Lecture Notes in Computer Science 1837

Edited by G. Goos, J. Hartmanis, and J. van Leeuwen

Berlin
Heidelberg
New York
Barcelona
Hong Kong
London
Milan
Paris
Singapore
Tokyo

Roland Backhouse José Nuno Oliveira (Eds.)

Mathematics of Program Construction

5th International Conference, MPC 2000
Ponte de Lima, Portugal, July 3-5, 2000
Proceedings

Series Editors

Gerhard Goos, Karlsruhe University, Germany
Juris Hartmanis, Cornell University, NY, USA
Jan van Leeuwen, Utrecht University, The Netherlands

Volume Editors

Roland Backhouse
University of Nottingham
School of Computer Science and Information Technology
Jubilee Campus, Nottingham NG8 1BB, UK
E-mail: rcb@cs.nott.ac.uk

José Nuno Oliveira
Universidade do Minho, Departamento de Informática
Campus de Gualtar, 4700-320 Braga, Portugal
E-mail: jno@di.uminho.pt

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Mathematics of program construction : 5th international conference ;
proceedings / MPC 2000, Ponte de Lima, Portugal, July 3 - 5, 2000.
Roland Backhouse ; José Nuno Oliveira (ed.). - Berlin ; Heidelberg ;
New York ; Barcelona ; Hong Kong ; London ; Milan ; Paris ; Singapore ;
Tokyo : Springer, 2000
(Lecture notes in computer science ; Vol. 1837)
ISBN 3-540-67727-5

CR Subject Classification (1998): D.1-2, F.2-4, G.2

ISSN 0302-9743
ISBN 3-540-67727-5 Springer-Verlag Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer is a company in the BertelsmannSpringer publishing group.
© Springer-Verlag Berlin Heidelberg 2000
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Da-TeX Gerd Blumenstein
Printed on acid-free paper SPIN: 10722010 06/3142 – 5 4 3 2 1 0

Preface

This volume contains the proceedings of MPC 2000, the fifth international conference on Mathematics of Program Construction. This series of conferences aims to promote the development of mathematical principles and techniques that are demonstrably useful and usable in the process of constructing computer programs (whether implemented in hardware or software). The focus is on techniques that combine precision with concision, enabling programs to be constructed by formal calculation. Within this theme, the scope of the series is very diverse, including programming methodology, program specification and transformation, programming paradigms, programming calculi, and programming language semantics.

The quality of the papers submitted to the conference was in general very high. However, the number of submissions has decreased compared to the previous conferences in the series. Each paper was refereed by at least five and often more committee members. In order to maintain the high standards of the conference the committee took a stringent view on quality; this has meant that, in some cases, a paper was rejected even though there was a basis for a good conference or journal paper but the submitted paper did not meet the committee's required standards. In a few cases a good paper was rejected on the grounds that it did not fit within the scope of the conference.

In addition to the 12 papers selected for presentation by the program committee, this volume contains the extended abstracts of three invited talks: *Integrating Programming, Properties, and Validation*, by Mark Jones (Oregon Graduate Institute, USA); *Regular Expressions Revisited: a Coinductive Approach to Streams, Automata, and Power Series*, by Jan Rutten (CWI, The Netherlands), and *Formal Methods and Dependability*, by Cliff Jones (University of Newcastle, UK).

The conference took place in Ponte de Lima, Portugal and was organized by the Informatics Department of Minho University, Braga, Portugal. The previous four conferences were held in 1989 at Twente, The Netherlands, in 1992 at Oxford, United Kingdom, in 1995 at Kloster Irsee, Germany, and in 1998 at Marstrand near Göteborg in Sweden. The proceedings of these conferences were published as LNCS 375, 669, 947, and 1422, respectively.

Four international events were co-located with the conference: the second workshop on *Constructive Methods for Parallel Programming*, the second workshop on *Generic Programming*, the workshop on *Subtyping and Dependent Types in Programming*, and the third workshop on *Attribute Grammars and their Applications*. We thank the organizers of these events for their interest in sharing the atmosphere of the conference.

April 2000

Roland Backhouse
José Nuno Oliveira

Acknowledgements

We are very grateful to the members of the program committee and their referees for their care and diligence in reviewing the submitted papers. We are also grateful to the local organization and the sponsoring institutions.

Program Committee

Roland Backhouse (co-chair, UK)
Richard Bird (UK)
Eerke Boiten (UK)
Dave Carrington (Australia)
Jules Desharnais (Canada)
José Fiadeiro (Portugal)
Jeremy Gibbons (UK)
Lindsay Groves (New Zealand)
Zhenjiang Hu (Japan)
John Hughes (Sweden)
Johan Jeuring (The Netherlands)
Burghard von Karger (Germany)
Dick Kieburtz (USA)
Carlos Delgado Kloos (Spain)
K. Rustan M. Leino (USA)
Christian Lengauer (Germany)
Lambert Meertens (The Netherlands)
Sigurd Meldal (Norway)
Eugenio Moggi (Italy)
Bernhard Moeller (Germany)
Oege de Moor (UK)
Dave Naumann (USA)
José N. Oliveira (co-chair, Portugal)
Kaisa Sere (Finland)
Mark Utting (New Zealand)
Phil Wadler (USA)

Organizing Committee

Pedro Rangel Henriques
Luís Soares Barbosa
José Bernardo Barros
Carla Oliveira

Sponsoring Institutions

The generous support of the following companies and institutions is gratefully acknowledged:

Universidade do Minho, Braga
Câmara Municipal, Ponte de Lima
Fundação para a Ciência e a Tecnologia (FAC Program), Portugal
Adega Cooperativa, Ponte de Lima
Andersen Consulting, Lisbon
Enabler, Porto
Pahldata, Lisbon
SIBS - Sociedade Interbancária de Serviços, Lisbon
Sidereus Ltd, Porto
TURIHAB - Solares de Portugal, Ponte de Lima

External Referees

All submitted papers were reviewed by members of the program committee and a number of external referees, who produced extensive review reports and without whose work the conference would lose its quality standards. To the best of our knowledge the list below is accurate. We apologize for any omissions or inaccuracies.

Scott Aaronson
Mikhail Auguston
Nuno Barreiro
Peter T. Breuer
Sharon Curtis
John Derrick
Thorsten Ehm
Colin Fidge
Marc Frappier
Daniel Fridlender
Sergei Gorlatch
Ian Hayes
Lorenz Huelsbergen
Graham Hutton
Patrik Jansson
Linas Laibinis
Antónia Lopes
A.K. McIver
Ray Nickson
Isabel Nunes
Peter C. Ölveczky
Dusko Pavlovic
John Reynolds
Markus Roggenbach
Mauno Rönkkö
Jeff Sanders
Bernhard Schätz
Tim Sheard
Mark Shields
Ganesh Sittampalam
Graeme Smith
Mike Spivey
Richard St-Denis
Ketil Stoelen
Elena Troubitsyna
Axel Wabenhorst
Michal Walicki
David Walker
Heike Wehrheim
Michel Wermelinger
Jim Woodcock

Table of Contents

Integrating Programming, Properties, and Validation 1
Mark P. Jones

Polytypic Values Possess Polykinded Types 2
Ralf Hinze

The Zip Calculus 28
Mark Tullsen

Separation and Reduction 45
Ernie Cohen

Reasoning about Non-terminating Loops Using Deadline Commands 60
Ian Hayes

Quantum Programming 80
J. W. Sanders and P. Zuliani

Regular Expressions Revisited:
A Coinductive Approach to Streams, Automata, and Power Series 100
J.J.M.M. Rutten

Proving Pointer Programs in Hoare Logic 102
Richard Bornat

On Guarded Commands with Fair Choice 127
Emil Sekerinski

Formal Methods and Dependability 140
Cliff B. Jones

Liberating Data Refinement 144
Eerke Boiten and John Derrick

Theorems about Composition 167
Michel Charpentier and K. Mani Chandy

The Universal Resolving Algorithm:
Inverse Computation in a Functional Language 187
Sergei Abramov and Robert Glück

Metacomputation-Based Compiler Architecture 213
William L. Harrison and Samuel N. Kamin

A Metalanguage for Programming with Bound Names
Modulo Renaming 230
Andrew M. Pitts and Murdoch J. Gabbay

Author Index 257