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Groups and Computation II
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Groups and Computation II

Workshop on Groups and Computation
June 7–10, 1995

Larry Finkelstein
William M. Kantor
Editors

NSF Science and Technology Center in Discrete Mathematics and Theoretical Computer Science
A consortium of Rutgers University, Princeton University, AT&T Labs, Bell Labs, and Bellcore

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Foreword

The second DIMACS workshop on Groups and Computation took place during June 1995. The first meeting was held in October 1991 at DIMACS; papers from that workshop were reported on in *Groups and Computation* Volume 11, in this same AMS-DIMACS series.

We at DIMACS are pleased at the progress in this emerging area that bridges the mathematics of group theory and computer science and the opportunity for the DIMACS center to continue to play a role in it.

We would like to thank the workshop organizers, Larry Finkelstein, William M. Kantor, and Charlie Sims, for their tireless efforts to bring together such an outstanding group of speakers. We extend our special thanks to Larry Finkelstein and William M. Kantor for their painstaking efforts to edit this volume.

Fred S. Roberts  
Director  
Bernard Chazelle  
Co-Director for Princeton  
Stephen R. Mahaney  
Associate Director
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Preface

The Workshop "Groups and Computation" took place at DIMACS, the Center for Discrete Mathematics and Theoretical Computer Science on the campus of Rutgers University, on June 7–10, 1995. This, and an earlier Workshop held on Oct 7-10, 1991, aimed at merging theory and practice within the broad area of computation with groups. The primary goal of the previous Workshop was to foster a dialogue between researchers studying the computational complexity of group algorithms and those engaged in the development of practical software. It was expected that this would lead to a deeper understanding of the mathematical issues underlying group computations, and such understanding would lead in turn to faster algorithms. Comments and subsequent work indicated that this goal had been achieved beyond our expectations. In particular, as a result of that Workshop, new collaborations formed to test the practicality of algorithms designed to meet the theoretical goal of faster asymptotic running times. Some of these have now been implemented and have been shown to have superior practical performance. The second Workshop was designed to reinforce the progress in these directions.

The scientific program consisted of invited lectures and research announcements, as well as informal discussions and software demonstrations. The eight extended talks (by L. Babai, B. Eick, C. Leedham-Green, J. Leon, C. Miller, C. Praeger and A. Niemeyer, D. Rockmore, and M. Sch"onert) discussed randomization, permutation groups, matrix groups, software systems, fast Fourier transforms and their applications to signal processing and data analysis, computations with finitely presented groups, as well as implementation and complexity questions. These topics were also discussed in further talks, as were additional ones such as group-theoretic computation with graphs, algorithms for permutation groups, properties of simple groups, and parallel architectures for matrix group computation. As in the previous Workshop, speakers ranged from established researchers to graduate students. The present Proceedings contains papers based on most, but not all, of their talks.

Software provided by the participants was available during the entire workshop and was discussed in a number of talks. One evening was devoted to informal software presentations using various systems, including numerous demonstrations by participants using GAP or Magma. In addition, there was a panel discussion whose theme was "Problems whose current algorithmic solutions are, in practice, either too time- or space-consuming". The panelists (G. Cooperman, G. Havas, J. Leon, J. Neubüser, M. Schönert and L. Soicher) were selected for their broad experience in building software for group computation.

What was most striking throughout the Workshop was the convergence of theory and practice begun at the first Workshop. Almost every talk concerning practical
algorithms mentioned complexity issues; almost every talk focused on complexity mentioned practical considerations. This was particularly evident when it came to research on algorithms for computing with matrix groups. In contrast with the situation for permutation groups, finite matrix groups are too “large”, from both a practical and a theoretical standpoint. As a result, very few computational problems for matrix groups have polynomial-time solutions (this is true even for simple-sounding problems such as finding the order of a matrix group). Particularly fascinating are the mathematical issues that have emerged as part of the search for reasonably efficient matrix group algorithms. This Proceedings contains several papers along these lines. The remarkable progress that has been achieved so far makes extensive use of the classification of finite simple groups, of randomized methods, and of polynomial computation using classical Symbolic Algebra methods. This progress could not have been predicted following the first DIMACS Workshop, which was dominated by permutation groups rather than matrix groups.

The first DIMACS Workshop came into being due to the formidable efforts of Danny Gorenstein, and hence the second one also owes much to him. We are grateful for the assistance of our co-organizer Charles Sims, and to the DIMACS staff for helping the workshop to function smoothly. Christine Thierviege of the American Mathematical Society provided invaluable assistance in the production of this Proceedings. Finally, we would like to thank DIMACS, the National Science Foundation, the National Security Agency and Rutgers University for their financial support of the workshop.

Larry Finkelstein
William M. Kantor
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Gilbert Baumslag and Charles F. Miller III, *Some open problems about infinite groups*
Kenneth Blaha, *Permutation group problems that may be hard to parallelize*
Frank Celler, *Matrix group algorithms in GAP*
Gene Cooperman, *Mixed matrix computations, parallel GAP, and large scale computations*
Bettina Eick, *Special presentations of finite polycyclic groups and their applications*
C.R. Leedham-Green, *Recognising matrix groups*
Reinhard Laue, *Algorithms for group actions: homomorphism principle and orderly generation applied to generating graphs*
Jeffrey S. Leon, *Partitions, refinements, and permutation group computation*
Steve Linton, *Recognising GL(n, 2) as a black box group*
Eddie H. Lo, *A polycyclic quotient algorithm*
Klaus Lux, *Determining socle series for projective indecomposable modules of group algebras*
David Maslen, *Computation of Fourier transforms on finite groups*
Takunari Miyazaki, *Canonical labeling of graphs: experiments with nauty*
Prabhav Morje, *On nearly linear algorithms for Sylow subgroups*
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Gretchen Ostheimer, *Algorithms for triangularizable subgroups of GL(n, Z)*
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Ferenc Rakoczi, *Some practical aspects of computing in nilpotent permutation groups*
Sarah Rees, *Free quotients of finitely presented groups*
Daniel M. Rockmore, *Applications of generalized FFT’s*
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Ákos Seress, *Basic tools for nearly linear time computations*
Michael Tseltman, *Computing permutation representations for matrix groups in a distributed environment*
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CLASSIC – non-constructive/constructive classical group recognition
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Bruce Cox, An overview of Magma
Permutation groups in Magma
Bettina Eick, Special AG systems and applications in GAP
George Havas, Finitely presented groups in Magma
Alexander Hulpke, A program to classify transitive permutation groups
Clement Lam, BDX – a Block Design eXplorer
Reinhard Laue, MOLGEN, a generator of chemical structures and a new generator of graphs
Eddie H. Lo, pqa, a program to compute polycyclic quotients given a finitely pre-
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Spyros Magliveras, Groups and designs
Cryptosystem PGM
Werner Nickel, Nilpotent quotients of finitely presented groups
Eamonn O’Brien, Exploring matrix groups
Modules in Magma
Anthony Pye, GAP code for handling reducible matrix groups
Martin Schönert, GAP 3.4.2.
Charles Sims, RKBP – The Rutgers Knuth-Bendix Package
Michael Slattery, Soluble groups in Magma
Leonard Soicher, GRAPE: a GAP package for computing with graphs, groups and geometries
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