

Lecture Notes in Artificial Intelligence 3763

Edited by J. G. Carbonell and J. Siekmann

Subseries of Lecture Notes in Computer Science

Hoon Hong Dongming Wang (Eds.)

Automated Deduction in Geometry

5th International Workshop, ADG 2004
Gainesville, FL, USA, September 16-18, 2004
Revised Papers



Springer

Series Editors

Jaime G. Carbonell, Carnegie Mellon University, Pittsburgh, PA, USA
Jörg Siekmann, University of Saarland, Saarbrücken, Germany

Volume Editors

Hoon Hong
North Carolina State University, Department of Mathematics
Box 8205, Raleigh, NC 27695, USA
E-mail: hong@math.ncsu.edu

Dongming Wang
Beihang University, School of Science
37 Xueyuan Road, Beijing 100083, China
E-mail: Dongming.Wang@lip6.fr

Library of Congress Control Number: 2005938552

CR Subject Classification (1998): I.2.3, I.3.5, F.4.1, I.5, G.2

LNCS Sublibrary: SL 7 – Artificial Intelligence

ISSN	0302-9743
ISBN-10	3-540-31332-X Springer Berlin Heidelberg New York
ISBN-13	978-3-540-31332-8 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2006
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11615798 06/3142 5 4 3 2 1 0

Preface

Automated Deduction in Geometry (ADG) is a series of international workshops where active researchers exchange ideas and views, present research results and progress, and demonstrate software tools on the *intersection* between geometry and automated deduction. This volume contains several excellent papers (selected via peer review) based on the talks given at the ADG 2004 meeting hosted by the University of Florida, USA, during September 16–18, 2004. The previous four meetings were held in Linz (2002), Zurich (2000), Beijing (1998), and Toulouse (1996).

This volume consists of 12 papers. The paper by *Laura I. Meikle* and *Jacques D. Fleuriot* shows how to prove the correctness of an algorithm for computing convex hulls, by using Hoare logic and Isabelle. The paper by *Judit Robu*, *Tetsuo Ida*, *Dorin Țepeneu*, *Hidekazu Takahashi*, and *Bruno Buchberger* shows how to prove the correctness of an origami construction (heptagon), by using the Theorema system and Gröbner bases. The paper by *Xuefeng Chen*, *Peng Li*, *Long Lin*, and *Dingkang Wang* shows how to treat degenerate cases in geometric theorems rigorously, by introducing partitioned-parametric Gröbner bases. The paper by *Pavel Pech* shows how to derive formulas for the area and radius of cyclic polygons, by using Gröbner bases. The paper by *Lu Yang* and *Zhenbing Zeng* shows how to solve certain piano movers' problems, by using a specialized real quantifier elimination method (discriminant chains). The paper by *Daniel Lichtblau* shows how to compute curves bounding trigonometric planar maps, by using Gröbner bases and some numerical methods. The paper by *Francisco Botana* and *Tomás Recio* tackles several non-trivial problems (continuity, locus generation, proving, and discovering) arising in dynamic geometry, by using Gröbner bases and other symbolic ideas and methods. The paper by *Britta Denner-Brosen* tackles other non-trivial problems (tracing and reachability) arising in dynamic geometry, by introducing an alternative method (to the standard purely algebraic method). The paper by *Tielin Liang* and *Dongming Wang* describes the design and a prototype for an object-oriented language suitable for (parametrically) computing, reasoning about, and visualizing geometric objects. The paper by *Dmytro Chibisov*, *Ernst W. Mayr*, and *Sergey Pankratov* shows how to solve the motion planning problem, by using real quantifier elimination and R-functions. The paper by *Hongbo Li* shows how to reconstruct an n D polyhedral scene from a single 2D line drawing, by using Grassmann–Cayley algebra and various other tools along with carefully chosen heuristics. The paper by *Gui-Fang Zhang* and *Xiao-Shan Gao* introduces planar generalized Stewart platforms and provides a complete characterization.

We, the editors, on behalf of the organizers, thank the speakers and the authors for their excellent talks and papers. On behalf of the speakers and the authors, we would like to thank Neil White, the General Chair of ADG 2004, for organizing the wonderful meeting, and Manfred Minimair, the Publicity Chair,

for making this emerging field known to wider communities. We would also like to thank the Program Committee members (listed on the next page) for lending all their time and expertise in ensuring the high quality of the talks and the papers. Due to all their tireless effort, the meeting was highly successful, fostering lively and insightful discussions, which certainly inspired the papers published in this volume. We eagerly look forward to meeting again in 2006 to share all the new exciting progress being made!

November 2005

Hoon Hong
Dongming Wang

Organization

Invited Speakers

Doron Zeilberger (Rutgers University, USA)

Ileana Streinu (Smith College, USA)

General Organization

Neil White (Gainesville, USA), Chair

Manfred Minimair (South Orange, USA), Publicity

Program Committee

Hoon Hong (Raleigh, USA), Chair

Andreas Dress (Bielefeld, Germany)

Christopher Brown (Annapolis, USA)

Deepak Kapur (Albuquerque, USA)

Dongming Wang (Beijing, China/Paris, France)

Franz Winkler (Linz, Austria)

Giuseppa Carrà Ferro (Catania, Italy)

Hongbo Li (Beijing, China)

Jacques D. Fleuriot (Edinburgh, UK)

Jürgen Richter-Gebert (Munich, Germany)

Laureano González-Vega (Santander, Spain)

Lu Yang (Chengdu, China)

Luis Fariñas del Cerro (Toulouse, France)

Meera Sitharam (Gainesville, USA)

Neil White (Gainesville, USA)

Quoc-Nam Tran (Beaumont, USA)

Rafael Sendra (Madrid, Spain)

Shang-Ching Chou (Wichita, USA)

Thierry Boy de la Tour (Grenoble, France)

Thomas Sturm (Passau, Germany)

Tomás Recio (Santander, Spain)

Volker Weispfenning (Passau, Germany)

Xiao-Shan Gao (Beijing, China)

Table of Contents

Mechanical Theorem Proving in Computational Geometry <i>Laura I. Meikle, Jacques D. Fleuriot</i>	1
Computational Origami Construction of a Regular Heptagon with Automated Proof of Its Correctness <i>Judit Robu, Tetsuo Ida, Dorin Țepeneu, Hidekazu Takahashi, Bruno Buchberger</i>	19
Proving Geometric Theorems by Partitioned-Parametric Gröbner Bases <i>Xuefeng Chen, Peng Li, Long Lin, Dingkang Wang</i>	34
Computations of the Area and Radius of Cyclic Polygons Given by the Lengths of Sides <i>Pavel Pech</i>	44
Symbolic Solution of a Piano Movers' Problem with Four Parameters <i>Lu Yang, Zhenbing Zeng</i>	59
Computing Curves Bounding Trigonometric Planar Maps: Symbolic and Hybrid Methods <i>Daniel Lichtblau</i>	70
Towards Solving the Dynamic Geometry Bottleneck Via a Symbolic Approach <i>Francisco Botana, Tomás Recio</i>	92
On the Decidability of Tracing Problems in Dynamic Geometry <i>Britta Denner-Brosen</i>	111
Towards a Geometric-Object-Oriented Language <i>Tielin Liang, Dongming Wang</i>	130
Spatial Planning and Geometric Optimization: Combining Configuration Space and Energy Methods <i>Dmytro Chibisov, Ernst W. Mayr, Sergey Pankratov</i>	156
n D Polyhedral Scene Reconstruction from Single 2D Line Drawing by Local Propagation <i>Hongbo Li</i>	169

Planar Generalized Stewart Platforms and Their Direct Kinematics
 Gui-Fang Zhang, Xiao-Shan Gao 198

Author Index 213