*YOUR TA’S NAME*:

*Lecture Worksheet*

*Thursday 10/15/2020*

**MAIN POINTS OF LECTURE**

1. When we conduct hypothesis testing (or significance testing) we use sample data to test particular claims about the value of a population parameter
2. AFTER THE BREAK: Hypothesis tests for means, differences in proportions, and differences in means
3. **We always operate under the assumption that the null hypothesis is true in the population**
4. “Rejecting” and “failing to reject” the null are the only possible outcomes of a hypothesis test
5. Hypothesis testing involves six steps:
6. State the null (H0) and alternative (H1) hypotheses
7. Check that the sample data conform to basic assumptions; if they do not, then do not go any further.
8. Choose an  probability level … that is, a probability associated with incorrectly rejecting the null hypothesis
9. Determine the “critical value” … that is, how large the test statistic must be in order to reject the null hypothesis at the given a level … it can be helpful to re-write the hypotheses in terms of the critical values. (For hypothesis tests about proportions: These will be Z values. For hypothesis tests about means, these will be t values)
10. Calculate the test statistic:

For hypothesis tests about proportions: $Z=\frac{\hat{p}-p\_{0}}{\sqrt{\frac{p\_{0}(1-p\_{0})}{N}}}$

For hypothesis tests about means: $t=\frac{\overline{Y}-μ\_{Y}}{{s\_{Y}}/{\sqrt{N}}}$

For hypothesis tests about differences in proportions: $Z=\frac{\hat{p}\_{1}-\hat{p}\_{2}-0}{\sqrt{\frac{\hat{p}(1-\hat{p})}{N\_{1}}+\frac{\hat{p}(1-\hat{p})}{N\_{2}}}}$

For hypothesis tests about differences in means: $t=\frac{\overline{Y}\_{1}-\overline{Y}\_{2}-0}{\sqrt{\frac{s\_{1}^{2}}{N\_{1}}+\frac{s\_{2}^{2}}{N\_{2}}}}$

1. Compare the test statistic to the critical value
	* If the test statistic is as large or larger than the critical value, then reject H0 (with probability of a of doing so even though H0 should not actually be rejected)
	* If the test statistic is less than the critical value, then do not reject H0 (with probability of b of doing so even though H0 should be rejected)

**QUESTIONS**

1. [From the recorded lecture] Does the average undergraduate student bring more than $40 to class? Using data from a survey conducted on the first day of my undergraduate research methods class, I found that the mean amount of money that the 75 students had on them was $43 with a standard deviation of $78. (Assume for now that students in my class represent a random sample of all undergraduate students.) Test the hypothesis that the average student brings more than $40 to class. Use =0.05.

Hypotheses: H0: ≤40 H1: >40

Assumptions: n>30

Confidence Level: a=0.05

Critical Value: 1.664 (Reject H0 if t > 1.664)

Test Statistic: $t=\frac{\bar{Y}-μ}{{s}/{\sqrt{n}}}=\frac{43-40}{78/\sqrt{75}}=\frac{3}{9.01}=0.333$

Conclusion: Fail to Reject H0

1. [From the recorded lecture] Did high school age boys’ condom use during last intercourse increase between 2009 and 2014? From the 2009 Youth Risk Behavior Survey, I found that 69% of high school age boys used a condom (n = 2,640). From the 2014 National Survey of Sexual Health and Behavior I found that 79% of high school age boys used a condom (n = 57). Test this hypothesis using =0.05.

Hypotheses: H0: p2014≤p2009 H1: p2014>p2009

Assumptions: 2,640(.69), 2,640(0.31), 57(0.79), and 57(0.21) all > 10 (but barely)

Confidence Level: a=0.05

Critical Value: 1.64 (Reject H0 if Z > 1.64)

Test Statistic:

$$\hat{p}=\frac{n\_{2009}\hat{p}\_{2009}+n\_{2014}\hat{p}\_{2014}}{n\_{2009}+n\_{2014}}=\frac{(2640)(0.69)+(57)(0.79)}{2640+57}=\frac{1866.63}{2697}=0.692$$

$$Z=\frac{\hat{p}\_{2014}-\hat{p}\_{2009}}{\sqrt{\frac{\hat{p}(1-\hat{p})}{n\_{2009}}+\frac{\hat{p}(1-\hat{p})}{n\_{2014}}}}=\frac{0.79-0.69}{\sqrt{\frac{0.692(0.308)}{2640}+\frac{0.692(0.308)}{57}}}=\frac{.1}{0.062}=1.613$$

Conclusion: Fail to Reject H0

1. [From the recorded lecture] Do men and women tend to bring the same amount of money to class? Using data from a survey conducted on the first day of my undergraduate research methods class, which included 21 men and 54 women, I found that men brought an average of $38 with a standard deviation of $59, while women brought an average of $45 with a standard deviation of $85. (Assume for now that students in my class represent a random sample of all undergraduate students.) Use =0.05 to test this hypothesis.

Hypotheses: H0: M=F H1: M≠F

Assumptions: Have to assume normal distribution…

Confidence Level: a=0.05

Critical Value: 2.086 (Reject H0 if |t| > 2.086)

Test Statistic: $t=\frac{\bar{x}\_{M}-\bar{x}\_{F}-0}{\sqrt{\frac{s\_{M}^{2}}{n\_{M}}+\frac{s\_{F}^{2}}{n\_{F}}}}=\frac{38-45-0}{\sqrt{\frac{59^{2}}{21}+\frac{85^{2}}{54}}}=\frac{-7}{17.31}=-.404$

Conclusion: Fail to Reject H0

1. [From the synchronous session] Were Minnesota kids more likely to be in families that received food stamps in 2010 than in 2007? Data from the 2007 and 2010 American Community Surveys show: **2007**: 7.1% of 13,511 sampled MN kids in such families. **2010**: 11.7% of 12,832 sampled MN kids in such families.
	1. Construct a 99% confidence interval for the difference in proportions between these two years

99% CI = $\hat{p}\_{2010}-\hat{p}\_{2007}\pm 2.57×\sqrt{\frac{\hat{p}(1-\hat{p})}{n\_{2007}}+\frac{\hat{p}(1-\hat{p})}{n\_{2010}}}$

$$\hat{p}=\frac{n\_{2007}\hat{p}\_{2007}+n\_{2010}\hat{p}\_{2010}}{n\_{2007}+n\_{2010}}=\frac{(13511)(0.071)+(12832)(0.117)}{13511+12832}=\frac{2460.625}{26343}=0.093$$

99% CI = $0.117-0.071\pm 2.57×\sqrt{\frac{0.093(0.907)}{13511}+\frac{0.093(0.907)}{12832}}$

99% CI = $0.117-0.071\pm 2.57×0.00358$

99% CI = $0.046\pm 0.0092$ … so, 0.0368 to 0.0552

* 1. Test the hypothesis that there was no difference between the two years in the rate of food stamp receipt. Use an  of 0.01.

Hypotheses: H0: p2007=p2010 H1: p2007≠p2010

Assumptions: All met

Confidence Level: a=0.01

Critical Value: 2.57 (Reject H0 if |Z| > 2.57)

Test Statistic:

$$\hat{p}=\frac{n\_{2007}\hat{p}\_{2007}+n\_{2010}\hat{p}\_{2010}}{n\_{2007}+n\_{2010}}=\frac{(13511)(0.071)+(12832)(0.117)}{13511+12832}=\frac{2460.625}{26343}=0.093$$

$$Z=\frac{\hat{p}\_{2010}-\hat{p}\_{2007}}{\sqrt{\frac{\hat{p}(1-\hat{p})}{n\_{2007}}+\frac{\hat{p}(1-\hat{p})}{n\_{2010}}}}=\frac{0.117-0.071}{\sqrt{\frac{0.093(0.907)}{13511}+\frac{0.093(0.907)}{12832}}}=\frac{0.046}{0.00358}=12.85$$

Conclusion: Reject H0