EIGHTH EDITION

Elementary Statistics

Ron Larson

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EIGHTH EDITION

Elementary Statistics

PICTURING THE WORLD

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Library of Congress Control Number: 2021921349

ScoutAutomatedPrintCode

ISBN 10: 0-13-749332-0
ISBN 13: 978-0-13-749332-6

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PREFACE

Welcome to *Elementary Statistics: Picturing the World*, Eighth Edition. You will find that this textbook is written with a balance of rigor and simplicity. It combines step-by-step instructions, 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 seven 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 Eighth Edition was a thorough update of the key features, examples, and exercises:

Examples This edition has 213 examples, nearly 50% of which are new or revised. Also, several of the examples now show an alternate solution or a check using technology.

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

Picturing the World Over 70% of these are new or revised.

Screen Displays In the examples, technology tips, and other features that show screen displays from Minitab®, Excel®, the TI-84 Plus, and StatCrunch®, the displays were revised as appropriate to make them more visually appealing, easy to follow, and reflective of the most up-to-date version of the software.

Exercises Over 30% of the more than 2300 exercises are new or revised.

Extensive Chapter Feature Updates A full 50% 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

References to Co-Requisite Help Margin notes have been included at point-of-use locations throughout this edition to remind students that they can get help reviewing a particular area of mathematics in the Integrated Review in MyLab Statistics.

Applet Activities Revisions have been made to the applet activities throughout the text to reflect changes to the corresponding online applets they reference. Applet activities are discussed further on the next page.

Study Strategies At the bottom of each chapter summary page in Chapters 1 through 10, there are study strategies that students can use to help improve their performance in college. These include tips on improving reading skills, avoiding procrastination, preparing for a test, taking notes, and other areas.

Features of the Eighth 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.
- **References to Co-Requisite Help** point students to extra math help.
- **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. The answers to these questions are included in the *Annotated Instructor's Edition.*

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 available in MyLab Statistics in the *Student Solutions Manual.*

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 with the book.

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. The answers to all test questions are provided in the *Annotated Instructor's Edition.*

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.pearson.com/math-stats-resources.**

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 Seventh 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 387. 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 xvi.

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 or at **www.pearson.com/math-stats-resources.** 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 237–241. 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.

MyLab Statistics Resources for Success

MyLab Statistics is available to accompany Pearson's market-leading text options, including *Elementary Statistics: Picturing The World*, 8e (access code required).

MyLab™ is the teaching and learning platform that empowers you to reach every student. MyLab Statistics combines trusted author content—including full eText and assessment with immediate feedback—with digital tools and a flexible platform to personalize the learning experience and improve results for each student. Integrated with StatCrunch®, a web-based statistical software program, students learn the skills they need to interact with data in the real world.

MyLab Statistics supports all learners, regardless of their ability and background, to provide an equal opportunity for success. Accessible resources support learners for a more equitable experience no matter their abilities. And options to personalize learning and address individual gaps helps to provide each learner with the specific resources they need to achieve success.

Student Resources

Each student learns at a different pace. Personalized learning pinpoints the precise areas where each student needs practice, giving all students the support they need—when and where they need it—to be successful.

StatCrunch® is integrated directly into MyLab Statistics. StatCrunch® is a powerful web-based statistical software that allows users to perform complex analyses, share data sets, and generate compelling reports of their data. The vibrant online community offers tens of thousands of shared data sets for students to analyze.

- **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. 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 allows 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 can be accessed on your laptop, smartphone, or tablet when you visit the StatCrunch website from your device's browser. For more information, visit the StatCrunch website, or contact your Pearson representative.

Exercises with Immediate Feedback The exercises in MyLab Statistics reflect the approach and learning style of this text, and regenerate algorithmically to give student unlimited opportunity for practice and mastery. Most exercises include learning aids, such as guided solutions and sample problems, and they offer helpful feedback when students enter incorrect answers.

Personalized Homework With Personalized Homework, students take a quiz or test and receive a subsequent homework assignment that is personalized based on their performance. This way, students can focus on just the topics they have not yet mastered.

Integrated Review *Elementary Statistics, Picturing the World with Integrated Review* can be used in corequisite courses, or simply to help students who enter without a full understanding of prerequisite skills and concepts.

MyLab courses provide the full suite of supporting resources for the Statistics course, plus additional assignments and for study aids from select intermediate algebra topics for students who will benefit from remediation.

Assignments for the integrated review content are pre-assigned in MyLab, making it easier than ever to create your course.

Mindset videos and assignable, open-ended **exercises** foster a growth mindset in students. This material encourages them to maintain a positive attitude about learning, value their own ability to grow, and view mistakes as learning opportunities—so often a hurdle for math students.

Personal Inventory Assessments are a collection of online exercises designed to promote self reflection and metacognition in students. These 33 assessments include topics such as a Stress Management Assessment, Diagnosing Poor Performance and Enhancing Motivation, and Time Management Assessment.

Instructor Resources

Your course is unique. So whether you'd like to build your own assignments, teach multiple sections, or set prerequisites, MyLab gives you the flexibility to easily create your course to fit your needs.

MyLab Features

Performance Analytics enable instructors to see and analyze student performance across multiple courses. Based on their current course progress, the student's performance is identified as above, at, or below expectations through a variety of graphs and visualizations.

Conceptual Question Library There are 1000 questions in the Assignment Manager that require students to apply their statistical understanding.

PowerPoint Presentations include lecture content and key graphics from the textbook. Accessible PowerPoint slides are also available and are built to align with WCAG 2.0 AA standards and Section 508 guidelines.

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover the objectives of the text.

Test Bank features printable PDF containing all the test exercises available in TestGen.

Accessibility Pearson works continuously to ensure our products are as accessible as possible to all students. Currently we work toward achieving WCAG 2.0 AA for our existing products (2.1 AA for future products) and Section 508 standards, as expressed in the Pearson Guidelines for Accessible Educational Web Media (https://www.pearson.com/accessibility-guidelines.html).

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ACKNOWLEDGMENTS

I owe a debt of gratitude to the many reviewers who helped me shape and refine *Elementary Statistics: Picturing the World,* Eighth Edition.

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Many thanks to Betsy Farber for her significant contributions to previous editions of the text.

I would also like to thank the staff of Larson Texts, Inc., who assisted with the production of the book. On a personal level, I am grateful to my spouse, Deanna Gilbert Larson, for her love, patience, and support. Also, a special thanks goes to R. Scott O'Neil.

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.

Ron Larson

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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

During 2020, the fastest-growing state in the United States was Idaho. In the same year, the Idaho cities of Meridian and Nampa were among the 10 fastest-growing cities in the United States.

Where You've Been

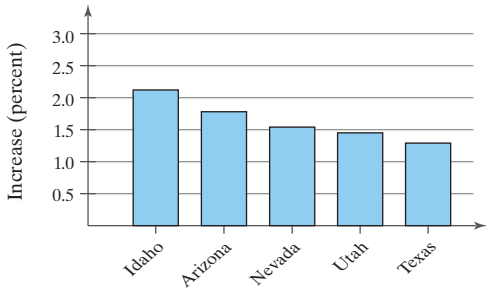
You are already familiar with many of the practices of statistics, such as taking surveys, collecting data, and describing populations. What you may not know is that collecting accurate statistical data is often difficult and costly. Consider, for instance, the monumental task of counting and describing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

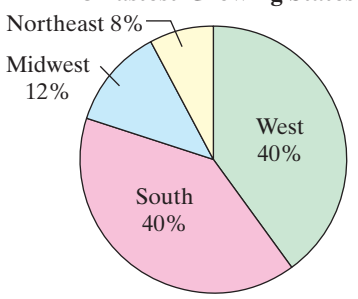
In Chapter 1, you will be introduced to the basic concepts and goals of statistics. For instance, statistics were used to construct the figures below, which show the fastest-growing U.S. states from 2019 to 2020 by the percent increase in population and by the numerical increase in population, along with the regions where these states are located.

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.

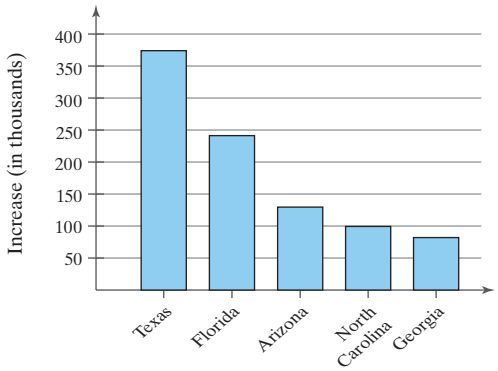
Fastest-Growing States (2019 to 2020)



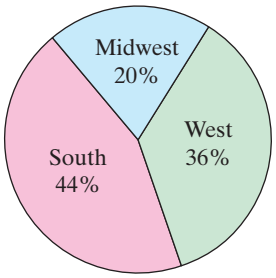
Regions of the 25 Fastest-Growing States



States with Greatest Numerical Population Increases (2019 to 2020)



Regions of the 25 States with Greatest Numerical Population Increases



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

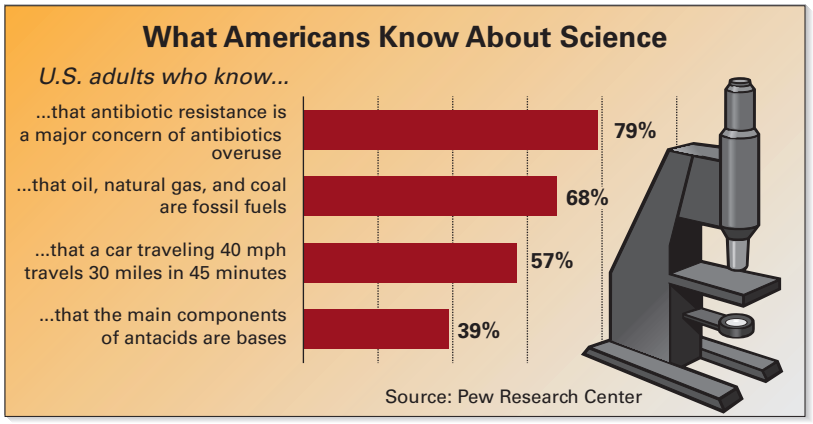
Almost every day you are exposed to statistics. For instance, consider the next two statements.

- "7 in 10 Americans believe the arts unify their communities, and 2 in 5 Americans have changed an opinion or perception based on an arts experience." *(Source: Americans for the Arts)*
- "Notably, 21% of 8–11 year-olds have a social media profile." *(Source: Smart Insights, Ltd.)*

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.

For help with percents and reading graphs, see *Integrated Review* at MyLab® Statistics



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 4464 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 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 Statistics 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.)

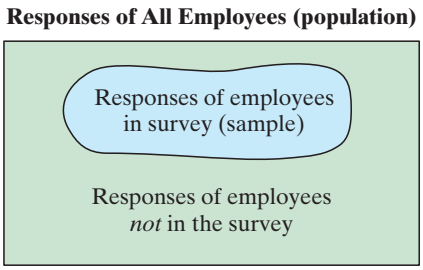
EXAMPLE 1

Identifying Data Sets

In a survey, 751 employees in the United States were asked how stressed they feel at work. Of the 751 respondents, 616 said that they feel at least a little stressed at work. Identify the population and the sample. Describe the sample data set. *(Adapted from The Marlin Company)*

SOLUTION

The population consists of the responses of all employees in the United States. The sample consists of the responses of the 751 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 616 employees who said that they feel at least a little stressed at work and 135 who said that they do not feel stressed at work.



TRY IT YOURSELF 1

In a survey of 1516 teens in the United States, 1228 said "mental health is a significant issue for young people in the U.S." Identify the population and the sample. Describe the sample data set. *(Adapted from National 4-H Council)*

Answer: Page A35

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 health care 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.*

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

DEFINITION

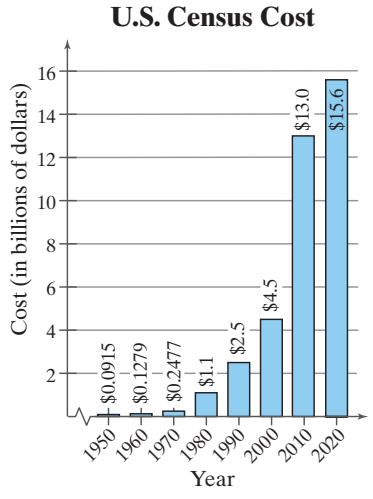
A **parameter** is a numerical description of a *population* characteristic.

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 616 of 751 employees surveyed feel at least a little stressed at work. Another sample may have a different number of employees who say they feel at least a little stressed at work. For the population, however, the number of employees who feel at least a little stressed at work does not change.

Picturing the World

What is the cost of the U.S. Census? According to estimates, it has been escalating with each decade. The cost of the 1950 Census was approximately $91.5 million. The most recent U.S. Census, taken in 2020, was estimated to cost a staggering $15.6 billion. (Source: U.S. Census Bureau and U.S. Government Accountability Office)



What are some of the costs involved in taking a census?

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. In the United States, a survey of about 9400 individuals aged 15 and over found that such individuals spent an average of 5.19 hours per day engaged in leisure and sports activities. *(Source: U.S. Bureau of Labor Statistics)*
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 5.19 hours per day 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 more than 1000 adults aged 65–80 found that 47% who report listening to loud or very loud music in their youth now report being hard of hearing. *(Source: The Harris Poll)*

Answer: Page A35

In this course, you will see how the use of statistics can help you make informed decisions. Consider the census that the U.S. government takes every decade. 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.)

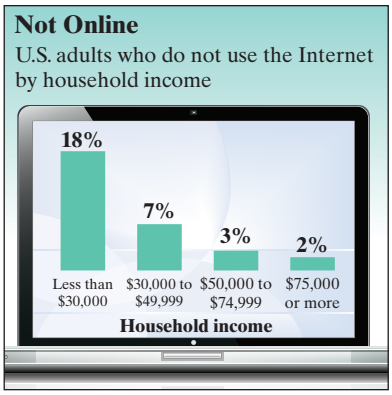
EXAMPLE 3

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 1502 U.S. adults found that 18% of adults from households earning less than $30,000 annually do not use the Internet, as shown in the figure at the left. *(Source: Pew Research Center)*

2. A study of 1000 U.S. 401(k) retirement plan participants found that the percentage who do not know how many years their retirement savings might last is 32%. *(Source: Charles Schwab & Co., Inc.)*



SOLUTION

1. The population consists of the responses of all U.S. adults, and the sample consists of the responses of the 1502 U.S. adults in the study. The part of this study that represents the descriptive branch of statistics involves the statement "18% of adults from households earning less than $30,000 annually do not use the Internet." Also, the figure represents the descriptive branch of statistics. A possible inference drawn from the study is that the Internet has been made inaccessible to lower-income households.

2. The population consists of the responses of all U.S. 401(k) retirement plan participants, and the sample consists of the responses of the 1000 U.S. 401(k) retirement plan participants in the study. The part of this study that represents the descriptive branch of statistics involves the statement "the percentage [of U.S. 401(k) retirement plan participants] who do not know how many years their retirement savings might last is 32%." A possible inference drawn from the study is that the amount of money a person needs for retirement is difficult to determine.

TRY IT YOURSELF 3

A study of 513 respondents to an Internet-wide survey found that 97% of the respondents said music is important to them, and 83% of the respondents said they actively look for new music. *(Source: Medium)*

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 A35

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.

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.*

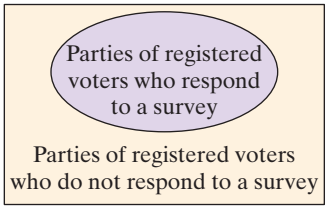
5. A statistic is a numerical description of a population characteristic.
6. A sample is a subset of a population.
7. It is impossible to obtain all the census data about the U.S. population.
8. Inferential statistics involves using a population to draw a conclusion about a corresponding sample.
9. A 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.*

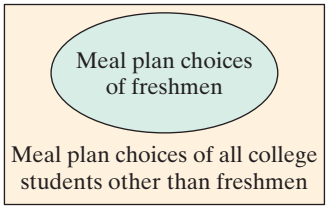
11. The salary of each employee of an advertising firm
12. The amount of energy collected from every solar panel on a photovoltaic power plant
13. A survey of 250 members from an organized union of over 20,000 members
14. The annual revenue of each team in a pro sports league
15. The carbon monoxide levels of 12 of 49 people who escaped a burning building
16. The number of electoral college votes for each state in the U.S. and the District of Columbia
17. The number of guests in each room of a hotel
18. The amount spent by every tenth person cashing out at a store
19. The nationality of every person passing through a customs station
20. The precipitation amounts at 15 locations in a county

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

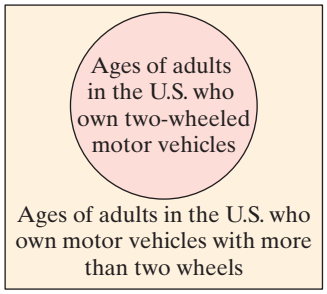
21. **Parties of Registered Voters**



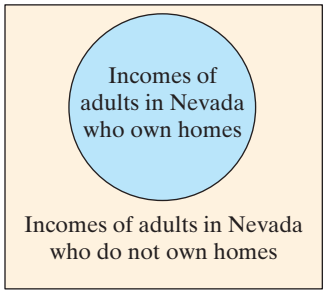
22. **Meal Plan Choices of College Students**



23. **Ages of Adults in the United States Who Own Moter Vehicles**



24. **Incomes of Adults in Nevada**



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 1021 U.S. adults found that 45% have a favorable view of Cuba. *(Source: Gallup)*

26. A study of 227 U.S. infants was conducted to explore norms of the gut microbiomes of healthy infants. *(Source: Scientific Reports)*

27. A survey of 1500 U.S. adults found that 59% have never had a vaccine reaction. *(Source: SingleCare)*

28. A survey of 1028 U.S. adults found that 7% of respondents have never heard of organ and tissue donation. *(Source: Research!America)*

29. A survey of 2111 U.S. small business owners found that 54% oppose increasing the minimum wage. *(Source: CNBC)*

30. A survey of 214 of the seniors graduating with a bachelor of science degree from a university found that 15% planned to obtain entry-level jobs in the health field.

31. A survey of 1001 U.S. adults found that 47% of respondents typically feel well rested on weekdays. *(Source: National Sleep Foundation)*

32. A survey of 366 automobile owners who purchased extended warranties found that 44% never used the warranty.

33. To gather information about starting salaries at companies listed in the Standard & Poor's 500, a researcher contacts 74 of the 500 companies.

34. In a survey of 679 members of a local children's museum about parenting attitudes, 575 of the participants were female and 423 of the participants were parents of two or more children. *(Source: University of California Press)*

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. The average salary for 24 of a hospital's 82 registered nurses is $71,000.

36. A survey of 919 college board members found that 89% think that their institution is a good place for members of racial and ethnic minorities. *(Source: Association of Governing Boards of Universities and Colleges)*

37. Sixty-two of the 97 passengers aboard the *Hindenburg* airship survived its explosion.

38. In January 2021, 54% of the governors of the 50 states in the United States were Republicans. *(Source: National Governors Association)*

39. In a survey of automobile owners, 6% said they had to change their engine control module at least once.

40. Voter registration records show that 47% of all voters in a county are registered as Democrats.

41. A survey of 1000 U.S. adults found that 79% think that the spread of infectious diseases 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 20.2. *(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 Immunity A study showed the same level of T cell production in senior citizens who are amateur cyclists as in young adults, but a significantly lower level of T cell production in senior citizens who do not exercise regularly. Is it appropriate to infer that exercise stimulates T cell production? Explain. *(Source: University of Birmingham)*

48. Weight Loss and High Blood Pressure A study showed an association between intentional weight loss and a decreased risk of high blood pressure. Is it appropriate to infer from this study that weight loss causes a decreased risk of high blood pressure? Explain. *(Source: European Association for the Study of Obesity)*

49. Sleep and Student Achievement A study of college students showed that participants earned higher scores on quizzes and midterm exams with better sleep. *(Source: The American Journal of Managed Care)*

(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.

1.2 Data Classification

What You Should Learn

- How to distinguish between qualitative data and quantitative data
- How to classify data with respect to the four levels of measurement: nominal, ordinal, interval, and ratio

Types of Data ■ Levels of Measurement

Types of Data

When conducting a study, it is important to know the kind of data involved. The type of data you are working with will determine which statistical procedures can be used. In this section, you will learn how to classify data by type and by level of measurement. Data sets can consist of two types of data: **qualitative data** and **quantitative data.**

DEFINITION

Qualitative data consist of attributes, labels, or nonnumerical entries.

Quantitative data consist of numbers that are measurements or counts.

EXAMPLE 1

Classifying Data by Type

The table shows a partial list of vulnerable, endangered, or critically endangered species and the approximate numbers of each species remaining. Which data are qualitative data and which are quantitative data? Explain your reasoning. *(Source: World Wildlife Fund)*

Vulnerable, Endangered, or Critically Endangered Species

Common species name	Number remaining
African elephant	415,000
Black-footed ferret	370
Giant panda	1864
Indus river dolphin	1816
Javan rhinoceros	60
North Atlantic right whale	400
Sunda tiger	400
Tapanuli orangutan	800
Vaquita	10

SOLUTION

The information shown in the table can be separated into two data sets. One data set contains the common species names and the other contains the numbers remaining. The names are nonnumerical entries, so these are qualitative data. The numbers remaining are numerical entries, so these are quantitative data.

TRY IT YOURSELF 1

The populations of several U.S. cities are shown in the table. Which data are qualitative data and which are quantitative data? Explain your reasoning. *(Source: U.S. Census Bureau)*

City	Population
Baltimore, MD	593,490
Chicago, IL	2,693,976
Glendale, AZ	252,381
Denver, CO	727,211
Portland, OR	654,741
San Francisco, CA	881,549

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