The Ackermann Award 2015

Anuj Dawar, Dexter Kozen, and Simona Ronchi Della Rocca

Members of the Jury of the EACSL Ackermann Award

Abstract

The eleventh Ackermann Award is presented at CSL'15 in Berlin, Germany. This year, again, the EACSL Ackermann Award is generously sponsored by the Kurt Gödel Society. Besides providing financial support for the Ackermann Award, the Kurt Gödel Society has also committed to inviting the recipients of the Award for a special lecture to be given to the Society in Vienna.

The 2015 Ackermann Award was open to PhD dissertations in topics specified by the CSL and LICS conferences, which were formally accepted as theses for the award of a PhD degree at a university or equivalent institution between 1 January 2013 and 31 December 2014. The Jury received ten nominations for the Ackermann Award 2015. The candidates came from a number of different countries across the world. The institutions at which the nominees obtained their doctorates represent eight countries in Europe, North America, and the Middle East.

The topics covered a wide range of Logic and Computer Science as represented by the LICS and CSL Conferences. All submissions were of a very high standard and contained remarkable contributions to their particular fields. The Jury wishes to extend its congratulations to all nominated candidates for their outstanding work. The Jury encourages them to continue their scientific careers and hopes to see more of their work in the future.

The task of the jury proved very difficult, and opinions were divided. In the end, the jury decided to award the **2015 Ackermann Award** jointly to two dissertations. The winners are (in alphabetical order):

- Hugo Férée from France, for his thesis
  Complexité d'ordre supérieur et analyse récursive
  approved by the Université de Lorraine, France, in 2014,
  supervised by Jean-Yves Marion and Mathieu Hoyrup; and
- Mickael Randour from Belgium, for his thesis
  Synthesis in Multi-Criteria Quantitative Games
  approved by the Université de Mons, Belgium, in 2014,
  supervised by Véronique Bruyère and Jean-François Raskin.

Digital Object Identifier 10.4230/LIPIcs.CSL.2015.xv

1 Hugo Férée

Citation. Hugo Férée receives the *2015 Ackermann Award* of the European Association of Computer Science Logic (EACSL) for his thesis

Complexité d'ordre supérieur et analyse récursive.

His thesis establishes deep and original results related to a variety of topics in the complexity of analytic and higher-order functions. By identifying the intrinsic limitations of the traditional approaches, they enable one to see beyond them. They provide a higher-order complexity theory which has been lacking and will certainly be recognized and used in the future. A brief survey of the content of the thesis follows, organized thematically.

24th EACSL Annual Conference on Computer Science Logic (CSL 2015).
Editor: Stephan Kreutzer; pp. xv–xviii
Leibniz International Proceedings in Informatics
LIPICS Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

Complexity of higher order real functionals. The study of computability over real numbers dates back to Turing's 1936 paper and has been an active area of research ever since. In the early 1980s serious work began on studying resource-bounded computability over the reals. That is, understanding what is and is not feasibly computable over the reals for various notions of computational feasibility. Férée starts from the results of Kawamura and Cook about functionals over $\mathtt{C}[0,1]$, the space of continuous functions over the unit interval. Namely he studies the case of norms over real functions defined on such a space and obtains several results allowing us to understand how imposing restrictions on the computational resources of these functionals affects their analytical properties. He introduces a new analytical notion expressing that the norm of a function highly depends on the value of the function at a point. He relates this analytical notion to computability and complexity: if a norm highly depends on a point then in order to compute the norm of a function, this function has to be evaluated at this point. In particular if a norm is efficiently computable then it cannot depend on too many points.

Complexity in analysis. The extension of computability theory from the natural numbers to objects coming from mathematical analysis is now well understood. However complexity theory is more problematic, but some extensions are available. Kawamura and Cook developed complexity theory for spaces that can be suitably represented by functions from finite strings to finite strings (functions of order type 1). The problem is then to understand when this approach can be used. Férée obtains results identifying a topological property of the space that is necessary for this approach to work. More precisely, if the space $\mathtt{C}(\mathtt{X},\mathtt{R})$ of continuous functions from a space $\mathtt{X}$ to the real numbers admits a representation making the complexity of the evaluation, from $\mathtt{C}(\mathtt{X},\mathtt{R}) \times \mathtt{X} \to \mathtt{R}$, well-defined, then $\mathtt{X}$ must be σ-compact. This result suggests that using higher order functions to represent objects may help in extending complexity notions to other spaces.

Higher order complexity. Until now, no satisfactory notion of complexity at higher-types has been given. Classical complexity theory provides notions of complexity for functions from $\mathtt{N} \to \mathtt{N}$ (order 1 functions, for instance the class $\mathtt{FPTIME}$) as well as functions from $\mathtt{N} \to \mathtt{N}$ to $\mathtt{N} \to \mathtt{N}$ (order 2 functions, for instance the class $\mathtt{BFF}$). The class $\mathtt{BFF}$ is defined for any finite type, however it is not a complexity class in the sense that it is not defined as a class of functions computable with limited resources (such as polynomial time). One reason for that is that there is no obvious notion of size for inputs, when they are themselves higher order functionals. Férée makes use of game semantics in order to represent the computation of higher order functionals and to measure their size and complexity. More precisely, he uses as inputs strategies in some sequential games whose size is supplied through a computation model called a higher-order Turing machine, consisting of a Turing machine that dialogues with its oracle describing the input. Then, using higher-order polynomials, a higher-order analogue of the usual polynomials, he defines a class of polynomial-time computable strategies. Finally, he applies this framework to the games used to solve the full abstraction problem for the class of higher-order computable PCF-functions, so supplying a notion of complexity over PCF.

Biographical Sketch. Hugo Férée was born on 20 September 1988 in Nancy. After completing his schooling there, he was a student at the École Normale Supérieure in Lyon from 2008, obtaining a Master's degree in Theoretical Computer Science in 2011, awarded jointly with the Université Claude Bernard. He then returned to Lorraine to pursue a PhD, which he successfully defended in December 2014. He currently holds a post-doctoral position at the Technische Universität Darmstadt in Germany.

2 Mickael Randour

Citation. Mickael Randour receives the *2015 Ackermann Award* of the European Association of Computer Science Logic (EACSL) for his thesis

Synthesis in Multi-Criteria Quantitative Games.

His thesis contains important theoretical and practical contributions to the analysis of quantitative games and the synthesis of winning strategies. The contributions are technically challenging and practically relevant. Several notions introduced in the thesis significantly advance the state of the art and open important new research perspectives.

Background. Reactive systems are computer systems that maintain a continuous interaction with their environment. Examples of reactive systems include controllers embedded in cars and aeroplanes, computer system device drivers, and communication protocols in networks. Producing reactive systems that behave correctly is a notoriously challenging problem due to factors such as concurrency, uncertainty, and real-time constraints. Moreover, their correctness is often critical, as they frequently appear in contexts in which lives are at stake. A reactive system is typically modelled as a game between two players, the system and its environment. The correctness of the system is then expressed in terms of a winning condition in the game. Often these winning conditions involve quantitative measures such as mean-payoff, total-payoff, or energy constraints. The analysis of such games is notoriously difficult.

Contributions of the thesis. Randour makes a number of contributions that advance our understanding of the quantitative games, the algorithms for solving them, and the complexity of the associated decision problems. In doing so, he introduces innovative concepts that can have a lasting impact on the research field.

One important innovation is the first analysis of multiple simultaneous objectives. Another is the introduction and analysis of so-called window objectives, a conservative approximation of the standard mean-payoff and total-payoff objectives. It is shown that window objectives provide a conservative approximation of the classical mean-payoff and total-payoff measures, with complexities that break the previous barriers. Finally, the thesis studies tradeoffs between traditional worst-case and expected-case analysis. Previously, classical games typically involve an environment which is purely antagonistic and ask for strict guarantees, whereas stochastic models attempt to optimize the expected payoff, with no guarantee on individual outcomes. In this thesis, Randour has shown that one can find a reasonable trade-off between these aspects: good expected performance in the everyday situations while ensuring a strict performance threshold even in the event of unlikely worst-case circumstances.

Biographical Sketch. Mickael Randour was born on 9 July 1984 in La Louvière. All of his higher education was completed at the Université de Mons, where he obtained a Bachelor's degree in 2008, a Master's degree in 2010 and a PhD in April 2014, all of them in Computer Science. In 2010 he was the recipient of an award from the *Fondation Emile Cornez* for the best graduating student from the university. He is currently a postdoctoral researcher at the École Nomrale Supérieure de Cachan in France.

3 Jury

The Jury for the **Ackermann Award 2015** consisted of eight members, two of them *ex officio*, namely, the president and the vice-president of EACSL. This year, for the first time, the jury also included a representative of SigLog (the ACM Special Interest Group on Logic and Computation).

The members of the jury were:

- Thierry Coquand (Chalmers University of Gothenburg),
- Anuj Dawar (University of Cambridge), the president of EACSL,
- Dexter Kozen (Cornell University), SigLog representative,
- Orna Kupferman (Hebrew University of Jerusalem),
- Daniel Leivant (Indiana University, Bloomington),
- Luke Ong (University of Oxford),
- Jean-Éric Pin (CNRS and Université Paris 7),
- Simona Ronchi Della Rocca (University of Torino), the vice-president of EACSL.

3.1 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.

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