## A Note to Students: How to Get the Most Out of This Text

I wrote this book for you. I have taught many, many Statistics students over the years, and they have taught me where students need help. This text is full of features to help you learn. Here are some important tips:

- 1. *Read the text*. My students have told me the book is easy to read and understand. Sometimes a student says to me, "I don't know how to do this exercise." If I'm in a tutorial and can't spend much time with each student, I sometimes point out a section and an example the student can read to help them understand. Usually, when I come back a few minutes later, the student is happily doing the exercise that was previously a stumbling block. This book can help you!
- 2. Do all of the exercises. You can learn statistical techniques only if you practise them. Depending on the approach your instructor has chosen, you will find solutions to at least the odd-numbered exercises in the Study Plan of the MyStatLab that accompanies this text. Don't ignore MyStatLab as a learning tool, even if your professor chooses not to use MyStatLab in your course evaluation. Start by taking the sample test for a chapter, and then use the Study Plan that guides you to areas where you need to do more work. From inside the Study Plan, you will have access to guided solutions and examples to help you learn.
- 3. *Rely on the Guides*. Guide to Technique and Guide to Decision Making features throughout the text will remind you of all the things you need to do and think about when performing certain tasks. The decision-making guides also point you to specific examples in

the text (with page numbers). You can find the guides quickly by looking at the detailed table of contents, or the Table of Guides on p. xiv.

- 4. *Refer to the Table of Examples.* On page xvii, you will find a list of all of the Examples in the book. If you need to look up how to do something, check there.
- 5. *Refer to the Table of Excel Instructions and Excel Templates.* On page xv, you will find a list of Excel instructions and descriptions of Excel templates. Use this list to quickly find what you need to know about Excel. Also, see Using Microsoft<sup>®</sup> Excel for Analyzing Data and Making Decisions (page xxvi) if you have any questions about how to find Excel templates or data sets, or how to install Excel add-ins.
- 6. *Refer to the Guide to the Descriptive and Inferential Techniques of Analyzing Data and Making Decisions, inside the formula card at the front of the book.* This overall guide to all the descriptive and inferential techniques in the text will direct you to specific chapter(s) for reference. Then you can use the detailed table of contents to locate the correct technique for the decision you need to make. If you know what type of data you have (data types are explained at the beginning of Chapter 2) and what type of decision you have to make, chapter and section headings will lead you directly to the technique you should use.

Finally, keep at it. Persist, practise, get help when you are stuck on something, and keep working. I wish you the best of luck with the material in this text, and most of all, I hope that you will learn enough to confidently analyze data and make better decisions.

## Preface

Many students (and professors) responded positively to the common-sense approach and plain language in the first edition of *Analyzing Data and Making Decisions*. The second edition retains the primary focus on decisions to be made, which motivates the discussion of statistical tools. Check the table of contents for most Statistics texts and you will see a list of tools, which isn't particularly useful if you are a student who hasn't yet learned how the tools are used. Check the table of contents of this text and you will see a list of decisions—a more natural organizing principle that is much easier for students to understand.

### NEW TO THIS EDITION

**Expanded Content** The content of the second edition is expanded with two new chapters:

- Chapter 11, Making Decisions with Three or More Samples, Quantitative Data—Analysis of Variance (ANOVA) covers Analysis of Variance techniques.
- Chapter 14, Analyzing Linear Relationships, Two or More Variables covers multiple regression, including the use of indicator variables.

**Instructions, Add-Ins, and Templates for Excel 2007** The text provides detailed instructions for using Excel 2007, with many new and updated illustrations of menus and dialogue boxes. (Note that Excel 2003 instructions are still available in MyStatLab.) New and updated Excel add-ins and templates are also available in MyStatLab. As before, the add-ins are designed specifically for this text and are tied directly to the textbook content.

**Integration with MyStatLab** MyStatLab content is now explicitly tied to the exercises in the text. Chapter Review

Exercises with red numbers are available for practice in MyStatLab and guided solutions are available. Furthermore, solutions to all of the odd-numbered Develop Your Skills and Chapter Review Exercises are now available to students through the MyStatLab Study Plan. Excel data files, add-ins, and templates are also included in the Study Plan (no more searching for lost CDs!). Instructor resources such as PowerPoint slides and full solutions are also available to professors through the Pearson Canada Inc. website (http://vig.pearsoned.ca).

**New Design** The second edition has a fresh and streamlined design, aimed at highlighting important features such as the Guide to Technique and Guide to Decision Making boxes. Examples (which students often use for reference) now stand out clearly in the text. The annotations and Table of Examples remain as guideposts for students. As before, there is a list of Excel instructions and templates for quick reference. Note that the Guide to Decision Making features now indicate related example(s), which should help students who need more detailed guidance on a particular technique.

**Updated and Reorganized Exercises** The second edition contains many new exercises, many of them based on items from the news or on Statistics Canada data. As well, the Chapter Review Exercises are now organized into four sections: *Warm-Up Exercises, Think and Decide* (which can be done without a computer), *Think and Decide Using Excel,* and *Test Your Knowledge* (containing capstone exercises).

## ORGANIZATION

Part I provides a general overview of how data can be used to make better decisions. Part II covers the use of graphs, tables, and numbers to describe and summarize data. Part III introduces students to the building blocks of inferential statistics. Part IV applies these concepts to a series of hypothesis tests with associated confidence intervals. Part V discusses analyzing relationships and includes both simple linear and multiple regression.

This book could be used as a foundation for a number of different statistics courses. I have designed Chapter 1 as a basic building block for any selection of topics covered in the book.

I have included coverage of non-parametric methods for non-normal quantitative data and ranked data in this textbook. Some introductory courses do not cover these topics; while this omission may be a necessary one, it is also one that may leave some students thinking that all quantitative data are normal! It is possible to use the text without covering these topics and without losing continuity.

## **FEATURES**

a) This book is designed first as a learning tool. I have presented a discussion of each new technique so that it flows naturally from the discussion that precedes it, which will allow students to make connections and build on previous knowledge.

I have included the following features to promote an ease of learning:

- Introduction and Learning Objectives. Each chapter begins with a list of learning objectives, which provide an overview of the chapter content. The Introduction provides context for the chapter material by describing a business problem or problems relevant to the chapter's theme.
- Develop Your Skills Exercises. At the end of every chapter section are questions designed to test and reinforce students' understanding of the material up to that point. I have developed the questions so that they are generally at the level of the examples I present in that section and provide immediate reinforcement of the material.
- Chapter Review Exercises. Every chapter has a set of exercises designed to test and reinforce students' understanding of all of the chapter content. These questions

require them to choose and apply the techniques in each chapter, but with no particular guidance about *which* technique to use. I have created these exercises so that in some instances they serve as building blocks for later discussions. All of the exercises are meaningful in the sense that they deal with realistic business problems or topics directly relevant to students' lives.

In the second edition, Chapter Review Exercises are organized into four sections: *Warm-Up Exercises, Think and Decide, Think and Decide Using Excel, and Test Your* Knowledge.

• Guide to Technique and Guide to Decision Making. The Guide to Technique boxes and Guide to Decision Making boxes summarize the steps involved in certain important statistical tasks. For example, in Chapter 2, I have included a Guide to Technique box that covers the comparison of histograms (see page 60). All of the hypothesis tests covered in this text are summarized in a Guide to Decision Making. These Guides summarize the type of data used and the type of decision involved in the test as well as all of the steps required to complete it. For an example see Guide to Decision Making: *Matched Pairs, Quantitative Data, Normal Differences— The t-Test to Decide About the Average Population Difference* ( $\mu_D$ ) These guides are listed in the detailed table of contents for easy reference.

#### GUIDE TO TECHNIQUE



#### GUIDE TO DECISION MAKING

Matched Pairs, Quantitative Data, Normal Differences—The *t*-Test to Decide About the Average Population Difference  $(\mu_{n})$ 

When:

- matched pairs of quantitative data with normally distributed differences • trying to make a decision about the average difference,  $\mu_D$  on the basis of  $\bar{x}_D$ , the average of the sample differences
- Steps: 1. Specify H<sub>0</sub>, the null hypothesis, which will be  $\mu_0 = 0$ . Specify your hypotheses in words that reflect the context of the problem.

- b) This book is also designed as a reference tool. Students will find the following features particularly helpful.
  - **Chapter Summaries.** At the end of each chapter I have included a comprehensive summary of the chapter content. Students who have a firm grasp of what the chapter has covered will be able to use the summary for review and as a reference.
  - · Meaningful Chapter and Section Headings. Students sometimes struggle to figure out which technique to apply to a particular problem; it is my hope with this book that this decision will actually prove to be quite simple to make. I have created descriptive chapter and section headings that convey the information students need to choose the correct statistical technique. For example, instead of a traditional title such as "Chi-Square Tests," I use "Comparing Many Population Proportions" in Chapter 12. Students will find the listing of the first and second-level headings in the detailed table of contents in this text a useful reference. The new Guide to the Descriptive and Inferential Techniques of Analyzing Data and Making Decisions, located in the formula card at the beginning of the text, also provides an overview of all of the techniques described in the text.
  - Annotated Examples. Every chapter has one or more examples that work through each of the statistical techniques I present. Each example also features a margin note, which describes what the example is about. Students will find the examples helpful references as they work through the Develop Your Skills and Chapter Review Exercises in each chapter. A list of the examples and their annotations can be found on p. xvii.

EXAMPLE <b>6.3B</b>	
Using the sampling distribution of $\hat{p}$ to make a decision about a popula- tion proportion	Suppose that the acceptable proportion of dented cans in the paint factory is 5%. Eleanor Bennett examines a random sample of 500 cans and finds that 6% of them are dented. What action should Eleanor take?
	It is likely that the sample of 500 cans is not more than 5% of the total population of paint cans. Therefore, even though the sampling is done without replacement, it is still appropriate to use the binomial distribution as the underlying probability model. Check the conditions:
	$np = 500(0.05) = 25 \ge 10$ $nq = 500(0.95) = 475 \ge 10$

• Carefully Designed Statistical Tables. Some of the tables in this text are presented using a non-standard approach so that they are easier for students to use and understand. For example, many books confine a normal table to one page and feature only the areas to the right of the mean. This design requires students to go through unnecessary mental hoops when doing

normal probability calculations. In this book I have presented the table over two pages, which shows the areas to the left of the mean as well as to the right. Providing this additional information simplifies normal probability calculations for students and it means the presentation matches the way Excel calculates and displays normal probabilities.

- c) Computers should make statistical analysis easier, not harder. Therefore, I have taken care to include several features that will ease students' introduction to using Excel for statistical analysis.
  - Excel Data Sets. I have created a number of data sets in Excel, which will allow students to work through the statistical techniques presented in the book. I have included data sets to accompany specific examples, Develop Your Skills questions, chapter-section discussions, and Chapter Review Exercises. All of the data sets are available in the Study Plan in MyStatLab. Availability of a data set is highlighted with an Excel data set icon in the margin.



• Excel Instructions. Detailed instructions about how to use Excel appear throughout. I have included screen captures of Excel dialogue boxes so that students can clearly see how to use Excel functions (highlighted in red text) and add-ins. Each instance is highlighted with an Excel icon in the margin and detailed instructions are highlighted with a red line in the margin. The Excel instructions presume students have only a limited prior knowledge of Excel. A list of Excel instructions and templates follows this preface (p. xxiii).



• Excel Templates. I have included Excel templates that automate the calculations required for the hypothesis tests and confidence intervals I have included in this textbook. You will find the templates in the Study Plan in MyStatlab. The templates are easy for students to use and feature cells that require input shaded in blue. The templates will remind students to check necessary conditions before proceeding with their calculations.



d) This book is not merely a Canadianized version of an American book. It is Canadian through and through, featuring Canadian examples, measurements, and references.

**Excel Add-ins** There are two distinct sets of Excel addins provided in MyStatLab. *Non-Parametric Tools* helps students calculate:

- · counts of positive and negative differences for the Sign Test
- rank sums for the Wilcoxon Rank Sum Test, or the Wilcoxon Signed Rank Sum Test
- the Spearman Rank Correlation Coefficient
- · Chi-square expected values for contingency tables

Multiple Regression Tools provides:

- models and summary measures for all possible regressions, with 2 to 8 explanatory variables
- regression prediction and confidence intervals, for models with 1 to 8 explanatory variables

## **SUPPLEMENTS**

- **Instructor's Solutions Manual.** Full and detailed solutions are provided for all of the Develop Your Skills and Chapter Review Exercises in the book. The solutions are "teaching" solutions that justify choice of technique and approach.
- **PowerPoint**<sup>®</sup> **Slides.** Properly designed with appropriate animations, PowerPoint slides can be very helpful to illustrate concepts. I recommend that you preview the slides that accompany this book before they are used in class. The animations can be very helpful, but not if they come as a surprise to the professor! The time spent in preparing them for your needs will yield real rewards in student learning.
- **Instructor's Resource Manual.** The Instructor's Resource Manual provides more detailed background for the discussion in the text. For example, occasionally a student will ask a professor to prove that

$$s = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}} = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

The IRM contains a suggested approach to proving this formula.

Where appropriate, I provide further explanation for the approaches I use in this text. For example, in Chapter 10, I recommend the unequal variances approach to the *t*-test of means as the default. I have provided an explanation for this approach in Chapter 10 of the Instructor's Resource Manual.

• Pearson Education Canada TestGen. This powerful computerized testing package contains more than 600 multiple-choice, true/false, and short answer questions. Each question includes a correct answer, a skill and difficulty level rating, a chapter section reference, and a text page reference. This state-of-the-art software package in the Windows platform enables instructors to create tailor-made, error-free tests quickly and easily. The Custom Test allows instructors to create an exam, administer it traditionally or online, and evaluate and track students' results—all with the click of the mouse.

### ACKNOWLEDGMENTS

Any textbook is built of a mind-boggling number of detailed elements. Getting them all down on the page with precision and style requires dedicated efforts from a whole team of people. I would like to thank all the people at Pearson Canada who helped me make this book a reality: Gary Bennett, Vice President, Editorial Director; Carolin Sweig, Sponsoring Editor; John Lewis, Developmental Editor; Laura Neves and Cheryl Jackson, Production Editors; Lynn O'Rourke and Cheryl Jackson, Production Coordinators; Anthony Leung, Designer; Jennifer McIntyre, Copy Editor; Melanie Christian, Technical Reviewer; Linda Jenkins and Susan Bindernagel, Proofreaders; and Sandy Cooke, Permissions Researcher.

As well, I want to again thank my friend and colleague Dan Phillips for updating the Excel add-ins and writing a whole new set for the second edition.

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- Michael Conte, Durham College
- Torben Drewes, Trent University
- Jim Graham, Dawson College
- Dave Kennedy, Lethbridge College
- Gerry Kowalchuk, Lethbridge College
- Eugene Li, Langara College
- · Doug MacDormand, Red Deer College
- Don St. Jean, George Brown College
- Oded Tal, Conestoga College

Finally, as always, I would like to thank the students who have attended my statistics classes over the years. I continue to learn from them.

Judith Skuce 2009

## Using Microsoft<sup>®</sup> Excel for Analyzing Data and Making Decisions

Throughout this text, Microsoft Excel is the software that illustrates how the computer can be used to do statistical analysis. When you are learning new techniques, it is useful to do some of the analysis and calculations by hand (with a calculator), and you will probably have to do calculations with only a calculator in test and exam situations. However, no one actually does much statistical analysis without the use of a computer. Using a computer is an integral part of the techniques discussed in this text.

## WHY EXCEL?



The Microsoft<sup>®</sup> Office software suite is widely used, in business and elsewhere. You probably already have some experience with Excel, and it is highly likely that this software is available to you at the educational institution where you are studying. It is also quite likely that Excel will be available to you in your workplace. For reasons of familiarity and availability, Excel was chosen to illustrate computer-based approaches to analyzing data and making decisions. Some basic facility with Excel is assumed (basic formulas, and use of Excel functions).

Excel has a built-in set of **Data Analysis** tools, which are used throughout the text. The standard installation of Excel does not usually include the **Data Analysis** tools. Follow these steps to activate them.

#### In Excel:

 Click on the Office button, and then click on Excel Options.

**Excel Options** is at the bottom of the Office button menu, as shown in Exhibit 2.

2. Click on **Add-Ins**. This will activate a window showing active and inactive application add-ins. At the bottom of the window, there is an option to manage Excel add-ins (see the illustration in Exhibit 3).

Click **<u>Go</u>**..., which will activate a window similar to what is shown in Exhibit 4 (it may not be exactly the same).

 Put a tick mark beside Analysis ToolPak. Click OK. You may be asked for your installation disks for Excel.

After you complete these steps, you will find **Data Analysis** available under the **Data** tab in the **Analysis** area. See Exhibit 5. Later in this text, you will be introduced to some of the **Data Analysis** tools.

While Excel is useful for an introductory course in statistics, it has some limitations. The MyStatLab that accompanies this text includes some additional Excel tools, described in following sections. As well, you should be aware that Excel does not always handle missing data correctly. You should always examine your data sets carefully, and adjust for missing data. Some of Excel's routines

### **EXHIBIT 1**



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### EXHIBIT 3

#### Manage Excel Add-Ins

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#### EXHIBIT 5



produce unacceptable graphs (the histogram is one example). In any case where Excel's limitations could be a problem for the techniques covered here, advice is provided in the text. If you carry on in your study of statistics, you should consider learning how to use specialized statistical software.

Even if you choose to use another statistical analysis software package, the methods and concepts discussed in this book will still be helpful. Although your software output may look a little different from the Excel output described in the book, it will probably contain the same elements.



The calculations required to analyze data or make decisions are repetitive. In some cases, Excel provides automatic functions to do some of the calculation required. In other cases, Excel formulas must be developed. A number of Excel

cases, Excel formulas must be developed. A number of Excel templates with built-in formulas have been designed to assist you. The templates are provided in an Excel workbook called Excel Templates in the Study Plan in MyStatLab. When you open this workbook you will see the individual templates organized by worksheet (see the worksheet tabs to locate the template you want). You will find instructions for selecting and using the Excel Templates workbook in Chapters 2, 7, 8, 9, 10, 12, 13, and 14.

The templates contain some cells that require input from the user, and these cells are always shaded blue. Other cells contain formulas, and you should take care not to accidentally overwrite them. (The Excel worksheets are not protected, so that you can copy and paste the templates into the spreadsheets that contain the data you are analyzing, if you wish.) You can view the formulas, and if you have some experience with Excel, you should be able to see the direct correspondence between them and your manual calculations.

## ADDITIONAL EXCEL ADD-INS

In the Study Plan in MyStatLab you will find files for additional add-ins for procedures not covered in the standard **Data Analysis** tools:

- Non-Parametric Tools. These add-ins provide calculations for non-parametric methods: the sign test, the Wilcoxon rank sum text, the Wilcoxon signed rank sum test, the Spearman rank correlation coefficient, and Chi-squared expected values. The add-ins automate calculations that would be time-consuming to do by hand for large data sets. The results of the calculations can then be input into the appropriate templates. Instructions for using the add-ins are included in the text, and there are also **Help** buttons to assist you.
- Multiple Regression Tools. These add-ins allow you to analyze and use linear relationships with one or more explanatory variables. They enable you to do all possible regressions for 2 to 8 explanatory variables, and create regression prediction and confidence intervals for models with 1 to 8 explanatory variables. Instructions for using add-ins are included in the text, and there are also **Help** buttons to assist you.

You may wish to install only one or both of the add-ins, depending on the material being covered in your course. When you see references to either of these add-ins in the text, you will need to install them.

The instructions for installing the add-ins are as follows.

- 1. Locate the files called *Non\_Parametric\_Tools\_ver2* and *Multiple\_Regression\_Tools* in the Study Plan in MyStatLab and then copy the files to your computer, taking note of where you put them (or, you may choose to just download and install one of the add-ins). If you know where other Excel add-ins are located in your file system, put the files in the same directory (but the files can be located anywhere).
- Start Excel and click on the Office button, and then click on Excel Options (see Exhibits 1 and 2 above).
- 3. Click on **Add-Ins**. This will activate a window showing active and inactive application add-ins. At the bottom of the window, there is an option to manage Excel add-ins (see Exhibit 3, above).
- 4. Click GO ..., which will activate a window similar to Exhibit 4, above. If Non-parametric Tools and Multiple\_Regression\_Tools are included in the list of add-ins, tick the boxes next to them, click OK, and you are done! If the add-ins do not appear in the list, select Browse, locate and select the Non\_Parametric\_Tools and Multiple\_Regression\_Tools files (according to your note in Step 1), and click OK.
- 5. You will now be returned to the **Add-Ins** dialogue box. **Non-Parametric Tools** and **Multiple\_Regression\_Tools** should now appear in the "Add-Ins available:" list. Tick the boxes next to them and click **OK**.

Now that you are back to the usual view of Excel, you will find the non-parametric tools and multiple regression tools under the **Add-Ins** tab (see Exhibit 6). These tools are described in more detail in Chapters 9, 10, 12, 13, and 14.

#### EXHIBIT 6

Non Parametric Tools and Multiple Regression Tools



## EXCEL DATA SETS 🏠



The data sets referenced in the text are available as Excel spreadsheets in the Study Plan in MyStatLab. Data set files have been created for examples and exercises in Chapters 1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, and 14.

If a data set file is required to illustrate an example or for you to complete an exercise, you will find a data set icon in the margin with the file name. The file names have specific prefixes to help you identify them.

- The prefix "DYS" corresponds to the exercises in the Develop Your Skills sections (for example, DYS02-6).
- The prefix "CRE" corresponds to the Chapter Review Exercises (for example, CRE02-16).

- The prefix "EXA" corresponds to examples in the text. For example, if a data set is available for Example 2.2a, the file is labelled EXA02-2a.
- The prefix "SEC" is used when the data set is used in the general discussion in a particular section of the text. For example, a data set is introduced in Section 2.1, and it is labelled SEC02-1.

Sometimes the same data file is used in a number of exercises. As a result, the same data set can have a number of different file names, one for each of the locations where the data set is used. This labelling system is designed to make it very easy for you to find the corresponding Excel files.

# Analyzing Data and Making Decisions Statistics for Business