

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

New York University, NY, 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

Roman Barták Michela Milano (Eds.)

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

Second International Conference, CPAIOR 2005
Prague, Czech Republic, May 30–June 1, 2005
Proceedings



Springer

Volume Editors

Roman Barták
Charles University
Faculty of Mathematics and Physics
Malostranské nám. 2/25, 118 00 Prague 1, Czech Republic
E-mail: roman.bartak@mff.cuni.cz

Michela Milano
DEIS
University of Bologna
Viale Risorgimento 2, 40136 Bologna, Italy
E-mail: mmilano@deis.unibo.it

Library of Congress Control Number: 2005926642

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

ISSN 0302-9743
ISBN-10 3-540-26152-4 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-26152-0 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

springeronline.com

© Springer-Verlag Berlin Heidelberg 2005
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India
Printed on acid-free paper SPIN: 11493853 06/3142 5 4 3 2 1 0

Preface

The 2nd International Conference on Integration of AI and OR Techniques in Constraint Programming for Combinatorial Optimization Problems (CPAIOR 2005) was held in Prague, Czech Republic, during May 31–June 1, 2005.

The conference is intended primarily as a forum to focus on the integration and hybridization of the approaches of constraint programming (CP), artificial intelligence (AI), and operations research (OR) technologies for solving large-scale and complex real-life optimization problems. Therefore, CPAIOR is never far from industrial applications.

The high number of submissions received this year, almost 100 papers, in witness to the interest of the research community in this conference. From these submissions, we chose 26 to be published in full in the proceedings.

This volume includes summaries of the invited talks of CPAIOR: one from industry, one from the embedded system research community, and one from the operations research community. The invited speakers were: Filippo Focacci from ILOG S.A., France, one of the leading companies in the field; Paul Pop, professor in the Embedded Systems Lab in the Computer and Information Science Department, Linköping University; and Paul Williams, full professor of Operations Research at the London School of Economics.

The day before CPAIOR, a Master Class was organized by Gilles Pesant, where leading researchers gave introductory and overview talks in the area of metaheuristics and constraint programming. The Master Class was intended for PhD students, researchers, and practitioners. We are very grateful to Gilles who brought this excellent program together.

For conference publicity we warmly thank Willem Jan van Hove and Petr Vilím who did a great job with the high number of submissions received. We are very grateful to Michel Rueher who took care of the non-trivial task of finding funds for covering speakers' expenses, proceedings, and student grants.

Many thanks to the Program Committee, who reviewed all the submissions in detail and discussed conflicting papers deeply. Due to the unexpected number of submissions, their load was almost double that expected and their effort was repaid with nothing more than a free dinner.

A special thanks goes to Ondřej Čepěk from Charles University and Milena Zeithamlová from Action M Agency who spent time in budgeting, planning, booking, and making it all work.

Finally, we would like to thank the sponsors who make it possible to organize this conference: the ARTIST Network of Excellence for sponsoring the talk by Paul Pop and making an interesting cross-fertilization possible; Carmen Systems, Sweden; CoLogNet, Network of Excellence; IISI (Intelligent Information Systems Institute, Cornell), USA; ILOG S.A., France; and SICS, Sweden.

Organization

Organizers

Charles University in Prague, Faculty of Mathematics and Physics
Action M Agency (local arrangements)

Executive Committee

Roman Barták, Charles University, Czech Republic (conference co-chair)
Michela Milano, Università di Bologna, Italy (conference co-chair)
Ondřej Čepek, Charles University, Czech Republic (organization chair)

Program Committee

Abderrahmane Aggoun, Cosytec, France
Philippe Baptiste, Ecole Polytechnique, France
Roman Barták, Charles University, Czech Republic (chair)
Chris Beck, University of Toronto, Canada
Mats Carlsson, SICS, Sweden
Ondřej Čepek, Charles University, Czech Republic
Hani El Sakkout, CISCO, UK
Bernard Gendron, CRT and Univ. of Montreal, Canada
Carmen Gervet, IC-Parc, UK
Carla Gomes, Cornell University, USA
John Hooker, Carnegie Mellon University, USA
Narendra Jussien, Ecole des Mines de Nantes, France
Stefan Karisch, Carmen Systems, Canada
Francois Laburthe, Bouygues, France
Andrea Lodi, Università di Bologna, Italy
Michela Milano, Università di Bologna, Italy (chair)
George Nemhauser, Georgia Tech, USA
Gilles Pesant, CRT and Ecole Polytechnique de Montréal, Canada
Jean-Francois Puget, ILOG, France
Jean-Charles Régin, Cornell University, USA
Michel Rueher, University of Nice-Sophia Antipolis, France
Meinolf Sellmann, Brown University, USA
Helmut Simonis, IC-Parc, UK
Sven Thiel, Max Planck Institute, Germany

Gilles Trombettoni, University of Nice-Sophia Antipolis, France
Michael Trick, Carnegie Mellon University, USA
Pascal van Hentenryck, Brown University, USA
Mark Wallace, Monash University, Australia
Weixiong Zhang, Washington University, USA

Additional Referees

Carlos Ansotegui	Vitaly Lagoon	Guillaume Rochart
Konstantin Artiouchine	Yahia Lebbah	Andrea Roli
Nicolas Beldiceanu	Olivier Lhomme	Benoit Rottembourg
Hachemi Bennaouer	Chu Min Li	Louis-Martin Rousseau
Thierry Benoist	Vassilis Liatsos	Jean-David Ruvini
Lucas Bordeaux	Tomas Liden	Andrew Sadler
Ken Brown	Ivana Ljubic	Paul Shaw
Tom Carchrae	Ivan Luzzi	Barbara Smith
Alberto Caprara	Roger Mailler	Stefano Smriglio
Filipe Carvalho	Michele Monaci	Peter Stuckey
David Daney	Bertrand Neveu	Andrea Tramontani
Pierre Deransart	Stefano Novello	Charlotte Truchet
Andrew Eremin	Ammar Oulamara	Jean-Paul Watson
Xavier Gandibleux	Nikos Papdacos	Quanshi Xia
Etienne Gaudin	Thierry Petit	Xiaolan Xie
Frédéric Goualard	Ulrich Pferschy	Neil Yorke-Smith
Laurent Granvilliers	Nikolai Pissaruk	Tallys Yunes
Jesper Hansen	Diego Fernandez Pons	Alessandro Zanarini
Warwick Harvey	Philippe Refalo	

Sponsors

ARTIST, Network of Excellence
Carmen Systems, Sweden
CoLogNet, Network of Excellence
IISI (Intelligent Information Systems Institute, Cornell), USA
ILOG S.A., France
SICS, Sweden

Table of Contents

Invited Papers

Integration of Rules and Optimization in Plant PowerOps <i>Thomas Bousonville, Filippo Focacci, Claude Le Pape, Wim Nuijten, Frederic Paulin, Jean-Francois Puget, Anna Robert, Alireza Sadeghin</i>	1
Embedded Systems Design: Optimization Challenges <i>Paul Pop</i>	16
Models for Solving the Travelling Salesman Problem <i>H. Paul Williams</i>	17

Technical Papers

Set Variables and Local Search <i>Magnus Ågren, Pierre Flener, Justin Pearson</i>	19
The Temporal Knapsack Problem and Its Solution <i>Mark Bartlett, Alan M. Frisch, Youssef Hamadi, Ian Miguel, S. Armagan Tarim, Chris Unsworth</i>	34
Simplifying Diagnosis Using LSAT: A Propositional Approach to Reasoning from First Principles <i>Andreas Bauer</i>	49
The <i>tree</i> Constraint <i>Nicolas Beldiceanu, Pierre Flener, Xavier Lorca</i>	64
Filtering Algorithms for the NVALUE Constraint <i>Christian Bessiere, Emmanuel Hebrard, Brahim Hnich, Zeynep Kiziltan, Toby Walsh</i>	79
Identifying and Exploiting Problem Structures Using Explanation-Based Constraint Programming <i>Hadrien Cambazard, Narendra Jussien</i>	94
A Hybrid Algorithm for a Class of Resource Constrained Scheduling Problems <i>Yingyi Chu, Quanshi Xia</i>	110

On the Minimal Steiner Tree Subproblem and Its Application in Branch-and-Price <i>Wilhelm Cronholm, Farid Ajili, Sofia Panagiotidi</i>	125
Constraint Programming Based Column Generation for Employee Timetabling <i>Sophie Demasse, Gilles Pesant, Louis-Martin Rousseau</i>	140
Scheduling Social Golfers Locally <i>Iván Dotú, Pascal Van Hentenryck</i>	155
Multiconsistency and Robustness with Global Constraints <i>Khaled Elbassioni, Irit Katriel</i>	168
Mixed Discrete and Continuous Algorithms for Scheduling Airborne Astronomy Observations <i>Jeremy Frank, Elif Kürklü</i>	183
Shorter Path Constraints for the Resource Constrained Shortest Path Problem <i>Thorsten Gellermann, Meinolf Sellmann, Robert Wright</i>	201
Improving the Coordination Between the Master Problem and the Subproblem in Constraint Programming Based Column Generation <i>Bernard Gendron, Hocine Lebbah, Gilles Pesant</i>	217
Group Construction for Airline Cabin Crew: Comparing Constraint Programming with Branch and Price <i>Jesper Hansen, Tomas Lidén</i>	228
A Search-Infer-and-Relax Framework for Integrating Solution Methods <i>John N. Hooker</i>	243
Combining Arc-Consistency and Dual Lagrangean Relaxation for Filtering CSPs <i>Mohand Ou Idir Khemmoudj, Hachemi Bennaceur, Anass Nagih</i>	258
Symmetry Breaking and Local Search Spaces <i>Steven Prestwich, Andrea Roli</i>	273
Combination of Among and Cardinality Constraints <i>Jean-Charles Régim</i>	288
On the Tractability of Smooth Constraint Satisfaction Problems <i>T.K. Satish Kumar</i>	304

A SAT-Based Decision Procedure for Mixed Logical/Integer Linear Problems <i>Hossein M. Sheini, Karem A. Sakallah</i>	320
Symmetry and Search in a Network Design Problem <i>Barbara M. Smith</i>	336
Integrating CSP Decomposition Techniques and BDDs for Compiling Configuration Problems <i>Sathiamoorthy Subbarayan</i>	351
Formulations and Reformulations in Integer Programming <i>Michael Trick</i>	366
Nondeterministic Control for Hybrid Search <i>Pascal Van Hentenryck, Laurent Michel</i>	380
Computing Explanations for the Unary Resource Constraint <i>Petr Vřilím</i>	396
Author Index	411