Contents

Preface xiv

Part 1 EXPLORING AND COLLECTING DATA

Chapter 1 Statistics, Data, & Decisions 1

1.1 The Role of Statistics in the World 2 • **1.2** So, What Is Statistics? 4
1.3 What *Are* Data? 7 • **1.4** Types of Variables (and Types of Data) 10
1.5 Data Quality 17 • **1.6** Data Sources—Where, How, and When 19

Ethics In Action 22
Technology Help: Statistics Packages 25
Mini Case Study Projects: Credit Card Company 25
Edmonton Oilers 25
Student Survey 25

Chapter 2 Displaying and Describing Categorical Data 30

2.1 The Three Rules of Data Analysis 31 • **2.2** Frequency Tables 32 • **2.3** Displaying a Categorical Variable 33 • **2.4** Exploring Two Categorical Variables: Contingency Tables 37
2.5 Simpson's Paradox 47 • **2.6** How to Make a Table That Has Legs! 48

Ethics In Action 53
Technology Help: Displaying Categorical Data on the Computer 55
Mini Case Study Project: Eddie's Hang-Up Display 56

Chapter 3 Displaying and Describing Quantitative Data 67

3.1 Displaying Quantitative Variables 68 • **3.2** Shape 72 • **3.3** Centre 74
3.4 Spread of the Distribution 76 • **3.5** Shape, Centre, and Spread—A Summary 78
3.6 Five-Number Summary and Boxplots 79 • **3.7** Comparing Groups 82
3.8 Identifying Outliers 84 • **3.9** Standardizing 85 • ***3.10** Time Series Plots 88
3.11 Transforming Skewed Data 91

Ethics In Action 95
Technology Help: Displaying and Summarizing Quantitative Variables 99
Mini Case Study Projects: Canada's CEO Top 100 100
Hotel Occupancy Rates 101
Value and Growth Stock Returns 101

Chapter 4 Correlation and Linear Regression 116

4.1 Looking at Scatterplots 119 • **4.2** Assigning Roles to Variables in Scatterplots 121
4.3 Understanding Correlation 122 • **4.4** Lurking Variables and Causation 127
4.5 The Linear Model 129 • **4.6** Correlation and the Line 130 • **4.7** Regression to the Mean 133 • **4.8** Checking the Model 137 • **4.9** Variation in the Model and R^2 139
4.10 Reality Check: Is the Regression Reasonable? 141 • **4.11** Nonlinear Relationships 145

Ethics In Action 150
Technology Help: Correlation and Regression 154
Mini Case Study Projects: Fuel Efficiency 155
Energy Use at YVR 155
Cost of Living 156
Canadian Banks 156

Part 2 MODELLING WITH PROBABILITY

Chapter 5 Randomness and Probability 168

5.1 Random Phenomena and Probability 169 • **5.2** The Nonexistent Law of Averages 171 • **5.3** Different Types of Probability 172
5.4 Probability Rules 174 • **5.5** Joint Probability and Contingency Tables 179
5.6 Conditional Probability 179 • **5.7** Constructing Contingency Tables 182
5.8 Probability Trees 183 • ***5.9** Reversing the Conditioning: Bayes' Rule 185
5.10 Fun with Probability! 187

Ethics In Action 189
Mini Case Study Project: Market Segmentation 192

Chapter 6 Random Variables and Probability Models 202

6.1 Expected Value of a Random Variable 204 • **6.2** Standard Deviation of a Random Variable 205 • **6.3** Properties of Expected Values, Variances, and Standard Deviations 208 • **6.4** Bernoulli Trials 212 • **6.5** Discrete Probability Models 213

Ethics In Action 222
Technology Help: Random Variables and Probability Models 224
Mini Case Study Project: Investment Options 224

Chapter 7 The Normal and Other Continuous Distributions 231

7.1 Continuous Random Variables 232 • **7.2** The Normal Distribution 233 **7.3** Normal Probability Plots 241 • **7.4** The Distribution of Sums of Normals 243 **7.5** The Normal Approximation for the Binomial 246 • **7.6** Other Continuous Random Variables 249

Ethics In Action 251
Technology Help: Probability Calculations and Plots 253
Mini Case Study Project: Price/Earnings and Stock Value 254

Chapter 8 Surveys and Sampling 262

8.1 Three Ideas of Sampling 263 • **8.2** Populations and Parameters 268 • **8.3** Common Sampling Designs 269 • **8.4** The Valid Survey 274 • **8.5** How to Sample Badly 275

Ethics In Action 278
Technology Help: Random Sampling 280
Mini Case Study Projects: Market Survey Research 280
Canadian Labour Force Survey 280

Chapter 9 Sampling Distributions and Confidence Intervals for Proportions 287

9.1 The Distribution of Sample Proportions 289 • **9.2** The Sampling Distribution for Proportions 290 • **9.3** The Central Limit Theorem—The Fundamental Theorem of Statistics 295 • **9.4** A Confidence Interval for a Proportion 299 **9.5** Margin of Error: Certainty vs. Precision 303 • **9.6** Choosing the Sample Size 307

Ethics In Action 312
Technology Help: Confidence Intervals for Proportions 314
Mini Case Study Projects: Real Estate Simulation 315
Investor Sentiment 316

Part 3 INFERENCE FOR DECISION-MAKING

Chapter 10 Testing Hypotheses About Proportions 325

10.1 Hypotheses 327 • **10.2** A Trial as a Hypothesis Test 328 • **10.3** P-Values 329 **10.4** The Reasoning of Hypothesis Testing 331 • **10.5** Alternative Hypotheses 333 **10.6** Alpha Levels and Significance 337 • **10.7** Critical Values 339 • **10.8** Confidence Intervals and Hypothesis Tests 340 • **10.9** Two Types of Errors 343 • ***10.10** Power 345

Ethics In Action 349
Technology Help: Hypothesis Tests 351
Mini Case Study Projects: Metal Production 352
Loyalty Program 353

Chapter 11 Confidence Intervals and Hypothesis Tests for Means 360

11.1 The Sampling Distribution for Means 361 • **11.2** How Sampling Distribution Models Work 362 • **11.3** Gossett and the *t*-Distribution 364 • **11.4** A Confidence Interval for Means 366 • **11.5** Assumptions and Conditions 368 **11.6** Testing Hypotheses About the Mean—The One-Sample *t*-Test 373

Ethics In Action 379
Technology Help: Inference for Means 381
Mini Case Study Projects: Real Estate 382
Social Media 383

Chapter 12 Comparing Two Groups 394

12.1 Comparing Two Means 396 • **12.2** The Two-Sample *t*-Test 398 • **12.3** Assumptions and Conditions 399 • **12.4** A Confidence Interval for the Difference Between Two Means 403 **12.5** The Pooled *t*-Test 405 • **12.6** Paired Data 412 • **12.7** Paired *t*-Methods 414 **12.8** Comparing Two Proportions 419

Ethics In Action 423
Technology Help: Comparing Two Means 426
Mini Case Study Projects: Terra Breads 429
Real Estate 429
Stanley Cup Fatigue (Data Analysis) 430

Chapter 13 Inference for Counts: Chi-Square Tests 446

13.1 Goodness-of-Fit Tests 448 • **13.2** Interpreting Chi-Square Values 453 **13.3** Examining the Residuals 454 • **13.4** Chi-Square Tests of Two-Way Tables 455

Ethics In Action 468
Technology Help: Chi-Square 470
Mini Case Study Projects: Kit and Ace 472
Coffee Consumption in Canada 473
Loyalty Program 474

Part 4 MODELS FOR DECISION-MAKING

Chapter 14 Inference for Regression 485

14.1 A Hypothesis Test and Confidence Interval for the Slope 487 • **14.2** Assumptions and Conditions 491 • **14.3** Standard Errors for Predicted Values 497 • **14.4** Using Confidence and Prediction Intervals 501 • **14.5** Extrapolation and Prediction 502 • **14.6** Unusual and Extraordinary Observations 505 • ***14.7** Working with Summary Values 508 • ***14.8** Linearity 510 **14.9** A Hypothesis Test for Correlation 512 • **14.10** ANOVA and the *F*-statistic 512

Ethics In Action 517
Technology Help: Regression Analysis 520
Mini Case Study Projects: Frozen Pizza 522
Global Warming? 522

Chapter 15 Multiple Regression 537

15.1 The Multiple Regression Model 540 • **15.2** Interpreting Multiple Regression Coefficients 542 • **15.3** Assumptions and Conditions for the Multiple Regression Model 544 **15.4** Testing the Multiple Regression Model 551 • **15.5** ANOVA Table, *F*-statistic, R^2, and Adjusted R^2 552 • **15.6** Building, Comparing, and Using Models 555 **15.7** Extending Multiple Regression 558 • ***15.8** The Logistic Regression Model 560 • **15.9** A Wrap-up Example 565

Ethics In Action 571
Technology Help: Regression Analysis 573
Mini Case Study Projects: Golf Success 574
Rating School Performance 575

Chapter 16 Statistical Modelling and the World of Business Statistics 586

16.1 Statistical Models 588 • **16.2** A Modelling Framework 591 • **16.3** One-Way Analysis of Variance (ANOVA) 594 • **16.4** A Short Tour of Other Statistical Methods in Business 601 • **16.5** The Future of Business Statistics 603

Technology Help: Analysis of Variance 607

Appendixes A-1

A. Answers A-1

B. Tables and Selected Formulas A-00

Index I-1

Preface

Motivated business students studying Statistics ask the question "How can I make better decisions?" Unfortunately, that is not the question most students are asking themselves on the first day of the course! As entrepreneurs and consultants, we know that in today's data-rich environment, knowledge of Statistics is essential to survive and thrive in the business world. But, as educators, we've seen a disconnect between the way business statistics is traditionally taught and the way it should be used in making business decisions. In *Business Statistics: A First Course*, we try to narrow the gap between theory and practice by presenting relevant statistical methods that will empower business students to make effective, data-informed decisions.

Of course, students should come away from their statistics course knowing how to think statistically and how to apply statistics methods with modern technology. But they must also be able to communicate their analyses effectively to others. When asked about statistics education, a group of CEOs from *Fortune* 500 companies recently said that, although they were satisfied with the technical competence of students who had studied Statistics, they found the students' ability to communicate their findings to be woefully inadequate.

Our *Plan*, *Do*, *Report* rubric provides a structure for solving business problems that mimics the correct application of statistics to solving real business problems. We emphasize the often-neglected thinking (Plan) and communication (Report) steps in problem solving, in addition to the methodology (Do). This approach requires up-to-date, real-world examples and data. So, we constantly strive to illustrate our lessons with current business issues and examples.

What's New in This Edition?

The second Canadian edition of *Business Statistics: A First Course* has a new structure to further help students focus on the central material. Examples and exercises are updated so that the story we tell is always tied to the ways Statistics informs modern business practice.

- **Recent data.** We teach with real data whenever possible, so we've updated data throughout the book. New examples reflect current stories in the news and recent economic and business events. Some of the *Mini Case Study Projects* have been updated with new data and new contexts.
- **Improved organization.** We have retained our "data first" presentation of topics, because we find that it provides students with both motivation and a foundation in real business decisions on which to build an understanding.
    - Chapters 1–4 have been streamlined to cover collecting, displaying, summarizing, and understanding data in four chapters. We find that this provides students with a solid foundation to launch their study of probability and statistics.
    - Chapters 5–9 introduce students to randomness and probability models. They then apply these new concepts to sampling. This provides a gateway to the core material on statistical inference. We've moved the discussion of probability trees and Bayes' rule into these chapters.
    - Chapters 10–13 cover inference for both proportions and means. We introduce inference by discussing proportions, because most students are better acquainted with proportions reported in surveys and news stories. However, this edition ties in the discussion of means immediately, so students can appreciate that the reasoning of inference is the same in a variety of contexts.
    - Chapters 14 and 15 cover regression-based models for decision-making.

- Chapter 16, the capstone chapter, now also includes a section on one-way analysis of variance. And the chapter points the way forward for further study of business statistics.

- **Streamlined design.** Our goal has always been an accessible text. This edition sports a new design that clarifies the purpose of each text element. The major theme of each chapter is more linear and easier to follow without distraction. Supporting material is clearly boxed and shaded, so students know where to focus their study efforts.
- **Enhanced *Technology Help* with expanded Excel 2013 coverage.** We've updated *Technology Help* with detailed instructions for Excel 2013 to almost every chapter.
- **Updated *Ethics in Action* features.** We've updated some of our *Ethics in Action* features.
- **Updated examples to reflect the changing world.** We live in a time of rapid and marked changes in Canadian, American, and world economies. Our examples and exercises have been updated to keep pace.
- **Increased focus on core material.** Statistics in practice means making smart decisions based on data. Students need to know the methods, how to apply them, and the assumptions and conditions that make them work. We've tightened our discussions to get students there as quickly as possible, focusing increasingly on the central ideas and core material.
- **MyLab Business Statistics performance data to improve exercises.** The authors analyzed aggregated student usage and performance data from MyLab Business Statistics 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.

  In addition to these changes, below is a detailed list of changes by chapter to the second Canadian edition.

  - **Chapter 1** encourages students' interest in and understanding of the discipline through a chapter opener and an introductory section called The Role of Statistics in the World. There is an expanded explanation of uncertainty, and a brief discussion of basic statistical literary. The chapter then moves immediately to a discussion of data types and includes a section on data quality.
  - **Chapter 2** introduces alternatives and variations on bar charts—dot plot, Pareto chart, and segmented bar charts—as an alternative to pie charts. New in the second edition is a discussion of mosaic plots, and a section on constructing good tables (How to Make a Table That Has Legs!)
  - **Chapter 3** has historical notes on the term *histogram*, the origins of stem-and-leaf displays, and the use of x-bar notation; an explanation of harmonic and geometric means, with illustrative examples; and the probability explanation of the $n - 1$ denominator of sample standard deviation. The second edition has a new section on transforming skewed data, and introduces the term "infographics."
  - **Chapter 4** has an expanded discussion of regression to the mean, historical vignettes, and a graphical illustration. The second edition has a new item on ecological correlation, and a new section on nonlinear relationships.
  - **Chapter 5** features expanded commentary about, and illustrations of, Bayes' Rule. The section called Fun with Probability! describes three famous probability puzzles.

- **Chapter 6** discusses random variables and focuses on discrete probability models. It includes a subsection on dependent random variables, important in finance and portfolio diversification. There is now a separate subsection on Bernoulli trials.
- **Chapter 7** is a new chapter on continuous probability models, focusing on the Normal distribution, with a chapter opener about the TSX. The second edition also has a brand-new section on Normal probability plots.
- **Chapter 8** discusses surveys and sampling, with additional explanations of *population*, *parameter*, *sample*, *statistic*, and *sampling frame* as well as sidebar discussions that help contextualize the concept of polls and surveys.
- **Chapter 9** includes stronger ties to material in previous and later chapters, to help students draw on what they have already learned.
- **Chapter 10** has a full illustration of the correspondence between the logic of hypothesis testing and proof by contradiction, as well as new explanations of concepts such as statistical versus practical significance and how the two error type probabilities are inversely related. The second edition has a clear tabular summary of the hypothesis testing process.
- **Chapter 11** includes feature boxes that connect Statistics to students' everyday life, including a feature on the Canadian Census, updated for the new federal law restoring the mandatory long-form census.
- **Chapter 12** has an additional example, a subsection about how the paired *t*-test works, and a separate section on comparing two proportions, with a new illustrative example on Snapchat usage by teenagers.
- **Chapter 13** combines the two topics, the chi-square test of homogeneity and the chi-square test of independence, into a single section, Chi-Square Tests of Two-Way Tables, showing how the two-proportion *z*-test can be recast as a two-way table and then extended to more rows and more columns.
- **Chapter 14** has a separate section on a hypothesis test of correlation, and a section on regression ANOVA and the *F*-statistic. The second edition has many updated exercises with more-current data sets.
- **Chapter 15** has two unique sections—one on building, comparing, and using models, and one that extends multiple regression to curvilinear models and categorical predictors. The second edition has a new section on logistic regression and a wrap-up example that ties together all the elements of multiple regression.
- **Chapter 16**, the capstone chapter, synthesizes key material from earlier chapters. It has a unified framework approach to statistical models for the inference techniques covered in the text. The second edition has a new section and expanded coverage of one-way analysis of variance. The chapter also provides a brief description of several business statistics methods beyond the scope of this text, and concludes with comments on the future of business statistics and big data.

Our Approach

Statistical Thinking

For all of our improvements, examples, and updates in this edition of *Business Statistics: A First Course*, we haven't lost sight of our original mission—writing a modern business statistics text that addresses the importance of *statistical thinking* in making business decisions that acknowledge how Statistics is actually used in business.

Statistics is practised with technology, and this insight informs everything from our choice of forms for equations (favouring intuitive forms over calculation forms) to our extensive use of real data. But most important, understanding the value of technology allows us to focus on teaching statistical thinking rather than calculation. The questions that motivate each of our hundreds of examples are not "How do you find the answer?" but "How do you think about the answer?", "How does it help you make a better decision?", and "How can you best communicate your decision?"

Our focus on statistical thinking ties the chapters of the book together. An introductory business statistics course covers an overwhelming number of new terms, concepts, and methods, and it is vital that students see their core: how we can understand more about the world and make better decisions by understanding what the data tell us. From this perspective, it is easy to see that the patterns we look for in graphs are the same as those we think about when we prepare to make inferences.

We can see that the many ways to draw inferences from data are several applications of the same core concepts. And it follows naturally that when we extend these basic ideas into more complex (and even more realistic) situations, the same basic reasoning is still at the core of our analyses.

Our Goal: Read This Book!

The best textbook in the world is of little value if it isn't read. Here are some of the ways we made *Business Statistics: A First Course* more approachable:

- ***Readability.*** We strive for a conversational, approachable style, and we introduce anecdotes to maintain interest. Instructors report (to their amazement) that their students read ahead of their assignments voluntarily. Students tell us (to *their* amazement) that they actually enjoy the book.
- ***Focus on assumptions and conditions.*** More than any other textbook, *Business Statistics: A First Course* emphasizes the need to verify assumptions when using statistical procedures. We reiterate this focus throughout the examples and exercises. We make every effort to provide templates that reinforce the practice of checking these assumptions and conditions, rather than rushing through the computations. Business decisions have consequences. Blind calculations open the door to errors that could easily be avoided by taking the time to graph the data, check assumptions and conditions, and then check again that the results and residuals make sense.
- ***Emphasis on graphing and exploring data.*** We consistently emphasize the importance of displaying data. Examples often illustrate the value of examining data graphically, and the *Exercises* reinforce this. Good graphics reveal structures, patterns, and occasional anomalies that could otherwise go unnoticed. These patterns often raise new questions and inform both the path of a resulting statistical analysis and the business decisions. Many new graphics found throughout the book demonstrate that the simple structures that underlie even the most sophisticated statistical inferences are the same ones we look for in the simplest examples. This helps tie the concepts of the book together to tell a coherent story.
- ***Consistency.*** We work hard to avoid the "do what we say, not what we do" trap. Having taught the importance of plotting data and checking assumptions and conditions, we are careful to model that behaviour throughout the book. (Check the *Exercises* in the chapter on multiple regression and you'll find us still requiring and demonstrating the plots and checks that were introduced in the early chapters.) This consistency

helps reinforce these fundamental principles and provides a familiar foundation for the more sophisticated topics.

- ***The need to read.*** In this book, important concepts, definitions, and sample solutions are not always set aside in boxes. The book needs to be read, so we've tried to make the reading experience enjoyable. The common approach of skimming for definitions or starting with the exercises and looking up examples just won't work here. (It never did work as a way to learn about and understand Statistics.)

Coverage

The topics covered in a business statistics course are, generally, mandated by our students' needs in their studies and in their future professions. But the *order* of these topics and the relative emphasis given to each is not well-established. *Business Statistics: A First Course* presents some topics sooner than or later than other texts. Although many chapters can be taught in a different order, we urge you to consider the order we have chosen.

We've been guided in the order of topics by the fundamental goal of designing a coherent course in which concepts and methods fit together to provide a new understanding of how reasoning with data can uncover new and important truths. Each new topic should fit into the growing structure of understanding that students develop throughout the course. For example, we teach inference concepts with proportions first and then with means. Most people have a wider experience with proportions, seeing them in polls and advertising. And by starting with proportions, we can teach inference with the Normal model and then introduce inference for means with the Student's *t*-distribution.

We introduce the concepts of association, correlation, and regression early. Our experience in the classroom shows that introducing these fundamental ideas early makes Statistics useful and relevant even at the beginning of the course. By Chapter 4, students can discuss relationships among variables in a meaningful way. Later in the semester, when we discuss inference, it is natural and relatively easy to build on the fundamental concepts learned earlier and enhance them with inferential methods.

GAISE Report

We've been guided in our choice of what to emphasize by the GAISE (Guidelines for Assessment and Instruction in Statistics Education) Report, which emerged from extensive studies of how students best learn Statistics. (**http://www.amstat.org/education/gaise/GaiseCollege_full.pdf**). Those recommendations, now officially adopted and recommended by the American Statistical Association, urge (among other detailed suggestions) that statistics education should:

1. Emphasize statistical literacy and develop statistical thinking.
2. Use real data.
3. Stress conceptual understanding rather than mere knowledge of procedures.
4. Foster active learning.
5. Use technology for developing conceptual understanding and analyzing data.
6. Make assessment a part of the learning process.

In this sense, this book is thoroughly modern.

This book recognizes both the changing curriculum and the changing pedagogy for teaching introductory statistics. It focuses on application, streamlines and reorganizes topics, sheds unneeded theoretical details, and recognizes learning styles of the current

generation of students, making it an attractive choice for single-term courses at Canadian business schools.

The Canadian edition uses illustrative case studies and chapter exercises that focus on business and management of Canadian companies, large and small. The writing has Canadian style, perspective, and sensibility, not just changes to spelling and metric measurements. The book recognizes that Canada has public policy, governmental structure and mandate (federal, provincial, and municipal), economic systems (banking and finance), social services, health care, sports, and entertainment that are different from those of the United States. While the book is indeed Canadian, it also shows how Statistics has no geographical borders and is a vital part of building and enhancing the global community.

Most chapter-opening examples reflect a Canadian situation that is then used within the chapter to illustrate new concepts. Throughout the chapters, exercises use Canadian sources and examples, as do most *Mini Case Study Projects*.

Features

A textbook isn't just words on a page: it is many features that come together to form a big picture. The features in *Business Statistics: A First Course* provide a real-world context for concepts, help students apply these concepts, promote problem solving, and integrate technology—all of which help students understand and see the big picture of business statistics.

Motivating Examples. Each chapter opens with a motivating example, often taken from the authors' consulting experiences. These companies—such as Angus Reid, Mountain Equipment Co-op, Manulife Financial, and Canada Goose—enhance and illustrate the story of each chapter, and show students how and why statistical thinking is so vital to modern business decision-making. We analyze the data from those companies throughout the chapter.

Learning Objectives. Each chapter begins with a list of learning objectives. These are brief but clear statements about what students are expected to know and to be able to demonstrate by the end of the chapter (or the end of the course). These will also help instructors with course planning and classroom delivery. Each end-of-chapter exercise references one or more learning objectives to guide students' assessment of their progress with the material.

Connections. Although the authors (and, we hope, the instructors) know how the chapters of a textbook are related to each other and understand the logic behind the sequencing, it may not be clear to students until they reach the end of the book. The Connections boxes explain how the current chapter is related to the previous chapter(s), and why its position in the sequence is appropriate.

Step-by-Step Guided Examples. The ability to clearly communicate statistical results is crucial to helping Statistics contribute to business decision-making. To that end, some examples in each chapter are presented as *Guided Examples*. A good solution is modelled in the right column while commentary appears in the left column.

The overall analysis follows our innovative **Plan, Do, Report** template. That template begins each analysis with a clear question about a decision and ends with a report which answers that question. To emphasize the decision aspect of each example, we present the **Report** step as a business memo that summarizes the results in the context of the example and states a recommendation if the data are able to support one. In addition, whenever possible we include limitations of the analysis or models in the concluding memo.

Mini Case Study Projects. Each chapter includes one or two *Mini Case Study Projects* that use real data and ask students to investigate a question or make a decision. Students define the objective, plan the process, complete the analysis, and report a conclusion. Data for the *Mini Case Study Projects* are available on MyLab Business Statistics.

What Can Go Wrong? Each chapter contains an innovative section called *What Can Go Wrong?* that highlights the most common statistical errors and the misconceptions people have about Statistics. The most common mistakes for the new user of statistical methods involve misusing a method, not miscalculating a statistic. Most of the mistakes we discuss have been experienced by the authors in a business context rather than a classroom situation. One of our goals is to arm students with the tools to detect statistical errors and to offer practice in recognizing when Statistics is misused, whether intentional or not. In this spirit, some of our exercises probe the understanding of such errors.

By Hand. Even though we encourage the use of technology to calculate statistical quantities, we realize the pedagogical benefits of doing a calculation by hand. The *By Hand* boxes break apart the calculation of some of the simpler formulas and help the student through the calculation of a worked example.

Reality Check. We regularly remind students that Statistics is about understanding the world and making decisions with data. Results that make no sense are probably wrong, no matter how carefully we think we did the calculations. Mistakes are often easy to spot with a little thought, so we ask students to stop for a reality check before interpreting results.

Notation Alert. Throughout this book, we emphasize the importance of clear communication. Proper notation is part of the vocabulary of Statistics, but it can be daunting. Students who know that in algebra n can stand for any variable may be surprised to learn that in Statistics n is always the sample size. Statisticians dedicate many letters and symbols for specific meanings (b , e , n , p , q , r , s , t , and z , along with many Greek letters all carry special connotations). Students learn more effectively when they are clear about the letters and symbols statisticians use.

Just Checking. To help students check their understanding of material they've just read, we ask questions at points throughout the chapter. These questions are a quick check and most involve little calculation. The answers are at the end of the exercise sets in each chapter so students can easily check themselves to be sure they understand the key ideas. The questions can also be used to motivate class discussion.

Math Boxes. In many chapters, we present the mathematical underpinnings of the statistical methods and concepts. Different students learn in different ways, and even the same student can understand the material by more than one path. By setting

these proofs, derivations, and justifications apart from the narrative, we allow the student to continue to follow the logical development of the topic at hand, yet also make available the underlying mathematics for greater depth.

What Have We Learned? These chapter-ending summaries highlight new concepts, define new terms introduced in the chapter, and list the skills that the student should have acquired. Students can think of these as study guides. If they understand the concepts in the summary, know the terms, and have the skills, they're probably ready for the exam.

Ethics in Action. Students are often surprised to learn that Statistics is not just plugging numbers into formulas. Most statistical analyses require a fair amount of judgment. The best guidance for these judgments is that we make an honest and ethical attempt to learn the truth. Anything less than that can lead to poor and even dangerous decisions. The *Ethics in Action* vignettes in each chapter illustrate some of the judgments needed in statistical analyses, identify possible errors, link the issues to widely accepted ethical guidelines in Statistics, and then propose ethically and statistically sound alternative approaches.

Exercises. We've worked hard to ensure that exercises contain relevant, modern, and real-world questions. Many come from news stories; some come from recent research articles. Whenever possible, the data are on MyLab Business Statistics (always in a variety of formats) so students can explore them further. Sometimes, because of the size of the data set, the data are only available electronically. Throughout the book, we pair the exercises so that each odd-numbered exercise (with answer in the back of the book) is followed by an even-numbered exercise on the same Statistics topic. Exercises are roughly ordered within each chapter by both topic and by level of difficulty.

Data Sources. Most of the data used in examples and exercises are from real-world sources, and we list many sources in this edition. Whenever we can, we include references to the internet data sources used, often in the form of URLs. As internet users (and, thus, our students) know well, URLs can "break" as websites evolve. To minimize the impact of such changes, we point as high in the address tree as is practical. Moreover, the data themselves often change as more recent values become available. The data we use are usually on MyLab Business Statistics. If you seek the data—or an updated version of the data—on the internet, we try to direct you to a good starting point.

Technology Help. In business, Statistics is practised with computers, but not with a single software platform. Instead of emphasizing a particular statistics program, at the end of each chapter, we summarize what students can find in the most common packages, often with annotated output. We then offer specific guidance for one of the most common packages, Excel®, to help students get started with the software of their choice.