

Deep Learning Adaptive Computation And Machine Learning Series

Elements of Causal Inference Jonas Peters 2017-11-29 A concise and self-contained introduction to causal inference, increasingly important in data science and machine learning. The mathematization of causality is a relatively recent development, and has become increasingly important in data science and machine learning. This book offers a self-contained and concise introduction to causal models and how to learn them from data. After explaining the need for causal models and discussing some of the principles underlying causal inference, the book teaches readers how to use causal models: how to compute intervention distributions, how to infer causal models from observational and interventional data, and how causal ideas could be exploited for classical machine learning problems. All of these topics are discussed first in terms of two variables and then in the more general multivariate case. The bivariate case turns out to be a particularly hard problem for causal learning because there are no conditional independences as used by classical methods for solving multivariate cases. The authors consider analyzing statistical asymmetries between cause and effect to be highly instructive, and they report on their decade of intensive research into this problem. The book is accessible to readers with a background in machine learning or statistics, and can be used in graduate courses or as a reference for researchers. The text includes code snippets that can be copied and pasted, exercises, and an appendix with a summary of the most important technical concepts.

Introduction to Machine Learning, fourth edition Ethem Alpaydin 2020-03-24 A substantially revised fourth edition of a comprehensive textbook, including new coverage of recent advances in deep learning and neural networks. The goal of machine learning is to program computers to use example data or past experience to solve a given problem. Machine learning underlies such exciting new technologies as self-driving cars, speech recognition, and translation applications. This substantially revised fourth edition of a comprehensive, widely used machine learning textbook offers new coverage of recent advances in the field in both theory and practice, including developments in deep learning and neural networks. The book covers a broad array of topics not usually included in introductory machine learning texts, including supervised learning, Bayesian decision theory, parametric methods, semiparametric methods, nonparametric methods, multivariate analysis, hidden Markov models, reinforcement learning, kernel machines, graphical models, Bayesian estimation, and statistical testing. The fourth edition offers a new chapter on deep learning that discusses training, regularizing, and structuring deep neural networks such as convolutional and generative adversarial networks; new material in the chapter on reinforcement learning that covers the use of deep networks, the policy gradient methods, and deep reinforcement learning; new material in the chapter on multilayer perceptrons on autoencoders and the word2vec network; and discussion of a popular method of dimensionality reduction, t-SNE. New appendixes offer background material on linear algebra and optimization. End-of-chapter exercises help readers to apply concepts learned. Introduction to Machine Learning can be used in courses for advanced undergraduate and graduate students and as a reference for professionals.

Introduction to Deep Learning Eugene Charniak 2019-01-29 A project-based guide to the basics of deep learning. This concise, project-driven guide to deep learning takes readers through a series of program-writing tasks that introduce them to the use of deep learning in such areas of artificial intelligence as computer vision, natural-language processing, and reinforcement learning. The author, a longtime artificial intelligence researcher specializing in natural-language processing, covers feed-forward neural nets, convolutional neural nets, word embeddings, recurrent neural nets, sequence-to-sequence learning, deep reinforcement learning, unsupervised models, and other fundamental concepts and techniques.

Students and practitioners learn the basics of deep learning by working through programs in Tensorflow, an open-source machine learning framework. “I find I learn computer science material best by sitting down and writing programs,” the author writes, and the book reflects this approach. Each chapter includes a programming project, exercises, and references for further reading. An early chapter is devoted to Tensorflow and its interface with Python, the widely used programming language. Familiarity with linear algebra, multivariate calculus, and probability and statistics is required, as is a rudimentary knowledge of programming in Python. The book can be used in both undergraduate and graduate courses; practitioners will find it an essential reference.

Machine Learning Kevin P. Murphy 2012-08-24 A comprehensive introduction to machine learning that uses probabilistic models and inference as a unifying approach. Today's Web-enabled deluge of electronic data calls for automated methods of data analysis. Machine learning provides these, developing methods that can automatically detect patterns in data and then use the uncovered patterns to predict future data. This textbook offers a comprehensive and self-contained introduction to the field of machine learning, based on a unified, probabilistic approach. The coverage combines breadth and depth, offering necessary background material on such topics as probability, optimization, and linear algebra as well as discussion of recent developments in the field, including conditional random fields, L1 regularization, and deep learning. The book is written in an informal, accessible style, complete with pseudo-code for the most important algorithms. All topics are copiously illustrated with color images and worked examples drawn from such application domains as biology, text processing, computer vision, and robotics. Rather than providing a cookbook of different heuristic methods, the book stresses a principled model-based approach, often using the language of graphical models to specify models in a concise and intuitive way. Almost all the models described have been implemented in a MATLAB software package—PMTK (probabilistic modeling toolkit)—that is freely available online. The book is suitable for upper-level undergraduates with an introductory-level college math background and beginning graduate students.

Machine Learning, second edition Kevin P. Murphy 2020 The second and expanded edition of a comprehensive introduction to machine learning that uses probabilistic models and inference as a unifying approach. This textbook offers a comprehensive and self-contained introduction to the field of machine learning, including deep learning, viewed through the lens of probabilistic modeling and Bayesian decision theory. This second edition has been substantially expanded and revised, incorporating many recent developments in the field. It has new chapters on linear algebra, optimization, implicit generative models, reinforcement learning, and causality; and other chapters on such topics as variational inference and graphical models have been significantly updated. The software for the book (hosted on github) is now implemented in Python rather than MATLAB, and uses state-of-the-art libraries including as scikit-learn, Tensorflow 2, and JAX.

Deep Reinforcement Learning Hands-On Maxim Lapan 2020-01-31 New edition of the bestselling guide to deep reinforcement learning and how it's used to solve complex real-world problems. Revised and expanded to include multi-agent methods, discrete optimization, RL in robotics, advanced exploration techniques, and more Key Features Second edition of the bestselling introduction to deep reinforcement learning, expanded with six new chapters Learn advanced exploration techniques including noisy networks, pseudo-count, and network distillation methods Apply RL methods to cheap hardware robotics platforms Book Description Deep Reinforcement Learning Hands-On, Second Edition is an updated and expanded version of the bestselling guide to the very latest reinforcement learning (RL) tools and techniques. It provides you with an introduction to the fundamentals of RL, along with the hands-on ability to code intelligent learning agents to perform a range of practical tasks. With six new chapters devoted to a variety of up-to-the-minute developments in RL, including discrete optimization (solving the Rubik's Cube), multi-agent methods, Microsoft's TextWorld environment, advanced exploration techniques, and more, you will come away from this book with a deep understanding of the latest

innovations in this emerging field. In addition, you will gain actionable insights into such topic areas as deep Q-networks, policy gradient methods, continuous control problems, and highly scalable, non-gradient methods. You will also discover how to build a real hardware robot trained with RL for less than \$100 and solve the Pong environment in just 30 minutes of training using step-by-step code optimization. In short, Deep Reinforcement Learning Hands-On, Second Edition, is your companion to navigating the exciting complexities of RL as it helps you attain experience and knowledge through real-world examples. What you will learn Understand the deep learning context of RL and implement complex deep learning models Evaluate RL methods including cross-entropy, DQN, actor-critic, TRPO, PPO, DDPG, D4PG, and others Build a practical hardware robot trained with RL methods for less than \$100 Discover Microsoft's TextWorld environment, which is an interactive fiction games platform Use discrete optimization in RL to solve a Rubik's Cube Teach your agent to play Connect 4 using AlphaGo Zero Explore the very latest deep RL research on topics including AI chatbots Discover advanced exploration techniques, including noisy networks and network distillation techniques Who this book is for Some fluency in Python is assumed. Sound understanding of the fundamentals of deep learning will be helpful. This book is an introduction to deep RL and requires no background in RL

Deep Learning Ian Goodfellow 2016-11-18 An introduction to a broad range of topics in deep learning, covering mathematical and conceptual background, deep learning techniques used in industry, and research perspectives. "Written by three experts in the field, Deep Learning is the only comprehensive book on the subject." —Elon Musk, cochair of OpenAI; cofounder and CEO of Tesla and SpaceX Deep learning is a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts. Because the computer gathers knowledge from experience, there is no need for a human computer operator to formally specify all the knowledge that the computer needs. The hierarchy of concepts allows the computer to learn complicated concepts by building them out of simpler ones; a graph of these hierarchies would be many layers deep. This book introduces a broad range of topics in deep learning. The text offers mathematical and conceptual background, covering relevant concepts in linear algebra, probability theory and information theory, numerical computation, and machine learning. It describes deep learning techniques used by practitioners in industry, including deep feedforward networks, regularization, optimization algorithms, convolutional networks, sequence modeling, and practical methodology; and it surveys such applications as natural language processing, speech recognition, computer vision, online recommendation systems, bioinformatics, and videogames. Finally, the book offers research perspectives, covering such theoretical topics as linear factor models, autoencoders, representation learning, structured probabilistic models, Monte Carlo methods, the partition function, approximate inference, and deep generative models. Deep Learning can be used by undergraduate or graduate students planning careers in either industry or research, and by software engineers who want to begin using deep learning in their products or platforms. A website offers supplementary material for both readers and instructors.

Probabilistic Machine Learning Kevin P. Murphy 2023-08-15 An advanced book for researchers and graduate students working in machine learning and statistics who want to learn about deep learning, Bayesian inference, generative models, and decision making under uncertainty. An advanced counterpart to Probabilistic Machine Learning: An Introduction, this high-level textbook provides researchers and graduate students detailed coverage of cutting-edge topics in machine learning, including deep generative modeling, graphical models, Bayesian inference, reinforcement learning, and causality. This volume puts deep learning into a larger statistical context and unifies approaches based on deep learning with ones based on probabilistic modeling and inference. With contributions from top scientists and domain experts from places such as Google, DeepMind, Amazon, Purdue University, NYU, and the University of Washington, this rigorous book is essential to understanding the vital issues in machine learning. Covers generation of high dimensional outputs, such as images, text, and graphs Discusses methods for discovering insights about data,

based on latent variable models Considers training and testing under different distributions Explores how to use probabilistic models and inference for causal inference and decision making Features online Python code accompaniment

Grokking Deep Learning Andrew W. Trask 2019-01-23 Summary Grokking Deep Learning teaches you to build deep learning neural networks from scratch! In his engaging style, seasoned deep learning expert Andrew Trask shows you the science under the hood, so you grok for yourself every detail of training neural networks. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About the Technology Deep learning, a branch of artificial intelligence, teaches computers to learn by using neural networks, technology inspired by the human brain. Online text translation, self-driving cars, personalized product recommendations, and virtual voice assistants are just a few of the exciting modern advancements possible thanks to deep learning. About the Book Grokking Deep Learning teaches you to build deep learning neural networks from scratch! In his engaging style, seasoned deep learning expert Andrew Trask shows you the science under the hood, so you grok for yourself every detail of training neural networks. Using only Python and its math-supporting library, NumPy, you'll train your own neural networks to see and understand images, translate text into different languages, and even write like Shakespeare! When you're done, you'll be fully prepared to move on to mastering deep learning frameworks. What's inside The science behind deep learning Building and training your own neural networks Privacy concepts, including federated learning Tips for continuing your pursuit of deep learning About the Reader For readers with high school-level math and intermediate programming skills. About the Author Andrew Trask is a PhD student at Oxford University and a research scientist at DeepMind. Previously, Andrew was a researcher and analytics product manager at Digital Reasoning, where he trained the world's largest artificial neural network and helped guide the analytics roadmap for the Synthesys cognitive computing platform. Table of Contents Introducing deep learning: why you should learn it Fundamental concepts: how do machines learn? Introduction to neural prediction: forward propagation Introduction to neural learning: gradient descent Learning multiple weights at a time: generalizing gradient descent Building your first deep neural network: introduction to backpropagation How to picture neural networks: in your head and on paper Learning signal and ignoring noise: introduction to regularization and batching Modeling probabilities and nonlinearities: activation functions Neural learning about edges and corners: intro to convolutional neural networks Neural networks that understand language: king - man + woman == ? Neural networks that write like Shakespeare: recurrent layers for variable-length data Introducing automatic optimization: let's build a deep learning framework Learning to write like Shakespeare: long short-term memory Deep learning on unseen data: introducing federated learning Where to go from here: a brief guide

Knowledge Graphs Mayank Kejriwal 2021-03-30 A rigorous and comprehensive textbook covering the major approaches to knowledge graphs, an active and interdisciplinary area within artificial intelligence. The field of knowledge graphs, which allows us to model, process, and derive insights from complex real-world data, has emerged as an active and interdisciplinary area of artificial intelligence over the last decade, drawing on such fields as natural language processing, data mining, and the semantic web. Current projects involve predicting cyberattacks, recommending products, and even gleaning insights from thousands of papers on COVID-19. This textbook offers rigorous and comprehensive coverage of the field. It focuses systematically on the major approaches, both those that have stood the test of time and the latest deep learning methods.

Linear Algebra and Optimization for Machine Learning Charu C. Aggarwal 2020-05-13 This textbook introduces linear algebra and optimization in the context of machine learning. Examples and exercises are provided throughout the book. A solution manual for the exercises at the end of each chapter is available to teaching instructors. This textbook targets graduate level students and professors in computer science, mathematics and data science. Advanced undergraduate students can also use this textbook. The chapters for this textbook are organized as follows: 1. Linear algebra and its applications: The chapters focus on the basics of linear algebra together with their common applications to singular value decomposition, matrix

factorization, similarity matrices (kernel methods), and graph analysis. Numerous machine learning applications have been used as examples, such as spectral clustering, kernel-based classification, and outlier detection. The tight integration of linear algebra methods with examples from machine learning differentiates this book from generic volumes on linear algebra. The focus is clearly on the most relevant aspects of linear algebra for machine learning and to teach readers how to apply these concepts. 2. Optimization and its applications: Much of machine learning is posed as an optimization problem in which we try to maximize the accuracy of regression and classification models. The “parent problem” of optimization-centric machine learning is least-squares regression. Interestingly, this problem arises in both linear algebra and optimization, and is one of the key connecting problems of the two fields. Least-squares regression is also the starting point for support vector machines, logistic regression, and recommender systems. Furthermore, the methods for dimensionality reduction and matrix factorization also require the development of optimization methods. A general view of optimization in computational graphs is discussed together with its applications to back propagation in neural networks. A frequent challenge faced by beginners in machine learning is the extensive background required in linear algebra and optimization. One problem is that the existing linear algebra and optimization courses are not specific to machine learning; therefore, one would typically have to complete more course material than is necessary to pick up machine learning. Furthermore, certain types of ideas and tricks from optimization and linear algebra recur more frequently in machine learning than other application-centric settings. Therefore, there is significant value in developing a view of linear algebra and optimization that is better suited to the specific perspective of machine learning.

Neural Networks and Deep Learning Charu C. Aggarwal 2018-08-25 This book covers both classical and modern models in deep learning. The primary focus is on the theory and algorithms of deep learning. The theory and algorithms of neural networks are particularly important for understanding important concepts, so that one can understand the important design concepts of neural architectures in different applications. Why do neural networks work? When do they work better than off-the-shelf machine-learning models? When is depth useful? Why is training neural networks so hard? What are the pitfalls? The book is also rich in discussing different applications in order to give the practitioner a flavor of how neural architectures are designed for different types of problems. Applications associated with many different areas like recommender systems, machine translation, image captioning, image classification, reinforcement-learning based gaming, and text analytics are covered. The chapters of this book span three categories: The basics of neural networks: Many traditional machine learning models can be understood as special cases of neural networks. An emphasis is placed in the first two chapters on understanding the relationship between traditional machine learning and neural networks. Support vector machines, linear/logistic regression, singular value decomposition, matrix factorization, and recommender systems are shown to be special cases of neural networks. These methods are studied together with recent feature engineering methods like word2vec. Fundamentals of neural networks: A detailed discussion of training and regularization is provided in Chapters 3 and 4. Chapters 5 and 6 present radial-basis function (RBF) networks and restricted Boltzmann machines. Advanced topics in neural networks: Chapters 7 and 8 discuss recurrent neural networks and convolutional neural networks. Several advanced topics like deep reinforcement learning, neural Turing machines, Kohonen self-organizing maps, and generative adversarial networks are introduced in Chapters 9 and 10. The book is written for graduate students, researchers, and practitioners. Numerous exercises are available along with a solution manual to aid in classroom teaching. Where possible, an application-centric view is highlighted in order to provide an understanding of the practical uses of each class of techniques.

Pattern Recognition and Machine Learning Christopher M. Bishop 2016-08-23 This is the first textbook on pattern recognition to present the Bayesian viewpoint. The book presents approximate inference algorithms that permit fast approximate answers in situations where exact answers are not feasible. It uses graphical models to describe probability distributions when no other books apply graphical models to machine learning. No

previous knowledge of pattern recognition or machine learning concepts is assumed. Familiarity with multivariate calculus and basic linear algebra is required, and some experience in the use of probabilities would be helpful though not essential as the book includes a self-contained introduction to basic probability theory.

Mathematics for Machine Learning Marc Peter Deisenroth 2020-04-23 The fundamental mathematical tools needed to understand machine learning include linear algebra, analytic geometry, matrix decompositions, vector calculus, optimization, probability and statistics. These topics are traditionally taught in disparate courses, making it hard for data science or computer science students, or professionals, to efficiently learn the mathematics. This self-contained textbook bridges the gap between mathematical and machine learning texts, introducing the mathematical concepts with a minimum of prerequisites. It uses these concepts to derive four central machine learning methods: linear regression, principal component analysis, Gaussian mixture models and support vector machines. For students and others with a mathematical background, these derivations provide a starting point to machine learning texts. For those learning the mathematics for the first time, the methods help build intuition and practical experience with applying mathematical concepts. Every chapter includes worked examples and exercises to test understanding. Programming tutorials are offered on the book's web site.

Probabilistic Machine Learning Kevin P. Murphy 2022-03-01 A detailed and up-to-date introduction to machine learning, presented through the unifying lens of probabilistic modeling and Bayesian decision theory. This book offers a detailed and up-to-date introduction to machine learning (including deep learning) through the unifying lens of probabilistic modeling and Bayesian decision theory. The book covers mathematical background (including linear algebra and optimization), basic supervised learning (including linear and logistic regression and deep neural networks), as well as more advanced topics (including transfer learning and unsupervised learning). End-of-chapter exercises allow students to apply what they have learned, and an appendix covers notation. Probabilistic Machine Learning grew out of the author's 2012 book, *Machine Learning: A Probabilistic Perspective*. More than just a simple update, this is a completely new book that reflects the dramatic developments in the field since 2012, most notably deep learning. In addition, the new book is accompanied by online Python code, using libraries such as scikit-learn, JAX, PyTorch, and Tensorflow, which can be used to reproduce nearly all the figures; this code can be run inside a web browser using cloud-based notebooks, and provides a practical complement to the theoretical topics discussed in the book. This introductory text will be followed by a sequel that covers more advanced topics, taking the same probabilistic approach.

Handbook of Neural Computation Pijush Samui 2017-07-18 *Handbook of Neural Computation* explores neural computation applications, ranging from conventional fields of mechanical and civil engineering, to electronics, electrical engineering and computer science. This book covers the numerous applications of artificial and deep neural networks and their uses in learning machines, including image and speech recognition, natural language processing and risk analysis. Edited by renowned authorities in this field, this work is comprised of articles from reputable industry and academic scholars and experts from around the world. Each contributor presents a specific research issue with its recent and future trends. As the demand rises in the engineering and medical industries for neural networks and other machine learning methods to solve different types of operations, such as data prediction, classification of images, analysis of big data, and intelligent decision-making, this book provides readers with the latest, cutting-edge research in one comprehensive text. Features high-quality research articles on multivariate adaptive regression splines, the minimax probability machine, and more Discusses machine learning techniques, including classification, clustering, regression, web mining, information retrieval and natural language processing Covers supervised, unsupervised, reinforced, ensemble, and nature-inspired learning methods

Perturbations, Optimization, and Statistics Tamir Hazan 2017-09-22 A description of perturbation-based methods developed in machine learning to

augment novel optimization methods with strong statistical guarantees. In nearly all machine learning, decisions must be made given current knowledge. Surprisingly, making what is believed to be the best decision is not always the best strategy, even when learning in a supervised learning setting. An emerging body of work on learning under different rules applies perturbations to decision and learning procedures. These methods provide simple and highly efficient learning rules with improved theoretical guarantees. This book describes perturbation-based methods developed in machine learning to augment novel optimization methods with strong statistical guarantees, offering readers a state-of-the-art overview. Chapters address recent modeling ideas that have arisen within the perturbations framework, including Perturb & MAP, herding, and the use of neural networks to map generic noise to distribution over highly structured data. They describe new learning procedures for perturbation models, including an improved EM algorithm and a learning algorithm that aims to match moments of model samples to moments of data. They discuss understanding the relation of perturbation models to their traditional counterparts, with one chapter showing that the perturbations viewpoint can lead to new algorithms in the traditional setting. And they consider perturbation-based regularization in neural networks, offering a more complete understanding of dropout and studying perturbations in the context of deep neural networks.

Art in the Age of Machine Learning Sofian Audry 2021-11-23 An examination of machine learning art and its practice in new media art and music. Over the past decade, an artistic movement has emerged that draws on machine learning as both inspiration and medium. In this book, transdisciplinary artist-researcher Sofian Audry examines artistic practices at the intersection of machine learning and new media art, providing conceptual tools and historical perspectives for new media artists, musicians, composers, writers, curators, and theorists. Audry looks at works from a broad range of practices, including new media installation, robotic art, visual art, electronic music and sound, and electronic literature, connecting machine learning art to such earlier artistic practices as cybernetics art, artificial life art, and evolutionary art. Machine learning underlies computational systems that are biologically inspired, statistically driven, agent-based networked entities that program themselves. Audry explains the fundamental design of machine learning algorithmic structures in terms accessible to the nonspecialist while framing these technologies within larger historical and conceptual spaces. Audry debunks myths about machine learning art, including the ideas that machine learning can create art without artists and that machine learning will soon bring about superhuman intelligence and creativity. Audry considers learning procedures, describing how artists hijack the training process by playing with evaluative functions; discusses trainable machines and models, explaining how different types of machine learning systems enable different kinds of artistic practices; and reviews the role of data in machine learning art, showing how artists use data as a raw material to steer learning systems and arguing that machine learning allows for novel forms of algorithmic remixes.

Artificial Intelligence in the Age of Neural Networks and Brain Computing Robert Kozma 2023-10-27 Artificial Intelligence in the Age of Neural Networks and Brain Computing, Second Edition demonstrates that present disruptive implications and applications of AI is a development of the unique attributes of neural networks, mainly machine learning, distributed architectures, massive parallel processing, black-box inference, intrinsic nonlinearity, and smart autonomous search engines. The book covers the major basic ideas of "brain-like computing" behind AI, provides a framework to deep learning, and launches novel and intriguing paradigms as possible future alternatives. The present success of AI-based commercial products proposed by top industry leaders, such as Google, IBM, Microsoft, Intel, and Amazon, can be interpreted using the perspective presented in this book by viewing the co-existence of a successful synergism among what is referred to as computational intelligence, natural intelligence, brain computing, and neural engineering. The new edition has been updated to include major new advances in the field, including many new chapters. Developed from the 30th anniversary of the International Neural Network Society (INNS) and the 2017 International Joint Conference on Neural Networks (IJCNN) Authored by top experts, global field pioneers, and researchers working on cutting-edge applications in signal

processing, speech recognition, games, adaptive control and decision-making Edited by high-level academics and researchers in intelligent systems and neural networks Includes all new chapters, including topics such as Frontiers in Recurrent Neural Network Research; Big Science, Team Science, Open Science for Neuroscience; A Model-Based Approach for Bridging Scales of Cortical Activity; A Cognitive Architecture for Object Recognition in Video; How Brain Architecture Leads to Abstract Thought; Deep Learning-Based Speech Separation and Advances in AI, Neural Networks

Deep Learning John D. Kelleher 2019-09-10 An accessible introduction to the artificial intelligence technology that enables computer vision, speech recognition, machine translation, and driverless cars. Deep learning is an artificial intelligence technology that enables computer vision, speech recognition in mobile phones, machine translation, AI games, driverless cars, and other applications. When we use consumer products from Google, Microsoft, Facebook, Apple, or Baidu, we are often interacting with a deep learning system. In this volume in the MIT Press Essential Knowledge series, computer scientist John Kelleher offers an accessible and concise but comprehensive introduction to the fundamental technology at the heart of the artificial intelligence revolution. Kelleher explains that deep learning enables data-driven decisions by identifying and extracting patterns from large datasets; its ability to learn from complex data makes deep learning ideally suited to take advantage of the rapid growth in big data and computational power. Kelleher also explains some of the basic concepts in deep learning, presents a history of advances in the field, and discusses the current state of the art. He describes the most important deep learning architectures, including autoencoders, recurrent neural networks, and long short-term networks, as well as such recent developments as Generative Adversarial Networks and capsule networks. He also provides a comprehensive (and comprehensible) introduction to the two fundamental algorithms in deep learning: gradient descent and backpropagation. Finally, Kelleher considers the future of deep learning—major trends, possible developments, and significant challenges.

Deep Learning Josh Patterson 2017-07-28 Although interest in machine learning has reached a high point, lofty expectations often scuttle projects before they get very far. How can machine learning—especially deep neural networks—make a real difference in your organization? This hands-on guide not only provides the most practical information available on the subject, but also helps you get started building efficient deep learning networks. Authors Adam Gibson and Josh Patterson provide theory on deep learning before introducing their open-source Deeplearning4j (DL4J) library for developing production-class workflows. Through real-world examples, you'll learn methods and strategies for training deep network architectures and running deep learning workflows on Spark and Hadoop with DL4J. Dive into machine learning concepts in general, as well as deep learning in particular Understand how deep networks evolved from neural network fundamentals Explore the major deep network architectures, including Convolutional and Recurrent Learn how to map specific deep networks to the right problem Walk through the fundamentals of tuning general neural networks and specific deep network architectures Use vectorization techniques for different data types with DataVec, DL4J's workflow tool Learn how to use DL4J natively on Spark and Hadoop

The Principles of Deep Learning Theory Daniel A. Roberts 2022-05-26 This volume develops an effective theory approach to understanding deep neural networks of practical relevance.

Introduction to Machine Learning Ethem Alpaydin 2014-08-22 Introduction -- Supervised learning -- Bayesian decision theory -- Parametric methods -- Multivariate methods -- Dimensionality reduction -- Clustering -- Nonparametric methods -- Decision trees -- Linear discrimination -- Multilayer perceptrons -- Local models -- Kernel machines -- Graphical models -- Brief contents -- Hidden markov models -- Bayesian estimation -- Combining multiple learners -- Reinforcement learning -- Design and analysis of machine learning experiments.

Learning Computer Architecture with Raspberry Pi Eben Upton 2016-09-13 Use your Raspberry Pi to get smart about computing fundamentals In the

1980s, the tech revolution was kickstarted by a flood of relatively inexpensive, highly programmable computers like the Commodore. Now, a second revolution in computing is beginning with the Raspberry Pi. Learning Computer Architecture with the Raspberry Pi is the premier guide to understanding the components of the most exciting tech product available. Thanks to this book, every Raspberry Pi owner can understand how the computer works and how to access all of its hardware and software capabilities. Now, students, hackers, and casual users alike can discover how computers work with Learning Computer Architecture with the Raspberry Pi. This book explains what each and every hardware component does, how they relate to one another, and how they correspond to the components of other computing systems. You'll also learn how programming works and how the operating system relates to the Raspberry Pi's physical components. Co-authored by Eben Upton, one of the creators of the Raspberry Pi, this is a companion volume to the Raspberry Pi User Guide An affordable solution for learning about computer system design considerations and experimenting with low-level programming Understandable descriptions of the functions of memory storage, Ethernet, cameras, processors, and more Gain knowledge of computer design and operation in general by exploring the basic structure of the Raspberry Pi The Raspberry Pi was created to bring forth a new generation of computer scientists, developers, and architects who understand the inner workings of the computers that have become essential to our daily lives. Learning Computer Architecture with the Raspberry Pi is your gateway to the world of computer system design.

Deep Learning on Graphs Yao Ma 2021-09-23 A comprehensive text on foundations and techniques of graph neural networks with applications in NLP, data mining, vision and healthcare.

Foundations of Deep Reinforcement Learning Laura Graesser 2019-11-20 The Contemporary Introduction to Deep Reinforcement Learning that Combines Theory and Practice Deep reinforcement learning (deep RL) combines deep learning and reinforcement learning, in which artificial agents learn to solve sequential decision-making problems. In the past decade deep RL has achieved remarkable results on a range of problems, from single and multiplayer games—such as Go, Atari games, and DotA 2—to robotics. Foundations of Deep Reinforcement Learning is an introduction to deep RL that uniquely combines both theory and implementation. It starts with intuition, then carefully explains the theory of deep RL algorithms, discusses implementations in its companion software library SLM Lab, and finishes with the practical details of getting deep RL to work. This guide is ideal for both computer science students and software engineers who are familiar with basic machine learning concepts and have a working understanding of Python. Understand each key aspect of a deep RL problem Explore policy- and value-based algorithms, including REINFORCE, SARSA, DQN, Double DQN, and Prioritized Experience Replay (PER) Delve into combined algorithms, including Actor-Critic and Proximal Policy Optimization (PPO) Understand how algorithms can be parallelized synchronously and asynchronously Run algorithms in SLM Lab and learn the practical implementation details for getting deep RL to work Explore algorithm benchmark results with tuned hyperparameters Understand how deep RL environments are designed Register your book for convenient access to downloads, updates, and/or corrections as they become available. See inside book for details.

Deep Learning Essentials Anurag Bhardwaj 2018-01-30 Get to grips with the essentials of deep learning by leveraging the power of Python Key Features Your one-stop solution to get started with the essentials of deep learning and neural network modeling Train different kinds of neural networks to tackle various problems in Natural Language Processing, computer vision, speech recognition, and more Covers popular Python libraries such as Tensorflow, Keras, and more, along with tips on training, deploying and optimizing your deep learning models in the best possible manner Book Description Deep Learning a trending topic in the field of Artificial Intelligence today and can be considered to be an advanced form of machine learning, which is quite tricky to master. This book will help you take your first steps in training efficient deep learning models and applying them in various practical scenarios. You will model, train, and deploy different kinds of neural networks such as Convolutional Neural Network, Recurrent

Neural Network, and will see some of their applications in real-world domains including computer vision, natural language processing, speech recognition, and so on. You will build practical projects such as chatbots, implement reinforcement learning to build smart games, and develop expert systems for image captioning and processing. Popular Python library such as TensorFlow is used in this book to build the models. This book also covers solutions for different problems you might come across while training models, such as noisy datasets, small datasets, and more. This book does not assume any prior knowledge of deep learning. By the end of this book, you will have a firm understanding of the basics of deep learning and neural network modeling, along with their practical applications. What you will learn Get to grips with the core concepts of deep learning and neural networks Set up deep learning library such as TensorFlow Fine-tune your deep learning models for NLP and Computer Vision applications Unify different information sources, such as images, text, and speech through deep learning Optimize and fine-tune your deep learning models for better performance Train a deep reinforcement learning model that plays a game better than humans Learn how to make your models get the best out of your GPU or CPU Who this book is for Aspiring data scientists and machine learning experts who have limited or no exposure to deep learning will find this book to be very useful. If you are looking for a resource that gets you up and running with the fundamentals of deep learning and neural networks, this book is for you. As the models in the book are trained using the popular Python-based libraries such as Tensorflow and Keras, it would be useful to have sound programming knowledge of Python.

Introduction to Machine Learning, fourth edition Ethem Alpaydin 2020-03-24 A substantially revised fourth edition of a comprehensive textbook, including new coverage of recent advances in deep learning and neural networks. The goal of machine learning is to program computers to use example data or past experience to solve a given problem. Machine learning underlies such exciting new technologies as self-driving cars, speech recognition, and translation applications. This substantially revised fourth edition of a comprehensive, widely used machine learning textbook offers new coverage of recent advances in the field in both theory and practice, including developments in deep learning and neural networks. The book covers a broad array of topics not usually included in introductory machine learning texts, including supervised learning, Bayesian decision theory, parametric methods, semiparametric methods, nonparametric methods, multivariate analysis, hidden Markov models, reinforcement learning, kernel machines, graphical models, Bayesian estimation, and statistical testing. The fourth edition offers a new chapter on deep learning that discusses training, regularizing, and structuring deep neural networks such as convolutional and generative adversarial networks; new material in the chapter on reinforcement learning that covers the use of deep networks, the policy gradient methods, and deep reinforcement learning; new material in the chapter on multilayer perceptrons on autoencoders and the word2vec network; and discussion of a popular method of dimensionality reduction, t-SNE. New appendixes offer background material on linear algebra and optimization. End-of-chapter exercises help readers to apply concepts learned. Introduction to Machine Learning can be used in courses for advanced undergraduate and graduate students and as a reference for professionals.

Deep Learning with PyTorch Luca Pietro Giovanni Antiga 2020-07-01 “We finally have the definitive treatise on PyTorch! It covers the basics and abstractions in great detail. I hope this book becomes your extended reference document.” —Soumith Chintala, co-creator of PyTorch Key Features Written by PyTorch’s creator and key contributors Develop deep learning models in a familiar Pythonic way Use PyTorch to build an image classifier for cancer detection Diagnose problems with your neural network and improve training with data augmentation Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About The Book Every other day we hear about new ways to put deep learning to good use: improved medical imaging, accurate credit card fraud detection, long range weather forecasting, and more. PyTorch puts these superpowers in your hands. Instantly familiar to anyone who knows Python data tools like NumPy and Scikit-learn, PyTorch simplifies deep learning

without sacrificing advanced features. It's great for building quick models, and it scales smoothly from laptop to enterprise. Deep Learning with PyTorch teaches you to create deep learning and neural network systems with PyTorch. This practical book gets you to work right away building a tumor image classifier from scratch. After covering the basics, you'll learn best practices for the entire deep learning pipeline, tackling advanced projects as your PyTorch skills become more sophisticated. All code samples are easy to explore in downloadable Jupyter notebooks. What You Will Learn Understanding deep learning data structures such as tensors and neural networks Best practices for the PyTorch Tensor API, loading data in Python, and visualizing results Implementing modules and loss functions Utilizing pretrained models from PyTorch Hub Methods for training networks with limited inputs Sifting through unreliable results to diagnose and fix problems in your neural network Improve your results with augmented data, better model architecture, and fine tuning This Book Is Written For For Python programmers with an interest in machine learning. No experience with PyTorch or other deep learning frameworks is required. About The Authors Eli Stevens has worked in Silicon Valley for the past 15 years as a software engineer, and the past 7 years as Chief Technical Officer of a startup making medical device software. Luca Antiga is co-founder and CEO of an AI engineering company located in Bergamo, Italy, and a regular contributor to PyTorch. Thomas Viehmann is a Machine Learning and PyTorch speciality trainer and consultant based in Munich, Germany and a PyTorch core developer. Table of Contents PART 1 - CORE PYTORCH 1 Introducing deep learning and the PyTorch Library 2 Pretrained networks 3 It starts with a tensor 4 Real-world data representation using tensors 5 The mechanics of learning 6 Using a neural network to fit the data 7 Telling birds from airplanes: Learning from images 8 Using convolutions to generalize PART 2 - LEARNING FROM IMAGES IN THE REAL WORLD: EARLY DETECTION OF LUNG CANCER 9 Using PyTorch to fight cancer 10 Combining data sources into a unified dataset 11 Training a classification model to detect suspected tumors 12 Improving training with metrics and augmentation 13 Using segmentation to find suspected nodules 14 End-to-end nodule analysis, and where to go next PART 3 - DEPLOYMENT 15 Deploying to production

Deep Learning Ian Goodfellow 2016-11-10 An introduction to a broad range of topics in deep learning, covering mathematical and conceptual background, deep learning techniques used in industry, and research perspectives. "Written by three experts in the field, Deep Learning is the only comprehensive book on the subject." —Elon Musk, cochair of OpenAI; cofounder and CEO of Tesla and SpaceX Deep learning is a form of machine learning that enables computers to learn from experience and understand the world in terms of a hierarchy of concepts. Because the computer gathers knowledge from experience, there is no need for a human computer operator to formally specify all the knowledge that the computer needs. The hierarchy of concepts allows the computer to learn complicated concepts by building them out of simpler ones; a graph of these hierarchies would be many layers deep. This book introduces a broad range of topics in deep learning. The text offers mathematical and conceptual background, covering relevant concepts in linear algebra, probability theory and information theory, numerical computation, and machine learning. It describes deep learning techniques used by practitioners in industry, including deep feedforward networks, regularization, optimization algorithms, convolutional networks, sequence modeling, and practical methodology; and it surveys such applications as natural language processing, speech recognition, computer vision, online recommendation systems, bioinformatics, and videogames. Finally, the book offers research perspectives, covering such theoretical topics as linear factor models, autoencoders, representation learning, structured probabilistic models, Monte Carlo methods, the partition function, approximate inference, and deep generative models. Deep Learning can be used by undergraduate or graduate students planning careers in either industry or research, and by software engineers who want to begin using deep learning in their products or platforms. A website offers supplementary material for both readers and instructors.

Reinforcement Learning, second edition Richard S. Sutton 2018-11-13 The significantly expanded and updated new edition of a widely used text

on reinforcement learning, one of the most active research areas in artificial intelligence. Reinforcement learning, one of the most active research areas in artificial intelligence, is a computational approach to learning whereby an agent tries to maximize the total amount of reward it receives while interacting with a complex, uncertain environment. In Reinforcement Learning, Richard Sutton and Andrew Barto provide a clear and simple account of the field's key ideas and algorithms. This second edition has been significantly expanded and updated, presenting new topics and updating coverage of other topics. Like the first edition, this second edition focuses on core online learning algorithms, with the more mathematical material set off in shaded boxes. Part I covers as much of reinforcement learning as possible without going beyond the tabular case for which exact solutions can be found. Many algorithms presented in this part are new to the second edition, including UCB, Expected Sarsa, and Double Learning. Part II extends these ideas to function approximation, with new sections on such topics as artificial neural networks and the Fourier basis, and offers expanded treatment of off-policy learning and policy-gradient methods. Part III has new chapters on reinforcement learning's relationships to psychology and neuroscience, as well as an updated case-studies chapter including AlphaGo and AlphaGo Zero, Atari game playing, and IBM Watson's wagering strategy. The final chapter discusses the future societal impacts of reinforcement learning.

Semi-Supervised Learning Olivier Chapelle 2010-01-22 A comprehensive review of an area of machine learning that deals with the use of unlabeled data in classification problems: state-of-the-art algorithms, a taxonomy of the field, applications, benchmark experiments, and directions for future research. In the field of machine learning, semi-supervised learning (SSL) occupies the middle ground, between supervised learning (in which all training examples are labeled) and unsupervised learning (in which no label data are given). Interest in SSL has increased in recent years, particularly because of application domains in which unlabeled data are plentiful, such as images, text, and bioinformatics. This first comprehensive overview of SSL presents state-of-the-art algorithms, a taxonomy of the field, selected applications, benchmark experiments, and perspectives on ongoing and future research. Semi-Supervised Learning first presents the key assumptions and ideas underlying the field: smoothness, cluster or low-density separation, manifold structure, and transduction. The core of the book is the presentation of SSL methods, organized according to algorithmic strategies. After an examination of generative models, the book describes algorithms that implement the low-density separation assumption, graph-based methods, and algorithms that perform two-step learning. The book then discusses SSL applications and offers guidelines for SSL practitioners by analyzing the results of extensive benchmark experiments. Finally, the book looks at interesting directions for SSL research. The book closes with a discussion of the relationship between semi-supervised learning and transduction.

Learning Deep Learning Magnus Ekman 2021-08 NVIDIA's Full-Color Guide to Deep Learning: All Students Need to Get Started and Get Results Learning Deep Learning is a complete guide to DL. Illuminating both the core concepts and the hands-on programming techniques needed to succeed, this book suits seasoned developers, data scientists, analysts, but also those with no prior machine learning or statistics experience. After introducing the essential building blocks of deep neural networks, such as artificial neurons and fully connected, convolutional, and recurrent layers, Magnus Ekman shows how to use them to build advanced architectures, including the Transformer. He describes how these concepts are used to build modern networks for computer vision and natural language processing (NLP), including Mask R-CNN, GPT, and BERT. And he explains how a natural language translator and a system generating natural language descriptions of images. Throughout, Ekman provides concise, well-annotated code examples using TensorFlow with Keras. Corresponding PyTorch examples are provided online, and the book thereby covers the two dominating Python libraries for DL used in industry and academia. He concludes with an introduction to neural architecture research (NAS), exploring important ethical issues and providing resources for further learning. Explore and master core concepts: perceptrons, gradient-based learning, sigmoid neurons, and back propagation See how DL frameworks make it easier to develop more complicated and useful neural networks Discover how convolutional

neural networks (CNNs) revolutionize image classification and analysis Apply recurrent neural networks (RNNs) and long short-term memory (LSTM) to text and other variable-length sequences Master NLP with sequence-to-sequence networks and the Transformer architecture Build applications for natural language translation and image captioning

Deep Learning Illustrated Jon Krohn 2019-08-05 "The authors' clear visual style provides a comprehensive look at what's currently possible with artificial neural networks as well as a glimpse of the magic that's to come." - Tim Urban, author of Wait But Why Fully Practical, Insightful Guide to Modern Deep Learning Deep learning is transforming software, facilitating powerful new artificial intelligence capabilities, and driving unprecedented algorithm performance. Deep Learning Illustrated is uniquely intuitive and offers a complete introduction to the discipline's techniques. Packed with full-color figures and easy-to-follow code, it sweeps away the complexity of building deep learning models, making the subject approachable and fun to learn. World-class instructor and practitioner Jon Krohn—with visionary content from Grant Beylveled and beautiful illustrations by Aglaé Bassens—presents straightforward analogies to explain what deep learning is, why it has become so popular, and how it relates to other machine learning approaches. Krohn has created a practical reference and tutorial for developers, data scientists, researchers, analysts, and students who want to start applying it. He illuminates theory with hands-on Python code in accompanying Jupyter notebooks. To help you progress quickly, he focuses on the versatile deep learning library Keras to nimbly construct efficient TensorFlow models; PyTorch, the leading alternative library, is also covered. You'll gain a pragmatic understanding of all major deep learning approaches and their uses in applications ranging from machine vision and natural language processing to image generation and game-playing algorithms. Discover what makes deep learning systems unique, and the implications for practitioners Explore new tools that make deep learning models easier to build, use, and improve Master essential theory: artificial neurons, training, optimization, convolutional nets, recurrent nets, generative adversarial networks (GANs), deep reinforcement learning, and more Walk through building interactive deep learning applications, and move forward with your own artificial intelligence projects Register your book for convenient access to downloads, updates, and/or corrections as they become available. See inside book for details.

AI and Machine Learning for Coders Laurence Moroney 2020-10-01 If you're looking to make a career move from programmer to AI specialist, this is the ideal place to start. Based on Laurence Moroney's extremely successful AI courses, this introductory book provides a hands-on, code-first approach to help you build confidence while you learn key topics. You'll understand how to implement the most common scenarios in machine learning, such as computer vision, natural language processing (NLP), and sequence modeling for web, mobile, cloud, and embedded runtimes. Most books on machine learning begin with a daunting amount of advanced math. This guide is built on practical lessons that let you work directly with the code. You'll learn: How to build models with TensorFlow using skills that employers desire The basics of machine learning by working with code samples How to implement computer vision, including feature detection in images How to use NLP to tokenize and sequence words and sentences Methods for embedding models in Android and iOS How to serve models over the web and in the cloud with TensorFlow Serving

Probabilistic Graphical Models Daphne Koller 2009-07-31 A general framework for constructing and using probabilistic models of complex systems that would enable a computer to use available information for making decisions. Most tasks require a person or an automated system to reason—to reach conclusions based on available information. The framework of probabilistic graphical models, presented in this book, provides a general approach for this task. The approach is model-based, allowing interpretable models to be constructed and then manipulated by reasoning algorithms. These models can also be learned automatically from data, allowing the approach to be used in cases where manually constructing a model is difficult or even impossible. Because uncertainty is an inescapable aspect of most real-world applications, the book focuses on probabilistic models, which make the uncertainty explicit and provide models that are more faithful to reality. Probabilistic Graphical Models discusses a variety of

models, spanning Bayesian networks, undirected Markov networks, discrete and continuous models, and extensions to deal with dynamical systems and relational data. For each class of models, the text describes the three fundamental cornerstones: representation, inference, and learning, presenting both basic concepts and advanced techniques. Finally, the book considers the use of the proposed framework for causal reasoning and decision making under uncertainty. The main text in each chapter provides the detailed technical development of the key ideas. Most chapters also include boxes with additional material: skill boxes, which describe techniques; case study boxes, which discuss empirical cases related to the approach described in the text, including applications in computer vision, robotics, natural language understanding, and computational biology; and concept boxes, which present significant concepts drawn from the material in the chapter. Instructors (and readers) can group chapters in various combinations, from core topics to more technically advanced material, to suit their particular needs.

Introduction to Natural Language Processing Jacob Eisenstein 2019-10-01 A survey of computational methods for understanding, generating, and manipulating human language, which offers a synthesis of classical representations and algorithms with contemporary machine learning techniques. This textbook provides a technical perspective on natural language processing—methods for building computer software that understands, generates, and manipulates human language. It emphasizes contemporary data-driven approaches, focusing on techniques from supervised and unsupervised machine learning. The first section establishes a foundation in machine learning by building a set of tools that will be used throughout the book and applying them to word-based textual analysis. The second section introduces structured representations of language, including sequences, trees, and graphs. The third section explores different approaches to the representation and analysis of linguistic meaning, ranging from formal logic to neural word embeddings. The final section offers chapter-length treatments of three transformative applications of natural language processing: information extraction, machine translation, and text generation. End-of-chapter exercises include both paper-and-pencil analysis and software implementation. The text synthesizes and distills a broad and diverse research literature, linking contemporary machine learning techniques with the field's linguistic and computational foundations. It is suitable for use in advanced undergraduate and graduate-level courses and as a reference for software engineers and data scientists. Readers should have a background in computer programming and college-level mathematics. After mastering the material presented, students will have the technical skill to build and analyze novel natural language processing systems and to understand the latest research in the field.

Foundations of Machine Learning, second edition Mehryar Mohri 2018-12-25 A new edition of a graduate-level machine learning textbook that focuses on the analysis and theory of algorithms. This book is a general introduction to machine learning that can serve as a textbook for graduate students and a reference for researchers. It covers fundamental modern topics in machine learning while providing the theoretical basis and conceptual tools needed for the discussion and justification of algorithms. It also describes several key aspects of the application of these algorithms. The authors aim to present novel theoretical tools and concepts while giving concise proofs even for relatively advanced topics. *Foundations of Machine Learning* is unique in its focus on the analysis and theory of algorithms. The first four chapters lay the theoretical foundation for what follows; subsequent chapters are mostly self-contained. Topics covered include the Probably Approximately Correct (PAC) learning framework; generalization bounds based on Rademacher complexity and VC-dimension; Support Vector Machines (SVMs); kernel methods; boosting; on-line learning; multi-class classification; ranking; regression; algorithmic stability; dimensionality reduction; learning automata and languages; and reinforcement learning. Each chapter ends with a set of exercises. Appendixes provide additional material including concise probability review. This second edition offers three new chapters, on model selection, maximum entropy models, and conditional entropy models. New material in the appendixes includes a major section on Fenchel duality, expanded coverage of concentration inequalities, and an entirely new entry on information

theory. More than half of the exercises are new to this edition.

Deep Learning from Scratch Seth Weidman 2019-09-09 With the resurgence of neural networks in the 2010s, deep learning has become essential for machine learning practitioners and even many software engineers. This book provides a comprehensive introduction for data scientists and software engineers with machine learning experience. You'll start with deep learning basics and move quickly to the details of important advanced architectures, implementing everything from scratch along the way. Author Seth Weidman shows you how neural networks work using a first principles approach. You'll learn how to apply multilayer neural networks, convolutional neural networks, and recurrent neural networks from the ground up. With a thorough understanding of how neural networks work mathematically, computationally, and conceptually, you'll be set up for success on all future deep learning projects. This book provides: Extremely clear and thorough mental models—accompanied by working code examples and mathematical explanations—for understanding neural networks Methods for implementing multilayer neural networks from scratch, using an easy-to-understand object-oriented framework Working implementations and clear-cut explanations of convolutional and recurrent neural networks Implementation of these neural network concepts using the popular PyTorch framework

Machine Learning for Data Streams Albert Bifet 2018-03-16 A hands-on approach to tasks and techniques in data stream mining and real-time analytics, with examples in MOA, a popular freely available open-source software framework. Today many information sources—including sensor networks, financial markets, social networks, and healthcare monitoring—are so-called data streams, arriving sequentially and at high speed. Analysis must take place in real time, with partial data and without the capacity to store the entire data set. This book presents algorithms and techniques used in data stream mining and real-time analytics. Taking a hands-on approach, the book demonstrates the techniques using MOA (Massive Online Analysis), a popular, freely available open-source software framework, allowing readers to try out the techniques after reading the explanations. The book first offers a brief introduction to the topic, covering big data mining, basic methodologies for mining data streams, and a simple example of MOA. More detailed discussions follow, with chapters on sketching techniques, change, classification, ensemble methods, regression, clustering, and frequent pattern mining. Most of these chapters include exercises, an MOA-based lab session, or both. Finally, the book discusses the MOA software, covering the MOA graphical user interface, the command line, use of its API, and the development of new methods within MOA. The book will be an essential reference for readers who want to use data stream mining as a tool, researchers in innovation or data stream mining, and programmers who want to create new algorithms for MOA.

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