Hypothesis Testing for Proportions

Motivation

- We have a claim about a population proportion
- We want to test if the claim is true
- Obtain data
- Test the claim
  - Make use of theory from sampling distributions
  - Use the normal distribution to calculate a p-value
  - Determine if there is evidence to support our claim based on our data (using the p-value)

Example *The cracking rate of ingots used in manufacturing airplanes is 20%. A new process is designed to lower the proportion of cracked ingots. In a random sample of 400 newly designed ingots, 16% of them are cracked. Is this evidence that the new process actually lowered the proportion of cracked ingots?*

Hypothesis Testing Procedure: SAMPLE

1.
2.
3.
4.
5.
6.
7.

Step one: (S)tate your Null and Alternative Hypotheses

- Null Hypothesis H_o
  -
  -
- Alternative Hypothesis H_a
  -
  -

So for example if I were to write up hypotheses for our ingots example:

Step Two: Check (A)ssumptions

1.

2.

3.

Step Three: Determing the Sampling Distribution (M)odel

Recall: the ________________________________ for the sample proportion $\hat{p}$ describes the behaviour of the sample proportion in repeated samplings from the population. Under the assumption of the null hypothesis:

Step Four: Calculate a Test Statistic

Definition: The ________________________________ is the value used to test whether or not the null hypothesis is true.

Step Five: Find a (p)-value

Definition: The ________________________________ is the probability of getting a test statistic equal to or more extreme than the observed value IF THE NULL HYPOTHESIS IS TRUE.

- $H_a : p < p_o$

- $H_a : p > p_o$

- $H_a : p \neq p_o$

Step Six: (L)ist your Decision

Small p-value

-
-
-

Large p-value

-
-
-
-

P-value	Evidence (against Ho)
Greater than .10	Little to no evidence
Between .05 and .10	Weak evidence
Between .01 and .05	Moderate Evidence
Less than .01	Strong evidence

A word about p-values

Throughout Hypothesis testing, there has typically always been a decision step. This step included a hard cutoff, called a significance level or α level. The value for this level was traditionally $\alpha = .05$. A hypothesis test would be done, and if your p-value was below this level, you would "reject" the Null Hypothesis.

In recent years, the American Statistical Association has come out against this type of decision making in favor of a strength of evidence approach. The idea is that we shouldn't restrict ourselves to these hard cutoffs as different problems may require more evidence than others. They want to get away from the idea that if your p-value is below some cutoff, then "magically" your result is important. We should always stop and think about what our results mean. There has been a push in the Statistical education world to adopt a different approach going forward. Ultimately we are making some kind of decision (see the next slide), but trying to avoid these direct reject or don't reject type of statements.

This new approach is probably different than you may have seen and what is still being used. We are trying this new idea for the first time to begin acclimating students to the approach that the Statistics world is trying to move towards.

Step Seven: Conclusion/(E)xplain

After making a decision based on our p-value and test statistic, we need to make a conclusion in a meaningful way.

Your conclusions should include:

-
-
-

Example *According to Consumer Reports, 60% of all U.S. adults like creamy peanut butter. To investigate this claim, a recent survey polled 675 randomly selected Americans and found that 374 liked creamy peanut butter. Is this evidence that the proportion of all U.S. adults who like creamy peanut butter is less than 60%? (use $\alpha = 0.05$).*

State your Null and Alternative Hypotheses:

Check Assumptions

Determine the sampling Distribution

Calculate a test statistic

Find a p-value

List your Decision

State you Conclusion

Example *A magazine is considering the launch of an online edition. The magazine plans to go ahead only if it's convinced that more than 25% of current readers would subscribe. The magazine contacts a simple random sample of 500 current subscribers, and 137 of those surveyed expressed interest. Should the company launch the online edition?*

Example *In 1996, 34% of all students K-12 in the U.S. had not been absent from school even once during the previous month. Researchers are interested in whether or not there is statistical evidence of a change in student attendance? In the 2000 survey, responses from 8302 randomly selected students showed that this figure has slipped to 33%. Perform a hypothesis test to answer this question.*

Example *According to the Association of American Medical Colleges, only 46% of medical school applicants were admitted to a medical school in fall of 2006. Upon hearing this, the trustees of City College expressed concern that only 77 of 180 students in their class of 2006 who applied to medical school were admitted. Should the trustees of City College be concerned that the acceptance rate for their students applying to medical school is significantly less than the national average?*

Perform a hypothesis test to answer this question.

Example *A random sample of 1000 U.S. adults were asked which soft drink they preferred, Pepsi or Coke. 528 people said they preferred Coke. Is this enough evidence to state that the population of U.S. adults have a preference between Coke and Pepsi?*