Exercises 7–2

1. What is the difference between a point estimate and an interval estimate of a parameter? Which is better? Why?

2. What information is necessary to calculate a confidence interval?

3. What is the maximum error of estimate?

4. What is meant by the 95% confidence interval of the mean?

5. What are three properties of a good estimator?

6. What statistic best estimates μ?

7. What is necessary to determine the sample size?

8. When one is determining the sample size for a confidence interval, is the size of the population relevant?

9. Find each.

a. $z_{\alpha/2}$ for the 99% confidence interval
b. $z_{\alpha/2}$ for the 98% confidence interval
c. $z_{\alpha/2}$ for the 95% confidence interval
d. $z_{\alpha/2}$ for the 90% confidence interval
e. $z_{\alpha/2}$ for the 94% confidence interval

10. Find the 95% confidence interval for the mean paid attendance at the Major League All-Star games. A random sample of the paid attendances is shown.

47,596	68,751	5,838
69,831	28,843	53,107
31,391	48,829	50,706
62,892	55,105	63,974
56,674	38,362	51,549
31,938	31,851	56,088
34,906	38,359	72,086
34,009	50,850	43,801
46,127	49,926	54,960
32,785	48,321	49,671

Source: *Time Almanac.*

11. A sample of the reading scores of 35 fifth-graders has a mean of 82. The standard deviation of the sample is 15.

a. Find the best point estimate of the mean.
b. Find the 95% confidence interval of the mean reading scores of all fifth-graders.
c. Find the 99% confidence interval of the mean reading scores of all fifth-graders.
d. Which interval is larger? Explain why.

12. Find the 90% confidence interval of the population mean for the incomes of western Pennsylvania credit unions. A random sample of 50 credit unions is shown. The data are in thousands of dollars.

84	14	31	72	26
49	252	104	31	8
3	18	72	23	55
133	16	29	225	138
85	24	391	72	158
4340	346	19	5	846
461	254	125	61	123
60	29	10	366	47
28	254	6	77	21
97	6	17	8	82

Source: *Pittsburgh Post Gazette.*

13. A study of 40 English composition professors showed that they spent, on average, 12.6 minutes correcting a student's term paper.

a. Find the best point estimate of the mean.
b. Find the 90% confidence interval of the mean time for all composition papers when $\sigma = 2.5$ minutes.
c. If a professor stated that he spent, on average, 30 minutes correcting a term paper, what would be your reaction?

14. A study of 35 golfers showed that their average score on a particular course was 92. The standard deviation of the sample is 5.

a. Find the best point estimate of the mean.
b. Find the 95% confidence interval of the mean score for all golfers.
c. Find the 95% confidence interval of the mean score if a sample of 60 golfers is used instead of a sample of 35.
d. Which interval is smaller? Explain why.

15. A survey of individuals who passed the seven exams and obtained the rank of Fellow in the actuarial field finds the average salary to be $150,000. If the standard deviation for the sample of 35 Fellows was $15,000, construct a 95% confidence interval for all Fellows.

Source: www.BeAnActuary.org.

16. A random sample of the number of farms (in thousands) in various states follows. Estimate the mean number of farms per state with 90% confidence.

47	95	54	33	64	4	8	57	9	80
8	90	3	49	4	44	79	80	48	16
68	7	15	21	52	6	78	109	40	50
29									

Source: *N.Y. Times Almanac.*

17. A study of 415 kindergarten students showed that they have seen on average 5000 hours of television. If the sample standard deviation is 900, find the 95% confidence level of the mean for all students. If a parent claimed that his children watched 4000 hours, would the claim be believable?

Source: U.S. Department of Education.

18. A random sample of 76 four-year-olds attending day-care centers showed that the yearly tuition averaged $3648. The standard deviation of the sample was $630, and the sample size was 50. Find the 90% confidence interval of the true mean. If a day-care center were starting up and wanted to keep tuition low, what would be a reasonable amount to charge?

19. Noise levels at various area urban hospitals were measured in decibels. The mean of the noise levels in 84 corridors was 61.2 decibels, and the standard deviation was 7.9. Find the 95% confidence interval of the true mean.

Source: M. Bayo, A. Garcia, and A. Garcia, "Noise Levels in an Urban Hospital and Workers' Subjective Responses," *Archives of Environmental Health* 50, no. 3, p. 249 (May–June 1995). Reprinted with permission of the Helden Dwight Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St. N.W., Washington, D.C. 20036-1802. Copyright © 1995.

20. The growing seasons for a random sample of 35 U.S. cities were recorded, yielding a sample mean of 190.7 days and a sample standard deviation of 54.2 days. Estimate the true mean population of the growing season with 95% confidence.

Source: *The Old Farmer's Almanac.*

21. A university dean of students wishes to estimate the average number of hours students spend doing

home
previ
be selected if he wants to be 99% confident of
whether the true mean differs from the sample mean by 1.5 hours?

22. In the hospital study cited in Exercise 19, the mean noise level in the 171 ward areas was 58.0 decibels, and the standard deviation was 4.8. Find the 90% confidence interval of the true mean.

Source: M. Bayo, A. Garcia, and A. Garcia, "Noise Levels in an Urban Hospital and Workers' Subjective Responses," *Archives of Environmental Health* 50, no. 3, p. 249 (May–June 1995). Reprinted with permission of the Helden Dwight Reid Educational Foundation. Published by Heldref Publications, 1319 Eighteenth St. N.W., Washington, D.C. 20036-1802. Copyright © 1995.

23. An insurance company is trying to estimate the average number of sick days that full-time food service workers use per year. A pilot study found the standard deviation to be 2.5 days. How large a sample must be selected if the company wants to be 95% confident of getting an interval that contains the true mean with a maximum error of 1 day?

24. A pizza shop owner wishes to find the 95% confidence interval of the true mean cost of a large plain pizza. How large should the sample be if she wishes to be accurate to within $0.15? A previous study showed that the standard deviation of the price was $0.26.

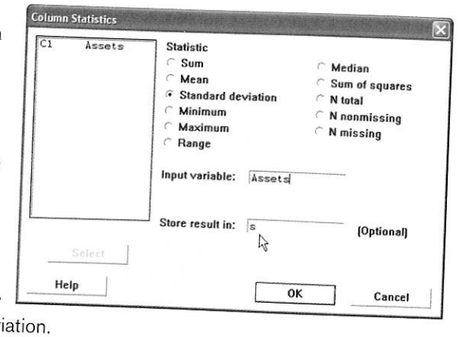
25. A researcher is interested in estimating the average monthly salary of sports reporters in a large city. He wants to be 90% confident that his estimate is correct. If the standard deviation is $1100, how large a sample is needed to get the desired information and to be accurate to within $150?

Technology *Step by Step*

MINITAB Step by Step

Finding a *z* Confidence Interval for the Mean

For Example 7–3, find the 90% confidence interval estimate for the mean amount of assets for credit unions in southwestern Pennsylvania.



1. Maximize the worksheet, then enter the data into C1 of a MINITAB worksheet. If sigma is known, skip to step 3.
2. Calculate the standard deviation for the sample. It will be used as an estimate for sigma.
   a) Select **Calc>Column statistics.**
   b) Click the option for Standard deviation.
   c) Enter **C1 Assets** for the Input variable and **s** for Store in:.

Exercises 7–4

1. In each case, find $\hat{p}$ and $\hat{q}$.

a. $n = 80$ and $X = 40$
b. $n = 200$ and $X = 90$
c. $n = 130$ and $X = 60$
d. $n = 60$ and $X = 35$
e. $n = 95$ and $X = 43$

2. (**ans**) Find $\hat{p}$ and $\hat{q}$ for each percentage. (Use each percentage for $\hat{p}$.)

a. 15%
b. 37%
c. 71%
d. 51%
e. 79%

3. A U.S. Travel Data Center survey conducted for *Better Homes and Gardens* of 1500 adults found that 39% said that they would take more vacations this year than last year. Find the 95% confidence interval for the true proportion of adults who said that they will travel more this year.

Source: *USA TODAY.*

4. A recent study of 100 people in Miami found 27 were obese. Find the 90% confidence interval of the population proportion of individuals living in Miami who are obese.

Source: Based on information from the Center for Disease Control and Prevention. *USA TODAY.*

5. The proportion of students in private schools is around 11%. A random sample of 450 students from a wide geographic area indicated that 55 attended private schools. Estimate the true proportion of students attending private schools with 95% confidence. How does your estimate compare to 11%?

Source: National Center for Education Statistics (www.nces.ed.gov).

6. The Gallup Poll found that 27% of adults surveyed nationwide said they had personally been in a tornado. How many adults should be surveyed to estimate the true proportion of adults who have been in a tornado with a 95% confidence interval 5% wide?

Source: www.pollingreport.com.

7. A survey found that out of 200 workers, 168 said they were interrupted three or more times an hour by phone messages, faxes, etc. Find the 90% confidence interval of the population proportion of workers who are interrupted three or more times an hour.

Source: Based on information from *USA TODAY* Snapshot.

8. A CBS News/*New York Times* poll found that 329 out of 763 adults said they would travel to outer space in their lifetime, given the chance. Estimate the true proportion of adults who would like to travel to outer space with 92% confidence.

Source: www.pollingreport.com.

9. A study by the University of Michigan found that one in five 13- and 14-year-olds is a sometime smoker. To see how the smoking rate of the students at a large school district compared to the national rate, the superintendent surveyed two hundred 13- and 14-year-old students and found that 23% said they were sometime smokers. Find the 99% confidence interval of the true proportion, and compare this with the University of Michigan study.

Source: *USA TODAY.*

10. A survey of 50 first-time white-water canoers showed that 23 did not want to repeat the experience. Find the 90% confidence interval of the true proportion of canoers who did not wish to canoe the rapids a second time. If a rafting company wants to distribute brochures for repeat trips, what is the minimum number it should print?

11. A survey of 85 families showed that 36 owned at least one DVD player. Find the 99% confidence interval of the true proportion of families who own at least one DVD player. If another survey in a different location found that the proportion of families who owned at least one DVD player was 0.52, would you consider that the proportion of families in this area was larger than in the area where the original survey was done?

12. In a certain countrywide school district, a survey of 350 students showed that 28% carried their lunches to school. Find the 95% confidence interval of the true proportion of students who carried their lunches to school. If the cafeteria manager wanted to be reasonably sure that all the children who didn't bring their lunches could purchase a lunch, how many lunches should she plan to make each day? Explain your answer.

13. In a Gallup Poll of 1005 individuals, 452 thought they were worse off financially than a year ago. Find the 95% confidence interval for the true proportion of individuals that feel they are worse off financially.

Source: Gallup Poll.

14. In a poll of 1000 likely voters, 560 say that the United States spends too little on fighting hunger at home. Find a 95% confidence interval for the true proportion of voters who feel this way.

Source: Alliance to End Hunger.

15. A medical researcher wishes to determine the percentage of females who take vitamins. He wishes to be 99% confident that the estimate is within 2 percentage points of the true proportion. A recent study of 180 females showed that 25% took vitamins.

a. How large should the sample size be?
b. If no estimate of the sample proportion is available, how large should the sample be?

16. A recent study indicated that 29% of the 100 women over age 55 in the study were widows.

a. How large a sample must one take to be 90% confident that the estimate is within 0.05 of the true proportion of women over age 55 who are widows?
b. If no estimate of the sample proportion is available, how large should the sample be?

17. A researcher wishes to estimate the proportion of adult males who are under 5 feet 5 inches tall. She wants to be 90% confident that her estimate is within 5% of the true proportion.

a. How large a sample should be taken if in a sample of 300 males, 30 were under 5 feet 5 inches tall?
b. If no estimate of the sample proportion is available, how large should the sample be?

18. Obesity is defined as a *body mass index* (BMI) of 3 kg/m^2 or more. A 95% confidence interval for the percentage of U.S. adults aged 20 years and over who were obese was found to be 22.4% to 23.5%. What was the sample size?

Source: National Center for Health Statistics (www.cdc.gov/nchs).

19. How large a sample should be surveyed to estimate the true proportion of college students who do laundry once a week within 3% with 95% confidence?

20. A federal report indicated that 27% of children ages 2 to 5 years had a good diet—an increase over previous years. How large a sample is needed to estimate the true proportion of children with good diets within 2% with 95% confidence?

Source: Federal Interagency Forum on Child and Family Statistics, *Washington Observer-Reporter.*

Extending the Concepts

21. If a sample of 600 people is selected and the researcher decides to have a maximum error of estimate of 4% on the specific proportion who favor gun control, find the degree of confidence. A recent study showed that 50% were in favor of some form of gun control.

22. In a study, 68% of 1015 adults said that they believe the Republicans favor the rich. If the margin of error was 3 percentage points, what was the confidence interval used for the proportion?

Source: *USA TODAY.*

Technology *Step by Step*

MINITAB
Step by Step

Find a Confidence Interval for a Proportion

MINITAB will calculate a confidence interval, given the statistics from a sample *or* given the raw data. In Example 7–9, in a sample of 500 nursing applications 60 were from men. Find the 90% confidence interval estimate for the true proportion of male applicants.

1. Select **Stat>Basic Statistics>1 Proportion.**
2. Click on the button for Summarized data. No data will be entered in the worksheet.
3. Click in the box for Number of trials and enter **500.**
4. In the Number of events box, enter **60.**
5. Click on [Options].
6. Type **90** for the confidence level.

55	42	125	62	134	73
39	69	23	94	73	24
51	55	26	66	41	67
15	53	56	91	20	78
70	25	62	115	17	36
58	56	33	75	20	16

Source: Based on information from the National Insurance Crime Bureau.

Using this information, answer these questions.

1. What are the hypotheses that you would use?
2. Is the sample considered small or large?
3. What assumption must be met before the hypothesis test can be conducted?
4. Which probability distribution would you use?
5. Would you select a one- or two-tailed test? Why?
6. What critical value(s) would you use?
7. Conduct a hypothesis test.
8. What is your decision?
9. What is your conclusion?
10. Write a brief statement summarizing your conclusion.
11. If you lived in a city whose population was about 50,000, how many automobile thefts per year would you expect to occur?

See page 460 for the answers.

Exercises 8–3

For Exercises 1 through 13, perform each of the following steps.

a. State the hypotheses and identify the claim.
b. Find the critical value(s).
c. Compute the test value.
d. Make the decision.
e. Summarize the results.

Use diagrams to show the critical region (or regions), and use the traditional method of hypothesis testing unless otherwise specified.

1. A survey claims that the average cost of a hotel room in Atlanta is \$69.21. To test the claim, a researcher selects a sample of 30 hotel rooms and finds that the average cost is \$68.43. The standard deviation of the population is \$3.72. At $\alpha = 0.05$, is there enough evidence to reject the claim?

Source: *USA TODAY.*

2. It has been reported that the average credit card debt for college seniors is \$3262. The student senate at a large university feels that their seniors have a debt much less than this, so it conducts a study of 50 randomly selected seniors and finds that the average debt is \$2995 with a sample standard deviation of \$1100. With $\alpha = 0.05$, is the student senate correct?

Source: *USA TODAY.*

3. A researcher estimates that the average revenue of the largest businesses in the United States is greater than \$24 billion. A sample of 50 companies is selected, and the revenues (in billions of dollars) are shown. At $\alpha = 0.05$, is there enough evidence to support the researcher's claim?

178	122	91	44	35
61	56	46	20	32
30	28	28	20	27
29	16	16	19	15
41	38	36	15	25
31	30	19	19	19
24	16	15	15	19
25	25	18	14	15
24	23	17	17	22
22	21	20	17	20

Source: *N.Y. Times Almanac.*

4. Full-time Ph.D. students receive an average salary of \$12,837 according to the U.S. Department of Education. The dean of graduate studies at a large state university feels that Ph.D. students in his state earn more than this. He surveys 44 randomly selected students and finds their average salary is \$14,445 with a standard deviation of \$1500. With $\alpha = 0.05$, is the dean correct?

Source: U.S. Department of Education/*Chronicle of Higher Education.*

5. A report in *USA TODAY* stated that the average age of commercial jets in the United States is 14 years. An executive of a large airline company selects a sample of 36 planes and finds the average age of the planes is 11.8 years. The standard deviation of the sample is 2.7 years. At $\alpha = 0.01$, can it be concluded that the average age of the planes in his company is less than the national average?

Source: *USA TODAY.*

6. The average production of peanuts in the state of Virginia is 3000 pounds per acre. A new plant food has been developed and is tested on 60 individual plots of land. The mean yield with the new plant food is 3120 pounds of peanuts per acre with a standard deviation of 578 pounds. At $\alpha = 0.05$, can one conclude that the average production has increased?

Source: *The Old Farmers' Almanac.*

7. The average 1-year-old (both genders) is 29 inches tall. A random sample of 30 one-year-olds in a large day-care franchise resulted in the following heights. At $\alpha = 0.05$, can it be concluded that the average height differs from 29 inches?

25	32	35	25	30	26.5	26	25.5	29.5	32
30	28.5	30	32	28	31.5	29	29.5	30	34
29	32	27	28	33	28	27	32	29	29.5

Source: www.healthepic.com.

8. At a certain university the mean income of parents of the entering class is reported to be \$91,600. The president of another university feels that the parents' income for her entering class is greater than \$91,600. She surveys 100 randomly selected families and finds the mean income to be \$96,321 with a standard deviation of \$9555. With $\alpha = 0.05$, is she correct?

Source: *Chronicle of Higher Education.*

9. Average undergraduate cost for tuition, fees, room, and board for all institutions last year was \$19,410. A random sample of costs this year for 40 institutions of higher learning indicated that the sample mean was \$22,098, and the sample standard deviation was \$6050. At the 0.01 level of significance, is there sufficient evidence to conclude that the cost of attendance has increased?

Source: *N.Y. Times Almanac.*

10. A real estate agent claims that the average price of a home sold in Beaver County, Pennsylvania, is \$60,000. A random sample of 36 homes sold in the county is selected, and the prices in dollars are shown. Is there enough evidence to reject the agent's claim at $\alpha = 0.05$?

9,500	54,000	99,000	94,000	80,000
29,000	121,500	184,750	15,000	164,450
6,000	13,000	188,400	121,000	308,000
42,000	7,500	32,900	126,900	25,225
95,000	92,000	38,000	60,000	211,000
15,000	28,000	53,500	27,000	21,000
76,000	85,000	25,225	40,000	97,000
284,000				

Source: *Pittsburgh Tribune-Review.*

11. The average U.S. wedding includes 125 guests. A random sample of 35 weddings during the past year in a particular county had a mean of 110 guests and a standard deviation of 30. Is there sufficient evidence at the 0.01 level of significance that the average number of guests differs from the national average?

Source: www.theknot.com.

12. The average salary for public school teachers for a specific year was reported to be \$39,385. A random sample of 50 public school teachers in a particular state had a mean of \$41,680 and a standard deviation of \$5975. Is there sufficient evidence at the $\alpha = 0.05$ level to conclude that the mean salary differs from \$39,385?

Source: *N.Y. Times Almanac.*

13. To see if young men ages 8 through 17 years spend more or less than the national average of \$24.44 per shopping trip to a local mall, the manager surveyed 33 young men and found the average amount spent per visit was \$22.97. The standard deviation of the sample was \$3.70. At $\alpha = 0.02$, can it be concluded that the average amount spent at a local mall is not equal to the national average of \$24.44?

Source: *USA TODAY.*

14. What is meant by a *P*-value?

15. State whether the null hypothesis should be rejected on the basis of the given *P*-value.

a. *P*-value = 0.258, $\alpha = 0.05$, one-tailed test
b. *P*-value = 0.0684, $\alpha = 0.10$, two-tailed test
c. *P*-value = 0.0153, $\alpha = 0.01$, one-tailed test
d. *P*-value = 0.0232, $\alpha = 0.05$, two-tailed test
e. *P*-value = 0.002, $\alpha = 0.01$, one-tailed test

16. A researcher claims that the yearly consumption of soft drinks per person is 52 gallons. In a sample of 50 randomly selected people, the mean of the yearly consumption was 56.3 gallons. The standard deviation of the sample was 3.5 gallons. Find the *P*-value for the test. On the basis of the *P*-value, is the researcher's claim valid?

Source: U.S. Department of Agriculture.

17. A study found that the average stopping distance of a school bus traveling 50 miles per hour was 264 feet. A group of automotive engineers decided to conduct a study of its school buses and found that for 20 buses, the average stopping distance of buses traveling 50 miles per hour was 262.3 feet. The standard deviation of the population was 3 feet. Test the claim that the average stopping distance of the company's buses is actually less than 264 feet. Find the *P*-value. On the basis of the *P*-value, should the null hypothesis be rejected at $\alpha = 0.01$? Assume that the variable is normally distributed.

Source: Snapshot, *USA TODAY,* March 12, 1992.

18. A store manager hypothesizes that the average number of pages a person copies on the store's copy

machine is less than 40. A sample of 50 customers' orders is selected. At $\alpha = 0.01$, is there enough evidence to support the claim? Use the *P*-value hypothesis-testing method.

2	2	2	5	32
5	29	8	2	49
21	1	24	72	70
21	85	61	8	42
3	15	27	113	36
37	5	3	58	82
9	2	1	6	9
80	9	51	2	122
21	49	36	43	61
3	17	17	4	1

19. A health researcher read that a 200-pound male can burn an average of 546 calories per hour playing tennis. Thirty-six males were randomly selected and tested. The mean of the number of calories burned per hour was 544.8. Test the claim that the average number of calories burned is actually less than 546, and find the *P*-value. On the basis of the *P*-value, should the null hypothesis be rejected at $\alpha = 0.01$? The standard deviation of the sample is 3. Can it be concluded that the average number of calories burned is less than originally thought?

20. A special cable has a breaking strength of 800 pounds. The standard deviation of the population is 12 pounds. A researcher selects a sample of 20 cables and finds that the average breaking strength is 793 pounds. Can one reject the claim that the breaking strength is 800 pounds? Find the *P*-value. Should the null hypothesis be rejected at $\alpha = 0.01$? Assume that the variable is normally distributed.

21. Several years ago the Department of Agriculture found that the average size of farms in the United States was 47.1 acres. A random sample of 50 farms was selected, and the mean size of the farm was 43.2 acres. The standard deviation of the sample was 8.6 acres. Test the claim at $\alpha = 0.05$ that the average farm size is smaller today, by using the *P*-value method. Should the Department of Agriculture update its information?

22. Ten years ago, the average acreage of farms in a certain geographic region was 65 acres. The standard deviation of the population was 7 acres. A recent study consisting of 22 farms showed that the average was 63.2 acres per farm. Test the claim, at $\alpha = 0.10$, that the average has not changed by finding the *P*-value for the test. Assume that σ has not changed and the variable is normally distributed.

23. A car dealer recommends that transmissions be serviced at 30,000 miles. To see whether her customers are adhering to this recommendation, the dealer selects a sample of 40 customers and finds that the average mileage of the automobiles serviced is 30,456. The standard deviation of the sample is 1684 miles. By finding the *P*-value, determine whether the owners are having their transmissions serviced at 30,000 miles. Use $\alpha = 0.10$. Do you think the α value of 0.10 is an appropriate significance level?

24. A motorist claims that the South Boro Police issue an average of 60 speeding tickets per day. These data show the number of speeding tickets issued each day for a period of one month. Assume σ is 13.42. Is there enough evidence to reject the motorist's claim at $\alpha = 0.05$? Use the *P*-value method.

72	45	36	68	69	71	57	60
83	26	60	72	58	87	48	59
60	56	64	68	42	57	57	
58	63	49	73	75	42	63	

25. A manager states that in his factory, the average number of days per year missed by the employees due to illness is less than the national average of 10. The following data show the number of days missed by 40 employees last year. Is there sufficient evidence to believe the manager's statement at $\alpha = 0.05$? (Use *s* to estimate σ.) Use the *P*-value method.

0	6	12	3	3	5	4	1
3	9	6	0	7	6	3	4
7	4	7	1	0	8	12	3
2	5	10	5	15	3	2	5
3	11	8	2	2	4	1	9

Extending the Concepts

26. Suppose a statistician chose to test a hypothesis at $\alpha = 0.01$. The critical value for a right-tailed test is +2.33. If the test value was 1.97, what would the decision be? What would happen if, after seeing the test value, she decided to choose $\alpha = 0.05$? What would the decision be? Explain the contradiction, if there is one.

27. The president of a company states that the average hourly wage of her employees is $8.65. A sample of 50 employees has the distribution shown. At $\alpha = 0.05$, is the president's statement believable? (Use *s* to approximate σ.)

Class	Frequency
8.35–8.43	2
8.44–8.52	6
8.53–8.61	12
8.62–8.70	18
8.71–8.79	10
8.80–8.88	2

Technology *Step by Step*

MINITAB Step by Step

Hypothesis Test for the Mean and the *z* Distribution

MINITAB can be used to calculate the test statistic and its *P*-value. The *P*-value approach does not require a critical value from the table. If the *P*-value is smaller than α, the null hypothesis is rejected. For Example 8–4, test the claim that the mean shoe cost is less than $80.

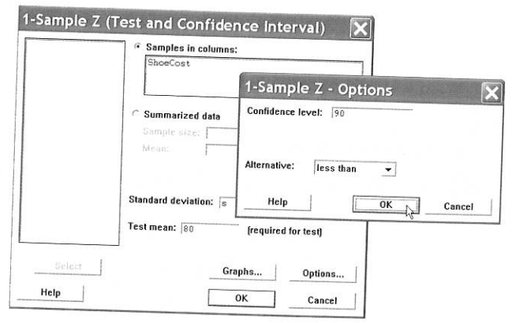
1. Enter the data into a column of MINITAB. Do not try to type in the dollar signs! Name the column **ShoeCost.**
2. If sigma is known, skip to step 3; otherwise estimate sigma from the sample standard deviation *s*.

Calculate the Standard Deviation in the Sample

a) Select **Calc>Column Statistics.**
b) Check the button for Standard deviation.
c) Select ShoeCost for the Input variable.
d) Type **s** in the text box for Store the result in:.
e) Click [OK].

Calculate the Test Statistic and *P*-Value

3. Select **Stat>Basic Statistics>1 Sample Z,** then select ShoeCost in the Variable text box.
4. Click in the text box and enter the value of sigma or type *s*, the sample standard deviation.
5. Click in the text box for Test mean, and enter the hypothesized value of **80.**
6. Click on [Options].
   a) Change the Confidence level to **90.**
   b) Change the Alternative to less than. This setting is crucial for calculating the *P*-value.
7. Click [OK] twice.



One-Sample Z: ShoeCost

```
Test of mu = 80 vs < 80
The assumed sigma 19.161

                                                    90%
                                                  Upper
Variable   N     Mean    StDev  SE Mean    Bound      Z      P
ShoeCost  36  75.0000  19.1610   3.1935  79.0926  -1.57  0.059
```

Since the *P*-value of 0.059 is less than α, reject the null hypothesis. There is enough evidence in the sample to conclude the mean cost is less than $80.

8. If a type II error was committed, explain what it would have been.
9. What did the studies prove?
10. Two statements are made about significance. One states that StopSmoke provides significant advantages, and the other states that StopSmoke is significantly less expensive than other leading brands. Are they referring to statistical significance? What other type of significance is there?

See page 461 for the answers.

Exercises 8–5

1. Give three examples of proportions.
2. Why is a proportion considered a binomial variable?
3. When one is testing hypotheses by using proportions, what are the necessary requirements?
4. What are the mean and the standard deviation of a proportion?

For Exercises 5 through 15, perform each of the following steps.

a. State the hypotheses and identify the claim.
b. Find the critical value(s).
c. Compute the test value.
d. Make the decision.
e. Summarize the results.

Use the traditional method of hypothesis testing unless otherwise specified.

5. A recent survey found that 64.7% of the population own their homes. In a random sample of 150 heads of households, 92 responded that they owned their homes. At the 0.01 level of significance, does that indicate a difference from the national proportion?

   Source: *N.Y. Times Almanac.*

6. Of families 48.8% have stock holdings. A random sample of 250 families indicated that 142 owned some type of stock. At what level of significance would you conclude that this was a significant difference?

   Source: *N.Y. Times Almanac.*

7. It has been reported that 40% of the adult population participate in computer hobbies during their leisure time. A random sample of 180 adults found that 65 engaged in computer hobbies. At $\alpha = 0.01$, is there sufficient evidence to conclude that the proportion differs from 40%?

   Source: *N.Y. Times Almanac.*

8. The percentage of physicians who are women is 27.9%. In a survey of physicians employed by a large university health system, 45 of 120 randomly selected physicians were women. Is there sufficient evidence at the 0.05 level of significance to conclude that the proportion of women physicians at the university health system exceeds 27.9%?

   Source: *N.Y. Times Almanac.*

9. An item in *USA TODAY* reported that 63% of Americans owned an answering machine. A survey of 143 employees at a large school showed that 85 owned an answering machine. At $\alpha = 0.05$, test the claim that the percentage is the same as stated in *USA TODAY.*

   Source: *USA TODAY.*

10. The *Statistical Abstract* reported that 17% of adults attended a musical play in the past year. To test this claim, a researcher surveyed 90 people and found that 22 had attended a musical play in the past year. At $\alpha = 0.05$, test the claim that this figure is correct.

    Source: *Statistical Abstract of the United States.*

11. The American Automobile Association (AAA) claims that 54% of fatal car/truck accidents are caused by driver error. A researcher studies 30 randomly selected accidents and finds that 14 were caused by driver error. Using $\alpha = 0.05$, can the AAA claim be refuted?

    Source: AAA/CNN.

12. A survey by *Men's Health* magazine stated that 14% of men said they used exercise to reduce stress. At $\alpha = 0.10$, test the claim that a random sample of 100 men was selected and 10 said that they used exercise to relieve stress. Use the *P*-value method. Could the results be generalized to all adult Americans?

13. In the *Journal of the American Dietetic Association,* it was reported that 54% of kids said that they had a snack after school. Test the claim that a random sample of 60 kids was selected and 36 said that they had a snack after school. Use $\alpha = 0.01$ and the *P*-value method. On the basis of the results, should parents be concerned about their children eating a healthy snack?

14. The Energy Information Administration reported that 51.7% of homes in the United States were heated by natural gas. A random sample of 200 homes found that 115 were heated by natural gas. Does the evidence support the claim, or has the percentage changed? Use $\alpha = 0.05$ and the *P*-value method. What could be different if the sample were taken in a different geographic area?

15. Researchers suspect that 18% of all high school students smoke at least one pack of cigarettes a day. At Wilson High School, with an enrollment of 300 students, a study found that 50 students smoked at least one pack of cigarettes a day. At $\alpha = 0.05$, test the claim that 18% of all high school students smoke at least one pack of cigarettes a day. Use the *P*-value method.

16. For a certain year a study reports that the percentage of college students using credit cards was 83%. A college dean of student services feels that this is too high for her university, so she randomly selects 50 students and finds that 40 of them use credit cards. At $\alpha = 0.04$, is she correct about her university?

    Source: *USA TODAY.*

17. For Americans using library services, the American Library Association (ALA) claims that 67% borrow books. A library director feels that this is not true so he randomly selects 100 borrowers and finds that 82 borrowed books. Can he show that the ALA claim is incorrect? Use $\alpha = 0.05$.

    Source: American Library Association; *USA TODAY.*

18. Nationally, at least 60% of Ph.D. students have paid assistantships. A college dean feels that this is not true in his state, so he randomly selects 50 Ph.D. students and finds that 26 have assistantships. At $\alpha = 0.05$, is the dean correct?

    Source: U.S. Department of Education, *Chronicle of Higher Education.*

19. A report by the NCAA states that 57.6% of football injuries occur during practices. A head trainer claims that this is too high for his conference, so he randomly selects 36 injuries and finds that 17 occurred during practices. Is his claim correct, at $\alpha = 0.05$?

    Source: *NCAA Sports Medicine Handbook.*

20. For a specific survey, the Gallup Poll reported that 45% of individuals felt they were worse off than 1 year ago. A politician feels that this is too high for her district, so she commissions her own survey and finds that, out of 150 randomly selected citizens, 58 feel they are worse off today than 1 year ago. At $\alpha = 0.05$, is the politician correct about her district?

    Source: Gallup Poll, *USA TODAY.*

Extending the Concepts

When *np* or *nq* is not 5 or more, the binomial table (Table B in Appendix C) must be used to find critical values in hypothesis tests involving proportions.

21. A coin is tossed 9 times and 3 heads appear. Can one conclude that the coin is not balanced? Use $\alpha = 0.10$. [*Hint:* Use the binomial table and find $2P(X \leq 3)$ with $p = 0.5$ and $n = 9$.]
22. In the past, 20% of all airline passengers flew first class. In a sample of 15 passengers, 5 flew first class. At $\alpha = 0.10$, can one conclude that the proportions have changed?
23. Show that $z = \dfrac{\hat{p} - p}{\sqrt{pq/n}}$ can be derived from $z = \dfrac{X - \mu}{\sigma}$ by substituting $\mu = np$ and $\sigma = \sqrt{npq}$ and dividing both numerator and denominator by n.

Technology *Step by Step*

MINITAB
Step by Step

Hypothesis Test for One Proportion and the *z* Distribution

MINITAB will calculate the test statistic and *P*-value for a test of a proportion, given the statistics from a sample or given the raw data. For Example 8–18, test the claim that 40% of all telephone customers have call-waiting service.

1. Select **Stat>Basic Statistics>1 Proportion.**
2. Click on the button for Summarized data. There are no data to enter in the worksheet.
3. Click in the box for Number of trials and enter **100.**
4. In the Number of events box enter **37.**
5. Click on [Options].
6. Type the complement of α, **99** for the confidence level.