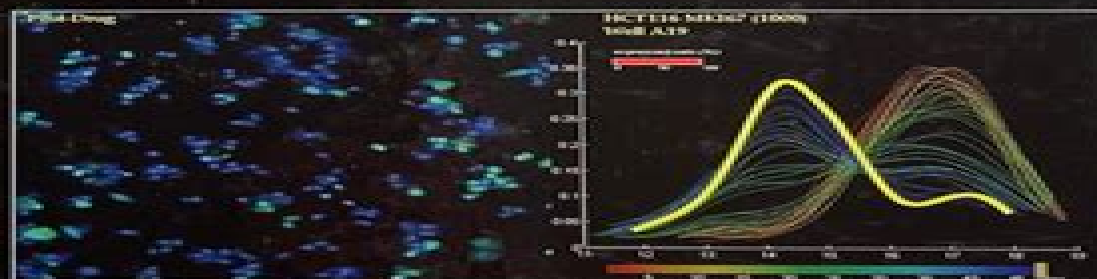


Epistemology of the Cell

A Systems Perspective on Biological Knowledge



EDWARD R. DOUGHERTY
MICHAEL L. BITTNER



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Epistemology Of The Cell A Systems Perspective On Biological Knowledge Ieee Press Series On Biomedical Engineering

**Martin Döring, Imme Petersen, Anne
Brüninghaus, Regine Kollek**



Epistemology Of The Cell A Systems Perspective On Biological Knowledge Ieee Press Series On Biomedical Engineering:

Epistemology of the Cell Edward R. Dougherty, Michael L. Bittner, 2011-08-17 Honorable mention Biomedicine and Neuroscience 2011 Prose Awards An examination of how the cell should be described in order to effectively process biological data The fruitful pursuit of biological knowledge requires one to take Einstein's admonition on science without epistemology as a practical demand for scientific research to recognize Waddington's characterization of the subject matter of biology and to embrace Wiener's conception of the form of biological knowledge in response to its subject matter It is from this vantage point that we consider the epistemology of the cell from the Preface In the era of high biological data throughput biomedical engineers need a more systematic knowledge of the cell in order to perform more effective data handling **Epistemology of the Cell** is the first authored book to break down this knowledge This text examines the place of biological knowledge within the framework of science as a whole and addresses issues focused on the specific nature of biology how biology is studied and how biological knowledge is translated into applications in particular with regard to medicine The book opens with a general discussion of the historical development of human understanding of scientific knowledge the scientific method and the manner in which scientific knowledge is represented in mathematics The narrative then gets specific for biology focusing on knowledge of the cell the basic unit of life The salient point is the analogy between a systems based analysis of factory regulation and the regulation of the cell Each chapter represents a key topic of current interest including Causality and randomness Translational science Stochastic validation classification Stochastic validation networks Model based experimentation in biology **Epistemology of the Cell** is written for biomedical researchers whose interests include bioinformatics biological modeling biostatistics and biological signal processing **Microbial genomics challenge Darwin** Didier Raoult, Eugene V. Koonin, The 200th anniversary of Darwin's birthday was celebrated in 2009 making the concept of Darwinism even more popular than at the time it was originally proposed to the extent that it has acquired quasi religious status His theory revolves around a Tree of Life in which all living organisms are considered to have descended from a single ancestor and each node represents a common ancestor It comprises hierarchy and dichotomy which are typical characteristics of the post biblical 19th century vision Indeed according to post modern philosophy also called the French theory the majority of theories including scientific ones are based only on meta narratives expressing the influence of a culture at a given time Buddhism or Hinduism may have generated a very different story of evolution Our way of thinking about life and the way we describe evolution have changed radically in the 21st century due to the genomic revolution Comparative genome analyses have demonstrated that gene repertoires are characterized by plasticity and there is strong evidence that nearly all genes have been exchanged at some point Genomic data show that the genetic information of living organisms is inherited not only vertically but also laterally Lateral gene transfers were at first observed only in bacteria

which contain genes originating from eukaryotes Archaea and viruses Such transfers were subsequently identified in all living organisms giant viruses have chimeric genomes and the human genome is a mosaic of genes with eukaryotic bacterial and viral origins We cannot identify a single common ancestor for the gene repertoire of any organism Furthermore a very high proportion of genes have been newly created through gene fusion or degradation and others show no homology to sequences found in other species It is now clear that every living organism has a variety of ancestors while exchanges between species are intense and the creation of new genes is frequent and permanent in all living organisms Our current genomic knowledge contradicts the tree of life theory as established by Darwin Recent analyses have produced bushes rather than resolved trees with the structure of some parts remaining elusive It becomes more and more obvious that phylogenetic relationships are better described by forests and networks and that species evolution looks more like a rhizome The chimerism and mosaic structure of all living organisms through both non vertical inheritance and de novo creation can only be assimilated and described by a post Darwinist concept In this Research Topic we wish to highlight the influence of microbiology and genomics on our understanding of the complexity of gene repertoires and also demonstrate how current knowledge does not support Darwin's theory Microbiology has offered a great advance in the way we perceive life Evidence obtained from studies on bacterial and viral evolution lateral inheritance phylogenetic trees and biodiversity continues to challenge what constituted until recently an unimpeded dogma in biology

Quantitative Assessment and Validation of Network Inference Methods in Bioinformatics Benjamin Haibe-Kains, Frank Emmert-Streib, 2015-04-14

Scientists today have access to an unprecedented arsenal of high tech tools that can be used to thoroughly characterize biological systems of interest High throughput omics technologies enable to generate enormous quantities of data at the DNA RNA epigenetic and proteomic levels One of the major challenges of the post genomic era is to extract functional information by integrating such heterogeneous high throughput genomic data This is not a trivial task as we are increasingly coming to understand that it is not individual genes but rather biological pathways and networks that drive an organism's response to environmental factors and the development of its particular phenotype In order to fully understand the way in which these networks interact or fail to do so in specific states disease for instance we must learn both the structure of the underlying networks and the rules that govern their behavior In recent years there has been an increasing interest in methods that aim to infer biological networks These methods enable the opportunity for better understanding the interactions between genomic features and the overall structure and behavior of the underlying networks So far such network models have been mainly used to identify and validate new interactions between genes of interest But ultimately one could use these networks to predict large scale effects of perturbations such as treatment by multiple targeted drugs However currently we are still at an early stage of comprehending methods and approaches providing a robust statistical framework to quantitatively assess the quality of network inference and its predictive potential The scope of this Research Topic in Bioinformatics and Computational Biology

aims at addressing these issues by investigating the various complementary approaches to quantify the quality of network models These validation techniques could focus on assessing quality of specific interactions global and local structures and predictive ability of network models These methods could rely exclusively on in silico evaluation procedures or they could be coupled with novel experimental designs to generate the biological data necessary to properly validate inferred networks

Who's Who in America, 1996 Marquis Who's Who, Inc,1995-09 We make very heavy use of WHO S WHO IN AMERICA in our library It s used daily to check biographical facts on people of distinction MARIE WATERS HEAD OF COLLECTION DEVELOPMENT UNIVERSITY OF CALIFORNIA AT LOS ANGELES Marquis Who s Who is proud to announce the Golden Anniversary 50th Edition of WHO S WHO IN AMERICA This the world s preeminent biographical resource keeps pace with a changing America with more than 17 500 new entries each year AND it speeds research with the Geographic Professional Indexes ANNUAL UPDATING enables Marquis Who s Who to bring users more new names to update more existing entries each year Every entry is selected researched to ensure the most current accurate biographical data for Who s Who users The Geographical Professional Indexes makes WHO S WHO IN AMERICA an even more useful research tool Now users can identify locate prospective partners new clients by profession in any of 38 categories as well as by country state or province or city Essential for quickly finding the entries you need More than 92 000 leaders decision makers innovators from every important field business finance government education science technology the arts more are profiled in this Golden Anniversary 50th Edition Entries include name occupation vital statistics parents marriage children education career civic political activities writings creative works awards professional memberships office address When you need authoritative accurate facts on our nation s leaders go to the preeminent record of American achievement that offers new information EVERY year Marquis WHO S WHO IN AMERICA

Error Estimation for Pattern Recognition Ulisses M. Braga Neto,Edward R. Dougherty,2015-06-17 This book is the first of its kind to discuss error estimation with a model based approach From the basics of classifiers and error estimators to distributional and Bayesian theory it covers important topics and essential issues pertaining to the scientific validity of pattern classification Error Estimation for Pattern Recognition focuses on error estimation which is a broad and poorly understood topic that reaches all research areas using pattern classification It includes model based approaches and discussions of newer error estimators such as bolstered and Bayesian estimators This book was motivated by the application of pattern recognition to high throughput data with limited replicates which is a basic problem now appearing in many areas The first two chapters cover basic issues in classification error estimation such as definitions test set error estimation and training set error estimation The remaining chapters in this book cover results on the performance and representation of training set error estimators for various pattern classifiers Additional features of the book include The latest results on the accuracy of error estimation Performance analysis of re substitution cross validation and bootstrap error estimators using analytical and simulation approaches Highly interactive computer based exercises and end

of chapter problems This is the first book exclusively about error estimation for pattern recognition Ulisses M Braga Neto is an Associate Professor in the Department of Electrical and Computer Engineering at Texas A M University USA He received his PhD in Electrical and Computer Engineering from The Johns Hopkins University Dr Braga Neto received an NSF CAREER Award for his work on error estimation for pattern recognition with applications in genomic signal processing He is an IEEE Senior Member Edward R Dougherty is a Distinguished Professor Robert F Kennedy 26 Chair and Scientific Director at the Center for Bioinformatics and Genomic Systems Engineering at Texas A M University USA He is a fellow of both the IEEE and SPIE and he has received the SPIE Presidents Award Dr Dougherty has authored several books including *Epistemology of the Cell A Systems Perspective on Biological Knowledge and Random Processes for Image and Signal Processing* Wiley IEEE Press

Philosophy of Systems Biology Sara Green, 2016-12-15 The emergence of systems biology raises many fascinating questions What does it mean to take a systems approach to problems in biology To what extent is the use of mathematical and computational modelling changing the life sciences How does the availability of big data influence research practices What are the major challenges for biomedical research in the years to come This book addresses such questions of relevance not only to philosophers and biologists but also to readers interested in the broader implications of systems biology for science and society The book features reflections and original work by experts from across the disciplines including systems biologists philosophers and interdisciplinary scholars investigating the social and educational aspects of systems biology In response to the same set of questions the experts develop and defend their personal perspectives on the distinctive character of systems biology and the challenges that lie ahead Readers are invited to engage with different views on the questions addressed and may explore numerous themes relating to the philosophy of systems biology This edited work will appeal to scholars and all levels from undergraduates to researchers and to those interested in a variety of scholarly approaches such as systems biology mathematical and computational modelling cell and molecular biology genomics systems theory and of course philosophy of biology

The Future of Scientific Practice Marta Bertolaso, 2015-10-06 Focusing on cell dynamics molecular medicine and robotics contributors explore the interplay between biological technological and theoretical ways of thinking The collection makes a strong contribution to current debates in the philosophy of science and the changing role of scientific practice

Philosophical Perspectives on the Engineering Approach in Biology Sune Holm, Maria Serban, 2020-06-07 *Philosophical Perspectives on the Engineering Approach in Biology* provides a philosophical examination of what has been called the most powerful metaphor in biology The machine metaphor The chapters collected in this volume discuss the idea that living systems can be understood through the lens of engineering methods and machine metaphors from both historical theoretical and practical perspectives In their contributions the authors examine questions about scientific explanation and methodology the interrelationship between science and engineering and the impact that the use of engineering metaphors in science may have for bioethics and science communication such as the worry that its wide

application reinforces public misconceptions of the nature of new biotechnology and biological life The book also contains an introduction that describes the rise of the machine analogy and the many ways in which it plays a central role in fundamental debates about e g design adaptation and reductionism in the philosophy of biology The book will be useful as a core reading for professionals as well as graduate and undergraduate students in courses of philosophy of science and for life scientists taking courses in philosophy of science and bioethics *The Role of Theory in Advancing 21st-Century Biology* National Research Council, Division on Earth and Life Studies, Board on Life Sciences, Committee on Defining and Advancing the Conceptual Basis of Biological Sciences in the 21st Century, 2008-02-22 Although its importance is not always recognized theory is an integral part of all biological research Biologists theoretical and conceptual frameworks inform every step of their research affecting what experiments they do what techniques and technologies they develop and use and how they interpret their data By examining how theory can help biologists answer questions like What are the engineering principles of life or How do cells really work the report shows how theory synthesizes biological knowledge from the molecular level to the level of whole ecosystems The book concludes that theory is already an inextricable thread running throughout the practice of biology but that explicitly giving theory equal status with other components of biological research could help catalyze transformative research that will lead to creative dynamic and innovative advances in our understanding of life

A Legacy for Living Systems Jesper Hoffmeyer, 2008-02-01 Gregory Bateson's contribution to 20th century thinking has appealed to scholars from a wide range of fields dealing in one way or another with aspects of communication and epistemology A number of his insights were taken up and developed further in anthropology psychology evolutionary biology and communication theory But the large trans disciplinary synthesis that in his own mind was his major contribution to science received little attention from the mainstream scientific communities This book represents a major attempt to revise this deficiency Scholars from ecology biochemistry evolutionary biology cognitive science anthropology and philosophy discuss how Bateson's thinking might lead to a fruitful reframing of central problems in modern science Most important perhaps Bateson's bioanthropology is shown to play a key role in developing the set of ideas explored in the new field of biosemiotics The idea that organismic life is indeed basically semiotic or communicative lies at the heart of the biosemiotic approach to the study of life The only book of its kind this volume provides a key resource for the quickly growing substratum of scholars in the biosciences philosophy and medicine who are seeking an elegant new approach to exploring highly complex systems

Principles of Biological Autonomy, a new annotated edition Francisco J. Varela, 2025-05-13 A new updated edition of the 1979 classic from one of the foremost authors in cognitive science and theoretical biology with the original text as well as more than 200 citations to current scientific developments Francisco Varela's *Principles of Biological Autonomy* was a groundbreaking text when it was first published in 1979 putting forth a novel theory of how living systems produce and maintain themselves This new edition edited and annotated by cognitive scientists Ezequiel Di Paolo and Evan Thompson

revised and complemented with introductory essays for each part of the book contains a wealth of ideas relevant to current projects in theoretical biology cognitive science systems theory philosophy of mind and philosophy of biology Over 220 margin annotations supplement the reading of the text linking to subsequent research and broader contemporary debates This foundational book introduces the key concept of autonomy derived as an elaboration of the idea of autopoiesis the self production and self distinction of living organisms Varela covers topics in systems theory neuroscience theories of perception and immune networks and offers a participatory epistemology that goes on to be further developed in later enactive literature These ideas are compelling not only for historical reasons but also because they still illuminate current efforts in developing the enactive approach toward wider and more challenging goals including language human cognition ethics and environmentalism

From Systems Biology to Systems Medicine James A. Marcum, 2020-07-09 Throughout most of the twentieth century the biomedical model dominated healthcare However the biomedical model had its critics who proposed alternative models to replace it Eventually biomedicine became fragmented at its foundations with a variety of approaches to its nature and practice Medicine's current response to this fragmentation is to combine these disparate approaches into a single system systems medicine In the present book I examine the shift during the postgenomics era from the biomedical model to systems medicine vis vis systems biology as well as the challenges facing systems medicine's implementation in the twenty first century The main goal of the present book is to provide a disciplinary framework for examining the rise of systems medicine especially in terms of the incorporation of systems biology into the biomedical model To realize that goal the following questions are addressed What is a disciplinary framework And why is this framework important for understanding systems biology and medicine Briefly a disciplinary framework represents the relational structure among disparate disciplines that support and ground a discipline and its corpus For traditional biology and medicine that framework consists of various disciplines within the biological and biomedical sciences including physiology neuroscience pathology and epidemiology to name a few For the present purpose systems biology within the last several decades is reshaping the disciplinary framework of the biological and biomedical sciences which is also responsible for the emergence of systems medicine In addition the challenges facing systems medicine especially its operationalization and implementation with respect to medical education and practice as well as research are also explored

Systems Biomedicine Edison T. Liu, Douglas A. Lauffenburger, 2009-09-17 Systems biology is a critical emerging field that quantifies and annotates the complexity of biological systems in order to construct algorithmic models to predict outcomes from component input Applications in medicine are revolutionizing our understanding of biological processes and systems Systems Biomedicine is organized around foundations computational modeling network biology and integrative biology with the extension of examples from human biology and pharmacology to focus on the applications of systems approaches to medical problems An integrative approach to the underlying genomic proteomic and computational biology principles provides researchers with

guidance in the use of qualitative systems and hypothesis generators To reflect the highly interdisciplinary nature of the field careful detail has been extended to ensure explanations of complex mathematical and biological principles are clear with minimum technical jargon Organized to reflect the important distinguishing characteristics of systems strategies in experimental biology and medicine Provides precise and comprehensive measurement tools for constructing a model of the system and tools for defining complexity as an experimental dependent variable Includes a thorough discussion of the applications of quantitative principles to biomedical problems

A Computational and Systems Biology Study

Carlo Vittorio Cannistraci, 2010 *Foundations of Biomedical Knowledge Representation* Arjen Hommersom, Peter J.F.

Lucas, 2016-02-03 Medicine and health care are currently faced with a significant rise in their complexity This is partly due to the progress made during the past three decades in the fundamental biological understanding of the causes of health and disease at the molecular sub cellular and organ level Since the end of the 1970s when knowledge representation and reasoning in the biomedical field became a separate area of research huge progress has been made in the development of methods and tools that are finally able to impact on the way medicine is being practiced Even though there are huge differences in the techniques and methods used by biomedical researchers there is now an increasing tendency to share research results in terms of formal knowledge representation methods such as ontologies statistical models network models and mathematical models As there is an urgent need for health care professionals to make better decisions computer based support using this knowledge is now becoming increasingly important It may also be the only way to integrate research results from the different parts of the spectrum of biomedical and clinical research The aim of this book is to shed light on developments in knowledge representation at different levels of biomedical application ranging from human biology to clinical guidelines and using different techniques from probability theory and differential equations to logic The book starts with two introductory chapters followed by 18 contributions organized in the following topical sections diagnosis of disease monitoring of health and disease and conformance assessment of health and personalization prediction and prognosis of health and disease treatment of disease and recommendations

Principles of Cellular Engineering

Michael R. King, 2011-04-28 This comprehensive work discusses novel biomolecular surfaces that have been engineered to either control or measure cell function at the atomic molecular and cellular levels Each chapter presents real results concepts and expert perspectives of how cells interact with biomolecular surfaces with particular emphasis on interactions within complex mechanical environments such as in the cardiovascular system In addition the book provides detailed coverage of inflammation and cellular immune response as a useful model for how engineering concepts and tools may be effectively applied to complex systems in biomedicine Accessible to biologists looking for new ways to model their results and engineers interested in biomedical applications Useful to researchers in biomaterials inflammation and vascular biology Excellent resource for graduate students as a textbook in cell tissue engineering or cell mechanics courses

Self-Modifying

Systems in Biology and Cognitive Science G. Kampis, 1991-04-30 The theme of this book is the self generation of information by the self modification of systems The author explains why biological and cognitive processes exhibit identity changes in the mathematical and logical sense This concept is the basis of a new organizational principle which utilizes shifts of the internal semantic relations in systems There are mathematical discussions of various classes of systems Turing machines input output systems synergetic systems non linear dynamics etc which are contrasted with the author's new principle The most important implications of this include a new conception on the nature of information and which also provides a new and coherent conceptual view of a wide class of natural systems This book merits the attention of all philosophers and scientists concerned with the way we create reality in our mathematical representations of the world and the connection those representations have with the way things really are Intelligent Systems Modeling and Decision Support in Bioengineering

Mahdi Mahfouf, 2006 Intelligent systems try to achieve through the use of computers flexible learning and adaptive activity like that found in the human brain For the first time this groundbreaking resource provides a detailed understanding of the analysis design and application of new intelligent systems in the biomedical industry

Contextualizing Systems Biology Martin Döring, Imme Petersen, Anne Brüninghaus, Regine Kollek, 2016-01-06 This collective monograph aims at contributing to an improved understanding of the epistemic presumptions sociocultural implications and historical backgrounds of the newly emerging and currently expanding approach of systems biology In doing so it offers empirically grounded valuable and reflexive information about a paradigmatic shift in the biosciences for a wide range of scientists working in the interdisciplinary areas of systems biology synthetic biology molecular biology biology the philosophy of science the sociology of science and scientific knowledge science and technology studies technology assessment and the like The authors of this monograph share the theoretical methodological premise that science is a culturally and socially embedded practice which characterizes our culture as a scientific one and at the same time draws its innovative potential from its socio cultural context This dialectic relationship lies at the heart of the current development of systems biology which is conceived as a so called successor of omics research and triggered by high throughput information technologies At the same time a need for a holistic conceptualization of complex biological processes emerges The title *Contextualizing Systems Biology* suggests that this book analyzes the development and advent of systems biology from different theoretical and methodological perspectives We investigate a variety of contexts ranging from the analysis of cognitive contexts such as basic theoretical concepts to regulative contexts policies to the concrete application of a systems biology in the socio scientific context of a European research project In empirically analyzing these different and interrelated layers and dimensions of systems biology the scope of the book goes beyond present attempts to investigate the advent of new approaches in the biological sciences as it frames and assesses systems biology from an interdisciplinary and integrated perspective **Computation in Cells and Tissues** R. Paton, Hamid Bolouri, W. Michael L. Holcombe, J. Howard

Parish, Richard Tateson, 2004-10-20 The field of biologically inspired computation has coexisted with mainstream computing since the 1930s and the pioneers in this area include Warren McCulloch Walter Pitts Robert Rosen Otto Schmitt Alan Turing John von Neumann and Norbert Wiener Ideas arising out of studies of biology have permeated algorithmics automata theory artificial intelligence graphics information systems and software design Within this context the biomolecular cellular and tissue levels of biological organisation have had a considerable inspirational impact on the development of computational ideas Such innovations include neural computing systolic arrays genetic and immune algorithms cellular automata artificial tissues DNA computing and protein memories With the rapid growth in biological knowledge there remains a vast source of ideas yet to be tapped This includes developments associated with biomolecular genomic enzymic metabolic signalling and developmental systems and the various impacts on distributed adaptive hybrid and emergent computation This multidisciplinary book brings together a collection of chapters by biologists computer scientists engineers and mathematicians who were drawn together to examine the ways in which the interdisciplinary displacement of concepts and ideas could develop new insights into emerging computing paradigms Funded by the UK Engineering and Physical Sciences Research Council EPSRC the CytoCom Network formally met on five occasions to examine and discuss common issues in biology and computing that could be exploited to develop emerging models of computation

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