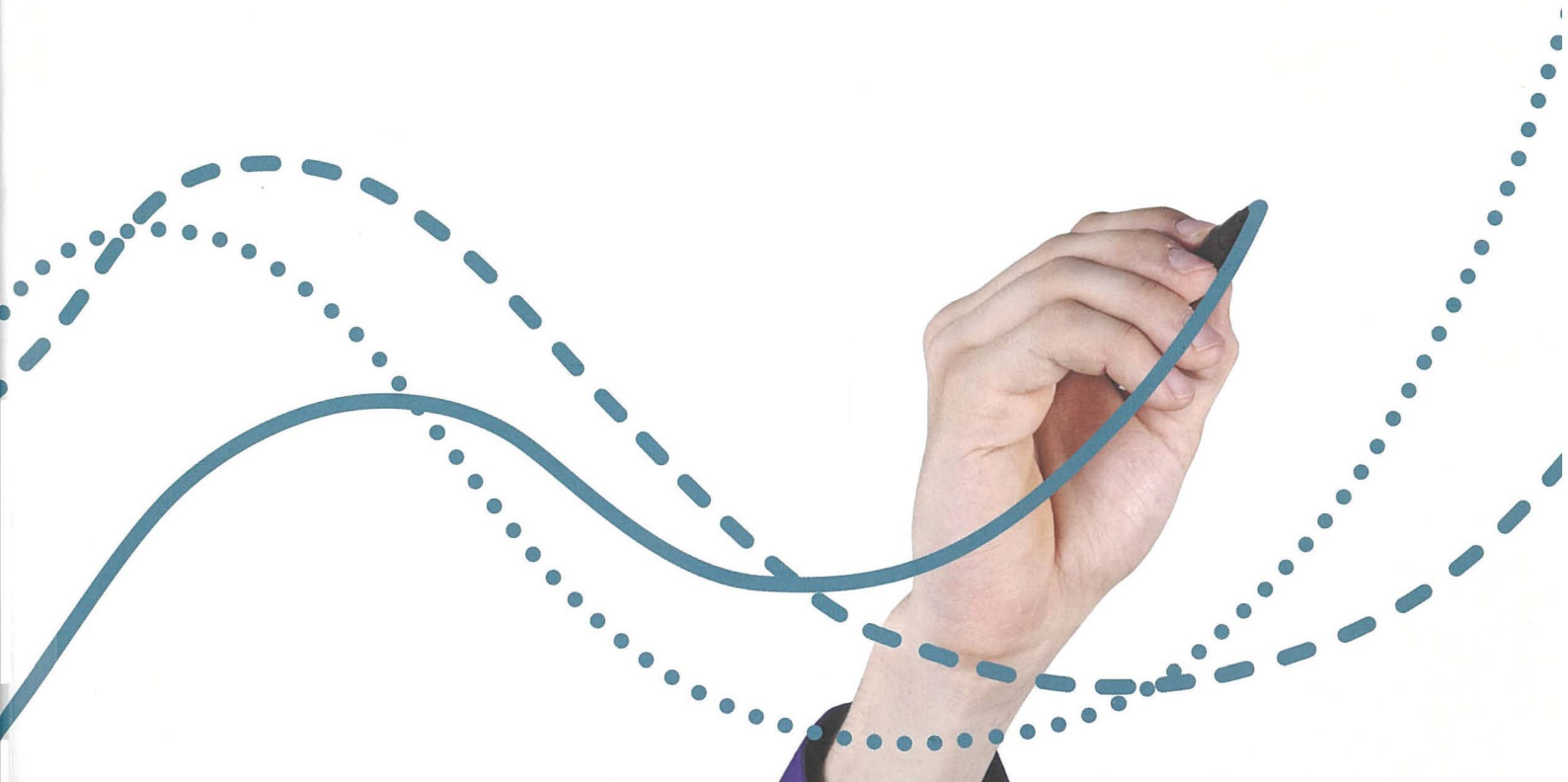


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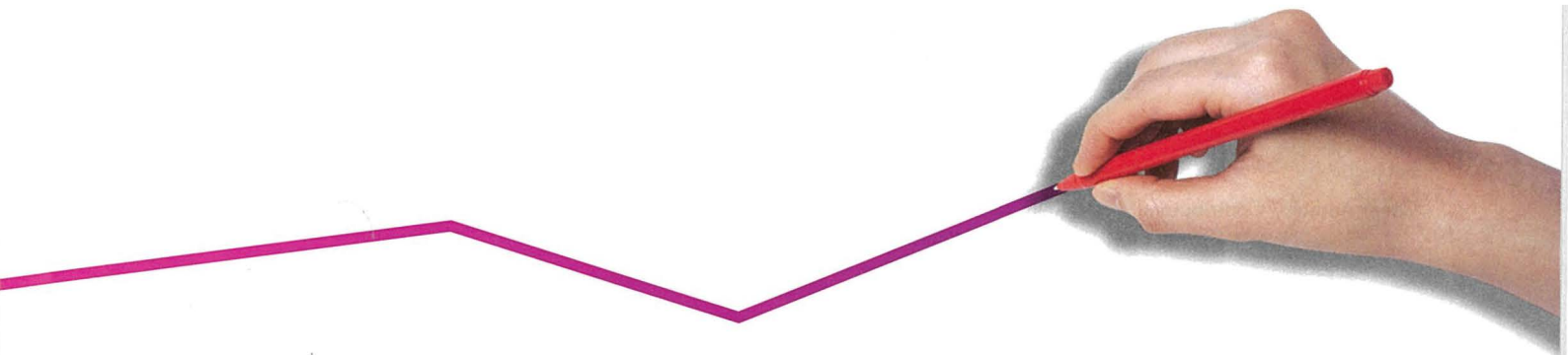
Essentials of **BUSINESS STATISTICS**

COMMUNICATING WITH NUMBERS



SANJIV JAGGIA
ALISON KELLY
SCOTT SALZMAN
DOINA OLARU
SIVAGOWRY SRINANATHAKUMAR
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Essentials of
BUSINESS STATISTICS
COMMUNICATING WITH NUMBERS



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Dr Scott Salzman completed his undergraduate degree in science, then followed this up with a degree in chemistry and later a doctorate in applied numerical modelling. Since graduating, he has provided numerical modelling direction for a variety of interdisciplinary and multidisciplinary projects. Dr Salzman has worked at times as a consultant, yet always retained a research perspective. He has taught numerical modelling to students from most academic disciplines and currently chairs the first year statistics unit of Deakin University Business School. Scott has co-authored more than 50 academic research articles, most of them peer reviewed and published in international journals. His published research reveals an ability to successfully apply numerical modelling techniques to a variety of problems. When he began tutoring students in statistics in 2011, he became aware of the intense anxiety that is often apparent and consequently, he is now committed to helping them.

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Dedication

SCOTT SALZMAN:

To my daughters Inika, Jessika, Shinae and Aylish. Be your best.

DOINA OLARU:

I wish to dedicate this text to my students.

SIVAGOWRY SRIANANTHAKUMAR:

I would like to dedicate my work to the memory of my loving parents Mr K. Manikawasaker and Mrs M. Yogeswary.

RABIUL BEG

To my wife, Farhat Sultana Beg.

CATHERINE LEIGHTON:

To my husband, Paul, and our children, Josh and Ruby.

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Reviewers

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Scott Salzman, Deakin University
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We want to thank and acknowledge the contributions of the team at McGraw-Hill Education who made this book possible. We appreciate the work of our product managers, Robert Ashworth and Lisa Coady, for their strong faith in this project and commitment to ensuring the high quality of this work, and our content developers, Cynthia Morali and Samantha Allemann, who helped implement the shared vision of this project and worked closely with the author team. Thanks also go to Carolina Bodin, our research coordinator, for her market research and Daisy Patiag, our senior content producer, for seamlessly coordinating the endless production details.

Now more than ever, no textbook is complete without the integration of outstanding digital learning resources. We thank the digital production team, Marisa Rey Bulen, Sarah Mahoney and Bethany Ng, for their tireless dedication to building the wealth of learning resources that are an integral part of this learning resource.

Preface

Statistics can be a fun and enlightening course for both students and teachers. We have found that an effective way to make statistics interesting is to use timely business applications to which students can relate. If interest can be sparked at the very outset, students may end up learning statistics without realising they are doing so. By carefully matching timely applications with statistical methods, students learn to appreciate the relevance of business statistics in our world today. In every chapter, students are exposed to statistical information conveyed in written form. By incorporating the perspective of professional users, it has been our goal to make the subject matter more relevant and the presentation of material more straightforward for students.

A unique emphasis on communicating with numbers . . . MAKES BUSINESS STATISTICS RELEVANT TO STUDENTS

In *Essentials of Business Statistics*, we have incorporated fundamental topics that are applicable for students with various backgrounds and interests. This feature is especially relevant as more universities move toward a one-semester introductory statistics course. Continuing the legacy of the American text, this local edition has allowed us to make the text more relevant and engaging for students studying in Australia and New Zealand. Combined with our interactive and engaging Connect and LearnSmart platforms, we hope this edition provides the best resource for students studying business statistics.



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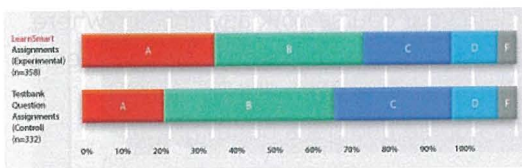
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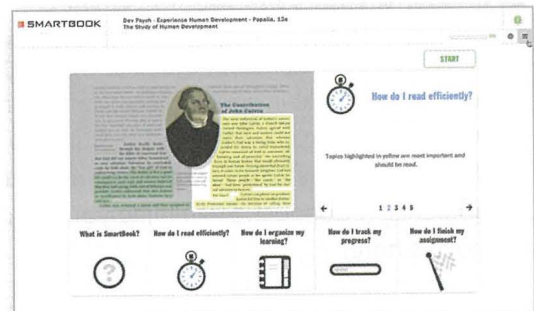
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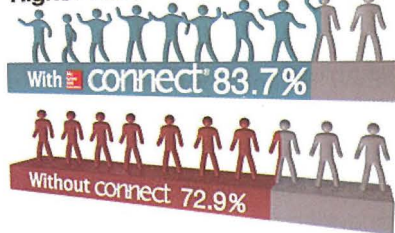


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The pedagogy is the key in helping students learn how to communicate and convey data in written format.



Tween survey

Luke McCaffrey manages a ski lodge at Mount Buller in Victoria, and is in need of a new marketing manager. He is a fairly tough interviewer and believes that the right applicant should have a basic understanding of data fundamentals, including some background with statistical methods. Luke is particularly interested in serving the needs of the 'tween' population (children aged 8 to 12 years old). He believes that tween spending power has grown over the past few years, and he wants their skiing experience to be memorable so that they want to return. At the end of last year's ski season Luke asked 20 tweens four specific questions.

- Q1. On your car drive to the resort, which radio station was playing?
- Q2. On a scale of 1 to 4, rate the quality of the food at the resort (where 1 is poor, 2 is fair, 3 is good and 4 is excellent).
- Q3. Presently, the main dining area closes at 3.00 pm. What time do you think it should close?
- Q4. How much of your own money did you spend at the lodge today?

The responses to these questions are shown in Table 11; this data can also be found on the text website, labelled **Tween_Survey**.

Luke asks each job applicant to use the responses to:

1. Classify them into the appropriate measurement scales.
2. Compare and contrast the type of information that can be extracted from each measurement scale.
3. Given the results of the survey, provide management with suggestions for improvement.

A synopsis of this case is presented at the end of the section 'Variables and scales of measurement'.

Integrated introductory cases

Each chapter opens with a real-life case study that forms the basis for several examples within the chapter. The questions included in the examples create a roadmap for mastering the most important learning outcomes within the chapter. A synopsis of each chapter's introductory case is presented when the last of these examples has been discussed. Instructors of distance learners may find these introductory cases particularly useful.

SYNOPSIS OF INTRODUCTORY CASE

A preliminary survey of tween preferences conducted by the management of a ski resort three hours away from Melbourne, revealed some interesting information.

- Tweens were first asked to name the radio station that they listened to on the way to the resort. Even though their responses are in the form of nominal data, the least sophisticated form of measurement, useful information can still be extracted from it. For instance, the responses show that 60% of the tweens listened to Arra Valley FM.



- If the resort wishes to contact tweens using this medium, it may want to direct its advertising dollars to this station.
- Next, the tweens were asked to rate the food quality at the resort on a scale of 1 to 4 (where 1 is poor, 2 is fair, 3 is good, and 4 is excellent). Their responses to food quality were ordinal in nature; that is, the responses can be categorised and ranked. The survey results with respect to food quality are disturbing. The majority of the tweens, 55% (11/20), felt that the food was, at best, fair. A more extensive study focusing on food quality appears necessary.

Writing with statistics

One of our most important innovations is the inclusion of a sample report within every chapter (except Chapter 1). Our intent is to show students how to convey statistical information in written form to those who may not know detailed statistical methods. For example, such a report may be needed as input for managerial decision making in sales, marketing, or company planning. Several similar writing exercises are provided at the end of each chapter. Each chapter also includes a synopsis that addresses questions raised from the introductory case. This serves as a shorter writing sample for students. Instructors of large sections may find these reports useful for incorporating writing into their statistics courses.

Writing with statistics

A study examined 7,925 severely obese adults who had gastric bypass surgery and an identical number of people who did not have the surgery. The study wanted to investigate whether or not losing weight through stomach surgery prolonged the lives of severely obese patients, by reducing death from heart disease, cancer and diabetes.



Over the course of the study, 534 of the participants died. Of those who died, the cause of death was classified as either a disease death (such as heart disease, cancer or diabetes) or a non-disease death (such as suicide or accident). Lawrence Plummer, a research analyst, is handed Table 4.11, which summarises the study's findings.

TABLE 4.11 Deaths cross-classified by cause and method of losing weight

Cause of death	Method of losing weight	
	No surgery	Surgery
Disease death	285	150
Non-disease death	36	63

Lawrence wants to use the sample information to:

1. Calculate and interpret relevant probabilities for the cause of death and the method of losing weight.
2. Determine whether the events 'Disease death' and 'No surgery' are independent.

Text at a glance *continued*

Unique coverage of regression analysis

We combine simple and multiple regression in one chapter, which we believe is a seamless grouping and eliminates needless repetition. This grouping allows more coverage of regression analysis than the vast majority of Essentials texts. This focus reflects the topic's growing use in practice. However, for those instructors who prefer to cover only simple regression, doing so is still an option.

Simple linear regression model

Regression analysis is one of the most important statistical methodologies used in business applications. This is because of its generality and applicability. It is used to examine the linear relationship between two or more variables. In the introductory case, Madelyn is interested in examining how income, working hours and the unemployment rate might influence debt repayments. In other scenarios we may want to: predict a company's sales based on its advertising expenditure; estimate an individual's salary based on education and years of experience; predict the selling price of a house on the basis of its size and location; or describe auto sales with respect to consumer income, interest rates and price discounts. In all of these examples we can use regression analysis to describe the relationships between the variables of interest.

With regression analysis, we explicitly assume that one variable, called the **response variable**, is influenced by other variables, called the **explanatory variables**. That is why the regression analysis is part of the family of dependence models. Consequently, we use information on the explanatory variables to predict or describe changes in the response variable. Alternative names for explanatory variables are independent, predictor, antecedent or exogenous variables, or regressors; while the response variable is often referred to as the dependent, predicted, consequent, criterion or endogenous variable, or the regressand.

No matter the response variable that we choose to examine, we cannot expect to predict its exact value because some omitted explanatory variables may also influence it. If the value of the response variable is uniquely determined by the values of the explanatory variables, we say that the relationship between the variables is **deterministic**. This is often the case in the physical sciences. For example, momentum p is the product of the mass m and speed (velocity) v of an object, that is, $p = mv$. However, in most fields of research we tend to find that the relationship between the explanatory variables and the response variable is **inexact**, due to the omission of relevant factors (sometimes not measurable) that influence the response variable, or due to measurement errors. For instance, debt repayments

LO
11.1

Written as taught

We introduce topics just the way we teach them; that is, the relevant tools follow the opening application. Our roadmap for solving problems is.

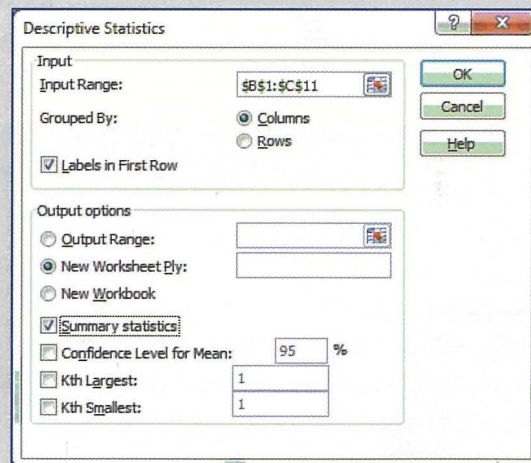
1. Start with intuition
2. Introduce mathematical rigour, and

3. Produce computer output that confirms results.

We use worked examples throughout the text to illustrate how to apply concepts to solve real-world problems.


Integration of Microsoft® Excel

We prefer that students first focus on and absorb the statistical material before replicating their results with a computer. We feel that solving each application manually provides students with a deeper understanding of the relevant concept. However, we recognise that, primarily due to cumbersome calculations or the need for statistical tables, the embedding of computer output is necessary. Microsoft Excel® is the primary software package used in this text and it is integrated within each chapter. We chose Excel over other statistical packages based on reviewer feedback and the fact that students benefit from the added spreadsheet experience. We provide brief guidelines for using Minitab, SPSS and JMP in chapter appendices; we give more detailed instructions on the text website.



Mechanical and applied exercises

Chapter exercises are a well-balanced blend of mechanical, computational-type problems followed by more ambitious, interpretive-type problems. We have found that simpler drill problems tend to build students' confidence prior to tackling more difficult applied problems. Moreover, we repeatedly use many data sets—including house prices, rents, stock returns, salaries and debt—in the text. For instance, students first use these real data to calculate summary measures and then continue on to make statistical inferences with confidence intervals and hypothesis tests and perform regression analysis.



EXERCISES 9.4

Mechanics

54. Consider the following hypotheses:
 $H_0: p \geq 0.38$
 $H_A: p < 0.38$

Compute the p -value based on the following sample information.

a. $x = 22, n = 74$
b. $x = 110, n = 300$
c. $\hat{p} = 0.34, n = 50$
d. $\hat{p} = 0.34, n = 400$

55. Which sets of sample information in the preceding question enable us to reject the null hypothesis at $\alpha = 0.01$ and at $\alpha = 0.10$?

56. Consider the following hypotheses:
 $H_0: p = 0.32$
 $H_A: p \neq 0.32$

Compute the p -value based on the following sample information

a. $x = 20, n = 66$
b. $x = 100, n = 264$
c. $\hat{p} = 0.40, n = 40$
d. $\hat{p} = 0.38, n = 180$

57. Which sets of sample information in the preceding question enable us to reject the null hypothesis at $\alpha = 0.05$ and at $\alpha = 0.10$?

58. Specify the critical value(s) for the following tests of the population proportion. The analysis is conducted at a 5% level of significance.

a. $H_0: p \leq 0.22; H_A: p > 0.22$
b. $H_0: p = 0.69; H_A: p \neq 0.69$
c. $H_0: p \geq 0.56; H_A: p < 0.56$

59. In order to conduct a hypothesis test of the population proportion, you sample 320 observations that result in 128 successes. Use the p -value approach to conduct the following tests at $\alpha = 0.05$.

a. $H_0: p \geq 0.45; H_A: p < 0.45$
b. $H_0: p = 0.45; H_A: p \neq 0.45$

Conceptual review

At the end of each chapter, we provide a conceptual review that provides a more holistic approach to reviewing the material. This section revisits the learning outcomes and provides the most important definitions, interpretations and formulas.

Conceptual review

LO 4.1 Describe fundamental probability concepts.

In order to assign the appropriate probability to an uncertain event, it is useful to establish some terminology. An **experiment** is a process that leads to one of several possible outcomes. A **sample space**, denoted S , of an experiment contains all possible outcomes of the experiment. An **event** is any subset of outcomes of an experiment, and is called a simple event if it contains a single outcome. Events are **exhaustive** if all possible outcomes of an experiment belong to the events. Events are **mutually exclusive** if they do not share any common outcome of an experiment.

A **probability** is a numerical value that measures the likelihood that an event occurs. It assumes a value between zero and one where a value zero indicates an impossible

Interactive end-of-chapter questions

Activities from the end of each chapter have been redesigned and built as interactive questions to allow students to practise what they are learning in a responsive environment that caters to every learning style.

Instructor library

The **Connect** instructor library is the place for additional resources to improve student engagement in and out of class. Instructors can select and use any asset that enhances their lecture:

- eBook
- PowerPoint presentations

Learning resources

McGraw-Hill **Connect** brings every learning resource that accompanies this text together in one place, and can also integrate and interact with your LMS. Connect allows instructors the opportunity to provide a blended or flipped classroom approach to their teaching.

PowerPoint presentations

These presentations cover the key points of the chapter and include figures and charts from the text where relevant.

Integration of Excel data sets

A convenient feature is the inclusion of an Excel data file link in many problems using data files in their calculation. The link allows students to easily launch into Excel, work the problem and return to Connect to key in the answer and receive feedback on their results.

- Test bank
- Instructor's solutions manual
- Digital image library

For more information, ask your McGraw-Hill Education Consultant.