

# **Dynamics of MultiAgent Systems Workshop**

17 – 21 December @Oort

## **Science:**

The main goals of this workshop were to discuss, explore and systematise the major dynamical aspects of MAS, to propose methodologies and frameworks for their modeling and to initiate the development of feasible approaches and methods for their formal specification, automated verification and algorithmic synthesis.

Discussion groups produced detailed notes of the state of the art and of open research questions in this area, which are shared on docs.google.com and undoubtedly will lead to further work towards solving the identified questions. Some of the main questions were:

1. How to specify multiagent systems where the agents and their functionalities change during the evolution of the system?
2. The problem of dynamic verification of such multiagent systems. There is already work on verification of some such types of multiagent systems, in particular of sensor networks, swarms, etc., but this is still an area in early development. We also realised that other scientific communities have done relevant research, too, e.g. process calculi in theoretical computer science, and actor languages in software engineering.
3. The problem of dynamic synthesis: how to design and incrementally recompute agents' strategies when the system changes?
4. How to do dynamic verification and synthesis if the agents have incomplete information (and should still be able to execute their strategies).
5. How to specify and verify multiagent systems where agents' capabilities are changing, both as a result of agents experiencing (hardware) faults, and as a result of acquiring or learning new capabilities. Learning -- in particular, multi-agent reinforcement learning - emerged as an important topic not anticipated by the organisers. A lot of discussion was centered on approaches to ensure safety and correctness of multiagent systems where agents are capable of learning. Some approaches to safe single- agent learning already exist, but for multi-agent learning this is an open research question.

## **Organization/Format:**

We found that the original format of the workshop, with talks in the morning and with discussions organized in thematic groups in the afternoon, generally worked well. We scheduled one extra talk (Ann Nowe on reinforcement learning) in the afternoon on Thursday, in response to significant common interest in dynamics produced by learning that emerged in the discussions during the previous days. We also felt that some time in the afternoon should be left free for discussions in smaller spontaneously emerging groups, rather than the organizers orchestrating all discussions in larger groups. We found that it is hard to go into detailed problem solving discussions in groups with over 6 participants. Towards the end (Thursday/Friday), participants preferred smaller discussion groups and bilateral talks to larger, organised groups.

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