

Approximation Algorithms For Np Hard Problems

Approximation Algorithms for NP-hard Problems Dorit S. Hochbaum 1997 This is the first book to fully address the study of approximation algorithms as a tool for coping with intractable problems. With chapters contributed by leading researchers in the field, this book introduces unifying techniques in the analysis of approximation algorithms. APPROXIMATION ALGORITHMS FOR NP-HARD PROBLEMS is intended for computer scientists and operations researchers interested in specific algorithm implementations, as well as design tools for algorithms. Among the techniques discussed: the use of linear programming, primal-dual techniques in worst-case analysis, semidefinite programming, computational geometry techniques, randomized algorithms, average-case analysis, probabilistically checkable proofs and inapproximability, and the Markov Chain Monte Carlo method. The text includes a variety of pedagogical features: definitions, exercises, open problems, glossary of problems, index, and notes on how best to use the book.

Design of Modern Heuristics Franz Rothlauf 2011-07-17 Most textbooks on modern heuristics provide the reader with detailed descriptions of the functionality of single examples like genetic algorithms, genetic programming, tabu search, simulated annealing, and others, but fail to teach the underlying concepts behind these different approaches. The author takes a different approach in this textbook by focusing on the users' needs and answering three fundamental questions: First, he tells us which problems modern heuristics are expected to perform well on, and which should be left to traditional optimization methods. Second, he teaches us to systematically design the "right" modern heuristic for a particular problem by providing a coherent view on design elements and working principles. Third, he shows how we can make use of problem-specific knowledge for the design of efficient and effective modern heuristics that solve not only small toy problems but also perform well on large real-world problems. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use. This book is written in an easy-to-read style and it is aimed at students and practitioners in computer science, operations research and information systems who want to understand modern heuristics and are interested in a guide to their systematic design and use.

Approximation Algorithms for NP-hard Routing Problems Greg N. Frederickson 1979

Algorithms and Computation 2005

Integer Programming and Combinatorial Optimization William H. Cunningham 1996-05-15 This book provides a critical update and synthesis of contemporary evidence for schizophrenia as a brain disease of early, neurodevelopmental origin; it does this through contributions from leading authorities in this field who work at multiple levels of biological and epidemiological enquiry. The work seeks both to integrate this evolving body of evidence and to examine the strengths and weaknesses of the neurodevelopmental model.

Approximation Algorithms for NP-hard Clustering Problems Ramgopal Reddy Mettu 2002 Given a set of n points and their pairwise distances, the goal of clustering is to partition the points into a "small" number of "related" sets. Clustering algorithms are used widely to manage, classify, and summarize many kinds of data. In this dissertation, we study the classic facility location and k -median problems in the context of clustering, and formulate and study a new optimization problem that we call the online median problem. For each of these problems, it is known to be NP-hard to compute a solution with cost less than a certain constant factor times the optimal cost. We give simple constant-factor approximation algorithms for the facility location, k -median, and online median problems with optimal or near-optimal time bounds. We also study distance functions that are "approximately" metric, and show that such distance functions allow us to obtain a faster online median algorithm and to generalize our analysis to other objective functions, such as that of the well-known k -means heuristic. Given n points, the associated interpoint distances and nonnegative point weights, and a

nonnegative penalty for each point, the facility location problem asks us to identify a set of cluster centers so that the weighted average cluster radii and the sum of the cluster center penalties are both minimized. The k -median problem asks us to identify exactly k cluster centers while minimizing just the weighted average cluster radii. We give a simple greedy algorithm for the facility location problem that runs in $O(n^2)$ time and produces a solution with cost at most 3 times optimal. For the k -median problem, we develop and make use of a sampling technique that we call "successive sampling," and give a randomized constant-factor approximation algorithm that runs in $O(n(k + \log\{n\} + \log^2\{n\}))$ time. We also give an $\Omega(nk)$ lower bound on the running time of any randomized constant-factor approximation algorithm for the k -median problem that succeeds with even a negligible constant probability. In many settings, it is desirable to browse a given data set at differing levels of granularity (i.e., number of clusters). To address this concern, we formulate a generalization of the k -median problem that we call the online median problem. The online median problem asks us to compute an ordering of the points so that, over all i , when a prefix of length i is taken as a set of cluster centers, the weighted average radii of the induced clusters is minimized. We show that a natural generalization of the greedy strategy that we call "hierarchically greedy" yields an algorithm that produces an ordering such that every prefix of the ordering is within a constant factor of the associated optimal cost. Furthermore, our algorithm has a running time of $\Theta(n^2)$. Finally, we study the performance of our algorithms in practice. We present implementations of our k -median and online median algorithms; our experimental results indicate that our approximation algorithms may be useful in practice.

Super - Polynomial Approximation Algorithms for NP - Hard Problems Hadas Taubman 2000

Approximation Algorithms for Certain NP-Hard Problems Alan Jay Wecker 1982

Techniques for Designing and Analyzing Algorithms Douglas R. Stinson 2021-08-05 Techniques for Designing and Analyzing Algorithms Design and analysis of algorithms can be a difficult subject for students due to its sometimes-abstract nature and its use of a wide variety of mathematical tools. Here the author, an experienced and successful textbook writer, makes the subject as straightforward as possible in an up-to-date textbook incorporating various new developments appropriate for an introductory course. This text presents the main techniques of algorithm design, namely, divide-and-conquer algorithms, greedy algorithms, dynamic programming algorithms, and backtracking. Graph algorithms are studied in detail, and a careful treatment of the theory of NP-completeness is presented. In addition, the text includes useful introductory material on mathematical background including order notation, algorithm analysis and reductions, and basic data structures. This will serve as a useful review and reference for students who have covered this material in a previous course. Features The first three chapters provide a mathematical review, basic algorithm analysis, and data structures Detailed pseudocode descriptions of the algorithms along with illustrative algorithms are included Proofs of correctness of algorithms are included when appropriate The book presents a suitable amount of mathematical rigor After reading and understanding the material in this book, students will be able to apply the basic design principles to various real-world problems that they may encounter in their future professional careers.

Linear Optimization and Duality Craig A. Tovey 2020-12-15 Linear Optimization and Duality: A Modern Exposition departs from convention in significant ways. Standard linear programming textbooks present the material in the order in which it was discovered. Duality is treated as a difficult add-on after coverage of formulation, the simplex method, and polyhedral theory. Students end up without knowing duality in their bones. This text brings in duality in Chapter 1 and carries duality all the way through the exposition. Chapter 1 gives a general definition of duality that shows the dual aspects of a matrix as a column of rows and a row of columns. The proof of weak duality in Chapter 2 is shown via the Lagrangian, which relies on matrix duality. The first three LP formulation examples in Chapter 3 are classic primal-dual pairs including the diet problem and 2-person zero sum games. For many engineering students, optimization is their first immersion in rigorous mathematics. Conventional texts assume a level of mathematical sophistication they

don't have. This text embeds dozens of reading tips and hundreds of answered questions to guide such students. Features Emphasis on duality throughout Practical tips for modeling and computation Coverage of computational complexity and data structures Exercises and problems based on the learning theory concept of the zone of proximal development Guidance for the mathematically unsophisticated reader About the Author Craig A. Tovey is a professor in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Institute of Technology. Dr. Tovey received an AB from Harvard College, an MS in computer science and a PhD in operations research from Stanford University. His principal activities are in operations research and its interdisciplinary applications. He received a Presidential Young Investigator Award and the Jacob Wolfowitz Prize for research in heuristics. He was named an Institute Fellow at Georgia Tech, and was recognized by the ACM Special Interest Group on Electronic Commerce with the Test of Time Award. Dr. Tovey received the 2016 Golden Goose Award for his research on bee foraging behavior leading to the development of the Honey Bee Algorithm.

Integer Programming and Combinatorial Optimization 1996

Approximation Algorithms for NP-hard Routing Problems Greg Norman Frederickson 1977

Algorithms 2005

Algorithms and Complexity 2003

Algorithms for Clustering Problems Moses Samson Charikar 2000

Proceedings of the Seventeenth Annual ACM-SIAM Symposium on Discrete Algorithms SIAM Activity Group on Discrete Mathematics 2006-01-01 Symposium held in Miami, Florida, January 22-24, 2006. This symposium is jointly sponsored by the ACM Special Interest Group on Algorithms and Computation Theory and the SIAM Activity Group on Discrete Mathematics. Contents Preface; Acknowledgments; Session 1A: Confronting Hardness Using a Hybrid Approach, Virginia Vassilevska, Ryan Williams, and Shan Leung Maverick Woo; A New Approach to Proving Upper Bounds for MAX-2-SAT, Arist Kojevnikov and Alexander S. Kulikov, Measure and Conquer: A Simple $O(2.288^n)$ Independent Set Algorithm, Fedor V. Fomin, Fabrizio Grandoni, and Dieter Kratsch; A Polynomial Algorithm to Find an Independent Set of Maximum Weight in a Fork-Free Graph, Vadim V. Lozin and Martin Milanic; The Knuth-Yao Quadrangle-Inequality Speedup is a Consequence of Total-Monotonicity, Wolfgang W. Bein, Mordecai J. Golin, Larry L. Larmore, and Yan Zhang; Session 1B: Local Versus Global Properties of Metric Spaces, Sanjeev Arora, László Lovász, Ilan Newman, Yuval Rabani, Yuri Rabinovich, and Santosh Vempala; Directed Metrics and Directed Graph Partitioning Problems, Moses Charikar, Konstantin Makarychev, and Yury Makarychev; Improved Embeddings of Graph Metrics into Random Trees, Kedar Dhamdhere, Anupam Gupta, and Harald Räcke; Small Hop-diameter Sparse Spanners for Doubling Metrics, T-H. Hubert Chan and Anupam Gupta; Metric Cotype, Manor Mendel and Assaf Naor; Session 1C: On Nash Equilibria for a Network Creation Game, Susanne Albers, Stefan Eilts, Eyal Even-Dar, Yishay Mansour, and Liam Roditty; Approximating Unique Games, Anupam Gupta and Kunal Talwar; Computing Sequential Equilibria for Two-Player Games, Peter Bro Miltersen and Troels Bjerre Sørensen; A Deterministic Subexponential Algorithm for Solving Parity Games, Marcin Jurdzinski, Mike Paterson, and Uri Zwick; Finding Nucleolus of Flow Game, Xiaotie Deng, Qizhi Fang, and Xiaoxun Sun, Session 2: Invited Plenary Abstract: Predicting the "Unpredictable", Rakesh V. Vohra, Northwestern University; Session 3A: A Near-Tight Approximation Lower Bound and Algorithm for the Kidnapped Robot Problem, Sven Koenig, Apurva Mudgal, and Craig Tovey; An Asymptotic Approximation Algorithm for 3D-Strip Packing, Klaus Jansen and Roberto Solis-Oba; Facility Location with Hierarchical Facility Costs, Zoya Svitkina and Éva Tardos; Combination Can Be Hard: Approximability of the Unique Coverage Problem, Erik D. Demaine, Uriel Feige, Mohammad Taghi Hajiaghayi, and Mohammad R. Salavatipour; Computing Steiner Minimum Trees in Hamming Metric, Ernst Althaus and Rouven Naujoks; Session 3B: Robust Shape Fitting via Peeling and Grating Coresets, Pankaj K. Agarwal, Sarel Har-Peled, and Hai Yu; Tightening Non-Simple Paths and Cycles on Surfaces, Éric Colin de Verdière and Jeff Erickson; Anisotropic Surface Meshing, Siu-Wing Cheng, Tamal K. Dey, Edgar A. Ramos, and Rephael Wenger; Simultaneous Diagonal Flips in Plane Triangulations, Prosenjit Bose, Jurek Czyzowicz, Zhicheng Gao, Pat Morin, and David R. Wood; Morphing Orthogonal Planar Graph Drawings, Anna Lubiw, Mark Petrick, and Michael Spriggs; Session 3C: Overhang, Mike Paterson and Uri Zwick; On the Capacity of Information Networks, Micah Adler, Nicholas J. A. Harvey, Kamal Jain, Robert Kleinberg, and April Rasala

Lehman; Lower Bounds for Asymmetric Communication Channels and Distributed Source Coding, Micah Adler, Erik D. Demaine, Nicholas J. A. Harvey, and Mihai Patrascu; Self-Improving Algorithms, Nir Ailon, Bernard Chazelle, Seshadhri Comandur, and Ding Liu; Cake Cutting Really is Not a Piece of Cake, Jeff Edmonds and Kirk Pruhs; Session 4A: Testing Triangle-Freeness in General Graphs, Noga Alon, Tali Kaufman, Michael Krivelevich, and Dana Ron; Constraint Solving via Fractional Edge Covers, Martin Grohe and Dániel Marx; Testing Graph Isomorphism, Eldar Fischer and Arie Matsliah; Efficient Construction of Unit Circular-Arc Models, Min Chih Lin and Jayme L. 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Srinivasa Rao; $O(\log \log n)$ -Competitive Dynamic Binary Search Trees, Chengwen Chris Wang, Jonathan Derryberry, and Daniel Dominic Sleator; The Rainbow Skip Graph: A Fault-Tolerant Constant-Degree Distributed Data Structure, Michael T. Goodrich, Michael J. Nelson, and Jonathan Z. Sun; Design of Data Structures for Mergeable Trees, Loukas Georgiadis, Robert E. Tarjan, and Renato F. Werneck; Implicit Dictionaries with $O(1)$ Modifications per Update and Fast Search, Gianni Franceschini and J. Ian Munro; Session 5A: Sampling Binary Contingency Tables with a Greedy Start, Ivona Bezáková, Nayantara Bhatnagar, and Eric Vigoda; Asymmetric Balanced Allocation with Simple Hash Functions, Philipp Woelfel; Balanced Allocation on Graphs, Krishnaram Kenthapadi and Rina Panigrahy; Superiority and Complexity of the Spaced Seeds, Ming Li, Bin Ma, and Louxin Zhang; Solving Random Satisfiable 3CNF Formulas in Expected Polynomial Time, Michael Krivelevich and Dan Vilenchik; Session 5B: Analysis of Incomplete Data and an Intrinsic-Dimension Helly Theorem, Jie Gao, Michael Langberg, and Leonard J. Schulman; Finding Large Sticks and Potatoes in Polygons, Olaf Hall-Holt, Matthew J. Katz, Piyush Kumar, Joseph S. B. Mitchell, and Arik Sityon; Randomized Incremental Construction of Three-Dimensional Convex Hulls and Planar Voronoi Diagrams, and Approximate Range Counting, Haim Kaplan and Micha Sharir; Vertical Ray Shooting and Computing Depth Orders for Fat Objects, Mark de Berg and Chris Gray; On the Number of Plane Graphs, Oswin Aichholzer, Thomas Hackl, Birgit Vogtenhuber, Clemens Huemer, Ferran Hurtado, and Hannes Krasser; Session 5C: All-Pairs Shortest Paths for Unweighted Undirected Graphs in $o(mn)$ Time, Timothy M. Chan; An $O(n \log n)$ Algorithm for Maximum st-Flow in a Directed Planar Graph, Glencora Borradaile and Philip Klein; A Simple GAP-Canceling Algorithm for the Generalized Maximum Flow Problem, Mateo Restrepo and David P. Williamson; Four Point Conditions and Exponential Neighborhoods for Symmetric TSP, Vladimir Deineko, Bettina Klinz, and Gerhard J. Woeginger; Upper Degree-Constrained Partial Orientations, Harold N. Gabow; Session 7A: On the Tandem Duplication-Random Loss Model of Genome Rearrangement, Kamalika Chaudhuri, Kevin Chen, Radu Mihaescu, and Satish Rao; Reducing Tile Complexity for Self-Assembly Through Temperature Programming, Ming-Yang Kao and Robert Schweller; Cache-Oblivious String Dictionaries, Gerth Støltting Brodal and Rolf Fagerberg; Cache-Oblivious Dynamic Programming, Rezaul Alam Chowdhury and Vijaya Ramachandran; A Computational Study of External-Memory BFS Algorithms, Deepak Ajwani, Roman Dementiev, and Ulrich Meyer; Session 7B: Tight Approximation Algorithms for Maximum General Assignment Problems, Lisa Fleischer, Michel X. Goemans, Vahab S. Mirrokni, and Maxim Sviridenko; Approximating the k -Multicut Problem, Daniel Golovin, Viswanath Nagarajan, and Mohit Singh; The Prize-Collecting Generalized Steiner Tree Problem Via A New Approach Of Primal-Dual Schema, Mohammad Taghi Hajiaghayi and Kamal Jain; 8/7-Approximation Algorithm for (1,2)-TSP, Piotr Berman and Marek Karpinski; Improved Lower and Upper Bounds for Universal TSP in Planar Metrics, Mohammad T. Hajiaghayi, Robert Kleinberg, and Tom Leighton; Session 7C: Leontief Economies Encode NonZero Sum Two-Player Games, B. Codenotti, A. Saberi, K. Varadarajan, and Y. Ye; Bottleneck Links, Variable Demand, and the Tragedy of the Commons, Richard Cole,

Yevgeniy Dodis, and Tim Roughgarden; The Complexity of Quantitative Concurrent Parity Games, Krishnendu Chatterjee, Luca de Alfaro, and Thomas A. Henzinger; Equilibria for Economies with Production: Constant>Returns Technologies and Production Planning Constraints, Kamal Jain and Kasturi Varadarajan; Session 8A: Approximation Algorithms for Wavelet Transform Coding of Data Streams, Sudipto Guha and Boulos Harb; Simpler Algorithm for Estimating Frequency Moments of Data Streams, Lakshimath Bhuvanagiri, Sumit Ganguly, Deepanjan Kesh, and Chandan Saha; Trading Off Space for Passes in Graph Streaming Problems, Camil Demetrescu, Irene Finocchi, and Andrea Ribichini; Maintaining Significant Stream Statistics over Sliding Windows, L.K. Lee and H.F. Ting; Streaming and Sublinear Approximation of Entropy and Information Distances, Sudipto Guha, Andrew McGregor, and Suresh Venkatasubramanian; Session 8B: FPTAS for Mixed-Integer Polynomial Optimization with a Fixed Number of Variables, J. A. De Loera, R. Hemmecke, M. Köppe, and R. Weismantel; Linear Programming and Unique Sink Orientations, Bernd Gärtner and Ingo Schurr; Generating All Vertices of a Polyhedron is Hard, Leonid Khachiyan, Endre Boros, Konrad Borys, Khaled Elbassioni, and Vladimir Gurvich; A Semidefinite Programming Approach to Tensegrity Theory and Realizability of Graphs, Anthony Man-Cho So and Yinyu Ye; Ordering by Weighted Number of Wins Gives a Good Ranking for Weighted Tournaments, Don Coppersmith, Lisa Fleischer, and Atri Rudra; Session 8C: Weighted Isotonic Regression under L1 Norm, Stanislav Angelov, Boulos Harb, Sampath Kannan, and Li-San Wang; Oblivious String Embeddings and Edit Distance Approximations, Tugkan Batu, Funda Ergun, and Cenk Sahinalp0898716012

This comprehensive book not only introduces the C and C++ programming languages but also shows how to use them in the numerical solution of partial differential equations (PDEs). It leads the reader through the entire solution process, from the original PDE, through the discretization stage, to the numerical solution of the resulting algebraic system. The well-debugged and tested code segments implement the numerical methods efficiently and transparently. Basic and advanced numerical methods are introduced and implemented easily and efficiently in a unified object-oriented approach.

DESIGN AND ANALYSIS OF ALGORITHMS PRABHAKAR GUPTA

2012-12-09 This well organized text provides the design techniques of algorithms in a simple and straight forward manner. It describes the complete development of various algorithms along with their pseudo-codes in order to have an understanding of their applications. The book begins with a description of the fundamental concepts and basic design techniques of algorithms. Gradually, it introduces more complex and advanced topics such as dynamic programming, backtracking and various algorithms related to graph data structure. Finally, the text elaborates on NP-hard, matrix operations and sorting network. Primarily designed as a text for undergraduate students of Computer Science and Engineering and Information Technology (B.Tech., Computer Science, B.Tech. IT) and postgraduate students of Computer Applications (MCA), the book would also be quite useful to postgraduate students of Computer Science and IT (M.Sc., Computer Science; M.Sc., IT). New to this Second Edition 1. A new section on Characteristics of Algorithms (Section 1.3) has been added 2. Five new sections on Insertion Sort (Section 2.2), Bubble Sort (Section 2.3), Selection Sort (Section 2.4), Shell Sort/Diminishing Increment Sort/Comb Sort (Section 2.5) and Merge Sort (Section 2.6) have been included 3. A new chapter on Divide and Conquer (Chapter 5) has also been incorporated

Fast Algorithms for NP-hard Problems which are Optimal Or Near-optimal with Probability One Routo Terada 1979

Bioinformatics Volker Sperschneider 2008-08-14 "There are fundamental principles for problem analysis and algorithm design that are continuously used in bioinformatics. This book concentrates on a clear presentation of these principles, presenting them in a self-contained, mathematically clear and precise manner, and illustrating them with lots of case studies from main fields of bioinformatics. Emphasis is laid on algorithmic "pearls" of bioinformatics, showing that things may get rather simple when taking a proper view into them. The book closes with a thorough bibliography, ranging from classic research results to very recent findings, providing many pointers for future research. Overall, this volume is ideally suited for a senior undergraduate or graduate course on bioinformatics, with a strong focus on its mathematical and computer science background."--BOOK JACKET.

Algorithms--ESA '93 Thomas Lengauer 1993 Symposium on Algorithms (ESA '93), held in Bad Honnef, near Bonn, in Germany, September 30 - October 2, 1993. The symposium is intended to launch an annual series of

international conferences, held in early fall, covering the field of algorithms. Within the scope of the symposium lies all research on algorithms, theoretical as well as applied, that is carried out in the fields of computer science and discrete applied mathematics. The symposium aims to cater to both of these research communities and to intensify the exchange between them. The volume contains 35 contributed papers selected from 101 proposals submitted in response to the call for papers, as well as three invited lectures: "Evolution of an algorithm" by Michael Paterson, "Complexity of disjoint paths problems in planar graphs" by Alexander Schrijver, and "Sequence comparison and statistical significance in molecular biology" by Michael S. Waterman.

Approximation Algorithms For Np Hard Problems

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