Interactive Computer Graphics: Functional, Procedural, and Device-level Methods by Peter Burger and Duncan Gillies, 1989, Addison–Wesley, Massachusetts, 540p., ISBN 0201-17439-1, $37.95 (US).

In the Preface, the authors stress that developing computer graphics programs requires not only an understanding of appropriate mathematical theory, but also knowledge of both how to describe a problem procedurally (i.e. in the form of algorithms) and the properties of hardware devices. Based on these three levels of abstraction, referred to as the functional, procedural, and device levels respectively, the authors suggest their text is a "theoretically well founded" treatment of the subject which offers "immediate practical use" and, by relating the functional description to the device level, provides an "effective methodology for graphics program development".

Although the theoretical treatment and insight into practical application is not as detailed as that of certain texts, such as *Procedural Elements for Computer Graphics* by David Rogers, the book is comprehensive, including topics such as device-level graphics that is how graphics devices operate, graphics libraries and standards, in particular the Graphical Kernel System (GKS), raster graphics, picture generation methods, for example clipping, hidden-surface removal, etc., model illumination, ray tracing, and animation. Further, new techniques and advanced algorithms, such as modeling optical phenomena, enhancing ray tracing by utilizing alternative data structures, and texture mapping, are presented in an easy-to-read fashion; one could conceive this book to be the modern version of the ubiquitous *Fundamentals of Interactive Computer Graphics* by Foley and van Dam.

Based on cost benefits, many geoscientists regard advanced computer graphics as desirable, but unwarranted, technology within their working environment. Burger and Gillies recognize that cogent visualization is not limited to 'state-of-the-art' hardware and present, where applicable, methods of generating visually effective images on affordable computers, that is personal computers. Some notable examples of such methods include ordered dithering, half-tone simulation, error-distribution algorithms, and color quantization algorithms. Commendably, all the color plates in the book were generated using either an Extended Graphics Adaptor system (EGA) or a Pluto system, both of which are supplied for IBM PC/AT compatible machines.

Intuitively, creating an image which simulates a real-world view requires an understanding of three-dimensional (3-D) space. In this respect, the mathematical analysis of such space is discussed, that is transformations, projections, clipping, etc., as well as the representation of shape. The authors have limited their discussion of the latter, which is an extensive subject in its own right, to spline curves and surfaces.

Although the book is well written and has good illustrations, there are few worked examples and little attention is given to implementation details, specifically appropriate data structures. Further, algorithms are presented in a Pascal style pseudocode, which, for the majority of geoscientific engineers who use the FORTRAN programming language, may be difficult to unravel.

In summary, *Interactive Computer Graphics: Functional, Procedural, and Device-level Methods* is a comprehensive text which can be used as both a general introduction and a reference to the subject of computer graphics. For those who wish to implement their own 2-D/3-D graphics package the book is a primary text which needs to be complimented by other, more detailed discussions on the subject. For those who have, or wish to acquire, a graphics system the book gives an excellent insight into the mechanics and capabilities of such a system.

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An Introduction to Applied Geostatistics by Edward H. Isaaks and R. Mohan Srivastava, 1989, Oxford University Press, New York, 561 p., ISBN 0-19-505012-6, ISBN 0-19-505013-4 (paperback), $55.00 cloth, $35.00 paper (US).

This book is a well-written and informative introduction to the subject of estimation from samples distributed in space. *An Introduction to Applied Geostatistics* assumes much less background in statistics than previous books on geostatistics, and includes much material on univariate and bivariate graphs and statistics. The result is a book that both stands on its own, and helps to bring variograms and kriging closer to the heart of statistics as practiced in the geosciences. Isaaks and Srivastava have not merely distilled the literature into an easy-to-read manual; they provide a synthesis of new and old methods ranging from elementary to advanced, and from the most widely used to the underused. The book has an extraordinary unity considering its length, and has an underlying philosophy throughout: that kriging has both a rigorous, theoretical validity and an intuitive appeal.

The book is divided into two parts: Chapters 1–7 cover basic measures of central tendency, dispersion, bivariate relationships, and spatial continuity. The second part, Chapters 8–21, treats estimation and advanced topics. Organization of the book is unconventional, covering estimation through kriging before modeling variograms, and spending two chapters in the first one-half describing the sample data set used throughout. In general, this organization works, for the book maintains smooth transitions between the elementary concepts and statistics in the beginning, to more difficult material in chapters on modeling variograms and cokriging.

Chapter 1 provides a roadmap for the book. The next three chapters survey the univariate statistics used in the balance of the book; bivariate statistics such as scatterplots, linear regression, and smoothed scatterplots; and descriptors of spatial relationships such as contour maps, indicator maps, and variograms. This chapter also introduces the h-scatterplot, which the authors use for tracking down aberrant points that distort variograms.

The next three Chapters, 5–7, examine the data used in all examples. Chapter 5 describes the complete data set of 78,000 values through the univariate, bivariate, and spatial statistics introduced in preceding chapters. From these values—in actuality digital elevation data—the authors derived two dimensionless variables, each sampled from the complete data set in ways simulating sampling campaigns in mineral exploration. Thus, the authors could judge the efficacy of geostatistical methods in dealing with the problems resulting from sampling methods, for example sampling only favorable areas in the second or third stage of a sampling campaign.

Chapter 8 defines weighted linear combinations, global vs local estimation, point vs block estimates, and estimation of the mean vs estimation of a distribution. Computing an estimate requires a model of the regionalized variable. Chapter 9, "Random Function Models", contains a good discussion of deterministic and random models, and the role played by uncertainty in the study of geologic phenomena. Instead of the abstract definitions present in most books on geostatistics, this book has concrete examples interspersed with abundant explanation. The problem of global estimation in the presence of spatially clustered data is approached from two directions in Chapter 10: the polygonal method, which assigns a polygon of influence to each sample, then uses the relative areas for weights; and the cell-declustering method, which weights samples by the inverse of the number of samples falling in each cell. Both methods perform equally well on data from the most equitable sampling of the study area. Neither method can be expected to perform well when samples represent only the most favorable areas. Chapter 11 describes four methods of estimating at a point: polygons, triangulation, local averages, and inverse distance methods. After introducing the ideas and measures of error and bias, the authors compare these methods in the presence of sample clustering. In Chapter 12, the rationale and equations for ordinary kriging are discussed in detail, and numerous examples illustrate the basic calculations and the effect of the variogram model on the weights and estimates. Unfortunately, the flow of the book breaks down at this point because the authors must introduce the idea of variogram models, which are treated in detail only later in Chapter 16. Kriged estimates compare favorably with those obtained in the preceding chapter. This chapter includes an excellent discussion on the part played by geologists' experience in using a variogram model. Chapter 13 presents kriging equations for block estimates, and a case study demonstrating shortcomings in the inverse-distance-squared method relative to block kriging.

Chapter 14 is important, for it discusses the effects of search strategy on the final elements. The issue of search strategy is not part of the theory of kriging, but arises when a programmer attempts to implement kriging on the computer. Some criticisms of kriging confuse principles of geostatistics with its implementation, which may be poor in many home-grown programs. Those persons setting out to write a program or use someone else's program should read this chapter carefully.

Cross validation is defined in Chapter 15 and used for comparing estimation methods, improving estimates, and for evaluating performance of estimation in the context of a goal, for example, selection of blocks to be mined.

In Chapter 16, the authors describe the process of fitting variogram models, including nested anisotropic models. This chapter is disappointing for two reasons. First, the authors mention but fail to show that fitting a model is an iterative task, usually requiring more work at a computer than the actual estimation stage (by which point most of the critical decisions have been made). Second, the chapter is too brief; its mere 30 p. belies the importance of the subject. The authors do not introduce simple models (e.g. spherical with nugget effect), show how practitioners fit them, then proceed to models with several nested structures and anisotropies. In my experience, a majority of observed variograms can be described more than adequately by simple models, so why not allow the newcomer to work first with these? Perhaps material in this chapter should have been split in half, and the elementary models presented before the chapters on estimation.

With Chapter 17, the authors introduce what I consider to be some advanced topics in geostatistics. Cokriging is described in Chapter 17 with more clarity than the norm in the geostatistical literature. Unfortunately, the example is unlikely to convince anyone that cokriging is worth the effort. This is one hazard in staying with one set of data throughout a book of this scope. In other applications, cokriging is effective indeed.

Nonparametric geostatistics—the subject of Chapter 18—are the most important new methods to come out of the 1980s. This chapter does a good job in presenting methods for both global and local estimates. Although mention is made that indicator kriging allows one to model continuity for each of many indicator variables created from a set of data, this idea is not developed, and the authors use the same variogram for all cutoffs. As a result, the advantages of nonparameteric geostatistics over parametric methods are unclear.

Chapter 19 explains issues and methods involved in change of support, and illustrate techniques in accounting for support in block selection. The next chapter, "Assessing Uncertainty", discusses confidence intervals in general, and shows the effect of sample data configurations on estimation variance. The authors show that estimation variance works when used to rank estimates by level of uncertainty, but can be a poor absolute measure of uncertainty because it relies heavily on the magnitude of the nugget effect as determined by the geostatistician. They advocate use of the relative variogram defined in Chapter 7 for computing confidence intervals sensitive to local variance.

The stated goal of the authors is to "present an introduction to the set of tools that has become known generally as *geostatistics*"; they succeed in their purpose. For each technique, the reader is presented with a statement of rationale, appropriate description of the mathematics, lucid explanation of the computations required, and a case study. The text is nearly free from conceptual, computational, and typographical errors. The writing is clear and informal without being colloquial. By using a single data set throughtout, the authors were able to build problems into the sample data sets, thus illustrating advantages of kriging and the limitations of estimations computed from biased samples.

An Introduction to Applied Geostatistics can be used as a textbook, reference book, a refresher for those familiar with the basics, and an introduction to new or unfamiliar methods.

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Quantitative Dynamic Stratigraphy by Timothy A. Cross, editor, 1990, Prentice-Hall, Englewood Cliffs, New Jersey, 625 p., ISBN 0-13-744749-3, $75.65 (Canadian).

In the Preface, T. A. Cross defines *Quantitative Dynamic Stratigraphy* as the application of mathematical, quantitative procedures to the analysis of geodynamic, stratigraphic, sedimentologic, and hydraulic attributes of sedimentary basins, treating them as features produced by the interactions of dynamic processes operating on physical configurations of the Earth at specific times and places.

In general, it is not possible to date the birth of a new scientific subdiscipline with precision. Quantitative Dynamic Stratigraphy (QDS) is exceptional in this respect. It can be said that QDS was born in February 1988, during a 4-day workshop at Lost Valley Range near Denver, Colorado, in the presence of representatives from its parents: Quantitative Stratigraphy and Dynamic Stratigraphy. The aims of the workshop were to identify major types and forms of empirical geological data required for constructing, testing, and verifying quantitative models, and to define research directions that will significantly enhance capabilities in predicting temporal and spatial relations of sedimentary facies, stratigraphic architecture, fluid movement, and diagenesis in subsurface strata. The book contains papers originally presented at the workshop. Recommendations made by the workshop participants are summarized by T. A. Cross and J. W. Harbaugh in the first paper.

Stratigraphy itself is concerned with the succession and chronology of layered rocks. Traditionally, it has had a strong paleontological component relating to life of past ages and evolutionary change as recorded by fossils. Quantitative stratigraphy attempts to construct geological time scales by the systematic treatment of presences and absences of fossil taxa, with consideration of facies changes, and with the ultimate aim to precisely date stratigraphic events in thousands or millions of years along the numerical time scale. Dynamic stratigraphy which, similar to quantitative stratigraphy, originated about 25 years ago adopted a geophysical approach to stratigraphy. In QDS these two approaches are combined with one another. For example, it is attempted to model the infilling of basins with sediments as a function of numerical time.

This book is concerned primarily with applications of numerical simulation and computer graphics to the modeling of sedimentological processes. In total, there are 35 papers which have been grouped into five sections: I—QDS models in sedimentary basin analysis (5 papers); II—Basin-scale QDS models (10 papers); III—Subbasin-scale QDS models (10 papers); IV—Stratigraphic resolution and model verification (7 papers); and V—Potential applications of QDS models (3 papers). Among the papers, there occur two computer programs with documentation: R. F. Gildner's STRIPPER (in BASIC), an interactive backstripping, decompaction, and geohistory program; and D. M. Tetzlaff's SEDO (in FORTRAN), a simple clastic sedimentation program for use in training and education. At the end of the book, there is an excellent subject–author index.

Computer programs for generating geohistory and burial-history plots have been in existence for the past 10 years. A number of authors deal with this topic which is one-dimensional, for example, for a specific well site. I. Lerche introduces a pseudoinverse procedure to incorporate overpressuring, fluid flow, and permeability variations through time, as well as models for paleoheat flux with hydrocarbon generation and accumulation.

In recent years, considerable progress has been made in the development of three-dimensional