

Section 3A

1.

$$H_0: \pi = 0.93$$

$$H_A: \pi < 0.93 \text{ (claim)}$$

Left-tailed test

3.

$$H_0: \pi = 0.74$$

$$H_A: \pi > 0.74 \text{ (claim)}$$

Right-tailed test

5.

$$H_0: \sigma = 2.9 \text{ inches}$$

$$H_A: \sigma \neq 2.9 \text{ inches (claim)}$$

Two-tailed test

7.

π_1 : The population proportion of women that hold CEO level jobs.

π_2 : The population proportion of men that hold CEO level jobs.

$$H_0: \pi_1 = \pi_2$$

$$H_A: \pi_1 < \pi_2 \text{ (claim)}$$

Left-tailed test

9.

π : The percentage of republicans that support decreasing taxes.

$$H_0: \pi = 0.5$$

$$H_A: \pi > 0.5 \text{ (claim)}$$

Right-tailed test

11.

$$H_0: \beta_1 = 0$$

$$H_A: \beta_1 > 0 \text{ (claim)}$$

Right-tailed test

13.

$$H_0: \mu = 18 \text{ thousand dollars}$$

$$H_A: \mu < 18 \text{ thousand dollars (claim)}$$

Left-tailed test

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15.

$$H_0: \sigma^2 = 0.5$$

$$H_A: \sigma^2 > 0.5 \text{ (claim)}$$

Right-tailed test

17.

μ_1 : The population mean average salary of female lawyers in NY.

μ_2 : The population mean average salary of male lawyers in NY.

$$H_0: \mu_1 = \mu_2$$

$$H_A: \mu_1 < \mu_2 \text{ (claim)}$$

Left-tailed test

19.

$$H_0: \rho = 0$$

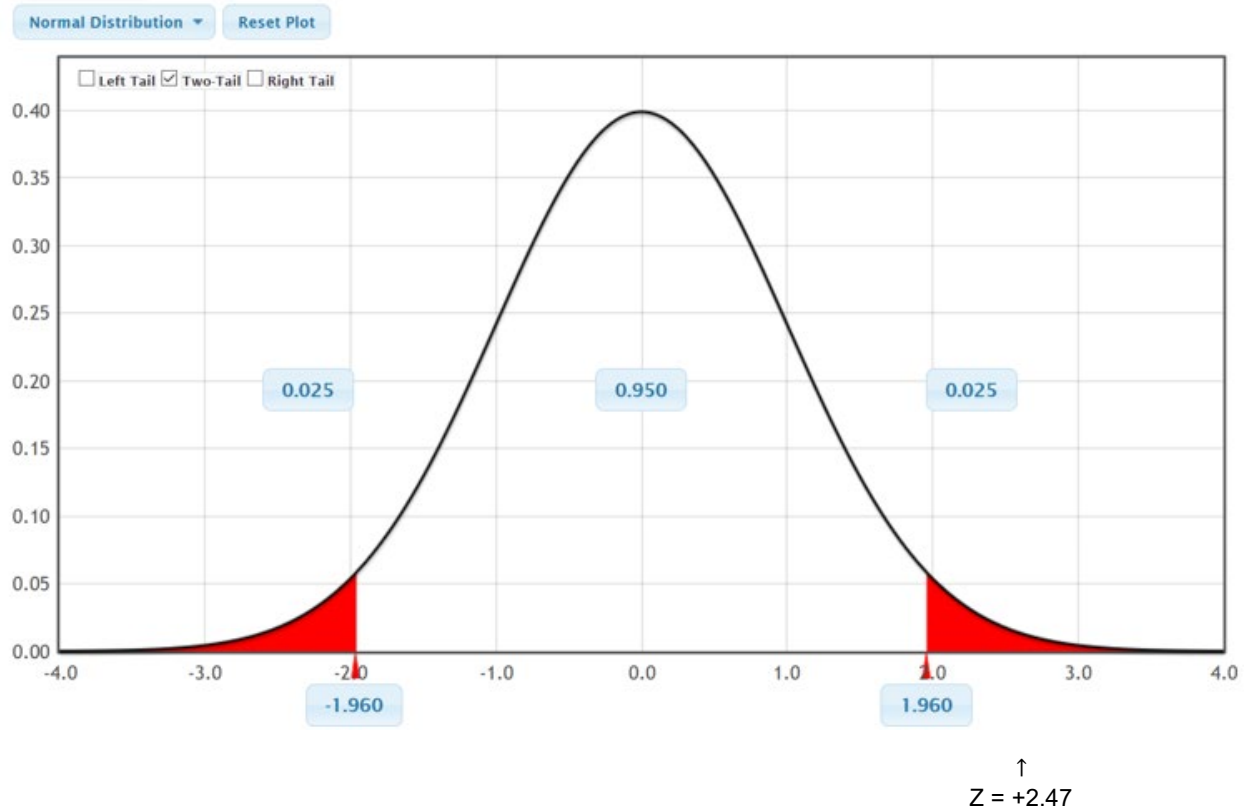
$$H_A: \rho > 0 \text{ (claim)}$$

Right-tailed test

Section 3B

1.

a)



b)

The test statistic does fall in the right tail of the normal Z-score distribution.

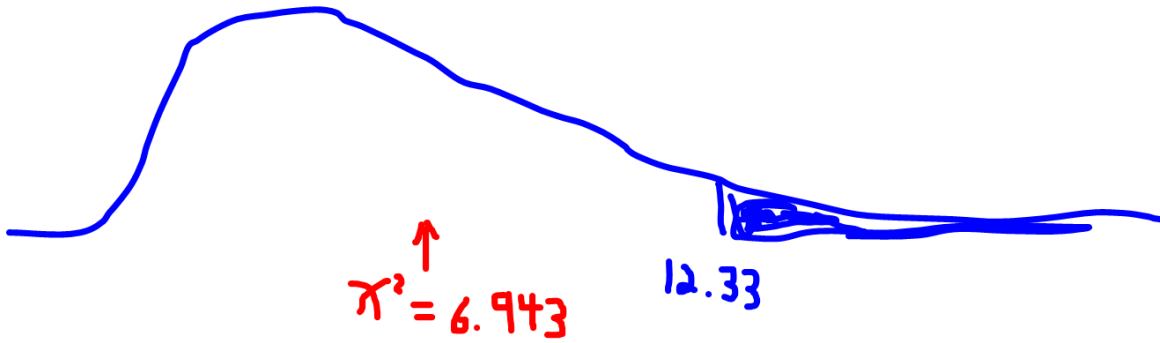
c)

Since the test statistic fell in the tail determined by the critical values, the sample data does significantly disagree with the null hypothesis.

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3.

a)



b)

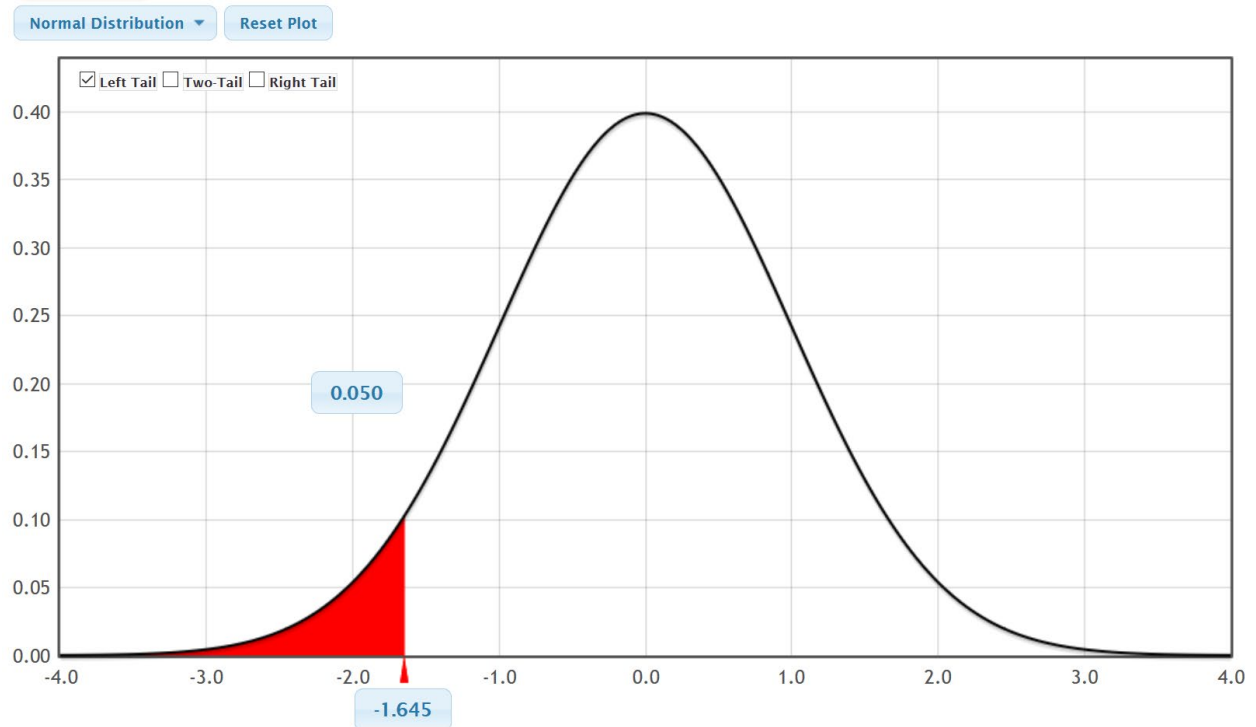
The test statistic does NOT fall in the right tail of the Chi-squared distribution.

c)

Since the test statistic did NOT fall in the tail determined by the critical values, the sample data does NOT significantly disagree with the null hypothesis.

5.

a)



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$$\uparrow$$
$$Z = -1.33$$

b)

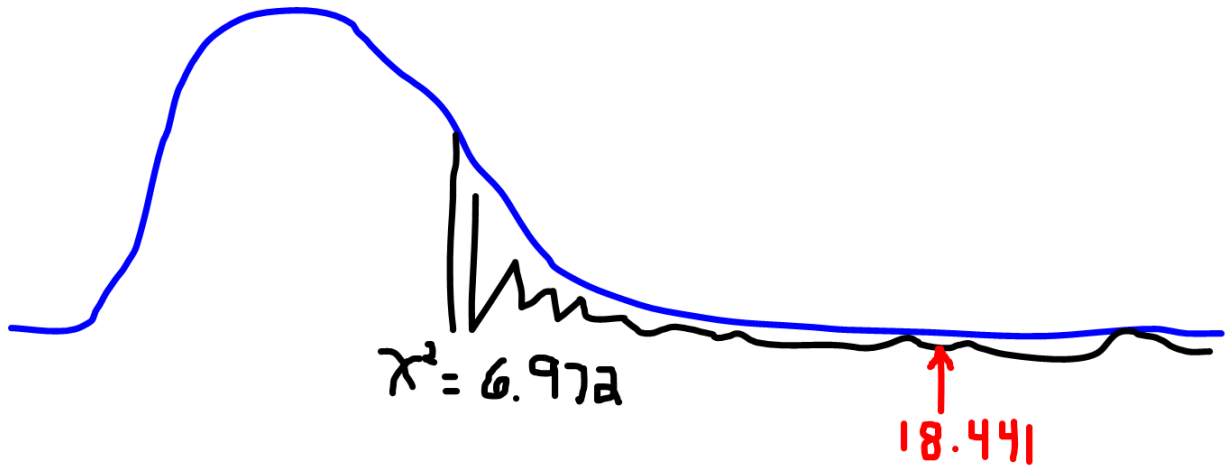
The test statistic does NOT fall in the left tail of the normal Z-score distribution.

c)

Since the test statistic did NOT fall in the tail determined by the critical values, the sample data does NOT significantly disagree with the null hypothesis.

7.

a)



b)

The test statistic does fall in the right tail of the Chi-squared distribution.

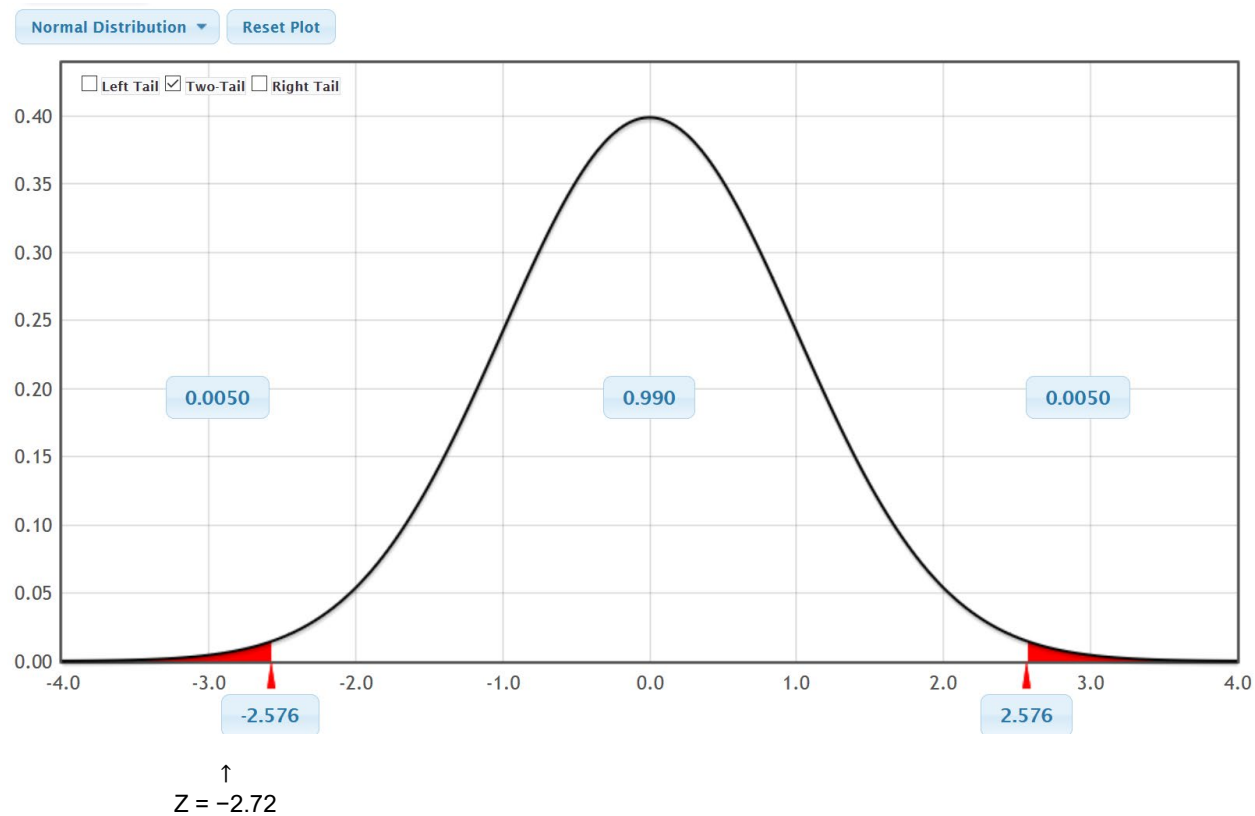
c)

Since the test statistic fell in the tail determined by the critical values, the sample data does significantly disagree with the null hypothesis.

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9.

a)



b)

The test statistic does fall in the left tail of the normal Z-score distribution.

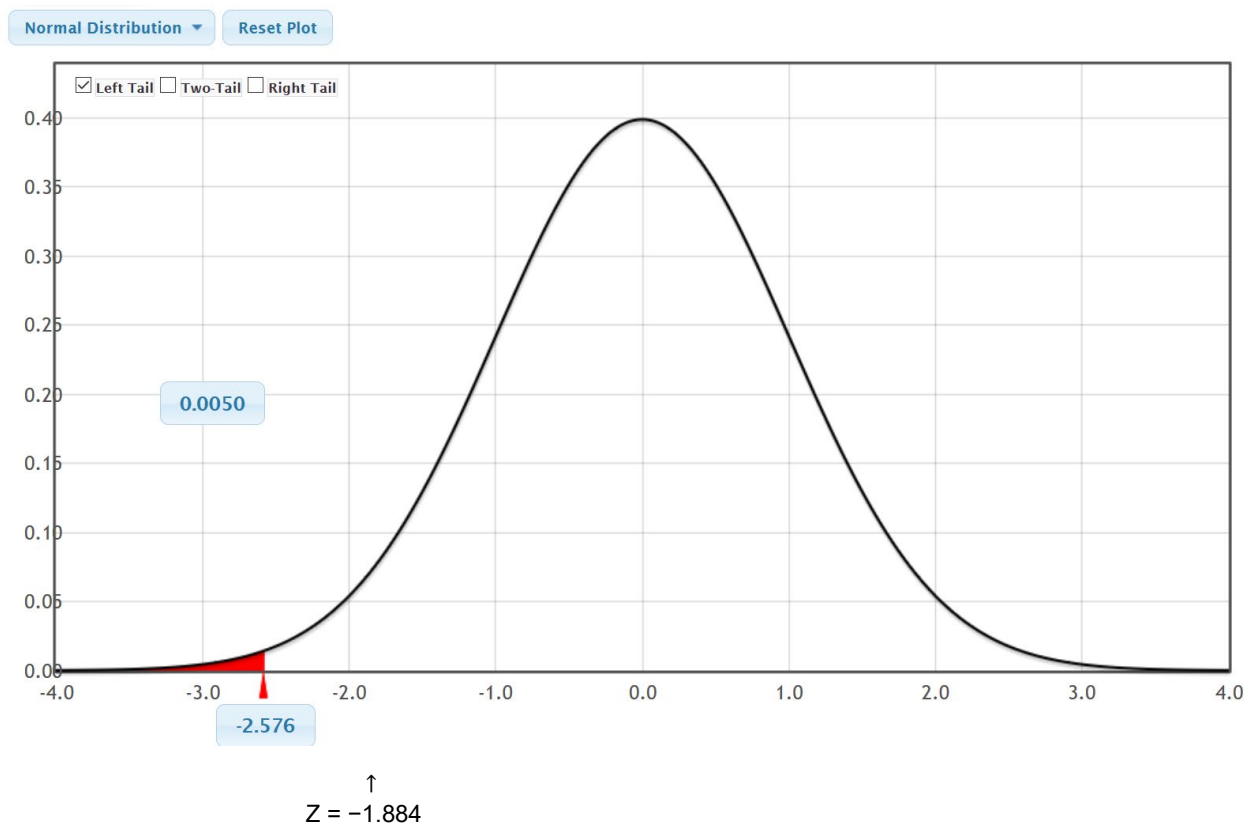
c)

Since the test statistic fell in one of the tails determined by the critical values, the sample data does significantly disagree with the null hypothesis.

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11.

a)



b)

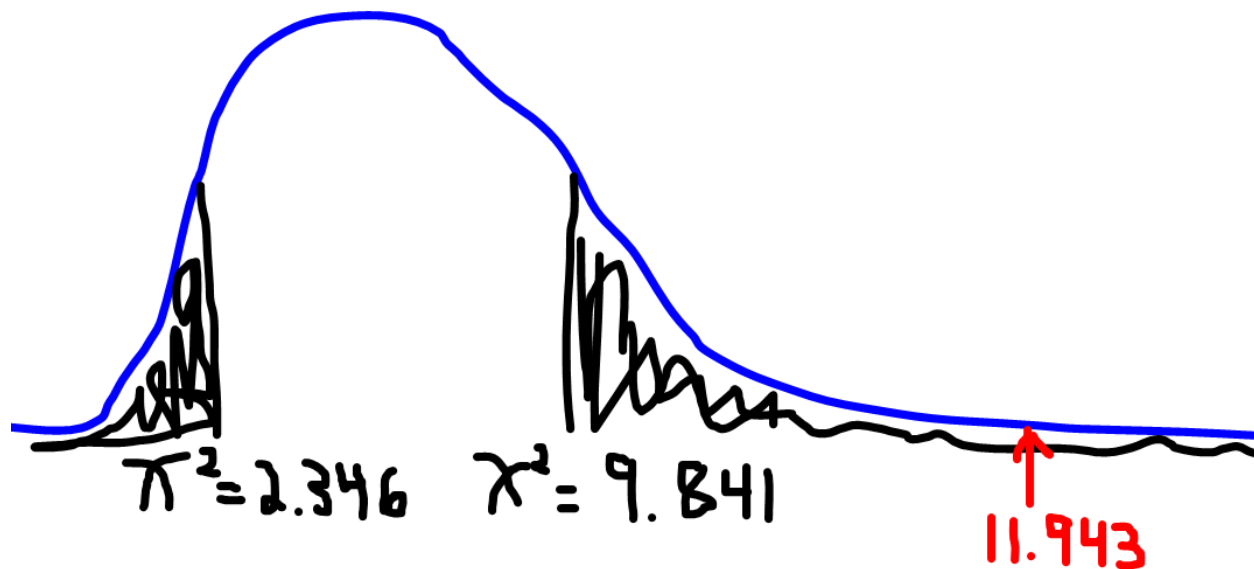
The test statistic does NOT fall in the left tail of the normal Z-score distribution.

c)

Since the test statistic did NOT fall in the left tail determined by the critical value, the sample data does NOT significantly disagree with the null hypothesis.

13.

a)



b)

The test statistic does fall in one of the tails of the Chi-squared distribution.

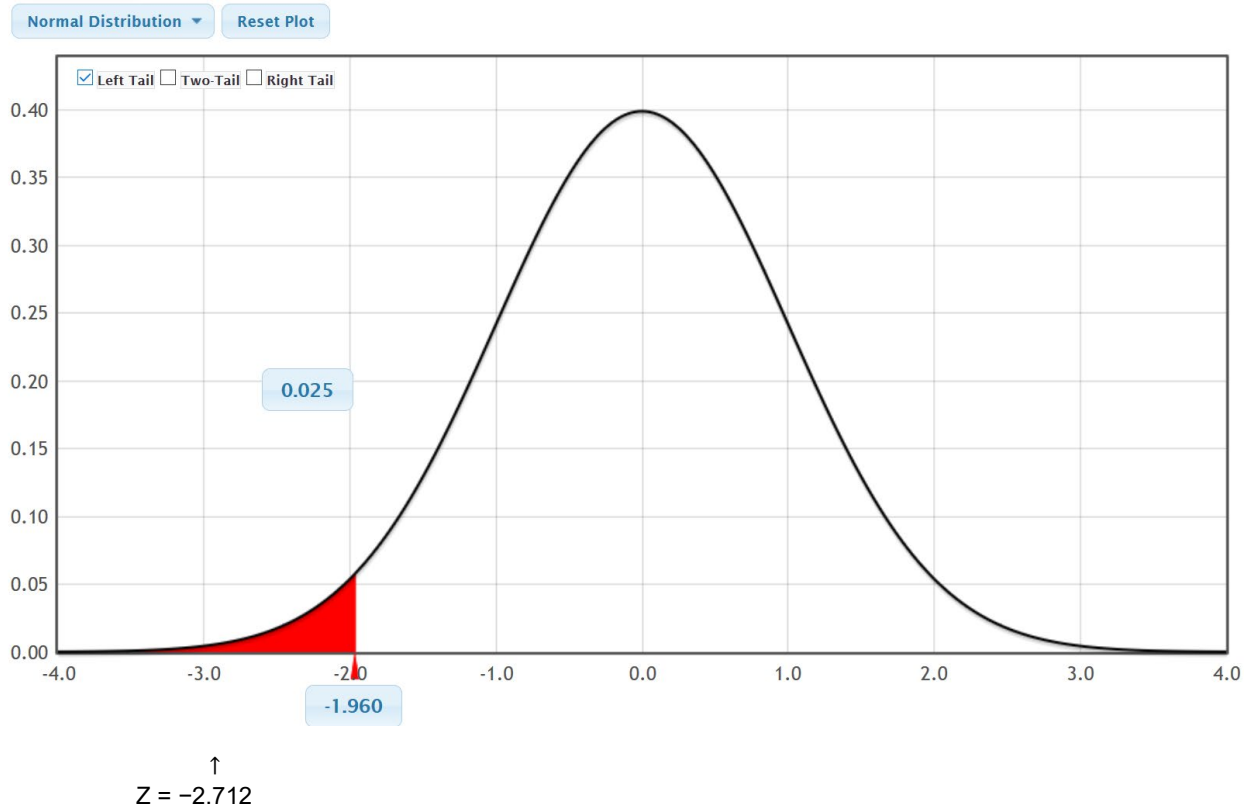
c)

Since the test statistic fell in one of the tails determined by the critical values, the sample data does significantly disagree with the null hypothesis.

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15.

a)



b)

The test statistic does fall in the left tail of the normal Z-score distribution.

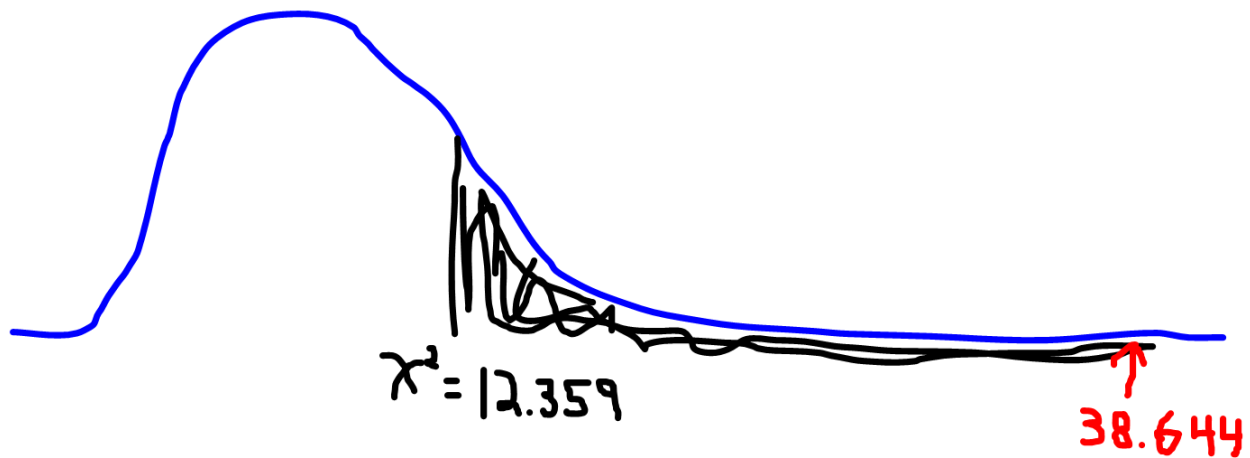
c)

Since the test statistic fell in the left tail determined by the critical value, the sample data significantly disagrees with the null hypothesis.

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17.

a)



b)

The test statistic does fall in the right tail of the Chi-squared distribution.

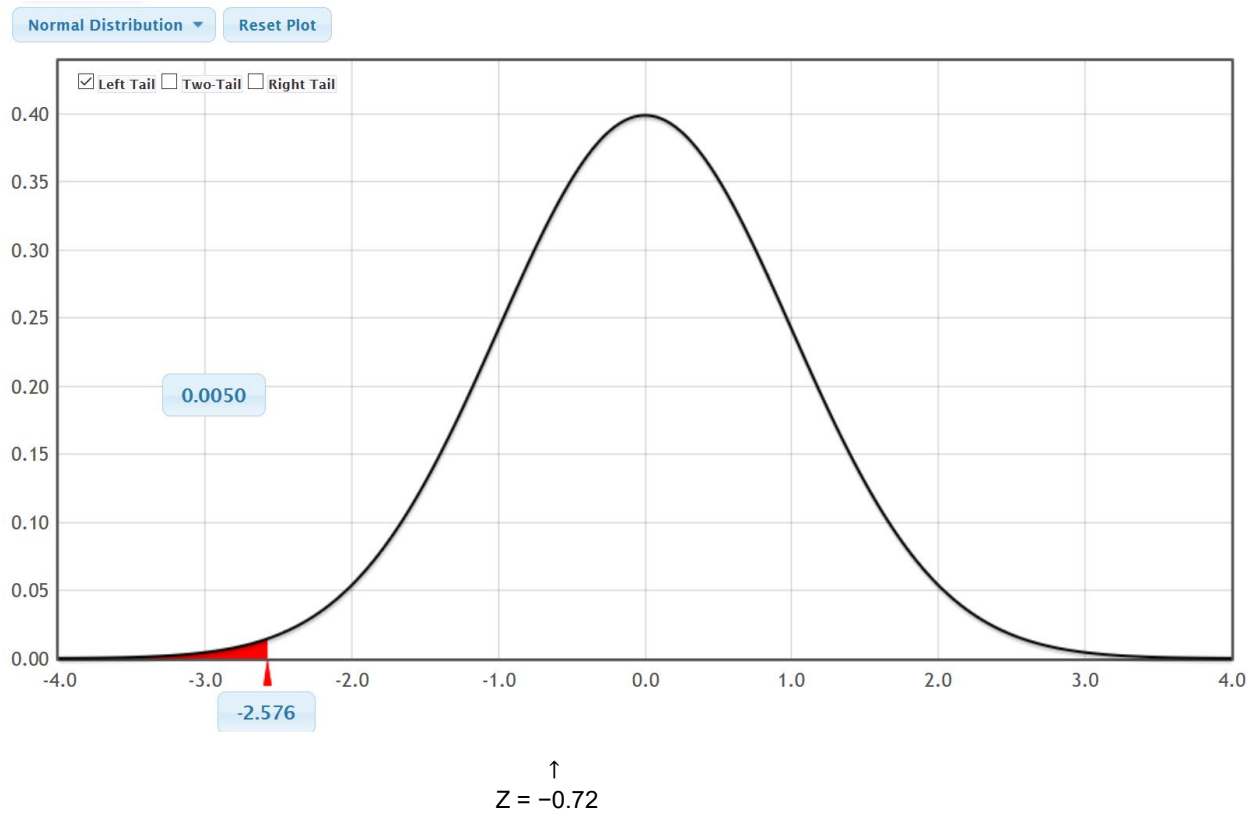
c)

Since the test statistic fell in the tail determined by the critical values, the sample data does significantly disagree with the null hypothesis.

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19.

a)



b)

The test statistic does NOT fall in the left tail of the normal Z-score distribution.

c)

Since the test statistic did NOT fall in the left tail determined by the critical value, the sample data does NOT significantly disagree with the null hypothesis.

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21.

Critical Values = ± 1.96

Since the Z-test statistic fell in one of the tails determined by the critical values, the sample data does significantly disagree with the null hypothesis.

23.

Critical Value = $+1.282$

Since the Z-test statistic fell in the right tail determined by the critical value, the sample data does significantly disagree with the null hypothesis.

25.

Critical Value = $+1.307$

Since the T-test statistic fell in the right tail determined by the critical value, the sample data does significantly disagree with the null hypothesis.

27.

Critical Value = $+42.558$

Since the chi-squared test statistic did not fall in the right tail determined by the critical value, the sample data does not significantly disagree with the null hypothesis.

29.

Critical Values: Lower critical value = $+6.843$, Upper critical value = 38.583

Since the chi-squared test statistic fell in one of the tails determined by the critical values, the sample data does significantly disagree with the null hypothesis.

31.

Z test statistic = $(0.835 - 0.9) \div 0.053 \approx -1.2264$

The sample proportion of 0.835 is 1.2264 standard errors below the population proportion of 0.9.

OR

The sample percentage of 83.5% is 1.2264 standard errors below the population percentage of 90%.

33.

T test statistic = $(135.7 - 100) \div 23.9 \approx +1.494$

The sample mean of 135.7 mg is 1.494 standard errors above the population mean of 100 mg.

35.

T test statistic = $(52.71 - 60) \div 6.42 \approx -1.136$

The sample mean of 52.71 thousand dollars is 1.136 standard errors below the population mean of 60 thousand dollars.

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Section 3C

	<i>P-value</i>	<i>P-value %</i>	<i>Significance Level %</i>	<i>Significance Level Proportion</i>	<i>Low P-value or High P-value?</i>	<i>Sample Data significantly disagree with H_0? (Yes or No)</i>	<i>Could be sampling variability or Unlikely?</i>	<i>Reject H_0 or fail to reject?</i>
1.	0.238	23.8%	5%	0.05	High	Not Sig	Could be	Fail
2.	0.0003		1%					
3.	5.7×10^{-6}	0.00057%	10%	0.1	Low	Sig	Unlikely	Reject
4.	0.441		5%					
5.	0.138	13.8%	1%	0.01	High	Not Sig	Could be	Fail
6.	0		10%					
7.	0.043	4.3%	5%	0.05	Low	Sig	Unlikely	Reject
8.	0.085		1%					
9.	1.4×10^{-4}	0.014%	10%	0.1	Low	Sig	Unlikely	Reject
10.	0.112		5%					
11.	0	0%	1%	0.01	Low	Sig	Unlikely	Reject
12.	0.539		10%					
13.	0.0006	0.06%	10%	0.1	Low	Sig	Unlikely	Reject
14.	2.5×10^{-7}		1%					
15.	0.861	86.1%	5%	0.05	High	Not Sig	Could be	Fail
16.	0.199		5%					

	<i>P-value</i>	<i>P-value %</i>	<i>Significance Level %</i>	<i>Significance Level Proportion</i>	<i>Low P-value or High P-value?</i>	<i>Sample Data significantly disagree with H_0? (Yes or No)</i>	<i>Could be sampling variability or Unlikely?</i>	<i>Reject H_0 or fail to reject?</i>
17.	0.034	3.4%	5%	0.05	Low	Sig	Unlikely	Reject
18.	0.128		1%					
19.	8.6×10^{-4}	0.086%	10%	0.1	Low	Sig	Unlikely	Reject
20.	0.0437		5%					
21.	0	0%	1%	0.01	Low	Sig	Unlikely	Reject
22.	0.612		10%					
23.	0.087	8.7%	5%	0.05	High	Not Sig	Could be	Fail
24.	0.0048		1%					
25.	5.5×10^{-7}	0.000055%	10%	0.1	Low	Sig	Unlikely	Reject
26.	0.0216		5%					
27.	0.444	44.4%	1%	0.01	High	Not Sig	Could be	Fail
28.	0.0539		10%					
29.	0.722	72.2%	10%	0.1	High	Not Sig	Could be	Fail
30.	3.8×10^{-3}		1%					
31.	0.0823	8.23%	5%	0.05	High	Not Sig	Could be	Fail
32.	0.0227		5%					

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33.

a) 0.0168 or 1.68%

b) If the null hypothesis is true, there is a 1.68% probability of getting the sample data or more extreme because of sampling variability.

c) Since the P-value 1.68% was lower than the significance level of 5%, the sample data does significantly disagree with the population proportion 0.93 in the null hypothesis.

d) Since the P-value 1.68% was lower than the significance level of 5%, it is unlikely for this sample data to occur because of sampling variability.

e) Since the P-value 1.68% was lower than the significance level of 5%, we should reject the null hypothesis.

35.

a) 0.1244 or 12.44%

b) If the null hypothesis is true, there is a 12.44% probability of getting the sample data or more extreme because of sampling variability.

c) Since the P-value 12.44% was higher than the significance level of 5%, the sample data does not significantly disagree with the population proportion 0.74 in the null hypothesis.

d) Since the P-value 12.44% was higher than the significance level of 5%, this sample data could have occurred because of sampling variability.

e) Since the P-value 12.44% was higher than the significance level of 5%, we should fail to reject the null hypothesis.

37.

a) 0.895 or 89.5%

b) If the null hypothesis is true, there is an 89.5% probability of getting the sample data or more extreme because of sampling variability.

c) Since the P-value 89.5% was higher than the significance level of 10%, the sample data does not significantly disagree with the population proportion 0.1 in the null hypothesis.

d) Since the P-value 89.5% was higher than the significance level of 10%, this sample data could have occurred because of sampling variability.

e) Since the P-value 89.5% was higher than the significance level of 10%, we should fail to reject the null hypothesis.

39.

P-value = 0.084 or 8.4%

41.

P-value = $0.0098 + 0.0098 = 0.0196$ or 1.96%

43.

P-value = 0.053 or 5.3%

45.

P-value = 0.000018 or 0.0018%

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Section 3D

	Claim	P-value	Evidence (Yes or No)	Formal Hypothesis Test Conclusion
1.	H_0	Low	Yes. Evidence	There is significant evidence to reject the claim.
2.	H_A	High		
3.	H_A	High	No. Not evidence.	There is not significant evidence to support the claim.
4.	H_0	Low		
5.	H_0	High	No. Not evidence.	There is not significant evidence to reject the claim.
6.	H_A	High		
7.	H_A	Low	Yes. Evidence	There is significant evidence to support the claim.
8.	H_0	High		
9.	H_0	Low	Yes. Evidence	There is significant evidence to reject the claim.
10.	H_A	Low		
11.	H_A	High	No. Not evidence.	There is not significant evidence to support the claim.
12.	H_0	High		
13.	H_0	Low	Yes. Evidence	There is significant evidence to reject the claim.
14.	H_A	High		
15.	H_A	Low	Yes. Evidence	There is significant evidence to support the claim.
16.	H_0	Low		
17.	H_0	High	No. Not evidence.	There is not significant evidence to reject the claim.
18.	H_A	Low		
19.	H_A	High	No. Not evidence.	There is not significant evidence to support the claim.
20.	H_0	Low		
21.	H_0	Low	Yes. Evidence	There is significant evidence to reject the claim.
22.	H_A	High		
23.	H_A	High	No. Not evidence.	There is not significant evidence to support the claim.
24.	H_0	High		
25.	H_0	Low	Yes. Evidence	There is significant evidence to reject the claim.
26.	H_A	Low		
27.	H_A	High	No. Not evidence.	There is not significant evidence to support the claim.
28.	H_0	Low		
29.	H_0	High	No. Not evidence.	There is not significant evidence to reject the claim.
30.	H_A	Low		

31.

- a) Since the P-value is lower than the significance level, we should reject the null hypothesis.
- b) Since the P-value is lower than the significance level, we do have significant evidence.
- c) There is significant evidence to support the claim that less than 4% of people showed side effects to the medication.
- d) Statistical evidence agrees with the hospital that less than 4% of the population will show side effects to the medication.

33.

- a) Since the P-value is lower than the significance level, we should reject the null hypothesis.
- b) Since the P-value is lower than the significance level, we do have significant evidence.
- c) There is significant evidence to reject the claim that the candidate will receive 54% of the vote.
- d) Statistical evidence disagrees with the statement that the candidate will receive 54% of the vote.

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35.

- a) Since the P-value is lower than the significance level, we should reject the null hypothesis.
- b) Since the P-value is lower than the significance level, we do have significant evidence.
- c) There is significant evidence to reject the claim that at least 50% of patients taking Toprol have seen improvement in their migraine symptoms.
- d) Statistical evidence disagrees with the statement that at least 50% of patients taking Toprol have seen improvement in their migraine symptoms. Statistical evidence suggest that it is more likely to be less than 50%.

37.

- a) Since the P-value is higher than the significance level, we should fail to reject the null hypothesis.
 - b) Since the P-value is higher than the significance level, we do not have significant evidence.
 - c) There is not significant evidence to support the claim that a higher percentage of people will vote for the democratic candidate over the republican candidate.
 - d) We do not have statistical evidence that agrees with the higher percentage for the democratic candidate. The voting percentages for the candidates seem very close. We do not have evidence one way or the other.
-

Section 3E

1.

Type 2 Error

3.

Beta Level

5.

Confidence Level

7.

Increase the sample size or increase the significance level.

9.

The probability of type 1 error (alpha level) will increase. The probability of type 2 error (beta level) will decrease.

11.

5% significance level (5% alpha level)

13.

A high P-value from biased data could result in a type 2 error.

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15.

a) A type 1 error would be that the company believes that very few airbags are defective when in reality many are defective. The company would decide to not recall the cars. This would be a grave mistake if many of the airbags are defective. The result would be deaths, injuries and lawsuits against the company for defective airbags.

b) A type 2 error would be that the company believes that many airbags are defective when in reality hardly any are defective. The company would decide recall the cars by mistake. This would result in a loss of money for the company since mechanics would replace many airbags that did not need to be replaced. The company may also face a loss of reputation since the airbag recall may scare customers from purchasing their cars in the future.

c) In this situation, the type 1 error was much more serious than the type 2 error. I would recommend the company avoid the type 1 error even if they make a type 2 error. So the company should decrease the significance level (alpha level) to 1% or even 0.5%. I would also recommend collecting more data before making a decision.

17.

a) A type 1 error would be Trisha believing that the stock price will drop when in reality it won't. She will sell the stock when the stock price will either remain the same or increase. Selling stock too early would result in a loss of money.

b) A type 2 error would be Trisha believing that the stock price will remain the same or increase when in reality it will increase. She will hold onto the stock when the stock price will decrease. Not selling the stock when the price will decrease would result in a loss of money.

c) Both type 1 and type 2 errors seem like they result in a loss of money. I would recommend leaving the significance level (alpha level) at 5% since this balances the errors. Trisha could also collect more data before making a decision.

19.

a) A type 1 error would be team believes the players' scoring will decrease when in reality it will increase. The team would decide to not resign a player that would be a real difference maker on their team. The result would be that they save money, but the team winning percentage may drop dramatically. This may result in a loss of revenue for the team as fans may not support the team, not buy tickets, or not buy merchandise.

b) A type 2 error would be team believes the players' scoring will increase or stay the same when in reality it will dramatically decrease. The team would decide to resign a player for a large contract when the player is no longer worth the contract. The result would be a huge loss of money without seeing an increase in the teams overall winning percentage. This may result in fans not supporting the team, not buying tickets, or not buying merchandise.

c) Both errors seem to be bad. The type 1 error may be slightly better since the saving of money on the contract may offset partially the loss of revenue for the team not winning. Though they would probably just spend that money on another player that they have more confidence in. Both type 1 and type 2 errors seem like they result in a loss of money. I would recommend leaving the significance level (alpha level) at 5% since this balances the errors.

Section 3F

1.

One-population Proportion Assumptions

- The categorical sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.
- There should be at least ten successes and at least ten failures.

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2.

One-population Mean Assumptions

- The quantitative sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.
- The sample size should be at least 30 or have a nearly normal shape.

3.

One-Population Randomized Simulation Assumptions

- The sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.

5.

One-population Proportion Assumptions

The categorical sample data should be collected randomly or be representative of the population. No. This was not a random sample. It was convenience data and would have a large amount of bias.

Data values within the sample should be independent of each other. No. People in the same store may be related or friends.

There should be at least ten successes and at least ten failures. No. There was at least 10 failures (71), but there was not at least 10 successes (8).

This data does not pass all the assumptions and should not be used to test a claim about the population.

7.

One-population Proportion Assumptions

The categorical sample data should be collected randomly or be representative of the population. No. This was not a random sample. It was convenience data and would have a large amount of bias.

Data values within the sample should be independent of each other. No. People in the same English class will be related or friends.

There should be at least ten successes and at least ten failures. No. There was at least 10 successes (26), but there was not at least 10 failures (8).

This data does not pass all the assumptions and should not be used to test a claim about the population.

9.

One-population Mean Assumptions

The quantitative sample data should be collected randomly or be representative of the population. Yes the sample data was collected randomly.

Data values within the sample should be independent of each other. Yes. Since Jimmy took a small random sample from a large population of homes in Oklahoma city, the homes are likely independent of each other. It is unlikely they are on the same street or owned by the same owner.

The sample size should be at least 30 or have a nearly normal shape. Yes. Even though the sample size was below 30 (28) the histogram was normal (bell-shaped).

This data does pass all of the assumptions and can be used to test the claim about the population.

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11.

One-population Mean Assumptions

The quantitative sample data should be collected randomly or be representative of the population. **Yes.** The data was collected randomly. A random cluster technique was used.

Data values within the sample should be independent of each other. **Maybe not.** Despite having a small random sample from a large population, all the data came from the same three streets. People living on the same street likely have similar socio-economic levels.

The sample size should be at least 30 or have a nearly normal shape. **Yes.** Despite the histogram being skewed right, the sample size was greater than 30 (63).

This data does not pass all the assumptions and should not be used to test a claim about the population.

13.

$H_0: \pi = 0.13$ (claim)

$H_A: \pi \neq 0.13$

Two-tailed test

One-Population Randomized Simulation Assumptions

The sample data should be collected randomly or be representative of the population. **Yes.** The sample data was collected randomly.

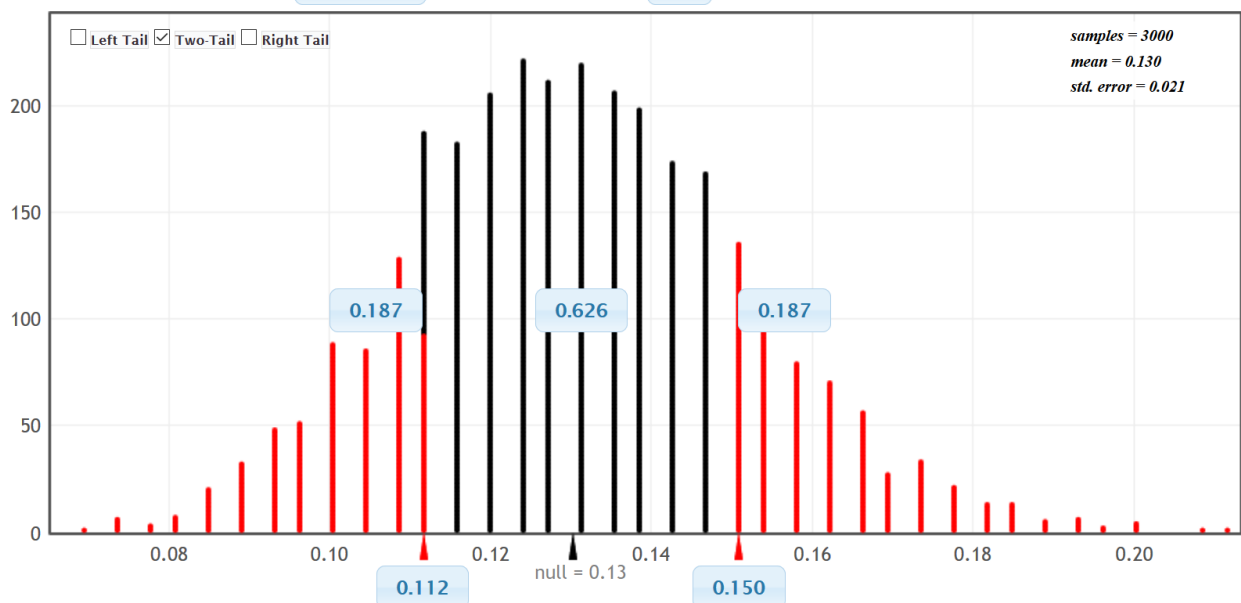
Data values within the sample should be independent of each other. **Maybe.** Since it was a small random sample from a large population of various materials we are unlikely to get materials by the same author but we may get materials from the same publisher since there are not that many publishers. Publishers may have similar policies about using digital materials.

Assuming the materials are independent, we will proceed with the test.

The P-value and test statistic will vary slightly because of sampling variability.

P-value Simulation

Randomization Dotplot of **Proportion** Null hypothesis: $p = 0.13$



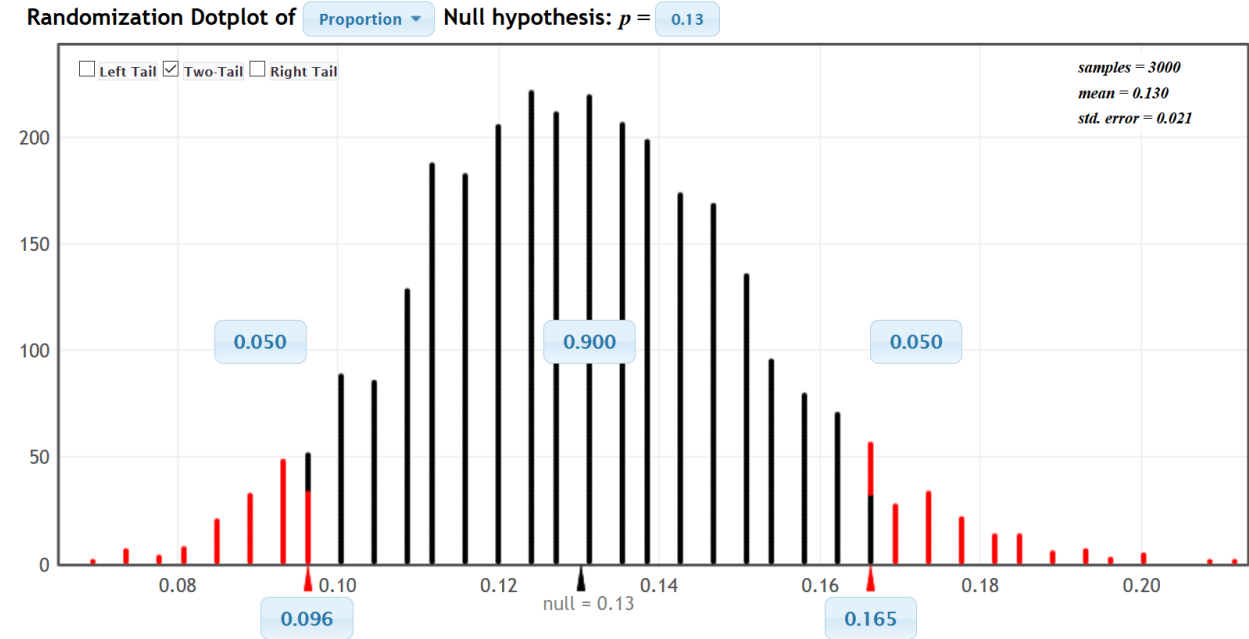
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(#13 continued)

Approximate P-value = $0.187 + 0.187 = 0.374$ or 37.4%

P-value sentence: If the null hypothesis is true and 13% of materials are digital, then there is a 37.4% probability of getting the sample data or more extreme because of sampling variability.

Critical Value Simulation (Simulations will vary.)



Notice the sample proportion of (0.15) does not fall in the tail determined by the simulation and the 10% significance level (5% in each tail). The sample data does not significantly disagree with the null hypothesis.

Fail to reject the null hypothesis.

Conclusion: There is not significant evidence to reject the claim that 13% of materials are digital.

The population percentage could be 13% since random sample data does not significantly disagree with it. However we do not have evidence.

Approximate Z-test statistic (answers will vary) = $(0.15 - 0.13) \div 0.021 \approx +0.952$ standard errors. (Not significant.)

15.

$H_0: \pi = 0.2$

$H_A: \pi > 0.2$ (claim)

Right-tailed test

One-Population Randomized Simulation Assumptions

The sample data should be collected randomly or be representative of the population. **Yes. The sample data was collected randomly.**

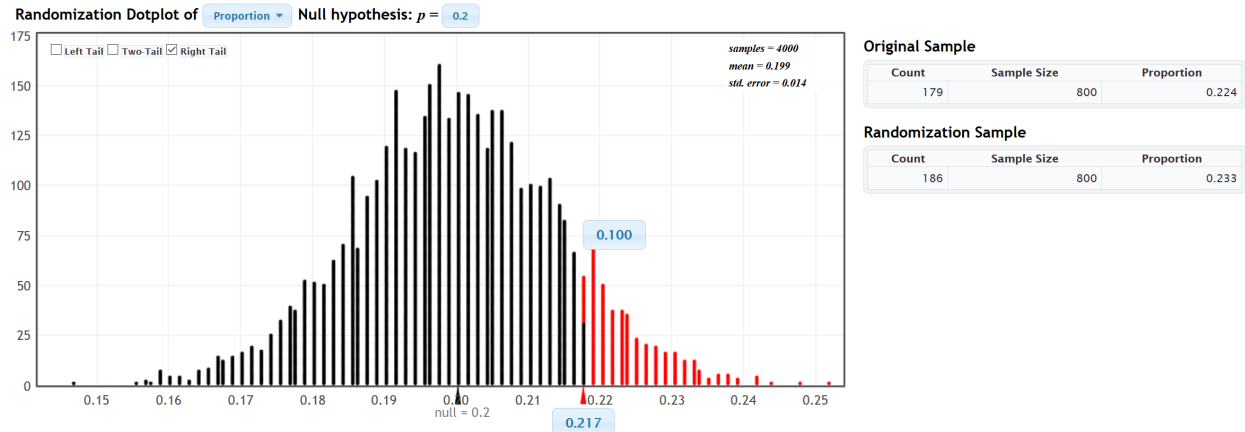
Data values within the sample should be independent of each other. **Yes. Since this is a small random sample of children from a large population, they are likely to be independent.**

The P-value and test statistic will vary slightly because of sampling variability.

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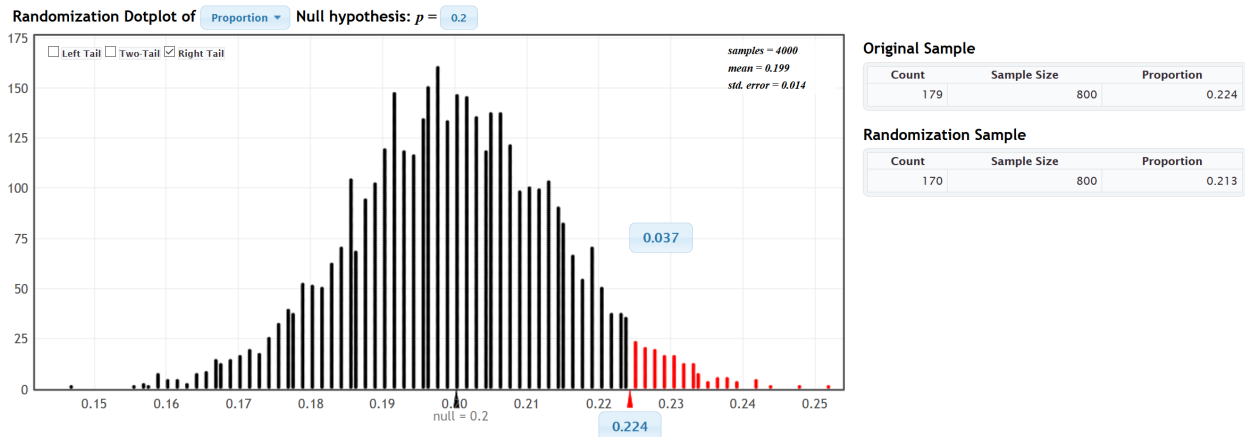
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(#15 continued) Critical Value Simulation (Simulations will vary.)



Notice the sample proportion of (0.224) does fall in the right tail determined by the simulation and the 10% significance level. The sample data significantly disagrees with the null hypothesis.

P-value Simulation (will vary)



Approximate P-value = 0.037 or 3.7%

P-value sentence: If the null hypothesis is true and 20% of children are obese, then there is a 3.7% probability of getting the sample data or more extreme because of sampling variability.

Reject the null hypothesis.

Conclusion: There is significant evidence to support the claim that more than 20% of children are obese.

We have statistical evidence that the population percentage of obese children is more than 20%

Approximate Z-test statistic (answers will vary) = $(0.224 - 0.2) \div 0.014 \approx +1.714$ standard errors. (Significant.)

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17.

$$H_0: \pi = 0.5$$

$$H_A: \pi > 0.5 \text{ (claim)}$$

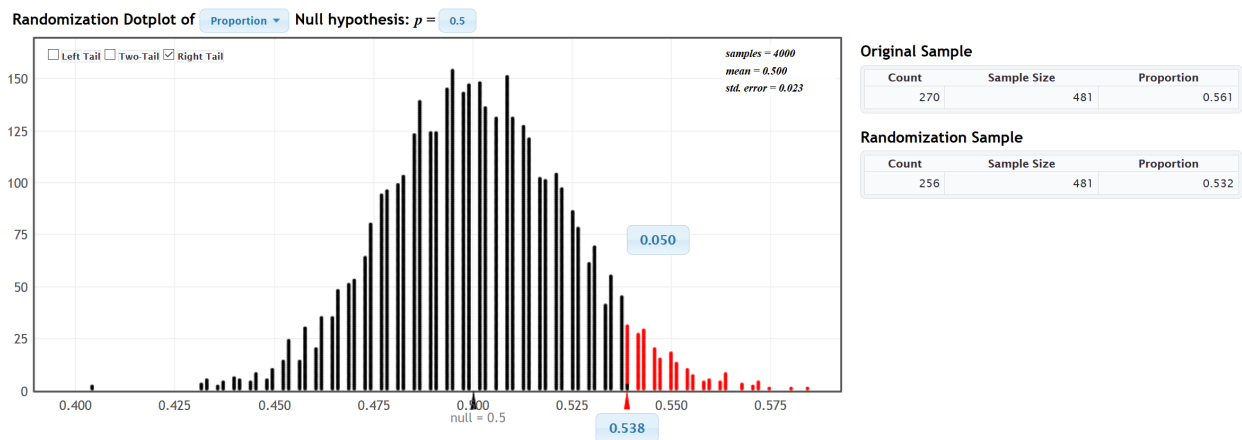
Right-tailed test

One-Population Randomized Simulation Assumptions

The sample data should be collected randomly or be representative of the population. **Yes.** The sample data was not collected randomly, however since it was a census of one semester, it may be representative.

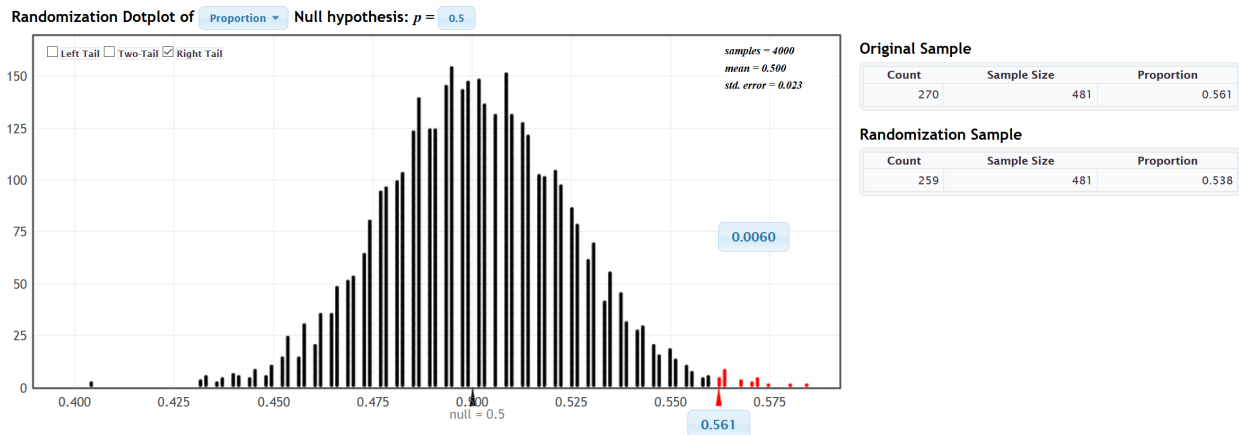
Data values within the sample should be independent of each other. **No.** The students came from the same statistics classes.

The P-value and test statistic will vary slightly because of sampling variability.



Notice the sample proportion of (0.561) falls in the right tail determined by the simulation and the 5% significance level. The sample data significantly disagrees with the null hypothesis.

P-value Simulation (will vary)



Approximate P-value = 0.006 or 0.6%

P-value sentence: If the null hypothesis is true and 50% of math 075 students are female, then there is a 0.6% probability of getting the sample data or more extreme because of sampling variability.

Reject the null hypothesis.

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Conclusion: There is significant evidence to support the claim that more than 50% of math 075 students are female.

Approximate Z-test statistic (answers will vary) = $(0.561 - 0.5) \div 0.023 \approx +2.65$ standard errors. (Significant.)

19.

$H_0 : \mu = 240$ feet

$H_A : \mu > 240$ feet (claim)

Assumptions

Random sample? Yes. Given it is a random sample.

Individual trees independent? Yes. A small random sample out of a large population. The trees are likely to be independent and not all measured from the same area.

At least 30 or normal? The shape is unknown so we must have a sample size of at least 30. There was 47 trees so it does pass the "30 or normal" requirement.

Z-test statistic = 2.109

The sample mean of 248 feet was 2.109 standard errors above the population mean of 240 feet. This indicates that the sample data does significantly disagree with the null hypothesis since the test statistics falls in the right tail corresponding to the critical value.

P-value = 0.0202 = 2.02%

If the null hypothesis is true and the population mean average height of redwood trees is 240 feet, there is a 2.02% probability of getting the sample data or more extreme because of sampling variability.

Since the P-value is less than our 5% significance level, it is unlikely that the sample data occurred by random chance (sampling variability).

Reject H_0

There is significant evidence to support the claim that the population mean average height of redwood trees is over 240 feet.

21.

$H_0 : \mu = \$3.50$

$H_A : \mu > \$3.50$ (claim)

Assumptions

Random sample? Yes. Given it is a random sample.

Individual independent? Yes. A small random sample out of a large population. The hamburgers probably did not come from the same restaurant.

At least 30 or normal? Even though the sample size is below 30 (24), the histogram looks normal. so it does pass the "30 or normal" requirement.

Z-test statistic = 1.633

The sample mean of \$3.88 was 1.633 standard errors above the population mean of \$3.50. This indicates that the sample data does significantly disagree with the null hypothesis since the test statistics falls in the right tail corresponding to the critical value.

P-value = 0.0508 = 5.08%

If the null hypothesis is true and the population mean average price of a hamburger is \$3.50, there is a 5.08% probability of getting the sample data or more extreme because of sampling variability.

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Since the P-value is less than our 10% significance level, it is unlikely that the sample data occurred by random chance (sampling variability).

Reject H_0

There is significant evidence to support the claim that the population mean average price of a hamburger is greater than \$3.50.

23.

$H_0 : \mu = 160$ pounds

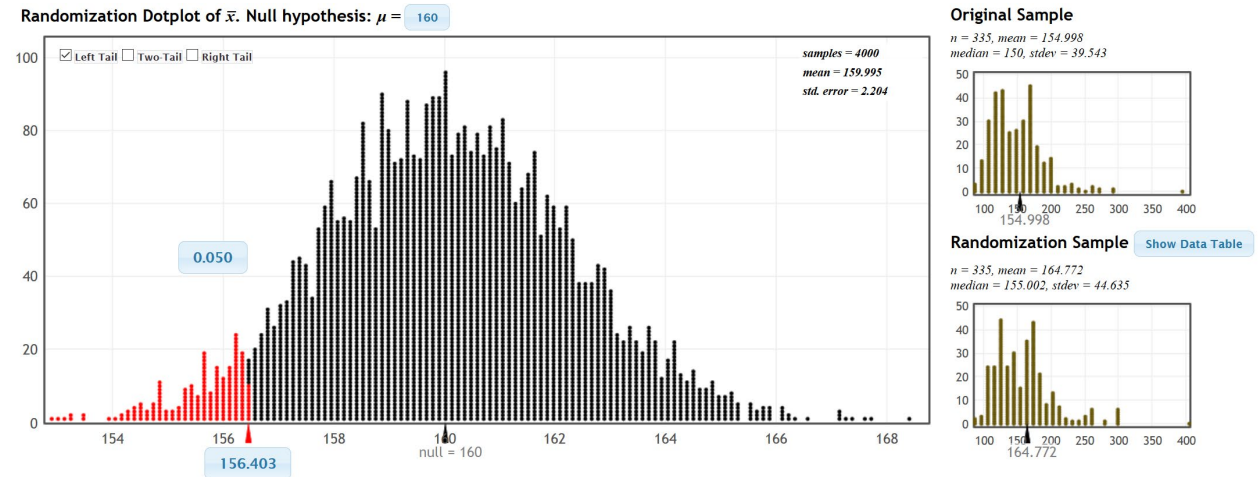
$H_A : \mu < 160$ pounds (claim)

Assumptions for randomized simulation

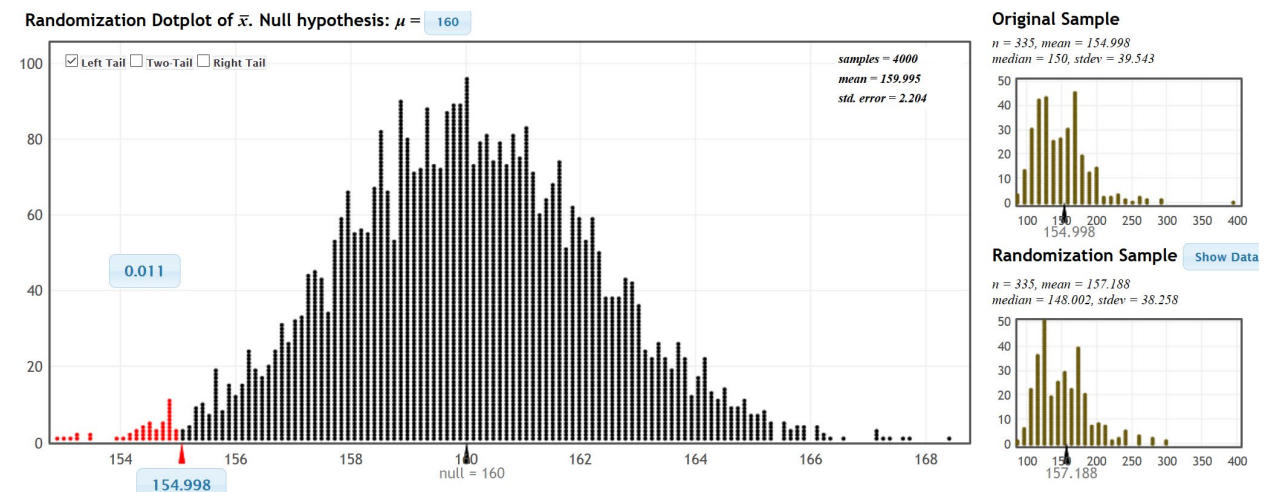
Random sample or representative? Yes. Even though the data was not a random sample, it was a census of all math 140 students in the semester. It is probably representative of all math 140 students from all semesters.

Individual independent? No. These students came from the same math 140 classes.

Randomized simulations and P-values will vary



The sample mean average weight was 154.998 pounds which did fall in the left tail determined by the simulation and the 5% significance level. This indicates that the sample data does significantly disagree with the null hypothesis.



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The estimated P-value from this simulation was 0.011 or 1.1%. If the null hypothesis is true, there is a 1.1% probability of getting the sample data or more extreme by random chance.

Since the P-value is less than the significance level of 5%, it is unlikely this sample data occurred by random chance (sampling variability).

Reject H_0

There is significant evidence to support the claim that the population mean average weight of math 140 students is less than 160 pounds.

Chapter 3 Review

1.

Hypothesis Test: A procedure for testing a claim about a population.

Null Hypothesis (H_0): A statement about the population that involves equality. It is often a statement about "no change", "no relationship" or "no effect".

Alternative Hypothesis (H_A or H_1): A statement about the population that does not involve equality. It is often a statement about a "significant difference", "significant change", "relationship" or "effect".

Population Claim: What someone thinks is true about a population.

Test Statistic: A number calculated in order to determine if the sample data significantly disagrees with the null hypothesis. There are a variety of different test statistics depending on the type of data.

One-Population Proportion Test Statistic (z): The sample proportion is this many standard errors above or below the population proportion in the null hypothesis.

One-Population Mean Test Statistic (t): The sample mean is this many standard errors above or below the population mean in the null hypothesis.

Critical Value: A number we compare our test statistic to in order to determine significance. In a sampling distribution or a theoretical distribution approximating the sampling distribution, the critical value shows us where the tail or tails are. The test statistic must fall in the tail to be significant.

Sampling Variability: Also called "random chance". The principle that random samples from the same population will usually be different and give very different statistics. The random samples will usually be different than the population parameter.

P-value: The probability of getting the sample data or more extreme because of sampling variability (by random chance) if the null hypothesis is true.

Significance Level (α): Also called the Alpha Level. This is the probability of making a type 1 error. The P-value is compared to this number to determine significance and sampling variability. If the P-value is lower than the significance level, then the sample data significantly disagrees with the null hypothesis and is unlikely to have happened because of sampling variability.

Randomized Simulation: A technique for visualizing sampling variability in a hypothesis test. The computer assumes the null hypothesis is true, and then generates random samples. If the sample data or test statistic falls in the tail, then the sample data significantly disagrees with the null hypothesis. This technique can also calculate the P-value and standard error without a formula.

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Type 1 Error: When biased sample data leads you to support the alternative hypothesis when the alternative hypothesis is actually wrong in the population.

Type 2 Error: When biased sample data leads you fail to reject the null hypothesis when the null hypothesis is actually wrong in the population.

Beta Level (β): The probability of making a type 2 error.

Conclusion: A final statement in a hypothesis test that addresses the claim and evidence.

2.

Randomized simulation is used to determine if sample data significantly disagrees with the null hypothesis and if the sample data occurred by random chance. The simulation can be used to calculate the P-value and determine the tail or tails and significance without a formula, test statistic, critical value, or theoretical curve. It also has less assumptions than traditional formula hypothesis tests.

3.

We can determine if sample data significantly disagrees with the null hypothesis in three ways.

If the test statistic falls in a tail determined by the critical value.

If the P-value is lower than the significance level.

If the sample statistic falls in a tail of the simulation determined by the significance level.

4.

Calculate the P-value. The P-value determines the probability of the sample data occurring by sampling variability if the null hypothesis was true.

5.

If the P-value is less than or equal to the significance level, we reject the null hypothesis.

If the P-value is greater than the significance level, we will fail to reject the null hypothesis.

6.

If the P-value is low, start the conclusion with "there is significant evidence".

If the P-value is high, start the conclusion with "there is not significant evidence".

If the claim is the null hypothesis, finish the conclusion with "to reject the claim".

If the claim is the alternative hypothesis, finish the conclusion with "to support the claim".

7.

One-population Mean Assumptions

- The quantitative sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.
- The sample size should be at least 30 or have a nearly normal shape.

One-population Proportion Assumptions

- The categorical sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.
- There should be at least ten successes and at least ten failures.

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One-Population Randomized Simulation Assumptions

- The sample data should be collected randomly or be representative of the population.
- Data values within the sample should be independent of each other.

8. Fill out the following table regarding test statistics and critical values.

Test Statistic	Critical Value	Does sample significantly disagree with H_0 or not?
$T = +1.774$	± 2.751	Does not significantly disagree since test stat not in tail.
$Z = -2.481$	-1.96	Does significantly disagree since test stat in tail.
$T = -3.394$	± 2.566	Does significantly disagree since test stat in tail.
$Z = +1.362$	$+1.645$	Does not significantly disagree since test stat not in tail.

9. Fill out the following table regarding P-value and Significance levels.

P-value	P-value %	Significance Level	Sampling Variability or Unlikely	Reject H_0 or Fail to reject H_0 ?
0.0002	0.02%	5%	Unlikely since P-value low	Reject H_0
0.3327	33.27%	1%	Could be sampling variability since P-value High	Fail to reject H_0
1.84×10^{-5}	0.00184%	10%	Unlikely since P-value low	Reject H_0
0.0941	9.41%	5%	Could be sampling variability since P-value High	Fail to reject H_0

10. Fill out the following table to practice writing conclusions.

P-value	Claim	Write the Conclusion addressing Evidence and claim
Low	H_0	There is significant evidence to reject the claim.
High	H_A	There is not significant evidence to support the claim.
High	H_0	There is not significant evidence to reject the claim.
Low	H_A	There is significant evidence to support the claim.

11.

a.

$$H_0: \mu = 98.6^\circ\text{F}$$

$$H_A: \mu < 98.6^\circ\text{F} \text{ (Claim)}$$

Left-tailed test

b.

$$H_0: \pi_1 = \pi_2 \text{ (Claim)}$$

$$H_A: \pi_1 > \pi_2$$

Right-tailed test

c.

$$H_0: \mu_1 = \mu_2 \text{ (Claim)}$$

$$H_A: \mu_1 \neq \mu_2$$

Two-tailed test

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12.

a.

A Type 1 Error occurs when biased sample data gives you a low P-value and leads you to reject the null hypothesis and support the alternative hypothesis, when the alternative hypothesis is actually wrong in the population.

b.

A Type 2 Error occurs when biased sample data gives you a high P-value and leads you to fail to reject the null hypothesis when the null hypothesis is actually wrong in the population.

c.

Alpha Level (α) or Significance Level

d.

Beta Level (β)

e.

Any time sample data does not reflect the population a type 1 or type 2 error may occur. It is often due to poor sampling techniques, not recognizing bias, or just sampling variability.

f.

To limit the chances of a type 1 error, decrease the significance level (alpha level).

g.

There are two ways to limit the chances of type 2 error. The preferred method is to raise the sample size (collect more data). If that is not possible, you can also raise the significance level.

h.

A 5% significance level tends to keep both type 1 and type 2 errors low.

i.

At a 1% significance level, there is a lower probability of type 1 error and a higher probability of type 2 error.

j.

At a 10% significance level, there is a higher probability of type 1 error and a lower probability of type 2 error.

13.

$H_0: \mu = 180$ pounds (claim)

$H_A: \mu \neq 180$ pounds

Two-tailed test

Assumptions Check

Random Sample? Yes. Given in the problem.

Individuals independent? Yes. This is a small random sample out of a huge population. The men are not likely to be related.

P-value (Two-tailed) = $0.030 + 0.030 = 0.060 = 6.0\%$

If the null hypothesis is true and the population mean average weight of all men is 180 pounds, then there is 6.0% probability of getting this sample data or more extreme by random chance.

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Since the P-value is higher than our significance level, the sample data does not significantly disagree with the null hypothesis and could happen by random chance.

Fail to reject H_0 .

There is not significant evidence to reject the articles claim that the population mean average weight of all men is 180 pounds.

(The article could be correct. We do not have any evidence to contradict it.)

14.

$$H_0: \mu = \$25$$

$$H_A: \mu > \$25 \text{ (claim)}$$

Right-tailed test

Assumptions Check

Random Sample? Yes. Given in the problem.

Individuals independent? Yes. This is a small random sample out of a huge population. The men are not likely to be related.

At least 30 or normal? The sample size is below 30, but since the histogram showed a normal shape, the data does pass the "30 or normal" requirement.

Test Statistic = 2.204

The sample mean of \$26.82 is 2.204 standard errors above the population mean of \$25. The test statistic indicates that the sample data significantly disagrees with the null hypothesis since it falls in the tail determined by the critical value.

$$P\text{-value} = 0.0181 = 1.81\%$$

If the null hypothesis is true and the population mean average salary of nurses is \$25, then there is 1.81% probability of getting this sample data or more extreme by random chance.

Since the P-value is lower than our significance level, the sample data was unlikely to happen by random chance.

Reject H_0 .

There is significant evidence to support the claim that that the population mean average salary for registered nurses is above \$25.

(The speaker at the convention is probably correct and we have evidence to back them up.)

15.

$$H_0: \pi = 0.1$$

$$H_A: \pi > 0.1 \text{ (claim)}$$

Right-tailed test

Assumptions Check

Random Sample? Yes. Given in the problem.

Individuals independent? Yes. This is a small random sample out of a huge population. The women are not likely to be related.

$$P\text{-value} = 0.0015 = 0.15\%$$

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If the null hypothesis is true and the population proportion of women with a tattoo is 10%, then there is 0.15% probability of getting this sample data or more extreme by random chance.

Since the P-value is lower than our significance level, the sample data does significantly disagree with the null hypothesis and is unlikely to happen by random chance.

Reject H_0 .

There is significant evidence to support the claim that more than 10% of all women have at least one tattoo.

(The article is probably correct and we have evidence to back it up.)
