Annual Report 2004

Work Group

Theoretical Computer Science

Prof. Dr. Helmut Alt – Prof. Dr. Günter Rote – Prof. Dr. Christian Knauer

January 2005

Institut für Informatik

Fachbereich Mathematik und Informatik

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1. Members of the Group

(a) <u>Professors</u>

Alt, Helmut, Dr.
Rote, Günter, Dr.
Knauer, Christian, Dr.

(b) <u>Assistants, scientific personnel, scholarship holders</u>

Abdo, Hosam (Egyptian government fellowship)
Brehm, Enno (Freie Universität Berlin, until March 31st)
Broser, Britta (Freie Universität Berlin)
Buchin, Kevin (graduate program *Combinatorics, Geometry, and Computation*)
Buchin, Maike (graduate program *Combinatorics, Geometry, and Computation*)
Dimitrov, Darko
Hoffmann, Frank, Dr. (Freie Universität Berlin)
Izmestiev, Ivan, Dr. (Freie Universität Berlin until March 31st)
Klein, Oliver (graduate program *Combinatorics, Geometry, and Computation*)
Klost, Claudia (Freie Universität Berlin,)
Kortenkamp, Ulrich, Dr. (Freie Universität Berlin, until March 31st)
Kriegel, Klaus, Priv.-Doz., Dr. (Freie Universität Berlin)
Lenz, Tobias (Freie Universität Berlin)
Ribó Mor, Ares (graduate program *Combinatorics, Geometry, and Computation*)
Scharf, Ludmila (Freie Universität Berlin, since February 8th)
Schulz, Andre (DFG)
Sturm, Astrid (EU)

(c) <u>Guests</u>

Panos Giannopoulos (since October 1st)
Esther Moet (Marie-Curie-Program since October 1st)

(d) <u>Secretary</u>

Knoll, Tamara (Freie Universität Berlin)

(e) <u>Coordinator of the graduate program</u>

Hoffkamp, Andrea (DFG)

(f) <u>Student assistants</u>

Schaust, Sven (DFG, since August 15th)
Zilske, Michael (DFG, since August 1st)

2. Guests and Lectures

PETER BRASS
(January 14th through 16th)
On simplices spanned by point sets

HANS ULRICH SIMON
Ruhr-Universität Bochum (January 19th)
On the Power of Statistical Learning

MARCO LÜBBECKE
Technische Universität Berlin (April 19th)
Covering Polygons by Rectangles

OSWIN AICHHOLZER
Technische Universität Graz (May 10th)
Abstract strategy games: Abalone and Pyraos

RICHARD WEISS
Tufts University (June 7th)
Generalized Polygons and Spherical Buildings

JEAN-DANIEL BOISSONNAT
INRIA Sophia Antipolis (June 28th)
Voronoi diagrams and surfaces

HEE-KAP AHN
Korean Advanced Institute of Science and Technology (KAIST) (August 2nd through 5th)

CHAN-SU SHIN
Korean Advanced Institute of Science and Technology (KAIST) (August 2nd through 5th)

ALEXANDER WOLFF
Universität Karlsruhe (August 15th through 28th)

CAROLA WENK
University of Texas at San Antonio (August 15th through 28th)

JEFF ERICKSON
University of Illinois (November 1st)
Greedy optimal homotopy and homology generators

VLADLEN KOLTUN
Tel Aviv University (November 1st through 3rd)
Pianos are not Flat: Rigid Motion Planning in Three Dimensions

RAIMUND SEIDEL
Universität des Saarlandes (November 8th)
Top-down analysis of path compression and related problems

RENÉ VAN OOSTRUM
Utrecht University (November 15th through 20th)

Flying Buckets and Applications

Esther Moet
Utrecht University (December 13th)
Guarding Art Galleries by Guarding Witnesses

3. Projects supported by external grants

- European graduate program Combinatorics, Geometry, and Computation financially supported by the the German Science Foundation (DFG)

Participating scientists:	Helmut Alt, Günter Rote
Coordination:	Andrea Hoffkamp
Scholarship holders:	Kevin Buchin
	Maike Buchin
	Oliver Klein
	Ares Ribó Mor
Duration of the program:	January 2000 through December 2005

  This European graduate program, which exists since January 2000, is a joint initiative with scientists from the Departments of Computer Science and Mathematics at ETH Zurich, Switzerland. The existing cooperation between the main partners Berlin and Zurich will be enhanced by other partner institutes in Belgium, Great Britain, the Netherlands, Poland, the Czech Republic, and Hungary. In Berlin the participating institutions are the three universities in Berlin - Free University, Humboldt University, Technical University - and the Konrad Zuse Center for Scientific Computing.

  Discrete mathematics and theoretical computer science are the main research fields in the program. In particular, geometrical aspects will play an important role. The major scientific goal of the program is to intensify the cooperation and interaction between discrete mathematics, algorithmics, and application areas. Therefore, especially at the partner institute in Zurich, faculty members working in application areas like geographic information systems, computer graphics, computer vision, and operations research, are participating.The program is subdivided into four basic research areas: combinatorics, geometry, optimization, and algorithms and computation. In each of these areas at least one of the partners in the program is an internationally renowned center of expertise.

- European graduate program Marie Curie Training Site financially supported by the European Commision

Participating scientists:	Helmut Alt, Günter Rote
Coordination:	Andrea Hoffkamp
Scholarship holders:	Esther Moet (since October 1st)
Duration of the program:	2002 through 2005

The Marie Curie Training Site is connected with the European Graduate Program COMBINATORICS, GEOMETRY, AND COMPUTATION. Young researchers pursuing doctoral studies can be supported. They are provided with the possibility of undertaking part of their doctoral studies in a country other than their own. Applicants must already have an advisor and a dissertation project in mathematics, computer science, or a related area at their home university.

The Marie Curie Training Site is a joint initiative of the three universities of Berlin - Free University, Technical University, Humboldt-University - and the Konrad-Zuse-Research Center.

The scientific program ranges from theoretical fundamentals to applications. The areas of research are combinatorics, geometry, optimization, algorithms and computation.

- Project POINT PATTERN MATCHING FOR THE ANALYSIS OF GEL IMAGES
  financially supported by the German Science Foundation (DFG) until June 30th 2001 and Bio-Rad Laboratories since July 10th 2001

Participants:	Helmut Alt (project leader)
	Klaus Kriegel, Frank Hoffmann,
	Darko Dimitrov
Duration of the project:	January 1st 1997 through June 30th 2001 (DFG)
	July 2001 through December 2003 (Bio-Rad)

This project started as a joint project of the Institute of Computer Science of Freie Universität and Deutsches Herzzentrum (German Heart Center) Berlin. The main topics of research are 2-dimensional gel images, that are produced by high-resolution gelelectophoresis-techniques. The gelelectrophoresis has been established to be a central molecular-biological method for the analysis of the protein/DNA-compound of tissue samples. Each "spot" in a gel image that has been produced by gelelectrophoresis represents one protein appearing in the sample.

Ten years ago, the interpretation of gel images was mainly based on the exact (and time consuming) examination by experienced specialists. Although, in the meanwhile several software packages have been developed, there is still a lot of work to do towards a fully automatical solution of the problem. The main goal of the project is to design and implement algorithms for two essential steps of this analysis procedure: The detection of spots in a given gel image and the gel-matching (assignment of corresponding spots from different pictures).

Within the matching, geometric distortions, that appear when producing protein samples, are to be equilibrated. The corresponding algorithmic problem is a variation of 2-dimensional pattern recognition, where the main difficulty is produced by geometric distortion. The approach developed within this project makes use of methods and data structures of Computational Geometry. Some features of the matching algorithm are completely new (e.g. matching of images which overlap only partially).

In the meanwhile these algorithms have proved to be a suitable supplement for some existing gel analysis packages. In consequence, we signed a licensing agreement with Bio-Rad Laboratories on the integration and the further development of our algorithms.

- ECG – EFFECTIVE COMPUTATIONAL GEOMETRY FOR CURVES AND SURFACES financially supported by the European Community within the 5th framework programme

Participating scientists:	Helmut Alt, Günter Rote (project leaders)
	Christian Knauer
	Ulrich Kortenkamp
	Tobias Lenz
	Astrid Sturm
Duration of the project:	May 1st 2001 through April 30th 2004

ECG – Effective Computational Geometry for Curves and Surfaces is a continuation project of GALIA and CGAL. It is a joint project of six work groups in Sophia Antipolis (lead contractor), Zürich, Saarbrücken, Tel Aviv, Groningen and Berlin. The main subject are the special problems arising with the proper handling of curves and curved surfaces in computational geometry.

We revisit the field of Computational Geometry in order to understand how structures that are well-known for linear objects behave when defined on curves and surfaces.

Algebraic issues:

Several operations on nonlinear geometric objects, often lying at the algorithm's bottleneck, are equivalent to manipulating polynomials. A fundamental question is the solution of algebraic systems, ubiquitous in the construction of new objects, such as intersections. Another crucial goal is the implementation of primitives with Boolean or discrete output, such as an object is contained in some bounding object.

Robustness issues:

Geometric programs are notorious for their non-robustness: algorithms are designed for a model of computation where real numbers are dealt with exactly and geometric algorithms are frequently only formulated for inputs in general position. This is not simply an academic problem. It is easy to crash any commercial CAD-system. Progress has been made only in recent years. A significant part of the progress was made by the proposers and centers around the so-called exact computation paradigm. We extend this paradigm to curved objects.

Approximating curves and surfaces:

Since algorithms for curves and surfaces are more involved, more difficult to make robust and typically several orders of magnitude slower than their linear counterparts, there is a need for approximate representations. Our objective is to provide robust and quality guaranteed approximations of curves and surfaces.

Patricipating sites:

INRIA Sophia Antipolis - France (coordinator)
ETH Zürich - Switzerland
Freie Universität Berlin - Germany
Rijksuniversiteit Groningen - Netherlands
MPI Saarbrücken - Germany
Tel Aviv University - Israel
A follow-up project ACS (Algorithms for Complex Shapes) will start in 2005. The main research themes for ACS will be:
1. Shape representation, approximation, reconstruction, and matching;
2. Motion and evolution;
3. Algebraic methods (for shapes and motion);
4. Algorihms with certified results;

- RESEARCH TRAINING NETWORK "COMBINATORIAL STRUCTURE OF INTRACTABLE PROBLEMS"
  financially supported by the European Community within the 5th framework programme

Participating scientists:	Helmut Alt (subproject leader)
	Stefan Felsner
	Günter Rote
Scholarship holder:	Vincenzo Marra (until January 31st)
	Daniel Kral (since October 1st)
Duration of the project:	September 1st 2002 through August 31st 2006

This project is an international network aiming for improved mobility and cooperation between member sites in: Barcelona, Berlin, Bielefeld, Bordeaux, Budapest, Oxford, Patras, Pisa and Prague.
The general objective of the project is to build up a framework for the analysis of intractable combinatorial problems focused on the structural aspects of the problems. Toward this goal, we will merge techniques from algebra, logic, geometry, probability and statistical physics. The purpose of such a merging is to gain deeper insight on the intrinsic algorithmic difficulty for the solution of many classical problems in Combinatorics and Graph Theory. As a major breakthrough, the use of high-level mathematical techniques will provide the means to overcome complexity issues by finding approximate solutions based on the structural knowledge of the problems.
Scientific objectives:

- Identifying occurrences of hard instances of combinatiorial problems
- Development of structural approaches for the analysis of hard instances of combinatorial problems
- Development of approximate algorithms based on structural knowledge
- Applications to particular hard problems in combinatorics and graph theory

The subproject implemented at our site is entitled "Geometry and order"

To find or to improve a structure on (large) point sets is a general problem which comes up in various applications. A deeper understanding of the combinatorial structure of point sets, geometric graphs and triangulations carries the potential of opening such problems for further investigations with the powerful tools provided by other areas of mathematics.

- RESEARCH PROJECT F3 OF THE DFG RESEARCH CENTRE MATHEMATICS FOR KEY TECHNOLOGIES *Visualization of Algorithms*
  financially supported by the German Science Foundation (DFG).

Participating scientists:	Ulrich Kortenkamp (project leader)
	Enno Brehm
	Dirk Materlik
Duration of the project:	March 2002 through March 2006

Dynamic Geometry deals with the constructional aspects of drawings in a dynamic setup. Several dynamic geometry software systems (DGS) have been developed during the last decade that can handle two-dimensional geometric constructions, e.g. as done with ruler and compass. As opposed to traditional, non-computer-aided, drawings, a dynamic aspect is added to a construction: all steps of a construction are stored by the software and can be recalled for other positions of the base elements, making it possible to move points to other positions while maintaining the mathematical restrictions encoded in the construction.

While a standalone DGS applications in itself is extremely useful for exploring geometry interactively, it is easy to imagine applications which simply make use of a DGS for its own purposes as a tool for calculation and visualization, e.g. CAD systems but also tools for visualizing and animating algorithms.

- RESEARCH PROJECT PSEUDOTRIANGULIERUNGEN UND BEWEGUNGEN VON GELENKSSYSTEMEN (Pseudotriangulations and Motions of Frameworks)
  financially supported by the German Science Foundation (DFG)

Participating scientists:	Günter Rote (project leader)
	André Schulz
Duration of the program:	March 2003 through June 2005

A *pseudotriangulation* is a partition of a planar region into polygons with exactly three convex vertices and an arbitrary number of reflex vertices (*pseudotriangles*), see Figure 1. An important subclass are the *pointed* pseudotriangulations, where every vertex is incident to an angle $> 180°$. They have $n - 2$ pseudotriangles and $2n - 3$ edges, and this is the smallest possible number for a pseudotriangulation. This geometric structure plays an important role as a data structure for planning
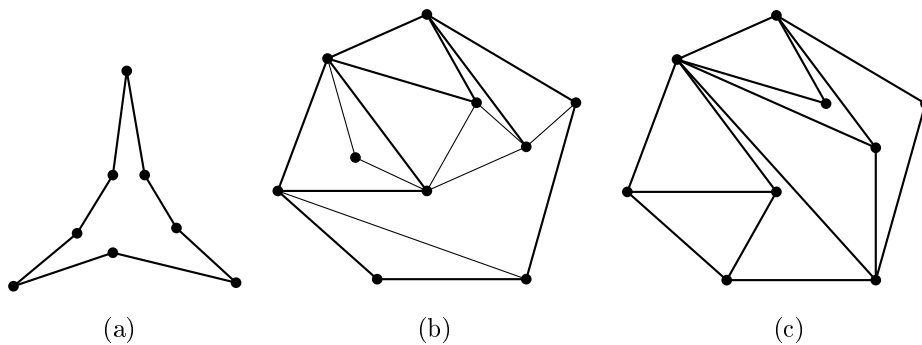
Figure 1: (a) a pseudotriangle (b) a pseudotriangulation (c) a pointed pseudotriangulation

collision-free paths among polyhedral obstacles and in planning non-colliding robot arm motion. Pseudotriangulations have many nice properties.

A *framework* consists of fixed-length bars (edges) which are connected by movable joints (vertices). Rigidity and flexibility of frameworks is a basic problem of mechanics (statics). Many questions about rigidity can be anwered on the basis of the combinatorial structure of the graph which underlies the framework. The Laman criterion (1971) characterizes minimally rigid frameworks in the plane:

> A *Laman graph* is a graph with n vertices and $2n - 3$ edges, such that every subgraph with $k \geq 2$ vertices contains at most $2k - 3$ edges.

These graphs are precisely the graphs which are rigid in any sufficiently "generic" embedding in the plane, but which become flexible after the removal of any edge, see Figure 2. Every pointed pseudotriangulation is a Laman graph, and the planar
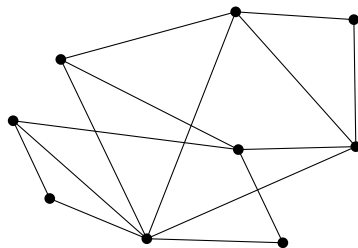

Figure 2: minimal rigid raph

Laman graphs are precisely the graphs which can be embedded as pointed pseudotriangulation.

The purpose of this project is to further explore the connections between pseudotriangulations and rigidity, in order to extend these structures to higher dimensions, and to get an improved understanding of three-dimensional rigidity.

- RESEARCH PROJECT VIRTUAL NAVIGATION IN FLUOROSCOPY BASED NEURO-SURGERY SYSTEMS
  financially supported by Schaerer-Mayfield-Technologies

Participating scientists:	Helmut Alt (project leader)
	Robert Günzler
	Frank Hoffmann
	Christian Knauer
	Klaus Kriegel
	Sven Schönherr
Duration of the program:	since May 2003

  Fluoroscopy is a widely-used imaging technique in neurosurgery. This especially applies to surgery in the region of the spinal column. However, the tradditional use of this technique (during the surgery) causes a considerable radiation exposure of both the surgeon and the patient. To avoid that, the following approach has been developed. In the initial phase of the surgery a few images are gathered as models of an anatomic region. These are snapshots with low radiation exposure. Later, during the surgery, real world data (positions in the operation field) are transformed and displayed into these models. The computation of the correct transformation is the principal aim of our project.
  We employ a 3d-tracking system, which is able to gauge positions in the operation field with high precision. The main idea consists in designing a special point cloud ("phantom") that has the following advantageous property: Any fluoroscopy image of the points allows to recompute the position of the phantom in the path of rays. We have incorporated two aspects in the design of the phantom. Firstly, one must be able to recognize the correct combinatorial matching between points in the image and phanton points. Secondly, the information about the points in the image must be sufficient to recompute the phantom position with high accuracy.
  In the medical application a sensor of the tracking system is fixed on the corresponding anatomic object (e.g. bone, vertebra). Only during the image aquisition phase the phantom is attached to the sensor. During the actual surgery one can simultaniously track the positions of an instrument in the operation field and of the fixed sensor. This way one gets the relative position of the instrument to the former phantom position, and thus, it is possible to transform and display the instrument into the model image.

4. **Publications and Lectures**

   (a) Publications in Journals (with a selection procedure)

   H. ALT, C. KNAUER, C. WENK. *Comparison of distance measures for planar curves.* Algorithmica, pp. 45–58, 2004

   H. ALT, C. KNAUER, G. ROTE, S. WHITESIDES. *On the Complexity of the Linkage Reconfiguration Problem.* Ed. J. Pach, Towards a Theory of Geometric Graphs, pp. 1–14, American Mathematical Society 2004.

   H. ALT, C. KNAUER, G. ROTE, S. WHITESIDES. *On the Complexity of the Linkage*

Reconfiguration Problem. Contemporary Mathematics, pp. 1–13, 2004.

P. BRASS, C. KNAUER. *Testing Congruence and Symmetry for General 3-dimensional Objects.* International Journal of Computational Geometry and Applications, Band 27, pp. 3–11, 2004.

A. EFRAT, F. HOFFMANN, C. KNAUER, K. KRIEGEL, G. ROTE, C. WENK. *Covering with Ellipses.* Algorithmica, Vol. 38, pp. 45–58, 2004.

R. HAAS, D. ORDEN, G. ROTE, F. SANTOS, B. SERVATIUS, H. SERVATIUS, D. SOUVAINE, I. STREINU, W. WHITELEY. *Planar minimally rigid graphs and pseudo-triangulations.* Computational Geometry, Theory and Applications, 2004.

C. KNAUER, H.-B. LINDEMANN, P. PFEIFFER. *Morphometric Relations between Tooth and Face Shapes.* Journal of Oral Rehabilitation, Band 31, pp. 972–978, 2004.

D. ORDEN, G. ROTE, F. SANTOS, B. SERVATIUS, H. SERVATIUS, W. WHITELEY. *Non-crossing frameworks with non-crossing reciprocals.* Discrete and Computational Geometry, Band 32, pp. 567–600, 2004.

A. RIBO MOR, M. NOY. *Recursively Constructible Families of Graphs.* In Special Issue on the Tutte Polynomial, Advances in Applied Mathematics, Band 32, pp. 350–363, Elsevier Science, Januar - Februar 2004.

(b) Publications in Conference Proceedings (with a selection procedure)

H. ALT, L. SCHARF. *Computing the Hausdorff distance between curved objects.* In Proceedings of the 20th European Workshop on Computational Geometry (EWCG), pp 223–236 Seville, Spain, 2004.

M. DE BERG, S. CABELLO, P. GIANNOPOULOS, C. KNAUER, R. VAN OOSTRUM, R. VELTKAMP. *Maximizing the Area of Overlap of two Unions of Disks under Rigid Motion.* In Proceedings of the 20th European Workshop on Computational Geometry (EWCG), pp. 73–76, Seville, Spain, 2004.

M. DE BERG, S. CABELLO, P. GIANNOPOULOS, C. KNAUER, R. VAN OOSTRUM, R. VELTKAMP. *Maximizing the area of overlap of two unions of disks under rigid motion.* In Proceedings of the 9th Scandinavian Workshop on Algorithm Theory (SWAT), pp. 138–149, Humlebaek, Denmark, 2004.

S. CABELLO, E. D. DEMAINE, G. ROTE. *Planar embeddings of graphs with specified edge lengths.* In Graph Drawing. GD 2003, Proceedings of the 11th International Symposium on Graph Drawing, Perugia, September 2003, Revised Papers, Lecture Notes in Computer Science, Band 2912, pp. 283–294, Springer-Verlag, 2004.

R. GÜNZLER, F. HOFFMANN, C. KNAUER, K. KRIEGEL, S. SCHÖNHERR U. WARSCHEWSKE. *Ein neues algorithmisches Verfahren zur Fluoroskopie-basierten Neuronavigation.* In Proceedings Workshop Bildverarbeitung für die Medizin (BVM) 2004, Springer, Berlin, Germany, 2004.

C. KNAUER, M. FELLOWS, N. NISHIMURA, P. RAGDE, F. ROSAMOND, U. STEGE, D. THILIKOS, S. WHITESIDES. *Faster Fixed-Parameter Tractable Algorithms for*

Matching and Packing Problems. Proceeding on the 12th Annual European Symposium on Algorithms (ESA), Bergen, Norwegen, 2004.

C. KNAUER, KYUNG-YONG CHWA, BYUNG-CHEOL JO, E. MOET, R. VAN OOSTRUM, CHAN-SU SHIN. *Guarding Art Galleries by Guarding Witnesses.* In Proceedings of the 20th European Workshop on Computational Geometry (EWCG), pp. 167–170, Seville, Spain. 2004.

C. KNAUER, KYUNG-YONG CHWA, BYUNG-CHEOL JO, E. MOET, R. VAN OOSTRUM, CHAN-SU SHIN. *Guarding Art Galleries by Guarding Witnesses.* In Proceedings of the The 15th Annual International Symposium on Algorithms and Computation (ISAAC), pp. 352–363, HKUST, Hong Kong, 2004.

C. KNAUER. *Similarity Search in Semialgebraic Pattern Spaces.* In Proceedings of the 20th European Workshop on Computational Geometry (EWCG), Seville, Spain, pp. 115–118, 2004.

G. ROTE. *Pursuit-evasion with imprecise target location.* In Proceedings of the 14th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA), Baltimore, pp. 747–753, 2004.

(c) Other Publications

H. ALT, J. DURAND-LOSE, EDS.. *Special Issue with selected contributions from STACS 2002.* Theory of Computing Systems, Band 37, 2004.

A. DUMITRESCU, G. ROTE. *On the Fréchet distance of a set of curves.* Proceedings of the 16th Canadian Conference on Computational Geometry, Montreal, 2004.

W. MULZER. *Umwegprobleme in Graphen und Polygonen.* Diplomarbeit, Institut für Informatik, Freie Universität Berlin, 2004.

L. SCHARF. *Computing the Hausdorff distance between sets of curves.* Diplomarbeit, Institut für Informatik, Freie Universität Berlin, January 2004.

(d) Technical Reports

B 04-15 DOCTORANDS OF COMPUTER SCIENCE. *2nd Doctorands'-Workshop, November 2004.* Institut für Informatik, Freie Universität Berlin.

(e) Lectures

HELMUT ALT
- *Geometric Methods in Shape Comparison and Matching*, Workshop "General Theory of Information Transfer and Combinatorics", Zentrum für interdisziplinäre Forschung, Bielefeld, April 28th.
- *A man, a dog, 2 Bernoullis, Euler, and Lagrange*, Korean Workshop on Computational Geometry, Schloss Dagstuhl, July 27th.
- *Voronoi Diagrams of Curves*, 4th Workshop on Combinatorics, Geometry, and Computing, Stels, Switzerland, October 4th through 7th.

- *Geometric Methods in Shape Comparison and Matching*, Workshop on Algorithms and Complexity, Bangalore, India, October 9th.

KEVIN BUCHIN
- *Insertion Orders for Incremental Construction of Delaunay Triangulations*, Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin, June 28th.
- *Locating Point Sets in Delaunay Triangulations*, 4th Workshop on Combinatorics, Geometry and Computating, Stels, Switzerland, October 4th through 7th.
- *Illustrating Terrains using Direction of Slope and Lighting*, 4th ICA Mountain Cartography Workshop, Vall de Núria, Catalonia, Spain, September 30th through October 2nd.
- *Inkrementelle Konstruktion der Delaunay Triangulierung von zufälligen Punkten*, 2. Doktoranden-Workshop des Instituts für Informatik der Freien Universitä Berlin, November 5th through 6th.

MAIKE BUCHIN
- *Discrete Approximation of the Fréchet Distance* Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin, June 5th.
- *On the Computability of the Fréchet Distance*, 4th Workshop on Combinatorics, Geometry, and Computation, Stels, Switzerland, October 4th through 7th.

BRITTA BROSER
- *Decidability in Dynamic Geometry*, 32. Berliner Algorithmen-Tag (BAT), Technische Universiät Berlin, July 12th.
- *Automated Deduction in Geometry*, Gainsville, Florida, USA, September 16th through 19th.
- *Algorithmen und Dynamische Geometrie*, 2. Doktoranden-Workshop des Instituts für Informatik der Freien Universitä Berlin, November 5th through 6th.

IVAN IZMESTIEV
- *On hull numbers of torus links*, Oberseminar Geometrie, Technische Universität Berlin, February 14th.
- *On the hull number of torus links*, Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin, November 1st.
- *On the hull number of torus links*, Seminar on Low-Dimensional Mathematics at POMI, St. Petersburg, December 24th.

OLIVER KLEIN
- *Lower bounds for shape matching with reference points*, Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin, May, 10th.
- *Lower Bounds for the Quality of Steiner Points and Shape Matching with Reference Points*, 4th Workshop on Combinatorics, Geometry, and Computation, Stels, Switzerland, October 4th through 7th.
- *Reference points and their applications for shape matching*, Colloquium of the Center for Geometry, Imaging and Virtual Environments (GIVE), Universiteit

Utrecht, The Netherlands, October 28th.

CHRISTIAN KNAUER
- *Similarity search in semialgebraic pattern spaces*, CG04, Sevilla, Spain, March 25th.
- *Counting dilation pairs*, Theory seminar, McGill University, Montreal Canada, September 22nd.

ARES RIBÓ MOR
- *The Maximum Number of Spanning Trees of a Planar Graph*, Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin , February 2nd.
- *1-D Self-Touching Configurations are Perturbable*, at the 4th CGC Workshop, Stels, Switzerland, October 4th through 7th.
- *The Maximum Number of Spanning Trees of a Planar Graph*, at the noon seminar of the Department of Discrete Mathematics of the Adam Mickiewicz University, Poznan, Poland, October 12th.
- *Advances in Counting Polyominoes on the Twisted Cylinder*, Colloquium of the graduate program *Combinatorics, Geometry, and Computation*, Freie Universität Berlin, November 8th.

GÜNTER ROTE
- *Computing the Fréchet distance between piecewise smooth curves*, 20th European Workshop on Computational Geometry, EWCG 2004, Seville, Spain, March 24th through 26nd.
- *Welche Kanten eines Würfels kann man sehen? (Which edges of a cube are visible?)*, Berliner MNU-Kongress (mathematics and science education), Technische Universität Berlin, September 2nd through 3rd.
- *How to unfold a carpenter's rule*, Technische Universität Graz, Austria, October 13th.

LUDMILA SCHARF
- *Computing the Hausdorff distance between curved objects*, EWGC 2004, Sevilla, Spain, March 24th through 26nd.

ANDRE SCHULZ
- *Optimierung über dem Polytop der gespitzten Pseudotriangulierungen (Optimization on the polytope of pointed pseudo-triangulations)*, FRICO 2004, Cottbus, September 24th

5. **Courses, Seminars, Exercises and Laboratories (WS 03/04 and SS 04)**

H. ALT, G ROTE, AND OTHER LECTURERS OF THE GRADUATE PROGRAM, *Lectures of the graduate program* Combinatorics, Geometry, and Computation, (winter semester 03/04).

H. ALT, *Entwurf und Analyse von Algorithmen (design and analysis of algorithms)*, course and exercises, (winter semester 03/04).

FRANK HOFFMANN, *Brückenkurs Mathematische Grundlagen für Bioinformatik und Nebenfach Informatik*, course and exercises, (winter semester 03/04).

FRANK HOFFMANN, *Mathematik für Informatiker I (Mathematics for computer scientists I)*, course and exercises, (winter semester 03/04).

IVAN IZMESTIEV, *Konvexe Geometrie (convex geometry)*, course and exercises, (winter semester 03/04).

C. KNAUER, *Ausgewählte Kapitel der Algorithmischen Geometrie (selected chapters of computational geometry)*, course and exercises, (winter semester 03/04).

K. KRIEGEL, *Mathematik für Informatiker III (Mathematics for computer scientists III)*, course and exercises, (winter semester 02/03).

K. KRIEGEL, *Informatik A*, course and exercises, (winter semester 03/04).

R ROTE, *Algorithmen und Programmierung III (algorithms and programming III)*, course and exercises, (winter semester 03/04).

H. ALT, C. KNAUER, K. KRIEGEL, G. ROTE, *Diplomanden- und Doktorandenseminar der Theoretischen Informatik (Seminar for M.S. and Ph.D. students in theoretical computer science)*, seminar, (winter semester 03/04).

F. HOFFMANN, *Seminar über on-line Bewegungsplanung (Seminar about on-line motion planning)*, seminar, (winter semester 03/04).

T. LENZ, R. ROTE, Praktikum *über Datenkompression (about data compression)*, seminar, (winter semester 03/04).

H. ALT, G. ROTE, AND OTHER LECTURERS OF THE GRADUATE PROGRAM, *Colloquium of the graduate program* Combinatorics, Geometry, and Computation, colloquium, (winter semester 03/04).

H. ALT, G. ROTE, AND OTHER LECTURERS OF THE GRADUATE PROGRAM, *Lectures of the graduate program* Combinatorics, Geometry, and Computation, (summer semester 04).

H. ALT, *Algorithmen für Fortgeschrittene (Algorithms for advanced)*, course and exercises, (summer semester 04).

F. HOFFMANN, *Mathematik für Informatiker II (Mathematics for computer scientists II)*, course and exercises, (summer semester 04).

C. KNAUER, *Grundlagen der Theoretischen Informatik (basics of theoretical computer science)*, course and exercises, (summer semester 04).

K. KRIEGEL, *Informatik B*, course and exercises, (summer semester 04).

R. ROTE, *Computergrafik*, course and exercises, (summer semester 04).

R. ROTE, *Gittererzeugung (mesh generation)*, course and exercises, (summer semester 04).

H. ALT, C. KNAUER, K. KRIEGEL, G. ROTE, *Diplomanden- und Doktorandenseminar der Theoretischen Informatik (Seminar for M.S. and Ph.D. students in theoretical computer science)*, seminar, (summer semester 04).

H. ALT, *Seminar über Algorithmen (Seminar about algorithms)*, seminar, (summer semester 04).

C. KNAUER, *Seminar über Algorithmische Geometrie (Seminar on computational geometry)*, seminar, (summer semester 04).

C. KNAUER, K. KRIEGEL, *Seminar über Navigationsalgorithmen für medizinische Anwendungen*, seminar, (summer semester 04).

H. ALT, L. SCHARF, Praktikum *zur Analyse von Formen*, (summer semester 04).

H. ALT, G. ROTE, AND OTHER LECTURERS OF THE GRADUATE PROGRAM, *Colloquium of the graduate program* Combinatorics, Geometry, and Computation, colloquium, (summer semester 04).

6. Diplomas

MARIA KNOBELSDORF.
Algorithmen zur Rekonstruktion glatter, geschlossener Kurven mit Schnittpunkten
(Algorithms for the reconstruction of smooth closed curves with intersection points)
Supervisor: Helmut Alt.

DIRK MATERLIK.
Skizzenerkennung zur Verbesserung der Benutzerschnittstelle interaktiver Geometriesoftware
(Sketch recognition improving the user interface of interactive geometry software)
Supervisor: Ulrich Kortenkamp.

WOLFGANG MULZER.
Graphentheoretische Dilatation von regulären n-Ecken
(Graph-theoretic dilation of regular n-gons)
Supervisor: Christian Knauer.

LUDMILA SCHARF.
Hausdorff-Abstand und Fréchet-Abstand von Spline-Kurven
(Hausdorff- and Fréchet distance of spline curves)
Supervisor: Helmut Alt.

7. Miscellaneous

HELMUT ALT
  – Speaker of the graduate program *Combinatorics, Geometry, and Computation.*
  – Speaker of the *Section Theoretical Informatics* (Fachausschuss Theoretische Informatik) of Gesellschaft für Informatik (GI).
  – Speaker of the Research Training Network *Combstru* in Berlin.
  – Member of the directorial board of *GIBU*(GI council of university professors).
  – Member of the Ph.D. committees for Martin Kutz and Felix von Hundelshausen.
  – Member of the commitee for the honorary Ph.D. award for Wilfried Brauer.
  – Chairman, search committee for teaching assistants.
  – Referee for DFG - Deutsche Forschungsgemeinschaft (German Science Foundation)
  – Referee for various journals and conferences

Britta Broser
– Coordination of the talks in the Noon Seminar.

Kevin Buchin
– Research stay at the Charles University Prague for attending the Doccourse Berlin - Prague 2004 from January 26th through March 2nd.

Maike Buchin
– Research stay at the Charles University Prague for attending the Doccourse Berlin - Prague 2004 from January 26th through March 2nd.

Frank Hoffmann
– Member of the committee for curriculum and examinations in computer science at the FU Berlin.
– Member of the committee for curriculum and examinations in computer science in bioinformatics at the FU Berlin.
– Member of the joint committee for bioinformatics at the FU Berlin.
– Member of the Ph.D. committee for Sven Rahmann.
– Referee for *Discrete Mathematics*.
– Referee for *International Journal Computational Geometry and Applications*.

Oliver Klein
– Research stay at the Charles University Prague for attending the Doccourse Berlin - Prague 2004 from January 26th through March 2nd.
– Research stay at Universiteit Utrecht, Institute of Information and Computing Sciences, Workgroup of Prof. Dr. Mark Overmars and Dr. Marc van Kreveld, Supervisor: Dr. Remco Veltkamp, since October 1st.

Christian Knauer
– Member of the search committee for a junior professorate in Didaktik der Informatik.
– Member of the committee for curriculum and examinations in computer science at the FU Berlin.
– Member of the program committee for SoCG 2004.
– Referee for the laboratory of Robert Günzler.
– Referee for the diploma thesis of Maria Knobelsdorf.
– Referee for the diploma thesis of Wolfgang Mulzer.
– Referee for the diploma thesis of Ludmilla Scharf.
– Referee for *Journal of Discrete Algorithms*.
– Referee for *Computational Geometry: Theory and Applications*.
– Referee for *COCOON*.
– Referee for *GD*.
– Referee for *Netherlands Organisation for Scientific Research (NWO)*.
– Referee for *Studienstiftung des deutschen Volkes*
– Organisation for the *Korean Workshop on Computational Geometry*.
– Organisation of the *2nd Doctorands'-Workshop*, Institut für Informatik, Freien Universität Berlin, November 5th through 6th.
– Proposal for the DFG-Project *Medizinische Navigation*.

KLAUS KRIEGEL
- Member of the tutor selection commitee.
- Referee for the journal *Operations Research*.
- Lecture about algorithms and data structures during the summer university, July 26th through August 8th.
- Proposal for the DFG-Project *Medizinische Navigation*.

ULRICH KORTENKAMP
- Visiting Professor at Technische Universität Berlin from April 1st through March 31st in the group of Prof. Günter M. Ziegler

TOBIAS LENZ
- Member of the institute council (Institutsrat) of computer science, Freie Universität Berlin.
- Member of the search committee for the position of a scientific assistant in theoretical computer science.
- Member of the tutor selection commitee.
- Referee for *SoCG 2005*.

ARES RIBÓ MOR
- Research stay at the Department of Discrete Mathematics of the Adam Mickiewicz University in Poznan, with Prof. Michal Karoński, October 1st through October 31st.

GÜNTER ROTE
- Editor of the journal *Computing*.
- Chairman of program committee for 21st Annual Symposium on Computational Geometry (SoCG), Pisa, June 2005.
- Chairman of the search committee for the position of a scientific assistant in theoretical computer science.
- Coordinator of the Erasmus/Socrates student exchange program for the departments of mathematics and computer science.
- Member of the selection committee for the position of professor in Computational Dynamics.
- Member of the Ph.D. committee for Ernesto Tapia
- Referee for the Ph.D. dissertation of Sergio Cabello (Utrecht)
- Referee for research review for *Netherlands Organisation for Scientific Research (NWO)*.
- Referee for the Conferences:
  ESA 2004, European Symposium on Algorithms.
  SoCG 2004, 20th Annual Symposium on Computational Geometry.
  STOC 2005, 37th ACM Symposium on Theory of Computing .
  SODA 2005, ACM-SIAM Symposium on Discrete Algorithms, January 2005, Vancouver.
  SWAT 2004, 9th Scandinavian Workshop on Algorithm Theory. July 8th through 10th.
  ISAAC 2004, 15th Annual International Symposium on Algorithms and Computation, Hongkong, December 20th through 22nd.

- Referee for the journals:
  Mathematical Programming, Applied Mathematics Letters, Discrete Mathematics, Discrete Optimization, Discrete and Computational Geometry.
- Coreferee for the diploma thesis of Marco Block
- Coreferee for the diploma thesis of Wolfgang Mulzer
- Research visit at TU Graz, Workshop on Pseudotriangulations, Austria, October 11th through 15th.

LUDMILA SCHARF
- Referee for *Computing*.

ANDRE SCHULZ
- Research visit at TU Graz, Workshop on Pseudotriangulations, Austria, October 11th through 15th.

Appendix:

Talks in the *Noon Seminar* 12.00 a.m.

January 6th: GÜNTER ROTE
Shapes for self-aligning micromechanical systems (MEMS)

January 8th: HELMUT ALT
Top-Down Analysis of Path Compression

January 13th: IVAN IZMESTIEV
Permanents: Van der Waerden conjecture and applications

January 15th: OLIVER KLEIN
The Centroid as a Reference Point for the Symmetric Difference in d Dimensions

January 16th: PETER BRASS
On simplices spanned by point sets

January 20th: FRANK HOFFMANN
How to explore rectilinear graphs

January 22nd: CLAUDIA KLOST
Computing the largest inscribed isothetic rectangle

January 27th: CHRISTIAN KNAUER
Guarding polygons by guarding witnesses

January 29th: ARES RIBÓ MOR
The Number of Spanning Trees of a Planar Graph

February 3rd: DIRK MATERLIK, DIPLOMVORTRAG
Skizzenerkennung zur Verbesserung der Benutzerschnittstelle interaktiver
Geometriesoftware

February 5th: GÜNTER ROTE
The flatness constant in the plane

February 10th: TOBIAS LENZ
An Old Algorithm For the Tree Isomorphism Problem and Practical Optimizations

February 12th: DARKO DIMITROV
Surface matching with characteristic points II

February 17th: ASTRID STURM
Ordered Stabbing

February 19th: HELMUT ALT
Fixed parameter tractability

February 24th: KLAUS KRIEGEL
On the two-watchtower problem

February 26th: ANDRE SCHULZ
A linear 5-Coloring Algorithm for Planar Graphs

March 2nd: IVAN IZMESTIEV
Minimizing the number of monochromatic rectangles in the grid and of 4-cycles in an edge-colored graph

March 4th: FRANK HOFFMANN
Guarded Guards

March 9th: CLAUDIA KLOST
Largest Empty Rectangle among a Point Set

March 11th: HOSAM ABDO
Exact volume computation for polytopes

March 16th:LUDMILA SCHARF
Efficient image retrieval through vantage objects

March 18th: CHRISTIAN KNAUER
Point set matching with k differences

March 23rd: OLIVER KLEIN
Factoring numbers in $O(\log n)$ arithmetic steps

March 25th: IVAN IZMESTIEV
Angle sum of a polytope: Gram's relation

March 30th: ARES RIBÓ MOR
Counting polyominos: a new lower bound for Klarner's constant

April 1st: MAIKE WALTHER
Factorising the cycle index of a transitive permutation group

April 6th: KEVIN BUCHIN
Central Limit Theorems for Euclidean Functionals

April 13th: TOBIAS LENZ
Simple Reconstruction of Non-Simple Curves (demonstrating Cinderella's new External Algorithm API)

April 15th: GÜNTER ROTE
Lower bound on the dilation of graphs in the plane

April 20th: MARTIN KUTZ
Angels on the Run

April 22th: KLAUS KRIEGEL
Approximation of the shortest watchman tour in rectilinear graphs

April 27th: ANDRE SCHULZ
Threshold Arrangements and the Knapsack Problem

April 29th: HELMUT ALT
A Man, a Dog, 2 Bernoullis, Euler, and Lagrange

May 4th: BRITTA BROSER
Tarski-Formulas: An Overview

May 6th: FRANK HOFFMANN
Exploring Trees with Little Memory

May 11th: DARKO DIMITROV
Softassign Point Matching

May 13th: HOSAM ABDO
Polyhedron Volume Computations and Cayley-Menger Determinant

May 18th: ESTHER MOET
Region inter-visibility in terrains

May 27th: OLIVER KLEIN
Topological Sweeplines and Horizon Trees

June 1st: LUDMILA SCHARF
On Finding a Guard that Sees Most and a Shop that Sells Most

June 3rd: ARES RIBÓ MOR
Schlegel Diagrams for 4-Polytopes

June 8th: MAIKE WALTHER
Discrete Approximation of the Fréchet Distance

June 10th: CLAUDIA KLOST
Symmetry detection in the plane

June 15th: KLAUS KRIEGEL
On Pseudo - Visibility Graphs

June 17th: IVAN IZMESTIEV
Reconstruction of a polytope from unfolding: a variational approach to the Alexandrov Theorem

June 22nd: TOBIAS LENZ
About Italy, 4-bed rooms, progressive level of detail representations, mesh (and bus passenger) compression and a lot of Pizza

June 24th: KEVIN BUCHIN
Walking in Delaunay Triangulations

June 29th: JEAN-DANIEL BOISSONNAT
The complexity of the Delaunay triangulation of points on a surface, and Moebius diagrams

July 1st: ANDRE SCHULZ
On the diameter of the PPT polytope

July 6th: HELMUT ALT
Voronoi Diagrams for Sets of Curves II

July 8th: FRANK HOFFMANN
Pushing Squares Around

July 13th: DARKO DIMITROV
Surface matching with constant approximation factor

July 15th: GÜNTER ROTE
The plane cannot be tiled by disks, even approximately

July 20th: CHRISTIAN KNAUER
Dictionaries that support deletemin in O(1) time

July 22nd: OLIVER KLEIN
Matching point sets in three dimensions

August 10th: IVAN IZMESTIEV
On the hull number of torus links

August 12th: GÜNTER ROTE
Almost tiling the plane by circular discs

August 17th: BRITTA BROSER
Configuration Spaces of Mechanical Linkages

August 19th: ARES RIBÓ MOR
Locked und Unlocked Chains of Planar Shapes

August 24th: CLAUDIA KLOST
Continuous Symmetry Measures

August 26th: HELMUT ALT
Smallest enclosed rectangles

August 31st: LUDMILA SCHARF
Approximation of Spatial Polygonal Curves by G^1 Arc Splines

September 2nd: KEVIN BUCHIN
Intersecting Delaunay Triangulations near the Boundary

September 7th: WOLFGANG MULZER
The Graph-Theoretic Dilation of Fat Planar Point Sets

September 9th: MAIKE BUCHIN
Ambient Isotopic Approximation of 2-Manifolds

September 14th: TOBIAS LENZ
Sampling: ε-sampling is not THE genuine truth

September 16th: KLAUS KRIEGEL
On Compact Representations of Visbility Graphs

September 21st: ANDRE SCHULZ
On embedding stacked 3-polytopes on the 3d grid

September 23th: HOSAM ABDO
Volume computation of the spherical polyhedron

September 28th: FRANK HOFFMANN
Rectilinear Art Galleries Revisited

September 30th: OLIVER KLEIN
The Steiner Point as a Reference Point: A Convex Lower Bound

October 12th: IVAN IZMESTIEV
Covering a complete graph by (not too large) complete subgraphs

October 14th: CHRISTIAN KNAUER
Counting dilation pairs

October 19th: MARIA KNOBELSDORF, DIPLOMVORTRAG
Algorithmen zur Rekonstruktion glatter, geschlossener Kurven mit Schnittpunkten
(Algorithms for the reconstruction of smooth closed curves with intersection points)

October 21st: WOLFGANG MULZER, DIPLOMVORTRAG
Graphentheoretische Dilatation von regulären n-Ecken
(Graph theoretic dilation of regular n-gons)

October 26th: PANOS GIANNOPOULOS
Minimizing the transportation distance for points in the plane under rigid motions

October 28th: DARKO DIMITROV
Interference detection of convex objects

November 2nd: VLADLEN KOLTUN
Pianos are not Flat: Rigid Motion Planning in Three Dimensions

November 4th: GÜNTER ROTE
Counting Pseudotriangulations

November 9th: CLAUDIA KLOST
The Seven Frieze Groups

November 11th: HELMUT ALT
Shape Fitting by Core Sets

November 16th: RENE VAN OOSTRUM (UNIVERSITÄT UTRECHT)
Flying Buckets and Applications

November 18th: ESTHER MOET
Weak Intervisibility in Terrains

November 23th: BRITTA BROSER
A certain geometric configuration

November 25th: GÜNTER ROTE
Counting Pseudotriangulations

November 30th: KEVIN BUCHIN
A Collection of Linear Expected Time Delaunay Triangulation Algorithms

December 2nd: LUDMILA SCHARF
Three Heuristics for Shape Matching

December 7th: TOBIAS LENZ
Dynamic Closest Pair Maintenance

December 9th: MAIKE BUCHIN
On the Computability of the Fréchet Distance Between Surfaces

December 14th: ARES RIBÓ MOR
1D self-touching configurations are perturbable

December 16th: RAÚL ROJAS
Geometric Problems in Robotics of Soccer

December 21st: WOLFGANG MULZER
SL=L