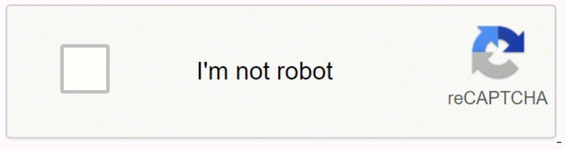

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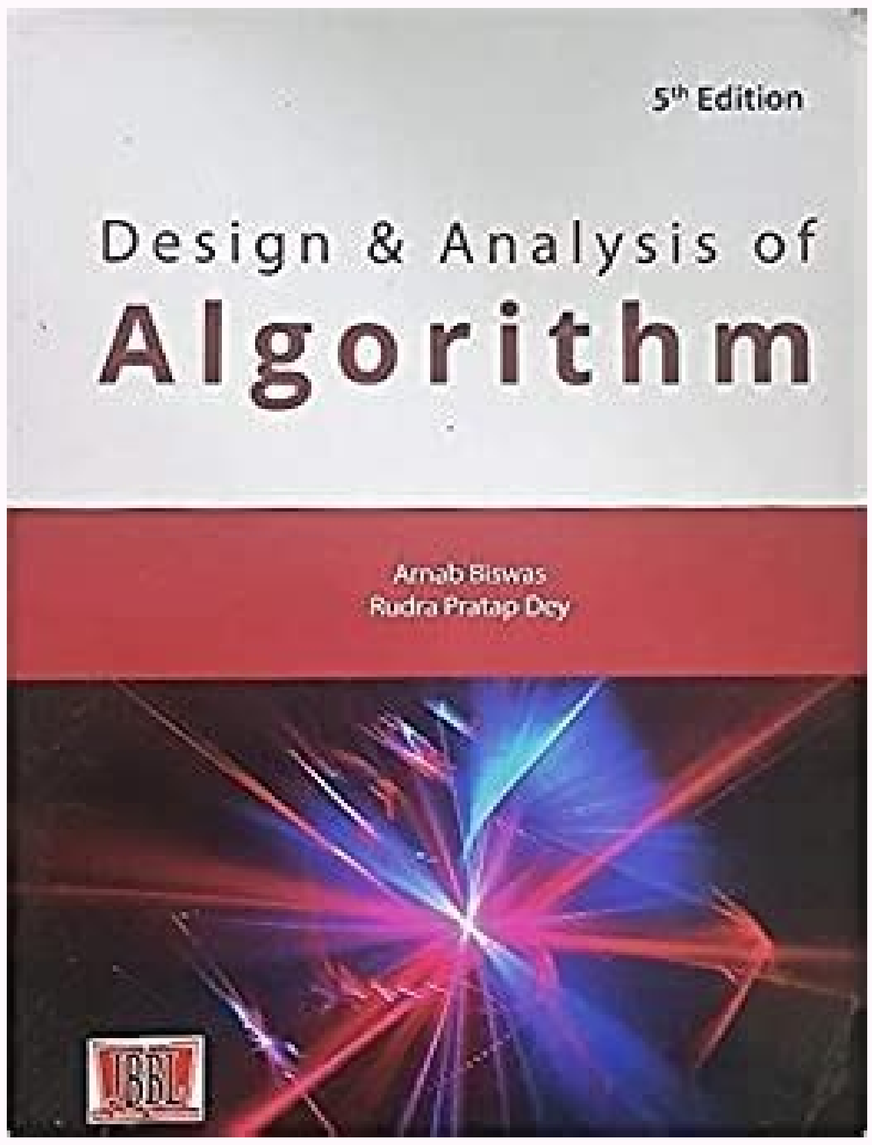

Scheduling to Minimize Total Weighted Completion Time: Performance Guarantees of LP–Based Heuristics and Lower Bounds

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Abstract. There has been recent success in using polyhedral formulations of scheduling problems not only to obtain good lower bounds in practice but also to develop provably good approximation algorithms. Most of these formulations rely on binary decision variables that are a kind of assignment variables. We present quite simple polynomial-time approximation algorithms that are based on linear programming formulations with completion time variables and give the best known performance guarantees for minimizing the total weighted completion time in several scheduling environments. This amplifies the importance of (appropriate) polyhedral formulations in the design of approximation algorithms with good worst-case performance guarantees.

In particular, for the problem of minimizing the total weighted completion time on a single machine subject to precedence constraints we present a polynomial-time approximation algorithm with performance ratio better than 2. This outperforms a $(4+\epsilon)$-approximation algorithm very recently proposed by Hall, Shmoys, and Wein that is based on time-indexed formulations. A slightly extended formulation leads to a performance guarantee of 3 for the same problem but with release dates. This improves a factor of 3.83 for the same problem and even the 4-approximation algorithm for the problem with release dates but without precedence constraints, both also due to Hall, Shmoys, and Wein.

By introducing new linear inequalities, we also show how to extend our technique to parallel machine problems. This leads, for instance, to the best known approximation algorithm for scheduling jobs with release dates on identical parallel machines. Finally, for the flow shop problem to minimize the total weighted completion time with both precedence constraints and release dates we present the first approximation algorithm that achieves a worst-case performance guarantee that is linear in the number of machines. We even extend this to multiprocessor flow shop scheduling.

The proofs of these results also imply guarantees for the lower bounds obtained by solving the proposed linear programming relaxations. This emphasizes the strength of linear programming formulations using completion time variables.

Algorithms for Generating Pareto fronts of Multi-objective Integer and Mixed-Integer Programming Problems

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Abstract Multi-objective integer or mixed-integer programming problems typically have disconnected feasible domains, making the task of constructing an approximation of the Pareto front challenging. The present paper shows that certain algorithms which were originally devised for continuous problems can be successfully adapted to approximate the Pareto front for integer, and mixed-integer, multi-objective optimization problems. Relationships amongst various scalarization techniques are established to motivate the choice of a particular scalarization in these algorithms. The proposed algorithms are tested by means of two-, three- and four-objective integer and mixed-integer problems, and comparisons are made. In particular, a new four-objective algorithm is used to solve a rocket injector design problem with a discrete variable, which is a challenging mixed-integer programming problem.

Key words: Multi-objective optimization, Integer programming, Mixed-integer programming, Scalarization, Pareto front, Efficient set, Numerical methods.

AMS subject classifications. 90C26, 90C29, 90C30, 90C56.

1 Introduction

Multi-objective optimization is concerned with simultaneous minimization of several conflicting objective functions. The aim is to obtain/approximate, and view, the set of trade-off, or compromise, solutions. This set of trade-off solutions is referred to, in the current article, as the (*weak*) *Pareto front*, or the (*weak*) *efficient set*, of the problem—a more precise definition is to be provided in Section 2. Once the set of Pareto points is at hand, the decision maker conveniently selects a suitable solution from this set, usually based on an additional criterion. These kinds of problems arise in many multidisciplinary applications, for example, in health [9, 52, 61], engineering [30, 50], mining [26, 59], and finance [45, 49].

If all variables of a multi-objective optimization problem belong to a continuous set, then the problem is called a *multi-objective continuous optimization* problem. If, on the other hand, the variables belong to a subset of integers, then the problem is a *multi-objective integer programming* one. When the model involves both integer and continuous variables the problem is referred to as a *multi-objective mixed-integer programming* problem. The latter case arises in many real-life applications, for example, the knapsack [10,28] and shortest-path problems [13,54]. Other types of mixed-integer multi-objective problems can be found in [43].

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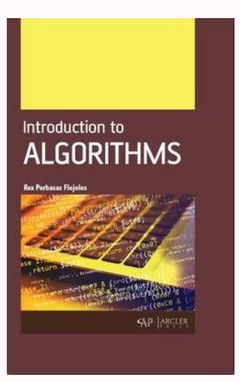

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The degenerate primer design problem

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ABSTRACT
A PCR primer sequence is called *degenerate* if some of its positions have several possible bases. The *degeneracy* of the primer is the number of unique sequence combinations it contains. We study the problem of designing a pair of primers with prescribed degeneracy that match a maximum number of given input sequences. Such problems occur when studying a family of genes that is known only in part, or is known in a related species. We prove that various simplified versions of the problem are hard, show the polynomiality of some restricted cases, and develop approximation algorithms for one variant. Based on these algorithms, we implemented a program called HYDEN for designing highly-degenerate primers for a set of genomic sequences. We report on the success of the program in an experimental scheme for identifying all human olfactory receptor (OR) genes. In that project, HYDEN was used to design primers with degeneracies up to 10^{10} that amplified with high specificity many novel genes of that family, tripling the number of OR genes known at the time.
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Keywords: PCR primer design; degenerate primers; optimization; human olfactory subgenome; protein families.

INTRODUCTION

A PCR (Polymerase Chain Reaction) primer sequence is called *degenerate* if some of its positions have several possible bases (Kwok *et al.*, 1994). For example, in the primer GG[CG]A[CTG]A the third position is C or G and the fifth is C, T or G. The *degeneracy* of the primer is the number of unique sequence combinations it contains. For example, the degeneracy of the above primer is 6. Degenerate primers are as easy and cheap to produce as regular unique primers, are useful for amplifying several related genomic sequences, and have been used in various applications. Most extant applications use low degeneracies of up to hundreds. In this paper we study the problem of designing primers of high degeneracy.

In a typical situation, one has a collection of related target sequences, , DNA sequences of homologous genes, and the goal is to design primers that will match as many of them as possible. A naïve solution would be to align the sequences without gaps, count the number of different nucleotides in each position along the alignment and seek a primer-length window (typically 20–30) where the product of the counts is low. Such a solution is insufficient because of gaps, the inappropriate objective function of the alignment, and, most notably, the exceedingly high degeneracy: When degeneracy is too high, unrelated sequences may be amplified as well, losing specificity. We may have to compromise by aiming to match many but not necessarily all the sequences. Our goal here is to develop an *ad hoc* method for designing primers that will allow tradeoff between the degeneracy and the coverage (the number of matched input sequences). We call this objective Degenerate Primer Design (DPD).

There are various reasons for studying DPD. For example, we were involved in a project with the groups of H.Lehrach (MPI Berlin) and D.Lancet (Weizmann) for finding new human olfactory receptor (OR) genes. At the outset of the project (which preceded the publication of the human genome), only 127 OR genes were known, and the goal was to selectively amplify additional OR genes using degenerate primers. The rationale was that primers which match many of the known genes, would also amplify many new genes from the same family as well, whose sequences are closely related. Most OR genes contain conserved regions, and so the primers would be designed to match such regions. OR genes are a single 1000bp exon, so amplification can be done on the genomic sequence. In gene families that contain introns, the same technique can be applied to selectively amplify cDNAs. The technique can be applied to various families, and to extracting genes from a particular family in an unsequenced species based on the known sequences of family members in a related species. In cDNA analysis, one can use degenerate primers for amplifying and then measuring frequencies of members of a gene family.

DPD is related to the Primer Selection Problem (Pearson *et al.*, 1996), in which the goal is to minimize the number of (non-degenerate) primers required to amplify a set of DNA sequences. Several algorithms have been developed to solve this problem, and some take into account various biological considerations and technical constraints (see, e.g., Doi and Imai, 1997). However, for large gene families, the number of primers needed to cover

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Nonoblivious 2-Opt heuristics for the traveling salesman problem. Approximation Limits of Linear Programs (Beyond Hierarchies). Validation of Distributed SDN Control Plane Under Uncertain Failures, IEEE/ACM Transactions on Networking, 27:3, (1234-1247), Online publication date: 1-Jun-2019.Brucato M, Abouzied A and Meliou A 2019. 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. Integrality gaps for strengthened linear relaxations of capacitated facility location, Mathematical Programming: Series A and B, 158:1-2, (99-141), Online publication date: 1-Jul-2016.D'Angelo G, Severini L and Velaj Y 2016. Thus unless P = NP, there are no efficient algorithms to find optimal solutions to such problems. Seamless Resource Sharing in Wearable Networks by Application Function Virtualization, IEEE Transactions on Mobile Computing, 18:6, (1393-1406), Online publication date: 1-Jun-2019.Wu S, Dimakis A and Sanghavi S Learning distributions generated by one-layer ReLU networks Proceedings of the 33rd International Conference on Neural Information Processing Systems, (8107-8117)Ghasemi M and Topcu U Perception-aware point-based value iteration for partially observable Markov decision processes Proceedings of the 28th International Joint Conference on Artificial Intelligence, (2371-2377)Im S, Kulkarni J and Munagala K 2017. Approximating Rooted Steiner Networks, ACM Transactions on Algorithms, 11:2, (1-22), Online publication date: 17-Nov-2014.Newell A, Potharaju R, Xiang L and Nita-Rotaru C On the Practicality of Integrity Attacks on Document-Level Sentiment Analysis Proceedings of the 2014 Workshop on Artificial Intelligent and Security Workshop, (83-93)Harvey N and Olver N Pipage rounding, pessimistic estimators and matrix concentration Proceedings of the twenty-fifth annual ACM-SIAM symposium on Discrete algorithms, (926-945)Chakravorty A, George T and Sabharwal Y Multicore Parallelization of the PTAS Dynamic Program for the Bin-Packing Problem Proceedings of the 15th International Conference on Distributed Computing and Networking - Volume 8314, (81-95)Gu A, Gupta A and Kumar A The power of deferral Proceedings of the forty-fifth annual ACM symposium on Theory of Computing, (525-534)Goldberg S and Liu Z The diffusion of networking technologies Proceedings of the twenty-fourth annual ACM-SIAM symposium on Discrete algorithms, (1577-1594)Liang H 2013. Korte, Bernhard and Vygen, Jens 2012. Fixed-Parameter Approximations for k-Center Problems in Low Highway Dimension Graphs, Algorithmica, 81:3, (1031-1052), Online publication date: 1-Mar-2019.Fang E, Liu H and Wang M 2019. Efficient shuffle management with SCache for DAG computing frameworks, ACM SIGPLAN Notices, 53:1, (305-316), Online publication date: 23-Mar-2018.Thapper J and Živný S 2018. 4, p. Williamson and David B. 49, Issue. Exact and approximate algorithms for discounted {0-1} knapsack problem, Information Sciences: an International Journal, 369:C, (634-647), Online publication date: 10-Nov-2016.Feige U and Jozeph S Separation between Estimation and Approximation Proceedings of the 2015 Conference on Innovations in Theoretical Computer Science, (271-276)Lee J, Raghavendra P and Steurer D Lower Bounds on the Size of Semidefinite Programming Relaxations Proceedings of the forty-seventh annual ACM symposium on Theory of Computing, (567-576)Chawla S, Makarychev K, Schramm T and Yaroslavtsev G Near Optimal LP Rounding Algorithm for CorrelationClustering on Complete and Complete k-partite Graphs Proceedings of the forty-seventh annual ACM symposium on Theory of Computing, (219-228)Shen C, Shuai H, Yang D, Lan Y, Lee W, Yu P and Chen M Forming Online Support Groups for Internet and Behavior Related Addictions Proceedings of the 24th ACM International on Conference on Information and Knowledge Management, (163-172)Guruganesh G, Sanità L and Swamy C Improved region-growing and combinatorial algorithms for k-route cut problems Proceedings of the twenty-sixth annual ACM-SIAM symposium on Discrete algorithms, (676-695)Li S On uniform capacitated k-median beyond the natural LP relaxation Proceedings of the twenty-sixth annual ACM-SIAM symposium on Discrete algorithms, (696-707)Byrka J, Pensyl T, Rybicki B, Srinivasan A and Trinh K An improved approximation for k-median, and positive correlation in budgeted optimization Proceedings of the twenty-sixth annual ACM-SIAM symposium on Discrete algorithms, (737-756)Duvillié G, Bougeret M, Boudet V, Dokka T and Giroudeau R On the Complexity of Wafer-to-Wafer Integration Proceedings of the 9th International Conference on Algorithms and Complexity - Volume 9079, (208-220)Crescenzi P, D'Angelo G, Severini L and Velaj Y Greedily Improving Our Own Centrality in A Network Proceedings of the 14th International Symposium on Experimental Algorithms - Volume 9125, (43-55)Miao D, Li J, Liu X and Gao H Vertex Cover in Conflict Graphs Proceedings of the 9th International Conference on Combinatorial Optimization and Applications - Volume 9486, (395-408)Feldmann A and Foschini L 2015. An Improved Approximation for k-Median and Positive Correlation in Budgeted Optimization, ACM Transactions on Algorithms, 13:2, (1-31), Online publication date: 29-May-2017.Chauhan A, Friedrich T and Quinzan F Approximating optimization problems using EAs on scale-free networks Proceedings of the Genetic and Evolutionary Computation Conference, (235-242)Hajiesmaili M, Chen M, Mallada E and Chau C 2017. 61, Issue. Approximation Algorithms for Connected Graph Factors of Minimum Weight, Theory of Computing Systems, 62:2, (441-464), Online publication date: 1-Feb-2018.Agarwal A, Chakaravarthy V, Choudhury A, Roy S and Sabharwal Y 2018. The book also covers methods for proving that optimization problems are hard to approximate. The Segmentation-Thickness Tradeoff in Online Marketplaces, Proceedings of the ACM on Measurement and Analysis of Computing Systems, 3:1, (1-26), Online publication date: 26-Mar-2019.Zheng J, Ma Q, Tian C, Dai H, Zhang W, Chen G and Zhang G Orchestrating service chain deployment with plutus in next generation cellular core Proceedings of the International Symposium on Quality of Service, (1-10)Zeng Y, Tong Y and Chen L 2019. Combinatorial Optimization. Fellows, Michael R. A throughput estimation model under two-link concurrent communications with partially overlapping channels and its application to channel assignment in IEEE 802.11n WLAN, International Journal of Space-Based and Situated Computing, 8:3, (123-137), Online publication date: 1-Jan-2018.Li Z, Chen Q and Koltun V Combinatorial optimization with graph convolutional networks and guided tree search Proceedings of the 32nd International Conference on Neural Information Processing Systems, (537-546)Lindgren E, Kocaoglu M, Dimakis A and Vishwanath S Experimental design for cost-aware learning of causal graphs Proceedings of the 32nd International Conference on Neural Information Processing Systems, (5284-5294)Cornelissen K, Hoeksma R, Manthey B, Narayanaswamy N, S. 3. 219. C. 434, Issue. 7391, Issue. 460. Braun, Gabor Fiorini, Samuel Pokutta, Sebastian and Steurer, David 2012. Approximation Algorithms for Multi-Dimensional Vector Assignment Problems. Theory of Computing Systems, Vol. Efficient and effective algorithms for clustering uncertain graphs, Proceedings of the VLDB Endowment, 12:6, (667-680), Online publication date: 1-Feb-2019.Chekuri C and Quanrud K On approximating (sparse) covering integer programs Proceedings of the Thirtieth Annual ACM-SIAM Symposium on Discrete Algorithms, (1596-1615)Li S On facility location with general lower bounds Proceedings of the Thirtieth Annual ACM-SIAM Symposium on Discrete Algorithms, (2279-2290)Bauer U and Rathod A Hardness of approximation for morse matching Proceedings of the Thirtieth Annual ACM-SIAM Symposium on Discrete Algorithms, (2663-2674)Jagannath R, Ganti R and Upadhye N Maximal Packing with Interference Constraints 2019 IEEE Wireless Communications and Networking Conference (WCNC), (1-6)Kobo H, Abu-Mahfouz A and Hancke G 2019. Vol. 167. Thus unless P = NP, there are no efficient algorithms to find optimal solutions to such problems. Transportation Science, Vol. Approximate Constraint Satisfaction Requires Large LP Relaxations, Journal of the ACM, 63:4, (1-22), Online publication date: 8-Nov-2016.Vester S Winning Cores in Parity Games Proceedings of the 31st Annual ACM/IEEE Symposium on Logic in Computer Science, (662-671)Fotakis D, Tzamos C and Zampetakis M Mechanism Design with Selective Verification Proceedings of the 2016 ACM Conference on Economics and Computation, (771-788)Harks T and Falkenhausen P 2016. Shmoys, published by Cambridge University Press. Approximability of Clique Transversal in Perfect Graphs, Algorithmica, 80:8, (2221-2239), Online publication date: 1-Aug-2018.Ee M and Sitters R 2018. Knapsack with variable weights satisfying linear constraints, Journal of Global Optimization, 69:3, (713-725), Online publication date: 1-Nov-2017.Zhu Y and Sameh A 2017. Wiese, Andreas Bonifaci, Vincenzo and Baruah, Sanjoy 2013. Yet most interesting discrete optimization problems are NP-hard. 135. Sentinel, IEEE/ACM Transactions on Networking, 27:5, (1859-1872), Online publication date: 1-Oct-2019.Feldmann A 2019. Networks, Vol. Two-Level Heuristic Algorithm for Utility-Based Data Placement and Rate Allocation in Content-Aware Networks. Approximating bounded-degree spanning trees and connected factors witlheaves, Operations Research Letters, 45:2, (115-118), Online publication date: 1-Mar-2017.Lokshtanov D, Panolan F, Ramanujan M and Saurabh S Lossy kernelization Proceedings of the 49th Annual ACM SIGACT Symposium on Theory of Computing, (224-237)Chan S, Lee J, Raghavendra P and Steurer D 2016. 62, Issue. Optimization with Uniform Size Queries, Algorithmica, 78:1, (255-273), Online publication date: 1-May-2017.Bandeira A, Boumal N and Singer A 2017. Optimizing item and subgroup configurations for social-aware VR shopping, Proceedings of the VLDB Endowment, 13:8, (1275-1289), Online publication date: 1-Apr-2020.Champati J and Liang B 2019. 3, p. Social Butterfly: Social Caches for Distributed Social Networks. Approximating Minimum-Cost Connected T-Joins, Algorithmica, 72:1, (126-147), Online publication date: 1-May-2015.Mu S, Lyu Y and Morihata A 2015. Load balancing in reducers for skewed data in MapReduce systems by using scalable simple random sampling, The Journal of Supercomputing, 74:7, (3415-3440), Online publication date: 1-Jul-2018.Medya S, Ranu S, Vachery J and Singh A 2018. Locating depots for capacitated vehicle routing, Networks, 68:2, (94-103), Online publication date: 1-Sep-2016.Chiang Y and Liao W 2016. A Lottery Model for Center-Type Problems With Outliers, ACM Transactions on Algorithms, 15:3, (1-25), Online publication date: 19-Jul-2019.Bansal N On a generalization of iterated and randomized rounding Proceedings of the 51st Annual ACM SIGACT Symposium on Theory of Computing, (1125-1135)Han K, Gui F, Xiao X, Tang J, He Y, Cao Z and Huang H 2019. 21, Issue. Traffic Load Balancing Schemes for Devolved Controllers in Mega Data Centers, IEEE Transactions on Parallel and Distributed Systems, 28:2, (572-585), Online publication date: 1-Feb-2017.Byrka J, Pensyl T, Rybicki B, Srinivasan A and Trinh K 2017. Interesting discrete optimization problems are everywhere, from traditional operations research planning problems, such as scheduling, facility location, and network design, to computer science problems in databases, to advertising issues in viral marketing. 201. Yusen Zhan Jun Wu Chongjun Wang and Junyuan Xie 2012. Rahul C and Waanders M 2018. Chekuri, Chandra and Ene, Alina 2011. Automata, Languages, and Programming. Green Multicell Cooperation in Heterogeneous Networks With Hybrid Energy Sources, IEEE Transactions on Wireless Communications, 15:12, (7911-7925), Online publication date: 1-Dec-2016.Brucato M, Beltran J, Abouzied A and Meliou A 2016. Learning in Combinatorial Optimization, Operations Research, 68:5, (1585-1604), Online publication date: 1-Sep-2020.Bar-Yehuda R, Censor-Hillel K, Maus Y, Pai S and Pemmaraju S Distributed Approximation on Power Graphs Proceedings of the 39th Symposium on Principles of Distributed Computing, (501-510)Tseng S, Tang A, Choudhury G and Tse S 2019. Mobile operators and content providers in next-generation SDN/NFV core networks, Computer Networks: The International Journal of Computer and Telecommunications Networking, 121:C, (112-123), Online publication date: 5-Jul-2017.Champati J and Liang B 2017. 2-Approximating Feedback Vertex Set in Tournaments, ACM Transactions on Algorithms, 17:2, (1-14), Online publication date: 1-Jun-2021.Cohen I, Einziger G, Friedman R and Scalosub G 2021. IEEE Transactions on Vehicular Technology, Vol. Kolman, Petr and Scheideler, Christian 2013. 350. Constant factor approximation for ATSP with two edge weights, Mathematical Programming: Series A and B, 172:1-2, (371-397), Online publication date: 1-Nov-2018.Kurpisz A, Mastrolilli M, Mathieu C, Mömke T, Verdugo V and Wiese A 2018. Scalable computation of high-order optimization queries, Communications of the ACM, 62:2, (108-116), Online publication date: 28-Jan-2019.Alijani R, Banerjee S, Gollapudi S, Kollias K and Munagala K 2019. Gasior, Dariusz and Drwal, Maciej 2012. How to design robust algorithms using noisy comparison Oracle, Proceedings of the VLDB Endowment, 14:10, (1703-1716), Online publication date: 1-Jun-2021.Ko S, Lai H, Shuai H, Lee W, Yu P and Yang D 2020. 9, p. Each chapter in the first part of the book is devoted to a single algorithmic technique, which is then applied to several different problems. Robust Quantitative Comparative Statics for a Multimarket Paradox, ACM Transactions on Economics and Computation, 5:1, (1-22), Online publication date: 3-Nov-2016.Kolamunna H, Hu Y, Perino D, Thilakarathna K, Makaroff D, Guan X and Seneviratne A AFV Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing, (981-991)Caragiannis I, Gourvès L and Monnot J Achieving proportional representation in conference programs Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence, (144-150)Cai Q, Filos-Ratsikas A and Tang P Facility location with minimax envy Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence, (137-143)Gørtz I and Nagarajan V 2016. The Limits of SDP Relaxations for General-Valued CSPs, ACM Transactions on Computation Theory, 10:3, (1-22), Online publication date: 30-Sep-2018.Dumitrescu A 2018. Designed as a textbook for graduate-level algorithms courses, the book will also serve as a reference for researchers who are interested in the heuristic solution of discrete optimization problems. This is the companion website for the book The Design of Approximation Algorithms by David P. Discrete optimization problems are everywhere, from traditional operations research planning problems, such as scheduling, facility location, and network design; to computer science problems in databases; to advertising issues in viral marketing. An electronic-only edition of the book is provided in our Download section. Improving the Betweenness Centrality of a Node by Adding Links, ACM Journal of Experimental Algorithmics, 23, (1-32), Online publication date: 15-Nov-2018.Fu Z, Song T, Qi Z and Guan H Efficient shuffle management with SCache for DAG computing frameworks Proceedings of the 23rd ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming, (305-316)Fomin F, Lokshtanov D, Saurabh S, Pilipczuk M and Wrochna M 2018. 868. The A Priori Traveling Repairman Problem, Algorithmica, 80:10, (2818-2833), Online publication date: 1-Oct-2018.Baveja A, Chavan A, Nikiforov A, Srinivasan A and Xu P 2018. Cont, Rama and Kukanov, Arseniy 2012. Designed as a textbook for graduate-level algorithms courses, the book will also serve as a reference for researchers interested in the heuristic solution of discrete optimization problems. Ilker Frenk, J. Exploring Tag Distribution in Multi-Reader RFID Systems, IEEE Transactions on Mobile Computing, 16:5, (1300-1314), Online publication date: 1-May-2017.Gazit N, Malandrino F and Hay D 2017. Multirobot Reconnection on Graphs: Problem, Complexity, and Algorithms, IEEE Transactions on Robotics, 34:5, (1299-1314), Online publication date: 1-Oct-2018.Gao X, Kong L, Li W, Liang W, Chen Y and Chen G 2017. Blessing of massive scale, Mathematical Programming: Series A and B, 176:1-2, (175-205), Online publication date: 1-Jul-2019.Harris D, Pensyl T, Srinivasan A and Trinh K 2019. Semidefinite and linear programming integrality gaps for scheduling identical machines, Mathematical Programming: Series A and B, 172:1-2, (231-248), Online publication date: 1-Nov-2018.Banfi J, Basilico N and Amigoni F 2018. Semi-Online Algorithms for Computational Task Offloading with Communication Delay, IEEE Transactions on Parallel and Distributed Systems, 28:4, (1189-1201), Online publication date: 1-Apr-2017.Gupta A, Krishnaswamy R, Kumar A and Panigrahi D Online and dynamic algorithms for set cover Proceedings of the 49th Annual ACM SIGACT Symposium on Theory of Computing, (537-550)Feige U and Tennenholtz M 2017. SSRN Electronic Journal, Gozupek, D. Assortment Optimization Under the Paired Combinatorial Logit Model, Operations Research, 68:3, (741-761), Online publication date: 1-May-2020.Modaresi S, Sauré D and Vielma J 2020. Throughput Satisfaction-Based Scheduling for Cognitive Radio Networks. Han, Lu Nath, Badri Iftode, Liviu and Muthukrishnan, S. A QPTAS for ε-Envy-Free Profit-Maximizing Pricing on Line Graphs, ACM Transactions on Economics and Computation, 9:3, (1-31), Online publication date: 30-Sep-2021.Hou G, Chen X, Wang S and Wei Z 2021. Harks, Tobias König, Felix G and Matuschke, Jannik 2013. Approximation Algorithms for Capacitated Location Routing. Routing Stability in Hybrid Software-Defined Networks, IEEE/ACM Transactions on Networking, 27:2, (790-804), Online publication date: 1-Apr-2019.Xie J, Guo D, Qian C, Liu L, Ren B and Chen H 2019. 354. p. , p. On the Maximum Betweenness Improvement Problem, Electronic Notes in Theoretical Computer Science (ENTCS), 322:C, (153-168), Online publication date: 18-Apr-2016.He Y, Wang X, He Y, Zhao S and Li W 2016. Single Restart with Time Stamps for Parallel Task Processing with Known and Unknown Processors, IEEE Transactions on Parallel and Distributed Systems, 31:1, (187-200), Online publication date: 1-Jan-2020.Zhang H, Rusmevichientong P and Topaloglu H 2020. 53, Issue. Eraslan, B. 2, p. Last-mile delivery made practical, Proceedings of the VLDB Endowment, 13:3, (320-333), Online publication date: 1-Nov-2019.Zheng J, Xu H, Zhu X, Chen G and Geng Y 2019. An Improved Approximation Algorithm for Knapsack Median Using Sparsification, Algorithmica, 80:4, (1093-1114), Online publication date: 1-Apr-2018.Zhang P, Xu Y, Jiang T, Li A, Lin G and Miyano E 2018. Each chapter in the first part of the book is devoted to a single algorithmic technique, which is then applied to several different problems. Tractable Open Loop Policies for Joint Overbooking and Capacity Control Over a Single Flight Leg with Multiple Fare Classes, Transportation Science, 46:4, (460-481), Online publication date: 1-Nov-2012.Rothvoß T The entropy rounding method in approximation algorithms Proceedings of the twenty-third annual ACM-SIAM symposium on Discrete algorithms, (356-372)Cheriyan J, Laekhanukit B, Naves G and Vetta A Approximating rooted Steiner networks Proceedings of the twenty-third annual ACM-SIAM symposium on Discrete algorithms, (1499-1511)Fellows M, Kulik A, Rosamond F and Shachnai H Parameterized approximation via fidelity preserving transformations Proceedings of the 39th international colloquium conference on Automata, Languages, and Programming - Volume Part I, (351-362)Chekuri C and Ene A Submodular cost allocation problem and applications Proceedings of the 38th international colloquim conference on Automata, languages and programming - Volume Part I, (354-366)Chiang Y and Liao W ENCORE: An energy-aware multicell cooperation in heterogeneous networks with content caching IEEE INFOCOM 2016 - The 35th Annual IEEE International Conference on Computer Communications, (1-9)Wu X and Loiseau P Algorithms for scheduling deadline-sensitive malleable tasks 2015 53rd Annual Allerton Conference on Communication, Control, and Computing (Allerton), (530-537) Hybrid Metaheuristics. This book shows how to design approximation algorithms: efficient algorithms that find provably near-optimal solutions. Tightness of the maximum likelihood semidefinite relaxation for angular synchronization, Mathematical Programming: Series A and B, 163:1-2, (145-167), Online publication date: 1-May-2017.Nip K, Wang Z and Wang Z 2017. PSPIKE+, Journal of Computational and Applied Mathematics, 311:C, (682-703), Online publication date: 1-Feb-2017.Kern W and Manthey B 2017. G. Raghavendra, Prasad and Steurer, David 2013. A hybrid approach to automatic IaaS service selection, Journal of Cloud Computing: Advances, Systems and Applications, 7:1, (1-18), Online publication date: 1-Dec-2018.Bampis E, Escoffier B and Mladenovic S Fair Resource Allocation Over Time Proceedings of the 17th International Conference on Autonomous Agents and MultiAgent Systems, (766-773) 2018. On the k-edge-incident subgraph problem and its variants, Discrete Applied Mathematics, 161:18, (2985-2991), Online publication date: 1-Dec-2013.Harks T, König F and Matuschke J 2013. Kulik, Ariel Rosamond, Frances and Shachnai, Hadas 2012. Solving the degree-concentrated fault-tolerant spanning subgraph problem by DC programming, Mathematical Programming: Series A and B, 169:1, (255-275), Online publication date: 1-May-2018.Briheche Y, Barbaresco F, Bennis F and Chablat D 2018. 81. 351. Towards Duality of Multicommodity Multiroute Cuts and Flows: Multilevel Ball-Growing. Balanced Partitions of Trees and Applications, Algorithmica, 71:2, (354-376), Online publication date: 1-Feb-2015.Cheriyan J, Friggstad Z and Gao Z 2015. Improved Approximation Algorithms for the Maximum Happy Vertices and Edges Problems, Algorithmica, 80:5, (1412-1438), Online publication date: 1-May-2018.Fiorini S, Krithika R, Narayanaswamy N and Raman V 2018. Chan, Siu On Lee, James R. Festa, Paola and Resende, Mauricio G. On the Complexity and Algorithms of Coalition Structure Generation in Overlapping Coalition Formation Games. Real-Time Systems, Vol. Scalable package queries in relational database systems, Proceedings of the VLDB Endowment, 9:7, (576-587), Online publication date: 1-Mar-2016.Kurpisz A, Mastrolilli M, Mathieu C, Mömke T, Verdugo V and Wiese A Semidefinite and Linear Programming Integrality Gaps for Scheduling Identical Machines Proceedings of the 18th International Conference on Integer Programming and Combinatorial Optimization - Volume 9682, (152-163)Svensson O, Tarnawski J and Végh L Constant Factor Approximation for ATSP withźTwo Edge Weights Proceedings of the 18th International Conference on Integer Programming and Combinatorial Optimization - Volume 9682, (226-237)Bansal N and Nagarajan V Approximation-Friendly Discrepancy Rounding Proceedings of the 18th International Conference on Integer Programming and Combinatorial Optimization - Volume 9682, (375-386)Angel E, Bampis E, Escoffier B and Lampis M Parameterized Power Vertex Cover Revised Selected Papers of the 42nd International Workshop on Graph-Theoretic Concepts in Computer Science - Volume 9941, (97-108)San Felice M, Williamson D and Lee O 2016. Noticeable network delay minimization via node upgrades, Proceedings of the VLDB Endowment, 11:9, (988-1001), Online publication date: 1-May-2018.Svensson O, Tarnawski J and Végh L 2018. A Randomized $$\mathrm {O}(\log n)$$O(logn)-Competitive Algorithm for the Online Connected Facility Location Problem, Algorithmica, 76:4, (1139-1157), Online publication date: 1-Dec-2016.Kolliopoulos S and Moysoglou Y 2016. Multi-channel design for random CSMA wireless networks: A stochastic geometry approach. Tractable Open Loop Policies for Joint Overbooking and Capacity Control Over a Single Flight Leg with Multiple Fare Classes. Automata, Languages and Programming. 46, Issue. Access Strategies for Network Caching, IEEE/ACM Transactions on Networking, 29:2, (609-622), Online publication date: 1-Apr-2021.Saha B Approximation Algorithms for Large Scale Data Analysis Proceedings of the 40th ACM SIGMOD-SIGACT-SIGAI Symposium on Principles of Database Systems, (30-32)Koley P, Saha A, Bhattacharya S, Ganguly N and De A 2021. The book also covers methods for proving that optimization problems are hard to approximate. 480. Demarcating Endogenous and Exogenous Opinion Dynamics: An Experimental Design Approach, ACM Transactions on Knowledge Discovery from Data, 15:6, (1-25), Online publication date: 31-Dec-2022.Elbassioni K 2021. Approximate Constraint Satisfaction Requires Large LP Relaxations. Competitive Algorithms from Competitive Equilibria, Journal of the ACM, 65:1, (1-33), Online publication date: 24-Jan-2018.Bergamini E, Crescenzi P, D'angelo G, Meyerhenke H, Severini L and Velaj Y 2018. Naor, Assaf 2012. Massively parallel algorithms for personalized pagerank, Proceedings of the VLDB Endowment, 14:9, (1668-1680), Online publication date: 1-May-2021.Addanki R, Galhotra S and Saha B 2021. 413. 7, Issue. 481. The second part revisits the techniques but offers more sophisticated treatments of them. Zhang, Shigeng He, Xiaoxian Song, Hong and Zhang, Daqiang 2013. Theoretical Complexity of Grid Cover Problems Used in Radar Applications, Journal of Optimization Theory and Applications, 179:3, (1086-1106), Online publication date: 1-Dec-2018.Gavagsaz E, Rezaee A and Haj Seyyed Javadi H 2018. Optimal Order Placement in Limit Order Markets. 341. Yet most such problems are NP-hard. Levin, Asaf and Yovel, Uri 2013. Computational Geometry Column 68, ACM SIGACT News, 49:4, (46-54), Online publication date: 15-Dec-2018.Soltani S, Martin P and Elgazzar K 2018. 1656. Improved Bounds in Stochastic Matching and Optimization, Algorithmica, 80:11, (3225-3252), Online publication date: 1-Nov-2018.Brucato M, Abouzied A and Meliou A 2018. and Noyan, Nilay 2012. Set Cover Problems with Small Neighborhood Covers, Theory of Computing Systems, 62:8, (1763-1797), Online publication date: 1-Nov-2018.Byrka J, Pensyl T, Rybicki B, Spoerhase J, Srinivasan A and Trinh K 2018. Summary of Recent Results, ACM SIGMETRICS Performance Evaluation Review, 45:2, (55-57), Online publication date: 11-Oct-2017.Hubáček P and Yogev E Hardness of continuous local search Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (1352-1371)Fomin F, Lokshtanov D, Pilipczuk M, Saurabh S and Wrochna M Fully polynomial-time parameterized computations for graphs and matrices of low treewidth Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (1419-1432)Gupta A, Nagarajan V and Singla S Adaptivity gaps for stochastic probing Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (1688-1702)Benhamouda F, Lepoint T, Mathieu C and Zhou H Optimization of bootstrapping in circuits Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (2423-2433)Hoberg R and Rothvoss T A logarithmic additive integrality gap for bin packing Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (2616-2625)Jansen K and Rohwedder L On the configuration-LP of the restricted assignment problem Proceedings of the Twenty-Eighth Annual ACM-SIAM Symposium on Discrete Algorithms, (2670-2678)Dutta A, Vijayaraghavan A and Wang A Clustering stable instances of euclidean k-means Proceedings of the 31st International Conference on Neural Information Processing Systems, (6503-6512)Thapper J and Živný S The limits of SDP relaxations for general-valued CSPs Proceedings of the 32nd Annual ACM/IEEE Symposium on Logic in Computer Science, (1-12)Zhu F, Xiao B, Liu J, Wang B, Pan Q and Chen L 2017. Lokshtanov D, Misra P, Ramanujan M, Saurabh S and Zehavi M FPT-approximation for FPT problems Proceedings of the Thirty-Second Annual ACM-SIAM Symposium on Discrete Algorithms, (199-218)Lokshtanov D, Misra P, Mukherjee J, Panolan F, Philip G and Saurabh S 2021. Topaloglu, Huseyin Birbil, S. Time Efficient Tag Searching in Multiple Reader RFID Systems. Fully Polynomial-Time Parameterized Computations for Graphs and Matrices of Low Treewidth, ACM Transactions on Algorithms, 14:3, (1-45), Online publication date: 31-Jul-2018.Krishnaswamy R, Li S and Sandeep S Constant approximation for k-median and k-means with outliers via iterative rounding Proceedings of the 50th Annual ACM SIGACT Symposium on Theory of Computing, (646-659)Fu Z, Song T, Qi Z and Guan H 2018. Efficient controller placement and reelection mechanism in distributed control system for software defined wireless sensor networks, Transactions on Emerging Telecommunications Technologies, 30:6, Online publication date: 18-Jun-2019.Kolamunna H, Thilakarathna K, Perino D, Makaroff D and Seneviratne A 2019. SSRN Electronic Journal, ElSawy, Hesham Hossain, Ekram and Camorlinga, Sergio 2013. Japanese Journal of Mathematics, Vol. 6755, Issue. Layout Decomposition for Triple Patterning Lithography, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 34:3, (433-446), Online publication date: 1-Mar-2015.Bandeira A, Charikar M, Singer A and Zhu A Multireference alignment using semidefinite programming Proceedings of the 5th conference on Innovations in theoretical computer science, (459-470)Im S, Kulkarni J and Munagala K Competitive algorithms from competitive equilibria Proceedings of the forty-sixth annual ACM symposium on Theory of computing, (313-322)Cheriyan J, Laekhanukit B, Naves G and Vetta A 2014. 4079. Approximation Algorithms for Capacitated Location Routing, Transportation Science, 47:1, (3-22), Online publication date: 1-Feb-2013.Ding B, Wang H, Jin R, Han J and Wang Z Optimizing index for taxonomy keyword search Proceedings of the 2012 ACM SIGMOD International Conference on Management of Data, (493-504)Ene A, Har-Peled S and Raichel B Geometric packing under non-uniform constraints Proceedings of the twenty-eighth annual symposium on Computational geometry, (11-20)Topaloglu H, Birbil S, Frenk J and Noyan N 2012. B. The second part revisits the techniques, but offers more sophisticated treatments of them. 2012. Dokka, Trivikram Crama, Yves and Spieksma, Frits 2013. 1, p. Partitioned EDF scheduling on a few types of unrelated multiprocessors. and Alagoz, F. Approximate by thinning, Science of Computer Programming, 98:P4, (484-515), Online publication date: 1-Feb-2015.Bei Yu , Kun Yuan , Duo Ding and Pan D 2015. 2013. 2011. An introduction to the Ribe program. 308. This book shows how to design approximation algorithms: efficient algorithms that find provably near-optimal solutions.The book is organized around several central algorithmic techniques for designing approximation algorithms, including greedy and local search algorithms, dynamic programming, linear and semidefinite programming, and randomization. Package queries, The VLDB Journal — The International Journal on Very Large Data Bases, 27:5, (693-718), Online publication date: 1-Oct-2018.Wu C, Wang Y, Lu Z, Pardalos P, Xu D, Zhang Z and Du D 2018. 47, Issue.

NLopt includes implementations of a number of different optimization algorithms. These algorithms are listed below, including links to the original source code (if any) and citations to the relevant articles in the literature (see Citing NLopt).. Even where I found available free/open-source code for the various algorithms, I modified the code at least slightly (and in some cases … Numerical analysis is the study of algorithms that use numerical approximation (as opposed to symbolic manipulations) for the problems of mathematical analysis (as distinguished from discrete mathematics).Numerical analysis finds application in all fields of engineering and the physical sciences, and in the 21st century also the life and social sciences, medicine, business … NPTEL provides E-learning through online Web and Video courses various streams. 01/09/2021 · State pattern is one of the behavioral design pattern.State design pattern is used when an Object changes its behavior based on its internal state. If we have to change behavior of an object based on its state, we can have a state variable in the Object and use if-else condition block to perform different actions based on the state. Design and Analysis of Algorithms. Stanford University, Winter 2022. Instructors: Nima Anari and Moses Charikar Time: Mon & Wed 9:45 am - 11:15 am Location: Zoom for the first three weeks, then NVIDIA Auditorium Course Description: This course will cover the basic approaches and mindsets for analyzing and designing algorithms and data structures. Topics include the … Course Description: This course introduces basic elements of the design and analysis of computer algorithms.Topics include asymptotic notations and analysis, divide and conquer strategy, greedy methods, dynamic programming, basic graph algorithms, NP-completeness, and approximation algorithms. 21/11/2019 · Loop Optimization is the process of increasing execution speed and reducing the overheads associated with loops. It plays an important role in improving cache performance and making effective use of parallel processing capabilities. Most execution time of a scientific program is spent on loops. 07/06/2015 · Algorithms Based on Piecewise Linear Approximations. There are a number of useful algorithms that use piecewise linear approximations to solve complicated problems for optimal solutions. Branch and Refine. The branch and refine algorithm is based on the piecewise linear approximation. It is an efficient way to solve a problem for the global … Theory@CS.CMU. Carnegie Mellon University has a strong and diverse group in Algorithms and Complexity Theory. We try to provide a mathematical understanding of fundamental issues in Computer Science, and to use this understanding to produce better algorithms, protocols, and systems, as well as identify the inherent limitations of efficient computation. Course Description: This course introduces basic elements of the design and analysis of computer algorithms.Topics include asymptotic notations and analysis, divide and conquer strategy, greedy methods, dynamic programming, basic graph algorithms, NP-completeness, and approximation algorithms. 29/07/2021 · Design an online book reader system (Object-Oriented Design). Asked In: Amazon, Microsoft, and many more interviews. Solution: Let’s assume we want to design a basic online reading system that provides the following functionality: • Searching the database of books and reading a book. • User membership creation and extension.

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