

DIMACS

Series in Discrete Mathematics
and Theoretical Computer Science

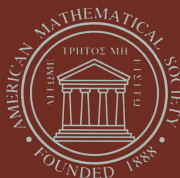
Volume 49

Contemporary Trends in Discrete Mathematics

From DIMACS and DIMATIA
to the Future

DIMATIA-DIMACS Conference
May 19–25, 1997
Štířín Castle, Czech Republic

Ronald L. Graham
Jan Kratochvíl
Jaroslav Nešetřil
Fred S. Roberts
Editors



American Mathematical Society

Selected Titles in This Series

- 49 **Ronald L. Graham, Jan Kratochvíl, Jaroslav Nešetřil, and Fred S. Roberts, Editors**, Contemporary Trends in Discrete Mathematics
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- 31 **Neil Immerman and Phokion G. Kolaitis, Editors**, Descriptive Complexity and Finite Models
- 30 **Sandeep N. Bhatt, Editor**, Parallel Algorithms: Third DIMACS Implementation Challenge
- 29 **Doron A. Peled, Vaughan R. Pratt, and Gerard J. Holzmann, Editors**, Partial Order Methods in Verification
- 28 **Larry Finkelstein and William M. Kantor, Editors**, Groups and Computation II
- 27 **Richard J. Lipton and Eric B. Baum, Editors**, DNA Based Computers
- 26 **David S. Johnson and Michael A. Trick, Editors**, Cliques, Coloring, and Satisfiability: Second DIMACS Implementation Challenge
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- 22 **Panos M. Pardalos, Mauricio G. C. Resende, and K. G. Ramakrishnan, Editors**, Parallel Processing of Discrete Optimization Problems
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(See the AMS catalog for earlier titles)

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Contemporary Trends in Discrete Mathematics

From DIMACS and DIMATIA
to the Future



Some participants of the DIMATIA-DIMACS conference in the park of the Štířín Castle. Photographs taken by A. Kotěšovcová on May 20, 1997.

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NSF Science and Technology Center
in Discrete Mathematics and Theoretical Computer Science
A consortium of Rutgers University, Princeton University,
Bell Labs, Telcordia Technologies (formerly Bellcore), and
NEC Research Institute



American Mathematical Society

This DIMACS volume contains papers from a DIMATIA-DIMACS conference on The Future of Discrete Mathematics. The conference was held May 19–25, 1997, at Štířín Castle, Czech Republic.

1991 *Mathematics Subject Classification*. Primary 05–06, 05Cxx, 05Dxx, 06A07, 11Bxx, 60C05, 68Rxx, 68Q15, 92C40.

Library of Congress Cataloging-in-Publication Data

Contemporary trends in discrete mathematics : from DIMACS and DIMATIA to the future : DIMATIA-DIMACS conference, May 19–25, 1997, Štířín Castle, Czech Republic / Ronald L. Graham, editors . . . [et al.].

p. cm. — (DIMACS series in discrete mathematics and theoretical computer science ; v. 49)
Papers from the DIMACS/DIMATIA Workshop on the Future of Discrete Mathematics.
Includes bibliographical references.

ISBN 0-8218-0963-6 (alk. paper)

1. Graph theory—Congresses. 2. Combinatorial analysis—Congresses. 3. Computer science—Mathematics—Congresses. I. Graham, Ronald L., 1935– . II. DIMATIA (Group) III. DIMACS (Group) IV. DIMACS/DIMATIA Workshop on the Future of Discrete Mathematics (1997 : Štířín Castle) V. Series.

QA166.C6355 1999

511'.5—dc21

99-19657

CIP

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10 9 8 7 6 5 4 3 2 1 04 03 02 01 00 99

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Foreword

The DIMACS-DIMATIA Workshop on The Future of Discrete Mathematics was held on May 19–25, 1997 at the Štiřín Castle in the Czech Republic. We would like to express our appreciation to Fred S. Roberts, Ronald Graham, Jaroslav Nešetřil and Jan Kratochvíl for their efforts to organize and plan this successful workshop.

The main focus of this workshop was on presenting current trends in discrete mathematics in all its versatility.

The workshop was part of the international cooperation between two centers, DIMACS and DIMATIA, which is supported by grants from the Czech and US National Science Foundations.

DIMACS gratefully acknowledges the generous support that makes its programs possible: The National Science Foundation, through its Science and Technology Center program, the National Security Agency, the New Jersey Commission on Science and Technology, DIMACS' partners at Rutgers, Princeton, AT&T Labs Research, Bell Labs, Telcordia Technologies (formerly Bellcore), and NEC Research Institute.

Fred S. Roberts
Director

Robert Sedgewick
Co-Director for Princeton

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Preface

The following book is an outgrowth of the DIMATIA-DIMACS conference “The Future of Discrete Mathematics” which was held at Štířín Castle in the vicinity of Prague in May 19-25, 1997. This was the inaugural conference under a program of official cooperation of the two centers, which is being supported by joint Czech Academy - National Science Foundation grants 055/1997 and NSF-INT-96-05174. The conference was further supported by Czech grants GAČR 201/1996/0194, GAUK 194/1996, FR MŠMT, and Czech-US Science and Technology grant 94051.

The ambitious aim of the meeting was to present current trends of Discrete Mathematics in all its versatility, width and depth. Discrete Mathematics has taken its place among the leading disciplines of mathematics and theoretical computer science. This is accompanied on one side by its growing importance in university curriculae and on the other side by its growing role in various applications which range from optimization to molecular biology.

More than 50 participants (including students from several participating universities) took part in the conference, and the enclosed program mirrors the quality and the scope of the meeting.

The present book is not just a conference proceedings. We have tried to assemble contributions to the volume that feature some of the most attractive fields of contemporary Discrete Mathematics. We believe that we have managed to put together a sample of both research papers and surveys that reflects the scope and excitement of the field. The delay between the conference and collection of final versions enabled the authors to reflect new developments and include new results from the relevant areas. All contributions were refereed and we take this opportunity to thank our referees for their help.

As expected, the largest number of papers deal with graph theory. Among them are surveys by W. Mader on topological minors and M. Simonovits on extremal graph theory. Research papers in this area include papers on path systems (A. Frank) and on the generalized matching problem and bounded tree-width (A. Gupta, D. Kaller, S. Mahajan, and T. Shermer). Several research papers are devoted to various versions of the classical coloring and recently introduced oriented chromatic number (A. Kostochka, T. Łuczak, G. Simonyi and E. Sopena; P. Boiron, E. Sopena, and L. Vignal; A. Sali and G. Simonyi). To the area of graph coloring problems also belongs a survey of choosability and list colorings by J. Kratochvíl, Zs. Tuza and M. Voigt. Most of these papers also investigate computational complexity of the various graph theoretical problems and investigate various problems of theoretical computer science.

A more structural (algebraic) approach is taken in papers by P. Mihók (a survey of reducibility of graph properties) and by J. Nešetřil and C. Tardif who survey the

recent solution of density problems in full generality. A survey of a recent solution of the problem of representations of partially ordered sets by circular orders is presented by W. T. Trotter. This paper also deals to a large extent with new developments in Ramsey theory. Geometrical Ramsey theorems related to the classical Erdős-Szekerés theorem appear in the paper by J. Nešetřil, J. Solymosi, and P. Valtr. Further geometrical problems are studied in an elegant paper by P. Ossona de Mendez and H. de Fraysseix on planar representations of graphs. Geometric methods are also used in the paper by G. Elekes on large homothetic subsets and by J. Griggs and G. Rote on distribution of vector sums.

Combinatorial questions of an algebraic nature are represented by articles by W. Hochstättler and M. Loeb1 on bases of lattices and M. Rosenfeld on matchings in finite fields, a work related to Hadamard matrices. Two papers are devoted to problems related to Davenport-Schinzel sequences intensively studied in Prague (P. Valtr surveying geometrical applications of this combinatorial structure, and M. Klazar considering several generalizations).

Problems of a purely computer science nature are studied in papers by S. Fekete, S. Kromberg, Ch. Moll, and W. Hochstättler on the complexity of the inverse shortest path problem and by J. Díaz, M. Serna, and P. Spirakis surveying linear and nonlinear systems, and in an extensive survey by R. G. Downey and M. R. Fellows devoted to parametrized complexity analysis.

Finally, applications are represented by a survey of F. S. Roberts on problems stemming from the social sciences and related to limitations on conclusions about optimal solutions or decision making imposed by considerations of measurement scales, and by a paper of V. Janota, P. Pančoška, and J. Nešetřil which is a further contribution to the literature on protein folding problems.

This book is the result of one of the first activities of the DIMATIA Center of Charles University. The Center for Discrete Mathematics, Theoretical Computer Science and Applications was established in September 1996 at Charles University in Prague as a joint project of Charles University, Academy of Sciences of the Czech Republic and Institute of Chemical Technology, Prague. The center is open and actively seeks partners from all parts of the world. The purpose of the center is to foster research in all fields of discrete mathematics and its modern applications and relationship to computer science, operations research and fields as diverse as biology, chemistry and the social sciences. Towards this end the center organizes a continuing program of workshops, conferences and research visits both in Prague and other places together with cooperating institutions. The project concentrates on research topics that are at the forefront of current research in discrete mathematics and theoretical computer science.

DIMATIA is a corporate structure founded by three leading Prague research groups working in discrete mathematics, theoretical computer science and their applications. The research team includes 14 permanent members, mostly mathematicians and computer scientists, though some members of the research team are physicists and chemists. All these members are staff members of the founding institutions – Faculty of Mathematics and Physics of the Charles University (V. Janota, M. Klazar, J. Kratochvíl, L. Kučera, M. Loeb1, J. Matoušek, J. Nešetřil, P. Pančoška, P. Valtr), Mathematical Institute of the Academy of Sciences of the Czech Republic (I. Havel, J. Krájčěk, P. Pudlák, J. Sgall) and Faculty of Chemical Engineering of the Institute of Chemical Technology, Prague (D. Turzík). This

number does not include associated researchers, foreign associates and graduate students.

The center has a Director (J. Nešetřil) to provide scientific leadership and day-to-day operation of the center. In that he is assisted by Deputy Director (J. Kratochvíl) and Scientific Secretary (V. Janota). Charles University provides the center with a part time secretary position.

The center has an International Scientific Advisory Board consisting of representatives of DIMATIA participating organizations. DIMATIA is an open institution, directed to cooperation on the whole European scale and open to further collaboration. This is a very special feature of the DIMATIA concept and key to its intended activities. Presently the foreign associates are Sobolev Institute of Mathematics, Novosibirsk; LaBRI Institute, Bordeaux; Pacific Institute of Mathematical Sciences; Institute of Computational Mathematics, Pisa; Operations Research Institute, Bonn; University Bielefeld; Mathematical Institute, Budapest; University Barcelona; and DIMACS.

DIMACS, the Center for Discrete Mathematics and Theoretical Computer Science, is a consortium of Rutgers and Princeton Universities and AT&T Labs, Bell Labs, Bellcore, and NEC Research Institute (a newly added partner). DIMACS has entered into the partnership with DIMATIA in order to enhance and stimulate international collaborations and direct the attention of the international mathematical sciences community toward the fields of discrete mathematics and theoretical computer science and their applications. Such an international partnership also offers outstanding young people from both sides the opportunity to be exposed to the world's leading mathematical scientists and to gain early international experiences. DIMACS is delighted to celebrate the opening of the DIMATIA Center and is enthusiastic about the partnership with such a leading scientific organization. The Štirín conference was the first joint project within the newly founded DIMATIA-DIMACS framework, which also includes more focused workshops, exchanges of visitors, and programs for postdoctoral fellows, graduate students, and undergraduates. We all believe and hope this was the first of many mutually beneficial and exciting scientific collaborations.

Ronald L. Graham
Jan Kratochvíl
Jaroslav Nešetřil
Fred S. Roberts

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Program

Monday May 19, 1997

4 - 6 p.m.

M. Rosenfeld: Three Problems in Combinatorial Number Theory

Robin Thomas: Permanents, Pfaffian Orientations, and Even Directed Circuits

Tuesday May 20, 1997

9 a.m.–12 noon

William T. Trotter: Ramsey Theory and Sequences of Random Variables

Vera Sós: On Combinatorial Number Theory

Fred S. Roberts: Meaningless Statements

2–6 p.m.

Jiří Matoušek: Upper Bounds in Geometric and Combinatorial Discrepancy

Günter Rote: Convex 3-polytopes Can Be Realized with Linearly Many Bits per Coordinate

Pavel Valtr: Several Recent Results on Geometric Graphs

Mary Inaba: Geometric Clustering Problem

Peter Brass: On Lattice-like Extremal Sets for Combinatorial Geometry Problems

Wednesday May 21, 1997

9 a.m.–12 noon

Joel Spencer: Sophisticated Probability

Tomasz Łuczak: Random Trees and Random Graphs

Krystyna T. Balińska: An Algorithmic Approach to a Random Process for Graphs with Bounded Degree

2–6 p.m.

Eugene Luks: Algorithmic Applications of the Simple Groups Classification

Luděk Kučera: Fast Deflection Routing of Long Messages

Josep Díaz: Approximation of #P Problems in RNC

Jiří Sgall: On Pairs of Intersecting Families

Conference banquet

Thursday May 22, 1997

9 a.m.–12 noon

Jaroslav Nešetřil: The Structure of Graph Homomorphisms

Jan Kratochvíl: List Colorings and Choosability of Graphs

Alexander Kostochka: On Colour-critical Graphs and Hypergraphs with Few Edges

Afternoon excursion to České Budějovice (exhibition of paintings by Načeradský and Nešetřil) and to Velké Popovice (brewery)

Friday May 23, 1997

9 a.m.–12 noon

László Lovász: Random Walks, Mixing, and Sampling

András Frank: Algorithms for Increasing the Connectivity of Graphs

Eric Sopena: Acyclic Improper Colorings

2–6 p.m.

Jan Krajčiek: Proof Complexity and Some Related Algebraico - combinatorial Problems

Arvind Gupta: Monadic Second Order Logic and Complement Problems

Mike Fellows: The Shortest Vector Problem and the Prospects for Cryptosystems Based on NP-Hard Problems

Gyorgy Elekes: Metric Combinatorics and Combinatorial Algebra

Gábor Simonyi: Information Theory in Combinatorics

William F. Smyth: Periodicity in Strings

Saturday May 24, 1997

9 a.m.–1 p.m.

Walter Deuber: Ramsey Theory and Linear Algebra

Graham Brightwell: Graph Homomorphisms and Branching Random Walks

Wolfgang Mader: An Extremal Problem for Subdivisions of K_5 and Topological Subgraphs in Graphs of Large GirthSándor P. Fekete: A New Exact Algorithm for General Orthogonal d -dimensional Knapsack Problems and a New Lower Bound for Bin Packing Problems

Shiyu Zhou: Computing undirected connectivity in small space

3–6 p.m.

Martin Klazar: Extremal Problems for Colored Trees

Miklós Simonovits: General Methods to Prove Exact Results in Extremal Graph Theory

Peter Mihók: The Structure of Hereditary Properties of Graphs and Minimal Reducible Bounds

Petr Pančoška: Proteins, Graphs and Spectra - Selected Problems

Sunday May 25, 1997

9–11 a.m.

Jerry Griggs: The Distribution of Subset Sums in R^m and in Finite Abelian Groups

Pavel Pudlák : New algorithms for satisfiability

List of participants

R. Babilon, DIMATIA
K. Balińska, Poznań
J. Balogh, Szeged
P. Brass, Germany
G. Brightwell, London
T. Dacic, PIMS
J. Díaz, Barcelona
W. Deuber, Bielefeld
G. Elekes, Budapest
S. Fekete, Köln
M. Fellows, PIMS
A. Frank, Budapest
H. de Fraysseix, Paris
J. Griggs, Columbia
A. Gupta, PIMS
P. Haxell, Waterloo
P. Hliněný, DIMATIA
M. Inaba, Tokyo
V. Janota, DIMATIA
T. Kaiser, DIMATIA
M. Klazar, DIMATIA
A. Kostochka, Novosibirsk
J. Krajíček, DIMATIA
J. Kratochvíl, DIMATIA
L. Kučera, DIMATIA
L. Lovász, Budapest
T. Łuczak, Poznań
E. Luks, Eugene
W. Mader, Hannover
J. Matoušek, DIMATIA
F. Matúš, Bielefeld
P. Mihók, Košice
J. Nešetřil, DIMATIA
P. Ossona de Mendez, Paris
P. Pančoška, DIMATIA
G. Pete, Szeged
P. Pudlák, DIMATIA
F. Roberts, DIMACS

M. Rosenfeld, Seattle
G. Rote, Germany
J. Sgall, DIMATIA
M. Simonovits, Budapest
G. Simonyi, Budapest
W. Smyth, Ottawa
E. Sopena, Bordeaux
V. T. Sós, Budapest
J. Spencer, DIMACS
C. Tardif, Bielefeld
R. Thomas, Atlanta
W. Trotter, Bonn
D. Turzík, DIMATIA
P. Valtr, DIMATIA
S. Zhou, DIMACS

ISBN 0-8218-0963-6



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