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Preface

This volume provides a snapshot of current work on the interaction of model checking and artificial intelligence. It is based on revised versions of a selection of the papers presented at the 6th Workshop on Model Checking and Artificial Intelligence (MoChArt), held as a satellite workshop of the Conference of the Association for the Advancement of Artificial Intelligence in Atlanta, Georgia, USA, in July 2010, as well as papers contributed subsequent to the workshop.

Model checking is an approach to verification based on the idea of representing the system of interest as a *model*, a semantic structure of which one can say that it supports the truth or falsity of a formula of a logic. Typically, the model describes the states of the system and its evolution over time, and the logic is a modal logic that describes the possible temporal behaviors of the system. A model checker is a software system that takes as inputs representations of the system and its specification in modal logic, and computes whether the specification holds in the system.

The interactions between model checking and artificial intelligence are rich and diverse. Originating in the 1980s as an approach to the verification of concurrent hardware processes and computer network communications protocols, model checking has found application in an increasingly broad range of areas. These days, model checking is applied by researchers working on computer software such as hardware device drivers and operating systems kernels, cryptographic protocols, and Web services protocols. Artificial intelligence applications include planning, stochastic process models, normative systems, autonomous robots, economic game theory models, and other forms of multi-agent systems. This broadening of the application area has also led to a broadening of the range of modal logics studied in the field, and there are now model checkers whose specification language is able to express modalities such as knowledge, belief, probability, strategy and obligation as well as time. Such modalities are of particular interest in areas of artificial intelligence dealing with autonomous and multi-agent systems.

In principle, a model checker conducts an exhaustive examination of the state space of the system in order to determine whether the specification holds. Underpinning the success of the area is a range of sophisticated optimization techniques and heuristic algorithms that enable this computation to be performed efficiently rather than by a brute force search. In this regard, model checking has benefited from a range of ideas from artificial intelligence, where efficient search over large and complex state spaces has long been a topic of interest. Ideas transferred from artificial intelligence to model checking include satisfiability solving, search heuristics such as A^*, and planning approaches to counter-example construction.

The MoChArt series of workshops aims to provide a forum for researchers interested in these interactions between artificial intelligence and model

checking. Previous editions of MoChArt were held with ECAI 2002, IJCAI 2003, CONCUR 2005, ECAI 2006 and ECAI 2008. For the 2010 edition at AAAI, the Program Committee carefully evaluated submissions for quality and relevance to the MoChArt theme, leading to a selection of papers that were presented at the workshop and distributed among the participants as AAAI working notes. The papers presented in this volume include revised versions of a selection of the papers presented at the workshop.

Several themes are touched upon by these papers. Concerning general search algorithms, the paper by Edelkamp and Sulewski describes the use of the graphical processing unit (GPU) for external memory breadth-first search.

The potential for the application of AI techniques to automated program verification is explored in the paper by Edelkamp, Kellershoff and Sulewski, which deals with the transformation of the problem of verification of C code to problems of action planning.

A strongly represented theme at the workshop was multi-agent systems and epistemic logic, building a bridge between AI concepts and model checking. The paper by Alechina, Logan, Nguyen and Rakib deals with abstraction for specifications concerned with resource requirements in multi-agent systems. Abstraction is also a key concern in the paper by Lomusciou, Qu and Russo, which considers automatic data abstraction in model-checking multi-agent systems. This paper is one of three dealing with epistemic logic. Huang, Luo and van der Meyden present results on improvements to bounded model checking for an extension of CTL with epistemic operators. Finally, Luo, Su, Gu, Wu and Yang study epistemic model checking of the Herbivore protocol, which involves knowledge and anonymity.

Several papers presented at the workshop have not been included in this volume, for a variety of reasons, including conflicts with publication in other venues. Stefan Leue presented an algorithm for finding the k shortest paths in graph, a problem which is relevant, among others, for stochastic model checking. Siddharth Srivastava spoke on computing applicability conditions for plans with loops, with various results conerning termination and other behaviors of transition systems applying not just to a particular planning formalism, and hence of interest to the model-checking community. There was also lively discussion on the general direction of the field, and on how best to foster interaction between the model-checking and artificial intelligence communities.

In addition to these improved versions of papers from the workshop working notes, this volume also contains an extended abstract of the invited talk presented at the workshop by Hector Geffner, who spoke on planning with incomplete information, stressing that while logic and theory are needed in planning, the bottom line is heavily empirical.

To round out the topics treated with a contribution to the theory of model checking, there is also a paper contributed after the event by Kupferman and Rosenberg, dealing with lower bounds for transformations from LTL to Deterministic Büchi automata.

Taken together, the papers in this volume provide a good sample of current research, and are representative of the diversity of interactions mentioned above and the quality of the field.

All papers in this volume were carefully reviewed by our Program Committee members or external reviewers. Our thanks go to the Program Committee and these reviewers for their diligent work in reviewing the submissions, to AAAI for hosting the meeting and handling logistics, to Springer for publication of these proceedings, to the creators of the wonderful EasyChair conference management system, and, of course, to the contributing authors.

December 2010

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