

PERSPECTIVES IN NEURAL COMPUTING

J.G. Taylor and C.L.T. Mannion (Eds.)

# Coupled Oscillating Neurons



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# Coupled Oscillating Neurons Perspectives In Neural Computing

**Egidio D'Angelo, Elisa Galliano, Chris I  
De Zeeuw**



## **Coupled Oscillating Neurons Perspectives In Neural Computing:**

**Coupled Oscillating Neurons** J.G. Taylor,C.L.T. Mannion,2012-12-06 This volume consists of proceedings of the one day conference on Coupled Oscillating Neurons held at King s College London on December 13th 1990 The subject is currently of increasing interest to neurophysiologists neural network researchers applied mathematicians and physicists The papers attempt to cover the major areas of the subject as the titles indicate It is hoped that the appearance of the papers some of which have been updated since their original presentation indicates why the subject is becoming of great excitement A better understanding of coupled oscillating neurons may well hold the key to a clearer appreciation of the manner in which neural networks composed of such elements can control complex behaviour from the heart to consciousness December 1991 J G Taylor King s College London C L T Mannion CONTENTS Contributors ix Introduction to Nonlinear Oscillators I Stewart Identical Oscillator Networks with Symmetry P B Ashwin 21 Bifurcating Neurones AV Holden J Hyde M A Muhamad H G Zhang 41 A Model for Low Threshold Oscillations in Neurons J L Hindmarsh R M Rose 81 Information Processing by Oscillating Neurons C L T Mannion J G Taylor 100 Gamma Oscillations Association and Consciousness R M J Cotterill C Nielsen 117 Modelling of Cardiac Rhythm From Single Cells to Massive Networks D Noble J C Denyer H F Brown R Winslow A Kimball 1 32 CONTRIBUTORS Ashwin P B Mathematics Institute University of Warwick Coventry CV4 7 AL UK Brown H F

**Coupled Oscillating Neurons** John Gerald Taylor,C. L. T. Mannion,1992      **Advances in Systems Engineering** V. H. Saran,Rakesh Kumar Misra,2021-01-23 This book comprises select proceedings of the 43rd National Systems Conference on Innovative and Emerging Trends in Engineering Systems NSC 2019 held at the Indian Institute of Technology Roorkee India The contents cover latest research in the highly multidisciplinary field of systems engineering and discusses its various aspects like systems design dynamics analysis modeling and simulation Some of the topics covered include computing systems consciousness systems electrical systems energy systems manufacturing systems mechanical systems literary systems social systems and quantum and nano systems Given the scope of the contents this book will be useful for researchers and professionals from diverse engineering and management background      **Reviews and Perspectives in**

**Neuromorphic Engineering: Novel Neuromorphic Computing Approaches** Pier Luigi Gentili,Siegfried Karg,Gyorgy Csaba ,Konrad Szaciłowski,2024-11-15 Frontiers in Neuroscience Neuromorphic Engineering is delighted to present the Reviews and Perspectives in series of article collections Reviews and Perspectives in Neuromorphic Engineering Novel Neuromorphic Computing Approaches Research Topic will publish high quality scholarly reviews and perspective papers on key topics in Neuromorphic Computing It aims to highlight recent advances in neuromorphic computing in software hardware and wetware whilst emphasizing important directions novel and unconventional approaches and new possibilities for future inquiries The research presented will promote discussion in the neuromorphic computing community that will translate to best practice applications We welcome Review Mini Review Opinion General Commentary and Perspective

articles on themes including but not limited to Innovative architectures and models in neuromorphic computing Oscillatory Neural Networks computing Reservoir computing Chemical computing Protein computing Synthetic cells Analog computing Bayesian inference and fuzzy logic Linking neuromorphic and quantum computing Novel materials for neuromorphic computing Unconventional neuromorphic approaches Photonic computing 3D integrated Neural Network Physical Chemistry of materials and systems for neuromorphic computing Current Catalog National Library of Medicine (U.S.),1993 First multi year cumulation covers six years 1965 70 **Oscillations in Neural Systems** Daniel S. Levine,Vincent R. Brown,Timothy Shirey,1999-09 Written for those interested in designing machines to perform intelligent functions those interested in studying how these functions are performed by living organisms this bk dicusses the mathematical structure functional significance of neural oscil **Time and the Brain** Robert Miller,2003-09-02 Since the days of Galileo time has been a fundamental variable in scientific attempts to understand the natural world Once the first recordings of electrical activity in the brain had been made it became clear that electrical signals from the brain consist of very complex temporal patterns This can now be demonstrated by recordings at the single unit level and by electroencephalography EEG Time and the Brain explores modern approaches to these temporal aspects of electrical brain activity The temporal structure as revealed from trains of impulses from single nerve cells and from EEG recordings are discussed in depth together with an exploration of correlations with behaviour and psychology The single cell and EEG approaches often tend to be segregated as the research occurs in laboratories in different parts of the world By bringing together modern information acquired using both methods it is hoped that they can become better integrated as complimentary windows on the information processing achieved by the brain Biophysically based Computational Models of Astrocyte ~ Neuron Coupling and their Functional Significance John Wade,Scott Kelso,Vincenzo Crunelli, Liam J. McDaid, Jim Harkin,2014-03-21 Neuroscientists are increasingly becoming more interested in modelling brain functions where capturing the biophysical mechanisms underpinning these functions requires plausible models at the level of neuron cells However cell level models are still very much in the embryo stage and therefore there is a need to advance the level of biological realism at the level of neurons synapses Recent publications have highlighted that astrocytes continually exchange information with multiple synapses if we are to fully appreciate this dynamic and coordinated interplay between these cells then more research on bidirectional signalling between astrocytes and neurons is required A better understanding of astrocyte neuron cell coupling would provide the building block for studying the regulatory capability of astrocytes networks on a large scale For example it is believed that local and global signalling via astrocytes underpins brain functions like synchrony learning memory and self repair This Research Topic aims to report on current research work which focuses on understanding and modelling the interaction between astrocytes and neurons at the cellular level Bottom up and at network level Top down Understanding astrocytic regulation of neural activity is crucial if we are to capture how information is represented and processed across

large neuronal ensembles in humans      **Advances in Computational Intelligence** Ignacio Rojas,Gonzalo Joya,Andreu Català,2021-08-20 This two volume set LNCS 12861 and LNCS 12862 constitutes the refereed proceedings of the 16th International Work Conference on Artificial Neural Networks IWANN 2021 held virtually in June 2021 The 85 full papers presented in this two volume set were carefully reviewed and selected from 134 submissions The papers are organized in topical sections on Deep Learning for Biomedicine Intelligent Computing Solutions for SARS CoV 2 Covid 19 Advanced Topics in Computational Intelligence Biosignals Processing Neuro Engineering and much more      **National Library of Medicine Current Catalog** National Library of Medicine (U.S.),1993      *Temporal Structure of Neural Processes Coupling Sensory, Motor and Cognitive Functions of the Brain* Daya Shankar Gupta,Arpan Banerjee,Dipanjan Roy,Federica Piras,2020-12-03 This eBook is a collection of articles from a Frontiers Research Topic Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series they are collections of at least ten articles all centered on a particular subject With their unique mix of varied contributions from Original Research to Review Articles Frontiers Research Topics unify the most influential researchers the latest key findings and historical advances in a hot research area Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers Editorial Office frontiersin.org about contact      **Directory of Published Proceedings** ,1993      The Brain: A Systems Neuroscience Perspective Vikas Rai,2024-10-10 The Brain A Systems Neuroscience Perspective is a comprehensive textbook designed for undergraduate students in neuroscience It offers a detailed exploration of brain dynamics spatial navigation and the neuroscience of Alzheimers disease with an emphasis on understanding complex concepts through simplified mathematical models The objective is to provide a solid foundation for readers in systems neuroscience Key Topics Fundamental Brain Dynamics Covers the basics of brain organization neural systems and the role of differential equations in neuroscience Chapters 1 3 Spatial Navigation Discusses the neural mechanisms underlying spatial navigation and the geometry of neural maps Chapter 4 Alzheimers Disease Presents a simplified mathematical theory of Alzheimers dementia exploring its onset progression and potential interventions Chapter 5 Key Features Accessible Approach Minimizes mathematical complexity to make the subject approachable for readers with a basic understanding of differential equations Standalone Resource Provides all essential knowledge on brain function making it a valuable tool for both coursework and self study Includes references for advanced readers      *Combined EEG in research and diagnostics: novel perspectives and improvements* Kamran Avanaki,Morten Mørup,Camillo Porcaro,Oscar Arias-Carrion,2023-03-23      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

**Understanding the Importance of Temporal Coupling of Neural Activities in Information Processing Underlying Action and Perception** Daya Shankar Gupta, Andreas Bahmer, 2021-10-20 **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 olivo-cerebellar system Egidio D'Angelo, Elisa Galliano, Chris I De Zeeuw, 2016-04-29 During the last decades investigations on the olivo cerebellar system have attained a high level of sophistication which led to redefinitions of several structural and functional properties of neurons synapses connections and circuits Research has expanded and deepened in so many directions and so many theories and models have been proposed that an ensemble review of the matter is now needed Yet hot topics remain open and scientific discussion is very lively at several fronts One major question here as well as in other major brain circuits is how single neurons and synaptic properties

emerge at the network level and contribute to behavioural regulation via neuronal plasticity Other major aspects that this Research Topic covers and discusses include the development and circuit organization of the olivo cerebellar network the established and recent theories of learning and motor control and the emerging role of the cerebellum in cognitive processing By touching on such varied and encompassing subjects this Frontiers Special Topic aims to highlight the state of the art and stimulate future research We hope that this unique collection of high quality articles from experts in the field will provide scientists with a powerful basis of knowledge and inspiration to enucleate the major issues deserving further attention

**Towards an Integrated Approach to Measurement, Analysis and Modeling of Cortical Networks A.**

Ravishankar Rao,Guillermo A. Cecchi,Ehud Kaplan,2016-03-17 The amount of data being produced by neuroscientists is increasing rapidly driven by advances in neuroimaging and recording techniques spanning multiple scales of resolution The availability of such data poses significant challenges for their processing and interpretation To gain a deeper understanding of the surrounding issues the Editors of this e Book reached out to an interdisciplinary community and formed the Cortical Networks Working Group and the genesis of this e Book thus began with the formation of this Working Group which was supported by the National Institute for Mathematical and Biological Synthesis in the USA The Group consisted of scientists from neuroscience physics psychology and computer science and meetings were held in person A detailed list of the group members is presented in the Editorial that follows At the time we started in 2010 the term big data was hardly in existence though the volume of data we were handling would certainly have qualified Furthermore there was significant interest in harnessing the power of supercomputers to perform large scale neuronal simulations and in creating specialized hardware to mimic neural function We realized that the various disciplines represented in our Group could and should work together to accelerate progress in Neuroscience We searched for common threads that could define the foundation for an integrated approach to solve important problems in the field We adopted a network centric perspective to address these challenges as the data are derived from structures that are themselves network like We proposed three inter twined threads consisting of measurement of neural activity analysis of network structures deduced from this activity and modeling of network function leading to theoretical insights This approach formed the foundation of our initial call for papers When we issued the call for papers we were not sure how many papers would fall into each of these threads We were pleased that we found significant interest in each thread and the number of submissions exceeded our expectations This is an indication that the field of neuroscience is ripe for the type of integration and interchange that we had anticipated We first published a special topics issue after we received a sufficient number of submissions This is now being converted to an e book to strengthen the coherence of its contributions One of the strong themes emerging in this e book is that network based measures capture better the dynamics of brain processes and provide features with greater discriminative power than point based measures Another theme is the importance of network oscillations and synchrony Current research is shedding light on the principles

that govern the establishment and maintenance of network oscillation states. These principles could explain why there is impaired synchronization between different brain areas in schizophrenics and Parkinson's patients. Such research could ultimately provide the foundation for an understanding of other psychiatric and neurodegenerative conditions. The chapters in this book cover these three main threads related to cortical networks. Some authors have combined two or more threads within a single chapter. We expect the availability of related work appearing in a single e-book to help our readers see the connection between different research efforts and spur further insights and research.

### **The Relevance of the Time**

**Domain to Neural Network Models** A. Ravishankar Rao, Guillermo A. Cecchi, 2011-09-18 A significant amount of effort in neural modeling is directed towards understanding the representation of information in various parts of the brain such as cortical maps and the paths along which sensory information is processed. Though the time domain is integral to an integral aspect of the functioning of biological systems, it has proven very challenging to incorporate the time domain effectively in neural network models. A promising path that is being explored is to study the importance of synchronization in biological systems. Synchronization plays a critical role in the interactions between neurons in the brain, giving rise to perceptual phenomena and explaining multiple effects such as visual contour integration and the separation of superposed inputs. The purpose of this book is to provide a unified view of how the time domain can be effectively employed in neural network models. A first direction to consider is to deploy oscillators that model temporal firing patterns of a neuron or a group of neurons. There is a growing body of research on the use of oscillatory neural networks and their ability to synchronize under the right conditions. Such networks of synchronizing elements have been shown to be effective in image processing and segmentation tasks and also in solving the binding problem, which is of great significance in the field of neuroscience. The oscillatory neural models can be employed at multiple scales of abstraction, ranging from individual neurons to groups of neurons, using Wilson-Cowan modeling techniques and eventually to the behavior of entire brain regions as revealed in oscillations observed in EEG recordings. A second interesting direction to consider is to understand the effect of different neural network topologies on their ability to create the desired synchronization. A third direction of interest is the extraction of temporal signaling patterns from brain imaging data such as EEG and fMRI. Hence, this Special Session is of emerging interest in the brain sciences as imaging techniques are able to resolve sufficient temporal detail to provide an insight into how the time domain is deployed in cognitive function. The following broad topics will be covered in the book: Synchronization, phase locking, behavior, image processing, image segmentation, temporal pattern analysis, EEG analysis, fMRI analysis, network topology and synchronizability, cortical interactions involving synchronization and oscillatory neural networks. This book will benefit readers interested in the topics of computational neuroscience, applying neural network models to understand brain function, extracting temporal information from brain imaging data, and emerging techniques for image segmentation using oscillatory networks.

## **Coupled Oscillating Neurons Perspectives In Neural Computing** Book Review: Unveiling the Power of Words

In a global driven by information and connectivity, the ability of words has become more evident than ever. They have the capability to inspire, provoke, and ignite change. Such is the essence of the book **Coupled Oscillating Neurons Perspectives In Neural Computing**, a literary masterpiece that delves deep into the significance of words and their effect on our lives. Compiled by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book's key themes, examine its writing style, and analyze its overall effect on readers.

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### **Table of Contents Coupled Oscillating Neurons Perspectives In Neural Computing**

1. Understanding the eBook Coupled Oscillating Neurons Perspectives In Neural Computing
  - The Rise of Digital Reading Coupled Oscillating Neurons Perspectives In Neural Computing
  - Advantages of eBooks Over Traditional Books
2. Identifying Coupled Oscillating Neurons Perspectives In Neural Computing
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an eBook Coupled Oscillating Neurons Perspectives In Neural Computing
  - User-Friendly Interface
4. Exploring eBook Recommendations from Coupled Oscillating Neurons Perspectives In Neural Computing
  - Personalized Recommendations
  - Coupled Oscillating Neurons Perspectives In Neural Computing User Reviews and Ratings

- Coupled Oscillating Neurons Perspectives In Neural Computing and Bestseller Lists
- 5. Accessing Coupled Oscillating Neurons Perspectives In Neural Computing Free and Paid eBooks
  - Coupled Oscillating Neurons Perspectives In Neural Computing Public Domain eBooks
  - Coupled Oscillating Neurons Perspectives In Neural Computing eBook Subscription Services
  - Coupled Oscillating Neurons Perspectives In Neural Computing Budget-Friendly Options
- 6. Navigating Coupled Oscillating Neurons Perspectives In Neural Computing eBook Formats
  - ePub, PDF, MOBI, and More
  - Coupled Oscillating Neurons Perspectives In Neural Computing Compatibility with Devices
  - Coupled Oscillating Neurons Perspectives In Neural Computing Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Coupled Oscillating Neurons Perspectives In Neural Computing
  - Highlighting and Note-Taking Coupled Oscillating Neurons Perspectives In Neural Computing
  - Interactive Elements Coupled Oscillating Neurons Perspectives In Neural Computing
- 8. Staying Engaged with Coupled Oscillating Neurons Perspectives In Neural Computing
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Coupled Oscillating Neurons Perspectives In Neural Computing
- 9. Balancing eBooks and Physical Books Coupled Oscillating Neurons Perspectives In Neural Computing
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Coupled Oscillating Neurons Perspectives In Neural Computing
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Coupled Oscillating Neurons Perspectives In Neural Computing
  - Setting Reading Goals Coupled Oscillating Neurons Perspectives In Neural Computing
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Coupled Oscillating Neurons Perspectives In Neural Computing
  - Fact-Checking eBook Content of Coupled Oscillating Neurons Perspectives In Neural Computing
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

### **Coupled Oscillating Neurons Perspectives In Neural Computing Introduction**

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