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Kontakt/Contact

Digizeitschriften e.V.
SUB Göttingen
Platz der Göttinger Sieben 1
37073 Göttingen

info@digizeitschriften.de

Book Reviews

Nigam AK, Puri PD, Gupta VK: *"Characterizations and Analysis of Block Designs"*. John Wiley & Sons, New York, Chichester, Brisbana, Toronto, Singapore 1988, p. V+176, £16.90

The concept of block designs has received much attention by many practitioners or experimenters and theoretical researchers in some areas of statistics, agriculture, education, biology, medicine, engineering, industry, as well as mathematics and combinatorics. During the last four decades the number of articles pertaining to block designs has been growing rapidly and steadily. In this sense, a list of about 240 references in the bibliography of the book is not enough to cover the present status of research activity comprehensively. There have been several well-known books on analysis for design of experiments which give an excellent amount of explanation. But, as for available books related to combinatorial aspects of block designs motivated from their statistical analysis, we can find only two as "Constructions and Combinatorial Problems in Design of Experiments" by D. Raghavarao (1971; Wiley, New York) and "Incomplete Block Designs" by P. W. M. John (1980; Marcel Dekker, New York). We thus have been looking forward to getting a new book which must provide a comprehensive and self-contained introduction of the current development on combinatorial aspects of block designs with strong impact on some advantage of statistical analysis and some motivation from key problems on analysis of experimental designs.

Under this circumstance, the present book is published in good time and is intended for a graduate-level course or as a reference. The topics treated here are devoted to some combinatorial characterizations of block designs which admit simplified analysis. This feature gives the book a special flavor. Thus, this book is just a candidate of our wish satisfying the above-mentioned requests.

Here, there have been given reasonable collections of available results, mainly from authors' and their colleagues' works, and routine explanations. The fundamental concepts in the analysis and characterization of block designs are firstly given and then some current development of research is explained. The writing style may be standard. But, unfortunately, up-to-date results and unsolved challenging problems have not been dealt with explicitly. This lack is disappointing to people who are interested in the area of experimental designs. Though the coverage of topics are under the purpose of writing the book, once one topic is chosen, the discussion should be exhaustive in either scope or depth. Furthermore, there are no exercise at all.

A description of the contents of each chapter follows. The titles of the chapter together with a list of the major subheadings may provide a reasonable impression of the contents. Chapter 1: Introduction. Some useful results on linear estimation for subsequent chapters. Chapter 2: Analysis of block designs. Framework of block designs with their analysis pertaining to the Ω^{-1}-matrix, along with the classification of designs. Chapter 3: Balanced and partially balanced designs. Analytical and combinatorial properties of (partially) balanced block designs with some characterizations; variance-balance, efficiency-balance, pairwise-balance, BIB, PBIB, PEB designs. Chapter 4: Kronecker product

designs. Combinatorial and statistical properties of designs constructed by the usual Kronecker products of incidence matrices of some BIB (or PBIB) designs. Chapter 5: Block designs with factorial structure. Analysis of block designs as factorials, along with the concept of factorial balance. Chapter 6: Cyclic designs. Constructions and analysis of several types of cyclic block designs. Chapter 7: Other useful incomplete block designs. Dual designs, linked block designs, supplemented block designs, designs with merged treatments, designs with missing blocks, α-designs, nearly balanced designs, trend free designs, designs for bioassays. Chapter 8: Other considerations in block designs. Optimality, robustness, connectedness, resistance, Grubb's estimator.

This book is, however, quite readable and shows a nice collection of results on analysis and characterization pertaining to block designs. In particular, the reviewer could recommend the book for graduate students who are interested in combinatorial aspects of block designs as statistical planning, and in combinatorial mathematics related to block designs, to find their own research problems in self-study. At the same time this book is also helpful to beginners and practitioners for understanding some ideas of the concepts used in block designs, though the Index is not rich.

Hiroshima 734 *Sanpei Kageyama*

Daley DJ, Vere-Jones D: *An Introduction to the Theory of Point Processes.* Springer-Verlag, New York, Berlin, Heidelberg, London, Paris, Tokyo 1988, XXI+702 pp., DM 145,–

As late as about twenty years ago, when this book was first conceived by the authors, point process theory in the modern sense hardly existed. There were only some fragmentary results on 'streams of events' relevant to queuing theory, and some simple models of phenomena involving randomly scattered points in a plane or in space.

However, that was the time (around 1970) when Matthes and his collaborators in Jena and East-Berlin began their penetrating study of infinitely divisible point processes. It was also the time when Brémaud and others managed to extend the martingale machinery, including the technique of Kalman filtering, to the point process setting. Further impetus to the development came from the Cambridge prodigy Rollo Davidson, who at his sudden death at age 25 left behind a wealth of ideas and problems in stochastic geometry, the exploration of which through the work of Papengelou and others led to the discovery of profound links between point process theory and statistical mechanics.

Since the early 1970's, the subject has branched out explosively in a multitude of directions, and today it might be more appropriate to speak about the 'theories' of point processes. It has become increasingly hard even for experts to keep up with the recent developments. The book under review is the first serious attempt to survey the whole field, and as such will be wellcome to everybody. The authors are to be complimented for their success in the difficult task of selecting from such a wide range of material, and in making the chosen topics accessible

to a broader audience. Their style of writing is admirably clear, and every page is both informative and highly enjoyable.

The degree of difficulty and sophistication increases chapter by chapter, starting from an elementary introductory level, and proceeding gradually to more and more advanced topics. Thus the first few chapters introduce the Poisson process, stationary point processes on the line, and renewal processes. They are followed by a chapter on finite point processes, which introduces moment measures, generating functionals and the so called Janossi measures. The latter are then used as a recurrent and unifying theme for the rest of the book.

The next few chapters develop the theory of random measures, where point processes constitute the special case when the measures are integer valued. This part of the book contains extensive treatments of general existence criteria, of infinite divisibility, and of weak convergence in the contexts of superpositions, translates and thinnings. Next come chapters on stationary processes, spectral theory and Palm distributions, and the main text concludes with a thorough but elementary discussion of the martingale approach to point processes, and of the related theories of conditioning and filtering. Three long appendices totalling 66 pages summarize the prerequisite material needed from general measure theory and the modern theory of random processes.

It is only human when, in spite of the authors' great scholarship, some errors have gone undetected into the printed version of the text. On my renewed browsing (I read most of the book in manuscript), I happened to notice an error in the proof of the fundamental Proposition 13.4.III, on the reduction of quasi-leftcontinuous point processes to homogeneous Poisson through a random time change. Here the set of constancy of the compensator is random, so one has to explore its predictability, to be able to conclude that no jumps of the point process can occur there.

Another detail which struck me is the authors' 'simple modification of Kallenberg's randomized lattice', in Example 10.6(b). The displayed inequalities on page 396 seem to be rather obviously wrong, and it is not clear in what sense the a.s. lattice character of the process is being preserved in the limit. In fact, the initial delay in finding a counterexample to Davidson's conjecture may very well have been due to the fact that people (including Davidson himself) insisted on using the polar representation of lines as points on the cylinder. The crucial step in the ultimate solution was to eliminate the requirement of isotropy, which made it possible to use the much simpler affine representation, where most of the difficulties with the construction in the text disappear.

Apart from such minor oversights, my only criticism regards the lack of historical references for most results quoted in the book. Here my concern is not so much the decency of giving proper credit to the original discoverers of the cited theorems, especially in cases when the latter are less than fifteen or twenty years old. More important from the point of view of the general reader is the fact that historical notes accompanying the results would have vastly increased the usefulness of the text as a general reference. In this regard, the first chapter on 'Early history' and the nineteen pages bibliography at the end can hardly compensate for the authors' neglect.

Nevertheless this is a valuable book, not only for the expert, but even more for the general probabilist or statistician, who will now have a natural first place to

look when a problem of point process character comes up. One may only hope that most libraries can afford to buy it.

Auburn, AL *Olav Kallenberg*

Read TRC, Cressie NAC: *Goodness-of-fit Statistics for Discrete Multivariate Data.* Springer-Verlag, New York 1988, pp. 211, DM 84,–

This book will be of interest in the year 2000, exactly 100 years after Karl Pearson's solution of the problem: Do the observed frequencies $n_1, \ldots, n_k$, $\sum n_l = n$, look like a sample of size n from a multinomial with expected frequencies $n\pi_1, \ldots, n\pi_k$? Pearson's invention of the "chi-squared" statistic,

$$\chi^2 = \sum (\mathrm{Obsd}_i - \mathrm{Exptd}_i)^2/\mathrm{Exptd}_i \ , \tag{1}$$

and the derivation of its asymptotic distribution began modern Statistics. This book gives the history of all work on this problem from the sampling (or significance test) point of view. The Bayesian view point is ignored. The great development of multinomial modeling discussed in so many modern books is naturally only tangential to this study.

Many alternatives to χ^2 have been suggested. Read & Cressie are particularly interested in the family of "power-divergence" statistics

$$2[\lambda(\lambda+1)]^{-1} \sum \mathrm{Obsd}_i \{(\mathrm{Obsd}_i/\mathrm{Exptd}_i)^\lambda - 1\} \ . \tag{2}$$

The name "power-divergence" comes from the power λ and the use of divergence to suggest difference of distributions. This family includes many statistics previously suggested e.g. $\lambda = 1$ leads to χ^2, $\lambda \to 0$ yields the loglikelihood ratio statistic, and so on. Read and Cressie for various reasons like the statistic for $\lambda = 2/3$! This book thus summarizes the literature concerned with why one would prefer one statistic rather than another in a given class of situations.

The accuracy with which one can approximate their null and non-null distributions is obviously a major issue. From the latter one can then make choices on the basis of which leads to a more powerful test. These approximate distributions are asymptotic – usually $n \to \infty$, k fixed but sometimes k is allowed to go up with n. In the latter case the multinomial is said to be *sparse.* Much of the checking of approximate distributions is done by simulation. In simple situations, exact distributions are available. The old question of whether to order by probabiliy or statistic values seems to remain open. There are some suggestions about exact distributions in Watson (1959) which could now be followed up using computer algebra. Darwin (1958) is not referenced but his suggested use of contour integration might now be computationally feasible.

One wants to use these methods also in problems where the cell probabilities are known functions of unknown parameters which must therefore be estimated. It was Fisher's solution of this problem which lead to his collision with Pearson. There are also times when the formation of the cells themselves depends on the data. These problems have lead to a large literature.

To my mind there is something odd about the presentation – its order, the repetition? – but the writing is always very good. I found it fascinating reading. Those who want to know what has been done so that they can work in these old areas will be very grateful to the authors. Although Read & Cressie don't make any simple recommendations, I will certainly compute (2) for various λ, as they do in many examples, in my next application. One wonders what the Food and Drug Administration would make of $\lambda = 2/3$? If the data were like that of Table 2.2, I could get significance at some λ and not at others – the FDA wouldn't like that! Actually the most amazing thing is that, after 100 years, it is still hard to beat χ^2.

G. S. Watson, Princeton University.

References

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Watson GS (1959) Some recent results in chi-square goodness-fit-tests. Biometrics 15:440–468

Princeton *G. S. Watson*

Aoki M: *State Space Modeling of Time Series.* Springer-Verlag, Berlin 1987, pp. XI+314, DM 120,–

During the last three decades time series analysis has undergone a rapid development. Especially in the field of identification of linear dynamic systems great progress has been made within this period. This holds true both for the development of theoretical methods and for applications. Essential contributions to this field have been made in parts of engineering, particularly in modern system and control theory and in signal processing. Examples are Kalman filtering or the structure theory for linear multi-input, multi-output (MIMO) systems. In a certain sense time series analysis is based on two essential areas: Statistics as being concerned with data processing and system theory as the branch of science which analyses dynamical phenomena; however, the second aspect has been partially neglected in statistics and econometrics.

The book presents a study of linear MIMO-systems, with emphasis laid on the state-space form. A part of the book is concerned with the now "classical" theory of such systems (which was founded by R. E. Kalman). This theory deals with the concept of the state, observability and controlability and with canonical forms. The main emphasis, however, is placed on two relatively new concepts, namely on balanced realizations and on Hankel norm approximation, both of which have attained great attention in engineering but have been rather neglected in statistics and econometrics.

As is well known, the state in a minimal state-space system, for given transfer function, is unique only up to basis transformation. A *balanced realization* corresponds to a special choice of this basis transformation, so that the observability Grammian and the controlability Grammian are identical and diagonal with diagonal elements arranged in decreasing order. The Hankel norm approximation is an approximation of the (block) Hankel matrix of the transfer function of a system (or of the covariance matrices of the outputs) by means of the corresponding Hankel matrix of a lower dimensional system with given order, in the sense of minimizing the Hankel norm.

Both concepts are used in engineering for model reduction, i.e. for approximating a given high dimensional system by a lower dimensional one. The main advantages of both methods are their speed of calculation and the possibility to find bounds in supremum norm for the approximation error of the transfer function. This supremum norm is appropriate for a number of control problems, however, the optimal supremum norm approximation is difficult to calculate. In model reduction usually the system to be approximated is taken to be known. Both model reduction methods, however, can be used as a step in an identification procedure by approximating a first estimate of the transfer function (or of the covariances of the outputs) by a lower dimensional system.

Whereas the theory of identification based on likelihood type criteria has reached a certain state of completeness now, there is still a great number of open problems in identification procedures as described above. The present book is a contribution to the mathematical analysis and the practical evaluation of such procedures. In addition the book tries to popularize the state-space approach for modeling of time series among econometricians. The book contains almost no statistical analysis (in the sense of inferential statistics using stochastic models) and in particular almost no asymptotic analysis of the estimation procedure described. For instance an analysis of the relative asymptotic efficiency of the procedure proposed in relation to the maximum likelihood estimators would be of interest. Also the problem of order estimation is mainly addressed in terms of non-stochastic analysis.

I found the book rather hard to read. For instance I would have liked more proofs in order to make the book more selfcontained. Also closely related topics are scattered throughout the book. In addition I found the notation sometimes confusing and there are numerous printing errors and some inprecisions in the text.

However, it should be said that the material presented makes the book interesting and valuable. The book presents a novel, interesting and potentially important identification procedure for MIMO-systems and in addition contains a lot of material about the structure of state-space systems. It is addressed to advanced (not excluding applied ones) modern econometricians and time series analysists.

Wien *M. Deistler*