9.12: Solutions

1.

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

3.

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

5.

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

7.

1. H_0: $p = 0.42$
2. H_a: $p < 0.42$

9.

1. H_0: $\mu = 15$
2. H_a: $\mu \neq 15$

11.

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.

13.

α = the probability that you think the bag cannot withstand -15 degrees F, when in fact it can

β = the probability that you think the bag can withstand -15 degrees F, when in fact it cannot

15.

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.

17.

0.019

19.

0.998

21.

A normal distribution or a Student's *t*-distribution

23.

Use a Student's *t*-distribution

25.

a normal distribution for a single population mean

27.

It must be approximately normally distributed.

29.

They must both be greater than five.

31.

binomial distribution

33.

The outcome of winning is very unlikely.

35.

H_0: μ > = 73
H_a: μ < 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.

37.

The shaded region shows a low *p*-value.

39.

Do not reject H_0.

41.

means

43.

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

45.

1. 3
2. 1.5
3. 1.8
4. 26

47.

X¯~N(2.5,1.526)X¯~N(2.5,1.526)" role="presentation" style="position: relative;">$\overline{X} \sim N\left(2.5, \frac{1.5}{\sqrt{26}}\right)$ $\overline{X} \sim N\left(2.5, \frac{1.5}{\sqrt{26}}\right)$

49.

This is a left-tailed test.

51.

This is a two-tailed test.

53.

Figure 9.19

55.

a right-tailed test

57.

a left-tailed test

59.

This is a left-tailed test.

61.

This is a two-tailed test.

62.

1. H_0: $\mu = 34$; H_a: $\mu \neq 34$
2. H_0: $p \leq 0.60$; H_a: $p > 0.60$
3. H_0: $\mu \geq 100{,}000$; H_a: $\mu < 100{,}000$
4. H_0: $p = 0.29$; H_a: $p \neq 0.29$
5. H_0: $p = 0.05$; H_a: $p < 0.05$
6. H_0: $\mu \leq 10$; H_a: $\mu > 10$
7. H_0: $p = 0.50$; H_a: $p \neq 0.50$
8. H_0: $\mu = 6$; H_a: $\mu \neq 6$
9. H_0: $p \geq 0.11$; H_a: $p < 0.11$
10. H_0: $\mu \leq 20{,}000$; H_a: $\mu > 20{,}000$

64.

c

66.

1. 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.
2. 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.
3. 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.
4. 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%.
5. Type I error: We conclude that fewer than 5% of adults ride the bus to work in Los 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.
6. Type I error: We conclude that the mean number of cars a person owns in their 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 their lifetime is not more than 10 when, in fact, it is more than 10.
7. 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.
8. 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.
9. 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 females who develop breast cancer is at least 11%, when in fact it is less than 11%.
10. 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.

68.

b

70.

d

72.

d

74.

1. H_0: $\mu \geq 50{,}000$
2. H_a: $\mu < 50{,}000$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ = the average lifespan of a brand of tires.
4. normal distribution
5. $z = -2.315$
6. p-value = 0.0103
7. Answers may vary.
8. 1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The p-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the mean lifespan of the tires is less than 50,000 miles.
9. (43,537, 49,463)

76.

1. H_0: $\mu = \$1.00$
2. H_a: $\mu \neq \$1.00$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ = the average cost of a daily newspaper.
4. normal distribution
5. $z = –0.866$
6. p-value = 0.3865
7. Answers may vary.
8. 1. Alpha: 0.01
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.01.
   4. Conclusion: There is sufficient evidence to support the claim that the mean cost of daily papers is $1. The mean cost could be $1.
9. ($0.84, $1.06)

78.

1. H_0: $\mu = 10$
2. H_a: $\mu \neq 10$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ the mean number of sick days an employee takes per year.
4. Student's t-distribution
5. $t = –1.12$
6. p-value = 0.300
7. Answers may vary.
8. 1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.05.
   4. Conclusion: At the 5% significance level, there is insufficient evidence to conclude that the mean number of sick days is not ten.
9. (4.9443, 11.806)

80.

1. H_0: $p \geq 0.6$
2. H_a: $p < 0.6$
3. Let P' = the proportion of students who feel more enriched as a result of taking Elementary Statistics.
4. normal for a single proportion
5. 1.12

6. p-value = 0.1308
7. Answers may vary.
8. 1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.05.
   4. Conclusion: There is insufficient evidence to conclude that less than 60 percent of the students feel more enriched.
9. Confidence Interval: (0.409, 0.654)
   The “plus-4s” confidence interval is (0.411, 0.648)

82.

1. H_0: $\mu = 4$
2. H_a: $\mu \neq 4$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ the average I.Q. of a set of brown trout.
4. two-tailed Student's t-test
5. $t = 1.95$
6. p-value = 0.076
7. Check student’s solution.
8. 1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.05
   4. Conclusion: There is insufficient evidence to conclude that the average IQ of brown trout is not four.
9. (3.8865,5.9468)

84.

1. H_0: $p \geq 0.13$
2. H_a: $p < 0.13$
3. Let P' = the proportion of Americans who have seen or sensed angels
4. normal for a single proportion
5. –2.688
6. p-value = 0.0036
7. Check student’s solution.
8. 1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The p-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the percentage of Americans who have seen or sensed an angel is less than 13%.
9. (0, 0.0623).
   The“plus-4s” confidence interval is (0.0022, 0.0978)

86.

1. H_0: $\mu \geq 129$
2. H_a: $\mu < 129$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ = the average time in seconds that Terri finishes Lap 4.
4. Student's t-distribution
5. $t = 1.209$
6. 0.8792
7. Check student’s solution.
8. 1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.05.
   4. Conclusion: There is insufficient evidence to conclude that Terri’s mean lap time is less than 129 seconds.
9. (128.63, 130.37)

88.

1. H_0: p = 0.60
2. H_a: p < 0.60
3. Let P' = the proportion of family members who shed tears at a reunion.
4. normal for a single proportion
5. –1.71
6. 0.0438
7. Check student’s solution.
8. 1. alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: p-value < alpha
   4. 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.
9. 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 Confidence Intervals) is (0.3861, 0.6139)

Note that here the “large-sample” 1 – 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.

90.

1. H_0: $\mu \geq 22$
2. H_a: $\mu < 22$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ = the mean number of bubbles per blow.
4. Student's t-distribution
5. –2.667
6. p-value = 0.00486
7. Check student’s solution.
8. 1. Alpha: 0.05
   2. Decision: Reject the null hypothesis.
   3. Reason for decision: The p-value is less than 0.05.
   4. Conclusion: There is sufficient evidence to conclude that the mean number of bubbles per blow is less than 22.
9. (18.501, 21.499)

92.

1. H_0: $\mu \leq 1$
2. H_a: $\mu > 1$
3. Let X¯X¯" role="presentation" style="position: relative;">$\overline{X}$ $\overline{X}$ = the mean cost in dollars of macaroni and cheese in a certain town.
4. Student's t-distribution
5. t = 0.340
6. p-value = 0.36756
7. Check student’s solution.
8. 1. Alpha: 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The p-value is greater than 0.05
   4. 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.
9. (0.8291, 1.241)

94.

1. H_0: p = 0.01

2. H_a: $p > 0.01$
3. Let P' = the proportion of errors generated
4. Normal for a single proportion
5. 2.13
6. 0.0165
7. Check student's solution.
8.
    1. Alpha: 0.05
    2. Decision: Reject the null hypothesis
    3. Reason for decision: The p-value is less than 0.05.
    4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the proportion of errors generated is more than 0.01.
9. Confidence interval: (0, 0.094).
   The"plus-4s" confidence interval is (0.004, 0.144).

96.

1. H_0: $p = 0.50$
2. H_a: $p < 0.50$
3. Let P' = the proportion of friends that has a pierced ear.
4. normal for a single proportion
5. –1.70
6. p-value = 0.0448
7. Check student's solution.
8.
    1. Alpha: 0.05
    2. Decision: Reject the null hypothesis
    3. Reason for decision: The p-value is less than 0.05. (However, they are very close.)
    4. Conclusion: There is sufficient evidence to support the claim that less than 50% of his friends have pierced ears.
9. Confidence Interval: (0.245, 0.515): The "plus-4s" confidence interval is (0.259, 0.519).

98.

1. H_0: $p = 0.40$
2. H_a: $p < 0.40$
3. Let P' = the proportion of schoolmates who fear public speaking.
4. normal for a single proportion
5. –1.01
6. p-value = 0.1563
7. Check student's solution.
8.
    1. Alpha: 0.05
    2. Decision: Do not reject the null hypothesis.
    3. Reason for decision: The p-value is greater than 0.05.
    4. Conclusion: There is insufficient evidence to support the claim that less than 40% of students at the school fear public speaking.
9. Confidence Interval: (0.3241, 0.4240): The "plus-4s" confidence interval is (0.3257, 0.4250).

100.

1. H_0: $p = 0.12$
2. H_a: $p < 0.12$
3. Let P'=P'=" role="presentation" style="position: relative;"> $P' =$ $P' =$ the proportion of NYC residents that smoke.
4. Normal for a single proportion
5. 0.2207
6. p-value = 0.5873
7. Answers may vary
8.
    1. alpha 0.05
    2. Decision: Do not reject the null hypothesis.

3. Reason for Decision: The *p*-value is greater than 0.05.
4. At the 5% significance level, there is insufficient evidence to conclude that the proportion of NYC residents who smoke is less than 0.14.

9. Confidence interval: Confidence Interval: (0.0502, 0.2070): The “plus-4s” confidence interval (see Confidence Intervals) is (0.0676, 0.2297).

102.

1. H_0: $p = 0.12$
2. H_a: $p < 0.12$
3. Let P'=P'=" role="presentation" style="position: relative;"> $P' =$ $P' =$ the proportion of NYC residents that smoke.
4. Normal for a single proportion
5. 0.2207
6. *p*-value = 0.5873
7. Answers may vary
8. 1. alpha 0.05
   2. Decision: Do not reject the null hypothesis.
   3. Reason for decision: The *p*-value is less than 0.05.
   4. Conclusion: At the 5% significance level, there is sufficient evidence to conclude that the mean salary of California registered nurses exceeds $69,110.
9. ($68,757, $73,485)

104.

c

106.

c

108.

1. H_0: $p = 0.488$ H_a: $p \neq 0.488$
2. *p*-value = 0.0114
3. alpha = 0.05
4. Reject the null hypothesis.
5. At the 5% level of significance, there is enough evidence to conclude that 48.8% of families own stocks.
6. The survey does not appear to be accurate.

110.

1. H_0: $p = 0.517$ H_a: $p \neq 0.517$
2. *p*-value = 0.9203.
3. alpha = 0.05.
4. Do not reject the null hypothesis.
5. 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.
6. 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.

112.

1. H_0: $\mu \geq 11.52$ H_a: $\mu < 11.52$
2. *p*-value = 0.000002 which is almost 0.
3. alpha = 0.05.
4. Reject the null hypothesis.
5. 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.
6. We would make the same conclusion if alpha was 1% because the *p*-value is almost 0.

114.

1. H_0: $\mu \leq 5.8$ H_a: $\mu > 5.8$
2. p-value = 0.9987
3. alpha = 0.05
4. Do not reject the null hypothesis.
5. 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.

116.

1. H_0: $\mu \geq 150$ H_a: $\mu < 150$
2. p-value = 0.0622
3. alpha = 0.01
4. Do not reject the null hypothesis.
5. At the 1% significance level, there is not enough evidence to conclude that first-year students study less than 2.5 hours per day, on average.
6. The student academic group's claim appears to be correct.
