reader learns that the author is a product of the Imperial College of Science and Technology (London, UK) and of Harvard University (Cambridge, MA, USA), with a highly respectable collection of research papers and contributions to other books. Currently, he is a professor of biomedical engineering at the University of Southern California. Obviously, all this vouchsafes ample credentials for the book, plus the added academic backing of the IEEE/EMBS Book Series Editor, Prof. Metin Akay. Congratulations to both of you!

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Networks and Artificial Intelligence for Biomedical Engineering

By Donna L. Hudson, and Maurice E. Cohen. IEEE Press. IEEE/EMBS Series on Biomedical Engineering. New York, 2000. xxiii + 306 pages. ISBN: 0-7803-3404-3.

This broad-based text, intended for advanced undergraduate and graduate students in biomedical engineering, provides introductions to a wide variety of the most important ideas and methodologies in the areas that are often referred to as "soft computing," as well as some of the more classical topics in artificial intelligence (AI) and statistical decision making. Numerous examples from the authors' work and the literature are used.

Biomedical applications would appear to be an unusually attractive application area for soft computing and AI. But the same problems that inspired these approaches—the need for intelligent decisions based on incomplete or poorly defined data, the lack of well-specified algorithms—are formidable challenges, particularly when placed in a clinical setting. The authors, colleagues at the University of California at San Francisco, understand this very well, and they have written a text ambitious for its goal of covering most of the basic topics in the field, including the difficulties in data collection and preliminary processing. Since all this occurs in about 300 pages, there are several challenges of a different sort, which are discussed below.

The book is organized as an introductory overview and three major sections: Neural Networks; Artificial Intelligence; and Alternative Approaches. The section on neural networks manages to cover, in eight chapters and 127 pages, many of the best known net architectures. The AI section has five chapters and covers expert systems, Bayesian systems, knowledge representation, and data structures (e.g., graphs and trees) with their search methods and, importantly, validation and evaluation of these methodologies. The final section, Alternative Approaches, discusses, in three chapters, genetic algorithms, fuzzy and probabilistic systems, and hybrids. The latter employ two or more of the many individual techniques already described. A fourth chapter in this section explores in depth a real hybrid system due to the authors.

The final chapter discusses the implications of new and anticipated technology on the topics of the book, but it is rather superficial and seems unnecessary. A relatively small number of exercises are presented at the end of each chapter. Many of them are intended to generate discussion, rather than computation, so they can serve as platforms for elaboration in or out of class.

In general, each topic (a Hopfield net, for example, or an expert system) is initially given a brief overview or "theoretical basis," followed by either a high-level algorithm that implements the technique or an example drawn from clinical experience, or both. This is a straightforward approach, and one that works for the authors most of the time. The "theoretical basis" in fact does not present much theory, and there isn't a great deal of mathematics in the book, although the student reader must be comfortable with matrix manipulation and vector calculus. The emphasis is on practical considerations, rather than on a rigorous development of the topics.

In text writing, as elsewhere, brevity can be a great virtue. In the present case, it's something of a two-edged sword. On the one edge, the volume is manageable for a course and friendly enough to be nonintimidating to students. On the other, there are approximately 500 sections and subsections in the 300 pages. By a deterministic algorithm, one computes that the average subtopic receives about 3/5 of one page, but many subtopics must receive rather less than that. Thus, the question arises, are some particular subtopics worthy of inclusion when their treatment is so skimpy? As just one example, the Hamming network is introduced on page 36. It's said to have applications in communication theory. As far as this reviewer could tell, it doesn't appear again in the book. Other than yet another network, the reason for its inclusion is not clear.

Parts of the book, especially in the first few sections, tend to be a little sloppy and in need of editing, as if they've been cut and pasted without the proper context. Here are some examples: Lyapunov functions are mentioned early on, but they are not defined, and the reference to their use as "energy functions" without further elaboration is confusing for the uninitiated; the symbols in equation (2.15) are not defined; in sections 4.2.3 and 4.2.4, the set Y and the function J are twice confused with each other. Section 4.8 is called a chapter summary, but it is not a summary, it is a section of references to the literature, so why not call it that? The index lists "Hamming" under Nets, but lists "Hopfield" twice, once under Nets and again under Networks. In a monograph, these kinds of faults are annoying, but the readers are presumably sophisticated enough to fill in some of the gaps and wade ahead. "Advanced" undergraduates and new graduates are another story, and the book is designed, in large part, as a text for them.

Despite these reservations, this book has important strengths, in addition to its wide range of topics. As mentioned above, the emphasis is on the practical aspects of biomedical computation. Chapter 7, which compares different network architectures, is particularly valuable for any student in this area, as are the chapters on validation and evaluation. The penultimate chapter, on a real hybrid system, is an interesting case study. The writing is often terse, but (with the caveats already discussed) generally down to earth and interesting, as for example in the discussion of chaos theory. In the hands of a capable and energetic instructor who will fill in the gaps and delve more deeply into selected topics, this text will be a valuable contribution to engineering education.

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Principles of Magnetic Resonance Imaging: A Signal Processing Perspective

By Zhi-Pei Liang and Paul C. Lauterbur. IEEE Press. IEEE/EMBS Series on Biomedical Engineering. ISBN 0-7803-4723-4.

Since the pioneer work done by Dr. Lauterbur in the 1970s, magnetic resonance imaging (MRI) has revolutionized the arena of medical imaging. Its ability to provide superb contrast between soft tissues and to allow repeated measurements without worrying about exposure to radiation has continued to gain clinical acceptance. More recently, research focuses on the applications of MRI in the study of brain activation, tissue viability, and pharmacological evaluation have further opened new avenues for the utilization of MRI. With blood-oxygen-level-dependent contrast, it is now possible to localize regions of brain activation during an external sensory and/or cognitive input, providing a noninvasive means to investigate how the brain works. In addition, diffusion-weighted and perfusion-weighted approaches have offered the potential to probe tissue viability after an ischemic event, which potentially can be employed to guide therapeutic interventions. Finally, both clinical trials and preclinical trials have now employed MR to reduce required sample sizes and hence decrease costs.

With the growing interests in MRI, numerous publications focusing on MRI have become available in the past several years. However, most of the books focus on either clinical applications or a specific topic of MRI. With the increased number of universities now offering MRI-related courses in the graduate level, it is highly desirable to have a book that focuses on the basic concepts of MRI and in textbook format. This book by Drs. Liang and Lauterbur can potentially fill this gap and serve as a textbook for a graduate-level MRI-related course.

This book starts with a brief introduction (Chapter 1) of the associated hardware of an MR system and the organization of the book, followed by a review of the required mathematical concepts of MRI (Chapter 2). Vector quantities and the definitions of some commonly used mathematical functions (e.g., Sinc function and Bessel functions) are given in Chapter 2. Furthermore, the most commonly used integral transforms for MRI, such as the Fourier transform and the Radon transform, are also introduced in Chapter 2 so as to prepare readers for the necessary mathematical framework for the subsequent chapters. It is perhaps worth pointing out that, although both Chapters 1 and 2 intend to be introductory materials, some basic knowledge of MR as well as mathematical skills are required. For example, the concepts of transverse magnetization and *k*-space have been discussed briefly in both Chapters 1 and 2. Without some basic knowledge of MRI, it may be difficult for students to understand why these mathematical functions or Fourier transform are essential to MRI.

Although the title of Chapter 3 is “Signal Generation and Detection,” the authors have emphasized substantially more the signal generation, while little attention has been given to the signal detection. Fundamental physical concepts of MR are reviewed in this chapter, which include the spin system, the Larmor frequency, the definitions of magnetization, the effects of RF excitation and how an RF can be utilized to rotate magnetization from the longitudinal direction to the transverse plane, the definitions of rotating frame, and finally the Bloch equation. The effects of relaxation in MR signal are also discussed and are incorporated into the Bloch equation. Obviously, because of the limited scope as well as the focus of this book, the authors did not go into great detail of the fundamental concepts of MRI. Nevertheless, the authors certainly have provided sufficient information to prepare the readers for the subsequent chapters.

Chapters 4 and 5 cover echo formation including RF echoes and gradient echoes and the concepts of spatial localization, respectively. In addition to the most commonly discussed two-pulse set up, such as a 90-180 combination to form a spin echo, the authors further extend to a three-pulse example. Mathematical derivations as to how five echoes can be generated with a three-pulse setup are clearly described. Furthermore, the concepts of extended phase graphs are also introduced to describe the five echoes generated with the three-pulse setup. Finally, gradient echo formations are given in the latter part of Chapter 4.

On the other hand, how the spatial localization in all three axes is achieved in MR imaging experiments is introduced in Chapter 5. This chapter clearly demonstrates the technical expertise of the authors, where major emphasis has been given to the signal processing aspects. The authors provide a detailed description of how slice selection can be achieved with an RF pulse and how the required gradient for slice selection can be included in the Bloch equation. Immediately after the descriptions of slice selection, frequency and phase encoding are given and followed by the imaging concepts. One of the nice features is the combined discussion of the application of gradient and the concepts of *k*-space. This feature should greatly facilitate the readers in grasping the imaging concepts as well as how spatial localization is achieved with MRI. Finally, different *k*-space sampling algorithms are described in the last part of Chapter 5. In addition to the normally employed approaches, which sample *k*-space rectilinearly, nonuniform sampling approaches are also introduced.

The focus of this book switches from signal- to image-related issues after Chapter 5. Several different reconstruction methods including the most commonly utilized Fourier approaches are given in Chapter 6. In addition, some of the less well-known reconstruction methods in the MR community such as backprojection approaches are also given, providing a good resource for readers to explore other possibilities for reconstructing MR images. In contrast, Chapter 7 introduces several different imaging sequences including inversion recovery, spin echo, and gradient echo sequences and the corresponding tissue contrast among different sequences.

Chapter 8 is an excellent chapter due to both its contents as well as its practical utility. Image resolution, noise, and artifact are covered. One of the frequently ignored topics in MR is the noise behavior, and yet it plays a critical role in imaging experiments. The authors have nicely discussed noise behavior, which is certainly of critical importance in the design of MR imaging experiments. Finally, several commonly seen imaging artifacts are addressed in the last section of this chapter. Although these imaging artifacts are commonly discussed and/or seen in imaging experiments, mathematical descriptions to characterize these artifacts have not been discussed extensively, particularly from the signal processing point of view. With the detailed discussions given by the authors, this section should provide the readers the insights of different imaging artifacts and how they can be minimized and/or eliminated in MR imaging experiments.

Chapter 9 focuses on one of the most exciting MR imaging approaches: fast imaging methods. In addition to the well-known EPI and conventional gradient echo imaging sequences, the authors also cover fast spin echo sequences, which are widely utilized clinically, and the burst imaging methods. This chapter also serves as a good introduction to Chapter 10, which focuses on the constrained reconstruction methods for MR imaging. Although it is possible to take advantage of our understanding of the underlying physical concepts of the spin systems, how echoes can be formed, and how *k*-space can be sampled so as to reduce data-acquisition time, the imaging time can be further reduced with the help of novel reconstruction methods. Detailed discussions of several different reconstruction methods are provided in Chapter 10, and it should serve as a good resource for readers who have special interests in reconstruction methods.

In summary, two distinct features associated with this book are worth pointing out. First, the overall design of this book is intended as a textbook for a graduate-school course offered presumably from the engineering departments. Exercises are provided at the end of each chapter. Second, detailed mathematical descriptions of the fundamental MR concepts, imaging concepts, and, more importantly, signal processing are certainly one of the major strengths of this book. The authors have successfully demonstrated the MR imaging concepts from a signal processing aspect. Overall, this is an excellent book and certainly should greatly facilitate students as well as MR researchers in the understanding, exploration, and utilization of MR imaging.

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