



Chapter 21 – More About Tests

Gallup Poll: Legalize Marijuana?

- <http://www.gallup.com/poll/144086/New-High-Americans-Support-Legalizing-Marijuana.aspx>
- Results for this Gallup poll are based on telephone interviews conducted Oct. 7-10, 2010, with a random sample of 1,025 adults, aged 18 and older, living in the continental U.S., selected using random-digit-dial sampling.
- Can we conclude that more people today said "legal" compared to 36% in 2006?

Support for Making Use of Marijuana Legal

Do you think the use of marijuana should be made legal, or not?



GALLUP

Review: Steps of a Hypothesis Test

- The hypotheses
 - H_0, H_A
 - Name the test
- The model
 - Check conditions
 - Fit the model, assuming H_0
 - $N(\quad, \quad)$
 - Draw the model
- Mechanics
 - Label information from the problem
 - Include the information on the model drawing; shade the appropriate tails.
 - Calculate the test statistic and p-value
- Conclusions
 - Statistical conclusion
 - Experimental conclusion

Determining H_0 and H_A

- The **null hypothesis** takes the form $H_0: \text{parameter} = \#$.
- The **alternative hypothesis** can be one- or two-sided.
 - One-sided: $<, >$
 - Two-sided: \neq
- For the following statements, set up the null and alternative hypotheses
 - Can we conclude that more people today said "legal" compared to 36% in 2006?
 - A researcher claims that the proportion who say "legal" has not changed from its value of 34% in 2000.
 - A researcher thinks that the proportion who say "not legal" is at most 50%.

P-values and Significance

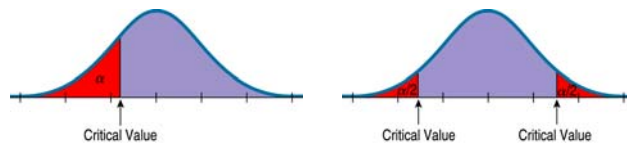
- The **p-value** is the probability of getting sample results at least as unusual as the observed statistic, given that the null hypothesis is true.
 - The lower the p-value, the more comfortable we are about rejecting the null hypothesis.
- If the p-value is LOW, reject H_0 .
- A given (arbitrary) threshold for the p-value is known as a **significance level**, or **alpha level**.
 - Denoted α .
 - Usually 0.05, 0.01, or 0.10.
 - When we reject the null hypothesis, we say that the test is “significant at that level”.
- When might we be okay with a higher significance level? When might we prefer a lower one?

High P-values

- Sometimes, you can stop the test before you even calculate the test statistic/p-value... Always draw a picture!
- Consider the Gallup Poll... $n = 1025$, 46% said legalize.
 1. Is there evidence to suggest more than 50% of all national adults say “legalize”?
 2. Is there evidence to say exactly 44% of all national adults say “legalize”?

Critical Values

- Before technology, people relied on tables filled with **critical values**, cutoffs on the z-axis that marked out an area of α .



- What would be the critical value when $\alpha = 0.05$ for
 1. A left-sided test?
 2. A right-sided test?
 3. A two-sided test?

Test and Confidence Intervals

- The outcome of the test is to we reject/fail to reject H_0 . But by how much? ... Construct a confidence interval.
 - Two-sided test at $\alpha \leftrightarrow (100 - \alpha)\%$ Confidence Level
 - One-sided test at $\alpha \leftrightarrow (100 - 2\alpha)\%$ Confidence Level
- Gallup Poll... $n = 1025$, 46% said legalize. Construct the appropriate confidence interval...
 1. Can we conclude that more people today said “legal” compared to 36% in 2006?
 2. A researcher claims that the proportion who say “legal” has not changed from it’s value of 34% in 2000.

Errors in Tests

		The Truth	
		H_0 True	H_0 False
My Decision	Reject H_0	Type I Error	OK
	Retain H_0	OK	Type II Error

- $P(\text{type I error}) = \alpha$
= $P(\text{Reject } H_0 \mid H_0 \text{ true})$
- $P(\text{type II error}) = \beta$
= $P(\text{Retain } H_0 \mid H_0 \text{ false})$
- Consider a jury trial. Truth is actual innocence/guilt. Decision is made by a jury.
 - What is a type I error? What is a type II error?

Power and Reducing Error

- The **power** of the test is the probability we correctly reject the null.
- The higher the power, the better... sort of...
- How can we reduce both kinds of error?

Exploring Power

- <http://www.intutor.com/statistics/CurveApplet.html>
- Observations...
 - Adjust α
 - As probability of Type I error decreases, the probability of a type II error increases
 - Adjust Position of H_A
 - Move close to H_0
 - Far from H_0
 - Adjust Sample Size
 - Even when H_A and H_0 are really close, we can still increase power

Practical vs. Statistical Significance

- As the sample size increases, we have more power to reject a false H_0 even though the difference may not seem substantial.
 - **Statistical Significance**
 - Proof of difference through a hypothesis test/ confidence interval
 - **Practical significance**
 - Small differences can be statistically significant, while not large enough to have any functional value
- Allergy Medicine Example:
 - When taking a certain allergy medicine, 25% of patients experienced headache as a side effect. Of those receiving the placebo, 22% experienced headaches as a side effect.
 - This difference was found to be statistically significant, but...

One More Example: Market Share

- The board of directors for Procter and Gamble is concerned that only 19.5% of the people who use toothpaste buy Crest toothpaste.
 - A marketing director suggests that the company invest in a new marketing campaign which will include advertisements and new labeling for the toothpaste.
 - The research department conducts product trials in test markets for one month to determine if the market share increases with new labels.
1. Write the company's null and alternative hypotheses.
 2. In this context, describe a Type I error and the impact such an error would have on the company.
 3. In this context, describe a Type II error and the impact such an error would have on the company.

Market Share (Continued)

4. Based on the data they collected during the trial the research department found that a 98% confidence interval for the proportion of all consumers who might buy Crest toothpaste was (16%, 28%). What conclusion should the company reach about the new marketing campaign?
5. What level of significance did the research department use?
6. Describe an advantage and a disadvantage of using a 5% alpha level of significance instead.

Market Share (Continued)

7. The board of directors asked the research department to extend the trial period so the decision can be made on two months worth of data. Will the power increase, decrease, or remain the same?
8. Over the trial month the market share rose to 22% of shoppers. The company's board decided that this increase was significant. Now that they have decided the new marketing campaign works, why might they still chose not to invest in the campaign?

Class Work

- To get credit, it is your responsibility to get checked off.
 1. Chapter 21 Handout
 - Checking solutions? No pens in the front!

Homework

- Textbook/Routine Homework
 - Due Next Week (25% chance of collection)
 1. Read Chapter 21
 2. Pg 552-556: #1, 3, 5, 7, 9, 13, 15, 19, 21, 23

Project

- Project 2 Analysis and Teammate Evaluation Due Next Time!