Guest Editor's Foreword

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The 26th Annual Symposium on Computational Geometry was held at Snowbird, Utah, from June 13–16, 2010. The conference program, consisting of 47 strong papers from a total of 145 submissions, was chosen by an international program committee that I had the honor to chair.

In consultation with the program committee, I invited several papers to be submitted in revised and expanded form to this special issue of *Discrete and Computational Geometry*. This continues a long-standing tradition of featuring, in special issues of leading journals devoted to research in computational geometry, a selection of what were viewed as the most significant among the conference papers; another special issue of *Computational Geometry: Theory and Applications* contains a further selection of papers. All submissions were carefully refereed and revised in accordance with the high standards of *Discrete and Computational Geometry*.

The five papers in this collection reflect the breadth and maturity of the field of discrete and computational geometry. They include algorithms and lower bounds and reveal rich connections with topology and combinatorial geometry.

Simplex range searching has been a major topic in computational geometry, the subject of numerous papers and an important component of many geometric algorithms. The paper “Optimal partition trees”, by Timothy Chan, presents a new method for constructing partition trees, one of the main tools in simplex range searching. Chan’s method combines several previous ideas and techniques (the reweighting method for converting average-case to worst-case bounds on crossing numbers, employing cuttings, using arrangement vertices as an accounting device) in an ingenious way that is both simpler and more powerful than in preceding work. The result are

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asymptotic bounds on space, query time and preprocessing time that are the best known and conjectured to be optimal.

Halfspace range searching, another building block in simplex range searching, takes a weighted set of points in $\mathbb{R}^d$ and asks for the total weight of points contained in a query halfspace. The paper “Tight lower bounds for halfspace range searching”, by Sunil Arya, David Mount and Jian Xia, establishes new lower bounds, on halfspace range query time as a function of space, in the semigroup arithmetic model, where weights are drawn from a commutative semigroup. For integral semigroups, the new lower bound matches an existing upper bound up to polylogarithmic factors. For general semigroups, the new lower bound improves a lower bound dating to 1993, and it matches the best known upper bound in the special case of idempotent semigroups when points are uniformly distributed in a cube.

The paper “Consistent digital line segments”, by Tobias Christ, Dömötör Pálvölgyi and Miloš Stojaković, presents a new scheme for digitization of line segments in the plane that satisfies a natural set of axioms that translate properties of Euclidean line segments into digital geometry. The scheme, based on a novel connection between consistent digital line segments and total orders on the integers, produces digital line segments whose Hausdorff distance from the original logarithmic in the segment length, which is asymptotically optimal. The result extends and generalizes the result of Chun–Korman–Nöllenburg–Tokuyama, presented at SoCG 2008, and settles in an affirmative manner the main open question raised in that earlier work.

Questions relating to the combinatorial complexity of free lines and maximal free line segments in the presence of obstacles in $\mathbb{R}^3$ play an important role in characterizing the complexity of visibility problems and have been the subject of extensive study in the past two decades. The paper “On the complexity of sets of free lines and line segments among balls in three dimensions”, by Marc Glisse and Sylvain Lazard, resolves two important open questions in this family, when the obstacles are unit balls. Specifically, (i) the set of lines avoiding unit balls can have cubic complexity, and (ii) the set of maximal segments avoiding unit balls can have quartic complexity. The first result almost matches the recent $O(n^{3+\epsilon})$ upper bound of Rubin, and the second shows, somewhat surprisingly, that the known quartic worst case complexity bound for obstacle-avoiding segments holds even when the obstacles are unit balls.

The paper “Linkless and flat embeddings in the 3-space”, by Ken-ichi Kawarabayashi, Stephan Kreutzer and Bojan Mohar, addresses the problem of constructing piecewise-linear embeddings of graphs in $\mathbb{R}^3$. More specifically, they consider the construction of embeddings in $\mathbb{R}^3$ that are linkless (no two disjoint cycles form a non-trivial link). In 1995, Robertson and Seymour proved that (i) there is a polynomial-time (now linear-time) algorithm, based on forbidden minors, for recognizing linklessly embeddable graphs, and (ii) if a graph has a linkless embedding it has a flat embedding, an embedding that makes its linklessness explicit. Van der Holst provided a polynomial (but $\Omega(n^5)$) time algorithm that constructs a linkless, but not necessarily flat, embedding, if one exists. The paper of Kawarabayashi, Kreutzer and Mohar provides an $O(n^2)$ algorithm to produce a flat (and hence linkless) embedding, strengthening van der Holst’s result and resolving a question posed by Lovasz.

I acknowledge with thanks the diligence, commitment and energy of the authors and the referees without which this special issue would not have been possible.