

The Computational Beauty Of Nature Computer Explorations Of Fractals Chaos Complex Systems And Adaptation

For centuries scientists have tried to understand the growth and development of multicellular organisms. More recently, with the help of mathematical models and computerized simulations, they have discovered algorithmic patterns and models that seem to describe the dynamic processes in which organisms grow, reproduce, and respond to external factors. In this fascinating and beautifully illustrated book, Hans Meinhardt explains and illustrates these structural growth patterns in the case of sea shells. The book delightfully conveys the intuitive appeal and the "touch of magic" in this research. A diskette packaged with the book contains a program that allows the reader to run the simulations on a PC. New patterns can be generated interactively to provide an insight into the process of biological pattern formation.

Anthony O'Hear takes a stand against the fashion for explaining human behaviour in terms of evolution. He maintains, controversially, that while the theory of evolution is successful in explaining the development of the natural world in general, it is of limited value when applied to the human world. Because of our reflectiveness and our rationality we take on goals and ideals which cannot be justified in terms of survival-promotion or reproductive advantage. O'Hear examines the nature of human self-consciousness, and argues that evolutionary theory cannot give a satisfactory account of such distinctive facets of human life as the quest for knowledge, moral sense, and the appreciation of beauty; in these we transcend our biological origins. It is our rationality that allows each of us to go beyond not only our biological but also our cultural inheritance: as the author says in the Preface, 'we are prisoners neither of our genes nor of the ideas we encounter as we each make our personal and individual way through life'.

For much of human evolution, the natural world was one of the most important contexts of children's maturation. Indeed, the experience of nature was, and still may be, a critical component of human physical, emotional, intellectual, and even moral development. Yet scientific knowledge of the significance of nature during the different stages of childhood is sparse. This book provides scientific investigations and thought-provoking essays on children and nature. Children and Nature incorporates research from cognitive science, developmental psychology, ecology, education, environmental studies, evolutionary psychology, political science, primatology, psychiatry, and social psychology. The authors examine the evolutionary significance of nature during childhood; the formation of children's conceptions, values, and sympathies toward the natural world; how contact with nature affects children's physical and mental development; and the educational and political consequences of the weakened childhood experience of nature in modern society.

Now available in an affordable softcover edition, this classic in Springer's acclaimed Virtual Laboratory series is the first comprehensive account of the computer simulation of plant development. 150 illustrations, one third of them in colour, vividly demonstrate the spectacular results of the algorithms used to model plant shapes and developmental processes. The latest in computer-generated images allow us to look at plants growing, self-replicating, responding to external factors and even mutating, without becoming entangled in the underlying mathematical formulae involved. The authors place particular emphasis on Lindenmayer systems - a notion conceived by one of the authors, Aristid Lindenmayer, and internationally recognised for its exceptional elegance in modelling biological phenomena. Nonetheless, the two authors take great care to present a survey of alternative methods for plant modelling.

A Computer Algebra Approach

The Beauty of Fractals
The Fabric of Reality
Sync
Human Nature and the Limits of Evolutionary Explanation

Computer Explorations of Fractals, Chaos, Complex Systems, and Adaptation

More physicists today are taking on the role of software developer as part of their research, but software development isn't always easy or obvious, even for physicists. This practical book teaches essential software development skills to help you automate and accomplish nearly any aspect of research in a physics-based field. Written by two PhDs in nuclear engineering, this book includes practical examples drawn from a working knowledge of physics concepts. You'll learn how to use the Python programming language to perform everything from collecting and analyzing data to building software and publishing your results. In four parts, this book includes: Getting Started: Jump into Python, the command line, data containers, functions, flow control and logic, and classes and objects Getting It Done: Learn about regular expressions, analysis and visualization, NumPy, storing data in files and HDF5, important data structures in physics, computing in parallel, and deploying software Getting It Right: Build pipelines and software, learn to use local and remote version control, and debug and test your code Getting It Out There: Document your code, process and publish your findings, and collaborate efficiently; dive into software licenses, ownership, and copyright procedures At the heart of the universe is a steady, insistent beat, the sound of cycles in sync. Along the tidal rivers of Malaysia, thousands of fireflies congregate and flash in unison; the moon spins in perfect resonance with its orbit around the earth; our hearts depend on the synchronous firing of ten thousand pacemaker cells. While the forces that synchronize the flashing of fireflies may seem to have nothing to do with our heart cells, there is in fact a deep connection. Synchrony is a science in its infancy, and Strogatz is a pioneer in this new frontier in which mathematicians and physicists attempt to pinpoint just how spontaneous order emerges from chaos. From underground caves in Texas where a French scientist spent six months alone tracking his sleep-wake cycle, to the home of a Dutch physicist who in 1665 discovered two of his pendulum clocks swinging in perfect time, this fascinating book spans disciplines, continents, and centuries. Engagingly written for readers of books such as Chaos and The Elegant Universe, Sync is a tour-de-force of nonfiction writing.

The acclaimed science writer icurates a visually striking, riotously colorful photographic display of physical patterns in the natural world (Publishers Weekly, starred review). Though at first glance the natural world may appear overwhelming in its diversity and complexity, there are regularities running through it, from the hexagons of a honeycomb to the spirals of a seashell and the branching veins of a leaf. Revealing the order at the foundation of the seemingly chaotic natural world, Patterns in Nature explores not only the math and science but also the beauty and artistry behind nature's awe-inspiring designs. Unlike the patterns we create, natural patterns are formed spontaneously from the forces that act in the physical world. Very often the same types of pattern and forms—such as spirals, stripes, branches, and fractals—recur in places that seem to have nothing in common, as when the markings of a zebra mimic the ripples in windblown sand. But many of these patterns can be described using the same mathematical and physical principles, giving a surprising unity to the kaleidoscope of the natural world. Richly illustrated with 250 color photographs and anchored by accessible and insightful chapters by esteemed science writer Philip Ball, Patterns in Nature reveals the organization at work in vast and ancient forests, powerful rivers, massing clouds, and coastlines carved out by the sea. By exploring similarities such as the branches of a tree and those of a river network, this spectacular visual tour conveys the wonder, beauty, and richness of natural pattern formation.

For students with a background in elementary algebra, this book provides a vivid introduction to the key phenomena and ideas of chaos and fractals, including the butterfly effect, strange attractors, fractal dimensions, Julia Sets and the Mandelbrot Set, power laws, and cellular automata. The book includes over 200 end-of-chapter exercises.

The Beauty of Mathematics in Computer Science
Clever Algorithms
Solving Evolution's Greatest Puzzle
The Nature of Physical Computation
Computational Beauty of Nature
Patterns in Nature
The Nature of Computation

"Computing systems are everywhere today. Even the brain is thought to be a sort of computing system. But what does it mean to say that a given organ or system computes? What is it about laptops, smartphones, and nervous systems that they are deemed to compute, and why does it seldom occur to us to describe stomachs, hurricanes, rocks, or chairs that way? The book provides an extended argument for the semantic view of computation, which states that semantic properties are involved in the nature of computing systems. Laptops, smartphones, and nervous systems compute because they are accompanied by representations. Stomachs, hurricanes, and rocks, for instance, which do not have semantic properties, do not compute. The first part of the book argues that the linkage between the mathematical theory of computability and the notion of physical computation is weak. Theoretical notions such as algorithms, effective procedure, program, and automaton play only a minor role in identifying physical computation. The second part of the book reviews three influential accounts of physical computation and argues that while none of these accounts is satisfactory, each of them highlights certain key features of physical computation. The final part of the book develops and argues for a semantic account of physical computation and offers a characterization of computational explanations"—

This book provides a handbook of algorithmic recipes from the fields of Metaheuristics, Biologically Inspired Computation and Computational Intelligence that have been described in a complete, consistent, and centralized manner. These standardized descriptions were carefully designed to be accessible, usable, and understandable. Most of the algorithms described in this book were originally inspired by biological and natural systems, such as the adaptive capabilities of genetic evolution and the acquired immune system, and the foraging behaviors of birds, bees, ants and bacteria. An encyclopedic algorithm reference, this book is intended for research scientists, engineers, students, and interested amateurs. Each algorithm description provides a working code example in the Ruby Programming Language.

This engaging collection of essays locates the debate between theism and naturalism in the broader context of reflection on imagination and aesthetics. The eleven original essays will be of interest to anyone who is fascinated by the power of imagination and the role of aesthetics in deciding between worldviews or philosophies of nature.

An introduction to computational complexity theory, its connections with mathematics, and its central role in the natural and social sciences, technology, and philosophy Mathematics and Computation provides a broad, conceptual overview of computational complexity theory—the mathematical study of efficient computation. With important practical applications to computer science and industry, computational complexity theory has evolved into a highly interdisciplinary field, with strong links to most mathematical areas and to a growing number of scientific endeavors. Avi Wigderson takes a sweeping survey of complexity theory, emphasizing the field's insights and challenges. He explains the ideas and motivations leading to key models, notions, and results. In particular, he looks at algorithms and complexity, computations and proofs, randomness and interaction, quantum and arithmetic computation, and cryptography and learning, all as parts of a cohesive whole with numerous cross-influences. Wigderson illustrates the immense breadth of the field, its beauty and richness, and its diverse and growing interactions with other areas of mathematics. He ends with a comprehensive look at the theory of computation, its methodology and aspirations, and the unique and fundamental ways in which it has shaped and will further shape science, technology, and society. For further reading, an extensive bibliography is provided for all topics covered. Mathematics and Computation is useful for undergraduate and graduate students in mathematics, computer science, and related fields, as well as researchers and teachers in these fields. Many parts require little background, and serve as an invitation to newcomers seeking an introduction to the theory of computation. Comprehensive coverage of computational complexity theory, and beyond High-level, intuitive exposition, which brings conceptual clarity to this central and dynamic scientific discipline Historical accounts of the evolution and motivations of central concepts and models A broad view of the theory of computation's influence on science, technology, and society Extensive bibliography Adaptation and the Future of Human Life

Puzzles in Logic, Languages and Computation

The Red Book

Modeling Complex Systems

The Beauty of Chemistry

Computational Geometry

Chaos and Fractals

How can we capture the unpredictable evolutionary and emergent properties of nature in software? How can understanding the mathematical principles behind our physical world help us to create digital worlds? This book focuses on a range of programming strategies and techniques behind computer simulations of natural systems, from elementary concepts in mathematics and physics to more advanced algorithms that enable sophisticated visual results. Readers will progress from building a basic physics engine to creating intelligent moving objects and complex systems, setting the foundation for further experiments in generative design. Subjects covered include forces, trigonometry, fractals, cellular automata, self-organization, and genetic algorithms. The book's examples are written in Processing, an open-source language and development environment built on top of the Java programming language. On the book's website (<http://www.natureofcode.com>), the examples run in the browser via Processing's JavaScript mode.

Fractals and chaos theory lead to startling graphics in this book by a renowned scientist, inventor, and artist, who coordinates information from disparate fields. Over 275 illustrations, 29 in color.

First-ever comprehensive introduction to the major new subject of quantum computing and quantum information.

"Contains numerous simple examples and illustrative diagrams....For anyone seeking information about eigenvalue inclusion theorems, this book will be a great reference." --Mathematical Reviews This book studies the original results, and their extensions, of the Russian mathematician S.A. Geršgorin who wrote a seminal paper in 1931 on how to easily obtain estimates of all n eigenvalues (characteristic values) of any given n-by-n complex matrix.

Algorithms and Applications

Oxford Textbook of Nature and Public Health

The Truth of Ecology

Children and Nature

Rational Algebraic Curves

How the Mind Works

An Elementary Introduction

Computational complexity is one of the most beautiful fields of modern mathematics, and it is increasingly relevant to other sciences ranging from physics to biology. But this beauty is often buried underneath layers of unnecessary formalism, and exciting recent results like interactive proofs, phase transitions, and quantum computing are usually considered too advanced for the typical student. This book bridges these gaps by explaining the deep ideas of theoretical computer science in a clear and enjoyable fashion, making them accessible to non-computer scientists and to computer scientists who finally want to appreciate their field from a new point of view. The authors start with a lucid and playful explanation of the P vs. NP problem, explaining why it is so fundamental, and so hard to resolve. They then lead the reader through the complexity of mazes and games; optimization in theory and practice; randomized algorithms, interactive proofs, and pseudorandomness; Markov chains and phase transitions; and the outer reaches of quantum computing. At every turn, they use a minimum of formalism, providing explanations that are both deep and accessible. The book is intended for graduate and undergraduate students, scientists from other areas who have long wanted to understand this subject, and experts who want to fall in love with this field all over again.

"Natural selection can preserve innovations, but it cannot create them. Nature's many innovations—some uncannily perfect—call for natural principles that accelerate life's ability to innovate." Darwin's theory of natural selection explains how useful adaptations are preserved over time. But the biggest mystery about evolution eluded him. As genetics pioneer Hugo de Vries put it, "natural selection may explain the survival of the fittest, but it cannot explain the arrival of the fittest." Can random mutations over a mere 3.8 billion years really be responsible for wings, eyeballs, knees, camouflage, lactose digestion, photosynthesis, and the rest of nature's creative marvels? And if the answer is no, what is the mechanism that explains evolution's speed and efficiency? In Arrival of the Fittest, renowned evolutionary biologist Andreas Wagner draws on over fifteen years of research to present the missing piece in Darwin's theory. Using experimental and computational technologies that were heretofore unimagined, he has found that adaptations are not just driven by chance, but by a set of laws that allow nature to discover new molecules and mechanisms in a fraction of the time that random variation would take. Consider the Arctic cod, a fish that lives and thrives within six degrees of the North Pole, in waters that regularly fall below 0 degrees. At that temperature, the internal fluids of most organisms turn into ice crystals. And yet, the arctic cod survives by producing proteins that lower the freezing temperature of its body fluids, much like antifreeze does for a car's engine coolant. The invention of those proteins is an archetypal example of nature's enormous powers of creativity. Meticulously researched, carefully argued, evocatively written, and full of fascinating examples from the animal kingdom, Arrival of the Fittest offers up the final puzzle piece in the mystery of life's rich diversity.

A wide-ranging appraisal of environmental thought. It explores such topics as the history of ecology, radical science studies and ecology, the need for greater theoretical sophistication in ecocriticism, the dubious legacy of Thoreau, and the contradictions of contemporary nature writing.

This is the first volume of a unique collection that brings together the best English-language problems created for students competing in the Computational Linguistics Olympiad. These problems are representative of the diverse areas presented in the competition and designed with three principles in mind: · To challenge the student analytically, without requiring any explicit knowledge or experience in linguistics or computer science; · To expose the student to the different kinds of reasoning required when encountering a new phenomenon in a language, both as a theoretical topic and as an applied problem; · To foster the natural curiosity students have about the workings of their own language, as well as to introduce them to the beauty and structure of other languages; · To learn about the models and techniques used by computers to understand human language. Aside from being a fun intellectual challenge, the Olympiad mimics the skills used by researchers and scholars in the field of computational linguistics. In an increasingly global economy where businesses operate across borders and languages, having a strong pool of computational linguists is a competitive advantage, and an important component to both security and growth in the 21st century. This collection of problems is a wonderful general introduction to the field of linguistics through the analytic problem solving technique. "A fantastic collection of problems for anyone who is curious about how human language works! These books take serious scientific questions and present them in a fun, accessible way. Readers exercise their logical thinking capabilities while learning about a wide range of human languages, linguistic phenomena, and computational models. " - Kevin Knight, USC Information Sciences Institute

Geršgorin and His Circles

Information—Consciousness—Reality

Mathematics and Computation

Art, Wonder, and Science

The Computational Beauty of Nature

Psychological, Sociocultural, and Evolutionary Investigations

Turning Images in Philosophy, Science, and Religion

The Beauty of Mathematics in Computer Science explains the mathematical fundamentals of information technology products and services we use every day, from Google Web Search to GPS Navigation, and from speech recognition to CDMA mobile services. The book was published in Chinese in 2011 and has sold more than 600,000 copies. Readers were surprised to find that many daily-used IT technologies were so tightly tied to mathematical principles. For example, the automatic classification of news articles uses the cosine law taught in high school. The book covers many topics related to computer applications and applied mathematics including: Natural language processing Speech recognition and machine translation Statistical language modeling Quantitive measurement of information Graph theory and web crawler Pagerank for web search Matrix operation and document classification Mathematical background of big data Neural networks and Google's deep learning Jun Wu was a staff research scientist in Google who invented Google's Chinese, Japanese, and Korean Web Search Algorithms and was responsible for many Google machine learning projects. He wrote official blogs introducing Google technologies behind its products in very simple languages for Chinese Internet users from 2006-2010. The blogs had more than 2 million followers. Wu received PhD in computer science from Johns Hopkins University and has been working on speech recognition and natural language processing for more than 20 years. He was one of the earliest engineers of Google, managed many products of the company, and was awarded 19 US patents during his 10-year tenure there. Wu became a full-time VC investor and co-founded Amino Capital in Palo Alto in 2014 and is the author of eight books.

An extraordinary and challenging synthesis of ideas uniting Quantum Theory, and the theories of Computation, Knowledge and Evolution, Deutsch's extraordinary book explores the deep connections between these strands which reveal the fabric of realityin which human actions and ideas play essential roles.

This introduction to computational geometry focuses on algorithms. Motivation is provided from the application areas as all techniques are related to particular applications in robotics, graphics, CAD/CAM, and geographic information systems. Modern insights in computational geometry are used to provide solutions that are both efficient and easy to understand and implement.

Presenting a theory of the theoryless, a computer scientist provides a model of how effective behavior can be learned even in a world as complex as our own, shedding new light on human nature.

A New Book of Nature

Images of Complex Dynamical Systems

How a New Understanding of the Universe Can Help Answer Age-Old Questions of Existence

The role of nature in improving the health of a population

Quantum Computation and Quantum Information

Designing Beauty: The Art of Cellular Automata

Nature, Culture, and Literature in America

This book illustrates how models of complex systems are built up and provides indispensable mathematical tools for studying their dynamics. This second edition includes more recent research results and many new and improved worked out examples and exercises.

The Computational Beauty of NatureComputer Explorations of Fractals, Chaos, Complex Systems, and AdaptationMIT Press

This fascinating, colourful book offers in-depth insights and first-hand working experiences in the production of art works, using simple computational models with rich morphological behaviour, at the edge of mathematics, computer science, physics and biology. It organically combines ground breaking scientific discoveries in the theory of computation and complex systems with artistic representations of the research results. In this appealing book mathematicians, computer scientists, physicists, and engineers brought together marvelous and esoteric patterns generated by cellular automata, which are arrays of simple machines with complex behavior. Configurations produced by cellular automata uncover mechanics of dynamic patterns formation, their propagation and interaction in natural systems: heart pacemaker, bacterial membrane proteins, chemical rectors, water permeation in soil, compressed gas, cell division, population dynamics, reaction-diffusion media and self-organisation. The book inspires artists to take on cellular automata as a tool of creativity and it persuades scientists to convert their research results into the works of art. The book is lavishly illustrated with visually attractive examples, presented in a lively and easily accessible manner.

Now approaching its tenth year, this hugely successful book presents an unusual attempt to publicise the field of Complex Dynamics. The text was originally conceived as a supplemented catalogue to the exhibition "Frontiers of Chaos", seen in Europe and the United States, and describes the context and meaning of these fascinating images. A total of 184 illustrations - including 88 full-colour pictures of Julia sets - are suggestive of a coffee-table book. However, the invited contributions which round off the book lend the text the required formality. Benoit Mandelbrot gives a very personal account, in his idiosyncratic self-centred style, of his discovery of the fractals named after him and Adrien Douady explains the solved and unsolved problems relating to this amusingly complex set.

Computers, Pattern, Chaos and Beauty

Computational Analysis of Storylines

Field Guide to Research with Python

Arrival of the Fittest

The Algorithmic Beauty of Seaweeds, Sponges and Corals

A Theory Revolutionizing Technology and Science

Beyond Evolution

With contributions by E.Abraham, D.Barnes, R.Carpenter, L.Collado, P.Dodds, S.Dudgeon, D.Garbary, S.Gatti, B.Helmuth, M.R.Koehl, H.Lasker, R.Merks., W.Müller, S.Muko, B. Rinkevich, J.Sanchez, P.Sloot, M.Vermeij

Images and text capture the astonishing beauty of the chemical processes that create snowflakes, bubbles, flames, and other wonders of nature. Chemistry is not just about microscopic atoms doing inscrutable things; it is the process that makes flowers and galaxies. We rely on it for bread-baking, vegetable-growing, and producing the materials of daily life. In stunning images and illuminating text, this book captures chemistry as it unfolds. Using such techniques as microphotography, time-lapse photography, and infrared thermal imaging, The Beauty of Chemistry shows us how chemistry underpins the formation of snowflakes, the science of champagne, the colors of flowers, and other wonders of nature and technology. We see the marvelous configurations of chemical gardens; the amazing transformations of evaporation, distillation, and precipitation; heat made visible; and more.

Human beings have always been affected by their surroundings. There are various health benefits linked to being able to access to nature; including increased physical activity, stress recovery, and the stimulation of child cognitive development. The Oxford Textbook of Nature and Public Health provides a broad and inclusive picture of the relationship between our own health and the natural environment. All aspects of this unique relationship are covered, ranging from disease prevention through physical activity in green spaces to innovative ecosystem services, such as climate change adaptation by urban trees. Potential hazardous consequences are also discussed including natural disasters, vector-borne pathogens, and allergies. This book analyses the complexity of our human interaction with nature and includes sections for example epigenetics, stress physiology, and impact assessments. These topics are all interconnected and fundamental for reaching a full understanding of the role of nature in public health and wellbeing. Much of the recent literature on environmental health has primarily described potential threats from our natural surroundings. The Oxford Textbook of Nature and Public Health instead focuses on how nature can positively impact our health and wellbeing, and how much we risk losing by destroying it. The all-inclusive approach provides a comprehensive and complete coverage of the role of nature in public health, making this textbook invaluable reading for health professionals, students, and researchers within public health, environmental health, and complementary medicine.

The central problem considered in this introduction for graduate students is the determination of rational parametrizability of an algebraic curve and, in the positive case, the computation of a good rational parametrization. This amounts to determining the genus of a curve: its complete singularity structure, computing regular points of the curve in small coordinate fields, and constructing linear systems of curves with prescribed intersection multiplicities. The book discusses various optimality criteria for rational parametrizations of algebraic curves.

Probably Approximately Correct

How Order Emerges from Chaos In the Universe, Nature, and Daily Life

Technological Nature

Why the Natural World Looks the Way It Does

The Algorithmic Beauty of Sea Shells

Nature-inspired Programming Recipes

Effective Computation in Physics

An assessment of human thought and behavior explores conundrums from the mind's ability to perceive three dimensions to the nature of consciousness, in an account that draws on beliefs in cognitive science and evolutionary biology.

By applying research in artificial intelligence to problems in the philosophy of science, Paul Thagard develops an exciting new approach to the study of scientific reasoning. This approach uses computational ideas to shed light on how scientific theories are discovered, evaluated, and used in explanations. Thagard describes a detailed computational model of problem solving and discovery that provides a conceptually rich yet rigorous alternative to accounts of scientific knowledge based on formal logic, and he uses it to illuminate such topics as the nature of concepts, hypothesis formation, analogy, and theory justification.

Why it matters that our relationship with nature is increasingly mediated and augmented by technology. Our forebears may have had a close connection with the natural world, but increasingly we experience technological nature. Children come of age watching digital nature programs on television. They inhabit virtual lands in digital games. And they play with robotic animals, purchased at big box stores. Until a few years ago, hunters could "telehunt"—shoot and kill animals in Texas from a computer anywhere in the world via a Web interface. Does it matter that much of our experience with nature is mediated and augmented by technology? In Technological Nature, Peter Kahn argues that it does, and shows how it affects our well-being. Kahn describes his investigations of children's and adults' experiences of cutting-edge technological nature. He and his team installed "technological nature windows" (50-inch plasma screens showing high-definition broadcasts of real-time local nature views) in inside offices on his university campus and assessed the physiological and psychological effects on viewers. He studied children's and adults' relationships with the robotic dog AIBO (including possible benefits for children with autism). And he studied online "telegardening" (a pastoral alternative to "telehunting"). Kahn's studies show that in terms of human well-being technological nature is better than no nature, but not as good as actual nature. We should develop and use technological nature as a bonus on life, not as its substitute, and re-envision what is beautiful and fulfilling and often wild in essence in our relationship with the natural world.

A review of recent computational (deep learning) approaches to understanding news and nonfiction stories.

NatureÖs Algorithms for Learning and Prospering in a Complex World

The Algorithmic Beauty of Plants

Making Sense of Events

Computational Philosophy of Science

The Nature of Code

Gary William Flake develops in depth the simple idea that recurrent rules can produce rich and complicated behaviors. In this book Gary William Flake develops in depth the simple idea that recurrent rules can produce rich and complicated behaviors. Distinguishing "agents" (e.g., molecules, cells, animals, and species) from their interactions (e.g., chemical reactions, immune system responses, sexual reproduction, and evolution), Flake argues that it is the computational properties of interactions that account for much of what we think of as "beautiful" and "interesting." From this basic thesis, Flake explores what he considers to be today's four most interesting computational topics: fractals, chaos, complex systems, and adaptation. Each of the book's parts can be read independently, enabling even the casual reader to understand and work with the basic equations and programs. Yet the parts are bound together by the theme of the computer as a laboratory and a metaphor for understanding the universe. The inspired reader will experiment further with the ideas presented to create fractal landscapes, chaotic systems, artificial life forms, genetic algorithms, and artificial neural networks.

This open access book chronicles the rise of a new scientific paradigm offering novel insights into the age-old enigmas of existence. Over 300 years ago, the human mind discovered the machine code of reality: mathematics. By utilizing abstract thought systems, humans began to decode the workings of the cosmos. From this understanding, the current scientific paradigm emerged, ultimately discovering the gift of technology. Today, however, our island of knowledge is surrounded by ever longer shores of ignorance. Science appears to have hit a dead end when confronted with the nature of reality and consciousness. In this fascinating and accessible volume, James Glattfelder explores a radical paradigm shift uncovering the ontology of reality. It is found to be information-theoretic and participatory, yielding a computational and programmable universe.