

## Preface

This volume contains the papers presented at IJCAR 2008, the 4th International Joint Conference on Automated Reasoning, held on August 12-15, 2008, in Sydney (Australia). The IJCAR conference series is aimed at unifying the different research principles within Automated Reasoning. IJCAR 2008 is the fusion of several major international events:

- **CADE**: The International Conference on Automated Deduction,
- **FroCoS**: The Symposium on Frontiers of Combining Systems,
- **FTP**: The Workshop on First-order Theorem Proving, and
- **TABLEAUX**: The Conference on Analytic Tableaux and Related Methods.

Previous versions of IJCAR were held at Seattle (USA) in 2006, Cork (Ireland) in 2004 and Siena (Italy) in 2001.

These proceedings comprise 4 contributions by invited speakers, 26 research papers and 13 system descriptions. It also includes a short overview of the CASC-J4 competition for automated theorem proving systems that was conducted during IJCAR 2008. The invited speakers were Hubert Comon-Lundh, Nachum Dershowitz, Aarti Gupta, and Carsten Lutz. Their talks covered a broad spectrum of Automated Reasoning, viz., verification of security protocols, proof theoretical frameworks for first-order logic, automated decision procedures and software verification, and description logics.

The contributed papers were selected from 80 research paper submissions and 17 system description submissions. Each submission was reviewed by at least three reviewers, and decisions were reached after two weeks of discussion through an electronic Program Committee meeting. The submissions, reviews and discussion were coordinated using the EasyChair conference management system. The accepted papers spanned a wide spectrum of research in Automated Reasoning, including saturation, equational reasoning and unification, automata-based methods, description logics and related logics, satisfiability modulo theory, decidable logics, reasoning about programs, and higher-order logics.

The Herbrand Award for distinguished contributions to automated reasoning was presented to Edmund M. Clarke in recognition of his role in the invention of model checking and his sustained leadership in the area for more than two decades. The selection committee for the Herbrand Award consists of the previous award winners of the last ten years, the trustees of CADE Inc., and the IJCAR 2008 Program Committee. The Herbrand award ceremony and the acceptance speech by Professor Clarke were part of the conference programme.

In addition to the Program Committee and the reviewers, many people contributed to the success of IJCAR 2008. Geoff Sutcliffe served as the publicity chair and organized the systems competition, CASC-J4. The IJCAR steering committee consisted of Alessandro Armando, Franz Baader (chair), Peter Baumgartner, Alan Bundy, Gilles Dowek, Rajeev Goré, Bernhard Gramlich, John Harrison, and Ullrich Hustadt. Special thanks go to Andrei Voronkov for his EasyChair system, which makes many tasks of a program chair much easier.

We would like to thank all people involved in organizing IJCAR 2008, as well as the sponsors the Australian National University, Intel, Microsoft Research and NICTA.

May 2008

Alessandro Armando  
Peter Baumgartner  
Gilles Dowek

# Conference Organization

## Programme Chairs

Alessandro Armando  
Peter Baumgartner  
Gilles Dowek

## Programme Committee

Christoph Benzmueller	Nicola Olivetti
Nikolaj Bjorner	Lawrence Paulson
Patrick Blackburn	Silvio Ranise
Maria Paola Bonacina	Christophe Ringeissen
Alessandro Cimatti	Albert Rubio
Roy Dyckhoff	Michael Rusinowitch
Silvio Ghilardi	Ulrike Sattler
Jürgen Giesl	Carsten Schürmann
Rajeev Gore	Natarajan Shankar
Bernhard Gramlich	Viorica Sofronie-Stokkermans
Reiner Hähnle	Geoff Sutcliffe
John Harrison	Cesare Tinelli
Deepak Kapur	Ashish Tiwari
Viktor Kuncak	Luca Viganò
Christopher Lynch	Andrei Voronkov
Tobias Nipkow	Toby Walsh
Hans de Nivelle	Frank Wolter

## Conference Chair

Peter Baumgartner

## Workshop and Tutorial Chair

Michael Norrish

## Publicity Chair

Geoff Sutcliffe

## Local Organization

Jinbo Huang, Michael Norrish, Andrew Slater, Toby Walsh

## External Reviewers

Andreas Abel	Isabelle Gnaedig	Sam Owre
Anbulagan	Guillem Godoy	Ruzica Piskac
Takahito Aoto	Alberto Griggio	David Plaisted
Clark Barrett	James Harland	Gian Luca Pozzato
Joachim Baumeister	Emmanuel Hebrard	Florian Rabe
Malgorzata Biernacka	Thomas Hillenbrand	Vincent Risch
Lars Birkedal	Dieter Hutter	Xavier Rival
Thomas Bolander	Swen Jacobs	Enric Rodriguez-
Bianca Boretti	Barbara Jobstmann	Carbonell
Olivier Bournez	Vladimir Komendantsky	Robert Rothenberg
Marco Bozzano	Boris Konev	Philipp Ruemmer
Paul Brauner	Konstantin Korovin	Gernot Salzer
James Bridge	Shuvendu Lahiri	Felix Schernhammer
Björn Bringert	Stephane Lengrand	Renate Schmidt
Chad Brown	Giacomo Lenzi	Thomas Schneider
Kai Bruennler	Alexei Lisitsa	Camilla Schwind
Roberto Bruttomesso	Thomas Lukasiewicz	Roberto Sebastiani
Richard Bubel	Carsten Lutz	Rob Shearer
Serge Burckel	Michael Maher	John Slaney
Guillaume Burel	Mark Marron	Aaron Stump
Serenella Cerrito	William McCune	Christino Tamon
Amine Chaieb	George Metcalfe	Alwen Tiu
Ernie Cohen	Aart Middeldorp	Stefano Tonetta
Sylvain Conchon	Pierluigi Minari	Duc-Khanh Tran
Dominik Dietrich	Boris Motik	Kumar Neeraj Verma
Yu Ding	Leonardo de Moura	Laurent Vigneron
Lucas Dixon	Jean-Yves Moyen	Marco Volpe
Bruno Dutertre	Peter Mueller	Dirk Walther
Mnacho Echenim	Cesar Munoz	Florian Widmann
Stephan Falke	Peter Müller	Claus-Peter Wirth
Christian Fermüller	Enrica Nicolini	Burkhart Wolff
Camillo Fiorentini	Robert Nieuwenhuis	Eric Wurbel
Melvin Fitting	Greg O'Keefe	Jian Zhang
Pascal Fontaine	Albert Oliveras	Daniele Zucchelli
Alexander Fuchs	Nicola Olivetti	
Martin Giese	Jan Otop	

# Table of Contents

## Session 1. Invited Talk

Software Verification: Roles and Challenges for Automatic Decision Procedures ( <i>invited talk</i> ) . . . . .	1
<i>Aarti Gupta</i>	

## Session 2. Specific Theories

Proving Bounds on Real-Valued Functions with Computations . . . . .	2
<i>Guillaume Melquiond</i>	
Linear Quantifier Elimination . . . . .	18
<i>Tobias Nipkow</i>	
Quantitative Separation Logic and Programs with Lists . . . . .	34
<i>Radu Iosif, Marius Bozga, Swann Perarnau</i>	
On Automating the Calculus of Relations . . . . .	50
<i>Peter Höfner, Georg Struth</i>	

## Session 3. Automated Verification

Towards SMT Model Checking of Array-based Systems . . . . .	66
<i>Silvio Ghilardi, Enrica Nicolini, Silvio Ranise, Daniele Zucchelli</i>	
Preservation of proof obligations from Java to the Java Virtual Machine . . . . .	82
<i>Gilles Barthe, Benjamin Gregoire, mariela pavlova</i>	
Efficient Well-Definedness Checking . . . . .	99
<i>Adam Darvas, Farhad Mehta, Arsenii Rudich</i>	

## Session 4. Protocol Verification

Proving Group Protocols Secure Against Eavesdroppers . . . . .	115
<i>Steve Kremer, Antoine Mercier, Ralf Treinen</i>	

## Session 5. System Descriptions 1

Automated Implicit Computational Complexity Analysis (System Description) . . . . .	131
<i>Martin Avanzini, Georg Moser, Andreas Schnabl</i>	

LogAnswer - A Deduction-Based Question Answering System (System Description) . . . . .	138
<i>Ulrich Furbach, Ingo Glöckner, Hermann Helbig, Björn Pelzer</i>	

A High-Level Implementation of a System for Automated Reasoning with Default Rules (System Description) . . . . .	146
<i>Christoph Beierle, Gabriele Kern-Isberner, Nicole Koch</i>	
The Abella Interactive Theorem Prover (System Description) . . . . .	153
<i>Andrew Gacek</i>	
LEO-II - A Cooperative Automatic Theorem Prover for Classical Higher-Order Logic (System Description) . . . . .	160
<i>Christoph Benzmueller, Lawrence Paulson, Frank Theiss, Arnaud Fietzke</i>	
KeYmaera: A Hybrid Theorem Prover for Hybrid Systems (System Description) . . . . .	168
<i>Andre Platzer, Jan-David Quesel</i>	
<b>Session 6. Invited Talk</b>	
The Complexity of Conjunctive Query Answering in Expressive Description Logics ( <i>invited talk</i> ) . . . . .	175
<i>Carsten Lutz</i>	
<b>Session 7. Modal Logics</b>	
A General Tableau Method for Deciding Description Logics, Modal Logics and Related First-Order Fragments . . . . .	190
<i>Renate Schmidt, Dmitry Tishkovsky</i>	
Terminating Tableaux for Hybrid Logic with the Difference Modality and Converse . . . . .	206
<i>Mark Kaminski, Gert Smolka</i>	
<b>Session 8. Herbrand Award Ceremony</b>	
<b>Session 9. Description Logics</b>	
Automata-based Axiom Pinpointing . . . . .	222
<i>Franz Baader, Rafael Penaloza</i>	
Individual Reuse in Description Logic Reasoning . . . . .	238
<i>Boris Motik, Ian Horrocks</i>	
The Logical Difference Problem for Description Logic Terminologies . . . . .	254
<i>Boris Konev, Dirk Walther, Frank Wolter</i>	
<b>Session 10. System Descriptions 2</b>	
Aligator: A Mathematica Package for Invariant Generation (System Description) . . . . .	270
<i>Laura Kovacs</i>	

leanCoP 2.0 and ileanCoP 1.2: High Performance Lean Theorem Proving in Classical and Intuitionistic Logic (System Descriptions) . . . . .	278
<i>Jens Otten</i>	
iProver – An instantiation-based theorem prover for first-order logic (System Description) . . . . .	287
<i>Konstantin Korovin</i>	
An Experimental Evaluation of Global Caching for $\mathcal{ALC}$ (System Description) . . . . .	294
<i>Rajeev Gore, Linda Postniece</i>	
Multi-Completion with Termination Tools (System Description) . . . . .	301
<i>Haruhiko Sato, Sarah Winkler, Masahito Kurihara, Aart Middeldorp</i>	
MTT: The Maude Termination Tool (System Description) . . . . .	308
<i>Francisco Duran, Salvador Lucas, Jose Meseguer</i>	
CELF – A Logical Framework for Deductive and Concurrent Systems (System Description) . . . . .	315
<i>Anders Schack-Nielsen, Carsten Schürmann</i>	
<b>Session 11. Invited Talk</b>	
Canonicity! ( <i>invited talk</i> ) . . . . .	322
<i>Nachum Dershowitz</i>	
<b>Session 12. Equational Theories</b>	
Unification and Matching Modulo Leaf-Permutative Equational Presentations . . . . .	327
<i>Thierry Boy de la Tour, Mnacho Echenim, Paliath Narendran</i>	
Modularity of Confluence, Constructed . . . . .	343
<i>Vincent van Oostrom</i>	
Automated Complexity Analysis Based on the Dependency Pair Method .	359
<i>Nao Hirokawa, Georg Moser</i>	
Canonical Inference for Implicational Systems . . . . .	375
<i>Maria Paola Bonacina, Nachum Dershowitz</i>	
<b>Session 13. Invited Talk</b>	
Challenges in the Automated Verification of Security Protocols ( <i>invited talk</i> ) . . . . .	391
<i>Hubert Comon-Lundh</i>	
<b>Session 14. Theorem Proving 1</b>	

Deciding Effectively Propositional Logic using DPLL and substitution sets	405
<i>Leonardo de Moura, Nikolaj Bjorner</i>	
Proof Systems for Effectively Propositional Logic	421
<i>Juan Antonio Navarro Perez, Andrei Voronkov</i>	
MaLAREa SG1: Machine Learner for Automated Reasoning with Semantic Guidance	436
<i>Josef Urban, Geoff Sutcliffe, Petr Pudlák, Jiri Vyskocil</i>	
<b>Session 15. CASC</b>	
CASC-J4 - The 4th IJCAR ATP System Competition ( <i>invited talk</i> )	452
<i>Geoff Sutcliffe</i>	
<b>Session 16. Theorem Proving 2</b>	
Labelled Splitting	454
<i>Arnaud Fietzke, Christoph Weidenbach</i>	
Engineering DPLL(T) + Saturation	470
<i>Leonardo de Moura, Nikolaj Bjorner</i>	
THF0 – The Core TPTP Language for Classical Higher-Order Logic	486
<i>Christoph Benzmueller, Florian Rabe, Geoff Sutcliffe</i>	
<b>Session 17. Logical Frameworks</b>	
Focusing in linear meta-logic	502
<i>Vivek Nigam, Dale Miller</i>	
<b>Session 18. Tree Automata</b>	
Certifying a Tree Automata Completion Checker	518
<i>Benoit Boyer, Thomas Genet, Thomas Jensen</i>	
Automated Induction with Constrained Tree Automata	534
<i>Adel bouhoula, Florent Jacquemard</i>	