STA130H1F

Midterm Test Review

Prof. Nathalie Moon

2018-10-22

Today's class

- Debrief of mid-semester questionnaire sent last week
- Information about midterm test
- Practice questions to review (some) ideas for the test

What you should study for the midterm

- NOTE: Today's review will *not cover all* concepts we covered
- All lecture slides
- All weekly practice problems
- Two midterms from Winter 2018 -> your test will be similar
  - However: last year the midterm was later in the term, so there are some questions you can ignore
- Online midterm review quiz (link on course webpage)

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Clarification about content

- You are not responsible for knowing the mathematical note at the end of the Week 4 slides
- You will not be asked to write R code. However, you may be required to read and interpret R code, make small modifications to code, and know the purpose of functions we've used

What to bring to your test

- Your student card
- Pens or pencils
- An aid sheet you've prepared yourself
  - 8.5 x 11 inch page
  - one-sided
  - handwritten
  - *Note*: you will need to submit your aid sheet with your test, so if you want to keep it make a copy in advance
- Don't bring a calculator

What to do when you arrive?

- Put your student card on your desk
- Coat/jackets on back of chair
- On your desk: pens/pencils only!
- See course website for more details about midterm rules / policies

Where and when is the test?

- Friday October 26 during your usual tutorial time, 2pm-4pm (but in different rooms)
- Where to go? Depends on your last name:
  - HS 610: A - Mahendra
  - PB B150: Mai - Z
- You will have 90 minutes to write the test.
- You must be in your test rooms at 2:10 to avoid missing out on time. No extra time will be given for late arrivals

Structure of test

The test is a combination of

- multiple choice
- true / false
- short answer (explain why / apply)
- answer questions that require you to write some sentences

Practice Questions

Question 1

A clinical oncologist is investigating the efficacy of a new treatment on reduction in tumour size. She randomly assigns patients to the new treatment or old treatment and compares the mean of the reduction in tumour size between the two groups. She carries out a statistical test and the P-value is 0.001. How many of the following are valid interpretations of the P-value?

TRUE I. The probability of observing a difference between the treatment groups as large or larger than she observed if the new treatment has the same efficacy as the old treatment.

FALSE II. The probability that both treatments work equally well.

FALSE III. The probability that the new treatment, on average, reduces tumour size more than the old treatment.

A. None

B. One

C. Two

D. Three

→ Type I ; does have effect ; does not

Question 2 → Type II ; does not ; does have effect

Fill in the respective blanks:
Suppose we wish to test the null hypothesis that a Yoga method does not have an effect on blood pressure versus the alternative that it does have an effect. A __ error would be make by concluding that the Yoga method __ on blood pressure if in fact the Yoga method __ on blood pressure.

✓A. Type 2; does not have an effect; does have an effect
B. Type 2; does not have an effect; does not have an effect
C. ~~Type 2~~ Type 1; does have an effect; does not have an effect
D. Type 1; does not have an effect; does have an effect
E. Type 1; does not have an effect; does not have an effect

	H_0 is true	H_0 false
don't reject H_0	✓	Type II error
do reject H_0	Type I error	✓

Question 3

In statistical inference, we want to make conclusions about what we think about the **theoretical world** (a scientific model or population) based on what we've observed in the **real world** (data, typically observed on a random sample).
Do the following items exist in the theoretical world or the real world?

- Statistic → real world
- Parameter → theoretical world
- Null hypothesis (and alternative hypothesis) → theoretical
- Test statistic → real world
- Simulated values of the test statistic under the null hypothesis
- P-value

↳ theoretical world.

↳ both! Related to the test statistic and the simulated values (under H_0)

Hands on activity

Task: Working in pairs, choose a way to randomly generate two outcomes with 50% probability of each outcome. For example:

- fliping a coin
- two pieces of paper (marked), one in each hand, behind your back

This has to be something you can *actually do* right now

Hands on activity: Hypothesis testing

H_0: Your experiment is fair (50-50 chance of each outcome)

H_A: Your experiment is NOT fair

Hands on activity: Hypothesis testing

H_0: Your experiment is fair (50-50 chance of each outcome)

H_A: Your experiment is NOT fair

We can re-write this in more mathematical notation:

H_0: $p = 0.5$

H_A: $p \neq 0.5$

where p is the probability of getting a "success" (ex: getting 'tails')

Hands on activity: Hypothesis testing

Generate data (and record your results).
Example: H, H, H, T, T, H, T, ...

Hands on activity: Hypothesis testing

Generate data (and record your results).
Example: H, H, H, T, T, H, T, ...

What should your test statistic be?

$\hat{p}$ = proportion of "tails" observed.

Calculate it and write it down.

$\hat{p} = 8/20$

Also write down your sample size.

$n = 20$

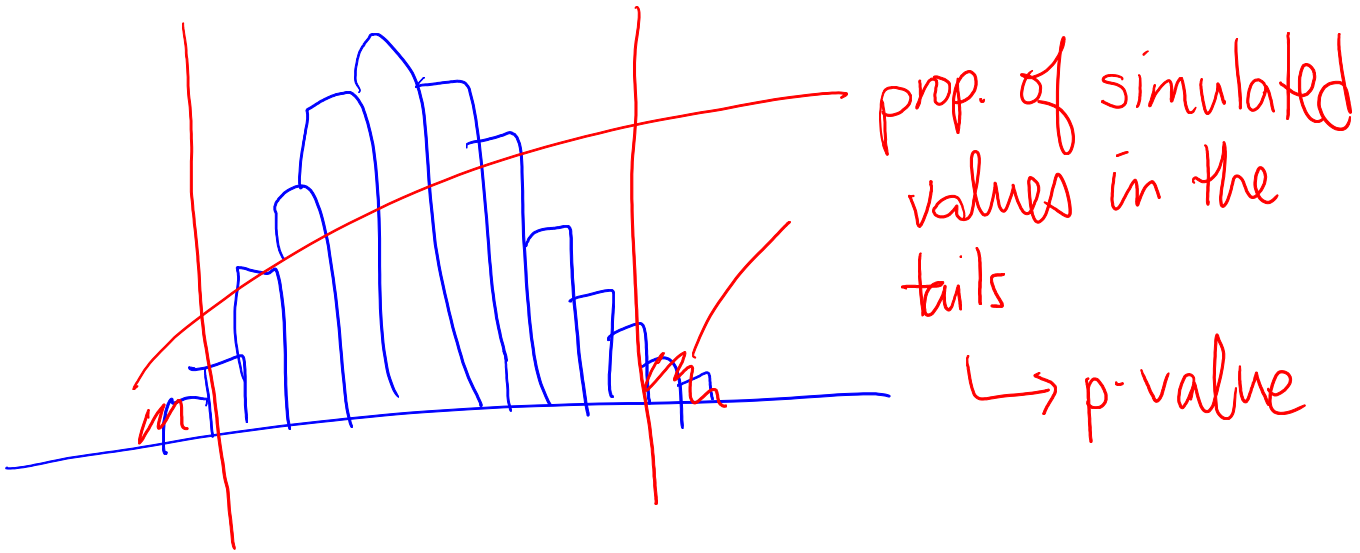
Hands on activity: Hypothesis testing

What's the next step? Let's do it.

Simulate data under H_0 (assuming H_0 true).

Hands on activity: Hypothesis testing

Lets look at a histogram of simulated values and calculate the p-value (your p-values will depend on your test statistic)



Hands on activity: Hypothesis testing

Lets look at a histogram of simulated values and calculate the p-value (your p-values will depend on your test statistic)

Be sure you that in your simulations you use the same sample size as in your actual sample (i.e. how much data did you collect)

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Interpretation of p-value:

Suppose your p-value was 0.26. Summarize the results of the hypothesis test in a paragraph using complete sentences.

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- Our objective here was to determine if our *coin-flipping* experiment was fair, with *50% chance of Heads and 50% chance of Tails*.

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Suppose your p-value was 0.26. Summarize the results of the hypothesis test in a paragraph using complete sentences.

- Our objective here was to determine if our *coin-flipping* experiment was fair, with *50% chance of Heads and 50% chance of Tails*.
- The proportion of *heads* we observed in *n* = 20 coin flips is 8.

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- The proportion of ~~*heads*~~ *tails* we observed in *n* coin flips is _.
- Under the assumption that the experiment was fair (H_0), we simulated ~~1~~ 0,000 samples of *n* (20) coin flips, and for each one calculated the proportion of ~~*heads*~~ *tails*.

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- The proportion of *heads* we observed in *n* coin flips is _.
- Under the assumption that the experiment was fair (H_0), we simulated 1,000 samples of *n* coin flips, and for each one calculated the proportion of *heads*.
- Among these 1,000 simulated proportions, 26% were at least as extreme as our test statistic (p-value = 0.26)

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- The proportion of *heads* we observed in *n* coin flips is _.
- Under the assumption that the experiment was fair (H_0), we simulated 1,000 samples of *n* coin flips, and for each one calculated the proportion of *heads*.
- Among these 1,000 simulated proportions, 26% were at least as extreme as our test statistic (p-value = 0.26)
- Therefore, we have no evidence against the null hypothesis that the *coin-flipping experiment* was fair.

Hands on activity: Hypothesis testing

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- The proportion of *heads* we observed in *n* coin flips is _.
- Under the assumption that the experiment was fair (H_0), we simulated 1,000 samples of *n* coin flips, and for each one calculated the proportion of *heads*.
- Among these 1,000 simulated proportions, 4% were at least as extreme as our test statistic (p-value = 0.04)

Hands on activity: Hypothesis testing

Interpretation of p-value:

Suppose your p-value was 0.04. Summarize the results of the hypothesis test in a paragraph using complete sentences.

- Our objective here was to determine if our *coin-flipping* experiment was fair, with *50% chance of Heads and 50% chance of Tails*.
- The proportion of *heads* we observed in *n* coin flips is _.
- Under the assumption that the experiment was fair (H_0), we simulated 1,000 samples of *n* coin flips, and for each one calculated the proportion of *heads*.
- Among these 1,000 simulated proportions, 4% were at least as extreme as our test statistic (p-value = 0.04)
- Therefore, we have moderate evidence against the null hypothesis that the *coin-flipping experiment* was fair. In other words, the data provide moderate evidence that the *coin-flipping experiment* was not fair. (not 50-50)

Case Study: NC births

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- A sample of 1,000 births from North Carolina in 2004

glimpse(ncbirths)

How many observations? How many variables?

1000 (rows)

13 (columns)

(Partial) review of plotting

We've used these plot geometries:

geom_boxplot geom_histogram geom_bar
geom_point geom_vline

Recall this plot vocabulary:

- Bar plots: modes, frequency
- Histograms / boxplots: centre, spread, modes (unimodal, bimodal, multimodal, no mode), frequency, symmetric / left-skewed / right-skewed, outliers

Case Study Question 1

What kind of variable is "mother's age" (mage)?

numerical

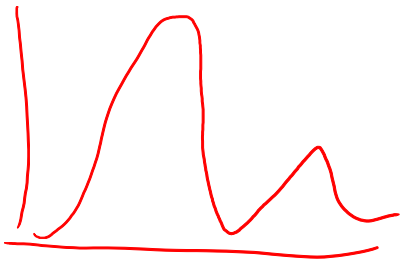
Case Study Question 1

What kind of variable is "mother's age" (mage)?

What kind of plot would you use to examine the distribution of this variable? Which ggplot geometry? histogram (or boxplot)

Case Study Question 1

bimodal

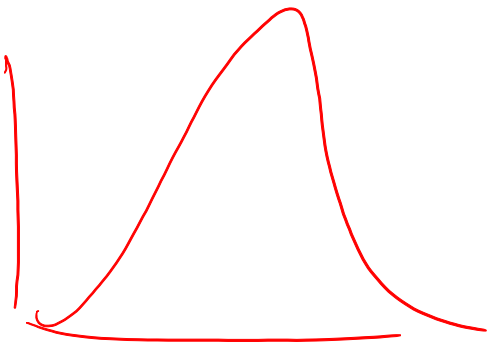


What kind of variable is "mother's age" (mage)?

What kind of plot would you use to examine the distribution of this variable? Which ggplot geometry?

uniform

What words can we use to describe this distribution?



- right skewed
- one mode (unimodal)
- possible outlier? Not clear

Case Study Question 1 (continued)

What kind of variable is "premie"?

categorical (premie and full term)

Case Study Question 1 (continued)

What kind of variable is "premie"?

What kind of plot would you use to examine the distribution of this variable? Which ggplot geometry?

barplot

Case Study Question 1 (continued)

What kind of variable is "premie"?

What kind of plot would you use to examine the distribution of this variable? Which ggplot geometry?

What words can we use to describe this distribution?

- frequency (counts for each)
- mode (full term)

Case Study Question 1 (continued)

What kind of plot would you use to compare the distribution of mother's age for premies vs full-term babies? Which ggplot geometry?

boxplot → one for premies
one for full term

How would you compare these two distribtions?

- medians are similar
- range (or IQR) are similar.
- one outlier in the "full term" group

★ on midterm: answer in full sentences

Case Study Question 2

Let's come up with a two-sample hypothesis test to compare means across two groups!

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What are two groups we could compare?

What do we want to compare across these two groups?

Case Study Question 2 (continued)

First, we write the null and alternative hypotheses:

Case Study Question 2 (continued)

Next, we choose a test statistic and calculate its value:

Case Study Question 2 (continued)

What's next?

Case Study Question 2 (continued)

What's next?

How can we think of doing this (without a computer)?

Case Study Question 2 (continued)

What's next?

How can we think of doing this (without a computer)?

Now we'll use R to do it.

Case Study Question 2 (continued)

What was our p-value?

Conclusion:

Where can you get help as you prepare for your midterm?

- My office hours:
  - Today after class (Oct 22nd)
  - Tuesday 10am-11am (Oct 23d)
- Piazza: Anytime
  - Any questions posted by Thursday (Oct 25th) will be answered.
  - No guarantee that questions posted on the day of the midterm (Oct 26th) will be answered before the midterm
- (EXTRA) TA office hours
  - Wednesday (Oct 24), 2pm-7pm
  - Thursday (Oct 25), 11am-4pm