

# Preface

We are pleased to present this collection of research and survey papers on the subject of *experimental algorithmics*. In September 2000, we organized the first Schloss Dagstuhl seminar on Experimental Algorithmics (seminar no. 00371), with four featured speakers and over 40 participants. We invited some of the participants to submit write-ups of their work; these were then refereed in the usual manner and the result is now before you. We want to thank the German states of Saarland and Rhineland-Palatinate, the Dagstuhl Scientific Directorate, our distinguished speakers (Jon Bentley, David Johnson, Kurt Mehlhorn, and Bernard Moret), and all seminar participants for making this seminar a success; most of all, we thank the authors for submitting the papers that form this volume.

Experimental Algorithmics, as its name indicates, combines algorithmic work and experimentation. Thus algorithms are not just designed, but also implemented and tested on a variety of instances. In the process, much can be learned about algorithms. Perhaps the first lesson is that designing an algorithm is but the first step in the process of developing robust and efficient software for applications: in the course of implementing and testing the algorithm, many questions will invariably arise, some as challenging as those originally faced by the algorithm designer. The second lesson is that algorithm designers have an important role to play in all stages of this process, not just the original design stage: many of the questions that arise during implementation and testing are algorithmic questions—efficiency questions related to low-level algorithmic choices and cache sensitivity, accuracy questions arising from the difference between worst-case and real-world instances, as well as other, more specialized questions related to convergence rate, numerical accuracy, etc. A third lesson is the evident usefulness of implementation and testing for even the most abstractly oriented algorithm designer: implementations yield new insights into algorithmic analysis, particularly for possible extensions to current models of computation and current modes of analysis, during testing, by occasionally producing counterintuitive results, and opening the way for new conjectures and new theory.

How then do we relate “traditional” algorithm design and analysis with experimental algorithmics? Much of the seminar was devoted to this question, with presentations from nearly 30 researchers featuring work in a variety

of algorithm areas, from pure analysis to specific applications. Certain common themes emerged: practical, as opposed to theoretical, efficiency; the need to improve analytical tools so as to provide more accurate predictions of behavior in practice; the importance of *algorithm engineering*, an outgrowth of experimental algorithmics devoted to the development of efficient, portable, and reusable implementations of algorithms and data structures; and the use of experimentation in algorithm design and theoretical discovery.

Experimental algorithmics has become the focus of several workshops: *WAE*, the Workshop on Algorithm Engineering, started in 1997 and has now merged with *ESA*, the European Symposium on Algorithms, as its applied track; *ALENEX*, the Workshop on Algorithm Engineering and Experiments, started in 1998 and has since paired with *SODA*, the ACM/SIAM Symposium on Discrete Algorithms; and *WABI*, the Workshop on Algorithms in Bioinformatics, started in 2001. It is also the focus of the *ACM Journal of Experimental Algorithmics*, which published its first issue in 1996. These various forums, along with special events, such as the *DIMACS Experimental Methodology Day* in Fall 1996 (extended papers from that meeting will appear shortly in the DIMACS monograph series) and the *School on Algorithm Engineering* organized at the University of Rome in Fall 2001 (lectures by Kurt Mehlhorn, Michael Jünger, and Bernard Moret are available online at [www.info.uniroma2.it/italiano/School/](http://www.info.uniroma2.it/italiano/School/)), have helped shape the field in its formative years. A number of computer science departments now have a research laboratory in experimental algorithmics, and courses in algorithms and data structures are slowly including more experimental work in their syllabi, aided in this respect by the availability of the LEDA library of algorithms and data structures (and its associated text) and by more specialized libraries such as the CGAL library of primitives for computational geometry. Experimental algorithmics also offers the promise of more rapid and effective transfer of knowledge from academic research to industrial applications.

The articles in this volume provide a fair sampling of the work done under the broad heading of experimental algorithmics. Featured here are:

- a survey of algorithm engineering in parallel computation—an area in which even simple measurements present surprising challenges;
- an overview of visualization tools—a crucial addition to the toolkit of algorithm designers as well as a fundamental teaching tool;
- an introduction to the use of fixed-parameter formulations in the design of approximation algorithms;
- an experimental study of cache-oblivious techniques for static search trees—an awareness of the memory hierarchy has emerged over the last 10 years as a crucial element of algorithm engineering, and cache-oblivious techniques appear capable of delivering the performance of cache-aware designs without requiring a detailed knowledge of the specific architecture used;

- a novel presentation of terms, goals, and techniques for deriving asymptotic characterizations of performance from experimental data;
- a review of algorithms in VLSI designs centered on the use of binary decision diagrams (BDDs)—a concept first introduced by Claude Shannon over 50 years ago that has now become one of the main tools of VLSI design, along with a description of the BDD-Portal, a web portal designed to serve as a platform for experimentation with BDD tools;
- a quick look at two problems in computational phylogenetics—the reconstruction, from modern data, of the evolutionary tree of a group of organisms, a problem that presents special challenges in that the “correct” solution is and will forever remain unknown;
- a tutorial on how to present experimental results in a research paper;
- a discussion of several approaches to algorithm engineering for problems in distributed and mobile computing; and
- a detailed case study of algorithms for dynamic graph problems.

We hope that these articles will communicate to the reader the exciting nature of the work and help recruit new researchers to work in this emerging area.

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