# Exercises

## Section 19.1

1. **Parameters and hypotheses** For each of the following situations, define the parameter (proportion or mean) and write the null and alternative hypotheses in terms of parameter values. Example: We want to know if the proportion of up days in the stock market is 50%. Answer: Let $p$ = the proportion of up days. $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$.
   a) A casino wants to know if their slot machine really delivers the 1 in 100 win rate that it claims.
   b) Last year, customers spent an average of $35.32 per visit to the company's website. Based on a random sample of purchases this year, the company wants to know if the mean this year has changed.
   c) A pharmaceutical company wonders if their new drug has a cure rate different from the 30% reported by the placebo.
   d) A bank wants to know if the percentage of customers using their website has changed from the 40% that used it before their system crashed last week.

2. **Hypotheses and parameters** As in Exercise 1, for each of the following situations, define the parameter and write the null and alternative hypotheses in terms of parameter values.
   a) Seat-belt compliance in Massachusetts was 65% in 2008. The state wants to know if it has changed.
   b) Last year, a survey found that 45% of the employees were willing to pay for on-site day care. The company wants to know if that has changed.
   c) Regular card customers have a default rate of 6.7%. A credit card bank wants to know if that rate is different for their Gold card customers.
   d) Regular card customers have been with the company for an average of 17.3 months. The credit card bank wants to know if their Gold card customers have been with the company on average the same amount of time.

## Section 19.2

3. **P-values** Which of the following are true? If false, explain briefly.
   a) A very high P-value is strong evidence that the null hypothesis is false.
   b) A very low P-value proves that the null hypothesis is false.
   c) A high P-value shows that the null hypothesis is true.
   d) A P-value below 0.05 is always considered sufficient evidence to reject a null hypothesis.

4. **More P-values** Which of the following are true? If false, explain briefly.
   a) A very low P-value provides evidence against the null hypothesis.
   b) A high P-value is strong evidence in favor of the null hypothesis.
   c) A P-value above 0.10 shows that the null hypothesis is true.
   d) If the null hypothesis is true, you can't get a P-value below 0.01.

5. **Hypotheses** For each of the following, write out the null and alternative hypotheses, being sure to state whether the alternative is one-sided or two-sided.
   a) A company reports that last year, 40% of their reports in accounting were on time. From a random sample this year, they want to know if that proportion has changed.
   b) A company wants to know if average click-through rates (in minutes) are shorter than the 5.4 minutes that customers spent on their old website before making a purchase.
   c) Last year, 42% of the employees enrolled in at least one wellness class at the company's site. Using a survey, they want to know if a greater percentage is planning to take a wellness class this year.
   d) A political candidate wants to know from recent polls if she's going to garner a majority of votes in next week's election.

6. **More hypotheses** For each of the following, write out the alternative hypothesis, being sure to indicate whether it is one-sided or two-sided.
   a) *Consumer Reports* discovered that 20% of a certain computer model had warranty problems over the first three months. From a random sample, the manufacturer wants to know if a new model has improved that rate.
   b) The last time a philanthropic agency requested donations, 4.75% of people responded. From a recent pilot mailing, they wonder if that rate has increased.
   c) The average age of a customer of a clothing store is 35.2 years. The company wants to know if customers who use their website are younger on average.
   d) A student wants to know if other students on her campus prefer Coke or Pepsi.

## Section 19.3

7. **Alpha true and false** Which of the following statements are true? If false, explain briefly.
   a) Using an alpha level of 0.05, a P-value of 0.04 results in rejecting the null hypothesis.
   b) The alpha level depends on the sample size.
   c) With an alpha level of 0.01, a P-value of 0.10 results in rejecting the null hypothesis.
   d) Using an alpha level of 0.05, a P-value of 0.06 means the null hypothesis is true.

**8. Alpha false and true** Which of the following statements are true? If false, explain briefly.

a) It is better to use an alpha level of 0.05 than an alpha level of 0.01.

b) If we use an alpha level of 0.01, then a P-value of 0.001 is statistically significant.

c) If we use an alpha level of 0.01, then we reject the null hypothesis if the P-value is 0.001.

d) If the P-value is 0.01, we reject the null hypothesis for any alpha level greater than 0.01.

## Section 19.4

**9. Critical values** For each of the following situations, find the critical value(s) for *z* or *t*.

a) $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$ at $\alpha = 0.05$.

b) $H_0: p = 0.4$ vs. $H_A: p > 0.4$ at $\alpha = 0.05$.

c) $H_0: \mu = 10$ vs. $H_A: \mu \neq 10$ at $\alpha = 0.05$; $n = 36$.

d) $H_0: p = 0.5$ vs. $H_A: p > 0.5$ at $\alpha = 0.01$; $n = 345$.

e) $H_0: \mu = 20$ vs. $H_A: \mu < 20$ at $\alpha = 0.01$; $n = 1000$.

**10. More critical values** For each of the following situations, find the critical value for *z* or *t*.

a) $H_0: \mu = 105$ vs. $H_A: \mu \neq 105$ at $\alpha = 0.05$; $n = 61$.

b) $H_0: p = 0.05$ vs. $H_A: p > 0.05$ at $\alpha = 0.05$.

c) $H_0: p = 0.6$ vs. $H_A: p \neq 0.6$ at $\alpha = 0.01$.

d) $H_0: p = 0.5$ vs. $H_A: p < 0.5$ at $\alpha = 0.01$; $n = 500$.

e) $H_0: p = 0.2$ vs. $H_A: p < 0.2$ at $\alpha = 0.01$.

## Section 19.5

**11. Errors** For each of the following situations, state whether a Type I, a Type II, or neither error has been made. Explain briefly.

a) A bank wants to know if the enrollment on their website is above 30% based on a small sample of customers. They test $H_0: p = 0.3$ vs. $H_A: p > 0.3$ and reject the null hypothesis. Later they find out that actually 28% of all customers enrolled.

b) A student tests 100 students to determine whether other students on her campus prefer Coke or Pepsi and finds no evidence that preference for Coke is not 0.5. Later, a marketing company tests all students on campus and finds no difference.

c) A human resource analyst wants to know if the applicants this year score, on average, higher on their placement exam than the 52.5 points the candidates averaged last year. She samples 50 recent tests and finds the average to be 54.1 points. She fails to reject the null hypothesis that the mean is 52.5 points. At the end of the year, they find that the candidates this year had a mean of 55.3 points.

d) A pharmaceutical company tests whether a drug lifts the headache relief rate from the 25% achieved by the placebo. They fail to reject the null hypothesis because the P-value is 0.465. Further testing shows that the drug actually relieves headaches in 38% of people.

**12. More errors** For each of the following situations, state whether a Type I, a Type II, or neither error has been made.

a) A test of $H_0: \mu = 25$ vs. $H_A: \mu > 25$ rejects the null hypothesis. Later it is discovered that $\mu = 24.9$.

b) A test of $H_0: p = 0.8$ vs. $H_A: p < 0.8$ fails to reject the null hypothesis. Later it is discovered that $p = 0.9$.

c) A test of $H_0: p = 0.5$ vs. $H_A: p \neq 0.5$ rejects the null hypothesis. Later is it discovered that $p = 0.65$.

d) A test of $H_0: p = 0.7$ vs. $H_A: p < 0.7$ fails to reject the null hypothesis. Later is it discovered that $p = 0.6$.

## Chapter Exercises

**13. One sided or two?** In each of the following situations, is the alternative hypothesis one-sided or two-sided? What are the hypotheses?

a) A business student conducts a taste test to see whether students prefer Diet Coke or Diet Pepsi.

b) PepsiCo recently reformulated Diet Pepsi in an attempt to appeal to teenagers. They run a taste test to see if the new formula appeals to more teenagers than the standard formula.

c) A budget override in a small town requires a two-thirds majority to pass. A local newspaper conducts a poll to see if there's evidence it will pass.

d) One financial theory states that the stock market will go up or down with equal probability. A student collects data over several years to test the theory.

**14. Which alternative?** In each of the following situations, is the alternative hypothesis one-sided or two-sided? What are the hypotheses?

a) A college dining service conducts a survey to see if students prefer plastic or metal cutlery.

b) In recent years, 10% of college juniors have applied for study abroad. The dean's office conducts a survey to see if that's changed this year.

c) A pharmaceutical company conducts a clinical trial to see if more patients who take a new drug experience headache relief than the 22% who claimed relief after taking the placebo.

d) At a small computer peripherals company, only 60% of the hard drives produced passed all their performance tests the first time. Management recently invested a lot of resources into the production system and now conducts a test to see if it helped.

**15. P-value** A medical researcher tested a new treatment for poison ivy against the traditional ointment. He concluded that the new treatment is more effective. Explain what the P-value of 0.047 means in this context.

**16. Another P-value** Have harsher penalties and ad campaigns increased seat-belt use among drivers and passengers? Observations of commuter traffic failed to find evidence of a significant change compared with three years ago. Explain what the study's P-value of 0.17 means in this context.

**17. Alpha** A researcher developing scanners to search for hidden weapons at airports has concluded that a new device is significantly better than the current scanner. He made this decision based on a test using $\alpha = 0.05$. Would he have made the same decision at $\alpha = 0.10$? How about $\alpha = 0.01$? Explain.

**18. Alpha, again** Environmentalists concerned about the impact of high-frequency radio transmissions on birds found that there was no evidence of a higher mortality rate among hatchlings in nests near cell towers. They based this conclusion on a test using $\alpha = 0.05$. Would they have made the same decision at $\alpha = 0.10$? How about $\alpha = 0.01$? Explain.

**19. Significant?** Public health officials believe that 98% of children have been vaccinated against measles. A random survey of medical records at many schools across the country found that, among more than 13,000 children, only 97.4% had been vaccinated. A statistician would reject the 98% hypothesis with a P-value of $P < 0.0001$.

a) Explain what the P-value means in this context.
b) The result is statistically significant, but is it important? Comment.

**20. Significant again?** A new reading program may reduce the number of elementary school students who read below grade level. The company that developed this program supplied materials and teacher training for a large-scale test involving nearly 8500 children in several different school districts. Statistical analysis of the results showed that the percentage of students who did not meet the grade-level goal was reduced from 15.9% to 15.1%. The hypothesis that the new reading program produced no improvement was rejected with a P-value of 0.023.

a) Explain what the P-value means in this context.
b) Even though this reading method has been shown to be significantly better, why might you not recommend that your local school adopt it?

**21. Groceries** In January 2011, Yahoo surveyed 2400 U.S. men. 1224 of the men identified themselves as the primary grocery shopper in their household.

a) Estimate the percentage of all American males who identify themselves as the primary grocery shopper. Use a 98% confidence interval. Check the conditions first.
b) A grocery store owner believed that only 45% of men are the primary grocery shopper for their family, and targets his advertising accordingly. He wishes to conduct a hypothesis test to see if the fraction is in fact higher than 45%. What does your confidence interval indicate? Explain.
c) What is the level of significance of this test? Explain.

**22. Is the Euro fair?** Soon after the Euro was introduced as currency in Europe, it was widely reported that someone had spun a Euro coin 250 times and gotten heads 140 times. We wish to test a hypothesis about the fairness of spinning the coin.

a) Estimate the true proportion of heads. Use a 95% confidence interval. Don't forget to check the conditions.
b) Does your confidence interval provide evidence that the coin is unfair when spun? Explain.
c) What is the significance level of this test? Explain.

**23. Approval 2011** In November 2011, Barack Obama's approval rating stood at 45% in Rasmussen's daily tracking poll of 1500 randomly surveyed U.S. adults.

a) Make a 95% confidence interval for his approval rating by all U.S. adults.
b) Based on the confidence interval, test the null hypothesis that Obama's approval rating was no worse than his November 2009 approval rating of 50%.

**24. Hard times** In June 2010, a random poll of 800 working men found that 9% had taken on a second job to help pay the bills. (www.careerbuilder.com)

a) Estimate the true percentage of men that are taking on second jobs by constructing a 95% confidence interval.
b) A pundit on a TV news show claimed that only 6% of working men had a second job. Use your confidence interval to test whether his claim is plausible given the poll data.

**25. Dogs** Canine hip dysplasia is a degenerative disease that causes pain in many dogs. Sometimes advanced warning signs appear in puppies as young as 6 months. A veterinarian checked 42 puppies whose owners brought them to a vaccination clinic, and she found 5 with early hip dysplasia. She considers this group to be a random sample of all puppies.

a) Explain why we cannot use this information to construct a confidence interval for the rate of occurrence of early hip dysplasia among all 6-month-old puppies.
*b) Construct a "plus-four" confidence interval and interpret it in this context.

**26. Fans** A survey of 81 randomly selected people standing in line to enter a football game found that 73 of them were home team fans.

a) Explain why we cannot use this information to construct a confidence interval for the proportion of all people at the game who are fans of the home team.
*b) Construct a "plus-four" confidence interval and interpret it in this context.

**27. Loans** Before lending someone money, banks must decide whether they believe the applicant will repay the loan. One strategy used is a point system. Loan officers assess information about the applicant, totaling points they award for the person's income level, credit history, current debt burden, and so on. The higher the point total, the more convinced the bank is that it's safe to make the loan. Any applicant with a lower point total than a certain cutoff score is denied a loan.