

Principles Of Multiscale Modeling Princeton University

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CITA Complex Modelling - Mette Ramsgaard
Thomsen 2021-01-15

CITA Complex Modelling investigates the
infrastructures of architectural design models.

By questioning the tools for integrating information across the expanded digital design chain, the book asks how to support feedback between different scales of design engagement moving from material design, across design, simulation and analysis to specification and fabrication. The book conveys the findings of the Complex Modelling research project a five-year framing project supported by the Independent Research Fund Denmark. Undertaken at CITA, the Centre for Information Technology and Architecture, The Royal Danish Academy of Fine Arts, School of Architecture, Complex Modelling asks how new interdisciplinary methods for adaptive parametrisation, advanced simulation, machine learning and robotic fabrication can be orchestrated within novel workflows that expand the agency of architecture.

Top-Down Causation and Emergence - Jan Voosholz 2021-08-06

This book presents the latest research, conducted by leading philosophers and scientists

from various fields, on the topic of top-down causation. The chapters combine to form a unique, interdisciplinary perspective, drawing upon George Ellis's extensive research and novel perspectives on topics including downwards causation, weak and strong emergence, mental causation, biological relativity, effective field theory and levels in nature. The collection also serves as a Festschrift in honour of George Ellis' 80th birthday. The extensive and interdisciplinary scope of this book makes it vital reading for anyone interested in the work of George Ellis and current research on the topics of causation and emergence.

Emergence in Context - Robert C. Bishop
2022-06-20

Science, philosophy of science, and metaphysics have long been concerned with the question of how order, stability, and novelty are possible and how they happen. How can order come out of disorder? This book introduces a new account, contextual emergence, seeking to answer these

questions. The authors offer an alternative picture of the world with an alternative account of how novelty and order arise, and how both are possible. Contextual emergence is grounded primarily in the sciences as opposed to logic or metaphysics. It is both an explanatory and ontological account of emergence that gets beyond the impasse between “weak” and “strong” emergence in the emergence debates. It challenges the “foundationalist” or hierarchical picture of reality and emphasizes the ontological and explanatory fundamentality of multiscale stability conditions and their contextual constraints, often operating globally over interconnected, interdependent, and interacting entities and their multiscale relations. It also focuses on the conditions that make the existence, stability, and persistence of emergent systems and their states and observables possible. These conditions and constraints are irreducibly multiscale relations, so it is not surprising that scientific explanation

is often multiscale. Such multiscale conditions act as gatekeepers for systems to access modal possibilities (e.g., reducing or enhancing a system's degrees of freedom). Using examples from across the sciences, ranging from physics to biology to neuroscience and beyond, this book demonstrates that there is an empirically well-grounded, viable alternative to ontological reductionism coupled with explanatory anti-reductionism (weak emergence) and ontological disunity coupled with the impossibility of robust scientific explanation (strong emergence). Central metaphysics of science concerns are also addressed. *Emergence in Context: A Treatise in Twenty-First Century Natural Philosophy* is written primarily for philosophers of science, but also professional scientists from multiple disciplines who are interested in emergence and particularly in the metaphysics of science. *Geometry and Invariance in Stochastic Dynamics* - Stefania Ugolini 2021
This book grew out of the Random

Transformations and Invariance in Stochastic Dynamics conference held in Verona from the 25th to the 28th of March 2019 in honour of Sergio Albeverio. It presents the new area of studies concerning invariance and symmetry properties of finite and infinite dimensional stochastic differential equations. This area constitutes a natural, much needed, extension of the theory of classical ordinary and partial differential equations, where the reduction theory based on symmetry and invariance of such classical equations has historically proved to be very important both for theoretical and numerical studies and has given rise to important applications. The purpose of the present book is to present the state of the art of the studies on stochastic systems from this point of view, present some of the underlying fundamental ideas and methods involved, and to outline the main lines for future developments. The main focus is on bridging the gap between deterministic and stochastic approaches, with

the goal of contributing to the elaboration of a unified theory that will have a great impact both from the theoretical point of view and the point of view of applications. The reader is a mathematician or a theoretical physicist. The main discipline is stochastic analysis with profound ideas coming from Mathematical Physics and Lie Group Geometry. While the audience consists essentially of academicians, the reader can also be a practitioner with Ph.D., who is interested in efficient stochastic modelling.

Multiscale Simulations and Mechanics of Biological Materials - Shaofan Li 2013-03-19
Multiscale Simulations and Mechanics of Biological Materials A compilation of recent developments in multiscale simulation and computational biomaterials written by leading specialists in the field Presenting the latest developments in multiscale mechanics and multiscale simulations, and offering a unique viewpoint on multiscale modelling of biological

materials, this book outlines the latest developments in computational biological materials from atomistic and molecular scale simulation on DNA, proteins, and nano-particles, to mesoscale soft matter modelling of cells, and to macroscale soft tissue and blood vessel, and bone simulations. Traditionally, computational biomaterials researchers come from biological chemistry and biomedical engineering, so this is probably the first edited book to present work from these talented computational mechanics researchers. The book has been written to honor Professor Wing Liu of Northwestern University, USA, who has made pioneering contributions in multiscale simulation and computational biomaterial in specific simulation of drug delivery at atomistic and molecular scale and computational cardiovascular fluid mechanics via immersed finite element method. Key features: Offers a unique interdisciplinary approach to multiscale biomaterial modelling aimed at both accessible introductory

and advanced levels. Presents a breadth of computational approaches for modelling biological materials across multiple length scales (molecular to whole-tissue scale), including solid and fluid based approaches. A companion website for supplementary materials plus links to contributors' websites (www.wiley.com/go/li/multiscale)

Multiscale Methods - Jacob Fish 2010

Small scale features and processes occurring at nanometer and femtosecond scales have a profound impact on what happens at a larger scale and over an extensive period of time. The primary objective of this volume is to reflect the state-of-the-art in multiscale mathematics, modeling, and simulations and to address the following barriers: What is the information that needs to be transferred from one model or scale to another and what physical principles must be satisfied during the transfer of information? What are the optimal ways to achieve such transfer of information? How can variability of physical

parameters at multiple scales be quantified and how can it be accounted for to ensure design robustness? The multiscale approaches in space and time presented in this volume are grouped into two main categories: information-passing and concurrent. In the concurrent approaches various scales are simultaneously resolved, whereas in the information-passing methods the fine scale is modeled and its gross response is infused into the continuum scale. The issue of reliability of multiscale modeling and simulation tools which focus on a hierarchy of multiscale models and an a posteriori model of error estimation including uncertainty quantification, is discussed in several chapters. Component software that can be effectively combined to address a wide range of multiscale simulations is also described. Applications range from advanced materials to nanoelectromechanical systems (NEMS), biological systems, and nanoporous catalysts where physical phenomena operates across 12

orders of magnitude in time scales and 10 orders of magnitude in spatial scales. This volume is a valuable reference book for scientists, engineers and graduate students practicing in traditional engineering and science disciplines as well as in emerging fields of nanotechnology, biotechnology, microelectronics and energy.

Managing Complexity: Insights, Concepts, Applications - Dirk Helbing 2007-10-13

The essays and lectures collected in this book center around knowledge transfer from the complex-system sciences to applications in business, industry and society, as viewed from a broad perspective. The contributions aim to raise awareness across the spectrum to meet the increasing need to integrate lessons from complexity research into everyday planning, decision making, logistics or optimization procedures and forecasting. The writing has been largely kept non-technical.

Genomic Signal Processing - Ilya Shmulevich 2014-09-08

Genomic signal processing (GSP) can be defined as the analysis, processing, and use of genomic signals to gain biological knowledge, and the translation of that knowledge into systems-based applications that can be used to diagnose and treat genetic diseases. Situated at the crossroads of engineering, biology, mathematics, statistics, and computer science, GSP requires the development of both nonlinear dynamical models that adequately represent genomic regulation, and diagnostic and therapeutic tools based on these models. This book facilitates these developments by providing rigorous mathematical definitions and propositions for the main elements of GSP and by paying attention to the validity of models relative to the data. Ilya Shmulevich and Edward Dougherty cover real-world situations and explain their mathematical modeling in relation to systems biology and systems medicine. Genomic Signal Processing makes a major contribution to computational biology, systems biology, and

translational genomics by providing a self-contained explanation of the fundamental mathematical issues facing researchers in four areas: classification, clustering, network modeling, and network intervention.

Integrated Design of Multiscale, Multifunctional Materials and Products - David L. McDowell
2009-09-30

Integrated Design of Multiscale, Multifunctional Materials and Products is the first of its type to consider not only design of materials, but concurrent design of materials and products. In other words, materials are not just selected on the basis of properties, but the composition and/or microstructure is designed to satisfy specific ranged sets of performance requirements. This book presents the motivation for pursuing concurrent design of materials and products, thoroughly discussing the details of multiscale modeling and multilevel robust design and provides details of the design methods/strategies along with selected examples

of designing material attributes for specified system performance. It is intended as a monograph to serve as a foundational reference for instructors of courses at the senior and introductory graduate level in departments of materials science and engineering, mechanical engineering, aerospace engineering and civil engineering who are interested in next generation systems-based design of materials. First of its kind to consider not only design of materials, but concurrent design of materials and products Treatment of uncertainty via robust design of materials Integrates the "materials by design approach" of Olson/Ques Tek LLC with the "materials selection" approach of Ashby/Granta Distinguishes the processes of concurrent design of materials and products as an overall systems design problem from the field of multiscale modeling Systematic mathematical algorithms and methods are introduced for robust design of materials, rather than ad hoc heuristics--it is oriented towards a true systems

approach to design of materials and products *Introduction to Computational Science* - Angela B. Shiflet 2014-03-30 Computational science is an exciting new field at the intersection of the sciences, computer science, and mathematics because much scientific investigation now involves computing as well as theory and experiment. This textbook provides students with a versatile and accessible introduction to the subject. It assumes only a background in high school algebra, enables instructors to follow tailored pathways through the material, and is the only textbook of its kind designed specifically for an introductory course in the computational science and engineering curriculum. While the text itself is generic, an accompanying website offers tutorials and files in a variety of software packages. This fully updated and expanded edition features two new chapters on agent-based simulations and modeling with matrices, ten new project modules, and an additional module on diffusion.

Besides increased treatment of high-performance computing and its applications, the book also includes additional quick review questions with answers, exercises, and individual and team projects. The only introductory textbook of its kind—now fully updated and expanded Features two new chapters on agent-based simulations and modeling with matrices Increased coverage of high-performance computing and its applications Includes additional modules, review questions, exercises, and projects An online instructor's manual with exercise answers, selected project solutions, and a test bank and solutions (available only to professors) An online illustration package is available to professors

Multicomponent and Multiscale Systems - Juergen Geiser 2015-08-21

This book examines the latest research results from combined multi-component and multi-scale explorations. It provides theory, considers underlying numerical methods and presents

brilliant computational experimentation. Engineering computations featured in this monograph further offer particular interest to many researchers, engineers and computational scientists working in frontier modeling and applications of multicomponent and multiscale problems. Professor Geiser gives specific attention to the aspects of decomposing and splitting delicate structures and controlling decomposition and the rationale behind many important applications of multi-component and multi-scale analysis. Multicomponent and Multiscale Systems: Theory, Methods and Applications in Engineering also considers the question of why iterative methods can be powerful and more appropriate for well-balanced multiscale and multicomponent coupled nonlinear problems. The book is ideal for engineers and scientists working in theoretical and applied areas.

Multiscale Cancer Modeling - Thomas S. Deisboeck 2010-12-08

Cancer is a complex disease process that spans multiple scales in space and time. Driven by cutting-edge mathematical and computational techniques, in silico biology provides powerful tools to investigate the mechanistic relationships of genes, cells, and tissues. It enables the creation of experimentally testable hypotheses, the integration of data across scales, and the prediction of tumor progression and treatment outcome (in silico oncology). Drawing on an interdisciplinary group of distinguished international experts, *Multiscale Cancer Modeling* discusses the scientific and technical expertise necessary to conduct innovative cancer modeling research across scales. It presents contributions from some of the top in silico modeling groups in the United States and Europe. The ultimate goal of multiscale modeling and simulation approaches is their use in clinical practice, such as supporting patient-specific treatment optimization. This volume covers state-of-the-art methods of multiscale

cancer modeling and addresses the field's potential as well as future challenges. It encourages collaborations among researchers in various disciplines to achieve breakthroughs in cancer modeling.

Artificial Chemistries - Wolfgang Banzhaf
2015-07-17

An introduction to the fundamental concepts of the emerging field of Artificial Chemistries, covering both theory and practical applications. The field of Artificial Life (ALife) is now firmly established in the scientific world, but it has yet to achieve one of its original goals: an understanding of the emergence of life on Earth. The new field of Artificial Chemistries draws from chemistry, biology, computer science, mathematics, and other disciplines to work toward that goal. For if, as it has been argued, life emerged from primitive, prebiotic forms of self-organization, then studying models of chemical reaction systems could bring ALife closer to understanding the origins of life. In

Artificial Chemistries (ACs), the emphasis is on creating new interactions rather than new materials. The results can be found both in the virtual world, in certain multiagent systems, and in the physical world, in new (artificial) reaction systems. This book offers an introduction to the fundamental concepts of ACs, covering both theory and practical applications. After a general overview of the field and its methodology, the book reviews important aspects of biology, including basic mechanisms of evolution; discusses examples of ACs drawn from the literature; considers fundamental questions of how order can emerge, emphasizing the concept of chemical organization (a closed and self-maintaining set of chemicals); and surveys a range of applications, which include computing, systems modeling in biology, and synthetic life. An appendix provides a Python toolkit for implementing ACs.

Structure and Function of the Extracellular Matrix - Bela Suki 2021-12-06

Structure and Function of the Extracellular Matrix: A Multiscale Quantitative Approach introduces biomechanics and biophysics with applications to understand the biological function of the extracellular matrix in health and disease. A general multiscale approach is followed by investigating behavior from the scale of single molecules, through fibrils and fibers, to tissues of various organ systems. Through mathematical models and structural information, quantitative description of the extracellular matrix function is derived with tissue specific details. The book introduces the properties and organization of extracellular matrix components and quantitative models of the matrix, and guides the reader through predicting functional properties. This book integrates evolutionary biology with multiscale structure to quantitatively understand the function of the extracellular matrix. This approach allows a fresh look into normal functioning as well as the pathological

alterations of the extracellular matrix. Professor Suki's book is written to be useful to undergraduates, graduate students, and researchers interested in the quantitative aspects of the extracellular matrix. Researchers working in mechanotransduction, respiratory and cardiovascular mechanics, and multiscale biomechanics of tendon, cartilage, skin, and bone may also be interested in this book. Examines the evolutionary origins and consequences of the extracellular matrix Delivers the first book to quantitatively treat the extracellular matrix as a multiscale system Presents problems and a set of computational laboratory projects in various chapters to aid teaching and learning Provides an introduction to the properties and organization of the extracellular matrix components

Agricultural Internet of Things and Decision Support for Precision Smart Farming - Annamaria Castrignano 2020-01-09
Agricultural Internet of Things and Decision

Support for Smart Farming reveals how a set of key enabling technologies (KET) related to agronomic management, remote and proximal sensing, data mining, decision-making and automation can be efficiently integrated in one system. Chapters cover how KETs enable real-time monitoring of soil conditions, determine real-time, site-specific requirements of crop systems, help develop a decision support system (DSS) aimed at maximizing the efficient use of resources, and provide planning for agronomic inputs differentiated in time and space. This book is ideal for researchers, academics, post-graduate students and practitioners who want to embrace new agricultural technologies. Presents the science behind smart technologies for agricultural management Reveals the power of data science and how to extract meaningful insights from big data on what is most suitable based on individual time and space Proves how advanced technologies used in agriculture practices can become site-specific, locally

adaptive, operationally feasible and economically affordable

Research Challenges in Modeling and Simulation for Engineering Complex Systems - Richard

Fujimoto 2017-08-18

This illuminating text/reference presents a review of the key aspects of the modeling and simulation (M&S) life cycle, and examines the challenges of M&S in different application areas. The authoritative work offers valuable perspectives on the future of research in M&S, and its role in engineering complex systems. Topics and features: reviews the challenges of M&S for urban infrastructure, healthcare delivery, automated vehicle manufacturing, deep space missions, and acquisitions enterprise; outlines research issues relating to conceptual modeling, covering the development of explicit and unambiguous models, communication and decision-making, and architecture and services; considers key computational challenges in the execution of simulation models, in order to best

exploit emerging computing platforms and technologies; examines efforts to understand and manage uncertainty inherent in M&S processes, and how these can be unified under a consistent theoretical and philosophical foundation; discusses the reuse of models and simulations to accelerate the simulation model development process. This thought-provoking volume offers important insights for all researchers involved in modeling and simulation across the full spectrum of disciplines and applications, defining a common research agenda to support the entire M&S research community.

Humanizing Digital Reality - Klaas De Rycke

2017-09-15

This book aims at finding some answers to the questions: What is the influence of humans in controlling CAD and how much is human in control of its surroundings? How far does our reach as humans really go? Do the complex algorithms that we use for city planning

nowadays live up to their expectations and do they offer enough quality? How much data do we have and can we control? Are today's inventions reversing the humanly controlled algorithms into a space where humans are controlled by the algorithms? Are processing power, robots for the digital environment and construction in particular not only there to rediscover what we already knew and know or do they really bring us further into the fields of constructing and architecture? The chapter authors were invited speakers at the 6th Symposium "Design Modelling Symposium: Humanizing Digital Reality", which took place in Ensa-Versailles, France from 16 - 20 September 2017.

Multiscale Modelling and Simulation - Sabine Attinger 2012-12-06

In August 2003, ETHZ Computational Laboratory (CoLab), together with the Swiss Center for Scientific Computing in Manno and the Universit della Svizzera Italiana (USI), organized the Summer School in "Multiscale

Modelling and Simulation" in Lugano, Switzerland. This summer school brought together experts in different disciplines to exchange ideas on how to link methodologies on different scales. Relevant examples of practical interest include: structural analysis of materials, flow through porous media, turbulent transport in high Reynolds number flows, large-scale molecular dynamic simulations, ab-initio physics and chemistry, and a multitude of others. Though multiple scale models are not new, the topic has recently taken on a new sense of urgency. A number of hybrid approaches are now created in which ideas coming from distinct disciplines or modelling approaches are unified to produce new and computationally efficient techniques

Mathematical Modelling in Engineering & Human Behaviour 2018 - Lucas Jódar
2019-04-15

This book includes papers in cross-disciplinary applications of mathematical modelling: from

medicine to linguistics, social problems, and more. Based on cutting-edge research, each chapter is focused on a different problem of modelling human behaviour or engineering problems at different levels. The reader would find this book to be a useful reference in identifying problems of interest in social, medicine and engineering sciences, and in developing mathematical models that could be used to successfully predict behaviours and obtain practical information for specialised practitioners. This book is a must-read for anyone interested in the new developments of applied mathematics in connection with epidemics, medical modelling, social issues, random differential equations and numerical methods.

Numerical Analysis and Optimization -
Mehiddin Al-Baali 2021

This book gathers selected, peer-reviewed contributions presented at the Fifth International Conference on Numerical Analysis

and Optimization (NAO-V), which was held at Sultan Qaboos University, Oman, on January 6-9, 2020. Each chapter reports on developments in key fields, such as numerical analysis, numerical optimization, numerical linear algebra, numerical differential equations, optimal control, approximation theory, applied mathematics, derivative-free optimization methods, programming models, and challenging applications that frequently arise in statistics, econometrics, finance, physics, medicine, biology, engineering and industry. Many real-world, complex problems can be formulated as optimization tasks, and can be characterized further as large scale, unconstrained, constrained, non-convex, nondifferentiable or discontinuous, and therefore require adequate computational methods, algorithms and software tools. These same tools are often employed by researchers working in current IT hot topics, such as big data, optimization and other complex numerical algorithms in the cloud, devising

special techniques for supercomputing systems. This interdisciplinary view permeates the work included in this volume. The NAO conference series is held every three years at Sultan Qaboos University, with the aim of bringing together a group of international experts and presenting novel and advanced applications to facilitate interdisciplinary studies among pure scientific and applied knowledge. It is a venue where prominent scientists gather to share innovative ideas and know-how relating to new scientific methodologies, to promote scientific exchange, to discuss possible future cooperations, and to promote the mobility of local and young researchers.

Imitation of Rigor - Mark Wilson 2022-01-27

"Mark Wilson aims to reconnect analytic philosophy with the evolving practicalities within science from which many of its grander concerns originally sprang. He offers an alternative history of how the subject might have developed had the insights of its philosopher/scientist

forebears not been cast aside in the vain pursuit of 'ersatz rigor'"--

Toward Accessible Multilevel Modeling in Systems Biology - Carsten Maus 2013-09-30

Promoted by advanced experimental techniques for obtaining high-quality data and the steadily accumulating knowledge about the complexity of life, modeling biological systems at multiple interrelated levels of organization attracts more and more attention recently. Current approaches for modeling multilevel systems typically lack an accessible formal modeling language or have major limitations with respect to expressiveness. The aim of this thesis is to provide a comprehensive discussion on associated problems and needs and to propose a concrete solution addressing them. At first, several formal modeling approaches are examined regarding their suitability for describing biological models at multiple organizational levels. Thereby, diverse aspects are taken into account, such as the ability to describe dynamically changing

hierarchical model structures and how upward and downward causation between different levels can be expressed. Based on the results of this study, a domain-specific language concept is developed to facilitate multilevel modeling in systems biology. The presented approach combines a rule-based modeling paradigm with dynamically nested model structures, attributed entities, and flexibly constrained reaction rates. Its expressive power, accessibility, and general usefulness for describing biological multilevel models are illustrated with the help of two exemplary case studies.

Unconventional Computation and Natural Computation - Cristian S. Calude 2015-08-07

This book constitutes the refereed proceedings of the 14th International Conference on Unconventional Computation and Natural Computation, UCNC 2015, held in Auckland, New Zealand, in August/September 2015. The 16 revised full papers were carefully reviewed and selected from 38 submissions. The papers

cover a wide range of topics including among others molecular (DNA) computing; quantum computing; optical computing; chaos computing; physarum computing; computation in hyperbolic spaces; collision-based computing; cellular automata; neural computation; evolutionary computation; swarm intelligence; nature-inspired algorithms; artificial immune systems; artificial life; membrane computing; amorphous computing; computational systems biology; genetic networks; protein-protein networks; transport networks; synthetic biology; cellular (in vivo) computing; and computations beyond the Turing model and philosophical aspects of computing.

Multiscale Methods in Science and Engineering - Björn Engquist 2006-03-30

Multiscale problems naturally pose severe challenges for computational science and engineering. The smaller scales must be well resolved over the range of the larger scales. Challenging multiscale problems are very

common and are found in e.g. materials science, fluid mechanics, electrical and mechanical engineering. Homogenization, subgrid modelling, heterogeneous multiscale methods, multigrid, multipole, and adaptive algorithms are examples of methods to tackle these problems. This volume is an overview of current mathematical and computational methods for problems with multiple scales with applications in chemistry, physics and engineering.

Encyclopedia of Applied and Computational Mathematics - Björn Engquist 2016-12-16

EACM is a comprehensive reference work covering the vast field of applied and computational mathematics. Applied mathematics itself accounts for at least 60 per cent of mathematics, and the emphasis on computation reflects the current and constantly growing importance of computational methods in all areas of applications. EACM emphasizes the strong links of applied mathematics with major areas of science, such as physics,

chemistry, biology, and computer science, as well as specific fields like atmospheric ocean science. In addition, the mathematical input to modern engineering and technology form another core component of EACM.

[Principles of Multiscale Modeling](#) - Weinan E 2011-07-07

A systematic discussion of the fundamental principles, written by a leading contributor to the field.

Springer Handbook of Semiconductor Devices - Massimo Rudan 2022-11-10

This Springer Handbook comprehensively covers the topic of semiconductor devices, embracing all aspects from theoretical background to fabrication, modeling, and applications. Nearly 100 leading scientists from industry and academia were selected to write the handbook's chapters, which were conceived for professionals and practitioners, material scientists, physicists and electrical engineers working at universities, industrial R&D, and

manufacturers. Starting from the description of the relevant technological aspects and fabrication steps, the handbook proceeds with a section fully devoted to the main conventional semiconductor devices like, e.g., bipolar transistors and MOS capacitors and transistors, used in the production of the standard integrated circuits, and the corresponding physical models. In the subsequent chapters, the scaling issues of the semiconductor-device technology are addressed, followed by the description of novel concept-based semiconductor devices. The last section illustrates the numerical simulation methods ranging from the fabrication processes to the device performances. Each chapter is self-contained, and refers to related topics treated in other chapters when necessary, so that the reader interested in a specific subject can easily identify a personal reading path through the vast contents of the handbook.

Crowd Dynamics, Volume 1 - Livio Gibelli

2019-01-22

This volume explores the complex problems that arise in the modeling and simulation of crowd dynamics in order to present the state-of-the-art of this emerging field and contribute to future research activities. Experts in various areas apply their unique perspectives to specific aspects of crowd dynamics, covering the topic from multiple angles. These include a demonstration of how virtual reality may solve dilemmas in collecting empirical data; a detailed study on pedestrian movement in smoke-filled environments; a presentation of one-dimensional conservation laws with point constraints on the flux; a collection of new ideas on the modeling of crowd dynamics at the microscopic scale; and others. Applied mathematicians interested in crowd dynamics, pedestrian movement, traffic flow modeling, urban planning, and other topics will find this volume a valuable resource. Additionally, researchers in social psychology, architecture, and engineering may find this

information relevant to their work.

Principles of Data Mining and Knowledge

Discovery - Luc de Raedt 2003-06-30

This book constitutes the refereed proceedings of the 5th European Conference on Principles of Data Mining and Knowledge Discovery, PKDD 2001, held in Freiburg, Germany, in September 2001. The 40 revised full papers presented together with four invited contributions were carefully reviewed and selected from close to 100 submissions. Among the topics addressed are hidden Markov models, text summarization, supervised learning, unsupervised learning, demographic data analysis, phenotype data mining, spatio-temporal clustering, Web-usage analysis, association rules, clustering algorithms, time series analysis, rule discovery, text categorization, self-organizing maps, filtering, reinforcement learning, support vector machines, visual data mining, and machine learning.

Systems Medicine - 2020-08-24

Technological advances in generated molecular and cell biological data are transforming biomedical research. Sequencing, multi-omics and imaging technologies are likely to have deep impact on the future of medical practice. In parallel to technological developments, methodologies to gather, integrate, visualize and analyze heterogeneous and large-scale data sets are needed to develop new approaches for diagnosis, prognosis and therapy. *Systems Medicine: Integrative, Qualitative and Computational Approaches* is an innovative, interdisciplinary and integrative approach that extends the concept of systems biology and the unprecedented insights that computational methods and mathematical modeling offer of the interactions and network behavior of complex biological systems, to novel clinically relevant applications for the design of more successful prognostic, diagnostic and therapeutic approaches. This 3 volume work features 132 entries from renowned experts in the fields and

covers the tools, methods, algorithms and data analysis workflows used for integrating and analyzing multi-dimensional data routinely generated in clinical settings with the aim of providing medical practitioners with robust clinical decision support systems. Importantly the work delves into the applications of systems medicine in areas such as tumor systems biology, metabolic and cardiovascular diseases as well as immunology and infectious diseases amongst others. This is a fundamental resource for biomedical students and researchers as well as medical practitioners who need to need to adopt advances in computational tools and methods into the clinical practice. Encyclopedic coverage: 'one-stop' resource for access to information written by world-leading scholars in the field of Systems Biology and Systems Medicine, with easy cross-referencing of related articles to promote understanding and further research Authoritative: the whole work is authored and edited by recognized experts in

the field, with a range of different expertise, ensuring a high quality standard Digitally innovative: Hyperlinked references and further readings, cross-references and diagrams/images will allow readers to easily navigate a wealth of information

Feedback Systems - Karl Johan Åström
2021-02-02

The essential introduction to the principles and applications of feedback systems—now fully revised and expanded This textbook covers the mathematics needed to model, analyze, and design feedback systems. Now more user-friendly than ever, this revised and expanded edition of *Feedback Systems* is a one-volume resource for students and researchers in mathematics and engineering. It has applications across a range of disciplines that utilize feedback in physical, biological, information, and economic systems. Karl Åström and Richard Murray use techniques from physics, computer science, and operations

research to introduce control-oriented modeling. They begin with state space tools for analysis and design, including stability of solutions, Lyapunov functions, reachability, state feedback observability, and estimators. The matrix exponential plays a central role in the analysis of linear control systems, allowing a concise development of many of the key concepts for this class of models. Åström and Murray then develop and explain tools in the frequency domain, including transfer functions, Nyquist analysis, PID control, frequency domain design, and robustness. Features a new chapter on design principles and tools, illustrating the types of problems that can be solved using feedback Includes a new chapter on fundamental limits and new material on the Routh-Hurwitz criterion and root locus plots Provides exercises at the end of every chapter Comes with an electronic solutions manual An ideal textbook for undergraduate and graduate students Indispensable for researchers seeking a self-

contained resource on control theory
[Time-Domain Finite Element Methods for Maxwell's Equations in Metamaterials](#) - Jichun Li
2012-12-15

The purpose of this book is to provide an up-to-date introduction to the time-domain finite element methods for Maxwell's equations involving metamaterials. Since the first successful construction of a metamaterial with both negative permittivity and permeability in 2000, the study of metamaterials has attracted significant attention from researchers across many disciplines. Thanks to enormous efforts on the part of engineers and physicists, metamaterials present great potential applications in antenna and radar design, sub-wavelength imaging, and invisibility cloak design. Hence the efficient simulation of electromagnetic phenomena in metamaterials has become a very important issue and is the subject of this book, in which various metamaterial modeling equations are introduced

and justified mathematically. The development and practical implementation of edge finite element methods for metamaterial Maxwell's equations are the main focus of the book. The book finishes with some interesting simulations such as backward wave propagation and time-domain cloaking with metamaterials.

High-Dimensional Probability - Roman Vershynin
2018-09-30

High-dimensional probability offers insight into the behavior of random vectors, random matrices, random subspaces, and objects used to quantify uncertainty in high dimensions.

Drawing on ideas from probability, analysis, and geometry, it lends itself to applications in mathematics, statistics, theoretical computer science, signal processing, optimization, and more. It is the first to integrate theory, key tools, and modern applications of high-dimensional probability. Concentration inequalities form the core, and it covers both classical results such as Hoeffding's and Chernoff's inequalities and

modern developments such as the matrix Bernstein's inequality. It then introduces the powerful methods based on stochastic processes, including such tools as Slepian's, Sudakov's, and Dudley's inequalities, as well as generic chaining and bounds based on VC dimension. A broad range of illustrations is embedded throughout, including classical and modern results for covariance estimation, clustering, networks, semidefinite programming, coding, dimension reduction, matrix completion, machine learning, compressed sensing, and sparse regression.

Multiscale Signal Analysis and Modeling - Xiaoping Shen
2012-09-18

Multiscale Signal Analysis and Modeling presents recent advances in multiscale analysis and modeling using wavelets and other systems. This book also presents applications in digital signal processing using sampling theory and techniques from various function spaces, filter design, feature extraction and classification,

signal and image representation/transmission, coding, nonparametric statistical signal processing, and statistical learning theory.

Princeton Companion to Applied

Mathematics - Nicholas J. Higham 2015-09-09

The must-have compendium on applied mathematics This is the most authoritative and accessible single-volume reference book on applied mathematics. Featuring numerous entries by leading experts and organized thematically, it introduces readers to applied mathematics and its uses; explains key concepts; describes important equations, laws, and functions; looks at exciting areas of research; covers modeling and simulation; explores areas of application; and more. Modeled on the popular Princeton Companion to Mathematics, this volume is an indispensable resource for undergraduate and graduate students, researchers, and practitioners in other disciplines seeking a user-friendly reference book on applied mathematics. Features nearly

200 entries organized thematically and written by an international team of distinguished contributors Presents the major ideas and branches of applied mathematics in a clear and accessible way Explains important mathematical concepts, methods, equations, and applications Introduces the language of applied mathematics and the goals of applied mathematical research Gives a wide range of examples of mathematical modeling Covers continuum mechanics, dynamical systems, numerical analysis, discrete and combinatorial mathematics, mathematical physics, and much more Explores the connections between applied mathematics and other disciplines Includes suggestions for further reading, cross-references, and a comprehensive index

Multiscale Analysis and Nonlinear Dynamics

- Misha Meyer Pesenson 2013-09-13

Since modeling multiscale phenomena in systems biology and neuroscience is a highly interdisciplinary task, the editor of the book

invited experts in bio-engineering, chemistry, cardiology, neuroscience, computer science, and applied mathematics, to provide their perspectives. Each chapter is a window into the current state of the art in the areas of research discussed and the book is intended for advanced researchers interested in recent developments in these fields. While multiscale analysis is the major integrating theme of the book, its subtitle does not call for bridging the scales from genes to behavior, but rather stresses the unifying perspective offered by the concepts referred to in the title. It is believed that the interdisciplinary approach adopted here will be beneficial for all the above mentioned fields.

Uncertainty Quantification in Multiscale Materials Modeling - Yan Wang 2020-03-12
Uncertainty Quantification in Multiscale Materials Modeling provides a complete overview of uncertainty quantification (UQ) in computational materials science. It provides practical tools and methods along with examples

of their application to problems in materials modeling. UQ methods are applied to various multiscale models ranging from the nanoscale to macroscale. This book presents a thorough synthesis of the state-of-the-art in UQ methods for materials modeling, including Bayesian inference, surrogate modeling, random fields, interval analysis, and sensitivity analysis, providing insight into the unique characteristics of models framed at each scale, as well as common issues in modeling across scales.

Computational Multiscale Modeling of Fluids and Solids - Martin Oliver Steinhauser 2008

The idea of the book is to provide a comprehensive overview of computational physics methods and techniques, that are used for materials modeling on different length and time scales. Each chapter first provides an overview of the physical basic principles which are the basis for the numerical and mathematical modeling on the respective length-

scale. The book includes the micro-scale, the meso-scale and the macro-scale. The chapters follow this classification. The book will explain in detail many tricks of the trade of some of the most important methods and techniques that are used to simulate materials on the perspective levels of spatial and temporal resolution. Case studies are occasionally included to further illustrate some methods or theoretical considerations. Example applications for all techniques are provided, some of which are from the author's own contributions to some of the research areas. Methods are explained, if possible, on the basis of the original publications but also references to standard text books established in the various fields are mentioned.

Multiscale Modelling in Sheet Metal Forming - Dorel Banabic 2016-10-20

This book gives a unified presentation of the research performed in the field of multiscale modelling in sheet metal forming over the course of more than thirty years by the members

of six teams from internationally acclaimed universities. The first chapter is devoted to the presentation of some recent phenomenological yield criteria (BBC 2005 and BBC 2008) developed at the CERTETA center from the Technical University of Cluj-Napoca. An overview on the crystallographic texture and plastic anisotropy is presented in Chapter 2. Chapter 3 is dedicated to multiscale modelling of plastic anisotropy. The authors describe a new hierarchical multi-scale framework that allows taking into account the evolution of plastic anisotropy during sheet forming processes. Chapter 4 is focused on modelling the evolution of voids in porous metals with applications to forming limit curves and ductile fracture. The chapter details the steps needed for the development of dissipation functions and Gurson-type models for non-quadratic anisotropic plasticity criteria like BBC 2005 and those based on linear transformations. Chapter 5 describes advanced models for the prediction of

forming limit curves developed by the authors. Chapter 6 is devoted to anisotropic damage in elasto-plastic materials with structural defects. Finally, Chapter 7 deals with modelling of the Portevin-Le Chatelier (PLC) effect. This volume contains contributions from leading researchers from the Technical University of Cluj-Napoca, Romania, the Catholic University of Leuven, Belgium, Clausthal University of Technology, Germany, Amirkabir University of Technology, Iran, the University of Bucharest, Romania, and the Institute of Mathematics of the Romanian Academy, Romania. It will prove useful to postgraduate students, researchers and engineers who are interested in the mechanical modeling and numerical simulation of sheet metal forming processes.

Physical Metallurgy - David E. Laughlin

2014-07-24

This fifth edition of the highly regarded family of

titles that first published in 1965 is now a three-volume set and over 3,000 pages. All chapters have been revised and expanded, either by the fourth edition authors alone or jointly with new co-authors. Chapters have been added on the physical metallurgy of light alloys, the physical metallurgy of titanium alloys, atom probe field ion microscopy, computational metallurgy, and orientational imaging microscopy. The books incorporate the latest experimental research results and theoretical insights. Several thousand citations to the research and review literature are included. Exhaustively synthesizes the pertinent, contemporary developments within physical metallurgy so scientists have authoritative information at their fingertips Replaces existing articles and monographs with a single, complete solution Enables metallurgists to predict changes and create novel alloys and processes