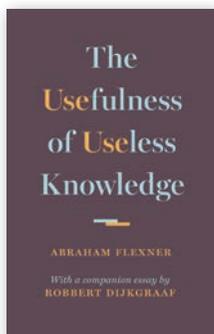
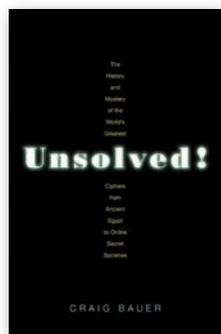
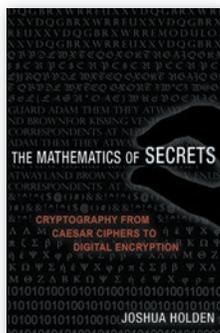
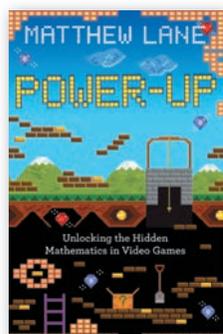




Computer Science & Information Science 2017

A Mathematical Theory of Communication by C. E. Shannon. Introduction. The recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist and Hartley on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information. The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design. If the number of messages in the set is finite then this number or any monotonic function of this number can be regarded as a measure of the information produced when one message is chosen from the set, all choices being equally likely. As was pointed out by Hartley the most natural choice is the logarithmic function. Although this definition must be generalized considerably when we consider the influence of the statistics of the message and when we have a continuous range of messages, we will in all cases use an essentially logarithmic measure. The logarithmic measure is more convenient for various reasons: 1. It is practically more useful. Parameters of engineering importance such as time, bandwidth, number of relays, etc., tend to vary linearly with the logarithm of the number of possibilities. For example, adding one relay to a group doubles the number of possible states of the relays. It adds 1 to the base 2 logarithm of this number. Doubling the time roughly squares the number of possible messages, or doubles the logarithm, etc. 2. It is nearer to our intuitive feeling as to the proper measure. This is closely related to (1) since we intuitively measure entities by linear comparison with common standards. One feels, for example, that two punched cards should have twice the capacity of one for information storage, and two identical channels twice the capacity of one for transmitting information. 3. It is mathematically more suitable. Many of the limiting operations are simple in terms of the logarithm but would require clumsy restatement in terms of the number of possibilities. The choice of a logarithmic base corresponds to the choice of a unit for measuring information. If the base 2 is used the resulting units may be called binary digits, or more briefly bits, a word suggested by J. W. Tukey. A device with two stable positions, such as a relay or a flip-flop circuit, can store one bit of information. N such devices can store N bits, since a unit of two possible states is 2^N and log₂ 2^N = N. If the base 10 is used the units may be called decimal digits. Since log₁₀ 2 = log₁₀ M / log₁₀ 2 = 3.32 log₁₀ M. [Nyquist, H., "Certain Factors Affecting Telegraph Speed," Bell System Technical Journal, April 1924, p. 324; "Certain Topics in Telegraph Transmission Theory," A.I.E.E. Trans., v. 47, April 1928, p. 617; Hartley, R. V. L., "Transmission of Information," Bell System Technical Journal, July 1928, p. 535. Fig. 1 - Schematic diagram of a general communication system. A decimal digit is about 3-1/3 bits. A digit wheel on a desk computing machine has ten stable positions and therefore has a storage capacity of one decimal digit. In analytical work where integration and differentiation are involved the base e is sometimes useful. The resulting units of information will be called natural units. Change from the base 2 to base e merely requires multiplication by log₂ e. By a communication system we will mean a system of the type indicated schematically in Fig. 1. It consists of essentially five parts: L, An information source which produces a message or sequence of messages to be communicated to the receiving terminal. The message may be of various types: (a) A multiplication of letters as in a telegraph of teletype system; (b) A single function of time f(t) as in radio or telephony; (c) A function of time and other variables as in black and white television - here the message may be thought of as a function f(x, y, t) of two space coordinates and time, the light intensity at point (x, y) and time t on a pickup tube plate; (d) Two or more functions of time, say f(t), g(t), h(t) - this is the case in "three-dimensional" sound transmission or if the system is intended to service several individual channels in multiplex; (e) Several functions of several variables - in color television the message consists of three functions f(x, y, t), g(x, y, t), h(x, y, t) defined in a three-dimensional continuum - we may also think of these three functions as components of a vector field defined in the region - similarly, several black and white television sources would produce "messages" consisting of a number of functions of three variables; (f) Various combinations also occur, for example in television with associated audio channel. 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The destination is the person (or thing) for whom the message is intended. We wish to consider certain general problems involving communication systems. To do this it is first necessary to represent the various systems involved as mathematical entities, suitably idealized from their physical counterparts. We may roughly classify communication systems into three main categories: discrete, continuous and mixed. By a discrete system we will mean one in which both the message and the signal are a sequence of discrete symbols. A typical case is telegraphy where the message is a sequence of letters and the signal a sequence of dots, dashes and spaces. A continuous system is one in which the message and signal are both treated as continuous functions, e.g., radio or television. A mixed system is one in which both discrete and continuous variables appear, e.g., PCM transmission of speech. This case has applications not only in communication theory, but also in the theory of computing machines, the design of telephone exchanges and other fields. In addition the discrete case forms a foundation for the continuous and mixed cases which will be treated in the second half of the paper. Part I. Discrete Noiseless Systems 1. The Discrete Noiseless Channel. Telegraphy and telephony are two simple examples of a discrete channel for transmitting information. Generally, a discrete channel will mean a system whereby a set of elementary symbols S₁, S₂, ... can be transmitted from one point to another. Each of the symbols S_i is assumed to have a certain duration in time t_i seconds (not necessarily the same for different S_i, for example the dots and dashes in telegraphy). It is not required that all possible sequences of the S_i be capable of transmission on the system; certain sequences only may be allowed. These will be possible signals for the channel. This in telegraphy suppose the symbols are: (1) A dot, consisting of a line closure for a unit of time and then line open for a unit of time; (2) A dash, consisting of three time units of closure and one unit open; (3) A letter space consisting of, say, three units of line open; (4) A word space of six units of line open. We might place the restriction on allowable sequences that no spaces follow each other (for two letter spaces are adjacent). It is identical with a word space. The question we now consider is how one can measure the capacity of such a channel to transmit information. In the telegraph case where all symbols are of the same duration, and any sequence of them is allowed, 32 symbols is allowed the answer is easy. Each symbol represents five bits of information. If the system transmits n symbols per sec and it is natural to say that the channel has a capacity of 5n bits per second. This does not mean that the telegraph channel will all ways be transmitting information at this rate - 5n is the maximum possible rate and whether or not the actual rate reaches this maximum depends on the source of information which feeds the channel, as will appear later. In the more general case with different lengths of symbols and constraints on the allowed sequences, we make the following definition: Definition: The capacity C of a discrete channel is given by C = Lim [over T] [arrow right] infinity [Ispaced log(M)T] where M(T) is the number of allowed signals of duration T. It is easily seen that in the telegraph case this reduces to the previous result. It can be shown that the limit in question will exist as a finite number in most cases of interest. Suppose all sequences of the symbols S₁, S₂, ... are allowed and these symbols have durations t₁, t₂, ... What is the channel capacity? If M(t) represents the number of sequences of duration t we have M(t) = M(t-t₁) + M(t-t₂) + ... + M(t-t_N). The total number is equal to the sum of the numbers of sequences ending in S₁, S₂, ... and these are M(t-t₁), M(t-t₂), ..., M(t-t_N), respectively. According to a well-known result in finite differences, N(t) is then asymptotic for large t to X_N, where X_N is the largest real solution of the characteristic equation: X^N + X^{N-1} + ... + X + 1 = 0 and therefore C = log₂ X_N. In case there are restrictions on allowed sequences we may still give the channel capacity by the same definition except that the M(t) are now defined as above. M(t) = M(t-t₁) + M(t-t₂) + ... + M(t-t_N) + N(t-t₁) + N(t-t₂) + ... + N(t-t_N) = 10) as we may be counting sequences of symbols according to the last or to the last symbol occurring. Hence C is less, where μ_i is the positive root of 1 = μ^{t₁} + μ^{t₂} + ... + μ^{t_N} + μ^{t₁} + μ^{t₂} + ... + μ^{t_N}. Solving this we find C = 0.539. A very general type of restriction which may be placed on allowed sequences is the following: We imagine a number of possible states a₁, a₂, ..., a_N each state only certain symbols from the set S₁, S₂, ... can be transmitted (different subsets for the different states). When one of these has been transmitted the state changes to a new state dependent on the old state and the particular symbol transmitted. The telegraph case is a simple example of this. There are two states depending on whether or not a space was transmitted; then only a dot or a dash can be sent next and the state always changes. If not, any symbol can be transmitted and the state changes if a space is sent, otherwise it remains the same. The conditions indicated in a linear graph as shown in Fig. 2. The junction points correspond to the Fig. 2 - Graphical representation of the constraints on telegraph symbols; states and the lines indicate the symbols in a state and the resulting state. In Appendix I, we show that if the conditions on allowed sequences are well specified, then C will exist and can be calculated in accordance with the following theorem: Theorem 1: Let P_{ij} be the duration of the i symbol which is allowable in state j and leads to state i. The channel capacity C is equal to log₂ W, where W is the largest real root of the determinant |LW^{t_{ij}} - P_{ij} μ_{ij} 0, μ_{ij} = δ_{ij} if i is j and is zero otherwise. For example, in the telegraph case (Fig. 2) the determinant is: | -[over j] (W^{t₁₁} - W^{t₁₂}) (W^{t₂₁} - W^{t₂₂}) (W^{t₃₁} - W^{t₃₂}) (W^{t₄₁} - W^{t₄₂}) | = 0. On expansion this leads to the equation given above for this case. 2. The Discrete Source of Information. We have seen that under very general conditions the logarithm of the number of possible signals in a discrete channel increases with time. The expansion can be specified by giving the rate of increase of the number of possible signals and the new source of information source. We now consider the information source in a mathematical model of a system which produces such a sequence of symbols governed by a set of probabilities, known as a stochastic process. We may consider a discrete source, therefore, to be represented by a stochastic process. Conversely, a stochastic process which produces a discrete sequence of symbols chosen from a finite set may be considered a discrete source. This will include such cases as: 1. Natural written languages such as English, German, Chinese, 2. Continuous information which has been rendered discrete by some quantizing process. For example, the quantized speech used in a PCM transmitter, or a quantized television signal. 3. Mathematical cases where we merely define abstractly a stochastic process which generates a set of symbols chosen from a finite set. 4. A sequence of symbols chosen from a finite set, successively before the time of the next choice. 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Catalog cover image of Claude Shannon by Laurel Cantor

Letter from the Advisers

The fields of computer science and information science have had unquestioned impact over the several decades of their existence. As academic disciplines, they have evolved to take a central role in science, mathematics, and engineering at universities and research institutions around the world. They have a rich history that connects to David Hilbert, Alan Turing, John von Neumann, Alonzo Church, Claude Shannon, and many other leading mathematicians and scientists of the twentieth century.

Computer science and information science now encompass core areas such as algorithms and data structures, programming methodology and languages, theoretical computer science, computer architecture, artificial intelligence, networking and wireless communications, social and energy networks, database systems, parallel and distributed computation, cryptography, information theory, privacy and security, machine learning, computer-human interaction, computer graphics, data analytics, probabilistic methods, signal processing, and operating systems. These fields are all expanding and have direct impact on the development of the computational and communication infrastructure that surrounds us today.

Research in computer science and information science now provides a foundation for research in many other fields, including computational biology, chemistry to physics, neuroscience, and all subareas of engineering. Indeed, computation and information now play an essential role in science, as scientists are confronted with massive amounts of data, computational models, and large-scale simulations of natural phenomena. More broadly, academics in all fields are recognizing the essential role of computer science and information science in the production and dissemination of knowledge in their disciplines.

As demonstrated by the titles in this catalog, Princeton University Press has a history of publishing in these areas and has begun developing a new book list dedicated to computer science and information science. It will include a select list of advanced field-shaping textbooks, outstanding research monographs, and excellent trade books of broad interest covering the areas mentioned above. We see this expansion as a logical extension of what Princeton University Press has published across the disciplines in recent years.

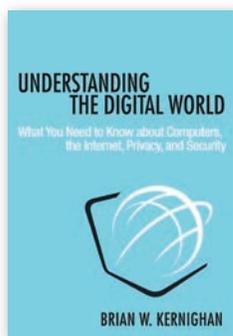
As advisers to this publishing venture, we hope that you will offer your suggestions or even consider contributing to a list that includes books by many leaders who have made computer science and information science what they are today.

Sanjeev Kulkarni & Robert Sedgewick

For more information, please contact:

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New

Understanding the Digital World

What You Need to Know about Computers, the Internet, Privacy, and Security

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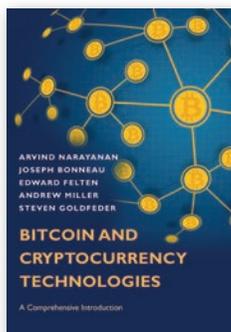
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Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller & Steven Goldfeder

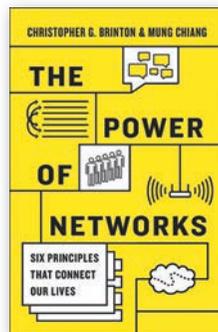
"Block chain technology is set to disrupt many different industries. If you want to get up to speed on this fast-moving technology, this book should be your first stop."

—Campbell R. Harvey, Duke University

Bitcoin and Cryptocurrency Technologies provides a comprehensive introduction to the revolutionary yet often misunderstood new technologies of digital currency. Whether you are a student, software developer, tech entrepreneur, or researcher in computer science, this authoritative and self-contained book tells you everything you need to know about the new global money for the Internet age.

How do Bitcoin and its block chain actually work? How secure are your bitcoins? How anonymous are their users? Can cryptocurrencies be regulated? These are some of the many questions this book answers.

2016. 336 pages. 11 halftones. 86 line illus. 7 tables.
Cl: 978-0-691-17169-2 \$49.50 | £41.95



New

The Power of Networks

Six Principles That Connect Our Lives

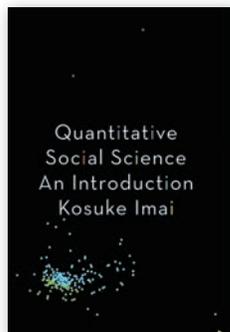
Christopher G. Brinton & Mung Chiang

"As humans, we are 'networked' by nature. Our bodies are networked from head to toe by the most sophisticated network that exists, and the value of networking was even understood by our ancestors as they began to network in order to hunt more efficiently. *The Power of Networks* explains how six basic networking principles connect our lives almost as an extension of our primordial instincts.... It is an absolutely intriguing book."

—Helder Antunes, Senior Director, Cisco's Corporate Strategic Innovations Group, and Chairman, OpenFog Consortium

What makes WiFi faster at home than at a coffee shop? How does Google order search results? Why do Amazon, Netflix, and YouTube use fundamentally different rating and recommendation methods—and why does it matter? Is it really true that everyone on Facebook is connected in six steps or less? And how do cat videos—or anything else—go viral? *The Power of Networks* answers questions like these for the first time in a way that all of us can understand and use, whether at home, the office, or school.

2016. 328 pages. 244 line illus.
Cl: 978-0-691-17071-8 \$35.00 | £27.95



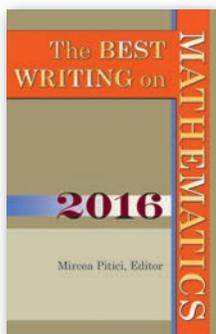
New
Quantitative Social Science
 An Introduction
 Kosuke Imai

“Kosuke Imai has produced a superb hands-on introduction to modern quantitative methods in the social sciences. Placing practical data analysis front and center, this book is bound to become a standard reference in the field of quantitative social science and an indispensable resource for students and practitioners alike.”
 —Alberto Abadie, Massachusetts Institute of Technology

Quantitative Social Science engages directly with empirical analysis, showing students how to analyze data using the R programming language and to interpret the results—it encourages hands-on learning, not paper-and-pencil statistics. More than forty data sets taken directly from leading quantitative social science research illustrate how data analysis can be used to answer important questions about society and human behavior.

Proven in the classroom, this one-of-a-kind textbook features numerous additional data analysis exercises and interactive R programming exercises, and also comes with supplementary teaching materials for instructors.

2017. 424 pages. 16 color illus. 9 halftones.
 77 line illus.
 Pa: 978-0-691-17546-1 \$49.50 | £41.95
 Cl: 978-0-691-16703-9 \$95.00 | £79.95



New
The Best Writing on Mathematics 2016
 Edited by Mircea Pitici

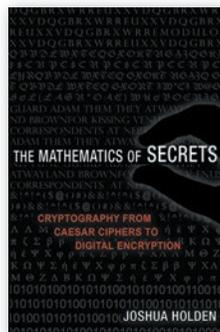
Praise for previous editions:

“Wonderful... [C]annot be recommended highly enough!”
 —Robert Schaefer, *New York Journal of Books*

“A volume of unexpectedly fascinating mathematical research, musings, and studies that explore subjects from art to medicine... [R]eaders from many disciplines will find much to pique their interest.”
 —*Publishers Weekly*

This annual anthology brings together the year’s finest mathematics writing from around the world. *The Best Writing on Mathematics 2016* makes available to a wide audience many articles not easily found anywhere else. Here Burkard Polster shows how to invent your own variants of the Spot It! card game, Steven Strogatz presents young Albert Einstein’s proof of the Pythagorean Theorem, Joseph Dauben and Marjorie Senechal find a treasure trove of math in New York’s Metropolitan Museum of Art, and Andrew Gelman explains why much scientific research based on statistical testing is spurious.

2017. 408 pages. 119 color illus. 12 halftones.
 31 line illus. 2 tables.
 Pa: 978-0-691-17529-4 \$32.95 | £27.95

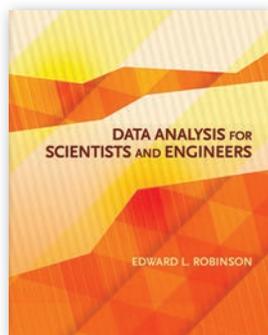


New
The Mathematics of Secrets
 Cryptography from Caesar Ciphers to Digital Encryption
 Joshua Holden

“*The Mathematics of Secrets* offers a fascinating survey of the ideas that have been used to create and crack secret messages, from ancient times to the present. It provides an enjoyable and accessible guide to these ideas for mathematicians, scientists, and anyone else who knows a little math and is interested in cryptography.”
 —John MacCormick, Dickinson College

The Mathematics of Secrets takes readers on a fascinating tour of the mathematics behind cryptography—the science of sending secret messages. Most books about cryptography are organized historically, or around how codes and ciphers have been used, such as in government and military intelligence or bank transactions. Joshua Holden instead shows how mathematical principles underpin the ways that different codes and ciphers operate. Holden focuses on both code making and code breaking and he discusses the majority of ancient and modern ciphers currently known.

2017. 374 pages. 3 halftones. 94 line illus.
 16 tables.
 Cl: 978-0-691-14175-6 \$29.95 | £24.95



New
Data Analysis for Scientists and Engineers
 Edward L. Robinson

"[A]n excellent overview of modern statistical techniques ... sure to become a definitive reference."

—Jeremy Kasdin, Princeton University

"*Data Analysis for Scientists and Engineers* stands out for its depth of materials and pedagogical presentation."

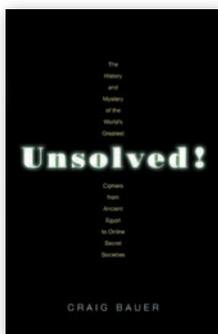
—Wade Fisher, Michigan State University

Based on a graduate course on data analysis that the author has taught for many years, and couched in the looser, workaday language of scientists and engineers who wrestle directly with data, this book is ideal for courses on data analysis and a valuable resource for students, instructors, and practitioners in the physical sciences and engineering.

2016. 408 pages. 96 line illus. 7 tables.
 Cl: 978-0-691-16992-7 \$75.00 | £62.95

Forthcoming
Bit by Bit
 Social Research in the Digital Age
 Matthew Salganik

Forthcoming
Ten Great Ideas about Chance
 Persi Diaconis & Brian Skyrms



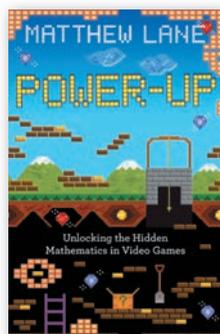
Forthcoming
Unsolved!
 The History and Mystery of the World's Greatest Ciphers from Ancient Egypt to Online Secret Societies
 Craig Bauer

"Exceptional. Not only are these ciphers fascinating individually, but together they provide a comprehensive picture of the different methods and types of encryption."

—Todd S. Sauter, former docent at the National Cryptologic Museum

In 1953, a man was found dead from cyanide poisoning near the Philadelphia airport with a picture of a Nazi aircraft in his wallet. Taped to his abdomen was an enciphered message. In 1912, a book dealer named Wilfrid Voynich came into possession of an illuminated cipher manuscript once belonging to Emperor Rudolf II, who was obsessed with alchemy and the occult. Wartime codebreakers tried—and failed—to unlock the book's secrets, and it remains an enigma to this day. In this lively and entertaining book, Craig Bauer examines these and other vexing ciphers yet to be cracked. Some may reveal the identity of a spy or serial killer, provide the location of buried treasure, or expose a secret society—while others may be elaborate hoaxes.

June 2017. 600 pages. 222 halftones.
 8 line illus. 17 tables.
 Cl: 978-0-691-16767-1 \$35.00 | £27.95



Forthcoming
Power-Up
 Unlocking the Hidden Mathematics in Video Games
 Matthew Lane

"What a delightful journey through the math of hidden worlds! This is much more than a book about video games. It's an exploration of interconnectedness and an invitation for the perpetually curious."

—Karim Ani, founder of Mathalicious

"Are you a video game enthusiast who is getting tired of being asked 'How can you waste time on such stuff?' This book is your answer! Matthew Lane skillfully weaves a tale of how video games can be important tools for teaching mathematics and physics. As a long-time video gamer, I highly recommend *Power-Up*."

—Paul J. Nahin, author of *In Praise of Simple Physics*

Power-Up reveals the hidden mathematics in many of today's most popular video games and explains why mathematical learning doesn't just happen in the classroom or from books—you're doing it without even realizing it when you play games on your cell phone.

June 2017. 264 pages. 80 halftones.
 50 line illus.
 Cl: 978-0-691-16151-8 \$29.95 | £24.95

Forthcoming

The Probability Lifesaver

All the Tools You Need to Understand Chance

Steven J. Miller

"This is a superb book by a gifted writer and mathematician."

—Larry Leemis, College of William & Mary

For students learning probability, its numerous applications, techniques, and methods can seem intimidating and overwhelming. That's where *The Probability Lifesaver* steps in. Designed to serve as a complete stand-alone introduction to the subject or as a supplement for a course, this accessible and user-friendly textbook helps students comfortably navigate probability's terrain and achieve positive results.

Princeton Lifesaver Study Guides

June 2017. 752 pages. 8 color illus.

64 line illus. 21 tables.

Pa: 978-0-691-14955-4 \$29.95 | £24.95

Cl: 978-0-691-14954-7 \$99.50 | £83.95

Forthcoming

Natural Complexity

A Modeling Handbook

Paul Charbonneau

"*Natural Complexity* takes readers to new frontiers in the physics of complexity."

—Simon DeDeo, Carnegie Mellon University and the Santa Fe Institute

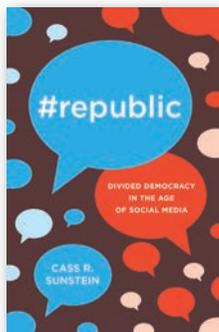
This book provides a short, hands-on introduction to the science of complexity using simple computational models of natural complex systems—with models and exercises drawn from physics, chemistry, geology, and biology.

Primers in Complex Systems

May 2017. 304 pages. 62 color illus. 1 halftone. 28 line illus. 19 tables.

Pa: 978-0-691-17035-0 \$49.50 | £41.95

Cl: 978-0-691-17684-0 \$99.50 | £83.95



New

#Republic

Divided Democracy in the Age of Social Media

Cass R. Sunstein

"America's leading legal academic gives us a way to address democracy's leading challenge—preserving a public informed enough to govern itself. Drawing on an incredible range of scholarship and experience, this book could not be more timely. Or urgently needed."

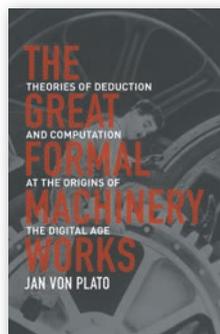
—Lawrence Lessig, Harvard Law School

Thoroughly rethinking the critical relationship between democracy and the Internet, Sunstein describes how the online world creates "cybercascades," exploits "confirmation bias," and assists "polarization entrepreneurs." And he explains why online fragmentation endangers the shared conversations, experiences, and understandings that are the lifeblood of democracy.

In response, Sunstein proposes practical and legal changes to make the Internet friendlier to democratic deliberation. These changes would get us out of our information cocoons by increasing the frequency of unchosen, unplanned encounters and exposing us to people, places, things, and ideas that we would never have picked for our Twitter feed.

2017. 280 pages. 1 halftone.

Cl: 978-0-691-17551-5 \$29.95 | £24.95



Forthcoming

The Great Formal Machinery Works

Theories of Deduction and Computation at the Origins of the Digital Age

Jan von Plato

"[A] lively and provocative history of mathematical logic, centered on the game-changing discoveries of Gödel, Turing, and Gentzen. Every mathematician interested in foundations will enjoy this book."

—John Stillwell, author of *Elements of Mathematics*

"Von Plato covers an immense territory with an impressive amount of novel things to say. He has written a very original book that is a major scholarly contribution to the history of logic."

—Paolo Mancosu, author of *The Adventure of Reason: Interplay between Philosophy of Mathematics and Mathematical Logic, 1900–1940*

The information age owes its existence to a little-known but crucial development, the theoretical study of logic and the foundations of mathematics. *The Great Formal Machinery Works* draws on original sources and rare archival materials to trace the history of the theories of deduction and computation that laid the logical foundations for the digital revolution.

June 2017. 392 pages.

Cl: 978-0-691-17417-4 \$35.00 | £27.95

Forthcoming

Noncooperative Game Theory

An Introduction for Engineers and Computer Scientists

João P. Hespanha

"João Hespanha's standing in the field is stellar and students will appreciate his textbook in courses. This well-written book is clear and focused, and organized around suitable modules and lectures. It contains compelling theoretical and computational exercises."
—Magnus Egerstedt, coauthor of *Graph Theoretic Methods in Multiagent Networks*

Noncooperative Game Theory offers students a fresh way of approaching engineering and computer science applications.

June 2017. 248 pages. 35 line illus. 4 tables.
Cl: 978-0-691-17521-8 \$65.00 | £54.95

Forthcoming

Disruptive Fixation

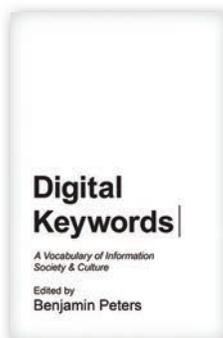
School Reform and the Pitfalls of Techno-Idealism

Christo Sims

In New York City in 2009, a new kind of public school opened its doors to its inaugural class of middle schoolers. Conceived by a team of game designers and progressive educational reformers and backed by prominent philanthropic foundations, it promised to reinvent the classroom for the digital age. *Disruptive Fixation* is ethnographer Christo Sims's account of how this "school for digital kids" reverted to a more conventional type of schooling with rote learning, an emphasis on discipline, and traditional hierarchies of authority.

Princeton Studies in Culture and Technology
Tom Boellstorff and Bill Maurer, Series Editors

April 2017. 224 pages. 1 line illus. 1 table.
Pa: 978-0-691-16399-4 \$27.95 | £22.95
Cl: 978-0-691-16398-7 \$80.00 | £66.95



New

Digital Keywords

A Vocabulary of Information Society and Culture

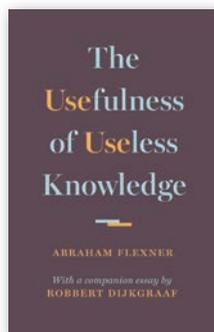
Edited by Benjamin Peters

"[A] new and revolutionary publication... *Digital Keywords* serves as an in-depth interrogation of the meaning and development of digitised language... Those wishing to gain a deeper understanding of the modern, digital world we all inhabit would be well advised to begin by taking a look at this book. Just as *Keywords* made its way firmly onto reference shelves in the 1970s, so too will *Digital Keywords* today."
—Jade Fell, *Engineering and Technology*

Inspired by Raymond Williams's 1976 classic *Keywords*, the timely collection *Digital Keywords* gathers pointed, provocative short essays on more than two dozen keywords by leading and rising digital media scholars from the areas of anthropology, digital humanities, history, political science, philosophy, religious studies, rhetoric, science and technology studies, and sociology. *Digital Keywords* examines and critiques the rich lexicon animating the emerging field of digital studies.

Princeton Studies in Culture and Technology
Tom Boellstorff and Bill Maurer, Series Editors

2016. 352 pages. 3 halftones. 1 table.
Pa: 978-0-691-16734-3 \$24.95 | £19.95
Cl: 978-0-691-16733-6 \$70.00 | £58.95



New

The Usefulness of Useless Knowledge

Abraham Flexner

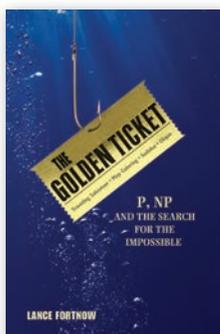
With a companion essay by Robbert Dijkgraaf

"Flexner's brilliant essay is as valuable today as when it was first published. And Dijkgraaf's eloquent companion essay, which admirably connects the situation facing past and present advocates of basic scientific research, is a pleasure to read. *The Usefulness of Useless Knowledge* will actually be very useful in the intense global debate over this vital topic."

—Neil Turok, Director and Niels Bohr Chair, Perimeter Institute for Theoretical Physics

In his classic essay "The Usefulness of Useless Knowledge," Abraham Flexner describes a great paradox of scientific research. The search for answers to deep questions, motivated solely by curiosity and without concern for applications, often leads not only to the greatest scientific discoveries but also to the most revolutionary technological breakthroughs. This brief book includes a new companion essay by Robbert Dijkgraaf, in which he shows that Flexner's defense of the value of "the unobstructed pursuit of useless knowledge" may be even more relevant today than it was in the early twentieth century.

2017. 112 pages.
Cl: 978-0-691-17476-1 \$9.95 | £8.95



New in Paperback
The Golden Ticket
 P, NP, and the Search for
 the Impossible
Lance Fortnow

“You will love this book. It’s completely accessible and captures the thrill, potential, and heart-break of an edgy mathematical problem in terms that nonmathematicians will appreciate. After reading *The Golden Ticket*, I sort of hope P isn’t NP after all.”

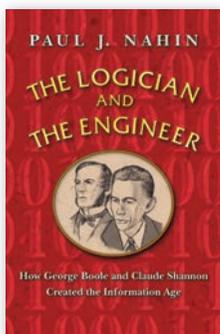
—Vint Cerf, Internet Pioneer

The P-NP problem is the most important open problem in computer science, if not all of mathematics. Simply stated, it asks whether every problem whose solution can be quickly checked by computer can also be quickly solved by computer. *The Golden Ticket* provides a nontechnical introduction to P-NP, its rich history, and its algorithmic implications for everything we do with computers and beyond. *The Golden Ticket* explores what we truly can and cannot achieve computationally, describing the benefits and unexpected challenges of this compelling problem.

2017. 192 pages. 41 halftones. 41 line illus.
 Pa: 978-0-691-17578-2 \$17.95 | £14.95
 Cl: 978-0-691-15649-1 \$26.95 | £21.95

One of Amazon.com’s Best Science Books of 2013

One of Choice’s Outstanding Academic Titles for 2013



Forthcoming in Paperback

The Logician and the Engineer

How George Boole and Claude Shannon Created the Information Age

Paul J. Nahin

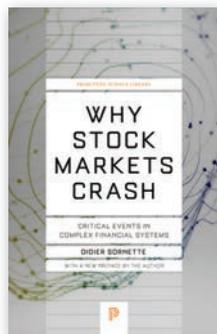
“Meshing logic problems with the stories of two extraordinary men . . . Paul Nahin fashions a tale of innovation and discovery. Alongside a gripping account of how Shannon built on Boole’s work, Nahin explores others key to the technological revolution, from Georg Cantor to Alan Turing.”

—*Nature*

Boolean algebra, also called Boolean logic, is at the heart of the electronic circuitry in everything we use—from our computers and cars, to home appliances. How did a system of mathematics established in the Victorian era become the basis for such incredible technological achievements a century later? In *The Logician and the Engineer*, Paul Nahin combines engaging problems and a colorful historical narrative to tell the remarkable story of how two men in different eras—mathematician and philosopher George Boole and electrical engineer and pioneering information theorist Claude Shannon—advanced Boolean logic and became founding fathers of the electronic communications age.

April 2017. 248 pages. 2 halftones.
 41 line illus. 25 tables.

Pa: 978-0-691-17600-0 \$17.95 | £14.95
 Cl: 978-0-691-15100-7 \$24.95 | £19.95



Forthcoming in Paperback

Why Stock Markets Crash

Critical Events in Complex Financial Systems

Didier Sornette

With a new preface by the author

“Didier Sornette’s insights into why markets behave as they do are fresh, productive, and provocative. This work is bound to become an important baseline for anyone trying to understand what will happen next in the stock and currency markets not only in the U.S. but in Europe and Asia as well.”

—Richard N. Foster, director,
 McKinsey & Company

Princeton Science Library

April 2017. 448 pages. 21 tables. 10 halftones.
 155 line illus.
 Pa: 978-0-691-17595-9 \$22.95 | £18.95

Forthcoming in Paperback

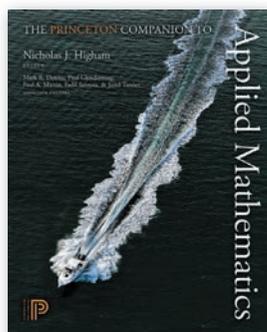
The Fascinating World of Graph Theory

**Arthur Benjamin,
 Gary Chartrand &
 Ping Zhang**

“Deftly written and dynamic. . . . A superb example of approachable mathematical writing.”

—*SIAM Review*

June 2017. 344 pages. 300 line illus.
 Pa: 978-0-691-17563-8 \$19.95 | £14.95
 Cl: 978-0-691-16381-9 \$29.95 | £24.95
 One of Choice’s Outstanding Academic Titles for 2015



The Princeton Companion to Applied Mathematics

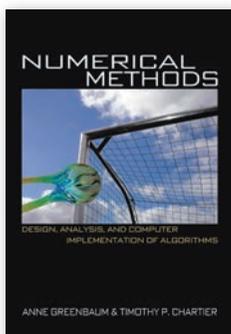
Edited by Nicholas J. Higham
Mark R. Dennis, Paul
Glendinning, Paul A. Martin,
Fadil Santosa & Jared Tanner,
associate editors

"[A]n excellent reference that successfully compiles into a readable and engaging form the broad range of topics that an applied mathematician might encounter in their career.... As a reader, I find myself flipping through the pages and becoming engaged in new and interesting ideas from the world of applied math."

—Joanna Bieri, *MAA Reviews*

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.

2015. 1032 pages. 23 color illus. 20 halftones.
160 line illus.
Cl: 978-0-691-15039-0 \$99.50 | £83.95



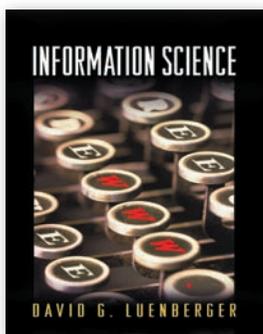
Numerical Methods Design, Analysis, and Computer Implementation of Algorithms

Anne Greenbaum &
Timothy P. Chartier

"Distinguishing features are the inclusion of many recent applications of numerical methods and the extensive discussion of methods based on Chebyshev interpolation. This book would be suitable for use in courses aimed at advanced undergraduate students in mathematics, the sciences, and engineering."

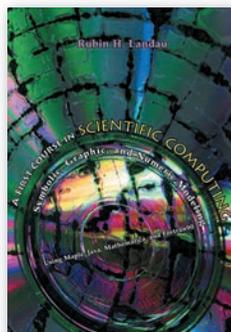
—*Choice*

2012. 472 pages. 78 halftones. 145 line illus.
Cl: 978-0-691-15122-9 \$115.00 | £95.95



Information Science David G. Luenberger

2006. 448 pages. 210 line illus. 6 halftones.
Cl: 978-0-691-12418-6 \$130.00 | £108.95
Winner of the 2006 Award for Best Professional/Scholarly Book in Computer and Information Science, Association of American Publishers



A First Course in Scientific Computing Symbolic, Graphic, and Numeric Modeling Using Maple, Java, Mathematica, and Fortran90

Rubin H. Landau

2005. 472 pages, 50 line illus.
Cl: 978-0-691-12183-3 \$115.00 | £95.95
Not for sale in South Asia

One of Choice's Outstanding Academic
Titles for 2005

Rubin H. Landau, Winner of the 2006
Undergraduate Computational Engineering
and Sciences Award, The Krell Institute

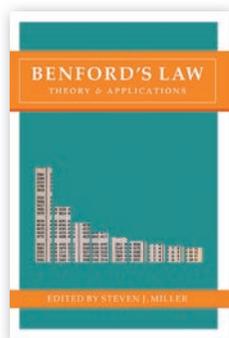
Discrete and Computational Geometry

Satyan L. Devadoss &
Joseph O'Rourke

"*Discrete and Computational Geometry* meets an urgent need for an undergraduate text bridging the theoretical sides and the applied sides of the field. It is an excellent choice as a textbook for an undergraduate course in discrete and computational geometry! The presented material should be accessible for most mathematics or computer science majors in their second or third year in college. The book also is a valuable resource for graduate students and researchers."

—Egon Schulte, *Zentralblatt MATH*

2011. 272 pages. 182 color illus. 4 line illus.
7 tables.
Cl: 978-0-691-14553-2 \$78.50 | £65.95



Benford's Law

Theory and Applications
Edited by Steven J. Miller

"This book will prove to be both a valuable reference and a first source to turn to for whoever is interested in the mathematical genesis and empirical usefulness of Benford's law."

—Walter Krämer, *Statistical Papers*

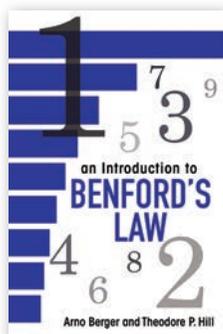
"This important, impressive, and well-crafted book presents the theory and many diverse applications of Benford's law."

—Iddo Ben-Ari, University of Connecticut

Beginning with the general theory, the contributors explain the prevalence of the bias, highlighting explanations for when systems should and should not follow Benford's law and how quickly such behavior sets in. They go on to discuss important applications in disciplines ranging from accounting and economics to psychology and the natural sciences. The contributors describe how Benford's law has been successfully used to expose fraud in elections, medical tests, tax filings, and financial reports. Additionally, numerous problems, background materials, and technical details are available online to help instructors create courses around the book.

2015. 464 pages. 43 halftones. 36 line illus. 47 tables.

Cl: 978-0-691-14761-1 \$75.00 | £62.95



An Introduction to Benford's Law

Arno Berger & Theodore P. Hill

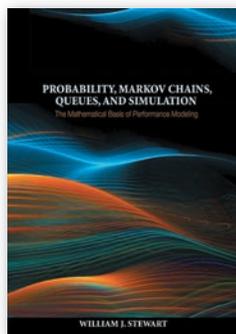
"A must-read for novices and experts alike. It can be used for a graduate-level topics course or as a reference text for researchers in the field. The exposition is outstanding, with hundreds of carefully chosen examples, figures and diagrams to illustrate the theory. For those who are up for a challenge, the book contains several open problems as well. *An Introduction to Benford's Law* will surely be the go-to text on the subject for years to come."

—Pieter C. Allaart, *MAA Book Review*

An Introduction to Benford's Law provides the first comprehensive treatment of Benford's law, the surprising logarithmic distribution of significant digits discovered in the late nineteenth century. Establishing the mathematical and statistical principles that underpin this intriguing phenomenon, the text combines up-to-date theoretical results with overviews of the law's colorful history, rapidly growing body of empirical evidence, and wide range of applications.

2015. 256 pages. 47 color illus. 4 line illus. 2 tables.

Cl: 978-0-691-16306-2 \$75.00 | £62.95



Probability, Markov Chains, Queues, and Simulation

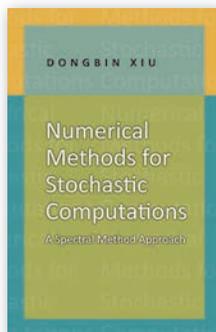
The Mathematical Basis of Performance Modeling
William J. Stewart

"The book represents a valuable text for courses in statistics and stochastic processes, so it is strongly recommended to libraries."

—Hassan S. Bakouch, *Journal of Applied Statistics*

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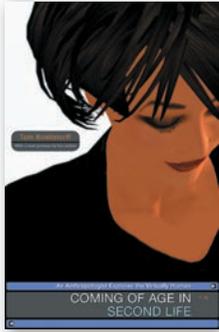
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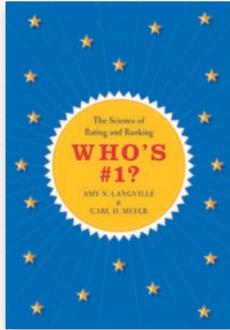
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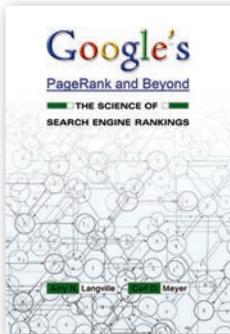
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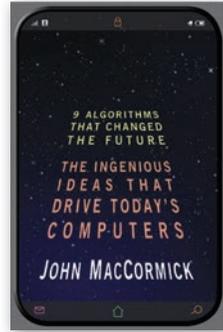
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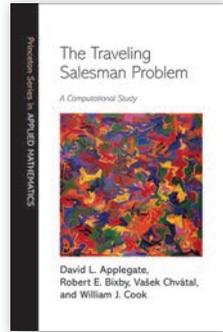
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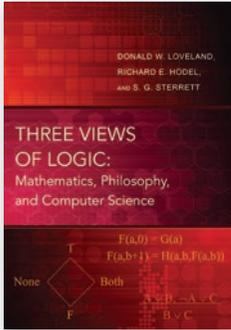
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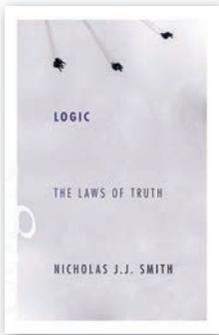
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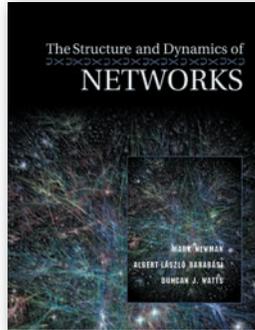
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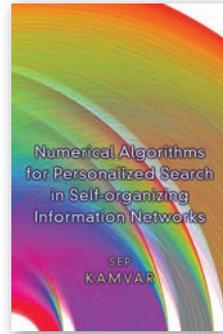
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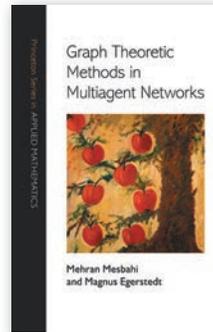
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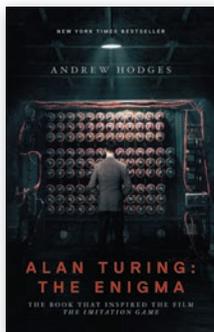
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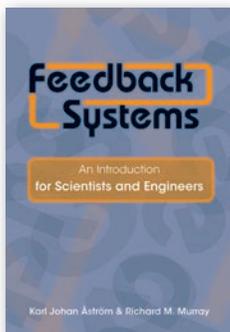
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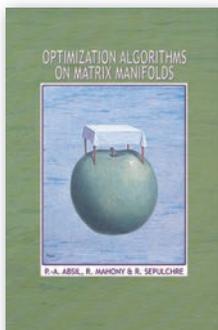
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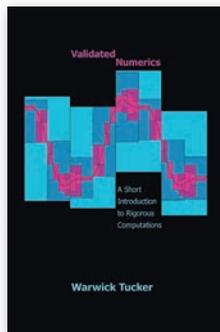
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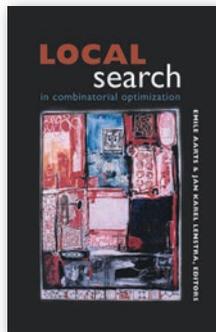


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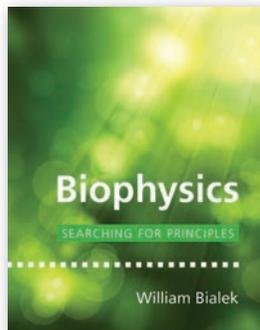
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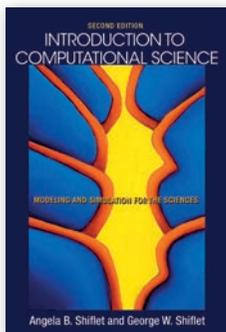
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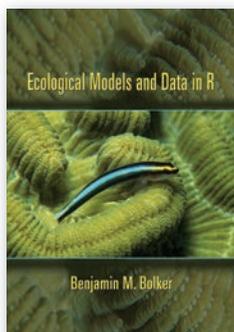
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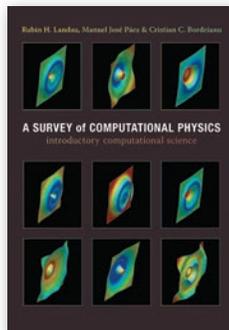
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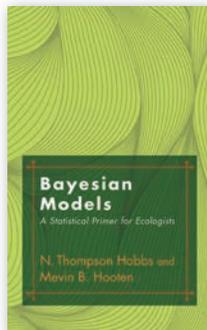
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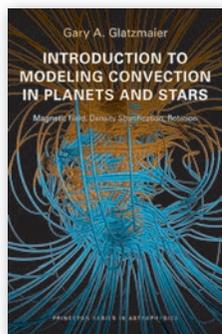
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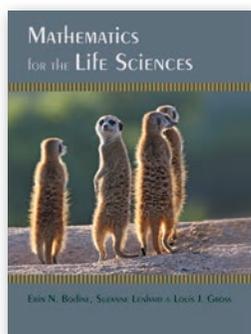
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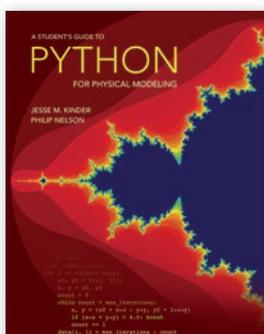
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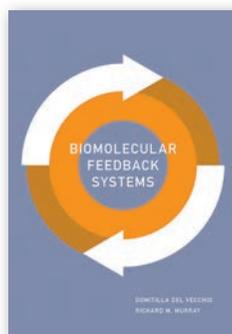
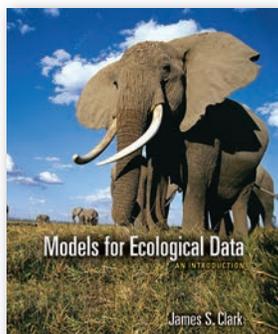
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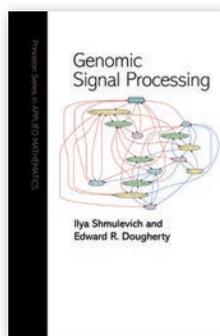
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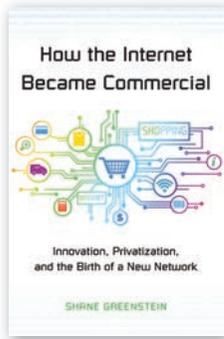


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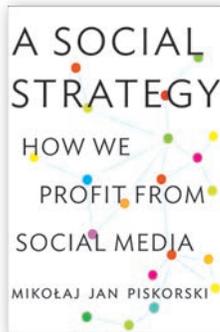
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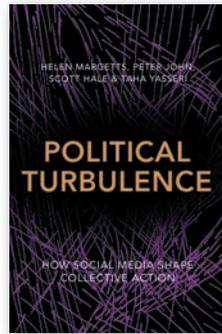
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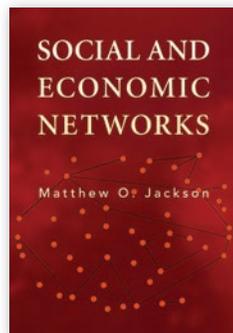
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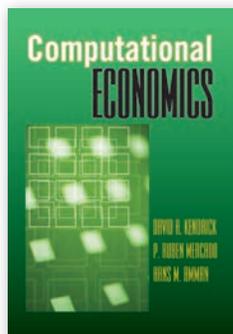
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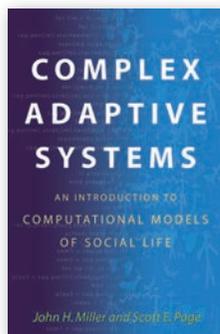
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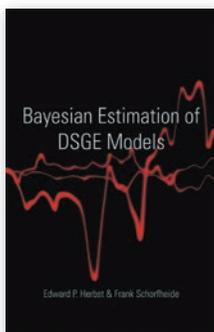
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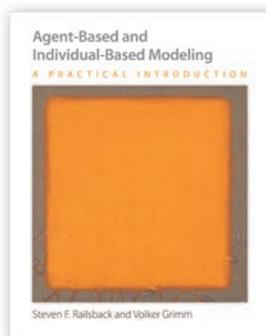
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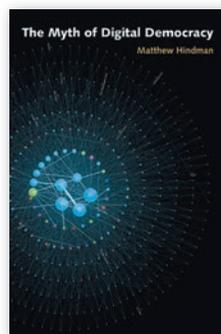
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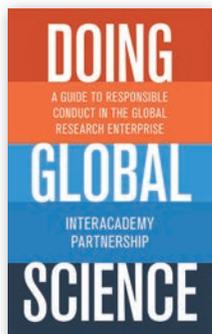
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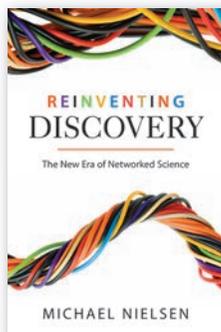
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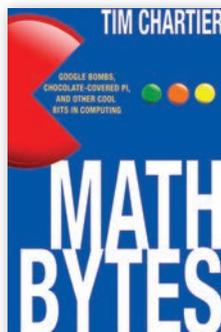
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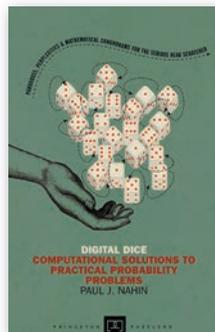


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