Executive Summary: Dagstuhl Seminar 10261 Algorithm Engineering

Giuseppe Italiano[1], David Johnson[2], Petra Mutzel[3] and Peter Sanders[4]

[1] Università di Roma "Tor Vergata", IT
[2] AT&T Labs – Research, Florham Park, US
[3] Technische Universität Dortmund, DE
[4] KIT – Karlsruhe Institute of Technology

Algorithm engineering (AE) consists of the design, theoretical analysis, implementation, and experimental evaluation of algorithms, with the aim of bridging the gap between theory and practice in the area of algorithms. In the last decade, this approach to algorithmic research has gained increasing attention. The aim of this seminar was to bring together researchers with different backgrounds, e.g., from combinatorial optimization, algorithmic theory, and algorithm engineering, in order to strengthen and foster collaborations in the area of algorithm engineering and to identify key research directions for the future.

The seminar was attended by 29 participants from both academia and industry. Much was accomplished, fostered by the productive atmosphere of the Dagstuhl Center. Here we describe some of the more important achievements.

The program consisted of a wide variety of presentations and discussion sessions. The presentations included several survey lectures, in addition to more specialized talks. David Bader and Roman Dementiev presented surveys of the challenges of multi-core and many-core architectures for algorithm engineers, and convinced us that the new computer architectures will strongly influence future algorithmic research. Rüdiger Schultz surveyed the area of stochastic programming, including bi-level problems (e.g., Stackelberg games) and risk aversion. A key issue is that, for at least some of the input data, only the probabilistic distribution is known in advance. This area was initially studied by mathematicians and experts in mathematical programming, but has been recently discovered by computer scientists. Catherine McGeoch and David Johnson provided surveys on experimental procedures. Giuseppe Italiano gave an overview of resilient algorithms and data structures, and Philippas Tsigas discussed lock-free data structures, both areas of increasing algorithmic interest. Peter Sanders described the aim of the German priority program SPP 1307 *Algorithm Engineering* which began running in 2007.

Beyond the survey lectures, highlights of the seminar included lectures on routing in networks (e.g., transit networks for public transportation, and highway networks), on specific stochastic optimization and game-theoretic problems (e.g., 2-stage stochastic Steiner tree, stochastic ad allocation, pricing lotteries, and risk-averse models), on mixed integer linear programming approaches (e.g., MIP domination), and on clustering algorithms.

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Arguably the most-appreciated features of the Seminar were the four lively open discussion sessions, which led to several concrete proposals for the future of the field which, as a result of the workshop, are now being actively pursued.

David Johnson moderated a discussion on topics for future DIMACS implementation challenges. (DIMACS is the Center for Discrete Mathematics and Theoretical Computer Science, and has a long-running series of such challenges.) We agreed that the next two challenges should be on *clustering and graph partitioning* and on the *Steiner tree problem* and its variants. The clustering challenge has now been approved by the DIMACS leadership, and will be co-led by Workshop participants David Bader, Dorothea Wagner, and Peter Sanders.

Catherine McGeoch moderated a discussion on methodological questions in algorithm engineering. These include runtime measurements, tuning for algorithm comparison, and guidelines (standards) for reporting. One major point of agreement was that page limits for experimental papers in electronic proceedings should be increased to provide room for more complete reporting of results.

Catherine also led a discussion on benchmark instance sets and code repositories, following an excellent talk by Dorothea Wagner on some of the desirable properties for benchmark sets, such as variety, relevance to practical performance, and parameterization (to allow for controlled experiments). It was suggested that testbeds should be encouraged to grow and evolve, but the question of how best to encourage this process remains open. As to code repositories, again a major problem is getting people to contribute – many are unwilling to post unpolished code (the "embarrassment factor") but also unable to spend the time needed to do the polishing.

The last discussion focused on the area Algorithm Engineering itself, and came up with several concrete actions we could take to improve its impact and outreach. In order to stimulate research in the area and to broaden its visibility, we decided to work to establish an annual prize for the best (or most influential) paper in the field. Eligibility would be restricted to an fixed but extended period (e.g., the last five years) so as to allow for some historical perspective. Several organizations (e.g., EATCS, SIGACT, ACM/SIAM) have since been approached as potential sponsors of the award, and we expect it to be established soon. In addition, we decided that it would be useful to have a website specifically for the Algorithm Engineering community, and, shortly after the workshop, Catherine McGeoch set up a home page with the domain name *algorithm-ee.org*, which will be useful for increasing the profile of the field as a discipline, expanding communication among researchers, and providing outreach to related areas. We also hope to form an official group which will support to reach the above aims (for instance, as an ACM SIG).

It is our impression that the participants enjoyed the great scientific atmosphere offered by Schloß Dagstuhl, and profited from the scientific program and the fruitful discussions. We are grateful for having had the opportunity to organize this seminar. Special thanks are due to Carsten Gutwenger for his assistance in the organization and the running of the seminar.