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Experimental Design Using ANOVA

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EXPERIMENTAL DESIGNS USING ANOVA

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Experimental Designs Using ANOVA

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Preface

Experimental Designs Using ANOVA is a textbook or reference book for people who have a background in basic descriptive and inferential statistics. Although we review basic descriptive statistics in Chapter 2 and the logic of basic ANOVA in Chapter 3, the reviews are slanted toward screening data and understanding the assumptions of analyses. In most universities, this book is likely to be appropriate for senior or first-year graduate study or for those who are taking part in a year-long research design and statistics course. An earlier version of this book was entitled *Computer-Assisted Research Design and Analysis,* emphasizing the use of statistical software both for analyzing data and designing the more complex experiments.

One distinctive feature of this book is the inclusion of the regression approach to ANOVA alongside the traditional approach. As we included more and more of the regression approach in our courses, we developed appreciation for the clarity and flexibility of this approach to ANOVA. The approach easily clarifies issues associated with unequal n and interaction contrasts, among others. It also greatly facilitates understanding of fractional factorials and other screening designs, which are the topics of Chapter 10. Although screening designs are not routinely included in a social science curriculum, they should be. They offer a powerful approach to pilot studies, as well as an organized method of research for areas where few cases are available.

With knowledge of how to set up a data set for the regression approach and with the availability of regression software, you will learn to appreciate the full flexibility of ANOVA conducted through regression. For the less complex designs, a traditional ANOVA approach to the technique is first taken. Then, the analysis is repeated

through methods associated with the general linear model. For the more complicated designs, the easier of the two approaches is demonstrated. Although we believe the regression approach is helpful, others may not agree; it is described in clearly defined subsections that could be omitted if desired.

Experimental Designs Using ANOVA includes details on how to perform both simple and complicated analyses by hand—through traditional means, through regression, and through the most recent (at the time of writing) versions of SPSS and SAS, with occasional demonstration of SYSTAT when it offers unique solutions to problems of design or analysis. Syntax and output for both basic and complicated analyses are shown, together with interpretive comments about the output. We also show syntax for SYSTAT for many of these analyses.

Chapters 4–7 review basic and complicated analyses for randomized-groups, repeated-measures, and mixed designs.[1] We then include illustrations of analyses for basic and complicated screening, Latin-square, ANCOVA, and nesting and random-effects designs.

Because more material is included than some instructors may want to cover in depth in one semester, instructors should choose the analyses most appropriate for their disciplines. However, because all chapters follow a similar outline, students can continue study on their own or readily find material they need when they encounter an unusual problem later on. We have used this book in manuscript form three times prior to publication. In the first 10 weeks of class, we cover material through Chapter 7 (mixed randomized-groups, repeated-measures designs). Students found the review of factorial designs at the end of Chapter 7 especially helpful. The remaining five weeks are used to cover the basics of ANCOVA, Latin-square, screening, and random-effects designs and to familiarize students with some of the complications of those designs. Thus, the first eight chapters comprise a fast-paced quarter course.

Chapters 4–11 follow the same common format as our more advanced text, *Using Multivariate Statistics*: general purpose and description, kinds of research questions that can be answered by the analysis, and then limitations and major assumptions of the analysis, together with recommendations if there is a violation of an assumption. The next section has an unrealistically small and often silly data set that is analyzed by traditional methods, through regression, and through the two software packages. These examples reflect our hobbies (skiing, belly dancing, and reading—primarily mystery and science fiction) and are meant to be immediately accessible to people from a variety of backgrounds. Except for being perhaps slightly amusing, they are intended to "get out of the way" so you can concentrate on the design and the statistical analysis. Or, if you prefer, you can substitute you own variable names and labels.

The next section of each chapter discusses varieties of the basic design, if there are any, followed by a section that covers issues particular to the analysis. The next section illustrates a complete analysis of a real-life data set (the data sets come from a variety of research areas). Although we are social scientists, we have consulted in

[1] We decided to use the terms that are used more widely in statistics rather than the between-subjects and within-subjects terms used in the social sciences, which are confusing in some settings.

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many research areas and have learned the necessity of quickly "getting up to speed" in a new area. The complete examples are eclectic and are described more fully in Appendix B. The data sets for the complete examples are on the accompanying CD. Those who find some of the examples less than compelling are urged to substitute a data set from their own research area and to follow the steps of analysis with it. The last section of each chapter compares several programs available for the analysis. Problem Sets are included at the end of each chapter, and answers to most of them are on the Student Suite CD that is bound in this book.

Once students have completed this course, they should be prepared to take a course in multivariate statistics, with *Using Multivariate Statistics* (5th ed., Allyn and Bacon, 2007), our other book, as text. Both books use the same outline for all technique chapters, making the transition from univariate to multivariate statistics easier.

We are aware of controversy surrounding use of tests of statistical significance instead of focusing on practical significance (effect size). We have chosen to continue the practice of using statistical significance levels to focus interpretation but have also emphasized measures of effect size, as well as confidence limits around effect size, for most analyses. The CD contains free software for effect sizes and confidence limits around them.

The book reflects our practical approach, emphasizing computer assistance in design and analysis of research, in addition to conceptual understanding fostered by presentation and interpretation of fundamental equations.

Students from two classes survived manuscript versions of the first incarnation of this book and made numerous very helpful comments. Much that is right about this book is due to their very careful reading of it.

We'd like to thank all of those anonymous reviewers who helped us sort out our thoughts so that we could try to make this book as clear as possible. John Jamieson of Lakehead University in Canada has provided helpful information about ANOVA for this book (and for our other book); Dave DeYoung of the California Department of Motor Vehicles has, as always, been generous with helpful suggestions. The reviews of the first edition by Dennis Doverspike of the University of Akron and Barry McLaughlin of University of California, Santa Cruz, were especially helpful.

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