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Descriptive Complexity of Formal Systems

18th IFIP WG 1.2 International Conference, DCFS 2016
Bucharest, Romania, July 5–8, 2016
Proceedings

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Preface

This volume contains the papers presented at DCFS 2016, the 18th International Conference on Descriptive Complexity of Formal Systems, held during July 6–8, 2016, in Bucharest, at the University of Bucharest. DCFS became a working conference in 2016, continuing the former Workshop on Descriptive Complexity of Formal Systems, which was a merger in 2002 of two other workshops: FDSR (Formal Descriptions and Software Reliability) and DCAGRS (Descriptive Complexity of Automata, Grammars and Related Structures).

DCAGRS was previously held in Magdeburg (1999), London (2000), and Vienna (2001). FDSR was previously held in Paderborn (1998), Boca Raton (1999), and San Jose (2000).

Since 2002, DCFS has been successively held in London, Ontario, Canada (2002), Budapest, Hungary (2003), London, Ontario, Canada (2004), Como, Italy (2005), Las Cruces, USA (2006), Novy Smokovec (High Tatras), Slovakia (2007), Charlottetown, Canada (2008), Magdeburg, Germany (2009), Saskatoon, Canada (2010), Giessen, Germany (2011), Porto, Portugal (2012), London, Ontario, Canada (2013), Turku, Finland (2014), and Waterloo, Ontario, Canada (2015).

This conference was an official event of the International Federation for Information Processing and IFIP Working Group 1.2 (Descriptive Complexity) and was jointly organized by the IFIP WG 1.2 and the Faculty of Mathematics and Computer Science of the University of the Bucharest.

The working conference was sponsored by the Department of Computer Science of the University of Bucharest and other sponsors.

Descriptive complexity is a field in computer science that deals with the size of all kinds of objects that occur in computational models, such as Turing machines, finite automata, grammars, splicing systems and others. The topics of this conference are related to all aspects of descriptive complexity and include, but are not limited to:

- Various modes of operations and complexity measures for automata, grammars, languages, and related systems
- Succinctness of description of objects, state-explosion-like phenomena
- Trade-offs between descriptive complexity and mode of operation
- Circuit complexity of Boolean functions and related measures
- Succinctness of description of (finite) objects
- Descriptive complexity in resource-bounded or structure-bounded environments
- Complexity aspects related to the combinatorics of words
- Structural complexity of formal systems as related to descriptive complexity
- Descriptive complexity of formal systems for applications (e.g., software reliability, software and hardware testing, modelling of natural languages)
- Descriptive complexity aspects of nature-motivated (bio-inspired) architectures and unconventional models of computing
- Frontiers between decidability and undecidability

- Universality and reversibility
- Blum static (a.k.a. Kolmogorov/Chaitin) complexity, algorithmic information

The working conference of DCFS 2016 included four invited lectures, 13 contributed papers, discussion sessions, and a visit of the surroundings of Bucharest city, concluded by the conference dinner.

The proceedings of DCFS 2016, published in this volume of the *Lecture Notes in Computer Science* series, were available at the workshop and contain the invited lectures and the contributed papers.

There were 21 submissions to DCFS 2016 by a total of 47 authors from 15 different countries – Canada, Germany, India, Italy, Portugal, Slovakia, South Africa, Brazil, Russia, Austria, Czech Republic, Romania, France, Poland, and the UK.

On the basis of at least three reviews for each contribution, an international committee selected 13 papers – which accounts for an acceptance rate of approximately 60 % – for inclusion in the workshop program and this proceedings volume. The submission and refereeing process was supported by the EasyChair conference management system.

We warmly thank those who contributed to the success of DCFS 2016:

- The invited speakers James Currie (University of Winnipeg, Winnipeg/Manitoba, Canada), Gabriel Istrate (Timioara, Romania), Galina Jirásková (Mathematical Institute Slovak Academy of Sciences, Kosice, Slovak Republic), and Mikhail V. Volkov (Ural Federal University, Ekaterinburg, Russia).
- The authors of contributed and discussion papers.
- The reviewers and the Program Committee for their excellent work in making this selection.
- The members of the Organizing Committee for their commitment in the preparation of the scientific sessions and social events
- The staff of Springer and, in particular, Computer Science Editorial, for the extremely helpful and efficient collaboration in making this volume available before the conference. As volume editors, we value their experience, advice, and instructions, which were very helpful for the preparation of this volume.
- All the speakers and participants for attending the DCFS workshop.

Special thanks go to the “Asociația Alumni Universității din București” for their financial and logistic support. We gratefully acknowledge the generous direct financial support of the Faculty of Mathematics and Computer Science of the University of Bucharest and the valuable in-kind support from Springer. Without this support, for which we are thankful, it would have been very difficult to conduct DCFS 2016.

We hope, as in the previous years, that DCFS 2016 has initiated new scientific discussions and stimulated research and scientific cooperation in the area of descriptive complexity, and trust that this volume will contribute to raising the interest in this field.

We look forward to seeing this year’s participants and many others at DCFS in 2017!

May 2016

Cezar Câmpeanu
Florin Manea
Jeffrey Shallit

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Abstracts of Invited Talks

Completely Reachable Automata

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Abstract. We present a few results and several open problems concerning complete deterministic finite automata in which every non-empty subset of the state set occurs as the image of the whole state set under the action of a suitable input word.

Supported by the Russian Foundation for Basic Research, grant no. 16-01-00795, the Ministry of Education and Science of the Russian Federation, project no. 1.1999.2014/K, and the Competitiveness Program of Ural Federal University. The paper was written during the second author's stay at Hunter College of the City University of New York as Ada Peluso Visiting Professor of Mathematics and Statistics with a generous support from the Ada Peluso Endowment

Words Avoiding Patterns, Enumeration Problems and the Chomsky Hierarchy

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Abstract. The study of words avoiding patterns is a mature branch of combinatorics on words. Patterns are themselves words, but their alphabets may be partitioned into variables, constants, function symbols such as reversal, or other tokens. As in the classical case of overlap-free words, one typically begins with the problem of whether pattern p is avoidable by an infinite string over alphabet Σ , and then moves on to sharper questions, such as language-theoretic properties of the set L of finite words over Σ avoiding p , and the problem of enumerating words of L of length n .

Strong techniques for the enumeration of regular or context-free languages are well-known, following Schützenberger’s foundational work. However, because of the pumping lemma, the language of binary overlap-free words is not context-free; nevertheless, there is a sharp description of the language of binary overlap-free words due to Cassaigne, via regular languages coding a sequence of operator applications. This leads to sharp characterization of the growth of the number of binary overlap-free words of length n , which turns out to be polynomial. The growth of the language L of finite words over Σ avoiding p has been studied in various cases, and has generally been exponential, but in a few instances polynomial.

With this background, it was natural for Shallit et al. to ask whether the language of binary words avoiding xx^R grows polynomially, or exponentially. The surprising answer turns out to be ‘neither’. It follows that the language in question is not context-free; interestingly, no more direct proof of this is known. The language of binary words avoiding $xx^R x$ also turns out to have growth intermediate between polynomial and exponential, but the analysis is simpler. Given these surprising results involving patterns over $\{x, x^R\}$, it is natural to study binary avoidability of patterns over $\{x, x^R, y, y^R\}$, and the related growth questions. Studying growth questions for 2-avoidable patterns over $\{x, x^R, y, y^R\}$ leads to consideration of an under-utilized tool originally due to Shelton, the method of fixing block inequalities.

This talk will give an overview of the above matters, ending with recent results and open problems.

Heapability, Interactive Particle Systems, Partial Orders: Results and Open Problems

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Abstract. We outline results and open problems concerning partitioning of integer sequences and partial orders into heapable subsequences (previously defined and established by Byers et al.).

Self-Verifying Finite Automata and Descriptive Complexity

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Abstract. We survey recent results on the descriptive complexity of self-verifying finite automata. In particular, we discuss the cost of simulation of self-verifying finite automata by deterministic finite automata, and the complexity of basic regular operations on languages represented by self-verifying finite automata.

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