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BOOK REVIEW

Ecological Models and Data in R, B.M. Bolker. Princeton University Press, Princeton, London (2008). 408pp., £32.95, ISBN: 978-0-691-12522-0

Likelihood is the central concept in ecological statistics. It describes the relationship between data and model parameters, and through maximising likelihood the best model is found. Independent of the specific focus of modern statistics in ecology, be it hypothesis testing ANOVAs or population model fitting using differential equation systems, maximum likelihood is at the heart of the statistical machinery. As anyone teaching statistics to ecology students now knows, thanks to Hilburn and Mangel's "Ecological Detective" (1997, Princeton), the underlying mathematics is an optimisation of a model fit under specific distributional assumptions. Still, we learn (and teach) along the classical lines: from *t*-test to ANCOVA, from correlation to multiple regression. GLMs are then treated as somewhat complicated generalisations (hence the name).

Bolker's book is the first "introductory" statistics book to dare and turn this scheme from its head onto its feet. He rightly starts not with the special case, say a *t*-test, but with the basics: probability distributions. (actually, he starts even earlier, with two chapters on software and visualisation of data, which, arguably, is the most crucial step of all statistical analysis. As statistics professor Bill Venables once sardonically said: "All this becomes even more glaring if you take the unusual step of plotting the data.") The next logical step in understanding statistical models are stochastic simulations (drawing randomly from specified distributions) and maximum likelihood. Necessarily, all these chapters are rather technical and mathematical. But once the reader has mastered their content (and that of optimising methods) all techniques are in place for the realm of classical, frequentist and Bayesian statistical analyses. Several hundred pages of classical textbook statistics now fit into one chapter with barely 20 pages – and it's all there, albeit in a rather condensed form. Another 20-page-chapter introduces time series, spatial analysis and mixed effect models. Some topics are not presented in this book, largely because they fall outside the logic of Bolker's advocated approach: non-parametric methods (e.g. resampling tests), data mining and multivariate statistics. Still, the foundations and logic of these methods are presented.

This book, similar to the "Ecological Detective", demands a lot of attention, despite its clear writing style, excellent ecological examples and extensive software support (all R-code, examples and data are available from the book's web site). It leads the reader to interpret data not merely in classical exploratory way, but rather encourages one to think of mechanistic, possibly dynamic models behind the observed patterns, and fit them to the data. EMD is a book that develops all skills required to do so. As such, it has to introduce topics not covered in any "introductory" textbook I am aware of: uncommon and mixed distributions, likelihood profiles, generalised least squares, simulated annealing, Kalman filters, state-space models and Bayesian implementations of these topics. The reward for this steep learning curve is a brilliant view not only of the methods we all apply routinely, but of their inner workings as well. Understanding the book prepares for a logistic regression – and for fitting a dynamic measles outbreak model to epidemiological data in a Bayesian framework! What else could one ask from a book on models and data? Bolker's book is a must-buy for anyone wanting to fit data to models and go beyond hypothesis testing, but it is certainly not an "introductory" text in the sense of "simple". This book is a tour de force for anyone who studied ecology for his or her interest of nature's working. But it is the one single book that can propel the statistical novice to the cutting edge of statistical ecology – albeit with blood, sweat and tears.

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