
BOOK REVIEW

André I. Khuri, Thomas Mathew, and Bimal K. Sinha, *Statistical Tests for Mixed Linear Models*, John Wiley & Sons, 1998, 352 pp., $69.95 (cloth).

The decomposition of variance components is an essential part of data analysis for researchers employing mixed models—i.e., those containing both fixed and random effects. In recent years, analysts have made significant breakthroughs regarding statistical tests for such models. *Statistical Tests for Mixed Linear Models*, written by André Khuri and his co-authors, presents a comprehensive, mathematical overview of these methods and extends past work to include hypothesis testing.

Traditional, analysis of variance (ANOVA) models are well developed for fixed effects models, which are those in which the researcher has complete control over assignment of factors and factor levels. For models with random effects (as often exists in observational studies, where for example, subject educational level varies but is not under the control of the researcher), too, ANOVA models have long existed. Models with both types of effects, however, present some special challenges, and *Statistical Tests for Mixed Linear Models* lays out appropriate solutions.

Covering both balanced (those with equal numbers of observations in all subclasses) and unbalanced models (those with at least one subclass with a different number of observations compared to the others), *Statistical Tests for Mixed Linear Models* presents derivations of both exact and optimal tests for variance component models, as well as guidance on using such tests for hypothesis testing. While little attention is paid to conducting such tests with commonly available statistical software (e.g., SPSS™ or SAS™)—in many instances such software cannot directly perform the tests described—the authors usually provide sufficient information to allow users (especially advanced users) to complete the tests on their own, generally aided by specific output given in standard ANOVA tables. In several places, conceptual algorithms are given to allow the reader to conduct tests not offered in standard software.

Designed primarily as a course textbook, *Statistical Tests for Mixed Linear Models* includes student exercises at the end of each chapter, an appendix that gives the solutions to selected problems, and an ample bibliography. Beyond formal use in the classroom, the book also may serve as a reference guide for researchers beyond their student years who wish to know more about exact or optimal tests for mixed linear models. Interested readers, however, should be aware that this is not an introductory text on experimental design or ANOVA. To make best use of *Statistical Tests for Mixed Linear Models*, readers should be well versed in both. For a good overview of experimental research design, see, for example, Montgomery (1991). A classic work on ANOVA is Scheffe (1959), and many more fine texts have come since.

For those interested specifically in the optimal tests presented in *Statistical Tests for Mixed Linear Models*, the authors recommend previous familiarity with the concept of optimal tests and the methods for deriving such tests (such as Lehmann, 1986). Readers would do well to heed this advice; indeed, Khuri and his co-authors would have greatly aided their readers had they included an introduction to optimal tests in *Statistical Tests for Mixed Linear Models*.

Viewed as either a textbook or a reference guide, *Statistical Tests for Mixed Linear Models* suffers from one major drawback for researchers who primarily use statistics (as opposed to statisticians who advance statistical methods)—too few applications of developed procedures to real data. No doubt, the almost purely mathematical exposition is not a drawback for statisticians or mathematicians, but it can be frustrating for those who want to learn how best to apply advanced methods to actual data. Working the sample problems may alleviate some of this concern.

Those already comfortable with mixed models will find much of use in *Statistical Tests for Mixed Linear Models.* The tests described therein will enable researchers to make stronger and more certain inferences from their data. Finally, teachers of advanced courses in experimental data analysis will have collected in one place many of the most recent advances in the field.

REFERENCES

Lehmann, E.L. 1986. *Testing Statistical Hypotheses*, Second Edition. New York: Wiley.

Montgomery, D.C. 1991. *Design and Analysis of Experiments*. New York: Wiley.

Scheffe, H. 1959. *The Analysis of Variance*. New York: Wiley.

Reviewed by

Richard Wallace
University of Michigan
