

# Preface

## About This Book

We believe firmly that analyzing data to uncover insight and meaning is one of the most important skills to prepare students for both the workplace and civic life. This is not a book about “statistics,” but is a book about understanding our world and, in particular, understanding how statistical inference and data analysis can improve the world by helping us see more clearly.

Since the first edition, we’ve seen the rise of a new science of data and been amazed by the power of data to improve our health, predict our weather, connect long-lost friends, run our households, and organize our lives. But we’ve also been concerned by data breaches, by a loss of privacy that can threaten our social structures, and by attempts to manipulate opinion.

This is not a book meant merely to teach students to interpret the statistical findings of others. We *do* teach that; we all need to learn to critically evaluate arguments, particularly arguments based on data. But more importantly, we wish to inspire students to examine data and make their own discoveries. This is a book about *doing*. We are not interested in a course to teach students to memorize formulas or to ask them to mindlessly carry out procedures. Students must learn to think critically with and about data, to communicate their findings to others, and to carefully evaluate others’ arguments.

## What’s New in the Third Edition

As educators and authors, we were strongly inspired by the spirit that created the Guidelines for Assessment and Instruction in Statistics Education (GAISE) (<http://amstat.org/asa/education/Guidelines-for-Assessment-and-Instruction-in-Statistics-Education-Reports.aspx>), which recommends that we

- teach statistical thinking, which includes teaching statistics as an investigative process and providing opportunities for students to engage in multivariate thinking;
- focus on conceptual understandings;
- integrate real data with a context and purpose;
- foster active learning;
- use technology to explore concepts and to analyze data;
- use assessments to improve and evaluate student learning.

These have guided the first two editions of the book. But the rise of data science has led us to rethink how we engage students with data, and so, in the third edition, we offer some new features that we hope will prepare students for working with the complex data that surrounds us.

More precisely, you’ll find

- An emphasis on what we call the Data Cycle, a device to guide students through the statistical investigation process. The Data Cycle includes four phases: Ask Questions, Consider Data, Analyze Data, and Interpret Data. A new marginal icon indicates when the Data Cycle is particularly relevant.
- An increased emphasis on formulating “statistical investigative questions” as an important first step in the Data Cycle. Previous editions have emphasized the other three steps, but we feel students need practice in formulating questions that will help them interpret data. To formulate questions is to engage in mathematical and statistical modeling, and this edition spends more time teaching this important skill.

- The end-of-chapter activities have been replaced by a series of “Data Projects.” These are self-guided activities that teach students important “data moves” that will help them navigate through the large and complex data sets that are so often found in the real world.
- The addition of a “Data Moves” icon. Some examples are based on extracts of data from much larger data sets. The Data Moves icon points students to these data sets and also indicate the “data moves” used to extract the data. We are indebted to Tim Erickson for the phrase “data moves” and the ideas that motivate it.
- A smoother and more refined approach to simulations in Chapter 5.
- Updated technology guides to match current hardware and software.
- Hundreds of new exercises.
- New and updated examples in each chapter.
- New and updated data sets, with the inclusion of more large data.

## Approach

Our text is concept-based, as opposed to method-based. We teach useful statistical methods, but we emphasize that applying the method is secondary to understanding the concept.

In the real world, computers do most of the heavy lifting for statisticians. We therefore adopt an approach that frees the instructor from having to teach tedious procedures and leaves more time for teaching deeper understanding of concepts. Accordingly, we present formulas as an aid to understanding the concepts, rather than as the focus of study.

We believe students need to learn how to

- Determine which statistical procedures are appropriate.
- Instruct the software to carry out the procedures.
- Interpret the output.

We understand that students will probably see only one type of statistical software in class. But we believe it is useful for students to compare output from several different sources, so in some examples we ask them to read output from two or more software packages.

## Coverage

The first two-thirds of this book are concept-driven and cover exploratory data analysis and inferential statistics—fundamental concepts that every introductory statistics student should learn. The final third of the book builds on that strong conceptual foundation and is more methods-based. It presents several popular statistical methods and more fully explores methods presented earlier, such as regression and data collection.

Our ordering of topics is guided by the process through which students should analyze data. First, they explore and describe data, possibly deciding that graphics and numerical summaries provide sufficient insight. Then they make generalizations (inferences) about the larger world.

**Chapters 1–4: Exploratory Data Analysis.** The first four chapters cover data collection and summary. Chapter 1 introduces the important topic of data collection and compares and contrasts observational studies with controlled experiments. This chapter also teaches students how to handle raw data so that the data can be uploaded to their statistical software. Chapters 2 and 3 discuss graphical and numerical summaries of single

variables based on samples. We emphasize that the purpose is not just to produce a graph or a number but, instead, to explain what those graphs and numbers say about the world. Chapter 4 introduces simple linear regression and presents it as a technique for providing graphical and numerical summaries of relationships between two numerical variables.

We feel strongly that introducing regression early in the text is beneficial in building student understanding of the applicability of statistics to real-world scenarios. After completing the chapters covering data collection and summary, students have acquired the skills and sophistication they need to describe two-variable associations and to generate informal hypotheses. Two-variable associations provide a rich context for class discussion and allow the course to move from fabricated problems (because one-variable analyses are relatively rare in the real world) to real problems that appear frequently in everyday life. We return to regression in Chapter 14, when we discuss statistical inference in the context of regression, which requires quite a bit of machinery. We feel that it would be a shame to delay until the end of the course all the insights that regression without inference can provide.

**Chapters 5–8: Inference.** These chapters teach the fundamental concepts of statistical inference. The main idea is that our data mirror the real world, but imperfectly; although our estimates are uncertain, under the right conditions we can quantify our uncertainty. Verifying that these conditions exist and understanding what happens if they are not satisfied are important themes of these chapters.

**Chapters 9–11: Methods.** Here we return to the themes covered earlier in the text and present them in a new context by introducing additional statistical methods, such as estimating population means, analyzing categorical variables, and analyzing relations between a numerical and a categorical variable. We also introduce multiple comparisons and use them to motivate the need for the statistical method of ANOVA.

**Chapters 12–14: Special Topics.** Students who have covered all topics up to this point will have a solid foundation in statistics. These final chapters build on that foundation and offer more details, as we explore the topics of designing controlled experiments, survey sampling, additional contexts for hypothesis testing, and using regression to make inferences about a population.

In Chapter 12 we provide guidance for reading scientific literature. Even if your schedule does not allow you to cover Chapter 12, we recommend using Section 12.3 to offer students the experience of critically examining real scientific papers.

## Organization

Our preferred order of progressing through the text is reflected in the Contents, but there are some alternative pathways as well.

**10-week Quarter.** The first eight chapters provide a full, one-quarter course in introductory statistics. If time remains, cover Sections 9.1 and 9.2 as well, so that students can solidify their understanding of confidence intervals and hypothesis tests by revisiting the topic with a new parameter.

**Proportions First.** Ask two statisticians, and you will get three opinions on whether it is best to teach means or proportions first. We have come down on the side of proportions for a variety of reasons. Proportions are much easier to find in popular news media (particularly around election time), so they can more readily be tied to students' everyday lives. Also, the mathematics and statistical theory are simpler; because there's no need to provide a separate estimate for the population standard deviation, inference is based on the Normal distribution, and no further approximations (that is, the  $t$ -distribution) are required. Hence, we can quickly get to the heart of the matter with fewer technical diversions.

The basic problem here is how to quantify the uncertainty involved in estimating a parameter and how to quantify the probability of making incorrect decisions when posing hypotheses. We cover these ideas in detail in the context of proportions. Students can then more easily learn how these same concepts are applied in the new context of means (and any other parameter they may need to estimate).

**Means First.** Conversely, many people feel that there is time for only one parameter and that this parameter should be the mean. For this alternative presentation, cover Chapters 6, 7, and 9, in that order. On this path, students learn about survey sampling and the terminology of inference (population vs. sample, parameter vs. statistic) and then tackle inference for the mean, including hypothesis testing.

To minimize the coverage of proportions, you might choose to cover Chapter 6, Section 7.1 (which treats the language and framework of statistical inference in detail), and then Chapter 9. Chapters 7 and 8 develop the concepts of statistical inference more slowly than Chapter 9, but essentially, Chapter 9 develops the same ideas in the context of the mean.

If you present Chapter 9 before Chapters 7 and 8, we recommend that you devote roughly twice as much time to Chapter 9 as you have devoted to previous chapters, because many challenging ideas are explored in this chapter. If you have already covered Chapters 7 and 8 thoroughly, Chapter 9 can be covered more quickly.

## Features

We've incorporated into this text a variety of features to aid student learning and to facilitate its use in any classroom.

### Integrating Technology

Modern statistics is inseparable from computers. We have worked to make this textbook accessible for any classroom, regardless of the level of in-class exposure to technology, while still remaining true to the demands of the analysis. We know that students sometimes do not have access to technology when doing homework, so many exercises provide output from software and ask students to interpret and critically evaluate that given output.

Using technology is important because it enables students to handle real data, and real data sets are often large and messy. The following features are designed to guide students.

- **TechTips** outline steps for performing calculations using TI-84<sup>®</sup> (including TI-84 + C<sup>®</sup>) graphing calculators, Excel<sup>®</sup>, Minitab<sup>®</sup>, and StatCrunch<sup>®</sup>. We do not want students to get stuck because they don't know how to reproduce the results we show in the book, so whenever a new method or procedure is introduced, an icon, , refers students to the TechTips section at the end of the chapter. Each set of TechTips contains at least one mini-example, so that students are not only learning to use the technology but also practicing data analysis and reinforcing ideas discussed in the text. Most of the provided TI-84 steps apply to all TI-84 calculators, but some are unique to the TI-84 + C calculator. Throughout the text, screenshots of TI calculators are labeled "TI-84" but are, in fact, from a TI-84 Plus C Silver Edition.
- All **data sets** used in the exposition and exercises are available at <http://www.pearsonhighered.com/mathstatsresources/>.

### Guiding Students

- Each chapter opens with a **Theme**. Beginners have difficulty seeing the forest for the trees, so we use a theme to give an overview of the chapter content.

- Each chapter begins by posing a real-world **Case Study**. At the end of the chapter, we show how techniques covered in the chapter helped solve the problem presented in the Case Study.
- **Margin Notes** draw attention to details that enhance student learning and reading comprehension.
  -  **Caution** notes provide warnings about common mistakes or misconceptions.
  -  **Looking Back** reminders refer students to earlier coverage of a topic.
  -  **Details** clarify or expand on a concept.
-  **Key Points** highlight essential concepts to draw special attention to them. Understanding these concepts is essential for progress.
-  **Snapshots** break down key statistical concepts introduced in the chapter, quickly summarizing each concept or procedure and indicating when and how it should be used.
-  **Data Moves** point students toward more complete source data.
- An abundance of worked-out **examples** model solutions to real-world problems relevant to students' lives. Each example is tied to an end-of-chapter exercise so that students can practice solving a similar problem and test their understanding. Within the exercise sets, the icon **TRY** indicates which problems are tied to worked-out examples in that chapter, and the numbers of those examples are indicated.
- The **Chapter Review** that concludes each chapter provides a list of important new terms, student learning objectives, a summary of the concepts and methods discussed, and sources for data, articles, and graphics referred to in the chapter.

## Active Learning

- Each chapter ends in a **Data Project**. These are activities designed for students to work alone or in pairs. Data analysis requires practice, and these sections, which grow increasingly more complex, are intended to guide students through basic “data moves” to help them find insight in complex data.
- All exercises are located at the end of the chapter. **Section Exercises** are designed to begin with a few basic problems that strengthen recall and assess basic knowledge, followed by mid-level exercises that ask more complex, open-ended questions. **Chapter Review Exercises** provide a comprehensive review of material covered throughout the chapter.

The exercises emphasize good statistical practice by requiring students to verify conditions, make suitable use of graphics, find numerical values, and interpret their findings in writing. All exercises are paired so that students can check their work on the odd-numbered exercise and then tackle the corresponding even-numbered exercise. The answers to all odd-numbered exercises appear in the back of the student edition of the text.

Challenging exercises, identified with an asterisk (\*), ask open-ended questions and sometimes require students to perform a complete statistical analysis.

- Most chapters include select exercises, marked with a **g** within the exercise set, to indicate that problem-solving help is available in the **Guided Exercises** section. If students need support while doing homework, they can turn to the Guided Exercises to see a step-by-step approach to solving the problem.

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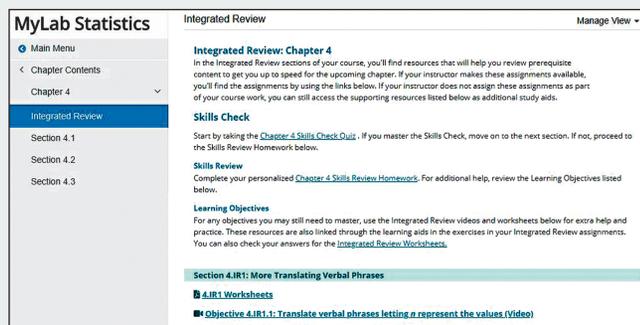
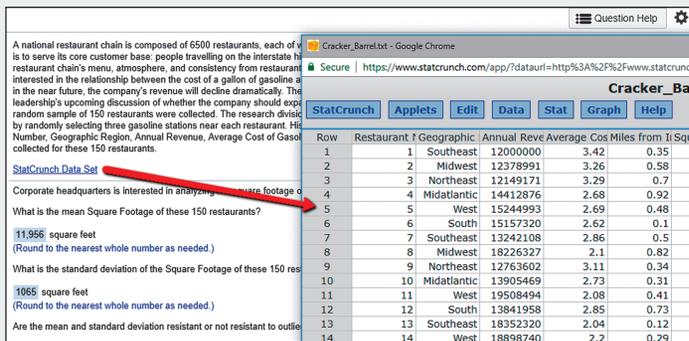
# MyLab Statistics Online Course for *Introductory Statistics: Exploring the World Through Data, 3e*

(Access Code Required)

MyLab™ Statistics 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 MyLab Statistics course, making learning the material as seamless as possible.

## NEW! Integrated Review

This MyLab includes a full suite of supporting Integrated Review resources for the Gould, *Introductory Statistics* course, including pre-made, assignable (and editable) quizzes to assess the prerequisite skills needed for each chapter, and personalized remediation for any gaps in skills that are identified. Each student, therefore, receives just the help that he or she needs—no more, no less.

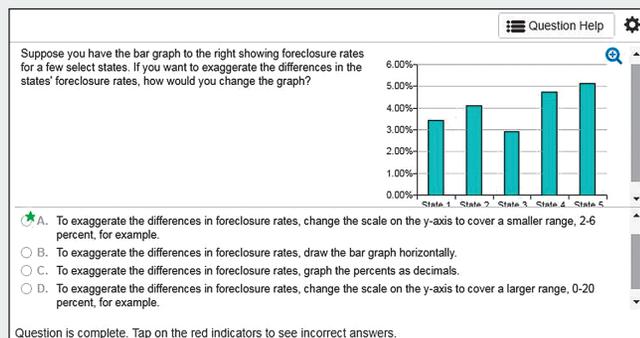
Row	Restaurant #	Geographic	Annual Reve	Average	Cos Miles from I	Sq
1	1	Southeast	12000000	3.42	0.35	
2	2	Midwest	12378991	3.26	0.58	
3	3	Northeast	12149171	3.29	0.7	
4	4	Midatlantic	14412876	2.68	0.92	
5	5	West	15244953	2.69	0.48	
6	6	South	15157320	2.62	0.11	
7	7	Southeast	13242108	2.86	0.5	
8	8	Midwest	18226327	2.1	0.82	
9	9	Northeast	12763602	3.11	0.34	
10	10	Midatlantic	13905469	2.73	0.31	
11	11	West	19508494	2.08	0.41	
12	12	South	13841958	2.85	0.73	
13	13	Southeast	18352320	2.04	0.12	
14	14	West	18898740	2.2	0.29	

## NEW! Data Projects

Data Projects from the text are assignable in MyLab Statistics and provide opportunities for students to practice statistical thinking beyond the classroom. **StatCrunch Projects** that either span the entire curriculum or focus on certain key concepts are also assignable in MyLab Statistics and encourage students to apply concepts to real situations and make data-informed decisions.

## UPDATED! Conceptual Questions

The Conceptual Question Library in MyLab Statistics includes 1,000 assignable questions that assess conceptual understanding. These questions are now correlated by chapter to make it easier than ever to navigate and assign these types of questions.



Suppose you have the bar graph to the right showing foreclosure rates for a few select states. If you want to exaggerate the differences in the states' foreclosure rates, how would you change the graph?

A. To exaggerate the differences in foreclosure rates, change the scale on the y-axis to cover a smaller range, 2-6 percent, for example.

B. To exaggerate the differences in foreclosure rates, draw the bar graph horizontally.

C. To exaggerate the differences in foreclosure rates, graph the percents as decimals.

D. To exaggerate the differences in foreclosure rates, change the scale on the y-axis to cover a larger range, 0-20 percent, for example.

Question is complete. Tap on the red indicators to see incorrect answers.

# Resources for Success

## Student Resources

### StatCrunch

StatCrunch® is powerful web-based statistical software that allows users to collect, crunch, and communicate with data. The vibrant online community offers tens of thousands of shared data sets for students and instructors to analyze, in addition to all of the data sets in the text or online homework. StatCrunch is integrated directly into MyLab Statistics or it can be purchased separately. Learn more at [www.statcrunch.com](http://www.statcrunch.com).

### Video Resources

Chapter Review videos walk students through solving some of the more complex problems and review key concepts from each chapter. Data Cycle of Everyday Things videos demonstrate for students that data collection and data analysis can be applied to answer questions about everyday life. StatTalk Videos, hosted by fun-loving statistician Andrew Vickers, demonstrate important statistical concepts through interesting stories and real-life events. Assessment questions for each video are also available.

### Data Sets

All data sets from the textbook are available in MyLab Statistics. They can be analyzed in StatCrunch or downloaded for use in other statistical software programs.

### Statistical Software Support

Instructors and students can copy data sets from the text and MyLab Statistics exercises directly into software such as StatCrunch or Excel®. Students can also access instructional support tools including tutorial videos, Study Cards, and manuals for a variety of statistical software programs including, StatCrunch, Excel, Minitab®, JMP®, R, SPSS, and TI 83/84 calculators.

### Student Solutions Manual

Written by James Lapp, this manual provides detailed, worked-out solutions to all odd-numbered text exercises. It is available in print and can be downloaded from MyLab Statistics. (ISBN-13: 978-0-13-518923-8; ISBN-10: 0-13-518923-3)

## Instructor Resources

### Instructor's Edition

Includes answers to all text exercises, as well as a set of Instructor Notes at the front of the text that offer chapter-by-chapter teaching suggestions and commentary. (ISBN-13: 978-0-13-516300-9; ISBN-10: 0-13-516300-5)

### Instructor Solutions Manual

Written by James Lapp, the Instructor Solutions Manual contains worked-out solutions to all text exercises. It can be downloaded from MyLab Statistics or from [www.pearson.com](http://www.pearson.com).

### PowerPoint Slides

PowerPoint slides provide an overview of each chapter, stressing important definitions and offering additional examples. They can be downloaded from MyLab Statistics or from [www.pearson.com](http://www.pearson.com).

### TestGen

TestGen® ([www.pearson.com/testgen](http://www.pearson.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, and modify test bank questions or add new questions. It is available for download from Pearson's online catalog, [www.pearson.com](http://www.pearson.com). The questions are also assignable in MyLab Statistics.

### Learning Catalytics

Now included in all MyLab Statistics courses, this student response tool uses students' smartphones, tablets, or laptops to engage them in more interactive tasks and thinking during lecture. Learning Catalytics™ fosters student engagement and peer-to-peer learning with real-time analytics. Access pre-built exercises created specifically for statistics.

### Question Libraries

In addition to StatCrunch Projects and the Conceptual Question Library, MyLab Statistics also includes a Getting Ready for Statistics library that contains more than 450 exercises on prerequisite topics.

## Statistical Software Bundle Options

### Minitab and Minitab Express™

Bundling Minitab software with educational materials ensures students have access to the software they need in the classroom, around campus, and at home. And having 12-month access to Minitab and Minitab Express ensures students can use the software for the duration of their course. ISBN 13: 978-0-13-445640-9  
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### JMP Student Edition

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An Excel add-in that enhances the analytical capabilities of Excel. XLSTAT is used by leading businesses and universities around the world. It is available to bundle with this text. For more information go to [www.pearsonhighered.com/xlstatupdate](http://www.pearsonhighered.com/xlstatupdate). (ISBN-13: 978-0-321-75940-5; ISBN-10: 0-321-75940-0)