

The Technological Singularity The Mit Press Essential Knowledge Series

Provocative, hopeful essays imagine a future that is not reduced to algorithms.

What artificial intelligence can tell us about the mind and intelligent behavior. What can artificial intelligence teach us about the mind? If AI's underlying concept is that thinking is a computational process, then how can computation illuminate thinking? It's a timely question. AI is all the rage, and the buzziest AI buzz surrounds adaptive machine learning: computer systems that learn intelligent behavior from massive amounts of data. This is what powers a driverless car, for example. In this book, Hector Levesque shifts the conversation to “good old fashioned artificial intelligence,” which is based not on heaps of data but on understanding commonsense intelligence. This kind of artificial intelligence is equipped to handle situations that depart from previous patterns—as we do in real life, when, for example, we encounter a washed-out bridge or when the barista informs us there's no more soy milk. Levesque considers the role of language in learning. He argues that a computer program that passes the famous Turing Test could be a mindless zombie, and he proposes another way to test for intelligence—the Winograd Schema Test, developed by Levesque and his colleagues. “If our

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goal is to understand intelligent behavior, we had better understand the difference between making it and faking it," he observes. He identifies a possible mechanism behind common sense and the capacity to call on background knowledge: the ability to represent objects of thought symbolically. As AI migrates more and more into everyday life, we should worry if systems without common sense are making decisions where common sense is needed. The noted inventor and futurist's successor to his landmark book *The Singularity Is Near* explores how technology will refashion the human race in the decades to come. Since it was first published in 2005, Ray Kurzweil's *The Singularity Is Near* and its vision of the future have been influential in spawning a worldwide movement with millions of followers, hundreds of books, major films (*Her*, *Lucy*, *Ex Machina*), and thousands of articles. During the succeeding decade many of Kurzweil's predictions about technological advancements have been borne out, and their viability has become familiar to the public through such now commonplace concepts as AI, intelligent machines, and bioengineering. In this entirely new book Ray Kurzweil brings a fresh perspective to advances in the singularity--assessing the progress of many of his predictions and examining the novel advancements that, in the near future, will bring a revolution in knowledge and an expansion of human potential. Among the topics he

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discusses are rebuilding the world, atom by atom with devices like nanobots; radical life extension beyond the current age limit of 120; reinventing intelligence by expanding biological capacity with nonbiological intelligence in the cloud; how life is improving with declines in areas such as poverty and violence; and the growth of technologies such as renewable energy and 3-D printing, which can be applied to everything from clothes to building materials to growing human organs. He also considers the potential perils of biotechnology, nanotechnology, and artificial intelligence, including such topics of current controversy as how AI will impact unemployment and the safety of autonomous cars, and After Life technology, which will reanimate people who have passed away through a combination of data and DNA.

The "genetic bomb" marks a turn in the history of humanity. The accident is a new form of warfare. It is replacing revolution and war. Sarajevo triggered the First World War. New York is what Sarajevo was. September 11th opened Pandora's box. The first war of globalization will be the global accident, the total accident, including the accident of science. And it is on the way. In 1968, Virilio abandoned his work in oblique architecture, believing that time had replaced space as the most important point of reflection because of the dominance of speed. We were basically on the verge of converting space time into

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space speed... Speed facilitates the decoding of the human genome, and the possibility of another humanity: a humanity which is no longer extra-territorial, but extra-human. *Crespuscular Dawn* expands Virilio's vision of the implosion of physical time and space, onto the micro-level of bioengineering and biotechnology. In this cat-and-mouse dialogue between Sylvère Lotringer and Paul Virilio, Lotringer pushes Virilio to uncover the historical foundations of his biotech theories. Citing various medical experiments conducted during World War II, Lotringer asks whether biotechnology isn't the heir to eugenics and the "science for racial improvement" that the Nazis enthusiastically embraced. Will the endocolonization of the body come to replace the colonization of one's own population by the military? Both biographical and thematic, the book explores the development of Virilio's investigation of space (architecture, urbanism) and time (speed and simultaneity) that would ultimately lay the foundation for his theories on biotechnology and his startling declaration that after the colonization of space begins the colonization of the body.

This volume contains a selection of authoritative essays exploring the central questions raised by the conjectured technological singularity. In informed yet jargon-free contributions written by active research scientists, philosophers and sociologists, it goes

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beyond philosophical discussion to provide a detailed account of the risks that the singularity poses to human society and, perhaps most usefully, the possible actions that society and technologists can take to manage the journey to any singularity in a way that ensures a positive rather than a negative impact on society. The discussions provide perspectives that cover technological, political and business issues. The aim is to bring clarity and rigor to the debate in a way that will inform and stimulate both experts and interested general readers. The first English translation of the book that established Paolo Virno as one of the most influential Italian thinkers of his generation. With the 1986 publication of this book in Italy, Paolo Virno established himself as one of the most influential Italian thinkers of his generation. Astonishingly, this crucial work has never before been published in an English translation. This MIT Press edition, translated by Italian philosopher and Insubordinations series editor Lorenzo Chiesa, is its first English-language version. Virno here engages, in an innovative and iconoclastic way, with some classical issues of philosophy involving experience, singularity, and the relation between ethics and language, while also offering a profoundly transformative political perspective that revolves around the Marxian notion of the "general intellect." Virno reconsiders Walter Benjamin's idea of a "loss

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of the aura" (brought on, Benjamin argued, by technical reproducibility), and postulates instead the existence of a new experience of uniqueness that, although deprived of every metaphysical aura, resides in the very process of late-capitalist serial reproduction. Writing after the defeat of contemporary leftist revolutionary movements in the West, Virno argues for the possibility of a "good life" originating immanently from existential and political crises. Taking speculative detours through the thought of philosophers ranging from Aquinas and Berkeley to Heidegger and Wittgenstein, with a specific focus on Kant and Hegel, Virno shows how a renewed reflection on basic theoretical problems helps us to better grasp what is happening now. This edition features a preface written by Virno in 2011.

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"Moral Machines is a fine introduction to the emerging field of robot ethics. There is much here that will interest ethicists, philosophers, cognitive scientists, and roboticists." ---Peter Danielson, Notre Dame Philosophical Reviews --

Experts review the latest research on the neocortex and consider potential directions for future research. Over the past decade, technological advances have dramatically increased information on the structural and functional organization of the brain, especially the cerebral cortex. This explosion of data has radically expanded our ability to characterize neural circuits and intervene at

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increasingly higher resolutions, but it is unclear how this has informed our understanding of underlying mechanisms and processes. In search of a conceptual framework to guide future research, leading researchers address in this volume the evolution and ontogenetic development of cortical structures, the cortical connectome, and functional properties of neuronal circuits and populations. They explore what constitutes “uniquely human” mental capacities and whether neural solutions and computations can be shared across species or repurposed for potentially uniquely human capacities. Contributors Danielle S. Bassett, Randy M. Bruno, Elizabeth A. Buffalo, Michael E. Coulter, Hermann Cuntz, Stanislas Dehaene, James J. DiCarlo, Pascal Fries, Karl J. Friston, Asif A. Ghazanfar, Anne-Lise Giraud, Joshua I. Gold, Scott T. Grafton, Jennifer M. Groh, Elizabeth A. Grove, Saskia Haegens, Kenneth D. Harris, Kristen M. Harris, Nicholas G. Hatsopoulos, Tarik F. Haydar, Takao K. Hensch, Wieland B. Huttner, Matthias Kaschube, Gilles Laurent, David A. Leopold, Johannes Leugering, Belen Lorente-Galdos, Jason N. MacLean, David A. McCormick, Lucia Melloni, Anish Mitra, Zoltán Molnár, Sydney K. Muchnik, Pascal Nieters, Marcel Oberlaender, Bijan Pesaran, Christopher I. Petkov, Gordon Pipa, David Poeppel, Marcus E. Raichle, Pasko Rakic, John H. Reynolds, Ryan V. Raut, John L. Rubenstein, Andrew B. Schwartz, Terrence J. Sejnowski, Nenad Sestan, Debra L. Silver, Wolf Singer, Peter L. Strick, Michael P. Stryker, Mriganka Sur, Mary Elizabeth Sutherland, Maria Antonietta Tosches, William A. Tyler, Martin Vinck, Christopher A. Walsh, Perry Zurn

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"AI and the Technological Singularity: A Fallacy or a Great Opportunity" is a collection of essays that addresses the question of whether the technological singularity—the notion that AI-based computers can program the next generation of AI-based computers until a singularity is achieved, where an AI-based computer can exceed human intelligence—is a fallacy or a great opportunity. The group of scholars that address this question have a variety of positions on the singularity, ranging from advocates to skeptics. No conclusion can be reached, as the development of artificial intelligence is still in its infancy, and there is much wishful thinking and imagination in this issue rather than trustworthy data. The reader will find a cogent summary of the issues faced by researchers who are working to develop the field of artificial intelligence and, in particular, artificial general intelligence. The only conclusion that can be reached is that there exists a variety of well-argued positions as to where AI research is headed.

An argument that—despite dramatic advances in the field—artificial intelligence is nowhere near developing systems that are genuinely intelligent. In this provocative book, Brian Cantwell Smith argues that artificial intelligence is nowhere near developing systems that are genuinely intelligent. Second wave AI, machine learning, even visions of third-wave AI: none will lead to human-level intelligence and judgment, which have been honed over millennia. Recent advances in AI may be of epochal significance, but human intelligence is of a different order than even the most powerful calculative ability enabled by new computational capacities. Smith calls this AI

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ability “reckoning,” and argues that it does not lead to full human judgment—dispassionate, deliberative thought grounded in ethical commitment and responsible action. Taking judgment as the ultimate goal of intelligence, Smith examines the history of AI from its first-wave origins (“good old-fashioned AI,” or GOF AI) to such celebrated second-wave approaches as machine learning, paying particular attention to recent advances that have led to excitement, anxiety, and debate. He considers each AI technology's underlying assumptions, the conceptions of intelligence targeted at each stage, and the successes achieved so far. Smith unpacks the notion of intelligence itself—what sort humans have, and what sort AI aims at. Smith worries that, impressed by AI's reckoning prowess, we will shift our expectations of human intelligence. What we should do, he argues, is learn to use AI for the reckoning tasks at which it excels while we strengthen our commitment to judgment, ethics, and the world.

The hidden costs of artificial intelligence, from natural resources and labor to privacy and freedom What happens when artificial intelligence saturates political life and depletes the planet? How is AI shaping our understanding of ourselves and our societies? In this book Kate Crawford reveals how this planetary network is fueling a shift toward undemocratic governance and increased inequality. Drawing on more than a decade of research, award-winning science, and technology, Crawford reveals how AI is a technology of extraction: from the energy and minerals needed to build and sustain its infrastructure, to the exploited workers behind

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"automated" services, to the data AI collects from us. Rather than taking a narrow focus on code and algorithms, Crawford offers us a political and a material perspective on what it takes to make artificial intelligence and where it goes wrong. While technical systems present a veneer of objectivity, they are always systems of power. This is an urgent account of what is at stake as technology companies use artificial intelligence to reshape the world.

Only a few books stand as landmarks in social and scientific upheaval. Norbert Wiener's classic is one in that small company. Founder of the science of cybernetics—the study of the relationship between computers and the human nervous system—Wiener was widely misunderstood as one who advocated the automation of human life. As this book reveals, his vision was much more complex and interesting. He hoped that machines would release people from relentless and repetitive drudgery in order to achieve more creative pursuits. At the same time he realized the danger of dehumanizing and displacement. His book examines the implications of cybernetics for education, law, language, science, technology, as he anticipates the enormous impact—in effect, a third industrial revolution—that the computer has had on our lives.

From the founding director of the MIT Center for Collective Intelligence comes a fascinating look at the remarkable capacity for intelligence exhibited by groups of people and computers working together. If you're like most people, you probably believe that humans are the most intelligent animals on our planet. But there's

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another kind of entity that can be far smarter: groups of people. In this groundbreaking book, Thomas Malone, the founding director of the MIT Center for Collective Intelligence, shows how groups of people working together in superminds -- like hierarchies, markets, democracies, and communities -- have been responsible for almost all human achievements in business, government, science, and beyond. And these collectively intelligent human groups are about to get much smarter. Using dozens of striking examples and case studies, Malone shows how computers can help create more intelligent superminds simply by connecting humans to one another in a variety of rich, new ways. And although it will probably happen more gradually than many people expect, artificially intelligent computers will amplify the power of these superminds by doing increasingly complex kinds of thinking. Together, these changes will have far-reaching implications for everything from the way we buy groceries and plan business strategies to how we respond to climate change, and even for democracy itself. By understanding how these collectively intelligent groups work, we can learn how to harness their genius to achieve our human goals. Drawing on cutting-edge science and insights from a remarkable range of disciplines, Superminds articulates a bold -- and utterly fascinating -- picture of the future that will change the ways you work and live, both with other people and with computers. This book explores the technologies that can be used in curricula to make education "smarter" and more adaptive in order to better meet the needs of today's

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learners. The main emphasis is based on the theory and best practices of incorporating emerging technologies into curricula so as to educate learners in the 21st century. The book provides valuable insights into the future of education and examines which pedagogies are most suitable for integrating emerging technologies. It will help educators and stakeholders design and implement curricula that effectively prepare learners for the challenges of tomorrow.

The idea of technological singularity, and what it would mean if ordinary human intelligence were enhanced or overtaken by artificial intelligence. The idea that human history is approaching a “singularity”—that ordinary humans will someday be overtaken by artificially intelligent machines or cognitively enhanced biological intelligence, or both—has moved from the realm of science fiction to serious debate. Some singularity theorists predict that if the field of artificial intelligence (AI) continues to develop at its current dizzying rate, the singularity could come about in the middle of the present century. Murray Shanahan offers an introduction to the idea of the singularity and considers the ramifications of such a potentially seismic event. Shanahan's aim is not to make predictions but rather to investigate a range of scenarios. Whether we believe that singularity is near or far, likely or impossible, apocalypse or utopia, the very idea raises crucial philosophical and pragmatic questions, forcing us to think seriously about what we want as a species. Shanahan describes technological advances in AI, both biologically inspired and engineered from scratch. Once human-level AI—theoretically

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possible, but difficult to accomplish—has been achieved, he explains, the transition to superintelligent AI could be very rapid. Shanahan considers what the existence of superintelligent machines could mean for such matters as personhood, responsibility, rights, and identity. Some superhuman AI agents might be created to benefit humankind; some might go rogue. (Is Siri the template, or HAL?) The singularity presents both an existential threat to humanity and an existential opportunity for humanity to transcend its limitations. Shanahan makes it clear that we need to imagine both possibilities if we want to bring about the better outcome.

To understand the mind and its place in Nature is one of the great intellectual challenges of our time, a challenge that is both scientific and philosophical. How does cognition influence an animal's behaviour? What are its neural underpinnings? How is the inner life of a human being constituted? What are the neural underpinnings of the conscious condition? Embodiment and the Inner Life approaches each of these questions from a scientific standpoint. But it contends that, before we can make progress on them, we have to give up the habit of thinking metaphysically, a habit that creates a fog of philosophical confusion. From this post-reflective point of view, the book argues for an intimate relationship between cognition, sensorimotor embodiment, and the integrative character of the conscious condition. Drawing on insights from psychology, neuroscience, and dynamical systems, it proposes an empirical theory of this three-way relationship whose principles, not being tied to the contingencies of biology or physics, are applicable to the whole space of possible minds in which humans and other animals are included. Embodiment and the Inner Life is one of very few

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books that provides a properly joined-up theory of consciousness, and will be essential reading for all psychologists, philosophers, and neuroscientists with an interest in the enduring puzzle of consciousness.

"The co-author of *Moral Machines* explores accountability challenges related to a world shaped by such technological innovations as combat drones, 3-D printers and synthetic organisms to consider how people of the near future can be protected, "--Novelist.

An accessible and engaging account of robots, covering the current state of the field, the fantasies of popular culture, and implications for life and work. Robots are entering the mainstream. Technologies have advanced to the point of mass commercialization—Roomba, for example—and adoption by governments—most notably, their use of drones.

Meanwhile, these devices are being received by a public whose main sources of information about robots are the fantasies of popular culture. We know a lot about C-3PO and Robocop but not much about Atlas, Motoman, Kiva, or Beam—real-life robots that are reinventing warfare, the industrial workplace, and collaboration. In this book, technology analyst John Jordan offers an accessible and engaging introduction to robots and robotics, covering state-of-the-art applications, economic implications, and cultural context. Jordan chronicles the prehistory of robots and the treatment of robots in science fiction, movies, and television—from the outsized influence of Mary Shelley's *Frankenstein* to Isaac Asimov's *I, Robot* (in which Asimov coined the term "robotics"). He offers a guided tour of robotics today, describing the components of robots, the complicating factors that make robotics so challenging, and such applications as driverless cars, unmanned warfare, and robots on the assembly line. Roboticists draw on such technical fields as power management, materials science,

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and artificial intelligence. Jordan points out, however, that robotics design decisions also embody such nontechnical elements as value judgments, professional aspirations, and ethical assumptions, and raise questions that involve law, belief, economics, education, public safety, and human identity. Robots will be neither our slaves nor our overlords; instead, they are rapidly becoming our close companions, working in partnership with us—whether in a factory, on a highway, or as a prosthetic device. Given these profound changes to human work and life, Jordan argues that robotics is too important to be left solely to roboticists.

How to make liberal democracies more inclusive and the digital economy more equitable: a guide for the coming Fourth Industrial Revolution. Around the world, liberal democracies are in crisis. Citizens have lost faith in their government; right-wing nationalist movements frame the political debate. At the same time, economic inequality is increasing dramatically; digital technologies have created a new class of super-rich entrepreneurs. Automation threatens to transform the free economy into a zero-sum game in which capital wins and labor loses. But is this digital dystopia inevitable? In *Cyber Republic*, George Zarkadakis presents an alternative, outlining a plan for using technology to make liberal democracies more inclusive and the digital economy more equitable. *Cyber Republic* is no less than a guide for the coming Fourth Industrial Revolution. Zarkadakis, an expert on technology and management, explains how artificial intelligence, together with intelligent robotics, sophisticated sensors, communication networks, and big data, will fundamentally reshape the global economy; a new "intelligent machine age" will force us to adopt new forms of economic and political organization. He envisions a future liberal democracy in which intelligent machines facilitate citizen assemblies, helping to extend citizen rights, and blockchains

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and cryptoeconomics enable new forms of democratic governance and business collaboration. Moreover, the same technologies can be applied to scientific research and technological innovation. We need not fear automation, Zarkadakis argues; in a post-work future, intelligent machines can collaborate with humans to achieve the human goals of inclusivity and equality.

How the future has been imagined and made, through the work of writers, artists, inventors, and designers. The future is like an unwritten book. It is not something we see in a crystal ball, or can only hope to predict, like the weather. In this volume of the MIT Press's Essential Knowledge series, Nick Montfort argues that the future is something to be made, not predicted. Montfort offers what he considers essential knowledge about the future, as seen in the work of writers, artists, inventors, and designers (mainly in Western culture) who developed and described the core components of the futures they envisioned. Montfort's approach is not that of futurology or scenario planning; instead, he reports on the work of making the future—the thinkers who devoted themselves to writing pages in the unwritten book. Douglas Engelbart, Alan Kay, and Ted Nelson didn't predict the future of computing, for instance. They were three of the people who made it. Montfort focuses on how the development of technologies—with an emphasis on digital technologies—has been bound up with ideas about the future. Readers learn about kitchens of the future and the vision behind them; literary utopias, from Plato's Republic to Edward Bellamy's Looking Backward and Charlotte Perkins Gilman's Herland; the Futurama exhibit at the 1939 New York World's Fair; and what led up to Tim Berners-Lee's invention of the World Wide Web. Montfort describes the notebook computer as a human-centered alternative to the idea of the computer as a room-sized “giant brain”; speculative practice in design and

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science fiction; and, throughout, the best ways to imagine and build the future.

The Red Queen's race -- The exponential nature of technology -- From Maxwell to the Internet -- The universal machine -- The quest for intelligent machines -- Cells, bodies, and brains -- Biology meets computation -- How the brain works -- Understanding the brain -- Brains, minds, and machines -- Challenges and promises -- Speculations

An account of the complex relationship between technology and romanticism that links nineteenth-century monsters, automata, and mesmerism with twenty-first-century technology's magic devices and romantic cyborgs.

Romanticism and technology are widely assumed to be opposed to each other. Romanticism—understood as a reaction against rationalism and objectivity—is perhaps the last thing users and developers of information and communication technology (ICT) think about when they engage with computer programs and electronic devices. And yet, as Mark Coeckelbergh argues in this book, this way of thinking about technology is itself shaped by romanticism and obscures a better and deeper understanding of our relationship to technology. Coeckelbergh describes the complex relationship between technology and romanticism that links nineteenth-century monsters, automata, and mesmerism with twenty-first-century technology's magic devices and romantic cyborgs. Coeckelbergh argues that current uses of ICT can be interpreted as attempting a marriage of Enlightenment rationalism and romanticism. He describes the “romantic dialectic,” when this new kind of material romanticism, particularly in the form of the cyborg as romantic figure, seems to turn into its opposite. He shows that both material romanticism and the objections to it are still part of modern thinking, and part of the romantic dialectic. Reflecting on what he calls “the end of the machine,”

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Coeckelbergh argues that to achieve a more profound critique of contemporary technologies and culture, we need to explore not only different ways of thinking but also different technologies—and that to accomplish the former we require the latter.

In 1969, John McCarthy and Pat Hayes uncovered a problem that has haunted the field of artificial intelligence ever since--the frame problem. The problem arises when logic is used to describe the effects of actions and events. Put simply, it is the problem of representing what remains unchanged as a result of an action or event. Many researchers in artificial intelligence believe that its solution is vital to the realization of the field's goals. Solving the Frame Problem presents the various approaches to the frame problem that have been proposed over the years. The author presents the material chronologically--as an unfolding story rather than as a body of theory to be learned by rote. There are lessons to be learned even from the dead ends researchers have pursued, for they deepen our understanding of the issues surrounding the frame problem. In the book's concluding chapters, the author offers his own work on event calculus, which he claims comes very close to a complete solution to the frame problem. Artificial Intelligence series

An authority on artificial intelligence introduces a theory that explores the workings of the human mind and the mysteries of thought

A comprehensive overview of an interdisciplinary approach to robotics that takes direct inspiration from the developmental and learning phenomena observed in children's cognitive development. Developmental robotics is a collaborative and

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interdisciplinary approach to robotics that is directly inspired by the developmental principles and mechanisms observed in children's cognitive development. It builds on the idea that the robot, using a set of intrinsic developmental principles regulating the real-time interaction of its body, brain, and environment, can autonomously acquire an increasingly complex set of sensorimotor and mental capabilities. This volume, drawing on insights from psychology, computer science, linguistics, neuroscience, and robotics, offers the first comprehensive overview of a rapidly growing field. After providing some essential background information on robotics and developmental psychology, the book looks in detail at how developmental robotics models and experiments have attempted to realize a range of behavioral and cognitive capabilities. The examples in these chapters were chosen because of their direct correspondence with specific issues in child psychology research; each chapter begins with a concise and accessible overview of relevant empirical and theoretical findings in developmental psychology. The chapters cover intrinsic motivation and curiosity; motor development, examining both manipulation and locomotion; perceptual development, including face recognition and perception of space; social learning, emphasizing such phenomena as joint attention and cooperation;

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language, from phonetic babbling to syntactic processing; and abstract knowledge, including models of number learning and reasoning strategies. Boxed text offers technical and methodological details for both psychology and robotics experiments.

The human brain has some capabilities that the brains of other animals lack. It is to these distinctive capabilities that our species owes its dominant position. Other animals have stronger muscles or sharper claws, but we have cleverer brains. If machine brains one day come to surpass human brains in general intelligence, then this new superintelligence could become very powerful. As the fate of the gorillas now depends more on us humans than on the gorillas themselves, so the fate of our species then would come to depend on the actions of the machine superintelligence. But we have one advantage: we get to make the first move. Will it be possible to construct a seed AI or otherwise to engineer initial conditions so as to make an intelligence explosion survivable? How could one achieve a controlled detonation? To get closer to an answer to this question, we must make our way through a fascinating landscape of topics and considerations. Read the book and learn about oracles, genies, singletons; about boxing methods, tripwires, and mind crime; about humanity's cosmic endowment and differential technological

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development; indirect normativity, instrumental convergence, whole brain emulation and technology couplings; Malthusian economics and dystopian evolution; artificial intelligence, and biological cognitive enhancement, and collective intelligence. Everything you've always wanted to know about self-driving cars, Netflix recommendations, IBM's Watson, and video game-playing computer programs. The future is here: Self-driving cars are on the streets, an algorithm gives you movie and TV recommendations, IBM's Watson triumphed on Jeopardy over puny human brains, computer programs can be trained to play Atari games. But how do all these things work? In this book, Sean Gerrish offers an engaging and accessible overview of the breakthroughs in artificial intelligence and machine learning that have made today's machines so smart. Gerrish outlines some of the key ideas that enable intelligent machines to perceive and interact with the world. He describes the software architecture that allows self-driving cars to stay on the road and to navigate crowded urban environments; the million-dollar Netflix competition for a better recommendation engine (which had an unexpected ending); and how programmers trained computers to perform certain behaviors by offering them treats, as if they were training a dog. He explains how artificial neural networks enable computers to perceive the world—and to play Atari

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video games better than humans. He explains Watson's famous victory on Jeopardy, and he looks at how computers play games, describing AlphaGo and Deep Blue, which beat reigning world champions at the strategy games of Go and chess. Computers have not yet mastered everything, however; Gerrish outlines the difficulties in creating intelligent agents that can successfully play video games like StarCraft that have evaded solution—at least for now. Gerrish weaves the stories behind these breakthroughs into the narrative, introducing readers to many of the researchers involved, and keeping technical details to a minimum. Science and technology buffs will find this book an essential guide to a future in which machines can outsmart people. A guide to information as the transformative tool of modern business. While we have been preoccupied with the latest i-gadget from Apple and with Google's ongoing expansion, we may have missed something: the fundamental transformation of whole firms and industries into giant information-processing machines. Today, more than eighty percent of workers collect and analyze information (often in digital form) in the course of doing their jobs. This book offers a guide to the role of information in modern business, mapping the use of information within work processes and tracing flows of information across supply-chain management, product development, customer relations, and sales.

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The emphasis is on information itself, not on information technology. Information, overshadowed for a while by the glamour and novelty of IT, is the fundamental component of the modern corporation. In *Information and the Modern Corporation*, longtime IBM manager and consultant James Cortada clarifies the differences among data, facts, information, and knowledge and describes how the art of analytics has all but eliminated decision making based on gut feeling, replacing it with fact-based decisions. He describes the working style of “road warriors,” whose offices are anywhere their laptops and cell phones are and whose deep knowledge of a given topic becomes their medium of exchange. Information is the core of the modern enterprise, and the use of information defines the activities of a firm. This essential guide shows managers and employees better ways to leverage information—by design and not by accident.

Singularity Hypotheses: A Scientific and Philosophical Assessment offers authoritative, jargon-free essays and critical commentaries on accelerating technological progress and the notion of technological singularity. It focuses on conjectures about the intelligence explosion, transhumanism, and whole brain emulation. Recent years have seen a plethora of forecasts about the profound, disruptive impact that is likely to result from further progress in these areas. Many commentators however doubt the

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scientific rigor of these forecasts, rejecting them as speculative and unfounded. We therefore invited prominent computer scientists, physicists, philosophers, biologists, economists and other thinkers to assess the singularity hypotheses. Their contributions go beyond speculation, providing deep insights into the main issues and a balanced picture of the debate.

In a series of essays, 34 influential researchers look at how the proliferation of computers and technology has and will affect culture and the arts.

There is no more important issue facing education, or humanity at large, than the fast approaching revolution in Artificial Intelligence or AI. This book is a call to educators everywhere to open their eyes to what is coming. If we do so, then the future will be shaped by us in the interests of humanity as a whole - but if we don't, it will be imposed by others. Britain and the US have an excellent education system in their schools and universities - excellent, but tailored to the twentieth century. The factory mass teaching methods of the third revolution era have failed to conquer enduring problems of inequity and unfairness. Students have to make progress at a set rate which demotivates some and bores others. And for all the new technologies, teachers remain weighed down by routine administration and only a narrow range of our aptitudes are encouraged. Will the fourth AI revolution be able to remedy these

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problems? We have allowed ourselves to believe that teaching can uniquely be done only by the teacher, but might it in fact be better carried out by AI machines? Or at least in concert with teachers? The evolution of AI, still in its infancy, raises a range of issues of enormous importance as we grapple with how we as humans will interact with it. AI will be an altogether new way of spreading quality education across the world, especially to those hundreds of millions who do not have it. And coming it is - the final part of the book stresses that we have to embrace AI and ensure that we shape it to the best advantage of humanity. If we get it wrong, there may be no second opportunity. The conclusion... Nothing matters more than education if we are to see AI liberate not infantilise humanity.

Passion for objects and love for science: scientists and students reflect on how objects fired their scientific imaginations. "This is a book about science, technology, and love," writes Sherry Turkle. In it, we learn how a love for science can start with a love for an object—a microscope, a modem, a mud pie, a pair of dice, a fishing rod. Objects fire imagination and set young people on a path to a career in science. In this collection, distinguished scientists, engineers, and designers as well as twenty-five years of MIT students describe how objects encountered in childhood became part of the fabric of their scientific selves. In two major essays that frame the collection, Turkle tells a story of inspiration and connection through objects that is often neglected in

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standard science education and in our preoccupation with the virtual. The senior scientists' essays trace the arc of a life: the gears of a toy car introduce the chain of cause and effect to artificial intelligence pioneer Seymour Papert; microscopes disclose the mystery of how things work to MIT President and neuroanatomist Susan Hockfield; architect Moshe Safdie describes how his boyhood fascination with steps, terraces, and the wax hexagons of beehives lead him to a life immersed in the complexities of design. The student essays tell stories that echo these narratives: plastic eggs in an Easter basket reveal the power of centripetal force; experiments with baking illuminate the geology of planets; LEGO bricks model worlds, carefully engineered and colonized. All of these voices—students and mentors—testify to the power of objects to awaken and inform young scientific minds. This is a truth that is simple, intuitive, and easily overlooked.

Algorithms will soon know more about us than we know ourselves. Where should machine automation end? Is it acceptable to have a digital assistant arrange your calendar, but not to have a robot spouse? Are companion robots acceptable for seniors in need of comfort, but not okay for toddlers exposed to emotional software that could influence their behavior? Is it desirable to live a life within the virtual reality of Facebook's Oculus Rift, but not if your thoughts are sold to advertisers who manipulate your purchases? We've entered an era where a myriad of personalization algorithms influence our every decision, and the lines between human assistance, automation, and extinction

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have blurred. We need to create ethical standards for the Artificial Intelligence usurping our lives, and allow individuals to control their identity based on their values. Otherwise, we sacrifice our humanity for productivity versus purpose and for profits versus people. Featuring pragmatic solutions drawing on economics, emerging technologies, and positive psychology, *Heartificial Intelligence* provides the first values-driven approach to algorithmic living--a definitive roadmap to help humanity embrace the present and positively define their future. Each chapter opens with a fictional vignette, helping readers imagine how they would respond to various Artificial Intelligence scenarios while demonstrating the need to codify their values, as the algorithms dominating society today are already doing. Funny, poignant, and accessible, this book paints a vivid portrait of how our lives might look in either a dystopia of robotic and corporate dominance, or a utopia where humans use technology to enhance our natural abilities to evolve into a long-lived, super-intelligent, and altruistic species. An accessible synthesis of ethical issues raised by artificial intelligence that moves beyond hype and nightmare scenarios to address concrete questions. Artificial intelligence powers Google's search engine, enables Facebook to target advertising, and allows Alexa and Siri to do their jobs. AI is also behind self-driving cars, predictive policing, and autonomous weapons that can kill without human intervention. These and other AI applications raise complex ethical issues that are the subject of ongoing debate. This volume in the MIT Press Essential Knowledge series offers an accessible

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synthesis of these issues. Written by a philosopher of technology, AI Ethics goes beyond the usual hype and nightmare scenarios to address concrete questions. Mark Coeckelbergh describes influential AI narratives, ranging from Frankenstein's monster to transhumanism and the technological singularity. He surveys relevant philosophical discussions: questions about the fundamental differences between humans and machines and debates over the moral status of AI. He explains the technology of AI, describing different approaches and focusing on machine learning and data science. He offers an overview of important ethical issues, including privacy concerns, responsibility and the delegation of decision making, transparency, and bias as it arises at all stages of data science processes. He also considers the future of work in an AI economy. Finally, he analyzes a range of policy proposals and discusses challenges for policymakers. He argues for ethical practices that embed values in design, translate democratic values into practices and include a vision of the good life and the good society.

Comparing the human brain with so-called artificial intelligence, the author probes past, present, and future attempts to create machine intelligence

New York Times Best Seller How will Artificial Intelligence affect crime, war, justice, jobs, society and our very sense of being human? The rise of AI has the potential to transform our future more than any other technology—and there's nobody better qualified or situated to explore that future than Max Tegmark, an MIT professor who's helped mainstream research on how to

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keep AI beneficial. How can we grow our prosperity through automation without leaving people lacking income or purpose? What career advice should we give today's kids? How can we make future AI systems more robust, so that they do what we want without crashing, malfunctioning or getting hacked? Should we fear an arms race in lethal autonomous weapons? Will machines eventually outsmart us at all tasks, replacing humans on the job market and perhaps altogether? Will AI help life flourish like never before or give us more power than we can handle? What sort of future do you want? This book empowers you to join what may be the most important conversation of our time. It doesn't shy away from the full range of viewpoints or from the most controversial issues—from superintelligence to meaning, consciousness and the ultimate physical limits on life in the cosmos.

A new collection of wide-ranging essays from one of cognitive science's most distinguished figures. Minds are complex artifacts, partly biological and partly social; only a unified, multidisciplinary approach will yield a realistic theory of how they came into existence and how they work. One of the foremost workers in this multidisciplinary field is Daniel Dennett. This book brings together his essays on the philosophy of mind, artificial intelligence, and cognitive ethology that appeared in inaccessible journals from 1984 to 1996. Highlights include "Can Machines Think?," "The Unimagined Preposterousness of Zombies," "Artificial Life as Philosophy," and "Animal Consciousness: What Matters and Why." Collected in a single volume, the essays are

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