

Thus, the 95% confidence interval for the percentage of American adults who say they have “a little” awareness of facial recognition technology is (59.1%, 62.9%).

- b. To establish if there is a statistical difference between the two subgroups, we can look at the confidence intervals for each of them and determine if the intervals overlap. If they do overlap, we cannot say that there is a statistical difference between the two. If they do not overlap, we can be 95% confident that one population parameter is different than the other. Begin by constructing the confidence intervals in the same manner as in part a., using the margin of errors given for each subpopulation.

Table 11.5.3

Age Group	Sample Proportion Who Responded “A Lot”	Margin of Error	95 % Confidence Interval for the Population Percentage
18- to 29-year-olds	29%	4.8%	(24.2%, 33.8%)
65+	20%	3.8%	(16.2%, 23.8%)

Notice that the confidence intervals for the two age groups do not overlap. Therefore, we can say that we are 95 % confident that 18- to 29-year-olds are more likely to say they know “a lot” about facial recognition technology than those 65 years old and older.

Skill Check Answers

1. $\frac{301}{432} \approx 0.697$ 2. (27.2%, 30.8%) 3. 3.3%

11.5 Exercises

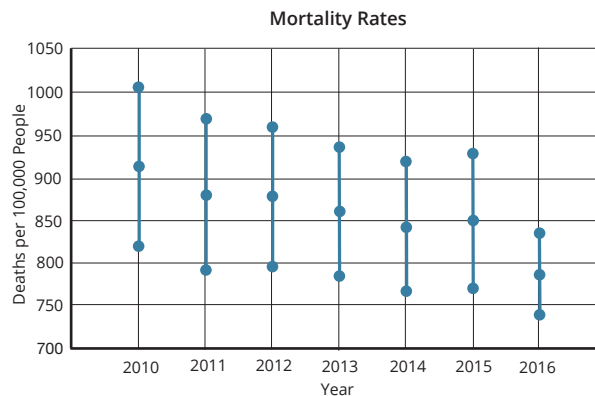
✓ CONCEPT CHECK

1. A _____ is a single-number estimate of a population parameter.
2. The margin of error is the largest possible distance from the _____ that a confidence interval will cover.
3. The range of all possible values for a population parameter is called the _____.
4. True or False: The level of confidence describes the likelihood that the data value in question will fall within the corresponding confidence interval.

APPLICATIONS

Find each specified point estimate or confidence interval.

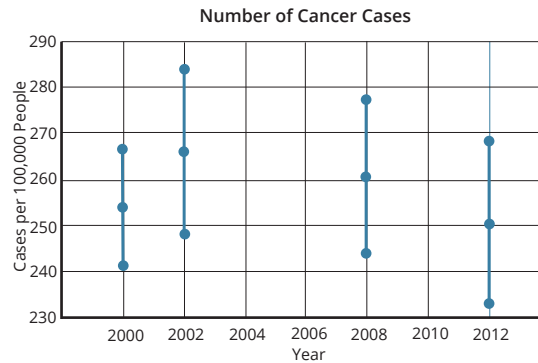
5. A survey of 42 randomly selected teachers finds that they spend a mean of \$18 per week on lunch. What is the best point estimate for the mean amount of money spent per week on lunch for all teachers?
6. The mean number of pets per student for a random sample of 47 students at Brown Elementary is 2.5 pets. What is the best point estimate for the mean number of pets per student for all students at Brown Elementary?
7. A survey of teachers reports that a point estimate for the mean amount of money spent each week on lunch is \$18.00. If the margin of error for a 95% confidence interval for the mean amount of money spent each week on lunch by all teachers is \$1.70, construct a 95% confidence interval for the mean amount of money spent each week on lunch for all teachers.
8. The mean batting average for a random sample of 35 professional baseball players is .283. If the margin of error for the population mean with a 99% level of confidence is .051, construct a 99% confidence interval for the mean batting average for professional baseball players.
9. The following graph¹⁹ shows the 95% confidence intervals for mortality rates across several countries from 2010 to 2016. The middle point of each segment indicates the mean. Use the graph to answer the following questions.



- a. Approximate the 95% confidence interval for 2010. Based on this, what can you say about the mortality at this point?
- b. Can we say with certainty that the 2012 mortality rate is below 900 deaths per 100,000 people? Explain your answer.
- c. Is there a year that we can be certain has a mortality rate below 850 deaths per 100,000 people?
- d. Compare the mortality rates for 2015 and 2016.

19 "Health Status," Organisation for Economic Co-Operation and Development, accessed January 4, 2022, https://stats.oecd.org/Index.aspx?DatasetCode=HEALTH_STAT.

10. The following graph²⁰ shows the 95% confidence intervals for the number of cancer cases in several countries in 2000, 2002, 2008, and 2012. The middle point of each segment indicates the mean. Use the graph to answer the following questions.



- Approximate the 95% confidence interval for 2000. Based on this, what can you say about the number of cancer cases in 2000?
 - Can we say with certainty that there were fewer than 280 cancer cases per 100,000 people in 2002? Explain your answer.
 - Is there a year that we can be certain had fewer than 270 cancer cases per 100,000 people?
 - Compare the number of cancer cases in 2000 and 2002.
11. While testing a new anesthetic drug, the researchers found that the 90% confidence interval for the percentage of patients whose pain is completely relieved by the drug is (76.2%, 81.4%). Interpret their results.
12. A survey was taken of 1028 high school students asking if they listen to music for more than two hours per day. The 95% confidence interval for such students is (71.8%, 78.0%). Interpret the result of the survey.

Construct and interpret each specified confidence interval.

13. A professor wants to estimate how many hours per week her students study. A simple random sample of 78 students had a mean of 15.0 hours of studying per week with a standard deviation of 2.3 hours per week. Construct and interpret a 90% confidence interval for the mean number of hours a student studies per week if the margin of error for the data using a 90% level of confidence is $E = 0.4$.
14. A faculty advocacy group is concerned about the amount of time teachers spend each week doing schoolwork at home. A simple random sample of 56 teachers had a mean of 8.0 hours per week working at home after school with a standard deviation of 1.5 hours per week. Construct and interpret a 95% confidence interval for the mean number of hours per week a teacher spends working at home if the margin of error for the data using a 95% level of confidence is $E = 0.4$.

20 "Health Status," Organisation for Economic Co-Operation and Development, accessed January 4, 2022, https://stats.oecd.org/Index.aspx?DatasetCode=HEALTH_STAT.

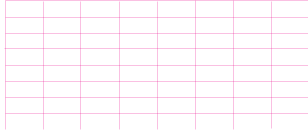
15. A writer for a computer magazine is working on an article about computer usage in American households. A simple random sample of 120 American households has a mean computer usage time of 19.2 hours per week with a standard deviation of 3.3 hours per week. Construct and interpret a 95% confidence interval for the mean computer usage time per week for all American households if the margin of error for the data using a 95% level of confidence is $E = 0.6$.
16. A survey of 85 randomly selected homeowners finds that they spend a mean of \$67 per month on home maintenance with a standard deviation of \$14 per month. Construct and interpret a 99% confidence interval for the mean amount of money spent per month on home maintenance by all homeowners if the margin of error for the data using a 99% level of confidence is $E = 4$.
17. A survey of 97 randomly selected homeowners found that the mean amount spent on lawn service was \$720 per year with a standard deviation of \$123 per year. Construct and interpret a 98% confidence interval for the mean amount of money spent on lawn service per household each year if the margin of error for the data using a 98% level of confidence is $E = 29$.
18. A survey of a simple random sample of 140 dieters revealed that the numbers of times they “cheated” on their diets had a mean of 7.0 times per week with a standard deviation of 1.5 times per week. Construct and interpret a 99% confidence interval for the mean number of times dieters “cheat” on their diets each week if the margin of error for the data using a 99% level of confidence is $E = 0.3$.
19. A physical therapist is investigating the mean recovery time after ACL surgery for patients involved in a new therapy regimen. For the purpose of the study, a successful recovery was defined to be the ability to walk without crutches. For 38 randomly selected patients, the mean recovery time after ACL surgery was found to be 22.6 days with a standard deviation of 3.7 days. Find and interpret a 99% confidence interval for the mean recovery time for all ACL surgery patients undergoing the same new therapy if the margin of error for the data using a 99% level of confidence is $E = 1.5$.
20. The manufacturers of Caudill automotive oil wish to estimate the mean number of miles that motorists drive between oil changes. A random sample of 54 motorists has a mean of 5900 miles driven between oil changes with a standard deviation of 1350 miles. Construct and interpret a 95% confidence interval for the mean number of miles driven between oil changes for all motorists if the margin of error for the data using a 95% level of confidence is $E = 360$.
21. Thirteen out of 147 randomly selected faculty members who were surveyed at a community college know sign language. Use the rule of thumb to construct and interpret a 95% confidence interval for the percentage of all faculty members at the community college who know sign language. If necessary, round your upper and lower endpoints to the nearest hundredth.
22. A random sample of 200 computer chips is obtained from one factory and 4% are found to be defective. Construct and interpret a 95% confidence interval for the proportion of all computer chips from that factory that are defective if the margin of error for the data using a 95% level of confidence is $E = 2.7\%$.

23. Out of 140 randomly selected kindergartners who were surveyed, 32 said that pancakes are their favorite breakfast food. Use the rule of thumb to construct and interpret a 95% confidence interval for the percentage of all kindergartners who say pancakes are their favorite breakfast food. If necessary, round your upper and lower endpoints to the nearest hundredth.
24. Out of 543 randomly selected patients of a local hospital who were surveyed, 492 reported that they were satisfied with the care they received. Use the rule of thumb to construct and interpret a 95% confidence interval for the percentage of all patients satisfied with their care at that hospital. If necessary, round your upper and lower endpoints to the nearest hundredth.
25. A survey of 145 randomly selected students at one college showed that only 87 checked their campus e-mail account on a regular basis. Use the rule of thumb to construct and interpret a 95% confidence interval for the percentage of students at that college who do not check their e-mail account on a regular basis. If necessary, round your upper and lower endpoints to the nearest hundredth.
26. A random sample of 200 computer chips is obtained from one factory and 4% are found to be defective. Construct and interpret a 99% confidence interval for the percentage of all computer chips from that factory that are *not* defective if the margin of error for the data using a 99% level of confidence is $E = 3.6\%$.
27. The Pew Research Center surveyed pairs of US teens and one of their parents in 2019. Their website provides a breakdown of the sample size along with the margin of error for a 95% confidence interval for the overall survey as well as for different subgroups of data.

Teen Group	Unweighted Sample Size	Margin of Error
Total teen Sample	1811	3.1 percentage points
All religiously affiliated teens	1246	3.7 percentage points
Christian	1179	3.9 percentage points
Protestant	680	5.2 percentage points
Evangelical	407	6.6 percentage points
Mainline	208	9.0 percentage points
Catholic	428	6.4 percentage points
Unaffiliated	555	5.7 percentage points

Source: "Methodology," Pew Research Center, September 8, 2020, <https://www.pewforum.org/2020/09/10/methodology-34/>.

- a. Use the data in the table to create a graph of the sample sizes of each category versus the margin of error percentage points. For each point (x, y) , let x represent the sample size and y represent the margin of error.
- b. Based on the graph from part a., what can you say about the margin of error compared with the sample size?
- c. Is it possible to create confidence intervals for the population percentages in each category using the data from the table?



28. The Pew Research Center surveyed US adult Twitter users in 2021 and reported the following.

“Seven in ten US adult Twitter news consumers have followed breaking news there.”

Their website provides a breakdown of the sample size along with the margin of error for a 95% confidence interval for the overall survey as well as for different subgroups of data.

Group	Unweighted Sample Size	Margin of Error
Total Sample	2548	3.4 percentage points
Gets news on Twitter	1783	4.0 percentage points
Does not get news on Twitter	751	6.1 percentage points
Among those who get news on Twitter		
Rep / Lean Rep	452	7.7 percentage points
Dem / Lean Dem	1311	4.8 percentage points

Source: “Methodology,” Pew Research Center, November 15, 2021, <https://www.pewresearch.org/journalism/2021/11/15/new-on-twitter-methodology/>.

- Use the data in the table to create a graph of the sample sizes of each category versus the margin of error percentage points. For each point (x, y) , let x represent the sample size and y represent the margin of error.
 - Based on the graph from part a., what can you say about the margin of error compared with the sample size?
 - Is it possible to create confidence intervals for the population percentages in each category using the data from the table?
29. The Pew Research Center reported the following based on a survey conducted among 4860 US adults.

“47% of Americans say dating is now harder than it was 10 years ago, while 19% say it’s easier and 33% say it’s about the same.”

Their website provides the margin of error of 2.1 percentage points for a 95% confidence interval for the overall survey. Interpret the provided margin of error.

30. A 2021 survey of US adults found that “Many Americans continue to experience mental health difficulties as pandemic enters second year. [...] Psychological distress is especially common among adults with lower family incomes.” Use the information in the table to answer the following questions.

Group	High Distress	Medium Distress	Low Distress	Unweighted Sample Size	Margin of Error (for 95% Confidence)
Upper Income	13%	22%	65%	2767	2.7%
Middle Income	18%	24%	56%	4810	2.2%
Lower Income	31%	25%	42%	2119	3.4%

Source: Pew Research Center, February 2021, <https://www.pewresearch.org/facttank/2021/03/16/many-americans-continue-to-experience-mental-health-difficulties-as-pandemic-enters-second-year/>.

- a. Construct a 95% confidence interval for the proportion of American adults with middle income who would say they have high distress.
- b. Is it correct to say that people with lower income are more likely to say they are highly distressed than those with upper income? Explain why or why not.
31. A 2021 survey of US adults found that “About seven-in-ten US adults say major tech companies have too much economic power and influence.” Use the information in the table to answer the following questions.

Group	Too much	About the Right Amount	Not Enough	Unweighted Sample Size	Margin of Error (for 95% Confidence)
US Adults	68%	25%	4%	4623	2.2%
Rep/Lean Rep	74%	22%	2%	1899	3.3%
Dem/Lean Dem	64%	29%	5%	2603	3.0%

Source: Pew Research Center, July 20, 2021, <https://www.pewresearch.org/facttank/2021/07/20/56-of-americans-support-more-regulation-of-major-technology-companies/>.

- a. Construct a 95% confidence interval for the proportion of American adults who would say major technology companies have too much power and influence in today’s economy.
- b. Is it correct to say that Republicans are more likely to say technology companies have too much power than Democrats? Explain why or why not.
32. Suppose a poll was taken of 3196 high-school seniors to investigate how many of them plan to go to college. The researchers learned that 68.7% plan to go to college.
- a. Use the rule of thumb to calculate the margin of error for a 95% confidence interval.
- b. Interpret the obtained margin of error and the interval.
33. According to the 2019–2020 National Pet Owners Survey, 67% of US households own a pet. Suppose another survey was taken of 1352 US households. The researchers determined that 59.3% of them own a pet.
- a. Use the rule of thumb to calculate the margin of error for a 95% confidence interval.
- b. Interpret the obtained margin of error and the interval.