D. R. Cox and P. A. W. Lewis, *The Statistical Analysis of Series of Events*. Methuen's Monographs on Applied Probability and Statistics (John Wiley), London, 1966. viii + 285 pp. $7.75.

Reviewed by E. J. Hannan

*Australian National University*

The title of this book describes its contents well. It is concerned with the statistical analysis of single realizations of point processes, though spatial as well as temporal processes are discussed. The book does not always give detailed and precise derivations (or even statements) of the results on which the analysis is to be founded. This is partly because such treatments are not always (at present) available and partly because the length and scope of the book would not permit their inclusion. As a result there is a good deal of purely mathematical imprecision of the kind commonly met in works which are truly concerned with the applications of mathematically derived results to "real life" situations. This kind of imprecision (for example the undiscussed assumption of the pointwise convergence of a Fourier series) seems acceptable in such a work. The alternative might be a mere pedantic adjunction of footnotes or paranthetic statements whose only real purpose might be to protect the writers against reviewers. (There is, of course, no excuse for a complicated statement when a simple one can be given or an ineffective proof when a short effective one is available.) The difficulty facing the writer who does not adopt one of the alternatives, of giving more or less complete proofs or no proofs at all, is that of deciding how much proof to give. Probably the only guide is to keep in mind a reasonable audience and to write to that audience. In the case of this book the audience seems to be both "the applied statistician with little inclination for theory", mentioned by the writers, and the theorist who wants a ready reference to help him when he is consulted with data as well as a stimulus in the way of a list of unsolved problems. For this audience an approach intermediate between "all proof" and "no proof" is probably acceptable, particularly if the account is well supported by references. In this work in cases where an incomplete discussion is given references to sources of a more complete account are generally supplied. There are 150 references given in the fourth appendix. (Only two of these are to Russian literature.) A student may find the book unsatisfactory for it is, in general, true that a proof which is incomplete or which relies heavily on heuristic arguments is more difficult, for one not familiar with a subject, than even quite a difficult complete proof. However if the intended audience is in fact that one described above then the authors seem to have written well to it.

One might have hoped, perhaps, for a general definition of the class of "point" processes to be studied and perhaps some initial systematic classification of these. The approach used is, instead, rather *ad hoc*. However again this is not unreasonable having in mind the purposes of the book.

The subject of the book has been well chosen for the statistical analysis of

point processes has become an important practical problem. This is evidenced by the examples which the authors discuss, which include data relating to pulses along a nerve fibre, arrivals at an intensive care unit, errors in messages, failures of a computer and of an air conditioning apparatus, coal mine disasters and road traffic data. (Earthquakes data is not used, but this is another important field.) In all cases the complete data is given and there are also many diagrams, of data as well as the results of the analysis of it. In spite of the great achievements of the probabilists in this field the data is (of course) usually generated by processes much more complex than have so far been analysed theoretically. Nevertheless these theoretical results form the basis from which a statistical analysis commences as well as a framework within which the statistical analysis is to be interpreted. The discussion of the details of the statistical analysis given in the book is probably sufficient, in most cases, to allow an accomplished statistician to apply the methods without further reference but the book could hardly be regarded as a primer of statistical methods for point processes. Again the achievement of this was undoubtedly impossible in a book of this length with this scope.

The first chapter of the book introduces the plan, which is basically to study statistical problems associated with Poisson processes and more general renewal processes as well as processes deviating from these, for example by reason of trends in the Poisson parameter with time or more general forms of variation of that parameter or because of association between neighbouring "waiting times." This chapter also introduces quite a large amount of numerical data which is graphically displayed. The second chapter deals with the Poisson process and the third with trends, both in the parameter and in the intervals between events. Chapters 4 and 5 deal with stationary processes and emphasise Fourier methods. Between them the two chapters comprise about one third of the book. The Fourier analysis is applied both to the series of intervals and to the continuous time process given by the number of events to time $t$ (or rather to its "differential increments"). One of the main difficulties is that of obtaining a worthwhile sampling theory *except* in cases where a Fourier analysis is not called for (e.g. for a Poisson process) since the models used to justify much sampling theory in spectral theory are not relevant here (particularly for the case of Fourier analysis of counts). The Chapters 6, 7 and 8 relate to renewal processes. The first discusses non parametric methods based on tests of chi-square, Kolmogorov-Smirnov or Cramér-von Mises type and emphasises a treatment founded on partial sums of order statistics obtained from appropriate multiples of the intervals between counts. Chapters 7 and 8 discuss autocorrelation in renewal intervals, branching renewal processes and superpositions of renewal processes. The second from the last chapter considers the problem of comparing rates of occurrence between Poisson processes and the last surveys some generalizations of the problem. Apart from the appendix of references there is one giving a large amount of numerical data, a second giving some asymptotic significance points of distribution free statistics and a third giving 38 exercises. There is a good author index, a good subject index and a detailed table of contents. The book is well printed and a careful reading revealed few errors or misprints.