Special Issue of Invited Papers in Honor of the Boris Trakhtenbrot Centenary

Preface

Boris (Boaz) Abramovich Trakhtenbrot (1921–2016)

This issue of *Fundamenta Informaticae* is dedicated to the memory of the late Boris/Boaz Abramovich Trakhtenbrot (Борис Авраамович Трахтенброт) – and commemorates the centennial of his birth on 20 February 1921 (Gregorian). Trakhtenbrot was a founding father of theoretical computer science in general and of the logic of computer science in particular. He passed away on 19 September 2016 in Rehovot, Israel.

Photograph courtesy Trakhtenbrot family.

Originally, an international conference was planned for February 2021 (100 years since his birth) in Israel in his memory and honor. On account of the coronavirus pandemic, that plan had to be abandoned. Instead, there was a two-day "hybrid" conference at Tel Aviv University, 24–25 October 2021, which included a memorial session. Writeups of those talks and other contributions in his honor comprise the issue before you.

Trakhtenbrot was born in Brichevo, a shtetl in northern Bessarabia (now Moldova), about which he always spoke fondly. He studied at the Moldovan State Pedagogical Institute in Kishinev, Chernivtsi National University (Ukraine), Kiev Mathematical Institute (Ukraine), and unofficially at Moscow University. After completing his Ph.D. in 1950, under Petr S. Novikov, he took a position at the Belinsky Pedagogical Institute in Penza (Western Russia), and in 1960 joined the just-established Mathematical Institute at Novosibirsk Akademgorodok, where he founded and headed the Theory of Automata and Mathematical Linguistics Department. He attained full professorship (Doktor nauk = Doctor of Sciences) in 1962. He also collaborated with computer designers and helped in the establishment of computer science departments behind the Iron Curtain. In 1980, Trakhtenbrot fulfilled his dream, came on aliyah to Israel, and joined Tel Aviv University. There he was instrumental in the growth phase of its computer science department, now the Blavatnik School of Computer Science.

Trakhtenbrot is universally admired as a founding father and long-standing pillar of the discipline of computer science. His contributions span the whole gamut of the theory of computer science and are breathtaking in scope. His doctoral dissertation inaugurated finite model theory. He introduced the use of monadic second-order logic as a specification formalism for the infinite behavior of finite automata. Trakhtenbrot was among the very first to consider time and space efficiency of algorithms ("signalizing functions") and to speak about abstract complexity measures. He initiated the study of topological aspects of ω-languages and provided a characterization of operators computable by finite automata. His later work dealt with various aspects of concurrency and continuous-time computational paradigms. His work has led to tools for algorithmic verification now embodied in numerous industrial tools.

Three justly famous theorems in theoretical computer science bear his name:

- **Trakhtenbrot's Theorem** (1950): *The validity of first-order statements that hold true for all finite universes is undecidable.*

- **Büchi-Elgot-Trakhtenbrot Theorem** (1962): *Finite automata and weak monadic second-order logic have the same expressive power.*

- **Borodin-Trakhtenbrot Gap Theorem** (1964): *There are arbitrarily large (computable) gaps in the hierarchy of complexity classes.*

Trakhtenbrot was also a master pedagogue and expositor. His book, *Algorithms and Automatic Computing Machines*, first written in Russian in 1957, was translated into English and a dozen other languages, and is universally recognized as the first important text in the field. Two other books, *Introduction to the Theory of Finite Automata* (1965) and *Finite Automata (Behavior and Synthesis)* (1973), were widely studied and translated multiple times. A whole generation of computer scientists was shaped by his books. He played the key rôle in the dissemination of Soviet computer science research in the West, writing surveys on such topics as Soviet approaches to brute force search (*perebor*).

Trakhtenbrot received numerous prizes and recognitions for his contributions, including *doctor honoris causa* from the Friedrich Schiller University in Jena in 1997. In 2001, in honor of his eightieth birthday and his "very important contribution to Formal Languages and Automata," he gave the keynote address at a joint plenary session of the International EATCS Colloquium on Automata, Languages and Programming (ICALP) and the ACM Symposium on Theory of Computing (SIGACT). In 2011, the European Association for Theoretical Computer Science (EATCS) bestowed him with their highest honor, the *Distinguished Achievements Award*.

The hybrid "Trakhtenbrot 100 Event", held in October 2021, included greetings by Dany Leviatan (former Rector of Tel Aviv University), Tova Milo (Dean of the Faculty of Exact Sciences), and Sivan Toledo (Head of the School of Computer Science). During the memorial session, Trakhtenbrot's son, Mark (Holon Institute of Technology), presented milestones of his life and academic career, and Yossi Halakhmi (his other son), Eli Shamir (Hebrew University), Arnon Avron (Tel Aviv), and Dorit Pardo (former student), shared memories. There were technical talks by Zvi Galil (Georgia Tech), Wolfgang Thomas (RWTH), Bruno Courcelle (LaBRI), Samson Abramsky (Oxford), Irene Guessarian (IRIF), Yuri Gurevich (Michigan), Wolfgang Reisig (Humboldt), Sergei Artemov (CUNY), Johann Makowsky (Technion), Irina Lomazova (HSE), Moshe Vardi (Rice), Jacques Sakarovitch (CNRS), Vladimir Lifschitz (Austin), and Mikołaj Bojańczyk (Warsaw). Recordings of these talks are available at `exact-sciences.tau.ac.il/events_Trakhtenbrot100`.

In February 2021, Irina Lomazova organized a one-day online seminar on logical foundations of computer science in honor of Trakhtenbrot at the Higher School of Economics in Moscow. See `pais.hse.ru/centenary`. And, in August 2022, the Federated Logic Conference (FLoC), which took place at the Technion in Haifa, Israel, convened a special memorial session.

The contributions in this issue reflect the breadth of Trakhtenbrot's interests. There are two historical pieces: "The 1966 International Congress of Mathematicians: A micro-memoir" by Yuri Gurevich and "Boris (Boaz) Trakhtenbrot – The beginning" by Mark Trakhtenbrot. Two contributions are on automata theory: "Morphisms and minimisation of weighted automata" by Sylvain Lombardy and Jacques Sakarovitch and "Affine completeness of some free binary algebras" by André Arnold, Patrick Cégielski, and Irène Guessarian. Three papers are on monadic second-order logic: "Solving infinite games in the Baire space" by Benedikt Brütsch and Wolfgang Thomas; "Order-theoretic trees: monadic second-order descriptions and regularity" by Bruno Courcelle; and "On the Tutte and matching polynomials for complete graphs" by Tomer Kotek and Johann Makowsky. Finite-model theory is the subject of "Structure and power: An emerging landscape" by Samson Abramsky. Non-classical approaches are taken in the following three articles: "Towards syntactic epistemic logic" by Sergei Artemov; "A generalization of falsity in finitely-many valued logics" by Nissim Francez; and "A note on calculi for non-deterministic many-valued logics" by Michael Kaminski. Last but not least, there is one contribution on concurrency: "Resource bisimilarity in Petri nets is decidable" by Irina Lomazova, Vladimir Bashkin, and Petr Jančar. Lomazova was Trakhtenbrot's last student in the USSR, but was forced to remove any references to him in her work after he departed for Israel.

We are especially delighted to be publishing this commemorative issue in *Fundamenta Informaticae*, where Trakhtenbrot was a long-serving editor (1981–2007) and remained as an honorary editor until his passing (and even beyond). We are grateful to all the contributors for helping make this a reality.

From right to left: Boaz Trakhtenbrot (1921–2016), editor of *Fundamenta Informaticae* from 1981; Cecylia Rauszer (1942–1994); Berta Trakhtenbrot (1921–2013), Boaz's wife; Zdzisław Pawlak (1926–2006), editor from 1977; Helena Rasiowa (1917–1994), founder and editor-in-chief from inception in 1977. (Photograph courtesy Andrzej Skowron.)

Boaz's wisdom, courage, and generosity are sorely missed by all who had the honor and pleasure of his acquaintance. His undaunted spirit should serve as an inspiration to all.

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