FUNDAMENTALS OF STATISTICS

INFORMED DECISIONS USING DATA 5e

Michael Sullivan, III

Pearson

Sullivan's Pathway to Making an Informed Decision

Begin your journey…

- **Making an Informed Decision** projects at the start of each chapter allow you to work with data in order to make informed decisions that impact your life.
- **Putting It Together** overviews show how material you are about to cover relates to prior material.

Preparation is key…

- **Preparing for This Section** lists all of the skills needed to be successful.
- **Preparing for This Section Quizzes** are available online to help you check your mastery.
- **Each Objective** is listed at the beginning of the section and then repeated in the text for easy reference.

Look at the model then practice, practice, practice…

- **Step-by-Step Annotated Examples** illustrate new concepts and methods in 3 steps:
  1. Problem
  2. Approach
  3. Solution
- **Examples** point to **Now Work Exercises** so you can solve similar exercises on your own.

Exercise Sets…

- **Putting It Together** exercises use skills you've acquired in various chapters. ***(See facing page)***
- **You Explain It!** exercises ask you to provide an interpretation of statistical results.
- **Retain Your Knowledge** exercises help you to maintain the skills you have acquired earlier in the course.

Check where you've been and test your mastery…

- **Putting It Together Sections** require you to decide which technique to use. ***(See facing page)***
- **End-of-Chapter Objectives** are listed with page references for easy review.
- **Chapter Tests** provide an opportunity to test your knowledge.

Apply yourself…

- **In-Class Activities** in the Student Activity Workbook allow you to experience statistics in a fun and exciting way by experiencing the process firsthand. ***(See facing page for a list of applet activities)***
- **Making an Informed Decision** projects require you to use data and statistical techniques learned in the chapter to make important life decisions.
- **End-of-Chapter Case Studies** tie statistical concepts together within an interesting application.

Sullivan's Guide to Putting It Together

Putting It Together Sections	Objective	Page(s)
5.6 Putting It Together: Which Method Do I Use?	1 Determine the appropriate probability rule to use 2 Determine the appropriate counting technique to use	284–285 285–287
9.3 Putting It Together: Which Method Do I Use?	1 Determine the appropriate confidence interval to construct	420–421
10.4 Putting It Together: Which Method Do I Use?	1 Determine the appropriate hypothesis test to perform (one sample)	460–461
11.4 Putting It Together: Which Method Do I Use?	1 Determine the appropriate hypothesis test to perform (two samples)	502–503

Putting It Together Exercises	Skills Utilized	Section(s) Covered	Page(s)
1.2.24 Passive Smoke	Variables, observational studies, designed experiments	1.1, 1.2	21
1.4.37 Comparing Sampling Methods	Simple random sampling and other sampling techniques	1.3, 1.4	36
1.4.38 Thinking about Randomness	Random sampling	1.3, 1.4	36
2.1.29 Online Homework	Variables, designed experiments, bar graphs	1.1, 1.2, 1.6, 2.1	73
2.2.53 Time Viewing a Webpage	Graphing data	2.2	93
2.2.54 Which Graphical Summary?	Choosing the best graphical summary	2.1, 2.2	93
2.2.55 Shark!	Graphing data	2.2	93–94
3.1.41 Shape, Mean, and Median	Discrete vs. continuous data, histograms, shape of a distribution, mean, median, mode, bias	1.1, 1.4, 2.2, 3.1	123
3.5.17 Earthquakes	Mean, median, range, standard deviation, relative frequency histogram, boxplots, outliers	2.2, 3.1, 3.2, 3.4, 3.5	164
3.5.18 Paternal Smoking	Observational studies, designed experiments, lurking variables, mean, median, standard deviation, quartiles, boxplots	1.2, 1.6, 3.1, 3.2, 3.4, 3.5	164–165
4.2.29 Housing Prices	Scatter diagrams, correlation, linear regression	4.1, 4.2	201
4.2.30 Smoking and Birth Weight	Observational study vs. designed experiment, prospective studies, scatter diagrams, linear regression, correlation vs. causation, lurking variables	1.2, 4.1, 4.2	201–202
4.3.15 A Tornado Model	Explanatory and response variables, scatter diagrams, correlation, least-square regression, interpret slope, coefficient of determination, residual plots, residual analysis	4.1, 4.2, 4.3	207–208
4.3.16 Exam Scores	Building a linear model	4.1, 4.2, 4.3	208
5.1.54 Drug Side Effects	Variables, graphical summaries of data, experiments, probability	1.1, 1.6, 2.1, 5.1	243
5.2.44 Speeding Tickets	Contingency tables, marginal distributions, empirical probabilities	4.4, 5.1	254
5.2.45 Red Light Cameras	Variables, relative frequency distributions, bar graphs, mean, standard deviation, probability, Simpson's Paradox	1.1, 2.1, 3.1, 3.2, 4.4, 5.1, 5.2	254–255
6.1.35 Sullivan Statistics Survey I	Mean, standard deviation, probability, probability distributions	3.1, 3.2, 5.1, 6.1	308
6.2.53 Beating the Stock Market	Expected value, binomial probabilities	6.1, 6.2	323
7.2.52 Birth Weights	Relative frequency distribution, histograms, mean and standard deviation from grouped data, normal probabilities	2.1, 2.2, 3.3, 7.2	350
8.1.33 Playing Roulette	Probability distributions, mean and standard deviation of a random variable, sampling distributions	6.1, 8.1	378–379
9.1.47 Hand Washing	Observational studies, bias, confidence intervals	1.2, 1.5, 9.1	405
9.2.49 Smoking Cessation Study	Experimental design, confidence intervals	1.6, 9.1, 9.2	419
10.2.38 Lupus	Observational studies, retrospective vs. prospective studies, bar graphs, confidence intervals, hypothesis testing	1.2, 2.1, 9.1, 10.2	449
10.2.39 Naughty or Nice?	Experimental design, determining null and alternative hypotheses, binomial probabilities, interpreting *P*-values	1.6, 6.2, 10.1, 10.2	449
11.1.36 Salk Vaccine	Completely randomized design, hypothesis testing	1.6, 11.1	480
11.2.18 Glide Testing	Matched pairs design, hypothesis testing	1.6, 11.2	490

(continued)

Putting It Together Exercises	Skills Utilized	Section(s) Covered	Page(s)
11.3.23 Online Homework	Completely randomized design, confounding, hypothesis testing	1.6, 11.3	501–502
12.1.27 The V-2 Rocket in London	Mean of discrete data, expected value, Poisson probability distribution, goodness-of-fit	6.1, 6.3, 12.1	526
12.1.28 Weldon's Dice	Addition Rule for Disjoint Events, classical probability, goodness-of-Fit	5.1, 5.2, 12.1	526
12.2.21 Women, Aspirin, and Heart Attacks	Population, sample, variables, observational study vs. designed experiment, experimental design, compare two proportions, chi-square test of homogeneity	1.1, 1.2, 1.6, 11.1, 12.2	541
12.4.17	Scatter diagrams; correlation; least-squares regression; hypothesis tests on the slope; confidence and prediction intervals	4.1, 4.2, 12.3, 12.4	561

Updated for this edition is the Student Activity Workbook. The Activity Workbook includes many tactile activities for the classroom. In addition, the workbook includes activities based on statistical applets. Below is a list of the applet activities.

Applet	Section	Activity Name
Mean versus Median	3.1	Understanding Measures of Center
Standard Deviation	3.2	Exploring Standard Deviation
Correlation by Eye	4.1	Exploring Properties of the Linear Correlation Coefficient
Regression by Eye	4.2	Minimizing the Sum of the Squared Residuals
Regression Influence	4.2	Understanding Influential Observations
Rolling a Single Die	5.1	Demonstrating the Law of Large Numbers
Binomial Distribution	6.2	Exploring a Binomial Distribution from Multiple Perspectives
Baseball Applet	6.2	Using Binomial Probabilities in Baseball
Sampling Distributions	8.1	Sampling from Normal and Non-normal Populations
Sampling Distributions Binary	8.2	Describing the Distribution of the Sample Proportion
Confidence Intervals for a Proportion	9.1	Exploring the Effects of Confidence Level, Sample Size, and Shape I
Confidence Intervals for a Mean	9.2	Exploring the Effects of Confidence Level, Sample Size, and Shape II
Political Poll Applet	10.2	The Logic of Hypothesis Testing
Hypothesis Tests for a Proportion	10.2	Understanding Type I Error Rates
Cola Applet	10.2	Testing Cola Preferences
Hypothesis Tests for a Mean	10.3	Understanding Type I Error Rates
Randomization Test Warts	11.1	Making an Inference about Two Proportions
Randomization Test Basketball	11.2	Predicting Basketball Game Outcomes
Randomization Test Sentence	11.2	Considering the Effects of Grammar
Randomization Test Kiss	11.2	Analyzing Kiss Data
Randomization Test Algebra	11.3	Using Randomization Test for Independent Means
Randomization Test Market	11.3	Comparing Bull and Bear Markets
Randomization Test Zillow	12.3	Using a Randomization Test for Correlation
Randomization Test Brain Size	12.3	Using a Randomization Test for Correlation

FUNDAMENTALS OF STATISTICS

INFORMED DECISIONS USING DATA 5e

Michael Sullivan, III
Joliet Junior College

Pearson

Director, Courseware Portfolio Management: Deirdre Lynch
Courseware Portfolio Manager: Patrick Barbera
Courseware Portfolio Management Assistant: Justin Billing
Managing Producer: Karen Wernholm
Content Producer: Tamela Ambush
Producer: Jean Choe
Manager, Content Development: Bob Carroll
Field Marketing Manager: Andrew Noble
Product Marketing Manager: Tiffany Bitzel
Marketing Assistant: Jennifer Myers
Senior Author Support/Technology Specialist: Joe Vetere
Manager, Rights and Permissions: Gina M. Cheselka
Manufacturing Buyer: Carol Melville, LSC Communications
Composition: Cenveo® Publisher Services/Nesbitt Graphics, Inc.
Associate Director of Design: Blair Brown
Cover Design: Tamara Newnam
Cover Image: Pogonici/Shutterstock

Library of Congress Cataloging-in-Publication Data

Names: Sullivan, Michael, III, 1967—
Title: Fundamentals of statistics : informed decisions using data / Michael Sullivan, III, Joliet Junior College.
Description: 5th edition. | Boston : Pearson, [2018] | Includes index.
Identifiers: LCCN 2016016749| ISBN 9780134508306 (pbk.) | ISBN 0134508300 (pbk.)
Subjects: LCSH: Statistics—Textbooks.
Classification: LCC QA276.12 .S846 2018 | DDC 519.5—dc23
LC record available at https://lccn.loc.gov/2016016749

Acknowledgements of third party content appear on page PC-1, which constitutes an extension of this copyright page.

1 16

Pearson

ISBN 10: 0-13-450830-0
ISBN 13: 978-0-13-450830-6

To My Wife Yolanda
and My Children
Michael, Kevin, and Marissa

This page intentionally left blank

Contents

Preface to the Instructor xi

Resources for Success xvi

Applications Index xxi

PART 1 **Getting the Information You Need** 1

1

Data Collection 2

1.1 Introduction to the Practice of Statistics 3
1.2 Observational Studies versus Designed Experiments 14
1.3 Simple Random Sampling 21
1.4 Other Effective Sampling Methods 28
1.5 Bias in Sampling 36
1.6 The Design of Experiments 42
Chapter 1 Review 52
Chapter Test 55
Making an Informed Decision: What College Should I Attend? 57
Case Study: Chrysalises for Cash (Online)

PART 2 **Descriptive Statistics** 59

2

Summarizing Data in Tables and Graphs 60

2.1 Organizing Qualitative Data 61
2.2 Organizing Quantitative Data 74
2.3 Graphical Misrepresentations of Data 94
Chapter 2 Review 103
Chapter Test 107
Making an Informed Decision: Tables or Graphs? 109
Case Study: The Day the Sky Roared (Online)

3

Numerically Summarizing Data 110

3.1 Measures of Central Tendency 111
3.2 Measures of Dispersion 124
3.3 Measures of Central Tendency and Dispersion from Grouped Data 140
3.4 Measures of Position and Outliers 147
3.5 The Five-Number Summary and Boxplots 157
Chapter 3 Review 165
Chapter Test 169
Making an Informed Decision: What Car Should I Buy? 171
Case Study: Who Was "A Mourner"? (Online)

Describing the Relation between Two Variables 172

4.1 Scatter Diagrams and Correlation 173
4.2 Least-Squares Regression 189
4.3 The Coefficient of Determination 203
4.4 Contingency Tables and Association 209
Chapter 4 Review 220
Chapter Test 225
Making an Informed Decision: Relationships among Variables on a World Scale 226
Case Study: Thomas Malthus, Population, and Subsistence (Online)

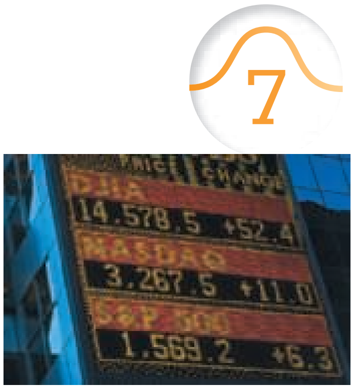
PART 3 Probability and Probability Distributions 227

Probability 228

5.1 Probability Rules 229
5.2 The Addition Rule and Complements 244
5.3 Independence and the Multiplication Rule 255
5.4 Conditional Probability and the General Multiplication Rule 261
5.5 Counting Techniques 271
5.6 Putting It Together: Which Method Do I Use? 284
Chapter 5 Review 289
Chapter Test 293
Making an Informed Decision: The Effects of Drinking and Driving 294
Case Study: The Case of the Body in the Bag (Online)

Discrete Probability Distributions 296

6.1 Discrete Random Variables 297
6.2 The Binomial Probability Distribution 308
Chapter 6 Review 323
Chapter Test 326
Making an Informed Decision: Should We Convict? 327
Case Study: The Voyage of the St. Andrew (Online)



The Normal Probability Distribution 328

7.1 Properties of the Normal Distribution 329
7.2 Applications of the Normal Distribution 339
7.3 Assessing Normality 350
7.4 The Normal Approximation to the Binomial Probability Distribution 355
Chapter 7 Review 360
Chapter Test 363
Making an Informed Decision: Stock Picking 364
Case Study: A Tale of Blood Chemistry (Online)

PART 4 Inference: From Samples to Population 365

8

Sampling Distributions 366

8.1 Distribution of the Sample Mean 367

8.2 Distribution of the Sample Proportion 380

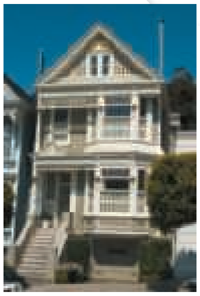
Chapter 8 Review 387

Chapter Test 389

Making an Informed Decision: How Much Time Do You Spend in a Day … ? 390

Case Study: Sampling Distribution of the Median (Online)

9



Estimating the Value of a Parameter 391

9.1 Estimating a Population Proportion 392

9.2 Estimating a Population Mean 406

9.3 Putting It Together: Which Procedure Do I Use? 420

Chapter 9 Review 423

Chapter Test 426

Making an Informed Decision: How Much Should I Spend for this House? 427

Case Study: Fire-Safe Cigarettes (Online)

10

Hypothesis Tests Regarding a Parameter 428

10.1 The Language of Hypothesis Testing 429

10.2 Hypothesis Tests for a Population Proportion 436

10.3 Hypothesis Tests for a Population Mean 450

10.4 Putting It Together: Which Method Do I Use? 460

Chapter 10 Review 463

Chapter Test 466

Making an Informed Decision: Selecting a Mutual Fund 467

Case Study: How Old Is Stonehenge? (Online)

11

Inferences on Two Samples 468

11.1 Inference about Two Population Proportions 469

11.2 Inference about Two Means: Dependent Samples 480

11.3 Inference about Two Means: Independent Samples 491

11.4 Putting It Together: Which Method Do I Use? 502

Chapter 11 Review 507

Chapter Test 510

Making an Informed Decision: Which Car Should I Buy? 512

Case Study: Control in the Design of an Experiment (Online)

12

Additional Inferential Techniques 513

12.1 Goodness-of-Fit Test 514

12.2 Tests for Independence and the Homogeneity of Proportions 527

12.3 Testing the Significance of the Least-Squares Regression Model 542

12.4 Confidence and Prediction Intervals 556

Chapter 12 Review 562

Chapter Test 566

Making an Informed Decision: Benefits of College 568

Case Study: Feeling Lucky? Well, Are You? (Online)

Appendix A Tables A-1

Appendix B Additional Topics at www.pearsonhighered.com/sullivanstats B-1

B.1 Lines B-1

B.2 Estimating a Population Standard Deviation B-6

B.3 Hypothesis Tests for a Population Standard Deviation B-12

B.4 Inference about Two Population Proportions: Dependent Samples B-17

B.5 Inference about Two Population Standard Deviations B-22

B.6 Comparing Three or more Means (One-Way Analysis of Variance) B-31

Answers ANS-1

Photo Credits PC-1

Index I-1

Preface to the Instructor

Capturing a Powerful and Exciting Discipline in a Textbook

Statistics is a powerful subject, and it is one of my passions. Bringing my passion for the subject together with my desire to create a text that would work for me, my students, and my school led me to write the first edition of this textbook. It continues to motivate me as I reflect on changes in students, in the statistics community, and in the world around us.

When I started writing, I used the manuscript of this text in class. My students provided valuable, insightful feedback, and I made adjustments based on their comments. In many respects, this text was written by students and for students. I also received constructive feedback from a wide range of statistics faculty, which has refined ideas in the book and in my teaching. I continue to receive valuable feedback from both faculty and students, and this text continues to evolve with the goal of providing clear, concise, and readable explanations, while challenging students to think statistically.

In writing this edition, I continue to make a special effort to abide by the Guidelines for Assessment and Instruction in Statistics Education (GAISE) for the college introductory course endorsed by the American Statistical Association (ASA). The GAISE Report, which has been updated in 2016, gives six recommendations for the course:

1. Emphasize statistical literacy and develop statistical thinking
2. Use real data in teaching statistics
3. Stress conceptual understanding
4. Foster active learning
5. Use technology for developing conceptual understanding
6. Use assessments to improve and evaluate student learning

Changes to this edition and the hallmark features of the text reflect a strong adherence to these important GAISE guidelines.

Putting It Together

When students are learning statistics, often they struggle with seeing the big picture of how it all fits together. One of my goals is to help students learn not just the important concepts and methods of statistics but also how to put them together.

At the front of the text, you'll see a pathway that provides a guide for students as they navigate through the process of learning statistics. The features and chapter organization in the fifth edition reinforce this important process.

New to This Edition

- **Over 350 New and Updated Exercises** The fifth edition makes a concerted effort to require students to write a few sentences that explain the results of their statistical analysis. To reflect this effort, the answers in the back of the text provide recommended explanations of the statistical results. In addition, exercises have been written to require students to understand pitfalls in faulty statistical analysis.
- **Over 100 New and Updated Examples** The examples continue to engage and provide clear, concise explanations for the students while following the Problem, Approach, Solution presentation. Problem lays out the scenario of the example, Approach provides insight into the thought process behind the methodology used to solve the problem, and Solution goes through the solution utilizing the methodology suggested in the approach.
- **Videos** The suite of videos available with this edition has been extensively updated. Featuring the author and George Woodbury, there are both instructional videos that develop statistical concepts and example videos. Most example videos have both by-hand solutions and technology solutions (where applicable). In addition, each Chapter Test problem has video solutions available.
- **Retain Your Knowledge** A new problem type. The Retain Your Knowledge problems occur periodically at the end of section exercises. These problems are meant to assist students in retaining skills learned earlier in the course so that the material is fresh for the final exam.
- **Big Data Problems** Data is ubiquitous today. The ability to collect data from a variety of sources has resulted in very large data sets. While analysis of data sets with tens of thousands of observations with thousands of variables is not practical at the introductory level, it is important for students to analyze data sets with more than fifty observations. These problems are marked with a icon and the data is available at www.pearsonhighered.com/sullivanstats.
- **Technology Help in MyStatLab** Problems in MyStatLab that may be analyzed using statistical packages now have an updated technology help feature. Marked with a icon, this features provides step-by-step instructions on how to obtain results using StatCrunch, TI-84 Plus/TI-84 Plus C, and Excel.
- **Instructor Resource Guide** The Instructor Resource Guide provides an overview of the chapter. It also details points to emphasize within each section and suggestions for presenting the material. In addition, the guide provides examples that may be used in the classroom.

Hallmark Features

- **Student Activity Workbook** The updated activity workbook contains many in-class activities that may be used to enhance your students' conceptual understanding of statistical concepts. The activities involve many tactile and applet-based simulations. Applets for the activities may be found at www.pearsonhighered.com/sullivanstats. In addition, the activity workbook includes many exercises that introduce **simulation** and **randomization methods** for statistical inference.

- Chapter 10 has simulation techniques that are powerful introductions to the logic of hypothesis testing. There are two activities that utilize simulation techniques. It also contains an activity on using Bootstrapping to test hypotheses for a single mean.
- Chapter 11 has randomization techniques for analyzing the difference of two proportions and the difference of two means. There are four activities for analyzing the difference of two proportions and two activities for analyzing the difference of two means.
- Chapter 12 has randomization techniques for analyzing the strength of association between two quantitative variables. There are two activities for a randomization test for correlation.

The workbook is accompanied by an instructor resource guide with suggestions for incorporating the activities into class.

- Because the use of **Real Data** piques student interest and helps show the relevance of statistics, great efforts have been made to extensively incorporate real data in the exercises and examples.
- **Putting It Together** sections appear in Chapters 5, 9, 10, and 11. The problems in these sections are meant to help students identify the correct approach to solving a problem. Many new exercises have been added to these sections that mix in inferential techniques from previous sections. Plus, there are new problems that require students to identify the inferential technique that may be used to answer the research objective (but no analysis is required). For example, see Problems 23 to 25 in Section 10.4.
- **Step-by-Step Annotated Examples** guide a student from problem to solution in three easy-to-follow steps.
- **"Now Work"** problems follow most examples so students can practice the concepts shown.
- Multiple types of **Exercises** are used at the end of sections and chapters to test varying skills with progressive levels of difficulty. These exercises include **Vocabulary and Skill Building**, **Applying the Concepts**, and **Explaining the Concepts**.
- **Chapter Review** sections include:
  - **Chapter Summary**.
  - A list of key chapter **Vocabulary**.
  - A list of **Formulas** used in the chapter.
  - **Chapter Objectives** listed with corresponding review exercises.
  - **Review Exercises** with all answers available in the back of the book.
  - **Chapter Test** with all answers available in the back of the book. In addition, the Chapter Test problems have **video solutions** available.

Integration of Technology

This book can be used with or without technology. Should you choose to integrate technology in the course, the following resources are available for your students:

- Technology Step-by-Step guides are included in applicable sections that show how to use Minitab®, Excel®, the TI-83/84, and StatCrunch to complete statistics processes.
- Any problem that has 12 or more observations in the data set has a icon indicating that data set is included on the companion website (http://www.pearsonhighered.com/sullivanstats) in various formats. Any problem that has a very large data set that is not printed in the text has a icon, which also indicates that the data set is included on the companion website. These data sets have many observations and often many variables.
- Where applicable, exercises and examples incorporate output screens from various software including Minitab, the TI-83/84 Plus C, Excel, and StatCrunch.
- Twenty new Applets are included on the companion website and connected with certain activities from the Student Activity Workbook, allowing students to manipulate data and interact with animations. See the front inside cover for a list of applets.
- Accompanying Technology Manuals are available that contain detailed tutorial instructions and worked out examples and exercises for the TI-83/84 and TI-89 and Excel.

Companion Website Contents

- Data Sets
- Twenty new Applets (See description on the insert in front of the text.)
- Formula Cards and Tables in PDF format
- Additional Topics Folder including:
  - Review of Lines
  - Estimating a Population Standard Deviation
  - Hypothesis Tests for a Population Standard Deviation
  - Inference about Two Population Proportions: Dependent Samples
  - Inference about Two Population Standard Deviations
  - Comparing Three or More Means (One-Way Analysis of Variance)
- A copy of the questions asked on the Sullivan Statistics Survey I and Survey II
- Consumer Reports projects that were formerly in the text
- Case Studies for each chapter

Key Chapter Content Changes

Chapter 1 Data Collection

The chapter now includes an expanded discussion of confounding, including a distinction between lurking variables and confounding variables.

Chapter 4 Describing the Relation between Two Variables

The conditional bar graphs in Section 4.4 have been drawn so that each category of the explanatory variable is grouped. This allows the student to see the complete distribution of each category of the explanatory variable. In addition, the material now includes stacked (or segmented) conditional bar graphs.

Chapter 6 Discrete Probability Distributions

The graphical representation of discrete probability distributions no longer is presented as a probability histogram. Instead, the graph of a discrete probability distribution is presented to emphasize that the data is discrete. Therefore, the graph of discrete probability distributions is drawn using vertical lines above each value of the random variable to a height that is the probability of the random variable.

Chapter 7 The Normal Probability Distribution

The assessment of normality of a random variable using normal probability plots has changed. We no longer rely on normal probability plots drawn using Minitab. Instead, we utilize the correlation between the observed data and normal scores. This approach is based upon the research of S. W. Looney and T. R. Gulledge in their paper, "Use of the Correlation Coefficient with Normal Probability Plots," published in the *American Statistician*. This material may be skipped without loss of continuity (especially for those who postponed the material in Chapter 4). Some problems from Chapter 9 through 13 may need to be skipped or edited, however.

Chapter 9 Estimating the Value of a Parameter

The Putting It Together section went through an extensive renovation of the exercises. Emphasis is placed on identifying the variable of interest in the study (in particular, whether the variable is qualitative or quantitative). In addition, there are problems that simply require the student to identify the type of interval that could be constructed to address the research concerns.

Chapter 10 Hypothesis Testing Regarding a Parameter

The Putting It Together section went through an extensive revision. Again, emphasis is placed on identifying the variable of interest in the study. The exercises include a mix of hypothesis tests and confidence intervals. Plus, there are problems that require the student to identify the type of inference that could be constructed to address the research.

Chapter 11 Inference on Two Samples

The material on inference for two dependent population proportions is now covered in Section B.4 utilizing the chi-square distribution. As in Chapter 9 and Chapter 10, the Putting It Together section's exercises were revised extensively. There is a healthy mix of two-sample and single-sample analysis (both hypothesis tests and confidence intervals). This will help students to develop the ability to determine the type of analysis required for a given research objective.

Chapter 12 Comparing Three or More Means

In Section 12.2, we now emphasize how to distinguish between the chi-square test for independence and the chi-square test for homogeneity of proportions.

Flexible to Work with Your Syllabus

To meet the varied needs of diverse syllabi, this book has been organized to be flexible.

You will notice the "Preparing for This Section" material at the beginning of each section, which will tip you off to dependencies within the course. The two most common variations within an introductory statistics course are the treatment of regression analysis and the treatment of probability.

- **Coverage of Correlation and Regression** The text was written with the descriptive portion of bivariate data (Chapter 4) presented after the descriptive portion of univariate data (Chapter 3). Instructors who prefer to postpone the discussion of bivariate data can skip Chapter 4 and return to it before covering Section 12.3.
- **Coverage of Probability** The text allows for light to extensive coverage of probability. Instructors wishing to minimize probability may cover Section 5.1 and skip the remaining sections. A mid-level treatment of probability can be accomplished by covering Sections 5.1 through 5.3. Instructors who will cover the chi-square test for independence will want to cover Sections 5.1 through 5.3. In addition, an instructor who will cover binomial probabilities will want to cover independence in Section 5.3 and combinations in Section 5.5.

Acknowledgments

Textbooks evolve into their final form through the efforts and contributions of many people. First and foremost, I would like to thank my family, whose dedication to this project was just as much theirs as mine: my wife, Yolanda, whose words of encouragement and support were unabashed, and my children, Michael, Kevin, and Marissa, who have been supportive throughout their childhood and now into adulthood (my how time flies). I owe each of them my sincerest gratitude. I would also like to thank the entire Mathematics Department at Joliet Junior College and my colleagues who provided support, ideas, and encouragement to help me complete this project. From Pearson Education: I thank Patrick Barbera, whose editorial expertise has been an invaluable asset; Deirdre Lynch, who has provided many suggestions that clearly demonstrate her expertise; Tamela Ambush, who provided organizational skills that made this project go smoothly; Tiffany Bitzel and Andrew Noble, for their marketing savvy and dedication to getting the word out; Vicki Dreyfus, for her dedication in organizing all the media; Rose Kernan, for her ability to control the production process; Dana Bettez for her editorial skill with the Instructor's Resource Guide; and the Pearson sales team, for their confidence and support of this book.

I also want to thank Ryan Cromar, Susan Herring, Craig Johnson, Kathleen McLaughlin, Alana Tuckey, and Dorothy Wakefield for their help in creating supplements. A big thank-you goes to Brad Davis and Jared Burch, who assisted in verifying answers for the back of the text and helped in proofreading. I would also like to acknowledge Kathleen Almy and Heather Foes for their help and expertise in developing the Student Activity Workbook. Finally, I would like to thank George Woodbury for helping me with the incredible suite of videos that accompanies the text. Many thanks to all the reviewers, whose insights and ideas form the backbone of this text. I apologize for any omissions.

CALIFORNIA *Charles Biles, Humboldt State University • Carol Curtis, Fresno City College • Jacqueline Faris, Modesto Junior College • Freida Ganter, California State University–Fresno • Sherry Lohse, Napa Valley College • Craig Nance, Santiago Canyon College • Diane Van Deusen, Napa Valley College* **COLORADO** *Roxanne Byrne, University of Colorado–Denver* **CONNECTICUT** *Kathleen McLaughlin, Manchester Community College • Dorothy Wakefield, University of Connecticut • Cathleen M. Zucco Teveloff, Trinity College* **DISTRICT OF COLUMBIA** *Monica Jackson, American University • Jill McGowan, Howard University* **FLORIDA** *Randall Allbritton, Daytona Beach Community College • Greg Bloxom, Pensacola State College • Anthony DePass, St. Petersburgh College Clearwater • Kelcey Ellis, University of Central Florida • Franco Fedele, University of West Florida • Laura Heath, Palm Beach Community College • Perrian Herring, Okaloosa Walton College • Marilyn Hixson, Brevard Community College • Daniel Inghram, University of Central Florida • Philip Pina, Florida Atlantic University • Mike Rosenthal, Florida International University • James Smart, Tallahassee Community College* **GEORGIA** *Virginia Parks, Georgia Perimeter College • Chandler Pike, University of Georgia • Jill Smith, University of Georgia • John Weber, Georgia Perimeter College* **HAWAII** *Eric Matsuoka at Leeward Community College* **IDAHO** *K. Shane Goodwin, Brigham Young University • Craig Johnson, Brigham Young University • Brent Timothy, Brigham Young University • Kirk Trigsted, University of Idaho* **ILLINOIS** *Grant Alexander, Joliet Junior College • Kathleen Almy, Rock Valley College • John Bialas, Joliet Junior College • Linda Blanco, Joliet Junior College • Kevin Bodden, Lewis & Clark Community College • Rebecca Bonk, Joliet Junior College • Joanne Brunner, Joliet Junior College • James Butterbach, Joliet Junior College • Robert Capetta, College of DuPage • Elena Catoiu, Joliet Junior College • Faye Dang, Joliet Junior College • Laura Egner, Joliet Junior College • Jason Eltrevoog, Joliet Junior College • Erica Egizio, Lewis University • Heather Foes, Rock Valley College • Randy Gallaher, Lewis & Clark Community College • Melissa Gaddini, Robert Morris University • Iraj Kalantari, Western Illinois University • Donna Katula, Joliet Junior College • Diane Long, College of DuPage • Heidi Lyne, Joliet Junior College • Jean McArthur, Joliet Junior College • Patricia McCarthy, Robert Morris University • David McGuire, Joliet Junior College • Angela McNulty, Joliet Junior College • Andrew Neath, Southern Illinois University-Edwardsville • Linda Padilla, Joliet Junior College • David Ruffato, Joliet Junior College • Patrick Stevens, Joliet Junior College • Robert Tuskey, Joliet Junior College • Stephen Zuro, Joliet Junior College* **INDIANA** *Susitha Karunaratne, Purdue University North Central • Jason Parcon, Indiana University–Purdue University Ft. Wayne • Henry Wakhungu, Indiana University* **KANSAS** *Donna Gorton, Butler Community College • Ingrid Peterson, University of Kansas* **LOUISIANA** *Melissa Myers, University of Louisiana at Lafayette* **MARYLAND** *Nancy Chell, Anne Arundel Community College • John Climent, Cecil Community College • Rita Kolb, The Community College of Baltimore County • Jignasa Rami, Community College of Baltimore County • Mary Lou Townsend, Wor-Wic Community College* **MASSACHUSETTS** *Susan McCourt, Bristol Community College • Daniel Weiner, Boston University • Pradipta Seal, Boston University of Public Health* **MICHIGAN** *Margaret M. Balachowski, Michigan Technological University • Diane Krasnewich, Muskegon Community College • Susan Lenker, Central Michigan University • Timothy D. Stebbins, Kalamazoo Valley Community College • Sharon Stokero, Michigan Technological University • Alana Tuckey, Jackson Community College* **MINNESOTA** *Mezbhur Rahman, Minnesota State University* **MISSOURI** *Farroll Tim Wright, University of Missouri–Columbia* **NEBRASKA** *Jane Keller, Metropolitan Community College* **NEW YORK** *Jacob Amidon, Finger Lakes Community College •*

Stella Aminova, Hunter College • Jennifer Bergamo, Onondaga Community College • Kathleen Cantone, Onondaga Community College • Pinyuen Chen, Syracuse University • Sandra Clarkson, Hunter College of CUNY • Rebecca Daggar, Rochester Institute of Technology • Bryan Ingham, Finger Lakes Community College • Anne M. Jowsey, Niagara County Community College • Maryann E. Justinger, Erie Community College–South Campus • Bernadette Lanciaux, Rochester Institute of Technology • Kathleen Miranda, SUNY at Old Westbury • Robert Sackett, Erie Community College–North Campus • Sean Simpson, Westchester Community College • Bill Williams, Hunter College of CUNY **NORTH CAROLINA** *Fusan Akman, Coastal Carolina Community College • Mohammad Kazemi, University of North Carolina–Charlotte • Janet Mays, Elon University • Marilyn McCollum, North Carolina State University • Claudia McKenzie, Central Piedmont Community College • Said E. Said, East Carolina University • Karen Spike, University of North Carolina–Wilmington • Jeanette Szwec, Cape Fear Community College* **NORTH DAKOTA** *Myron Berg, Dickinson State University • Ronald Degges, North Dakota State University* **OHIO** *Richard Einsporn, The University of Akron • Michael McCraith, Cuyaghoga Community College* **OREGON** *Daniel Kim, Southern Oregon University • Jong Sung Kin, Portland State University* **SOUTH CAROLINA** *Diana Asmus, Greenville Technical College • Dr. William P. Fox, Francis Marion University • Cheryl Hawkins, Greenville Technical College • Rose Jenkins, Midlands Technical College • Lindsay Packer, College of Charleston • Laura Shick, Clemson University* **TENNESSEE** *Tim Britt, Jackson State Community College • Nancy Pevey, Pellissippi State Technical Community College • David Ray, University of Tennessee–Martin* **TEXAS** *Edith Aguirre, El Paso Community College • Ivette Chuca, El Paso Community College • Aaron Gutknecht, Tarrant County College • Jada Hill, Richland College • David Lane, Rice University • Alma F. Lopez, South Plains College • Shanna Moody, University of Texas at Arlington* **UTAH** *Joe Gallegos, Salt Lake City Community College • Alia Maw, Salt Lake City Community College* **VIRGINIA** *Kim Jones, Virginia Commonwealth University • Vasanth Solomon, Old Dominion University* **WEST VIRGINIA** *Mike Mays, West Virginia University* **WISCONSIN** *William Applebaugh, University of Wisconsin–Eau Claire • Carolyn Chapel, Western Wisconsin Technical College • Beverly Dretzke, University of Wisconsin–Eau Claire • Jolene Hartwick, Western Wisconsin Technical College • Thomas Pomykalski, Madison Area Technical College • Walter Reid, University of Wisconsin-Eau Claire*

Michael Sullivan, III
Joliet Junior College

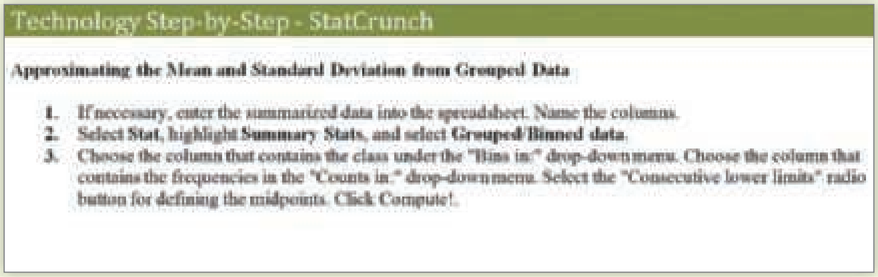
Resources for Success

MyStatLab® Online Course for *Fundamentals of Statistics: Informed Decisions Using Data 5e* by Michael Sullivan, III **(access code required)**

MyStatLab is available to accompany Pearson's market leading text offerings. To give students a consistent tone, voice, and teaching method each text's flavor and approach is tightly integrated throughout the accompanying MyStatLab course, making learning the material as seamless as possible.

New! Technology Support Videos

In these videos, the author demonstrates the easy-to-follow steps needed to solve a problem in several different formats—by-hand, TI-84 Plus C, and StatCrunch.



Technology Step-by-Step - StatCrunch

Approximating the Mean and Standard Deviation from Grouped Data

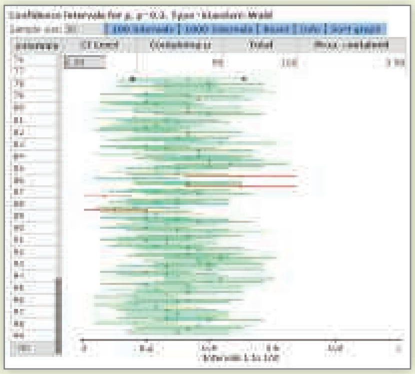
1. If necessary, enter the summarized data into the spreadsheet. Name the columns.
2. Select **Stat**, highlight **Summary Stats**, and select **Grouped/Binned data**.
3. Choose the column that contains the class under the "Bins in:" drop-down menu. Choose the column that contains the frequencies in the "Counts in:" drop-down menu. Select the "Consecutive lower limits" radio button for defining the midpoints. Click Compute!.

Technology Step-by-Step

Technology Step-by-Step guides show how to use StatCrunch®, Excel®, and the TI-84 graphing calculators to complete statistics processes.

Interactive Applets

Applets are a powerful tool for developing statistical concepts and enhancing understanding. There are twenty new applets that accompany the text and many activities in the Student Activity Workbook that utilize these applets.



www.mystatlab.com

Resources for Success

MyStatLab® Online Course

(access code required)

MyStatLab from Pearson is the world's leading online resource for teaching and learning statistics; integrating interactive homework, assessment, and media in a flexible, easy-to-use format. MyStatLab is a course management system that helps individual students succeed.

- The author analyzed aggregated student usage and performance data from MySTatLab for the previous edition of this text. The results of this analysis helped improve the quality and quantity of exercises that matter the most to instructors and students.
- MyStatLab can be implemented successfully in any environment—lab-based, traditional, fully online, or hybrid—and demonstrates the quantifiable difference that integrated usage has on student retention, subsequent success, and overall achievement.
- MyStatLab's comprehensive gradebook automatically tracks students' results on tests, quizzes, homework, and in the study plan. Instructors can use the gradebook to provide positive feedback or intervene if students have trouble. Gradebook data can be easily exported to a variety of spreadsheet programs, such as Microsoft Excel.

MyStatLab provides **engaging experiences** that personalize, stimulate, and measure learning for each student. In addition to the resources below, each course includes a full interactive online version of the accompanying textbook.

- **Personalized Learning:** MyStatLab's personalized homework, and adaptive and companion study plan features allow your students to work more efficiently spending time where they really need to.
- **Tutorial Exercises with Multimedia Learning Aids:** The homework and practice exercises in MyStatLab align with the exercises in the textbook, and most regenerate algorithmically to give students unlimited opportunity for practice and mastery. Exercises offer immediate helpful feedback, guided solutions, sample problems, animations, videos, statistical software tutorial videos and eText clips for extra help at point-of-use.
- **Learning Catalytics™:** MyStatLab now provides Learning Catalytics—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.
- **Videos** tie statistics to the real world.
  - **StatTalk Videos:** Fun-loving statistician Andrew Vickers takes to the streets of Brooklyn, NY, to demonstrate important statistical concepts through interesting stories and real-life events. This series of 24 fun and engaging videos will help students actually understand statistical concepts. Available with an instructor's user guide and assessment questions.
- **Additional Question Libraries:** In addition to algorithmically regenerated questions that are aligned with your textbook, MyStatLab courses come with two additional question libraries:
  - **450 exercises in Getting Ready for Statistics** cover the developmental math topics students need for the course. These can be assigned as a prerequisite to other assignments, if desired.
  - **1000 exercises** in the **Conceptual Question Library** require students to apply their statistical understanding.
- **StatCrunch™:** MyStatLab integrates the web-based statistical software, StatCrunch, within the online assessment platform so that students can easily analyze data sets from exercises and the text. In addition, MyStatLab includes access to www.statcrunch.com, a vibrant online community where users can access tens of thousands of shared data sets, create and conduct online surveys, perform complex analyses using the powerful statistical software, and generate compelling reports.
- **Statistical Software, Support and Integration:** We make it easy to copy our data sets, from both the eText and the MyStatLab questions, into software such as StatCrunch, Minitab®, Excel®, and more. Students have access to a variety of support tools—Technology Tutorial Videos, Technology Study Cards, and Technology Manuals for select titles—to learn how to effectively use statistical software.

MyStatLab Accessibility:

- MyStatLab is compatible with the JAWS screen reader, and enables multiple-choice, fill-in-the-blank and free-response problem-types to be read, and interacted with via keyboard controls and math notation input. MyStatLab also works with screen enlargers, including ZoomText, MAGic®, and SuperNova. And all MyStatLab videos accompanying texts with copyright 2009 and later have closed captioning.
- More information on this functionality is available at http://mystatlab.com/accessibility.

And, MyStatLab comes from an **experienced partner** with educational expertise and an eye on the future.

- Knowing that you are using a Pearson product means knowing that you are using quality content. That means that our eTexts are accurate and our assessment tools work. It means we are committed to making MyStatLab as accessible as possible.

- Whether you are just getting started with MyStatLab, or have a question along the way, we're here to help you learn about our technologies and how to incorporate them into your course.

To learn more about how MyStatLab combines proven learning applications with powerful assessment, visit **www.mystatlab.com** or contact your Pearson representative.

MathXL® for Statistics Online Course

(access code required)

MathXL® is the homework and assessment engine that runs MyStatLab. (MyStatLab is MathXL plus a learning management system.)

With MathXL for Statistics, instructors can:

- Create, edit, and assign online homework and tests using algorithmically generated exercises correlated at the objective level to the textbook.
- Create and assign their own online exercises and import TestGen® tests for added flexibility.
- Maintain records of all student work, tracked in MathXL's online gradebook.

With MathXL for Statistics, students can:

- Take chapter tests in MathXL and receive personalized study plans and/or personalized homework assignments based on their test results.
- Use the study plan and/or the homework to link directly to tutorial exercises for the objectives they need to study.
- Students can also access supplemental animations and video clips directly from selected exercises.
- Knowing that students often use external statistical software, we make it easy to copy our data sets, both from the eText and the MyStatLab questions, into software like StatCrunch™, Minitab, Excel and more.

MathXL for Statistics is available to qualified adopters. For more information, visit our website at www.mathxl.com, or contact your Pearson representative.

StatCrunch™

StatCrunch is 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 thousand 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. Also, 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.

Full access to StatCrunch is available with a MyStatLab kit, and StatCrunch is available by itself to qualified adopters. StatCrunch Mobile is also now available; just visit www.statcrunch.com from the browser on your smart phone or tablet. For more information, visit our website at www.statcrunch.com, or contact your Pearson representative.

TestGen®

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. TestGen is algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions. The software and testbank are available for download from Pearson's Instructor Resource Center.

Learning Catalytics™

Foster student engagement and peer-to-peer learning

Generate class discussion, guide your lecture, and promote peer-to-peer learning with real-time analytics. MyMathLab and MyStatLab now provide Learning Catalytics—an interactive student response tool that uses students' smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking.

Instructors, you can:

- Pose a variety of open-ended questions that help your students develop critical thinking skills
- Monitor responses to find out where students are struggling
- Use real-time data to adjust your instructional strategy and try other ways of engaging your students during class
- Manage student interactions by automatically grouping students for discussion, teamwork, and peer-to-peer learning

Resources for Success

Instructor Resources

Annotated Instructor's Edition

(ISBN-10: 0-13-450992-7; ISBN 13: 978-0-13-450992-1)
Margin notes include helpful teaching tips, suggest alternative presentations, and point out common student errors. Exercise answers are included in the exercise sets when space allows. The complete answer section is located in the back of the text.

Instructor's Resource Center

All instructor resources can be downloaded from www.pearsonhighered.com/irc. This is a password-protected site that requires instructors to set up an account or, alternatively, instructor resources can be ordered from your Pearson Higher Education sales representative.

Instructor's Solutions Manual (Download only)

by GEX Publishing Services.
Fully worked solutions to every textbook exercise, including the chapter review and chapter tests. Case Study Answers are also provided. Available from the Instructor's Resource Center and MyStatLab.

Online Test Bank

A test bank derived from TestGen is available on the Instructor's Resource Center. There is also a link to the TestGen website within the Instructor Resource area of MyStatLab.

PowerPoint® Lecture Slides

Free to qualified adopters, this classroom lecture presentation software is geared specifically to the sequence and philosophy of *Statistics: Informed Decisions Using Data.* Key graphics from the book are included to help bring the statistical concepts alive in the classroom. Slides are available for download from the Instructor's Resource Center and MyStatLab.

New! Instructor's Guide for Student Activity Workbook (Download only)

by Heather Foes and Kathleen Almy, *Rock Valley College* and Michael Sullivan, III, *Joliet Junior College*. Accompanies the activity workbook with suggestions for incorporating the activities into class. The Guide is available from the Instructor's Resource Center and MyStatLab.

New! Instructor's Resource Guide
(Download only)

by Michael Sullivan, III, *Joliet Junior College*.
This guide presents an overview of each chapter along with details about concepts that should be emphasized for each section. The resource guide also provides additional examples (complete with solutions) for each section that may be used for classroom presentations. This Guide is available from the Instructor's Resource Center and MyStataLab.

Student Resources

New! Author in the Classroom Videos

by Michael Sullivan, III, *Joliet Junior College and George Woodbury, College of the Sequoias*
The suite of videos available with this edition has been extensively updated. Featuring the author and George Woodbury, there are both instructional videos that develop statistical concepts and example videos. Most example videos have both by-hand solutions and technology solutions (where applicable). In addition, each Chapter Test problem has video solutions available.

Student's Solutions Manual

by GEX Publishing Services
(ISBN 10: 0-13-450997-8 ; ISBN 12: 978-0-13-450997-6)
Fully worked solutions to odd-numbered exercises with all solutions to the chapter reviews and chapter tests.

Technology Manuals

The following technology manuals contain detailed tutorial instructions and worked-out examples and exercises. Available on the Pearson site: www.pearsonhighered.com/mathstatsresources

- **Excel Manual (including XLSTAT)** by Alana Tuckey, *Jackson Community College*
- **Graphing Calculator Manual for the TI-83/84 Plus and TI-89** by Kathleen McLaughlin and Dorothy Wakefield

New! Student Activity Workbook

by Heather Foes and Kathleen Almy, ***Rock Valley College***, and Michael Sullivan, III, ***Joliet Junior College***
(ISBN 13: 978-0-13-411610-5; ISBN 10: 0-13-411610-0) Includes classroom and applet activities that allow students to experience statistics firsthand in an active learning environment. Also introduces resampling methods that help develop conceptual understanding of hypothesis testing.

This page intentionally left blank

Applications Index

Accounting
client satisfaction, 23–24

Aeronautics
moonwalkers, 11
O-ring failures on Columbia, 117
Spacelab, 493–495

Agriculture
optimal level of fertilizer, 45–46
orchard damage, 55–56
yield
  of orchard, 35
  soybean, 136

Airline travel. ***See*** **Travel**

Animals/Nature
American black bears, weight and length of, 184–185, 187, 207, 554, 561
cricket chirps and temperature, 225, 567
shark attacks, 93–94, 222

Anthropometrics
height and age in males, 155, 567
upper leg length of 20- to 29-year-old males, 376–377
waist circumference of males, 363

Appliances
refrigerator life span, 337

Astronomy
life on Mars, 294

Banking
ATM withdrawals, 378, 457
credit-card debt, 404, 464
credit cards, 385–386, 462
savings, retirement, 403

Biology
alcohol effects, 50, 54
blood types, 240
cholesterol level, 36
DNA sequences, 282, 294
HDL cholesterol, 417–418, 555
hemoglobin, in cats, 156
plastic resin effect on organ weight, 457–458
reaction time, 50, 54, 488, 500
testosterone levels, 463

Biomechanics
grip strength, 567

Business. ***See also*** **Work**
acceptance sampling, 269, 283, 386
advertising
  campaign, 35
  effective commercial, 104
  humor in, 55
airline customer opinion, 34
ball bearing manufacturing, 349
bolts production, 54, 137–138
buying new cars, 138–139, 526
car rentals, 489
car sales, 87
CEO performance, 185, 200, 554–555, 561
coffee sales, 293
customer satisfaction, 30
customer service, 354
defective products, 270–271, 294
Disney World statistics conference, 242
employee morale, 35
entrepreneurship, 389
fast-food restaurant, 74–75, 83
new store opening decision, 40
oil change time, 377
packaging error, 269–270, 283, 292
quality control, 34, 35, 154–155, 260, 462
shopping habits of customers, 40
Speedy Lube, 350
stocks on the NASDAQ, 282
stocks on the NYSE, 282
target demographic information gathering, 36
traveling salesperson, 282
unemployment and inflation, 88
union membership, 101
waiting in line, 306, 336, 458, 460, 488
worker injury, 102
worker morale, 28
Yelp ratings for restaurant, 107

Chemistry
calcium in rainwater, 458–459
pH in rain, 416, 510–511
pH in water, 120, 135
reaction time, 336, 488, 500

Combinatorics
arranging flags, 292
clothing option, 282
combination locks, 282
committee, 269
committee formation, 282, 294
committee selection, 283
license plate numbers, 282, 292
seating arrangements, 288
starting lineups, 288

Communication(s)
caller ID, 41
cell phone, 55
  brain tumors and, 15
  conversations, 478–479
  crime rate and, 187
  exclusive use of, 467
  in the John, 404
  rates and, 337
  servicing, 435
  time spent on, 115, 363
do-not-call registry, 41
e-mail, 425
high-speed Internet service, 53, 404
length of phone calls, 336
newspaper article analysis, 223–224
social media, 254, 269, 415
teen, 270
text messaging
  while driving, 462
  number of texts, 71

Computer(s). ***See also*** **Internet**
download time, 35
DSL Internet connection speed, 35
e-mail, 425
fingerprint identification, 261
passwords, 283, 294
toner cartridges, 170
user names, 282

Construction
concrete, 207
concrete mix, 119, 135
housing starts, 416–417
new road, 107

Consumers
Coke or Pepsi preferences, 51
name brand preference, gender differences in, 479
taste test, 19

Crime(s)
aggravated assault, 422
burglaries, 95
fingerprints, 261
identity theft, 69
larceny theft, 241–242
rate of cell phones, 187
robberies, 101
speeding, 36
violent, 90–91, 92, 155, 225–226
weapon of choice, 251–252
weapons used in murder/homicide, 104

Criminology
fraud detection, 156, 157

Demographics
age married, 417
births, live, 104, 306–307
childless women between 40-44 years of age, 386
family size, 102–103
households speaking foreign language as primary language, 40
life expectancy, 9, 187, 260
living alone, 447, 526
marital status and happiness, 219
number of live births, 50- to 54-year-old mothers, 306–307
population
  age of, 146–147
  residential, shift in, 525
  of selected countries, 9
southpaws, 259

Drugs. ***See also*** **Pharmaceuticals**
AndroGel, 403
Aspirin, 541
Celebrex, 540
marijuana use, 288
Nexium, 447
Viagra, 243
Zoloft, 511

Economy
abolishing the penny, 404
health care expenditures, 102
poverty, 69
unemployment and inflation, 88
unemployment rates, 223

Education. ***See also*** **Test(s)**
advanced degrees, 389
bachelor's degree, elapsed time to earn, 498–499
birthrate and, 183
board work, 269
bullies, 11
calculus exam score, 11
class attendance, 200
  seating and, 524
college
  campus safety, 29
  complete rate, 435, 480
  course redesign, 479
  drug use among students, 11
  enrollment to, 93
  exam skills, 502
  graduating from, 426
  literature selection, 26–27
  self-study courses, 466
  student retention, 465
  survey, 70, 241
  textbook packages required, 40
course average, 146
course selection, 27
day care, 3-year-old, 240
developmental math, 48
distribution of educational attainment, 566
dropping course, 541
exam grades/scores, 112–113, 114, 117, 120, 122, 125, 135, 163, 208, 255
  study time, 198
exam time, 119, 135
faculty opinion poll, 27
GPA, 106, 146, 168
  vs. seating choice, 564–565
grade distribution, 525
grade inflation, 106
graduation rates, 107, 188, 201, 502
health and, 539
illicit drug use among students, 11, 40
income and, 198
invest in, 554, 561
journal costs, 121
level of, feelings on abortion, 218
marriage and, 288
mathematics
  studying college, 465
  teaching, 447
  TIMMS exam, 184
  TIMS report and Kumon, 504
music's impact on learning, 46–47
online homework, 73, 155, 501–502
premature birth and, 564
professors
  choosing, 138
  online rating of, 188
quality of, 447
school
  admissions, 154
  confidence, 480
  dropouts, 268
  e-cigs usage, 435, 540
  enrollment, 88
  illegal drug use in, 11
  multitasking, 505
  National Honor Society, 288
  seat selection in classroom, 292
  student loans, 354, 462, 463
self-injurious behaviors, 326
sleep disorders and academic performance, 511
smoking and, 511
speed reading, 163
student opinion poll/survey, 27, 28, 36
student services fees, 36
study time, 363, 459
teaching reading, 48
time spent on homework, 108
visual *vs.* textual learners, 500
working students, 11

Electricity
charge life of battery, 389
Christmas lights, 259
light bulbs, 283, 348–349

Electronics
televisions in the household, 89

Employment. ***See*** **Work**

Energy
carbon dioxide emissions and energy production, 198
consumption, 458
gas price, 102, 138
oil reserves, 101–102
during pregnancy, 388

Engineering
batteries and temperature, 51
bearing failures, 170
bolts production, 54
charge life of battery, 389
concrete strength, 553, 560
driving under the influence (DUI) simulator, 489
filling machines, 389, 459
glide testing, 490
hardness testing, 489
linear rotary bearing, 465
O-ring thickness, 354
prolong engine treatment, 436
ramp metering, 500
tire design, 51
triple modular redundancy, 260
valve pressure, 435

Entertainment. ***See also*** **Leisure and recreation**
Academy Award winners, 92, 378
Demon Roller Coaster, 355
movie ratings, 53
Mythbusters, 502
neighborhood party, 269
People Meter measurement, 33
raffle, 13
student survey, 156–157
television
  in bedroom, obesity and, 19
  hours of watching, 355, 418
  luxury or necessity, 403
  number of, 388–389
  watching, 378
theme park spending, 422
tickets to concert, 22

Environment
carbon monoxide levels, 426–427
CO_2 emissions, 156
pH in rain, 416
Secchi disk, 426, 488

Exercise
caffeine-enhanced workout, 487
routines, 289
sustained physical activity, 480

Family
gender income inequality, 448
ideal number of children, 105, 294, 306, 425, 462
imprisoned members of, 426
infidelity among married men, 447
smarter kids, 461
spanking, 322
structure, 539
values, 403

Farming. ***See also*** **Agriculture**
incubation times for hen eggs, 336, 348, 349

Fashion
women's preference for shoes, 106

Finance. ***See also*** **Investment(s)**
ATM withdrawals, 378, 457
car prices, 167
cash/credit, 504
cigarette tax rates, 90, 146
cost of kids, 102
course redesign, 461
credit-card debt, 404, 464
credit cards, 385–386, 462
credit risk, 541
credit scores, 207, 541, 552–553, 560
dealer's profit, 122
deficit reduction, 404, 479
derivatives, 260
dividend yield, 90, 146
educational attainment, 64–65, 66–67, 99–100
  earnings and, 71, 106
estate tax returns, 422
federal debt, 93
FICO credit score, 184, 198–199, 458, 552–553
Gini index, 90
health care expenditures, 102
income
  adjusted gross income, 106
  age *vs.*, 187–188
  average, 90
  distribution, 106, 170
  household, 31–32, 40
  median, 90, 101, 170, 183
  per capita, birth rate and, 108
  by region, 268
  student survey, 156
IRS audits, 261
net worth, 123, 389
retirement savings, 403, 436
stock analysis, 446
stock market, 185–186, 200, 379–380, 555, 561
stock price, random walk in, 404
taxing, 326, 416
tax rates, 96, 417, 501

tax revenue, 101
Twitter stock, 93

Firearms
muzzle velocity, 167, 422, 487
weapon of choice, 251–252

Food. ***See also*** **Nutrition**
accuracy of drive thru orders, 447
allergies, 389
cauliflowers, 405
cheeseburgers, fat and calories, 221–222
chewing and consumption amount, 47–48
chocolates, 146
consumption of popcorn, 435
cookies
  Chips Ahoy, 355
  chocolate chip, 164, 348, 349
  diameter of, 105
  Girl Scout, 293–294
decision making and hunger, 165
dining out, 70–71
fast-food restaurants, 348, 349, 378
green tea, 50
insect fragments, 378
McDonald, 91
M&M, 121, 136, 163, 239–240, 523
number of drinks, 419
nut mix, 146
peanuts, 523
pizza, 435
priming for, 50–51
quality control, 435
soda preferences, 448
sugary beverages, 499
Tootsie Pops, 416

Gambling. ***See also*** **Game(s)**
betting on sports, 282
lotteries, 259, 282
  Cash Five Lottery, 294, 307
  instant winner, 288
  PICK 3, 292
  PICK 4, 292
  Powerball, 307
  state, 293
roulette, 241, 253, 291, 307, 378–379, 563

Game(s). ***See also*** **Gambling**
BlackJack, 307
card drawing, 268, 283, 292
coin toss, 240, 259
Dictator Game, 51
die/dice, 526
  fair, 566
  loaded, 243, 525
  rolling, 87, 240, 242, 259
five-card stud, 292–293
Jumble, 294
Lingo, 289
Little Lotto, 283
Mega Millions, 283
poker
  flush, 270
  royal flush, 270
  seven-card stud, 240
  three-card, 325
  winning, 377
Text Twist, 288
Trivial Pursuit, 499–500

Gardening
planting tulips, 240, 270

Gender
behavior at work, 506
flexibility and, 501
lupus and, 449
step pulses and, 501
wage gap, 506
weight gain and, 261

Genetics
Huntington's disease, 241
sickle-cell anemia, 241

Geography
highest elevation for continents, 73
random sample of states, 27

Geology
density of Earth, 362
earthquakes, 89, 164
Old Faithful geyser (Yellowstone Park), 121, 136–137, 163–164, 170, 377

Government
federal debt, 93
IRS audits, 261
New Deal policies, 402–403
Social Security numbers, 282
Social Security reform, 386
state, 11
trust and confidence in, 322
type of, 9
waste, 12, 500

Grains. ***See*** **Agriculture**

Health. ***See also*** **Exercise; Medicine**
alcohol dependence treatment, 48
alcohol effects on brain, 457
allergy sufferers, 321, 322
blood alcohol concentration, 122
blood types, 240
body mass index, 478
bone mineral density and cola consumption, 56, 200
brain tumors and cell phones, 15
burning calories, 100
calories *vs.* sugar, 565
cancer, 19
  cell phones and brain tumors, 15
  cholesterol, 36
  death in, 268
  lung, 16, 20–21
  passive smoke and lung cancer, 20–21
  power lines and, 20–21
  skin, coffee consumption and, 19
  survival rates, 122
cardiac arrest, 338
dihydrogen monoxide deaths, 41–42
doctor visits, 253
drug side effects, 243
ebola breakout, 51
education and, 539
effect of Lipitor on cardiovascular disease, 43–44
emergency room visit, 325, 465
fitness club member satisfaction, 35
flu shots for seniors, 15
ginkgo and memory, 49
hair and heart disease, 19
hand-washing behavior, 405
happiness and, 19, 218, 539
headache, 163
health care expenditures, 102
hearing/vision problems, 253
heart attacks, 541
HIV test false positives, 259
hospital-acquired conditions, 252
hospital admissions, 122, 506
hygiene habits, 11
hypertension, 11, 51, 426
insomnia, 49
kidney stone treatment, 219
LDL cholesterol, 50
life expectancy, 187
Lipitor, 447
live births, 104, 146
lung cancer and, 16, 20–21
Lyme disease *vs.* drownings, 187
marriage/cohabitation and weight gain, 19–20
migraine, 435
obesity, 187
  social well being and, 539–540
  television in the bedroom and, 19
osteoporosis treatment, 509–510
overweight, 40, 102, 435
pulse rates, 120, 135–136, 157, 501
self-injurious behaviors, 326
shrinking stomach and diet, 49
skinfold thickness procedure, 169
sleep disorders, 511
sleeping habits of students, 40
smoking, 12, 270
  birth weight, 116–117, 201–202
  cessation program, 419
  cigar, 253
  e-cig study, 540
  educational attainment and, 511
  hypnotism to quit, 511
  lung cancer and, 16, 20–21
  paternal, 164–165
  during pregnancy, 447–448
  profile of, 540
  survival rates, 219
  tar and nicotine levels in cigarettes, 554, 560–561
  weight gain from quitting, 511
sneezing habits, 321–322, 360, 465
St. John's wort and depression, 49
television stations and life expectancy, 187
testosterone levels, 463
tooth whitener, 48, 54
vitamins, 164
weight of college students, 40
women, aspirin, and heart attacks, 541

Height(s)
arm span *vs.*, 510
father and son, 488
females
  five-year-old, 338
  20 years of age, 457

head circumference *vs.*, 184–185, 199, 207, 553, 560
of males *vs.* females, 139, 154
no-hitters, 168–169
10-year-old males, 337

Houses and housing
apartments, 222, 287–288, 565
appreciation, 91–92
females living at home, 360
garage door code, 282
home ownership, 105, 404
household winter temperature, 145–146
increase in assessments, 386
males living at home, 360
pricing, 201
rents, 307, 565
single-family home price, 435
square footage, 145
Zestimates, 555–556

Insurance
collision claims, 504
credit scores and, 541
life, 307, 326

Intelligence
brain size and, 186
IQ scores, 87, 122, 132–133, 137, 138, 155, 186, 424, 462–463
predictions, 561

Internet
connection time, 121
frequency of use of, 70
high speed access, 404
linear transformations, 123, 138
online homework, 73, 501–502
online search, 55
time viewing a Web page, 93
Web page design, 20, 479

Investment(s)
beating the stock market, 323
comparing stock sectors, 505–506
deciding on, 12
diversification, 139, 187
dividend yield, 90, 146
hot stock tips, 307
mutual funds, 137, 467
rate of return on, 76–79, 84, 91, 137, 139, 156, 377, 501
  pundit predictions on, 446
return on, 92
in Roth IRA, 76–79
savings, 145
stock fund manager performance, 480
stock price, 71, 93
Super Bowl results and, 448
volume of stock
  Altria Group, 91
  PepsiCo, 417
  Starbucks, 459

Landscaping
golf course, 282

Language
foreign, 385, 404
spoken at home, 253

Law(s)
antismoking, 566
chief justices, 168
death penalty, 404, 463
driver's license, 12
fair packaging and labeling, 435
gun control, 40
jury selection, 283, 322

Law enforcement
age of death-row inmates, 458
racial profiling, 524

Leisure and recreation. *See also* Entertainment
Bachelor party, 71–72
Boy Scouts merit badge requirement, 27
dining out, 70–71, 72
kids and, 501
Six Flags over Mid-America, 242
vacation time, 363

Literacy. *See* Reading

Manufacturing
bolts production, 137–138
copper tubing, 388
products made in America, 69–70, 218, 268–269
prolong engine treatment, 436
steel rods, 349
tire production, 362

Marriage
age and, 88, 198, 305–306
age difference, married couples, 504
births to unmarried women, 225–226
couples at work, 253
divorce rates, 91
education and, 288
extramarital affairs, 505
happiness and, 219
infidelity and, 40, 447
purchases hidden by couples, 326
unemployment rates, 223

Math
Benford's Law of frequency of digits, 523

Media
death penalty, 478

Medicine. *See also* Drugs; Health; Pharmaceuticals
abortion, 218
alcohol dependence treatment, 48
alcohol effects on brain, 457
allergy sufferers, 321, 322
Alzheimer's disease treatment, 53
AndroGel, 403
bacteria in hospital, 500
blood alcohol concentration, 122
blood types, 72, 240
Cancer Prevention Study II, 53
cardiac arrest, 338
carpal tunnel syndrome, 19
cholesterol level, 36
cosmetic surgery, 68
depression, 49
drug side effects, 243
ebola breakout, 51
effect of Lipitor on cardiovascular disease, 43–44
emergency room visits, 325
flu season, 68
folate and hypertension, 11
gum disease, 422
HDL cholesterol, 417–418, 555
heart attacks, 541
kidney stone treatment, 219
Lipitor, 447
live births, 104, 146
lupus and, 449
migraine, 435
placebo effect, 253–254
Salk vaccine, 480
side effects, 479
sleep apnea, 422
wart treatment, 12

Meteorology. *See* Weather

Military
atomic bomb, protection from, 461
Iraq War, 479
night vision goggles, 54
peacekeeping missions, 35
satellite defense system, 261
V-2 rocket hits in London, 526

Miscellaneous
aluminum bottle, 501
birthdays, 241, 252, 270
diameter of Douglas fir trees, 425–426
drinking glass shape, 56
filling bottles, 459
fingerprints, 261
sleeping, 379, 415, 462
tattoos, 478
Titanic survivors, 288
toilet flushing, 97–98, 321, 322, 360
wet suits, 505

Money. *See also* Finance; Investment(s)
abolishing the penny, 404
cash/credit, 504
credit-card debt, 464
FICO credit score, 184, 198–199, 458
retirement and, 403, 436

Morality
Gallup Organization findings on, 359–360
poll on state of American, 321, 322
unwed women having children, 505
voting decisions and, 566

Mortality
bicycle deaths, 525
pedestrian death, 525
Titanic disaster, 564

Motor vehicle(s). *See also* Transportation
accident
  fatal traffic, 447
  red-light camera programs, 254–255

blood alcohol concentration (BAC) for drivers involved in, 415, 447
BMWs, 12
braking distance, 225, 489
buying car, 137, 526
car accidents, 101
car color, 71, 322
carpoolers, 163
car prices, 167
car rentals, 489
cars owned by college graduates, 362
collision coverage claims, 504
crash test results, 416, 511
driving age, 325–326
driving under influence, 260
fatalities
  alcohol-related, 88
  driver, 254, 269
  traffic, 291
flight time, 119, 135
gas mileage/fuel economy, 91, 462
gas price, 102, 138
male *vs.* female drivers, 186, 201
miles per gallon, 119, 135, 338
new cars, 289
new *vs.* used car, 222
octane in fuel, 489–490
oil change, 377
seat belts, 422
SMART car, 155–156
speeding tickets, 254, 269
SUV *vs.* car, 488, 511
wearing helmets, 523

Music
arranging songs, 282
effect on learning, 46–47
length of songs, 113–114
playing songs, 269, 282, 283

Nutrition. *See also* Food
alcohol abstention, 478
bone mineral density and cola consumption, 56, 200
caffeinated sports drinks, 425
calories
  burning of, 100
  cheeseburgers, 221–222
  vs. sugar, 565
chewing and food consumption, 47–48
decision making and hunger, 165
dietary habits, 293
dissolving rates of vitamins, 164
eating together, 447
fat in, 91
  cheeseburgers, 221–222
overweight, 102, 435
time spent eating or drinking, 416, 466
Zone diet, 466–467

Obstetrics. *See also* Pediatrics
birth(s)
  gestation period, 154, 337, 348, 376
  multiple, 242
  premature, 564
  prenatal care, 539

Pediatrics. *See also* Obstetrics
age of mother at childbirth, 147, 163
birth rate, 108
birth weight, 146, 154, 201–202, 337, 350
  gestation period *vs.*, 292
  36 weeks of, 336
crawling babies, 416
energy during pregnancy, 388
head circumference *vs.* heights, 184, 199, 207
midwives, 20
sleeping patterns of pregnant women, 465

Pets
households with dogs, 240
talking to, 447

Pharmaceuticals. *See also* Drugs; Medicine
alcohol dependence treatment, 48
Aspirin, 541
Celebrex, 540
cholesterol research, 36
cold medication, 48
drug effectiveness, 50
Lipitor, 43–44, 447
memory drug, 49
Nexium, 447
Prevnar, 478
skin ointment, 56

Physics
muzzle velocity, 167, 422, 487

Politics
affiliation, 105, 218, 270, 448, 540–541
decisions, 462
elections
  county, 35
  predictions, 386, 505
  presidential, 564
  Senate, 240, 308, 404
estate taxes, 34–35
exit polls, 41
Future Government Club, 28, 35
health care and health insurance, 36
mayor and small business owners, 54
morality and voting, 566
Partisan Conflict Index (PCI), 85
philosophy of, 448
political grammar, 479–480
poll, 36
presidents
  age at inauguration, 91, 163
  birthplaces of, 72
  inaugural addresses, 169
  inauguration costs, 100
  inauguration day, 103
  random sample of, 27
public knowledge about, 11
public policy survey, 55
pundit predictions on, 446–447
views, 122
village poll, 28
voter polls, 35, 36

Polls and surveys
abortion, 218
annoying behavior, 422
blood donation, 403
boys are preferred, 360
of city residents, 35
college, 70, 241
Current Population Survey, 41
on desirability attributes, 70, 218
dream job, 71
dropping course, 541
educational background, 107
election, 42, 386
e-mail survey, 40, 41
exit, 41
faculty opinion, 27
on family values, 403
on frequency of having sex, 40
gender of children in family, 282
gun control, 404
happiness and health, 218
on high-speed Internet service, 53
informed opinion, 41
liars, 360
on life satisfaction, 385
on long life, 425, 460
on marriage being obsolete, 385
on morality, 321, 322
number of drinks, 419
order of the questions, 40–41
police department, 40
political, 36
population, 41
random digit dialing, 41
reading number of books, 418
registered voters, 320
response rate, 40, 41
retirement planning, 422
rotating choices, 41
seat belts, 422
student opinion, 27
student sample for, 27
supermajority results, 466
tattoos, 478
on televisions in the household, 89, 93, 305
TVaholics, 458
village, 28
wording of questions, 41
working hours, 415

Psychiatry
attention deficit-hyperactivity disorder, 386

Psychology
depression, 49
ESP and, 446
fear of flying, 386
helper-hinderer infant experiment, 449
insomnia relief, 49
well-being and commuting, 184, 198, 207, 403, 552, 560

Psychometrics
IQ scores, 87, 122, 137, 155, 186, 424, 459–460, 463

Reading
America reads, 362
at bedtime, 460
number of books read, 403–404, 416, 418
rates, 348, 349, 377, 458

Recreation. ***See*** **Leisure and recreation**

Religion
affiliation, 566
in Congress, 524
teen prayer, 465–466
trust in organized, 292

Residential. ***See*** **Houses and housing**

Sex and sexuality
family structure and, 539
sexual intercourse frequency, 40

Social work

Society
abortion issue, 218
affirmative action, 404
death penalty, 404, 478
divorce, opinion regarding, 91
dog ownership, 261
family structure, 252
marijuana use, 288
poverty, 69, 80–82, 96–97, 146
racial profiling, 322
sexual relations, 417
social well being and obesity, 539–540
superstition, 403
unwed women having children, 505
Valentine's Day, 403
volunteers and, 240

Sports
athletics participation, 323
baseball
batting averages, 11, 138, 154
Bonds' 756th homerun ball, 55
cold streaks, 260
ERA champions, 154
factory production, 362
home runs, 92, 240, 242, 293, 541
Ichiro's Hit Parade, 306
jersey numbers, 12
most valuable player, 68–69, 103
safety, 320
starting lineup, 282
variability, 389
winning percentage, 187, 294
World Series, 306, 563
basketball
free throws, 89, 240, 320
point spread, 221, 349
salary negotiations, 123
betting on, 261
bowling, 260
caffeinated sports drinks, 425
car racing, INDY 500, 282
fastball, 422, 504
football
completion rate for passes, 53
fans of, 404
fumbles, 387
National Football League combine, 243
point spread, 448
Super Bowl investing, 448
golf
balls, 270, 465
club comparisons, 50
pitching wedge, 338
hockey
National Hockey League, 524
Stanley Cup, 325
human growth hormone (HGH) use among high school athletes, 34
organized play, 240
soccer, 98, 287
captains, 27
World Cup Tournament, 89
swimming, 154
television commentator, 404
tennis, Wimbledon tournament, 326, 427
triathlon, 154

Statistics
classifying probability, 243
coefficient of skewness, 139
coefficient of variation, 139–140
Fish Story, 136
mean absolute deviation, 139
in media, 448
midrange, 123
net worth, 123, 389
number of tickets issued, 168
outliers, 418
practical significance, 459, 479
probability, 240
shape, mean and median, 123
simulation, 242, 292, 308, 322, 379, 405, 418–419, 448–449, 460
trimmed mean, 123

Surveys. ***See*** **Polls and surveys**

Temperature
cricket chirps and, 225, 567
household winter, 145–146
human, 465

Test(s)
ACT scores, 350, 457
crash results, 416
essay, 289
FICO score, 123, 458, 552–553
IQ scores, 87, 122, 124–125, 137, 155, 186, 424, 463
multiple-choice, 55, 294
SAT scores, 137, 155, 186, 288, 307–308, 350, 435, 457, 459
Wechsler Intelligence Scale, 362

Time
for commute, 138, 184, 198, 207, 403, 552, 560
drive-through service, 107, 377, 378, 415
eruptions *vs.* length of eruption, 207
exam, 119, 135
flight, 119, 135, 321, 322, 359
oil change, 377
online, 105
viewing Web page, 93
reaction, 50, 54, 488, 500
spent eating or drinking, 416, 466
study, 459
travel, 120–121, 136, 157, 168
waiting, 93, 140, 509

Transportation. ***See also*** **Motor vehicle(s)**
alcohol-related traffic fatalities, 88
flight time, 321, 322, 359
overbooking flights, 322–323
time spent in drive-through, 377
to work, 253

Travel
airline reservations, 386
creative thinking during, 362
fear of flying, 386
taxes, 416
text while driving, 462
Titanic survivors, 564
unhealthy commute, 184, 198, 207, 403, 552, 560
walking in airport, 499

Weapons. ***See*** **Firearms**

Weather
forecast, 289
hurricanes, 185, 200, 207, 553, 560
likelihood of rain, 268
Memohis snowfall, 355
temperatures, 137
tornadoes, 207–208, 417

Weight(s)
American Black Bears, 184–185, 187, 199, 207, 554, 561
birth, 336, 350
body mass index, 478
car *vs.* miles per gallon, 185, 186, 199, 207
of coins, 170
gaining, 261, 422–423, 511
gestation period *vs.*, 292
of kidneys, 137
males *vs.* females, 168

Work. ***See also*** **Business**
behavior and gender, 506
employee morale, 28
married couples, 253
multiple jobs, 270
rate of unemployment, 223
transportation to, 253
unemployment, 88
walk to, 405
working hours, 121

PART 1 Getting the Information You Need

CHAPTER 1
Data Collection

Statistics is a process—a series of steps that leads to a goal. This text is divided into four parts to help the reader see the process of statistics.

Part 1 focuses on the first step in the process, which is to determine the research objective or question to be answered. Then information is obtained to answer the questions stated in the research objective.

1

Data Collection

Outline

1.1 Introduction to the Practice of Statistics

1.2 Observational Studies versus Designed Experiments

1.3 Simple Random Sampling

1.4 Other Effective Sampling Methods

1.5 Bias in Sampling

1.6 The Design of Experiments

Making an Informed Decision

It is your senior year of high school. You will have a lot of exciting experiences in the upcoming year, plus a major decision to make—which college should I attend? The choice you make may affect many aspects of your life—your career, where you live, your significant other, and so on, so you don't want to simply choose the college that everyone else picks. You need to design a questionnaire to help you make an informed decision about college. In addition, you want to know how well the college you are considering educates its students. See Making an Informed Decision on page 57.

PUTTING IT TOGETHER

Statistics plays a major role in many aspects of our lives. It is used in sports, for example, to help a general manager decide which player might be the best fit for a team. It is used in politics to help candidates understand how the public feels about various policies. And statistics is used in medicine to help determine the effectiveness of new drugs.

Used appropriately, statistics can enhance our understanding of the world around us. Used inappropriately, it can lend support to inaccurate beliefs. Understanding statistical methods will provide you with the ability to analyze and critique studies and the opportunity to become an informed consumer of information. Understanding statistical methods will also enable you to distinguish solid analysis from bogus "facts."

To help you understand the features of this text and for hints to help you study, read the ***Pathway to Success*** on the front inside cover of the text.

1.1 Introduction to the Practice of Statistics

Objectives

1. Define statistics and statistical thinking
2. Explain the process of statistics
3. Distinguish between qualitative and quantitative variables
4. Distinguish between discrete and continuous variables
5. Determine the level of measurement of a variable

1 Define Statistics and Statistical Thinking

What is statistics? Many people say that statistics is numbers. After all, we are bombarded by numbers that supposedly represent how we feel and who we are. For example, we hear on the radio that 50% of first marriages, 67% of second marriages, and 74% of third marriages end in divorce (Forest Institute of Professional Psychology, Springfield, MO).

Another interesting consideration about the "facts" we hear or read is that two different sources can report two different results. For example, a November 10, 2015 poll by CBS News and the *New York Times* indicated that 62% of Americans believed the country was on the wrong track. However, a November 17, 2015 poll by *Bloomberg* indicated that 69% of Americans believed the country was on the wrong track. Is it possible that the percent of Americans who believe the country is on the wrong track could increase by 7% in one week, or is something else going on? Statistics helps to provide the answer.

Certainly, statistics has a lot to do with numbers, but this definition is only partially correct. Statistics is also about where the numbers come from (that is, how they were obtained) and how closely the numbers reflect reality.

Definition

Statistics is the science of collecting, organizing, summarizing, and analyzing information to draw conclusions or answer questions. In addition, statistics is about providing a measure of confidence in any conclusions.

Let's break this definition into four parts. The first part states that statistics involves the collection of information. The second refers to the organization and summarization of information. The third states that the information is analyzed to draw conclusions or answer specific questions. The fourth part states that results should be reported using some measure that represents how convinced we are that our conclusions reflect reality.

What is the information referred to in the definition? The information is **data**, which the *American Heritage Dictionary* defines as "a fact or proposition used to draw a conclusion or make a decision." Data can be numerical, as in height, or nonnumerical, as in gender. In either case, data describe characteristics of an individual.

In Other Words
Anecdotal means that the information being conveyed is based on casual observation, not scientific research.

Analysis of data can lead to powerful results. Data can be used to offset anecdotal claims, such as the suggestion that cellular telephones cause brain cancer. After carefully collecting, summarizing, and analyzing data regarding this phenomenon, it was determined that there is no link between cell phone usage and brain cancer. See Examples 1 and 2 in Section 1.2.

Because data are powerful, they can be dangerous when misused. The misuse of data usually occurs when data are incorrectly obtained or analyzed. For example, radio or television talk shows regularly ask poll questions for which respondents must call in or use the Internet to supply their vote. Most likely, the individuals who are going to call in are those who have a strong opinion about the topic. This group is not likely to be representative of people in general, so the results of the poll are not meaningful. Whenever we look at data, we should be mindful of where the data come from.

Even when data tell us that a relation exists, we need to investigate. For example, a study showed that breast-fed children have higher IQs than those who were not breast-fed. Does this study mean that a mother who breast-feeds her child will increase the child's IQ? Not necessarily. It may be that some factor other than breast-feeding contributes to the IQ of the children. In this case, it turns out that mothers who breast-feed generally have higher IQs than those who do not. Therefore, it may be genetics that leads to the higher IQ, not breast-feeding.* This illustrates an idea in statistics known as the *lurking variable*. A good statistical study will have a way of dealing with lurking variables.

A key aspect of data is that they vary. Consider the students in your classroom. Is everyone the same height? No. Does everyone have the same color hair? No. So, within groups there is variation. Now consider yourself. Do you eat the same amount of food each day? No. Do you sleep the same number of hours each day? No. So even considering an individual there is variation. Data vary. One goal of statistics is to describe and understand the sources of variation. Variability in data may help to explain the different results obtained by the CBS News/*New York Times* and *Bloomberg* polls described at the beginning of this section.

Because of this variability, the results that we obtain using data can vary. In a mathematics class, if Bob and Jane are asked to solve $3x + 5 = 11$, they will both obtain $x = 2$ as the solution when they use the correct procedures. In a statistics class, if Bob and Jane are asked to estimate the average commute time for workers in Dallas, Texas, they will likely get different answers, even though both use the correct procedure. The different answers occur because they likely surveyed different individuals, and these individuals have different commute times. Bob and Jane would get the same result if they both asked *all* commuters or the same commuters about their commutes, but how likely is this?

So, in mathematics when a problem is solved correctly, the results can be reported with 100% certainty. In statistics, when a problem is solved, the results do not have 100% certainty. In statistics, we might say that we are 95% confident that the average commute time in Dallas, Texas, is between 20 and 23 minutes. Uncertain results may seem disturbing now but will feel more comfortable as we proceed through the course.

Without certainty, how can statistics be useful? Statistics can provide an understanding of the world around us because recognizing where variability in data comes from can help us to control it. Understanding the techniques presented in this text will provide you with powerful tools that will give you the ability to analyze and critique media reports, make investment decisions, or conduct research on major purchases. This will help to make you an informed citizen, consumer of information, and critical and statistical thinker.

2 Explain the Process of Statistics

Consider the following scenario.

> You are walking down the street and notice that a person walking in front of you drops $100. Nobody seems to notice the $100 except you. Since you could keep the money without anyone knowing, would you keep the money or return it to the owner?

NOTE Obtaining a truthful response to a question such as this is challenging. In Section 1.5, we present some techniques for obtaining truthful responses to sensitive questions. •

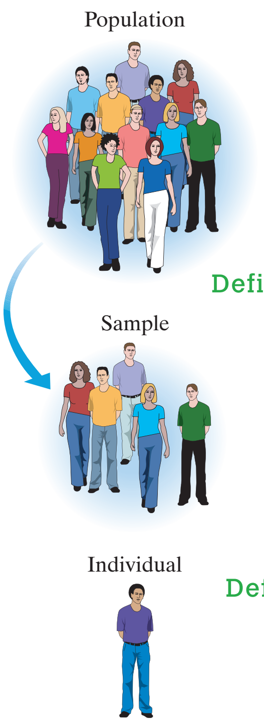
Suppose you wanted to use this scenario as a gauge of the morality of students at your school by determining the percent of students who would return the money. How might you do this? You could attempt to present the scenario to every student at the school, but this would be difficult or impossible if the student body is large. A second possibility is to present the scenario to 50 students and use the results to make a statement about all the students at the school.

*In fact, a study found that a gene called FADS2 is responsible for higher IQ scores in breast-fed babies. *Source:* Duke University, "Breastfeeding Boosts IQ in Infants with 'Helpful' Genetic Variant," *Science Daily* 6 November 2007.

Definitions

The entire group to be studied is called the **population**. An **individual** is a person or object that is a member of the population being studied. A **sample** is a subset of the population that is being studied. See Figure 1.

Figure 1



In the \$100 study presented, the population is all the students at the school. Each student is an individual. The sample is the 50 students selected to participate in the study.

Suppose 39 of the 50 students stated that they would return the money to the owner. We could present this result by saying that the percent of students in the survey who would return the money to the owner is 78%. This is an example of a *descriptive statistic* because it describes the results of the sample without making any general conclusions about the population.

Definitions

A **statistic** is a numerical summary of a sample. **Descriptive statistics** consist of organizing and summarizing data. Descriptive statistics describe data through numerical summaries, tables, and graphs.

So 78% is a statistic because it is a numerical summary based on a sample. Descriptive statistics make it easier to get an overview of what the data are telling us.

If we extend the results of our sample to the population, we are performing *inferential statistics*.

Definition

Inferential statistics uses methods that take a result from a sample, extend it to the population, and measure the reliability of the result.

The generalization contains uncertainty because a sample cannot tell us everything about a population. Therefore, inferential statistics includes a level of confidence in the results. So rather than saying that 78% of all students would return the money, we might say that we are 95% confident that between 74% and 82% of all students would return the money. Notice how this inferential statement includes a *level of confidence* (measure of reliability) in our results. It also includes a range of values to account for the variability in our results.

One goal of inferential statistics is to use statistics to estimate *parameters*.

Definition

A **parameter** is a numerical summary of a population.

EXAMPLE 1 Parameter versus Statistic

Suppose 48.2% of all students on your campus own a car. This value represents a parameter because it is a numerical summary of a population. Suppose a sample of 100 students is obtained, and from this sample we find that 46% own a car. This value represents a statistic because it is a numerical summary of a sample. •

• **Now Work Problem 7**

The methods of statistics follow a process.

CAUTION!
Many nonscientific studies are based on *convenience samples*, such as Internet surveys or phone-in polls. The results of any study performed using this type of sampling method are not reliable.

The Process of Statistics

1. *Identify the research objective.* A researcher must determine the question(s) he or she wants answered. The question(s) must clearly identify the population that is to be studied.
2. *Collect the data needed to answer the question(s) posed in (1).* Conducting research on an entire population is often difficult and expensive, so we typically look at a sample. This step is vital to the statistical process, because

(continued)

if the data are not collected correctly, the conclusions drawn are meaningless. Do not overlook the importance of appropriate data collection. We discuss this step in detail in Sections 1.2 through 1.6.

3. *Describe the data.* Descriptive statistics allow the researcher to obtain an overview of the data and can help determine the type of statistical methods the researcher should use. We discuss this step in detail in Chapters 2 through 4.
4. *Perform inference.* Apply the appropriate techniques to extend the results obtained from the sample to the population and report a level of reliability of the results. We discuss techniques for measuring reliability in Chapters 5 through 8 and inferential techniques in Chapters 9 through 12.

EXAMPLE 2 The Process of Statistics: Minimum Wage

CBS News and the *New York Times* conducted a poll September 12–15, 2014, and asked, “As you may know, the federal minimum wage is currently $7.25 an hour. Do you favor or oppose raising the minimum wage to $10.10?” The following statistical process allowed the researchers to conduct their study.

1. *Identify the research objective.* The researchers wanted to determine the percentage of adult Americans who favor raising the minimum wage. Therefore, the population being studied was adult Americans.
2. *Collect the data needed to answer the question posed in (1).* It is unreasonable to expect to survey the more than 200 million adult Americans to determine how they feel about the minimum wage. So the researchers surveyed a sample of 1009 adult Americans. Of those surveyed, 706 stated they favor an increase in the minimum wage to $10.10 an hour.
3. *Describe the data.* Of the 1009 individuals in the survey, 70% (= 706/1009) believe the minimum wage should be raised to $10.10 an hour. This is a descriptive statistic because it is a numerical summary of the data.
4. *Perform inference.* CBS News and the *New York Times* wanted to extend the results of the survey to all adult Americans. Remember, when generalizing results from a sample to a population, the results are uncertain. To account for this uncertainty, researchers reported a 3% *margin of error*. This means that CBS News and the *New York Times* feel fairly certain (in fact, 95% certain) that the percentage of *all* adult Americans who favor an increase in the minimum wage to $10.10 an hour is somewhere between 67% (70% − 3%) and 73% (70% + 3%).

• **Now Work Problem 49**

3 Distinguish between Qualitative and Quantitative Variables

Once a research objective is stated, a list of the information we want to learn about the individuals must be created. **Variables** are the characteristics of the individuals within the population. For example, recently my son and I planted a tomato plant in our backyard. We collected information about the tomatoes harvested from the plant. The individuals we studied were the tomatoes. The variable that interested us was the weight of a tomato. My son noted that the tomatoes had different weights even though they came from the same plant. He discovered that variables such as weight may vary.

If variables did not vary, they would be constants, and statistical inference would not be necessary. Think about it this way: If each tomato had the same weight, then knowing the weight of one tomato would allow us to determine the weights of all tomatoes. However, the weights of the tomatoes vary. One goal of research is to learn the causes of the variability so that we can learn to grow plants that yield the best tomatoes.

Variables can be classified into two groups: *qualitative* or *quantitative*.

Definitions

Qualitative, or categorical, variables allow for classification of individuals based on some attribute or characteristic.

Quantitative variables provide numerical measures of individuals. The values of a quantitative variable can be added or subtracted and provide meaningful results.

Many examples in this text will include a suggested **approach**, or a way to look at and organize a problem so that it can be solved. The approach will be a suggested method of *attack* toward solving the problem. This does not mean that the approach given is the only way to solve the problem, because many problems have more than one approach leading to a correct solution.

EXAMPLE 3 Distinguishing between Qualitative and Quantitative Variables

Problem Determine whether the following variables are qualitative or quantitative.

(a) Gender
(b) Temperature
(c) Number of days during the past week that a college student studied
(d) Zip code

Approach Quantitative variables are numerical measures such that meaningful arithmetic operations can be performed on the values of the variable. Qualitative variables describe an attribute or characteristic of the individual that allows researchers to categorize the individual.

Solution

(a) Gender is a qualitative variable because it allows a researcher to categorize the individual as male or female. Notice that arithmetic operations cannot be performed on these attributes.
(b) Temperature is a quantitative variable because it is numeric, and operations such as addition and subtraction provide meaningful results. For example, 70°F is 10°F warmer than 60°F.
(c) Number of days during the past week that a college student studied is a quantitative variable because it is numeric, and operations such as addition and subtraction provide meaningful results.
(d) Zip code is a qualitative variable because it categorizes a location. Notice that, even though zip codes are numeric, adding or subtracting zip codes does not provide meaningful results. •

• **Now Work Problem 15**

Example 3(d) shows us that a variable may be qualitative while having numeric values. Just because the value of a variable is numeric does not mean that the variable is quantitative.

4 Distinguish between Discrete and Continuous Variables

We can further classify quantitative variables into two types: *discrete* or *continuous*.

Definitions

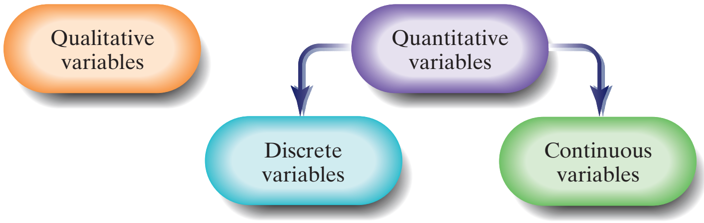
A **discrete variable** is a quantitative variable that has either a finite number of possible values or a countable number of possible values. The term *countable* means that the values result from counting, such as 0, 1, 2, 3, and so on. A discrete variable cannot take on every possible value between any two possible values.

A **continuous variable** is a quantitative variable that has an infinite number of possible values that are not countable. A continuous variable may take on every possible value between any two values.

In Other Words
If you count to get the value of a quantitative variable, it is discrete. If you measure to get the value of a quantitative variable, it is continuous.

Figure 2 illustrates the relationship among qualitative, quantitative, discrete, and continuous variables.

Figure 2



EXAMPLE 4 Distinguishing between Discrete and Continuous Variables

Problem Determine whether the quantitative variables are discrete or continuous.

(a) The number of heads obtained after flipping a coin five times.

(b) The number of cars that arrive at a McDonald's drive-thru between 12:00 P.M. and 1:00 P.M.

(c) The distance a 2015 Toyota Prius can travel in city driving conditions with a full tank of gas.

Approach A variable is discrete if its value results from counting. A variable is continuous if its value is measured.

Solution

(a) The number of heads obtained by flipping a coin five times is a discrete variable because we can count the number of heads obtained. The possible values of this discrete variable are 0, 1, 2, 3, 4, 5.

(b) The number of cars that arrive at a McDonald's drive-thru between 12:00 P.M. and 1:00 P.M. is a discrete variable because we find its value by counting the cars. The possible values of this discrete variable are 0, 1, 2, 3, 4, and so on. Notice that this number has no upper limit.

(c) The distance traveled is a continuous variable because we measure the distance (miles, feet, inches, and so on). •

• **Now Work Problem 23**

Continuous variables are often rounded. For example, if a certain make of car gets 24 miles per gallon (mpg) of gasoline, its miles per gallon must be greater than or equal to 23.5 and less than 24.5, or $23.5 \le \text{mpg} < 24.5$.

The type of variable (qualitative, discrete, or continuous) dictates the methods that can be used to analyze the data.

The list of observed values for a variable is **data**. Gender is a variable; the observations male and female are data. **Qualitative data** are observations corresponding to a qualitative variable. **Quantitative data** are observations corresponding to a quantitative variable. **Discrete data** are observations corresponding to a discrete variable. **Continuous data** are observations corresponding to a continuous variable.

EXAMPLE 5 Distinguishing between Variables and Data

Problem Table 1 presents a group of selected countries and information regarding these countries as of July, 2015. Identify the individuals, variables, and data in Table 1.

Table 1

Country	Government Type	Life Expectancy (years)	Population (in millions)
Australia	Federal parliamentary democracy	82.15	22.8
Canada	Constitutional monarchy	81.76	35.1
France	Republic	81.75	66.6
Morocco	Constitutional monarchy	76.71	33.3
Poland	Republic	77.40	38.6
Sri Lanka	Republic	76.56	22.1
United States	Federal republic	79.68	321.4

Source: CIA *World Factbook*

Approach An individual is an object or person for whom we wish to obtain data. The variables are the characteristics of the individuals, and the data are the specific values of the variables.

Solution The individuals in the study are the countries: Australia, Canada, and so on. The variables measured for each country are *government type*, *life expectancy*, and *population*. The variable *government type* is qualitative because it categorizes the individual. The variables *life expectancy* and *population* are quantitative.

The quantitative variable *life expectancy* is continuous because it is measured. The quantitative variable *population* is discrete because we count people. The observations are the data. For example, the data corresponding to the variable *life expectancy* are 82.15, 81.76, 81.75, 76.71, 77.40, 76.56, and 79.68. The following data correspond to the individual Poland: a republic government with residents whose life expectancy is 77.40 years and population is 38.6 million people. Republic is an instance of qualitative data that results from observing the value of the qualitative variable *government type*. The life expectancy of 77.40 years is an instance of quantitative data that results from observing the value of the quantitative variable *life expectancy*.

• **Now Work Problem 45**

5 Determine the Level of Measurement of a Variable

Rather than classify a variable as qualitative or quantitative, we can assign a level of measurement to the variable.

Definitions

A variable is at the **nominal level of measurement** if the values of the variable name, label, or categorize. In addition, the naming scheme does not allow for the values of the variable to be arranged in a ranked or specific order.

A variable is at the **ordinal level of measurement** if it has the properties of the nominal level of measurement, however the naming scheme allows for the values of the variable to be arranged in a ranked or specific order.

A variable is at the **interval level of measurement** if it has the properties of the ordinal level of measurement and the differences in the values of the variable have meaning. A value of zero does not mean the absence of the quantity. Arithmetic operations such as addition and subtraction can be performed on values of the variable.

A variable is at the **ratio level of measurement** if it has the properties of the interval level of measurement and the ratios of the values of the variable have meaning. A value of zero means the absence of the quantity. Arithmetic operations such as multiplication and division can be performed on the values of the variable.

In Other Words
The word ***nominal*** comes from the Latin word **nomen**, which means to name. When you see the word **ordinal**, think order.