

Lecture Notes in Computer Science

2470

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

Springer

Berlin

Heidelberg

New York

Barcelona

Hong Kong

London

Milan

Paris

Tokyo

Pascal Van Hentenryck (Ed.)

Principles and Practice of Constraint Programming– CP 2002

8th International Conference, CP 2002
Ithaca, NY, USA, September 9-13, 2002
Proceedings



Springer

Series Editors

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

Volume Editor

Pascal Van Hentenryck
Brown University
Box 1910, Providence, RI 02912, USA
E-mail: pvh@cs.brown.edu

Cataloging-in-Publication Data applied for

Die Deutsche Bibliothek - CIP-Einheitsaufnahme

Principles and practice of constraint programming : 8th international conference ; proceedings / CP 2002, Ithaca, NY, USA September 9 - 13, 2002. Pascal Van Hentenryck (ed.). - Berlin ; Heidelberg ; New York ; Barcelona ; Hong Kong ; London ; Milan ; Paris ; Tokyo : Springer, 2002 (Lecture notes in computer science ; Vol. 2470)
ISBN 3-540-44120-4

CR Subject Classification (1998): D.1, D.3.2-3, I.2.3-4, F.3.2, F.4.1, I.2.8

ISSN 0302-9743

ISBN 3-540-44120-4 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-Verlag Berlin Heidelberg New York,
a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2002
Printed in Germany

Typesetting: Camera-ready by author, data conversion by DA-TeX Gerd Blumenstein
Printed on acid-free paper SPIN: 10871314 06/3142 5 4 3 2 1 0

Preface

This volume is the conference record for the Eighth International Conference on Principles and Practice of Constraint Programming (CP 2002) held at Cornell University, Ithaca (USA) on September 9-13, 2002. The series of CP conferences deals with original papers on all aspects of computing with constraints. After a few annual workshops, the conferences were held at Cassis (France) in 1995, at Cambridge (USA) in 1996, in Schloss Hagenberg (Austria) in 1997, at Pisa (Italy) in 1998, at Alexandria (USA) in 1999, at Singapore in 2000, and at Paphos (Cyprus) in 2001.

One of the most appealing features of constraint programming is its multi-disciplinary nature, which gives rise to a unique combination of theoretical and experimental research and which provides bridges between areas that are often thought of as separate and remote. The theme of CP 2002, which was chosen together with Carla Gomes (the conference chair), was to emphasize this multi-disciplinary nature. CP 2002 tried to broaden the audience of the CP series and to reach out to a number of communities which are increasingly interested in CP, but do not (yet) participate in the CP conferences. The objective was to encourage cross-fertilization of ideas from various fields which have been looking at related problems from different, often complementary, angles. This theme was present in many aspects of the conference, including the program committee, the invited talks and tutorials, the computational symposium on graph coloring and generalizations and, of course, the papers that truly capture the wide variety of research encompassed under the umbrella of constraint programming.

About 146 papers were submitted in response to the call for papers. After the reviewing period and some online discussion, the program committee met physically at Brown University on June 14 and 15. The program committee decided to accept two types of papers: technical and innovative application papers. Both types of papers were reviewed rigorously and held to very high standards. The separation into two tracks crystallizes two fundamental ways to make significant advances to the field as it matures; it also acknowledges that the evaluation criteria ought to be different for each type of contribution. In particular, innovative application papers advance the state of the art by presenting innovative applications and systems, by providing insightful evaluations of constraint programming technology, and/or by enhancing and extending existing ideas to solve complex industrial problems. At the end of the two days, the program committee accepted 44 papers (6 of which are innovative applications), which is an acceptance ratio of around 30%. In addition, the program committee also accepted 16 posters, which were allocated 5 pages in these proceedings. In general, these posters were selected because the program committee felt that they contain a very promising, although somewhat premature, idea. Finally, CP 2002 continued the wonderful doctoral program initiated in previous years. This program makes it possible for students to present their work and receive feedback from more senior members

of the community. CP 2002 featured 25 of these young promising researchers, each of whom was given one page in the proceedings to describe their ongoing research.

CP 2002 has been fortunate to attract outstanding invited talks and tutorials. Professors Edward Clarke, Rina Dechter, Jean-Louis Lassez, George Nemhauser, and David Schmoys all kindly accepted our invitation to speak at CP 2002. Nicolas Beldiceanu and Jean-Charles Régin, Frédéric Benhamou, Mats Carlsson and Christian Schulte, and John Hooker kindly agreed to give tutorials on global constraints, interval reasoning, constraint programming languages and systems, and the integration of constraint and integer programming. In addition, the doctoral program also featured a number of tutorials about research and career issues. Finally, we were lucky to have David Johnson, Anuj Mehrotra, and Michael Trick organize the symposium on graph coloring and generalizations in conjunction with the conference.

As constraint programming grows and matures, so does the organization of its conferences. I have been fortunate to work with many talented and dedicated individuals who made outstanding contributions to the conference. I am extremely grateful to Carla Gomes, the conference chair. In addition to her organization skills and her unlimited energy and passion, she helped define, shape, and implement the theme of the conference. She truly was an amazing ambassador for the conference. I also would like to thank the outstanding program committee who worked very hard under tight deadlines, Francesca Rossi for chairing the wonderful doctoral program whose integration in the technical program was as smooth as humanly possible, Peter van Beek for chairing and orchestrating the successful workshop program, Helmut Simonis for chairing the innovative applications program, and Ramon Bejar, the publicity chair. And, last but not least, I am deeply grateful to Lori Agresti and Laurent Michel for their work in the trenches in preparing, running, and concluding the PC meeting at Brown.

July 2002

Pascal Van Hentenryck

Organization

Conference Chair:	Carla Gomes, Cornell University, USA
Program Chair:	Pascal Van Hentenryck, Brown University, USA
Innovative Applications:	Helmut Simonis, Parc Technologies, UK
Doctoral Program:	Francesca Rossi, University of Padova, Italy
Workshop Chair:	Peter van Beek, University of Waterloo, Canada
Publicity Chair:	Ramon Bejar, Cornell University, USA
Local Arrangements:	Beth Howard, Cornell University, DK

Program Committee

Slim Abdennadher, University of Munich, Germany
Fahiem Bacchus, University of Toronto, Canada
Pedro Barahona, Universidade Nova de Lisboa, Portugal
Nicolas Beldiceanu, SICS, Sweden
Frederic Benhamou, University of Nantes, France
Alexander Bockmayr, LORIA, France
Mats Carlsson, SICS, Sweden
Philippe Codognet, University of Paris 6, France
Hubert Comon, ENS, France
Maria Garcia de la Banda, Monash University, Australia
Ian Gent, University of St. Andrews, UK
Hector Geffner, Universitat Pompeu Fabra, Spain
Carla Gomes, Cornell University, USA
Martin Henz, National University of Singapore, Singapore
John Hooker, CMU, USA
Richard Korf, UCLA, USA
Pedro Meseguer, IIIA-CSIC, Spain
George Nemhauser, Georgia Tech., USA
Barry O'Sullivan, University College Cork, Ireland
Gilles Pesant, University of Montreal, Canada
Jochen Renz, Vienna University of Technology, Austria
Francesca Rossi, University of Padova, Italy
Michel Rueher, University of Nice, France
Christian Schulte, Saarland University, Germany
Bart Selman, Cornell University, USA
Pascal Van Hentenryck, Brown University, USA
Moshe Vardi, Rice University, USA
Gerard Verfaillie, ONERA, France
Mark Wallace, IC-PARC, UK
Joachim Walser, I2 Technologies, USA
Brian Williams, MIT, USA
Makoto Yokoo, NTT, Japan

Referees

Slim Abdennadher	Alfonso Gerevini	Bart Massey
F. Ajili	Carla Gomes	Iain McDonald
Paula Amaral	Frederic Goualard	Pedro Meseguer
Matthieu Andre	Jean Goubault-Larrecq	Bernd Meyer
Ola Angelsmark	Laurent Granvilliers	Laurent Michel
Alexis Anglada	Martin Grohe	Michela Milano
Fahiem Bacchus	Martin Henz	Eric Monfroy
Pedro Barahona	Katsutoshi Hirayama	J. Moura Pires
Tania Bedrax-Weiss	Petra Hofstedt	Guy Narboni
Ramon Bejar	John Hooker	George Nemhauser
Nicolas Beldiceanu	Holger Hoos	Bertrand Neveu
Frederic Benhamou	Wuh Hui	Barry O'Sullivan
Christian Bessière	Joxan Jaffar	Maria Osorio
Stefano Bistarelli	Vipul Jain	Greger Ottosson
Alexander Bockmayr	Ari Jonsson	Andrew Parkes
Patrice Boizumault	Peter Jonsson	Gilles Pesant
Lucas Bordeaux	Narendra Jussien	Thierry Petit
James Bowen	Jin-Kao Hao	Evgueni Petrov
Pascal Brisset	Thomas Kasper	Nicolai Pisaruk
Mathias Broxvall	George Katsirelos	Steven Prestwich
Mats Carlsson	Alexander Knapp	Patrick Prosser
Manuel Carro	Richard Korf	Alessandra Raffaeta
Carlos Castro	Per Kreuger	Jean-Charles Régin
Martine Ceberio	Ludwig Krippahl	Jochen Renz
Philippe Codognet	Bhaskar Krishnamachari	Christophe Rigotti
Dave Cohen	Arnaud Lallouet	Jussi Rintanen
Hubert Comon	Arnaud Lalourt	Francesca Rossi
Jorge Cruz	Javier Larrosa	Louis-Martin Rousseau
Joseph Culberson	Yahia Lebbah	Andrew Rowley
Romuald Debruyne	Jimmy Lee	Michel Rueher
Joerg Denzinger	M. Lema	Harald Ruess
Yannis Dimopoulos	Michel Lemaitre	Irena Rusu
Carmel Domshlak	Jonathan Lever	Frederic Saubion
Olivier Dubois	Olivier Lhomme	Thomas Schiex
Torsten Fahle	James Little	Joachim Schimpf
Boi Faltings	Pierre Lopez	Craig Schmidt
Cesar Fernandez	Carsten Lutz	Christian Schulte
Filippo Focacci	Ines Lynce	Dale Schuurmans
Thom Fruehwirth	Arnold Maestre	Evgeny Selensky
Philippe Galinier	Vicky Mak	Bart Selman
Maria Garcia de la Banda	Felip Manyà	Helmut Simonis
Hector Geffner	Kim Marriott	Daniel Singer
Ian Gent	Michael Marte	Barbara Smith
Yan Georget	Lionel Martin	Harald Sondergaard

Finnegan Southey	Marc van Dongen	Brian Williams
Peter Stuckey	Pascal Van Hentenryck	Thorsten Winterer
Peter Szeredi	Moshe Vardi	Armin Wolf
Armagan Tarim	Gerard Verfaillie	Quanshi Xia
Sven Thiel	Thierry Vidal	Roland Yap
Carme Torras	Razvan Voicu	Makoto Yokoo
Erlendur Torsteinsson	Mark Wallace	Tallys Yunes
Michael Trick	Richard Wallace	Hantao Zhang
Gilles Trombettoni	Paul Joachim Walser	Weixiong Zhang
Beek van Peter	Toby Walsh	Yuanlin Zhang

CP Organizing Committee

Alan Borning, University of Washington, USA
 Alex Brodsky, George Mason University, USA
 Jacques Cohen, Brandeis University, USA
 Alain Colmerauer, University of Marseille, France
 Rina Dechter, University of California at Irvine, USA
 Eugene Freuder, chair, University of Cork, Ireland
 Hervé Gallaire, Xerox, USA
 Joxan Jaffar, National University of Singapore, Singapore
 Jean-Pierre Jouannaud, University of Paris Sud, France
 Jean-Louis Lassez, New Mexico Tech, USA
 Michael Maher, Griffith University, Australia
 Ugo Montanari, University of Pisa, Italy
 Anil Nerode, Cornell University, USA
 Jean-François Puget, ILOG, France
 Francesca Rossi, University of Padova, Italy
 Vijay Saraswat, AT&T Research, USA
 Gert Smolka, Univ. des Saarlandes, Germany
 Ralph Wachter, Office of Naval Research, USA
 Toby Walsh, University of Cork, Ireland
 Roland Yap, National University of Singapore, Singapore

Sponsoring Institutions

We gratefully acknowledge the support of AAAI, the Association for Logic Programming (ALP), CoLogNet, Cosytec, ILOG, and the Intelligent Information Systems Institute (IISI) at Cornell University.

Table of Contents

Technical Papers

Reduced Cost-Based Ranking for Generating Promising Subproblems	1
<i>Michela Milano and Willem J. van Hoeve</i>	
Integrating Constraint and Integer Programming for the Orthogonal Latin Squares Problem	17
<i>Gautam Appa, Ioannis Mourtos, and Dimitris Magos</i>	
On Optimal Correction of Inconsistent Linear Constraints	33
<i>Paula Amaral and Pedro Barahona</i>	
Temporal Planning through Mixed Integer Programming: A Preliminary Report	47
<i>Yannis Dimopoulos and Alfonso Gerevini</i>	
A New Multi-resource <i>cumulatives</i> Constraint with Negative Heights	63
<i>Nicolas Beldiceanu and Mats Carlsson</i>	
On the Sum Constraint: Relaxation and Applications	80
<i>Tallys H. Yunes</i>	
Global Constraints for Lexicographic Orderings	93
<i>Alan Frisch, Brahim Hnich, Zeynep Kiziltan, Ian Miguel, and Toby Walsh</i>	
A Global Filtering Algorithm for Handling Systems of Quadratic Equations and Inequations	109
<i>Yahia Lebbah, Michel Rueher, and Claude Michel</i>	
Amplification of Search Performance through Randomization of Heuristics	124
<i>Vincent A. Cicirello and Stephen F. Smith</i>	
Computing the Envelope for Stepwise-Constant Resource Allocations	139
<i>Nicola Muscettola</i>	
Local Probing Applied to Scheduling	155
<i>Olli Kamaraenen and Hani El Sakkout</i>	
A Hybrid Approach for SAT	172
<i>Djamal Habet, Chu Min Li, Laure Devendeville, and Michel Vasquez</i>	
Recovering and Exploiting Structural Knowledge from CNF Formulas	185
<i>Richard Ostrowski, Éric Grégoire, Bertrand Mazure, and Lakhdar Saïs</i>	
Towards a Symmetric Treatment of Satisfaction and Conflicts in Quantified Boolean Formula Evaluation	200
<i>Lintao Zhang and Sharad Malik</i>	

Accelerating Random Walks	216
<i>Wei Wei and Bart Selman</i>	
Scaling and Probabilistic Smoothing:	
Efficient Dynamic Local Search for SAT	233
<i>Frank Hutter, Dave A. D. Tompkins, and Holger H. Hoos</i>	
Learning and Solving Soft Temporal Constraints:	
An Experimental Study	249
<i>Francesca Rossi, Alessandro Sperduti, Kristen B. Venable, Lina Khatib, Paul Morris, and Robert Morris</i>	
Opportunistic Specialization in Russian Doll Search	264
<i>Pedro Meseguer, Martí Sánchez, and Gérard Verfaillie</i>	
Range-Based Algorithm for Max-CSP	280
<i>Thierry Petit, Jean-Charles Régin, and Christian Bessière</i>	
Resolution Complexity of Random Constraints	295
<i>David G. Mitchell</i>	
Constraint Satisfaction, Bounded Treewidth, and Finite-Variable Logics ...	310
<i>Víctor Dalmau, Phokion G. Kolaitis, and Moshe Y. Vardi</i>	
Determining the Number of Solutions to Binary CSP Instances	327
<i>Ola Angelsmark, Peter Jonsson, Svante Linusson, and Johan Thapper</i>	
Consistency Checking for Qualitative Spatial Reasoning	
with Cardinal Directions	341
<i>Spiros Skiadopoulos and Manolis Koubarakis</i>	
Open Constraint Satisfaction	356
<i>Boi Faltings and Santiago Macho-Gonzalez</i>	
Beyond NP: Arc-Consistency for Quantified Constraints	371
<i>Lucas Bordeaux and Eric Monfroy</i>	
Secure Distributed Constraint Satisfaction:	
Reaching Agreement without Revealing Private Information	387
<i>Makoto Yokoo, Koutarou Suzuki, and Katsutoshi Hirayama</i>	
A Dual Graph Translation of a Problem in ‘Life’	402
<i>Barbara M. Smith</i>	
Groups and Constraints: Symmetry Breaking during Search	415
<i>Ian P. Gent, Warwick Harvey, and Tom Kelsey</i>	
Partial Symmetry Breaking	431
<i>Iain McDonald and Barbara Smith</i>	
Symmetry Breaking Revisited	446
<i>Jean-François Puget</i>	

Breaking Row and Column Symmetries in Matrix Models	462
<i>Pierre Flener, Alan M. Frisch, Brahim Hnich, Zeynep Kiziltan, Ian Miguel, Justin Pearson, and Toby Walsh</i>	
Solving the Kirkman's Schoolgirl Problem in a Few Seconds	477
<i>Nicolas Barnier and Pascal Brisset</i>	
Inferring Constraint Types in Constraint Programming	492
<i>David Lesaint</i>	
Model-Based Programming: Controlling Embedded Systems by Reasoning About Hidden State	508
<i>Brian C. Williams and Michel D. Ingham</i>	
The Adaptive Constraint Engine	525
<i>Susan L. Epstein, Eugene C. Freuder, Richard Wallace, Anton Morozov, and Bruce Samuels</i>	
Indexical-Based Solver Learning	541
<i>Thi Bich Hanh Dao, Arnaud Lallouet, Andrei Legtchenko, and Lionel Martin</i>	
Learning the Empirical Hardness of Optimization Problems: The Case of Combinatorial Auctions	556
<i>Kevin Leyton-Brown, Eugene Nudelman, and Yoav Shoham</i>	
Restart Policies with Dependence among Runs: A Dynamic Programming Approach	573
<i>Yongshao Ruan, Eric Horvitz, and Henry Kautz</i>	

Innovative Applications

Visopt ShopFloor: On the Edge of Planning and Scheduling	587
<i>Roman Barták</i>	
Constraint Programming Contribution to Benders Decomposition: A Case Study	603
<i>Thierry Benoist, Etienne Gaudin, and Benoît Rottembourg</i>	
Modeling Camera Control with Constrained Hypertubes	618
<i>Marc Christie, Éric Languénou, and Laurent Granvilliers</i>	
Robust and Parallel Solving of a Network Design Problem	633
<i>Claude Le Pape, Laurent Perron, Jean-Charles Régin, and Paul Shaw</i>	
Connections Reservation with Rerouting for ATM Networks: A Hybrid Approach with Constraints	649
<i>Muriel Lauvergne, Philippe David, and Patrice Boizumault</i>	
Communication and Computation in Distributed CSP Algorithms	664
<i>Cèsar Fernández, Ramón Béjar, Bhaskar Krishnamachari, and Carla Gomes</i>	

Posters

Continuous First-Order Constraint Satisfaction with Equality and Disequality Constraints	680
<i>Stefan Ratschan</i>	
A Relaxation of the Cumulative Constraint	686
<i>John N. Hooker and Hong Yan</i>	
Improving GSAT Using 2SAT	691
<i>Peter J. Stuckey and Lei Zheng</i>	
A Relational Constraint Solver for Model-Based Engineering	696
<i>Jakob Mauss, Frank Seelisch, and Mugur Tatar</i>	
Conflict-Based Repair Techniques for Solving Dynamic Scheduling Problems	702
<i>Abdallah Elkhyari, Christelle Gu��ret, and Narendra Jussien</i>	
Scaling Properties of Pure Random Walk on Random 3-SAT	708
<i>Andrew J. Parkes</i>	
Criticality and Parallelism in Structured SAT Instances	714
<i>Andrea Roli</i>	
Characterizing SAT Problems with the Row Convexity Property	720
<i>Hachemi Bennaceur and Chu Min Li</i>	
Interchangeability in Soft CSPs	726
<i>Stefano Bistarelli, Boi Faltings, and Nicoleta Neagu</i>	
On Constraint Problems with Incomplete or Erroneous Data	732
<i>Neil Yorke-Smith and Carmen Gerv��t</i>	
Heuristic Constraint Propagation	738
<i>Meinolf Sellmann and Warwick Harvey</i>	
An Arc-Consistency Algorithm for the Minimum Weight All Different Constraint	744
<i>Meinolf Sellmann</i>	
Algebraic Properties of CSP Model Operators	750
<i>Y. C. Law and Jimmy H. M. Lee</i>	
AC-3 _d an Efficient Arc-Consistency Algorithm with a Low Space-Complexity	755
<i>Marc R. C. van Dongen</i>	

Doctoral Program

Integrating Search Objects in Asynchronous Constraint Solving	761
<i>Georg Ringwelski</i>	

Distributed Constraint-Based Railway Simulation	762
<i>Hans Schlenker</i>	
Symmetry Breaking in Peaceably Coexisting Armies of Queens	763
<i>Karen E. Petrie</i>	
Batch Processing with Sequence Dependent Setup Times	764
<i>Petr Vilkım</i>	
Interactive Heuristic Search Algorithm	765
<i>Tomáš Müller</i>	
On Constraint Problems with Incomplete or Erroneous Data	766
<i>Neil Yorke-Smith</i>	
Design of a New Metaheuristic for MAXSAT Problems	767
<i>Andrea Roli</i>	
Disjunctive and Continuous Constraint Satisfaction Problems	768
<i>Miguel A. Salido and Federico Barber</i>	
Tuning Randomization in Backtrack Search SAT Algorithms	769
<i>Inês Lynce and João Marques-Silva</i>	
Constraint Solving in Test-Data Generation	770
<i>Yuan Zhan</i>	
Improving Cost Calculations for Global Constraints in Local Search	772
<i>Markus Bohlin</i>	
A Modeling Framework for Constraints	773
<i>Gerrit Renker</i>	
A Linear Programming Based Satisfiability Solver Using a New Horn-Driven Search Tree Design	775
<i>Linda van Norden and Hans van Maaren</i>	
A Concurrent Constraint Programming Approach for Trajectory Determination of Autonomous Vehicles	777
<i>Luis Quesada and Peter Van Roy</i>	
Using Constraint Propagation to Accelerate Column Generation in Aircraft Scheduling	778
<i>Mattias Grönkvist</i>	
Solving and Learning Soft Temporal Constraints; Ceteris Paribus Statements Represented as Soft Constraints Problems	779
<i>Kristen B. Venable</i>	
A Partially Solved Form for Heterogeneous Constraints in Disjunctive Normal Form	780
<i>Frank Seelisch</i>	
Models of Injection Problems	781
<i>Brahim Hnich and Toby Walsh</i>	

Partial Symmetry Breaking	782
<i>Iain McDonald</i>	
Automatic Generation of Implied Clauses for SAT	783
<i>Lyndon Drake, Alan Frisch, and Toby Walsh</i>	
Bridging the Gap between SAT and CSP	784
<i>Carlos Ansótegui and Felip Manyà</i>	
Reducing Symmetry in Matrix Models	786
<i>Zeynep Kiziltan</i>	
Studying Interchangeability in Constraint Satisfaction Problems	787
<i>Nicoleta Neagu</i>	
Constraint Modeling in the Context of Academic Task Assignment	789
<i>Robert Glaubius and Berthe Y. Choueiry</i>	
Design Tradeoffs for Autonomous Trading Agents	790
<i>Ioannis A. Vetsikas</i>	
Author Index	793