assigned today Due Monday 27
- Performance assessment (PA) assigned today Due next Tuesday 21
- Lab 2 Due Wednesday
- I will upload the full calendar tonight

Outline

1. Housekeeping
2. Case study: Is yawning contagious?
    1. Competing claims
    2. Testing via simulation
    3. Checking for independence
3. Case study: Tapping on caffeine
4. Application exercise



Your turn

Do you think yawning is contagious?

(a) Yes
(b) No
(c) Don't know

Is yawning contagious?

An experiment conducted by the MythBusters tested if a person can be subconsciously influenced into yawning if another person near them yawns.

http://www.discovery.com/tv-shows/mythbusters/videos/is-yawning-contagious-minimyth.htm

50 people were randomly assigned to two groups:

- treatment: see someone yawn, $n = 34$
- control: don't see someone yawn, $n = 16$

	Treatment	Control	Total
Yawn	10	4	14
Not Yawn	24	12	36
Total	34	16	50
% Yawners			

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Based on the proportions we calculated, do you think yawning is really contagious, i.e. are seeing someone yawn and yawning dependent?

- The observed differences might suggest that yawning is contagious, i.e. seeing someone yawn and yawning are dependent

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- Perhaps if we were to repeat the experiment, we would see slightly different results
- So we will do just that - well, somewhat - and see what happens
- Instead of actually conducting the experiment many times, we will *simulate* our results

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1. "There is nothing going on."
   Seeing someone yawn and yawning are *independent*, observed difference in proportions of yawners in the treatment and control is simply due to chance. $\rightarrow$ *Null hypothesis*

Two competing claims

1. "There is nothing going on."
   Seeing someone yawn and yawning are *independent*, observed difference in proportions of yawners in the treatment and control is simply due to chance. → *Null hypothesis*
2. "There is something going on."
   Seeing someone yawn and yawning are *dependent*, observed difference in proportions of yawners in the treatment and control is not due to chance. → *Alternative hypothesis*

A trial as a hypothesis test

- H_0: Defendant is innocent
- H_A: Defendant is guilty
- Present the evidence: collect data.
- Judge the evidence: "Could these data plausibly have happened by chance if the null hypothesis were true?"
- Make a decision: "How unlikely is unlikely?"

Outline

Simulation setup

- A regular deck of cards is comprised of 52 cards: 4 aces, 4 of numbers 2-10, 4 jacks, 4 queens, and 4 kings.
- Take out two aces from the deck of cards and set them aside.
- The remaining 50 playing cards to represent each participant in the study:
  - 14 face cards (including the 2 aces) represent the people who yawn.
  - 36 non-face cards represent the people who don't yawn.

[DEMO: Watch me go through the activity before you start it in your teams.]

Activity: Running the simulation

1. Shuffle the 50 cards at least 7 times to ensure that the cards counted out are from a random process
2. Divide the cards into two decks:
   - deck 1: 16 cards $\rightarrow$ control
   - deck 2: 34 cards $\rightarrow$ treatment
3. Count the number of face cards (yawners) in each deck
4. Calculate the difference in proportions of yawners *(treatment - control)*, and submit this value using your clicker (value must be between 0 and 1) - **only one submission per team per simulation**
5. Repeat steps (1) - (4) many times

Why shuffle 7 times: *http://www.dartmouth.edu/~chance/course/topics/winning_number.html*

Outline

Your turn

Do the simulation results suggest that yawning is contagious, i.e. does seeing someone yawn and yawning appear to be dependent?
(Hint: In the actual data the difference was 0.04, does this appear to be an unusual observation for the chance model?)

(a) Yes

(b) No

Outline

Tapping on caffeine

- In a double-blind experiment a sample of male college students were asked to tap their fingers at a rapid rate.
- The sample was then divided at random into two groups of 10 students each.
- Each student drank the equivalent of about two cups of coffee, which included about 200 mg of caffeine for the students in one group but was decaffeinated coffee for the second group.
- After a two hour period, each student was tested to measure finger tapping rate (taps per minute).

Data

	Taps	Group
1	246	Caffeine
2	248	Caffeine
3	250	Caffeine
4	252	Caffeine
5	248	Caffeine
6	250	Caffeine
...		
16	248	NoCaffeine
17	242	NoCaffeine
18	244	NoCaffeine
19	246	NoCaffeine
20	242	NoCaffeine

Your turn

What type of plot would be useful to visualize the distributions of tapping rate in the caffeine and no caffeine groups.

(a) Bar plot
(b) Mosaic plot
(c) Pie chart
(d) Side-by-side box plots
(e) Single box plot

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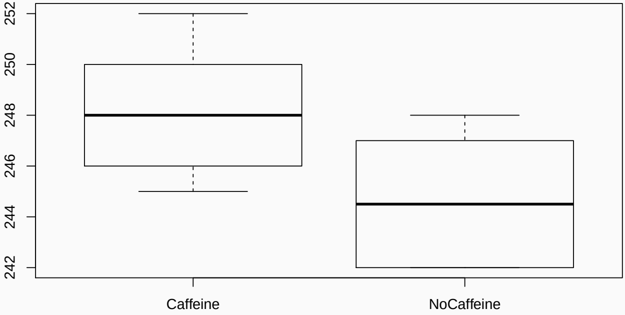
Exploratory data analysis

Compare the distributions of tapping rates in the caffeine and no caffeine groups.

	Caffeine	No Caffeine	Difference
mean	248.3	244.8	3.5
SD	2.21	2.39	-0.18
median	248	245	3
IQR	3.5	4.25	-0.75



Your turn

We are interested in finding out if caffeine increases tapping rate. Which of the following are the correct set of hypotheses?

(a) $H_0 : \mu_{caff} = \mu_{no\ caff}$
$H_A : \mu_{caff} < \mu_{no\ caff}$

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(c) $H_0 : \bar{x}_{caff} = \bar{x}_{no\ caff}$
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(d) $H_0 : \mu_{caff} > \mu_{no\ caff}$
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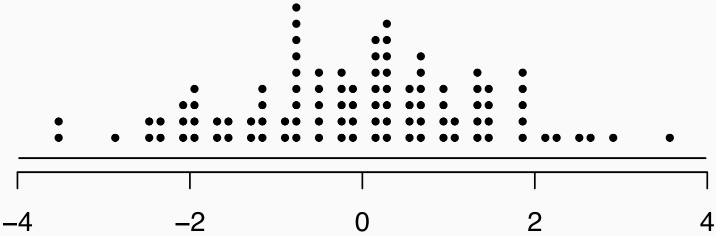
- On 20 index cards write the tapping rate of each subject in the study.
- Shuffle the cards and divide them into two stacks of 10 cards each, label one stack “caffeine” and the other stack “no caffeine”.
- Calculate the average tapping rates in the two simulated groups, and record the difference on a dot plot.
- Repeat steps (2) and (3) many times to build a *randomization distribution*.

Below is a randomization distribution of 100 simulated differences in means ($\bar{x}_c - \bar{x}_{nc}$). Calculate the p-value for the hypothesis test evaluating whether caffeine increases average tapping rate.

	Caffeine	No Caffeine	Difference
mean	248.3	244.8	3.5



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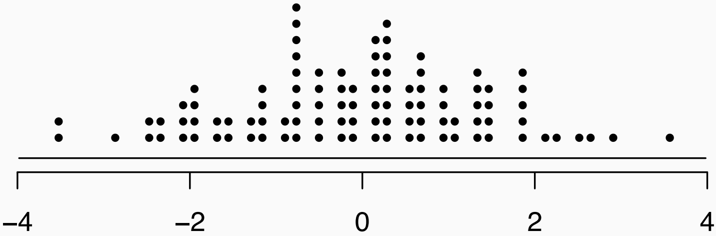

1/100 = 0.01

Testing for the median

Describe how could we use the same approach to test whether the median tapping rate is higher for the caffeine group?

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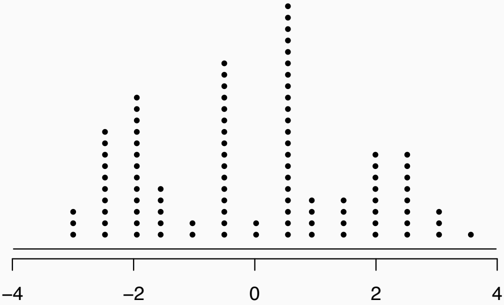
Use the same simulation scheme but record the difference between the medians instead of the means, and calculate the p-value as the proportion of simulations where the simulated difference in medians is at least 3.

Below is a randomization distribution of 100 simulated differences in medians ($med_c - med_{nc}$). Do the data provide convincing evidence that caffeine increases median tapping rate?

	Caffeine	No Caffeine	Difference
median	248	245	3



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Application exercise: 1.4 Randomization testing

See the course website for instructions.