Semester Report SS05 of Kevin Buchin

Name:	Kevin Buchin
Supervisor:	Günter Rote
Field of Research:	Computational Geometry
Topic:	Geometric Structures on Point Sets, Probabilistic Analysis of Geometric Algorithms, Space-Filling Curves
PhD Student	in the program since May 2003

Field of Research and Results

Until May I visited the *Theory of Combinatorial Algorithms* group of Prof. Emo Welzl at the ETH Zurich. With Dr. Joachim Giesen I worked on the *flow complex*, a topological complex defined by a set of points.

The flow complex is a data structure, similar to the Delaunay triangulation, to organize a set of possibly weighted points in $\mathbb{R}^d$. It is a cell complex based on the flow in the direction of the steepest ascent of the power distance function to the given set of points. Its structure has been examined in detail in two and three dimensions but only little was known about its structure in general.

We worked on a general algorithm for computing the flow complex in any dimension. A property of this algorithm is that it reflects the recursive structure of the flow complex. We used the algorithm to generalize and simplify the proof of the homotopy equivalence of alpha- and flow-shapes previously known in three dimensions.

The results we have so far, I will present at the Canadian Conference on Computational Geometry in August. Open problems we are now considering are bounds on the complexity of the complex in dimensions higher than two and an algorithm for computing the combinatorial structure of the complex.

I implemented the incremental construction of Delaunay triangulations along space-filling curves with CGAL. The algorithm works also on non-uniform data and in three dimensions surprisingly well. I am therefore interested in giving an analysis for non-uniform point distributions, e.g the normal distribution. I am also planning to integrate the ordering along space-filling curves into CGAL.

Activities

Talks

- *Incremental Construction along Space-Filling Curves*
  European Workshop on Computational Geometry in Eindhoven, the Netherlands, March 9, 2005

- *Incremental Construction along Space-Filling Curves*
  Noon Seminar of the Theory of Combinatorial Algorithms group at the ETH Zurich, April 7, 2005

- *Tropical Mathematics*
  Noon Seminar of Theoretical Computer Science at the FU Berlin, June 7, 2005

- *The Flow Complex: General Structure and Algorithm*
  Noon Seminar of the Theory of Combinatorial Algorithms group at the ETH Zurich, July 8, 2005

- *The Flow Complex: General Structure and Algorithm*
  CGC-Colloquium at the FU Berlin, July 11, 2005

Attended workshops and schools

- *Spring School on Computational Geometry*
  in Eindhoven, the Netherlands, March 7 and 8, 2005

- *21st European Workshop on Computational Geometry*
  in Eindhoven, the Netherlands, March 9 to 11, 2005

- *Spring School on Enumerative Combinatorics*
  in Netzeband, June 1 to 4, 2005

- *3rd Gremo's Workshop on Open Problems*
  in Kappel am Albis, Switzerland, July 4 and 5, 2005

Attended lectures and seminars

- *Noon Seminar* of the Theory of Combinatorial Algorithms group at the ETH Zurich, until May 12, 2005
- *Lecture Approximate Methods in Geometry* by Bernd Gärtner, Joachim Giesen and Emo Welzl at the ETH Zurich, March 29 to May 12, 2005
- *Lecture Computational Algebraic Geometry* by Bernd Sturmfels at the ETH Zurich, April 6 to May 12, 2005
- *Monday Lectures and Colloquia* of CGC in Berlin since May 17, 2005
- *Noon Seminar* of Theoretical Computer Science at the FU Berlin since May 17, 2005

Preview

In August I will attend the *Canadian Conference on Computational Geometry* and present the work I did with Joachim Giesen at the ETH Zurich. After the Conference I will visit Carola Wenk at the University of Texas at San Antonio for two weeks. I will participate in the GI-Dagstuhl Research Seminar *Algorithms for Sensor and Ad Hoc Networks* in November.