Approximation Algorithms

for NP—HARD PROBLEMS

edited by

DORIT S. HOCHBAUM

Approximation Algorithms For Np Hard Problems

Greg N. Frederickson

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* Vijay V. Vazirani,2002-12-05 Covering the basic techniques used in the latest research work the author consolidates progress made so far including some very recent and promising results and conveys the beauty and excitement of work in the field He gives clear lucid explanations of key results and ideas with intuitive proofs and provides critical examples and numerous illustrations to help elucidate the algorithms Many of the results presented have been simplified and new insights provided Of interest to theoretical computer scientists operations researchers and discrete mathematicians **Approximation Algorithms for NP-hard Routing Problems** Greg Norman Frederickson,1977 **Approximation Algorithms for NP-hard Routing Problems** Greg N. Frederickson,1979 **Approximation Algorithms for Certain NP-Hard Problems** Alan Jay Wecker,1982 **Fast Algorithms for NP-hard Problems which are Optimal Or Near-optimal with Probability One** Routo Terada,1979

    Super - Polynomial Approximation Algorithms for NP - Hard Problems Hadas Taubman,2000 **Handbook of Approximation Algorithms and Metaheuristics** Teofilo F. Gonzalez,2007-05-15 Delineating the tremendous growth in this area the Handbook of Approximation Algorithms and Metaheuristics covers fundamental theoretical topics as well as advanced practical applications It is the first book to comprehensively study both approximation algorithms and metaheuristics Starting with basic approaches the handbook presents the methodologies to design and analyze efficient approximation algorithms for a large class of problems and to establish inapproximability results for another class of problems It also discusses local search neural networks and metaheuristics as well as multiobjective problems sensitivity analysis and stability After laying this foundation the book applies the methodologies to classical problems in combinatorial optimization computational geometry and graph problems In addition it explores large scale and emerging applications in networks bioinformatics VLSI game theory and data analysis Undoubtedly sparking further developments in the field this handbook provides the essential techniques to apply approximation algorithms and metaheuristics to a wide range of problems in computer science operations research computer engineering and economics Armed with this information

researchers can design and analyze efficient algorithms to generate near optimal solutions for a wide range of computational intractable problems *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 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 Sariel Har Peled and Hai Yu Tightening Non Simple Paths and Cycles on Surfaces ric Colin de Verdi re 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

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methods efficiently and transparently Basic and advanced numerical methods are introduced and implemented easily and efficiently in a unified object oriented approach **The Design of Approximation Algorithms** David P. Williamson,David B. Shmoys,2011-04-26 Discrete optimization problems are everywhere from traditional operations research planning scheduling facility location and network design to computer science databases to advertising issues in viral marketing Yet most such problems are NP hard unless P NP there are no efficient algorithms to find optimal solutions This book shows how to design approximation algorithms efficient algorithms that find provably near optimal solutions The book is organized around central algorithmic techniques for designing approximation algorithms including greedy and local search algorithms dynamic programming linear and semidefinite programming and randomization Each chapter in the first section is devoted to a single algorithmic technique applied to several different problems with more sophisticated treatment in the second section The book also covers methods for proving that optimization problems are hard to approximate Designed as a textbook for graduate level algorithm courses it will also serve as a reference for researchers interested in the heuristic solution of discrete optimization problems   Approximation Algorithms for Combinatorial Optimization ,2004   **Algorithmics for Hard Problems** Juraj Hromkovič,2013-03-14 Algorithmic design especially for hard problems is more essential for success in solving them than any standard improvement of current computer technologies Because of this the design of algorithms for solving hard problems is the core of current algorithmic research from the theoretical point of view as weIl as from the practical point of view There are many general textbooks on algorithmics and several specialized books devoted to particular approaches such as local search randomization approximation algorithms or heuristics But there is no textbook that focuses on the design of algorithms for hard computing tasks and that systematically explains combines and compares the main possibilities for attacking hard algorithmic problems As this topic is fundamental for computer science this book tries to elose this gap Another motivation and probably the main reason for writing this book is connected to education The considered area has developed very dynamically in recent years and the research on this topic discovered several profound re sults new concepts and new methods Some of the achieved contributions are so fundamental that one can speak about paradigms which should be ineluded in the education of every computer science student Unfortunately this is very far from reality This is because these paradigms are not sufficiently known in the computer science community and so they are insufficiently communicated to students and practitioners   **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   **Approximation Algorithms for Combinatorial Optimization** Klaus Jansen,Samir Khuller,2003-07-31 This book constitutes the refereed proceedings of the Third International Workshop on Approximation Algorithms for Combinatorial Optimization Problems APPROX 2000 held in Saarbrcken Germany in September 2000 The 22 revised full papers presented together with four invited contributions were carefully reviewed and selected from 68 submissions The topics dealt with include design and analysis of approximation algorithms inapproximibility results on line problems randomization techniques average case analysis approximation classes scheduling problems routing and flow problems coloring and partitioning cuts and connectivity packing and covering geometric problems network design and various applications   Improved Approximation Algorithms for the Uncapacitated Facility Location Problem Fabián Ariel Chudak,1998   *Complexity In Numerical Optimization* Panos M Pardalos,1993-07-31 Computational complexity originated from the interactions between computer science and numerical optimization is one of the major theories that have revolutionized the approach to solving optimization problems and to analyzing their intrinsic difficulty The main focus of

complexity is the study of whether existing algorithms are efficient for the solution of problems and which problems are likely to be tractable The quest for developing efficient algorithms leads also to elegant general approaches for solving optimization problems and reveals surprising connections among problems and their solutions This book is a collection of articles on recent complexity developments in numerical optimization The topics covered include complexity of approximation algorithms new polynomial time algorithms for convex quadratic minimization interior point algorithms complexity issues regarding test generation of NP hard problems complexity of scheduling problems min max fractional combinatorial optimization fixed point computations and network flow problems The collection of articles provide a broad spectrum of the direction in which research is going and help to elucidate the nature of computational complexity in optimization The book will be a valuable source of information to faculty students and researchers in numerical optimization and related areas

Approximation Algorithms for the Multi-level Facility Location Problem Nathan John Edwards,2001   Stability in Multi-agent Environments and Approximation Algorithms for NP-hard Graph Problems Roee Engelberg,Ṭekhniyon, Makhon ṭekhnologi le-Yiśra'el. Fakultah le-mad'e ha-mahshev,2009   *Algorithmics for Hard Problems* Juraj Hromkovič,2001-05-22 An introduction to the methods of designing algorithms for hard computing tasks concentrating mainly on approximate randomized and heuristic algorithms and on the theoretical and experimental comparison of these approaches according to the requirements of the practice This is the first book to systematically explain and compare all the main possibilities of attacking hard computing problems It also closes the gap between theory and practice by providing at once a graduate textbook and a handbook for practitioners dealing with hard computing problems   **Complexity in Numerical Optimization** Panos M. Pardalos,1993 Computational complexity originated from the interactions between computer science and numerical optimization is one of the major theories that have revolutionized the approach to solving optimization problems and to analyzing their intrinsic difficulty The main focus of complexity is the study of whether existing algorithms are efficient for the solution of problems and which problems are likely to be tractable The quest for developing efficient algorithms leads also to elegant general approaches for solving optimization problems and reveals surprising connections among problems and their solutions This book is a collection of articles on recent complexity developments in numerical optimization The topics covered include complexity of approximation algorithms new polynomial time algorithms for convex quadratic minimization interior point algorithms complexity issues regarding test generation of NP hard problems complexity of scheduling problems min max fractional combinatorial optimization fixed point computations and network flow problems The collection of articles provide a broad spectrum of the direction in which research is going and help to elucidate the nature of computational complexity in optimization The book will be a valuable source of information to faculty students and researchers in numerical optimization and related areas

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