Simulation-based HTs for SLR

11/14/24

Housekeeping

Data for end of class (copy when needed):

```
library(readr)
birthwt <- read.csv("https://raw.githubusercontent.com/midd-stat201-fall2024/midd-stat201-fall2024.gi
```

- Office hours changed this week:
  - Friday: cancelled, moved to next week before midterm
- Homework 8 due tonight
- Office hours next week:
  - Monday 2:00-4:00pm
  - Tuesday: 11am-12:00pm, 4:00-5:00pm

Simulation-based HT for slope

Recall our hypotheses for the slope: $H_0 : \beta_1 = 0$ versus $H_A : \beta_1 \neq 0$

How might we use simulation to test these hypotheses? (i.e. how can we simulate "null world"?)

- Under H_0, there is no relationship between x and y, so we can shuffle/permute/break up the (x_i, y_i) under H_0
  - i.e. there is no special correspondence between x_i and y_i

Randomization test (demonstration)

Here's how it would look like using cards. Repeat the following B times:

1. Write down all $x_1, \ldots, x_n$ values and all $y_1, \ldots, y_n$ values on cards.
2. Shuffle the response variable cards to get $y_1^{shuff}, \ldots, y_n^{shuff}$
3. Deal out the shuffled responses to pair with an explanatory: $(x_1, y_1^{shuff}), \ldots, (x_n, y_n^{shuff})$
4. Fit linear regression model to these shuffled data and record b_1

- Convince yourself this corresponds to $H_0 : \beta_1 = 0$!
- We are *not* sampling with replacement

`evals`

Let's return to our `evals` data and model: $\text{score} = \beta_0 + \beta_1 \,\text{bty\_avg} + \epsilon$

First six rows of original data:

course_id	bty_avg	score
1	5	4.7
2	5	4.1
3	5	3.9
4	5	4.8
5	3	4.6
6	3	4.3

First six rows of one iteration of *shuffled data:*

course_id	bty_avg	score	score_shuff
1	5	4.7	4.5
2	5	4.1	3.9
3	5	3.9	3.7
4	5	4.8	3.8
5	3	4.6	4.7
6	3	4.3	4.6

Your turn!!

$$\text{score} = \beta_0 + \beta_1 \, \text{bty\_avg} + \epsilon$$

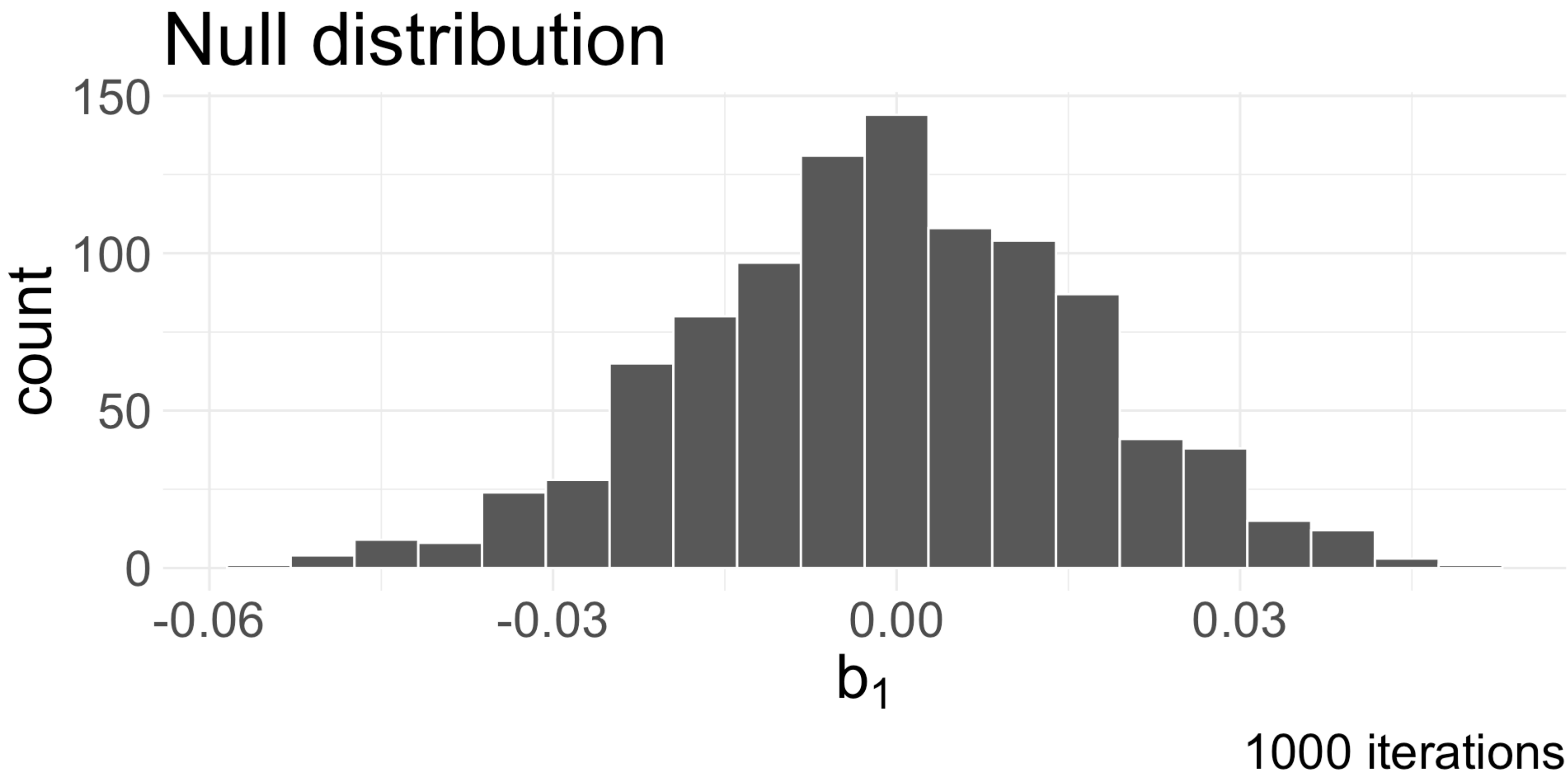
In groups, obtain the null distribution for this H_0 via simulation and visualize it using `ggplot` with **informative** title and axis labels. (You could be expected to do something like this for your midterm…)

- Suggestion: in a ***relevant*** place in your code, use the data frame `evals` to create a new data frame called `evals_null`
  - `evals_null` should have a variable called `score_shuffle` that represents the shuffled `score`s

`evals` null distribution

$H_0 : \beta_1 = 0$ (there is no linear relationship between `score` and `bty_avg`)

$H_A : \beta_1 > 0$ (there is a positive linear relationship between `score` and `bty_avg`)

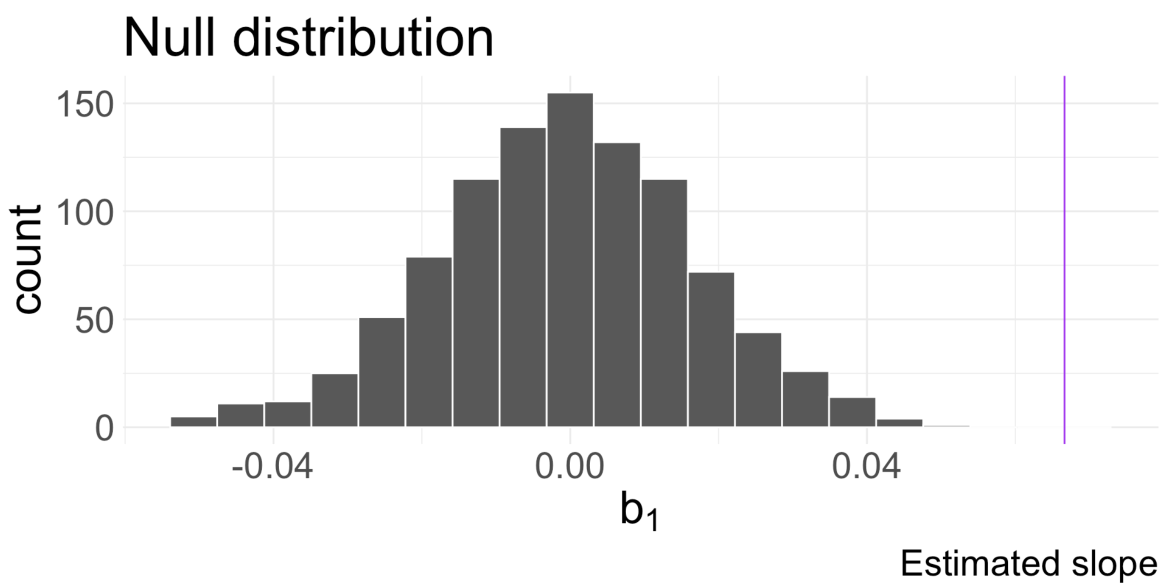


p-value

```r
score_lm <- lm(score ~ bty_avg, data = evals)
tidy(score_lm)
```

term	estimate	std.error	statistic	p.value
(Intercept)	3.880338	0.0761430	50.961213	0.00e+00
bty_avg	0.066637	0.0162912	4.090382	5.08e-05

- Compare our observed fitted $b_{1,obs} = 0.067$ coefficient to null distribution:



- Recall: $H_A : \beta_1 > 0$
- p-value is calculated as $\frac{\text{number of simulated } b_1 > 0.067}{B} = 0$