Fields Workshop on Discrete and Computational Geometry

(Program)

Carleton University, Ottawa, July 31-August 4, 2017

Overview

At this five-day workshop, a group of 30-35 researchers will work on open problems in the area of discrete and computational geometry. The main focus of the workshop is in the design and analysis of algorithms and data structures to solve problems on geometric structures.

Organizers

Ahmad Biniaz, Prosenjit Bose, Jean-Lou De Carufel, Vida Dujmović, Anil Maheshwari, Pat Morin, Michiel Smid, and Sander Verdonschot.

Invited Speakers

Adrian Dumitrescu	University of Wisconsin-Milwaukee
John Iacono	New York University
Elmar Langetepe	University of Bonn
Wolfgang Mulzer	Freie Universität Berlin
Csaba D. Tóth	California State University Northridge
Paz Carmi	Ben-Gurion University of the Negev
Wouter Meulemans	Technische Universiteit Eindhoven
Karim Abu-Affash	Shamoon College of Engineering

Confirmed Participants

Karim Abu Affash, Anthony D'Angelo, Yeganeh Bahoo, Luis Barba, Ahmad Biniaz, Prosenjit Bose, Pilar Cano, Paz Carmi, Jean-Lou De Carufel, Farah Chanchary, Vida Dujmović, Adrian Dumitrescu, Darryl Hill, John Iacono, Kshitij Jain, Elena Khramtcova, Bahram Kouhestani, Elmar Langetepe, Anna Lubiw, Anil Maheshwari, Saeed Mehrabi, Wouter Meulemans, Pat Morin, Debajyoti Mondal, Wolfgang Mulzer, Tim Ophelders, Claire Pennarun, Michiel Smid, Khadijeh Sheikhan, Luís Fernando Schultz Xavier da Silveira, Csaba D. Tóth, Sander Verdonschot.

Tentative Schedule

Monday July 31

09:00	Invited talk (Adrian Dumitrescu)
10:00	Break
10:30	Open problems session
12:00	Lunch (on own)
14:00	Invited talk (Wolfgang Mulzer)
15:00	Break

15:30	Group work session
16:30	End of the first day

Tuesday August 1

09:00	Invited talk (John Iacono)
10:00	Break
10:30	Group work session
12:00	Lunch (on own)
14:00	Invited talk (Elmar Langetepe)
15:00	Break
15:30	Group work session
16:30	End of the second day

Wednesday August 2

09:00	Invited talk (Csaba D. Tóth)
10:00	Break
10:30	Group work session
12:00	Lunch (on own)
14:00	Invited talk (Paz Carmi)
15:00	Break
15:30	Group work session
16:30	End of the third day

Thursday August 3

09:00	Invited talk (Wouter Meulemans)
10:00	Break
10:30	Group work session
12:00	Lunch (on own)
14:00	Invited talk (Karim Abu Affash)
15:00	Break
15:30	Group work session
16:30	End of the fourth day

Friday August 4

09:00	Group work session
10:00	Break
10:30	Wrap-up session
12:00	End of the workshop

Abstracts of Talks

Adrian Dumitrescu: Geometric spanners

Given a planar point set S, what does a good transportation network connecting these points look like? It all depends on one's requirements, so the answer may be not unique. A survey of plane geometric spanners is provided together with open problems envisioned by users and designers.

Wolfgang Mulzer: Computational geometry with limited work-space: state of the art and challenges

Over the last few years, the study of geometric algorithms with bounded work-space has seen tremendous growth. New techniques have been developed for algorithms that use a constant amount of constant work-space, and general methods for time-space trade-offs have been devised. I will sketch some of these recent developments, and I will mention directions for future research.

Based on joint work with many people, in particular Tetsuo Asano, Bahareh Banyassady, Matias Korman, Andre van Renssen, Marcel Roeloffzen, Paul Seiferth, and Yannik Stein

John Iacono: Recent progress on 3SUM, 3POL, $X+Y$ and related geometric problems

Elmar Langetepe: Firefighting in discrete and continuous models

Regarding recent news from the south of Europe or the west of Northern Amerika efficient firefighting and fire protection is still a very important but also very difficult task. In this talk we present pure theoretical results for some discrete and continuous models of firefighting. The talk will provide some overview of existing results for area fire and also aims to give some insight in the corresponding very different proof ideas and techniques. We mainly focus on the influence of the speed difference between fire expansion and fire protection and we are searching for lower and upper bounds. Furthermore, we weave in some of our own recent approaches and contributions to the subject and mention interesting challenges. It seems that also the use of evolutionary strategies might help to support the theoretical analysis.

Csaba D. Tóth: Weakly simple polygons: recognition and reconstruction

In applications in clustering, cartography, and visualization, nearby vertices and edges are often bundled to a common node or arc, due to data compression or low resolution. This raises the computational problem of deciding whether a given mapping of a graph into the plane can be perturbed into a proper embedding, in which the vertices are represented by distinct points and the

edges by interior-disjoint Jordan arcs between the corresponding vertices.
We present efficient algorithms for several variants of this problem. A recognition algorithm determines in $O(n \log n)$ time whether a piece-wise linear map of a given graph can be perturbed into an embedding by any $epsilon>0$. In the reconstruction problem, we are given m line segments in the plane, and ask whether the segment endpoints can be perturbed by at most epsilon, for any $epsilon>0$, to obtain a planar straight-line graph. We show that the problem is NP-complete in general, and we give $O(m)$-time algorithms in the special case: when all segments are collinear, or the set of segment endpoints are in general position. (Joint work with Hugo Akitaya.)

Karim Abu-Affash: Connected unit disk subgraphs of diameter k

Wouter Meulemans: Computational Geovisualization

Visualization, by its geometric nature, is a field rich of inspiration for computational-geometry problems and geometric algorithms may often find applications in visualization. I will discuss several recent results that relate to geovisualization, that is, visualizing data in a geographic context. Emphasis will lie with visualization of data where geographic accuracy is not the primary concern, but is not fully discarded either.

Paz Carmi: d-Greedy t-spanner

We introduce a new geometric spanner, d-greedy, whose construction is based on a generalization of the known path-greedy and gap-greedy spanners. The d-greedy spanner combines the most desirable properties of geometric spanners both in theory and in practice. More specifically, it has the same theoretical and practical properties as the path-greedy spanner: a natural definition, small degree, linear number of edges, low weight, and strong $(1+epsilon)$-spanner for every $epsilon>0$. The d-greedy algorithm is an improvement over the path-greedy algorithm with respect to the number of shortest path queries and hence with respect to its construction time. We show how to construct such a spanner for a set of n points in the plane in $O(n^2 \log n)$ time.
The d-greedy spanner has an additional parameter, d, which indicates how close it is to the path-greedy spanner on the account of the number of shortest path queries. For $d = t$ the output spanner is identical to the path-greedy spanner, while the number of shortest path queries is, in practice, linear.
Finally, we show that for a set of n points placed independently at random in a unit square the expected construction time of the d-greedy algorithm is $O(n \log n)$. Our analysis indicates that the d-greedy spanner gives the best results

among the known spanners of expected $O(n \log n)$ time for random point sets. Moreover, analysis implies that by setting $d = t$, the d-greedy algorithm provides a spanner identical to the path-greedy spanner in expected $O(n \log n)$ time.