Book Reviews

Mathematical and Statistical Methods for Genetic Analysis.
By Kenneth Lange. Springer Series in Statistics for Biology
and Health. New York: Springer-Verlag, 1997. Pp. 265.
$54.95 (cloth).

Ever since Gregor Mendel deduced the probabilistic "laws" of
heredity, mathematical and statistical methods have proved to
be essential for genetic analyses. To keep pace both with the
flood of genetic information pouring into journals and public
databases and with our evolving knowledge of the complexity
of genetic mechanisms, new models of genetic analysis are
continually needed, particularly for traits measured in obser-
vational studies of humans. *Mathematical and Statistical Meth-
ods for Genetic Analysis* provides a solid bridge between mod-
ern genetics and advanced statistical methods, and it is filled
with mathematical and statistical insights into the development
of new genetic models. This book can be used not only as an
advanced textbook for graduate students in statistics and
mathematical modeling but also as a superb synthesis of recent
statistical-genetics developments that any practitioner in this
field will find immensely useful.

As implied by the title and explicitly stated in the preface,
this book is not intended as a cookbook for performing a
genetic study; rather, the anticipated audience of this book is
students who are already sophisticated in theoretical statistics,
as well as in calculus and linear algebra. Readers with a suit-
able background are guided through fundamental statistical
and mathematical concepts and then through a keen demon-
stration of how these methods can be adapted for genetic
research.

The book is composed of 13 chapters, of which the first
describes the basic principles of population genetics; a brief
appendix gives a summary of molecular genetics. Although
these are nice summaries, I suspect that they would be too
brief for mathematicians who have no background in biology;
serious students of statistical genetics should look elsewhere
for a fuller introduction to basic genetics. Chapter 2 covers
the EM algorithm, with applications to ascertainment correc-
tion for segregation analysis. Chapter 3 discusses Newton's
Method and Scoring, which are indispensable methods for ob-
taining maximum-likelihood estimates, and it illustrates their
application for empirical Bayes estimation of allele frequencies.
Some topics related to categorical data analysis, such as the
transmission/disequilibrium test and tests for clustering of mul-
tinomial data, are covered in chapter 4. Kinship coefficients
and their generalizations to more than two people are clearly

presented in chapter 5, along with efficient recursive compu-
tational methods. These ideas of probabilistic descriptions of
genetic relationships are key to genetic applications and are
further expanded in chapter 6—for example, by partitioning
the covariances of a pedigree into their genetic contributions.

Chapter 7 covers computational methods for pedigree anal-
yses, a topic on which Lange has published extensively. Al-
though this chapter is full of key ideas that will prove useful
for both segregation and linkage analyses, it was disappointing
to not see more discussion of the hidden Markov methods that
are the basis of the Lander-and-Green algorithm used in pop-
ular genetic-analysis software. Nonetheless, the breadth of top-
ics covered is impressive, and generous insights appear
throughout. Chapters 8–13 cover the polygenic model (with
novel approximations), Markov-Chain Monte Carlo methods,
evolutionary trees, radiation-hybrid mapping, models of re-
combination, and Poisson approximation. The explanations
offered for the Markov-Chain Monte Carlo approach and for
Poisson approximation, two highly active areas of research,
are self-contained and worth reading for any statistician in-
terested in these topics. The general steps needed to derive a
genetic model are provided in each chapter, but readers who
wish to get the most out of this book should plan to sit down
with pencil and paper to fill in the details. Each chapter in-
cludes 10–12 problems to work through that reinforce the
mathematical concepts.

Mathematical and Statistical Methods for Genetic Analysis
synthesizes many of the key statistical and mathematical topics
that are used for genetic analyses. Lange indicates that this
book represents his polished notes from years of teaching at
UCLA and the University of Michigan, as well as a synthesis
of his own published work. This bias toward Lange's own
work is perhaps the book's greatest strength, because it allows
him to offer deeper statistical and mathematical explanations
for genetic analyses than are found in most other sources. This
book is a must-read for students wishing to move into the field
of statistical genetics, as well as for practicing statisticians who
wish to adapt familiar statistical methods for genetic analyses.

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