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Developments in Language Theory

25th International Conference, DLT 2021
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Proceedings

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Preface

The 25th International Conference on Developments in Language Theory (DLT 2021) was held in Porto, Portugal, during August 16–20, 2021. The conference took place in an hybrid format with both in-person and online participation. It was organized by the Center of Mathematics of the University of Porto (Centro de Matemática da Universidade do Porto, CMUP) and the Faculty of Science of the University of Porto (FCUP).

The DLT conference series 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: grammars, acceptors, and transducers for words, trees and graphs; algebraic theories of automata; algorithmic, combinatorial, and algebraic properties of words and languages; variable length codes; symbolic dynamics; cellular automata; polyominoes and multidimensional patterns; decidability questions; image manipulation and compression; efficient text algorithms; relationships to cryptography, concurrency, complexity theory, and logic; bio-inspired computing; quantum computing.

Since its establishment by Grzegorz Rozenberg and Arto Salomaa in Turku (1993), the DLT conference had been held biennially, taking place in Magdeburg (1995), Thessaloniki (1997), Aachen (1999), and Vienna (2001). Since 2001 the conference has been held annually, taking place in Europe in every odd year and outside Europe in every even year: Kyoto (2002), Szeged (2003), Auckland (2004), Palermo (2005), Santa Barbara (2006), Turku (2007), Kyoto (2008), Stuttgart (2009), London (2010), Milano (2011), Taipei (2012), Marne-la-Vallée (2013), Ekaterinburg (2014), Liverpool (2015), Montréal (2016), Liège (2017), Tokyo (2018), and Warsaw (2019). In 2020, the DLT conference was planned to be held in Tampa, Florida, but due to the COVID-19 pandemic it was canceled. However, accepted papers of DLT 2020 were published in volume 12086 of Lecture Notes in Computer Science. Authors of these papers were welcome to present their work at DLT 2021.

In 2018, the DLT conference series instituted the Salomaa Prize, to honour the work of Arto Salomaa, as well as the success of automata and formal languages theory. The prize is founded by the University of Turku. The ceremony for the Salomaa Prize 2020 took place during DLT 2021, and we here by congratulate the winners Joël Ouaknine and James Worrell.

This volume contains the invited contributions and the accepted papers of DLT 2021. There were 48 submissions by 101 authors from 18 countries: Belgium, Czech Republic, Ecuador, Finland, France, Germany, India, Italy, Japan, Latvia, Netherlands, Poland, Russia, Slovakia, South Korea, Switzerland, UK and USA. Each of the submissions was reviewed by three referees, except for three submissions that only had two reviews each. All submissions were thoroughly discussed by the Program Committee (PC) who decided to accept 27 papers (56% acceptance rate) to be presented at the conference. We would like to thank the members of the Program Committee, and

all external referees, for their work in evaluating the papers and the valuable comments that led to the selection of the contributed papers.

There were five invited talks, that were presented by the following speakers:

- Jean-Paul Allouche (CNRS, IMJ-PRG, and UPMC, France)
- Henning Fernau (Universität Trier, Germany)
- Michal Koucký (Charles University, Czech Republic)
- Alexandra Silva (University College London, UK)
- Benjamim Steinberg (City College of New York, USA)

We warmly thank the invited speakers, as well as all authors of submitted papers. Their efforts were the basis for the success of the conference.

The EasyChair conference system provided excellent support in the selection of the papers, the preparation of these proceedings, and the production of the conference schedule. We would like to thank Springer's editorial staff, and in particular Anna Kramer, Guido Zosimo-Landolfo, Christine Reiss, and Raghuram Balasubramanian for their help during the process of publishing this volume.

We are grateful to the Organizing Committee members: Sabine Broda, Bruno Loff, António Machiavelo, and Shinnosuke Seki. A special thank goes to Inês Maia from Pé de Cabra, Lda. Thanks are also due to our colleague Samuel Lopes, head of CMUP.

DLT 2021 was financially supported by Fundação para a Ciência e Tecnologia (FCT) through Centro de Matemática da Universidade do Porto (UIDB/00144/ 2020), Universidade do Porto, CRACS (INESC-TEC), Turismo de Portugal, and Câmara Municipal do Porto.

Finally, we would like to thank all participants who, either in-person or virtually, made the 25th edition of DLT a scientific and successful event, and the departure point for new research and collaborations.

We look forward to DLT 2022 at the University of South Florida, Tampa, USA.

June 2021

Nelma Moreira
Rogério Reis

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Abstracts of Invited Talks

Computing Edit Distance

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Abstract. Edit distance (or Levenshtein distance) is a measure of similarity of strings. The edit distance of two strings x, y is the minimum number of character insertions, deletions, and substitutions needed to convert x into y. It has numerous applications in various fields from text processing to bioinformatics so algorithms for edit distance computation attract lot of attention. In this talk I will survey recent progress on computational aspects of edit distance in several contexts: computing edit distance approximately, computing edit distance in streaming model, and exchanging similar strings in communication complexity model. I will point out many problems that are still open in those areas.

Keywords: Edit distance · Approximation algorithms · Streaming algorithms · Document Exchange Problem

Guarded Kleene Algebra with Tests

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Abstract. Guarded Kleene Algebra with Tests (GKAT) is an efficient fragment of KAT, as it allows for almost linear decidability of equivalence. In this talk, we will review the basics of GKAT and describe its (co)algebraic properties. We will describe two completeness results and an automaton model that plays a key role in their proof. We will show examples of different models of GKAT that can be used in program verification and discuss future directions of research.

Keywords: Kleene algebra · Program verification · Decision procedures · Program equivalence · Coequations

The material in this talk is based on the publications [1, 2].

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2. Smolka, S., Foster, N., Hsu, J., Kappé, T., Kozen, D., Silva, A.: Guarded Kleene algebra with tests: verification of uninterpreted programs in nearly linear time. Proc. ACM Program. Lang. **4**(POPL), 61:1–61:28 (2020). https://doi.org/10.1145/3371129

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