Tributes 48

60 Jahre DVMLG

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The history of logic in Darmstadt goes back to 1874, when Ernst Schröder (1841–1902) was appointed as a professor at the *Polytechnikum Darmstadt* (1874–1876) which in 1877 became the *Technische Hochschule Darmstadt*.

The precursor of the current research group in logic was created in the year 1970 when Rudolf Wille (1937–2017) founded the research group *AG1: Allgemeine Algebra*. It was enlarged in 1971 with the appointments of Peter Burmeister (1941–2019) and Klaus Keimel (1939–2017) as new professors.[1] Later, Christian Herrmann (born 1943), who had received his doctorate under the supervision of Wille in 1972, became an *außerplanmäßiger Professor* (extraordinary professor) in this group.

In addition to universal algebra, topics of AG1 were partial and topological algebraic structures, discrete mathematics, and lattice theory involving aspects of decidability and axiomatizability.

Also in 1971, Peter Zahn (born 1930) came to Darmstadt joining the research group of Detlef Laugwitz, where he completed his Habilitation in 1973 and later became *außerplanmäßiger Professor*; after Laugwitz's retirement, Zahn joined the logic group working primarily on predicative foundations of mathematics influenced by Paul Lorenzen. In 1978, Bernhard Ganter (born 1949), who had received his doctorate under the supervision of Rudolf Wille in 1974, joined the AG1 as professor but moved in 1993 to the TU Dresden.

The research group on *Formal Concept Analysis* emerged from AG1; this group focused on graph-based logic systems for concept analysis in knowledge acquisition and processing applications (Burmeister, Ganter, Wille). Research in this direction is still being pursued in co-operation with the *Ernst Schröder Zentrum für Begriffliche Wissensverarbeitung* e.V. which started in 1983 with Wille as its first *Sprecher*.

During the second half of the 1970s Darmstadt was one site of the multinational seminar on Dana Scott's continuous lattices resulting in the famous *Compendium of Continuous Lattices* published with Springer in 1980. The Darmstadt site was represented by Klaus Keimel and his student Gerhard

[1] Logic has been also represented at the Computer Science Department, notably by Wolfgang Bibel (born 1938), one of the pioneers of Artificial Intelligence in Germany, who founded the research group of *Intellektik* (1988–2004).

B. Löwe & D. Sarikaya (*eds.*), ***60 Jahre DVMLG*** (2022), pp. 133–137.

Gierz who also worked on sheaf representations of ordered algebraic structures. Karl-Heinrich Hofmann (born 1932), another co-author of this volume, joined the Mathematics Department in Darmstadt in 1982.

Keimel was also the main contributor and organizer of the later edition *Continuous Lattices and Domains* which appeared in 2003 with Cambridge University Press. This was a strongly revised version which systematically treated also the more general case of domains, i.e., directed complete partial orders lacking a top element, which are of central importance in the denotational semantics of programming languages.

One may add here that Gerd Mitschke worked in Darmstadt during the first half of the 1970s and organized in Darmstadt one of the first informal meetings on λ-calculus (20–25 August 1973) gathering the few experts who initiated the renaissance of this subject including Henk Barendregt, Roger Hindley, Gordon Plotkin and Chris Wadsworth. Mitschke's work was mainly syntactical and disjoint from the group of people interested in continuous lattices.

In 1995 Klaus Keimel, the newly appointed Thomas Streicher (born 1958) and the aforementioned Christian Herrmann started the *AG14: Logik und mathematische Grundlagen der Informatik* (Logic and the Mathematical Foundations of Computer Science) while the remaining AG1 focused on *Universal Algebra* (later joined by Thomas Ihringer, 1953–2015, who became *außerplanmäßiger Professor* in 1996) and *Formal Concept Analysis* (Burmeister, Wille).

Martin Hofmann (1965–2018), who together with Streicher introduced the groupoid model for Martin-Löf type theory, worked in the AG14 as research assistant from 1995 to 1998 and received his Habilitation in 1999 when he was already lecturer at the University of Edinburgh. He also joined the AG14 as a professor in the summer term 2001 before he moved to the Department of Computer Science of the *Ludwig-Maximilians-Universität München*. In this period starting with his habilitation work, he developed his type-theory based approach to characterize computational complexity classes in a logical way.

Both the AG1 and the AG14 were re-united around 2003/2004 in connection with the new appointments of Martin Otto (born 1961) in 2003 and—as successor of Rudolf Wille—Ulrich Kohlenbach (born 1962) in 2004 and the research group was renamed in *AG Logik*.

The logic group organized the *Colloquium Logicum 2008* (an installment of the biannual conference coordinated by the DVMLG) at TU Darmstadt with a special evening lecture by Professor Georg Kreisel in connection with his 85th birthday.

From 2010 to 2015, Martin Ziegler (born 1968, now Professor at KAIST) joined the AG Logik. With Kohlenbach and Ziegler as principal investiga-

PhD candidate	Year	Supervisor
Julian Bitterlich	2019	Otto
Eyvind Martol Briseid	2009	Kohlenbach
Felix Canavoi	2018	Otto
Jaime Gaspar	2011	Kohlenbach
Alexander Kartzow	2011	Otto
Daniel Körnlein	2016	Kohlenbach
Angeliki Koutsoukou-Argyraki	2016	Kohlenbach
Alexander P. Kreuzer	2012	Kohlenbach
Peter Lietz	2004	Streicher
Tobias Löw	2006	Streicher
Carsten Rösnick	2014	Ziegler
Pavol Safarik	2013	Kohlenbach
Florian Steinberg	2016	Kohlenbach & Ziegler
Jonathan Weinberger	2021	Streicher

FIGURE 1. PhD graduations of the *AG Logik* in alphabetic order

tors, the *AG Logik* took part in the Darmstadt-Tokyo PhD School on Mathematical Fluid Dynamics (2011–2016, DFG International Research Training Group 1529). Since 2017, Kord Eickmeyer (born 1979) has been a permanent lecturer in the logic group. In 2021, Pascal Schweitzer, who had been appointed as professor in the *AG Didaktik* (Research Group: Mathematics Education), became also a co-member of the *AG Logik* given the close connection between his research and the area of Logic in Computer Science. Finally, in 2021, Anton Freund (born 1990), who had been a postdoctoral researcher in Kohlenbach's research group, received a prestigious *Emmy-Noether-Programm* award from the German Science Foundation (DFG) and was appointed in October 2021 as *Assistenzprofessor* in the *AG Logik*.

In recent years, the *AG Logik* has been representing the subject area of mathematical logic viewed as an applied foundational discipline between mathematics and computer science. Research activities focus on the application of proof-theoretic, recursion-theoretic, categorical, algebraic and model-theoretic methods from mathematical logic to mathematics and computer science. Besides classical mathematical logic (represented by proof theory, computability theory and model theory) this involves proof mining, constructive type theory, categorical logic, universal algebra, domain and lattice theory, finite model theory and complexity theory. Within mathematics, a primary field of applications in the proof- and recursion-theoretic setting is the extraction of new information from proofs in areas of core

Habilitation candidate	Year	Mentor
Achim Blumensath	2008	Otto
Kord Eickmeyer	2020	Otto
Laurenţiu Leuştean	2009	Kohlenbach
Vassilis Gregoriades	2015	Kohlenbach
Sam Sanders	2022	Kohlenbach
Matthias Schröder	2016	Streicher
Benno van den Berg	2011	Streicher

FIGURE 2. Habilitations of the Logic Group in alphabetic order

mathematics (proof mining: Kohlenbach). The goal of this applied reorientation of proof theory is the use of proof-theoretic transformations such as appropriate functional interpretations for the analysis of prima facie non-effective proofs in mathematics for the purpose of extracting new results from given proofs. This concerns qualitative aspects such as generalizations of proofs (e.g., from a linear Banach space setting to metric structures) and new uniformity results (independence of existence assertions from certain parameters) as well as quantitative aspects such as the extraction of explicit rates of convergence or—in cases where this is precluded—rates of metastability, oscillation bounds and other effective data from proofs. This novel proof mining approach, for which the logic group in Darmstadt is internationally recognized as the leading center, has been applied in many areas of (mostly nonlinear) analysis including approximation theory, fixed point theory, ergodic theory, abstract Cauchy problems, non-smooth optimization, hyperbolic geometry, pursuit-evasion games.

Complementing this applied proof-theoretic research, also foundational goals are pursued such as the calibration of the proof-theoretic strength of mathematical theorems, e.g., in combinatorics and concrete independence results (Freund). The proof-theoretic research is also connected to methods in categorical logic, constructive systems of set theory and type theory and homotopic type-theoretic foundations (Streicher) as well as dilators and ordinal notation systems (Freund).

The model-theoretic research of the logic group has close links to discrete mathematics (graphs and hypergraphs, Eickmeyer, Otto, Schweitzer) and algebra (group theory, Schweitzer).

Concerning logic in computer science and the mathematical foundations of computer science, major activities revolve around issues of semantics. On the one hand, this involves the mathematical foundation of the semantics and the logic of programming languages (Streicher); on the other hand,

logics and formal systems are investigated in the sense of model theoretic semantics, with respect to expressiveness and definability, with an emphasis on computational aspects (algorithmic and finite model theory, descriptive complexity: Eickmeyer, Otto, Schweitzer) as well as practical and theoretical aspects of the graph isomorphism problem and algorithmic symmetry detection. Besides specific application domains in computer science, as, e.g., verification, data bases and knowledge representation, there is work on foundational issues in the areas of computability and complexity, as well as type theory and category theory (Streicher).

Overall, the logic group forms an internationally well connected cluster of expertise, with a characteristic emphasis on the connections that mathematical logic has to offer, both with respect to other areas within mathematics and with respect to logic in computer science.

Since the formation of the *AG Logik* in its current form in 2004 many doctoral dissertations and habilitations have been completed, listed in Figures 1 and 2.

The logic group conducted many research projects with external funding such as individual DFG projects in the areas of finite model theory (Blumensath, Otto), proof mining (Kohlenbach) and semantics (Keimel), participated in DFG-cooperation projects with, e.g., Novosibirsk (Herrmann, Keimel, Kohlenbach, Streicher) and South Africa (Keimel, Kohlenbach, Streicher) and took part in the EU working group APPSEM II (Keimel, Kohlenbach, Streicher, Ziegler).

Current research projects are *Continuous Order Transformations: A Bridge between Ordinal Analysis, Reverse Mathematics, and Combinatorics* (Emmy-Noether-Programm; Freund), *Proof Mining in Convex Optimization and related areas* (DFG KO 1737/6-2; Kohlenbach), and *Next generation algorithms for grabbing and exploiting symmetry* (ENGAGES, ERC Consolidator Grant; Schweitzer). The Logic Group takes also part in the new Research Profile Theme *Cognitive Science* of the TU Darmstadt (Kohlenbach).