Math 160 – Quiz 10
Due Thursday, May 2nd

Name Key

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Express the null hypothesis and the alternative hypothesis in symbolic form. Use the correct symbol (μ, p, σ) for the indicated parameter.

1) An entomologist writes an article in a scientific journal which claims that fewer than 14 in ten thousand male fireflies are unable to produce light due to a genetic mutation. Use the parameter p, the true proportion of fireflies unable to produce light. 1) B

A) H_0: $p = 0.0014$ H_1: $p > 0.0014$
B) H_0: $p \geq 0.0014$ H_1: $p < 0.0014$
C) H_0: $p > 0.0014$ H_1: $p \leq 0.0014$
D) H_0: $p < 0.0014$ H_1: $p \geq 0.0014$

Assume that the data has a normal distribution and the number of observations is greater than fifty. Find the critical z value used to test a null hypothesis.

2) $\alpha = 0.05$ for a two-tailed test. 2) D
A) ±1.645 B) ±2.575 C) ±1.764 D) ±1.96

3) $\alpha = 0.09$ for a right-tailed test. 3) C
A) ±1.34 B) 1.96 C) 1.34 D) ±1.96

4) $\alpha = 0.05$ for a left-tailed test. 4) B
A) −1.96 B) −1.645 C) ±1.96 D) ±1.645

Use the given information to find the P-value. Also, use a 0.05 significance level and state the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

5) The test statistic in a right-tailed test is $z = 0.52$. 5) D
A) 0.0195; reject the null hypothesis
B) 0.6030; fail to reject the null hypothesis
C) 0.3015; reject the null hypothesis
D) 0.3015; fail to reject the null hypothesis

Formulate the indicated conclusion in nontechnical terms. Be sure to address the original claim.

6) An entomologist writes an article in a scientific journal which claims that fewer than 4 in ten thousand male fireflies are unable to produce light due to a genetic mutation. Assuming that a hypothesis test of the claim has been conducted and that the conclusion is to reject the null hypothesis, state the conclusion in nontechnical terms. 6) C

A) There is not sufficient evidence to support the claim that the true proportion is less than 4 in ten thousand.
B) There is sufficient evidence to support the claim that the true proportion is greater than 4 in ten thousand.
C) There is sufficient evidence to support the claim that the true proportion is less than 4 in ten thousand.
D) There is not sufficient evidence to support the claim that the true proportion is greater than 4 in ten thousand.

Claim $p < 0.0014$

H_0: $p \geq 0.0014$ (reject this)

H_1: $p < 0.0014$ (claim)

Assume that a hypothesis test of the given claim will be conducted. Identify the type I or type II error for the test.

7) A psychologist claims that more than 7.1% of adults suffer from extreme shyness. Identify the type II error for the test. 7) A

(A) Fail to reject the statement that the percentage of adults who suffer from extreme shyness is less than or equal to 7.1% when that percentage is actually greater than 7.1%.

B) Reject the statement that the percentage of adults who suffer from extreme shyness is less than or equal to 7.1% when that percentage is actually 7.1%.

C) Reject the statement that the percentage of adults who suffer from extreme shyness is less than or equal to 7.1% when that percentage is actually greater than than 7.1%.

D) Fail to reject the claim that the percentage of adults who suffer from extreme shyness is greater than or equal to 7.1% when that percentage is actually less than 7.1%.

8) A skeptical paranormal researcher claims that the proportion of Americans that have seen a UFO is less than 4 in a thousand. Identify the type I error for the test. 8) A

(A) Reject the statement that the proportion of Americans that have seen a UFO is greater than or equal to 4 in a thousand when that proportion is actually less than 4 in a thousand.

B) Reject the claim that the proportion of Americans that have seen a UFO is less than or equal to 4 in a thousand when that proportion is actually less than 4 in a thousand.

C) Fail to reject the statement that the proportion of Americans that have seen a UFO greater than is equal to 4 in a thousand when that proportion is actually 4 in a thousand.

BINOMIAL PROPORTION HYPTOTHESIS TESTING. Test the claims given below in questions 9--12. Label and show all 5 steps of the hypothesis testing algorithm for each question on separate paper. Show the work for both the Critical Value (CV) and P-value Methods of decision making when doing Step 4 of the algorithm. There is no need to fill in the answer blanks that appear below, just right of each question. You will be graded on the work you turn in on separate paper.

9) A poll of 1068 adult Americans reveals that 48% of the voters surveyed prefer the Democratic candidate for the presidency. At the 0.05 level of significance, test the claim that at least half of all voters prefer the Democrat. 9) do not reject the claim

10) According to a recent poll 53% of Americans would vote for the incumbent president. If a random sample of 100 people results in 45% who would vote for the incumbent, test the claim that the actual percentage is 53%. Use a 0.10 significance level. 10) do not reject the claim

11) In a survey, 1864 out of 2246 randomly selected adults in the United States said that texting while driving should be illegal. Use a 5% level of significance to test the claim that more than 80% of adults believe that texting while driving should be illegal. 11) sample data support the claim

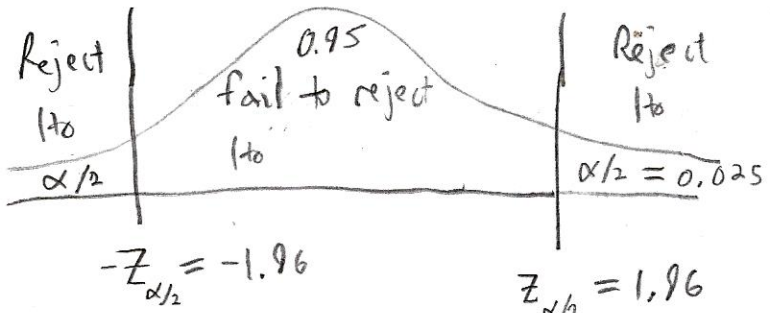
12) In a presidential election, 308 out of 611 voters surveyed said that they voted for the candidate who won. Use a 0.01 significance level to test the claim that among all voters, the percentage who believe that they voted for the winning candidate is equal to 43%. 12) reject the claim

(1) Claim: $p < \frac{14}{10000}$ or $p < 0.0014$

$H_0: p \geq 0.0014$

$H_1: p < 0.0014$

(2)

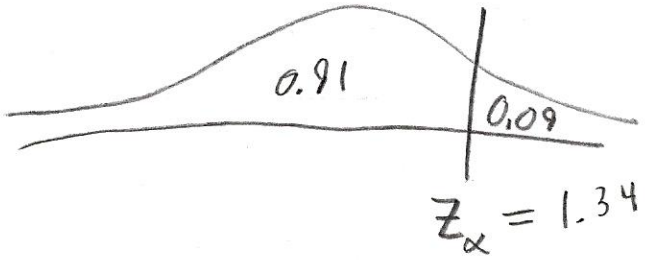


invnorm(0.025) = −1.96

invnorm(.975) = 1.96

or use the z table

(3)



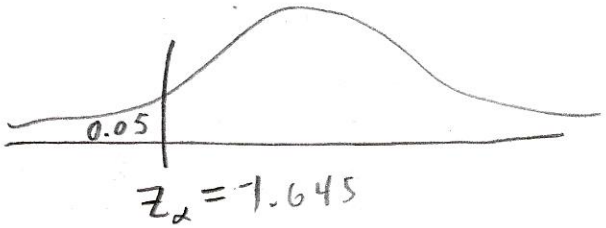
invnorm(0.91) = 1.34

or use the z table

look up 0.91 in the table body

find z.

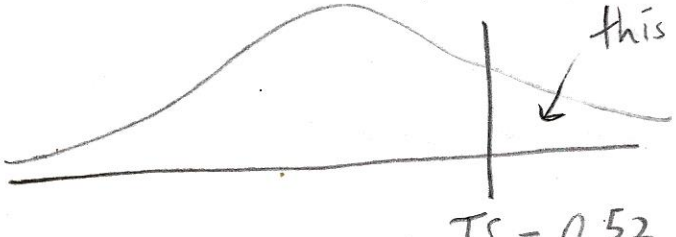
(4)



invnorm(0.05) = −1.645

or lookup 0.05 in body of z table

(5)



use normalcdf(−10, 0.52)

or look up the probability associated with z = 0.52, then subtract this value from 1.

pvalue = 1 − 0.6985

= 0.3015

Since p-val > α, fail to reject Ho.

(7) claim: $p > 0.071$

H_0: $p \leq 0.071$ ← false

H_1: $p > 0.071$ ← true

A type II error is made when H_0 is false & we fail to reject it. Assume a type II error has been made. Then $p \leq 0.071$ is not a true statement and H_1 is true and we don't recognize it. Instead, we fail to reject H_0, and conclude the sample evidence doesn't support the claim, when in reality it does.

(8) claim $p < 0.0014$

H_0: $p \geq 0.0014$ ← true, but rejected

H_1: $p < 0.0014$ ← false, but accepted

A type I error occurs when we reject H_0, and its really true.

(4) $n = 1068$

$\hat{p} = 0.48$ sample proportion

$p = 0.5$; $q = 1 - p = 0.5$

$\alpha = 0.05$

p - binomial population proportion
- is related to a binomial experiment
- is the prob. of success
- is the hypothesized value of the true proportion

Claim: at least half of all voters prefer democrat

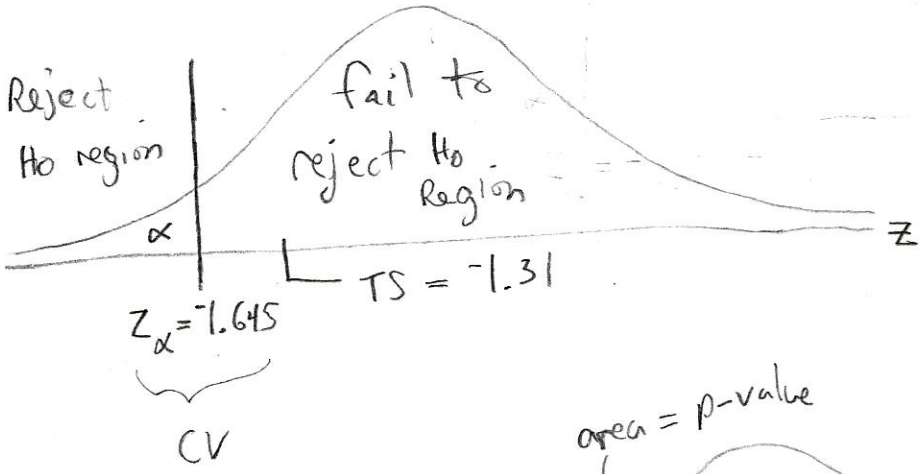
Symbolic form: $p \geq 0.5$

Step1 H_0: $p \geq 0.5$ (claim)

Step2 H_1: $p < 0.5$ (left-tailed test)

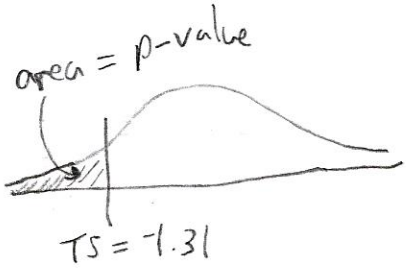
Step3 The test statistic is $z = \dfrac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \dfrac{0.48 - 0.50}{\sqrt{\frac{(0.5)^2}{1068}}} \approx -1.31$

Step4 (CV method)



The test statistic (TS) is located along the horizontal axis, right of the critical value ($z_\alpha = -1.645$) in the fail to reject Ho Region

Step4 (P-value method)



The area under the sampling distribution curve, left of the TS is the p-value = 0.0951 and p-val > α, so we

Step5 There is not sufficient evidence to warrant rejection of the claim that at least half of the voters prefer democrat.

(10) $n = 100$

$\hat{p} = 0.45$ sample proportion

$p = 0.53$ hypothesized value of true population proportion

$\alpha = 0.10$ (10%) the probability we will make the wrong decision by rejecting a true H_0.

Claim The actual % of the population that would vote for the incumbent is 53%

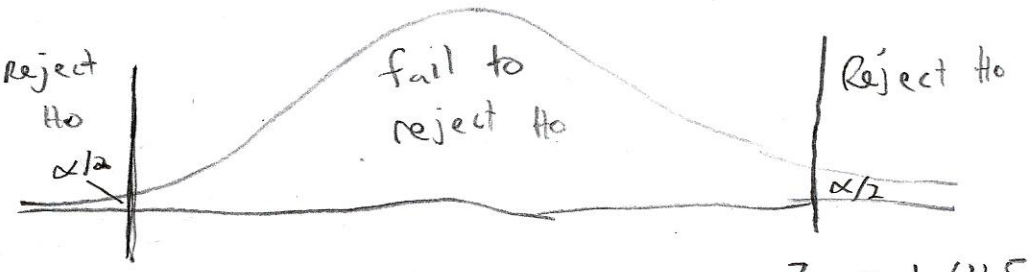
Step1 : $H_0 : p = 0.53$ (claim)

Step2: $H_1 : p \neq 0.53$ (2-tailed test)

Step3 The test statistic is $z = \dfrac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \dfrac{0.45 - 0.53}{\sqrt{\frac{(0.53)(1-0.53)}{100}}} = \dfrac{-0.08}{0.049909}$

≈ -1.60

Step4 CV method



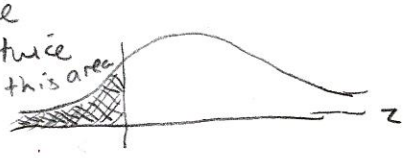
$-z_{\alpha/2} = -1.645$ $\quad z_{\alpha/2} = 1.645$

The test statistic is located along the horizontal axis, between the 2 CVs, in the fail to reject H_0 region.

Step4 P-value method

The p-value is twice the area left of the TS.

p-value = twice this area



TS = -1.60

$p\text{-val.} = (2)(0.0548) > \alpha \Rightarrow$ fail to reject H_0

Step5 There is not sufficient evidence to warrant rejection of the claim that the actual % of people who would vote for the incumbent president is 53%.

(11) $\hat{p} = \frac{x}{n} = \frac{1864}{2246} \approx 0.83$

$\alpha = 0.05$

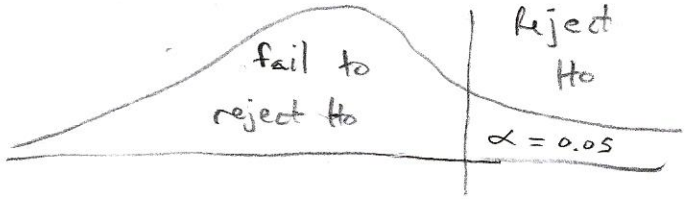
$p > .80$ claim: more than 80% of all adults

Step1 $H_0: p \leq 0.80$

Step2 $H_1: p > 0.80$ (claim, right-tailed test)

Step3 The test statistic is $z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.83 - 0.8}{\sqrt{\frac{(0.8)(0.2)}{2246}}} \approx 3.55$

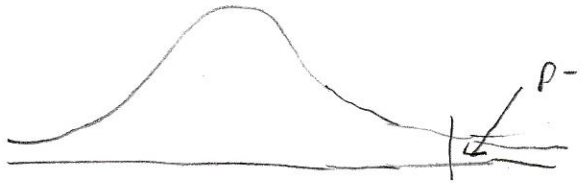
Step4 CV method



$z_\alpha = 1.645$

The TS is located along the horizontal axis, right of the CV (z_α) in the rejection region

Step5 P-value



Since p-val $\leq \alpha$, reject H_0.

TS = 3.55

Step 5 The sample data support the claim that more than 80% of adults believe that texting while driving should be illegal.

(12) $\hat{p} = \frac{x}{n} = \frac{308}{611} \doteq 0.504$

$\alpha = 0.01$

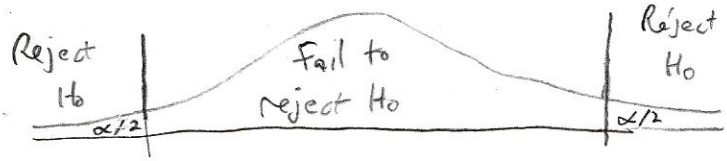
Claim: $p = 0.43$

Step1 $H_0: p = 0.43$ (claim)

Step2 $H_1: p \neq 0.43$ (2 tailed test)

Step3 the test statistic is $z = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.504 - 0.43}{\sqrt{\frac{(0.43)(0.57)}{611}}} \approx 3.70$

Step4 CV method $\alpha/2 = 0.01/2 = 0.005$



$-z_{\alpha/2} = -2.575$ $\quad z_{\alpha/2} = 2.575$

The TS is located in the critical region.

Step4 P-value

TS = 3.70

p-val $= 2(1 - 0.9999) = 0.0002$

and p-val $\leq \alpha \Rightarrow$ reject H_0

Step5 There is sufficient evidence to warrant rejection of the claim that among all voters, the % who believe they voted for the winning candidate is equal to 43%.