

A Mathematical Theory Of Communication

Third printing. First paperback printing. Original copyright date: 2013.

From atom bombs to rebounding slinkies, open your eyes to the mathematical magic in the everyday. Mathematics isn't just for academics and scientists, a fact meteorologist and blogger Peter Lynch has spent the past several years proving through his Irish Times newspaper column and blog, That's Maths. Here, he shows how maths is all around us, with chapters on the beautiful equations behind designing a good concert venue, predicting the stock market and modelling the atom bomb, as well as playful meditations on everything from coin-stacking to cartography. If you left school thinking maths was boring, think again!

The general concept of information is here, for the first time, defined mathematically by adding one single axiom to the probability theory. This Mathematical Theory of Information is explored in fourteen chapters: 1. Information can be measured in different units, in anything from bits to dollars. We will here argue that any measure is acceptable if it does not violate the Law of Diminishing Information. This law is supported by two independent arguments: one derived from the Bar-Hillel ideal receiver, the other is based on Shannon's noisy channel. The entropy in the 'classical information theory' is one of the measures conforming to the Law of Diminishing Information, but it has, however, properties such as being symmetric, which makes it unsuitable for some applications. The measure reliability is found to be a universal information measure. 2. For discrete and finite signals, the Law of Diminishing Information is defined mathematically, using probability theory and matrix algebra. 3. The Law of Diminishing Information is used as an axiom to derive essential properties of information. Byron's law: there is more information in a lie than in gibberish. Preservation: no information is lost in a reversible channel. Etc. The Mathematical Theory of Information supports colligation, i. e. the property to bind facts together making 'two plus two greater than four'. Colligation is a must when the information carries knowledge, or is a base for decisions. In such cases, reliability is always a useful information measure. Entropy does not allow colligation.

Presents a new physical and mathematical theory of irreversible deformations and ductile fracture of metals that acknowledges the continuous change in the structure of materials during deformation and the accumulation of deformation damage. Plastic deformation, viscous destruction, evolution of structure, creep processes, and long-term strength of metals and stress relaxation are described in the framework of a unified approach and model. The author then expands this into a mathematical model for determining the mechanical characteristics of quasi-samples of standard mechanical properties in deformed semi-finished products.

Stochastic Communities presents a theory of biodiversity by analyzing the distribution of abundances among species in the context of a community. The basis of this theory is a distribution called the "J distribution." This distribution is a pure hyperbola and mathematically implied by the "stochastic species hypothesis" assigning equal probabilities of birth and death within the population of each species over varying periods of time. The J distribution in natural communities has strong empirical support resulting from a meta-study and strong theoretical support from a theorem that is mathematically implied by the stochastic species hypothesis.

The Mathematical Theory of Tone Systems patterns a unified theory defining the tone system in functional terms based on the principles and forms of uncertainty theory. This title uses geometrical nets and other measures to study all classes of used and theoretical tone systems, from Pythagorean tuning to superparticular pentatonics.

Hundreds of examples of past and prevalent tone systems are featured. Topics include Fuzziness and Sonance, Wavelets and Nonspecificity, Pitch Granulation and Ambiguity, Equal Temperaments, Mean Tone Systems. Well Tempered Systems, Ptolemy Systems, and more. Appendices include extended lists of tone systems and a

catalogue of historical organs with subsemitones.

"Mathematical Theory of Dispersion-Managed Optical Solitons" discusses recent advances covering optical solitons, soliton perturbation, optical cross-talk, Gabitov-Turitsyn Equations, quasi-linear pulses, and higher order Gabitov-Turitsyn Equations. Focusing on a mathematical perspective, the book bridges the gap between concepts in engineering and mathematics, and gives an outlook to many new topics for further research. The book is intended for researchers and graduate students in applied mathematics, physics and engineering and also it will be of interest to those who are conducting research in nonlinear fiber optics. Dr. Anjan Biswas is an Associate Professor at the Department of Applied Mathematics & Theoretical Physics, Delaware State University, Dover, DE, USA; Dr. Daniela Milovic is an Associate Professor at the Department of Telecommunications, Faculty of Electronic Engineering, University of Nis, Serbia; Dr. Matthew Edwards is the Dean of the School of Arts and Sciences at Alabama A & M University in Huntsville, AL, USA.

Gives a complete and rigorous presentation of the mathematical study of the expressions - hemivariational inequalities - arising in problems that involve nonconvex, nonsmooth energy functions. A theory of the existence of solutions for inequality problems involving nonconvexity and nonsmoothness is established.

Scientific knowledge grows at a phenomenal pace--but few books have had as lasting an impact or played as important a role in our modern world as *The Mathematical Theory of Communication*, published originally as a paper on communication theory more than fifty years ago. Republished in book form shortly thereafter, it has since gone through four hardcover and sixteen paperback printings. It is a revolutionary work, astounding in its foresight and contemporaneity. The University of Illinois Press is pleased and honored to issue this commemorative reprinting of a classic.

Winner of the Neumann Prize for the History of Mathematics **Named a best book of the year by Bloomberg and Nature** ***'Best of 2017' by The Morning Sun** "We owe Claude Shannon a lot, and Soni & Goodman's book takes a big first step in paying that debt." —San Francisco Review of Books "Soni and Goodman are at their best when they invoke the wonder an idea can instill. They summon the right level of awe while stopping short of hyperbole." —Financial Times "Jimmy Soni and Rob Goodman make a convincing case for their subtitle while reminding us that Shannon never made this claim himself." —The Wall Street Journal "Soni and Goodman have done their research...A Mind at Play reveals the remarkable human behind some of the most important theoretical and practical contributions to the information age." —Nature "A Mind at Play shows us that you don't need to be a genius to learn from a genius. Claude Shannon's inventive, vibrant life demonstrates how vital the act of play can be to making the most of work." —Inc. "A charming account of one of the twentieth century's most distinguished scientists...Readers will enjoy this portrait of a modern-day Da Vinci." —Fortune In their second collaboration, biographers Jimmy Soni and Rob Goodman present the story of Claude Shannon—one of the foremost intellects of the twentieth century and the architect of the Information Age, whose insights stand behind every computer built, email sent, video streamed, and webpage loaded. Claude Shannon was a groundbreaking polymath, a brilliant tinkerer, and a digital pioneer. He constructed the first wearable computer, outfoxed Vegas casinos, and built juggling robots. He also wrote the seminal text of the digital revolution, which has been called

“the Magna Carta of the Information Age.” In this elegantly written, exhaustively researched biography, Soni and Goodman reveal Claude Shannon’s full story for the first time. With unique access to Shannon’s family and friends, *A Mind at Play* brings this singular innovator and always playful genius to life.

This book is an evolution from my book *A First Course in Information Theory* published in 2002 when network coding was still at its infancy. The last few years have witnessed the rapid development of network coding into a research field of its own in information science. With its root in information theory, network coding has not only brought about a paradigm shift in network communications at large, but also had significant influence on such specific research fields as coding theory, networking, switching, wireless communications, distributed data storage, cryptography, and optimization theory.

While new applications of network coding keep emerging, the fundamental results that lay the foundation of the subject are more or less mature. One of the main goals of this book therefore is to present these results in a unifying and coherent manner. While the previous book focused only on information theory for discrete random variables, the current book contains two new chapters on information theory for continuous random variables, namely the chapter on differential entropy and the chapter on continuous-valued channels. With these topics included, the book becomes more comprehensive and is more suitable to be used as a textbook for a course in an electrical engineering department.

From the bestselling author of the acclaimed *Chaos and Genius* comes a thoughtful and provocative exploration of the big ideas of the modern era: Information, communication, and information theory. Acclaimed science writer James Gleick presents an eye-opening vision of how our relationship to information has transformed the very nature of human consciousness. A fascinating intellectual journey through the history of communication and information, from the language of Africa’s talking drums to the invention of written alphabets; from the electronic transmission of code to the origins of information theory, into the new information age and the current deluge of news, tweets, images, and blogs. Along the way, Gleick profiles key innovators, including Charles Babbage, Ada Lovelace, Samuel Morse, and Claude Shannon, and reveals how our understanding of information is transforming not only how we look at the world, but how we live. A New York Times Notable Book A Los Angeles Times and Cleveland Plain Dealer Best Book of the Year Winner of the PEN/E. O. Wilson Literary Science Writing Award

not a coincidence, but is the result of a carefully planned time of landing (sun elevation) and lander orientation (sun azimuth). * The picture was started 25 seconds after touchdown and took 15 seconds to acquire. The alternating bright and dark vertical striations at the left side of the image and the fine particles deposited on the footpad at the right side were caused by a turbulent cloud of dust raised by the lander's retrorockets. † *F. O. Huck and S. D. Wall, "Image quality prediction: An aid to the Viking Lander imaging investigation on Mars. "

Appl. Opt. 15, 1748-1766 (1976). tT. A. Mutch, A. B. Binder, F. O. Huck, E. C. Levinthal, S. Liebes, Jr. , E. C. Morris, W. R. Patterson, J. B. Pollack, C. Sagan and G. R. Taylor, "The Surface of Mars: The view from the Viking 1 Lander. " Science 193, 791-801 (1976). VISUAL COMMUNICATION An Information Theory Approach Chapter 1 Introduction 1. 1 OBJECTIVE I The fundamental problem of communication, as Shannon stated it, is that of reproducing at one point either exactly or approximately a message selected at another point. In the classical model of communication (Fig. 1. 1), the information source selects a desired message from a set of possible messages which the transmitter changes into the signal that is actually sent over the communication channel to the receiver. The receiver changes this signal back into a message, and hands this message to the destination.

This book features 13 papers presented at the Fifth International Symposium on Recurrence Plots, held August 2013 in Chicago, IL. It examines recent applications and developments in recurrence plots and recurrence quantification analysis (RQA) with special emphasis on biological and cognitive systems and the analysis of coupled systems using cross-recurrence methods. Readers will discover new applications and insights into a range of systems provided by recurrence plot analysis and new theoretical and mathematical developments in recurrence plots. Recurrence plot based analysis is a powerful tool that operates on real-world complex systems that are nonlinear, non-stationary, noisy, of any statistical distribution, free of any particular model type and not particularly long. Quantitative analyses promote the detection of system state changes, synchronized dynamical regimes or classification of system states. The book will be of interest to an interdisciplinary audience of recurrence plot users and researchers interested in time series analysis of complex systems in general. Pulsing with drama and excitement, *Infinitesimal* celebrates the spirit of discovery, innovation, and intellectual achievement-and it will forever change the way you look at a simple line. On August 10, 1632, five men in flowing black robes convened in a somber Roman palazzo to pass judgment on a deceptively simple proposition: that a continuous line is composed of distinct and infinitely tiny parts. With the stroke of a pen the Jesuit fathers banned the doctrine of infinitesimals, announcing that it could never be taught or even mentioned. The concept was deemed dangerous and subversive, a threat to the belief that the world was an orderly place, governed by a strict and unchanging set of rules. If infinitesimals were ever accepted, the Jesuits feared, the entire world would be plunged into chaos. In *Infinitesimal*, the award-winning historian Amir Alexander exposes the deep-seated reasons behind the rulings of the Jesuits and shows how the doctrine persisted, becoming the foundation of calculus and much of modern mathematics and technology. Indeed, not everyone agreed with the Jesuits. Philosophers, scientists, and mathematicians across Europe embraced infinitesimals as the key to scientific progress, freedom of thought, and a more tolerant society. As Alexander reveals, it wasn't long before the two camps set off

on a war that pitted Europe's forces of hierarchy and order against those of pluralism and change. The story takes us from the bloody battlefields of Europe's religious wars and the English Civil War and into the lives of the greatest mathematicians and philosophers of the day, including Galileo and Isaac Newton, Cardinal Bellarmine and Thomas Hobbes, and Christopher Clavius and John Wallis. In Italy, the defeat of the infinitely small signaled an end to that land's reign as the cultural heart of Europe, and in England, the triumph of infinitesimals helped launch the island nation on a course that would make it the world's first modern state. From the imperial cities of Germany to the green hills of Surrey, from the papal palace in Rome to the halls of the Royal Society of London, Alexander demonstrates how a disagreement over a mathematical concept became a contest over the heavens and the earth. The legitimacy of popes and kings, as well as our beliefs in human liberty and progressive science, were at stake—the soul of the modern world hinged on the infinitesimal.

Mathematical Foundations for Signal Processing, Communications, and Networking describes mathematical concepts and results important in the design, analysis, and optimization of signal processing algorithms, modern communication systems, and networks. Helping readers master key techniques and comprehend the current research literature, the book offers a comprehensive overview of methods and applications from linear algebra, numerical analysis, statistics, probability, stochastic processes, and optimization. From basic transforms to Monte Carlo simulation to linear programming, the text covers a broad range of mathematical techniques essential to understanding the concepts and results in signal processing, telecommunications, and networking. Along with discussing mathematical theory, each self-contained chapter presents examples that illustrate the use of various mathematical concepts to solve different applications. Each chapter also includes a set of homework exercises and readings for additional study. This text helps readers understand fundamental and advanced results as well as recent research trends in the interrelated fields of signal processing, telecommunications, and networking. It provides all the necessary mathematical background to prepare students for more advanced courses and train specialists working in these areas.

Information is a core concept in animal communication: individuals routinely produce, acquire, process and store information, which provides the basis for their social life. This book focuses on how animal acoustic signals code information and how this coding can be shaped by various environmental and social constraints. Taking birds and mammals, including humans, as models, the authors explore such topics as communication strategies for “public” and “private” signaling, static and dynamic signaling, the diversity of coded information and the way information is decoded by the receiver. The book appeals to a wide audience, ranging from bioacousticians, ethologists and ecologists to evolutionary biologists. Intended for students and researchers alike, it promotes the idea that Shannon and Weaver’s *Mathematical Theory of*

Communication still represents a strong framework for understanding all aspects of the communication process, including its dynamic dimensions.

This review of literature on perspective constructions from the Renaissance through the 18th century covers 175 authors, emphasizing Peiro della Francesca, Guidobaldo del Monte, Simon Stevin, Brook Taylor, and Johann Heinrich. It treats such topics as the various methods of constructing perspective, the development of theories underlying the constructions, and the communication between mathematicians and artisans in these developments.

The first edition of this book was the first to cover in depth the mathematical theory of nonblocking multistage interconnecting networks, which is applicable to both communication and computer networks. This comprehensively updated new edition not only introduces the classical theory of the fundamental point-to-point network but also has a renewed emphasis on the latest multicast and multirate networks. The book can serve as either a one- or two-semester textbook for graduate students of information science, (electronic) communications, and applied mathematics. In addition, as all the relevant literature is organized and evaluated under one structured framework, the volume is an essential reference for researchers in those areas.

Number Theory in Science and Communication introduces non-mathematicians to the fascinating and diverse applications of number theory. This best-selling book stresses intuitive understanding rather than abstract theory. This revised fourth edition is augmented by recent advances in primes in progressions, twin primes, prime triplets, prime quadruplets and quintuplets, factoring with elliptic curves, quantum factoring, Golomb rulers and "baroque" integers.

At the intersection of mathematics, engineering, and computer science sits the thriving field of compressive sensing. Based on the premise that data acquisition and compression can be performed simultaneously, compressive sensing finds applications in imaging, signal processing, and many other domains. In the areas of applied mathematics, electrical engineering, and theoretical computer science, an explosion of research activity has already followed the theoretical results that highlighted the efficiency of the basic principles. The elegant ideas behind these principles are also of independent interest to pure mathematicians. A Mathematical Introduction to Compressive Sensing gives a detailed account of the core theory upon which the field is built. With only moderate prerequisites, it is an excellent textbook for graduate courses in mathematics, engineering, and computer science. It also serves as a reliable resource for practitioners and researchers in these disciplines who want to acquire a careful understanding of the subject. A Mathematical Introduction to Compressive Sensing uses a mathematical perspective to present the core of the theory underlying compressive sensing.

Most coding theory experts date the origin of the subject with the 1948 publication of A Mathematical Theory of Communication by Claude Shannon. Since then, coding theory has grown into a discipline with many practical applications (antennas, networks, memories), requiring various mathematical techniques, from commutative algebra, to semi-definite programming, to algebraic geometry. Most topics covered in the Concise

Encyclopedia of Coding Theory are presented in short sections at an introductory level and progress from basic to advanced level, with definitions, examples, and many references. The book is divided into three parts: Part I fundamentals: cyclic codes, skew cyclic codes, quasi-cyclic codes, self-dual codes, codes and designs, codes over rings, convolutional codes, performance bounds Part II families: AG codes, group algebra codes, few-weight codes, Boolean function codes, codes over graphs Part III applications: alternative metrics, algorithmic techniques, interpolation decoding, pseudo-random sequences, lattices, quantum coding, space-time codes, network coding, distributed storage, secret-sharing, and code-based-cryptography. Features Suitable for students and researchers in a wide range of mathematical disciplines Contains many examples and references Most topics take the reader to the frontiers of research Originally developed by Claude Shannon in the 1940s, information theory laid the foundations for the digital revolution, and is now an essential tool in telecommunications, genetics, linguistics, brain sciences, and deep space communication. In this richly illustrated book, accessible examples are used to introduce information theory in terms of everyday games like '20 questions' before more advanced topics are explored. Online MatLab and Python computer programs provide hands-on experience of information theory in action, and PowerPoint slides give support for teaching. Written in an informal style, with a comprehensive glossary and tutorial appendices, this text is an ideal primer for novices who wish to learn the essential principles and applications of information theory.

The subject of this book is theory of quantum system presented from information science perspective. The central role is played by the concept of quantum channel and its entropic and information characteristics. Quantum information theory gives a key to understanding elusive phenomena of quantum world and provides a background for development of experimental techniques that enable measuring and manipulation of individual quantum systems. This is important for the new efficient applications such as quantum computing, communication and cryptography. Research in the field of quantum informatics, including quantum information theory, is in progress in leading scientific centers throughout the world. This book gives an accessible, albeit mathematically rigorous and self-contained introduction to quantum information theory, starting from primary structures and leading to fundamental results and to exiting open problems.

[Copyright: 954b78507fe87322677fd7ea171299fc](https://doi.org/10.1007/978-1-4939-9873-2)