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Developments in Language Theory

21st International Conference, DLT 2017
Liège, Belgium, August 7–11, 2017
Proceedings

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Preface

The 21st International Conference on Developments in Language Theory (DLT 2017) was organized by the Department of Mathematics of the University of Liège, Belgium, during August 7–11, 2017.

The DLT conference series is one of the major international conference series in language theory and related areas. The DLT conference was established by G. Rozenberg and A. Salomaa in 1993. Since then, the DLT conferences have been held on every odd year: Magdeburg, Germany (1995), Thessaloniki, Greece (1997), Aachen, Germany (1999), and Vienna, Austria (2001). Since 2001, a DLT conference has been taking place in Europe on every odd year and outside Europe on every even year. The locations of DLT conferences since 2002 were: Kyoto, Japan (2002), Szeged, Hungary (2003), Auckland, New Zealand (2004), Palermo, Italy (2005), Santa Barbara, California, USA (2006), Turku, Finland (2007), Kyoto, Japan (2008), Stuttgart, Germany (2009), London, Ontario, Canada (2010), Milan, Italy (2011), Taipei, Taiwan (2012), Marne-la-Vallée, France (2013), Ekaterinburg, Russia (2014), Liverpool, UK (2015), and Montréal, Canada (2016). This 21st edition was thus the first time that the conference was organized in Belgium.

The series of International Conferences on Developments in Language Theory provides a forum for presenting current developments in formal languages and automata. Its scope is very general and includes, among others, the following topics and areas: combinatorial and algebraic properties of words and languages; grammars, acceptors and transducers for strings, trees, graphs, arrays; algebraic theories for automata and languages; codes; efficient text algorithms; symbolic dynamics; decision problems; relationships to complexity theory and logic; picture description and analysis; polyominoes and bidimensional patterns; cryptography; concurrency; cellular automata; bio-inspired computing; quantum computing.

The papers submitted to DLT 2017 were from 19 countries including Belgium, Canada, Czech Republic, France, Germany, Hungary, India, Italy, Japan, The Netherlands, Poland, Portugal, Republic of Korea, Russia, Slovakia, South Africa, Thailand, and USA.

This volume of *Lecture Notes in Computer Science* contains the papers that were presented at DLT 2017. There were 47 qualified submissions. Each submission was handled by three Program Committee members and received at least three reviews. The committee decided to accept 24 papers. The volume also includes the abstracts or full papers of the invited speakers:

- Véronique Bruyère (University of Mons): “Computer-Aided Synthesis: A Game-Theoretic Approach”
- Sergei Kitaev (University of Strathclyde): “A Comprehensive Introduction to the Theory of Word-Representable Graphs”
- Robert Mercaş (Loughborough University): “On the Number of Factors with Maximal-Exponent in Words”

- Balasubramanian Ravikumar (Sonoma State University): "Language Approximation: Asymptotic and Non-asymptotic Results"
- Eric Rowland (Hofstra University): "Binomial Coefficients, Valuations, and Words"
- Michał, Skrzypczak (University of Warsaw): "Connecting Decidability and Complexity for MSO Logic"

We warmly thank all the invited speakers and all the authors of the submitted papers. We also would like to thank all the members of the Program Committee and all the external reviewers (listed in the proceedings) for their excellent work in evaluating the papers. We finally thank all the members of the Organizing Committee at the University of Liège.

The organization of the conference benefited from the support of the F.R.S.-FNRS, the Faculty of Sciences of the University of Liège and the Research Unit in Mathematics of the University of Liège. The reviewing process was organized using the EasyChair conference system created by Andrei Voronkov. We would like to acknowledge that this system greatly helped to improve the efficiency of the committee work. Finally, we wish to thank the editors of the *Lecture Notes in Computer Science series* and Springer.

May 2017

Émilie Charlier
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Abstract of Invited Talks

Computer Aided Synthesis: A Game-Theoretic Approach

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Abstract. In this invited contribution, we propose a comprehensive introduction to game theory applied in computer aided synthesis. In this context, we give some classical results on two-player zero-sum games and then on multi-player non zero-sum games. The simple case of one-player games is strongly related to automata theory on infinite words. All along the article, we focus on general approaches to solve the studied problems, and we provide several illustrative examples as well as intuitions on the proofs.

A Comprehensive Introduction to the Theory of Word-Representable Graphs

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Abstract. Letters x and y alternate in a word w if after deleting in w all letters but the copies of x and y we either obtain a word $xyxy\cdots$ (of even or odd length) or a word $yxyx\cdots$ (of even or odd length). A graph $G=(V,E)$ is word-representable if and only if there exists a word w over the alphabet V such that letters x and y alternate in w if and only if $xy \in E$.

Word-representable graphs generalize several important classes of graphs such as circle graphs, 3-colorable graphs and comparability graphs. This paper offers a comprehensive introduction to the theory of word-represent-able graphs including the most recent developments in the area.

On the Number of Factors with Maximal-Exponent in Words

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A *repetition* (unary pattern) is represented as concatenations of several instances of the same factor. A word contains a repetition if it has one as a factor, and it is said to be repetition-free, otherwise. The word shshsh is an example of a *cube*, that is three consecutive repetitions of the factor sh. If, for a given alphabet, every infinite word contains an instance of the repetition, then such a repetition is called unavoidable for an alphabet of that size. Otherwise, it can be avoided by an infinity of words constructed over such an alphabet [5].

The investigation of repetitions has been around from the beginnings of the Combinatorics on Words research area. People were interested in how it is possible to avoid them [30, 36, 37], what bounds exist on the unavoidable ones [11, 12, 31, 34], and extended the notion of avoidability to other settings, such as the abelian one [14–16, 25, 26, 32], the case of words with “don’t cares” [7, 22, 28], as well as other similar extensions [13, 18, 23, 33, 35]. Counting different types of repetitions has also been a highly investigated topic [6, 18, 19, 21, 24, 29]. Moreover, most of these topics have been accompanied by algorithmical results related to the identification and counting of repetitions [8, 10, 20, 27].

Similar to the way that repetitions are defined, one can extend the notion by allowing a fractional exponent. A *period* of a word is an interval at which each of it’s previous symbols repeat. In the case of repetitions, given that these are concatenations of the same factor, we immediately conclude that the length of the factor represents a period of the word. Whence, we can say that every word has an *exponent* equal to its length divided by a period. The word alfalfa has a period of 3 and its exponent is 7 / 3. As a direct consequence, considering the prefix of the word that determines its minimal period, will give us the highest exponent for that word. Maximal-exponent factors are those factors of a word that have the highest exponent among all factors of the word. For the word abaca, its maximal-exponent factors are aba and aca, respectively, each of a 3 / 2 exponent. Bounds on the maximal-exponent that a factor of a word can have been thoroughly investigated [11, 12, 31, 34]. Even more, recently it has been proven that every word has at most as many runs as its length [4, 9, 17]. A run represents a factor of a word that is a repetition of exponent at least two, such that extending it to either left or right (considering the letter before, or the letter following the factor) breaks its periodicity (renders a smaller exponent for the newly obtained factor). The factor anana represents a run in the word bananas since its exponent is 2.5 and both banana and ananas have exponent 1, therefore smaller.

The runs conjecture, which stood open for over 15 years, contributed to the investigation of the number of maximal-exponent factors in a word. In particular, after being proven that the number of such factors is no more than 3.11 times the size of the word [3] when looking at square-free words (the upper bound for words that are not square-free is the length of the word and is a direct consequence of the runs result) this bound was already improved in the extended version of the former paper to 2.25 times the length of the word [1]. Furthermore, in the latter, the authors also provide a lower bound on the number of such factors, showing that there exist words that have at least 2/3 times the length of the word maximal-exponent factors. An important observation is that in this particular case, the exponents that are investigated are in fact obtained with the help of the longest border of the respective factor. A border of a word is any prefix that also occurs as a suffix of the word.

This talk will focus on work carried out together with Golnaz Badkobeh and Maxime Crochemore [2] and will have as its main focus both the lower and the upper bounds on the number of factors with maximal-exponent.

References

1. Badkobeh, G., Crochemore, M.: Computing maximal-exponent factors in an overlap-free word. J. Comput. Syst. Sci. **82**(3), 477–487 (2016)
2. Badkobeh, G., Crochemore, M., Mercaş, R.: Counting maximal-exponent factors in words. Theor. Comput. Sci. **658**, 27–35 (2017)
3. Badkobeh, G., Crochemore, M., Toopsuwan, C.: Computing the maximal-exponent repeats of an overlap-free string in linear time. In: Calderón-Benavides, L., González-Caro, C., Chávez, E., Ziviani, N. (eds.) SPIRE 2012. LNCS, vol. 7608, pp. 61–72. Springer, Heidelberg (2012). doi:10.1007/978-3-642-34109-0_8
4. Bannai, H., I, T., Inenaga, S., Nakashima, Y., Takeda, M., Tsuruta, K.: The “runs” theorem. CoRR abs/1406.0263v7 (2014)
5. Bean, D., Ehrenfeucht, A., McNulty, G.: Avoidable patterns in strings of symbols. Pac. J. Math. **85**, 261–294 (1979)
6. Blanchet-Sadri, F., Mercaş, R., Scott, G.: Counting distinct squares in partial words. In: International Conference on Automata and Formal Languages. AFL, pp. 122–133 (2008)
7. Blanchet-Sadri, F., Mercaş, R., Scott, G.: A generalization of Thue freeness for partial words. Theor. Comput. Sci. **410**(8–10), 793–800 (2009)
8. Crochemore, M.: An optimal algorithm for computing the repetitions in a word. Inf. Process. Lett. **12**(5), 244–250 (1981)
9. Crochemore, M., Mercas, R.: On the density of lyndon roots in factors. Theor. Comput. Sci. **656**, 234–240 (2016)
10. Crochemore, M., Rytter, W.: Squares, cubes, and time-space efficient string searching. Algorithmica **13**(5), 405–425 (1995)
11. Currie, J.D., Rampersad, N.: A proof of Dejean’s conjecture. Math. Comput. **80**(274), 1063–1070 (2011)
12. Dejean, F.: Sur un théorème de Thue. J. Comb. Theor. **13**(1), 90–99 (1972)
13. Dekking, F.: On repetitions of blocks in binary sequences. J. Comb. Theor. **20**(3), 262–299 (1976)

14. Erdös, P.: Some unsolved problems. Magyar Tudományos Akadémia Matematikai Kutató Intézete **6**, 221–254 (1961)
15. Evdokimov, A.: Strongly asymmetric sequences generated by a finite number of symbols. Doklady Akademii Nauk SSSR **179**, 1268–1271 (1968). Russian. English translation in Soviet Mathematics Doklady **9**(1968), 536–539 (1968)
16. Evdokimov, A.: The existence of a basis that generates 7-valued iteration-free sequences. Diskretnyĭ Analiz **18**, 25–30 (1971)
17. Fischer, J., Holub, Š., I, T., Lewenstein, M.: Beyond the runs theorem. In: Iliopoulos, C., Puglisi, S., Yilmaz, E. (eds.) SPIRE 2015. LNCS, vol. 9309, pp. 277–286. Springer, Cham (2015). doi:10.1007/978-3-319-23826-5_27
18. Fraenkel, A.S., Simpson, R.J.: How many squares must a binary sequence contain? Electron. J. Comb. **2**, R2 (1995)
19. Fraenkel, A.S., Simpson, R.J.: How many squares can a string contain? J. Comb. Theor. **82** (1), 112–120 (1998)
20. Gusfield, D.: Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology. Cambridge University Press, New York (1997)
21. Halava, V., Harju, T., Kärki, T.: On the number of squares in partial words. RAIRO - Theor. Inf. Appl. **44**(1), 125–138 (2010)
22. Halava, V., Harju, T., Kärki, T., Séébold, P.: Overlap-freeness in infinite partial words. Theor. Comput. Sci. **410**(8–10), 943–948 (2009)
23. Huova, M., Karhumäki, J., Saarela, A.: Problems in between words and abelian words: k-abelian avoidability. Theor. Comput. Sci. **454**, 172–177 (2012)
24. Ilie, L.: A note on the number of squares in a word. Theor. Comput. Sci. **380**(3), 373–376 (2007)
25. Justin, J.: Characterization of the repetitive commutative semigroups. J. Algebra **21**, 87–90 (1972)
26. Keränen, V.: Abelian squares are avoidable on 4 letters. In: Kuich, W. (ed.) ICALP 1992. LNCS, vol. 623, pp. 41–52. Springer, Heidelberg (1992). doi:10.1007/3-540-55719-9_62
27. Kolpakov, R., Kucherov, G.: Finding maximal repetitions in a word in linear time. In: Annual Symposium on Foundations of Computer Science. FOCS, pp. 596–604 (1999)
28. Manea, F., Mercaş, R.: Freeness of partial words. Theor. Comput. Sci. **389**(1–2), 265–277 (2007)
29. Manea, F., Seki, S.: Square-density increasing mappings. In: Manea, F., Nowotka, D. (eds.) WORDS 2015. LNCS, vol. 9304, pp. 160–169. Springer, Cham (2015). doi:10.1007/978-3-319-23660-5_14
30. Morse, M., Hedlund, G.: Unending chess, symbolic dynamics and a problem in semigroups. Duke Math. J. **11**(1), 1–7 (1944)
31. Pansiot, J.J.: A propos d'une conjecture de F. Dejean sur les répétitions dans les mots. In: Diaz, J. (ed.) ICALP 1983. LNCS, vol. 154, pp. 585–596. Springer, Heidelberg (1983). doi:10.1007/BFb0036939
32. Pleasants, P.: Non repetitive sequences. Proc. Camb. Philos. Soc. **68**, 267–274 (1970)
33. Rampersad, N., Shallit, J., Wang, M.W.: Avoiding large squares in infinite binary words. Theor. Comput. Sci. **339**(1), 19–34 (2005)
34. Rao, M.: Last cases of Dejean's conjecture. Theor. Comput. Sci. **412**(27), 3010–3018 (2011)
35. Rao, M.: On some generalizations of abelian power avoidability. Theor. Comput. Sci. **601**, 39–46 (2015)

36. Thue, A.: Über unendliche Zeichenreihen. Norske Vid. Selsk. Skr. I, Mat. Nat. Kl. Christiana **7**, 1–22 (1906). (Reprinted in Selected Mathematical Papers of Axel Thue, T. Nagell, editor, Universitetsforlaget, Oslo, Norway (1977), pp. 139–158)
37. Thue, A.: Über die gegenseitige Lage gleicher Teile gewisser Zeichenreihen. Norske Videnskabers Selskabs Skrifter, I Mathematisch-Naturwissenschaftliche Klasse Christiana **1**, 1–67 , (Reprinted in Selected Mathematical Papers of Axel Thue, T. Nagell, editor, Universitetsforlaget, Oslo, Norway (1977), pp. 413–478) (1912)

Language Approximation: Asymptotic and Non-asymptotic Results

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Abstract. Approximation is a central concept in computational problem solving and an effective way to deal with intractable problems as well as in contexts with limited resources. Our specific focus will be on using finite automaton as a computational model, and study how well various languages can be approximately recognized by finite automata (FA). In [1] and [10], a notion of approximation was introduced that measures the proportion of inputs of a problem (or language L) that are correctly processed by a machine M. In [2–7] and other works, several regular and non-regular languages were considered and the question how well they can be approximately recognized by a finite automaton was addressed. Specifically, in [5], it was shown that Majority language over {0, 1} (the set of strings with more 1's than 0's) can't be approximated by a FA of any size much better than a 1-state FA that accepts (or rejects) all strings. In this presentation, in addition to theoretical results, we will also explore approximation by finite automaton as a tool for algorithm design - for recognition, optimization as well as counting problems. We also consider some decision questions related to approximations - such as computing the success ratio (defined as the fraction of the inputs correctly processed in the limit) of a given FA, relative to specific, nonregular languages.

Most of the prior work listed above deals with approximation in an asymptotic sense - how well is a language approximated by a machine when the length of the string is arbitrarily large. For the notion of approximation to be useful in practice, we should consider the case of fixed (or bounded) length inputs. Specifically, we consider for various languages L (including Majority language and Center = the set of strings w of length n over {0, 1} such that $[n/2]$-th bit is 1 where $|w|$ = n), and for a given integer n, which FA best approximates the language L over strings of length at most n. We provide a general algorithm to find efficient, and in some cases, an optimal approximating finite automaton with a specified number of states. Finally, we will attempt to present some case studies in which approximate computation enables the solution of hard counting problems.

References

1. Cai, J.-Y.: With probability one, a random oracle separates PSPACE from the polynomial-time hierarchy. In: Proceedings of 18th ACM Symposium on Theory of Computing, pp. 21–29 (1986)

2. Combs, J., Ravikumar, B.: DFA for approximate integer multiplication. In: Presentation at SIAM Conference on Discrete Mathematics, Atlanta, Georgia, June 2016
3. Cordy, B., Salomaa, K.: On the existence of regular approximations. Theoret. Comput. Sci. **387**, 125–135 (2007)
4. Eisman, G., Ravikumar, B.: Approximate recognition of non-regular languages by finite automata. In: Australasian Symposium on Computer Science, pp. 219–228 (2005)
5. Eisman, G., Ravikumar, B.: On approximating non-regular languages by regular languages. Fundamenta Informaticae. **110**(1–4), pp. 125–142 (2011)
6. Kappes, M., Kintala, C.M.R.: Tradeoffs between reliability and conciseness of deterministic finite automata. J. Automata Lang. Comb. **9**, 281–292 (2004)
7. Kappes, M., Niener, F.: Succinct representations of languages by DFA with different levels of reliability. Theoret. Comput. Sci. **330**, 299–310 (2005)
8. Nrederhof, M.-J.: Practical experiments with regular approximations of context-free languages. In: Proceedings of Information Processing and Management of Uncertainty on Knowledge Based Systems, pp. 891–895 (1996)
9. Ponitz, A., Tittmann, P.: Improved upper bounds for self-avoiding walks in Z^d. Electron. J. Comb. **7**(Research Paper R-21) (2000)
10. Wilber, R.E.: Randomness and the density of hard problems. In: Proceedings of 24th IEEE Foundations of Computer Science, pp. 335–342 (1983)

Binomial Coefficients, Valuations, and Words

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Abstract. The study of arithmetic properties of binomial coefficients has a rich history. A recurring theme is that p-adic statistics reflect the base-p representations of integers. We discuss many results expressing the number of binomial coefficients $\binom{n}{m}$ with a given p-adic valuation in terms of the number of occurrences of a given word in the base-p representation of n, beginning with a result of Glaisher from 1899, up through recent results by Spiegelhofer–Wallner and Rowland.

Connecting Decidability and Complexity for MSO Logic (Extended Abstract)

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Abstract. This work is about studying reasons for (un)decidability of variants of Monadic Second-order (MSO) logic over infinite structures. Thus, it focuses on connecting the fact that a given theory is (un)decidable with certain measures of complexity of that theory.

The first of the measures is the topological complexity. In that case, it turns out that there are strong connections between high topological complexity of languages available in a given logic, and its undecidability. One of the milestone results in this context is the Shelah's proof of undecidability of MSO over reals.

The second complexity measure focuses on the axiomatic strength needed to actually prove decidability of the given theory. The idea is to apply techniques of reverse mathematics to the classical decidability results from automata theory. Recently, both crucial theorems of the area (the results of Büchi and Rabin) have been characterised in these terms. In both cases the proof gives strong relations between decidability of the mso theory with concepts of classical mathematics: determinacy, Ramsey theorems, weak Konig's lemma, etc...

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