

Tractability

Practical Approaches to
Hard Problems

EDITED BY

Lucas Bordeaux, Youssef Hamadi
and Pushmeet Kohli

CAMBRIDGE

Tractability Practical Approaches To Hard Problems

**David Fleet, Tomas Pajdla, Bernt
Schiele, Tinne Tuytelaars**



Tractability Practical Approaches To Hard Problems:

Tractability Lucas Bordeaux, Youssef Hamadi, Pushmeet Kohli, 2014-02-06 An overview of the techniques developed to circumvent computational intractability a key challenge in many areas of computer science *Tractability* Lucas Bordeaux, Youssef Hamadi (Computer science researcher), Pushmeet Kohli, 2014 An overview of the techniques developed to circumvent computational intractability a key challenge in many areas of computer science Tractability Lucas Bordeaux, Pushmeet Kohli, 2014 *Encyclopedia of Bioinformatics and Computational Biology*, 2018-08-21 Encyclopedia of Bioinformatics and Computational Biology ABC of Bioinformatics Three Volume Set combines elements of computer science information technology mathematics statistics and biotechnology providing the methodology and in silico solutions to mine biological data and processes The book covers Theory Topics and Applications with a special focus on Integrative omics and Systems Biology The theoretical methodological underpinnings of BCB including phylogeny are covered as are more current areas of focus such as translational bioinformatics cheminformatics and environmental informatics Finally Applications provide guidance for commonly asked questions This major reference work spans basic and cutting edge methodologies authored by leaders in the field providing an invaluable resource for students scientists professionals in research institutes and a broad swath of researchers in biotechnology and the biomedical and pharmaceutical industries Brings together information from computer science information technology mathematics statistics and biotechnology Written and reviewed by leading experts in the field providing a unique and authoritative resource Focuses on the main theoretical and methodological concepts before expanding on specific topics and applications Includes interactive images multimedia tools and crosslinking to further resources and databases **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 well 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 close 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 results new concepts and new methods Some of the achieved contributions are so fundamental that one can speak about paradigms which should be included 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 The

Complexity of Valued Constraint Satisfaction Problems Stanislav Živný, 2012-10-19 The topic of this book is the following optimisation problem given a set of discrete variables and a set of functions each depending on a subset of the variables minimise the sum of the functions over all variables This fundamental research problem has been studied within several different contexts of discrete mathematics computer science and artificial intelligence under different names Min Sum problems MAP inference in Markov random fields MRFs and conditional random fields CRFs Gibbs energy minimisation valued constraint satisfaction problems VCSPs and for two state variables pseudo Boolean optimisation In this book the author presents general techniques for analysing the structure of such functions and the computational complexity of the minimisation problem and he gives a comprehensive list of tractable cases Moreover he demonstrates that the so called algebraic approach to VCSPs can be used not only for the search for tractable VCSPs but also for other questions such as finding the boundaries to the applicability of certain algorithmic techniques The book is suitable for researchers interested in methods and results from the area of constraint programming and discrete optimisation

Fundamental Computational Problems and Algorithms for SuperHyperGraphs Takaaki Fujita, Florentin Smarandache , Hypergraphs extend traditional graphs by allowing edges known as hyperedges to connect more than two vertices rather than just pairs This paper explores fundamental problems and algorithms in the context of SuperHypergraphs an advanced extension of hypergraphs enabling modeling of hierarchical and complex relationships Topics covered include constructing SuperHyperGraphs recognizing SuperHyperTrees and computing SuperHyperTree width We address a range of optimization problems such as the SuperHypergraph Partition Problem Reachability Minimum Spanning SuperHypertree and Single Source Shortest Path Furthermore adaptations of classical problems like the Traveling Salesman Problem Chinese Postman Problem and Longest Simple Path Problem are presented in the SuperHypergraph framework

A Comprehensive Guide Through the Italian Database Research Over the Last 25 Years Sergio Flesca, Sergio Greco, Elio Masciari, Domenico Saccà, 2017-05-29 This book offers readers a comprehensive guide to the evolution of the database field from its earliest stages up to the present and from classical relational database management systems to the current Big Data metaphor In particular it gathers the most significant research from the Italian database community that had relevant intersections with international projects Big Data technology is currently dominating both the market and research The book provides readers with a broad overview of key research efforts in modelling querying and analysing data which over the last few decades have become massive and heterogeneous areas

Engineering Secure and Dependable Software Systems Alexander Pretschner, Peter Müller, 2019-08-15 Almost all technical systems currently either interface with or are themselves largely software systems Software systems must not harm their environment but are also often vulnerable to security attacks with potentially serious economic political and physical consequences so a better understanding of security and safety and improving the quality of complex software systems are crucial challenges for the functioning of society This book presents

lectures from the 2018 Marktoberdorf summer school Engineering Secure and Dependable Software Systems an Advanced Study Institute of the NATO Science for Peace and Security Programme The lectures give an overview of the state of the art in the construction and analysis of safe and secure systems Starting from the logical and semantic foundations that enable reasoning about classical software systems they extend to the development and verification of cyber physical systems which combine computational and physical components and have become pervasive in aerospace automotive industry automation and consumer appliances Safety and security have traditionally been considered separate topics but several lectures in this summer school emphasize their commonalities and present analysis and construction techniques that apply to both The book will be of interest to all those working in the field of software systems and cyber physical systems in particular

Neutrosophic Sets and Systems, vol. 77/2025 Florentin Smarandache, Mohamed Abdel-Basset, Maikel Leyva-Vázquez, 2025-01-31 Neutrosophic Sets and Systems has been created for publications on advanced studies in neutrosophy neutrosophic set neutrosophic logic neutrosophic probability neutrosophic statistics that started in 1995 and their applications in any field such as the neutrosophic structures developed in algebra geometry topology etc Neutrosophy is a new branch of philosophy that studies the origin nature and scope of neutralities as well as their interactions with different ideational spectra This theory considers every notion or idea together with its opposite or negation and with their spectrum of neutralities in between them i e notions or ideas supporting neither nor The and ideas together are referred to as Neutrosophy is a generalization of Hegel's dialectics the last one is based on and only According to this theory every idea tends to be neutralized and balanced by and ideas as a state of equilibrium In a classical way are disjoint two by two But since in many cases the borders between notions are vague imprecise Sorites it is possible that and of course have common parts two by two or even all three of them as well Neutrosophic Set and Neutrosophic Logic are generalizations of the fuzzy set and respectively fuzzy logic especially of intuitionistic fuzzy set and respectively intuitionistic fuzzy logic In neutrosophic logic a proposition has a degree of truth T a degree of indeterminacy I and a degree of falsity F where T, I, F are standard or non standard subsets of $[0, 1]$ Neutrosophic Probability is a generalization of the classical probability and imprecise probability Neutrosophic Statistics is a generalization of the classical statistics Advancing Uncertain Combinatorics through Graphization, Hyperization, and Uncertainization: Fuzzy, Neutrosophic, Soft, Rough, and Beyond Takaaki Fujita, Florentin Smarandache, 2025-01-24 This book is the sixth volume in the series of Collected Papers on Advancing Uncertain Combinatorics through Graphization Hyperization and Uncertainization Fuzzy Neutrosophic Soft Rough and Beyond Building upon the foundational contributions of previous volumes this edition focuses on the exploration and development of Various New Uncertain Concepts further enriching the study of uncertainty and complexity through innovative theoretical advancements and practical applications The volume is meticulously organized into 15 chapters each presenting unique perspectives and contributions to the field From theoretical explorations to real world applications these chapters provide a

cohesive and comprehensive overview of the state of the art in uncertain combinatorics emphasizing the versatility and power of the newly introduced concepts and methodologies

The first chapter SuperHypertree depth Structural Analysis in SuperHyperGraphs explores the concept of SuperHypertree depth an extension of the classical graph parameter Tree depth and its hypergraph counterpart Hypertree depth By introducing hierarchical nesting within SuperHyperGraphs where both vertices and edges can represent recursive subsets this study investigates the mathematical properties and structural implications of these extended parameters The findings highlight the relationships between SuperHypertree depth and its traditional graph theoretic equivalents providing a deeper understanding of their applicability to hierarchical and complex systems

The second chapter Obstructions for Hypertree width and SuperHypertree width examines the role of ultrafilters as obstructions in determining Hypertree width and extends the concept to SuperHypertree width Building on hypergraph theory which abstracts traditional graph frameworks into more complex domains the study investigates how recursive structures within SuperHyperGraphs redefine the computational and structural properties of these parameters Ultrafilters with their broad mathematical significance serve as critical tools for understanding the limitations and potentials of these advanced graph metrics

The third chapter SuperHypertree Length and SuperHypertree Breadth in SuperHyperGraphs investigates the extension of the graph theoretic parameters Tree length and Tree breadth to the realms of hypergraphs and SuperHyperGraphs By leveraging the hierarchical nesting of SuperHyperGraphs the study explores how these parameters adapt to increasingly complex and multi level structures Comparative analyses between these extended parameters and their classical counterparts reveal new insights into their relevance and utility in advanced graph and hypergraph theory

Plithogenic Sets which generalize Fuzzy and Neutrosophic Sets are extended in the fourth chapter Extended HyperPlithogenic Sets and Generalized Plithogenic Graphs to Extended Plithogenic Sets HyperPlithogenic Sets and SuperHyperPlithogenic Sets This study further investigates their application to graph theory through the concepts of Extended Plithogenic Graphs and Generalized Extended Plithogenic Graphs The chapter provides a concise exploration of these frameworks offering insights into their potential for addressing uncertainty and complexity in graph structures

Soft Sets provide an effective framework for decision making by mapping parameters to subsets of a universal set addressing uncertainty and vagueness

The fifth chapter Double Framed Superhypersoft Set and Double Framed Treesoft Set introduces the Double Framed SuperHypersoft Set and the Double Framed Treesoft Set as extensions of traditional and advanced soft set frameworks such as Hypersoft and SuperHypersoft Sets The chapter explores their relationships with existing concepts offering new tools to handle complex decision making scenarios with enhanced structural flexibility

The sixth paper HyperPlithogenic Cubic Set and SuperHyperPlithogenic Cubic Set introduces the concepts of the HyperPlithogenic Cubic Set and SuperHyperPlithogenic Cubic Set which extend the Plithogenic Cubic Set by integrating both interval valued and single valued fuzzy memberships These sets leverage multi attribute aggregation techniques inherent to plithogenic structures

allowing for nuanced representations of uncertainty. Additionally, related constructs such as the HyperPlithogenic Fuzzy Cubic Set, HyperPlithogenic Intuitionistic Fuzzy Cubic Set, and HyperPlithogenic Neutrosophic Cubic Set are explored further, enriching the theoretical and practical applications of this framework.

The seventh chapter, *L Neutrosophic Sets and Nonstationary Neutrosophic Sets*, extends the foundational concepts of fuzzy sets by integrating Neutrosophic and Plithogenic frameworks. By introducing *L Neutrosophic Sets* and *Nonstationary Neutrosophic Sets*, the study enhances the representation of uncertainty through independent membership components, truth indeterminacy, and falsity. These advanced constructs also incorporate multi-dimensional and contradictory attributes, providing a robust means of modeling complex decision-making and uncertain data. Plithogenic and Rough Sets, known for generalizing uncertainty modeling and classification, are extended in the eighth chapter, *Forest HyperPlithogenic and Forest HyperRough Sets*, to *Forest HyperPlithogenic Sets*, *Forest SuperHyperPlithogenic Sets*, *Forest HyperRough Sets*, and *Forest SuperHyperRough Sets*. These frameworks incorporate hierarchical and recursive structures to advance existing set-theoretic paradigms. The chapter explores their applications in multi-level data analysis and uncertainty classification, demonstrating their adaptability to complex systems.

Building on Fuzzy Neutrosophic and Plithogenic Sets, the tenth chapter, *Symbolic HyperPlithogenic Sets*, introduces *Symbolic HyperPlithogenic Sets* and *Symbolic n SuperHyperPlithogenic Sets*. These sets incorporate symbolic components and algebraic coefficients, enabling flexible operations within a defined prevalence order. By extending symbolic representation into hyperplithogenic and superhyperplithogenic domains, the chapter opens new pathways for addressing uncertainty and hierarchical complexity in mathematical modeling.

Soft Sets, designed to manage uncertainty and imprecision, have evolved through various extensions like *Hypersoft Sets* and *SuperHypersoft Sets*. The eleventh chapter, *N SuperHypersoft and Bijective SuperHypersoft Sets*, introduces *N SuperHypersoft Sets*, *N Treesoft Sets*, *Bijective SuperHypersoft Sets*, and *Bijective Treesoft Sets*. These new constructs enhance decision-making frameworks by incorporating advanced hierarchical and bijective relationships, building on existing theories and expanding their applications.

Plithogenic Sets, known for integrating multi-valued attributes and contradictions, and Rough Sets, which partition data into definable approximations, are combined in the twelfth chapter, *Plithogenic Rough Sets*, to form *Plithogenic Rough Sets*. This fusion provides a powerful framework for addressing uncertainty in dynamic and complex decision-making scenarios, offering a novel approach to uncertainty modeling.

Expanding on Neutrosophic Sets, which represent truth indeterminacy and falsehood, this chapter introduces *Plithogenic Duplets* and *Plithogenic Triplets*. These constructs leverage the Plithogenic framework to incorporate attribute values and contradiction measures.

The thirteenth chapter, *Plithogenic Duplets and Triplets*, examines their relationships with Neutrosophic Duplets and Triplets, offering new tools for multi-dimensional data representation and decision-making.

Building on foundational concepts like Rough Sets and Vague Sets, the fourteenth chapter, *SuperRough and SuperVague Sets*, introduces *SuperRough Sets* and *SuperVague Sets*. These generalized frameworks

extend uncertainty modeling by incorporating hierarchical structures The study also demonstrates that SuperRough Sets can evolve into SuperHyperRough Sets providing further generalizations for advanced data classification and analysis The fifteenth chapter Neutrosophic TreeSoft Expert and ForestSoft Sets revisits the Neutrosophic TreeSoft Set which combines the hierarchical structure of TreeSoft Sets with the Neutrosophic framework for uncertainty representation Additionally it introduces the Neutrosophic TreeSoft Expert Set incorporating expert knowledge into the model The chapter also explores the ForestSoft Set and its extension the Neutrosophic ForestSoft Set to provide multi level tree structured approaches for complex data representation and analysis

Multi-Agent Systems and Agreement Technologies Natalia Criado Pacheco, Carlos Carrascosa, Nardine Osman, Vicente Julián Inglada, 2017-06-22 This book constitutes the revised selected papers from the 14th European Conference on Multi Agent Systems EUMAS 2016 and the Fourth International Conference on Agreement Technologies AT 2016 held in Valencia Spain in December 2016 The 43 papers and 2 invited papers presented in this volume were carefully reviewed and selected from 68 submissions The papers cover thematic areas as agent and multi agent system models algorithms applications simulations theoretical studies and for AT the thematic areas are algorithms

Computer Vision -- ECCV 2014 David Fleet, Tomas Pajdla, Bernt Schiele, Tinne Tuytelaars, 2014-08-14 The seven volume set comprising LNCS volumes 8689 8695 constitutes the refereed proceedings of the 13th European Conference on Computer Vision ECCV 2014 held in Zurich Switzerland in September 2014 The 363 revised papers presented were carefully reviewed and selected from 1444 submissions The papers are organized in topical sections on tracking and activity recognition recognition learning and inference structure from motion and feature matching computational photography and low level vision vision segmentation and saliency context and 3D scenes motion and 3D scene analysis and poster sessions

Neuro-Symbolic Artificial Intelligence: The State of the Art Md Kamruzzaman Sarker, 2022-01-15 Neuro symbolic AI is an emerging subfield of Artificial Intelligence that brings together two hitherto distinct approaches Neuro refers to the artificial neural networks prominent in machine learning symbolic refers to algorithmic processing on the level of meaningful symbols prominent in knowledge representation In the past these two fields of AI have been largely separate with very little crossover but the so called third wave of AI is now bringing them together This book *Neuro Symbolic Artificial Intelligence The State of the Art* provides an overview of this development in AI The two approaches differ significantly in terms of their strengths and weaknesses and from a cognitive science perspective there is a question as to how a neural system can perform symbol manipulation and how the representational differences between these two approaches can be bridged The book presents 17 overview papers all by authors who have made significant contributions in the past few years and starting with a historic overview first seen in 2016 With just seven months elapsed from invitation to authors to final copy the book is as up to date as a published overview of this subject can be Based on the editors own desire to understand the current state of the art this book reflects the breadth and depth of the latest developments in neuro symbolic AI and will be of interest to students

researchers and all those working in the field of Artificial Intelligence **Approximation and Online Algorithms** Laura Sanità, Martin Skutella, 2016-01-12 This book constitutes the thoroughly refereed post workshop proceedings of the 13th International Workshop on Approximation and Online Algorithms WAOA 2015 held in Patras Greece in September 2015 as part of ALGO 2015 The 17 revised full papers presented were carefully reviewed and selected from 40 submissions Topics of interest for WAOA 2015 were algorithmic game theory algorithmic trading coloring and partitioning competitive analysis computational advertising computational finance cuts and connectivity geometric problems graph algorithms inapproximability mechanism design natural algorithms network design packing and covering paradigms for the design and analysis of approximation and online algorithms parameterized complexity scheduling problems and real world applications

Computer Science -- Theory and Applications Farid M. Ablae, Ernst W. Mayr, 2010-06-14 Annotation This book constitutes the proceedings of the 5th International Computer Science Symposium in Russia CSR 2010 held in Kazan Russia in June 2010 The 30 papers presented were carefully reviewed and selected from 62 submissions The scope of topics of the symposium was quite broad and covered basically all areas of the foundations of theoretical computer science **Bayesian**

Optimization and Data Science Francesco Archetti, Antonio Candelieri, 2019-09-25 This volume brings together the main results in the field of Bayesian Optimization BO focusing on the last ten years and showing how on the basic framework new methods have been specialized to solve emerging problems from machine learning artificial intelligence and system optimization It also analyzes the software resources available for BO and a few selected application areas Some areas for which new results are shown include constrained optimization safe optimization and applied mathematics specifically BO s use in solving difficult nonlinear mixed integer problems The book will help bring readers to a full understanding of the basic Bayesian Optimization framework and gain an appreciation of its potential for emerging application areas It will be of particular interest to the data science computer science optimization and engineering communities *Submodularity in*

Dynamics and Control of Networked Systems Andrew Clark, Basel Alomair, Linda Bushnell, Radha Poovendran, 2015-12-21 This book presents a framework for the control of networked systems utilizing submodular optimization techniques The main focus is on selecting input nodes for the control of networked systems an inherently discrete optimization problem with applications in power system stability social influence dynamics and the control of vehicle formations The first part of the book is devoted to background information on submodular functions matroids and submodular optimization and presents algorithms for distributed submodular optimization that are scalable to large networked systems In turn the second part develops a unifying submodular optimization approach to controlling networked systems based on multiple performance and controllability criteria Techniques are introduced for selecting input nodes to ensure smooth convergence synchronization and robustness to environmental and adversarial noise Submodular optimization is the first unifying approach towards guaranteeing both performance and controllability with provable optimality bounds in static as well as time varying networks

Throughout the text the submodular framework is illustrated with the help of numerical examples and application based case studies in biological energy and vehicular systems The book effectively combines two areas of growing interest and will be especially useful for researchers in control theory applied mathematics networking or machine learning with experience in submodular optimization but who are less familiar with the problems and tools available for networked systems or vice versa It will also benefit graduate students offering consistent terminology and notation that greatly reduces the initial effort associated with beginning a course of study in a new area

Algorithms and Data Structures Pat Morin, Subhash Suri, 2023-07-27 This book constitutes the refereed proceedings of the 18th International Symposium on Algorithms and Data Structures WADS 2023 held during July 31 August 2 2023 The 47 regular papers presented in this book were carefully reviewed and selected from a total of 92 submissions They present original research on the theory design and application of algorithms and data structures

Signal Processing and Machine Learning for Biomedical Big Data Ervin Sejdic, Tiago H. Falk, 2018-07-04 Within the healthcare domain big data is defined as any high volume high diversity biological clinical environmental and lifestyle information collected from single individuals to large cohorts in relation to their health and wellness status at one or several time points Such data is crucial because within it lies vast amounts of invaluable information that could potentially change a patient's life opening doors to alternate therapies drugs and diagnostic tools Signal Processing and Machine Learning for Biomedical Big Data thus discusses modalities the numerous ways in which this data is captured via sensors and various sample rates and dimensionalities Capturing analyzing storing and visualizing such massive data has required new shifts in signal processing paradigms and new ways of combining signal processing with machine learning tools This book covers several of these aspects in two ways firstly through theoretical signal processing chapters where tools aimed at big data be it biomedical or otherwise are described and secondly through application driven chapters focusing on existing applications of signal processing and machine learning for big biomedical data This text aimed at the curious researcher working in the field as well as undergraduate and graduate students eager to learn how signal processing can help with big data analysis It is the hope of Drs Sejdic and Falk that this book will bring together signal processing and machine learning researchers to unlock existing bottlenecks within the healthcare field thereby improving patient quality of life Provides an overview of recent state of the art signal processing and machine learning algorithms for biomedical big data including applications in the neuroimaging cardiac retinal genomic sleep patient outcome prediction critical care and rehabilitation domains Provides contributed chapters from world leaders in the fields of big data and signal processing covering topics such as data quality data compression statistical and graph signal processing techniques and deep learning and their applications within the biomedical sphere This book's material covers how expert domain knowledge can be used to advance signal processing and machine learning for biomedical big data applications

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