Series Editors

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

Volume Editors

Jonathan Schaeffer
Martin Müller
Yngvi Björnsson
University of Alberta
Department of Computing Science
Edmonton, Alberta, Canada T6G 2E8
E-mail: {jonathan;mmueller;yngvi}@cs.ualberta.ca

Cataloging-in-Publication Data applied for

A catalog record for this book is available from the Library of Congress.

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie;
detailed bibliographic data is available in the Internet at <http://dnb.ddb.de>.

CR Subject Classification (1998): G, I.2.1, I.2.6, I.2.8, F.2, E.1

ISSN 0302-9743

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 is a part of Springer Science+Business Media

springeronline.com

© Springer-Verlag Berlin Heidelberg 2003
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Olgun Computergrafik
Printed on acid-free paper SPIN: 10968413 06/3142 543210
Preface

The Computers and Games (CG) series began in 1998 with the objective of showcasing new developments in artificial intelligence (AI) research that used games as the experimental test-bed. The first two CG conferences were held at Hamamatsu, Japan (1998, 2000). Computers and Games 2002 (CG 2002) was the third event in this biennial series. The conference was held at the University of Alberta (Edmonton, Alberta, Canada), July 25–27, 2002. The program consisted of the main conference featuring refereed papers and keynote speakers, as well as several side events including the Games Informatics Workshop, the Agents in Computer Games Workshop, the Trading Agents Competition, and the North American Computer Go Championship.

CG 2002 attracted 110 participants from over a dozen countries. Part of the success of the conference was that it was co-located with the National Conference of the American Association for Artificial Intelligence (AAAI), which began in Edmonton just as CG 2002 ended.

The CG 2002 program had 27 refereed paper presentations. The papers ranged over a wide variety of AI-related topics including search, knowledge, learning, planning, and combinatorial game theory. Research test-beds included one-player games (blackjack, sliding-tile puzzles, Sokoban), two-player games (Amazons, awari, chess, Chinese chess, clobber, Go, Hex, Lines of Action, Othello, shogi), multi-player games (Chinese checkers, cribbage, Diplomacy, hearts, spades), commercial games (role-playing games, real-time strategy games), and novel applications (Post’s Correspondence Problem).

The Computers and Games conference has traditionally appealed to researchers working on artificial intelligence problems that have been motivated by the desire to build high-performance programs for the classic board and card games. However, the commercial games industry has its own set of challenging AI problems that need to be investigated. These problems are difficult, in part because they need solutions that have tight real-time constraints. Further, from the research point of view, many of these research problems have “fuzzy” outcomes. Our community is used to classic performance metrics such as tree size or winning percentage, whereas the commercial games community values the intangible “fun factor” and is not interested in world-beating programs. In an attempt to get more communication between these two communities, we strove to diversify the range of interest for CG by trying to attract more commercial involvement. We were partially successful, enjoying invited talks from Scott Grieg (BioWare, Corp.) and Denis Papp (TimeGate Studios), as well as three refereed papers.
We want to thank our keynote speakers for their excellent presentations:

- Murray Campbell (IBM T.J. Watson Research Center): “Deep Blue: Five Years Later.”
- Matt Ginsberg (Computational Intelligence Research Laboratory, University of Oregon): “GIB: Imperfect Information in a Computationally Challenging Game.”
- Scott Grieg (BioWare, Corp.): “Tales from the Trenches: Practical AI in Video Games.”
- John Romein (Free University, Amsterdam): “Solving Awari Using Large-Scale Parallel Retrograde Analysis.”
- Peter Stone (University of Texas at Austin): “The Trading Agent Competition: Two Champion Adaptive Bidding Agents.”

All the keynote presentations were conference highlights – a reflection of the quality of the speakers and their talks.

This conference would not have been possible without the tireless efforts of many people. The quality of the papers presented at Computers and Games 2002 is a reflection of the excellent job done by the program committee and the referees. Numerous other people helped make this event a success: Darse Billings, Jim Easton, Amanda Hansen, Akihiro Kishimoto, Tony Marsland, Louise Whyte, Peter Yap, and Ling Zhao. Thank you!

Finally, we thank the Department of Computing Science (University of Alberta), the University of Alberta (Research), and BioWare Corp. for their sponsorship.

August 2003

Yngvi Björnsson,
Martin Müller,
Jonathan Schaeffer
Organization

Executive Committee

Co-chairs

Jonathan Schaeffer (University of Alberta)
Martin Müller (University of Alberta)
Yngvi Björnsson (University of Alberta)

Program Committee

Mark Brockington (BioWare)
John Buchanan (Electronic Arts)
Michael Buro (NEC)
Murray Campbell (IBM)
Ian Frank (Future University, Hakodate)
Matt Ginsberg (University of Oregon)
Reijer Grimbergen (Saga University)
Robert Holte (University of Alberta)
Hiroyuki Iida (Shizuoka University)
Andreas Junghanns (DaimlerChrysler)
Graham Kendall (University of Nottingham)
Richard Korf (UCLA)
John Laird (University of Michigan)
Mike Littman (AT&T Research)
Denis Papp (TimeGate Studios)
Duane Szafron (University of Alberta)
Jaap van den Herik (University of Maastricht)
Computers and Games 2002 conference attendees
Table of Contents

Part 1: Evaluation and Learning

Distinguishing Gamblers from Investors at the Blackjack Table ............ 1
   David Wolfe

MOUSE(µ): A Self-teaching Algorithm that Achieved Master-Strength
at Othello.......................................................... 11
   Konstantinos Tournavitis

Investigation of an Adaptive Cribbage Player ......................... 29
   Graham Kendall and Stephen Shaw

Learning a Game Strategy Using Pattern-Weights and Self-play .......... 42
   Ari Shapiro, Gil Fuchs, and Robert Levinson

Part 2: Search

PDS-PN: A New Proof-Number Search Algorithm.......................... 61
   Mark H.M. Winands, Jos W.H.M. Uiterwijk, and Jaap van den Herik

A Generalized Threats Search Algorithm .............................. 75
   Tristan Cazenave

Proof-Set Search .................................................. 88
   Martin Müller

A Comparison of Algorithms for Multi-player Games ................... 108
   Nathan Sturtevant

Selective Search in an Amazons Program .............................. 123
   Henry Avetisyan and Richard J. Lorentz

Playing Games with Multiple Choice Systems .......................... 142
   Ingo Althöfer and Raymond Georg Snatzke

The Neural MoveMap Heuristic in Chess ................................ 154
   Levente Kocsis, Jos W.H.M. Uiterwijk, Eric Postma,
   and Jaap van den Herik

Board Maps and Hill-Climbing for Opening
and Middle Game Play in Shogi .................................... 171
   Reijer Grimbergen and Jeff Rollason
# Table of Contents

## Part 3: Combinatorial Games/Theory

Solitaire Clobber ................................................... 188  
*Erik D. Demaine, Martin L. Demaine, and Rudolf Fleischer*

Complexity of Error-Correcting Codes Derived  
from Combinatorial Games ........................................ 201  
*Aviezri S. Fraenkel and Ofer Rahat*

Analysis of Composite Corridors .............................. 213  
*Teigo Nakamura and Elwyn Berlekamp*

## Part 4: Opening/Endgame Databases

New Winning and Losing Positions for $7 \times 7$ Hex ................. 230  
*Jing Yang, Simon Liao, and Miroslaw Pawlak*

Position-Value Representation in Opening Books .................. 249  
*Thomas R. Lincke*

Indefinite Sequence of Moves in Chinese Chess Endgames ........... 264  
*Haw-ren Fang, Tsan-sheng Hsu, and Shun-chin Hsu*

## Part 5: Commercial Games

ORTS: A Hack-Free RTS Game Environment ...................... 280  
*Michael Buro*

Causal Normalization: A Methodology for Coherent Story Logic Design in Computer Role-Playing Games .......................... 292  
*Craig A. Lindley and Mirjam Eladhari*

A Structure for Modern Computer Narratives ................... 308  
*Clark Verbrugge*

## Part 6: Single-Agent Search/Planning

Tackling Post’s Correspondence Problem ......................... 326  
*Ling Zhao*

Perimeter Search Performance ..................................... 345  
*Carlos Linares López and Andreas Junghanns*

Using Abstraction for Planning in Sokoban ....................... 360  
*Adi Botea, Martin Müller, and Jonathan Schaeffer*
Part 7: Computer Go

A Small Go Board Study of Metric and Dimensional Evaluation Functions ........................................ 376
Bruno Bouzy

Local Move Prediction in Go ........................................ 393
Erik van der Werf, Jos W.H.M. Uiterwijk, Eric Postma,
and Jaap van den Herik

Evaluating Kos in a Neutral Threat Environment: Preliminary Results .... 413
William L. Spight

Author Index .......................................................... 429

Game Index .......................................................... 431