

E Chapter 1 Exercises

Respond thoughtfully to the following exercises.

- Eighty-nine percent of Americans polled are in favor of arts education being taught in public schools.
 - Does the above numerical value describe a parameter or a statistic?
 - After reading the above statement, you decide to campaign for the arts in education and use the statement: “A majority of Americans are in favor of art education, which shows their love of arts. Americans support ballet teaching in public schools.” What branch of statistics would you be applying?
- The average lifespan of Americans in 1990 was 75.37 years.
 - Does the above numerical value describe a parameter or a statistic?
 - Giving a complete breakdown of the above statement into categories of gender, race, and geographical region would be an example of which branch of statistics?
- Determine whether the following data sets are qualitative or quantitative and classify each set according to its level of measurement.
 - The street addresses of houses along North Lamar Avenue
 - The years in which Christmas falls on a Sunday
 - The monthly rates for digital cable service for five competing companies
- Jake wanted to know the most popular brand of cereal among teenagers. He stood in the center of the cereal aisle at the local grocery and surveyed every 10th teenager who approached him.
 - How many biases can you name?
 - In what ways could Jake better collect data to answer his question?
- A university dorm housing only freshmen and sophomores assigns freshmen to odd-numbered rooms and sophomores to even-numbered rooms. Would choosing every 10th room give a representative sample of dorm residents? What about sampling every 5th room?
- If someone is looking at the proportion of students who are left-handed, is your statistics class a good sample? Is this class a good indicator of the male-to-female ratio on a campus?
- A supermarket wants to decide whether or not to carry a new brand of salsa and uses a free taste-test stand in the store.
 - What is the population being studied?
 - What sampling method is being used?
 - Is the sample obtained for the taste test representative of the population?
- Explain how cluster sampling is different from stratified sampling. If you wanted to make sure to include certain characteristics of the population in the sample, would you use cluster sampling or stratified sampling?
- How could you use cluster sampling if you want to know the average price of gasoline at gas stations located within a mile of rental car return locations at airports?
- A researcher wants to determine the average age of people attending the state fair.
 - Give three different methods of sampling that could be used in this scenario. Which method is best and why?
 - Describe any potential for bias in the method you chose as “best” in part a.

11. Suppose that a researcher wants to determine the optimal number of hours of sleep that the average adult requires each night.
 - a. Identify the following: the population and appropriate type of study to conduct.
 - b. Give a brief discussion on how you would set up and conduct this type of study using the steps covered in Section 1.3.
12. Convenience sampling is the sampling technique most prone to bias. However, it is possible to obtain a representative sample using the convenience method. Give one example of how the convenience method could produce a representative sample and one example of it producing a biased sample.
13. Suppose that the governor of Nebraska wants to determine his approval rating among his constituents. A team from the governor's staff is assigned to the task. Four of the state's largest cities are chosen, and 100 registered voters from each city are chosen to be included in the sample.
 - a. Identify the sampling technique for this scenario.
 - b. Describe three potential sources of bias.

Answer the following questions for Exercises 14 and 15.

- a. What is the population being studied?
 - b. What is the sample?
 - c. What are the sample statistics?
 - d. Describe at least 2 potential sources of bias.
14. In a 2018 Pew Research Center poll of 3,425 US adults who are members of the center's nationally representative American Trends Panel, subjects were asked about their preferred mode of news consumption. The results were as follows:
- | | |
|-------------|-----|
| Television: | 44% |
| Online: | 34% |
| Radio: | 14% |
| Print: | 7% |

Source: Pew Research Center. "Americans Still Prefer Watching to Reading the News - and Mostly Still Through Television." 29 Nov. 2018. http://www.journalism.org/2018/12/03/americans-still-prefer-watching-to-reading-the-news-and-mostly-still-through-television/pj_2018-12-03_read-watch-listen_0-02/ (23 July 2019).

15. According to a survey conducted from Sept. 15 to Oct. 10, 2017 by Gallup and Northeastern University, 73% of Americans surveyed say artificial intelligence will eliminate more jobs than it creates. Results were based on a mail survey of 3,297 Americans over the age of 18.

Source: Gallup, Inc. and Northeastern University. "Optimism and Anxiety." January 2018. <https://www.northeastern.edu/gallup/pdf/OptimismAnxietyNortheasternGallup.pdf> (23 July 2019).

E Chapter 2 Exercises

Create a frequency distribution with the indicated number of classes for each set of data. Include the frequency, class boundaries, midpoint, relative frequency, and cumulative frequency of each class. Use the frequency distribution to answer the questions.

- The following list contains the percentage of students who transferred from the community college to a university for 21 community colleges in one state. Use six classes that have a class width of 3. Begin with a lower limit of 13 percent.

20.7	20.9	17.1	18.1	20.6	18.5	25.6
21.6	20.2	15.7	22.0	19.5	21.7	24.3
13.8	25.1	22.8	21.3	18.9	29.5	19.4

- What class contains the largest percentage of transfers?
 - Is it reasonable to say of the 21 schools, more than half of them had transfer rates below 22%? Explain.
 - What conclusions can you draw, if any, from the frequency distribution?
- The following list contains the pass rates, as the percentage of students passing the course, for students taking English Composition I from 24 different sections of the course one fall semester. Use five classes that have a class width of 10%. Begin with a lower limit of 35%.

0.457	0.421	0.701
0.397	0.446	0.766
0.422	0.434	0.742
0.454	0.481	0.752
0.482	0.515	0.773
0.616	0.435	0.775
0.597	0.486	0.751
0.647	0.639	0.758

- Which class represents the most common pass rate for English Composition I?
- Do most English Composition I classes have a pass rate of at least 65%?
- What conclusions, if any, can you draw from the frequency distribution?

Create a stem-and-leaf plot for the given data. Be sure to include a key to your stem-and-leaf plot.

3. The following data represent the number of people, in millions, employed by postsecondary institutions in the last 16 years.

3.97	3.45	3.97	3.34	3.98	3.25	3.21	3.63
4.13	3.97	3.97	3.92	3.89	3.80	3.71	3.54

4. The United States accounted for 23.9% of all imported cars in 2017. The list below gives the percentage of total imported cars that were imported by the next highest 14 countries.

7.8	6.6	5.9	4.8	4.6	4.1	3.8
2.7	2.3	1.7	1.5	1.5	1.4	1.3

Source: Workman, Daniel. "Car Imports by Country." 15 April 2019. <http://www.worldstopexports.com/cars-imports-by-country/> (24 July 2019).

Determine which type of graph would most clearly depict the data described.

5. The total commission paid by a company to its employees each month for a year.
6. The commission paid by a company to each of its employees for the month of June.
7. The commission paid by a company to each of its employees for the month of June, specifically comparing the commission paid to sales representatives with 10 years or more of experience to those with less than 10 years of experience.
8. Average commission paid to sales representatives in this field across the country.

Use the given frequency distribution to answer the questions.

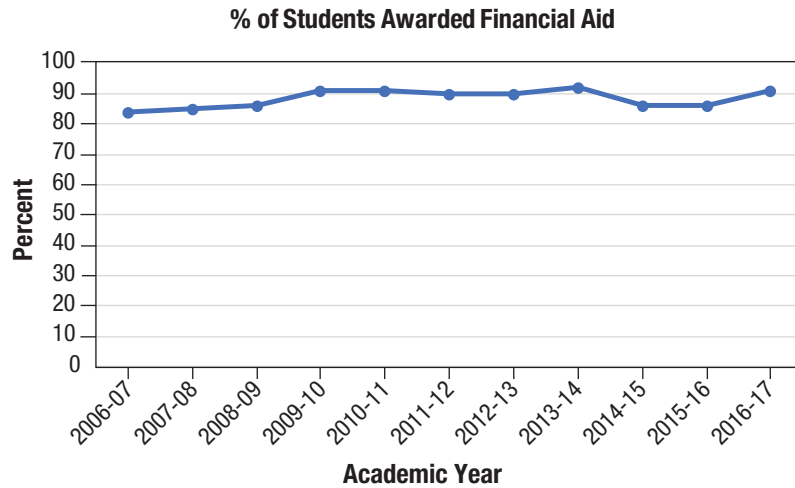
Amara works as a sales associate at a large home furnishings and accessories store. Her earnings are based partially on salary and partially on commissions she earns from sales. Because her commission rate is dependent on the price of the item sold, it is important that she keeps a detailed record of her sales. For the month of August, the frequency table of her sales is as follows.

Item Price	Number of Items Sold
\$0 - \$149.99	24
\$150 - \$299.99	31
\$300 - \$449.99	14
\$450 - \$599.99	11
\$600 - \$749.99	16
\$750 and above	12

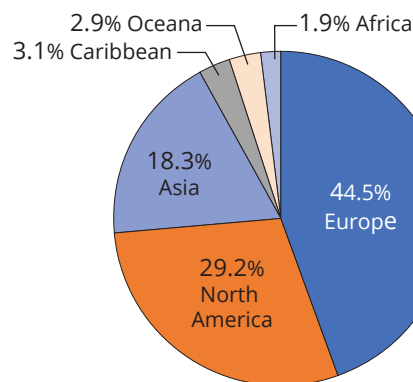
9. What is the relative frequency for the 4th class?
10. What is the cumulative frequency for items less than \$600?
11. What is the upper class boundary for the 2nd class?
12. What is the class width?
13. What percentage of Amara's sales were for items that cost between \$300 and \$599.99?
14. How many items did Amara sell in August?
15. What was the maximum price of most of Amara's sales items?

Use the given graphs to answer the questions.

16. The graph below shows the percentage of students awarded any form of financial aid at one community college. Use this graph to answer the following questions.



- What is the overall trend for this line graph?
 - Have there been any periods where the amount of financial aid increased?
 - Have there been any periods where the amount of financial aid decreased?
 - If you were preparing a summary of the data, what would you use as a title for your graph which is both truthful and catchy?
17. Global purchases of imported cars totaled \$752.9 billion USD in 2017. From a continental perspective, the pie chart below shows the percentages of imports by region. Use this pie chart to answer the following questions.
- Which region had the highest percentage of imports?
 - Which region had the lowest percentage of imports?
 - What was the percentage of imports from Asia?
 - What was the percentage of imports from Europe and North America?

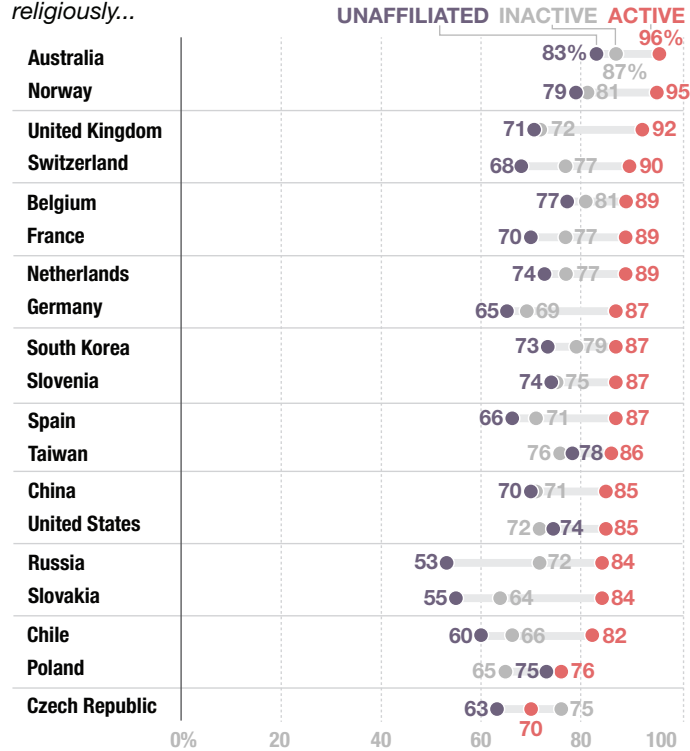


Source: Workman, Daniel. "Car Imports by Country." 15 April 2019. <http://www.worldstopexports.com/cars-imports-by-country/> (24 July 2019).

18. The following graph shows the percentage of respondents who say they currently do not smoke, among those who are religiously unaffiliated, inactive, or active. Use this graph to answer the following questions.

Actively religious less likely to smoke

% who say they do **not** currently smoke, among those are religiously...



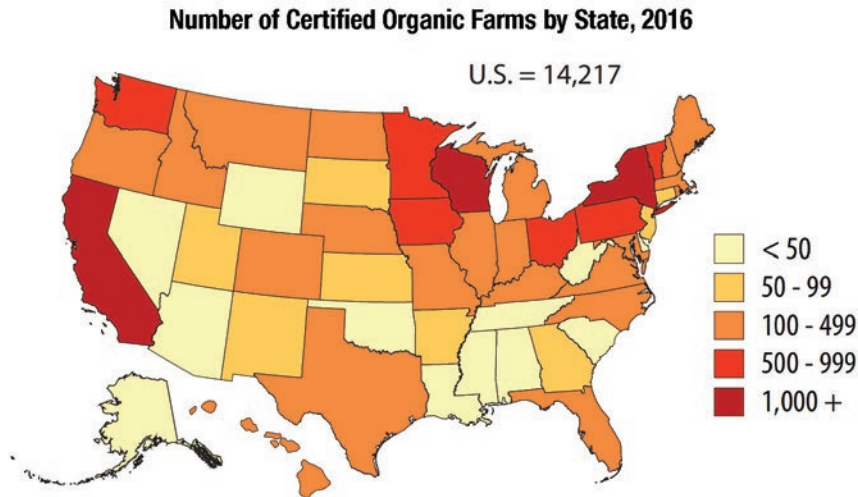
Note: the actively religious are those who identify with a religion and attend religious services at least once per month. Inactives are those who identify with a religion and attend less often. Unaffiliated are those who do not identify with a religious group.

PEW RESEARCH CENTER

Source: Pew Research Center. "Actively religious less likely to smoke." 28 Jan. 2019. http://www.pewforum.org/2019/01/31/religions-relationship-to-happiness-civic-engagement-and-health-around-the-world/pf_1-23-19_religion_wellbeing-24/ (24 July 2019).

- Which country has the highest percentage of non-smokers among those who are actively religious?
- Which country has the lowest percentage of non-smokers among those not religiously affiliated?
- Which country has the largest range of non-smokers?
- Is it true that those who are religiously active are less likely to smoke than those that are not religiously active?

19. The following graph shows the number of organic farms by state. Use this graph to answer the following questions.
- Which states have the largest number of organic farms?
 - How many organic farms does Alaska have?
 - How many organic farms are in the United States?
 - How many organic farms do the majority of the states have?



Source: USDA. NASS Highlights. "2016 Certified Organic Survey." Oct. 2017. https://www.nass.usda.gov/Publications/Highlights/2017/2016_Certified_Organic_Survey_Highlights.pdf (24 July 2019).

20. The following graph depicts the pass rates in one state for students in their first year taking a credit-bearing math class, with different types of math remediation methods, based on the students' ACT scores. The remediation methods are defined as follows:

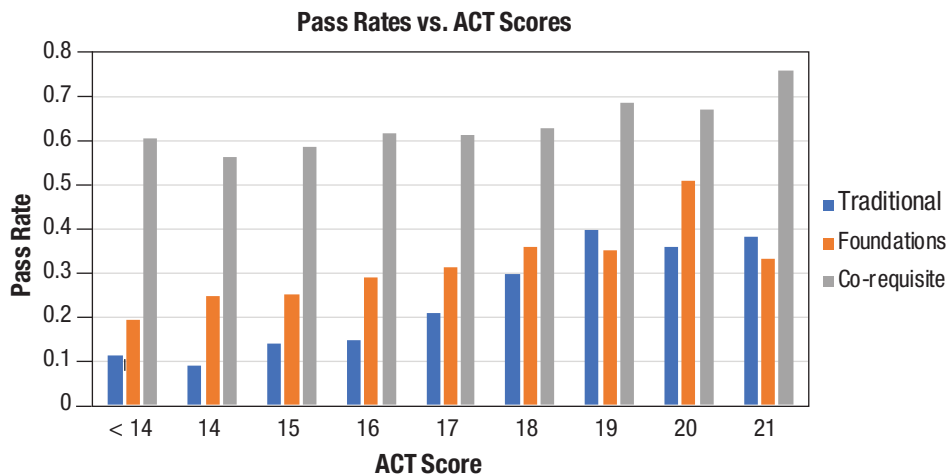
Traditional - as many developmental classes as deemed necessary taken before credit-bearing class

Foundations - only 1 developmental class taken before credit-bearing class

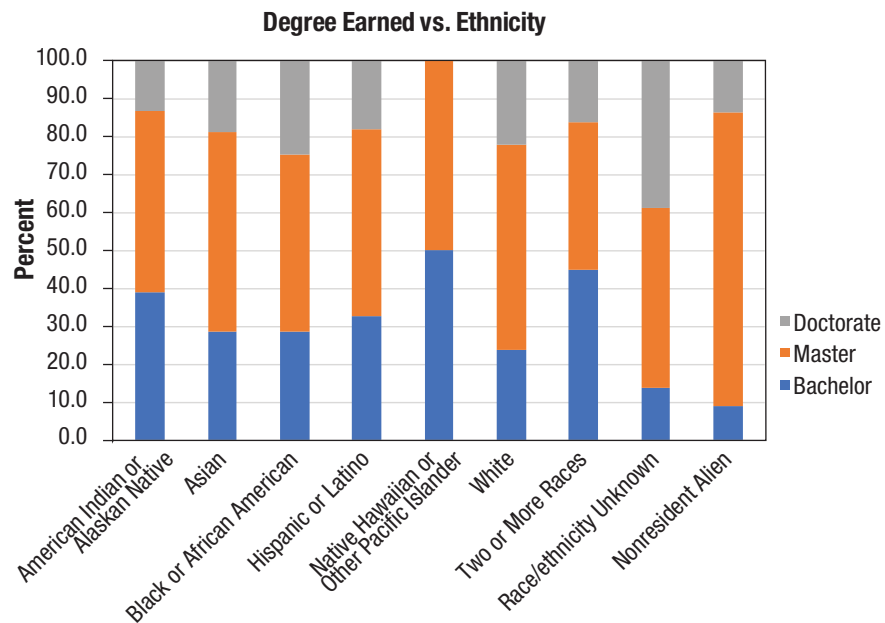
Co-requisite - developmental support offered at the same time as the credit-bearing class

Use the graph to answer the following questions:

- Which remediation method produces the highest pass rates?
- Which remediation method produces the lowest pass rates?
- Does a student's ACT score affect which remediation method is best?



21. The following graph shows the percentage of each type of degree awarded by a prestigious university between July 1, 2016 and June 30, 2017, based on the student's race or ethnicity. Use the graph to answer the following questions.
- For which race/ethnicity was the largest percentage of the degrees awarded masters degrees?
 - Of the degrees awarded to Asian students, which type of degree accounted for the smallest percentage?
 - Can you tell from this graph which race/ethnicity was awarded the most degrees?



E Chapter 3 Exercises

Respond thoughtfully to the following exercises.

- Four friends went out to eat one evening, and the mean price of their dinners was \$10.54. If the prices of the first three meals were \$9.62, \$11.59, and \$10.03, what was the cost of the fourth meal?
- Suppose that a list of company CEOs is compiled, and 37% are over the age of 45. True or false: Q_3 must be greater than 45.
- Suppose that 200 employees at a major theme park are surveyed, and 54% are under the age of 25.
 - True or false: Of those surveyed, the mean age must be under 25.
 - True or false: Of those surveyed, the median age must be under 25.
- Give one example of a data set with a large variation and one example of a data set with a small variation.
- The mean grade for Test 2 in Marquette's biology class is 73, and the standard deviation is 8 points. If the standard score for Marquette's test is 1.25, what is her grade?
- Neikia wants to determine the average amount of money moviegoers typically spend on snacks at the theater. He surveys 150 people leaving the theater one evening, and finds that 79 did not spend any money on refreshments. The maximum amount spent was \$22.50.
 - What is the largest possible value for the mean?
 - What is the median amount spent on refreshments?
- Suppose that Julie's height has a standard score of 0.44. True or false: Julie is taller than average.
- The mean cost of individual health insurance in one region of the country is \$421 per month with a standard deviation of \$78. Of those in the region who have individual health insurance, approximately what percentage spend between \$343 and \$499 on their insurance each month? Assume that individual health insurance costs in the region have a bell-shaped distribution.
- The mean upload speed for a particular Internet provider is 500 KBps with a standard deviation of 60 KBps. Use Chebyshev's Theorem to estimate the percentage of customers who should be able to upload data at speeds between 320 and 680 KBps.
- True or false: If the standard deviation of a data set is zero, then all of the values in the set must be the same number.

11. Calculate the sample standard deviation and sample variance of the following monthly prices of cellular phone plans.

\$44.99, \$59.99, \$34.49, \$89.99, \$54.99, \$65.99, \$49.99

12. Find the GPA of a student who received the following grades. Note that an A is equivalent to a 4.0, a B is equivalent to a 3.0, and a C is equivalent to a 2.0.

Biology II (3-hour class): B

Biology II Lab (1-hour class): A

English 212 (3-hour class): B

German 101 (3-hour class): C

Precalculus (3-hour class): C

Scuba Diving (2-hour class): A

13. Find the approximate mean of the following data, which represent the number of debit card purchases in one month for a random sample of college students.

Number of Debit Card Purchases in One Month	
Class	Frequency
0–7	8
8–15	3
16–23	9
24–31	5

14. If we know that an ACT score was 21 and that score was in the 67th percentile, can we determine how many students were in the sample? Why or why not?
15. The following numbers represent the numbers from a five-number summary for the number of child abuse cases reported per county during a one-week period. Unfortunately, the numbers have been shuffled and are no longer in the right order. Can you still determine which number is the first quartile, Q_1 ? Explain your answer.

14, 17.5, 8, 12.5, 21

16. Maeve wants to calculate the average final exam grade of the students that she teaches. Her first class, which had 42 students in it, averaged an 88 on their final exam. Her second class of 55 students averaged an 81 and her last class of 48 students averaged an 84. What is the average final exam grade of her students?

E Chapter 4 Exercises

Counting Techniques

Use counting techniques to answer each question.

1. Suppose you have money to buy 5 new downloads for your phone. If there are 12 new downloads you'd like to have, in how many different ways could you purchase your 5? (Assume that the order of the downloads does not matter.)
2. In planning the teaching assignments for next semester, Mr. Hinton must have a teacher in each of the 7 grades during each of the 6 periods of the day. If he has 10 teachers to choose from, which allows 3 teachers to be on break at a time, how many different teaching schedules could he come up with?
3. The student council at one high school must choose 2 representatives from each of the sophomore, junior, and senior classes to attend the annual student council convention. If there are 6 sophomores, 5 juniors, and 7 seniors on the student council, in how many ways can the group be chosen for the convention?
4. The Pancake House offers hash browns with up to five different toppings: cheese, ham, bacon, onions, and mushrooms. In how many different ways can the hash browns be served?
5. Richard is assigned the task of setting the passwords for every computer at his office. Different computers have different guidelines as to how the password may be set. How many different four-digit passwords using the digits 0–9 can he create under each of the following guidelines?
 - a. The passwords must be odd and greater than 3000.
 - b. The passwords must be even and greater than 4000.
 - c. The passwords must be even and less than 5000.
6. Suppose that there are eight employees at a café in downtown Jackson, MS. The boss needs one employee to serve as host or hostess, one to clean tables, and one to supervise the kitchen. In how many ways can these tasks be assigned?
7. Chandra has ten pieces of jewelry in her jewelry case, and she wants to take four pieces with her on vacation. In how many ways can she select the jewelry for her trip?
8. A homeowner wants to plant some new trees in her yard. If she has 6 pink crape myrtles, 4 red oak trees, and 5 yellow poplar trees to plant in one row down the drive, in how many different ways can she plant them?
9. In planning the room assignments for the overnight field trip, Mrs. Viant needs to put 3 students and 1 chaperone in each room. If there are 12 students and 4 chaperones on the trip, how many room assignments can she possibly have for the rooms 100, 101, 102, and 103?
10. A stock symbol, or ticker symbol, is an arrangement of characters representing publicly traded companies. Originally, stocks traded on the New York Stock Exchange (NYSE) were represented by a ticker with up to 3 characters from the English alphabet and the digits 0-9 where repetition was allowed. What is the maximum number of stocks that could have originally been listed on the NYSE?

Counting Techniques and Probability

Use the most appropriate method to find the probability for each scenario.

11. If 56% of adults attend church services in a typical month, 46% listen to a Christian radio broadcast in a typical month, and 39% do both, what's the probability that a randomly selected adult will neither attend church nor listen to a Christian radio broadcast in a typical month?
12. A computer generates a 3-digit combination code for the lockbox on a rental property. The computer uses the digits 0-9 with repetition. Find the probability that the next code will consist of only odd digits.
13. Find the probability that out of the 1319 college freshmen on campus, you are randomly chosen by the yearbook staff to give a quote about your first year at college, which will be published in the yearbook.
14. In the dice game Yahtzee you achieve the most points by throwing a Yahtzee, which is throwing the same number on 5 different dice. Find the probability that you don't roll a Yahtzee in one roll.
15. In a large doll store, 47% of the dolls blink, 56% of the dolls have movable legs and arms, and 23% of the dolls neither blink nor have movable limbs. Find the probability that a doll chosen at random will both blink and have movable limbs.
16. In a class of 87 people, 27 wear glasses, 32 are blonde, and 38 are neither blonde nor wear glasses. Find the probability that a student chosen at random will have blonde hair and wear glasses.
17. Joe is eating colored candies, and he has 5 orange candies and 5 yellow candies left. If he randomly selects one candy at a time to eat, what is the probability that he eats the rest of the candies so that the colors alternate?
18. Emily has a bad habit of losing her keys. This time, she estimates that there is a 0.2 chance that she left them in her office, a 0.35 chance that she left them in her bag, and a 0.15 chance that she left them on the kitchen counter. What is the probability that her keys will be in none of these places?
19. Robert is ordering dessert, and he wants the fudge pie. The waitress tells him that he can have up to four toppings: ice cream, chocolate sauce, whipped cream, and a cherry. Since he cannot decide how many of the toppings he wants, he tells the waitress to surprise him. If the waitress randomly chooses which toppings to add, what is the probability that Robert gets just chocolate sauce and a cherry?
20. Out of 62 people surveyed, 22 own a laptop computer, 39 own a desktop computer, and 9 own no computer at all. What is the probability that a person selected at random from those surveyed owns both a laptop and a desktop computer?
21. Find the probability of drawing four cards from a standard deck of cards and not getting all aces. There are 52 cards in a standard deck of cards, of which four are aces.
22. What's the probability of rolling a total of at least 11 with two dice?
23. Raffle tickets for a trip to Miami are assigned three-digit numbers using the digits 0–9. What is the probability that the number on the winning ticket is either even or less than 300? (Assume that all possible ticket numbers are eligible to win.)
24. There are 5 red wines and 7 white wines in a box. Calculate the probability of randomly choosing 2 bottles of red wine one after another without replacement.
25. In a class of 28 students, the teacher randomly chooses students to answer questions by having a computer select assigned seat numbers. What is the probability that the same student is selected to answer 2 questions in a row if the computer is allowed to choose seat numbers with replacement?

26. A gumball machine at the local pizza place is filled with plastic toys. The machine is filled with 28 rings, 35 bouncy balls, 18 rubber spiders, and 41 tattoos. Suppose you and three friends want to get four toys from the machine, and you would like 2 rings and 2 tattoos. Find the probability that you get what you want on the first 4 tries. (This requires some thought. Don't undercount!)

E Chapter 5 Exercises

Properties of a Probability Distribution

Answer the question and explain your reasoning.

1. A poster advertising the latest game at a casino lists the probabilities of winning various amounts of money. Can this be a true probability distribution?



2. An insurance company posts the following likelihood for each of the six different types of claims their company covers. Can this be a probability distribution?

Insurance Claims	
X	$P(X)$
Auto physical damage	0.33
Injury claims	0.09
Homeowner's claims	0.21
Health Insurance claims	0.19
Life insurance	0.16
Commercial Claims	0.02

Mean and Standard Deviation for Discrete Probability Distributions

Find each indicated expected value or standard deviation.

3. A nationwide coffee chain is downsizing its branches in six states. It has already told the store managers in five of the six states the amount of downsizing that will occur. The store managers in the sixth state know that the downsizing that has occurred in the other states has the following distribution. If they assume that the probabilities in this distribution represent the likelihood that their stores will be downsized by the given percentages, what percentage of their employees could they expect to be downsized, and with how much variation?

Coffee Chain Downsizing	
Percentage Downsized	Probability
10%	0.25
15%	0.35
20%	0.25
25%	0.10
40%	0.05

4. Suppose that a friend is helping put on a fundraiser for the local animal shelter. One activity is a game using a bowl that contains six green marbles and eight blue marbles. To play the game, each person draws two marbles without replacement (and without looking). If both marbles are green, the player wins \$25. If not, the player must donate \$10 to the animal shelter. The marbles are then replaced for the next player.
 - a. Calculate the expected value of the game for the player.
 - b. Suppose that the marble game is played 350 times. How much money would you expect to be donated to the animal shelter?
5. Begin by creating a probability distribution for the number of heads in five tosses of a coin.
 - a. Explain why this distribution meets the conditions for a binomial distribution.
 - b. Use the discrete probability distribution to calculate the expected value of the random variable.
 - c. The expected value of the random variable is equal to the mean of the distribution. As mentioned in the list of properties of the binomial distribution, the mean of a binomial distribution is given by $\mu = np$. Use this formula to calculate the mean of this probability distribution.
 - d. Does the value you calculated in part b. match the value you calculated in part c.? Explain why or why not.
6. Use the discrete probability distribution you created for Exercise 4.
 - a. Calculate the standard deviation of this distribution. Interpret the standard deviation.
 - b. For a binomial distribution, the formula for standard deviation is $\sigma = \sqrt{np(1-p)}$. Use this formula to calculate the standard deviation for the coin toss distribution. Does this number match the value you calculated in part a.? Explain why or why not.

Discrete Probability Distributions

For each scenario, state the appropriate probability distribution to use, and then find each specified probability.

7. If, in a typical work day, the president of a company is interrupted twice, what is the probability that in a five-day work week she will be interrupted more than 12 times?
8. One day while cleaning out your junk drawer at home, you put all of the loose batteries in a pile. Realizing later that two out of the eight were actually new batteries, you decide that it's necessary to test each battery before throwing it away. What is the probability that the two new batteries are within the first four batteries that you test?
9. Philip is running late for work, and he needs his black socks. Unfortunately, Philip never matches his socks, so there are ten loose white and two loose black socks in his drawer. If he reaches in and randomly grabs two socks at once, what is the probability that he gets the two black socks he needs?
10. Every time Vera goes to the mall, she has a 0.6 chance of forgetting where she parked her car. If she goes to the mall five times this month, what is the probability that she will forget where she has parked fewer than two times?
11. Your boss has ordered lunch for everyone at the office. There are twelve chicken salad plates and six tuna salad plates to choose from. If you randomly select three plates for yourself and two coworkers, what is the probability that they all contain chicken salad?
12. You forgot to study for your statistics quiz, and you don't know the answers to any of the ten questions on the page. If each question has four multiple-choice options (one of which is correct), what is the probability that you will guess the right answer on at least one question?
13. One southern city experiences an ice storm on average once every eight years. Calculate the probability that there is an ice storm in the city twice in the next three years.
14. It is more common in southern states for high school students to take the ACT than the SAT. Assume that the probability that a southern high school student takes the ACT is 0.93 and the probability that a southern high school student takes the SAT is 0.35. Suppose that a group of 24 southern high school students is randomly selected.
 - a. What is the probability that all 24 students have taken the ACT?
 - b. What is the probability that half have taken the SAT?

E Chapter 6 Exercises

Properties of Normal Distributions

Complete each statement.

1. A normal curve is single-peaked, which tells us that it has _____ mode(s). (State the number of modes.)
2. A normal curve is symmetric about its mean, which tells us that the value of the mean equals the value of the _____ and equals the value of the _____.
3. A normal curve is _____-shaped.
4. You can completely describe a normal distribution by two numbers, the _____ and the _____.
5. The total area under a normal curve equals _____. (State the numerical value.)

Probability, Area, and Standard Scores for Normal Distributions

Complete each exercise. Round your answer to two decimal places for a percentage and four decimal places for a probability.

6. What percentage of the values in a normal distribution is more than one standard deviation away from the mean?
7. What percentage of the values in a normal distribution is greater than the mean but less than two standard deviations above the mean?
8. What is the probability that a single value from a normal distribution is greater than three standard deviations above the mean?
9. What is the area under the curve of a normal distribution between one and three standard deviations below the mean?
10. What is the relative frequency of the data greater than two standard deviations above the mean of a normal distribution?
11. What percentage of the data values in a normal distribution is less than the first quartile?
12. Kanuk, the polar bear, is pregnant. If gestation periods for polar bears are normally distributed with a mean of 32.0 weeks and a standard deviation of 1.5 weeks, then what is the likelihood that Kanuk's baby will be born before 30 weeks?
13. A local pizza parlor offers a free pizza if it is not delivered in 30 minutes or less. The mean time between ordering and delivery is 24.0 minutes with a standard deviation of 3.0 minutes, and the times are normally distributed. What percentage of the pizzas will be given away?
14. Candy was surprised when the doctor told her that her baby's weight was in the 85th percentile. If babies' weights are normally distributed, which of the following would be a reasonable standard score for her baby's weight?
 - a. 85
 - b. -2.75
 - c. 1.04
 - d. 0
 - e. Not enough information

15. Suppose you are told that your Body Mass Index (BMI) was below the first quartile. If BMI scores are normally distributed, which of the following would be a reasonable standard score for your BMI?
- 0
 - 2.45
 - 2.45
 - Not enough information
16. The following table gives values for four normal distributions. Find the missing value in each row of the table.

	μ	σ	x	$P(X \leq x)$
a.	22.0	1.8	24.0	
b.		0.24	116.00	0.3228
c.	0.46		0.72	0.85
d.	1052	66		0.1131

17. The following table gives values for four normal distributions. Find the missing values in each row of the table.

	μ	σ	q_1	q_3
a.	15.0	2.1		
b.		200	3300	
c.			55.0	85.0
d.	1.8			2.2

18. The US Department of Labor reports that in 2018, adults aged 20-24 years worked an average of 34.8 hours per week. Do you think that this variable could be represented by a normal distribution? If the distribution is not actually normal, how would you expect it to deviate from normal?
- Source:** Labor Force Statistics from the Current Population Survey, United States Department of Labor, Bureau of Labor Statistics. 18 Jan. 2019. <https://www.bls.gov/cps/cpsaat22.htm> (18 January 2019).
19. A manufacturer claims that the average lifetime hours of a LED light bulb is about 40,000 hours. Explain whether or not you think that the lifetime hours of a light bulb could be represented by a normal distribution.
20. The mean demand for electricity in the average household is 936 kilowatt hours (kWh) in any given month. Suppose the usage is described by a normal random variable with a standard deviation of 110 kWh. If this description of the demand for electricity is correct, what generating capacity per household must be available in order for the load to be met 99.5% of the time?
21. In order to ride the Death Trap at the amusement park, guidelines say that participants must be between 60 and 74 inches tall. Consider two separate groups of tourists. The mean height of group A is 64.00 inches with a standard deviation of 1.77 inches and the mean height of Group B is 69.50 inches with a standard deviation of 1.50 inches. Determine the percentage of each group that would be able to ride the Death Trap. Assume that heights are normally distributed.

Normal Distribution Approximation of Binomial Probability

Approximate the binomial probability using the normal distribution. You may safely assume that the conditions for using the normal distribution approximation have been met for each scenario.

22. A phone company reports that 51% of its customers subscribe to its high-speed Internet service. If 180 customers are randomly selected for a survey, what is the probability that more than 94 of them subscribe to the high-speed Internet service?
23. What is the probability that more than 35 out of 119 college algebra students will attend a late afternoon study session provided by their professor? Previous experience tells the professor that there is a 40% probability that a given student will attend the study session.
24. What is the probability that fewer than 45 calculus students will fail their calculus course this semester? There are 210 students currently enrolled in the class, and previous semesters indicate that there is a 28% chance of an individual student failing this course.

E Chapter 7 Exercises

Sampling Distributions and Probability

Answer each question.

1. The mean lifetime of laptop computers produced by one company is 4.6 years with a standard deviation of 1.1 years. Consider random samples of 55 laptop computers. What is the standard deviation of the sampling distribution of the sample means?
2. Suppose that for 18-to-25-year-olds, the mean number of football games watched each football season is 19.0 games with a standard deviation of 3.7 games. If 31 randomly selected people in this age range are surveyed, what is the probability that the mean number of football games watched by this group is no more than 17 games per season?
3. In one city, 83% of eligible voters are registered to vote. If 425 randomly selected eligible voters are surveyed, what is the probability that at least 82% are registered to vote?
4. A local fast-food restaurant reports that the mean number of hamburgers it sells per day is 235.0 with a standard deviation of 11.3 hamburgers. Consider a random sample of 31 days. What is the probability that the mean number of hamburgers sold per day for the sample will differ from the population mean by more than 3 hamburgers?
5. The mean size of candy bars from one candy maker is 39.0 grams with a standard deviation of 2.3 grams. If you produce a sampling distribution of sample means using samples of size 40 from the candy production line, what would be the mean of the sampling distribution?
6. The mean blade length of a rapier, which is a fencing sword, is 90.0 cm with a standard deviation of 4.2 cm. If 38 rapiers are randomly sampled, what is the probability that their mean blade length is less than 88 cm?
7. The mean length of an adult blue whale is 30.0 meters with a standard deviation of 5.7 meters. If a random sample of 31 whales is taken, what is the probability that their mean length differs from the population mean by less than 2 meters?
8. Suppose that, for a particular make and model of car, the mean sale price for car dealerships nationwide is \$24,560 with a standard deviation of \$390. What is the probability that the sale price for this car at the car dealership in your area will be no more than \$24,000? Assume that the car prices are normally distributed.
9. One brand of light bulbs has a mean lifetime of 400 hours with a standard deviation of 28 hours. What is the probability that the lifetime of one randomly chosen bulb will differ from the mean by over 50 hours? Assume that the population is normally distributed.
10. At one regional grocery store chain, a customer spends an average of \$7.29 on produce in each visit with a standard deviation of \$2.33. Find the probability that the mean amount spent on produce per visit for 55 randomly selected shoppers will be less than \$7.
11. At a local elementary school, students miss a mean of 4.1 days of school each year with a standard deviation of 1.1 days. What is the probability that the mean number of days missed for a random sample of 30 students will be no more than 3.5?
12. At one theater, moviegoers spend a mean of \$6.32 on refreshments with a standard deviation of \$2.55. What is the probability that the mean amount spent on refreshments by a random sample of 50 moviegoers will be between \$6 and \$7?
13. At a local accounting firm, the mean fee for completing an individual's tax return is \$225 with a standard deviation of \$28. Consider a random sample of 33 individual tax returns from this firm. What is the probability that the mean amount billed for the sample differs from the population mean by more than \$5?

14. At one supermarket, patrons purchase a mean of 17.0 items each visit with a standard deviation of 8.2 items. Suppose that 53 customers are randomly selected. What is the probability that the mean number of items purchased by customers in the sample differs from the population mean by less than 2 items?
15. Salaries of employees at a large factory are normally distributed with a mean of \$27,500 and a standard deviation of \$2900. Consider the mean salary of a group of 8 employees and the mean salary of a group of 15 employees. Which group's mean would you expect to be closer to \$27,500?
16. A study of Transatlantic flights revealed an average cruising altitude of 37,500 feet. Consider the mean cruising altitude of a group of 12 randomly selected flights compared to the mean cruising altitude of 45 randomly selected flights. Which group's mean cruising altitude would you expect to be closer to 37,500?

E Chapter 8 Exercises

Note: For all exercises in this section, you may assume that all samples of a given size have an equal probability of being chosen. Unless otherwise indicated, assume that the population standard deviation is unknown.

Confidence Intervals and Margins of Error

Find each specified confidence interval or margin of error.

1. A survey of 21 accountants finds that they spend a mean of \$45.00 each week on lunch with a standard deviation of \$3.63. Using a margin of error of \$2.00, give an interval estimate for the mean amount of money accountants spend on lunch each week, and interpret the interval. Assume that the population is normally distributed.
2. In a random sample of 35 students at a local college, 19 regularly carry a laptop computer to class. Using this sample and a margin of error of 12.1%, construct and interpret an interval estimate for the proportion of all students at the college who carry a laptop computer to class.
3. Out of 300 randomly selected sets of wireless speakers chosen off of an assembly line, a manufacturer found that only 2% were defective. Using a 95% level of confidence, calculate the margin of error for the proportion of all sets of wireless speakers from this manufacturer that are defective.
4. A random sample of 253 working mothers was surveyed regarding the cost of health care. The mean amount of money spent on health care by these working mothers each year was \$1300. Suppose that the population standard deviation is known to be \$289 per year. Calculate the margin of error for the population mean using a 98% level of confidence.
5. Fifteen randomly selected dentists were timed while brushing their own teeth for a recent study. The mean amount of time spent on brushing their teeth was 2.13 minutes with a standard deviation of 0.45 minutes. Calculate the margin of error for the mean amount of time all dentists spend brushing their teeth. Use a 99% level of confidence. Assume that the population is normally distributed.
6. Of 600 bags of rice randomly selected from a train after a wreck, 230 were damaged in the train wreck. The insurance company needs to estimate the proportion of bags of rice on the entire train that were damaged in the wreck. Construct and interpret a 99% confidence interval for the proportion of all bags of rice that were damaged.
7. From a random sample of 49 stray dogs, a veterinarian finds that their mean weight is 41.0 pounds with a standard deviation of 8.5 pounds. Construct and interpret a 98% confidence interval for the mean weight of all stray dogs in this area.
8. Although male polar bears weigh only about one pound at birth, the mean weight of a random sample of 10 adult male polar bears is 1200 pounds with a standard deviation of 100 pounds. Construct and interpret a 98% confidence interval for the mean weight of all adult male polar bears. Assume that the population is normally distributed.
9. The following sample of volumes of soda (in ounces) was taken from 14 cans randomly selected from an assembly line.

12.01	12.02	11.95	11.99	11.94	12.01	12.03
11.98	12.00	12.03	11.98	12.05	11.93	11.98

Build and interpret a 95% confidence interval for the population variance for the volumes of soda in all the soda cans that come off that particular assembly line.

10. The following is a random sample of the numbers of daily hits a website receives. Construct and interpret a 99% confidence interval for the mean number of hits the website gets if the population standard deviation is known to be 3822.1.

7881	10,101	16,157	17,377	16,690	16,363	13,282	6882	8207	12,098	13,971
17,968	16,615	14,310	8401	10,689	19,011	18,222	17,538	16,005	13,192	7344

Minimum Sample Sizes for Interval Estimates

Calculate the minimum sample size needed to construct a confidence interval with the desired characteristics.

11. A researcher wants to interview military personnel returning from war regarding their experiences overseas. The researcher wants to know the proportion of soldiers who would not choose to return to combat duty overseas if given the choice. If the researcher desires to construct a 90% confidence interval with a 5% margin of error, how many soldiers must the researcher interview? An estimate for the proportion of soldiers who would not return to combat duty overseas if given the choice is 76%.
12. Juan is interning for the summer at a marketing firm. One of his assignments is to conduct research to estimate the percentage of Americans who shop at after-Christmas sales. He needs his results to have a 99% level of confidence and a maximum error of 2%. If previous estimates have shown the percentage to be 20%, how many people must Juan survey?
13. A researcher is looking to estimate the mean LSAT score of law school applicants who completed their undergraduate degrees at small liberal arts colleges. She wants a 99% level of confidence and a maximum margin of error of 2 points. How many applicants must she survey if previous studies show the standard deviation to be approximately 9 points?

For each of the following scenarios, determine whether the normal distribution, t-distribution, or neither distribution can be used to create a confidence interval.

14. A fashion publication wants to estimate the average amount of money that women spend on cosmetics per month. A sample of 250 women is chosen at random and the sample mean computed to be \$34.65 with a standard deviation of \$7.30. The population standard deviation is unknown.
15. A manufacturer wishes to evaluate the durability of their reciprocating saw blades by estimating the average number of hours of work that their blades can withstand. A sample of 95 blades saw a mean of 42.7 hours of work before breaking, with a standard deviation of 5.1 hours. The population standard deviation is known to be 5 hours.
16. A geologist wants to estimate the average temperature of a particular soil layer deep within the earth's strata. He takes temperature readings at randomly selected times over the course of a month. The collected sample of 75 temperature readings is approximately normal with an average of 58.3 and a standard deviation of 2.9 degrees. Assume the population standard deviation is known to be 2 degrees.
17. A spin instructor wishes to estimate the number of calories his clients burn during a regular one-hour class. He randomly chooses 18 different clients over the course of 3 weeks and, based on the estimates given by their bikes, determines that the mean number of calories burned is 535 with a standard deviation of 40 calories. The distribution is found to be skewed right and the population standard deviation is unknown.

E Chapter 9 Exercises

Construct and interpret each specified confidence interval.

- Two math teachers each believe that their own very large class is doing better than the other class. The teachers decide to determine whose class is doing better by looking at scores from a recent exam. A random sample of 40 scores from Class A yields a mean exam score of 88.5. Assume that the population standard deviation of the exam scores for Class A is 5.7. A random sample of 37 scores from Class B yields a mean exam score of 85.3. Assume that the population standard deviation of the exam scores for Class B is 6.2. Construct and interpret a 95% confidence interval for the true difference between the mean exam scores for Classes A and B.
- Insurance companies assert that more accidents are caused by people who talk on the phone while driving than by people who do not. Cellular phone companies dispute this assertion. Independent studies were done by an insurance company and a cell phone company. The results are in the following table. Construct and interpret a 95% confidence interval for the true difference between the proportions of accidents occurring while the driver was talking on the phone for the populations from which the samples were drawn for the two studies.

Number of Accidents		
	Driver on Phone	Driver Not on Phone
Cell Phone Company Study	44	50
Insurance Company Study	71	63

- To determine how well a new drug reduces a fever, 10 adults running a fever in a hospital agree to take the new drug instead of the traditional treatment. Their temperatures are taken before the drug is administered and 30 minutes after taking the drug. The results are shown in the following table. Construct and interpret a 99% confidence interval for the mean change in temperatures of patients after taking this new drug.

Patient Temperatures (in °F)										
First Temperature	100.1	101.3	102.1	102.7	101.9	100.8	103.1	102.5	103.5	101.7
Second Temperature	98.9	99.1	99.2	99.0	98.7	98.6	99.4	99.2	100.1	99.2

- Voters in a dry county (meaning no alcohol is sold in the county) will soon decide whether the county should remain dry. Local businesspeople fear that more people in the food industry than in the general population favor the sale of alcohol. A survey of local restaurant and convenience store owners is conducted, as well as a survey of the general population. The results of the surveys are shown in the following table. Construct and interpret a 90% confidence interval for the true difference between the population proportions of the food industry owners and the general population who favor the sale of alcohol.

Results of Survey		
	Food Industry	General Population
Favor Alcohol Sale	54	32
Oppose Alcohol Sale	19	20

5. Does an apple a day keep the doctor away? To test this theory, a pediatrician asks 12 children to be a part of a study. With parental consent, the number of doctor's visits from the previous six months is recorded for each child. The children are then asked to eat an apple each day for the next six months, after which the number of doctor's visits for that time period is again recorded for each child. Use the following table to construct and interpret a 95% confidence interval for the true mean change in the number of doctor's visits during a six-month period for children who eat an apple a day for six months.

Number of Doctor's Visits												
Without Apples	2	1	2	2	3	0	4	1	2	1	2	0
With Apples	1	1	0	2	2	1	1	2	0	0	2	1

6. Who makes better grades, students who live on-campus or off-campus? To answer this question, suppose you survey both types of students on your campus, asking each to confidentially give you their GPAs. For the 28 on-campus students surveyed, you calculate their mean GPA to be 3.15 with a standard deviation of 0.76 points. For the 26 off-campus students surveyed, you calculate their mean GPA to be 3.32 with a standard deviation of 0.68 points. Assuming that both population distributions are approximately normal and the population variances are equal, construct and interpret a 90% confidence interval for the true difference between the mean GPAs of students who live on-campus and off-campus.
7. A popular magazine is conducting a study in order to rank each state according to the overall health of its citizens. One measure that is used is the mean number of times each citizen exercises per week. For the 85 people surveyed in State A, the mean exercise rate was 1.9 times per week. For the 91 people surveyed in State B, the mean exercise rate was 2.3 times per week. Assume that the population standard deviations of the citizens' exercise rates are 0.5 times per week for State A and 1.1 times per week for State B. Construct and interpret a 95% confidence interval for the true difference between the mean exercise rates for these two states.
8. A research firm is hired by a snack food company to determine where it should focus its resources for a new advertising campaign. Specifically, it is interested in comparing the snack food preferences of adults and children. To do this, 100 adults and 100 children are surveyed. Among the adults, 62% say that they prefer salty over sweet snack food. Among the children, 54% say that they prefer salty over sweet snack food. Construct and interpret a 95% confidence interval for the true difference between the population proportions of adults and children who prefer salty over sweet snack food.
9. Comparing results on standardized tests is a very common way to evaluate programs within certain university settings. The Board of Trustees of State Institutions for Higher Learning (IHL) in one state often evaluates programs based on how students perform on these tests. Suppose that in 2018, the land grant university reported that a random sample of 101 students who took the GRE had a mean verbal score of 464.3. Also in 2018, the State University reported that a random sample of 216 students who took the GRE had a mean verbal score of 455.8. Assume that the population standard deviations of students' GRE verbal scores are 5.1 for the land grant university and 7.4 for the State University. Construct and interpret a 90% confidence interval for the true difference between the population means of students' GRE verbal scores for the land grant university and the State University.

10. A television station is interested in the number of televisions that the average family has in its home. The station executives performed a survey in two different areas of town to see if there was a difference by area. After surveying 20 homes in Area A, they found that the mean number of televisions found in each home was 2.4 with a standard deviation of 0.5. In Area B, they found that after sampling 15 homes, the mean number of televisions was 1.9 with a standard deviation of 0.7. Assume that both population distributions are approximately normal and the population variances are not the same. Construct and interpret a 90% confidence interval to estimate the true difference between the mean numbers of TVs per home in the two areas.
11. One petroleum company claims that using its engine-cleaning product will improve a car's gas mileage. It was added to six cars, and here are the before and after gas mileages (in miles per gallon). Construct and interpret a 95% confidence interval for the true mean improvement in gas mileage for cars that use the engine-cleaning product.

Gas Mileage (in Miles per Gallon)						
Without Engine Cleaner	29	48	43	35	21	19
With Engine Cleaner	31	50	46	43	29	20

12. Have you ever noticed that air currents can speed up air travel in certain directions? With this in mind, a businessperson wants to determine how much faster the return trip from Dallas to Atlanta is than the initial trip from Atlanta to Dallas. He records the times for his next seven flights to and from Dallas and obtains the following data. Assuming that both population distributions are approximately normal and the variances of the two populations are not the same, construct and interpret a 90% confidence interval for the true difference between the mean times for flights from Atlanta to Dallas and flights from Dallas to Atlanta. (**Hint:** Convert all times to minutes.)

Flight Times	
Atlanta to Dallas	Dallas to Atlanta
1 h 49 min	1 h 32 min
1 h 51 min	1 h 23 min
2 h 03 min	1 h 38 min
1 h 47 min	1 h 26 min
1 h 53 min	1 h 30 min
2 h 01 min	1 h 19 min
1 h 45 min	1 h 28 min

13. A coach wants to compare the consistency of the two best batters on his baseball team. The coach considers the number of times per game that each player gets on base. For a sample of 15 games, John's sample variance is 4.389 and Mark's sample variance is 3.981. Assume that the population distributions of the numbers of times per game that the players get on base are both approximately normal. Construct and interpret a 95% confidence interval for the ratio of the population variances for the two different batters.

14. To ensure that the braking time of a client's car meets the manufacturer's specifications, a mechanic decides to compare the consistency of its braking distances to a car that is known to meet the manufacturer's specifications. The mechanic measures the braking distance, in feet, of the client's car 12 times and calculates a sample variance of 313.6. He then measures the braking distance of the control car 12 times and calculates a sample variance of 304.8. Assume that the population distributions of the braking distances are approximately normal for both cars. Construct and interpret a 99% confidence interval for the ratio of the population variances for the two different cars.
15. A professor decides to compare the variance in the annual salaries of associate professors with the variance in the annual salaries of full professors. A sample of 15 associate professors reveals a sample variance of 609,961. A sample of 14 full professors reveals a sample variance of 674,041. Construct and interpret a 90% confidence interval for the ratio of the population variances for the different ranks of professors.

E Chapter 10 Exercises

Hypothesis Tests

Perform each hypothesis test. Assume that all random samples had an equal chance of being chosen. For each exercise, complete the following steps.

- a. State the null and alternative hypotheses.
 - b. Determine which distribution to use for the test statistic, and state the level of significance.
 - c. Calculate the test statistic.
 - d. Draw a conclusion and interpret the decision.
1. A manufacturer is responsible for making barrels used to store crude oil, which are designed to hold exactly 55 gallons of oil. As part of a routine quality check, a factory manager randomly tests 27 barrels off the assembly line and finds that their mean capacity is 54.7 gallons with a standard deviation of 0.8 gallons. Can the manager say with 99% confidence that the requirements are being met? Assume that the population distribution is approximately normal.
 2. Sarah, a university junior, chose to live on the honors floor of her dorm because she was told that the students on that floor would be quiet and studious. In fact, Sarah was told that students on the honors floor study 11 hours per week. After living on the honors floor for a few months, Sarah is convinced that the students around her study less than 11 hours a week. To test her claim, Sarah polls 10 students on her floor regarding the number of hours per week that they spend studying. Use the results listed in the table below to test Sarah's claim at the 0.10 level of significance. Assume that the population distribution is approximately normal.

Hours of Study per Week										
Hours of Study	12	4	14	9	8	6	10	12	11	9

3. TransAir, an international airline company, has a new jumbo jet that it believes will decrease the mean transatlantic flight time from Newark to London Heathrow. To be faster than its competitors, the mean must be less than 6 h 50 min. Because of costs, the agency monitoring the flight times only requires that eight trials be run. The results are given in the table below. If the FAA requires that the agency be 90% confident of its findings, what should the agency report? Assume that the population distribution is approximately normal.

Flying Times from Newark to London	
	Flying Time
Flight 1	6 h 32 min
Flight 2	6 h 28 min
Flight 3	6 h 51 min
Flight 4	6 h 2 min
Flight 5	6 h 51 min
Flight 6	7 h 2 min
Flight 7	6 h 36 min
Flight 8	6 h 42 min

4. A computer program designer has developed an online questionnaire that she believes will take a mean time of 15 minutes to complete. Suppose that she samples 35 volunteers and finds that the mean time to complete the questionnaire is 14.0 minutes. Determine if there is sufficient evidence to conclude that the mean completion time for the online questionnaire differs from its intended duration. Use a 0.05 level of significance and assume that the population standard deviation is known to be 2.5 minutes.
5. A manufacturer of hearing-aid batteries has developed a new process that it believes will increase the usable life of each battery. Currently, the usable lifetimes for these batteries have a mean of 264 hours. Test the hypothesis that the process increases the usable life of these batteries at the 0.01 level of significance. A sample of 50 batteries is tested and found to have a mean of 271.0 hours with a standard deviation of 16.9 hours. Assume that the population standard deviation is known to be 16.9 hours.
6. If it is true that fewer than 4 people per day use a particular public restroom at the state park, the park services will close the restroom. To determine the action the park should take, the number of uses is recorded each day for a 35-day period. The results are given in the following table. At the 5% level of significance, should the park close the restroom? Assume that the population standard deviation is known to be 2.1 uses per day.

Daily Restroom Uses						
3	3	3	1	2	6	9
0	2	4	3	3	5	3
7	3	0	2	1	4	1
0	0	6	3	5	10	5
3	4	0	5	2	4	6

Suppose that the actual mean usage rate for the restroom is 4 times a day. Did the park make the right decision? If not, what type of error was made?

7. While trying to convince her friends that more than half of all sophomores live off-campus, Bren took a survey of a random sample of sophomores and collected the following data. Does this evidence support Bren's claim that more than half of all sophomores live off-campus at the 0.10 level of significance?

Sophomores Living On-Campus		
	Live On-Campus	Live Off-Campus
In-state Resident	25	47
Out-of-state Resident	38	19

A friend of Bren's went to the registrar's office and found out that actually 975 out of 3788 sophomores lived off-campus this year. Based on this information, did Bren make an error in her conclusion? If so, what type of error did she make?

8. Don believes that fewer than one-third of the students at his college hold part-time jobs while in school. To test his claim, he randomly selects 116 students from whom he collects the following data. Does this evidence support Don's claim at the 0.05 level of significance?

Students Holding Part-Time Jobs	
	Part-Time Job Held
Yes	32
No	84

In a campus-wide end-of-year survey, the office of research was able to determine that 33% of students say they held a part-time job. Did Don draw the correct conclusion? If not, what type of error did he make?

9. A student organization that promotes diversity believes that the percentage of minority students is no longer 35%. In a random sample of 250 students, 97 of the students are minorities. Does this evidence support the organization's claim that the percentage of minority students is not 35% at the 0.01 level of significance?

The registrar reports that 38% of currently enrolled students are minorities according to their admissions records. Based on this new information, did the organization draw the correct conclusion? If not, what type of error was made?

10. A clothing designer produces thousands of pairs of blue jeans each week. The denim for each pair of jeans is cut by a machine, and if the cuts are not made properly, then the jeans will not be properly sized once they are sewn together. To ensure that the jeans are properly sized, the variance in the lengths of the denim, which are measured in millimeters, must be less than 0.25. To test the accuracy of the cuts, 20 pieces of denim are pulled from the line after being cut by the machine and their lengths are measured. The variance in these lengths is found to be 0.1369. Does this evidence support the claim that the variance in the lengths of the denim is less than 0.25, at the 0.10 level of significance?
11. From microminis to floor-length skirts, a historian believes that the variance in the lengths of hems on dresses and skirts is more now than at any other point in recorded history. Specifically, she claims that the variance in the lengths of skirts' hems, which are measured in inches, is more than 15.5. To test her claim, she randomly selects 25 dresses and skirts from a department store and measures the hem length of each. She finds that the variance in the lengths of the hems is 17.3. Does this evidence support the historian's claim, at the 0.05 level of significance?
12. A statistics professor is concerned that the variance in the grades on the final exam will not be 138, as it has been in previous semesters. She randomly selects 35 of her many exams and finds that the variance in the grades is 142. Does this evidence support the professor's claim at the 0.01 level of significance?

13. A city police department has always had an equal number of officers on patrol in each beat. However, each month the police chief reevaluates to make sure that he is utilizing the department's resources and manpower effectively. To do this, he records the number of calls received from each beat over the course of the month. The data for one month are summarized below. Does this evidence support the claim that there is a difference in the number of calls between the different areas of the city, at the 0.05 level of significance?

Calls Received in One Month				
	Beat 1	Beat 2	Beat 3	Beat 4
Number of Calls	28	19	31	38

14. A factory workers' union is appealing to the factory management for more vacation time for its employees. The union claims that workers are more productive when they come back from vacation than before. The following table contains the production rates, measured in units per hour, for a sample of employees. The union feels that it needs to be 90% confident of its claim before going into talks with the employers. Does the union have strong enough evidence to support its claim?

Production Rates				
	100–125 Units per Hour	126–150 Units per Hour	More Than 150 Units per Hour	Total
Before Vacation	210 workers	319 workers	58 workers	587
After Vacation	178 workers	387 workers	60 workers	625
Total	388	706	118	1212

15. A sociologist wants to study the education levels of people living in various regions of the United States. He surveys a random sample of 100 people in each of the following regions: Northeast, Southeast, Midwest, and West. The results obtained are found in the following table. Does this evidence support the sociologist's claim that the level of education differs by region, at the 0.05 level of significance?

Education Levels					
	Less Than a High School Diploma	High School Graduate, No College	Some College or Associate Degree	College Graduate	Total
Northeast	11	29	45	15	100
Southeast	19	28	44	9	100
Midwest	15	25	47	13	100
West	13	31	42	14	100
Total	58	113	178	51	400

E Chapter 11 Exercises

Perform each of the following tests. Assume that the necessary criteria are met for each scenario.

- Psychologists believe that test anxiety can reduce a student's score on an exam. An educational psychologist administers a test to two groups of students, one group that has test anxiety and one group that does not. Use the information in the following table to test the psychologists' claim at the 0.05 level of significance.

Test Scores			
	n	\bar{x}	σ
With Test Anxiety	35	65.9	8.9
Without Test Anxiety	38	73.2	11.5

- A company that manufactures baseball bats believes that its new bat will allow players to hit the ball more than 30 feet farther, on average, than its current model. The managers hire a professional baseball player known for hitting home runs to hit 10 balls with each bat and they measure the distance each ball is hit to test their claim. The results of the batting experiment are shown below. Test the company's claim using a 0.05 level of significance. Assume that the variances of the two populations are equal.

Baseball Hitting Distances (in Feet)	
New Model	Old Model
235	200
240	210
253	231
267	218
243	210
237	209
250	210
241	229
251	234
248	231

- For male and female married couples, do husbands gain more weight after marriage than their wives? Answer this question by performing a hypothesis test using a 0.05 level of significance. Data on the amount of weight gained during the first year of marriage were collected from 10 couples and are given in the following table. Negative values indicate weight lost.

Weight Gained (in Pounds)										
Husband	10	15	8	7	3	10	12	20	-5	4
Wife	11	8	4	2	-1	8	15	15	-10	3

4. A blackjack pit boss at a casino is concerned that one of the tables is not generating the same revenue, on average, as the other three tables. The amount of revenue (in whole dollars) received during one particular three-hour period is recorded at each table each night for five nights. The results are given in the table below. Based on these data, can the pit boss conclude that at least one of the tables is not generating the same mean revenue as the other tables? Use a 0.05 level of significance.

Revenue (in Dollars)			
Table 1	Table 2	Table 3	Table 4
8534	9821	10,542	7367
7845	8997	9982	8021
8901	7905	8934	9034
9371	8923	9344	6703
7782	6675	8745	8432

5. The company manufacturing a new antibiotic ointment claims that it speeds healing time for minor cuts and scrapes. To test this claim, a researcher conducts an experiment involving 30 participants who have recently suffered a minor cut or scrape. Half of the group is asked to apply the new ointment twice daily, and the other half of the group is not allowed to treat the cuts with any medication. The researcher tracks the length of time it takes for each cut to heal. The cuts treated with the new ointment took a mean of 4.6 days to heal, with a standard deviation of 1.3 days. The cuts that did not receive treatment took a mean of 6.1 days to heal, with a standard deviation of 1.6 days. Test the company's claim at the 0.01 level of significance. Assume that the population variances are not equal.
6. Are people with low incomes more likely to cheat on their taxes than people with high incomes? To test this claim, a researcher anonymously surveys 50 taxpayers with low annual incomes and 50 taxpayers with high annual incomes. Of those with low incomes, 7 admit that they were not completely honest on their most recent federal income tax returns. Of those with high incomes, 5 admit that they were not entirely honest on their most recent federal income tax returns. Evaluate the claim by performing a hypothesis test at the 0.05 level of significance.
7. An education professor believes that a new teaching pedagogy will change the number of disciplinary problems that occur in the classroom. For her study, the professor randomly selects 10 students from one elementary school. For one month, the students are taught using the new pedagogy. The next month, the students are taught without changing the pedagogy. For each month, the number of times that each student was disciplined is recorded. Test the professor's claim at the 0.01 level of significance.

Number of Times Disciplined										
Single-Gender Class	1	2	0	4	3	6	1	2	0	0
Mixed-Gender Class	2	2	1	6	3	9	0	4	0	1

8. Are people who live in Atlanta more likely to own a pet than people who live in Chicago? A survey of 50 Atlantians found that 37 of them own a pet. A survey of 55 fathers found that 35 of them are pet owners. Answer the question by performing a hypothesis test using a 0.05 level of significance.
9. A psychologist is convinced that attitude plays a central role in health. Along those lines, he believes that people who attend church regularly are healthier. The psychologist decides to test his claim by comparing the mean number of doctor's visits per year, excluding routine checkups, for adults who attend church regularly and those who do not. To test his claim, he randomly selects 75 adults who regularly attend church and finds that in the past year they had a mean of 1.4 doctor's visits. Assume that the population standard deviation for adults who regularly attend church is known to be 0.4 doctor's visits per year. He also randomly selects 75 adults who do not regularly attend church, and he finds that in the past year they had a mean of 1.6 doctor's visits. Assume that the population standard deviation for adults who do not regularly attend church is known to be 0.5 doctor's visits per year. Use the 0.05 level of significance to test this claim.
10. A nutritionist believes that the variance of the weights, measured in pounds, of people on diets is less than the variance of the weights of the general population. The sample variance for a sample of 15 people on diets is 256.02. The sample variance for a sample of 15 random people is 367.91. Test the nutritionist's claim using a 0.05 level of significance. Does the evidence support the nutritionist's claim?

E Chapter 12 Exercises

Answer each question.

1. The following table gives the heights and corresponding batting averages for a sample of 12 professional baseball players.

Heights and Batting Averages												
Height (in Inches), x	70	73	73	71	68	76	71	75	73	73	75	73
Batting Average, y	.248	.273	.245	.202	.304	.349	.226	.250	.233	.273	.237	.229

- a. Calculate the correlation coefficient.
 - b. Is the correlation coefficient statistically significant at the 0.05 level? At the 0.01 level?
 - c. Should a regression line be used to model the data and make predictions? Why or why not?
2. The following table gives the college GPAs and corresponding annual incomes after graduation for a sample of nine young adults.

College GPAs and Annual Incomes after Graduation									
GPA, x	3.1	3.8	2.9	1.8	2.7	3.5	3.2	2.2	4.0
Annual Income, y	\$38,000	\$36,500	\$39,500	\$29,000	\$33,000	\$40,500	\$26,000	\$30,000	\$61,000

- a. Before calculating the correlation coefficient, what kind of relationship would you expect to see between the two variables?
 - b. Calculate the correlation coefficient and coefficient of determination.
 - c. Is r statistically significant at the 0.05 level? At the 0.01 level?
 - d. Suppose that your college GPA is 3.3. Using the regression model for these data, make a prediction for your future annual income.
3. The interest rate that day for a 30-year mortgage and the corresponding number of new loans taken out at a large regional bank are given for 12 consecutive days.

Interest Rates and Numbers of New Loans Taken Out												
Interest Rate (%), x	4.54	4.57	4.62	4.62	4.59	4.63	4.68	4.75	4.83	4.90	5.01	5.01
New Loans, y	10	8	7	7	7	9	9	8	6	5	4	4

- a. Before calculating the correlation coefficient, what kind of relationship would you expect to see between the two variables?
- b. Calculate the correlation coefficient and coefficient of determination.
- c. Is r statistically significant at the 0.05 level? At the 0.01 level?
- d. Suppose that the average interest rate for a given month is 4.75%. Using the regression model for these data, make a prediction for the number of new loans taken out.

4. The following table gives the average price of gas and the corresponding SUV sales at a local car dealership for ten randomly selected months in 2003.

Gas Prices and SUV Sales										
Price of Gas (per Gallon), x	\$1.26	\$1.24	\$1.51	\$1.37	\$1.53	\$1.43	\$1.35	\$1.49	\$1.42	\$1.58
SUVs Sold, y	45	44	36	45	40	43	47	39	47	37

- Before calculating the correlation coefficient, what kind of relationship would you expect to see between the two variables?
 - Calculate the correlation coefficient and coefficient of determination.
 - Is r statistically significant at the 0.05 level? At the 0.01 level?
 - Suppose that the average gas price for one month is \$1.40. How many SUVs should the car dealership expect to sell?
 - Obviously, these data from 2003 should not be used for predictions this year. However, can you think of ways that the data might be useful for today's car dealerships?
5. A lifeguard collected the following data while the lifeguard was observing the beach on the first day of each month, over the course of a year.

Numbers of Swimsuits and Seagulls												
Swimsuits, x	0	8	11	28	77	120	150	250	100	44	12	5
Seagulls, y	2	78	92	106	102	200	300	376	298	55	15	3

- From analyzing the data above, can you conclude that there is a significant linear relationship between the two variables at the 0.05 level? At the 0.01 level?
 - Could you predict how many seagulls would be visible if you can see 200 swimsuits? What about 500 swimsuits?
 - What reasonable conclusions can you make regarding your findings?
6. Consider the following data from a recent study that included 14 participants who have used a cell phone consistently over the course of several years. For each participant, the number of years they had been using a cell phone was recorded, along with an estimate of the probability that they would get cancer in their lifetime, based on a complex system of multiple factors.

Cancer Risk and Number of Years Using a Cell Phone														
Years Using a Cell Phone, x	2	3.1	1.5	0.9	4	1.5	3.9	2	5	4.4	2.1	4.9	8	6.2
Cancer Risk, y	0.35	0.11	0.45	0.28	0.55	0.78	0.55	0.38	0.74	0.81	0.15	0.09	0.66	0.2

- From analyzing the data, can you conclude that there is a significant linear relationship between the two variables at the 0.05 level? At the 0.01 level?
- Is it reasonable to make predictions of cancer risk based on cell phone usage?
- If you were a cell phone company, what would you do with the results of this study?

7. The following data were collected from a used car dealership regarding the selling prices of used cars and the numbers of miles on the cars when they were sold.

Mileages and Selling Prices of Used Cars	
Mileage, x	Selling Price, y
23,547	\$21,803
48,710	\$17,995
33,952	\$18,995
14,876	\$20,863
133,691	\$4970
30,417	\$28,500
29,104	\$22,597
54,000	\$17,600
63,079	\$14,999
133,172	\$10,995
110,000	\$8000
63,263	\$15,995

- Can you conclude that there is a significant linear relationship between the two variables the 0.05 level? At the 0.01 level?
 - Predict the selling price of a vehicle that has 42,000 miles on it.
 - How much of the variation in the selling prices is associated with the variation in the mileages on the cars when they were sold?
8. Consider the following data collected on airline tickets. The following table lists the distance from Dallas, Texas to the destination and the corresponding price of the airline ticket.

Distances and Ticket Prices to Destinations from Dallas, TX		
Distance (in Miles), x	Destination	Ticket Price, y
1573.61	New York	\$212
1329.96	Washington, DC	\$234
1316.38	Miami	\$275
782.50	Atlanta	\$231
2203.26	Seattle	\$312
967.73	Chicago	\$185
1368.18	Baltimore	\$267
453.18	Memphis	\$229
521.11	New Orleans	\$345

- Is there a significant linear relationship at the 0.05 level between distance traveled and price of a ticket from Dallas, Texas?
- Predict the price of a ticket to San Francisco from Dallas assuming that there is a distance of 1465 miles between the two cities.

9. The following data represent the thread counts of various bedsheets and their corresponding prices.

Thread Counts and Prices of Bedsheets								
Thread Count, x	150	200	225	250	275	300	350	400
Price (in Dollars), y	18	21	25	28	30	31	35	45

- Calculate the sum of squared errors, SSE.
 - Calculate the standard error of estimate, S_e .
 - Construct a 95% prediction interval for the price of 350-thread-count sheets.
 - Construct a 95% confidence interval for the y -intercept of the regression line.
 - Construct a 95% confidence interval for the slope of the regression line.
10. The following data were collected on the numbers of years of post-high-school education and the annual incomes of eight people ten years after graduation from high school.

Post-High-School Education and Annual Income								
Education after High School (in Years), x	2	3	3	4	5	6	6	8
Annual Income (in Thousands of Dollars), y	35	41	38	45	65	89	95	115

- Calculate the sum of squared errors, SSE.
 - Calculate the standard error of estimate, S_e .
 - Construct a 95% prediction interval for the annual income of someone ten years after graduation from high school who had seven years of post-high-school education.
 - Construct a 95% confidence interval for the y -intercept of the regression line.
 - Construct a 95% confidence interval for the slope of the regression line.
11. In addition to the thread count of bed sheets, let's explore if the number of colors used is linearly related to the price of the sheets. Determine if a statistically significant linear relationship exists between these explanatory variables and the response variable at the 0.05 level. If the linear relationship is significant, write the multiple regression equation that best fits the data.

Thread Counts, Colors, and Prices of Bed Sheets		
Thread Count, x_1	Number of Colors, x_2	Price (in Dollars), y
150	2	18
200	1	21
225	2	25
250	4	28
275	3	30
300	2	31
350	1	35
400	4	45

12. In addition to the number of years of post-high-school education, the number of years of work experience also influences a person's salary. Determine if a statistically significant linear relationship exists between these explanatory variables and the response variable at the 0.05 level. If the linear relationship is significant, write the multiple regression equation that best fits the data.

Education, Work Experience, and Annual Income		
Education after High School (in Years), x_1	Work Experience (in Years), x_2	Annual Income (in Thousands of Dollars), y
2	8	35
3	7	41
3	5	38
4	6	45
5	6	65
6	5	89
6	4	95
8	4	115