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

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.

The book largely represents the extended version of select papers from the Inter- tional Conference on Intelligent Unmanned System ICIUS 2007 which was jointly organized by the Center for Unmanned System Studies at Institut Teknologi Bandung, Artificial Muscle Research Center at Konkuk University and Institute of Bio-inspired Structure and Surface Engineering, Nanjing University of Aeronautics and Astrona- ics. The joint-event was the 3rd conference extending from International Conference on Emerging System Technology (ICEST) in 2005 and International Conference on Technology Fusion (ICTF) in 2006 both conducted in Seoul. ICIUS 2007 was focused on both theory and application primarily covering the topics on robotics, autonomous vehicles and intelligent unmanned technologies. The conference was arranged into three parallel symposia with the following scope of topics: Unmanned Systems: Micro air vehicle, Underwater vehicle, Micro-satellite, - manned aerial vehicle, Multi-agent systems, Autonomous ground vehicle, Blimp, Swarm intelligence, learning and control Robotics and Biomimetics: Artificial muscle actuators, Smart sensors, Design and applications of MEMS/NEMS system, Intelligent robot system, Evolutionary al- rithm, Control of biological systems, AI and expert systems, Biological learning control systems, Neural networks, Genetic algorithm Control and Intelligent System: Distributed intelligence, Distributed/decentralized intelligent control, Distributed or decentralized control methods, Distributed and - bedded systems, Embedded intelligent control, Complex systems, Discrete event s- tems, Hybrid systems, Networked control systems, Delay systems, Fuzzy systems, Identification and estimation, Nonlinear systems, Precision motion control, Control applications, Control engineering education.

An argument that the complexities of brain function can be understood hierarchically, in terms of different levels of abstraction, as silicon computing is.

Drawing on the latest exciting research, Essential Biological Psychology provides students with a solid grasp of the relationship between mind and behaviour, and a detailed understanding of the underlying structure and physiological mechanisms that underpin it. The functions of the nervous system are explained and implications for health are explored. Throughout the book, Jim Barnes encourages students to evaluate essential concepts and theoretical issues. Features include: key concepts highlighted throughout the text enables students to grasp the fundamental knowledge and understanding of the structures and functions of the human nervous system that are relevant to the study of psychology the snapshot of key studies detailed in the textboxes allow critical evaluation of the role of physiology in human behaviour against a backdrop of up to date research clear explanations of the key methods in the text give students an appreciation of the contributions made by the different approaches and research methods that are used in biological psychology memory maps and diagrams within the text encourage learning and allow students to formulate memory aids to assist recall in exam conditions a companion website found at www.sagepub.co.uk/barnes consists of PowerPoint lecture slides and a testbank for teachers (50 questions per chapter) as well as interactive self-assessment testbank for students (10 questions per chapter) Electronic inspection copies are available to instructors.

This book enhances our understanding of biological control, integrating historical analysis, theoretical models and case studies in an ecological framework.

This book describes important techniques, developments, and applications of computational intelligence in system control. Chapters present: an introduction to the fundamentals of neural networks, fuzzy logic, and evolutionary computing a rigorous treatment of intelligent control industrial applications of intelligent control and soft computing, including transportation, petroleum, motor drive, industrial automation, and fish processing other knowledge-based techniques, including vehicle driving aid and air traffic management Intelligent Adaptive Control provides a state-of-the-art treatment of practical applications of computational intelligence in system control. The book cohesively covers introductory and advanced theory, design, implementation, and industrial use - serving as a singular resource for the theory and application of intelligent control, particularly employing fuzzy logic, neural networks, and evolutionary computing.

A practical guide to neural data analysis techniques that presents sample datasets and hands-on methods for analyzing the data. As neural data becomes increasingly complex, neuroscientists now require skills in computer programming, statistics, and data analysis. This book teaches practical neural data analysis techniques by presenting example datasets and developing techniques and tools for analyzing them. Each chapter begins with a specific example of neural data, which motivates mathematical and statistical analysis methods that are then applied to the data. This practical, hands-on approach is unique among data analysis textbooks and guides, and equips the reader with the tools necessary for real-world neural data analysis. The book begins with an introduction to MATLAB, the most common programming platform in neuroscience, which is used in the book. (Readers familiar with MATLAB can skip this chapter and might decide to focus on data type or method type.) The book goes on to cover neural field data and spike train data, spectral analysis, generalized linear models, coherence, and cross-frequency coupling. Each chapter offers a stand-alone case study that can be used separately as part of a targeted investigation. The book includes some mathematical discussion but does not focus on mathematical or statistical theory, emphasizing the practical instead. References are included for readers who want to explore the theoretical more deeply. The data and accompanying MATLAB code are freely available on the authors' website. The book can be used for upper-level undergraduate or graduate courses or as a professional reference.

This volume is composed of invited papers on learning and control. The contents form the proceedings of a workshop held in January 2008, in Hyderabad that honored the 60th birthday of Doctor Mathukumalli Vidyasagar. The 14 papers, written by international specialists in the field, cover a variety of interests within the broader field of learning and control. The diversity of the research provides a comprehensive overview of a field of great interest to control and system theorists.

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
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.

An introduction to the computational biology of reaching and pointing, with an emphasis on motor learning. Neuroscience involves the study of the nervous system, and its topics range from genetics to inferential reasoning. At its heart, however, lies a search for understanding how the environment affects the nervous system and how the nervous system, in turn, empowers us to interact with and alter our environment. This empowerment requires motor learning. The Computational Neurobiology of Reaching and Pointing addresses the neural mechanisms of one important form of motor learning. The authors integrate material from the computational, behavioral, and neural sciences of motor control that is not available in any other single source. The result is a unified, comprehensive model of reaching and pointing. The book is intended to be used as a text by graduate students in both neuroscience and bioengineering and as a reference source by experts in neuroscience, robotics, and other disciplines. The book begins with an overview of the evolution, anatomy, and physiology of the motor system, including the mechanisms for generating force and maintaining limb stability. The sections that follow, "Computing Locations and Displacements", "Skills, Adaptations, and Trajectories", and "Predictions, Decisions, and Flexibility", present a theory of sensorially guided reaching and pointing that evolves organically based on computational principles rather than a traditional structure-by-structure approach. The book also includes five appendixes that provide brief refreshers on fundamentals of biology, mathematics, physics, and neurophysiology, as well as a glossary of relevant terms. The authors have also made supplemental materials available on the Internet. These web documents provide source code for simulations, step-by-step derivations of certain mathematical formulations, and expanded explanations of some concepts.

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.

Neural Networks for Control brings together examples of all the most important paradigms for the application of neural networks to robotics and control. Primarily concerned with engineering problems and approaches to their solution through neurocomputing systems, the book is divided into three sections: general principles, motion control, and applications domains (with evaluations of the possible applications by experts in the applications areas.) Special emphasis is placed on designs based on optimization or reinforcement, which will become increasingly important as researchers address more complex engineering challenges or real biological-control problems.A Bradford Book. Neural Network Modeling and Connectionism series

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.

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.

Neuroergonomics: The Brain at Work and in Everyday Life details the methodologies that are useful for keeping an ideal human-machine system up-to-date, along with information on how to prevent potential overload and minimize errors. It discusses neural measures and the proper methods and technologies to maximize performance, thus providing a resource for neuroscientists who want to learn more about the technologies and real-time tools that can help them assess cognitive and motivational states of human operators and close the loop for advanced human-machine interaction. With the advent of new and improved tools that allow monitoring of brain activity in the field and better identification of neurophysiological markers that can index impending overload or fatigue, this book is a timely resource on the topic. Includes neurobiological models to better understand risky decision-making and cognitive countermeasures, augmented cognition, and brain stimulations to enhance performance and mitigate human error Features innovative methodologies and protocols using psychophysiological measurements and brain imaging techniques in realistic operational settings Discusses numerous topics, including cognitive performance in psychological and neurological disorders, brain computer interfaces (BCI), and human performance monitoring in ecological conditions, virtual reality, and serious gaming

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

Reaching for objects in our surroundings is an everyday activity that most humans perform seamlessly a hundred times a day. It is nonetheless a complex behavior that requires the perception of objects’ features, action selection, movement planning, multi-joint coordination, force regulation, and the integration of all of these properties during the actions themselves to meet the successful demands of extremely varied task goals. Even though reach-to-grasp behavior has been studied for decades, it has, in recent years, become a particularly growing area of multidisciplinary research because of its crucial role in activities of daily living and broad range of applications to other fields, including physical rehabilitation, prosthetics, and robotics. This volume brings together novel and exciting research that sheds light into the complex sensory-motor processes involved in the selection and production of reach-to-grasp behaviors. It also offers a unique life-span and multidisciplinary perspective on the development and multiple processes involved in the formation of reach-to-grasp. It covers recent and exciting discoveries from the fields of developmental psychology and learning sciences, neurophysiology and brain sciences, movement sciences, and the dynamic field of developmental robotics, which has become a very active applied field relying on biologically inspired models. This volume is a rich and valuable resource for students and professionals in all of these research fields, as well as cognitive sciences, rehabilitation, and other applied sciences.

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.

Advances in Motor Learning and Control surveys the latest, most important advances in the field, surpassing the confines of debate between proponents of the information processing and dynamical systems. Zelaznik, editor of the Journal of Motor Behavior from 1989 to 1996, brings together a variety of perspectives. Some of the more difficult topics-such as behavioral analysis of trajectory formation and the dynamic pattern perspective of rhythmic movement-are presented in tutorial fashion. Other chapters provide a foundation for understanding increasingly specialized areas of study.

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.

Progress in Brain Research is the most acclaimed and accomplished series in neuroscience, firmly established as an extensive documentation of the advances in contemporary brain research. The volumes, some of which are derived from important international symposia, contain authoritative reviews and original articles by invited specialists. The rigorous editing of the volumes assures that they will appeal to all laboratory and clinical brain research workers in the various disciplines: neuroanatomy, neurophysiology, neuropharmacology, neuroendocrinology, neuropathology, basic neurology, biological psychiatry, and the behavioral sciences. This volume, The Cerebellum and Memory Formation: Structure, Computation and Function, covers topics including feedback control of cerebellar learning; cortico-cerebellar organization and skill acquisition; cerebellar plasticity and learning in the oculomotor system, and more. Leading authors review the state-of-the-art in their field of investigation, and provide their views and perspectives for future research The volume reflects current thinking about the ways in which the cerebellum can engage in learning, and the contributors come from a variety of research fields. The chapters express perspectives from different levels of analysis that range from molecular and cellular mechanisms through to long-range systems that allow the cerebellum to communicate with other brain areas.

Explain why the early 21st century may represent a historical turning point in educational practice around the world and discusses how to create learning environments that will help all children take control of their own learning.

This book aims at gathering roboticists, control theorists, neuroscientists, and mathematicians, in order to promote a multidisciplinary research on movement analysis. It follows the workshop " Geometric and Numerical Foundations of Movements " held at LAAS-CNRS in Toulouse in November 2015[1]. Its objective is to lay the foundations for a mutual understanding that is essential for synergetic development in motion research. In particular, the book promotes applications to robotics --and control in general-- of new optimization techniques based on recent results from real algebraic geometry.

Biological Learning and ControlHow the Brain Builds Representations, Predicts Events, and Makes DecisionsMIT Press

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.
This handbook presents state-of-the-art research in reinforcement learning, focusing on its applications in the control and game theory of dynamic systems and future directions for related research and technology. The contributions gathered in this book deal with challenges faced when using learning and adaptation methods to solve academic and industrial problems, such as optimization in dynamic environments with single and multiple agents, convergence and performance analysis, and online implementation. They explore means by which these difficulties can be solved, and cover a wide range of related topics including: deep learning; artificial intelligence; applications of game theory; mixed modality learning; and multi-agent reinforcement learning. Practicing engineers and scholars in the field of machine learning, game theory, and autonomous control will find the Handbook of Reinforcement Learning and Control to be thought-provoking, instructive and informative. .
A novel theoretical framework that describes a possible rationale for the regularity in how we move, how we learn, and how our brain predicts events. In Biological Learning and Control, Reza Shadmehr and Sandro Mussa-Ivaldi present a theoretical framework for understanding the regularity of the brain's perceptions, its reactions to sensory stimuli, and its control of movements. They offer an account of perception as the combination of prediction and observation: the brain builds internal models that describe what should happen and then combines this prediction with reports from the sensory system to form a belief. Considering the brain's control of movements, and variations despite biomechanical similarities among old and young, healthy and unhealthy, and humans and other animals, Shadmehr and Mussa-Ivaldi review evidence suggesting that motor commands reflect an economic decision made by our brain weighing reward and effort. This evidence also suggests that the brain prefers to receive a reward sooner than later, devaluing or discounting reward with the passage of time; then as the value of the expected reward changes in the brain with the passing of time (because of development, disease, or evolution), the shape of our movements will also change. The internal models formed by the brain provide the brain with an essential survival skill: the ability to predict based on past observations. The formal concepts presented by Shadmehr and Mussa-Ivaldi offer a way to describe how representations are formed, what structure they have, and how the theoretical concepts can be tested.
Popular science at its most exciting: the breaking new world of chronobiology - understanding the rhythm of life in humans and all plants and animals. The entire natural world is full of rhythms. The early bird catches the worm -and migrates to an internal calendar. Dormice hibernate away the winter. Plants open and close their flowers at the same hour each day. Bees search out nectar-rich flowers day after day. There are cicadas that can breed for only two weeks every 17 years. And in humans: why are people who work anti-social shifts more illness prone and die younger? What is jet-lag and can anything help? Why do teenagers refuse to get up in the morning, and are the rest of us really 'larks' or

'owls'? Why are most people born (and die) between 3am-5am? And should patients be given medicines (and operations) at set times of day, because the body reacts so differently in the morning, evening and at night? The answers lie in our biological clocks the mechanisms which give order to all living things. They impose a structure that enables us to change our behaviour in relation to the time of day, month or year. They are reset at sunrise and sunset each day to link astronomical time with an organism's internal time.

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.

Although somatosensory system works in tandem with the motor system in biology, the majority of the prosthetics research and commercial efforts had focused on accommodating movement deficits. With the development of neuroprostheses in the last 15 years, it has become evident that somatosensory input (mainly as touch and proprioception) is essential for motor control, manipulating objects, and embodiment, in addition to its primary role for sensory perception. Somatosensory Feedback for Neuroprosthetics covers all relevant aspects to facilitate learning and doing research and development in the field. To understand the properties of the body to create viable solutions, this book starts with chapters reviewing the basic anatomy, physiology, and psychophysics of the somatosensory system, sensorimotor control, and instrumentation. Some sections are dedicated to invasive (peripheral and central, mainly cortical) and noninvasive (vibrotactile, electrotactile, etc.) approaches. Final chapters cover future technologies such as novel sensors and electrodes, safety, and clinical testing, and help to make up future prospects for this field with an emphasis on development and end use. With contributions from renowned experts, the contents include their recent findings and technical details necessary to understand those findings. Provides a concise review of the somatosensory system and latest advances in the use of somatosensory feedback for neuroprosthetics Analyzes many approaches to somatosensory feedback Provides the most detailed work on somatosensory neuroprostheses, their development, and applications in real life work.

Recent interest in nonchemical methods of pest control has brought renewed attention to the biological control of plant pests in the fields of entomology, plant pathology, and weed science. Ecological Interactions and Biological Control addresses issues of theory and practice common to all three fields. Focusing on systems rather than on individual

This book explores the nature of cognitive representations and processes in speech motor control, based primarily on evidence from speech timing. It engages with the key question of whether phonological representations are spatio-temporal, as in the Articulatory Phonology approach, or symbolic (atemporal and non-quantitative); this issue has fundamental implications for the architecture of the speech production planning system, particularly with regard to the number of planning components and the type of timing mechanisms. Alice Turk and Stefanie Shattuck-Hufnagel outline a number of arguments in favour of an alternative to the Articulatory Phonology/Task Dynamics model. They demonstrate that a different framework is needed to account for evidence from speech and non-speech timing behaviour, and specifically that three separate planning components must be posited: Phonological Planning, Phonetic Planning, and Motor-Sensory Implementation. The approach proposed in the book provides a clearer and more comprehensive account of what is known about motor timing in general and speech timing in particular. It will be of interest to phoneticians and phonologists from all theoretical backgrounds as well as to speech clinicians and technologists.

This book is the second edition of Facet Theory and the Mapping Sentence: Evolving Philosophy, Use and Application (2014). It consolidates the qualitative and quantitative research positions of facet theory and delves deeper into their qualitative application in psychology, social and the behavioural sciences and in the humanities. In their traditional quantitative guise, facet theory and its mapping sentence incorporate multi-dimensional statistics. They are also a way of thinking systematically and thoroughly about the world. The book is particularly concerned with the development of the declarative mapping sentence as a tool and an approach to qualitative research. The evolution of the facet theory approach is presented along with many examples of its use in a wide variety of research domains. Since the first edition, the major advance in facet theory has been the formalization of the use of the declarative mapping sentence and this is given a prominent position in the new edition. The book will be compelling reading for students at all levels and for academics and research professionals from the humanities, social sciences and behavioural sciences.

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.

From economics and business to the biological sciences to physics and engineering, professionals successfully use the powerful mathematical tool of optimal control to make management and strategy decisions. Optimal Control Applied to Biological Models thoroughly develops the mathematical aspects of optimal control theory and provides insight into the application of this theory to biological models. Focusing on mathematical concepts, the book first examines the most basic problem for continuous time ordinary differential equations (ODEs) before discussing more complicated problems, such as variations of the initial conditions, imposed bounds on the control, multiple states and controls, linear dependence on the control, and free terminal time. In addition, the authors introduce the optimal control of discrete systems and of partial differential equations (PDEs). Featuring a user-friendly interface, the book contains fourteen interactive sections of various applications, including immunology and epidemic disease models, management decisions in harvesting, and resource allocation models. It also develops the underlying numerical methods of the applications and includes the MATLAB® codes on which the applications are based. Requiring only basic knowledge of multivariable calculus, simple ODEs, and mathematical models, this text shows how to adjust controls in biological systems in order to achieve proper outcomes.

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

This book discusses some of the innumerable ways in which computational methods can be used to facilitate research in biology and medicine - from storing enormous amounts of biological data to solving complex biological problems and enhancing treatment of various grave diseases.