dence.[1] The mistake stems from our attempt to simplify the description of the encoding process by pretending the C register had $n-1$ bits. In reality, the decoder requires a full n-bit register C, which we here denote C^0. The bit positions are numbered left to right, C_0 through C_{n-1}, of which the leftmost bit position C_0 is not needed for encoding. Thus the $n-1$ bit register C used in the encoding process is bits C_1 through C_{n-1} of C^0. We repeat here the decoding process using the n-bit register C^0. We rename the positions of the A register as A_0 through A_{n-1}.

The A register is initialized with value 1 in position A_0 and zeros in the remaining positions. The C^0 register is initialized with value 0 in position C_0, and the leftmost $n-1$ binary symbols of the code string in positions C_1 through C_{n-1}. The decoding steps are as follows for decoding symbol x following the so-far decoded subsequence s:

a) Subtract 1 from position $k(s)$ of C^0 and A and leave the results in auxiliary registers R and A, respectively.
b) If value R is nonnegative, x is decoded as $h(s)$, and value R is placed in C^0. If A_0 is 0, shift C^0 and A left one position. Fill the vacated rightmost position of C^0 with the next binary symbol of the codestring, and the vacated rightmost position of A with 0.
c) If R is negative, x is decoded as $l(s)$. Register A is reinitialized, and register C^0 is shifted left $k(s)$ positions. The vacated $k(s)$ rightmost positions of C^0 are replaced by the next $k(s)$ symbols of the code string.

[1]G. G. Langdon, Jr., and J. Rissanen, *IEEE Trans. Inform. Theory*, vol. IT-28, pp. 800–803, Sept. 1982.

Book Reviews

Progress in Pattern Recognition, Vol. I, L. N. Kanal and A. Rosenfeld, Eds. (Amsterdam: North Holland, 1981).

GODFRIED T. TOUSSAINT, MEMBER, IEEE

This book is a collection of ten papers spanning most topics of concern in pattern recognition and written by established researchers in the field. It is the first in a new series of volumes to be edited by Laveen Kanal and Azriel Rosenfeld devoted to pattern recognition in its broadest sense. Six of the papers in this volume are surveys and thus the book should be quite useful to someone wanting an up-to-date report on "progress in pattern recognition."

The first paper by K. S. Fu is titled "Recent Progress in Syntactic Pattern Recognition" and is a short survey of this area and some of its applications to texture and waveform analysis.

The second survey, "Medium Level Vision," by L. Mero and T. Vamos, overviews the fuzzy area lying between "low-level" and "high-level" vision, two areas well treated in the past. If the successive processing performed on a grey level picture to arrive at a final decision as to what is in the picture is divided into n subprocesses $P_1, P_2, \cdots, P_n$, then P_1 is *low-level vision*, P_n is *high-level vision*, and $P_2, P_3, \cdots, P_{n-1}$ belong to *medium-level vision*. We see that in fact this topic is quite large, and it thus comes as no surprise that this survey is quite deficient as a result. The topics surveyed under the rubric *medium-level vision* include line detection, curve detection, corner finding, region merging, feature extraction, line labeling, and scene segmentation. A typical medium-level vision task is to decompose a simple polygon into convex parts. This task does not belong to P_1 because a polygon has already been obtained from a grey level picture by edge-enhancement and polygonal line fitting techniques. Neither does it belong to P_n since no effort is made at making "sense" out of the resulting convex parts. Yet the entire field of polygonal decomposition [1] is left out of this discussion. Neither are the topics discussed necessarily up to date. The section on line detection discusses the well-known (but dated) Hough transform proposed by Duda and Hart [2]. This approach has had numerous improvements more recently [3]–[5], but none of these results are mentioned. In spite of its drawbacks, the paper is written with unusual clarity and is worth reading.

Kendal Preston, Jr., provides a detailed survey of image processing software systems and languages. He makes the convincing case that rapid proliferation in these areas may be stultifying and pleads for coordination among research groups in this field.

Jun-ichiro Toriwaki of Toyohashi University and Shigeki Yokoi of Mie University are the authors of a staggering seventy-seven page, first-rate survey of distance transformations and skeletons of digitized pictures with applications. This paper is a tremendous effort at formalizing and unifying this area of image processing. Not only have the authors also developed generalizations of the more well-known distance transforms and skeletons, but they have applied them to several applications problems in an impressive manner. This chapter should be quite useful for anyone teaching a course in image processing.

The only paper in the book to have more authors than words in its title concerns "Mathematical Aspects of Image Reconstruction from Projections," by M. D. Altschuler, Y. Censor, G. T. Herman, A. Lent, R. M. Lewitt, S. N. Srihari, H. Tuy, and J. K. Udupa. As the authors point out, the importance of this area in diagnostic radiology is unquestionable. This paper presents a thorough discussion (175 references) of the mathematics associated with practical image reconstruction from projections. Topics discussed include reconstruction from incomplete data, optimization theory and iterative techniques, three-dimensional reconstruction, and various problems concerned with displaying reconstructions.

The last survey paper by J. K. Aggarwal, L. S. Davis, W. N. Martin, and J. N. Roach concerns representation methods for three-dimensional objects. This is a microsurvey (sweet and short) of two topics: representations based on volume and on surface descriptions. It is really a pointer to the literature [6].

The remaining four papers are not surveys but rather contributions in a particular narrow domain. If we were to apply traditional cluster analysis techniques to the articles appearing in this book we would observe the values of several attributes, for example, a) number of authors, b) number of pages, c) number of figures, and d) number of references. Each article would then be represented by a point in four-dimensional attribute space and a variety of algorithms using a variety of distance measures could be used to obtain partitions of the points into groups. Ryszard Michalski and Edwin Diday present a radically new approach to clustering in their paper "A Recent Advance in Data Analysis: Clustering Objects into Classes Characterized by Conjunctive Concepts." In this approach, rather than obtaining numerical properties of the articles in this book, we would characterize each article by simple descriptions such as "survey paper," "paper describing new results," "paper containing many mathematical symbols," etc. More to the point, the descriptions used in this new method are conjunctive statements built from relations on selected object attributes. Their method is compared to traditional methods used in numerical taxonomy on what appears to be an "ivory tower" example problem and comes out quite well. This work is a nice example of cooperation between artificial intelligence and statistics and may prove to be quite useful. A lot more experimentation on "real world" problems would have to be done to convince this reviewer.

In "Database Representations in Hierarchical Scene Analysis," by M. G. Thomason and R. C. Gonzalez, the authors focus on properties of relational databases as they apply to problems in scene analysis.

In "Analysis and Synthesis of Image Patterns by Spatial Interaction Models," R. L. Kashyap considers various types of spatial interaction models for representing images: recursive and Markov defined over finite and infinite lattices. He discusses statistical procedures for determining the appropriate type of model for an image and for estimating the unknown parameters in the model.

Last and least is the paper by T. W. Ryan and B. R. Hunt titled "Recognition of Stereo-Image Cross-Correlation Errors." The most striking feature of this article is the paradoxical fact that it does not contain an introduction while at the same time it does. That it does follows from the fact that there is an eight page section titled Introduction. That it does not follows from the fact that nowhere in these eight pages do the authors say what results or contributions are going to be presented in the paper. This paper may contain a valuable contribution; this reader does not know if it does, however, since he gave up reading the paper after the Introduction.

References

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[4] G. S. Zabele and J. Koplowitz, "On improving line detection in noisy images," in *Proc. IEEE Conf. Pattern Recognition and Image Processing*, Chicago, IL, pp. 146–149, 1979.

[5] V. Alagar and L. Thiel, "Algorithms for detecting M-dimensional objects in N-dimensional spaces," *IEEE Trans. Pattern Anal. Machine Intell.*, vol. 3, pp. 245–256, May 1981.

[6] *Proc. Fifth Int. Conf. Pattern Recognition*, Miami Beach, FL, session on 3-D Analysis, pp. 1064–1098, Dec. 1980.

Godfried T. Toussaint obtained a B.Sc. degree from the University of Tulsa and an M.A.Sc. and Ph.D. degrees from the University of British Columbia in 1968, 1970, and 1972, respectively, all in electrical engineering. Since then he has been teaching and doing research in the areas of statistics, information theory, pattern recognition, image processing, computational linguistics, artificial intelligence, and computational geometry in the School of Computer Science, McGill University, except for the summers of 1975 and 1977 which he spent as a Visiting Scholar in the Information Systems Laboratory, Stanford University. He is a council member of the North American Branch of the Classification Society, a member of the Advisory Board of the Journal of Structure Classification, an Associate Editor of the Plenum Press Series on Advanced Applications in Pattern Recognition, an Associate Editor of the IEEE Transactions on Information Theory, and an Associate Editor of Pattern Recognition. He was the recipient of the 1978 Pattern Recognition Society Best Paper of the Year Award. His academic interests at the moment are directed mainly at geometry and book writing.

BOOKS RECEIVED

Michael Kaplan

Noise and its Effect on Communication, 2nd ed., Nelson M. Blachman, (Melbourne, FL: Krieger Publishing Company, 1982, xiv + 259 pp., ISBN 0-89874-256-0, $26.50).

This is a new edition of the book of the same name published by McGraw-Hill in 1966. It is forty-seven pages longer than the original, but otherwise not greatly different. The problems, of which there are now many more than before, and elaboration of methods presented in the original edition for calculating statistics of nonlinear transformations of Gaussian processes, account for much of the additional material. Chapter 5, "Nonlinear Devices," alone received twenty-two of the forty-seven new pages. The original references have not, in general, been updated; for example, the coding theory reference is to Peterson's 1961 book, the information theory references are to Shannon, and most of the post-1966 references related to communication theory are to the author's own work. An entertaining oversight is that page references in the new edition, having been copied without change from the old, are obsolete (there are two examples on new page 243).

Special Functions in Queuing Theory and Related Stochastic Processes, H. M. Srivastava and B. R. K. Kashyap (New York: Academic Press, 1982, xii + 308 pp.).

A survey of the roles of a variety of special functions (the variants of the Bessel and hypergeometric constituting two of the many species considered) in the closed-form analysis of queues and related systems. The special functions of interest are reviewed rapidly in fifty pages of preliminaries, following which the book begins in earnest. Chapter 1, "Poisson Queues I" deals with passage-times and occupancy distributions for systems modeled by birth-and-death processes, and with waiting-times in a variant of M/M/1 in which waiting is bounded. Chapter 2, "Poisson Queues II" brings in priorities (head-of-line, alternating), as well as bulk arrivals and service. Chapter 3, "Queues with Variable Parameters" permits balking, reneging and other variants of the basic birth-and-death model where the parameters can be time- or state-dependent. Chapter 4, "Queues with Poisson Arrivals or Service" generalizes further to M/G/1 and GI/M/1, as well as to models derived from these in which balking is allowed, or in which the arrivals are inhomogeneous Poisson or the queues double-ended, or in which the service is prioritized or evolves in multiple concurrent phases; heavy-traffic and diffusion approximations, and the so-called "PERT" approach to the analysis of M/G/1 and GI/M/1 are included. Chapter 5, "Queues with General Arrival and General Service Distributions" deals with just two topics: the double-ended queue in which both customer- and server-arrivals are of general renewal type, and the calculation of the generating-function for the sum of the waiting-times in a GI/G/1 busy period. Chapter 6, "Miscellaneous Results" moves over a variegated landscape: population genetics, chance-constrained linear programming, and statistics are examples of the applications considered in the thirty-four pages that close the technical presentation. There is an excellent bibliography at the end of the book, including over 500 references.

The topics considered are perhaps rather classical, and certainly outside the networks/control/computation-oriented subculture that drives the best of modern research in queueing-theory. But the old results and models are still important, and many of these, with non-standard variants, are presented here in a terse yet lucid prose that just hums right along. I like the book.

Encyclopedia of Statistical Sciences, Volumes 1 and 2, Samuel Kotz and Norman L. Johnson, Eds. (New York: Wiley-Interscience, 1982, x + 480 pp. (Vol. 1) and viii + 613 pp. (Vol. 2)).

These are the first two volumes of what is projected to be an eight-volume set running to some four or five thousand pages. On the evidence of the two volumes in hand, this is an encyclopaedia that will be fun to own. The contributors are many and distinguished, the entries are signed and provided—often generously—with up-to-date references, the selection of topics is scholarly, and the cross-referencing conscientious.

The organization is lexicographic; *Volume 1* spans *A* to *Circular Probable Error*, *Volume 2* winds up at *Eye Estimate*. A small sampler from **Volume 1**: G. J. Chaitin writes on *Algorithmic Information Theory*, H. Chernoff on *Chernoff Faces*, E. Cinlar on *Chung Processes*, I. J. Good on *Axioms of Probability*, D. V. Lindley on *Bayesian Inference*, L. Takács on *Ballot Problems*, H. Taylor on *Brownian Motion*. And from