



## EXERCISES

- Margin of error.** A TV newscaster reports the results of a poll of voters, and then says, "The margin of error is plus or minus 4%." Explain carefully what that means.
- Margin of error.** A medical researcher estimates the percentage of children exposed to lead-base paint, adding that he believes his estimate has a margin of error of about 3%. Explain what the margin of error means.
- Conditions.** For each situation described below, identify the population and the sample, explain what  $p$  and  $\hat{p}$  represent, and tell whether the methods of this chapter can be used to create a confidence interval.
  - Police set up an auto checkpoint at which drivers are stopped and their cars inspected for safety problems. They find that 14 of the 134 cars stopped have at least one safety violation. They want to estimate the percentage of all cars that may be unsafe.
  - A TV talk show asks viewers to register their opinions on prayer in schools by logging on to a Web site. Of the 602 people who voted, 488 favored prayer in schools. We want to estimate the level of support among the general public.
  - A school is considering requiring students to wear uniforms. The PTA surveys parent opinion by sending a questionnaire home with all 1245 students; 380 surveys are returned, with 228 families in favor of the change.
  - A college admits 1632 freshmen one year, and four years later 1388 of them graduate on time. The college wants to estimate the percentage of all their freshman enrollees who graduate on time.
- More conditions.** Consider each situation described. Identify the population and the sample, explain what  $p$  and  $\hat{p}$  represent, and tell whether the methods of this chapter can be used to create a confidence interval.
  - A consumer group hoping to assess customer experiences with auto dealers surveys 167 people who recently bought new cars; 3% of them expressed dissatisfaction with the salesperson.
  - What percent of college students have cell phones? 2883 students were asked as they entered a football stadium, and 243 said they had phones with them.
  - 240 potato plants in a field in Maine are randomly checked, and only 7 show signs of blight. How severe is the blight problem for the U.S. potato industry?
  - 12 of the 309 employees of a small company suffered an injury on the job last year. What can the company expect in future years?
- Conclusions.** A catalog sales company promises to deliver orders placed on the Internet within 3 days. Follow-up calls to a few randomly selected customers show that a 95% confidence interval for the proportion of all orders that arrive on time is  $88\% \pm 6\%$ . What does this mean? Are these conclusions correct? Explain.
  - Between 82% and 94% of all orders arrive on time.
  - 95% of all random samples of customers will show that 88% of orders arrive on time.
  - 95% of all random samples of customers will show that 82% to 94% of orders arrive on time.
  - We are 95% sure that between 82% and 94% of the orders placed by the sampled customers arrived on time.
  - On 95% of the days, between 82% and 94% of the orders will arrive on time.
- More conclusions.** In January 2002, two students made worldwide headlines by spinning a Belgian euro 250 times and getting 140 heads—that's 56%. That makes the 90% confidence interval (51%, 61%). What does this mean? Are these conclusions correct? Explain.
  - Between 51% and 61% of all euros are unfair.
  - We are 90% sure that in this experiment this euro landed heads on between 51% and 61% of the spins.
  - We are 90% sure that spun euros will land heads between 51% and 61% of the time.
  - If you spin a euro many times, you can be 90% sure of getting between 51% and 61% heads.
  - 90% of all spun euros will land heads between 51% and 61% of the time.
- Confidence intervals.** Several factors are involved in the creation of a confidence interval. Among them are the sample size, the level of confidence, and the margin of error. Which statements are true?
  - For a given sample size, higher confidence means a smaller margin of error.
  - For a specified confidence level, larger samples provide smaller margins of error.
  - For a fixed margin of error, larger samples provide greater confidence.
  - For a given confidence level, halving the margin of error requires a sample twice as large.
- Confidence intervals, again.** Several factors are involved in the creation of a confidence interval. Among them are the sample size, the level of confidence, and the margin of error. Which statements are true?
  - For a given sample size, reducing the margin of error will mean lower confidence.
  - For a certain confidence level, you can get a smaller margin of error by selecting a bigger sample.
  - For a fixed margin of error, smaller samples will mean lower confidence.
  - For a given confidence level, a sample 9 times as large will make a margin of error one third as big.
- Cars.** What fraction of cars is made in Japan? The computer output below summarizes the results of a random sample of 50 autos. Explain carefully what it tells you.
 

z-Inter val for propor tion  
With 90.00% confidence,  
0.29938661 < p[japan] < 0.46984416

10. **Parole.** A study of 902 decisions made by the Nebraska Board of Parole produced the following computer output. Assuming these cases are representative of all cases that may come before the Board, what can you conclude?
- z-Interval for proportion  
With 95.00% confidence,  
0.56100658 < p(parole) < 0.62524619
11. **Contaminated chicken.** In January 2007 *Consumer Reports* published their study of bacterial contamination of chicken sold in the United States. They purchased 525 broiler chickens from various kinds of food stores in 23 states and tested them for types of bacteria that cause food-borne illnesses. Laboratory results indicated that 83% of these chickens were infected with *Campylobacter*.
- Construct a 95% confidence interval.
  - Explain what your confidence interval says about chicken sold in the United States.
  - A spokesperson for the U.S. Department of Agriculture dismissed the *Consumer Reports* finding, saying, "That's 500 samples out of 9 billion chickens slaughtered a year. . . . With the small numbers they [tested], I don't know that one would want to change one's buying habits." Is this criticism valid? Explain.
12. **Contaminated chicken, second course.** The January 2007 *Consumer Reports* study described in Exercise 11 also found that 15% of the 525 broiler chickens tested were infected with *Salmonella*.
- Are the conditions for creating a confidence interval satisfied? Explain.
  - Construct a 95% confidence interval.
  - Explain what your confidence interval says about chicken sold in the United States.
13. **Baseball fans.** In a poll taken in March of 2007, Gallup asked 1006 national adults whether they were baseball fans. 36% said they were. A year previously, 37% of a similar-size sample had reported being baseball fans.
- Find the margin of error for the 2007 poll if we want 90% confidence in our estimate of the percent of national adults who are baseball fans.
  - Explain what that margin of error means.
  - If we wanted to be 99% confident, would the margin of error be larger or smaller? Explain.
  - Find that margin of error.
  - In general, if all other aspects of the situation remain the same, will smaller margins of error produce greater or less confidence in the interval?
  - Do you think there's been a change from 2006 to 2007 in the real proportion of national adults who are baseball fans? Explain.
14. **Cloning 2007.** A May 2007 Gallup Poll found that only 11% of a random sample of 1003 adults approved of attempts to clone a human.
- Find the margin of error for this poll if we want 95% confidence in our estimate of the percent of American adults who approve of cloning humans.
  - Explain what that margin of error means.
  - If we only need to be 90% confident, will the margin of error be larger or smaller? Explain.
  - Find that margin of error.
- e) In general, if all other aspects of the situation remain the same, would smaller samples produce smaller or larger margins of error?
15. **Contributions, please.** The Paralyzed Veterans of America is a philanthropic organization that relies on contributions. They send free mailing labels and greeting cards to potential donors on their list and ask for a voluntary contribution. To test a new campaign, they recently sent letters to a random sample of 100,000 potential donors and received 4781 donations.
- Give a 95% confidence interval for the true proportion of their entire mailing list who may donate.
  - A staff member thinks that the true rate is 5%. Given the confidence interval you found, do you find that percentage plausible?
16. **Take the offer.** First USA, a major credit card company, is planning a new offer for their current cardholders. The offer will give double airline miles on purchases for the next 6 months if the cardholder goes online and registers for the offer. To test the effectiveness of the campaign, First USA recently sent out offers to a random sample of 50,000 cardholders. Of those, 1184 registered.
- Give a 95% confidence interval for the true proportion of those cardholders who will register for the offer.
  - If the acceptance rate is only 2% or less, the campaign won't be worth the expense. Given the confidence interval you found, what would you say?
17. **Teenage drivers.** An insurance company checks police records on 582 accidents selected at random and notes that teenagers were at the wheel in 91 of them.
- Create a 95% confidence interval for the percentage of all auto accidents that involve teenage drivers.
  - Explain what your interval means.
  - Explain what "95% confidence" means.
  - A politician urging tighter restrictions on drivers' licenses issued to teens says, "In one of every five auto accidents, a teenager is behind the wheel." Does your confidence interval support or contradict this statement? Explain.
18. **Junk mail.** Direct mail advertisers send solicitations (a.k.a. "junk mail") to thousands of potential customers in the hope that some will buy the company's product. The acceptance rate is usually quite low. Suppose a company wants to test the response to a new flyer, and sends it to 1000 people randomly selected from their mailing list of over 200,000 people. They get orders from 123 of the recipients.
- Create a 90% confidence interval for the percentage of people the company contacts who may buy something.
  - Explain what this interval means.
  - Explain what "90% confidence" means.
  - The company must decide whether to now do a mass mailing. The mailing won't be cost-effective unless it produces at least a 5% return. What does your confidence interval suggest? Explain.
19. **Safe food.** Some food retailers propose subjecting food to a low level of radiation in order to improve safety, but sale of such "irradiated" food is opposed by many people. Suppose a grocer wants to find out what his customers think. He has cashiers distribute surveys at checkout and

ask customers to fill them out and drop them in a box near the front door. He gets responses from 122 customers, of whom 78 oppose the radiation treatments. What can the grocer conclude about the opinions of all his customers?

20. **Local news.** The mayor of a small city has suggested that the state locate a new prison there, arguing that the construction project and resulting jobs will be good for the local economy. A total of 183 residents show up for a public hearing on the proposal, and a show of hands finds only 31 in favor of the prison project. What can the city council conclude about public support for the mayor's initiative?
21. **Death penalty, again.** In the survey on the death penalty you read about in the chapter, the Gallup Poll actually split the sample at random, asking 510 respondents the question quoted earlier, "Generally speaking, do you believe the death penalty is applied fairly or unfairly in this country today?" The other 510 were asked "Generally speaking, do you believe the death penalty is applied unfairly or fairly in this country today?" Seems like the same question, but sometimes the order of the choices matters. Suppose that for the second way of phrasing it, only 54% said they thought the death penalty was fairly applied.
- What kind of bias may be present here?
  - If we combine them, considering the overall group to be one larger random sample of 1020 respondents, what is a 95% confidence interval for the proportion of the general public that thinks the death penalty is being fairly applied?
  - How does the margin of error based on this pooled sample compare with the margins of error from the separate groups? Why?
22. **Gambling.** A city ballot includes a local initiative that would legalize gambling. The issue is hotly contested, and two groups decide to conduct polls to predict the outcome. The local newspaper finds that 53% of 1200 randomly selected voters plan to vote "yes," while a college Statistics class finds 54% of 450 randomly selected voters in support. Both groups will create 95% confidence intervals.
- Without finding the confidence intervals, explain which one will have the larger margin of error.
  - Find both confidence intervals.
  - Which group concludes that the outcome is too close to call? Why?
23. **Rickets.** Vitamin D, whether ingested as a dietary supplement or produced naturally when sunlight falls on the skin, is essential for strong, healthy bones. The bone disease rickets was largely eliminated in England during the 1950s, but now there is concern that a generation of children more likely to watch TV or play computer games than spend time outdoors is at increased risk. A recent study of 2700 children randomly selected from all parts of England found 20% of them deficient in vitamin D.
- Find a 98% confidence interval.
  - Explain carefully what your interval means.
  - Explain what "98% confidence" means.
24. **Pregnancy.** In 1998 a San Diego reproductive clinic reported 49 live births to 207 women under the age of 40 who had previously been unable to conceive.
- Find a 90% confidence interval for the success rate at this clinic.
  - Interpret your interval in this context.
  - Explain what "90% confidence" means.
  - Do these data refute the clinic's claim of a 25% success rate? Explain.
25. **Payments.** In a May 2007 Experian/Gallup Personal Credit Index poll of 1008 U.S. adults aged 18 and over, 8% of respondents said they were very uncomfortable with their ability to make their monthly payments on their current debt during the next three months. A more detailed poll surveyed 1288 adults, reporting similar overall results and also noting differences among four age groups: 18–29, 30–49, 50–64, and 65+.
- Do you expect the 95% confidence interval for the true proportion of all 18- to 29-year-olds who are worried to be wider or narrower than the 95% confidence interval for the true proportion of all U.S. consumers? Explain.
  - Do you expect this second poll's overall margin of error to be larger or smaller than the Experian/Gallup poll's? Explain.
26. **Back to campus again.** In 2004 ACT, Inc., reported that 74% of 1644 randomly selected college freshmen returned to college the next year. The study was stratified by type of college—public or private. The retention rates were 71.9% among 505 students enrolled in public colleges and 74.9% among 1139 students enrolled in private colleges.
- Will the 95% confidence interval for the true national retention rate in private colleges be wider or narrower than the 95% confidence interval for the retention rate in public colleges? Explain.
  - Do you expect the margin of error for the overall retention rate to be larger or smaller? Explain.
27. **Deer ticks.** Wildlife biologists inspect 153 deer taken by hunters and find 32 of them carrying ticks that test positive for Lyme disease.
- Create a 90% confidence interval for the percentage of deer that may carry such ticks.
  - If the scientists want to cut the margin of error in half, how many deer must they inspect?
  - What concerns do you have about this sample?
28. **Pregnancy, II.** The San Diego reproductive clinic in Exercise 24 wants to publish updated information on its success rate.
- The clinic wants to cut the stated margin of error in half. How many patients' results must be used?
  - Do you have any concerns about this sample? Explain.
29. **Graduation.** It's believed that as many as 25% of adults over 50 never graduated from high school. We wish to see if this percentage is the same among the 25 to 30 age group.
- How many of this younger age group must we survey in order to estimate the proportion of non-grads to within 6% with 90% confidence?
  - Suppose we want to cut the margin of error to 4%. What's the necessary sample size?
  - What sample size would produce a margin of error of 3%?

30. **Hiring.** In preparing a report on the economy, we need to estimate the percentage of businesses that plan to hire additional employees in the next 60 days.
- How many randomly selected employers must we contact in order to create an estimate in which we are 98% confident with a margin of error of 5%?
  - Suppose we want to reduce the margin of error to 3%. What sample size will suffice?
  - Why might it not be worth the effort to try to get an interval with a margin of error of only 1%?
31. **Graduation, again.** As in Exercise 29, we hope to estimate the percentage of adults aged 25 to 30 who never graduated from high school. What sample size would allow us to increase our confidence level to 95% while reducing the margin of error to only 2%?
32. **Better hiring info.** Editors of the business report in Exercise 30 are willing to accept a margin of error of 4% but want 99% confidence. How many randomly selected employers will they need to contact?
33. **Pilot study.** A state's environmental agency worries that many cars may be violating clean air emissions standards. The agency hopes to check a sample of vehicles in order to estimate that percentage with a margin of error of 3% and 90% confidence. To gauge the size of the problem, the agency first picks 60 cars and finds 9 with faulty emissions systems. How many should be sampled for a full investigation?
34. **Another pilot study.** During routine screening, a doctor notices that 22% of her adult patients show higher than normal levels of glucose in their blood—a possible warning signal for diabetes. Hearing this, some medical researchers decide to conduct a large-scale study, hoping to estimate the proportion to within 4% with 98% confidence. How many randomly selected adults must they test?
35. **Approval rating.** A newspaper reports that the governor's approval rating stands at 65%. The article adds that the poll is based on a random sample of 972 adults and has a margin of error of 2.5%. What level of confidence did the pollsters use?
36. **Amendment.** A TV news reporter says that a proposed constitutional amendment is likely to win approval in the upcoming election because a poll of 1505 likely voters indicated that 52% would vote in favor. The reporter goes on to say that the margin of error for this poll was 3%.
- Explain why the poll is actually inconclusive.
  - What confidence level did the pollsters use?



### JUST CHECKING Answers

- No. We know that in the sample 17% said "yes"; there's no need for a margin of error.
- No, we are 95% confident that the percentage falls in some interval, not exactly on a particular value.
- Yes. That's what the confidence interval means.
- No. We don't know for sure that's true; we are only 95% confident.
- No. That's our level of confidence, not the proportion of people receiving unsolicited text messages. The sample suggests the proportion is much lower.
- Wider.
- Lower.
- Smaller.