Approximation Algorithms

for NP—HARD PROBLEMS

edited by

DORIT S. HOCHBAUM

Approximation Algorithms For Np Hard Problems

Franz Rothlauf

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   **Approximation Algorithms for NP-hard Routing Problems** Greg Norman Frederickson,1977   **Super - Polynomial Approximation Algorithms for NP - Hard Problems** Hadas Taubman,2000   *Approximation Algorithms for NP-hard Routing Problems* Greg N. Frederickson,1979   *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   **Fast Algorithms for NP-hard Problems which are Optimal Or Near-optimal with Probability One** Routo Terada,1979   **DESIGN AND ANALYSIS OF ALGORITHMS** PRABHAKAR GUPTA,VINEET AGARWAL,MANISH VARSHNEY,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   *Proceedings of the Seventeenth Annual ACM-SIAM Symposium on Discrete Algorithms* SIAM Activity Group on Discrete Mathematics,Association for Computing Machinery,Society for Industrial and Applied 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 20 288n 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 L szl Lov sz 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 R cke 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 S rensen 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 va Tardos Combination Can Be Hard Approximability of the Unique

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

Algorithms for Clustering Problems Moses Samson Charikar,2000 **Algorithms** ,2005 **Linear Optimization and Duality** Craig A. Tovey,2020-12-15 Linear Optimization and Dualiyy 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   Algorithms and Computation ,2005   **Integer Programming and Combinatorial Optimization** ,1996   *Integer Programming and Combinatorial Optimization* William H. Cunningham,S. Thomas McCormick,Maurice Queyranne,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   Algorithms and Complexity ,2003   □□□□□□□ ,2001

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