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simple computational abilities of neurons, and there are on the order of 10^{11} neurons. Both these facts run counter to other connectionist models but easily fit SDM.

Sparse Distributed Memory will be of interest to anyone doing research in neural models or brain physiology. As the theory is refined, the book will also be of interest to those trying to find applications for neural models. Finally, it will be fascinating to anyone who is even slightly curious about human intelligence and how it might arise from the brain.

Terry Rooker is a graduate student at the Oregon Graduate Institute. His research interests include computer speech recognition using neural networks.

Pattern Recognition

Scott W. Shaw

Pattern Recognition (New York: John Wiley and Sons, 1987, 144 pages, ISBN 0-471-61120-4) by Mike James is a concise survey of the practice of image recognition. The title might be somewhat misleading because the term pattern recognition generally refers to the statistical or syntactic classification of abstract entities. This book, however, discusses techniques

for processing and extracting information only from images. The intended audience has an undergraduate education or less, with little math or computer experience. The goal of this book is to give the average personal computer user some exposure to computer image analysis and its benefits. Toward this end, the book is a success. However, it is not appropriate as a college text or reference work. The text is well composed and reads easily, but the depth of coverage is disappointingly thin. The text might be a good introduction to the subject for a technical manager whose time is limited or a hobbyist with no formal background in the subject.

The book begins with an introduction to images and how they are acquired, digitized, and stored. In this discussion, James points out that images are functions from spatial coordinates to grey levels. He then cautions the reader not to view image analysis as a branch of function theory. This bias against formal mathematics persists throughout the book.

The second chapter provides a brief introduction to pattern recognition (as it is more commonly known), that is, clustering vectors and constructing discriminant functions. This

short outline covers everything from the definition of a probability to the perceptron learning algorithm.

The third chapter deals with identifying local image features, such as lines and edges, by template matching and linear edge operators. The Sobel operator, various gradient approximations, and the Laplacian are presented with short, heuristic descriptions. This discussion is followed by a chapter on frequency domain operations, including an introduction to the Fast Fourier Transform, spatial filtering, and a brief section on Fourier descriptors. The text is augmented throughout with example images illustrating the concepts being described. These images are indispensable for providing the reader with an intuitive feel for the operations. However, simple visual inspection of image-processing results can lead to a false sense of confidence in computational algorithms. An accompanying mathematical analysis is often far more enlightening.

The fifth chapter is devoted to image regions and boundaries. A particularly useful section motivates the use of variable thresholds for region segmentation. This chapter contains

a concise and lucid discussion of relaxation techniques but neglects to warn the reader of the computational demands they impose. Several pages are then devoted to texture analysis, with good examples of textures and their associated co-occurrence matrixes. This chapter and the following do an exceptional job of explaining the difference between four- and eight-connectivity and the consequences of choosing one or the other.

The last chapter covers binary image operations, such as morphological operators (although this term is not used), thinning algorithms, and shape classification by moments. This chapter is one of the most useful in the book because it describes operations that might be used on a simple, assembly line, part-recognition system.

Throughout the text, key concepts are illustrated with programming examples. These programs are written in Basic, a choice the author defends as being "partly due to the availability of a low cost Basic compiler for the PC" and "partly due to the simplicity of the language." He claims that any block-structured language could have been used. Why then didn't he choose Pascal or C, both of which have low-cost compilers available? It is unlikely that anyone with enough interest to actually implement the programs in the book would need the supposed simplicity of Basic. The serious reader who wishes to experiment with the ideas contained in this book will most likely become frustrated if Basic is the language of choice. The complex data structures and operations required by a real image-understanding system would soon outstrip Basic's limited capabilities.

The general topic of image pattern recognition contains a vast amount of material to present in a book of fewer than 150 pages. Describing such a broad and disjoint field is difficult in any format, and the author has done an excellent job of condensing the core of the subject into a small space. There is risk in such condensation, however. The reader who does not experiment on his or her own might be misled into believing this is a well-defined engineering discipline with tidy solutions. In fact, it is still a research subject, and even the simplest images can be extremely difficult to interpret by machine. Most of the techniques presented in this book have been known for 10

years or more, and the reason computer vision systems are not ubiquitous is that they often prove unreliable in practice. This point is not really brought out in the text.

Another danger in condensing a mathematical subject such as pattern recognition for a lay audience is the confusing treatment of essential rigor. For example, the author defines the convolution c of an image a with an image b as $c_{mn} = \sum_{ij} a_{ij} b_{i-m, j-n}$.

This equation is, of course, not a convolution but a correlation. The author makes this distinction in the following section, but why bother to introduce the incorrect form at all? This attempt to gloss over mathematical detail results in confusion and inaccuracy.

As an aside, the mathematics are amateurishly typeset. In this age of computer text formatting, there is no excuse for a major publisher such as Wiley to release a book with such glaring typesetting errors as misplaced limits on integrals and offset superscripts. Also, the text of the book does not contain reference citations. Some of the techniques presented in this book are directly attributable to particular authors

who deserve credit for their contributions. These citations should have been inserted into the text so that the reader could be directed to a detailed, reliable source. A suggested reading list that appears at the end of the book contains several image-processing and pattern-recognition texts but omits such standard works as *Pattern Classification and Scene Analysis* (Wiley, 1973) by Duda and Hart and *Computer Vision* (Prentice Hall, 1982) by Ballard and Brown.

Overall, this book provides a list of techniques and practical advice for a first-time image-processing programmer. Although not a serious technical treatise, it is well written, in a style that might be found in a magazine such as *BYTE*. Unfortunately, the figures and mathematical typesetting detract from the quality of the book. The scope is broad and the details scarce. The results might have been more satisfying if the author had focused on accuracy rather than heuristic handwaving.

Scott Shaw is a research engineer in the Remote Measurements Laboratory of SRI International, Menlo Park, California. His research interests are in automated signal and image interpretation.