



Elementary Statistics

Picturing the World

SEVENTH EDITION

Ron Larson • Betsy Farber



SEVENTH EDITION

Elementary Statistics

PICTURING THE WORLD

GLOBAL EDITION

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* Available at www.pearsonglobaleditions.com/larson and in MyLab Statistics.



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PREFACE

Welcome to *Elementary Statistics: Picturing the World*, Seventh Edition. You will find that this textbook is written with a balance of rigor and simplicity. It combines step-by-step instruction, real-life examples and exercises, carefully developed features, and technology that makes statistics accessible to all.

I am grateful for the overwhelming acceptance of the first six editions. It is gratifying to know that my vision of combining theory, pedagogy, and design to exemplify how statistics is used to picture and describe the world has helped students learn about statistics and make informed decisions.

What's New in this Edition

The goal of the Seventh Edition was a thorough update of the key features, examples, and exercises:

Examples This edition has 213 examples, over 60% of which are new or revised. Also, several of the examples now show an alternate solution or a check using technology.

Technology Examples In addition to showing screen displays from Minitab®, Excel®, and the TI-84 Plus, this edition also shows screen displays from StatCrunch®.

Try It Yourself Over 40% of the 213 Try It Yourself exercises are new or revised.

Picturing the World Over 50% of these are new or revised.

Tech Tips New to this edition are technology tips that appear in most sections. These tips show how to use Minitab, Excel, the TI-84 Plus, or StatCrunch to solve a problem.

Exercises Over 40% of the more than 2300 exercises are new or revised.

Extensive Chapter Feature Updates Over 60% of the following key features are new or revised, making this edition fresh and relevant to today's students:

- Where You've Been and Where You're Going
- Uses and Abuses: Statistics in the Real World
- Real Statistics—Real Decisions: Putting it all together
- Chapter Technology Project

Revised Content Here is a summary of the content changes.

- **Section 1.1** now has more discussion about populations and samples, how to identify them, and their relationships to parameters and statistics. Also, the Venn Diagrams have been redrawn to use clearer labeling to help students distinguish between a population and a sample.
- **In Section 1.3**, the figure depicting systemic sampling has been redrawn to more clearly depict the sampling process.
- **Section 2.1** now has more discussion of class widths and open-ended classes. Also, a figure showing a histogram and its corresponding frequency polygon was added after Example 4.
- **In Section 2.4**, Example 9 was rewritten to explain the use of an open-ended class.

- **Section 2.5** now has a Study Tip discussing outliers and modified box-and-whisker plots. On pages 146 and 147, students are shown how to create modified box-and-whisker plots using technology.
- **In Section 3.1**, the solutions to the examples were rewritten to explain why a formula was chosen to find a probability.
- **In Chapter 5**, in addition to using a table, examples were revised and Tech Tips were added to show how to find areas or probabilities using technology.
- **In Chapter 6**, in addition to using a table, examples were revised and Tech Tips were added to show how to find critical values using technology. Also, the exercises in this chapter were revised to ask more conceptual questions.
- **Section 6.2** now has more explanation about why the t -distribution is needed when σ is unknown. Also, the flowchart on page 336 was revised to illustrate when it is not possible to use the normal distribution or the t -distribution to construct a confidence interval.
- **In Chapters 7–9**, in addition to using a table, examples were revised and Tech Tips were added to show how to find P -values and critical values using technology.
- **Section 8.2** now shows the formula for the number of degrees of freedom for the t -test often used by technology.
- **In Section 9.1**, the requirements to use a correlation coefficient r to make an inference about a population have been revised.

Features of the Seventh Edition

Guiding Student Learning

Where You've Been and Where You're Going Each chapter begins with a two-page visual description of a real-life problem. *Where You've Been* connects the chapter to topics learned in earlier chapters. *Where You're Going* gives students an overview of the chapter.

What You Should Learn Each section is organized by learning objectives, presented in everyday language in *What You Should Learn*. The same objectives are then used as subsection titles throughout the section.

Definitions and Formulas are clearly presented in easy-to-locate boxes. They are often followed by **Guidelines**, which explain *In Words* and *In Symbols* how to apply the formula or understand the definition.

Margin Features help reinforce understanding:

- **Study Tips** show how to read a table, interpret a result, help drive home an important interpretation, or connect different concepts.
- **Tech Tips** show how to use Minitab, Excel, the TI-84 Plus, or StatCrunch to solve a problem.
- **Picturing the World** is a “mini case study” in each section that illustrates the important concept or concepts of the section. Each Picturing the World concludes with a question and can be used for general class discussion or group work.

Examples and Exercises

Examples Every concept in the text is clearly illustrated with one or more step-by-step examples. Most examples have an interpretation step that shows the student how the solution may be interpreted within the real-life context of the example and promotes critical thinking and writing skills. Each example, which is numbered and titled for easy reference, is followed by a similar exercise called **Try It Yourself** so students can immediately practice the skill learned. The answers to these exercises are in the back of the book, and the worked-out solutions are in the *Student's Solutions Manual* available in MyLab Statistics.

Technology Examples Many sections contain an example that shows how technology can be used to calculate formulas, perform tests, or display data. Screen displays from Minitab, Excel, the TI-84 Plus, and StatCrunch are shown. Additional screen displays are presented at the ends of selected chapters, and detailed instructions are given in separate technology manuals available in MyLab Statistics.

Exercises The exercises give students practice in performing calculations, making decisions, providing explanations, and applying results to a real-life setting. The section exercises are divided into three parts:

- **Building Basic Skills and Vocabulary** are short answer, true or false, and vocabulary exercises carefully written to nurture student understanding.
- **Using and Interpreting Concepts** are skill or word problems that move from basic skill development to more challenging and interpretive problems.
- **Extending Concepts** go beyond the material presented in the section. They tend to be more challenging and are not required as prerequisites for subsequent sections.

Technology Answers Answers in the back of the book are found using calculations by hand and by tables. Answers found using technology (usually the TI-84 Plus) are also included when there are discrepancies due to rounding.

Review and Assessment

Chapter Summary Each chapter concludes with a Chapter Summary that answers the question *What did you learn?* The objectives listed are correlated to Examples in the section as well as to the Review Exercises.

Chapter Review Exercises A set of Review Exercises follows each Chapter Summary. The order of the exercises follows the chapter organization. Answers to all odd-numbered exercises are given in the back of the book.

Chapter Quizzes Each chapter has a Chapter Quiz. The answers to all quiz questions are provided in the back of the book. For additional help, see the step-by-step video solutions available in MyLab Statistics.

Chapter Tests Each chapter has a Chapter Test. The questions are in random order.

Cumulative Review There is a Cumulative Review after Chapters 2, 5, 8, and 10. Exercises in the Cumulative Review are in random order and may incorporate multiple ideas. Answers to all odd-numbered exercises are given in the back of the book.

Statistics in the Real World

Uses and Abuses: Statistics in the Real World Each chapter discusses how statistical techniques should be used, while cautioning students about common abuses. The discussion includes ethics, where appropriate. Exercises help students apply their knowledge.

Applet Activities Selected sections contain activities that encourage interactive investigation of concepts in the lesson with exercises that ask students to draw conclusions. The applets are available in MyLab Statistics and at www.pearsonglobaleditions.com/larson.

Chapter Case Study Each chapter has a full-page Case Study featuring actual data from a real-world context and questions that illustrate the important concepts of the chapter.

Real Statistics—Real Decisions: Putting it all together This feature encourages students to think critically and make informed decisions about real-world data. Exercises guide students from interpretation to drawing of conclusions.

Chapter Technology Project Each chapter has a Technology project using Minitab, Excel, and the TI-84 Plus that gives students insight into how technology is used to handle large data sets or real-life questions.

Continued Strong Pedagogy from the Sixth Edition


Versatile Course Coverage The table of contents was developed to give instructors many options. For instance, the *Extending Concepts* exercises, applet activities, Real Statistics—Real Decisions, and Uses and Abuses provide sufficient content for the text to be used in a two-semester course. More commonly, I expect the text to be used in a three-credit semester course or a four-credit semester course that includes a lab component. In such cases, instructors will have to pare down the text's 46 sections.

Graphical Approach As with most introductory statistics texts, this text begins the descriptive statistics chapter (Chapter 2) with a discussion of different ways to display data graphically. A difference between this text and many others is that **it continues to incorporate the graphical display of data throughout the text**. For example, see the use of stem-and-leaf plots to display data on page 409. This emphasis on graphical displays is beneficial to all students, especially those utilizing visual learning strategies.

Balanced Approach The text strikes a **balance among computation, decision making, and conceptual understanding**. I have provided many Examples, Exercises, and Try It Yourself exercises that go beyond mere computation.

Variety of Real-Life Applications I have chosen real-life applications that are representative of the majors of students taking introductory statistics courses. I want statistics to come alive and appear relevant to students so they understand the importance of and rationale for studying statistics. I wanted the applications to be **authentic**—but they also need to be **accessible**. See the Index of Applications on page 16.

Data Sets and Source Lines The data sets in the book were chosen for interest, variety, and their ability to illustrate concepts. Most of the **250-plus data sets** contain real data with

source lines. The remaining data sets contain simulated data that are representative of real-life situations. All data sets containing 20 or more entries are available in a variety of formats in MyLab™ Statistics. In the exercise sets, the data sets that are available electronically are indicated by the icon .

Flexible Technology Although most formulas in the book are illustrated with “hand” calculations, I assume that most students have access to some form of technology, such as Minitab, Excel, StatCrunch, or the TI-84 Plus. Because technology varies widely, the text is flexible. **It can be used in courses with no more technology than a scientific calculator—or it can be used in courses that require sophisticated technology tools.** Whatever your use of technology, I am sure you agree with me that the goal of the course is not computation. Rather, it is to help students gain an understanding of the basic concepts and uses of statistics.

Prerequisites Algebraic manipulations are kept to a minimum—often I display informal versions of formulas using words in place of or in addition to variables.

Choice of Tables My experience has shown that students find a **cumulative distribution function (CDF)** table easier to use than a “0-to-z” table. Using the CDF table to find the area under the standard normal curve is a topic of Section 5.1 on pages 259–263. Because some teachers prefer to use the “0-to-z” table, an alternative presentation of this topic is provided in Appendix A.

Page Layout Statistics instruction is more accessible when it is carefully formatted on each page with a consistent open layout. This text is the first college-level statistics book to be written so that, when possible, its features are not split from one page to the next. Although this process requires extra planning, the result is a presentation that is clean and clear.

Meeting the Standards

MAA, AMATYC, NCTM Standards This text answers the call for a **student-friendly text that emphasizes the uses of statistics.** My goal is not to produce statisticians but to produce informed consumers of statistical reports. For this reason, I have included exercises that require students to interpret results, provide written explanations, find patterns, and make decisions.

GAISE Recommendations Funded by the American Statistical Association, the Guidelines for Assessment and Instruction in Statistics Education (GAISE) Project developed six recommendations for teaching introductory statistics in a college course. These recommendations are:

- Emphasize statistical literacy and develop statistical thinking.
- Use real data.
- Stress conceptual understanding rather than mere knowledge of procedures.
- Foster active learning in the classroom.
- Use technology for developing conceptual understanding and analyzing data.
- Use assessments to improve and evaluate student learning.

The examples, exercises, and features in this text embrace all of these recommendations.

Technology Resources

MyLab Statistics Online Course (access code required)

Used by nearly one million students a year, MyLab Statistics is the world’s leading online program for teaching and learning statistics. MyLab Statistics delivers assessment, tutorials, and multimedia resources that provide engaging and personalized experiences for each student, so learning can happen in any environment.

Personalized Learning Not every student learns the same way or at the same rate. Personalized learning in the MyLab gives instructors the flexibility to incorporate the approach that best suits the needs of their course and students.

- Based on their performance on a quiz or test, **personalized homework** allows students to focus on just the topics they have not yet mastered.
- With **Companion Study Plan Assignments** you can assign the Study Plan as a prerequisite to a test or quiz, guiding students through the concepts they need to master.

Preparedness Preparedness is one of the biggest challenges in statistics courses. Pearson offers a variety of content and course options to support students with just-in-time remediation and key-concept review as needed.

- **Redesign-Ready Course Options** Many new course models have emerged in recent years, as institutions “redesign” to help improve retention and results. At Pearson, we’re focused on tailoring solutions to support your plans and programs.
- **Getting Ready for Statistics Questions** This question library contains more than 450 exercises that cover the relevant developmental math topics for a given section. These can be made available to students for extra practice or assigned as a prerequisite to other assignments.

Conceptual Understanding Successful students have the ability to apply their statistical ideas and knowledge to new concepts and real-world situations. Providing frequent opportunities for data analysis and interpretation helps students develop the 21st century skills that they need in order to be successful in the classroom and workplace.

- **Conceptual Question Library** There are 1,000 questions in the Assignment Manager that require students to apply their statistical understanding.
- **Modern statistics is practiced with technology,** and MyLab Statistics makes learning and using software programs seamless and intuitive. Instructors can copy data sets from the text and MyLab Statistics exercises directly into software such as StatCrunch or Excel®. Students can also access instructional support tools including tutorial videos, Study Cards, and manuals for a variety of statistical software programs including StatCrunch, Excel, Minitab®, JMP®, R, SPSS, and TI 83/84 calculators.

Motivation Students are motivated to succeed when they are engaged in the learning experience and understand the relevance and power of statistics.

- **Exercises with Immediate Feedback** Homework and practice exercises in MyLab Statistics regenerate algorithmically to give students unlimited opportunity for

practice and mastery. Instructors can choose from the many exercises available for the author's approach—or even choose additional exercises from other MyLab Statistics courses. Most exercises include learning aids, such as guided solutions, sample problems, extra help at point-of-use, and immediate feedback when students enter incorrect answers.

- Instructors can create, import, and manage online homework assignments, quizzes, and tests—or start with sample assignments—all of which are automatically graded, allowing instructors to spend less time grading, and more time teaching.

Data & Analytics MyLab Statistics provides resources to help instructors assess and improve student results. A comprehensive gradebook with enhanced reporting functionality makes it easier for instructors to manage courses efficiently.

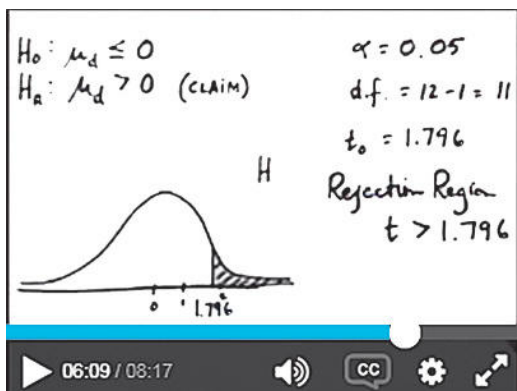
- **Reporting Dashboard** Instructors can view, analyze, and report learning outcomes, gaining the information they need to keep our students on track. Available via the Gradebook and fully mobile-ready, the Reporting Dashboard presents student performance data at the class, section, and program levels in an accessible, visual manner. Its finegrain reports allow instructors and administrators to compare performance across different courses, across individual sections and within each course.
- **Item Analysis** Instructors can track class-wide understanding of particular exercises in order to refine your class lectures or adjust the course/department syllabus. Just-in-time teaching has never been easier.

Accessibility Pearson works continuously to ensure our products are as accessible as possible to all students. We are working toward achieving WCAG 2.0 Level AA and Section 508 standards, as expressed in the Pearson Guidelines for Accessible Educational Web Media, www.pearson.com/mylab/statistics/accessibility.

The following feature is new to the MyLab Statistics course of this edition:

UPDATED! Video Program

Chapter Review Exercises come to life with new review videos that help students understand key chapter concepts. Section Lecture Videos work through examples and elaborate on key objectives.



StatCrunch

Integrated directly into MyLab Statistics, StatCrunch® is powerful web-based statistical software that allows users to perform complex analyses, share data sets, and generate compelling reports of their data.

- **Collect** Users can upload their own data to StatCrunch or search a large library of publicly shared data sets, spanning almost any topic of interest. A Featured Data page houses the best data sets, making it easy for instructors to use current data in their course. Data sets from the text and from online homework exercises can also be accessed and analyzed in StatCrunch. An online survey tool allows users to quickly collect data via web-based surveys.
- **Crunch** A full range of numerical and graphical methods allow users to analyze and gain insights from any data set. Interactive graphics help users understand statistical concepts, and are available for export to enrich reports with visual representations of data.
- **Communicate** Reporting options help users create a wide variety of visually-appealing representations of their data.

StatCrunch is integrated into MyLab Statistics, but it is also available by itself to qualified adopters. StatCrunch is also now available on your smartphone or tablet when you visit www.statcrunch.com from the device's browser. For more information, visit our website at www.statcrunch.com, or contact your Pearson representative.

NEW! StatCrunch Question Library

This library of questions provides opportunities for students to analyze and interpret data sets in StatCrunch. Instructors can assign individual questions from the library by topic or they can assign questions from the same data set as a longer assignment that spans multiple learning objectives.

Cracker Barrel (Question #1)

Row	Geographic	Annual Revenue	Average Cost of Gasoline	Miles from Interstate
1	Southeast	12000000	3.42	0.35
2	Midwest	12378991	3.26	0.58
3	Northeast	12149171	3.29	0.7
4	Midatlantic	14412876	2.68	0.92
5	West	15244993	2.69	0.48
6	South	15157320	2.62	0.1
7	Southeast	13242108	2.86	0.5
8	Midwest	18226327	2.1	0.82
9	Northeast	12763602	3.11	0.34
10	Midatlantic	13905469	2.73	0.31
11	West	19508494	2.08	0.41
12	South	13841958	2.85	0.73
13	Southeast	18352320	2.04	0.12
14	West	18898740	2.2	0.29

Question is complete. Tap on the red in...
 All parts showing
 Show completed problem

Resources for Success

Instructor Resources

Instructor's Solutions Manual (downloadable)

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I have worked hard to make this text a clean, clear, and enjoyable one from which to teach and learn statistics. Despite my best efforts to ensure accuracy and ease of use, many users will undoubtedly have suggestions for improvement. I welcome your suggestions.



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CHAPTER 1

Introduction to Statistics

1.1
An Overview of Statistics

1.2
Data Classification
Case Study

1.3
Data Collection and
Experimental Design
Activity
Uses and Abuses
Real Statistics—Real Decisions
History of Statistics—Timeline
Technology



For the first 10 months of 2016, construction completions of privately-owned housing units in the U.S. was greatest in the south.



Where You've Been

You are already familiar with many of the practices of statistics, such as taking surveys, collecting data, and describing populations. What you may not know is that collecting accurate statistical data is often difficult and costly. Consider, for instance, the monumental task of counting and describing the entire population of the

United States. If you were in charge of such a census, how would you do it? How would you ensure that your results are accurate? These and many more concerns are the responsibility of the United States Census Bureau, which conducts the census every decade.



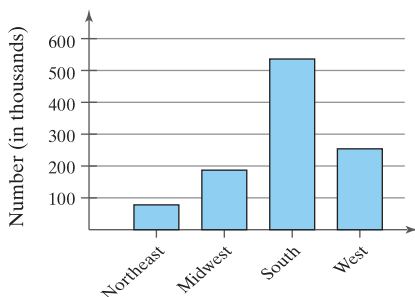
Where You're Going

In Chapter 1, you will be introduced to the basic concepts and goals of statistics. For instance, statistics were used to construct the figures below, which show the numbers, by region in the U.S., of construction completions of privately-owned housing units for October of 2016 and for the first 10 months of 2016, as numbers in thousands and as percents of the total.

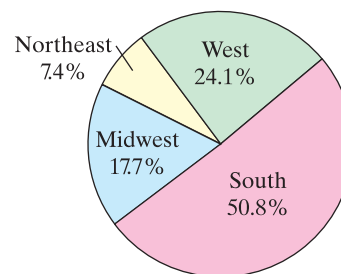
For the 2010 Census, the Census Bureau sent short forms to every household. Short forms ask all members of

every household such things as their gender, age, race, and ethnicity. Previously, a long form, which covered additional topics, was sent to about 17% of the population. But for the first time since 1940, the long form was replaced by the American Community Survey, which surveys more than 3.5 million households a year throughout the decade. These households form a sample. In this course, you will learn how the data collected from a sample are used to infer characteristics about the entire population.

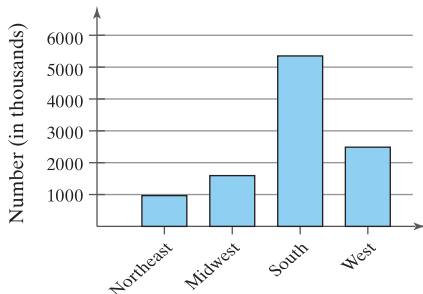
Housing Units Completed in the U.S. (October 2016)



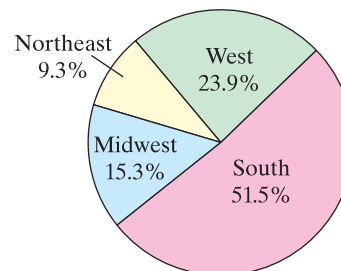
Housing Units Completed in the U.S. (October 2016)



Housing Units Completed in the U.S. (January–October 2016)



Housing Units Completed in the U.S. (January–October 2016)



1.1 An Overview of Statistics

What You Should Learn

- ▶ A definition of statistics
- ▶ How to distinguish between a population and a sample and between a parameter and a statistic
- ▶ How to distinguish between descriptive statistics and inferential statistics

A Definition of Statistics ■ Data Sets ■ Branches of Statistics

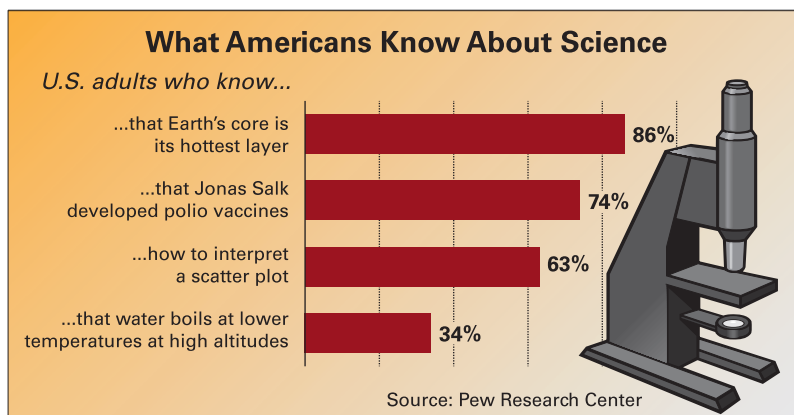
A Definition of Statistics

Almost every day you are exposed to statistics. For instance, consider the next two statements.

- According to a survey, more than 7 in 10 Americans say a nursing career is a prestigious occupation. (*Source: The Harris Poll*)
- “Social media consumes kids today as well, as more score their first social media accounts at an average age of 11.4 years old.” (*Source: Influence Central’s 2016 Digital Trends Study*)

By learning the concepts in this text, you will gain the tools to become an informed consumer, understand statistical studies, conduct statistical research, and sharpen your critical thinking skills.

Many statistics are presented graphically. For instance, consider the figure shown below.



The information in the figure is based on the collection of **data**. In this instance, the data are based on the results of a science quiz given to 3278 U.S. adults.

DEFINITION

Data consist of information coming from observations, counts, measurements, or responses.

The use of statistics dates back to census taking in ancient Babylonia, Egypt, and later in the Roman Empire, when data were collected about matters concerning the state, such as births and deaths. In fact, the word *statistics* is derived from the Latin word *status*, meaning “state.” The modern practice of statistics involves more than counting births and deaths, as you can see in the next definition.

DEFINITION

Statistics is the science of collecting, organizing, analyzing, and interpreting data in order to make decisions.

Data Sets

There are two types of data sets you will use when studying statistics. These data sets are called **populations** and **samples**.



Study Tip

A *census* consists of data from an entire population. But, unless a population is small, it is usually impractical to obtain all the population data. In most studies, information must be obtained from a random sample.

DEFINITION

A **population** is the collection of *all* outcomes, responses, measurements, or counts that are of interest. A **sample** is a subset, or part, of a population.

A sample is used to gain information about a population. For instance, to estimate the unemployment rate for the *population* of the United States, the U.S. Bureau of Labor uses a *sample* of about 60,000 households.

A sample should be representative of a population so that sample data can be used to draw conclusions about that population. Sample data must be collected using an appropriate method, such as *random sampling*. When sample data are collected using an *inappropriate* method, the data cannot be used to draw conclusions about the population. (You will learn more about random sampling and data collection in Section 1.3.)

EXAMPLE 1

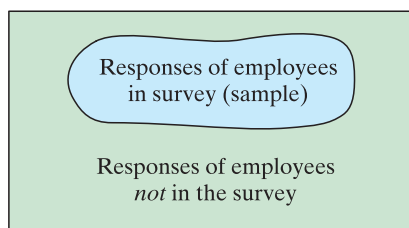
Identifying Data Sets

In a survey, 834 employees in the United States were asked whether they thought their jobs were highly stressful. Of the 834 respondents, 517 said yes. Identify the population and the sample. Describe the sample data set. (*Source: CareerCast Job Stress Report*)

SOLUTION

The population consists of the responses of all employees in the United States. The sample consists of the responses of the 834 employees in the survey. In the Venn diagram below, notice that the sample is a subset of the responses of all employees in the United States. Also, the sample data set consists of 517 people who said yes and 317 who said no.

Responses of All Employees (population)



TRY IT YOURSELF 1

In a survey of 1501 ninth to twelfth graders in the United States, 1215 said “leaders today are more concerned with their own agenda than with achieving the overall goals of the organization they serve.” Identify the population and the sample. Describe the sample data set. (*Source: National 4-H Council*)

Answer: Page A31

Whether a data set is a population or a sample usually depends on the context of the real-life situation. For instance, in Example 1, the population is the set of responses of all employees in the United States. Depending on the purpose of the survey, the population could have been the set of responses of all employees who live in California or who work in the healthcare industry.



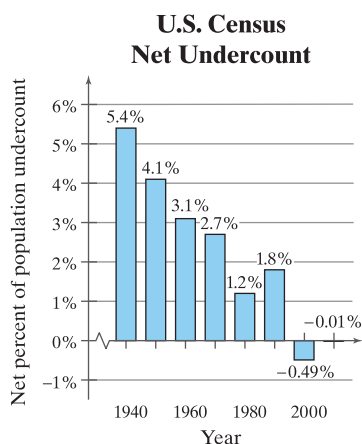
Study Tip

To remember the terms parameter and statistic, try using the mnemonic device of matching the first letters in *population parameter* and the first letters in *sample statistic*.



Picturing the World

How accurate is the count of the U.S. population taken each decade by the Census Bureau? According to estimates, the net undercount of the U.S. population by the 1940 census was 5.4%. The accuracy of the census has improved greatly since then. The net undercount in the 2010 census was -0.01% . (This means that the 2010 census overcounted the U.S. population by 0.01% , which is about 36,000 people.) (Source: U.S. Census Bureau)



What are some difficulties in collecting population data?

Two important terms that are used throughout this course are **parameter** and **statistic**.

DEFINITION

A **parameter** is a numerical description of a *population* characteristic.

A **statistic** is a numerical description of a *sample* characteristic.

It is important to note that a sample statistic can differ from sample to sample, whereas a population parameter is constant for a population. For instance, consider the survey in Example 1. The results showed that 517 of 834 employees surveyed think their jobs are highly stressful. Another sample may have a different number of employees that say their jobs are highly stressful. For the population, however, the number of employees who think that their jobs are highly stressful does not change.

EXAMPLE 2

Distinguishing Between a Parameter and a Statistic

Determine whether each number describes a population parameter or a sample statistic. Explain your reasoning.

1. A survey of several hundred collegiate student-athletes in the United States found that, during the season of their sport, the average time spent on athletics by student-athletes is 50 hours per week. (Source: *Penn Schoen Berland*)
2. The freshman class at a university has an average SAT math score of 514.
3. In a random check of several hundred retail stores, the Food and Drug Administration found that 34% of the stores were not storing fish at the proper temperature.

SOLUTION

1. Because the average of 50 hours per week is based on a subset of the population, it is a sample statistic.
2. Because the average SAT math score of 514 is based on the entire freshman class, it is a population parameter.
3. Because 34% is based on a subset of the population, it is a sample statistic.

TRY IT YOURSELF 2

Determine whether each number describes a population parameter or a sample statistic. Explain your reasoning.

- a. Last year, a small company spent a total of \$5,150,694 on employees' salaries.
- b. In the United States, a survey of a few thousand adults with hearing loss found that 43% have difficulty remembering conversations. (Source: *The Harris Poll*)

Answer: Page A31

In this course, you will see how the use of statistics can help you make informed decisions that affect your life. Consider the census that the U.S. government takes every decade. When taking the census, the Census Bureau attempts to contact everyone living in the United States. Although it is impossible to count everyone, it is important that the census be as accurate as it can be because public officials make many decisions based on the census information. Data collected in the census will determine how to assign congressional seats and how to distribute public funds.

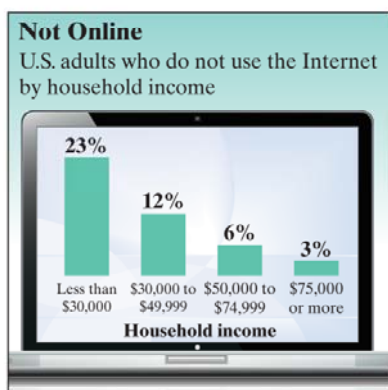
Branches of Statistics

The study of statistics has two major branches: **descriptive statistics** and **inferential statistics**.

DEFINITION

Descriptive statistics is the branch of statistics that involves the organization, summarization, and display of data.

Inferential statistics is the branch of statistics that involves using a sample to draw conclusions about a population. A basic tool in the study of inferential statistics is probability. (You will learn more about probability in Chapter 3.)



Study Tip

Throughout this course you will see applications of both branches of statistics. A major theme in this course will be how to use sample statistics to make inferences about unknown population parameters.

EXAMPLE 3

Descriptive and Inferential Statistics

For each study, identify the population and the sample. Then determine which part of the study represents the descriptive branch of statistics. What conclusions might be drawn from the study using inferential statistics?

1. A study of 2560 U.S. adults found that of adults not using the Internet, 23% are from households earning less than \$30,000 annually, as shown in the figure at the left. (Source: *Pew Research Center*)
2. A study of 300 Wall Street analysts found that the percentage who incorrectly forecasted high-tech earnings in a recent year was 44%. (Adapted from *Bloomberg News*)

SOLUTION

1. The population consists of the responses of all U.S. adults, and the sample consists of the responses of the 2560 U.S. adults in the study. The part of this study that represents the descriptive branch of statistics involves the statement “23% [of U.S. adults not using the Internet] are from households earning less than \$30,000 annually.” Also, the figure represents the descriptive branch of statistics. A possible inference drawn from the study is that lower-income households cannot afford access to the Internet.
2. The population consists of the high-tech earnings forecasts of all Wall Street analysts, and the sample consists of the forecasts of the 300 Wall Street analysts in the study. The part of this study that represents the descriptive branch of statistics involves the statement “the percentage [of Wall Street analysts] who incorrectly forecasted high-tech earnings in a recent year was 44%.” A possible inference drawn from the study is that the stock market is difficult to forecast, even for professionals.

TRY IT YOURSELF 3

A study of 1000 U.S. adults found that when they have a question about their medication, three out of four adults will consult with their physician or pharmacist and only 8% visit a medication-specific website. (Source: *Finn Futures™ Health poll*)

- a. Identify the population and the sample.
- b. Determine which part of the study represents the descriptive branch of statistics.
- c. What conclusions might be drawn from the study using inferential statistics?

Answer: Page A31

1.1 EXERCISES

For Extra Help: MyLab Statistics

Building Basic Skills and Vocabulary

1. How is a sample related to a population?
2. Why is a sample used more often than a population?
3. What is the difference between a parameter and a statistic?
4. What are the two main branches of statistics?

True or False? In Exercises 5–10, determine whether the statement is true or false. If it is false, rewrite it as a true statement.

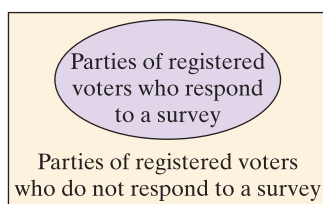
5. A statistic is a numerical description of a population characteristic.
6. A sample is a subset of a population.
7. It is impossible to obtain all the census data about the U.S. population.
8. Inferential statistics involves using a population to draw a conclusion about a corresponding sample.
9. A population is the collection of some outcomes, responses, measurements, or counts that are of interest.
10. A sample statistic will not change from sample to sample.

Classifying a Data Set In Exercises 11–20, determine whether the data set is a population or a sample. Explain your reasoning.

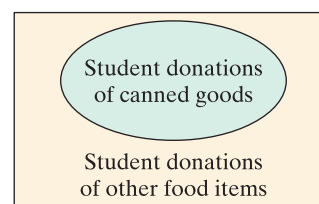
11. A survey of 95 shopkeepers in a commercial complex with 550 shopkeepers
12. The amount of energy collected from every solar panel on a photovoltaic power plant
13. The height of each athlete participating in the Summer Olympics
14. The value of purchase by every sixth person entering a departmental store
15. The triglyceride levels of 10 patients in a clinic with 50 patients
16. The number of children in 25 households out of 75 households in a neighborhood
17. The final score of each gamer in a tournament
18. The ages at which all the presidents of a country were elected
19. The incomes of the top 10 taxpayers of a country
20. The air contamination levels at 20 locations near a factory

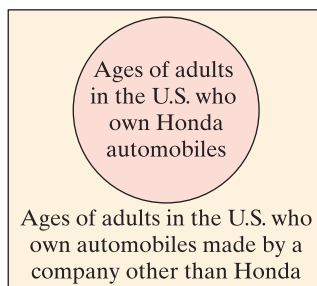
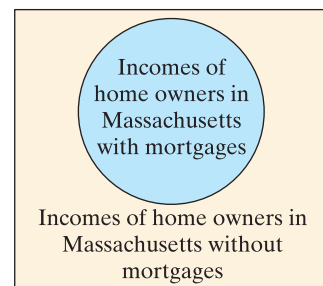
Graphical Analysis In Exercises 21–24, use the Venn diagram to identify the population and the sample.

21. Parties of Registered Voters



22. Student Donations at a Food Drive



23. Ages of Adults in the United States Who Own Automobiles**24. Incomes of Home Owners in Massachusetts**

Using and Interpreting Concepts

Identifying Data Sets In Exercises 25–34, identify the population and the sample. Describe the sample data set.

25. A survey of 1020 U.S. adults found that 42% trust their political leaders. (Source: Gallup)
26. A study of 203 infants was conducted to find a link between fetal tobacco exposure and focused attention in infancy. (Source: *Infant Behavior and Development*)
27. A survey of 3301 U.S. adults found that 39% received an influenza vaccine for a recent flu season. (Source: *U.S. Centers for Disease Control and Prevention*)
28. A survey of 1500 employees worldwide found that 62% of the respondents working in a foreign country settle there.
29. A survey of 159 U.S. law firms found that the average hourly billing rate for partners was \$604. (Source: *The National Law Journal*)
30. A survey of 328 children in a city in Belgium found that 86% planned to visit their grandparents during the summer vacation.
31. Of the 112.5 million blood donations collected globally, approximately 50% are collected from high-income countries. (Source: *World Health Organization*)
32. A survey of 1468 laptop users found that 81% preferred the use of mouse over touchpad.
33. To gather information about the best mutual funds listed on a recognized stock exchange website, a researcher collects data about 134 of the 1000 mutual funds.
34. A survey of 1060 parents of 13- to 17-year-olds found that 636 of the 1060 parents have checked their teen's social media profile. (Source: *Pew Research Center*)

Distinguishing Between a Parameter and a Statistic In Exercises 35–42, determine whether the number describes a population parameter or a sample statistic. Explain your reasoning.

35. Forty out of a high school's 500 students who took the midterm examination received a C grade.
36. A survey of 1058 college board members found that 56.3% think that college completion is a major priority or the most important priority for their board. (Source: *Association of Governing Boards of Universities and Colleges*)
37. Out of the 40 million casualties in the UK during World War II, two million were reported to be civilians.

38. In January 2016, 62% of the governors of the 50 states in the United States were Republicans. *(Source: National Governors Association)*
39. Employee records show that all the employees in an organization have received substantial increments over their joining salaries.
40. In a survey of 650 teachers, 16% reported that there have been instances of bullying in their class.
41. A survey of 2008 U.S. adults found that 80% think that the militant group known as ISIS is a major threat to the well-being of the United States. *(Source: Pew Research Center)*
42. In a recent year, the average math score on the ACT for all graduates was 20.6. *(Source: ACT, Inc.)*
43. **Descriptive and Inferential Statistics** Which part of the survey described in Exercise 31 represents the descriptive branch of statistics? What conclusions might be drawn from the survey using inferential statistics?
44. **Descriptive and Inferential Statistics** Which part of the survey described in Exercise 32 represents the descriptive branch of statistics? What conclusions might be drawn from the survey using inferential statistics?

Extending Concepts

45. **Identifying Data Sets in Articles** Find an article that describes a survey.
 - (a) Identify the sample used in the survey.
 - (b) What is the population?
 - (c) Make an inference about the population based on the results of the survey.
46. **Writing** Write an essay about the importance of statistics for one of the following.
 - A study on the effectiveness of a new drug
 - An analysis of a manufacturing process
 - Drawing conclusions about voter opinions using surveys
47. **Exercise and Cognitive Ability** A study of 876 senior citizens shows that participants who exercise regularly exhibit less of a decline in cognitive ability than those who barely exercise at all. From this study, a researcher infers that your cognitive ability increases the more you exercise. What is wrong with this type of reasoning? *(Source: Neurology)*
48. **Increase in Obesity Rates** A study shows that the obesity rate among adolescents has steadily increased since 1988. From this study, a researcher infers that this trend will continue in future years. What is wrong with this type of reasoning? *(Source: Journal of the American Medical Association)*
49. **Sleep and Student Achievement** A study shows the closer that participants were to an optimal sleep duration target, the better they performed on a standardized test. *(Source: Eastern Economics Journal)*
 - (a) Identify the sample used in the study.
 - (b) What is the population?
 - (c) Which part of the study represents the descriptive branch of statistics?
 - (d) Make an inference about the population based on the results of the study.