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Guest Editor's Foreword

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The 25th Annual Symposium on Computational Geometry took place at Aarhus University in Aarhus, Denmark, in June 2009. The conference program was very strong; from that program I have selected nine outstanding papers for presentation in this special issue. The papers were revised and carefully reviewed according to the high standards of *Discrete & Computational Geometry*.

The nine papers in this issue reflect the diversity of the field of computational geometry: they include algorithmic and lower bound results, practical algorithms with experimentally verified performance and deep explorations of the boundaries of Asymptopia, results for the plane and for high-dimensional spaces, and topics ranging from classical convex hulls to rigidity theory to topological persistence. Several of the papers describe significant breakthroughs, resolving long-open questions in their areas.

Andrea Vattani analyzes the performance of the popular k-means algorithm. Although the algorithm works well in practice, Vattani shows that there are configurations of input points that require exponentially many iterations for the algorithm to converge, even in the plane. Vattani's lower bound strengthens previous bounds substantially, from $2^{\Omega(\sqrt{n})}$ to $2^{\Omega(n)}$.

Csaba Tóth resolves a long-standing open problem about the worst-case complexity of planar binary space partitions (BSPs). For any set of disjoint line segments in the plane, Tóth shows how to construct an autopartition (a BSP built by extending the given segments) whose total complexity is $O(n\frac{\log n}{\log\log n})$. This upper bound matches the lower bound for the problem and settles a question that had been open for 20 years.

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Katoh and Tanigawa prove the "molecular conjecture," thus settling a classic problem in rigidity theory that had been open for more than 25 years. The conjecture (now a theorem) says that a generically rigid body-and-hinge framework remains rigid even if the assumption of general position is weakened by constraining all the hinges for each body to lie in the same hyperplane. The molecular conjecture had previously been proven in the two-dimensional special case; this paper establishes the result for general dimensions.

Chin, Guo, and Sun prove that the Minimum Manhattan Network problem is NP-complete. A t-spanner for a planar point set T is a network G such that the shortest path in G between any two points $p, q \in T$ has length at most t times the distance between p and q. If the distance metric is Euclidean, then a 1-spanner is the complete graph. However, if the distance metric is L_1 (and G is restricted to have only Manhattan edges) then the total length of a 1-spanner may be less than that of the complete graph. This paper shows that finding the shortest Manhattan 1-spanner is NP-complete, settling a more than ten year old question.

Abam and de Berg also consider spanners, but from the perspective of kinetic data structures (KDSs). They show that a $(1+\epsilon)$-spanner can be maintained efficiently for a set of n points moving in $\Re^d$. The number of combinatorial changes to the spanner is near optimal; data structure updates and flight plan changes take only polylogarithmic time. Unlike previous KDSs, the performance of this data structure does not depend on the spread of the points.

de Silva, Morozov, and Vejdemo-Johansson introduce circular functions into the framework of nonlinear dimensionality reduction algorithms. Even when high-dimensional nonlinear data contain simple linear structures, those structures may require more than one dimension to represent. This work uses persistent cohomology to recognize circular structures (the simplest case of this phenomenon) and produce a low-dimensional representation for them.

Lin and Yap address the problem of approximating a nonsingular curve in the plane when the curve is represented implicitly. Their scheme combines two ideas from earlier work, parametrizability and nonlocal isotopy, to produce an algorithm whose performance far exceeds that of its predecessors.

Chazelle and Mulzer consider a suite of problems involving computing three-dimensional convex hulls of subsets of the vertices of a known convex polyhedron. They show that these *hereditary convex hull* problems can often be solved faster than computing the convex hull of the subset from scratch. In particular, if a convex polyhedron has n vertices, the convex hull of any subset of its vertices can be found in $O(n)$ time: embedding a set of points in a larger polyhedron circumvents the $\Omega(n \log n)$-hardness of the convex hull problem.

Afshani, Hamilton, and Zeh present the first lower bound result separating the performance of I/O-efficient algorithms and cache-oblivious algorithms. Cache-oblivious algorithms must be able to handle any memory hierarchy efficiently, while I/O-efficient algorithms are tuned to a particular memory hierarchy. This paper shows that this difference has consequences: cache-oblivious range reporting with optimal queries requires strictly more space than an I/O-efficient algorithm.

I am grateful to the authors and the referees for their hard work in bringing this special issue to fruition. Many of these papers are substantial improvements over the already-excellent versions presented in the conference, and this is due to the diligence, commitment, and energy of the authors and referees.

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