important references; coefficients of inbreeding and relationship, to which the author had earlier applied his *trimats*, are particularly well treated. Gillois' completely general covariance formula is derived.

Part III contains an account of departures from panmixia (in the narrow sense defined above). Finite population size, mating between relatives, and assortative mating are treated in Chapter 9, with a discussion of consanguinity in various human populations. Selection is introduced through the concept of genic fitness; many particular cases are treated. The fact that the equilibrium gene frequencies at a multi-allelic locus correspond to a maximum of the mean fitness is proved, but the stronger theorem, that the mean fitness is an increasing function, is omitted. But appearances are deceptive, for later we find a proof of Fisher's Fundamental Theorem of Natural Selection for the multiple-allele, discrete-generation case, which purports to be exact. That is, Jacquard appears to prove $\Delta W = V_A/W$ exactly. Now if this were true, it would render the rather difficult proofs about the increasing nature of the mean fitness obsolete because the additive variance (V_A) is necessarily non-negative.

Working through p. 269 we find (allowing for three misprints) that in the expansion of the expression for W' only 12 of the 16 terms are zero, not 13 as Jacquard asserts. The one he has missed is

$$\frac{1}{W^2}\sum_{ij} p_i p_j \delta_{ij} \omega_i \omega_j,$$

which corresponds to the term $\mathcal{Z}$ of Li (1969). It may be small, but it is, in general, non-zero.

There follows a section on demographic measures of selection, including Crow's " Index of opportunity for selection ". Chapter 11 deals with mutation, with some stochastic treatment. Chapter 12, on migration, has been contributed by M. Courgeau, and the book ends with an account of Wright's gene-frequency distribution theory, a note on simulation techniques, and a chapter on " evolution " which includes a discussion of genetic load and some comments on human diversity.

The book is well produced, and the printers have grappled manfully with Jacquard's notation. The paucity of references is a little disturbing: much of the present treatment can be traced to Kempthorne (1957), but he is only mentioned once in the text, and then only in passing.

References

Kempthorne, O. 1957. *An Introduction to Genetic Statistics*. New York: Wiley.
Li, C. C. 1969. Increment of average fitness for multiple alleles. *Proc. Nat. Acad. Sci. Wash.*, *62*, 395-398.

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LINEAR MODELS. S. R. Searle. Wiley, New York, 1971. Pp. xxi+532. £9·50.

Reading this book gives one the uncomfortable feeling of observing the results of an animal-breeding program, in which years of toil have led to a huge animal that can barely walk, so costly that few can afford it, generating products that nobody wants. At the outset the breeding program may have been based on excellent principles, but what was useful in moderation turns out to be of doubtful value in excess. Indeed, one is led to doubt the principles themselves.

The linear model in statistics assumes that the value of an observed variable can be accounted for by a linear function of other variables, if necessary with added terms corresponding to interactions between these variables, and a residual or " error " which, it is supposed, conforms to a Normal probability distribution. Strictly speaking the Normal assumption need not be made if only least-squares estimation is undertaken; but what is then the justification for least squares?

Geneticists are familiar with the linear model in many contexts from simple linear regression to the conplexities of variance components in biometrical genetics. In some quarters familiarity has bred contempt, for the essence of a linear model is simplicity, and once that has disappeared in a welter of effects, interactions, deviations and residuals, the conceptual advantage of having a model at all is lost. One must be thankful that Searle's book was not available to Kepler: would even Newton's genius have been enough to see through all the terms?

The book starts with an excellent account of generalised inverse matrices, a relatively new mathematical development which contributes much to an understanding of the analysis of the linear model. Chapter 2 is a condensed account of distribution theory and the theory of quadratic forms, and the remainder of the book treats linear models of ever-increasing complexity, culminating in one which has an associated matrix of 36 rows and columns. This defeats the compositor, and is therefore typewritten, covering the last twenty-one pages of the text (and hence costing 36p?).

It is a characteristic of modern statistical texts that scant reference is made to those responsible for the major developments. In eight pages of references, only five pre-war papers are cited. Searle has treated the linear model and least squares estimation without referring to Gauss, regression without referring to Galton and Pearson, and the analyses of variance and covariance (and maximum-likelihood estimation) without referring to Fisher. This neglect of the foundations conveys the impression that the basic principles are universally accepted. How very far from the truth!

Searle avoids these issues, referring to least-squares, for example, as a " well accepted method of estimation " whose " rationale will not be discussed here ". The absence of any discussion of principles, in a book that in other respects treats its subject exhaustively, leaves the impression that the author is more concerned with exploiting matrix methods for their own sake than with the utility of the final product, rather as the animal breeder might appreciate the points of an animal without reference to its uses.

One topic of biological interest which Searle omits (or, at least, which remains hidden from the reviewer) is the estimation of a linear functional relationship, what Karl Pearson called finding " lines and planes of closest fit ", and later writers " principal component analysis ". Perhaps the author does not regard it as a " model "; it is certainly linear.

A book, then, for the connoisseur, particularly of matrix mathematics. At nearly £10 libraries will have to chain it, and the rest of us keep it unused in a safe at the bank, along with Granny's best dinner service.

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