

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

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

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Laurent Perron Michael A. Trick (Eds.)

Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems

5th International Conference, CPAIOR 2008
Paris, France, May 20-23, 2008
Proceedings

Volume Editors

Laurent Perron
ILOG
9, rue de Verdun
94253 Gentilly Cedex, France
E-mail: lperron@ilog.fr

Michael A. Trick
Tepper School of Business
Carnegie Mellon University
Pittsburgh, PA, 15213, USA
E-mail: trick@cmu.edu

Library of Congress Control Number: 2008926947

CR Subject Classification (1998): G.1.6, G.1, G.2.1, F.2.2, I.2, J.1

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

ISSN	0302-9743
ISBN-10	3-540-68154-X Springer Berlin Heidelberg New York
ISBN-13	978-3-540-68154-0 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 2008
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 12270859 06/3180 5 4 3 2 1 0

Preface

The 5th International Conference on Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems (CPAIOR 2008) was held in Paris, France May 20–23, 2008.

The purpose of this conference series is to bring together researchers in the fields of constraint programming, artificial intelligence, and operations research to explore ways of solving large-scale, practical optimization problems through integration and hybridization of the fields' different techniques. Through the years, this research community is discovering that the fields have much in common, and there has been tremendous richness in the resulting cross-fertilization of fields.

This year, we allowed submissions of both long (15 page) and short (5 page) papers, with short papers either being original work, a reduced version of a long paper, or an extended abstract of work published elsewhere. We were not surprised by the 69 submissions in the long paper category: this is an active field with many researchers. We were surprised by the 61 short paper submissions. This was far more than predicted. With 130 high-quality submissions, competition for acceptance in this year's program was particularly fierce. In the end, we accepted 18 long papers and 22 short papers for presentation and publication in this volume.

In addition to the selected papers, there were three invited talks. Those speakers were Cindy Barnhart, Professor of Civil and Environmental Engineering at the Massachusetts Institute of Technology, Pascal Van Hentenryck, Professor of Computer Science at Brown University, and François Laburthe, Director of Operations Research and Innovation at Amadeus, a leading information technology firm in the travel industry.

On May 20, a Master Class was held, organized by Cindy Barnhart and Laurent Michel, Assistant Professor of Computer Science and Engineering at the University of Connecticut. The theme of the Master Class was "Modeling Practical Problems: The OR/CP Interface." The Master Class is intended for PhD students, researchers and practitioners.

Thursday afternoon was given over to three workshops: Open-Source Software for Integer and Constraint Programming, organized by Robin Lougee-Heimer of IBM Research and Ionut Aron, formerly of IBM Research, Bin Packing and Placement Constraints, organized by a group led by Nicolas Beldiceanu of EMN Nantes, and Constraint-Based Methods for Bioinformatics, organized by Agostino Dovier of the University of Udine.

This year, the conference organization was divided. While we handled the program, François Fages, Senior Research Scientist INRIA, joined Laurent in the conference organization. François and Laurent, with the help of the colloquium office at INRIA, were responsible for organizing the venue, finding sponsorship

funds, and the million other details that go into running a successful conference. François was also particularly helpful in assisting us with program policy decisions, and we are grateful for his thoughts and experience.

We would particularly like to thank the Program Committee for their efforts. No one expected 130 submissions, and they did a tremendous job of reading, reviewing, and commenting on papers in a timely and insightful fashion.

Finally, we would like to thank the sponsors who make this possible. These include the Association for Constraint Programming, INRIA, Microsoft Research/INRIA Joint Center, National ICT Australia, ILOG, COSYTEC, Intelligent Information Systems Institute at Cornell, KLS OPTIM, Jeppesen Technology Services and the energy company Total.

May 2008

Laurent Perron
Michael Trick

Organization

Conference Chairs

François Fages, INRIA, France
Laurent Perron, ILOG, France

Program Chairs

Laurent Perron, ILOG, France
Michael Trick, Carnegie Mellon, USA

Master Class Chairs

Cynthia Barnhart, MIT, USA
Laurent Michel, University of Connecticut, USA

Program Committee

Ionut Aron, IBM Research, USA
Philippe Baptiste, École Polytechnique, France
Chris Beck, University of Toronto, Canada
Frédéric Benhamou, University of Nantes, France
Bob Bosch, Oberlin College, USA
Edmund Burke, University of Nottingham, UK
Amedeo Cesta, ISTC-CNR Rome, Italy
John Chinneck, Carleton University, Canada
Emilie Danna, ILOG, USA
Andrew Davenport, IBM, USA
Yves Deville, UCLouvain, Belgium
Hani El Sakkout, Cisco, USA
François Fages, INRIA, France
Bernard Gendron, University of Montreal, Canada
Carla Gomes, Cornell University, USA
Youssef Hamadi, Microsoft Research Cambridge, UK
John Hooker, Carnegie Mellon, USA
Kazuyoshi Inoue, NS Solutions, Japan
Narendra Jussien, École des Mines de Nantes, France
Thorsten Koch, ZIB, Germany
François Laburthe, Amadeus, France
Claude Le Pape, Schneider Electric, France
Janny Leung, Chinese University of Hong Kong, Hong Kong

Andrea Lodi, University of Bologna, Italy
Robin Lougee-Heimer, IBM Research, USA
Anuj Mehrotra, University of Miami, USA
Laurent Michel, University of Connecticut, USA
Michela Milano, University of Bologna, Italy
Yehuda Naveh, IBM Research, Israel
Barry O'Sullivan, University College Cork, Ireland
Gilles Pesant, Polytechnique Montreal, Canada
Jean-François Puget, ILOG, France
Jean-Charles Régin, ILOG, France
Louis-Martin Rousseau, Polytechnique Montreal, Canada
Michel Rueher, University of Nice, France
David Ryan, University of Auckland, New Zealand
Meinolf Sellmann, Brown University, USA
Helmuth Simonis, University College Cork, Ireland
Stephen Smith, Carnegie Mellon, USA
Barbara Smith, University of Leeds, UK
Pascal Van Hentenryck, Brown University, USA
Willem-Jan Van Hoeve, Carnegie Mellon, USA
Alkis Vazacopoulos, Fair Isaac, USA
Mark Wallace, Monash University, Australia
Laurence Wolsey, UCLouvain, Belgium
Tallys Yunes, University of Miami, USA

External Reviewers

Tobias Achterberg	Yahia Lebbah
Timo Berthold	Michele Lombardi
Simon Boivin	Xavier Lorca
Lucas Bordeaux	Julien Martin
Hélène Collavizza	Jean-Noël Monette
Sophie Demassey	Angelo Oddi
Bistra Dilkina	Claude-Guy Quimper
Ari Freund	Yossi Richter
Oded Fuhrmann	Aurélien Rizk
Jonathan Gaudreault	Frederic Saubion
Carmen Gervet	Pierre Schaus
Frédéric Gualard	Andrew See
Stefan Heinz	Gil Shurek
Dejan Jovanović	Peter Stuckey
Arnaud Lallouet	Oliver Weide
	Alessandro Zanarini

Table of Contents

Invited Talks

Airline Scheduling: Accomplishments, Opportunities and Challenges <i>Cynthia Barnhart</i>	1
Selected Challenges from Distribution and Commerce in the Airline and Travel Industry <i>François Laburthe</i>	2
30 Years of Constraint Programming (Abstract) <i>Pascal Van Hentenryck</i>	5

Long Papers

Constraint Integer Programming: A New Approach to Integrate CP and MIP <i>Tobias Achterberg, Timo Berthold, Thorsten Koch, and Kati Wolter</i>	6
New Filtering for the <i>cumulative</i> Constraint in the Context of Non-Overlapping Rectangles <i>Nicolas Beldiceanu, Mats Carlsson, and Emmanuel Poder</i>	21
Multi-stage Benders Decomposition for Optimizing Multicore Architectures <i>Luca Benini, Michele Lombardi, Marco Mantovani, Michela Milano, and Martino Ruggiero</i>	36
Fast and Scalable Domino Portrait Generation <i>Hadrien Cambazard, John Horan, Eoin O'Mahony, and Barry O'Sullivan</i>	51
Gap Reduction Techniques for Online Stochastic Project Scheduling <i>Grégoire Doms and Pascal Van Hentenryck</i>	66
Integrating Symmetry, Dominance, and Bound-and-Bound in a Multiple Knapsack Solver <i>Alex S. Fukunaga</i>	82
Cost Propagation – Numerical Propagation for Optimization Problems <i>Birgit Grohe and Dag Wedelin</i>	97
Fitness-Distance Correlation and Solution-Guided Multi-point Constructive Search for CSPs <i>Ivan Heckman and J. Christopher Beck</i>	112

Leveraging Belief Propagation, Backtrack Search, and Statistics for Model Counting	127
<i>Lukas Kroc, Ashish Sabharwal, and Bart Selman</i>	
The Accuracy of Search Heuristics: An Empirical Study on Knapsack Problems	142
<i>Daniel H. Leventhal and Meinolf Sellmann</i>	
A Novel Approach for Detecting Symmetries in CSP Models.....	158
<i>Christopher Mears, Maria Garcia de la Banda, Mark Wallace, and Bart Demoen</i>	
Amsaa: A Multistep Anticipatory Algorithm for Online Stochastic Combinatorial Optimization	173
<i>Luc Mercier and Pascal Van Hentenryck</i>	
Optimal Deployment of Eventually-Serializable Data Services	188
<i>Laurent Michel, Alexander Shvartsman, Elaine Sonderegger, and Pascal Van Hentenryck</i>	
Counting Solutions of Knapsack Constraints	203
<i>Gilles Pesant and Claude-Guy Quimper</i>	
From High-Level Model to Branch-and-Price Solution in G12	218
<i>Jakob Puchinger, Peter J. Stuckey, Mark Wallace, and Sebastian Brand</i>	
Simpler and Incremental Consistency Checking and Arc Consistency Filtering Algorithms for the Weighted Spanning Tree Constraint	233
<i>Jean-Charles Régin</i>	
Stochastic Satisfiability Modulo Theories for Non-linear Arithmetic	248
<i>Tino Teige and Martin Fränzle</i>	
A Hybrid Constraint Programming / Local Search Approach to the Job-Shop Scheduling Problem	263
<i>Jean-Paul Watson and J. Christopher Beck</i>	

Short Papers

Counting Solutions of Integer Programs Using Unrestricted Subtree Detection	278
<i>Tobias Achterberg, Stefan Heinz, and Thorsten Koch</i>	
Rapidly Solving an Online Sequence of Maximum Flow Problems with Extensions to Computing Robust Minimum Cuts	283
<i>Doug Altner and Özlem Ergun</i>	

A Hybrid Approach for Solving Shift-Selection and Task-Sequencing Problems	288
<i>Ada Barlatt, Amy M. Cohn, and Oleg Gusikhin</i>	
Solving a Log-Truck Scheduling Problem with Constraint Programming.....	293
<i>Nizar El Hachemi, Michel Gendreau, and Louis-Martin Rousseau</i>	
Using Local Search to Speed Up Filtering Algorithms for Some NP-Hard Constraints	298
<i>Philippe Galinier, Alain Hertz, Sandrine Paroz, and Gilles Pesant</i>	
Connections in Networks: A Hybrid Approach	303
<i>Carla P. Gomes, Willem-Jan van Hoeve, and Ashish Sabharwal</i>	
Efficient Haplotype Inference with Combined CP and OR Techniques ...	308
<i>Ana Graça, João Marques-Silva, Inês Lynce, and Arlindo L. Oliveira</i>	
Integration of CP and Compilation Techniques for Instruction Sequence Test Generation	313
<i>Boris Gutkovich</i>	
Propagating Separable Equalities in an MDD Store	318
<i>T. Hadzic, J.N. Hooker, and P. Tiedemann</i>	
The Weighted CFG Constraint	323
<i>George Katsirelos, Nina Narodytska, and Toby Walsh</i>	
CP with ACO	328
<i>Madjid Khichane, Patrick Albert, and Christine Solnon</i>	
A Combinatorial Auction Framework for Solving Decentralized Scheduling Problems (Extended Abstract)	333
<i>Hoong Chuin Lau, Kong Wei Lye, and Viet Bang Nguyen</i>	
Constraint Optimization and Abstraction for Embedded Intelligent Systems	338
<i>Paul Maier and Martin Sachenbacher</i>	
A Parallel Macro Partitioning Framework for Solving Mixed Integer Programs	343
<i>Mahdi Namazifar and Andrew J. Miller</i>	
Guiding Stochastic Search by Dynamic Learning of the Problem Topography	349
<i>Yehuda Naveh</i>	
Hybrid Variants for Iterative Flattening Search	355
<i>Angelo Oddi, Amedeo Cesta, Nicola Policella, and Stephen F. Smith</i>	

Global Propagation of Practicability Constraints	361
<i>Thierry Petit and Emmanuel Poder</i>	
The Polytope of Tree-Structured Binary Constraint Satisfaction Problems	367
<i>Meinolf Sellmann</i>	
A Tabu Search Method for Interval Constraints	372
<i>Charlotte Truchet, Marc Christie, and Jean-Marie Normand</i>	
The Steel Mill Slab Design Problem Revisited	377
<i>Pascal Van Hentenryck and Laurent Michel</i>	
Filtering Atmost1 on Pairs of Set Variables	382
<i>Willem-Jan van Hoeve and Ashish Sabharwal</i>	

Extended Abstract

Mobility Allowance Shuttle Transit (MAST) Services: MIP Formulation and Strengthening with Logic Constraints	387
<i>Luca Quadrioglio, Maged M. Dessouky, and Fernando Ordóñez</i>	
Author Index	393