

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, Lancaster, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Zurich, Switzerland*

John C. Mitchell

*Stanford University, Stanford, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*TU Dortmund University, Dortmund, Germany*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Gerhard Weikum

*Max Planck Institute for Informatics, Saarbrücken, Germany*

More information about this series at <http://www.springer.com/series/7407>

Phillip James · Markus Roggenbach (Eds.)

# Recent Trends in Algebraic Development Techniques

23rd IFIP WG 1.3 International Workshop, WADT 2016  
Gregynog, UK, September 21–24, 2016  
Revised Selected Papers

*Editors*  
Phillip James  
Swansea University  
Swansea  
UK

Markus Roggenbach  
Swansea University  
Swansea  
UK

ISSN 0302-9743                      ISSN 1611-3349 (electronic)  
Lecture Notes in Computer Science  
ISBN 978-3-319-72043-2              ISBN 978-3-319-72044-9 (eBook)  
<https://doi.org/10.1007/978-3-319-72044-9>

Library of Congress Control Number: 2017960875

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

© IFIP International Federation for Information Processing 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature  
The registered company is Springer International Publishing AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Preface

The 23rd International Workshop on Algebraic Development Techniques (WADT 2016) took place in Gregynog, Wales, UK, during September 21–24, 2016. The workshop took place under the auspices of IFIP WG 1.3 and was organized by the Department of Computer Science of Swansea University, UK. At the workshop, there were three invited talks and 20 contributed presentations, covering specification languages such as Event-B, CASL, and Maude, foundations of system specification such as institutions, monads, logics and their combinations, axiomatizations of data types, graph models and graph transformations, and applications including algebraic databases, service-oriented computing, ontologies, and the Internet of Things. Participants of the workshop travelled from Argentina, Canada, France, Germany, Ireland, Italy, The Netherlands, Norway, Poland, Portugal, Spain, Sweden, the USA, and the UK. This volume contains selected, peer-reviewed papers that were invited for submission after the workshop.



**Fig. 1.** Participants of WADT 2016 at Gregynog.

The algebraic approach to system specification encompasses many aspects of the formal design of software systems. Originally born as formal method for reasoning about abstract data types, it now covers new specification frameworks and programming paradigms (such as object-oriented, aspect-oriented, agent-oriented, logic, and higher-order functional programming) as well as a wide range of application areas (including information systems, concurrent, distributed, and mobile systems). The workshop provided an opportunity to present recent and ongoing work, to meet colleagues, and to discuss new ideas and future trends. Typical topics of interest are:

- Foundations of algebraic specification
- Other approaches to formal specification, including process calculi and models of concurrent, distributed, and mobile computing
- Specification languages, methods, and environments
- Semantics of conceptual modelling methods and techniques
- Model-driven development
- Graph transformations, term rewriting, and proof systems
- Integration of formal specification techniques
- Formal testing, quality assurance, validation, and verification

The WADT can look back on a proud history of workshops. The first workshop took place in 1982 in Sorpesee, followed by Passau (1983), Bremen (1984), Braunschweig (1986), Gullane (1987), Berlin (1988), Wusterhausen (1990), Dourdan (1991), Caldes de Malavella (1992), S. Margherita (1994), Oslo (1995), Tarquinia (1997), Lisbon (1998), Chateau de Bonas (1999), Genoa (2001), Frauenchiemsee (2002), Barcelona (2004), La Roche en Ardenne (2006), Pisa (2008), Etelsen (2010), Salamanca (2012), and Sinaia (2014).

These proceedings collect selected contributions of varying nature:

- Kenneth Johnson, John Tucker, and Victoria Wang contribute a fully peer-reviewed paper based on their invited talk: “Theorizing Monitoring: Algebraic Models of Web Monitoring in Organisations.”
- Alessio Lomuscio and Till Mossakowski presented invited talks at the workshop. These proceedings include abstracts for these talks, “Advances in Verification of Multi-Agent System” and “The Distributed Ontology, Model and Specification Language – DOL”, respectively.
- Furthermore, this volume includes two fully peer-reviewed survey papers. Renato Neves, Alexandre Madeira, Luis Barbosa, and Manuel A. Martins, “Asymmetric Combination of Logics Is Functorial: A Survey”; and Ryan Wisnesky, David I. Spivak, and Patrick Schultz, “Algebraic Model Management.”
- Finally, the main body of this volume comprises nine peer-reviewed papers that present new results in the field of algebraic development techniques.

We hope that reading the contributions in this volume will bring as much joy as we had at our workshop in September 2016 in Gregynog.

# Organization

## Steering Committee

Andrea Corradini	Università di Pisa, Italy
José Luiz Fiadeiro	Royal Holloway, University of London, UK
Rolf Hennicker	Ludwig-Maximilians-Universität, Germany
Hans-Jörg Kreowski	Universität Bremen, Germany
Till Mossakowski	Otto-Von-Guericke-Universität Magdeburg, Germany
Fernando Orejas	Universitat Politècnica de Catalunya, Spain
Francesco Parisi-Presicce	Università di Roma, Italy
Markus Roggenbach (Chair)	Swansea University, UK
Grigore Roşu	University of Illinois at Urbana-Champaign, USA
Andrzej Tarlecki	Warsaw University, Poland

## Program Committee

Mihai Codescu	Libera Università di Bolzano, Italy
Andrea Corradini	Università di Pisa, Italy
José Luiz Fiadeiro	Royal Holloway, University of London, UK
Rolf Hennicker	Ludwig-Maximilians-Universität, Germany
Phillip James (Co-chair)	Swansea University, UK
Einar Broch Johnsen	Universitetet i Oslo, Norway
Alexander Knapp	Universität Augsburg, Germany
Narciso Martí-Oliet	Universidad Complutense de Madrid, Spain
Till Mossakowski	Otto-Von-Guericke-Universität Magdeburg, Germany
Mohammadreza Moussavi	Högskolan i Halmstad, Sweden
Peter Ölveczky	Universitetet i Oslo, Norway
Detlef Plump	University of York, UK
Florian Rabe	Jacobs University, Germany
Markus Roggenbach (Co-chair)	Swansea University, UK
Lutz Schröder	Friedrich-Alexander Universität, Germany
Ionut Tutu	Royal Holloway, University of London, UK

## Additional Reviewers

Hubert Baumeister	Danmarks Tekniske Universitet, Denmark
Ferruccio Damiani	Università Degli Studi Di Torino, Italy
David Frutos Escrig	Universidad Complutense de Madrid, Spain
Martin Glauer	Otto Von Guericke Universität Magdeburg, Germany
Sergey Goncharov	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Christian Johansen	Universitetet i Oslo, Norway
Miguel Palomino	Universidad Complutense de Madrid, Spain
Andrei Popescu	Technische Universität München, Germany
Adrian Riesco	Universidad Complutense de Madrid, Spain
Martin Steffen	Universitetet i Oslo, Norway
John Tucker	Swansea University, UK

# Contents

## Abstracts of Invited Talks

Advances in Verification of Multi-agent Systems . . . . .	3
<i>Alessio Lomuscio</i>	
The Distributed Ontology, Model and Specification Language – DOL . . . . .	5
<i>Till Mossakowski</i>	

## Full Papers of Invited Talks

Theorising Monitoring: Algebraic Models of Web Monitoring in Organisations . . . . .	13
<i>Kenneth Johnson, John V. Tucker, and Victoria Wang</i>	

## Survey Papers

Asymmetric Combination of Logics is Functorial: A Survey. . . . .	39
<i>Renato Neves, Alexandre Madeira, Luis S. Barbosa, and Manuel A. Martins</i>	
Algebraic Model Management: A Survey. . . . .	56
<i>Patrick Schultz, David I. Spivak, and Ryan Wisnesky</i>	

## Regular Papers

Probability Functions in the Context of Signed Involutive Meadows (Extended Abstract) . . . . .	73
<i>Jan A. Bergstra and Alban Ponse</i>	
A Calculus of Virtually Timed Ambients . . . . .	88
<i>Einar Broch Johnsen, Martin Steffen, and Johanna Beate Stumpf</i>	
An Institution for Event-B . . . . .	104
<i>Marie Farrell, Rosemary Monahan, and James F. Power</i>	
On the Most Suitable Axiomatization of Signed Integers . . . . .	120
<i>Hubert Garavel</i>	
Observational Semantics for Dynamic Logic with Binders . . . . .	135
<i>Rolf Hennicker and Alexandre Madeira</i>	

Towards Critical Pair Analysis for the Graph Programming Language GP 2. . . . .	153
<i>Ivaylo Hristakiev and Detlef Plump</i>	
Canonical Selection of Colimits . . . . .	170
<i>Till Mossakowski, Florian Rabe, and Mihai Codrescu</i>	
Formalizing and Validating the P-Store Replicated Data Store in Maude . . . . .	189
<i>Peter Csaba Ölveczky</i>	
Generic Hoare Logic for Order-Enriched Effects with Exceptions . . . . .	208
<i>Christoph Rauch, Sergey Goncharov, and Lutz Schröder</i>	
<b>Author Index</b> . . . . .	223