BOOKS

Parameter Estimation in Engineering and Science, by James V. Beck and Kenneth J. Arnold, published by John Wiley and Sons, 1977. 501 + XIX pages. $24.95.

Parameter estimation is one of the most fundamental tasks of the scientist or engineer. It is a rapidly growing field to which many disciplines are contributing. The user who wants to keep abreast of current developments must take account of contributions from theoretical statisticians, workers in optimization and numerical analysts as well as in his own field. If his interests include sequential estimation, then the voluminous literature of control theory must also be followed.

To select the most useful material from this field and present it in a form suitable for assimilation by students is indeed a formidable task in which the authors have been only partly successful. They have chosen to lay particular emphasis on the statistical assumptions underlying various commonly used regression procedures and how some deviations from the most common assumptions can be handled and to treat sequential estimation as well as normal regression procedures.

Appropriately selected material from the book could provide support for undergraduate or graduate courses. Necessary basic knowledge in probability and statistics is presented briefly in two early chapters and a review is provided in summary form of the matrix operations used later in the book. These sections are useful for reference and revision but some previous acquaintance with this material would be desirable.

Within the main body of the book, linear estimation is treated first algebraically and then by matrix procedures. This is followed by non-linear regression and a shorter chapter on some aspects of optimal experimental design.

The points made are generally described in detail and illustrated by examples, many drawn from the authors' field of heat transfer, and ample sets of problems are provided at the ends of the chapters. Most attention is paid to the detailed description of methods for parameter estimation, including ordinary and weighted lest squares and maximum likelihood with and without prior information. The analysis of the results of regression analysis and their use in model building receive less emphasis.

There is useful discussion of some topics not easily found elsewhere in text books for the chemical engineer. Chapter 5 includes the treatment of errors in the independent variables in linear regression by a Lagrange multiplier method, but there is no reference to other work on this problem. Chapter 6 includes sequential linear estimation with the matrix inversion lemma, the sensitivity of this procedure to prior variance estimates and computational accuracy, and a very useful treatment of measurement errors that are correlated in time. There are some useful general discussions of the role of sensitivity coefficients in estimation and experimental design.

Doubt must be expressed about the stability of the method advocated in Chapter 7 for sequential non-linear estimation and there is no reference to other work in this area.

The discussions of the minimization of generalized sums of squares and of optimal experimental design are both limited and selective in scope and while containing some interesting ideas cannot be considered to represent the current state of the art. Section headings sometimes appear to promise more than they deliver. For example, a section purporting to illustrate regression procedures for differential equation models treats only cases with analytical solutions which are thus no different from the algebraic models considered earlier. Several sections claim to deal with multi-response data, but in almost all examples considered it is assumed that the responses are statistically independent and can thus be treated by simple weighted least squares. A brief remark about the case where the correlation between the responses is unknown could only be understood by consulting the original reference. Explanations are occasionally lacking in clarity and a few misleading misprints are to be found.

I shall be glad to have this volume on my shelves, providing solutions in readily accessible form to many simple and some more complex regression problems. For a well balanced student text, however, or for an authoritative survey of the current state of the art in this field I shall continue to look elsewhere.

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ERRATA

In "Scaling Laws and the Differential Equations of an Entrained Flow Coal Gasifier" by R. S. Kane and R. A. McCallister [*AIChE J.*, 24, 58 (1978)], the following should read:

$$S \approx \frac{r_c V_{\theta c}}{R V_{zc}} = \left(\frac{1 + \sin\alpha}{2}\right) \frac{V_{\theta c}}{V_{zc}} = \frac{R^2}{n_n R_n^2} \sin\alpha \cos\beta \quad (17)$$

Equation (17) indicates that the swirl number for the gasifier is a function of the geometry only. The swirl number is largest for jets that enter tangential to the wall and is zero for jets aimed directly at the center of the gasifier. According to Beer and Chigier, strong swirling flows, S greater than 0.6, provide flame stabilization and promote mixing in a recirculation region near the core. The swirl number for gasifier conditions is approximately 3 and represents very strong swirl. In the dimensionless form of the governing equations, the swirl number is an important parameter as it is directly related to ratios of characteristic velocities. The interpretation of velocity ratios in terms of the geometry and the swirl number is given below:

$$\frac{V_{\theta c}}{V_{zc}} = \frac{2S}{1 + \sin\alpha};$$

$$\frac{V_{\theta c}}{V_{rc}} = \frac{4S}{(1 + \sin\alpha)\cos\alpha \cos\beta};$$

$$\frac{V_{rc}}{V_{zc}} = \frac{1}{2} \cos\alpha \cos\beta \quad (18)$$