Tiziana Calamoneri
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Preface

The 6th International Conference on Algorithms and Complexity (CIAC 2006) was held in Rome, Italy during May 29–31, 2006. These proceedings contain all contributed papers presented at CIAC 2006, together with the invited lectures delivered at the conference. The Program Committee consisted of:

- Nicola Galesi, Univ. of Rome "La Sapienza", Italy
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In response to a call for papers, the Program Committee received 80 submissions, and selected 33 papers for inclusion in the scientific program. In addition to the contributed papers, Kurt Mehlhorn (MPI, Germany), Franco P. Preparata (Brown Univ., USA) and Pavel Pudlák (Academy of Sciences, Czech Republic) were invited to give plenary lectures at the conference. All the work of the Program Committee was done electronically. The selection was based on originality, quality and relevance to theoretical computer science. The submissions were refereed as carefully as time permitted; it is expected that many of them will appear in a more polished form in scientific journals in the future.

We wish to thank all authors who submitted papers for consideration, the Program Committee for its hard work, as well as those external reviewers who assisted the Program Committee in the evaluation process. A special thanks to the Organizing Committee for a very dedicated work.

May 2006

Tiziana Calamoneri
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Reliable and Efficient Geometric Computing*

Kurt Mehlhorn

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Reliable implementation of geometric algorithms is a notoriously difficult task. Algorithms are usually designed for the Real-RAM, capable of computing with real numbers in the sense of mathematics, and for non-degenerate inputs. But, real computers are not Real-RAMs and inputs are frequently degenerate.

In the first part of the talk we illustrate the pitfalls of geometric computing by way of examples [KMP+04]. The examples demonstrate in a lucid way that standard and frequently taught algorithms can go completely astray when naively implemented with floating point arithmetic.

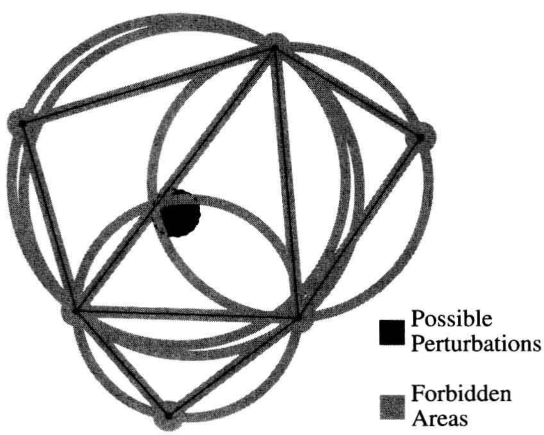

Fig. 1. The figure illustrates the concept of controlled perturbation for an incremental Delaunay diagram algorithm. A diagram of six points is already constructed and a seventh point t is to be inserted. The point is replaced by a random point t' in a δ disk centered at t. When t' is inserted, it is subject to sidedness tests with respect to edges of the current diagram and incircle tests with respect to faces of the current diagram. Each edge and each face defines a forbidden region for t'. The forbidden region is either a strip around the edge or an annulus around a circle. If t' lies outside the forbidden regions, the floating point evaluation of the geometric predicates gives the correct results. It is also necessary to guarantee a certain minimal distance between any pair of perturbed points.

In the second part of the talk, we discuss approaches to reliable and efficient geometric computing, in particular the controlled or active perturbation

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approach introduced by D. Halperin and co-workers [HS98, HR, HL03]. It proposes to slightly perturb the given input in a carefully chosen way so as to avoid degeneracies and so as to reduce the arithmetic demand. The exact solution on the perturbed input (not the original input!) is then computed. The scheme only applies when an approximate result suffices. This is the case whenever inputs are only approximately known.

We build on the work of Halperin et. al. and show that controlled perturbation is a general and simple technique for making a large class of geometric algorithms reliable. We also quantify the relation between the amount of perturbation and the precision of the floating point system. We exemplify the method on examples [FKMS05, MO]. Figure 1 illustrates the technique for the case of a Delaunay diagram computation.

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Beware of the Model: Reflections on Algorithmic Research

Franco P. Preparata

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Over the past four decades the design and analysis of algorithms has been a vibrant area of computer science research, since it was early realized that adoption of a superior algorithm could achieve accelerations unattainable by conceivable technological improvements.

Evaluation of the performance of algorithms must dispense with the details of different platforms and refer to a sort of abstract machine that effectively captures the important features of concrete computers. This abstraction is the computation model, which is intended to be simple to ease formal analysis but at the same time reflective of reality to afford reliable predictions. Indeed, the dialectics of simplicity and reflectivity is the essence of model development.

The Random-Access-Machine (RAM) is the standard model of the sequential processor, and its simplicity has unleashed vigorous algorithmic research. However, simplification means selection of features to be represented in the model, so that details originally judged secondary or irrelevant are likely to reassert their significance when, under the pressure of technological innovations, the model reaches beyond its intended confines.

The first danger is that a model may take a life of its own, thereby becoming itself the reality and defining the "rules of the game". An obvious illustration of this potential danger is the occasional misuse of the "asymptotic-analysis viewpoint", whereby some algorithms declared "optimal" are unlikely to be ever translated into programs. However, there are more subtle shortcomings. Indeed, being remiss in critically scrutinizing the applicability of the model to specific situations may be the source of very serious disappointments. There are several such incidents in the history of algorithmic research. A sample is described below:

1. Computational Geometry adopted (with not much scrutiny) the model of the *real-RAM*, obtained by endowing the RAM with real-number (exact) arithmetic. Inaccurate results may result fatal in the evaluation of the sign of predicates. For example, the efficient BentleyOttmann algorithm for reporting the intersections of a set of segments in the plane, involves a predicate represented by the sign of a thirddegree polynomial in the coordinates. Inaccuracies may invalidate the result. The shortcoming may be avoided, however, by adding integer arithmetic capabilities of specified degree to the original RAM model, i.e., by adopting a sort of the bounded-degree-RAM.

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2. The feasibility of parallel computation posed the question of the corresponding model. The discussion centered on the interconnection of modules of the RAM type and an important performance goal was the achievementt of polylog-time computations (NC-class). As usual, processing elements were assumed to have unit-time arithmetic capabilities. In this context, Csanky's algorithm, achieving $O(\log^2 n)$ time for matrix inversion, was an exhilarating surprise. A closer look reveals that, since approximate arithmetic is not known or likely to be applicable to Csanky's method, integer arithmetic requires operand length of $O(n)$ bits for inverting $n \times n$ matrices. Here again, overlooking the arithmetic details of the model, leads to the invalidation of this result.
3. Very-Large-Scale-Integration opened up the possibility of massive parallellism, whose typical model was an interconnection of RAM-type processors with unit-time interprocessor communication. Therefore the emphasis was directed towards small-diameter networks, i.e., trees and hypercubes. However, the area-time theory of layouts reveals that such networks have links of length linear in the problem size. Since in future technologies transmission time is bound to grow with wirelength, hypercubic connections are manifestly nonscalable.
4. Finally, a case study from Computational Biology is not directly concerned with a computation model, but rather with the modeling of the process to which algorithmic research is applied. Sequencingby-Hybridization was presented as a potential alternative for DNA-sequencing. A microarray containing a complete library of oligonucleotides of length k is the platform of a biochemical experiment intended to yield *all* substrings of length k of a target sequence. The algorithmic task is the reconstruction of the target from its substrings. A number of very interesting results were obtained based on the hypothesis of ideal "noiseless" hybridization: a substring is reported if and only if present in the target. A closer look at the biochemical behavior reveals an enormously more complex noisy reality, which casts a negative shadow on the future of the technology.