Preface

These joint proceedings contain the papers of the Computer Games Workshop (CGW 2015) and the General Intelligence in Game-Playing Agents (GIGA 2015) workshop, which were both held in Buenos Aires, Argentina. These workshops took place on July 26 and 27, 2015, respectively, in conjunction with the 24th International Conference on Artificial Intelligence (IJCAI 2015). These two workshops reflect the large interest in AI research for games.

The Computer and Games Workshop series is an international forum for researchers interested in all aspects of artificial intelligence (AI) and computer game playing. Earlier workshops took place in Montpellier, France (2012), Beijing, China (2013), and Prague, Czech Republic (2014). For the fourth edition of the Computer Games Workshop, 16 submissions were received in 2015. Each paper was sent to two reviewers. In the end, 10 papers were accepted for presentation at the workshop, of which eight made it into these proceedings. The published papers cover a wide range of topics related to computer games. They collectively discuss eight abstract games: Chinese checkers, Go Fish, Lost Cities, Morpion Solitaire, Phantom Domineering, Phantom Go, Settlers of Catan, and Surakarta. Additionally, one paper is on a roguelike game and one paper is on the Pancake Problem.

The GIGA workshop series has been established to become the major forum for discussing, presenting, and promoting research on general game playing (GGP). It aims at building intelligent software agents that can, given the rules of any game, automatically learn a strategy for playing that game at an expert level without any human intervention. The workshop intends to bring together researchers from subfields of AI to discuss how best to address the challenges and further advance the state of the art of general game-playing systems and generic artificial intelligence. Following the inaugural GIGA Workshop at IJCAI 2009 in Pasadena (USA), follow-up events took place at IJCAI 2011 in Barcelona (Spain) and IJCAI 2013 in Beijing (China). This fourth workshop on General Intelligence in Game-Playing Agents received 11 submissions. Each paper was sent to two reviewers. In the end, 10 papers were accepted for presentation at the workshop, of which four made it into these proceedings. The accepted papers cover topics such as general video game playing, advanced simulation-based methods, heuristics, and learning.

In all, 44 % of the submitted papers for both workshops were selected for these proceedings. Here we provide a brief outline of the 12 contributions, in the order in which they appear in the proceedings. They are divided into two parts: the first eight belong to the Computer Games Workshop and the last four to the GIGA Workshop.

Computer Games Workshop

"Challenges and Progress on Using Large Lossy Endgame Databases in Chinese checkers," written by Nathan Sturtevant, discusses using large endgame databases to improve the performance of minimax and Monte Carlo tree search (MCTS)-based agents in Chinese checkers. Several challenges are faced in how to properly integrate the endgame databases and how to correct errors that occur because of the compression that is used when storing the endgame data. Experimental results suggest that minimax-based approaches are able to do a better job of using the endgame data than MCTS approaches.

"Sequential Halving for Partially Observable Games," authored by Tom Pepels, Tristan Cazenave, and Mark Winands, investigates sequential halving as a selection policy in the following four partially observable games: Go Fish, Lost Cities, Phantom Domineering, and Phantom Go. Additionally, H-MCTS is studied, which uses sequential halving at the root of the search tree, and UCB elsewhere. Experimental results reveal that H-MCTS performs the best in Go Fish, whereas its performance is on par in Lost Cities and Phantom Domineering. Sequential halving as a flat Monte Carlo search appears to be the stronger technique in Phantom Go.

"An Experimental Investigation on the Pancake Problem," by Bruno Bouzy, discusses the pancake problem. It is an NP-hard problem and linked to the genome rearrangement problem also called sorting by reversals (SBR). To date, the best theoretical R-approximation was 2 with an algorithm, which gives a 1.22 experimental R-approximation on stacks with a size smaller than 70. In this paper a Monte Carlo search (MCS) approach with nested levels and specific domain-dependent simulations is used. The paper shows that MCS is an alternative to iterative deepening depth first search for sorting large stacks of pancakes. At a given level and with a given number of polynomial-time domain-dependent simulations, MCS is a polynomial-time algorithm as well. MCS at level 3 gives a 1.04 experimental R-approximation, which is a breakthrough. At level 1, MCS solves stacks of size 512 with an experimental R-approximation value of 1.20.

"485 – A New Upper Bound for Morpion Solitaire," a joint collaboration by Henryk Michalewski, Andrzej Nagórko, and Jakub Pawlewicz, shows a new upper bound of 485 moves for the 5T variant of the Morpion Solitaire game. This is achieved by encoding Morpion 5T rules as a linear program and solving 126,912 instances of this program on special octagonal boards. To show the correctness of this method, the rules of the game have been analyzed and the potential of a given position has been used. By solving continuous-valued relaxations of linear programs on these boards, an upper bound of 586 moves is obtained. Further analysis of original, not relaxed, mixed-integer programs leads to an improvement of this bound to 485 moves. However, this is achieved at a significantly higher computational cost.

"Multi-Agent Retrograde Analysis," by Tristan Cazenave, proposes a new predator–prey game. This domain is modeled as a board game where three predators are trying to capture a prey. Each agent has five possible moves: going up, down, left, right, or staying in the same location. The game terminates if the prey is on the same location as a predator or if the prey cannot move to an empty location. Small boards up to 9×9

have been solved using retrograde analysis. The outcome is that the predator–prey game is always lost for the prey when there are at least three predators.

"The Surakarta Bot Revealed," by Mark Winands, presents the ideas behind the agent SIA, which won the Surakarta tournament at the ICGA Computer Olympiad five times. The paper first describes SIA's $\alpha\beta$-based variable-depth search mechanism. Enhancements such as multi-cut forward pruning and realization probability search improve the agent considerably. Next, features of the static evaluation function are discussed as well. Experimental results indicate that features, which reward distribution of the pieces and penalize pieces that clutter together, give a genuine improvement in the playing strength.

"Learning to Trade in Strategic Board Games," written by Heriberto Cuayáhuitl, Simon Keizer, and Oliver Lemon, describes a data-driven approach for automatic trading in the game of Settlers of Catan. Their experiments are based on data collected from human players trading in text-based natural language. The performance of Bayesian networks, conditional random fields, and random forests have been compared in the task of ranking trading offers, and are evaluated both in an offline setting and online while playing the game against a rule-based baseline. Experimental results show that agents trained from data from average human players can outperform rule-based trading behavior, and that the random forest model achieves the best results.

"Argumentative AI Director Using Defeasible Logic Programming," a joint effort by Ramiro Agis, Andrea Cohen, and Diego Martínez, presents a novel implementation of an AI director that uses argumentation techniques to decide dynamic adaptations in the level generation of a roguelike game called *HermitArg*. The architecture of the game introduces *smart items* with defeasible information to be analyzed in a dialectical process.

GIGA Workshop

"On the Cross-Domain Reusability of Neural Modules for General Video Game Playing," written by Alex Braylan, Mark Hollenbeck, Elliot Meyerson, and Risto Miikkulainen, considers a general approach to knowledge transfer in which an agent learning with a neural network adapts how it reuses existing networks as it learns in a new domain. This approach is domain-agnostic and requires no prior assumptions about the nature of task relatedness or mappings. The method's performance and applicability are analyzed in high-dimensional Atari 2600 general video game playing.

"The GRL System: Learning Board Game Rules with Piece-Move Interactions," written by Peter Gregory, Henrique Coli Schumann, Yngvi Björnsson, and Stephan Schiffel, studies the problem of learning formal models of the rules of board games, using as input only example sequences of the moves made in playing those games. This work is distinguished from previous work in this area in that the interactions are learned between the pieces in the games. A previous game rule acquisition system is supplemented by allowing pieces to be added and removed from the board during play, and using a planning domain model acquisition system to encode the relationships between the pieces that interact during a move.

"Creating Action Heuristics for General Game Playing Agents," authored by Michal Trutman and Stephan Schiffel, investigates an approach that learns online heuristics that guide the simulations of MCTS in GGP. This approach generates heuristics that estimate the usefulness of actions by analyzing the game rules as opposed to the simulation results. Experimental results show the potential of this approach.

"Space-Consistent Game Equivalence Detection in General Game Playing," by Haifeng Zhang, Dangyi Liu, and Wenxin Li, discusses that GGP agents can efficiently enhance their intelligence by taking advantage of experience from past games. The authors argue that it is necessary for agents to detect equivalence between games. This paper defines game equivalence formally and concentrates on a specific scale, space-consistent game equivalence (SCGE). To detect SCGE, an approach is proposed mainly reducing the complex problem to some well-studied problems. An evaluation of the approach is performed at the end.

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