The Ackermann Award 2018

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Abstract

The Ackermann Award is the EACSL Outstanding Dissertation Award for Logic in Computer Science. It is presented during the annual conference of the EACSL (CSL'xx). This contribution reports on the 2018 edition of the award.

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Category Award Description

1 The Ackermann Award 2018

The fourteenth Ackermann Award is presented at CSL'18 in Birmingham, UK. The 2018 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 2016 and 31 December 2017. The Jury received eleven nominations for the 2018 Award. The candidates came from a number of different countries around the world. The institutions at which the nominees obtained their doctorates represent six different countries in Asia, Europe and North America.

The EACSL Ackermann Award is generously sponsored by the association *Alumni der Informatik Dortmund e. V.*[1]

The topics covered a wide range of topics 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 **2018 Ackermann Award** to:

Amina Doumane from France, for her thesis
On the Infinitary Proof Theory of Logics with Fixed Points
approved by the Université Paris Diderot in 2017.

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

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Citation

Amina Doumane receives the *2018 Ackermann Award* of the European Association of Computer Science Logic (EACSL) for her thesis

On the infinitary proof theory of logics with fixed points.

Doumane's thesis is a new and significant contribution to proof theory in computation, focussing on logics extended with fixpoints. As a main contribution, it gives the first constructive proof of the completeness of Kozen's axiomatisation of the linear-time mu-calculus, which is an ingenious application of automata over infinite words. Another large part studies the infinitary proof theory of a fixpoint extension of multiplicative additive linear logic, a challenging topic due to the non-well-founded nature of infinitary proofs. The dissertation is lengthy, but sustains a high level of technical sophistication throughout, including a masterful and innovative blend of proof-theoretic and automata-theoretic techniques.

Background of the Thesis

Amina Doumane's thesis lies at the interface between two of the main areas of logic in computer science: proof theory and verification.

Proof theory deals with the definition of formal proof objects and the study of their structure, with a particular emphasis on various forms of computational content in proofs. Indeed, for about fifty years, several proof transformations originally designed to obtain normal forms of proofs (typically, to ease their study in logic) have been shown to correspond to interesting computational mechanisms, often independently implemented in programming languages. This conceptual bridge is known as the *Curry-Howard correspondence*. In its simplest form, it relates proof normalization in natural deduction for intuitionistic logic with program reductions in lambda calculus. It has been further extended to incorporate classical logic, sequent calculus, cut elimination, and focalization, generating in this way a fruitful dialogue between logic and programming.

In *verification*, logic also plays a central role. In this context, one is particularly interested in logics that allow expressive specifications of software systems while remaining decidable. Automata theory is often used for this purpose, exploiting its deep connections with the logics under consideration. One may also rely on deductive systems such as analytic tableaux that are similar to those studied in proof theory, but appear here in the context of verification algorithms.

Amina Doumane has worked more specifically on fixed point logics, also called μ-calculi, such as the modal μ-calculus, but also on first-order logic extended with (co)inductive predicates. To reason informally about these logics, various (co)inductive proof principles have been proposed. Dr. Doumane has formalized and transferred these principles to first-order logic and studied their properties extensively. She allows infinite proofs (non-well-founded derivation trees) while imposing some validity condition to rule out unsound derivations, to obtain formal proofs that may be seen as modelling the informal proofs by infinite descent. This approach, which can be found in some form in many tableaux systems for μ-calculi, is of particular interest since it introduces objects which are close to the (infinitary) semantics of the considered fixed point logics. It often yields useful support for algorithmic methods and provides an intermediate system between semantics and finitary proof systems.

Despite the natural character and the usefulness of such infinitary deduction systems, no general framework had been developed for their study at the beginning of Amina Doumane's PhD. Moreover, infinite proofs had not been considered from the point of view of structural proof theory. The only exception was the seminal work of Luigi Santocanale who proved, together with Jérôme Fortier, that an infinitary sequent calculus – for a purely additive logic – satisfied the cut-elimination property. However, the logical fragment they captured was quite restrictive.

Contributions of the Thesis

In this setting, Amina Doumane has obtained several important results during her PhD, while developing her scientific vision:

- After some initial results on the semantics of linear logic with fixed points in Ludics, the thesis investigates completeness problems in more expressive logics and develops potential connections with ω-automata. Amina Doumane considered the linear-time μ-calculus and, together with David Baelde, Lucca Hirschi and Alexis Saurin, obtained a completeness result restricted to a fragment corresponding to inclusions of Büchi automata. This result is a consequence of the completeness theorem proved by Kaivola in 1995, but the approach differs, relying on infinite proofs to obtain a new and more perspicuous argument.
- The previous work crucially relies on structural aspects of infinitary calculi (notably, the proper distinction of occurrences) which come from proof theory. This has motivated further developments aimed at giving a truly proof-theoretic status to infinite proofs. Specifically, Amina has shown that the infinitary calculus for multiplicative additive linear logic enjoys cut elimination and focalization. These two results form the basis of the modern study of proofs, an open and exciting field of future research, especially regarding the computational expressivity of these calculi. One should note here that, while this result adds only multiplicative connectives to the earlier result by Fortier and Santocanale, this addition is both highly challenging and significant, since it now seems easy to obtain cut elimination for richer systems, e.g., classical first-order logic with fixed points.
- Finally, Amina has pursued her own earlier work on completeness for linear-time μ-calculus. By identifying new connections between infinitary proofs and automata theory (e.g., non-determinization of alternating parity automata), she has managed to obtain a new *constructive* completeness argument; previous completeness proofs were non-constructive. For this result, published at LICS 2017, she has received the *Kleene award for the best student paper.*

Biographical Sketch

Amina Doumane completed her early education in Khouribga and Rabat, Morocco. She obtained a *Mathematical logics master MPRI* in 2013 and and a *Computer Science master MPRI* in 2014 at University Paris Diderot. Her PhD work was carried out at the University Paris Diderot under the supervision of David Baelde, Pierre-Louis Curien and Alexis Saurin. Since completing her PhD in 2017, she has been working as a postdoctoral researcher with Damien Pous at ENS Lyon. Besides the already mentioned *Kleene award for the best student paper* at LICS 2017, she received the *Gilles Kahn thesis prize* from the *Société Informatique de France* for her PhD thesis.

2 Jury

The jury for the **Ackermann Award 2018** 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),
- Mikołaj Bojańczyk (University of Warsaw),
- Anuj Dawar (University of Cambridge),
- Dexter Kozen (Cornell University),
- Dale Miller (INRIA Saclay), SigLog representative,
- Luke Ong (University of Oxford),
- Simona Ronchi Della Rocca (University of Torino), the vice-president of EACSL,
- Thomas Schwentick (TU Dortmund University), the president of EACSL.

3 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.

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.

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