Austral. & New Zealand J. Statist. **41**(4), 1999, 493–501

BOOK REVIEWS

Chance Encounters: a First Course in Data Analysis and Inference. By Chris Wild & George Seber. John Wiley & Sons: New York. 2000. xviii+611 pages. A$75 (hardcover). ISBN 0-471-32936-3

Another first-year textbook. What makes this one sufficiently different that it will stand out in a crowded market and deserve some attention? First, it is very well written, with dozens of well chosen and interesting examples, case studies and anecdotes, and much good advice on practical data analysis issues. Second, it is written by two local statisticians (from the University of Auckland) who have a great deal of experience in teaching very large introductory statistics courses (see Wild, 1995; Wild, Triggs & Pfannkuch, 1997). Third, the authors are not afraid to give their own opinions and guidance where needed.

The authors describe their book as 'an intuitive, data-oriented, graphical, and computer-oriented introduction to making sense of the world through statistics'. There has been a trend for some time now in teaching introductory statistics, to emphasize data analysis and statistical thinking rather than the mathematical and probabilistic framework of statistics or a collection of standard statistical techniques. This book achieves that goal better than any other I have seen. The authors take many opportunities to guide students to think carefully about data, to use graphics effectively and extensively for exploration and confirmation of structure in data, and to avoid drawing inappropriate conclusions from data.

Hundreds of exercises are included, mostly aimed at testing understanding rather than computational skill. Many examples involve real data, often previously unpublished. The review exercises at the end of each chapter are often probing, using the context of the data to stimulate statistical thinking.

The book is computer-oriented without being closely tied to any particular software package. The authors assume students will be using computers for most analyses and consequently do not attempt to teach formulas designed for hand calculation. Instead, they show some computer output in places (mostly from MINITAB) and provide limited instructions on how to do some procedures using MINITAB, EXCEL, and S-PLUS or R.

This text's nearest competitor is Griffiths, Stirling & Weldon (1998); both books take a similar approach to the subject, and both give many local examples.

The book is divided into 12 chapters. Each chapter begins with a Chapter overview and concludes with a Summary, Glossary and Review exercises. Most sections, and some subsections, have a review quiz and exercises. In general, the explanations are very clear, the case studies are interesting, the writing is readable, and the graphics are helpful.

The first chapter discusses the role of statistics and the collection of data, and includes sections on polls and surveys, experimentation and observational studies. the section on polls and surveys is typical of the general approach, with a careful discussion of the sources of bias and error, some classic case studies (the surveys of Shere Hite and the *Literary Digest* polling of US presidential elections), some good new examples (mostly from New Zealand), a quiz and some thought provoking exercises.

Chapter 2, 'Tools for exploring univariate data', provides general advice on summarizing data in tables and graphs, and covers dot plots, stem-and-leaf plots, histograms, the mean, median, quartiles, range, interquartile range, standard deviation, boxplots, bar graphs, and Pareto charts. The section on rounding numbers is valuable, providing such advice as 'It is dangerous to round numbers that will be used in calculations . . . Round numbers for presentation'. The ideas introduced here are used throughout the rest of the book.

'Exploratory tools for relationships' is the title of Chapter 3. It is organized around the type of data: two quantitative variables, quantitative *vs.* qualitative variables, and two qualitative variables. This chapter is excellent, providing an intuitive introduction to many statistical concepts through well-chosen examples.

Probability and proportions are introduced in Chapter 4. There is a section discussing 'Where do probabilities come from?' before the material on sample spaces, probability rules and distributions. Only those parts of probability theory which are used for inference are introduced. Bayes' theorem, for example, is not covered, although the authors show how to reverse the order of conditioning using a two-way table. The material is illustrated by various case studies including AIDS testing and nuclear reactor safety.

Chapters 5 and 6 provide relatively standard coverage of discrete random variables and continuous random variables including the binomial and normal distributions.

Chapter 7 is pivotal, covering sampling distributions of the sample mean and sample proportion, standard errors and the t-distribution.

The authors manage to keep the discussion of confidence intervals for means and proportions in Chapter 8 relatively simple. Confidence intervals for the mean, and for the difference between two means, are covered only for the case where the standard deviations are unknown. For the difference between two means, the standard deviations are not pooled. (At last, a textbook that does not try to cover all the variations!) There is a useful discussion of how to interpret the situation in which two separate confidence intervals overlap. Another section discusses the 'margin of error' reported in media polls.

Chapter 9, 'Significance testing: using data to test hypotheses', approaches this subject through the P-value. The use of critical values is not discussed and the concept of 'accepting' or 'rejecting' hypotheses is discouraged. The P-value is interpreted as a measure of the evidence against the null hypothesis. This chapter includes a section called 'Why tests should be supplemented by intervals'.

Chapter 10, 'Data on a continuous variable', revisits inference for the mean and provides some limited discussion of non-parametric tests and one-way ANOVA. This chapter is the most awkward in the book, because the authors have tried to do too much. The very brief comments on the sign test, Wilcoxon test and Kruskal–Wallis test are insufficient to be of much use. The authors warn against parametric inferences about variances and suggest using Levene's test. As well as non-parametric tests, there are brief mentions of normal probability plots, robust methods, and transformations. This material would be better omitted or properly developed. On the other hand, there is a very good section called 'Blocking, stratification and related samples'.

Tables of counts are discussed in Chapter 11. The most unusual feature of this chapter is the careful distinction between a test for homogeneity and a test for independence on a two-way table. The distinction may well be lost on most first-year students, especially since the chi-squared statistics are the same in both cases. The chapter concludes with some excellent examples of Simpson's paradox.

Regression is covered in Chapter 12. The discussion on causation is very good. Some non-linear examples are given which show the possibilities rather than teaching students how to handle such problems. The authors advise 'You should not let the questions you want to ask be dictated by the tools you know how to use'. I would have preferred to see an example showing how to fit an exponential trend, because this arises so often. The section on correlation seemed a little out of place at the end of the chapter — it would have fitted naturally near the beginning and before the sections on least squares and inference.

There are answers to selected problems at the back of the book. In addition, there will be a complete solution manual for instructors and a second solution manual for students with every second review exercise omitted.

It is becoming essential for introductory textbooks to have an associated web site with supplementary materials. The web site for this book is at http://www.wiley.com/college/wild/

The authors promise to provide the web site with all relevant data, additional data and exercises, PowerPoint slides, two additional chapters (on control charts and time series), additional topics and other material.

If I were still teaching a large introductory statistics course to science students, I would enthusiastically adopt this textbook, but I currently teach a large introductory statistics course to business and commerce students, and they could well think there were too many examples from science and

medicine. We have a tough job as it is to convince them that statistics is important to them. Nevertheless, the authors are to be congratulated on a superb book. For several years, *Introduction to the Practice of Statistics* by Moore & McCabe (1999) has been the recognized benchmark to which other books aspire; Wild and Seber have now raised the standard of introductory textbooks another notch!

ROB J. HYNDMAN
Monash University

References

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Experiments in Ecology. By A.J. Underwood. Cambridge University Press. 1997. A$60 (paperback). xviii + 504 pages. ISBN 0-521-55696-1

The author's justification for adding to the growing number of introductory statistics textbooks is that 'few books focus on the nature of biological experiments from the perspective of biological hypotheses and the practical problems that biologists routinely encounter'. The chapter headings give an idea of the material covered (but not the depth): Introduction; A framework for investigating biological patterns and processes; Populations, frequency distributions and samples; Statistical tests of null hypotheses; Statistical tests on samples; Simple experiments comparing the means of two populations; Analysis of variance; More analysis of variance; Nested analysis of variance; Factorial experiments; Construction of any analysis from general principles; Some common and some particular experimental designs; Analyses involving relationships among variables; Conclusions: where to from here?

Professor Underwood (University of Sydney) has an international reputation in ecology. His work in writing a user-friendly text about elementary experimental design for ecological students is commended. Being a statistician, I am not prepared to comment on the ecological content.

Although he is a skilled practitioner in this area, Professor Underwood has made an error in his potted account of the logic of statistical hypothesis testing, given in Chapter 2. On p. 17 he writes, 'If the null hypothesis is disproven, the hypothesis is supported by falsification of its alternatives. If the null hypothesis is retained, the hypothesis and models are themselves falsified.' The statistical procedure of not rejecting the null hypothesis is not the same as falsification. He corrects this in a later chapter.

There are other statistical errors. The justification for the use of some of the tests is wrong. For example, when discussing the sign test, the author writes, on p. 130,

> The major advantage of this test is that it requires no assumptions about the shape of the distribution of data being sampled except that the distribution of proportions of positive or negative differences should be a binomial distribution.

The presentation of some of the material is eccentric. Professor Underwood makes no distinction between model parameters and parameter estimates throughout his book. He uses non-standard notation for factors in his model. When discussing testing of equality of means, he writes as his null hypothesis that the value of the test statistic equals one (see pp. 153–154).

The author comes out strongly for the pooled two-sample t-test instead of the more general parametric two-sample test. Yet (as any practising statistician knows) the test of equality of variances is not robust to departures from normality, and this is not mentioned. I find it strange that he can have