

30th International Conference on Types for Proofs and Programs

TYPES 2024, June 10–14, 2024, Copenhagen, Denmark

Edited by

Rasmus Ejlers Møgelberg
Benno van den Berg



LIPICs

Editors

Rasmus Ejlers Møgelberg 

IT University of Copenhagen, Denmark

mogel@itu.dk

Benno van den Berg 

University of Amsterdam, The Netherlands

b.vandenberg3@uva.nl

ACM Classification 2012

Theory of computation → Categorical semantics; Theory of computation → Constructive mathematics;

Theory of computation → Denotational semantics; Theory of computation → Type theory; Theory of

computation → Lambda calculus; Software and its engineering → Functional languages

ISBN 978-3-95977-376-8

Published online and open access by

Schloss Dagstuhl – Leibniz-Zentrum für Informatik GmbH, Dagstuhl Publishing, Saarbrücken/Wadern, Germany. Online available at <https://www.dagstuhl.de/dagpub/978-3-95977-376-8>.

Publication date

July, 2025

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <https://portal.dnb.de>.

License

This work is licensed under a Creative Commons Attribution 4.0 International license (CC-BY 4.0):

<https://creativecommons.org/licenses/by/4.0/legalcode>.



In brief, this license authorizes each and everybody to share (to copy, distribute and transmit) the work under the following conditions, without impairing or restricting the authors' moral rights:

- Attribution: The work must be attributed to its authors.

The copyright is retained by the corresponding authors.

Digital Object Identifier: 10.4230/LIPIcs.TYPES.2024.0

ISBN 978-3-95977-376-8

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

LIPIcs – Leibniz International Proceedings in Informatics

LIPIcs is a series of high-quality conference proceedings across all fields in informatics. LIPIcs volumes are published according to the principle of Open Access, i.e., they are available online and free of charge.

Editorial Board

- Christel Baier (TU Dresden, DE)
- Roberto Di Cosmo (Inria and Université Paris Cité, FR)
- Faith Ellen (University of Toronto, CA)
- Javier Esparza (TU München, DE)
- Holger Hermanns (Universität des Saarlandes, Saarbrücken, DE and Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Wadern, DE)
- Daniel Král' (Leipzig University, DE and Max Planck Institute for Mathematics in the Sciences, Leipzig, DE)
- Sławomir Lasota (University of Warsaw, PL)
- Meena Mahajan (Institute of Mathematical Sciences, Chennai, IN – Chair)
- Chih-Hao Luke Ong (Nanyang Technological University, SG)
- Eva Rotenberg (Technical University of Denmark, Lyngby, DK)
- Pierre Senellart (ENS, Université PSL, Paris, France)
- Alexandra Silva (Cornell University, Ithaca, US)

ISSN 1868-8969

<https://www.dagstuhl.de/lipics>

To the memory of Peter Aczel and Thomas Streicher.

■ Contents

Preface	
<i>Rasmus Ejlers Møgelberg and Benno van den Berg</i>	0:ix
List of Authors	
.....	0:ix
Papers	
Formalizing equivalences without tears	
<i>Tom de Jong</i>	1:1–1:6
Constructive substitutes for König’s lemma	
<i>Dominique Larchey-Wendling</i>	2:1–2:23
A Foundation for Synthetic Stone Duality	
<i>Felix Cherubini, Thierry Coquand, Freek Geerligs, and Hugo Moeneclaey</i>	3:1–3:20
Separating Terms by means of Multi Types, Coinductively	
<i>Adrienne Lancelot</i>	4:1–4:18
Implementing a Type Theory with Observational Equality, using Normalisation by Evaluation	
<i>Matthew Sirman, Meven Lennon-Bertrand, and Neel Krishnaswami</i>	5:1–5:22
Data Types with Symmetries via Action Containers	
<i>Philipp Joram and Niccolò Veltri</i>	6:1–6:22
Synthetic 1-Categories in Directed Type Theory	
<i>Jacob Neumann and Thorsten Altenkirch</i>	7:1–7:23
Effective Kan Fibrations for W-Types in Homotopy Type Theory	
<i>Shinichiro Tanaka</i>	8:1–8:20
Complexity of cubical cofibration logics I: coNP-complete examples	
<i>Robert Rose and Daniel R. Licata</i>	9:1–9:21



■ Preface

The TYPES meetings are a forum to present new and ongoing work in all aspects of type theory and its applications, especially in formalized and computer assisted reasoning and computer programming. This volume constitutes the post-proceedings of the 30th International Conference on Types for Proofs and Programs, TYPES 2024, that was held at the IT University of Copenhagen, Denmark, from 10 to 14 June 2024.

The meetings from 1990 to 2008 were annual workshops corresponding to five consecutive EU-funded networking projects. Since 2009, TYPES has been run as an independent conference series. Previous TYPES meetings were organised by Antibes (1990), Edinburgh (1991), Båstad (1992), Nijmegen (1993), Båstad (1994), Torino (1995), Aussois (1996), Kloster Irsee (1998), Lökeberg (1999), Durham (2000), Berg en Dal near Nijmegen (2002), Torino (2003), Jouy-en-Josas near Paris (2004), Nottingham (2006), Cividale del Friuli (2007), Torino (2008), Aussois (2009), Warsaw (2010), Bergen (2011), Toulouse (2013), Paris (2014), Tallinn (2015), Novi Sad (2016), Budapest (2017), Braga (2018), Oslo (2019), Turin (2020), Leiden (2021), Nantes (2022), Valencia (2023). The 2020 and 2021 editions were virtual, because of the SARSCoV-2 pandemics.

The TYPES areas of interest include, but are not limited to: Foundations of type theory and constructive mathematics; Homotopy type theory; Applications of type theory; Dependently typed programming; Industrial uses of type theory technology; Meta-theoretic studies of type systems; Proof assistants and proof technology; Automation in computer-assisted reasoning; Links between type theory and functional programming; Formalizing mathematics using type theory; Type theory in linguistics.

The TYPES conferences are all based on contributed talks based on short abstracts; reporting work in progress and work presented or published elsewhere. A post-proceedings volume is prepared after the conference, whose papers must represent unpublished work. Submitted papers to the post-proceedings are subject to a full peer-review process.

The conference program of TYPES 2024 consisted of 57 contributed talks, and five invited talks by Brigitte Pientka (McGill University, Canada), Egbert Rijke (University of Ljubljana, Slovenia), Talia Ringer (University of Illinois at Urbana-Champaign, USA), Nicola Gambino (University of Manchester, UK), and Michael Rathjen (University of Leeds, UK). The last two of these constituted a special session in memory of Peter Aczel, who passed away in August 2023. This volume is dedicated to the memory of him, and of Thomas Streicher, who passed away in January 2024.

The conference was a successful event with 109 registered participants. All the details of the conference can be found at <https://types2024.itu.dk/>.


For the post-proceedings, 13 papers were initially submitted, out of which 9 were accepted. We thank all the authors and reviewers for their hard work to make this possible!


Benno van den Berg and Rasmus Ejlers Møgelberg, May 2025.





■ List of Authors


Thorsten Altenkirch  (7)
University of Nottingham, UK


Felix Cherubini  (3)
University of Gothenburg, Sweden;
Chalmers University of Technology,
Gothenburg, Sweden


Thierry Coquand  (3)
University of Gothenburg, Sweden;
Chalmers University of Technology,
Gothenburg, Sweden

Tom de Jong  (1)
School of Computer Science,
University of Nottingham, UK

Freek Geerligs  (3)
University of Gothenburg, Sweden;
Chalmers University of Technology,
Gothenburg, Sweden


Philipp Joram  (6)
Department of Software Science,
Tallinn University of Technology, Estonia


Neel Krishnaswami  (5)
University of Cambridge, UK


Adrienne Lancelot  (4)
Inria & LIX, École Polytechnique, UMR 7161,
Palaiseau, France; Université Paris Cité, CNRS,
IRIF, F-75013, Paris, France


Dominique Larchey-Wendling  (2)
Université de Lorraine, CNRS, LORIA,
F-54000 Nancy, France

Meven Lennon-Bertrand  (5)
University of Cambridge, UK


Daniel R. Licata  (9)
Dept. of Mathematics & Computer Science,
Wesleyan University, Middletown, CT, USA


Hugo Moeneclaey  (3)
University of Gothenburg, Sweden;
Chalmers University of Technology,
Gothenburg, Sweden

Jacob Neumann  (7)
University of Nottingham, UK

Robert Rose  (9)
Dept. of Mathematics & Computer Science,
Wesleyan University, Middletown, CT, USA

Matthew Sirman  (5)
University of Cambridge, UK

Shinichiro Tanaka  (8)
Institute for Logic, Language and Computation,
University of Amsterdam, The Netherlands

Niccolò Veltri  (6)
Department of Software Science,
Tallinn University of Technology, Estonia

30th International Conference on Types for Proofs and Programs (TYPES 2024).

Editors: Rasmus Ejlers Møgelberg and Benno van den Berg



Leibniz International Proceedings in Informatics

Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

