Business Statistics

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AUSTRALIA / NEW ZEALAND

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Business Statistics: Australia and New Zealand
6th Edition
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Preface

Business is complex and requires effective management to succeed. Managing complexity requires many skills. There are more competitors, more places to sell products and more places to locate workers. As a consequence, effective decision making is more crucial than ever before. On the other hand, nowadays managers have more access to larger and more detailed data that are potential sources of information for making well-informed objective decisions. However, to achieve this, potential managers need to know which statistical techniques they should use to extract useful information from the data available to them and make informed decisions. For students preparing for the business world, it is not enough to focus merely on mastering a diverse set of statistical techniques and calculations. A course and its recommended textbook must provide a complete picture of statistical concepts and their applications to the real world. *Business Statistics – Australia and New Zealand* is designed to demonstrate that statistical methods are vital tools for today's businesses and managers to improve their decision-making skills.

This book is a thorough Australasian adaptation of the most popular and best-selling United States (US) text, *Statistics for Management and Economics* (9th edition) by Gerald Keller. This edition is a further attempt to make the basic business and economics statistics subject a more effective and enjoyable learning experience for both instructors and students at Australasian universities. It uses familiar local terminology, together with examples, exercises and cases which draw upon Australasian data. To enhance flexibility, we have also rearranged a number of chapters from the US edition. For example, we have incorporated the data collection chapter with types of data at the start of the book, introduce estimation and hypothesis testing in separate chapters, present inference about population variance in another chapter and single population and two or more populations in different chapters. Furthermore, we have included a chapter on index numbers which includes some important topics such as the construction of the Australian Consumer Price Index, as well as comparison of Laspeyres and Paasche index numbers, etc.

When solving problems, *Business Statistics – Australia and New Zealand* uses its unique 'ICI' approach which is renowned for its consistent, proven three-step method to solving problems. The '*Identify*, *Compute* and *Interpret*' approach teaches you how to determine the appropriate technique, how to compute the statistics and how to interpret the results in the context of the problem at hand. The *compute* stage can be completed either manually (with the aid of a calculator) or using Excel (on the computer), or both.

Today, most subjects use the computer and statistical software or spreadsheets. This book contains step-by-step instructions and commands, with screen images, to teach students how to use Microsoft Excel® to solve statistical problems. Additionally, most examples, exercises and cases feature raw data. These data sets are available to download from the **CourseMate for Business Statistics** website, accessible through http://login.cengage.com using the access card that comes with each new copy of this book.

Key features of our approach

1. Systematic approach

This edition retains the systematic approach introduced in the US edition, which teaches students how to recognise which statistical technique to use. We believe that this skill is

the most important one to develop, yet it is the one students have the greatest difficulty in mastering. As each technique is introduced, we demonstrate how to recognise when its use is appropriate and when it is not. A feature of this approach is the review chapter (Chapter 22) presented in the book that allows students to hone their technique-selection skills. In the review chapter, a flowchart develops the logical process for choosing the correct technique. Our ICI approach divides the solution of statistical problems into three parts: (1) identify the technique; (2) calculate/compute the required sample statistics; and (3) interpret the results. Our focus has been on the first and third parts, as the sample statistics could be produced relatively easily with a computer.

When demonstrating examples, we start the solutions by reviewing the appropriateness of the method to be used. One of the main benefits of our approach is that it allows instructors to de-emphasise mathematical manipulation. Consequently, students can spend more time properly setting up the procedure and interpreting the statistical results, and less time grinding out the arithmetic.

For students without access to a computer and statistical software, we continue to teach how to calculate statistics manually (with the exception of the most complicated procedures), and most exercises can be solved in this way.

2. Cases

Recent academic conferences devoted to improving the teaching of applied statistics have advocated the use of cases to help motivate students. In practice, a statistician often has access only to raw data and the correct procedure to employ is not obvious; our approach allows us to offer more realistic applications. In fact, many of the cases are based on real studies that have been reported in newspapers, magazines, journals, on television and at academic conferences. Several from our own consulting projects have also been included. Such applications can motivate students, who unfortunately often believe that statistics is not very relevant to their future careers. We believe that our approach can change these attitudes. More than 80 cases are included in the book. Students are expected to analyse the cases and draw conclusions in the same way as the original authors did. These cases are neither summaries of what a particular statistician did to solve a problem, nor glorified exercises; rather, they give students the opportunity to see for themselves how statistical problem solving works.

3. Review chapter

The review chapter is included in the book to help students practise identifying the correct techniques. This chapter reviews all the statistical methods covered in the book and provides exercises and cases that require the use of several different statistical procedures. It, therefore, provides practice in the technique identification skills that are required for statistics exams and, ultimately, in any real-life application of statistics.

4. Use of Excel

Because the use of spreadsheets is so widespread, we believe that Microsoft® Excel is an important addition to this book. However, spreadsheets are not designed for use as statistical software, although they are increasingly capable in data analysis. Because of this limitation, we offer *Data Analysis Plus*® macros and workbooks that can be added to the Excel menu and used to solve sophisticated statistical problems beyond Excel's existing capabilities. Excel macros are created to complement Excel's menu of statistical procedures. All statistical techniques introduced in this book can be calculated using either Excel's *Analysis ToolPak* or

Data Analysis Plus 9.0® which is compatible with Excel 2010. These macros are available to download from the **CourseMate for Business Statistics** website, accessible through http://login.cengagebrain.com using the access card that comes with each new copy of this book. The CD–ROM also contains Version 7.0 of *Data Analysis Plus*® which is compatible with previous versions of Excel.

The Excel spreadsheet package is used extensively and presented consistently throughout the book to calculate sample statistics. Most examples in the chapters present manual and using the computer (Excel) solutions, allowing students to see both methods together and to use the preferred method. This feature provides flexibility, allowing the instructor to decide when manual or computer calculations should be emphasised. Detailed instructions and Excel commands provided for the examples make it easy for instructors and students to make use of the computer. They also eliminate the need for instructors to teach how to use the software.

Data files are provided in Excel format for most of the examples, exercises and cases. The sixth edition includes hundreds of data files, some consisting of thousands of observations, which emphasise a central theme in the book – statistical techniques convert data into information. For students who will conduct statistical analyses manually, we have also provided the summary statistics (e.g. means and variances) for exercises, allowing most exercises to be solved manually.

5. Exercises

There are over 1500 exercises of varying levels of difficulty. At the end of most sections we supply, under the heading 'Learning the techniques', exercises that help students to learn the arithmetic involved in a specific procedure. 'Applying the techniques' exercises then stress when and why the technique is used and how the results assist in the decision-making process. 'Computer applications' help students gain hands-on experience in applying the techniques to solve problems using real-world data and Microsoft® Excel. Supplementary exercises appear at the end of each chapter. As they cover all the topics presented in that chapter, they allow students to practise identifying which of the techniques encountered in that chapter should be employed. They also tend to be more realistic than the other types of exercises.

We are optimistic that the systematic approach used in this book will be successful in helping students to understand how, when and why statistics are used. We hope that the realistic examples, exercises and cases we present, wherever possible with Australasian data, will make the subject more interesting and will persuade students that statistics can play a vital role in managerial decision making.

This text is suitable for a one- or two-semester subject in a business program. Although various sections can be omitted, we strongly urge instructors to attempt to complete most of the statistical inference part of the book. Like a house under construction, the structure of the systematic approach is stronger when most of the various components are in place. Nonetheless, the book has been designed so that chapters can be omitted relatively easily.

Unique features

- *Chapter opening examples* illustrate the use of techniques introduced in that chapter. These examples are designed to help students learn the concepts in the chapters. These chapter opening examples are revisited at the relevant section of the chapter, where they are solved.
- *'Seeing statistics' boxes* refer to applets that are introduced to illustrate statistical concepts visually. They are adapted from *Seeing Statistics* by Gary McClelland and customised to

this text. Nineteen Java applets with a total of 72 applet exercises are available to download from the **CourseMate for Business Statistics** website, accessible through http://login.cengagebrain.com using the access card that comes with each new copy of this book.

- *In addition to the examples provided in each chapter*, in this edition we have included 'Real-life applications' sections which illustrate the fundamental applications of statistics in finance, marketing, human resources management, operations management, accounting and economics.
- *'Key concept' boxes* are included after each technique has been introduced. These boxes will allow students to see a technique's essential requirements, in addition to giving them a way to easily review their understanding. This will be further enhanced by the summary flowchart presented in the review chapter.
- *Several new exercises are added to each chapter*. In particular, new applied exercises are added to the chapter on probability to help students visualise and understand concepts.
- *Several new data sets* have been added to the existing computer exercises section of each chapter. For those students who wish to solve the computer exercises containing data sets manually, summary statistics to these data sets are provided within each exercise.
- *Improved and expanded Data Analysis Plus® add-ins for Excel* have been incorporated.
- *In addition to the applets*, we have included several Excel workbooks that feature worksheets for confidence interval estimators and test statistics. By changing one or more inputs, students can learn, for example, the effect of increasing sample sizes on confidence intervals or on test statistics.
- Appendix A: Summary solutions for selected exercises is available in the book.

Resources guide

As you read this text you will find a number of features in every chapter to enhance your study of ***Business Statistics 6e*** and help you understand how the theory is applied in the real world.

Part opening paragraphs introduce the chapters in each Part to give you an overview of how the chapters relate to each other.

Learning objectives give you a clear sense of what each chapter will cover and what you should be able to do after reading the chapter.


PART ONE

Descriptive measures and probability

Chapter 3 Graphical descriptive techniques – Nominal data
Chapter 4 Graphical descriptive techniques – Numerical data
Chapter 5 Numerical descriptive measures
Chapter 6 Probability
Chapter 7 Random variables and discrete probability distributions
Chapter 8 Continuous probability distributions

To help you organise the material that you are about to learn, we have divided the rest of the book into three parts.

Part 1 covers descriptive statistics and probability. These topics constitute the foundation of statistical inference. Chapter 3 introduces the graphical techniques for nominal data and Chapter 4 deals with graphical techniques for numerical data. Chapter 5 presents numerical measures, which are used to summarise data. The summary measures introduced in Chapter 5 will be used to make inferences about parameters in later chapters. In Chapters 6 to 8, we present probability and probability distributions that will provide the link between sample statistics and population parameters.

Everything we do in this book is mostly built upon these six chapters. However, Part 1 does much more than just lay the foundation. Both descriptive statistics and probability are subjects that are worth learning for their own intrinsic values.

We all make decisions on a daily basis, most of which are made under uncertainty. Consider an investor who must decide which investment to make, how much money to invest and for how long that investment should be held. There are a large number of events over which the investor has no control. All that the investor can do is attempt to assess the risks and returns associated with each investment. As you will discover, probability plays a central role in this assessment.

We believe that all business and economics graduates will have many opportunities to apply statistical inference techniques and concepts. However, not all of them will do so because of a lack of either knowledge (despite the best efforts of statistics lecturers) or confidence. Descriptive techniques are so common that it is virtually impossible to ignore them. Newspapers, magazines, company annual reports and presentations are filled with applications of descriptive statistics. Knowing how to use and interpret them is a critical skill for all of us.


2

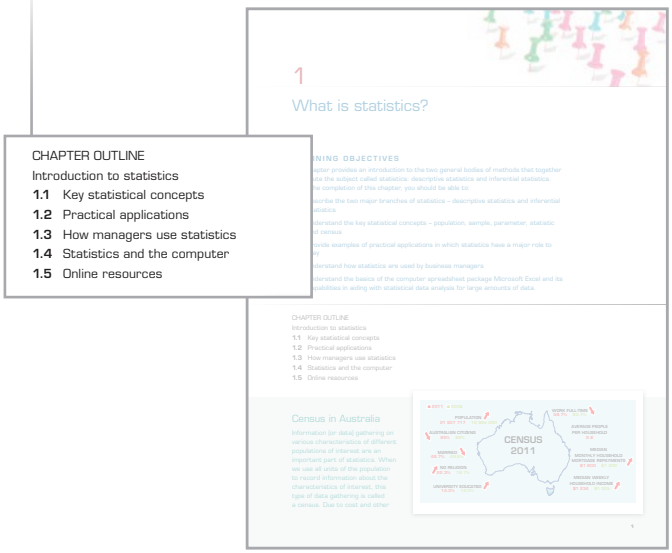
Types of data, data collection and sampling

LEARNING OBJECTIVES

This chapter discusses the types of data and various methods of collecting data.
At the completion of this chapter, you should be able to:

LO1 describe different types of data
LO2 understand the primary and secondary sources of statistical data
LO3 explain the various methods of collecting data
LO4 explain the basic sampling plans
LO5 identify the appropriate sampling plan for data collection in a particular experiment
LO6 understand the main types of errors involved in sampling.

Chapter outlines at the start of each chapter demonstrate the key concepts that will be covered.


CHAPTER OUTLINE

Introduction to statistics
1.1 Key statistical concepts
1.2 Practical applications
1.3 How managers use statistics
1.4 Statistics and the computer
1.5 Online resources

1

What is statistics?

Census in Australia

CENSUS 2011

Real World Examples are used at the beginning of every chapter. They highlight a specific problem that can be solved using the statistical techniques that will be covered in the chapter. The problem is answered later in the chapter.

Income and its allocation to food

One of the most important empirical regularities in consumption economics is Engel's law. The law states that the proportion of income allocated to food [*w*$_f$] falls with increasing income. This means that a rich consumer would spend a lesser proportion of his/her income on food than a poor consumer, who would allocate a greater proportion of his/her income to food. For example, in 2011 the per capita GDP of India was US$3652 and the per capita GDP of Australia was US$39 428. It is interesting to note that Indians, on average, allocate about one-third of their income to food expenses, while Australians allocate only one-tenth of their income to food.

Two statisticians, Working (in 1943) and Leser (in 1963), modelled Engel's law into a linear regression framework. In order to investigate this law, we need to develop the relationship between income and the proportion of income allocated to food. We have collected data from 46 countries, which are stored in file CH04:\Engel. After we have presented the statistical technique, we will return to this problem and solve it (see page 176).

Source: Shutterstock.com/Pavel Sanis

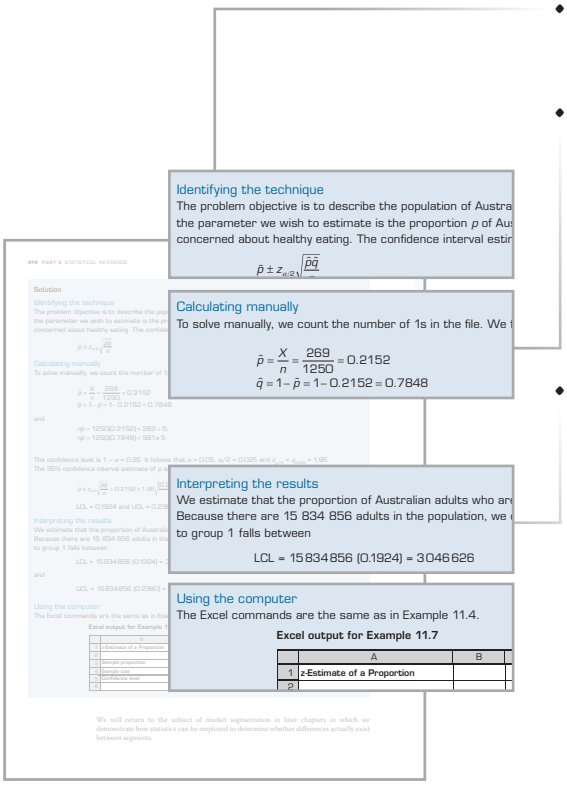
Margin definitions are key terms, which are defined and included in the margins for easy reference.

SSA envelope plan

Introduction

hypothesis
A proposition or conjecture which the statistician will test by means called hypothesis testing.

Interesting Examples are used throughout each chapter. These are designed to teach you to use the authors' unique three-step approach to problem solving, and to help you apply statistics to real business problems.



Identifying the technique

The problem objective is to describe the population of Austra
the parameter we wish to estimate is the proportion *p* of Au
concerned about healthy eating. The confidence interval estir

$$\bar{p} \pm z_{\alpha/2}\sqrt{\frac{\bar{p}\bar{q}}{}}$$

Calculating manually

To solve manually, we count the number of 1s in the file. We

$$\hat{p} = \frac{X}{n} = \frac{269}{1250} = 0.2152$$

$$\hat{q} = 1 - \hat{p} = 1 - 0.2152 = 0.7848$$

Interpreting the results

We estimate that the proportion of Australian adults who ar
Because there are 15 834 856 adults in the population, we
to group 1 falls between

LCL = 15 834 856 (0.1924) = 3 046 626

Using the computer

The Excel commands are the same as in Example 11.4.

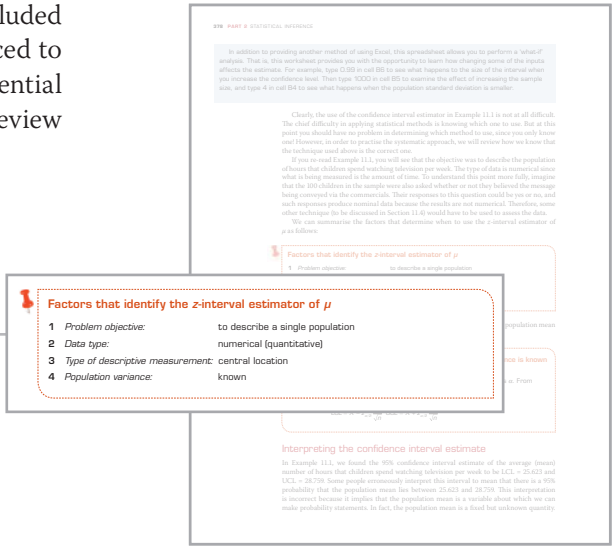
Excel output for Example 11.7

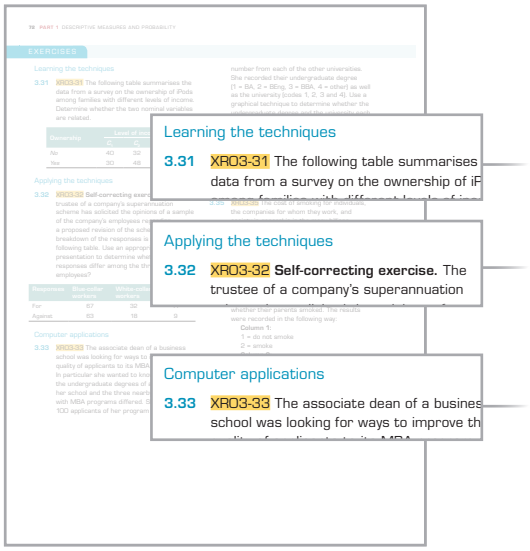
	A	B
1	z-Estimate of a Proportion	
2		

You will learn to:

- **identify** the right statistical technique to use by focusing on the relationship between the problem and data type
- **compute** the answer either by hand calculation, or by calculating it in Microsoft Excel® when you see a 'Using the computer' heading with instructions and 'commands' boxes, which included step-by-step instructions on how to complete the examples using Microsoft Excel®
- **interpret** the answer in the context of the problem.

Factors that identify boxes are included after each technique has been introduced to allow you to appreciate a technique's essential requirements, and to enable you to review your understanding of each technique.



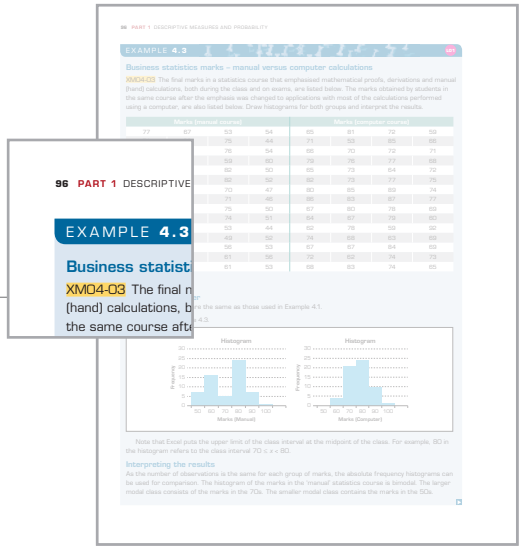


The text contains over 1500 **exercises**, located at the end of each section in chapters.

These include:

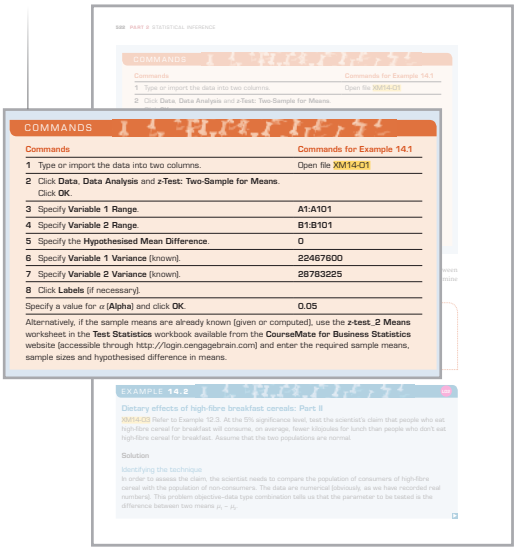
- **Learning the techniques:** exercises that help you to learn the arithmetic involved in a specific procedure.
- **Applying the technique:** exercises that highlight when and why the techniques are used and how the results assist in the decision-making process.
- **Computer applications:** help you gain hands-on experience in applying the techniques to solve problems using real world data and Microsoft Excel®.

Data files, highlighted throughout the text, enable you to complete the examples, exercises and case studies in the text without having to spend time inputting raw data. These data files are available on the accompanying **CourseMate for Business Statistics** website (http://login.cengagebrain.com).

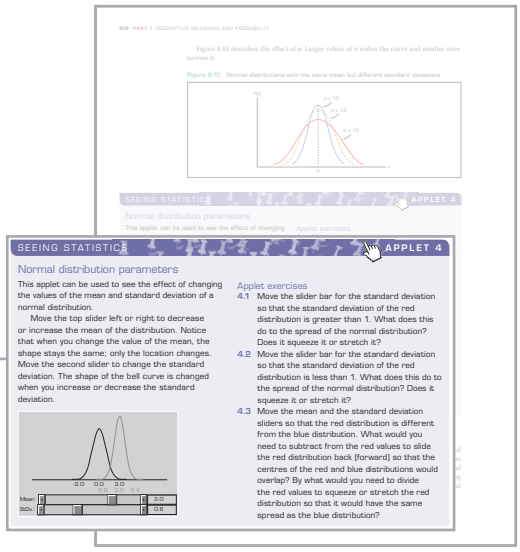


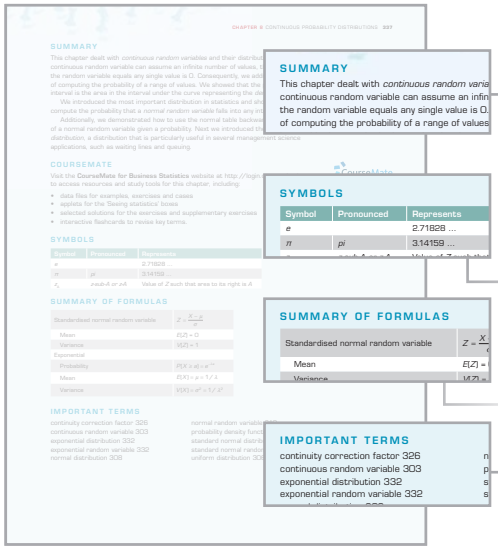
Real-Life Applications features are included throughout the text to demonstrate real-world applications of statistics in the areas of finance, marketing, human resource management, accounting and economics.

Commands boxes can be found in chapters and include step-by-step instructions on how to complete exercises in Microsoft Excel®.



Seeing statistics boxes also appear throughout the text. These direct you to the accompanying **CourseMate for Business Statistics** website (http://login.cengagebrain.com) where you can view applets, which enhance your comprehension by providing visual insight into statistical concepts.

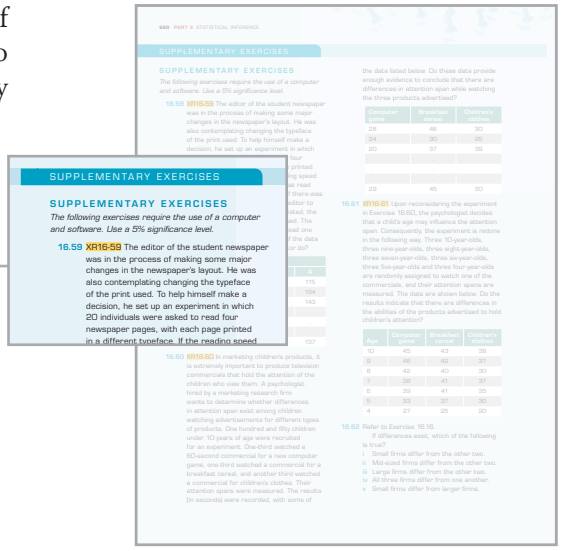




At the end of each chapter you will find:

- a **summary** section that consolidates your knowledge of the content of the chapter by reviewing key concepts and drawing out their wider significance,
- a recap of relevant **symbols**,
- a **summary of formulas** from the chapter, and
- a list of **important terms**.

Supplementary exercises at the end of each chapter give you the opportunity to further test your understanding of the key concepts covered.

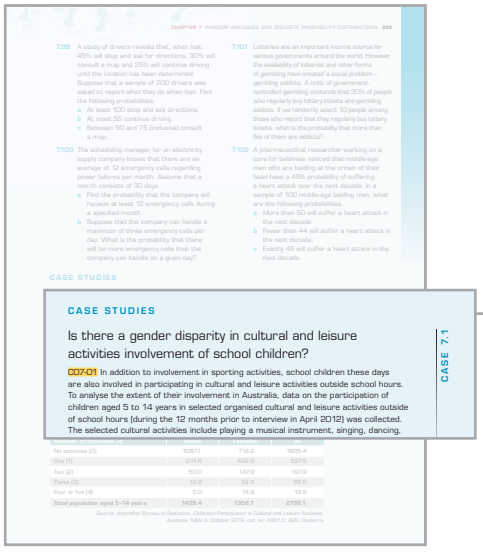


SUPPLEMENTARY EXERCISES

SUPPLEMENTARY EXERCISES

The following exercises require the use of a computer and software. Use a 5% significance level.

16.59 XR16-59 The editor of the student newspaper was in the process of making some major changes in the newspaper's layout. He was also contemplating changing the typeface of the print used. To help himself make a decision, he set up an experiment in which 20 individuals were asked to read four newspaper pages, with each page printed in a different typeface. If the reading speed



CASE STUDIES

CASE STUDIES

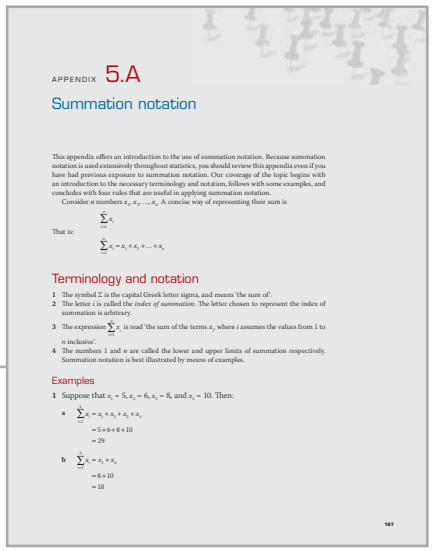
Is there a gender disparity in cultural and leisure activities involvement of school children?

CASE 7.1

CD7-01 In addition to involvement in sporting activities, school children these days are also involved in participating in cultural and leisure activities outside school hours. To analyse the extent of their involvement in Australia, data on the participation of children aged 5 to 14 years in selected organised cultural and leisure activities outside of school hours (during the 12 months prior to interview in April 2012) was collected. The selected cultural activities include playing a musical instrument, singing, dancing,

Case studies are included at the end of each chapter to assist you in applying the statistical techniques you are learning to real-world problems

Appendices throughout the text included step-by-step instructions on how to perform complex statistical calculations.



APPENDIX 5.A

Summation notation

This appendix offers an introduction to the use of summation notation. Because summation notation is used extensively throughout statistics, you should review this appendix even if you have had previous exposure to summation notation. Our coverage of the topic begins with an introduction to the necessary terminology and notation, follows with some examples, and concludes with four rules that are useful in applying summation notation.

Consider n numbers $x_1, x_2, \ldots, x_n$. A concise way of representing their sum is

$$\sum_{i=1}^{n} x_i$$

That is:

$$\sum_{i=1}^{n} x_i = x_1 + x_2 + \ldots + x_n$$

Terminology and notation

1 The symbol Σ is the capital Greek letter sigma, and means 'the sum of'.

2 The letter i is called the *index of summation*. The letter chosen to represent the index of summation is arbitrary.

3 The expression $\sum_{i=1}^{n} x_i$ is read 'the sum of the terms x_i where i assumes the values from 1 to n inclusive'.

4 The numbers 1 and n are called the lower and upper limits of summation respectively. Summation notation is best illustrated by means of examples.

Examples

1 Suppose that $x_1 = 5$, $x_2 = 6$, $x_3 = 8$, and $x_4 = 10$. Then:

a $\sum_{i=1}^{4} x_i = x_1 + x_2 + x_3 + x_4$
$= 5 + 6 + 8 + 10$
$= 29$

b $\sum_{i=2}^{3} x_i = x_2 + x_3$
$= 6 + 10$
$= 18$

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CourseMate

Online resources

Visit http://login.cengagebrain.com and login using the code card in the front of this text for a 12-month access to the *Business Statistics 6e* **CourseMate** website. You'll find interactive self-assessments, quizzes, glossary, flashcards, crosswords, case questions, and more tools to help you excel in your studies.

For the Instructor

Cengage Learning is pleased to provide you with a selection of resources that will help you prepare for your lectures. These teaching tools are available on the companion website accessible via http://login.cengage.com.

Instructor Solutions Manual

This includes complete solutions to all the end-of chapter conceptual questions and problems in the text. Also provided are full answers to the online student chapter review quizzes.

PowerPoint™ presentations

Chapter-by-chapter PowerPoint presentations cover the main concepts addressed within the text and can be edited to suit your own requirements. Use these slides to enhance your lecture presentations and to reinforce the key principles of your subject, or for student handouts.

ExamView® test bank

ExamView helps you to create, customise and deliver tests in minutes for both print and online applications. The Quick Test Wizard and Online test Wizard guide you step by step through the test-creation process. With ExamView's complete word-processing abilities, you can add an unlimited number of new questions to the bank, edit existing questions and build tests of up to 250 questions using up to 12 question types. You can also export the files into Blackboard or WebCT.

Artwork

These digital files of graphs, tables, pictures and flow charts from the text can be used in a variety of media. Add them into your course management system, use them within student handouts or copy them into lecture presentations.

APLIA

Online homework has never been easier! APLIA is the perfect solution for your homework management needs, with assignable questions and an online gradebook. Once set up by instructors, students can access additional online review questions related to the text.

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1

What is statistics?

LEARNING OBJECTIVES

This chapter provides an introduction to the two general bodies of methods that together constitute the subject called statistics: descriptive statistics and inferential statistics.

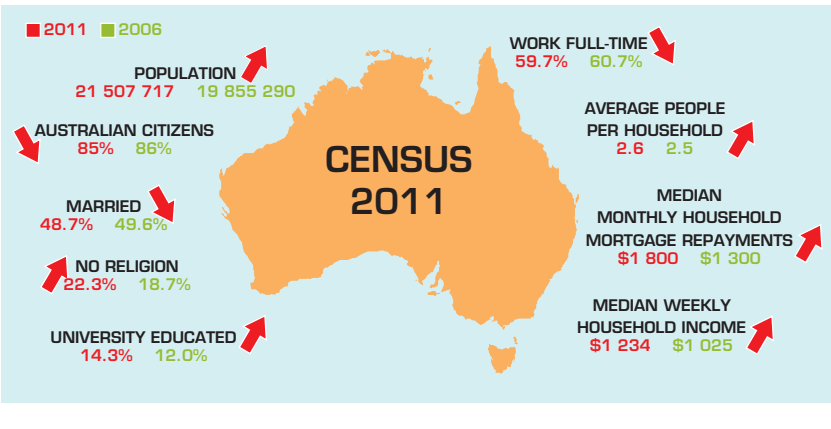
At the completion of this chapter, you should be able to:

- **LO1** describe the two major branches of statistics – descriptive statistics and inferential statistics
- **LO2** understand the key statistical concepts – population, sample, parameter, statistic and census
- **LO3** provide examples of practical applications in which statistics have a major role to play
- **LO4** understand how statistics are used by business managers
- **LO5** understand the basics of the computer spreadsheet package Microsoft Excel and its capabilities in aiding with statistical data analysis for large amounts of data.

CHAPTER OUTLINE

Census in Australia

Information (or data) gathering on various characteristics of different populations of interest are an important part of statistics. When we use all units of the population to record information about the characteristics of interest, this type of data gathering is called a census. Due to cost and other



resource implications, census of the whole population is done only every five years in Australia. The peak Australian government statistics agency, the *Australian Bureau of Statistics*, carries out the census, the two latest being conducted in 2006 and 2011. A census provides a snapshot of the population characteristics in the year it is held. We will discuss census and other forms of data collection in detail in this chapter.

Introduction to statistics

Today we have access to more data than ever, through the ever-increasing use of information technology to make informed decisions. Statistics is a body of principles and methods concerned with extracting useful information from a set of data to help people make decisions. The role of this book is to describe how, when and why managers and statisticians conduct statistical procedures. Such description is important as you come across different kinds of information and data to which you need to apply different statistical procedures.

In general, statistics can be subdivided into two basic areas: *descriptive statistics* and *inferential statistics*.

Descriptive statistics

descriptive statistics
Methods of organising, summarising and presenting data in ways that are useful, attractive and informative to the reader.

Descriptive statistics deals with methods of organising, summarising and presenting data in a convenient and informative form. One form of descriptive statistics uses graphical techniques, which allow statistics practitioners to present data in ways that make it easy for the reader to extract useful information. The main attraction of a graphical presentation is that the message can be easily understood by any layperson. In Chapters 3 and 4 we will present a variety of graphical methods.

Another form of descriptive statistics uses numerical techniques to summarise data. One such method you would have already used frequently is calculating an average or mean. Chapter 5 introduces several numerical statistical measures that describe different features of the data.

The actual technique we use depends on what specific information we would like to extract. Consider the use of descriptive statistics in the following examples.

EXAMPLE **1.1** LO1

Business statistics marks

A student enrolled in a business program is attending his first lecture of the compulsory business statistics course. The student is somewhat apprehensive because he believes the myth that the course is difficult. To alleviate his anxiety, the student asks the lecturer about last year's exam marks of the business statistics course. Because, like all statistics lecturers, this one is friendly and helpful, he obliges and provides a list of the final marks. The marks are composed of all the within-semester assessment items plus the end-of-semester final exam. What information can the student obtain from the list?

This is a typical statistics problem. The student has the data (marks) and needs to apply statistical techniques to get the information he requires. This is a function of *descriptive statistics*.

In this example, we can see at least three important pieces of information. The first is the 'typical' mark. We call this a *measure of central location.* The average is one such measure. In Chapter 5 we will introduce another useful measure of central location, the median. In the above example, the median is the middle mark of the class when the marks are arranged in

ascending or descending order. That is, there are 50% of the students who obtained marks less than the median mark, while 50% received marks greater than the median value.

Suppose the student was told that the average mark last year was 67. Is this enough information to reduce his anxiety? The student would likely respond 'no' because he would like to know whether most of the marks were close to the average mark of 67 or were scattered far below and above the average. He needs a *measure of variability*. The simplest such measure is the *range* (discussed further in Chapter 5), which is calculated by subtracting the smallest number from the largest. Suppose the largest mark is 96 and the smallest is 24, then the range is (96 – 24 =) 72. Unfortunately, this provides little information as the range doesn't say where most of the marks are located. Whether most data are located near 24 or near 96 or somewhere in the middle, the range is still 72. We need other measures of variability such as the variance and standard deviation, to reflect the true picture of the spread of the data, which will be introduced in Chapter 5. Moreover, the student must determine more about the marks. In particular he needs to know how the marks are distributed between 24 and 96. The best way to do this is to use a graphical technique, the histogram, to be introduced in Chapter 4.

EXAMPLE **1.2** LO1,3

Comparing weekly sales between two outlets

A fast-food franchiser wishes to compare the weekly sales level over the past year at two particular outlets. Descriptive statistical methods could be used to summarise the actual sales levels (perhaps broken down by food item) in terms of a few numerical measures, such as the average weekly sales level and the degree of variation from this average that weekly sales may undergo. Tables and charts could be used to enhance the presentation of the data so that a manager could quickly focus on the essential differences in sales performance at the two outlets.

There is much more to statistics, however, than these descriptive methods. Decision-makers are frequently forced to make decisions based on a set of data that is only a small subgroup (sample) of the total set of relevant data (population).

Inferential statistics

Inferential statistics is a body of methods for drawing conclusions (i.e. making inferences) about characteristics of a population, based on information available in a sample taken from the population. The following example illustrates the basic concepts involved in inferential statistics.

inferential statistics
Methods used to draw conclusions about a population based on information provided by a sample of the population.

EXAMPLE **1.3** LO1–4

Profitability of a new life insurance policy

An Australia-wide automobile club (consisting of about 2 million members) is contemplating extending its services to its members by introducing a new life insurance policy. After some careful financial analysis, the club has determined that the proposed insurance policy would break even if at least 10% of all current members subscribing to the club also purchase the policy. The question here is how can inferential statistics be used by the automobile club to make a decision about introducing their new life insurance policy?

To obtain additional information before reaching a decision on whether or not to proceed with the new insurance policy, the automobile club has decided to conduct a survey of 500 randomly selected current

members. The collection of all its current 2 million or so members is called the *population*. The 500 members selected from the entire population for the analysis are referred to as a *sample*. Each member in the sample is asked if they would purchase the policy if it were offered at some specified price. Suppose that 60 of the members in this sample reply positively. While a positive response by 60 out of 500 members (12%) is encouraging, it does not assure the automobile club that the proposed insurance policy will be profitable. The challenging question here is how to use the response from these 500 sampled members to conclude that at least 10% of all 2 million or so members would also respond positively. The data are the proportion of positive response among the 500 members in the sample. However, we are not so much interested in the response of the 500 members as we are in knowing what the response would be from all of the club's current members. To accomplish this goal we need another branch of statistics – *inferential statistics*.

If the automobile club concludes, based on the sample information, that at least 10% of all its members in the population would purchase the proposed insurance policy, the club is relying on inferential statistics. The club is drawing a conclusion, or making a statistical inference, about the entire population of its 2 million or so members on the basis of information provided by only a sample of 500 members taken from the population. The available data tell us that 12% of this particular sample of members would purchase; the inference that at least 10% of all its members would purchase the new insurance policy may or may not be correct. It may be that, by chance, the club selected a particularly agreeable sample and that, in fact, no more than 5% of the entire population of members would purchase.

Whenever an inference is made about an entire population on the basis of evidence provided by a sample taken from the population, there is a chance of drawing an incorrect conclusion. Fortunately, other statistical methods allow us to determine the reliability of the statistical inference. They enable us to establish the degree of confidence we can place in the inference, assuming the sample has been properly chosen. These methods would enable the automobile club in Example 1.3 to determine, for example, the likelihood that less than 10% of the population of its members would purchase, given that 12% of the members sampled said they would purchase. If this likelihood is deemed small enough, the automobile club will probably proceed with its new venture.

1.1 Key statistical concepts

Statistical inference problems involve three key concepts: the population, the sample and the statistical inference. We now discuss each of these concepts in more detail.

Population

population
The set of all items of interest.

A **population** is the group of all items of interest to a statistics practitioner. It is frequently very large and may, in fact, be infinitely large. In the language of statistics, the word *population* does not necessarily refer to a group of people. It may, for example, refer to the population of diameters of ball bearings produced at a large plant. In Example 1.3, the population of interest consists of all 2 million or so members.

parameter
A descriptive measure of a population.

A descriptive measure of a population is called a **parameter**. The parameter of interest in Example 1.3 was the proportion of all members who would purchase the new policy.

Sample

sample
A set of data drawn from the studied population.

A **sample** is a subset of data drawn from the population. In Example 1.3, the sample of interest consists of the 500 selected members.

A descriptive measure of a sample is called a **statistic**. We use sample statistics to make inferences about population parameters. In Example 1.3, the proportion of the 500 members who would purchase the life insurance policy would be a sample statistic that could be used to estimate the corresponding population parameter of interest, the population proportion. Unlike a parameter, which is a constant, a statistic is a variable whose value varies from sample to sample. In Example 1.3, 12% is a value of the sample statistic based on the selected sample.

statistic
A descriptive measure of a sample.

Statistical inference

Statistical inference is the process of making an estimate, forecast or decision about a population parameter, based on the sample data. Because populations are usually very large, it is impractical and expensive to investigate or survey every member of a population. (Such a survey is called a census.) It is far cheaper and easier to take a sample from the population of interest and to draw conclusions about the population parameters based on information provided by the sample.

For instance, political pollsters predict, on the basis of a sample of about 1500 voters, how the entire 16 million eligible voters from the Australian population will cast their ballots; and quality control supervisors estimate the proportion of defective units being produced in a massive production process from a sample of only several hundred units.

Because a statistical inference is based on a relatively small subgroup of a large population, statistical methods can never decide or estimate with certainty. Since decisions involving large amounts of money often hinge on statistical inferences, the reliability of the inferences is very important. As a result, each statistical technique includes a measure of the reliability of the inference. For example, if a political pollster predicts that a candidate will receive 40% of the vote, the measure of reliability might be that the true proportion (determined on election day) will be within 3% of the estimate on 95% of the occasions when such a prediction is made. For this reason, we build into the statistical inference a measure of reliability. There are two such measures, the **confidence level** and the **significance level**. The *confidence level* is the proportion of times that an estimating procedure would be correct, if the sampling procedure were repeated a very large number of times. For example, a 95% confidence level would mean that, in a very large number of repeated samples, estimates based on this form of statistical inference will be correct 95% of the time. When the purpose of the statistical inference is to draw a conclusion about a population, the *significance level* measures how frequently the conclusion will be wrong in the long run. For example, a 5% significance level means that, in repeated samples, this type of conclusion will be wrong 5% of the time. We will introduce these terms in Chapters 11 and 13.

confidence level
The degree of certainty we have that our interval contains the value of the parameter.

significance level
The relative frequency of a wrong conclusion.

1.2 Practical applications

Throughout the text, you will find examples, exercises and cases that describe actual situations from the business world in which statistical procedures have been used to help make decisions. For each example, exercise or case, you will be asked to choose and apply the appropriate statistical technique to the given data and to reach a conclusion. We cover such applications in accounting, economics, finance, management and marketing. Below is a summary of some of the case studies we have analysed in this textbook with partial data, to illustrate additional applications of inferential statistics. But you will have to wait until you work through these cases in the relevant chapters (where some data is also presented) to find out the conclusions and results.

CASE 3.6

Differing average weekly earnings of men and women in Australia

While a lot has been achieved in Australia to reduce the difference between men and women in a number of social status indicators, wage differences are still a matter of concern. The following table presents the average weekly earnings of male and female adults for each Australian state and territory and for Australia as a whole. Present the information using appropriate graphical techniques.

Average weekly (all employees total) earnings (A$), May 2012

State/Territory	Males	Females
New South Wales	1266.60	843.80
Victoria	1214.60	784.30
Queensland	1270.10	807.40
South Australia	1165.90	762.50
Western Australia	1556.30	834.30
Tasmania	1069.90	742.00
Northern Territory	1419.30	973.20
ACT	1546.50	1172.90
Total (Australia)	1253.10	744.80

Source: Australian Bureau of Statistics, *Average Weekly Earnings*, May 2012, cat. no. 6302.0, ABS, Canberra

CASE 5.9

Aussies and Kiwis are leading in education

According to the 2011 published statistics on the human development index (HDI) by the UN, Australians and New Zealanders are leading the world. The HDI is calculated using three indices, namely, education index, GDP index and life expectancy index. The education index data for the top 20, the middle 20 and the bottom 20 of the 176 countries listed in the UN report are recorded. Part of the data are given below. Use suitable numerical summary (central location and variability) measures to analyse the data.

Top 20	Education index	Bottom 20	Education index
Australia	0.993	Eritrea	0.539
Cuba	0.993	…	…
Denmark	0.993	…	…
Finland	0.993	Chad	0.334
New Zealand	0.993	Mali	0.331
…	…	Burkina Faso	0.301
Slovenia	0.969	Niger	0.282

Source: *Human Development Report 2009,* United Nations Development Program (UNDP), New York, 2011

CASE 15.1

Comparing salary offers for finance and marketing MBA majors - I

In the last few years, there has been an increase in the number of web-based companies that offer job placement services. The manager of one such company wanted to investigate the job offers recent MBAs were obtaining. In particular, she wanted to know

whether finance majors were being offered higher salaries than marketing majors. In a preliminary study, she randomly sampled 50 recently graduated MBAs, half of whom majored in finance and half in marketing. From each she recorded the highest salary offer (including benefits). Can we infer that finance majors obtain higher salary offers than do marketing majors among MBAs? Verify the underlying assumptions.

Gold lotto

CASE 17.1

Gold lotto is a national lottery that operates as follows. Players select eight different numbers (six primary and two supplementary numbers) from 1 and 45. Once a week, the corporation that runs the lottery selects eight numbers (six primary and two supplementary numbers) at random from 1 to 45. Winners are determined by how many numbers on their tickets agree with the numbers drawn. In selecting their numbers, players often look at past patterns as a way to help predict future drawings. A regular feature that appears in the newspaper identifies the number of times each number has occurred in the past. The data recorded in the following table appeared in the 20 January 2013 edition of the *Queensland Sunday Mail* after the completion of draw 3287. What would you recommend to anyone who believes that past patterns of the lottery numbers are useful in predicting future drawings?

Drawing frequency of lotto numbers since draw 413

Lotto number	Number of times drawn	Lotto number	Number of times drawn	Lotto number	Number of times drawn
1	274	16	246	31	252
2	257	17	249	32	256
.	.	.	.	.	.
.	.	.	.	.	.
14	240	29	248	44	230
15	265	30	231	45	242

Does unemployment affect the average hourly earnings of New Zealanders?

CASE 18.1

Wages in the labour market are very much influenced by the demand and supply of labour. In any profession or industry, when there is an over supply of labour, the workers will be at a disadvantage and will not be able to demand high wages and vice versa. During the mining boom in Perth, unusually high wages were paid, due to the shortage of workers to work in the mining fields. This has impacted heavily on the other sectors of the economy (e.g. the house prices in Perth were inflated to astonishingly high levels). In New Zealand, also, in the last few decades the average hourly earnings have fluctuated, depending on the state of the economy, especially on the level of labour supply. When the number of unemployed persons increases, it is expected that the average hourly earnings would fall. The data in the file presents the quarterly data for the average hourly earnings and the total number of unemployed persons in New Zealand during the period March 1994 to Sept 2012. Is there any evidence in New Zealand to support the proposition that the higher (lower) the number of unemployed the lower (higher) the average hourly earnings?

Period	Number unemployed	Average hourly earnings ($)
Mar. 1994	170300	14.98
Jun. 1994	147000	15.10
Sep. 1994	135800	15.10
Dec. 1994	134800	15.16
.	.	.
.	.	.
.	.	.
Dec. 2011	150700	26.59
Mar. 2012	171200	26.96
Jun. 2012	156400	27.00
Sep. 2012	170000	27.31

Source: Income Tables, Statistics New Zealand, December 2012

The objective of the problem described in Case 3.6 is to use the descriptive graphical and numerical techniques to analyse the differences in weekly earnings of men and women in Australia; Case 5.9 is to compare the central location and variability of the education index of the top and bottom 20 countries in the world; Case 15.1 is to compare two populations, the variable of interest being the salary of MBA graduates specialising in marketing and finance. Case 17.1 is a day-to-day real-life application. The objective of the problem is to see how statistical inference can be used to determine whether some numbers in a lotto draw occur more often than others. Case 18.1 illustrates another statistical objective. In this case, we need to analyse the relationship between two variables: average hourly earnings and the total number of unemployed persons in New Zealand. By applying the appropriate statistical technique, we will be able to determine whether the two variables are related, and, if so, whether reducing the number of unemployed leads to higher average salary earnings. As you will discover, the technique also permits statistics practitioners to include other variables to determine whether they affect average salary earnings.

1.3 How managers use statistics

As we have already pointed out, statistics is about acquiring and using information. However, the statistical result is not the end product. Managers use statistical techniques to help them make decisions. In general, statistical applications are driven by the managerial problem. The problem creates the need to acquire information. This in turn drives the data-gathering process. When the manager acquires data, he or she must convert the data into information by means of one or more statistical techniques. The information then becomes part of the decision process.

Many business students will take or have already taken a subject in marketing. In the introductory marketing subject, students are taught about market segmentation. Markets are segmented to develop products and services for specific groups of consumers. For example, the Coca-Cola Company produces several different cola products.

There is Coca-Cola Classic, Coca-Cola Vanilla, Coca-Cola Zero, Coke, Diet Coke and Caffeine-Free Diet Coke. Each product is aimed at a different market segment. For example, Coca-Cola Classic is aimed at people who are older than 30, Coca-Cola Vanilla is aimed primarily at women, Coke is aimed at the teen market, Diet Coke is marketed towards individuals concerned about their weight or sugar intake, and Caffeine-Free Diet Coke is for

people who are health-conscious. In order to segment the cola market, Coca-Cola had to determine that all consumers were not identical in their wants and needs. The company then had to determine the different parts of the market and ultimately design products that were profitable for each part of the market. As you might guess, statistics plays a critical but not exclusive role in this process.

Because there is no single way to segment a market, managers must try different segmentation variables. Segmentation variables include geographic (e.g. states, cities, country towns), demographic (e.g. age, gender, occupation, income, religion), psycho-graphic (e.g. social class, lifestyle, personality) and behaviouristic (e.g. brand loyalty, usage, benefits sought). Consumer surveys are generally used by marketing researchers to determine which segmentation variables to use. For example, Coca-Cola used age and lifestyle. The age of consumers generally determines whether they buy Coca-Cola Classic or Coke. Lifestyle determines whether they purchase regular, diet or caffeine-free cola. Surveys and statistical techniques would tell the marketing manager that the 'average' Coca-Cola Classic drinker is older than 30, whereas the 'average' Coke drinker is a teenager. Census data and surveys are used to measure the size of the two segments. Surveys would also inform about the number of cola drinkers who are concerned about kilojoules and/or caffeine. The conversion of the raw data in the survey into statistics is only one part of the process. The marketing manager must then make decisions about which segments to pursue (not all segments are profitable), how to sell and how to advertise.

In this book, we will address the part of the process that collects the raw data and produces the statistical result. By necessity, we must leave the remaining elements of the decision process to the other subjects that constitute business programs. We will demonstrate, however, that all areas of management can and do use statistical techniques as part of the information system.

1.4 Statistics and the computer

In almost all practical applications of statistics, the statistics practitioner must deal with large amounts of data. In order to calculate various statistical measures, the statistics practitioner would have to perform various calculations on the data; although the calculations do not require any great mathematical skill, the sheer amount of arithmetic makes this aspect of the statistical method time-consuming and tedious. Fortunately, numerous commercially prepared computer programs are available to perform these calculations. In most of the examples used to illustrate statistical techniques in this book, we will provide two methods for answering the question:

1 **Calculating manually.** Except where doing so is prohibitively time-consuming, we will show how to answer the questions using hand calculations (with only the aid of a calculator). It is useful for you to produce some solutions in this way, because by doing so you will gain insights into statistical concepts.
2 **Using Microsoft Excel.** Many business students own a spreadsheet package, and university and TAFE subjects incorporate a spreadsheet into their curriculum. We have chosen to use Microsoft Excel 2010 because we believe that it is and will continue to be the most popular spreadsheet package and is the most accessible package. Excel also comes with a limited statistical tool called **Data Analysis**. Consequently, we have included (on the **CourseMate for Business Statistics** website – see Section 1.5) a statistical software add-in, **Data Analysis Plus 9.0** for Excel 2010 (and Data Analysis Plus 7.0 and 5.1 for earlier versions of Excel), and also created various other macros that can be loaded on to your computer to enable you to use Excel for almost all procedures. Detailed instructions are provided for all techniques. An introduction to the use of Excel is provided in Appendix 1A of this chapter.