

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

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

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

University of California, Los Angeles, CA, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Eduard Ayguadé Gerald Baumgartner
J. Ramanujam P. Sadayappan (Eds.)

Languages and Compilers for Parallel Computing

18th International Workshop, LCPC 2005
Hawthorne, NY, USA, October 20-22, 2005
Revised Selected Papers

Volume Editors

Eduard Ayguadé
Computer Architecture Department
Universitat Politècnica de Catalunya
08034 Barcelona, Catalunya, Spain
E-mail: eduard@cepba.upc.es

Gerald Baumgartner
Department of Computer Science
Louisiana State University
Baton Rouge, LA 70803, USA
E-mail: gb@csc.lsu.edu

J. Ramanujam
Department of Electrical and Computer Engineering
Louisiana State University
Baton Rouge, LA 70803, USA
E-mail: jxr@ece.lsu.edu

P. Sadayappan
Department of Computer Science and Engineering
The Ohio State University
Columbus, OH 43210, USA
E-mail: saday@cis.ohio-state.edu

Library of Congress Control Number: 2006939009

CR Subject Classification (1998): D.3, D.1.3, F.1.2, B.2.1, C.2.4, C.2, E.1, D.4

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

ISSN	0302-9743
ISBN-10	3-540-69329-7 Springer Berlin Heidelberg New York
ISBN-13	978-3-540-69329-1 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 is a part of Springer Science+Business Media

springer.com

© Springer-Verlag Berlin Heidelberg 2006
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11967729 06/3142 5 4 3 2 1 0

Preface

The 18th International Workshop on Languages and Compilers for High-Performance Computing was scheduled to be held in New Orleans, Louisiana, in October 2005. Unfortunately, because of the devastation caused by Hurricane Katrina the meeting needed to be moved. It was held in Hawthorne, New York, thanks to help from IBM. The workshop is an annual forum for leading research groups to present their current research activities and the latest results, covering languages, compiler techniques, runtime environments, and compiler-related performance evaluation for parallel and high-performance computing. Sixty-five researchers from Canada, France, Japan, Korea, P.R. China, Spain, Switzerland, Taiwan, UK, and the USA attended the workshop.

Thirty-four research papers (26 regular papers and eight short papers) were presented at the workshop. These papers were reviewed by the Program Committee; external reviewers were used as needed. The authors then received additional comments during the workshop. The revisions after the workshop are now assembled into these final proceedings.

We thank Siddhartha Chatterjee from the IBM T.J. Watson Research Center for his keynote talk titled “The Changing Landscape of Parallel Computing.” The workshop included a special session titled “High-Productivity Languages for HPC: Compiler Challenges” consisting of invited talks on the three languages being developed by the DARPA High-Productivity Computing Systems (HPCS) vendors. The talks were given by Steve Dietz (from Cray on the language Chapel), Vivek Sarkar (from IBM on the language X10), and David Chase (from Sun on the language Fortress). Frederica Darema gave a presentation during the workshop banquet about the proposed Dynamic Data-Driven Applications Systems (DDDAS) program at the US National Science Foundation.

The workshop was sponsored by the US National Science Foundation and by International Business Machines Corporation. Their generous contribution is greatly appreciated. We appreciate the assistance offered by the staff in the Department of Computer Science and Engineering at the Ohio State University and thank Alex Ramirez of Universitat Politècnica de Catalunya (Spain) for generous help with the paper submission and review software. Our special thanks go to the LCPC 2005 Program Committee and the external reviewers for their efforts in reviewing the submissions. Advice and suggestions from both the Steering Committee and the Program Committee are much appreciated. Finally, we wish to thank all the authors and participants for their contributions and lively discussions, which made the workshop a success.

November 2006

Eduard Ayguadé, Gerald Baumgartner,
J. (Ram) Ramanujam, P. (Saday) Sadayappan

Organization

Committees

General/Program Co-chairs:	Eduard Ayguadé (Universitat Politècnica de Catalunya, Spain)
	Gerald Baumgartner (Louisiana State University, USA)
	J. (Ram) Ramanujam (Louisiana State University, USA)
	P. (Saday) Sadayappan (The Ohio State University, USA)
Program Committee:	Nancy Amato (Texas A&M University, USA)
	Gheorghe Almási (IBM Thomas J. Watson Research Center, USA)
	Eduard Ayguadé (Universitat Politècnica de Catalunya, Spain)
	Gerald Baumgartner (Louisiana State University, USA)
	Calin Cascaval (IBM Thomas J. Watson Research Center, USA)
	Rudolf Eigenmann (Purdue University, USA)
	Zhiyuan Li (Purdue University, USA)
	Sam Midkiff (Purdue University, USA)
	J. (Ram) Ramanujam (Louisiana State University, USA)
	Lawrence Rauchwerger (Texas A&M University, USA)
	P. (Saday) Sadayappan (The Ohio State University, USA)
	Bjarne Stoustrup (Texas A&M University, USA)
	Peng Wu (IBM Thomas J. Watson Research Center, USA)

VIII Organization

Local Organizing Committee:	Gheorghe Almási (IBM Thomas J. Watson Research Center, USA)
	Calin Cascaval (IBM Thomas J. Watson Research Center, USA)
	Peng Wu (IBM Thomas J. Watson Research Center, USA)
Steering Committee:	Utpal Banerjee (Intel Corporation, USA)
	David Gelernter (Yale University, USA)
	Alex Nicolau (University of California, Irvine, USA)
	David Padua (University of Illinois at Urbana-Champaign, USA)

Sponsors

National Science Foundation, USA
International Business Machines Corporation

Table of Contents

Revisiting Graph Coloring Register Allocation: A Study of the Chaitin-Briggs and Callahan-Koblenz Algorithms	1
<i>Keith D. Cooper, Anshuman Dasgupta, and Jason Eckhardt</i>	
Register Pressure in Software-Pipelined Loop Nests: Fast Computation and Impact on Architecture Design	17
<i>Alban Douillet and Guang R. Gao</i>	
Manipulating MAXLIVE for Spill-Free Register Allocation	32
<i>Shashi Deepa Arcot, Henry Gordon Dietz, and Sarojini Priyadarshini Rajachidambaram</i>	
Optimizing Packet Accesses for a Domain Specific Language on Network Processors	47
<i>Tao Liu, Xiao-Feng Li, Lixia Liu, Chengyong Wu, and Roy Ju</i>	
Array Replication to Increase Parallelism in Applications Mapped to Configurable Architectures	62
<i>Heidi E. Ziegler, Priyadarshini L. Malusare, and Pedro C. Diniz</i>	
Generation of Control and Data Flow Graphs from Scheduled and Pipelined Assembly Code	76
<i>David C. Zaretsky, Gaurav Mittal, Robert Dick, and Prith Banerjee</i>	
Applying Data Copy to Improve Memory Performance of General Array Computations	91
<i>Qing Yi</i>	
A Cache-Conscious Profitability Model for Empirical Tuning of Loop Fusion	106
<i>Apan Qasem and Ken Kennedy</i>	
Optimizing Matrix Multiplication with a Classifier Learning System	121
<i>Xiaoming Li and María Jesús Garzarán</i>	
A Language for the Compact Representation of Multiple Program Versions	136
<i>Sebastien Donadio, James Brodman, Thomas Roeder, Kamen Yotov, Denis Barthou, Albert Cohen, María Jesús Garzarán, David Padua, and Keshav Pingali</i>	
Efficient Computation of May-Happen-in-Parallel Information for Concurrent Java Programs	152
<i>Rajkishore Barik</i>	

Evaluating the Impact of Thread Escape Analysis on a Memory Consistency Model-Aware Compiler	170
<i>Chi-Leung Wong, Zehra Sura, Xing Fang, Kyungwoo Lee, Samuel P. Midkiff, Jaejin Lee, and David Padua</i>	
Concurrency Analysis for Parallel Programs with Textually Aligned Barriers	185
<i>Amir Kamil and Katherine Yelick</i>	
Titanium Performance and Potential: An NPB Experimental Study	200
<i>Kaushik Datta, Dan Bonachea, and Katherine Yelick</i>	
Efficient Search-Space Pruning for Integrated Fusion and Tiling Transformations	215
<i>Xiaoyang Gao, Sriram Krishnamoorthy, Swarup Kumar Sahoo, Chi-Chung Lam, Gerald Baumgartner, J. Ramanujam, and P. Sadayappan</i>	
Automatic Measurement of Instruction Cache Capacity	230
<i>Kamen Yotov, Sandra Jackson, Tyler Steele, Keshav Pingali, and Paul Stodghill</i>	
Combined ILP and Register Tiling: Analytical Model and Optimization Framework	244
<i>Lakshminarayanan Renganarayana, U. Ramakrishna, and Sanjay Rajopadhye</i>	
Analytic Models and Empirical Search: A Hybrid Approach to Code Optimization	259
<i>Arkady Epshteyn, María Jesús Garzarán, Gerald DeJong, David Padua, Gang Ren, Xiaoming Li, Kamen Yotov, and Keshav Pingali</i>	
Testing Speculative Work in a Lazy/Eager Parallel Functional Language	274
<i>Alberto de la Encina, Ismael Rodríguez, and Fernando Rubio</i>	
Loop Selection for Thread-Level Speculation	289
<i>Shengyue Wang, Xiaoru Dai, Kiran S. Yellajyosula, Antonia Zhai, and Pen-Chung Yew</i>	
Software Thread Level Speculation for the Java Language and Virtual Machine Environment	304
<i>Christopher J.F. Pickett and Clark Verbrugge</i>	
Lightweight Monitoring of the Progress of Remotely Executing Computations	319
<i>Shuo Yang, Ali R. Butt, Y. Charlie Hu, and Samuel P. Midkiff</i>	

Using Platform-Specific Performance Counters for Dynamic Compilation	334
<i>Florian Schneider and Thomas R. Gross</i>	
A Domain-Specific Interpreter for Parallelizing a Large Mixed-Language Visualisation Application	347
<i>Karen Osmond, Olav Beckmann, Anthony J. Field, and Paul H.J. Kelly</i>	
Compiler Control Power Saving Scheme for Multi Core Processors	362
<i>Jun Shirako, Naoto Oshiyama, Yasutaka Wada, Hiroaki Shikano, Keiji Kimura, and Hironori Kasahara</i>	
Code Transformations for One-Pass Analysis	377
<i>Xiaogang Li and Gagan Agrawal</i>	
Scalable Array SSA and Array Data Flow Analysis	397
<i>Silvius Rus, Guobin He, and Lawrence Rauchwerger</i>	
Interprocedural Symbolic Range Propagation for Optimizing Compilers	413
<i>Hansang Bae and Rudolf Eigenmann</i>	
Parallelization of Utility Programs Based on Behavior Phase Analysis	425
<i>Xipeng Shen and Chen Ding</i>	
A Systematic Approach to Model-Guided Empirical Search for Memory Hierarchy Optimization	433
<i>Chun Chen, Jacqueline Chame, Mary Hall, and Kristina Lerman</i>	
An Efficient Approach for Self-scheduling Parallel Loops on Multiprogrammed Parallel Computers	441
<i>Arun Kejariwal, Alexandru Nicolau, and Constantine D. Polychronopoulos</i>	
Dynamic Compilation for Reducing Energy Consumption of I/O-Intensive Applications	450
<i>Seung Woo Son, Guangyu Chen, Mahmut Kandemir, and Alok Choudhary</i>	
Supporting SELL for High-Performance Computing	458
<i>Bjarne Stroustrup and Gabriel Dos Reis</i>	
Compiler Supports and Optimizations for PAC VLIW DSP Processors	466
<i>Yung-Chia Lin, Chung-Lin Tang, Chung-Ju Wu, Ming-Yu Hung, Yi-Ping You, Ya-Chiao Moo, Sheng-Yuan Chen, and Jenq-Kuen Lee</i>	
Author Index	475