# Preface

This text is based on a course I teach at the University of Chicago for students in Computational Neuroscience. It is a continuation of the previously published text *Signal Processing for Neuroscientists: An Introduction to the Analysis of Physiological Signals* and includes some of the more advanced topics of linear and nonlinear systems analysis and multichannel analysis. In the following, it is assumed that the reader is familiar with the basic concepts that are covered in the introductory text and, to help the student, multiple references to the basics are included.

The popularity of signal processing in neuroscience is increasing, and with the current availability and development of computer hardware and software it may be anticipated that the current growth will continue. Because electrode fabrication has improved and measurement equipment is getting less expensive, electrophysiological measurements with large numbers of channels are now very common. In addition, neuroscience has entered the age of light, and fluorescence measurements are fully integrated into the researcher's toolkit. Because each image in a movie contains multiple pixels, these measurements are multichannel by nature. Furthermore, the availability of both generic and specialized software packages for data analysis has altered the neuroscientist's attitude toward some of the more complex analysis techniques. Interestingly, the increased accessibility of hardware and software may lead to a rediscovery of analysis procedures that were initially described decades ago. At the time when these procedures were developed, only few researchers had access to the required instrumentation, but now most scientists can access both the necessary equipment and modern computer hardware and software to perform complex experiments and analyses.

The considerations given above have provided a strong motivation for the development of this text, where we discuss several advanced techniques, rediscover methods to describe nonlinear systems, and examine the analysis of multichannel recordings. The first chapter describes two very specialized algorithms: Lomb's algorithm to analyze unevenly sampled data sets and the Hilbert transform to detect instantaneous phase and amplitude of a signal. The remainder of the text can be divided into two main components: (I) modeling systems (Chapter 2) and the analysis of nonlinear systems with the Volterra and Wiener series (Chapters 3–5) and (II) the analysis of multichannel measurements using a statistical approach (Chapter 6) and examination of causal relationships (Chapter 7). Throughout this text, we adopt an informal approach to the development of algorithms and we include practical examples implemented in MATLAB. (All the MATLAB scripts used in this text can be obtained via http://www.elsevierdirect.com/companions/9780123849151)

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