

Analysis Of Parallel Spike Trains Springer Series

From Neuron to Cognition via Computational Neuroscience Michael A. Arbib, James J. Bonaiuto. 2016-11-11 A comprehensive, integrated, and accessible textbook presenting core neuroscientific topics from a computational perspective, tracing a path from cells and circuits to behavior and cognition. This textbook presents a wide range of subjects in neuroscience from a computational perspective. It offers a comprehensive, integrated introduction to core topics, using computational tools to trace a path from neurons and circuits to behavior and cognition. Moreover, the chapters show how computational neuroscience—methods for modeling the causal interactions underlying neural systems—complements empirical research in advancing the understanding of brain and behavior. The chapters—all by leaders in the field, and carefully integrated by the editors—cover such subjects as action and motor control; neuroplasticity, neuromodulation, and reinforcement learning; vision; and language—the core of human cognition. The book can be used for advanced undergraduate or graduate level courses. It presents all necessary background in neuroscience beyond basic facts about neurons and synapses and general ideas about the structure and function of the human brain. Students should be familiar with differential equations and probability theory, and be able to pick up the basics of programming in MATLAB and/or Python. Slides, exercises, and other ancillary materials are freely available online, and many of the models described in the chapters are documented in the brain operation database, BODB (which is also described in a book chapter). Contributors Michael A. Arbib, Joseph Ayers, James Bednar, Andrej Bicanski, James J. Bonaiuto, Nicolas Brunel, Jean-Marie Cabelguen, Carmen Canavier, Angelo Cangelosi, Richard P. Cooper, Carlos R. Cortes, Nathaniel Daw, Paul Dean, Peter Ford Dominey, Pierre Enel, Jean-Marc Fellous, Stefano Fusi, Wulfram Gerstner, Frank Grasso, Jacqueline A. Griego, Ziad M. Hafed, Michael E. Hasselmo, Auke Ijspeert, Stephanie Jones, Daniel Kersten, Jeremie Knuesel, Owen Lewis, William W. Lytton, Tomaso Poggio, John Porrill, Tony J. Prescott, John Rinzel, Edmund Rolls, Jonathan Rubin, Nicolas Schweighofer, Mohamed A. Sherif, Malle A. Tagamets, Paul F. M. J. Verschure, Nathan Vierling-Claasen, Xiao-Jing Wang, Christopher Williams, Ransom Winder, Alan L. Yuille

Dynamic Neuroscience Zhe Chen, Sridevi V. Sarma. 2017-12-27 This book shows how to develop efficient quantitative methods to characterize neural data and extra information that reveals underlying dynamics and neurophysiological mechanisms. Written by active experts in the field, it contains an exchange of innovative ideas among researchers at both computational and experimental ends, as well as those at the interface. Authors discuss research challenges and new directions in emerging areas with two goals in mind: to collect recent advances in statistics, signal processing, modeling, and control methods in neuroscience; and to welcome and foster innovative or cross-disciplinary ideas along this line of research and discuss important research issues in neural data analysis. Making use of both tutorial and review materials, this book is written for neural, electrical, and biomedical engineers; computational neuroscientists; statisticians; computer scientists; and clinical engineers.

Stochastic Biomathematical Models Mostafa Bachar, Jerry J. Batzel, Susanne Ditlevsen. 2012-10-19 Stochastic biomathematical models are becoming increasingly important as new light is shed on the role of noise in living systems. In certain biological systems, stochastic effects may even enhance a signal, thus providing a biological motivation for the noise observed in living systems. Recent advances in stochastic analysis and increasing computing power facilitate the analysis of more biophysically realistic models, and this book provides researchers in computational neuroscience and stochastic systems with an overview of recent developments. Key concepts are developed in chapters written by experts in their respective fields. Topics include: one-dimensional homogeneous

diffusions and their boundary behavior, large deviation theory and its application in stochastic neurobiological models, a review of mathematical methods for stochastic neuronal integrate-and-fire models, stochastic partial differential equation models in neurobiology, and stochastic modeling of spreading cortical depression.

Olfactory memory networks: from emotional learning to social behaviors Regina M. Sullivan, Donald A. Wilson, Nadine Ravel, Anne-Marie Mouly. 2015-05-08 Odors are powerful stimuli that can evoke emotional states, and support learning and memory. Decades of research have indicated that the neural basis for this strong “odor-emotional memory” connection is due to the uniqueness of the anatomy of the olfactory pathways. Indeed, unlike the other sensory systems, the sense of smell does not pass through the thalamus to be routed to the cortex. Rather, odor information is relayed directly to the limbic system, a brain region typically associated with memory and emotional processes. This provides olfaction with a unique and potent power to influence mood, acquisition of new information, and use of information in many different contexts including social interactions. Indeed, olfaction is crucially involved in behaviors essential for survival of the individual and species, including identification of predators, recognition of individuals for procreation or social hierarchy, location of food, as well as attachment between mating pairs and infant-caretaker dyads. Importantly, odors are sampled through sniffing behavior. This active sensing plays an important role in exploratory behaviors observed in the different contexts mentioned above. Odors are also critical for learning and memory about events and places and constitute efficient retrieval cues for the recall of emotional episodic memories. This broad role for odors appears highly preserved across species. In addition, the consistent early developmental emergence of olfactory function across diverse species also provides a unique window of opportunity for analysis of myriad behavioral systems from rodents to nonhuman primates and humans. This, when combined with the relatively conserved organization of the olfactory system in mammals, provides a powerful framework to explore how complex behaviors can be modulated by odors to produce adaptive responses, and to investigate the underlying neural networks. The present research topic brings together cutting edge research on diverse species and developmental stages, highlighting convergence and divergence between humans and animals to facilitate translational research.

Mathematics as a Tool Johannes Lenhard, Martin Carrier. 2017-04-04 This book puts forward a new role for mathematics in the natural sciences. In the traditional understanding, a strong viewpoint is advocated, on the one hand, according to which mathematics is used for truthfully expressing laws of nature and thus for rendering the rational structure of the world. In a weaker understanding, many deny that these fundamental laws are of an essentially mathematical character, and suggest that mathematics is merely a convenient tool for systematizing observational knowledge. The position developed in this volume combines features of both the strong and the weak viewpoint. In accordance with the former, mathematics is assigned an active and even shaping role in the sciences, but at the same time, employing mathematics as a tool is taken to be independent from the possible mathematical structure of the objects under consideration. Hence the tool perspective is contextual rather than ontological. Furthermore, tool-use has to respect conditions like suitability, efficacy, optimality, and others. There is a spectrum of means that will normally differ in how well they serve particular purposes. The tool perspective underlines the inevitably provisional validity of mathematics: any tool can be adjusted, improved, or lose its adequacy upon changing practical conditions.

Brain Oscillations, Synchrony and Plasticity Jos J. Eggermont. 2021-01-11 *Brain Oscillations, Synchrony and Plasticity: Basic Principles and Application to Auditory-Related Disorders* discusses the role of brain oscillations, especially with respect to the auditory system and how those oscillations are measured, change over the lifespan, and falter leading to a variety of psychiatric and neurological disorders. The book begins with a description of these cortical rhythm oscillations and how they function in both the normal and pathological brain. It explains how these oscillations are important to auditory, executive and attention brain networks and how they relate to the development, production and deterioration of speech and language. In addition, treatment of

malfunctioning cortical rhythms are reviewed using neuromodulation, such as transcranial magnetic, direct current, random noise, and alternating current stimulation, as well as focused ultrasound. The book concludes by describing the potential role of oscillations in dyslexia, autism, schizophrenia and Alzheimer's disease. Introduces readers to brain imaging methods such as structural and functional magnetic resonance imaging, EEG and magnetoencephalography, in the study of brain oscillations, synchrony and networks of the normal and pathological brain Highlights the role of brain oscillations in perception and cognition, in particular with respect to the auditory system, speech and language Describes lifespan changes, from preterm to senescence, of brain oscillations, brain networks and how they relate to the development and deterioration of speech and language Explains the effects of hearing loss on neural network change in the auditory and non-auditory networks such as the default mode-, the salience-, the executive- and attention networks Illustrates the breakdown of network connections in auditory-related disorders such as tinnitus and in psychiatric disorders with a strong auditory, speech and language component

Recent Advances and the Future Generation of Neuroinformatics Infrastructure Xi

Cheng, Daniel R. Weinberger, Daniel Marcus, John Van Horn, Venkata Satyanand Mattay, Qian Luo. 2015-12-11 The huge volume of multi-modal neuroimaging data across different neuroscience communities has posed a daunting challenge to traditional methods of data sharing, data archiving, data processing and data analysis. Neuroinformatics plays a crucial role in creating advanced methodologies and tools for the handling of varied and heterogeneous datasets in order to better understand the structure and function of the brain. These tools and methodologies not only enhance data collection, analysis, integration, interpretation, modeling, and dissemination of data, but also promote data sharing and collaboration. This Neuroinformatics Research Topic aims to summarize the state-of-art of the current achievements and explores the directions for the future generation of neuroinformatics infrastructure. The publications present solutions for data archiving, data processing and workflow, data mining, and system integration methodologies. Some of the systems presented are large in scale, geographically distributed, and already have a well-established user community. Some discuss opportunities and methodologies that facilitate large-scale parallel data processing tasks under a heterogeneous computational environment. We wish to stimulate on-going discussions at the level of the neuroinformatics infrastructure including the common challenges, new technologies of maximum benefit, key features of next generation infrastructure, etc. We have asked leading research groups from different research areas of neuroscience/neuroimaging to provide their thoughts on the development of a state of the art and highly-efficient neuroinformatics infrastructure. Such discussions will inspire and help guide the development of a state of the art, highly-efficient neuroinformatics infrastructure.

Computational Intelligence Juan Julián Merelo, Agostinho Rosa, José M. Cadenas, António Dourado Correia, Kurosh Madani, António Ruano, Joaquim Filipe. 2016-11-21 This book includes a selection of revised and extended versions of the best papers from the seventh International Joint Conference on Computational Intelligence (IJCCI 2015), held in Lisbon, Portugal, from 12 to 14 November 2015, which was composed of three co-located conferences: The International Conference on Evolutionary Computation Theory and Applications (ECTA), the International Conference on Fuzzy Computation Theory and Applications (FCTA), and the International Conference on Neural Computation Theory and Applications (NCTA). The book presents recent advances in scientific developments and applications in these three areas, reflecting the IJCCI's commitment to high quality standards.

Information Processing and Management of Uncertainty Anne Laurent, Olivier Strauss, Bernadette Bouchon-Meunier, Ronald R. Yager. 2014-07-17 These three volumes (CCIS 442, 443, 444) constitute the proceedings of the 15th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems, IPMU 2014, held in Montpellier, France, July 15-19, 2014. The 180 revised full papers presented together with five invited talks were carefully reviewed and selected from numerous submissions. The papers are organized in topical sections on uncertainty and imprecision on the web of data; decision support and uncertainty management in agri-environment; fuzzy implications; clustering; fuzzy measures and integrals; non-classical logics; data

analysis; real-world applications; aggregation; probabilistic networks; recommendation systems and social networks; fuzzy systems; fuzzy logic in boolean framework; management of uncertainty in social networks; from different to same, from imitation to analogy; soft computing and sensory analysis; database systems; fuzzy set theory; measurement and sensory information; aggregation; formal methods for vagueness and uncertainty in a many-valued realm; graduality; preferences; uncertainty management in machine learning; philosophy and history of soft computing; soft computing and sensory analysis; similarity analysis; fuzzy logic, formal concept analysis and rough set; intelligent databases and information systems; theory of evidence; aggregation functions; big data - the role of fuzzy methods; imprecise probabilities: from foundations to applications; multinomial logistic regression on Markov chains for crop rotation modelling; intelligent measurement and control for nonlinear systems.

Advances in Intelligent Data Analysis XII Allan Tucker, Frank Höppner, Arno Siebes, Stephen Swift. 2013-10-16 This book constitutes the refereed conference proceedings of the 12th International Conference on Intelligent Data Analysis, which was held in October 2013 in London, UK. The 36 revised full papers together with 3 invited papers were carefully reviewed and selected from 84 submissions handling all kinds of modeling and analysis methods, irrespective of discipline. The papers cover all aspects of intelligent data analysis, including papers on intelligent support for modeling and analyzing data from complex, dynamical systems.

Proceedings. 24. Workshop Computational Intelligence, Dortmund, 27. - 28. November 2014 Hoffmann, Frank, Huellermeier, E.. 2014-11-20

Synergies of Soft Computing and Statistics for Intelligent Data Analysis Rudolf Kruse, Michael R. Berthold, Christian Moewes, María Ángeles Gil, Przemysław Grzegorzewski, Olgierd Hryniewicz. 2012-09-07 In recent years there has been a growing interest to extend classical methods for data analysis. The aim is to allow a more flexible modeling of phenomena such as uncertainty, imprecision or ignorance. Such extensions of classical probability theory and statistics are useful in many real-life situations, since uncertainties in data are not only present in the form of randomness --- various types of incomplete or subjective information have to be handled. About twelve years ago the idea of strengthening the dialogue between the various research communities in the field of data analysis was born and resulted in the International Conference Series on Soft Methods in Probability and Statistics (SMPS). This book gathers contributions presented at the SMPS'2012 held in Konstanz, Germany. Its aim is to present recent results illustrating new trends in intelligent data analysis. It gives a comprehensive overview of current research into the fusion of soft computing methods with probability and statistics. Synergies of both fields might improve intelligent data analysis methods in terms of robustness to noise and applicability to larger datasets, while being able to efficiently obtain understandable solutions of real-world problems.

Analysis of Parallel Spike Trains Sonja Grün, Stefan Rotter. 2010-08-18 Solid and transparent data analysis is the most important basis for reliable interpretation of experiments. The technique of parallel spike train recordings using multi-electrode arrangements has been available for many decades now, but only recently gained wide popularity among electro physiologists. Many traditional analysis methods are based on firing rates obtained by trial-averaging, and some of the assumptions for such procedures to work can be ignored without serious consequences. The situation is different for correlation analysis, the result of which may be considerably distorted if certain critical assumptions are violated. The focus of this book is on concepts and methods of correlation analysis (synchrony, patterns, rate covariance), combined with a solid introduction into approaches for single spike trains, which represent the basis of correlations analysis. The book also emphasizes pitfalls and potential wrong interpretations of data due to violations of critical assumptions.

Introducing Computation to Neuroscience Ad Aertsen, Sonja Grün, Pedro E. Maldonado, Günther Palm. 2022-11-10 This book brings together a selection of papers by George Gerstein, representing his long-term endeavor of making neuroscience into a more rigorous science inspired by physics, where he had his roots. Professor Gerstein was many years ahead of the field, consistently striving for quantitative analyses, mechanistic models, and conceptual clarity. In doing so, he pioneered

Computational Neuroscience, many years before the term itself was born. The overarching goal of George Gerstein's research was to understand the functional organization of neuronal networks in the brain. The editors of this book have compiled a selection of George Gerstein's many seminal contributions to neuroscience--be they experimental, theoretical or computational--into a single, comprehensive volume. The aim is to provide readers with a fresh introduction of these various concepts in the original literature. The volume is organized in a series of chapters by subject, ordered in time, each one containing one or more of George Gerstein's papers.

Brain-Inspired Computing Katrin Amunts, Lucio Grandinetti, Thomas Lippert, Nicolai Petkov. 2016-12-10 This book constitutes revised selected papers from the Second International Workshop on Brain-Inspired Computing, BrainComp 2015, held in Cetraro, Italy, in July 2015. The 14 papers presented in this volume were carefully reviewed and selected for inclusion in this book. They deal with brain structure and function; computational models and brain-inspired computing methods with practical applications; high performance computing; and visualization for brain simulations.

Intracranial EEG Nikolai Axmacher. 2023-08-01 This book offers the first, comprehensive guide to planning and conducting intracranial EEG studies, and analyzing intracranial EEG data. The chapters address core questions in the field of intracranial EEG research. They are written by internationally recognized experts in the domain of intracranial EEG and acknowledge the heterogeneity of approaches in this field. The particular format of the book allows readers to find clear guidelines, hands-on expertise and invaluable background information for planning and conducting state-of-the-art intracranial EEG research projects. Besides offering a reference guide to newcomers in the field, it also provides scholarly information for the more experienced researcher and inspiration for the expert. The book covers a wide range of topics, with a special emphasis on aspects in which intracranial EEG data differ from other types of data in the cognitive neurosciences. It discusses typical patient characteristics and implantation schemes, ethical issues, and practical considerations for planning and running intracranial EEG experiments. It addresses signal characteristics and the physiological background of oscillatory and non-oscillatory aspects of intracranial EEG signals. It describes complex pre-processing steps such as advantages and disadvantages of different referencing schemes, and how to identify the location of electrodes. In addition, it answers specific questions on data processing, addressing core aspects of statistical analysis, and suggesting guidelines for data presentation. Further, it covers advanced topics such as causal interventions (i.e. deep brain stimulation), acquisition and analysis of single-unit data and multimodal recordings, and discusses important future challenges and opportunities in the field of intracranial EEG research.

Stochastic Models for Spike Trains of Single Neurons S.K. Srinivasan, Gopalan Sampath. 2013-03-13
1 Some basic neurophysiology 4 The neuron 1. 1 4 1. 1. 1 The axon 7 1. 1. 2 The synapse 9 12 1. 1. 3 The soma 1. 1. 4 The dendrites 13 13 1. 2 Types of neurons 2 Signals in the nervous system 14 2. 1 Action potentials as point events - point processes in the nervous system 15 18 2. 2 Spontaneous activi~ in neurons 3 Stochastic modelling of single neuron spike trains 19 3. 1 Characteristics of a neuron spike train 19 3. 2 The mathematical neuron 23 4 Superposition models 26 4. 1 superposition of renewal processes 26 4. 2 Superposition of stationary point processe- limiting behaviour 34 4. 2. 1 Palm functions 35 4. 2. 2 Asymptotic behaviour of n stationary point processes superposed 36 4. 3 Superposition models of neuron spike trains 37 4. 3. 1 Model 4. 1 39 4. 3. 2 Model 4. 2 - A superposition model with 40 two input channels 40 4. 3. 3 Model 4. 3 4. 4 Discussion 41 43 5 Deletion models 5. 1 Deletion models with 1nd~endent interaction of excitatory and inhibitory sequences 44 VI 5. 1. 1 Model 5. 1 The basic deletion model 45 5. 1. 2 Higher-order properties of the sequence of r-events 55 5. 1. 3 Extended version of Model 5. 1 - Model 60 5. 2 5. 2 Models with dependent interaction of excitatory and inhibitory sequences - MModels 5. 3 and 5.

Statistical analysis of multi-cell recordings: linking population coding models to experimental data Matthias Bethge, Philipp Berens, Jakob Macke. 2012-01-01 Modern recording techniques such as multi-electrode arrays and 2-photon imaging are capable of simultaneously monitoring the activity of

large neuronal ensembles at single cell resolution. This makes it possible to study the dynamics of neural populations of considerable size, and to gain insights into their computations and functional organization. The key challenge with multi-electrode recordings is their high-dimensional nature. Understanding this kind of data requires powerful statistical techniques for capturing the structure of the neural population responses and their relation with external stimuli or behavioral observations. Contributions to this Research Topic should advance statistical modeling of neural populations. Questions of particular interest include: 1. What classes of statistical methods are most useful for modeling population activity? 2. What are the main limitations of current approaches, and what can be done to overcome them? 3. How can statistical methods be used to empirically test existing models of (probabilistic) population coding? 4. What role can statistical methods play in formulating novel hypotheses about the principles of information processing in neural populations? This Research Topic is connected to a one day workshop at the Computational Neuroscience Meeting 2009 in Berlin (<http://www.cnsorg.org/2009/workshops.shtml> and <http://www.kyb.tuebingen.mpg.de/bethge/workshops/cns2009/>)

Analysis of Neural Data Robert E. Kass, Uri T. Eden, Emery N. Brown. 2014-07-08 Continual improvements in data collection and processing have had a huge impact on brain research, producing data sets that are often large and complicated. By emphasizing a few fundamental principles, and a handful of ubiquitous techniques, *Analysis of Neural Data* provides a unified treatment of analytical methods that have become essential for contemporary researchers. Throughout the book ideas are illustrated with more than 100 examples drawn from the literature, ranging from electrophysiology, to neuroimaging, to behavior. By demonstrating the commonality among various statistical approaches the authors provide the crucial tools for gaining knowledge from diverse types of data. Aimed at experimentalists with only high-school level mathematics, as well as computationally-oriented neuroscientists who have limited familiarity with statistics, *Analysis of Neural Data* serves as both a self-contained introduction and a reference work.

Advances in Intelligent Data Analysis X João Gama, Elizabeth Bradley, Jaakko Hollmen. 2011-10-25 This book constitutes the refereed proceedings of the 10th International Conference on Intelligent Data Analysis, IDA 2011, held in Porto, Portugal, in October 2011. The 19 revised full papers and 16 revised poster papers resented together with 3 invited papers were carefully reviewed and selected from 73 submissions. All current aspects of intelligent data analysis are addressed, particularly intelligent support for modeling and analyzing complex, dynamical systems. The papers offer intelligent support for understanding evolving scientific and social systems including data collection and acquisition, such as crowd sourcing; data cleaning, semantics and markup; searching for data and assembling datasets from multiple sources; data processing, including workflows, mixed-initiative data analysis, and planning; data and information fusion; incremental, mixed-initiative model development, testing and revision; and visualization and dissemination of results; etc.

Neuroscience in the 21st Century Donald W. Pfaff, Nora D. Volkow. 2016-10-27 Edited and authored by a wealth of international experts in neuroscience and related disciplines, this key new resource aims to offer medical students and graduate researchers around the world a comprehensive introduction and overview of modern neuroscience. Neuroscience research is certain to prove a vital element in combating mental illness in its various incarnations, a strategic battleground in the future of medicine, as the prevalence of mental disorders is becoming better understood each year. Hundreds of millions of people worldwide are affected by mental, behavioral, neurological and substance use disorders. The World Health Organization estimated in 2002 that 154 million people globally suffer from depression and 25 million people from schizophrenia; 91 million people are affected by alcohol use disorders and 15 million by drug use disorders. A more recent WHO report shows that 50 million people suffer from epilepsy and 24 million from Alzheimer's and other dementias. Because neuroscience takes the etiology of disease—the complex interplay between biological, psychological, and sociocultural factors—as its object of inquiry, it is increasingly valuable in understanding an array of medical conditions. A recent report by the United States'

Surgeon General cites several such diseases: schizophrenia, bipolar disorder, early-onset depression, autism, attention deficit/ hyperactivity disorder, anorexia nervosa, and panic disorder, among many others. Not only is this volume a boon to those wishing to understand the future of neuroscience, it also aims to encourage the initiation of neuroscience programs in developing countries, featuring as it does an appendix full of advice on how to develop such programs. With broad coverage of both basic science and clinical issues, comprising around 150 chapters from a diversity of international authors and including complementary video components, *Neuroscience in the 21st Century* in its second edition serves as a comprehensive resource to students and researchers alike.

Springer Handbook of Bio-/Neuro-Informatics Nikola Kasabov. 2013-11-30 The Springer Handbook of Bio-/Neuro-Informatics is the first published book in one volume that explains together the basics and the state-of-the-art of two major science disciplines in their interaction and mutual relationship, namely: information sciences, bioinformatics and neuroinformatics. Bioinformatics is the area of science which is concerned with the information processes in biology and the development and applications of methods, tools and systems for storing and processing of biological information thus facilitating new knowledge discovery. Neuroinformatics is the area of science which is concerned with the information processes in biology and the development and applications of methods, tools and systems for storing and processing of biological information thus facilitating new knowledge discovery. The text contains 62 chapters organized in 12 parts, 6 of them covering topics from information science and bioinformatics, and 6 cover topics from information science and neuroinformatics. Each chapter consists of three main sections: introduction to the subject area, presentation of methods and advanced and future developments. The Springer Handbook of Bio-/Neuroinformatics can be used as both a textbook and as a reference for postgraduate study and advanced research in these areas. The target audience includes students, scientists, and practitioners from the areas of information, biological and neurosciences. With Forewords by Shun-ichi Amari of the Brain Science Institute, RIKEN, Saitama and Karlheinz Meier of the University of Heidelberg, Kirchhoff-Institute of Physics and Co-Director of the Human Brain Project.

Neural Assemblies Günther Palm. 2022-07-28 In the new edition of *Neural Assemblies*, the author places his original ideas and motivations within the framework of modern and cognitive neuroscience and gives a short and focused overview of the development of computational neuroscience and artificial neural networks over the last 40 years. In this book the author develops a theory of how the human brain might function. Starting with a motivational introduction to the brain as an organ of information processing, he presents a computational perspective on the basic concepts and ideas of neuroscience research on the underlying principles of brain function. In addition, the reader is introduced to the most important methods from computer science and mathematical modeling that are required for a computational understanding of information processing in the brain. Written by an expert in the field of neural information processing, this book offers a personal historical view of the development of artificial intelligence, artificial neural networks, and computational cognitive neuroscience over the last 40 years, with a focus on the realization of higher cognitive functions rather than more peripheral sensory or motor organization. The book is therefore aimed at students and researchers who want to understand how the basic neuroscientific and computational concepts in the study of brain function have changed over the last decades.

Quantitative analysis of neuroanatomy Julian M L Budd, Hermann Cuntz, Stephen J Egle, Patrik Krieger. 2016-03-22 The true revolution in the age of digital neuroanatomy is the ability to extensively quantify anatomical structures and thus investigate structure-function relationships in great detail. Large-scale projects were recently launched with the aim of providing infrastructure for brain simulations. These projects will increase the need for a precise understanding of brain structure, e.g., through statistical analysis and models. From articles in this Research Topic, we identify three main themes that clearly illustrate how new quantitative approaches are helping advance our understanding of neural structure and function. First, new approaches to reconstruct

neurons and circuits from empirical data are aiding neuroanatomical mapping. Second, methods are introduced to improve understanding of the underlying principles of organization. Third, by combining existing knowledge from lower levels of organization, models can be used to make testable predictions about a higher-level organization where knowledge is absent or poor. This latter approach is useful for examining statistical properties of specific network connectivity when current experimental methods have not yet been able to fully reconstruct whole circuits of more than a few hundred neurons.

Nanotechnology and Neuroscience: Nano-electronic, Photonic and Mechanical Neuronal Interfacing Massimo De Vittorio, Luigi Martiradonna, John Assad. 2014-07-08 This book describes the use of modern micro- and nanofabrication technologies to develop improved tools for stimulating and recording electrical activity in neuronal networks. It provides an overview of the different ways in which the “nano-world” can be beneficial for neuroscientists, including improvement of mechanical adhesion of cells on electrodes, tight-sealed extracellular recordings or intracellular approaches with strongly reduced invasiveness and tools for localized electrical or optical stimulation in optogenetics experiments. Specific discussion of fabrication strategies is included, to provide a comprehensive guide to develop micro and nanostructured tools for biological applications. A perspective on integrating these devices with state-of-the-art technologies for large-scale in vitro and in vivo experiments completes the picture of neuronal interfacing with micro- and nanostructures.

Advances in Electronics Engineering Zahriladha Zakaria, Rabiah Ahmad. 2019-12-16 This book presents the proceedings of ICCEE 2019, held in Kuala Lumpur, Malaysia, on 29th–30th April 2019. It includes the latest advances in electrical engineering and electronics from leading experts around the globe.

Computational Systems Neurobiology N. Le Novère. 2012-07-20 Computational neurosciences and systems biology are among the main domains of life science research where mathematical modeling made a difference. This book introduces the many different types of computational studies one can develop to study neuronal systems. It is aimed at undergraduate students starting their research in computational neurobiology or more senior researchers who would like, or need, to move towards computational approaches. Based on their specific project, the readers would then move to one of the more specialized excellent textbooks available in the field. The first part of the book deals with molecular systems biology. Functional genomics is introduced through examples of transcriptomics and proteomics studies of neurobiological interest. Quantitative modelling of biochemical systems is presented in homogeneous compartments and using spatial descriptions. A second part deals with the various approaches to model single neuron physiology, and naturally moves to neuronal networks. A division is focused on the development of neurons and neuronal systems and the book closes on a series of methodological chapters. From the molecules to the organ, thinking at the level of systems is transforming biology and its impact on society. This book will help the reader to hop on the train directly in the tank engine.

Signal Processing for Neuroscientists Wim van Drongelen. 2006-12-18 Signal Processing for Neuroscientists introduces analysis techniques primarily aimed at neuroscientists and biomedical engineering students with a reasonable but modest background in mathematics, physics, and computer programming. The focus of this text is on what can be considered the ‘golden trio’ in the signal processing field: averaging, Fourier analysis, and filtering. Techniques such as convolution, correlation, coherence, and wavelet analysis are considered in the context of time and frequency domain analysis. The whole spectrum of signal analysis is covered, ranging from data acquisition to data processing; and from the mathematical background of the analysis to the practical application of processing algorithms. Overall, the approach to the mathematics is informal with a focus on basic understanding of the methods and their interrelationships rather than detailed proofs or derivations. One of the principle goals is to provide the reader with the background required to understand the principles of commercially available analyses software, and to allow him/her to construct his/her own analysis tools in an environment such as MATLAB®. Multiple color illustrations are integrated in the text. Includes an introduction to biomedical signals, noise characteristics, and recording techniques

Basics and background for more advanced topics can be found in extensive notes and appendices A Companion Website hosts the MATLAB scripts and several data files:

<http://www.elsevierdirect.com/companion.jsp?ISBN=9780123708670>

Modern Mathematical Tools and Techniques in Capturing Complexity Leandro

Pardo, Narayanaswamy Balakrishnan, Maria Angeles Gil. 2011-05-26 Real-life problems are often quite complicated in form and nature and, for centuries, many different mathematical concepts, ideas and tools have been developed to formulate these problems theoretically and then to solve them either exactly or approximately. This book aims to gather a collection of papers dealing with several different problems arising from many disciplines and some modern mathematical approaches to handle them. In this respect, the book offers a wide overview on many of the current trends in Mathematics as valuable formal techniques in capturing and exploiting the complexity involved in real-world situations. Several researchers, colleagues, friends and students of Professor María Luisa Menéndez have contributed to this volume to pay tribute to her and to recognize the diverse contributions she had made to the fields of Mathematics and Statistics and to the profession in general. She had a sweet and strong personality, and instilled great values and work ethics in her students through her dedication to teaching and research. Even though the academic community lost her prematurely, she would continue to provide inspiration to many students and researchers worldwide through her published work.

Spiking Neuron Models Wulfram Gerstner, Werner M. Kistler. 2002-08-15 This is an introduction to spiking neurons for advanced undergraduate or graduate students. It can be used with courses in computational neuroscience, theoretical biology, neural modeling, biophysics, or neural networks. It focuses on phenomenological approaches rather than detailed models in order to provide the reader with a conceptual framework. No prior knowledge beyond undergraduate mathematics is necessary to follow the book. Thus it should appeal to students or researchers in physics, mathematics, or computer science interested in biology; moreover it will also be useful for biologists working in mathematical modeling.

Similarity-Based Pattern Recognition Aasa Feragen, Marcello Pelillo, Marco Loog. 2015-10-04 This book constitutes the proceedings of the Third International Workshop on Similarity Based Pattern Analysis and Recognition, SIMBAD 2015, which was held in Copenhagen, Denmark, in October 2015. The 15 full and 8 short papers presented were carefully reviewed and selected from 30 submissions. The workshop focus on problems, techniques, applications, and perspectives: from supervised to unsupervised learning, from generative to discriminative models, and from theoretical issues to empirical validations.

Correlated neuronal activity and its relationship to coding, dynamics and network architecture Tatjana Tchumatchenko, Ruben Moreno-Bote. 2014-12-03 Correlated activity in populations of neurons has been observed in many brain regions and plays a central role in cortical coding, attention, and network dynamics. Accurately quantifying neuronal correlations presents several difficulties. For example, despite recent advances in multicellular recording techniques, the number of neurons from which spiking activity can be simultaneously recorded remains orders magnitude smaller than the size of local networks. In addition, there is a lack of consensus on the distribution of pairwise spike cross correlations obtained in extracellular multi-unit recordings. These challenges highlight the need for theoretical and computational approaches to understand how correlations emerge and to decipher their functional role in the brain.

The Senses: A Comprehensive Reference. 2020-09-30 *The Senses: A Comprehensive Reference*, Second Edition, Seven Volume Set is a comprehensive reference work covering the range of topics that constitute current knowledge of the neural mechanisms underlying the different senses. This important work provides the most up-to-date, cutting-edge, comprehensive reference combining volumes on all major sensory modalities in one set. Offering 264 chapters from a distinguished team of international experts, *The Senses* lays out current knowledge on the anatomy, physiology, and molecular biology of sensory organs, in a collection of comprehensive chapters spanning 4 volumes. Topics covered include the perception, psychophysics, and higher order processing of sensory

information, as well as disorders and new diagnostic and treatment methods. Written for a wide audience, this reference work provides students, scholars, medical doctors, as well as anyone interested in neuroscience, a comprehensive overview of the knowledge accumulated on the function of sense organs, sensory systems, and how the brain processes sensory input. As with the first edition, contributions from leading scholars from around the world will ensure *The Senses* offers a truly international portrait of sensory physiology. The set is the definitive reference on sensory neuroscience and provides the ultimate entry point into the review and original literature in Sensory Neuroscience enabling students and scientists to delve into the subject and deepen their knowledge. All-inclusive coverage of topics: updated edition offers readers the only current reference available covering neurobiology, physiology, anatomy, and molecular biology of sense organs and the processing of sensory information in the brain Authoritative content: world-leading contributors provide readers with a reputable, dynamic and authoritative account of the topics under discussion Comprehensive-style content: in-depth, complex coverage of topics offers students at upper undergraduate level and above full insight into topics under discussion

Analysis of Parallel Spike Trains Sonja Grün, Stefan Rotter. 2010-08-30 Solid and transparent data analysis is the most important basis for reliable interpretation of experiments. The technique of parallel spike train recordings using multi-electrode arrangements has been available for many decades now, but only recently gained wide popularity among electro physiologists. Many traditional analysis methods are based on firing rates obtained by trial-averaging, and some of the assumptions for such procedures to work can be ignored without serious consequences. The situation is different for correlation analysis, the result of which may be considerably distorted if certain critical assumptions are violated. The focus of this book is on concepts and methods of correlation analysis (synchrony, patterns, rate covariance), combined with a solid introduction into approaches for single spike trains, which represent the basis of correlations analysis. The book also emphasizes pitfalls and potential wrong interpretations of data due to violations of critical assumptions.

Information Processing in the Cortex Ad Aertsen, Valentino Braitenberg. 2012-04-19 There is a tradition of theoretical brain science which started in the forties (Wiener, McCulloch, Turing, Craik, Hebb). This was continued by a small number of people without interruption up to the present. It has definitely provided main guiding lines for brain science, the development of which has been spectacular in the last decades. However, within the bulk of experimental neuroscience, the theoreticians some times had a difficult stand, since it was felt that the times were not ripe yet and the methods not yet available for a development of a true theoretical speciality in this field. Thus theory remained in the hands of a fairly small club which recruited its members from theoretical physicists, mathematicians and some experimentalists with amateurish theoretical leanings. The boom of approaches which go by the name of 'computational neuroscience', 'neuronal networks', 'associative memory', 'spinglass theory', 'parallel processing' etc. should not blind one for the fact that the group of people professionally interested in realistic models of brain function up to the present date remains rather small and suffers from a lack of professional organization. It was against this background that we decided to organize a meeting on Theoretical Brain Science. The meeting was held April 18 - 20, 1990 and took place at Schloss Ringberg, West-Germany, a facility sponsored by the Max-Planck-Society.

Mathematical and Theoretical Neuroscience Giovanni Naldi, Thierry Nieuwenhuis. 2018-03-20 This volume gathers contributions from theoretical, experimental and computational researchers who are working on various topics in theoretical/computational/mathematical neuroscience. The focus is on mathematical modeling, analytical and numerical topics, and statistical analysis in neuroscience with applications. The following subjects are considered: mathematical modelling in Neuroscience, analytical and numerical topics; statistical analysis in Neuroscience; Neural Networks; Theoretical Neuroscience. The book is addressed to researchers involved in mathematical models applied to neuroscience.

Modeling in Computational Biology and Biomedicine Frédéric Cazals, Pierre

Kornprobst. 2012-11-06 Computational biology, mathematical biology, biology and biomedicine are

currently undergoing spectacular progresses due to a synergy between technological advances and inputs from physics, chemistry, mathematics, statistics and computer science. The goal of this book is to evidence this synergy by describing selected developments in the following fields: bioinformatics, biomedicine and neuroscience. This work is unique in two respects - first, by the variety and scales of systems studied and second, by its presentation: Each chapter provides the biological or medical context, follows up with mathematical or algorithmic developments triggered by a specific problem and concludes with one or two success stories, namely new insights gained thanks to these methodological developments. It also highlights some unsolved and outstanding theoretical questions, with a potentially high impact on these disciplines. Two communities will be particularly interested in this book. The first one is the vast community of applied mathematicians and computer scientists, whose interests should be captured by the added value generated by the application of advanced concepts and algorithms to challenging biological or medical problems. The second is the equally vast community of biologists. Whether scientists or engineers, they will find in this book a clear and self-contained account of concepts and techniques from mathematics and computer science, together with success stories on their favorite systems. The variety of systems described represents a panoply of complementary conceptual tools. On a practical level, the resources listed at the end of each chapter (databases, software) offer invaluable support for getting started on a specific topic in the fields of biomedicine, bioinformatics and neuroscience.

Strengthening Links Between Data Analysis and Soft Computing Przemyslaw

Grzegorzewski, Marek Gagolewski, Olgierd Hryniewicz, María Ángeles Gil. 2014-09-10 This book gathers contributions presented at the 7th International Conference on Soft Methods in Probability and Statistics SMPS 2014, held in Warsaw (Poland) on September 22-24, 2014. Its aim is to present recent results illustrating new trends in intelligent data analysis. It gives a comprehensive overview of current research into the fusion of soft computing methods with probability and statistics. Synergies of both fields might improve intelligent data analysis methods in terms of robustness to noise and applicability to larger datasets, while being able to efficiently obtain understandable solutions of real-world problems.

Advances in Intelligent Data Analysis XI Jaakko Hollmen, Frank Klawonn, Allan Tucker. 2012-10-20 This book constitutes the refereed proceedings of the 11th International Conference on Intelligent Data Analysis, IDA 2012, held in Helsinki, Finland, in October 2012. The 32 revised full papers presented together with 3 invited papers were carefully reviewed and selected from 88 submissions. All current aspects of intelligent data analysis are addressed, including intelligent support for modeling and analyzing data from complex, dynamical systems. The papers focus on novel applications of IDA techniques to, e.g., networked digital information systems; novel modes of data acquisition and the associated issues; robustness and scalability issues of intelligent data analysis techniques; and visualization and dissemination results.

Information Decomposition of Target Effects from Multi-Source Interactions Joseph

Lizier, Nils Bertschinger, Juergen Jost, Michael Wibral. 2018-09-04 This book is a printed edition of the Special Issue Information Decomposition of Target Effects from Multi-Source Interactions that was published in Entropy

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