Book Reviews

Probabilistic Information Theory, Discrete and Memoryless Models—F. Jelinek (New York: McGraw-Hill, 1968, 609 pp. $19.50).

This book provides a comprehensive treatment of the class of problems defined by the title and can provide a good basis for a first graduate course in information theory and serve as a basic reference text for researchers in this area. Jelinek's repeated use of basic tools to treat successively more complex problems has much to recommend it. The student has an opportunity to learn basic techniques by at first applying them to simple problems and then, by repeated application, to reinforce this knowledge. Of particular merit here is the author's exhaustive treatment of the source-coding problem, including both performance bounds and practical realizations. This serves as solid basis for the subsequent treatment of the noisy-channel-coding problem. In particular, the channel-coding problem is not obscured by the introduction of numerous new techniques.

It may be difficult for some students to identify the significant concepts because of the exhaustive treatment of detail material and basically repetitious arguments. In my opinion, however, the pedagogical advantages of this approach outweigh the disadvantages. The often skipped over details can also be of significant value to researchers.

My negative comments (as anticipated by the author in his preface) are directed at the limited scope of problems considered. As an example, practical applications of coding often require a basic understanding of both probabilistic and algebraic techniques. It is unfortunate that basic algebraic decoding techniques were omitted. Less significant is the restriction to memoryless models. Inclusion of simple nonamnesiac discrete models could have been accomplished easily and would have represented a desirable addition.

In summary, I feel that Jelinek's book represents a significant addition to available literature in information theory. As noted, however, the material in this book should be complemented by other available literature, specifically including algebraic decoding techniques and continuous models.

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Information Theory and Reliable Communication—Robert G. Gallager (New York: Wiley, 1968, 588 + xiv pp., $16.95).

This book is the best book in its field to appear to date. It is well organized, clearly written, complete, and authoritative, and I feel quite safe in predicting that it will be the standard work in its field for some time.

The subject of the book is what is often called "Shannon" or "narrow sense" Information Theory, viz., the mathematical theory of communication of information over unreliable (i.e., finite capacity) channels. The traditional source-encoder-channel-decoder configuration is assumed, and the basic problem considered is the construction of the encoder–decoder pair to obtain the highest possible reliability (as well as the estimation of the best attainable reliability). Most of the book, in fact all but one chapter, is devoted to finding the theoretical capabilities of communication channels via coding theorems and converses.

Although the book has an engineering or applied flavor, it is a high-level book and makes no compromise with mathematical rigor. Further, a number of important results appear here for the first time. In particular, the treatment of the continuous-time Gaussian channel. All proofs, even difficult ones, are given in all their detail. The readers' burden is eased, however, since considerable intuition and discussion of the methods of proof are included. In a number of cases, the author has included new and simple proofs for previously difficult theorems. The book, however, is somewhat light on motivating discussion connecting the many parts of the theory. In particular, perhaps the introductory chapter might have been longer than just 12 pages.

The book is intended primarily as a text book for a first-year graduate course. Its use to this end will, however, be compromised by the sophistication of the mathematical methods and concepts, and the above-mentioned relative lack of motivating discussion. It will undoubtedly be necessary for an instructor using the book to supply large quantities of intuition and explanation. However, with a proper selection of chapters and sections (a guide is given in the preface), and with a competent instructor, it is certainly the best text book for a high-level course on this subject.

The organization of the book is such that, by and large, the more difficult and sophisticated material in a given chapter is postponed until the end. This pleasant fact is particularly good for self-study, since a reader can go just as far and as deeply into a chapter as his skill, interests, and fortitude will take him. However, I would only recommend this book for self-study to highly skilled and sophisticated readers.

Finally, in its third possible application as a reference book for workers in the field, the book is unsurpassed. It is complete and correct and even contains many previously unpublished results.

There are two introductory chapters in which, among other things, the information measure is postulated and its properties discussed. There is no axiomatic derivation of the information measure, which is probably just as well, since such treatments contribute little to the development of the theory and often lead to confusion.

The third chapter treats "noiseless" coding of memoryless sources in a competent though essentially conventional way. The chapter concludes with a new and relatively simple proof of a form of the "asymptotic equipartition property" for sources with memory.

There is considerable emphasis (reflecting the author's orientation and preference) on proving channel-coding theorems and converses (for digital transmission) and the estimation of error bounds. The treatment of this subject contains an even simpler derivation of the coding theorem (an error bound) than in the author's celebrated paper, "A Simple Derivation of the Coding Theorem and Some Applications" (*IEEE Trans. Information Theory*, vol. IT-11, pp. 3–18, January 1965). Advanced subjects are also treated. Chapters 4 and 5 on this subject are perhaps the best in the book.

Chapter 6 represents a complete change of pace from the rest of the book, since it contains constructive coding techniques as opposed to existence theorems. This substantial chapter (over 100 pages) includes an introduction to algebra, the fundamentals of algebraic coding theory (including BCH codes and decoding techniques, convolutional codes and burst-correcting codes), and sequential decoding. This well written chapter may well be used alone as a text for a one-semester course in algebraic coding theory.

Chapter 7 is devoted to general (discrete-time) channels, and Chapter 8 to waveform channels. Included in the latter chapter is the substantial treatment to the continuous-time Gaussian channel mentioned above.

Finally, Chapter 9, a discussion of coding with a fidelity-criterion, is the first complete and correct collection of the important theorems on this subject. Unfortunately the chapter makes rather hard reading and the proofs appear to be not as well thought out as in the previous chapters. Perhaps this will be remedied in another edition.

Before concluding, let me mention the excellent collection of problems (the solutions are available from the author) used to illustrate the material in the text, and to introduce tangential and supplementary material. The bibliography is rather limited, which is somewhat of a disappointment. Finally, the index is adequate.

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BOOKS RECEIVED

COMPILED BY THOMAS COVER

Analysis of Lumped Electrical Systems, C. W. Merriam, III (New York: Wiley, 1969, 580 pp., $14.95).

Computerized Approximation and Synthesis of Linear Networks, J. Viech (New York: Wiley, 1969, 477 pp., $14.95).

Distribution-Free Statistical Tests, James V. Bradley (Englewood Cliffs, N. J.: Prentice-Hall, 1968, 388 pp., $11.66).

Electrical Network Theory, Norman Balabanian and Theodore A. Bickart (New York: Wiley, 1969, 931 pp. $19.95).

Estimation Theory and Applications, N. E. Nahi (New York: Wiley, 1969, 280 pp., $14.95). A concrete introduction to the theory of estimation intended for first-year engineering graduate work.

Filtering for Stochastic Processes with Applications to Guidance, Richard S. Bucy and Peter D. Joseph (New York: Wiley, 1968, 195 + sviii pp., $12.95).

Introduction to Optimization Practice, Lucas Pun (New York: Wiley, 1969, 309 pp., $14.95).

Matrix-Computer Methods in Engineering, Louis A. Pipes and Shahen A. Hovanessian (New York: Wiley, 1969, 333 pp., $12.95).

Physics of Semiconductor Devices, S. M. Sze (New York: Wiley, 1969, 811 pp., $19.95).

Probability and Information Theory, M. Behara, K. Krickeberg, and J. Wolfowitz, Eds. (New York: Springer, 1969, 256 pp., $4.50). This volume contains the invited lectures presented at the First International Symposium at McMaster University, Canada, April 1968. Contributors include Wolfowitz, Kemperman, Billingsley, Rao, and other notable members of the statistical fraternity.

Signal Theory, L. E. Franks (Englewood Cliffs, N. J.: Prentice-Hall, 1969, 317 pp., $12.95). This book uses and develops the formalism of functional analysis in signal analysis and signal processing problems. Most of the applications are in communication theory. (To be reviewed.)

The State Variable Approach to Continuous Estimation with Applications to Analog Communication Theory, Donald L. Snyder (Cambridge, Mass.: M.I.T. Press, 1969, 112 pp., $7.50). A monograph emphasizing nonlinear estimation by means of the state variable approach; based on the author's Ph.D. dissertation. (To be reviewed.)

The Technology of Computer Music, M. V. Mathews (Cambridge, Mass.: M.I.T. Press, 1969, 188 pp., $12.00). Intended for people who employ or are planning to employ the computer in sound generation and processing.

Transmission of Information by Orthogonal Functions, Henning F. Harmuth (New York: Springer, 1968, 340 pp. $10.00).