Biological Learning And Control How The Brain Builds Representations Predicts Events And Makes Decisions Computational Neuroscience

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BEARD EDWARDS

Discovering the Brain IGI Global Biological Control: Global Impacts, Challenges and Future Directions of Pest Management provides a historical summary of organisms and main strategies used in biological control, as well as the key challenges confronting biological control in the 21st century. Biological control has been implemented for millennia, initially practised by growers moving beneficial species from one local area to another. Today, biological control has evolved into a formal science that provides ecosystem services to protect the environment and the resources used by humanity. With contributions from dedicated scientists and practitioners from around the world, this comprehensive book highlights important successes, failures and challenges in biological control efforts. It advocates that biological control must be viewed as a global endeavour and provides suggestions to move practices forward in a changing world. Biological Control is an invaluable resource for conservation specialists, pest management practitioners and those who research invasive species, as well

as students studying pest management science.

Learning-Based Control Routledge

In the era of cyber-physical systems, the area of control of complex systems has grown to be one of the hardest in terms of algorithmic design techniques and analytical tools. The 23 chapters, written by international specialists in the field, cover a variety of interests within the broader field of learning, adaptation, optimization and networked control. The editors have grouped these into the following 5 sections: "Introduction and Background on Control Theory, "Adaptive Control and Neuroscience, "Adaptive Learning Algorithms, "Cyber-Physical Systems and Cooperative Control, "Applications.The diversity of the research presented gives the reader a unique opportunity to explore a comprehensive overview of a field of great interest to control and system theorists. This book is intended for researchers and control engineers in machine learning, adaptive control, optimization and automatic control systems, including Electrical Engineers, Computer Science Engineers, Mechanical Engineers, Aerospace/Automotive Engineers, and Industrial Engineers. It could be used as a text or reference for advanced courses in complex control systems. • Collection of chapters from several well-known professors and researchers that will showcase their recent work • Presents different state-of-the-art control approaches and theory for complex systems • Gives algorithms that take into consideration the presence of modelling uncertainties, the unavailability of the model, the possibility of cooperative/non-cooperative goals and malicious attacks compromising the security of networked teams • Real system examples and figures throughout, make ideas concrete - Includes chapters from several well-known professors and researchers that showcases their recent work - Presents different state-of-the-art control approaches and theory for complex systems - Explores the presence of modelling uncertainties, the unavailability of the model, the possibility of cooperative/non-cooperative goals, and malicious attacks compromising the security of networked teams - Serves as a helpful reference for researchers and control engineers working with machine learning, adaptive control, and automatic control systems

From Neuron to Cognition via Computational Neuroscience Routledge

Approx.242 pages - Translates the principles of motor control to improve sensorimotor outcomes in patients - Reviews coordination topics including locomotor coordination, visual perception and head stability - Explores movement analysis knowledge in rehabilitative tools

Introducing Biological Energetics CRC Press

A complete guide to the state of the art theoretical and manufacturing developments of body sensor network, design, and algorithms In Body Sensor Networking, Design, and Algorithms, professionals in the field of Biomedical Engineering and e-health get an in-depth look at advancements, changes, and developments. When it comes to advances in the industry, the text looks at cooperative networks, noninvasive and implantable sensor microelectronics, wireless sensor networks, platforms, and optimization—to name a few. Each chapter provides essential information needed to understand the current landscape of technology and mechanical developments. It covers subjects

including Physiological Sensors, Sleep Stage Classification, Contactless Monitoring, and much more. Among the many topics covered, the text also includes additions such as: Over 120 figures, charts, and tables to assist with the understanding of complex topics Design examples and detailed experimental works A companion website featuring MATLAB and selected data sets Additionally, readers will learn about wearable and implantable devices, invasive and noninvasive monitoring, biocompatibility, and the tools and platforms for long-term, low-power deployment of wireless communications. It’s an essential resource for understanding the applications and practical implementation of BSN when it comes to elderly care, how to manage patients with chronic illnesses and diseases, and use cases for rehabilitation.

Biological Collections Springer

How to Build a Brain provides a detailed exploration of a new cognitive architecture - the Semantic Pointer Architecture - that takes biological detail seriously, while addressing cognitive phenomena. Topics ranging from semantics and syntax, to neural coding and spike-timing-dependent plasticity are integrated to develop the world's largest functional brain model.

The Computational Neurobiology of Reaching and Pointing MIT Press

Research on assistive technologies is undergoing many developments in its effectiveness in helping those with varying impairments. New technologies are constantly being created, researched, and implemented for those who need these technological aides in daily life. Assistive Technologies for Physical and Cognitive Disabilities combines worldwide cases on people with physical and cognitive disabilities with the latest applications in assistive technologies. This reference work brings different researchers together under one title to discuss current findings, developments, and ongoing research in the area of rehabilitative technology. This reference book is of critical use to professionals, researchers, healthcare practitioners, caretakers, academicians, and students.

Handbook of Reinforcement Learning and Control Now Publishers

An examination of the link between the vigor with which we move and the value that the brain assigns to the goal of the movement. Why do we reflexively run toward people we love, but only walk toward others? In Vigor, Reza Shadmehr and Alaa Ahmed examine the link between how the brain assigns value to things and how it controls our movements. They find that brain regions thought to be principally involved in decision making also affect movement vigor—and that brain regions thought to be principally responsible for movement also bias patterns of decision making. Shadmehr and Ahmed first consider the relationship of value and vigor from a behavioral and mathematical perspective, considering a series of fascinating observations—including, for example, data showing that people in certain cities tend to walk faster than those living elsewhere—through the lens of optimal foraging theory. They then go on to explore the neural basis of vigor and valuation, synthesizing results from experiments that have measured activity in various brain structures and neuromodulators, including dopamine and serotonin. They speculate that in the future, technologies may be able to predict our personal preferences by measuring our movements; through the

vigor with which we move, we unwittingly reveal one of our well-guarded secrets: how much we value the object of our attention.

Optimal Control Applied to Biological Models MIT Press

Nikolai Aleksandrovich Bernstein was one of the great neuroscientists of the twentieth century and highly respected by Western scientists even though most have never read his most important book entitled On the Construction of Movements. Bernstein's Construction of Movements: The Original Text and Commentaries is the first English translation. It supplements the translated text with a series of commentaries by scientists who knew Bernstein personally, as well as leaders in related fields including physics, motor control, and biomechanics. While written in 1947, Bernstein’s book is anything but obsolete, making this English translation and accompanying commentaries an invaluable text. The translated original text presents in detail Bernstein’s views on the evolutionary history of biological movement and his multi-level hierarchical scheme of the construction of movements in higher animals, including humans. The following commentaries address Bernstein’s personality, the history of the book, and current views on different aspects of neuroscience covered in Bernstein’s text. Ultimately, they present "a book within the book" to showcase how Bernstein’s heritage has developed over the past years. This classic, available for the first time to an English-speaking audience, will prove beneficial to students, instructors, and experts of neuroscience, physics, neurophysiology, motor control, motor rehabilitation, biomechanics, dynamical systems, and related fields.

Bernstein's Construction of Movements Springer

This book focuses on a critical issue in the study of physical agents, whether natural or artificial: the quantitative modelling of sensory–motor coordination. Adopting a novel approach, it defines a common scientific framework for both the intelligent systems designed by engineers and those that have evolved naturally. As such it contributes to the widespread adoption of a rigorous quantitative and refutable approach in the scientific study of ‘embodied’ intelligence and cognition. More than 70 years after Norbert Wiener’s famous book Cybernetics: or Control and Communication in the Animal and the Machine (1948), robotics, AI and life sciences seem to be converging towards a common model of what we can call the ‘science of embodied intelligent/cognitive agents’. This book is interesting for an interdisciplinary community of researchers, technologists and entrepreneurs working at the frontiers of robotics and AI, neuroscience and general life and brain sciences.

How to Build a Brain MIT Press

The recent success of Reinforcement Learning and related methods can be attributed to several key factors. First, it is driven by reward signals obtained through the interaction with the environment. Second, it is closely related to the human learning behavior. Third, it has a solid mathematical foundation. Nonetheless, conventional Reinforcement Learning theory exhibits some shortcomings particularly in a continuous environment or in considering the stability and robustness of the controlled process. In this monograph, the authors build on Reinforcement Learning to present a learning-based approach for controlling

dynamical systems from real-time data and review some major developments in this relatively young field. In doing so the authors develop a framework for learning-based control theory that shows how to learn directly suboptimal controllers from input-output data. There are three main challenges on the development of learning-based control. First, there is a need to generalize existing recursive methods. Second, as a fundamental difference between learning-based control and Reinforcement Learning, stability and robustness are important issues that must be addressed for the safety-critical engineering systems such as self-driving cars. Third, data efficiency of Reinforcement Learning algorithms need be addressed for safety-critical engineering systems. This monograph provides the reader with an accessible primer on a new direction in control theory still in its infancy, namely Learning-Based Control Theory, that is closely tied to the literature of safe Reinforcement Learning and Adaptive Dynamic Programming.

Visual Cortex and Deep Networks MIT Press

An argument that the complexities of brain function can be understood hierarchically, in terms of different levels of abstraction, as silicon computing is. The vast differences between the brain's neural circuitry and a computer's silicon circuitry might suggest that they have nothing in common. In fact, as Dana Ballard argues in this book, computational tools are essential for understanding brain function. Ballard shows that the hierarchical organization of the brain has many parallels with the hierarchical organization of computing; as in silicon computing, the complexities of brain computation can be dramatically simplified when its computation is factored into different levels of abstraction. Drawing on several decades of progress in computational neuroscience, together with recent results in Bayesian and reinforcement learning methodologies, Ballard factors the brain's principal computational issues in terms of their natural place in an overall hierarchy. Each of these factors leads to a fresh perspective. A neural level focuses on the basic forebrain functions and shows how processing demands dictate the extensive use of timing-based circuitry and an overall organization of tabular memories. An embodiment level organization works in reverse, making extensive use of multiplexing and on-demand processing to achieve fast parallel computation. An awareness level focuses on the brain's representations of emotion, attention and consciousness, showing that they can operate with great economy in the context of the neural and embodiment substrates.

Biological Control John Wiley & Sons

"This multi-volume book delves into the many applications of information technology ranging from digitizing patient records to high-performance computing, to medical imaging and diagnostic technologies, and much more"--

An Introductory Course in Computational Neuroscience MIT Press

The brain ... There is no other part of the human anatomy that is so intriguing. How does it develop and function and why does it sometimes, tragically, degenerate? The answers are complex. In Discovering the Brain, science writer Sandra Ackerman cuts through the complexity to bring this vital topic to the public. The 1990s were declared the

"Decade of the Brain" by former President Bush, and the neuroscience community responded with a host of new investigations and conferences. Discovering the Brain is based on the Institute of Medicine conference, Decade of the Brain: Frontiers in Neuroscience and Brain Research. Discovering the Brain is a "field guide" to the brainâ€"an easy-to-read discussion of the brain's physical structure and where functions such as language and music appreciation lie. Ackerman examines: How electrical and chemical signals are conveyed in the brain. The mechanisms by which we see, hear, think, and pay attentionâ€"and how a "gut feeling" actually originates in the brain. Learning and memory retention, including parallels to computer memory and what they might tell us about our own mental capacity. Development of the brain throughout the life span, with a look at the aging brain. Ackerman provides an enlightening chapter on the connection between the brain's physical condition and various mental disorders and notes what progress can realistically be made toward the prevention and treatment of stroke and other ailments. Finally, she explores the potential for major advances during the "Decade of the Brain," with a look at medical imaging techniquesâ€"what various technologies can and cannot tell usâ€"and how the public and private sectors can contribute to continued advances in neuroscience. This highly readable volume will provide the public and policymakersâ€"and many scientists as wellâ€"with a helpful guide to understanding the many discoveries that are sure to be announced throughout the "Decade of the Brain."

Brain Computation as Hierarchical Abstraction IGI Global

Empirical data on neural control of motor action and perception have not yet been put into the context of a coherent theory. Dr. Feldman's goal for the proposed book is to illustrate that the field is now at a stage where the data can be used to formulate some core principles that underlie action and perception and to present the foundation of a scientific theory of motor control. Dr. Feldman is a well-known expert and has been active in the field for a long time. In the proposed book he will outline an approach to the analysis of action and perception that he and his colleagues have been using for the past 50 years or so. His theoretical approach will not only help to explain past empirical research, but should also help to inform and provide a structure for future empirical studies.

Assistive Technologies for Physical and Cognitive Disabilities Springer Nature

Changsheng Hua proposes two approaches, an input/output recovery approach and a performance index-based approach for robustness and performance optimization of feedback control systems. For their data-driven implementation in deterministic and stochastic systems, the author develops Q-learning and natural actor-critic (NAC) methods, respectively. Their effectiveness has been demonstrated by an experimental study on a brushless direct current motor test rig. The author: Changsheng Hua received the Ph.D. degree at the Institute of Automatic Control and Complex Systems (AKS), University of Duisburg-Essen, Germany, in 2020. His research interests include model-based and data-driven fault diagnosis and fault-tolerant techniques.

Clinical Technologies: Concepts, Methodologies, Tools and Applications MIT Press

The inventor of the PalmPilot shares a compelling new theory of intelligence, brain function, and the future of artificial intelligence. Tech innovator Jeff Hawkins reshaped our relationship to computers with devices like the PalmPilot. Now he stands ready to revolutionize both neuroscience and computing in one stroke, with a new understanding of intelligence itself. In this book, Hawkins develops a powerful theory of human cognition and explains how, based on his theory, we can finally build intelligent machines. According to Hawkins, the brain is a complex system that remembers sequences of events and their nested relationships. This style of organization reflects the true structure of the world and allows us to make increasingly accurate predictions. This memory-prediction process in turn forms the basis of intelligence, perception, creativity, and even consciousness. In an engaging style accessible to the general reader, Hawkins shows how a clear understanding of brain function can be applied to building intelligent machines, in silicon, that will exceed our human ability in surprising ways. Written with acclaimed science writer Sandra Blakeslee, On Intelligence is a landmark book in its scope and clarity. “Brilliant and imbued with startling clarity . . . the most important book in neuroscience, psychology, and artificial intelligence in a generation.” —Malcolm Young, University of Newcastle

Handbook of Learning and Approximate Dynamic Programming Oxford University Press

This book provides a conceptual and computational framework to study how the nervous system exploits the anatomical properties of limbs to produce mechanical function. The study of the neural control of limbs has historically emphasized the use of optimization to find solutions to the muscle redundancy problem. That is, how does the nervous system select a specific muscle coordination pattern when the many muscles of a limb allow for multiple solutions? I revisit this problem from the emerging perspective of neuromechanics that emphasizes finding and implementing families of feasible solutions, instead of a single and unique optimal solution. Those families of feasible solutions emerge naturally from the interactions among the feasible neural commands, anatomy of the limb, and constraints of the task. Such alternative perspective to the neural control of limb function is not only biologically plausible, but sheds light on the most central tenets and debates in the fields of neural control, robotics, rehabilitation, and brain-body co-evolutionary adaptations. This perspective developed from courses I taught to engineers and life scientists at Cornell University and the University of Southern California, and is made possible by combining fundamental concepts from mechanics, anatomy, mathematics, robotics and neuroscience with advances in the field of computational geometry. Fundamentals of Neuromechanics is intended for neuroscientists, roboticists, engineers, physicians, evolutionary biologists, athletes, and physical and occupational therapists seeking to advance their understanding of neuromechanics. Therefore, the tone is decidedly pedagogical, engaging, integrative, and practical to make it accessible to people coming from a broad spectrum of disciplines. I attempt to tread the line between making the mathematical exposition accessible to life scientists, and convey the wonder and complexity

of neuroscience to engineers and computational scientists. While no one approach can hope to definitively resolve the important questions in these related fields, I hope to provide you with the fundamental background and tools to allow you to contribute to the emerging field of neuromechanics.

The Nature of Explanation National Academies Press

A textbook for students with limited background in mathematics and computer coding, emphasizing computer tutorials that guide readers in producing models of neural behavior. This introductory text teaches students to understand, simulate, and analyze the complex behaviors of individual neurons and brain circuits. It is built around computer tutorials that guide students in producing models of neural behavior, with the associated Matlab code freely available online. From these models students learn how individual neurons function and how, when connected, neurons cooperate in a circuit. The book demonstrates through simulated models how oscillations, multistability, post-stimulus rebounds, and chaos can arise within either single neurons or circuits, and it explores their roles in the brain. The book first presents essential background in neuroscience, physics, mathematics, and Matlab, with explanations illustrated by many example problems. Subsequent chapters cover the neuron and spike production; single spike trains and the underlying cognitive processes; conductance-based models; the simulation of synaptic connections; firing-rate models of large-scale circuit operation; dynamical systems and their components; synaptic plasticity; and techniques for analysis of neuron population datasets, including principal components analysis, hidden Markov modeling, and Bayesian decoding. Accessible to undergraduates in life sciences with limited background in mathematics and computer coding, the book can be used in a “flipped” or “inverted” teaching approach, with class time devoted to hands-on work on the computer tutorials. It can also be a resource for graduate students in the life sciences who wish to gain computing skills and a deeper knowledge of neural function and neural circuits.

Autonomous Robots MIT Press

A mathematical framework that describes learning of invariant representations in the ventral stream, offering both theoretical development and applications. The ventral visual stream is believed to underlie object recognition in primates. Over the past fifty years, researchers have developed a series of quantitative models that are increasingly faithful to the biological architecture. Recently, deep learning convolution networks—which do not reflect several important features of the ventral stream architecture and physiology—have been trained with extremely large datasets, resulting in model neurons that mimic object recognition but do not explain the nature of the computations carried out in the ventral stream. This book develops a mathematical framework that describes learning of invariant representations of the ventral stream and is particularly relevant to deep convolutional learning networks. The authors propose a theory based on the hypothesis that the main computational goal of the ventral stream is to compute neural representations of images that are invariant to transformations commonly encountered in the visual environment and are learned from unsupervised experience. They describe a general theoretical

framework of a computational theory of invariance (with details and proofs offered in appendixes) and then review the application of the theory to the feedforward path of the ventral stream in the primate visual cortex.

Neurobiology of Motor Control

National Academies Press

A complete resource to Approximate Dynamic Programming (ADP), including on-line simulation code Provides a tutorial that readers can use to start implementing the learning algorithms provided in the book Includes ideas, directions, and recent results on current research issues and addresses applications where ADP has been successfully implemented The contributors are leading researchers in the field