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Series Editors

Gerhard Goos, Karlsruhe University, Germany
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Volume Editors

Peter G. Clote
Boston College
Department of Computer Science and Department of Biology
Fulton Hall 410B, Chestnut Hill, MA 02467, USA
E-mail: clote@bc.edu

Helmut Schwichtenberg
Ludwig-Maximilian-Universität München
Mathematisches Institut
Theresienstr. 39, 80333 München, Germany
E-mail: schwicht@rz.mathematik.uni-muenchen.de

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Preface

CSL is the annual conference of the European Association for Computer Science Logic (EACSL). CSL 2000 is the 14th such annual conference, thus witnessing the importance and sustained international interest in the application of methods from mathematical logic to computer science. The current conference was organized by the Mathematics Institute and the Computer Science Institute of the Ludwig-Maximilians-Universität München (LMU), with generous financial support from the Deutsche Forschungsgemeinschaft, Forschungsinstitut für angewandte Softwaretechnologie (FAST e.V.), Münchener Universitätsgesellschaft e.V., and Siemens AG. Our sponsors' generosity enabled, among other things, stipends for the financial support of students as well as of researchers from Eastern Europe.

Topics in the call for papers for CSL 2000 included: automated deduction and interactive theorem proving, categorical logic and topological semantics, constructive mathematics and type theory, domain theory, equational logic and term rewriting, finite model theory, database theory, higher order logic, lambda and combinatory calculi, logical aspects of computational complexity, logical foundations of programming paradigms, logic programming and constraints, linear logic, modal and temporal logics, model checking, program extraction, program logics and semantics, program specification, transformation and verification. The invited speakers were: Moshe Vardi (Houston), Paul Beame (Washington), Andreas Blass (Ann Arbor), Egon Börger (Pisa), Yuri Gurevich (Redmond), Bruno Poizat (Lyons), Wolfram Schulte (Redmond), Saharon Shelah (Jerusalem), and Colin Sterling (Edinburgh). Special thanks to Moshe Vardi for being willing to speak in the place of Miklós Ajtai (Almaden), who could not attend the meeting.

The day of 24 August 2000, during the week-long CSL 2000 meeting, was reserved for the *Gurevich Symposium*, a special, one-day tribute to the scientific contributions of Professor Yuri Gurevich, at the occasion of his 60th birthday. Many of the previously listed invited speakers delivered a talk at the Gurevich Symposium. As editors of the proceedings, we would like to dedicate this volume of the Springer Lecture Notes in Computer Science to Professor Gurevich.

We would like to thank the Program Committee, the referees, and our sponsors for making this conference possible. A special thanks goes to the Organizing Committee for its professional work ranging from practical to editorial matters. Finally, thanks to the assistance of the authors, who formatted their articles using LaTeXwith Springer macros. This allowed rapid production of the proceedings first distributed at the conference.

May 2000 Peter Clote and Helmut Schwichtenberg

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Yuri Gurevich: The Evolution of a Research Life from Algebra through Logic to Computer Science
by Egon Börger (University of Pisa)

Yuri Gurevich is the man whose life embraces three worlds—Russia, Israel, and United States—and whose research spans three disciplines—algebra, logic, and computer science—all of which shaped the 20th century. In each of these research areas Gurevich set milestones and became a leading figure. Indeed the outstanding constant in his life is his courage and strength to think about the *fundamentals* which underly problems of *impact* in the field.

He was born on May 7, 1940, in Nikolayev (Ukraine) and was moved by life through Stalingrad (41-42), Chimkent (Uzbekistan, 42-44), Cheliabinsk (44-59, school and polytechnic) to Sverdlovsk where he studied, graduated, and taught at the Ural University (59-64, 65-71) and where he married Zoe, a student of mathematics and later system programmer who has given him two daughters, Hava and Naomi, and accompanies his life.

Gurevich started his research in algebra where he became famous through his work on ordered abelian groups. For his diploma in 1962 he solved [1][1] one of the problems which was listed as open in Petr Kontorovich's algebra seminar. Gurevich learned logic from Kleene's *Introduction to Metamathematics* and in 1962 heard about Tarski's program of classifying elementary theories into decidable and undecidable. A year after Tarski and Smielev announced the decidability of the elementary theory of ordered abelian groups but then found an error in their proof, Gurevich proved the decidability of the first-order theory of ordered abelian groups [3], which became his PhD thesis (1964) and made him an assistant professor at the University of Krasnoyarsk (64-65).

Since the theorems in the then known algebra of ordered abelian groups were not first-order, and the standard extensions of classical first-order logic (like monadic second-order logic) give rise to undecidable theories, Gurevich wondered whether there is a logic that fits ordered abelian groups, so that the corresponding theory expresses most of the relevant algebra but yet is manageable and hopefully decidable. He proved that the extension of the elementary theory of ordered abelian groups with quantification over so-called convex subgroups, even though it is much richer than the elementary theory and expresses virtually all known algebra of ordered abelian groups, is not only decidable [25], but allows the elimination of the elementary quantifiers. When in 1973, via Krasnodar (71-72) and Tbilisi (Georgia, 72-73), Gurevich emigrated to Israel (Beer Sheva, 74-82), he met Saharon Shelah, studied Shelah's seminal paper on the theory of order (Annals of Mathematics, 1975), and solved in [26, 27] most of its numerous conjectures, which led to a still ongoing fruitful collaboration between the two logicians (see the survey [64]).

For Hilbert's *Entscheidungsproblem*, one of the major themes of mathematical logic in the twentieth century, Gurevich [6] resolved the most difficult of the

[1] The numbers in brackets refer to the Annotated Publication List at http://research.microsoft.com/~gurevich/, except where marked by *reference below*.

prefix-predicate classes and thereby completed the prefix-predicate classification of the fragments of the restricted predicate calculus as decidable or undecidable. He found a general explanation of the classifiability phenomenon [13], confirmed it for the classification of fragments with function symbols [18], and conjectured the classification of fragments with equality and at least one function symbol, one of the most difficult problems in the area which was later proved by Saharon Shelah. Details can be found in [2] (reference below).

The year 1982, when the University of Michigan appointed Gurevich, marks the beginning of his commitment to computer science and of his close collaboration with Andreas Blass from the mathematics department there. Gurevich shaped the two emerging fields of finite model theory and of average case complexity. It started with his first talk to a computer science conference [41], where Gurevich saw Moshe Vardi applying the definability theorem of first-order logic to databases, which were assumed to be possibly infinite - and immediately worried whether such classical theorems would remain valid if only finite databases were allowed. The answer turned out to be negative [60], the counter-example to Lyndon's interpolation theorem [72] gave a uniform sequence of constant-depth polynomial-size (functionally) monotone boolean circuits not equivalent to any (however nonuniform) sequence of constant-depth polynomial-size positive boolean circuits. Other landmark contributions to finite model theory are the characterization of primitive recursive (resp. recursive) functions over finite structures as log-space (resp. polynomial time) computable [51], the characterization of the inflationary fixed-point extension of first-order logic as equi-expressive with its least fixed-point extension on finite structures [70], the boundedness of every first-order expressible datalog query [83], etc.

Gurevich's contributions to complexity theory are no less important. He solved special but important cases of NP-hard problems [54], on time-space trade-offs [87], on linear time [82], and critically analyzed some non-traditional approaches [81,80], but above all we see Gurevich work here on average case complexity, side by side with Leonid Levin. An NP-hard problem, when equipped with a probability distribution, may become easy. For example, for random graphs with n vertices and a fixed edge probability, the algorithm of [71] solves the Hamiltonian Circuit Problem in average time $O(n)$. In 1984, Leonid Levin generalized the NP-completeness theory to such distributional (DNP) problems and constructed one DNP problem that was hard in the average case. [76] provides new hard cases and shows that Levin's original deterministic reductions are inadequate, which led Levin and Venkatesan to define more powerful randomizing reductions. [88,93,94,96,97] contains pioneering work towards establishing the average-case intractability of important problems.

Reconsidering Turing's thesis and the fundamental problem of semantics of programming languages led Gurevich to his epochal concept of Abstract State Machines [74,92,103,141]. It has already triggered hundreds of publications, in finite model theory [109,120,135], in complexity theory [118,121], and in numerous areas of applied computer science, e.g. programming languages, protocols, architectures, and embedded control software (see the survey in [1] (reference below) and [77,89,98,106,107,111,116,117,119,121,122,137-140]); even more importantly it is changing the way we think about high-level software design and analysis. In this extraordinarily rich, deep, and wide ranging life in research, all the strands are woven together. By investing that wealth into building and leading the Foundations of Software Engineering group at Microsoft Research (since August 1998), Gurevich professes his conviction that there is nothing more practical than a good theory.

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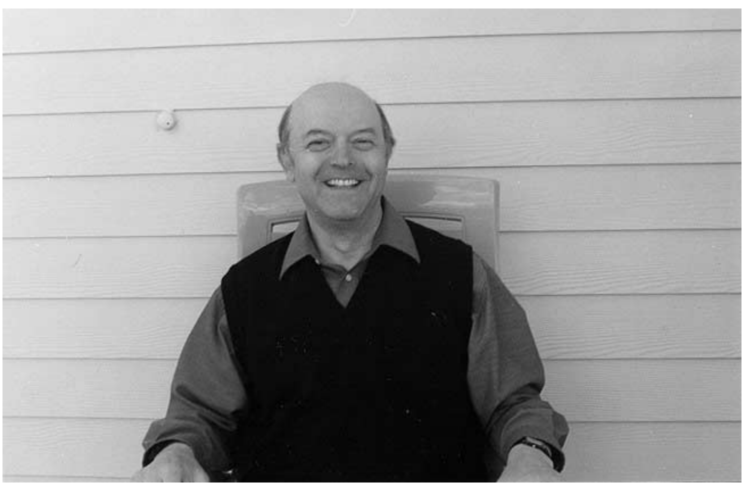

Yuri Gurevich

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