

The Multi-Agent Programming Contest

*Tristan Behrens, Mehdi Dastani, Jürgen Dix, Jomi Hübner,
Michael Köster, Peter Novák, Federico Schlesinger*

■ *The International Multi-Agent Programming Contest (MAPC), is a community-serving effort to facilitate advances in programming multiagent systems (MASs) by developing benchmark problems, enabling head-to-head comparison of MASs, and supporting educational efforts in the design and implementation of MASs.*

The International Multi-Agent Programming Contest (MAPC), is a community-serving effort to facilitate advances in programming multiagent systems (MASs) by developing benchmark problems, enabling head-to-head comparison of MASs, and supporting educational efforts in the design and implementation of MASs. It was started in 2005 and is an annual event that attracts between 5 and 10 teams. It has since been organized by the AI group at Clausthal University of Technology. MAPC is not collocated with any other event. Using our MASSim platform, the participants are running their own systems locally and only interact with the tournament server over the Internet.

A steering committee oversees the whole process and determines the organization committee. The scenario changes every other year: the current one is “Agents on Mars.” The goal was to implement a team of heterogeneous, cooperating agents to occupy zones on planet Mars. The infrastructure on Mars is given by a directed graph (300 nodes). Agents could take on roles (explorer, sentinel, saboteur, repairer, inspector) and needed to cooperate in an environment with incomplete knowledge so as to win against a competing team: the graph was not known, and each action comes at a price. Conquered terrain brings in money to improve agents.

The timeline of the contest is as follows. A preliminary scenario description is published each year in February so that par-

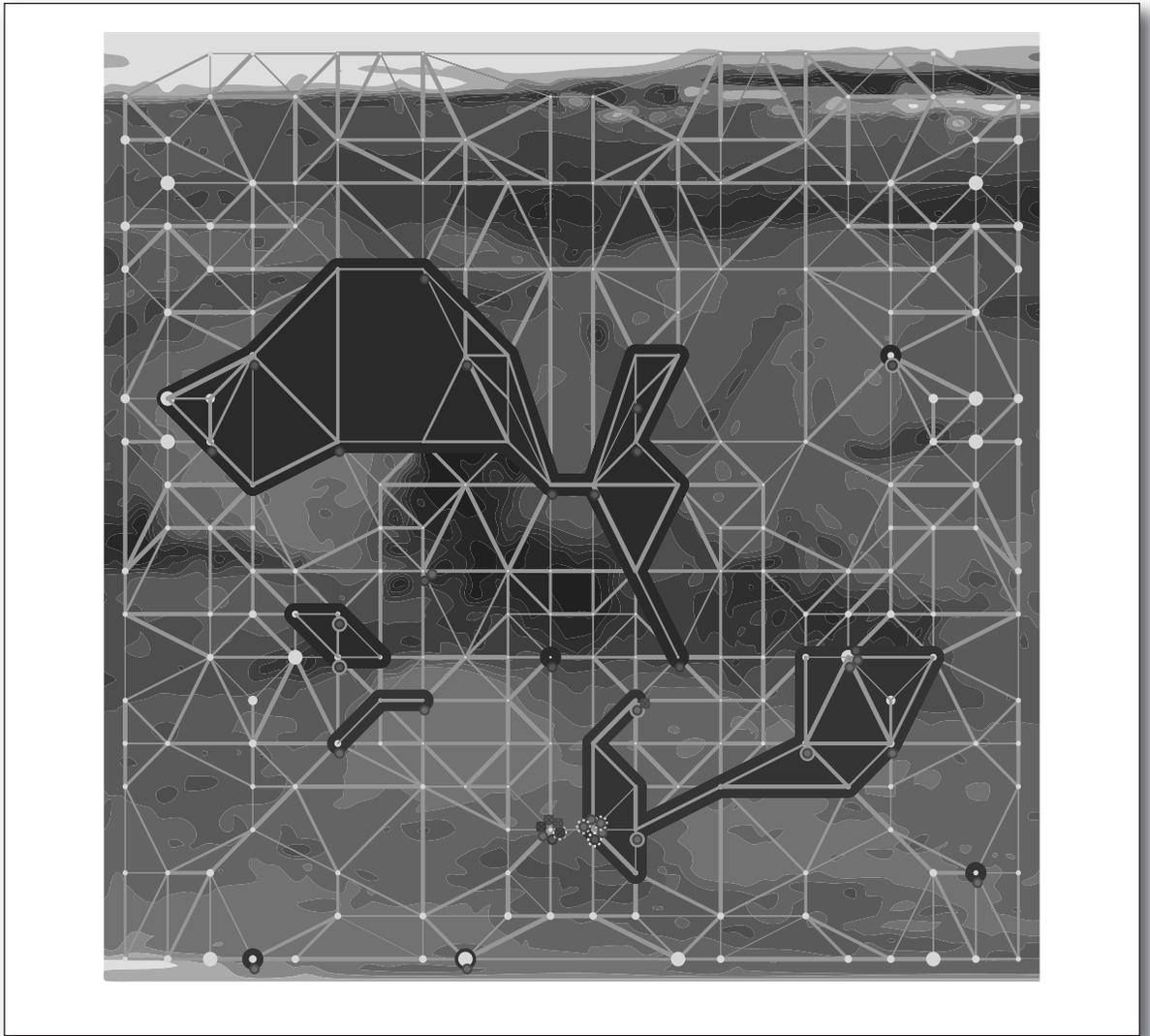


Figure 1. Agents on Mars.

. The green team (shaded circles represent agents) controls the green zone while the blue team has the bigger darker-shaded zone. The size of the vertices describe their values while the width of the edges represent the traveling costs.

ticipants can plan ahead and work on the overall structure of a MAS. The precise scenario (size of the graph, certain parameters) is only fixed when the tournament starts. Each August, a testing phase is scheduled. The winner is determined in September in a series of matches (points are added up) and receives a prize worth 500 euros (in books, courtesy of Springer). The participants have to publish the source code and elaborate on their strategies for the proceedings. Details of past contests can be found on the MAPC webpages.

MASSim as the Online Platform

MASSim is MAPC's central infrastructure: an application server providing the MAPC tournament infrastructure. Its most important purpose is the

execution of game simulations. The platform is flexible and can accommodate a wide range of discrete simulations formulated in terms of a sequence of perception-deliberation-action steps. Furthermore, it facilitates the tournament execution, gathers tournament statistics, generates game visualizations, and provides a live web interface to a running tournament. Published as open source, it is straightforward to develop new scenarios or to adapt existing ones to specific needs.

Scenarios and Application Domains

Which application domains are the targets of the MAPC? We have created scenarios that require coordinated action between the agents and where no efficient centralized solution is known. We aim

to evaluate approaches used for constructing a MAS, not so much the particular algorithmic strategy it employs (often both are intertwined).

From 2008 to 2010, in order to increase cooperation and coordination between agents, we played the “Cows and Cowboys” scenario, in which agent teams had to herd cows to their own corral (given obstacles and fences that could be opened and closed to let cows through).

Lessons Learned

In our first scenario we learned that coordination between the agents did not pay off. The key to winning was simply an efficient implementation of the A* algorithm (thus a low-level feature).

The “Cows and Cowboys” scenario taught us that cooperation is challenging and needed for a good performance. “Agents on Mars” showed us that heterogeneity adds another dimension to the problem space. The overall problem increased in complexity due to the different roles for the agents.

An interesting by-product is that MASSim was used in more than 20 courses worldwide and proved to be suitable for the classroom. Although the contest does not exclusively focus on agent-oriented programming languages, its association with the community boosted progress and maturing of the field and resulted in advances in several dimensions of MAS implementation techniques (such as debugging MAS).

Relation to Other Contests

There are several contests for benchmarking MASs, including the well-known ones: the RoboCup, the Trading Agent Competition, ORTS, and the Google AI Challenge. In contrast to these, MAPC enables a long deliberation phase of 2 seconds. It focuses on system design and engineering, rather than on algorithmics of the scenario. Other contests in the AI field include the SAT competition in theorem proving, the International Planning Competition (IPC), or the General Game Playing Competition. Unlike MAPC, they aim at advances in solving specific hard algorithmic problems and revolve around formal specification languages.

For comparing MAS implementation approaches, we cannot constrain the participating systems to a particular approach. Rather, we explicitly allow programmers complete freedom of choice of their favorite MAS approach, methodology (including ad hoc implementations), and software and hardware infrastructure, as far as these yield insights in analysis, design, and general development of multiagent systems. Ideally, winning the MAPC tournament should be the result of systematic use of the features of the underlying MAS

implementation techniques and methodologies, such as agent autonomy or team decentralization. It should not just be a matter of clever strategies or programming tricks.

Final Remarks

In the course of its seven-year existence, MAPC served as a catalyzer for progress in the field of agent-oriented programming. It also provided the community with several interesting benchmark scenarios. We believe such benchmarks have a potential to serve also other areas concerned with algorithmic approaches to implementation of decision making in embodied MASs, such as the computational game theory or partially observable Markov decision process (POMDP) communities.

The tournament platform, MASSim, is freely available from multiagentcontest.org, and we encourage everybody to download it and use it in the classroom.

Mehdi Dastani is associate professor at the Intelligent Systems Group at Utrecht University, the Netherlands. His research interests include MAS theories and applications, in particular specification and programming languages for MASs and logics to reason about multiagent specifications and programs.

Tristan Behrens earned his Ph.D. from Clausthal University of Technology in 2012 and has been a coorganizer since 2008.

Jürgen Dix is a full professor and head of the AI group at Clausthal University of Technology. He worked in deductive databases, nonmonotonic reasoning, and knowledge representation and reasoning in the past.

Michael Köster is a Ph.D. student at Clausthal University of Technology and a coorganizer of the MAPC.

Federico Schlesinger is a Ph.D. student at Clausthal University of Technology and a coorganizer of the MAPC.

Jomi F. Hübner is an associate professor at Federal University of Santa Catarina, Brazil. His main research interests are multiagent organization and tools for development of agent-based systems. The main projects he is codeveloping are Moise (an organizational model and platform) and Jason (a language for belief desire intention agents).

Peter Novák is a postdoctoral fellow at Delft University of Technology. He received his doctoral degree in 2009 from Clausthal University of Technology. His research revolves around programming techniques for autonomous agents and their interactions with dynamic environments. He has been involved in the organization of MAPC since its start in 2005.