

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Alfred Kobsa

University of California, Irvine, CA, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

TU Dortmund University, Germany

Madhu Sudan

Microsoft Research, Cambridge, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Gerhard Weikum

Max Planck Institute for Informatics, Saarbruecken, Germany

Marco T. Morazán Sven-Bodo Scholz (Eds.)

Implementation and Application of Functional Languages

21st International Symposium, IFL 2009
South Orange, NJ, USA, September 23-25, 2009
Revised Selected Papers

Volume Editors

Marco T. Morazán

Seton Hall University, Department of Mathematics and Computer Science
400 South Orange Avenue, South Orange, NJ 07079, USA

E-mail: morazanm@shu.edu

Sven-Bodo Scholz

University of Hertfordshire, School of Computer Science
College Lane, Hatfield, Herts AL10 9AB, UK

E-mail: S.Scholz@herts.ac.uk

Library of Congress Control Number: 2010936304

CR Subject Classification (1998): F.3, D.3, D.2, F.4.1, D.1, D.2.4

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN 0302-9743

ISBN-10 3-642-16477-3 Springer Berlin Heidelberg New York

ISBN-13 978-3-642-16477-4 Springer 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. Violations are liable to prosecution under the German Copyright Law.

springer.com

© Springer-Verlag Berlin Heidelberg 2010
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper 06/3180

Preface

This volume contains the selected peer-reviewed revised articles that were presented at the 21st International Symposium on Implementation and Application of Functional Languages (IFL 2009). IFL 2009 was held September 23–25, 2009 at Seton Hall University in South Orange, NJ, USA. This version of the IFL symposium marked a milestone by being the first ever to be held in the United States. Our goals are to make IFL a regular event held in the USA and in Europe by alternating the host continent every year and to foster collaborations, interactions, and friendships between researchers and practitioners on both continents and beyond.

The IFL symposia bring together researchers and practitioners that are actively engaged in the implementation and the use of functional and function-based programming languages. Every year IFL provides a venue for the presentation and discussion of new ideas and concepts, of work in progress, and of publication-ripe results. Participants are invited to submit either a draft paper or an extended abstract describing work to be presented at the symposium. These submissions are screened by the Program Committee Chair to make sure they are within the scope of IFL. The submissions accepted for presentation appear in the *draft* proceedings distributed at the symposium. Submissions appearing in the draft proceedings are not peer-reviewed publications. After the symposium, authors are given the opportunity to consider the feedback received from discussions at the symposium and are invited to submit revised, full articles to the formal review process. The revised submissions are reviewed by the Program Committee using prevailing academic standards, and the best submissions are chosen to appear in the formal proceedings. This volume is the result of the work done by the IFL 2009 Program Committee and the contributing authors.

Benjamin C. Pierce, the IFL 2009 guest speaker from the University of Pennsylvania, delivered an engaging talk entitled “How to Build Your Own Bidirectional Programming Language.” Pierce focused on the semantics and the implementation of programming languages that not only update their output based on changes in the input, but that also update their input based on changes made to the output. In addition, Pierce discussed several sample applications that are well-suited for bidirectional programming languages, like bidirectional transformations on trees for XML documents, on relational data, and on strings. He enthusiastically engaged questions posed by IFL 2009 participants and we thank him for his contribution to IFL 2009.

Following in the IFL tradition, IFL 2009 provided participants with an opportunity to get to know each other and to talk outside the formal setting of presentations with a social event on the second day of the symposium. Participants traveled to Manhattan to visit the observatory at Rockefeller Center and to walk across the Brooklyn Bridge. After the visit to Manhattan, participants

traveled to the symposium's banquet dinner in the Ironbound neighborhood of Newark, NJ where they were treated to a traditional Spanish tapas and dinner feast with a flamenco show.

Shortly before IFL 2009, the programming languages community lost one of its most distinguished members. In June of 2009 Peter J. Landin passed away. At IFL, we dearly felt his passing. IFL has honored Peter since 2003 by awarding each year the Peter J. Landin Award to the best article presented at the symposium. The recipients of the award for IFL 2009 are Vincent St-Amour and Marc Feeley, from the Université de Montréal in Canada, for their contribution entitled "*PICOBIT: A Compact Scheme System for Microcontrollers.*"

IFL 2009 was made possible by the generous support provided by Jane Street Capital, Seton Hall University's Office of the Provost, Seton Hall University's College of Arts and Sciences, and Seton Hall University's Department of Mathematics and Computer Science. At Seton Hall, a heart-felt thank you for their extraordinary efforts to make IFL 2009 a success is extended to Associate Provost Kirk Rawn, Dean Joseph R. Marbach, Dean Susan Kilduff, Joan Guetti, Lysa D. Martinelli, and Thomas A. McGee. We are equally grateful to Yaron Minsky from Jane Street Capital. A debt of gratitude for addressing every need that came up during the symposium is owed to Rositsa Abrasheva, Florian Buchegger, and Barbara Mucha. We thank all the members of the Program Committee for their advice, time, and thoughtful reviews and all the members of the organizing committee for their logistical support without which this volume would have never have become a reality. We are very grateful to Daniel P. Friedman from the University of Indiana for selflessly assisting with the editing of the articles appearing in this volume. Finally, we thank the authors for submitting their articles and trusting that we would do our best to positively showcase their work.

In closing, we trust that the readers of this volume will find its contents engaging hopefully inspiring them to start or continue their work on the implementation and the use of functional languages. Make sure to join us at a future version of IFL!

April 2010

Marco T. Morazán
Sven-Bodo Scholz

Organization

Program Committee

Peter Achten	University of Nijmegen, The Netherlands
Jost Berthold	University of Copenhagen, Denmark
Andrew Butterfield	University of Dublin, Ireland
Robby Findler	Northwestern University, USA
Kathleen Fisher	AT&T Research, USA
Cormac Flanagan	UCSC, USA
Matthew Flatt	University of Utah, USA
Matthew Fluet	Rochester Institute of Tech., USA
Daniel Friedman	Indiana University, USA
Andy Gill	University of Kansas, USA
Clemens Grelck	University of Amsterdam, The Netherlands
Jurriaan Hage	Utrecht University, The Netherlands
Ralf Hinze	Oxford University, UK
Paul Hudak	Yale University, USA
John Hughes	Chalmers University, Sweden
Patricia Johann	University of Strathclyde, UK
Yukiyoshi Kameyama	University of Tsukuba, Japan
Marco T. Morazán (Chair)	Seton Hall University, USA
Rex Page	University of Oklahoma, USA
Fernando Rubio	Universidad Complutense, Spain
Sven-Bodo Scholz	University of Hertfordshire, UK
Manuel Serrano	INRIA Sophia-Antipolis, France
Chung-chieh Shan	Rutgers University, USA
David Walker	Princeton University, USA
Viktória Zsók	Eötvös Loránd University, Hungary

Additional Reviewers

Emil Axelsson	Tamás Kozsik	Wouter Swierstra
Duncan Coutts	Koji Nakazawa	Máté Tejfel
Conal Elliott	Michal Palka	Kai Trojahner
Giang Hoang	Frank Penczek	Varmo Vene
Hideya Iwasaki	Zoltán Porkoláb	Janis Voigtländer
Casey Klein	Nick Smallbone	Timothy Zwiebel
Edward Kmett	James Swaine	

Local Organizing Committee

Rositsa Abrasheva	Seton Hall University
Lori Brown	Seton Hall University
Florian Buchbegger	Johannes Kepler Universität
Paul Fisher	Seton Hall University
Joan Guetti	Seton Hall University
Marco T. Morazán (Chair)	Seton Hall University
Kirk Rawn	Seton Hall University
Žanna Slaveniece	AXA Equitable
Michael Soupios	Seton Hall University

Sponsoring Institutions

Jane Street Capital, New York, USA

Office of the Provost, Seton Hall University, USA

College of Arts and Sciences, Seton Hall University, USA

Department of Computer Science, Seton Hall University, USA

Table of Contents

PICOBIT: A Compact Scheme System for Microcontrollers	1
<i>Vincent St-Amour and Marc Feeley</i>	
Introducing Kansas Lava	18
<i>Andy Gill, Tristan Bull, Garrin Kimmell, Erik Perrins, Ed Komp, and Brett Werling</i>	
iTasks 2: iTasks for End-users	36
<i>Bas Lijnse and Rinus Plasmeijer</i>	
ChalkBoard: Mapping Functions to Polygons	55
<i>Kevin Matlage and Andy Gill</i>	
Implementing Fusion-Equipped Parallel Skeletons by Expression Templates	72
<i>Kiminori Matsuzaki and Kento Emoto</i>	
Arity Raising in Manticore	90
<i>Lars Bergstrom and John Reppy</i>	
Symbiotic Expressions	107
<i>Robert Bernecky, Stephan Herhut, and Sven-Bodo Scholz</i>	
Stream Fusion on Haskell Unicode Strings	125
<i>Thomas Harper</i>	
Nested and Dynamic Contract Boundaries	141
<i>T. Stephen Strickland and Matthias Felleisen</i>	
Pull-Ups, Push-Downs, and Passing It Around: Exercises in Functional Incrementalization	159
<i>Sean Leather, Andres Löh, and Johan Jeuring</i>	
A Typical Synergy: Dynamic Types and Generalised Algebraic Datatypes	179
<i>Thomas van Noort, Peter Achten, and Rinus Plasmeijer</i>	
The Very Lazy λ -Calculus and the STEC Machine	198
<i>Jan Rochel</i>	
Engineering Higher-Order Modules in SML/NJ	218
<i>George Kuan and David MacQueen</i>	
Author Index	237