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CSL 2020, January 13–16, 2020, Barcelona, Spain

Edited by

Maribel Fernández

Anca Muscholl

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Editors

Maribel Fernández
King's College London, UK
maribel.fernandez@kcl.ac.uk

Anca Muscholl
University of Bordeaux, France
anca@labri.fr

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Preface

This volume contains the papers presented at CSL 2020, the 28th edition in the series of Computer Science Logic (CSL), the annual conference of the European Association for Computer Science Logic (EACSL). CSL 2020 was held in Barcelona, Spain, 13-16 January 2020. Until 2018 CSL took place in August/September, and CSL 2020 is the first conference in the series scheduled in January.

CSL started as a series of international workshops, and became an international conference in 1992. Previous editions of CSL were held in Birmingham (2018), Stockholm (2017), Marseille (2016), Berlin (2015), Vienna (2014), Torino (2013), Fontainebleau (2012), Bergen (2011), Brno (2010), Coimbra (2009), Bologna (2008), Lausanne (2007), Szeged (2006), Oxford (2005), Karpacz (2004), Vienna (2003), Edinburgh (2002), Paris (2001), Munich (2000), Madrid (1999), Brno (1998), Aarhus (1997), Utrecht (1996), Paderborn (1995), Kazimierz (1994), Swansea (1993) and San Miniato (1992).

CSL is an interdisciplinary conference, spanning across both basic and application-oriented research in mathematical logic and computer science. It is a forum for the presentation of research on all aspects of logic and applications, including automated deduction and interactive theorem proving, constructive mathematics and type theory, equational logic and term rewriting, automata and games, game semantics, modal and temporal logic, logical aspects of computational complexity, finite model theory, computational proof theory, logic programming and constraints, lambda calculus and combinatory logic, domain theory, categorical logic and topological semantics, database theory, specification, extraction and transformation of programs, logical aspects of quantum computing, logical foundations of programming paradigms, verification and program analysis, linear logic, higher-order logic, non-monotonic reasoning.

CSL 2020 received 82 submissions from 32 countries. The programme committee selected 32 papers for presentation at the conference. Each paper was reviewed by at least three members of the programme committee, with the help of external reviewers. The submission and reviewing process, programme committee discussion, and author notifications were all handled by the Easychair conference management system. In addition to the contributed papers, there were five invited talks, by

- Véronique Cortier (LORIA, France)
- Anuj Dawar (University of Cambridge, UK)
- Artur Jeż (University of Wrocław, Poland)
- Delia Kesner (University Paris Diderot, France)
- Iddo Tzameret (Royal Holloway, UK)

We thank the five invited speakers for contributing to the success of the conference with their interesting talks and papers.

A special regular item in the CSL programme is the Ackermann Award presentation. This is the EACSL Outstanding Dissertation Award for Logic in Computer Science. This year, the jury decided to give the Ackermann Award for 2019 to

> Antoine Mottet for his PhD thesis entitled *Dichotomies in Constraint Satisfaction Canonical Functions and Numeric CSPs*,

supervised by Manuel Bodirsky at the Technical University of Dresden. The award was officially presented at the conference on the 15th January 2020. The citation of the award,

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an abstract of the thesis and a biographical sketch of the recipient are included in the proceedings.

We are very grateful to all the members of the CSL 2020 programme committee and external reviewers for their careful and efficient evaluation of the papers submitted. We would like to thank also the members of the organisation committee, and in particular the chair, Albert Atserias, for taking care of every detail to make the conference enjoyable for all the participants. It was also a pleasure to work with Thomas Schwentick who, as the EACSL president, provided excellent guidance. The proceedings of CSL 2020 are published as a volume in the LIPIcs series. We thank Michael Wagner and all the Dagstuhl/LIPIcs team for their ongoing support and for the high quality preparation of these proceedings.

Maribel Fernández and Anca Muscholl October 25, 2019

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Ackermann Award 2019

The fifteenth Ackermann Award is presented at CSL'20 in Barcelona, Spain. The 2020 Ackermann Award was open to any PhD dissertation on any topic represented at the annual CSL and LICS conferences that were formally accepted by a degree-granting institution in fulfillment of the PhD degree between 1 January 2017 and 31 December 2018. The Jury received eleven nominations for the 2019 Award. The candidates came from a number of different countries around the world. The institutions at which the nominees obtained their doctorates represent seven different countries in Europe, North America and South America.

Again this year, EACSL Ackermann Award is generously sponsored by the association Alumni der Informatik Dortmund e.V.[1]

The topics covered a wide range of areas in Logic and Computer Science as represented by the LICS and CSL conferences. All submissions were of a very high quality and contained significant contributions to their particular fields. The jury wish to extend their congratulations to all the nominated candidates for their outstanding work.

The wide range of excellent candidates presented the jury with a difficult task. After an extensive discussion, one candidate stood out and the jury unanimously decided to award the **2019 Ackermann Award** to:

Antoine Mottet from France, for his thesis
Dichotomies in Constraint Satisfaction Canonical Functions and Numeric CSPs
approved by *Technische Universität Dresden* in 2018.

Citation

Antoine Mottet receives the *2019 Ackermann Award* of the European Association of Computer Science Logic (EACSL) for his thesis

Dichotomies in Constraint Satisfaction Canonical Functions and Numeric CSPs.

Mottet's thesis is a significant contribution to the area of Constraint Satisfaction Problems over infinite domains. It confirms the Dichotomy conjecture of Bodirsky and Pinsker for α_0-categorical structures for a substantial special case using a generic approach that establishes ties with CSPs for finite structures. As a corollary it yields a new and simpler proof of the complexity dichotomy for MMSNP. It further proves dichotomies for two significant classes of structures that are first-order reducts of $(\mathbb{Z}, <, +)$. The thesis shows a strong mathematical background and a great maturity in Universal Algebra, Model Theory, and Ramsey theory, as well as a strong sense of Computational Complexity.

Background of the Thesis

A Constraint Satisfaction Problem (CSP) can be formulated as a decision problem where the input consists of two structures A, B, and the aim is to determine whether there is a homomorphism from A to B. Much of the study has focused on *non-uniform CSP*, where the structure B is fixed. E.g., if B is a triangle graph then CSP is just the 3-colourability problem. Feder and Vardi conjectured that, for each finite structure B, CSP is either

[1] www.cs.tu-dortmund.de/nps/en/Alumni/index.html

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solvable in polynomial time or NP-complete. This famous *dichotomy conjecture* has spawned considerable research and has been confirmed independently by Bulatov and Zhuk in 2017, one of the most significant results in Theoretical Computer Science of the last decade.

However, many problems such as the feasibility problem for a given system of linear inequalities over the rational numbers can be stated in the form of CSP over a set definable in an infinite structure B, but not for any finite B. The case of a general infinite structure is easily shown to be too broad to admit any kind of classification of CSPs. An active research program has been to look at structures that are well-behaved. One class of structures that have received attention are the ω-categorical structures, which include the rational order and the integers with equality. Within these, particular attention has been paid to structures $\mathfrak{M}$ that are *finitely-bounded* and *homogeneous*. The former means that the finite structures that can be embedded in $\mathfrak{M}$ are universally axiomatizable, while the latter means that every isomorphism on a finite substructure of $\mathfrak{M}$ can be extended to $\mathfrak{M}$. Bodirsky and Pinsker conjectured that the dichotomy conjecture holds for CSPs defined over a reduct of a finitely bounded homomogeneous structure. This *dichotomy conjecture for infinite structures* is still open, and has been a touchstone for much further investigation.

Another line of work has been the study of CSP over structures definable from structures related to arithmetic, such as the integers with addition and order. Here the motivation is not from the dichotomy conjecture but from the high relevance of these problems for applications.

Contributions of the Thesis

Mottet's thesis makes significant contributions to both lines of research, the case of finitely bounded homogeneous structures and the case of structures related to arithmetic.

In the case of finitely bounded homogeneous structures, the first major contribution of the thesis is a reduction that allows one to lift tractability results from the finite case to the infinite case. Tractability here means membership in PTIME, but the reduction can also be used to lift results on definability of a CSP via Datalog, a stronger condition than PTIME membership. The reduction and corresponding lifting results give a uniform approach to many tractability results in the literature. A second contribution is a means to lift intractability results from the finite to the infinite case. By combining the two lifting techniques, Mottet is able to establish the Bodirsky-Pinsker for a special case of finitely bounded homogeneous structures, those that are definiable over an infinite set with interpretations for a set of unary predicates.

A second contribution in the same line deals with CSPs that are definable in a certain logic: *Monotone Monadic Strict NP* (MMSNP). Feder and Vardi gave a randomized PTIME reduction between (ordinary finite-domain) CSPs and MMSNP, and Kun showed that this reduction could be de-randomized. Putting this together with the recent proof of the dichotomy conjecture, we see that every MMNSP is either NP-complete or in PTIME. The thesis provides a new proof of this result, avoiding derandomization but instead going through the infinite case. In the process, the proof resolves a number of other questions concerning CSPs definable over infinite structures.

The second half of the thesis turns to CSPs related to arithmetic. A first contribution in this line deals with "numeric CSPs": CSPs over structures whose relations are first-order definable in a reduct of the integers with the linear ordering relation. Mottet proves the dichotomy conjecture for such structures, in the process obtaining a characterization of the tractable cases. A second significant result establishes the dichotomy conjecture for CSPs over the integers with addition and a single constant.

In summary, the thesis contributes a set of fundamental results that are relevant to a number of communities within computer science. The depth and breadth of the techniques applied are also extremely impressive, with the proofs making use of a dazzling variety of techniques, ranging from model theory, universal algebra, combinatorics, and complexity theory.

Biographical Sketch

Antoine Mottet obtained a Bachelor's degree in Computer Science at *École Normale Supérieure de Lyon*, France, and a Master's degree in Computer Science at *École Normale Supérieure de Cachan*, France. His PhD work was carried out at the *Technische Universität Dresden* under the supervision of Manuel Bodirsky. Since completing his PhD in 2018, he has been working as a postdoctoral researcher at *Charles University* in Prague, Czech Republic.

Jury

The jury for the **Ackermann Award 2019** consisted of eight members, two of them *ex officio*, namely, the president and the vice-president of EACSL. In addition, the jury also included a representative of SIGLOG (the ACM Special Interest Group on Logic and Computation).

The members of the jury were:

- Christel Baier (TU Dresden),
- Michael Benedikt (University of Oxford),
- Mikołaj Bojańczyk (University of Warsaw),
- Jean Goubault-Larrecq (ENS Paris-Saclay),
- Dexter Kozen (Cornell University),
- Dale Miller (INRIA Saclay), SigLog representative,
- Simona Ronchi Della Rocca (University of Torino), the vice-president of EACSL,
- Thomas Schwentick (TU Dortmund University), the president of EACSL.

Previous winners

Previous winners of the Ackermann Award were

2005, Oxford:
Mikołaj Bojańczyk from Poland,
Konstantin Korovin from Russia, and
Nathan Segerlind from the USA.

2006, Szeged:
Balder ten Cate from the Netherlands, and
Stefan Milius from Germany.

2007, Lausanne:
Dietmar Berwanger from Germany and Romania,
Stéphane Lengrand from France, and
Ting Zhang from the People's Republic of China.

2008, Bertinoro:
Krishnendu Chatterjee from India.

2009, Coimbra:
Jakob Nordström from Sweden.

2010, Brno:
no award given.

2011, Bergen:
Benjamin Rossman from USA.
2012, Fontainebleau:
Andrew Polonsky from Ukraine, and
Szymon Toruńczyk from Poland.
2013, Turin:
Matteo Mio from Italy.
2014, Vienna:
Michael Elberfeld from Germany.
2015, Berlin:
Hugo Férée from France, and
Mickael Randour from Belgium.
2016, Marseille:
Nicolai Kraus from Germany
2017, Stockholm:
Amaury Pouly from France.
2018, Birmingham:
Amina Doumane from France.

Detailed reports on their work appeared in the CSL proceedings and are also available on the EACSL homepage.