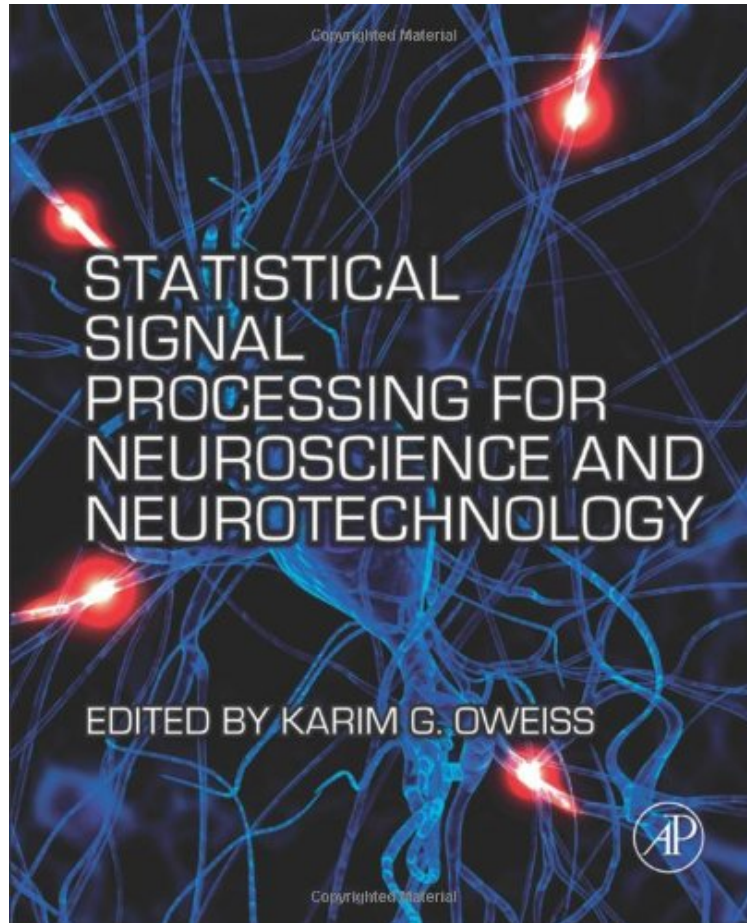


(Download free ebook) Statistical Signal Processing for Neuroscience and Neurotechnology

Statistical Signal Processing for Neuroscience and Neurotechnology

From Academic Press

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From Academic Press : Statistical Signal Processing for Neuroscience and Neurotechnology before purchasing it in order to gauge whether or not it would be worth my time, and all praised Statistical Signal Processing for Neuroscience and Neurotechnology:

0 of 0 people found the following review helpful. Numerical Analysis of Thought and Information Processing By Clandestine Library For Further Reading This book is quite informative of the more recent ways neuroscience and neurotechnology has been numerically analyzed. Granted that neuroscience and neurotechnology have recently received some momentum, this book would be of good benefit for those looking for some texts that focus on the numerical methods used in studying and interpreting complex networks (biological and technological). The first half of the book focuses on biology. The second half focuses on technology. In both, it is easily seen that many advances have already been made with much of it requiring simply adjusting, but there is some room for major advancements. The chapters on prosthetic of hand gripping and neuroimaging offer a glimpse into what technologies have existed thus far to assist procurement of data on neural correlates and medical advances relating to paralysis and brain-machine communications. The book notes that studying the brain is really a sophisticated task since the brain is the most

sophisticated organ in the universe. The amount of neural networks and the complexity of cognition speak volumes on this. The dynamics of thought are what make these studies in "electrical" activity different from non-biological "electrical" activity. Really the only way to study the brain is by statistical clumping of neural activity and monitoring/interpreting spike trains. This seems to be the reason why the book notes "statistical" on the title. Overall it is a medium-to-high read. It is very much mathematically involved, but most chapters are not overwhelming. However, prior knowledge of statistics and process control approaches does help. Here are the contents (this is not exhaustive):

Ch. 1 - Introduction
Mainly an overview of all other chapters

Ch. 2 - Detection and Classification of Extracellular Action Potential Recordings
Classification of "spikes" in neural activity recordings, stochastic considerations of "noise" that emerges from raw data, transform domain used to reduce noise, approaches to spike sorting - distinguishing one neuron from a mixture of neurons, practical implementation problems in implants ("on a chip"), using sensible sensory models for safe neural cluster differentiations

Ch. 3 - Information-Theoretic Analysis of Neural Data
Shannon's information theory which focused on digital communication is mentioned on how it can be applied to neuroscience, differences in Shannon and neuroscience interpretation of entropy, encoding channel, Rate Distortion Theory

Ch. 4 - Identification of Nonlinear Dynamics in Neural Population Activity
Attempt at quantitative modeling of hippocampus (as it serves function in cognition) and understanding of its neuronal network, a nonlinear model is developed which consists of spiking neuron modeling and Volterra series, Multiple input multiple output and multiple input single output configurations, the model is applied to data from rats and a two lever experiment

Ch. 5 - Graphical Models of Functional and Effective Neuronal Connectivity
Focuses on reviewing different approaches in studying neuronal connectivities which are relevant to memory and learning, the approaches are used in experimental data from rats and relevant findings are discussed

Ch. 6 - State Space Modeling of Neural Spike Train and Behavioral Data
What the chapter title says, some studies on animals are used to assess State Space Modeling

Ch. 7 - Neural Decoding for Motor and Communication Prostheses
Focuses on decoding of neural signals to improve prosthetic design, discusses motor and communication prostheses with neural activity, two types of neural activity - plan and movement activity; data from studies in animals discussed, trajectory models for goal directed movements are proposed and tested, propositions to decoding neural signals

Ch. 8 - Inner Products for Representation and Learning in the Spike Train Domain
Framework for machine learning methods for spike trains

Ch. 9 - Signal Processing and Machine Learning for Signal-trial Analysis of Simultaneously Acquired EEG and fMRI
Essentially about issues with EEG and fMRI equipment, as these are neuroimaging tools, and focuses on issues of design of such equipment

Ch. 10 - Statistical Pattern Recognition and Machine Learning in Brain-Computer Interfaces
About how to link the brain to machines via brain-computer interfaces

Ch. 11 - Prediction of Muscle Activity from Cortical Signals to Restore Hand Grasp in Subjects with Spinal Chord Injury
On prosthetics of gripping, some review of current technologies, experiment is done on monkeys to evaluate functional electrical stimulation and brain-machine interfaces

0 of 0 people found the following review helpful. A good survey of the field
By E.Swope
I have to commend the editor for putting together a good overview of an emerging field. As someone approaching this book from outside the field of engineering I am not in a good position to comment on how comprehensive an overview it is. My background is in cognitive science and neuropsychology. I have done graduate level research in the former and have graduate and post-graduate training in the latter. I picked this book up to catch up on where the field has gone since I left graduate school, and to bridge generations, as I have a daughter who is currently studying biomedical engineering. While this text might be viewed as an introduction to the field, a fair bit of knowledge is required to understand the work presented. Even as someone with extensive study and training in related fields, this was a difficult read. There is no question as to its being more tipped towards engineering than biology, neurology or medicine, and, my feeling after reading this book is that there is much work which needs to be done to bridge those fields. My overall impression on completion of this volume is that one discipline (engineering) can not see the forest for the trees, while perhaps the opposite may be said of cognitive science. This is more of a critique of the approach than of the text itself, and one which I believe is recognized to some extent. E.g., (from the concluding pages of chapter 3) "he (Shannon) explicitly divorced meaning from the definition of information. Consequently Classical information theory concentrates on the condition for reliably communicating signals not just the information they might convey." Clearly the focus is on signal without content. My issue with the approach, and several of the studies reported in this volume is that sometimes that content is assumed or "assigned". This is poor science (i.e. assuming or assigning vs. hypothesizing and testing). This critique would extend to the use of instruments and false assumptions about what they measure. I paid particular attention to chapter 9, which the editor described as an elegant approach, using EEG and fMRI. The trouble I have with that (both approach and description of same) is that EEG is not a terribly accurate measure. Again assumption is coming into play, and that gets into dangerous territory. I can see that the research presented can be useful in guiding development of simple prosthetics, where a circuit board analogy might hold. The difficulty comes in when one tries to develop such a device which could be voluntarily controlled. That is where content/ meaning comes into play. It is not enough to know that a signal is transmitted across several groups of neurons, synapses... reliably, if we do not know what information that signal is conveying. Perhaps this volume can provide significant guidance on where the fields need to merge, cooperate, guide one another. What would facilitate that is identifying areas where the

theory or technique is weak or where knowledge is lacking. That would prove more valuable than plugging in assigned values for meaning and content. That is my only real criticism of the text (that it is less critical than it ought to be in evaluation of (scientific) methodology and use of instrumentation). 0 of 0 people found the following review helpful. statistical approach is a good sign of progress

By W Boudville

The book is a collection of research papers that describe how to use advanced signal processing methods and statistics in the analysis of signals collected from brain cells. One way to appreciate this book is to recognise that its very existence is due to vast progress made in the last 20 years in experimental methods for brain cell stimulation. While much earlier work was done at the level of triggering single cells and in studying and modifying the action potential, now it is possible to perform stimuli across larger numbers of cells, and to observe outputs at multiple places. The so-called MIMO approach. The sheer mass of data that can now be collected necessitates a statistical approach, as opposed perhaps to a deterministic outlook when you are just looking at a few cells. Broadly, the book moves up to a more systems level study. Though what might be considered systems level in the text might seem laughably low level in a few years, as we gain understanding. Of the chapters, the third is the most general. It looks at Claude Shannon's classic information theoretic analysis and applies this to neural data. This chapter is the intersection between neuroscience and information theory. To be sure, the discussion occurs at a fairly abstract level. Experimentalists might chafe at this, but the results are quite general. And the rest of the book does go on to more specific experimental situations.

This is a uniquely comprehensive reference that summarizes the state of the art of signal processing theory and techniques for solving emerging problems in neuroscience, and which clearly presents new theory, algorithms, software and hardware tools that are specifically tailored to the nature of the neurobiological environment. It gives a broad overview of the basic principles, theories and methods in statistical signal processing for basic and applied neuroscience problems. Written by experts in the field, the book is an ideal reference for researchers working in the field of neural engineering, neural interface, computational neuroscience, neuroinformatics, neuropsychology and neural physiology. By giving a broad overview of the basic principles, theories and methods, it is also an ideal introduction to statistical signal processing in neuroscience. A comprehensive overview of the specific problems in neuroscience that require application of existing and development of new theory, techniques, and technology by the signal processing community. Contains state-of-the-art signal processing, information theory, and machine learning algorithms and techniques for neuroscience research. Presents quantitative and information-driven science that has been, or can be, applied to basic and translational neuroscience problems.

"Large-scale recording of multiple single neurons has become an indispensable tool in system neuroscience. The chapters of this edited volume will take the reader from spike detection and processing through analyses to modeling and interpretation. Both experimentalists and theorists will benefit from the well-condensed and organized content."

Gyrgy Buzski, M.D., Ph.D. Center for Molecular and Behavioral Neuroscience Rutgers University

From the Back Cover

This is a uniquely comprehensive reference that summarizes the state of the art of signal processing and machine learning theory and techniques applied to emerging problems in neuroscience, with special emphasis on basic and clinical applications of neurotechnology. Written by experts in the field, the book is an ideal reference for engineering researchers and graduate students working in the field of neural engineering, neuroprosthesis, brain machine and brain computer interfaces, computational and systems neuroscience, neuroinformatics, and neurophysiology. It provides a broad overview of the basic principles, theories and methods of statistical signal processing, information theory and machine learning and their applications in neuroscience. Features: Provides a comprehensive overview of classical and modern signal processing theory and techniques for analyzing neural data. Presents quantitative and information-driven science that has been, or can be, applied to basic and translational neuroscience problems. Discusses practical implementation issues and design considerations for neurotechnology, particularly related to neuroprosthetic and brain machine interface system design.

Karim G. Oweiss received his Ph.D. in Electrical Engineering and Computer Science from the University of Michigan, Ann Arbor in 2002 and has been with the Department of Electrical and Computer Engineering and the Neuroscience program at Michigan State University since 2003. He is a member of the IEEE and Society for Neuroscience and was awarded the excellence in Neural Engineering award from the National Science Foundation in 2001.

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About the Author

Karim G. Oweiss received his B.S. (1993) and M.S. (1996) degrees with honors in electrical engineering from the University of Alexandria, Egypt, and his Ph.D. (2002) in electrical engineering and computer science from the University of Michigan, Ann Arbor. In that year he also completed postdoctoral training with the Department of Biomedical Engineering at the University of Michigan. In 2003, he joined the Department of Electrical and Computer Engineering and the Neuroscience Program at Michigan State University, where he is currently an associate professor and director of the Neural Systems Engineering Laboratory. His research interests are

in statistical signal processing, information theory, machine learning, and control theory, with direct applications to studies of neuroplasticity, neural integration and coordination in sensorimotor systems, neurostimulation and neuromodulation in brain-machine interfaces, and computational neuroscience. Professor Oweiss is a member of the IEEE and the Society for Neuroscience. He served as a member of the board of directors of the IEEE Signal Processing Society on Brain-Machine Interfaces and is currently an active member of the technical and editorial committees of the IEEE Biomedical Circuits and Systems Society, the IEEE Life Sciences Society, and the IEEE Engineering in Medicine and Biology Society. He is also associate editor of IEEE Signal Processing Letters, Journal of Computational Intelligence and Neuroscience, and EURASIP Journal on Advances in Signal Processing. He currently serves on an NIH Federal Advisory Committee for the Emerging Technologies and Training in Neurosciences. In 2001, Professor Oweiss received the Excellence in Neural Engineering Award from the National Science Foundation.