Quantum Computing For Computer Scientists

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Quantum Computing - Kuldeep Singh Kaswan 2023-05-09
A helpful introduction to all aspects of quantum computing Quantum computing is a field combining quantum mechanics—the physical science of nature at the scale of atoms and subatomic particles—and information science. Where ordinary computing uses bits, logical values whose position can either be 0 or 1, quantum computing is built around qubits, a fundamental unit of quantum information which can exist in a superposition of both states. As quantum computers are able to complete certain kinds of functions more accurately and

efficiently than computers built on classical binary logic, quantum computing is an emerging frontier which promises to revolutionize information science and its applications. This book provides a concise, accessible introduction to quantum computing. It begins by introducing the essentials of quantum mechanics that information and computer scientists require, before moving to detailed discussions of quantum computing in theory and practice. As quantum computing becomes an ever-greater part of the global information technology landscape, the knowledge in Quantum Computing will position

readers to join a vital and highly marketable field of research and development. The book's readers will also find: Detailed diagrams and illustrations throughout A broadly applicable quantum algorithm that improves on the best-known classical algorithms for a wide range of problems In-depth discussion of essential topics including key distribution, cluster state quantum computing, superconducting qubits, and more Quantum Computing is perfect for advanced undergraduate and graduate students in computer science, engineering, mathematics, or the physical sciences, as well as for researchers and academics at the intersection of these fields who want a concise reference.

Research Anthology on Advancements in Quantum Technology - Management Association, Information Resources 2021-03-19 Quantum technology has arrived as one of the most important new topics of research, as it is the newest way to create computing power, harness secure communications, and use sensitive measurement methods that surpass the capabilities of modern supercomputers. If successfully developed, quantum computers and technology will be able to perform algorithms at impressively quick rates and solve problems that were previously deemed impossible.

This technology will disrupt what is already known about computing and will be able to reach new heights, speeds, and problem-solving capabilities not yet seen. Beyond its inherent benefits comes the fact that quantum technology will create improvements in many everyday gadgets as well, spanning many industries. The Research Anthology on Advancements in Quantum Technology presents the latest discoveries in quantum technology itself along with providing its essential uses, applications, and technologies that will impact computing in modern times and far into the future. Along with this overview comes a look at quantum technology in many different fields such as healthcare, communications, aviation, automotive, forecasting, and more. These industries will be looked at from the perspective of data analytics, pattern matching, cryptography, algorithms, and more. This book is essential for computer scientists, engineers, professionals, researchers, students, and practitioners interested in the latest information on quantum technology.

Quantum Computing - National Academies of Sciences, Engineering, and Medicine 2019-04-27 Quantum mechanics, the subfield of

physics that describes the behavior of very small (quantum) particles, provides the basis for a new paradigm of computing. First proposed in the 1980s as a way to improve computational modeling of quantum systems, the field of quantum computing has recently garnered significant attention due to progress in building small-scale devices. However, significant technical advances will be required before a large-scale, practical quantum computer can be achieved. Quantum Computing: Progress and Prospects provides an introduction to the field, including the unique characteristics and constraints of the technology, and assesses the feasibility and implications of creating a functional quantum computer capable of addressing real-world problems. This report considers hardware and software requirements, quantum algorithms, drivers of advances in quantum computing and quantum devices, benchmarks associated with relevant use cases, the time and resources required, and how to assess the probability of success. *Frontiers of Engineering* - National Academy of Engineering 2019-02-28 This volume presents papers on the topics covered at the National Academy of Engineering's 2018 US Frontiers of Engineering Symposium.

Every year the symposium brings together 100 outstanding young leaders in engineering to share their cutting-edge research and innovations in selected areas. The 2018 symposium was held September 5-7 and hosted by MIT Lincoln Laboratory in Lexington, Massachusetts. The intent of this book is to convey the excitement of this unique meeting and to highlight innovative developments in engineering research and technical work.

Computer Science - Edward K. Blum 2011-12-02 Computer Science: The Hardware, Software and Heart of It focuses on the deeper aspects of the two recognized subdivisions of Computer Science, Software and Hardware. These subdivisions are shown to be closely interrelated as a result of the stored-program concept. Computer Science: The Hardware, Software and Heart of It includes certain classical theoretical computer science topics such as Unsolvability (e.g. the halting problem) and Undecidability (e.g. Godel's incompleteness theorem) that treat problems that exist under the Church-Turing thesis of computation. These problem topics explain inherent limits lying at the heart of software, and in effect define boundaries beyond which computer science professionals cannot go beyond. Newer topics

such as Cloud Computing are also covered in this book. After a survey of traditional programming languages (e.g. Fortran and C++), a new kind of computer Programming for parallel/distributed computing is presented using the message-passing paradigm which is at the heart of large clusters of computers. This leads to descriptions of current hardware platforms for large-scale computing, such as clusters of as many as one thousand which are the new generation of supercomputers. This also leads to a consideration of future quantum computers and a possible escape from the Church-Turing thesis to a new computation paradigm. The book's historical context is especially helpful during this, the centenary of Turing's birth. Alan Turing is widely regarded as the father of Computer Science, since many concepts in both the hardware and software of Computer Science can be traced to his pioneering research. Turing was a multi-faceted mathematician-engineer and was able to work on both concrete and abstract levels. This book shows how these two seemingly disparate aspects of Computer Science are intimately related. Further, the book treats the theoretical side of Computer Science as well, which also derives from Turing's research. Computer Science: The Hardware, Software and Heart of It is designed as a professional book for practitioners and researchers working in the related fields of Quantum Computing, Cloud Computing, Computer Networking, as well as non-scientist readers. Advanced-level and undergraduate students concentrating on computer science, engineering and mathematics will also find this book useful.

Quantum Computing for Computer Scientists - Noson S. Yanofsky 2014-05-14

Finally, a textbook that explains quantum computing using techniques and concepts familiar to computer scientists.

Minds, Machines, and the Multiverse - Julian Brown 2002-04-05

The imminent arrival of the quantum computer, millions of times faster than today's computers, promises to launch a scientific gold rush of the new millennium. After consulting with both the computer's debunkers and the leading minds behind the breakthrough, Brown explains the quantum computer's development thus far.

Quantum Computer Systems: Research for Noisy Intermediate-Scale Quantum Computers - Yongshan Ding 2020-06-17

This book targets computer scientists and engineers who are

familiar with concepts in classical computer systems but are curious to learn the general architecture of quantum computing systems. It gives a concise presentation of this new paradigm of computing from a computer systems' point of view without assuming any background in quantum mechanics. As such, it is divided into two parts. The first part of the book provides a gentle overview on the fundamental principles of the quantum theory and their implications for computing. The second part is devoted to state-of-the-art research in designing practical quantum programs, building a scalable software systems stack, and controlling quantum hardware components. Most chapters end with a summary and an outlook for future directions. This book celebrates the remarkable progress that scientists across disciplines have made in the past decades and reveals what roles computer scientists and engineers can play to enable practical-scale quantum computing.

Quantum Information - Gernot Alber 2003-07-01

A self-contained introduction to the basic theoretical concepts, experimental techniques and recent advances in the fields of quantum communication, quantum information and quantum computation. The introductory and self-contained character of the contributions should make this book particularly attractive to students and active researchers in physics and computer science who want to become acquainted with the underlying basic ideas and recent advances in the rapidly evolving field of quantum information processing.

Quantum Machine Learning - Peter Wittek 2014-09-10

Quantum Machine Learning bridges the gap between abstract developments in quantum computing and the applied research on machine learning. Paring down the complexity of the disciplines involved, it focuses on providing a synthesis that explains the most important machine learning algorithms in a quantum framework. Theoretical advances in quantum computing are hard to follow for computer scientists, and sometimes even for researchers involved in the field. The lack of a step-by-step guide hampers the broader understanding of this emergent interdisciplinary body of research. Quantum Machine Learning sets the scene for a deeper understanding of the subject for readers of different backgrounds. The author has carefully constructed a clear comparison of classical learning algorithms and their quantum counterparts, thus making differences in computational complexity and

learning performance apparent. This book synthesizes of a broad array of research into a manageable and concise presentation, with practical examples and applications. Bridges the gap between abstract developments in quantum computing with the applied research on machine learning Provides the theoretical minimum of machine learning, quantum mechanics, and quantum computing Gives step-by-step guidance to a broader understanding of this emergent interdisciplinary body of research *Quantum Walks for Computer Scientists* - Salvador Venegas-Andraca 2022-05-31 Quantum computation, one of the latest joint ventures between physics and the theory of computation, is a scientific field whose main goals include the development of hardware and algorithms based on the quantum mechanical properties of those physical systems used to implement such algorithms. Solving difficult tasks (for example, the Satisfiability Problem and other NP-complete problems) requires the development of sophisticated algorithms, many ofwhich employ stochastic processes as their mathematical basis. Discrete random walks are a popular choice among those stochastic processes. Inspired on the success of discrete random walks in algorithm development, quantum walks, an emerging field of quantum computation, is a generalization of random walks into the quantum mechanical world. The purpose of this lecture is to provide a concise yet comprehensive introduction to quantum walks. Table of Contents: Introduction / Quantum Mechanics / Theory of Computation / Classical Random Walks / Quantum Walks / Computer Science and Quantum Walks / Conclusions *Quantum Computation and Quantum Information* - Michael A. Nielsen 2010-12-09 One of the most cited books in physics of all time, Quantum Computation and Quantum Information remains the best textbook in this exciting field of science. This 10th anniversary edition includes an introduction from the authors setting the work in context. This comprehensive textbook describes such remarkable effects as fast quantum algorithms, quantum teleportation, quantum cryptography and quantum error-correction. Quantum mechanics and computer science are introduced before moving on to describe what a quantum computer is, how it can be used to solve problems faster than 'classical' computers and its real-world implementation. It concludes with an in-depth treatment of quantum

information. Containing a wealth of figures and exercises, this well-known textbook is ideal for courses on the subject, and will interest beginning graduate students and researchers in physics, computer science, mathematics, and electrical engineering.

Frontiers in Quantum Computing - Luigi Maxmilian Caligiuri 2020-10

Quantum Computing is an ever-increasing field of interest both from a conceptual and applied standpoint. Quantum Computing, belonging to the so called "Quantum Information Science", is founded on the principles of Quantum Mechanics and Information Science. Quantum Mechanics has radically changed our vision and understanding of the physical reality and has had also an enormous technological and societal impact. On the other hand, the developing of Information Theory, including computer science and communications theory, made possible the information "revolution" which had a deep impact on our everyday life. Quantum Computing then relates to the possibility to represent, process and manipulate information by using the principles of quantum mechanics. Apart the theoretical importance of quantum computing to further understand the quantum mechanical behavior of physical systems and the physical foundation of information itself at the most elementary level, probably the most interesting feature of Quantum Computing is related to the possibility to design and realize an actual quantum computer which processes information in the form of quantum-bits or qubits. The great interest of scientific community in the realization of such devices mainly concerns the common believe they could be enormously faster than their classical counterparts so allowing their employment in all the applied fields where computational power is a key feature. Furthermore, the study of Quantum Computing, both at the physical and computational level, would be very important for a deeper understanding of the quantum behavior of a very wide range of physical systems including condensed matter, living systems, elementary particles, astrophysical structures and so on. Despite the general theoretical basis of quantum computing are sufficiently understood, the actual realization of a general-purpose and really usable quantum computer has posed great difficulties so far, mainly related to the issue of "quantum decoherence", the computational speed and scalability many of which still remain substantially

unsolved. This volume doesn't mean to represent a complete or a beginner guide to Quantum Computing but has the aim to present some of its most interesting and fascinating developments in different frontier areas related to both theoretical and applied aspects, such, for example, the possibility to realize a quantum superfast "hypercomputing" system using water molecules as physical substrate to process, storage and retrieve information; the connection between quantum computers and quantum gravity; the development of an "instantaneous quantum computer algorithm"; the realization of a universal quantum computer, of a brain-like quantum supercomputer and many others frontiers topics. The target audience of this book is then composed by scientists and researchers interested in the most advanced theoretical and applied developments of quantum computation and quantum information.

Quantum Computing for Programmers - Robert Hundt 2022-03-31
Takes readers from the basics to detailed derivations and open-source implementations of more than 25 fundamental quantum algorithms.

A Shortcut Through Time - George Johnson 2004-02-10

In this remarkably illustrative and thoroughly accessible look at one of the most intriguing frontiers in science and computers, award-winning New York Times writer George Johnson reveals the fascinating world of quantum computing—the holy grail of super computers where the computing power of single atoms is harnassed to create machines capable of almost unimaginable calculations in the blink of an eye. As computer chips continue to shrink in size, scientists anticipate the end of the road: A computer in which each switch is comprised of a single atom. Such a device would operate under a different set of physical laws: The laws of quantum mechanics. Johnson gently leads the curious outsider through the surprisingly simple ideas needed to understand this dream, discussing the current state of the revolution, and ultimately assessing the awesome power these machines could have to change our world.

Quantum Computing for Babies - Chris Ferrie 2018-04-02
"Quantum Computing for Babies is a colorfully simple introduction to the magical world of quantum computers. Babies (and grownups!) will discover the difference between bits and qubits and how quantum computers will change our future"--

Programming the Universe - Seth

Lloyd 2007-03-13

Is the universe actually a giant quantum computer? According to Seth Lloyd, the answer is yes. All interactions between particles in the universe, Lloyd explains, convey not only energy but also information—in other words, particles not only collide, they compute. What is the entire universe computing, ultimately? "Its own dynamical evolution," he says. "As the computation proceeds, reality unfolds." Programming the Universe, a wonderfully accessible book, presents an original and compelling vision of reality, revealing our world in an entirely new light.

Automatic Quantum Computer Programming - Lee Spector 2006-04-18

Automatic Quantum Computer Programming provides an introduction to quantum computing for non-physicists, as well as an introduction to genetic programming for non-computer-scientists. The book explores several ways in which genetic programming can support automatic quantum computer programming and presents detailed descriptions of specific techniques, along with several examples of their human-competitive performance on specific problems. Source code for the author's QGAME quantum computer simulator is included as an appendix, and pointers to additional online resources furnish the reader with an array of tools for automatic quantum computer programming.

Quantum Computing Since Democritus - Scott Aaronson 2013-03-14

Takes students and researchers on a tour through some of the deepest ideas of maths, computer science and physics.

Technology Road Mapping for Quantum Computing and Engineering - Mishra, Brojo Kishore 2022-03-25

Quantum computing is radically different from the conventional approach of transforming bit-strings from one set of zeros and ones to another. With quantum computing, everything changes. The physics used to understand bits of information and the devices that manipulate them are vastly different. Quantum engineering is a revolutionary approach to quantum technology. Technology Road Mapping for Quantum Computing and Engineering explores all the aspects of quantum computing concepts, engineering, technologies, operations, and applications from the basics to future advancements. Covering topics such as machine learning, quantum software technology, and technology road mapping, this book is an excellent resource for data scientists, engineers,

students and professors of higher education, computer scientists, researchers, and academicians.

Machine Learning with Quantum Computers - Maria Schuld 2021-11-18

This book offers an introduction into quantum machine learning research, covering approaches that range from "near-term" to fault-tolerant quantum machine learning algorithms, and from theoretical to practical techniques that help us understand how quantum computers can learn from data. Among the topics discussed are parameterized quantum circuits, hybrid optimization, data encoding, quantum feature maps and kernel methods, quantum learning theory, as well as quantum neural networks. The book aims at an audience of computer scientists and physicists at the graduate level onwards. The second edition extends the material beyond supervised learning and puts a special focus on the developments in near-term quantum machine learning seen over the past few years.

Quantum Computing for Computer Scientists - Noson S. Yanofsky 2008-08-11

The multidisciplinary field of quantum computing strives to exploit some of the uncanny aspects of quantum mechanics to expand our computational horizons. Quantum Computing for Computer Scientists takes readers on a tour of this fascinating area of cutting-edge research. Written in an accessible yet rigorous fashion, this book employs ideas and techniques familiar to every student of computer science. The reader is not expected to have any advanced mathematics or physics background. After presenting the necessary prerequisites, the material is organized to look at different aspects of quantum computing from the specific standpoint of computer science. There are chapters on computer architecture, algorithms, programming languages, theoretical computer science, cryptography, information theory, and hardware. The text has step-by-step examples, more than two hundred exercises with solutions, and programming drills that bring the ideas of quantum computing alive for today's computer science students and researchers.

Adiabatic Quantum Computation and Quantum Annealing - Catherine C. McGeoch 2014-07-01

Adiabatic quantum computation (AQC) is an alternative to the better-known gate model of quantum computation. The two models are polynomially equivalent, but otherwise quite dissimilar: one property that distinguishes AQC from the gate model is its analog nature.

Quantum annealing (QA) describes a type of heuristic search algorithm that can be implemented to run in the "native instruction set" of an AQC platform. D-Wave Systems Inc. manufactures {quantum annealing processor chips} that exploit quantum properties to realize QA computations in hardware. The chips form the centerpiece of a novel computing platform designed to solve NP-hard optimization problems. Starting with a 16-qubit prototype announced in 2007, the company has launched and sold increasingly larger models: the 128-qubit D-Wave One system was announced in 2010 and the 512-qubit D-Wave Two system arrived on the scene in 2013. A 1,000-qubit model is expected to be available in 2014. This monograph presents an introductory overview of this unusual and rapidly developing approach to computation. We start with a survey of basic principles of quantum computation and what is known about the AQC model and the QA algorithm paradigm. Next we review the D-Wave technology stack and discuss some challenges to building and using quantum computing systems at a commercial scale. The last chapter reviews some experimental efforts to understand the properties and capabilities of these unusual platforms. The discussion throughout is aimed at an audience of computer scientists with little background in quantum computation or in physics.

Automatic Quantum Computer Programming - Lee Spector 2006-10-04

Once realized, the potential of large-scale quantum computers promises to radically transform computer science. Despite large-scale international efforts, however, essential questions about the potential of quantum algorithms are still unanswered. Automatic Quantum Computer Programming is an introduction both to quantum computing for non-physicists and to genetic programming for non-computer-scientists. The book explores several ways in which genetic programming can support automatic quantum computer programming and presents detailed descriptions of specific techniques, along with several examples of their human-competitive performance on specific problems.

Mathematics of Quantum Computation - Ranee K. Brylinski 2002-02-14

Among the most exciting developments in science today is the design and construction of the quantum computer. Its realization will be the result of multidisciplinary efforts, but ultimately, it is mathematics that

lies at the heart of theoretical quantum computer science. Mathematics of Quantum Computation brings together leading computer scientists, mathematicians, and physicists to provide the first interdisciplinary but mathematically focused exploration of the field's foundations and state of the art. Each section of the book addresses an area of major research, and does so with introductory material that brings newcomers quickly up to speed. Chapters that are more advanced include recent developments not yet published in the open literature. Information technology will inevitably enter into the realm of quantum mechanics, and, more than all the atomic, molecular, optical, and nanotechnology advances, it is the device-independent mathematics that is the foundation of quantum computer and information science. Mathematics of Quantum Computation offers the first up-to-date coverage that has the technical depth and breadth needed by those interested in the challenges being confronted at the frontiers of research.

Quantum Computing - Eleanor G. Rieffel 2014-08-29
A thorough exposition of quantum computing and the underlying concepts of quantum physics, with explanations of the relevant mathematics and numerous examples. The combination of two of the twentieth century's most influential and revolutionary scientific theories, information theory and quantum mechanics, gave rise to a radically new view of computing and information. Quantum information processing explores the implications of using quantum mechanics instead of classical mechanics to model information and its processing. Quantum computing is not about changing the physical substrate on which computation is done from classical to quantum but about changing the notion of computation itself, at the most basic level. The fundamental unit of computation is no longer the bit but the quantum bit or qubit. This comprehensive introduction to the field offers a thorough exposition of quantum computing and the underlying concepts of quantum physics, explaining all the relevant mathematics and offering numerous examples. With its careful development of concepts and thorough explanations, the book makes quantum computing accessible to students and professionals in mathematics, computer science, and engineering. A reader with no prior knowledge of quantum physics (but with sufficient knowledge of linear algebra) will be able to gain a fluent understanding by working

through the book.

Quantum Computer Science - N. David Mermin 2007-08-30 In the 1990's it was realized that quantum physics has some spectacular applications in computer science. This book is a concise introduction to quantum computation, developing the basic elements of this new branch of computational theory without assuming any background in physics. It begins with an introduction to the quantum theory from a computer-science perspective. It illustrates the quantum-computational approach with several elementary examples of quantum speed-up, before moving to the major applications: Shor's factoring algorithm, Grover's search algorithm, and quantum error correction. The book is intended primarily for computer scientists who know nothing about quantum theory, but will also be of interest to physicists who want to learn the theory of quantum computation, and philosophers of science interested in quantum foundational issues. It evolved during six years of teaching the subject to undergraduates and graduate students in computer science, mathematics, engineering, and physics, at Cornell University.

Quantum Computing Explained - David McMahon 2007-12-14 A self-contained treatment of the fundamentals of quantum computing This clear, practical book takes quantum computing out of the realm of theoretical physics and teaches the fundamentals of the field to students and professionals who have not had training in quantum computing or quantum information theory, including computer scientists, programmers, electrical engineers, mathematicians, physics students, and chemists. The author cuts through the conventions of typical jargon-laden physics books and instead presents the material through his unique "how-to" approach and friendly, conversational style. Readers will learn how to carry out calculations with explicit details and will gain a fundamental grasp of: * Quantum mechanics * Quantum computation * Teleportation * Quantum cryptography * Entanglement * Quantum algorithms * Error correction A number of worked examples are included so readers can see how quantum computing is done with their own eyes, while answers to similar end-of-chapter problems are provided for readers to check their own work as they learn to master the information. Ideal for professionals and graduate-level students alike, Quantum Computing Explained delivers the fundamentals of quantum computing readers need

to be able to understand current research papers and go on to study more advanced quantum texts.

Quantum Walks for Computer Scientists - Salvador Elí as Venegas-Andraca 2008 "Quantum computation, one of the latest joint ventures between physics and the theory of computation, is a scientific field whose main goals include the development of hardware and algorithms based on the quantum mechanical properties of those physical systems used to implement such algorithms." "Solving difficult tasks (for example, the Satisfiability Problem and other NP-complete problems) requires the development of sophisticated algorithms, many of which employ stochastic processes as their mathematical basis. Discrete random walks are a popular choice among those stochastic processes." "Inspired on the success of discrete random walks in algorithm development, quantum walks, an emerging field of quantum computation, is a generalization of random walks into the quantum mechanical world." "The purpose of this lecture is to provide a concise yet comprehensive introduction to quantum walks."--BOOK JACKET.

Explorations in Quantum Computing - Colin P. Williams 2010-12-07

By the year 2020, the basic memory components of a computer will be the size of individual atoms. At such scales, the current theory of computation will become invalid. "Quantum computing" is reinventing the foundations of computer science and information theory in a way that is consistent with quantum physics - the most accurate model of reality currently known. Remarkably, this theory predicts that quantum computers can perform certain tasks breathtakingly faster than classical computers — and, better yet, can accomplish mind-boggling feats such as teleporting information, breaking supposedly "unbreakable" codes, generating true random numbers, and communicating with messages that betray the presence of eavesdropping. This widely anticipated second edition of Explorations in Quantum Computing explains these burgeoning developments in simple terms, and describes the key technological hurdles that must be overcome to make quantum computers a reality. This easy-to-read, time-tested, and comprehensive textbook provides a fresh perspective on the capabilities of quantum computers, and supplies readers with the tools necessary to make their own foray into this exciting

field. Topics and features: concludes each chapter with exercises and a summary of the material covered; provides an introduction to the basic mathematical formalism of quantum computing, and the quantum effects that can be harnessed for non-classical computation; discusses the concepts of quantum gates, entangling power, quantum circuits, quantum Fourier, wavelet, and cosine transforms, and quantum universality, computability, and complexity; examines the potential applications of quantum computers in areas such as search, code-breaking, solving NP-Complete problems, quantum simulation, quantum chemistry, and mathematics; investigates the uses of quantum information, including quantum teleportation, superdense coding, quantum data compression, quantum cloning, quantum negation, and quantum cryptography; reviews the advancements made towards practical quantum computers, covering developments in quantum error correction and avoidance, and alternative models of quantum computation. This text/reference is ideal for anyone wishing to learn more about this incredible, perhaps "ultimate," computer revolution. Dr. Colin P. Williams is Program Manager for Advanced Computing Paradigms at the NASA Jet Propulsion Laboratory, California Institute of Technology, and CEO of Xtreme Energetics, Inc. an advanced solar energy company. Dr. Williams has taught quantum computing and quantum information theory as an acting Associate Professor of Computer Science at Stanford University. He has spent over a decade inspiring and leading high technology teams and building business relationships with and Silicon Valley companies. Today his interests include terrestrial and Space-based power generation, quantum computing, cognitive computing, computational material design, visualization, artificial intelligence, evolutionary computing, and remote olfaction. He was formerly a Research Scientist at Xerox PARC and a Research Assistant to Prof. Stephen W. Hawking, Cambridge University.

Quantum Computing - Jozef Gruska 1999

This book takes a very broad view of quantum computing – from very basic principles to algorithms, automata, networks, quantum information and quantum processors.

Will We Ever Have a Quantum Computer? - Mikhail I. Dyakonov 2020-03-23

This book addresses a broad community of physicists, engineers,

computer scientists and industry professionals, as well as the general public, who are aware of the unprecedented media hype surrounding the supposedly imminent new era of quantum computing. The central argument of this book is that the feasibility of quantum computing in the physical world is extremely doubtful. The hypothetical quantum computer is not simply a quantum variant of the conventional digital computer, but rather a quantum extension of a classical analog computer operating with continuous parameters. In order to have a useful machine, the number of continuous parameters to control would have to be of such an astronomically large magnitude as to render the endeavor virtually infeasible. This viewpoint is based on the author's expert understanding of the gargantuan challenges that would have to be overcome to ever make quantum computing a reality. Knowledge of secondary-school-level physics and math will be sufficient for understanding most of the text.

Elements of Quantum Computing - Seiki Akama 2014-07-14
A quantum computer is a computer based on a computational model which uses quantum mechanics, which is a subfield of physics to study phenomena at the micro level. There has been a growing interest on quantum computing in the 1990's and some quantum computers at the experimental level were recently implemented. Quantum computers enable super-speed computation and can solve some important problems whose solutions were regarded impossible or intractable with traditional computers. This book provides a quick introduction to quantum computing for readers who have no backgrounds of both theory of computation and quantum mechanics. "Elements of Quantum Computing" presents the history, theories and engineering applications of quantum computing. The book is suitable to computer scientists, physicists and software engineers.

Quantum Information Processing and Quantum Error Correction - Ivan Djordjevic 2012-04-16
Quantum Information Processing and Quantum Error Correction is a self-contained, tutorial-based introduction to quantum information, quantum computation, and quantum error-correction. Assuming no knowledge of quantum mechanics and written at an intuitive level suitable for the engineer, the book gives all the essential principles needed to design and implement quantum electronic and photonic circuits. Numerous examples from a wide area of application are given to show how

the principles can be implemented in practice. This book is ideal for the electronics, photonics and computer engineer who requires an easy-to-understand foundation on the principles of quantum information processing and quantum error correction, together with insight into how to develop quantum electronic and photonic circuits. Readers of this book will be ready for further study in this area, and will be prepared to perform independent research. The reader completed the book will be able design the information processing circuits, stabilizer codes, Calderbank-Shor-Steane (CSS) codes, subsystem codes, topological codes and entanglement-assisted quantum error correction codes; and propose corresponding physical implementation. The reader completed the book will be proficient in quantum fault-tolerant design as well. Unique Features Unique in covering both quantum information processing and quantum error correction - everything in one book that an engineer needs to understand and implement quantum-level circuits. Gives an intuitive understanding by not assuming knowledge of quantum mechanics, thereby avoiding heavy mathematics. In-depth coverage of the design and implementation of quantum information processing and quantum error correction circuits. Provides the right balance among the quantum mechanics, quantum error correction, quantum computing and quantum communication. Dr. Djordjevic is an Assistant Professor in the Department of Electrical and Computer Engineering of College of Engineering, University of Arizona, with a joint appointment in the College of Optical Sciences. Prior to this appointment in August 2006, he was with University of Arizona, Tucson, USA (as a Research Assistant Professor); University of the West of England, Bristol, UK; University of Bristol, Bristol, UK; Tyco Telecommunications, Eatontown, USA; and National Technical University of Athens, Athens, Greece. His current research interests include optical networks, error control coding, constrained coding, coded modulation, turbo equalization, OFDM applications, and quantum error correction. He presently directs the Optical Communications Systems Laboratory (OCSL) within the ECE Department at the University of Arizona. Provides everything an engineer needs in one tutorial-based introduction to understand and implement quantum-level circuits Avoids the heavy use of mathematics by not assuming the

previous knowledge of quantum mechanics Provides in-depth coverage of the design and implementation of quantum information processing and quantum error correction circuits *The Simulated Multiverse* - Rizwan Virk 2021-10-15 Do multiple versions of ourselves exist in parallel universes living out their lives in different timelines? In this follow up to his bestseller, The Simulation Hypothesis, MIT Computer Scientist and Silicon Valley Game Pioneer Rizwan Virk explores these topics from a new lens: that of simulation theory. If we are living in a digital universe, then many of the complexities and baffling characteristics of our reality start to make more sense. Quantum computing lets us simulate complex phenomena in parallel, allowing the simulation to explore many realities at once to find the most "optimum" path forward. Could this explain not only the enigmatic Mandela Effect but provide us with a new understanding of time and space? Bringing his unique trademark style of combining video games, computer science, quantum physics and computing with lots of philosophy and science fiction, Virk gives us a new way to think about not just our universe, but all possible realities!
Quantum Computing for Computer Scientists - Noson Yanofsky 2008 The multidisciplinary field of quantum computing strives to exploit some of the uncanny aspects of quantum mechanics to expand our computational horizons. Quantum Computing for Computer Scientists takes readers on a tour of this fascinating area of cutting-edge research. Written in an accessible yet rigorous fashion, this book employs ideas and techniques familiar to every student of computer science. The reader is not expected to have any advanced mathematics or physics background. After presenting the necessary prerequisites, the material is organized to look at different aspects of quantum computing from the specific standpoint of computer science. There are chapters on computer architecture, algorithms, programming languages, theoretical computer science, cryptography, information theory, and hardware. The text has step-by-step examples, more than two hundred exercises with solutions, and programming drills that bring the ideas of quantum computing alive for today's computer science students and researchers.
Quantum Computing from the Ground Up - Riley Tipton Perry 2012-07-11 Quantum computing — the application of quantum mechanics to information — represents a

fundamental break from classical information and promises to dramatically increase a computer's power. Many difficult problems, such as the factorization of large numbers, have so far resisted attack by classical computers yet are easily solved with quantum computers. If they become feasible, quantum computers will end standard practices such as RSA encryption. Most of the books or papers on quantum computing require (or assume) prior knowledge of certain areas such as linear algebra or quantum mechanics. The majority of the currently-available literature is hard to understand for the average computer enthusiast or interested layman. This text attempts to teach quantum computing from the ground up in an easily readable way, providing a comprehensive tutorial that includes all the necessary mathematics, computer science and physics. Errata(s) Errata

Quantum Computing for Everyone

- Chris Bernhardt 2020-09-08 An accessible introduction to an exciting new area in computation, explaining such topics as qubits, entanglement, and quantum teleportation for the general reader. Quantum computing is a beautiful fusion of quantum physics and computer science, incorporating some of the most stunning ideas from twentieth-century physics into an entirely new way of thinking about computation. In this book, Chris Bernhardt offers an introduction to quantum computing that is accessible to anyone who is comfortable with high school mathematics. He explains qubits, entanglement, quantum teleportation, quantum algorithms, and other quantum-related topics as clearly as possible for the general reader. Bernhardt, a mathematician himself, simplifies the mathematics as much as he can and provides elementary examples that illustrate both how the math works and what it means. Bernhardt introduces the basic unit of quantum computing, the qubit, and explains how the qubit can be measured; discusses entanglement—which, he says, is easier to describe mathematically than verbally—and what it means when two qubits are entangled (citing Einstein's characterization of what happens when the measurement of one entangled qubit affects the second as "spooky action at a distance"); and introduces quantum cryptography. He recaps standard topics in classical computing—bits, gates, and logic—and describes Edward Fredkin's ingenious billiard ball computer. He defines quantum gates, considers the speed of

quantum algorithms, and describes the building of quantum computers. By the end of the book, readers understand that quantum computing and classical computing are not two distinct disciplines, and that quantum computing is the fundamental form of computing. The basic unit of computation is the qubit, not the bit.

An Introduction to Quantum Computing - Phillip Kaye 2007

The authors provide an introduction to quantum computing. Aimed at advanced undergraduate and beginning graduate students in these disciplines, this text is illustrated with diagrams and exercises.

The Simulation Hypothesis - Rizwan Virk 2019-03-31

The Simulation Hypothesis, by best-selling author, renowned MIT computer scientist and Silicon Valley video game designer Rizwan Virk, is the first serious book to explain one of the most daring and consequential theories of our time. Riz is the Executive Director of Play Labs At MIT, a video game startup incubator at the MIT Game Lab. Drawing from research and concepts from computer science, artificial intelligence, video games, quantum physics, and referencing both speculative fiction and ancient eastern spiritual texts, Virk shows how all of these traditions come together to point to the idea that we may be inside a simulated reality like the Matrix. The Simulation Hypothesis is the idea that our physical reality, far from being a solid physical universe, is part of an increasingly sophisticated video game-like simulation, where we all have multiple lives, consisting of pixels with its own internal clock run by some giant Artificial Intelligence. Simulation theory explains some of the biggest mysteries of quantum and relativistic physics, such as quantum indeterminacy, parallel universes, and the integral nature of the speed of light. Recently, the idea that we may be living in a giant video game has received a lot of attention: "There's a one in a billion chance we are not living in a simulation" -Elon Musk "I find it hard to argue we are not in a simulation." -Neil deGrasse Tyson "We are living in computer generated reality." -Philip K. Dick Video game technology has developed from basic arcade and text adventures to MMORPGs. Video game designer Riz Virk shows how these games may continue to evolve in the future, including virtual reality, augmented reality, Artificial Intelligence, and quantum computing. This book shows how this evolution could lead us to the point of being able to develop all encompassing virtual worlds like the Oasis in Ready Player One, or the

simulated reality in the Matrix. While the idea sounds like science fiction, many scientists, engineers, and professors have given the Simulation Hypothesis serious consideration. Futurist Ray Kurzweil has popularized the idea of downloading our consciousness into a silicon based device, which would mean we are just digital information after all. Some, like Oxford lecturer Nick Bostrom, goes further and thinks we may in fact be artificially intelligent consciousness inside such a simulation already! But the Simulation Hypothesis is not just a modern idea. Philosophers like Plato have been telling us that we live in a "cave" and can only see shadows of the real world. Mystics of all traditions have long contended that we are living in some kind of "illusion "and that there are other realities which we can access with our minds. While even Judeo-Christian traditions have this idea, Eastern traditions like Buddhism and Hinduism make this idea part of their core tradition — that we are inside a dream world ("Maya" or illusion, or Vishnu's Dream), and we have "multiple lives" playing different characters when one dies, continuing to gain experience and "level up" after completing certain challenges. Sounds a lot like a video game! Whether you are a computer scientist, a fan of science fiction like the Matrix movies, a video game enthusiast, or a spiritual seeker, The Simulation Hypothesis touches on all these areas, and you will never look at the world the same way again!