# New book: *Introduction to Time Series Analysis and Forecasting* by Douglas C. Montgomery, Cheryl L. Jennings and Murat Kulahci, 2008, 445 pages, ISBN 978-0-471-65397-4, John Wiley & Sons, hardcover, US$115.00.

Time series analysis is the field of statistics that deals with time-oriented or longitudinal data. Many researchers dealing with time series data usually ignore temporal autocorrelation structure in the data and carry out ordinary least square regression analysis, which in fact violates the assumption of independence, one of the most fundamental assumptions of normal statistics. Moreover, depending on research design, researchers rightly use a repeated measures analysis on temporally autocorrelated data or longitudinal data which penalizes the degrees of freedom for the within-subject *F*-tests by a factor called Box's epsilon (more conservative), or Huynh-Feldt epsilon, or Greenhouse-Geisser epsilon (both less conservative than the Box's epsilon; Quinn & Keough, 2002) to allow possible departures of the variance-covariance matrix of the measurements from the assumption of sphericity. However, such an approach is not always useful depending on the research design one has used.

Researchers in many fields, including various disciplines of biology, face the need to understand and use the concept of time series analysis and predict some future events. On the other hand, books on time series analysis tend to be theoretical and highly technical (e.g., Brockwell & Davis, 1991; Box *et al*., 1994; Fuller, 1995; Chatfield, 1996; Reinsel, 1997; Lütkepohl, 2005). This new book, *Introduction to Time Series Analysis and Forecasting* is intended to fill the gap between the theory and practice by introducing the analysis of time-oriented data and construction of short- and medium-term statistical forecasts. It is written for students at the level of first-year graduate or advanced undergraduate studies.

Main concepts of time series analysis and prediction are introduced in seven chapters in this book: Introduction to Forecasting (forecasting problem, terminology, features of time series data); Statistics Background for Forecasting (autocovariance and autocorrelation functions, transformations, differencing and decomposing of time series data); Regression Analysis and Forecasting (cross-section and time series regression data, least squares and maximum likelihood model fitting); Exponential Smoothing Methods (smoothing constants, forecasting and constructing prediction intervals); Autoregressive Integrated Moving Average (ARIMA) Models (introduction to ARIMA models and identifying and fitting these models to non-seasonal and seasonal time series); Transfer Functions and Intervention Models, and Survey of Other Forecasting Methods (multivariate time series models and forecasting, state space models, ARCH and GARCH models, and neural networks). Statistical tables and additional data sets were given as appendices. Also, URL addresses of time series data sets are given, although the FTP site for the book itself was non-functional (as of November 7, 2008).

No one does the time series analysis by hand. Therefore, demonstration of using such common statistical software packages as JMP®, Minitab®, and SAS® in analyzing time-oriented data and reading their outputs is highly commendable. Also, statistics is learned only by doing. For this reason, each chapter ends with a large number of exercises, which are intended to employ the data sets given in Appendix B. It would have been useful if answers to some of the exercises were given in the book.

In many disciplines of biology, we deal with a wide variety of time-oriented data and attempt to make some predictions. Such attempts are clearly important not only for understanding underlying mechanisms in fundamental research, but also for making predictions in applied biological sciences. In population ecology, for example, dissecting time series data of population abundance to reveal underlying causal mechanism (detecting density dependence or independence, delayed density dependence etc.) for dynamical patterns exhibited by populations is important from the fundamental ecology viewpoint. But, it is equally important from the viewpoint of management of populations (Turchin, 2003; Begon *et al*., 2006): whether it is a population of harvested species, or a population of protected species, or a population of pest species. Populations exhibit various dynamical patterns from somewhat static to chaotic. Time series data of populations can include trends (not necessarily

homogeneous), seasonal and irregular variations. We employ various analytical techniques starting from detrending of population time series to detecting the nature of cycles using such spectral analyses as Fourier transformation or wavelet analysis. Therefore, I personally would have been delighted if such a clearly written introduction to time series analysis included introductions to spectral analysis.

Usage of analysis of time-oriented data and forecasting is rather diverse and common in other fields of biology and easily illustrated by examples, which I refrain. Only thing remains is to recommend this book to fellow biologists who deal with time-oriented data and encourage them to become students of this authoritative book.

## References

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