A Report on the 2002 Workshop on Computational Logic in Multi-agent Systems (CLIMA'02)

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The Computational Logic in Multi-agent Systems (CLIMA) workshop series aims at periodically bringing together researchers to discuss techniques, based on computational logic, for representing, programming and reasoning about multi-agent systems in a formal way.

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, among others, the agent paradigm virtually invaded every sub-field of Computer Science, not least because of the Internet and 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, procedures, or attending implementations, environments, tools, and standards. Computational Logic approaches problems, and provides solutions, at a sufficient level of abstraction so that they generalise from problem domain to problem domain, being therefore a privileged candidate to provide an added value to the research in MAS, while at the same time benefitting from the major challenge of dealing with real world issues and

applications there to be found.

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'99), and affiliated with ICLP'99. In the following year, the name of the workshop changed to Computational Logic in Multi-Agent Systems (CLIMA'00), taking place in London, UK, and affiliated with CL'2000. The subsequent edition, CLIMA'01, took place in Paphos, Cyprus, affiliated with ICLP'01. This year's edition, CLIMA'02 [6, 5], which we here report, took place in Copenhagen, Denmark, on August the 1st of 2002, being affiliated with ICLP'02 and part of FLOC'02.

The 2002 edition of CLIMA received 25 submissions of which 12 were selected for presentation, after a careful review process where each paper was independently reviewed by three members of the Program Committee.

The workshop consisted of five sessions: four devoted to the oral presentation of the selected papers and subsequent discussion; and one devoted to a panel discussion, Paolo Torroni being the invited moderator. There follows a brief summary of the workshop.

Session 1 - Agents: Arguments and Updates

Schroeder and Schweimeier presented a framework based on logic programming with 3-valued multi-agent argumentation and fuzzy unification, for knowledge representation and reasoning in agents, to accommodate arguments for negotiating agents when agent communication is subject to uncertainty [13].

Leite et al. introduced MLUPS, an extension of the update command language LUPS to allow for the specification of the flexible evolution of hierarchically related groups of agents, based on logic programming, thus assigning them declarative semantics [11].

Kakas and Moraïtis presented a modular argumentation framework for modelling agent deliberation, where object level arguments can be made conditional on agents' roles and the priority relation amongst such roles can, in turn, be made conditional on contexts, on top of which a simple form of abduction allows dealing with incomplete knowledge [10].

Session 2 - Logics for Agents

Toyama et al. introduced a translation of multi-agent autoepistemic logic (MAEL), a logic for multi-agent systems based on Moore's autoepistemic logic, into logic programming, and showed the correspondence between MAEL extensions and the stable models of the corresponding logic program [15].

Leite, on behalf of *Dell'Acqua et al.*, presented an extension of their previous work on abductive logic programming based multi-agent systems, in which agents can update themselves and each other, eliminate contradictory update rules, abduce hypotheses to explain observations, and use them to generate actions, with asynchronous based communication through the use of buffers [4].

Harland and Winikoff discussed the formalisation and implementation issues of BDI-type agents, using a Linear Logic based calculus that allows a mixture of forward- and backward-chaining techniques [7].

Session 3 - BDI Agent Systems

Bordini and Moreira presented their investigations on how far the Asymmetry Thesis Principles formulated by Rao and Georgeff are actually met by the abstract agent specification language AgentSpeak(L), hence contributing to the reconciliation between practice and theory of BDI-based agents [3].

Araragi et al. proposed the formalisation and a method to solve a verification problem that arises in implementing a commitment strategy for the BDI architecture, namely the verification of the suitability and/or feasibility of the intentions of an agent [1].

Nide et al. presented an extension of their previously introduced deduction system for CTL-based propositional BDI Logics using sequent calculus, with mental state consistency features, as a step towards the use of the expressive power of BDI Logics as executable specification languages of rational agents [12].

Session 4 - Agents: Speculative Computation and Introspection

Hayashi et al. addressed the issue of integrating speculative computation and action execution through logic programming, namely by devising a method for plan modification when speculative computation fails or actions are executed [8].

Iwanuma and Inoue presented a refinement of the first-order consequence-finding procedure based on clausal tableaux SOL, with conditional answer computation and skip-preference, to formalise speculative computation in a master-slave multi-agent system [9].

Bolander discussed his investigations on finding consistent classes of formulas under the syntactical treatment of knowledge and belief, identifying some maximal sets of introspective beliefs that strong introspective agents can consistently maintain so as to avoid the paradoxes of self-reference [2].

Session 5 - Panel Discussion

The last session of the workshop was devoted to a panel discussion, entitled "Logics and Multi-agents: towards a new symbolic model of cognition" [14], moderated by *Paolo Torroni*. In spite of the late hour (we were the last participants to leave FLOC'02) and the unexpectedly high temperature in Copenhagen, several interesting topics related to the role of CL in MAS and the new challenges brought to CL by MAS were discussed, with valuable contributions by most participants. Topics such as: the need to focus more attention on reasoning about goals (e.g. combination, decomposition, commitment, etc.); the importance of continuing the investigations on speculative computation; the problem of grounding agent beliefs and reasoning on the real world; the possibility of a new symbolic model of cognition, emergent from the combination of CL with MAS; the role of abduction, revision and updates as means to describe dynamic systems; and, as ever, the need for non-toy applications, were at the heart of the discussion.

The Workshop was followed by a very relaxing dinner at a typical Danish restaurant, thanks to Thomas Bolander.

References

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[14] Paolo Torroni. Logics and multi-agents: towards a new symbolic model of cognition. In Dix et al. [5], pages 177–180. Panel Discussion Abstract.

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