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Computational Logic in Multi-Agent Systems

4th International Workshop, CLIMA IV
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Revised Selected and Invited Papers

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Preface

Over recent years, the notion of agency has claimed a major role in defining the trends of modern research. Influencing a broad spectrum of disciplines such as sociology, psychology, philosophy and many more, the agent paradigm virtually invaded every subfield of computer science, because of its promising applications for the Internet and in robotics.

Multi-agent systems (MAS) are communities of problem-solving entities that can perceive and act upon their environments to achieve their individual goals as well as joint goals. The work on such systems integrates many technologies and concepts in artificial intelligence and other areas of computing. There is a full spectrum of MAS applications that have been and are being developed: from search engines to educational aids to electronic commerce and trade.

Although commonly implemented by means of imperative languages, mainly for reasons of efficiency, the agent concept has recently increased its influence in the research and development of computational logic-based systems.

Computational logic, by virtue of its nature both in substance and method, provides a well-defined, general, and rigorous framework for systematically studying computation, be it syntax, semantics, and procedures, or implementations, environments, tools, and standards. Computational logic approaches problems, and provides solutions, at a sufficient level of abstraction so that they generalize from problem domain to problem domain, afforded by the nature of its very foundation in logic, both in substance and method, which constitutes one of its major assets.

The purpose of the Computational Logic and Multi-agent Systems (CLIMA) series of workshops is to discuss techniques, based on computational logic, for representing, programming, and reasoning about multi-agent systems in a formal way. This is clearly a major challenge for computational logic, to deal with real-world issues and applications.

The first workshop in this series took place in Las Cruces, New Mexico, USA, in 1999, under the designation Multi-agent Systems in Logic Programming (MASLP 1999), and affiliated with ICLP 1999. In the following year, the name of the workshop changed to Computational Logic in Multi-agent Systems (CLIMA 2000), taking place in London, UK, and affiliated with CL 2000. The subsequent edition, CLIMA 2001, took place in Paphos, Cyprus, affiliated with ICLP 2001. CLIMA 2002, took place in Copenhagen, Denmark, on August 1st, 2002, and was affiliated with ICLP 2002 and was part of FLOC 2002.

The 4th International Workshop on Computational Logic in Multi-agent Systems, CLIMA IV (renamed because it took place in 2004 instead of 2003), was co-located with the 7th International Conference on Logic Programming and Nonmonotonic Reasoning (LPNMR-7) and with the 8th International Symposium on Artificial Intelligence and Mathematics, and was held on January 6–7 in Fort Lauderdale, Florida, USA.

For CLIMA IV, we received 25 submissions of which 13 were selected for presentation, after a careful review process where each paper was independently reviewed by three members of the Program Committee. After the workshop, authors were invited to resubmit revised and extended versions of their papers. After a second round of reviewing, 11 papers were finally selected for publication.

This book contains such revised and extended papers together with two invited contributions coauthored by the CLIMA IV invited speakers: V.S. Subrahmanian from the University of Maryland and Michael Fisher from the University of Liverpool. It is composed of five parts: (i) invited papers, (ii) negotiation in multi-agent systems, (iii) planning in multi-agent systems, (iv) knowledge revision and update in multi-agent systems, and (v) learning in multi-agent systems. There follows a brief overview of the book.

Invited Papers

In *Distributed Algorithms for Dynamic Survivability of Multi-agent Systems, V.S. Subrahmanian, S. Kraus, and Y. Zhang* address the problem of survivability of a multi-agent system. They present three distributed algorithms that ensure that a multi-agent system will survive with maximal probability. Such algorithms extend existing centralized algorithms for survivability but are completely distributed and are adaptive in the sense that they can dynamically adapt to changes in the probability with which nodes will survive.

M. Fisher, C. Ghidini, and B. Hirsch, in their paper on *Programming Groups of Rational Agents*, develop a programming language to deal with agents that cooperate with each other and build teams and organizations. They suggest an executable temporal logic, augmented by the concepts of capabilities, beliefs, and confidence. An implementation in Java is described and illustrated by various examples.

Negotiation in Multi-agent Systems

M. Gavanelli, E. Lamma, P. Mello, and P. Torroni present *An Abductive Framework for Information Exchange in Multi-agent Systems*. They propose a framework for information sharing among abductive agents whose local knowledge bases are enlarged with a set of abduced hypotheses.

In *Fault Tolerant and Fixed Scalable Structure of Middle Agents* by *P. Tichý*, the design and implementation of a structure of middle-agents called dynamic hierarchical teamworks is described. This structure has a user-defined level of fault-tolerance and is scalable.

An approach to negotiation using linear logic (LL) is introduced by *P. Küngas and M. Matskin* in the paper *Symbolic Negotiation with Linear Logic*. This paper extends their previous work by taking advantage of a richer fragment of LL and introducing two sorts of nondeterministic choices into negotiation. This allows agents to reason and negotiate under certain degrees of uncertainty.

Planning in Multi-agent Systems

S. Costantini and A. Tocchio, in *Planning Experiments in the DALI Logic Programming Language*, discuss how some features of the new logic programming language DALI for agents and multi-agent systems are suitable for programming agents equipped with planning capabilities.

In *A New HTN Planning Framework for Agents in Dynamic Environments*, *H. Hayashi, K. Cho, and A. Ohsuga* extend previous work where they presented an agent life cycle that interleaves HTN planning, action execution, knowledge updates, and plan modification. The agent life cycle is extended so that the agent can handle partial-order plans.

Knowledge Revision and Update in Multi-agent Systems

In the paper *Revising Knowledge in Multi-agent Systems Using Revision Programming with Preferences*, *I. Pivkina, E. Pontelli, and T.C. Son* extend *Marek and Truszczyński's* framework of *Revision Programming* to allow for the specification of preferences, thus allowing users to introduce a bias in the way agents select one between alternative feasible ways of updating their knowledge. An answer set-based computation methodology is presented.

A. Bracciali and P. Torroni, in their preliminary report *A New Framework for Knowledge Revision of Abductive Agents Through Their Interaction*, describe a multi-agent framework for revising agents' knowledge through cooperation with other agents, where abduction and a constraint relaxation algorithm play the central role.

P. Dell'Acqua in his paper *Weighted Multi-dimensional Logic Programs*, extends *Leite et al.*'s framework of *Multi-dimensional Dynamic Logic Programs* by adding weights to the acyclic digraph that defines agent relationships in a multi-agent setting, thus allowing the addition of a measure of strength to the knowledge relationships represented by the edges.

In the paper *(Dis)Belief Change Based on Messages Processing*, *L. Perrussel and J.-M. Thévenin* explore a belief revision framework where agents have to deal with information received from other agents. A preference relation over the agents embedded in the multi-agent system is specified and agents' epistemic states are modelled by keeping track of current (consistent) beliefs, current disbeliefs, and potential beliefs.

Learning in Multi-agent Systems

A.G. Hernandez, A. El Fallah-Seghrouchni, and H. Soldano address the issue of *Learning in BDI Multi-agent Systems*. Their implementation enables multiple agents executed as parallel functions in a single Lisp image. In addition, their approach keeps consistency between learning and the theory of practical reasoning.

C. Child and K. Stathis define *The Apriori Stochastic Dependency Detection (ASDD) Algorithm for Learning Stochastic Logic Rules*. They show that stochastic rules produced by their algorithm are capable of reproducing an accurate world model in a simple predator-prey environment, and that a model can be produced with less experience than is required by a brute force method which records relative frequencies of state, action, and next state.

We would like to take this opportunity to thank the authors who answered our call with very good quality contributions, the invited speakers, and all workshop attendants. We would also like to thank the members of the Program Committee for ensuring the high quality of CLIMA IV by giving their time and expertise so that each paper could undergo two rounds of reviewing.

July 2004

Jürgen Dix
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