preface the authors state that use of simulation is "out of reach" but surely this is no longer the case. The authors offer no advice on what model might be appropriate if the null model is rejected. Examination of moments and probability plots can be useful in this regard.

Notwithstanding these doubts, this scholarly well-written book is a recommended purchase for your institute library.

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COX, D. R. and WERMOUTH, N. **Multivariate Dependencies: Models, Analysis and Interpretation**. Chapman & Hall, London, 1996. xii + 255 pp. £35.00/$64.95. ISBN 0-412-75410-X.

The focus of this book is on primary analyses of observational studies which were planned with the objective of describing and interpreting variation between individuals. Chapter 1 is an introduction to the conceptual issues in the application of statistics to scientific fields such as the social and medical sciences. This chapter mentions types of data sets, types of recorded measurements, types of variables, such as intermediate variables, surrogate variables, explanatory variables and mentions criteria for models and model selection. Throughout there are careful references to discussion in later chapters.

The first half of Chapter 2 discusses graphs and conditions for conditional and marginal independence between variables. In section 2.7, the important topic of the multitude of interpretations for a regression coefficient is discussed. Causality is the topic of the last section of chapter 2 and then again in chapter 8 section 7. The chapter 2 discussion exhibits the traditional avoidance by statisticians in giving a meaning to the statement "A causes B" and then ascertaining whether "A causes B." Yet many of the examples are taken from epidemiology and medical studies in which the goal of the study is to assess the amount of evidence for a causal statement (e.g. Does excessive alcohol intake during pregnancy cause low birth-weight newborns as compared to no alcohol intake during pregnancy?). Statisticians can tell researchers that they should not deduce causation from correlation but they will often go on to do so in spite of this advice. Thus it is incumbent upon the statistician to utilize a meaningful working definition of causality and quantify for the researcher the assumptions under which the data can supply evidence for the causal statement. The Chapter 8 discussion is very interesting and leaves this reviewer wishing that the authors had spent more time on a working definition of causality, problems with unobserved confounders, confounding by intermediate variables and problems with noncompliance and the intention to treat analysis. These problems could have been usefully illustrated by the graphs discussed in chapter 2. Under the assumption that most social scientists really do wish to make causal statements, these problems are very important.

Chapter 6 contains representative data analyses. These are nice exploratory analyses. The exploratory nature of the analyses (consisting of many small regression analyses and hypotheses tests) is consistent with the non-causal approach of the authors. The authors' illustrations make clear the usefulness of the graphs discussed in chapter 2 in representing the results of the many regression analyses. One concern is the strong dependence on the linear model in testing marginal and conditional independence. It would have been nice to see some discussion of how much the marginal and conditional independence results depend on the assumption of a functional form for the regressions.

In summary this book is rather useful for the biometrician who is interested in exploratory analysis for multivariate data and who wishes to determine possible causes of an effect. The book demonstrates the effective use of graphs to represent the results of exploratory analyses. However the biometrician conducting a confirmatory analysis, or the biometrician who wishes to determine the level of support in a data set for a causal statement, may wish to look elsewhere.

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WAND, M. P. and JONES, M. C. **Kernel Smoothing**. Chapman & Hall, London, 1995. xii + 212 pp. £34.00/$69.95. ISBN 0-412-55270-1.

Kernel methods are now quite widely used as statistical smoothing techniques. A browse through recent issues of *Biometrics* will confirm this, with applications appearing in quite a number of biometrical settings. The aims of this book are "to develop the reader's intuition and mathematical skills required for a comprehensive understanding of kernel smoothing, and hence smoothing problems in general". The book succeeds in doing this very well.

There are other ways of smoothing data but the authors of this book are atttracted by the simplicity of the kernel prescription and by the fact that it can be defined in simple expressions. This has the advantage of making the mathematical analysis of the properties of the estimators more amenable. After a short introduction, the four principal chapters of the book deal with 'Univariate kernel density estimation', the important topic of 'Bandwidth selection', the extension to 'Multivariate kernel density estimation' and the analogous techniques of 'Kernel regression'. By design, the emphasis is on these straightforward settings although the final chapter on 'Selected extra topics' indicates how

the same principles apply to dependent, length-biased, right-censored and noise-corrupted data, and to the estimation of hazard, spectral density and intensity functions. Bibliographic notes are kept to the end of each chapter, to avoid distraction from the development of the main ideas.

The book does not have a particular biometrical orientation as its aim is to give a more general introduction. There are some real data examples but, in keeping with the aims of the book, the figures aim to illustrate the properties of kernel estimators. Mean squared errors and similar quantities feature strongly and the text is a very useful reference for all the key results on bias, variance and other properties, and for detailed descriptions of how to construct estimators of different types and in different settings. An important question in smoothing data is how to choose the 'bandwidth' parameter which controls the amount of smoothing that takes place. The chapter on this topic for density estimation is particularly helpful in reviewing much of the recent work on the topic, an area in which both of the authors have made important contributions. In keeping with the emphasis of the book on density estimation, the section on bandwidth selection for regression is quite short, simply indicating how one of the more successful techniques for density estimation can be extended to the regression setting.

Exercises are provided at the end of each chapter to give readers an opportunity to practice for themselves the kinds of analysis which are developed in the text. However, the book also contains important material on computational aspects, mostly through the Appendices. In particular, the role of binning in allowing efficient calculations is explained very clearly. Reference is also made to software which can be used to implement nonparametric smoothing techniques in a convenient manner. This includes a library of functions written in S-Plus by Matt Wand which is available over the internet.

In summary, this book provides a very clear and useful account of the theory of kernel smoothing. It is an excellent starting point for those who would like an introduction to how these estimators can be constructed and an understanding of their properties.

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MACDONALD, I. L. and ZUCCHINI, W. **Hidden Markov and Other Models for Discrete-valued Time Series**. Chapman & Hall, London, 1997. xvi + 236 pp. £35.00/$59.95. ISBN 0-412-55850-5.

Continuous-valued time series are conventionally tackled using ARMA models. Discrete time series do not have such a general model, but 'hidden Markov' models have proven to be versatile and computationally tractable. This is a book of two parts. The first part, one chapter, consists of a survey of models for discrete-valued time series, including Markov chains, DARMA models of Jacobs and Lewis, marginal models, bivariate geometric models, Markov regression models, parameter-driven models, and state-space models. In each case the treatment is quite cursory, and gives main formulas and references.

The second part considers hidden Markov models and has three chapters: basic models, extensions and modifications, and applications. The second chapter is the meat of the book, and begins by considering aspects of hidden Markov models in speech processing. It is not until p. 66 that the authors define a hidden Markov chain: Suppose there is an irreducible homogeneous Markov chain $\{C_t\}$. Let $\{S_t\}$ be a non-negative integer valued random process, $t = 1, \ldots, T$, such that, conditional on $\{C_t\}$, the random variables $\{S_t,\ t = 1, \ldots, T\}$ are mutually independent. Then S_t is said to be generated by a hidden Markov model. This is illustrated nicely by a conditional independence graph. The authors consider the situation when the conditional distribution of S_t is either Poisson or binomial. They argue that these models can accommodate a wider range of correlational structures than can Markov chain models, or any of the other discrete time models surveyed in Part 1.

The third chapter considers extensions and modifications to the basic model in two ways: modifications of the parameter process and modifications of the state-dependent distributions, for example to second-order Markov chains, and to multivariate models.

The final chapter contains some applications of the preceding work. For biometricians interest would lie in epileptic seizure counts, a time series of births in a particular hospital, locomotory behaviour of *Locusta migratoria*, and homicides and suicides in Cape Town. Goodness of fit was assessed using the AIC and BIC criteria. The data for these examples are given in an Appendix.

This book is largely concerned with theoretical aspects of hidden Markov methods, although the relevant papers by the two authors in the bibliography are on applications which are discussed in the final chapter. There is some mention of computing methods, usually using NAG routines or standard applications of SAS or Splus, but there are no programs given for fitting these models. One omission I thought surprising was that there was no mention of Monte Carlo Markov Chains (MCMC) or the package BUGS which, I imagine, could handle some of the analyses. Bayesian methods are only mentioned briefly in the context of state-space models.

Thus the book would prove useful as a review of methods of analysing discrete-valued time series, but the applied statistician would have his/