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Preface

This book contains the papers of the 4th International Conference on Computers and Games (CG 2004) held at the Bar-Ilan University in Ramat-Gan, Israel. The conference took place during July 5–7, 2004, in conjunction with the 12th World Computer-Chess Championship (WCCC) and the 9th Computer Olympiad.

The biennial Computers and Games conference series is a major international forum for researchers and developers interested in all aspects of artificial intelligence in computer-game playing. After two terms in Japan and one in North America, the fourth conference was held in Israel.

The Program Committee (PC) received 37 submissions. Each paper was initially sent to two referees. Only if conflicting views on a paper were presented, was it sent to a third referee. With the help of many referees (see list after this preface), the PC accepted 21 papers for presentation and publication after a post-conference editing process. For the majority of the papers this implied a second refereeing process.

The PC invited Brian Sheppard as a keynote speaker for CG 2004. Moreover, Dr. Sheppard was Guest of Honour at the 9th Computer Olympiad and recipient of the 2002 ChessBase Award for his publication "Towards Perfect Play of Scrabble." Dr. Sheppard's contribution "Efficient Control of Selective Simulations" was taken as the start of these proceedings and as a guideline for the order of the other contributions. Brian Sheppard's contribution deals with Scrabble, Poker, Backgammon, Bridge, and even Go. So, his contribution is followed by papers on these games if presented at the conference. Otherwise the international and varied nature of the papers of CG 2004 would be difficult to order owing to their diversity of backgrounds and their many different views on games and related issues. This diversity, however, makes the book attractive for all readers.

Dr. Sheppard's contribution is followed by a Poker contribution, viz., "Game-Tree Search with Adaptation in Stochastic Imperfect-Information Games" by Darse Billings et al. and a Backgammon contribution, viz., "*-Minimax Performance in Backgammon" by Thomas Hauk et al. Since the paper on Backgammon uses *-Minimax Search, we decided to let it be preceded by "Rediscovering *-Minimax Search" by the same authors. Then four papers on Go follow. The remaining papers are on Chinese chess (two papers), and thereafter one paper for each of the following games: Amazons, Arimaa, Chess, Dao, Gaps, Kayles, Kriegspiel, Loa, and Sum Games. The book is completed by three contributions on multi-player games.

We hope that our readers will enjoy reading the efforts of the researchers. Below we provide a brief characterization of the 22 contributions in the order given above. It is a summary of their abstracts, yet it provides a fantastic three-page overview of the progress in the field.

"Efficient Control of Selective Simulations" by Brian Sheppard describes a search technique that estimates the value of a move in a state space by averaging the results of a selected sample of continuations. Since exhausted search is ineffective in domains characterized by non-determinism, imperfect information, and high branching factors, the prevailing question is: can a selective search improve upon static analysis? The author's answer to this question is affirmative.

"Game-Tree Search with Adaptation in Stochastic Imperfect-Information Games" is written by Darse Billings, Aaron Davidson, Terence Schauenberg, Neil Burch, Michael Bowling, Robert Holte, Jonathan Schaeffer, and Duane Szafron. It deals with real-time opponent modelling to improve the evaluation-function estimates. The new program called VEXBOT is able to defeat PSOPTI, the best poker-playing program at the time of writing.

"Rediscovering *-MINIMAX Search" by Thomas Hauk, Michael Buro, and Jonathan Schaeffer provides new insights into the almost forgotten STAR 1 and STAR 2 algorithms (Ballard, 1983) by making them fit for stochastic domains.

"*-MINIMAX Performance in Backgammon" also by Thomas Hauk, Michael Buro, and Jonathan Schaeffer presents the first performance results for Ballard's (1983) *-MINIMAX algorithms applied to Backgammon. It is shown that with effective move ordering and probing STAR 2 considerably outperforms EXPECTIMAX. Moreover, empirical evidence is given that today's sophisticated evaluation functions do not require deep searches for good checker play in Backgammon.

"Associating Shallow and Selective Global Tree Search with Monte Carlo for 9×9 Go" by Bruno Bouzy continues to advocate that Monte-Carlo search is effective in examining search trees. An iteratively-deepening min-max algorithm is applied with the help of random games to compute mean values. The procedure is stopped as soon as one move at the root is proved to be superior to the other moves. Experiments demonstrate the relevance of this approach.

"Learning to Estimate Potential Territory in the Game of Go" is a contribution by Erik van der Werf, Jaap van den Herik, and Jos Uiterwijk. It investigates methods for estimating potential territory in the game of Go. New trainable methods are presented for learning to estimate potential territory from examples. Experiments show that all methods described are greatly improved by adding knowledge of life and death.

"An Improved Safety Solver for Computer Go" by Xiaozhen Niu and Martin Müller describes new, stronger search-based techniques including region merging and a new method for efficiently solving weakly dependent regions. In a typical final position, more than half the points on the board can be proved safe by the current solver. This result almost doubles the number of proven points compared to the earlier reported percentage of 26.4.

"Searching for Compound Goals Using Relevancy Zones in the Game of Go" is written by Jan Ramon and Tom Croonenborghs. A compound goal is constructed from less complex atomic goals, using standard connectives. Compound-goal

search obtains exact results. A general method is proposed that uses relevancy zones for searching for compound goals.

"Rule-Tolerant Verification Algorithms for Completeness of Chinese-Chess Endgame Databases" by Haw-ren Fang attempts to verify a conjecture, viz., that the rule of checking indefinitely has much more effect on staining the endgame databases than other special rules. It turned out that three endgame databases, KRKCC, KRKPPP, and KRKCGG are complete with the Asian rule set, but stained by the Chinese rules.

"An External-Memory Retrograde Analysis Algorithm" by Ping-hsun Wu, Ping-Yi Liu, and Tsan-sheng Hsu gives a new sequential algorithm for the construction of large endgame databases. The new algorithm works well even when the number of positions is larger than the number of bits in the main memory computer. A 12-men database KCPGGMMKGGMM is built. It has 8,785,969,200 positions after removing symmetrical positions. The construction process took 79 hours. The author found the largest DTM and DTC values currently known, viz., 116 and 96.

"Generating an Opening Book for Amazons" is by Akop Karapetyan and Richard Lorentz. The authors discuss a number of possible methods for creating opening books. They focus mainly on automatic construction and explain which seem best suited for games with large branching factors such as Amazons.

"Building a World-Champion Arimaa Program" by David Fotland describes a new two-player strategy game designed by Omar Syed. The game is difficult for computers. Omar offers a $10,000 prize to the first program to beat a human top player. Bot-Bomb won the 2004 computer championship, but failed to beat Omar for the prize. The article describes why this is so.

"Blockage Detection in King and Pawn Endgames" by Omid David Tabibi, Ariel Felner, and Nathan S. Netanyahu is the only contribution on chess. A blockade detection method with practically no additional overhead is described. The method checks several criteria to find out whether the blockage is permanent.

"Dao: a Benchmark Game" is written by Jeroen Donkers, Jaap van den Herik, and Jos Uiterwijk. The contribution describes many detailed properties of Dao and its solution. The authors conclude that the game can be used as a benchmark of search enhancements. As an illustration they provide an example concerning the size of a transposition table in α-β Search.

"Incremental Transpositions" by Bernard Helmstetter and Tristan Cazenave deals with two single-agent games, viz., Gaps and Morpion Solitaire. The authors distinguish between transpositions that are due to permutations of commutative moves and transpositions that are not. They show a depth-first algorithm which can detect the transpositions of the first class without the use of a transposition table. In a variant of Gaps, the algorithm searches more efficiently with a small transposition table. In Morpion Solitaire a transposition table is not even needed.

"Kayles on the Way to the Stars" by Rudolf Fleischer and Gerhard Trippen provides a solution for a previously stated open problem in proving that determining the value of a game position needs only polynomial time in a star of bounded degree. So, finding the winning move — if one exists — can be done in linear time based on the data calculated before.

"Searching over Metapositions in Kriegspiel" is written by Andrea Bolognesi and Paolo Ciancarini. It describes the rationale of a program playing basic endgames. It is shown how the branching factor of a game tree can be reduced in order to employ an evaluation function and a search algorithm.

"The Relative History Heuristic" is authored by Mark Winands, Erik van der Werf, Jaap van den Herik, and Jos Uiterwijk. The authors propose a new method for move ordering. It is an improvement of the history heuristic. Some ideas are taken from the butterfly heuristic. Instead of only recording moves which are best in a node, moves which are applied in the search tree are also recorded. Both scores are taken into account in the relative history heuristic. So, moves are favored which on average are good over moves which are sometimes best.

"Locally Informed Global Search for Sums of Combinatorial Games" by Martin Müller and Zhichao Li describes algorithms that utilize the subgame structure to reduce the runtime of global α-β Search by orders of magnitude. An important issue is the independence of subgames. Important notions of a subgame are temperature or its thermograph. The new algorithms exhibit improving solution quality with increasing time limits.

"Current Challenges of Multi-Player Game Search" by Nathan Sturtevant focuses on the card games Hearts and Spades. The article deals with the optimality of current search techniques and the need for good opponent modelling in multi-player game search.

"Preventing Look-Ahead Cheating with Active Objects" by Jouni Smed and Harri Hakonen first discusses a lockstep protocol. This requires that the player starts at announcing a commitment to an action and thereafter announces the action itself. Since the lockstep protocol requires separate transmissions, it slows down the turns of the games. Another method to prevent look-ahead cheating is the use of active objects. It relies on parameterizing the probability of catching cheaters. The smaller the probability, the less bandwidth and transmissions are required.

"Strategic Interactions in the TAC 2003 Supply Chain Tournament" is a joint effort of Joshua Estelle, Yevgeniy Vorobeychik, Michael P. Wellman, Satinder Singh, Christopher Kiekintveld, and Vishal Soni. The authors introduce a preemptive strategy designed to neutralize aggressive procurement, perturbing the field to a more profitable equilibrium. It may be counterintuitive that an action designed to prevent others from achieving their goals actually helps them. Yet, strategic analysis employing an empirical game-theoretic methodology verifies and provides insight into the results.

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September 2005

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Nathan Netanyahu,

Maastricht, Reykjavik, and Ramat-Gan

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