Lecture 23--Wed, Dec 1, 2010

Announcements

Sunday Stats is Dec 5th, 3 to 4:30 pm.
Note: we won't cover section 9.7; pages 381-3
Get your Official Crib Sheet this Friday in DS.
Quiz 7a, 7b, is up. Quiz 8 on Hypo Test up soon
Bonus Review Quiz 9 will go up next week covering the entire course. I drop your lowest of the 9 quizzes; so this Quiz 9 is optional but it cannot hurt you and will help you review the course—good to see if you are ready for the Final Exam—but it is timed and only three attempts per IU [not each question]!

Your Personal Cheat Sheet

1 DIS SEC: 1;HAIJIANG STUDENT

RES EC 212 OFFICIAL CRIB SHEET–MUST BE PICKED

YOU MAY WRITE ANYTHING YOU WISH ON THIS SHEET, BUT YOU MUST
NOR ANY CUTTING AND PASTING. YOU MAY WRITE ON THE FRONT AN
ADD MORE SHEETS. YOU CANNOT PHOTOCOPY ANOTHER PERSON'S C
THESE RULES, I WILL TAKE IT FROM YOU BEFORE THE FINAL BEGINS.
TABLES AT THE EXAM WHETHER YOU PREPARE THIS CRIB SHEET OR N
TABLES THAT WILL BE USED AT THE FINAL EXAM ON OUR WEB SITE BI
At the Final Exam in Totman Gym: You will sit in alphabetical ord
the # at top left of this page. Your photo id is needed to take the fin

With any Hypothesis Test, there are:

- Two Ways to be Correct
- and two ways to be Wrong
- And each of these 4 outcomes has an associated probability

Only 4 outcomes can happen

		State of Nature: Null Hypothesis is	
	You decide:	True	False
Your mere mortal decision, based on limited data	Null True (Don't reject H_0)	**Correct Prob = 1-α confidence level**	**Type II Error Prob = β**
	Null False (Reject H_0)	**Type I Error Prob = α significance level**	**Correct Prob = 1- β Power of the test**

α and β are inversely related

↓ **α** and ↑ **β**

Thus, if you merely try to reduce one type of error,

you increase the probability of making the other one for any given n (sample size)

But:

- You, the researcher, get to pick the significance level, **α**
- So think about how serious a type I error is relative to a type II error
- And use the inverse relationship to your advantage

The Only Way to get both **α** and **β** to go down:

INCREASE n; your sample size

Get more information to insure more accurate decisions!

But once have new n:

α and **β** are inversely related

H_o : Parachute will Open

You decide:	State of Nature is that H_o is True -- OPEN	Parachute will H_o is False –Not Open
Fail to reject H_o		
Reject H_o		

We focus more on the prob of Type I Error; rejecting H_o when it is actually true. That probability is **α**, the significance level.

Most frequently used values for **α** are:

.01 and .05 and .10

The probability of a Type I Error is **α**, the significance level.

If **α** =.01 — 1% significance level → you'll reject an actually true H_o one out of every 100 decisions.

α = .05 — 5% — 1 out of 20.

α = .10 — 10% — 1 out of 10.

NASA Challenger Disaster

H_o: launch will be safe

H_a: launch will NOT BE safe

What should alpha and beta be? Which one should be pushed lower, allowing the other to get bigger?

Decide	State of Nature: H_o is really: T (Safe)	F (Not Safe)	
Fail to Reject H_o → T	C p=(1 - α)	E, Type 2 p = β	→ Kill 7 astronauts
Reject H_o H_o → F	E, Type 1 p = α	C p=(1 - β) delay launch	

With this error you merely piss off some folks in RVs ready to see the show!

Court Room Example
State the Null and Alternative Hypotheses

H_o: Peterson is innocent

H_a: He murdered her & baby

Which do your prefer?

1. decrease α and let β increase
2. increase α and let β decrease
3. We are talking about life and death and I cannot decide what to do.

Thus only 4 outcomes can happen

		State of Nature: Null Hypothesis is	
	Jury decides:	True innocent	False guilty
Jury's decision, based on limited data	Null True (Don't reject H_0) NOT guilty	**Correct Prob = 1- α confidence level**	**Type II Error Prob = β**
	Null False (Reject H_0) Guilty	**Type I Error Prob = α significance level**	**Correct Prob = 1- β Power of the test**

Witness Clears Man Executed In Texas for 1985 Slaying

- Associated Press
  Tuesday, November 22, 2005; A02
- HOUSTON -- A decade after Ruben Cantu was executed for capital murder he was cleared of the murder.
- Which error was made: Type 1 or 2?

http://www.washingtonpost.com/wp-dyn/content/article/2005/11/21/AR2005112101384.html?referrer=email&referrer=email

Pretzel machine example.

A snack food company produces a 454 gram (one pound) bag of pretzels.
Important that mean net weight, μ, of the bags is kept at 454 grams.

QA department tests whether the true mean weight, μ, being packaged is 454 grams.
We know that these weights are ND
And we know σ = 7.8 grams!

State the Null and Alternative Hypotheses

H_o: μ = 454 g machine is OK

H_a: μ ≠ 454 g machine is out-of-whack

Test at the 10% significance level

What is the correct value for the test statistic, Z; [absolute value]? Recall 10% significance level, σ=7.8 g
Round answer to three decimal places.

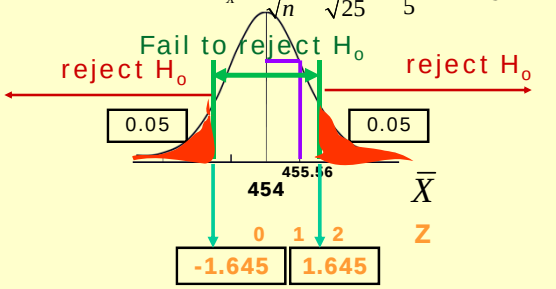
Step 3: **Three substeps:**

1. Z is the test statistic, why? Because σ is known
2. α = 0.10
3. Draw a picture of the decision rule

Pretzels in a bag

The Decision Rule:

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{7.8}{\sqrt{25}} = \frac{7.8}{5} = 1.56 grams$$



Step 4: Wt in grams for 25 random bags; sum of x = 11,250

465	456	438	454	447
449	442	449	446	447
468	433	454	463	450
446	447	456	452	444
447	456	456	435	450

Step 4: Use your sample data to find the value of the test statistic

From the sample data, find the sample mean.

$$\bar{X} = \frac{\sum x}{n} = \frac{11,250}{25} = 450 \ grams$$

Is that close enough?

Step 4: find the value of the test statistic

Calculate your value of the test statistic z, b/c we know σ

$$Z = \frac{\bar{X} - \mu_{\bar{X}}}{\sigma_{\bar{X}}} = \frac{450 - 454}{\frac{7.8}{\sqrt{25}}} = -2.56*$$

Step 5. Compare to critical Z

Step 5. Decide

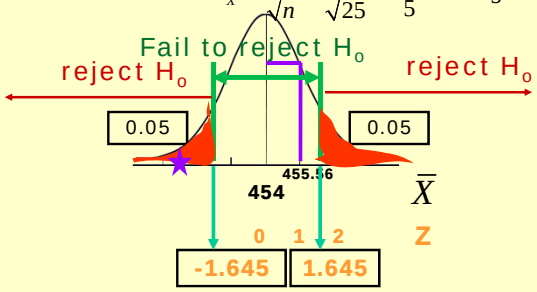
$$z^* < -z_{.05}$$

Clearly falls in the Reject H_o zone

Pretzels in a bag

The Decision Rule:

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{7.8}{\sqrt{25}} = \frac{7.8}{5} = 1.56 grams$$



Step 6. Conclusion in words

At the 10% significance level, we have sufficient evidence to conclude that the packing machine needs adjusting b/c it is not putting an average [mean amount] of 454 g in the bags.

p-Value approach

- p-value: Probability of obtaining a test statistic more extreme than the observed sample value given H_0 is true
  - Also called observed level of significance
  - Smallest value of α for which H_0 can be rejected

p-Value Approach

- Convert Sample Statistic (e.g. x-bar) to your value of the Test Statistic (*Z or t* statistic)
- Obtain the p-value from a table or computer
- Compare the p-value with α
  - If p-value $< \alpha$, reject H_0
  - If p-value $\geq \alpha$, do not reject H_0
    - Recall tie goes to the null

Step 4: p-value method

Calculate your value of the test statistic z, b/c we know σ

$$Z = \frac{\bar{X} - \mu_{\bar{X}}}{\sigma_{\bar{X}}} = \frac{450 - 454}{\frac{7.8}{\sqrt{25}}} = -2.56^*$$

Area to the left of -2.56 is .0052 [z-table]

2*.0052 < α thus we reject H_o

We multiplied by 2 because 2-tailed test

Hypothesis Tests for Proportions

Steps:

1. H_o: π = a number between 0 and 1
2. H_a: π > or < or ≠ same number
3. 3 sub-steps to form decision rule
4. Use sample data
5. Decide
6. Conclusion

Test Statistic for Proportions

$$z = \frac{p - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

where:

p = Sample proportion

π_0 = Hypothesized population proportion

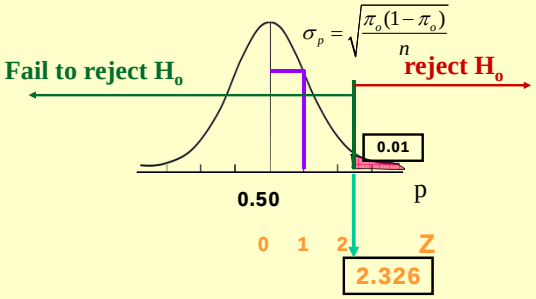
n = Sample size

Does a majority of American Adults now disapprove of Obama's job as President?

1. Ho: π =.50 [or less, since not a majority]
2. Ha: π >.50 [a majority disapprove]
3. Test criterion:
   1. Test statistic; only Z for proportions (large n)
   2. Significance level, α = 0.01 Why not .10?
   3. Determine decision rule. Picture of the rule:

The decision rule:

Under H_o is True



Step 4:bring in the sample data:

4. Get value of test statistic from your sample data.
   1) Calculate the sample's descriptive statistics

$$p = \frac{781}{1533} = 0.51$$

Step 4 continued

4. Get value of test statistic from your sample data.
   2) Calculate the value of the test statistic

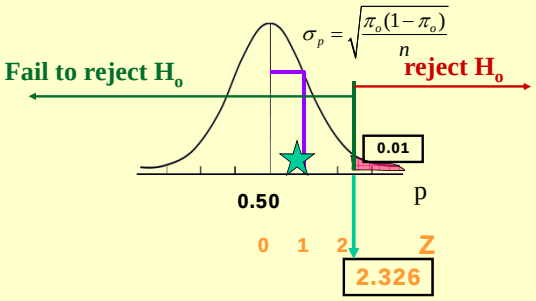
$$z = \frac{p - \pi_o}{\sqrt{\frac{\pi_o(1-\pi_o)}{n}}} = \frac{.51-.50}{\sqrt{\frac{.5(.5)}{1533}}} = \frac{.01}{.0128} = 0.78*$$

Decision:

5. Make decision: Compare value of the test statistic found in Step 4 to the test criterion of Step 3.
   1. Fail to Reject Ho in favor of Ha
   2. Why? b/c $Z^* < Z_{.01}$

The decision rule:

Under H_o is True



Conclusion:

6. There is insufficient evidence, **at the 1% significance level**, to conclude that a **majority** [more than 50%] of American Adults now disapprove of the job President Obama is doing.

Step 4: p-value method

Calculate your value of the test statistic z, b/c large n for proportions

$$z = \frac{p - \pi_o}{\sqrt{\frac{\pi_o(1-\pi_o)}{n}}} = \frac{.51-.50}{\sqrt{\frac{.5(.5)}{1533}}} = \frac{.01}{.0128} = 0.78^*$$

Area to the right of 0.78 is .2177 [z-table]

.2177 ≥ α thus we fail to reject H_o

We do NOT multiply by 2 because it is 1-tailed test

Are you a vegetarian?

Yes - 1

No - 2

Some people believe that as much as 10% of Americans are vegetarians. Others doubt it is that high.
Thus some think it is larger than 10% others less than 10%.

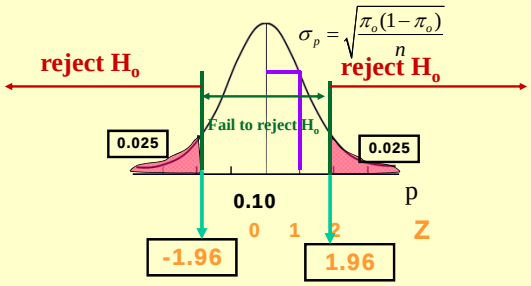
Suppose I take a random sample of 200 Americans and ask if they are vegetarians and 16 say they are vegetarians.

Do the data allow you to conclude that 10% of Americans are not vegetarians.

1. Ho: π = .10
2. Ha: π ≠ .10
3. Test criterion:
   1. Test statistic; only Z for proportions (large n)
   2. Significance level, α = 0.05 Given.
   3. Determine decision rule. Picture of the rule:

The decision rule:

Under H_o is True



bring in the sample data:

4. Get value of test statistic from your sample data.
   1. Calculate the sample's descriptive statistics

$$p = \frac{16}{200} = 0.08$$

From the sample data:

4. Get value of test statistic from your sample data.
   - Calculate the value of the test statistic
   - Round answer to two decimal places and include the sign!

After first 3 steps, bring in the sample data:

4. Get value of test statistic from your sample data.
   2. Calculate the value of the test statistic

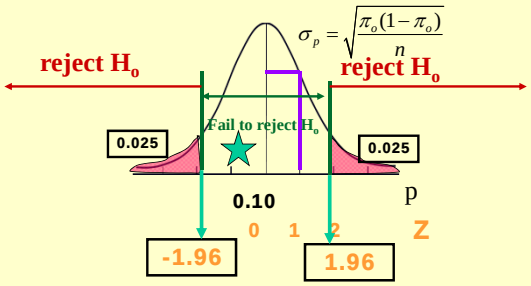
$$z = \frac{p-\pi_o}{\sqrt{\frac{\pi_o(1-\pi_o)}{n}}} = \frac{.08-.10}{\sqrt{\frac{.1(.9)}{200}}} = \frac{-.02}{.021} = -.95^*$$

Decision:

5. Make decision: Compare value of the test statistic found in Step 4 to the test criterion of Step 3.
   1. Fail to Reject Ho in favor of Ha

The decision rule:

Under H_o is True



Conclusion:

6. There is not sufficient evidence, **at the 5% significance level**, to conclude that the true proportion of Americans that are vegetarians is not .10 [or 10%].

Step 4: p-value method

Calculate your value of the test statistic z, b/c we large n for proportions

$$z = \frac{p - \pi_o}{\sqrt{\frac{\pi_o(1-\pi_o)}{n}}} = \frac{.08 - .10}{\sqrt{\frac{.1(.9)}{200}}} = \frac{-.02}{.021} = -.95^*$$

Area to the left of -.95 is .1711 [z-table]

2*.1711 ≥ α thus we fail to reject H_o

We multiply by 2 because it is a 2-tailed test