CHAPTER 9: HYPOTHESIS TESTING SINGLE MEAN AND SINGLE PROPORTION

Exercise 1. You are testing that the mean speed of your cable Internet connection is more than three Megabits per second. What is the random variable? Describe in words.

Solution The random variable is the mean Internet speed in Megabits per second.

Exercise 2. You are testing that the mean speed of your cable Internet connection is more than three Megabits per second. State the null and alternative hypotheses.

Solution \[ H_0: \mu \leq 3 \]

\[ H_a: \mu > 3 \]

Exercise 3. The American family has an average of two children. What is the random variable? Describe in words.

Solution The random variable is the mean number of children an American family has.

Exercise 4. The mean entry level salary of an employee at a company is $58,000. You believe it is higher for IT professionals in the company. State the null and alternative hypotheses.

Solution \[ H_0: \mu = 58,000 \]

\[ H_a: \mu > 58,000 \]

Exercise 5. A sociologist claims the probability that a person picked at random in Times Square in New York City is visiting the area is 0.83. You want to test to see if the proportion is actually less. What is the random variable? Describe in words.

Solution The random variable is the proportion of people picked at random in Times Square
visiting the city.

Exercise 6. A sociologist claims the probability that a person picked at random in Times Square in New York City is visiting the area is 0.83. You want to test to see if the claim is correct. State the null and alternative hypotheses.

Solution

\[ H_0: p = 0.83 \]
\[ H_a: p \neq 0.83 \]

Exercise 7. In a population of fish, approximately 42% are female. A test is conducted to see if, in fact, the proportion is less. State the null and alternative hypotheses.

Solution

\[ H_0: p = 0.42 \]
\[ H_a: p < 0.42 \]

Exercise 8. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was 3 years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. If you were conducting a hypothesis test to determine if the mean length of jail time has increased, what would the null and alternative hypotheses be? The distribution of the population is normal.

State the null and alternative hypotheses.

a. \( H_0: \) __________
b. \( H_a: \) __________

Solution

a. \( H_0: \mu = 2.5 \) (or, \( H_0: \mu \leq 2.5 \))
b. \( H_a: \mu > 2.5 \)

Exercise 9. A random survey of 75 death row inmates revealed that the mean length of time on death row is 17.4 years with a standard deviation of 6.3 years. If you were conducting
a hypothesis test to determine if the population mean time on death row could likely be 15 years, what would the null and alternative hypotheses be?

a. $H_0$: __________

b. $H_a$: __________

Solution

a. $H_0: \mu = 15$

b. $H_a: \mu \neq 15$

Exercise 10. The National Institute of Mental Health published an article stating that in any one-year period, approximately 9.5 percent of American adults suffer from depression or a depressive illness. Suppose that in a survey of 100 people in a certain town, seven of them suffered from depression or a depressive illness. If you were conducting a hypothesis test to determine if the true proportion of people in that town suffering from depression or a depressive illness is lower than the percent in the general adult American population, what would the null and alternative hypotheses be?

a. $H_0$: __________

b. $H_a$: __________

Solution

a. $H_0: p = 0.095$

b. $H_a: p < 0.095$

Exercise 11. The mean price of mid-sized cars in a region is $32,000. A test is conducted to see if the claim is true. State the Type I and Type II errors in complete sentences.

Solution

Type I: The mean price of mid-sized cars is $32,000, but we conclude that it is not $32,000. Type II: The mean price of mid-sized cars is not $32,000, but we conclude that it is $32,000.

Exercise 12. A sleeping bag is tested to withstand temperatures of -15 °F. You think the bag cannot stand temperatures that low. State the Type I and Type II errors in complete sentences.

Solution

Type I: The bag can withstand -15 °F, but you conclude that it cannot stand
temperatures that low. Type II: The bag cannot withstand -15 °F, but you conclude that it can.

Exercise 13. *For Exercise 9.12, what are α and β in words?*

Solution $\alpha$ = the probability that you think the bag cannot withstand -15 degrees F, when in fact it can $\beta$ = the probability that you think the bag can withstand -15 degrees F, when in fact it cannot

Exercise 14. *In words, describe 1 – $\beta$ for Exercise 9.12.*

Solution $1 - \beta$ is $1 - \text{the probability of a Type II error. It represents the power of the test. A valid test will have a high power; therefore, a low probability of a Type II error.}$

Exercise 15. *A group of doctors is deciding whether or not to perform an operation. Suppose the null hypothesis, $H_0$, is: the surgical procedure will go well. State the Type I and Type II errors in complete sentences.*

Solution Type I: The procedure will go well, but the doctors think it will not. Type II: The procedure will not go well, but the doctors think it will.

Exercise 16. *A group of doctors is deciding whether or not to perform an operation. Suppose the null hypothesis, $H_0$, is: the surgical procedure will go well. Which is the error with the greater consequence?*

Solution The Type II error has the greater consequence because the doctors will move forward with the procedure when it will not go well.

Exercise 17. *The power of a test is 0.981. What is the probability of a Type II error?*

Solution 0.019

Exercise 18. *A group of divers is exploring an old sunken ship. Suppose the null hypothesis, $H_0$, is: the sunken ship does not contain buried treasure. State the Type I and Type II errors in*
complete sentences.

Solution

Type I: The ship does not contain buried treasure, but the divers think it does. Type II: The ship does contain buried treasure, but the divers think it does not.

Exercise 19. A microbiologist is testing a water sample for E-coli. Suppose the null hypothesis, \(H_0\), is: the sample does not contain E-coli. The probability that the sample does not contain E-coli, but the microbiologist thinks it does is 0.012. The probability that the sample does contain E-coli, but the microbiologist thinks it does not is 0.002. What is the power of this test?

Solution

0.998

Exercise 20. A microbiologist is testing a water sample for E-coli. Suppose the null hypothesis, \(H_0\), is: the sample contains E-coli. Which is the error with the greater consequence?

Solution

A Type I error has the greater consequence. Thinking there are no E-coli when there are can cause more exposure to the bacteria.

Exercise 21. Which two distributions can you use for hypothesis testing for this chapter?

Solution

A normal distribution or a Student’s \(t\)-distribution

Exercise 22. Which distribution do you use when the standard deviation is not known? Assume sample size is large.

Solution

Use a normal distribution.

Exercise 23. Which distribution do you use when the standard deviation is not known and you are testing one population mean? Assume sample size is large.

Solution

Use a Student’s \(t\)-distribution.

Exercise 24. A population mean is 13. The sample mean is 12.8, and the sample standard deviation
is two. The sample size is 20. What distribution should you use to perform a hypothesis test? Assume the underlying population is normal.

Solution a Student’s $t$-distribution

Exercise 25. A population has a mean is 25 and a standard deviation of five. The sample mean is 24, and the sample size is 108. What distribution should you use to perform a hypothesis test?

Solution a normal distribution for a single population mean

Exercise 26. It is thought that 42% of respondents in a taste test would prefer Brand A. In a particular test of 100 people, 39% preferred Brand A. What distribution should you use to perform a hypothesis test?

Solution a normal distribution for a single population proportion

Exercise 27. You are performing a hypothesis test of a single population mean using a Student’s $t$-distribution. What must you assume about the distribution of the data?

Solution It must be approximately normally distributed.

Exercise 28. You are performing a hypothesis test of a single population mean using a Student’s $t$-distribution. The data are not from a simple random sample. Can you accurately perform the hypothesis test?

Solution No, for a hypothesis test, the data are assumed to be from a simple random sample.

Exercise 29. You are performing a hypothesis test of a single population proportion. What must be true about the quantities of $np$ and $nq$?

Solution They must both be greater than five.

Exercise 30. You are performing a hypothesis test of a single population proportion. You find out
that \( np \) is less than five. What must you do to be able to perform a valid hypothesis test?

Solution Increase the sample size so that \( np \) is greater than five.

Exercise 31. You are performing a hypothesis test of a single population proportion. The data come from which distribution?

Solution binomial distribution

Exercise 32. When do you reject the null hypothesis?

Solution When the \( p \)-value is smaller than a preconceived alpha.

Exercise 33. The probability of winning the grand prize at a particular carnival game is 0.005. Is the outcome of winning very likely or very unlikely?

Solution The outcome of winning is very unlikely.

Exercise 34. The probability of winning the grand prize at a particular carnival game is 0.005. Michele wins the grand prize. Is this considered a rare or common event? Why?

Solution This is considered a rare event because the probability of it occurring is so low.

Exercise 35. It is believed that the mean height of high school students who play basketball on the school team is 73 inches with a standard deviation of 1.8 inches. A random sample of 40 players is chosen. The sample mean was 71 inches, and the sample standard deviation was 1.5 years. Do the data support the claim that the mean height is less than 73 inches? The \( p \)-value is almost zero. State the null and alternative hypotheses and interpret the \( p \)-value.

Solution 

\[ H_0: \mu \geq 73 \]
\[ H_a: \mu < 73 \]

The \( p \)-value is almost zero, which means there is sufficient data to conclude that the
mean height of high school students who play basketball on the school team is less than 73 inches at the 5% level. The data do support the claim.

Exercise 36. The mean age of graduate students at a University is at most 31 years with a standard deviation of two years. A random sample of 15 graduate students is taken. The sample mean is 32 years and the sample standard deviation is three years. Are the data significant at the 1% level? The p-value is 0.0264. State the null and alternative hypotheses and interpret the p-value.

Solution \[ H_0: \mu \leq 31 \]
\[ H_a: \mu > 31 \]
The p-value is 0.0264, so the data are not significant at the 1% level.

Exercise 37. Does the shaded region represent a low or a high p-value compared to a level of significance of 1%?

Solution The shaded region shows a low p-value.

Exercise 38. What should you do when \( \alpha > p\text{-value} \)?

Solution Reject \( H_0 \).

Exercise 39. What should you do if \( \alpha = p\text{-value} \)?

Solution Do not reject \( H_0 \).
Exercise 40. If you do not reject the null hypothesis, then it must be true. Is this statement correct? State why or why not in complete sentences.

Solution No. The fact that you do not reject \( H_0 \) does not mean \( H_0 \) is true. It means the sample data have failed to provide sufficient evidence to cast serious doubt about the truthfulness of the null hypothesis. Additional samples must be taken.

Exercise 41. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

Is this a test of means or proportions?

Solution means

Exercise 42. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

What symbol represents the random variable for this test?

Solution \( \bar{x} \)
Exercise 43. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

In words, define the random variable for this test.

Solution

the mean time spent in jail for 26 first-time convicted burglars

Exercise 44. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

Is the population standard deviation known and, if so, what is it?

Solution

yes, 1.5

Exercise 45. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the
mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

Calculate the following:

a. $\overline{x} = \underline{_______}$

b. $\sigma = \underline{_______}$

c. $s_x = \underline{_______}$

d. $n = \underline{_______}$

Solution

a. 3  
b. 1.5  
c. 1.8  
d. 26

Exercise 46. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years with a standard deviation of 1.8 years. Suppose that it is somehow known that the population standard deviation is 1.5. Conduct a hypothesis test to determine if the mean length of jail time has increased. Assume the distribution of the jail times is approximately normal.

Since both $\sigma$ and $s_x$ are given, which should be used? In one to two complete sentences, explain why.

Solution $\sigma$

Exercise 47. Suppose that a recent article stated that the mean time spent in jail by a first-time convicted burglar is 2.5 years. A study was then done to see if the mean time has increased in the new century. A random sample of 26 first-time convicted burglars in a recent year was picked. The mean length of time in jail from the survey was three years
with a standard deviation of 1.8 years. Suppose that it is somehow known that the
population standard deviation is 1.5. Conduct a hypothesis test to determine if the
mean length of jail time has increased. Assume the distribution of the jail times is
approximately normal.

State the distribution to use for the hypothesis test.

Solution

\[ \overline{X} \sim N(2.5, \frac{1.5}{\sqrt{26}}) \]

Exercise 48

A random survey of 75 death row inmates revealed that the mean length of time on
death row is 17.4 years with a standard deviation of 6.3 years. Conduct a hypothesis
test to determine if the population mean time on death row could likely be 15 years.

a. Is this a test of means or proportions?

b. State the null and alternative hypotheses.

\[ H_0: \quad \text{ } \quad H_a: \quad \text{ } \]

c. Is this a right-tailed, left-tailed, or two-tailed test?

d. What symbol represents the Random Variable for this test?

e. In words, define the random variable for this test.

f. Is the population standard deviation known and, if so, what is it?

g. Calculate the following:

i. \( \overline{x} = \) _____

ii. \( s = \) _____

iii. \( n = \) _____

h. Which test should be used?

i. State the distribution to use for the hypothesis test.

j. Find the p-value.

k. At a pre-conceived \( \alpha = 0.05 \), what is your:

i. Decision:

ii. Reason for the decision:
iii. Conclusion (write out in a complete sentence):

Solution

a. mean

b. $H_0: \mu = 15$ $H_a: \mu \neq 15$

c. two-tailed

d. $\bar{x}$

e. The mean time spent on death row for 75 inmates

f. No.

g. i. $\bar{x} = 17.4$

ii. $s = 6.3$

iii. $n = 75$

h. $t_{74}$

i. Student’s-t

j. 0.0015

k. At a pre-conceived $\alpha = 0.05$, what is your:

i. Decision: Reject the null hypothesis.

ii. Reason for the decision: $p$-value < alpha

iii. Conclusion: At the 5% level of significance, there is sufficient evidence to conclude that the mean time spent on death row is not 15 years.

Exercise 49  Assume $H_0: \mu = 9$ and $H_a: \mu < 9$. Is this a left-tailed, right-tailed, or two-tailed test?

Solution  This is a left-tailed test.

Exercise 50  Assume $H_0: \mu \leq 6$ and $H_a: \mu > 6$. Is this a left-tailed, right-tailed, or two-tailed test?

Solution  This is a right-tailed test.

Exercise 51  Assume $H_0: p = 0.25$ and $H_a: p \neq 0.25$. Is this a left-tailed, right-tailed, or two-tailed test?
Exercise 52  *Draw the general graph of a left-tailed test.*

Solution

Exercise 53  *Draw the graph of a two-tailed test.*

Solution

Exercise 54  *A bottle of water is labeled as containing 16 fluid ounces of water. You believe it is less than that. What type of test would you use?*

Solution  a left-tailed test

Exercise 55  *Your friend claims that his mean golf score is 63. You want to show that it is higher than that. What type of test would you use?*

Solution  a right-tailed test

Exercise 56  *A bathroom scale claims to be able to identify correctly any weight within a pound. You think that it cannot be that accurate. What type of test would you use?*
Exercise 57  You flip a coin and record whether it shows heads or tails. You know the probability of getting heads is 50%, but you think it is less for this particular coin. What type of test would you use?

Solution  a left-tailed test

Exercise 58  If the alternative hypothesis has a not equals ( ≠ ) symbol, you know to use which type of test?

Solution  a two-tailed test

Exercise 59  Assume the null hypothesis states that the mean is at least 18. Is this a left-tailed, right-tailed, or two-tailed test?

Solution  This is a left-tailed test.

Exercise 60  Assume the null hypothesis states that the mean is at most 12. Is this a left-tailed, right-tailed, or two-tailed test?

Solution  This is a right-tailed test.

Exercise 61  Assume the null hypothesis states that the mean is equal to 88. The alternative hypothesis states that the mean is not equal to 88. Is this a left-tailed, right-tailed, or two-tailed test?

Solution  This is a two-tailed test

Exercise 62  Some of the following statements refer to the null hypothesis, some to the alternate hypothesis. State the null hypothesis, \( H_0 \), and the alternative hypothesis, \( H_a \), in terms of the appropriate parameter (\( \mu \) or \( p \)).

a. The mean number of years Americans work before retiring is 34.
b. At most 60% of Americans vote in presidential elections.

c. The mean starting salary for San Jose State University graduates is at least $100,000 per year.

d. Twenty-nine percent of high school seniors get drunk each month.

e. Fewer than 5% of adults ride the bus to work in Los Angeles.

f. The mean number of cars a person owns in her lifetime is not more than ten.

g. About half of Americans prefer to live away from cities, given the choice.

h. Europeans have a mean paid vacation each year of six weeks.

i. The chance of developing breast cancer is under 11% for women.

j. Private universities' mean tuition cost is more than $20,000 per year.

Solution

a. \( H_0: \mu = 34; Ha: \mu \neq 34 \)

b. \( H_0: p \leq 0.60; Ha: p > 0.60 \)

c. \( H_0: \mu \geq 100,000; Ha: \mu < 100,000 \)

d. \( H_0: p = 0.29; Ha: p \neq 0.29 \)

e. \( H_0: p = 0.05; Ha: p < 0.05 \)

f. \( H_0: \mu \leq 10; Ha: \mu > 10 \)

g. \( H_0: p = 0.50; Ha: p \neq 0.50 \)

h. \( H_0: \mu = 6; Ha: \mu \neq 6 \)

i. \( H_0: p \geq 0.11; Ha: p < 0.11 \)

j. \( H_0: \mu \leq 20,000; Ha: \mu > 20,000 \)

Exercise 63

Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin? The alternative hypothesis is:

a. \( p < 0.30 \)
b. \( p \leq 0.30 \)
c. \( p \geq 0.30 \)
d. \( p > 0.30 \)

Solution    d

Exercise 64    A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 attended the midnight showing.

An appropriate alternative hypothesis is:

a. \( p = 0.20 \)
b. \( p > 0.20 \)
c. \( p < 0.20 \)
d. \( p \leq 0.20 \)

Solution    c

Exercise 65    Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher.

Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test.

The null and alternative hypotheses are:

a. \( H_0: \bar{x} = 4.5, H_a: \bar{x} > 4.5 \)
b. \( H_0: \mu \geq 4.5, H_a: \mu < 4.5 \)
c. \( H_0: \mu = 4.75, H_a: \mu > 4.75 \)
d. \( H_0: \mu = 4.5 H_a: \mu > 4.5 \)

Solution    d
State the Type I and Type II errors in complete sentences given the following statements.

a. The mean number of years Americans work before retiring is 34.

b. At most 60% of Americans vote in presidential elections.

c. The mean starting salary for San Jose State University graduates is at least $100,000 per year.

d. Twenty-nine percent of high school seniors get drunk each month.

e. Fewer than 5% of adults ride the bus to work in Los Angeles.

f. The mean number of cars a person owns in his or her lifetime is not more than ten.

g. About half of Americans prefer to live away from cities, given the choice.

h. Europeans have a mean paid vacation each year of six weeks.

i. The chance of developing breast cancer is under 11% for women.

j. Private universities mean tuition cost is more than $20,000 per year.

Solution

a. Type I error: We conclude that the mean is not 34 years, when it really is 34 years. Type II error: We conclude that the mean is 34 years, when in fact it really is not 34 years.

b. Type I error: We conclude that more than 60% of Americans vote in presidential elections, when the actual percentage is at most 60%. Type II error: We conclude that at most 60% of Americans vote in presidential elections when, in fact, more than 60% do.

c. Type I error: We conclude that the mean starting salary is less than $100,000, when it really is at least $100,000. Type II error: We conclude that the mean starting salary is at least $100,000 when, in fact, it is less than $100,000.

d. Type I error: We conclude that the proportion of high school seniors who get drunk each month is not 29%, when it really is 29%. Type II error: We conclude that the proportion of high school seniors who get drunk each month is 29% when, in fact, it is not 29%.

e. Type I error: We conclude that fewer than 5% of adults ride the bus to work in Los Angeles. Type II error: We conclude that more than 5% of adults ride the bus to work in Los Angeles.
Angeles, when the percentage that do is really 5% or more. Type II error: We conclude that 5% or more adults ride the bus to work in Los Angeles when, in fact, fewer that 5% do.

f. Type I error: We conclude that the mean number of cars a person owns in his or her lifetime is more than 10, when in reality it is not more than 10. Type II error: We conclude that the mean number of cars a person owns in his or her lifetime is not more than 10 when, in fact, it is more than 10.

g. Type I error: We conclude that the proportion of Americans who prefer to live away from cities is not about half, though the actual proportion is about half. Type II error: We conclude that the proportion of Americans who prefer to live away from cities is half when, in fact, it is not half.

h. Type I error: We conclude that the duration of paid vacations each year for Europeans is not six weeks, when in fact it is six weeks. Type II error: We conclude that the duration of paid vacations each year for Europeans is six weeks when, in fact, it is not.

i. Type I error: We conclude that the proportion is less than 11%, when it is really at least 11%. Type II error: We conclude that the proportion of women who develop breast cancer is at least 11%, when in fact it is less than 11%.

j. Type I error: We conclude that the average tuition cost at private universities is more than $20,000, though in reality it is at most $20,000. Type II error: We conclude that the average tuition cost at private universities is at most $20,000 when, in fact, it is more than $20,000.

Exercise 67  For statements a-j in Exercise 9.109, answer the following in complete sentences.

a. State a consequence of committing a Type I error.

b. State a consequence of committing a Type II error.

Solution

a. Type I: Pension funds make investments that have maturity greater than 34 years. As a consequence, they do not have sufficient funds available for retirees' payout.
Type II: Pension funds act conservatively, and make investments that have maturity of at most 34 years (possibly losing out on higher interest earnings).

b. Type I: Too many voting booths are set up, costing tax payers more than required.
Type II: We do not have adequate voting booths, which result in longer waiting times at some booths.

c. Type I: San Jose' State University understates the value of its graduate degrees in its promotional materials.
Type II: San Jose' State University overstates the earning potential of its graduates.

d. Type I: We place less importance on educating high school seniors about the harmful effects of drinking (if 29% is considered to be too low).
Type II: (If 29% is considered too high,) more resources than needed are spent to raise public awareness about the dangers of teenage drinking.

e. Type I: Less public transportation is available than the demand necessitates.
Type II: Resources that could have been spent on education, for instance, get diverted towards providing public transportation in Los Angeles.

f. Type I: Car dealerships end up spending more on advertising new makes and models of cars to induce customers into buying newer cars.
Type II: Car dealerships choose not to advertise new makes and models as much as they probably should.

g. Type I: Housing supply falls short of demand in the suburbs beyond city limits where Americans prefer to live.
Type II: Too much housing is available beyond city limits, and not enough within the city limits.

h. Type I: European travel destinations spend less on advertisements to entice tourists than they probably should (if they think paid vacation time is less than six weeks).
Type II: We (Americans) start feeling resentful about not having six weeks' paid vacation like the Europeans!

i. Type I: Less resources are devoted towards research and development of new drugs
for breast cancer treatment than warranted.
Type II: Doctors prescribe preventive mammograms more often than evidence would suggest necessary.
j. Type I: Estimates of student debt based on these numbers are overstated.
Type II: Estimates of student debt based on these numbers are understated, and consequently the magnitude of student debt becomes staggering.

Exercise 68  When a new drug is created, the pharmaceutical company must subject it to testing before receiving the necessary permission from the Food and Drug Administration (FDA) to market the drug. Suppose the null hypothesis is “the drug is unsafe.” What is the Type II Error?

a. To conclude the drug is safe when in fact, it is unsafe.
b. Not to conclude the drug is safe when, in fact, it is safe.
c. To conclude the drug is safe when, in fact, it is safe.
d. Not to conclude the drug is unsafe when, in fact, it is unsafe.

Solution  
b

Exercise 69  A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing. The Type I error is to conclude that the percent of EVC students who attended is

a. at least 20%, when in fact, it is less than 20%.
b. 20%, when in fact, it is 20%.
c. less than 20%, when in fact, it is at least 20%.
d. less than 20%, when in fact, it is less than 20%.

Solution  
a
Exercise 70  It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than seven hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated a mean of 7.24 hours with a standard deviation of 1.93 hours. At a level of significance of 5%, do LTCC Intermediate Algebra students get less than seven hours of sleep per night, on average?

The Type II error is not to reject that the mean number of hours of sleep LTCC students get per night is at least seven when, in fact, the mean number of hours

a. is more than seven hours.

b. is at most seven hours.

c. is at least seven hours.

d. is less than seven hours.

Solution  d

Exercise 71  Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis tes, the Type I error is:

a. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is higher

b. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is the same

c. to conclude that the mean hours per week currently is 4.5, when in fact, it is higher

d. to conclude that the mean hours per week currently is no higher than 4.5, when in fact, it is not higher

Solution  b
Exercise 72  It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than seven hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated a mean of 7.24 hours with a standard deviation of 1.93 hours. At a level of significance of 5%, do LTCC Intermediate Algebra students get less than seven hours of sleep per night, on average?

The distribution to be used for this test is $\bar{X} \sim \_\_$

a. $N\left(7.24, \frac{1.93}{\sqrt{22}}\right)$

b. $N(7.24, 1.93)$

c. $t_{22}$

d. $t_{21}$

Solution  d

Exercise 73  The National Institute of Mental Health published an article stating that in any one-year period, approximately 9.5 percent of American adults suffer from depression or a depressive illness. Suppose that in a survey of 100 people in a certain town, seven of them suffered from depression or a depressive illness. Conduct a hypothesis test to determine if the true proportion of people in that town suffering from depression or a depressive illness is lower than the percent in the general adult American population.

a. Is this a test of one mean or proportion?

b. State the null and alternative hypotheses.

$H_0$: ____________________ $H_a$: ____________________

c. Is this a right-tailed, left-tailed, or two-tailed test?

d. What symbol represents the random variable for this test?
e. In words, define the random variable for this test.

f. Calculate the following:
   i. \( x = \) ________________
   ii. \( n = \) ________________
   iii. \( p' = \) ________________

g. Calculate \( \sigma_x = \) __________. Show the formula set-up.

h. State the distribution to use for the hypothesis test.

i. Find the p-value.

j. At a pre-conceived \( \alpha = 0.05 \), what is your:
   i. Decision:
   ii. Reason for the decision:
   iii. Conclusion (write out in a complete sentence):

Solution

a. proportion
b. \( H_0: p = 0.095 \) \( Ha: p < 0.95 \)
c. left-tailed
d. \( p' \)
e. the proportion of people that town surveyed suffering from depression or a depressive illness
f. i. \( x = 7 \)
   ii. \( n = 100 \)
   iii. \( p' = 0.07 \)
g. \( \sigma = \sqrt{\frac{pq}{n}} = \sqrt{\frac{(0.095)(0.905)}{100}} = 0.023 \)
Exercise 74  
A particular brand of tires claims that its deluxe tire averages at least 50,000 miles before it needs to be replaced. From past studies of this tire, the standard deviation is known to be 8,000. A survey of owners of that tire design is conducted. From the 28 tires surveyed, the mean lifespan was 46,500 miles with a standard deviation of 9,800 miles. Using alpha = 0.05, is the data highly inconsistent with the claim?

Solution  

a. $H_0: \mu \geq 50,000$

b. $H_a: \mu < 50,000$

c. Let $\bar{X}$ = the average lifespan of a brand of tires.

d. normal distribution

e. $z = -2.315$

f. $p$-value = 0.0103

g. Check student’s solution.

h.  
i. alpha: 0.05

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: The $p$-value is less than 0.05.

iv. Conclusion: There is sufficient evidence to conclude that the mean lifespan of the tires is less than 50,000 miles.

i. (43,537, 49,463)

Exercise 75  
From generation to generation, the mean age when smokers first start to smoke varies. However, the standard deviation of that age remains constant of around 2.1 years. A
A survey of 40 smokers of this generation was done to see if the mean starting age is at least 19. The sample mean was 18.1 with a sample standard deviation of 1.3. Do the data support the claim at the 5% level?

Solution

a. $H_0 : \mu \geq 19$

b. $H_a : \mu < 19$

c. Let $\bar{X}$ = the mean age at which a smoker first starts to smoke.

d. normal distribution

e. $z = -2.71$

f. $p$-value = 0.0034

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: The $p$-value is less than 0.05.

iv. Conclusion: $\mu < 19$

i. $(17.449, 18.757)$

Exercise 76

The cost of a daily newspaper varies from city to city. However, the variation among prices remains steady with a standard deviation of 20¢. A study was done to test the claim that the mean cost of a daily newspaper is $1.00. Twelve costs yield a mean cost of 95¢ with a standard deviation of 18¢. Do the data support the claim at the 1% level?

Solution

a. $H_0 : \mu = 1.00$

b. $H_a: \mu \neq 1.00$

c. Let $\bar{X}$ = the average cost of a daily newspaper.

d. normal distribution

e. $z = -0.866$

f. $p$-value = 0.3865
Exercise 77  An article in the San Jose Mercury News stated that students in the California state university system take 4.5 years, on average, to finish their undergraduate degrees. Suppose you believe that the mean time is longer. You conduct a survey of 49 students and obtain a sample mean of 5.1 with a sample standard deviation of 1.2. Do the data support your claim at the 1% level?

Solution  

a. \( H_0 : \mu \leq 4.5 \)

b. \( H_a : \mu > 4.5 \)

c. Let \( \bar{X} \) = the average time to finish an undergraduate degree.

d. Student’s-t distribution

e. \( z = 3.5 \)

f. \( p\)-value = 0.0005

g. Check student’s solution.

h.  

i. Alpha: 0.01

ii. Decision: Reject the null hypothesis

iii. Reason for decision: The \( p\)-value is less than the 0.01.

iv. Conclusion: \( \mu > 4.5 \)

i. (4.7553, 5.4447)

Exercise 78  The mean number of sick days an employee takes per year is believed to be about ten. Members of a personnel department do not believe this figure. They randomly survey eight employees. The number of sick days they took for the past year are as follows: 12;
Let \( x \) = the number of sick days they took for the past year. Should the personnel team believe that the mean number is ten?

Solution

a. \( H_0: \mu = 10 \)

b. \( H_a: \mu \neq 10 \)

c. Let \( \bar{X} \) = the mean number of sick days an employee takes per year.

d. Student’s \( t \)-distribution

e. \( t = -1.12 \)

f. \( p \)-value = 0.300

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Do not reject the null hypothesis.

iii. Reason for decision: The \( p \)-value is greater than 0.05.

iv. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the mean number of sick days is not ten.

i. (4.9443, 11.806)

Exercise 79

In 1955, Life Magazine reported that the 25 year-old mother of three worked, on average, an 80 hour week. Recently, many groups have been studying whether or not the women’s movement has, in fact, resulted in an increase in the average work week for women (combining employment and at-home work). Suppose a study was done to determine if the mean work week has increased. 81 women were surveyed with the following results. The sample mean was 83; the sample standard deviation was ten. Does it appear that the mean work week has increased for women at the 5% level?

Solution

a. \( H_0 : \mu \leq 80 \)

b. \( H_0 : \mu > 80 \)

c. Let \( \bar{X} \) = the average work week for women.

d. Student’s-\( t \) distribution

e. 2.7
f. $p$-value = 0.0042

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: The $p$-value is less than 0.05.

iv. Conclusion: There is sufficient evidence to conclude that the mean work week for women is more than 80 hours.

i. (80.789,85.211)

Exercise 80

Your statistics instructor claims that 60 percent of the students who take her Elementary Statistics class go through life feeling more enriched. For some reason that she can’t quite figure out, most people don’t believe her. You decide to check this out on your own. You randomly survey 64 of her past Elementary Statistics students and find that 34 feel more enriched as a result of her class. Now, what do you think?

Solution

a. $H_0$: $p \geq 0.6$

b. $H_a$: $p < 0.6$

c. Let $P’$ = the proportion of students who feel more enriched as a result of taking Elementary Statistics.

d. normal for a single proportion

e. 1.12

f. $p$-value = 0.1308

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Do not reject the null hypothesis.

iii. Reason for decision: The $p$-value is greater than 0.05.

iv. Conclusion: There is insufficient evidence to conclude that less than 60 percent of her students feel more enriched.

i. Confidence Interval: (0.409, 0.654)
The “plus-4s” confidence interval is (0.411, 0.648)

**Exercise 81**  
A Nissan Motor Corporation advertisement read, “The average man’s I.Q. is 107. The average brown trout’s I.Q. is 4. So why can’t man catch brown trout?” Suppose you believe that the brown trout’s mean I.Q. is greater than four. You catch 12 brown trout. A fish psychologist determines the I.Q.s as follows: 5; 4; 7; 3; 6; 4; 5; 3; 6; 3; 8; 5.  
Conduct a hypothesis test of your belief.

**Solution**

a. $H_0: \mu \leq 4$
b. $H_a: \mu > 4$
c. Let $\overline{X}$ = the average I.Q. of a set of brown trout.
d. $t_{11}$
e. $t = 1.96$
f. $p$-value = 0.0380
g. Check student’s solution.
h. i. Alpha: 0.05
   ii. Decision: Reject the null hypothesis when $\alpha = 0.05$, but do not reject null when $\alpha = 0.01$.
   iii. Reason for decision: The $p$-value is less than 0.05 but greater than 0.01.
   iv. Conclusion: When $\alpha = 0.05$, there is sufficient evidence to conclude that the mean IQ for brown trout is greater than four. When $\alpha = 0.01$, there is insufficient evidence to conclude that the mean IQ for brown trout is greater than four.
i. (3.8865, 5.9468)

**Exercise 82**  
Refer to **Exercise 1.119**. Conduct a hypothesis test to see if your decision and conclusion would change if your belief were that the brown trout’s mean I.Q. is not four.

**Solution**

a. $H_0: \mu = 4$
b. $H_a: \mu \neq 4$
c. Let \( \bar{X} \) the average I.Q. of a set of brown trout.
d. two-tailed Student’s t-test
e. \( t = 1.95 \)
f. \( p \)-value = 0.076
g. Check student’s solution.
i. Alpha: 0.05
ii. Decision: Reject the null hypothesis.
iii. Reason for decision: The \( p \)-value is greater than 0.05
iv. Conclusion: There is insufficient evidence to conclude that the average IQ of brown trout is not four.
i. (3.8865,5.9468)

Exercise 83  According to an article in Newsweek, the natural ratio of girls to boys is 100:105. In China, the birth ratio is 100:114 (46.7% girls). Suppose you don’t believe the reported figures of the percent of girls born in China. You conduct a study. In this study, you count the number of girls and boys born in 150 randomly chosen recent births. There are 60 girls and 90 boys born of the 150. Based on your study, do you believe that the percent of girls born in China is 46.7?

Solution  
a. \( H_0: \ p = 0.467 \)
b. \( H_a: \ p \neq 0.467 \)
c. Let \( P' \) = the proportion of births in China that are girls.
d. normal for a single proportion
e. \(-1.64\)
f. \( p \)-value = 0.1000
g. Check student’s solution.
i. alpha: 0.05
ii. Decision: Do not reject the null hypothesis.
iii. Reason for decision: The \( p \)-value is greater than 0.05.
iv. Conclusion: There is insufficient evidence to conclude that the proportion of girls born in China is not 0.467.

i. Confidence Interval: (0.3216, 0.4784)
The “plus-4s” confidence interval is (0.3251, 0.4801).

Exercise 84  
A poll done for Newsweek found that 13% of Americans have seen or sensed the presence of an angel. A contingent doubts that the percent is really that high. It conducts its own survey. Out of 76 Americans surveyed, only two had seen or sensed the presence of an angel. As a result of the contingent’s survey, would you agree with the Newsweek poll? In complete sentences, also give three reasons why the two polls might give different results.

Solution  
a. $H_0: p \geq 0.13$
b. $H_a: p < 0.13$
c. Let $P' = $ the proportion of Americans who have seen or sensed angels
d. normal for a single proportion
e. –2.688
f. $p$-value = 0.0036
g. Check student’s solution.
h. i. alpha: 0.05
   ii. Decision: Reject the null hypothesis.
   iii. Reason for decision: The $p$-value is less than 0.05.
   iv. Conclusion: There is sufficient evidence to conclude that the percentage of Americans who have seen or sensed an angel is less than 13%.
i. (0, 0.0623).
The “plus-4s” confidence interval is (0.0022, 0.0978)

Exercise 85  
The mean work week for engineers in a start-up company is believed to be about 60 hours. A newly hired engineer hopes that it’s shorter. She asks ten engineering friends in start-ups for the lengths of their mean work weeks. Based on the results that follow,
should she count on the mean work week to be shorter than 60 hours?

Data (length of mean work week): 70; 45; 55; 60; 65; 55; 55; 60; 50; 55.

Solution

a. $H_0: \mu \geq 60$

b. $H_a: \mu < 60$

c. Let the mean length of work weeks for engineers at the company.

d. $t_9$

e. $-1.33$

f. $p$-value = 0.1086

g. Check student’s solution.

h.  
   i. Alpha: 0.05

   ii. Decision: Do not reject the null hypothesis.

   iii. Reason for decision: The $p$-value is greater than 0.05

   iv. Conclusion: There is insufficient evidence that the mean work week for company engineers is shorter than 60 hours.

i. (51.886, 62.114)

Exercise 86  
Use the “Lap time” data for Lap 4 (see Appendix C) to test the claim that Terri finishes Lap 4, on average, in less than 129 seconds. Use all twenty races given.

Solution

a. $H_0: \mu \geq 129$

b. $H_a: \mu < 129$

c. Let $\bar{X}$ = the average time in seconds that Terri finishes Lap 4.

d. Student’s-t distribution.

e. $t = 1.209$

f. 0.8792

g. Check student’s solution.

h.  
   i. Alpha: 0.05

   ii. Decision: Do not reject the null hypothesis.

   iii. Reason for decision: The $p$-value is greater than 0.05.
iv. Conclusion: There is insufficient evidence to conclude that Terri’s mean lap time is less than 129 seconds.

Exercise 87  
*Use the “Initial Public Offering” data (see Appendix C) to test the claim that the mean offer price was $18 per share. Do not use all the data. Use your random number generator to randomly survey 15 prices.*

Solution  
*Answers will vary.*

a. $H_0: \mu = $18

b. $H_a: \mu \neq $18

c. Let $\bar{X}$ = the mean initial public offering (IPO) price for stocks in 1999.

d. Student’s t distribution

The following values are based on the random sample:

$15.00, $13.41, $17.00, $24.00, $15.00, $23.00, $12.00, $18.00, $16.00, $34.00, $14.00, $23.00, $18.00, $16.00, $10.00

e. $t = -0.07$

f. 0.9465

g. Check student’s solution.

h.  
   i. Alpha: 0.05

   ii. Decision: Do not reject the null hypothesis.

   iii. Reason for decision: The $p$-value is greater than 0.05.

   iv. Conclusion: There is insufficient evidence to conclude that the average IPO stock price in 1999 was not $18.

i. ($14.57, $21.22)

Exercise 88  
"Asian Family Reunion," by Chau Nguyen

*Every two years it comes around.*

*We all get together from different towns.*
In my honest opinion,
It’s not a typical family reunion.
Not forty, or fifty, or sixty,
But how about seventy companions!
The kids would play, scream, and shout
One minute they’re happy, another they’ll pout.
The teenagers would look, stare, and compare
From how they look to what they wear.
The men would chat about their business
That they make more, but never less.
Money is always their subject
And there’s always talk of more new projects.
The women get tired from all of the chats
They head to the kitchen to set out the mats.
Some would sit and some would stand
Eating and talking with plates in their hands.
Then come the games and the songs
And suddenly, everyone gets along!
With all that laughter, it’s sad to say
That it always ends in the same old way.
They hug and kiss and say "good-bye"
And then they all begin to cry!
I say that 60 percent shed their tears
But my mom counted 35 people this year.
She said that boys and men will always have their pride,
So we won't ever see them cry.
I myself don't think she's correct,
So could you please try this problem to see if you object?
Solution

a. $H_0: \ p = 0.60$

b. $H_a: \ p < 0.60$

c. Let $P' =$ the proportion of family members who shed tears at a reunion.

d. normal for a single proportion

e. $-1.71$

f. $0.0438$

g. Check student's solution.

h.  
i. alpha: 0.05

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: $p$-value < alpha

iv. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportion of family members who shed tears at a reunion is less than 0.60. However, the test is weak because the $p$-value and alpha are quite close, so other tests should be done.

i. We are 95% confident that between 38.29% and 61.71% of family members will shed tears at a family reunion. (0.3829, 0.6171). The “plus-4s” confidence interval (see chapter 8) is (0.3861, 0.6139)

Note that here the “large-sample” $1 - \text{PropZTest}$ provides the approximate $p$-value of 0.0438. Whenever a $p$-value based on a normal approximation is close to the level of significance, the exact $p$-value based on binomial probabilities should be calculated whenever possible. This is beyond the scope of this course.

Exercise 89

"The Problem with Angels," by Cyndy Dowling

Although this problem is wholly mine,

The catalyst came from the magazine, Time.

On the magazine cover I did find

The realm of angels tickling my mind.

Inside, 69% I found to be

In angels, Americans do believe.
Then, it was time to rise to the task,  
Ninety-five high school and college students I did ask.  
Viewing all as one group,  
Random sampling to get the scoop.  
So, I asked each to be true,  
"Do you believe in angels?" Tell me, do!  
Hypothesizing at the start,  
Totally believing in my heart  
That the proportion who said yes  
Would be equal on this test.  
Lo and behold, seventy-three did arrive,  
Out of the sample of ninety-five.  
Now your job has just begun,  
Solve this problem and have some fun.

Solution

a. $H_0$: $p = 0.69$

b. $H_a$: $p \neq 0.69$

c. Let $P'$ = the proportion of Americans who believe in angels.

d. Normal distribution for a single proportion.

e. 1.65

f. $p$-value = 0.0984

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Do not reject the null hypothesis.

iii. Reason for decision: The $p$-value is greater than 0.05.

iv. Conclusion: There is insufficient evidence to conclude that 69% of Americans do not believe in angels.

i. Confidence Interval: (0.6836, 0.8533). The “plus-4s” confidence interval (see chapter 8) is (0.6732, 0.8420)
Exercise 90  "Blowing Bubbles," by Sondra Prull

Studying stats just made me tense,
I had to find some sane defense.
Some light and lifting simple play
To float my math anxiety away.
Blowing bubbles lifts me high
Takes my troubles to the sky.
POIK! They’re gone, with all my stress
Bubble therapy is the best.
The label said each time I blew
The average number of bubbles would be at least 22.
I blew and blew and this I found
From 64 blows, they all are round!
But the number of bubbles in 64 blows
Varied widely, this I know.
20 per blow became the mean
They deviated by 6, and not 16.
From counting bubbles, I sure did relax
But now I give to you your task.
Was 22 a reasonable guess?
Find the answer and pass this test!

Solution

a. $H_0: \mu \geq 22$

b. $H_a: \mu < 22$

c. Let $\bar{X}$ = the mean number of bubbles per blow.

d. Student’s t-distribution

e. $-2.667$

f. $p$-value = 0.00486

g. Check student’s solution.
h.  
i. Alpha: 0.05  
ii. Decision: Reject the null hypothesis.  
iii. Reason for decision: The p-value is less than 0.05.  
iv. Conclusion: There is sufficient evidence to conclude that the mean number of bubbles per blow is less than 22.  
i. (18.501, 21.499)  

Exercise 91  
"Dalmatian Darnation," by Kathy Sparling  

A greedy dog breeder named Spreckles  
Bred puppies with numerous freckles  
The Dalmatians he sought  
Possessed spot upon spot  
The more spots, he thought, the more shekels.  
His competitors did not agree  
That freckles would increase the fee.  
They said, “Spots are quite nice  
But they don’t affect price;  
One should breed for improved pedigree.”  
The breeders decided to prove  
This strategy was a wrong move.  
Breeding only for spots  
Would wreak havoc, they thought.  
His theory they want to disprove.  
They proposed a contest to Spreckles  
Comparing dog prices to freckles.  
In records they looked up  
One hundred one pups:  
Dalmatians that fetched the most shekels.  
They asked Mr. Spreckles to name
An average spot count he'd claim
To bring in big bucks.
Said Spreckles, “Well, shucks,
It's for one hundred one that I aim.”
Said an amateur statistician
Who wanted to help with this mission.
“Twenty-one for the sample
Standard deviation's ample:
They examined one hundred and one
Dalmatians that fetched a good sum.
They counted each spot,
Mark, freckle and dot
And tallied up every one.
Instead of one hundred one spots
They averaged ninety six dots
Can they muzzle Spreckles’
Obsession with freckles
Based on all the dog data they've got?

Solution

a. \( H_0: \mu \geq 101 \)
b. \( H_a: \mu < 101 \)
c. Let \( \bar{X} \) = the mean number of spots on an expensive Dalmatian.
d. Student’s \( t \)-distribution
e. \(-2.39\)
f. \( p \)-value = 0.0093
g. Check student’s solution.
h. i. Alpha: 0.05
   ii. Decision: Reject the null hypothesis.
      iii. Reason for decision: The \( p \)-value is less than 0.05.
iv. Conclusion: There is sufficient evidence to support the claim that the most expensive Dalmatians have less than 101 spots.

Exercise 92

"Macaroni and Cheese, please!!" by Nedda Misherghi and Rachelle Hall

As a poor starving student I don't have much money to spend for even the bare necessities. So my favorite and main staple food is macaroni and cheese. It's high in taste and low in cost and nutritional value.

One day, as I sat down to determine the meaning of life, I got a serious craving for this, oh, so important, food of my life. So I went down the street to Greatway to get a box of macaroni and cheese, but it was SO expensive! $2.02 !!! Can you believe it? It made me stop and think. The world is changing fast. I had thought that the mean cost of a box (the normal size, not some super-gigantic-family-value-pack) was at most $1, but now I wasn't so sure. However, I was determined to find out. I went to 53 of the closest grocery stores and surveyed the prices of macaroni and cheese. Here are the data I wrote in my notebook:

Price per box of Mac and Cheese:

- 5 stores @ $2.02
- 15 stores @ $0.25
- 3 stores @ $1.29
- 6 stores @ $0.35
- 4 stores @ $2.27
- 7 stores @ $1.50
- 5 stores @ $1.89
- 8 stores @ 0.75.

I could see that the cost varied but I had to sit down to figure out whether or not I was right. If it does turn out that this mouth-watering dish is at most $1, then I'll throw a big cheesy party in our next statistics lab, with enough macaroni and cheese for just me. (After all, as a poor starving student I can't be expected to feed our class of
Solution

a. $H_0: \mu \leq 1$

b. $H_a: \mu > 1$

c. Let $\bar{X}$ = the mean cost in dollars of macaroni and cheese in a certain town.

d. Student’s $t$-distribution

e. $t = 0.340$

f. $p$-value = 0.36756

g. Check student’s solution.

h. i. Alpha: 0.05

   ii. Decision: Do not reject the null hypothesis.

   iii. Reason for decision: The $p$-value is greater than 0.05

   iv. Conclusion: The mean cost could be $1, or less. At the 5% significance level, there is insufficient evidence to conclude that the mean price of a box of macaroni and cheese is more than $1.

i. (0.8291, 1.241)

Exercise 93

"William Shakespeare: The Tragedy of Hamlet, Prince of Denmark," by Jacqueline Ghodsi

THE CHARACTERS (in order of appearance):

• HAMLET, Prince of Denmark and student of Statistics

• POLONIUS, Hamlet’s tutor

• HOROTIO, friend to Hamlet and fellow student

Scene: The great library of the castle, in which Hamlet does his lessons

Act I

(The day is fair, but the face of Hamlet is clouded. He paces the large room. His tutor, Polonius, is reprimanding Hamlet regarding the latter’s recent experience. Horatio is seated at the large table at right stage.)

POLONIUS: My Lord, how cans’t thou admit that thou hast seen a ghost! It is but a figment of your imagination!
HAMLET: I beg to differ; I know of a certainty that five-and-seventy in one hundred of us, condemned to the whips and scorns of time as we are, have gazed upon a spirit of health, or goblin damn’d, be their intents wicked or charitable.

POLONIUS If thou doest insist upon thy wretched vision then let me invest your time; be true to thy work and speak to me through the reason of the null and alternate hypotheses. (He turns to Horatio.) Did not Hamlet himself say, “What piece of work is man, how noble in reason, how infinite in faculties? Then let not this foolishness persist. Go, Horatio, make a survey of three-and-sixty and discover what the true proportion be. For my part, I will never succumb to this fantasy, but deem man to be devoid of all reason should thy proposal of at least five-and-seventy in one hundred hold true.

HORATIO (to Hamlet): What should we do, my Lord?

HAMLET: Go to thy purpose, Horatio.

HORATIO: To what end, my Lord?

HAMLET: That you must teach me. But let me conjure you by the rights of our fellowship, by the consonance of our youth, but the obligation of our ever-preserved love, be even and direct with me, whether I am right or no.

(Horatio exits, followed by Polonius, leaving Hamlet to ponder alone.)

Act II

(The next day, Hamlet awaits anxiously the presence of his friend, Horatio. Polonius enters and places some books upon the table just a moment before Horatio enters.)

POLONIUS: So, Horatio, what is it thou didst reveal through thy deliberations?

HORATIO: In a random survey, for which purpose thou thyself sent me forth, I did discover that one-and-forty believe fervently that the spirits of the dead walk with us. Before my God, I might not this believe, without the sensible and true avouch of mine own eyes.

POLONIUS: Give thine own thoughts no tongue, Horatio. (Polonius turns to Hamlet.) But look to’t I charge you, my Lord. Come Horatio, let us go together, for this is not our
HAMLET: To reject, or not to reject, that is the question: whether 'tis nobler in the mind to suffer the slings and arrows of outrageous statistics, or to take arms against a sea of data, and, by opposing, end them. (Hamlet resarily attends to his task.) (Curtain falls)

Solution

a. \( H_0: p \geq 0.75 \)
b. \( H_a: p < 0.75 \)
c. Let \( P' \) = the proportion of the population who have seen a ghost
d. normal for a single proportion
e. –1.82
f. \( p \)-value = 0.0345
g. Check student’s solution.
h. i. Alpha: 0.01
   ii. Decision: Do not reject the null hypothesis.
   iii. Reason for decision: \( p \)-value > alpha
   iv. Conclusion: At the 1% significance level, there is insufficient evidence to conclude that the proportion of the population that has seen a ghost is less than 0.75.
i. Confidence Interval: (0.5331, 0.7685).
The “plus-4s” confidence interval is (0.563, 0.757).

Exercise 94  "Untitled," by Stephen Chen

I’ve often wondered how software is released and sold to the public. Ironically, I work for a company that sells products with known problems. Unfortunately, most of the problems are difficult to create, which makes them difficult to fix. I usually use the test program X, which tests the product, to try to create a specific problem. When the test program is run to make an error occur, the likelihood of generating an error is 1%. So, armed with this knowledge, I wrote a new test program Y that will generate the same error that test program X creates, but more often. To find out if my test program
is better than the original, so that I can convince the management that I'm right, I ran my test program to find out how often I can generate the same error. When I ran my test program 50 times, I generated the error twice. While this may not seem much better, I think that I can convince the management to use my test program instead of the original test program. Am I right?

Solution

a. \( H_0: p = 0.01 \)
b. \( H_a: p > 0.01 \)
c. Let \( P' \) = the proportion of errors generated
d. Normal for a single proportion
e. 2.13
f. 0.0165
g. Check student’s solution.

h. i. Alpha: 0.05
   ii. Decision: Reject the null hypothesis
   iii. Reason for decision: The \( p \)-value is less than 0.05.
   iv. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportion of errors generated is more than 0.01.
i. Confidence interval: (0, 0.094).
The “plus-4s” confidence interval is (0.004, 0.144).

Exercise 95

“Japanese Girls’ Names,” by Kumi Furuichi

It used to be very typical for Japanese girls’ names to end with “ko.” (The trend might have started around my grandmothers’ generation, and its peak might have been around my mother’s generation.) “Ko” means “child” in Chinese characters. Parents would name their daughters with “ko” attaching to other Chinese characters which have meanings that they want their daughters to become, such as Sachiko – a happy child, Yoshiko – a good child, Yasuko – a healthy child, and so on.
However, I noticed recently that only two out of nine of my Japanese girlfriends at this school have names that end with “ko.” More and more, parents seem to have become creative, modernized, and, sometimes, westernized in naming their children.

I have a feeling that, while 70 percent or more of my mother’s generation would have names with “ko” at the end, the proportion has dropped among my peers. I wrote down all my Japanese friends’, ex-classmates’, co-workers, and acquaintances’ names that I could remember. Following are the names. (Some are repeats.) Test to see if the proportion has dropped for this generation.

Ai, Akemi, Akiko, Ayumi, Chiaki, Chie, Eiko, Eri, Eriko, Fumiko, Harumi, Hitomi, Hiroko, Hiroko, Hidemi, Hisako, Hinako, Izumi, Izumi, Junko, Junko, Kana, Kanako, Kanayo, Kayo, Kayoko, Kazumi, Keiko, Kei, Kumi, Kumiko, Kyoko, Kyoko, Madoka, Maho, Mai, Maiko, Maki, Miki, Mikiko, Mina, Minako, Miyako, Momoko, Nana, Naoko, Naoko, Naoko, Noriko, Rieko, Rika, Rika, Rumiko, Rei, Reiko, Reiko, Sachiko, Sachiko, Sachiyo, Saki, Sayaka, Sayoko, Sayuri, Seiko, Shiho, Shizuka, Sumiko, Takako, Takako, Tomoe, Tomoe, Tomoko, Touko, Yasuko, Yasuko, Yasuyo, Yoko, Yoko, Yoko, Yoshiko, Yoshiko, Yoshiko, Yuka, Yuki, Yuki, Yukiko, Yuko, Yuko. Test at the 1% level.

Solution

a. $H_0: \ p \geq 0.70$

b. $H_a: \ p < 0.70$

c. Let $P' = \text{the proportion of friends or acquaintances who have a name ending in “ko.”}$

d. normal for a single proportion

e. -2.99

f. $p$-value = 0.0014

g. Check student’s solution.
h. i. alpha: 0.01

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: The $p$-value is less than 0.01.

iv. Conclusion: At the 1% significance level, there is sufficient evidence to conclude that the proportion of friends or acquaintances who have a name ending in “ko” is less than 0.70.

i. Confidence Interval: (0.453, 0.658): The “plus-4s” confidence interval is (0.453, 0.654).

Exercise 96

“Phillip’s Wish,” by Suzanne Osorio

My nephew likes to play.

Chasing the girls makes his day.

He asked his mother

If it is okay

To get his ear pierced.

She said, “No way!”

To poke a hole through your ear,

Is not what I want for you, dear.

He argued his point quite well,

Says even my macho pal, Mel,

Has gotten this done.
It’s all just for fun.

C’mon please, mom, please, what the hell.

Again Phillip complained to his mother,

Saying half his friends (Including their brothers)

Are piercing their ears,

And they have no fears.

He wants to be like the others.

She said, “I think it’s much less.

We must do a hypothesis test.

And if you are right,

I won’t put up a fight.

But, if not, then my case will rest.”

We proceeded to call fifty guys

To see whose prediction would fly.

Nineteen of the fifty

Said piercing was nifty,

And earrings they’d occasionally buy.

Then there’s the other thirty-one,

Who said they’d never have this done.
So now this poem’s finished.

Will his hopes be diminished,

Or will my nephew have his fun?

Solution

a. \( H_0: p = 0.50 \)

b. \( H_a: p < 0.50 \)

c. Let \( P' \) = the proportion of friends that has a pierced ear.

d. normal for a single proportion

e. \(-1.70\)

f. \( p\)-value = 0.0448

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Reject the null hypothesis

iii. Reason for decision: The \( p\)-value is less than 0.05. (However, they are very close.)

iv. Conclusion: There is sufficient evidence to support the claim that less than 50\% of his friends have pierced ears.

i. Confidence Interval: (0.245, 0.515): The “plus-4s” confidence interval is (0.259, 0.519).

Exercise 97

“The Craven,” by Mark Salangsong

One upon a morning dreary
In stats class I was weak and weary.

Pondering over last night’s homework,

Whose answers were now on the board,

This I did and nothing more.

While I nodded, nearly napping,

Suddenly, there came a tapping,

As someone gently rapping,

Rapping my head as I snore.

Quoth the teacher, “Sleep no more.”

“In every class you fall asleep,”

The teacher said, his voice was deep.

“So a tally I’ve begun to keep

Of every class you nap and snore.

The percentage being forty-four.”

“My dear teacher I must confess,

While sleeping is what I do best.

The percentage, I think, must be less,

A percentage less than forty-four.”

“We’ll see,” he said and walked away,
And fifty classes from that day

He counted till the month of May

The classes in which I napped and snored.

The number he found was twenty-four.

At a significance level of 0.05,

Please tell me am I still alive?

Or did my grade just take a dive,

Plunging down beneath the floor?

Upon thee I hereby implore.

Solution

a. $H_0$: $p = 0.44$

b. $H_a$: $p < 0.44$

c. Let $P'$ = the proportion of classes in which the student falls asleep.

d. normal for a single proportion

e. 0.57

f. $p$-value = 0.7156

g. Check student’s solution.

h.

i. alpha: 0.05

ii. Decision: Do not reject the null hypothesis.
iii. Reason for decision: The $p$-value is greater than 0.05.

iv. Conclusion: There is insufficient evidence to support the claim that the student falls asleep in less than 44% of classes.

i. (0.3415, 0.6185) Confidence Interval: (0.3415, 0.6185): The “plus-4s” confidence interval is (0.3482, 0.6148).

Exercise 98  
*Toastmasters International cites a report by Gallop Poll that 40% of Americans fear public speaking. A student believes that less than 40% of students at her school fear public speaking. She randomly surveys 361 schoolmates and finds that 135 report they fear public speaking. Conduct a hypothesis test to determine if the percent at her school is less than 40%.*

**Solution**

a. $H_0: \ p = 0.40$

b. $H_a: \ p < 0.40$

c. Let $P' = \text{the proportion of schoolmates who fear public speaking.}$

d. normal for a single proportion

e. $-1.01$

f. $p$-value = 0.1563

g. Check student’s solution.

h.  
i. Alpha: 0.05

ii. Decision: Do not reject the null hypothesis.

iii. Reason for decision: The $p$-value is greater than 0.05.

iv. Conclusion: There is insufficient evidence to support the claim that less than 40% of students at the school fear public speaking.

i. Confidence Interval: (0.3241, 0.4240): The “plus-4s” confidence interval is (0.3257, 0.4250).

Exercise 99  
*Sixty-eight percent of online courses taught at community colleges nationwide were taught by full-time faculty. To test if 68% also represents California’s percent for full-
time faculty teaching the online classes, Long Beach City College (LBCC) in California, was randomly selected for comparison. In the same year, 34 of the 44 online courses LBCC offered were taught by full-time faculty. Conduct a hypothesis test to determine if 68% represents California. NOTE: For more accurate results, use more California community colleges and this past year's data.

Solution

a. \( H_0: p = 0.68 \)
b. \( H_a: p \neq 0.68 \)
c. Let \( P' \) = the proportion of online courses at LBCC that are taught by full-time faculty.
d. normal for a single proportion.
e. 1.32
f. 0.1873
g. Check student’s solution.
h. i. \( \alpha \) = 0.05
   ii. Decision: Do not reject the null hypothesis.
   iii. Reason for decision: The \( p \)-value is greater than 0.05
   iv. At the 5% level, the data do not provide statistically significant evidence that the true proportion of online courses taught by full-time faculty is not 68%.
i. Confidence Interval: (0.65, 0.90); The “plus-4s” confidence interval is (0.6275, 0.8725).

Exercise 100

According to an article in Bloomberg Businessweek, New York City’s most recent adult smoking rate is 14%. Suppose that a survey is conducted to determine this year’s rate. Nine out of 70 randomly chosen N.Y. City residents reply that they smoke. Conduct a hypothesis test to determine if the rate is still 14% or if it has decreased.

Solution

a. \( H_0: p = 0.14 \)
b. \( H_a: p < 0.14 \)
c. Let \( P' \) = the proportion of NYC residents that smoke.
d. normal for a single proportion
e. \(-0.2756\)
f. \(p\)-value = 0.3914
g. Check student’s solution.
h. i. \(\alpha\): 0.05
   ii. Decision: Do not reject the null hypothesis.
   iii. Reason for decision: The \(p\)-value is greater than 0.05.
   iv. At the 5% significance level, there is insufficient evidence to conclude that the proportion of NYC residents who smoke is less than 0.14.
i. Confidence Interval: (0.0502, 0.2070): The “plus-4s” confidence interval (see chapter 8) is (0.0676, 0.2297).

Exercise 101  The mean age of De Anza College students in a previous term was 26.6 years old. An instructor thinks the mean age for online students is older than 26.6. She randomly surveys 56 online students and finds that the sample mean is 29.4 with a standard deviation of 2.1. Conduct a hypothesis test.

Solution  a. \(H_0: \mu = 26.6\)
b. \(H_a: \mu > 26.6\)
c. Let \(\bar{x}\) = the mean age for online students at De Anza College.
d. Student’s \(t\)-distribution
   e. 9.98
   f. \(p\)-value = 0.0000
   g. Check student’s solution.
h. i. \(\alpha\): 0.01
   ii. Decision: Reject the null hypothesis.
   iii. Reason for decision: The \(p\)-value is less than 0.01.
   iv. There is sufficient evidence to conclude that the mean age of online students at De Anza College is greater than 26.6 years.
i. (28.8, 30.0)
Exercise 102  Registered nurses earned an average annual salary of $69,110. For that same year, a survey was conducted of 41 California registered nurses to determine if the annual salary is higher than $69,110 for California nurses. The sample average was $71,121 with a sample standard deviation of $7,489. Conduct a hypothesis test.

Solution

a. $H_0: \mu = 69,110$

b. $H_a: \mu > 69,110$

c. Let $\bar{X}$ = the mean salary in dollars for California registered nurses.

d. Student’s $t$-distribution

e. $t = 1.719$

f. $p$-value: 0.0466

g. Check student’s solution.

h. i. Alpha: 0.05

ii. Decision: Reject the null hypothesis.

iii. Reason for decision: The $p$-value is less than 0.05.

iv. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean salary of California registered nurses exceeds $69,110.

i. ($68,757, $73,485)

Exercise 103  La Leche League International reports that the mean age of weaning a child from breastfeeding is age four to five worldwide. In America, most nursing mothers wean their children much earlier. Suppose a random survey is conducted of 21 U.S. mothers who recently weaned their children. The mean weaning age was nine months (3/4 year) with a standard deviation of 4 months. Conduct a hypothesis test to determine if the mean weaning age in the U.S. is less than four years old.

Solution

a. $H_0: \mu = 4$

b. $H_a: \mu < 4$

c. Let $\mu$ represent the mean age at which American mothers wean their children
d. Student’s t-distribution

e. −44.7

f. \( p \)-value = 0.0000

g. Check student’s solution.

h.  
   i. alpha: 0.01

   ii. Decision: Reject the null hypothesis.

   iii. Reason for decision: \( p \)-value is less than 0.01.

   iv. There is sufficient evidence to conclude that the mean age at which American mothers wean their children is less than four years old.

i. (0.60 years, 0.90 years) or approximately (7.2 months, 10.8 months), when the sample standard deviation is rounded to 0.33.

Exercise 104 Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin? After conducting the test, your decision and conclusion are

a. Reject \( H_0 \): There is sufficient evidence to conclude that more than 30% of teen girls smoke to stay thin.

b. Do not reject \( H_0 \): There is not sufficient evidence to conclude that less than 30% of teen girls smoke to stay thin.

c. Do not reject \( H_0 \): There is not sufficient evidence to conclude that more than 30% of teen girls smoke to stay thin.

d. Reject \( H_0 \): There is sufficient evidence to conclude that less than 30% of teen girls smoke to stay thin.

Solution  c

Exercise 105 A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC)
students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing.

At a 1% level of significance, an appropriate conclusion is:

a. There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
b. There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is more than 20%.
c. There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
d. There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is at least 20%.

Solution

Exercise 106

Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test.

At a significance level of $a = 0.05$, what is the correct conclusion?

a. There is enough evidence to conclude that the mean number of hours is more than 4.75
b. There is enough evidence to conclude that the mean number of hours is more than 4.5
c. There is not enough evidence to conclude that the mean number of hours is more than 4.5
d. There is not enough evidence to conclude that the mean number of hours is more than 4.75
Exercise 107  

According to the Center for Disease Control website, in 2011 at least 18% of high school students have smoked a cigarette. An Introduction to Statistics class in Davies County, KY conducted a hypothesis test at the local high school (a medium sized–approximately 1,200 students–small city demographic) to determine if the local high school’s percentage was lower. One hundred fifty students were chosen at random and surveyed. Of the 150 students surveyed, 82 have smoked. Use a significance level of 0.05 and using appropriate statistical evidence, conduct a hypothesis test and state the conclusions.

a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. $H_0: p \geq 0.18; H_a: p < 0.18$

b. $p$-value = 1

c. alpha = 0.05

d. Do not reject the null hypothesis.
e. At the 5% level of significance, there is not enough evidence to conclude that the local high school’s proportion of students who smoke is less than 0.18.
A recent survey in the N.Y. Times Almanac indicated that 48.8% of families own stock. A broker wanted to determine if this survey could be valid. He surveyed a random sample of 250 families and found that 142 owned some type of stock. At the 0.05 significance level, can the survey be considered to be accurate?

a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. $H_0: p = 0.488$; $H_a: p \neq 0.488$

b. $p$-value = 0.0114

c. Alpha = 0.05

d. Reject the null hypothesis.

e. At the 5% level of significance, there is enough evidence to conclude that 48.8% of families own stocks.

f. The survey does not appear to be accurate.

Driver error can be listed as the cause of approximately 54% of all fatal auto accidents, according to the American Automobile Association. Thirty randomly selected fatal accidents are examined, and it is determined that 14 were caused by driver error. Using $\alpha = 0.05$, is the AAA proportion accurate?
a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. \( H_0: p = 0.54; H_a: p \neq 0.54 \)

b. \( p \)-value = 0.4203

c. Alpha = 0.05

d. Do not reject the null hypothesis.

e. At the 5% significance level, there is not enough evidence to conclude that the proportion of fatal accidents that are the driver’s fault is not 0.54.

f. It appears that the American Automobile Association’s claim is accurate.

Exercise 110

The US Department of Energy reported that 51.7% of homes were heated by natural gas. A random sample of 221 homes in Kentucky found that 115 were heated by natural gas. Does the evidence support the claim for Kentucky at the \( \alpha = 0.05 \) level in Kentucky? Are the results applicable across the country? Why?

a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.
d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. $H_0: p = 0.517; H_a: p \neq 0.517$

b. $p$-value = 0.9203.

c. Alpha = 0.05.

d. Do not reject the null hypothesis.

e. At the 5% significance level, there is not enough evidence to conclude that the proportion of homes in Kentucky that are heated by natural gas is 0.517.

f. However, we cannot generalize this result to the entire nation. First, the sample’s population is only the state of Kentucky. Second, it is reasonable to assume that homes in the extreme north and south will have extreme high usage and low usage, respectively. We would need to expand our sample base to include these possibilities if we wanted to generalize this claim to the entire nation.

Exercise 111

For Americans using library services, the American Library Association claims that at most 67% of patrons borrow books. The library director in Owensboro, Kentucky feels this is not true, so she asked a local college statistic class to conduct a survey. The class randomly selected 100 patrons and found that 82 borrowed books. Did the class demonstrate that the percentage was higher in Owensboro, KY? Use $\alpha = 0.01$ level of significance. What is the possible proportion of patrons that do borrow books from the Owensboro Library?
a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. \( H_0: p \leq 0.67 \) \( H_a: p > 0.67 \)

b. \( p \)-value = 0.0007

c. Alpha = 0.01.

d. Reject the null hypothesis.

e. At the 1% significance level, there is enough evidence to conclude that the proportion of patrons in Owensboro, KY who borrow books is more than 0.67. The class demonstrated that the percentage was higher than 67%.

f. To determine the possible proportion of patrons who do borrow books, construct a 95% confidence interval. It is (0.7447, 0.8953). We are 95% confident that the true population proportion of patrons in Owensboro, KY who borrow books is between 0.7447 and 0.8953 (between 74.47% and 89.53%).

Exercise 112

The Weather Underground reported that the mean amount of summer rainfall for the northeastern US is at least 11.52 inches. Ten cities in the northeast are randomly selected and the mean rainfall amount is calculated to be 7.42 inches with a standard deviation of 1.3 inches. At the \( \alpha = 0.05 \) level, can it be concluded that the mean rainfall was below the reported average? What if \( \alpha = 0.01 \)? Assume the amount of summer
rainfall follows a normal distribution.

a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. \( H_0: \mu \geq 11.52; H_a: \mu < 11.52 \)

b. p-value = 0.000002 which is almost 0.

c. Alpha = 0.05.

d. Reject the null hypothesis.

e. At the 5% significance level, there is enough evidence to conclude that the mean amount of summer rain in the northeaster US is less than 11.52 inches, on average.

f. We would make the same conclusion if alpha was 1% because the p-value is almost 0.

Exercise 113

A survey in the N.Y. Times Almanac finds the mean commute time (one way) is 25.4 minutes for the 15 largest US cities. The Austin, TX chamber of commerce feels that Austin’s commute time is less and wants to publicize this fact. The mean for 25 randomly selected commuters is 22.1 minutes with a standard deviation of 5.3 minutes. At the \( \alpha = 0.10 \) level, is the Austin, TX commute significantly less than the mean commute time for the 15 largest US cities?
a. State the null and alternate hypothesis.

b. State the p-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. $H_0: \mu = 25.4$  $H_1: \mu < 25.4$

b. $p$-value = 0.0024

c. Alpha = 0.10.

d. Reject the null hypothesis.

e. At the 10% level of significance, there is enough evidence to conclude that the one-way mean commute in Austin, TX is less than 25.4 miles, which is the mean commute for the 15 largest US cities.

Exercise 114

A report by the Gallup Poll found that a woman visits her doctor, on average, at most 5.8 times each year. A random sample of 20 women results in these yearly visit totals:

3; 2; 1; 3; 7; 2; 9; 4; 6; 6; 8; 0; 5; 6; 4; 2; 1; 3; 4; 1

At the $\alpha = 0.05$ level can it be concluded that the sample mean is higher than 5.8 visits per year?

a. State the null and alternate hypothesis.

b. State the p-value.
c. State alpha.

d. What is your decision?

e. Write a conclusion.

f. Answer any other questions asked in the problem.

Solution

a. \( H_0: \mu \leq 5.8 \quad H_a: \mu > 5.8 \)

b. \( p\)-value = 0.9987

c. Alpha = 0.05

d. Do not reject the null hypothesis.

e. At the 5% level of significance, there is not enough evidence to conclude that a woman visits her doctor, on average, more than 5.8 times a year.

Exercise 115

According to the N.Y. Times Almanac the mean family size in the U.S. is 3.18. A sample of a college math class resulted in the following family sizes:

5; 4; 5; 4; 4; 6; 4; 3; 3; 5; 6; 3; 3; 2; 7; 4; 5; 2; 2; 2; 3; 2

At \( \alpha = 0.05 \) level, is the class’ mean family size greater than the national average? Does the Almanac result remain valid? Why?

a. State the null and alternate hypothesis.

b. State the \( p\)-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.
f. Answer any other questions asked in the problem.

Solution

a. \( H_0 \mu = 3.18 \ Ha: \mu > 3.18 \)

b. \( p\)-value = 0.0179

c. alpha = 0.05.

d. Reject the null hypothesis.

e. At the 5% level of significance, there is enough evidence to conclude that the class’ mean family size is greater than the national average of 3.18.

f. However, the almanac claim can still be considered valid. This sample does not meet the requirements for inference. It is not a randomly generated sample, and the size is too small to assume normalcy.

Exercise 116

The student academic group on a college campus claims that freshman students study at least 2.5 hours per day, on average. One Introduction to Statistics class was skeptical. The class took a random sample of 30 freshman students and found a mean study time of 137 minutes with a standard deviation of 45 minutes. At \( \alpha = 0.01 \) level, is the student academic group’s claim correct?

a. State the null and alternate hypothesis.

b. State the \( p\)-value.

c. State alpha.

d. What is your decision?

e. Write a conclusion.
f. Answer any other questions asked in the problem.

Solution

a. \( H_0: \mu \geq 150 \) \( H_a: \mu < 150 \)

b. \( p\)-value = 0.0622

c. alpha = 0.01

d. Do not reject the null hypothesis.

e. At the 1\% significance level, there is not enough evidence to conclude that freshmen students study less than 2.5 hours per day, on average.

f. The student academic group’s claim appears to be correct.