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Computational Logic in Multi-Agent Systems

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Preface

These are the proceedings of the 11th International Workshop on Computational Logic in Multi-Agent Systems (CLIMA-XI), held during August 16–17, in Lisbon, collocated with the 19th European Conference on Artificial Intelligence (ECAI-2010).

Multi-agent systems are communities of problem-solving entities that can perceive and act upon their environment in order to achieve both their individual goals and their joint goals. The work on such systems integrates many technologies and concepts from artificial intelligence and other areas of computing as well as other disciplines. Over recent years, the agent paradigm gained popularity, due to its applicability to a full spectrum of domains, such as search engines, recommendation systems, educational support, e-procurement, simulation and routing, electronic commerce and trade, etc. Computational logic provides a well-defined, general, and rigorous framework for studying the syntax, semantics and procedures for the various tasks in individual agents, as well as the interaction between, and integration among, agents in multi-agent systems. It also provides tools, techniques and standards for implementations and environments, for linking specifications to implementations, and for the verification of properties of individual agents, multi-agent systems and their implementations.

The purpose of the CLIMA workshops is to provide a forum for discussing techniques, based on computational logic, for representing, programming and reasoning about agents and multi-agent systems in a formal way.

Former CLIMA editions have been conducted in conjunction with other major Computational Logic and AI events such as CL in 2000, ICLP in 2001 and 2007, FLoC in 2002, LPNMR and AI-Math in 2004, JELIA in 2004 and 2008 and MATES in 2009. In 2005 CLIMA was not associated with any major event.

The 11th edition of the CLIMA workshop featured some new elements. For the first time, these are not post-workshop proceedings, but regular proceedings published in time for the workshop. In addition, CLIMA featured two thematic Special Sessions.

Norms and Normative Multi-Agent Systems: Norms are pervasive in everyday life and influence the conduct of the entities subject to them. One of the main functions of norms is to regulate the behavior and relationships of agents. Accordingly, any agent or multi-agent system, if intended to operate in or model a realistic environment has to take into account norm regulating. Norms have been proposed in multi-agent systems and computer science to deal with coordination issues, to deal with security issues of multi-agent systems, to model legal issues in electronic institutions and electronic commerce, to model multi-agent organizations, etc.

Logics for Games and Strategic Reasoning: Strategic reasoning occurs in many multi-agent systems. This is especially evident in game-theoretical and

decision-theoretical models of MAS, but also in more informal settings using the game metaphor (e.g., computer games or social network services). Mathematical logic can contribute to this view in many ways by providing specifications, models, and/or algorithms for game-like scenarios. We invited papers that address how logic can contribute to our understanding, modeling and analysis of games, but also ones that investigate how the metaphor of games and strategies can help in constructing and using logical formalisms.

We believe that emphasizing particular areas each year helps to attract attention to these important research topics.

In line with the high standards of previous CLIMA editions, the review process was very selective, the final acceptance rate being below 50%. From 31 submissions, a Program Committee of 54 top-level researchers from 18 countries and 11 additional reviewers selected 14 papers for presentation, authored by 43 researchers worldwide.

These proceedings feature the 14 regular papers, as well as abstracts of four invited talks, given by Toby Walsh (NICTA, Australia), Ron van der Meyden (University of New South Wales, Australia), Thomas Ågotnes (University of Bergen, Norway), and Stefan Woltran (TU Vienna, Austria).

Toby Walsh considered in his talk “Is Computational Complexity a Barrier to Manipulation?” voting rules and whether they can be manipulated. While the well-known Gibbard-Satterthwaite theorem (related to Arrow’s paradox) states that most systems can be manipulated, a way out might be that manipulation is *computationally too expensive* to carry out. He suggests studying this problem empirically and investigates various interesting phase transitions (which prove to be important in other areas).

Ron van der Meyden considers “Games and Strategic Notions in Information Flow Security.” A computer system or a group of agents often do not want to disclose confidential information. But adversaries might be able to deduce such data. The talk was about giving precise definitions of information flow security and their complexity from the viewpoint of epistemic logic.

Thomas Ågotnes talked about “Group Announcements: Logic and Games.” He reviewed the classical results in dynamic epistemic logics where the problem of changing knowledge of individual agents is modeled. Public announcement logic emerged out of this research. Thomas extends this work by considering *group announcements*, where a subgroup of agents announce truthfully their knowledge. He discussed the logical and rational principles governing this kind of behavior.

Stefan Woltran discussed “Strong Equivalence in Argumentation.” Equivalence in classical monotonic logic is well understood. But equivalence in non-monotonic theories (i.e., the same answer sets, default extensions, etc.) is quite different. The talk presented the main results obtained in the last few years and related them to argumentation frameworks.

The three contributions accepted for the *Norms and Normative Multi-Agent Systems* session address the problem of verifying the compliance of business

processes against relevant regulations, the diagnosis of commitment violations, and the modeling agent and multi-agent systems using institutions and norms.

The paper “What Happened to My Commitment? Exception Diagnosis Among Misalignment and Misbehavior” by Özgür Kafali and Federico Chesani Torroni discusses the issue of detecting violation of commitments in an e-Contracts scenario. The authors argue that one of the possible reasons for misalignment of commitment in contracts depends on temporal aspects. Accordingly a contract and the commitments it contains are formalized in \mathcal{REC} , a form of reactive event calculus. They then propose an architecture and an algorithm for the diagnosis of the possible types of misalignments (i.e., violations) of commitments.

Davide D’Aprile, Laura Giordano, Valentina Gliozzi, Alberto Martelli, Gian Luca Pozzato and Daniele Theseider Dupré in their contribution on “Verifying Business Process Compliance by Reasoning About Actions” propose the use of temporal action theory as a common language to model business processes as well as the norms governing the processes. Temporal action theory combines answer set programming and dynamic linear time temporal logic. The combination allows for the representation in the same language of the business processes and the norms governing them (where obligations are represented as commitments). In this way verifying compliance amounts to checking that no execution of the process leaves some commitments unfulfilled. The verification can then be done using bounded model checking.

The aim of Jomi F. Hübner, Olivier Boissier and Rafael H. Bordini in “From Organisation Specification to Normative Programming in Multi-Agent Organisations” is to provide an automatic translation from a specification in a high-level organization modeling language (*MOISE*) to a program in a simpler normative programming language (*NOPL*) that can be interpreted by an artifact-based organization management structure (*OMI*) with the aim of bringing more flexibility to developing an *OMI*. This is claimed to be the case since one can more easily change the translation than a Java implementation of the *OMI*.

The special session on *Logic for Games and Strategic Reasoning* consisted of four papers. In the paper titled “Exploring the Boundary of Half Positionality,” Alessandro Bianco, Marco Faella, Fabio Mogavero and Aniello Murano consider languages of infinite words that can be interpreted as winning conditions in infinite games. Half positionality means that the proponent in the game can restrict her search for a winning strategy to positional strategies only. As the main result, the authors describe a novel sufficient condition for half positionality, more general than what was previously known. The paper has a strong link to work on application of games in logic – more precisely in verification techniques for strategic and temporal logics, where restricting the search to a limited set of simple possibilities is an important issue.

In “Playing Extensive Form Games in Parallel,” Sujata Ghosh, R. Ramanujam and Sunil Easaw Simon consider a player playing simultaneously against different opponents in two extensive games. For the analysis, the authors propose a variant of dynamic logic for EF games. They present a complete axiomatization of the logic and show that it is decidable. Thus, the focus of the paper is

application of logical formalisms to analysis of a specific kind of agent interaction, and characterizing general properties of such interactions.

“Finding Uniform Strategies for Multi-Agent Systems” by Jan Calta, Dmitry Shkatov and Holger Schlingloff presents another study of game-like interactions. An algorithm for finding uniform strategies in imperfect information games is proposed, which finds all maximal uniform strategies for enforcing a property expressible in alternating-time temporal logic (ATL). This can be seen as a semantic study of an important variant of strategic logics, but also as a step towards automated program synthesis for decentralized distributed systems of agents.

Finally, Jonathan Zvesper and Krzysztof Apt present their “Proof-Theoretic Analysis of Rationality for Strategic Games with Arbitrary Strategy Sets.” Here the focus is again on characterization of general properties of games. More precisely, the authors provide an axiomatic proof of the statement “true common belief of rationality implies that the players will choose only strategies that survive the iterated elimination of strictly dominated strategies,” where rationality means playing only strategies one believes to be best responses. An appropriate proof system is introduced, proved sound, and then shown capable of providing a formal derivation for the statement.

The remaining CLIMA papers cover a variety of topics, such as logics, knowledge representation, reasoning, agent programming languages, to name a few. A short summary of each paper follows.

The contribution by Sara Miner More and Pavel Naumov on “Hypergraphs of Multiparty Secrets” investigates the completeness of an axiomatization of a logic of secrets. The aim of the logic of secrets is to study the interdependencies between pieces of information, called secrets because they might be known by some parties and unknown by others.

The paper “Combining Logics in Simple Type Theory” by Christoph Benzmüller provides a good insight into the advances of the field on combining logics, in particular on the use of simple type theory (STT). Specifically, the author presents an embedding of (normal) quantified multimodal logic, and of other logics such as intuitionistic logics, access control logics, and logics for spatial reasoning in STT, and illustrates how STT can be used to reason about or within the combination of the logics embedded in SST. It also provides a set of experiments on the use of STT automated reasoners for the solution of several problems.

In “Speculative Abductive Reasoning for Hierarchical Agent Systems,” Jiefei Ma, Krysia Broda, Randy Goebel, Hiroshi Hosobe, Alessandra Russo and Ken Satoh introduce the concept of speculative reasoning. This framework allows one to manage multiple revisable answers within the context of multi-agent systems, by introducing a novel abductive framework to hierarchical speculative reasoning.

“Formal Semantics of a Dynamic Epistemic Logic for Describing Knowledge Properties of Pi-Calculus Processes” by Pedro Arturo Gongora, Francisco Hernandez-Quiroz and Eric Ufferman presents an embedding of the process

algebra of π -calculus in a multi-agent framework, in particular the notions of agency and knowledge. This is done through a variant of multi-agent dynamic epistemic logic, where epistemic actions of agents are π -calculus processes. In the semantics, these processes are translated to corresponding model updates. Thus, the proposal allows one to model agent interaction by a collection of π -calculus processes. Moreover, given a collection of such processes, we can derive dynamics of knowledge that it entails.

“Model Checking Agent Programs by Using the Program Interpreter” by Sung-Shik Jongmans, Koen Hindriks and M. Birna van Riemsdijk reports a new approach to explicit-state, on-the-fly model checking for agent programs. The idea is to reuse the program interpreter for generating the state space. The model checking algorithm is built on top of it by implementing efficient transformations of temporal properties to Buchi automata and an efficient bookkeeping mechanism that maintains track of the states that have already been visited. The approach is evaluated experimentally, with very promising results.

The paper “An Agent Language with Destructive Assignment and Model-Theoretic Semantics” by Robert Kowalski and Fariba Sadri presents an agent language that combines agent functionality with model-theoretic semantics. The underlying framework is that of abductive logic programming (ALP).

“A Dialogue Games Framework for the Operational Semantics of Logic Agent-Oriented Languages,” by Stefania Costantini and Arianna Tocchio, introduces an operational semantics based on dialogue games that have their roots in the philosophy of argumentation. This allows for a uniform and modular way of modeling all the components of the interpreter.

We thank all the authors of all the papers submitted to CLIMA-XI for submitting papers and for revising their contributions to be included in these proceedings. We are very grateful to the members of the CLIMA-XI Program Committee and the additional reviewers. Their service ensured the high quality of the accepted papers.

A special thank you goes to Ulle Endriss, the ECAI-2010 Workshop Chair, and to the local organizers in Lisbon for their help and support. We are very grateful to them for handling the registration and for a very enjoyable social program.

June 2010

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