Agenda

1. HW #4 due on Wednesday (will do 1 problem)
2. Initial Project Proposals due in one week
3. More on hypothesis testing
4. Simulation

Warm-up: Hypothesis Testing for the Mites Our goal for this randomization simulatio was to assess the likelihood that exposure to mites was associated, *to a statistically significant* degree, with a decrease in wilt disease after exposure to Verticillium, a fungus that causes wilt disease.

```
library(mosaic)
tally(outcome ~ treatment, data = Mites)

##          treatment
## outcome   mites no mites
##   no wilt    15        4
##   wilt       11       17

tally(outcome ~ treatment, data = Mites, format = "proportion")

##          treatment
## outcome       mites  no mites
##   no wilt 0.5769231 0.1904762
##   wilt    0.4230769 0.8095238

tbl <- tally(outcome ~ treatment, data = Mites, format = "proportion")
obs_diff_prop <- tbl[2,2] - tbl[2,1]
obs_diff_prop

## [1] 0.3864469
```

```
null_dist <- do(5000) * tally(outcome ~ shuffle(treatment), data = Mites)

null_dist <- null_dist %>%
  mutate(prop_wilt_nomites = wilt.no.mites/(wilt.no.mites+no.wilt.no.mites)) %>%
  mutate(prop_wilt_mites = wilt.mites/(wilt.mites+no.wilt.mites)) %>%
  mutate(diff_prop = prop_wilt_nomites - prop_wilt_mites)

ggplot(data = null_dist, aes(diff_prop)) +
  geom_histogram(bins = 10)
qdata(~diff_prop, p = c(0.025, 0.975), data = null_dist)

##         quantile     p
## 2.5%  -0.3021978 0.025
## 97.5%  0.3003663 0.975

2 * pdata(~diff_prop, q = obs_diff_prop, data = null_dist, lower.tail = FALSE)

## [1] 0.002
```

1. What was the *null hypothesis* for your simulation?
2. What was the *test statistic*?
3. Where did the test statistic lie in the *null distribution*?
4. Did this evidence cause you to *reject* or *fail to reject* the null hypothesis?
5. Write *one* sentence to your grandpa summarizing what you've learned about mites and wilt disease.

What's Wrong? Here are several situations where there is an incorrect application of the ideas presented in this section. Write a short paragraph explaining what is wrong in each situation and why it is wrong.

1. A researcher tests the following null hypothesis: $H_0 : \bar{x} = 23$

2. A study with $\bar{x} = 45$ reports statistical significance for $H_a : \mu > 50$.

3. A researcher tests the hypothesis $H_0 : \mu = 350$ and concludes that the population mean is equal to 350.

4. A test preparation company wants to test that the average score of their students on the ACT is better than the national average score of 21.1. They state their null hypothesis to be $H_0 : \mu > 21.2$.

5. A study summary says that the results are statistically significant and the p-value is 0.98.

Determining hypotheses State the approporiate null hypothesis H_0 and alternative hypothesis H_A in each of the following cases:

1. A 2008 study reported that 88% of students owned a cell phone. You plan to take a simple random sample of students to see if the percentage has changed.

2. Experiments on learning in animals sometimes measure how long it takes a mouse to find its way through a maze. The mean time is 20 seconds for one particular maze. A researcher thinks that playing rap music will affect the time it takes the mice to complete the maze. She measures how long each of 12 mice takes with the rap music as a stimulus.

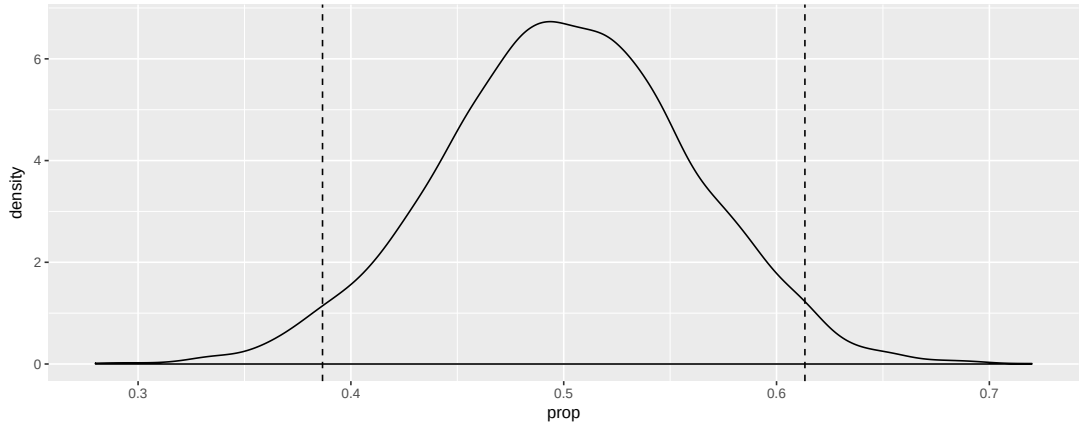
Millenials and Marriage In the national debate on same-sex marriage, it is commonly stated that half of all Americans favor same-sex marriage. In 2014, Pew Research conducted a poll of millenials (Americans born after 1980) and found that 66% answered "yes" when asked: "Do you favor same-sex marriage?" The poll was a random sample of 75 millenials. Does this poll provide convincing evidence that the opinion of millenials is different from those of Americans at large?

1. Write out the *null hypothesis* and the *alternative hypothesis* that are being evaluated, using proper notation.

2. Explain how you could use cards, a coin, or a die to simulate the *null distribution*.

3. What is the value of the observed *test statistic*?

4. In the null distribution below, the dotted vertical lines cut of 2.5% of the distribution in each tail (5% total). Indicate with a solid vertical line the location of the observed test statistic, and shade the area under the curve corresponding to the p-value.



5. The p-value for this test is p = .0064. Using $\alpha = 0.05$, what is your decision regarding the viability of the null hypothesis?

6. Write *one* sentence to your grandpa summarizing what you've learned about the millenials and their opinions on same-sex marriage.

Alcohol Awareness A study of alcohol awareness among college students reported a higher awareness for students enrolled in a health and safety class than for those enrolled in a statistics class. The difference is described as being statistically significant. Explain what this means in simple terms and offer an explanation for why the health and safety students had a higher mean score.

Understanding levels of significance

1. Explain in plain language why a significance test that is significant at the 5% level must always be significant at the 10% level. Draw a picture!

2. You are told that a significance test is significant at the 5% level. From this information can you determine whether or not it is significant at the 1% level.