Book Reviews

A Relatively New Specialty

Explorations in Mathematical Anthropology. Papers from a symposium, Berkeley, Calif., Dec. 1966. PAUL KAY, Ed. M.I.T. Press, Cambridge, Mass., 1971. xviii, 286 pp., illus. $12.

Anthropology, like the other social sciences, is becoming more and more mathematically minded. In the last few years, the number of articles in the major anthropological journal with "mathematical content" has risen sharply, and a number of books utilizing mathematical formats are appearing. Some anthropologists who are not mathematically minded view the relatively new specialty of "mathematical anthropology" with some suspicion and ambivalence. The suspicion stems from the belief that an anthropologist's mission consists in the study of whole cultures in natural contexts, an endeavor which they feel is intrinsically inimical to mathematical treatment, and the ambivalence stems from the lively possibility that they may have to reequip themselves intellectually to understand the work of a minority of colleagues who are using an arcane language to discover problems that were never problems in the past and to create disturbances in long-trusted understandings. It is too early to say that "mathematical anthropology" has come into its own. That will probably not occur until the formalists solve a set of substantive problems with which anthropologists are familiar and which have resisted their understanding in the past.

If one is interested in the kind of problems that anthropologists can solve and in the way anthropologists are thinking, this book is a good place to start. The mathematics is all well motivated, and there is not one instance of arid formalism that serves only to restate the obvious. The editor's introductions (to each of 14 articles) are superbly clarifying and intelligent and will conscientiously induct the novice into the subject.

The book falls naturally into four sections: Algebraic Methods, Computer Methods, Classical Methods, and Probabilistic Methods. The editor believes that "the chief areas of mathematics and related fields that . . . will in the future become of interest to anthropologists are, roughly in order of importance, (i) abstract algebra in a wide sense, including, for example, set theory, mathematical logic and axiomatic method, (ii) computer technology, and (iii) probability and statistics." If the future of mathematical anthropology depends, however, on the ability of its practitioners to catch the imagination of their colleagues, and if the contents of the book are representative of the work that is going on in mathematical anthropology, I would reverse the order (agreeing with the editor that most of the assumptions behind classical methods are too difficult to meet in social anthropology). To many social scientists abstract algebra is simply too far removed from their substantive concerns to illuminate the subject for them, whereas probabilistic methods have an intuitive appeal ("magical mathematics") and provide methods for the solution of empirical problems that many are faced with and few can solve.

The book is difficult to review in that it represents a collection of interests rather than a coherent point of view. To be sure, the writers share a point of view about the theory of data (this is what I think distinguishes them from their nonmathematical colleagues), but it is latent rather than evident in their choice of topics. A brief run-through will have to suffice.

Under Algebraic (in the wide sense described above) Methods four articles are included: William Geoghegan's "Information processing systems in culture," Roger Keesing's "Formalization and the construction of ethnographies," John Boyd's "Componential analysis and the substitution property," and Roy D'Andrade's "Procedures for predicting kinship terminologies from features of social organization." Geoghegan's widely known but hitherto unpublished piece takes an axiomatic approach to the construction of a dynamic model of individual choice behavior under cultural constraints, and he uses a flowchart technique as a display vehicle for a descriptive decision model which has implications both for cognition and for ethnography. Keesing also uses flow charts to display decision procedures, but the resemblance of his work to Geoghegan's is superficial. In Keesing's work it is difficult to discover both the locus of decision making and the implications of his models. John Boyd, who is probably the most astute algebraist in social anthropology, displays a solution method for the choice of one formal (componential) account over another which has important implications for the development of the psycholinguistic and semantic interests with which American social anthropology has been so notably occupied, while D'Andrade's attention to zero entries in 2×2 contingency tables enables him to make logical statements about the relationship between semantic variables and social ones (kinship terminologies and residence and descent). D'Andrade uses a stimulus sampling model to predict distributions and the direction of change in social systems, and his distributions show good fits. He is dissatisfied with the stimulus sampling model, which he now regards as dated, but his method of examining frequency tables for logical implications is still being developed.

Under Computer Methods, Volney Stefflre and his associates report on a computational method of reproducing clumps of related (similar) beliefs (and their associated contexts) which is derived from and represents an advance in that area in anthropology called ethnosemantics and which will be of interest to psycholinguists. Benjamin Colby uses the General Inquirer program for a content analysis of Japanese folk tales, and John Gilbert writes a delightful essay on the computer analysis of genealogical data and on the use of computers in anthropology.

The section Classical Methods includes an essay by Eliot Chapple on his quarter century of research on the mathematical theory of interaction. Chapple cannot yet provide full results, but he shows some of the difficulty in the use of classical mathematics which has led him to suggest that the complex problems he is dealing with may require recourse to the general theory of relaxation oscillators.

The last section, Probabilistic Methods, contains new solutions to three important anthropological problems: (i) the problem of the conditions for cultural stability, (ii) the problems of measuring endogamy and exogamy, and (iii) the problem of the degree to which culture is shared within and between groups. Hans Hoffmann studies the age grading system of the Galla in Ethiopia and suggests that the limiting vector of a Markov process might represent the structure of the system better than do the distributions observed by the ethnographer at any one time (for anthropologists the work of Asmaram Legesse supersedes this effort). Kimball Romney has devised an iterative procedure for the measurement of endogamy and exogamy that is both intuitively satisfying and gives promise of resolving many problems in the conceptualization of empirical models of systems of symmetric and asymmetric exchange (a task which has been undertaken by Alice K. Adams). He has solved the problem of measuring endogamy rates for populations of unequal size, which had resisted previous investigators. John Roberts and his colleagues have worked out a method of defining the degree of sharedness of culture within a single group, using a new measure of concordance (with Robert Kozelka), as well as a way of using preference mappings to show both similarity and contrast between cultures in their attitude toward systemic cultural patterns (here using clothing, but elsewhere using family size and composition). Two last essays, by Peggy Sanday and her associates, take first a logical and then a statistical approach to the problems of understanding correlation matrices generated by Murdock's cross-cultural sample.

For social scientists interested in the diversity of interests that mathematical anthropologists hold, or for anthropologists who have been hearing about their results and wondering where they came from, this book will be most useful. It is a shame that it took so long in publication, because some of the results may seem old hat to the cognoscenti, but for the reviewer, at least, it is extremely helpful to have them all together in one volume.

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Data and Models

Systems Analysis and Simulation in Ecology. Vol. 1. BERNARD C. PATTEN, Ed. Academic Press, New York, 1971. xvi, 608 pp., illus. $27.50.

This book, the first volume of two, seeks to convince us that a new science of *systems ecology* is born, and documents, according to the editor, "a move away from the explanatory or cognitive criterion of truth, a soft criterion . . . toward . . . a hard one with the potential of leading ultimately to optimal design and control of ecosystems." The parents of systems ecology, sire and dam respectively, are the hardware and brute force tactics of engineering and the esthetic patterns and properties of nature as revealed by ecologists. This volume begins by detailing the contribution of engineering, but contains no similar primer of ecological fundamentals and is therefore intended to recruit from the ecological rather than the engineering field.

The book is divided into three parts: an introductory section on modeling, a section on single species models, and a group of chapters on many-species systems. The introduction consists of the editor's summary of the practicalities of computer use in ecology, a thorough and lucid "how-to" lesson later exemplified in chapter 9, and a chapter by N. E. Kowal on the philosophy of the modeling approach. Together these take up one third of the book; their content is good, basic information for one starting on the systems ecology path (even though the essence of the second chapter was given in a couple of pages by R. Levins five years ago) and is worth digesting. In part 2 F. M. Williams, S. P. Hubbell, and N. R. Glass give their algal growth, isopod energetics, and fish predation models respectively, in the most ecologically interesting chapters of the book. Part 3 comprises a general "ecosystem" model—actually limited to six hypothetical species—by R. R. Lassiter and D. W. Hayne, a model by R. V. O'Neill of radiocesium movement through forest floor arthropod populations, and three attempts to model field data published by other ecologists: two old-field succession studies, the moose-wolf interaction on Isle Royale, and R. Lindeman's Cedar Bog Lake data.

After reading the book, I think I have a good idea of what the contributors are trying to do. In some cases the stated aims are quite modest, being no more than to gain insight into the construction of the models themselves (rather than the ecological patterns they are supposed to imitate). Another gain might be to reveal where ecological studies are deficient in information. That is one goal of chapter 6, but the gaps (for the modelers) are ubiquitous and general, even obvious, and no useful specification results. The predictive properties of the models might be chief assets, but, at least at the ecosystem level, the obvious tests are either impossible or impractical, especially when the input is 30-year-old data. Certainly some ecological insights are gained, however, among which F. M. Williams's remarks on coexistence in the phytoplankton and the properties of the secondary succession model could be mentioned.

Most models have to do with energy fluxes between compartments and deal with calories per unit time, weight, or area or some combination thereof. It would be gratifying indeed if the 40-odd years of such accumulated ecological data were finally to prove useful. But the use of existing data and of supposed relationships is dubious indeed, for numerous of the relationships that may be important are not yet known and must be guessed, and others (such as Holling's predator-prey functions cited in several chapters) lack confirmation of a broad applicability. The lesson seems to be, particularly if real prediction and testing are planned, that model-builders must collect their own data. Ecology will always need people with ideas and imagination, insight and intuition. To solve its complex numerical interactions, it may also need the services of computers and people who can program them with facility, although this at present remains to be demonstrated. If we have both sets of talents in one "systems ecologist," progress is all the more likely.

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