Theory of Electric Boolean Games (Internship Proposal)

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Keywords: Automata theory, temporal logic, verification and synthesis, game theory.

1 Context

Game theory [4] occupies a central position in Theoretical Computer Science and Artificial Intelligence. It provides tools which allow one to solve problems in interaction systems where the participants—agents—act to bring about their possibly conflicting tasks. These agents can be software or electronic components, robots, or human users of a system.

We are interested here in classes of games (iterated Boolean games [2] in their electric version [3]), which enjoy more than a theoretical significance. They can be succinctly represented and are predesignated to be used as such in eventual concrete implementations.

Resources are crucial for information systems. Some actions consume resources while others produce resources. It is then important to take them into consideration. Strategically, agents must not only follow a strategy which helps them to obtain their objectives. They also need to be careful so as not to run out of resources.

2 Proposal

This internship will focus on mutli-agent systems and on the search of solutions to problems related to the competition between non-cooperative agents with bounded resources.

The internship will be advised by Youssouf Oualhadj and Nicolas Troquard (Algorithmic Complexity and Logic Laboratory, UPEC).

The problem of checking whether a vector of strategies in an iterated electric Boolean game is a Nash equilibrium is PSPACE-complete. However, one does not know how to *synthesise* a pure Nash equilibrium. One does not know either how to decide whether a game admits a Nash equilibrium. Perhaps some classes of objectives (less expressive than Linear Temporal Logic (LTL) [1]) are already interesting and simpler to solve. Identifying such classes of objectives and providing a solution would be a contribution. Gutierrez *et al.* [2] have obtained results in the "non-electric" case for objectives expressed in a fragment of LTL.

The scientific goal is to solve the problem of synthesising pure Nash equilibria in iterated electric Boolean games for non-trivial classes of temporal objectives.

The student assigned to this internship must have a prior knowledge in automata theory, and in temporal logic.

References

[1] Christel Baier and Joost-Pieter Katoen. *Principles of model checking.* MIT Press, 2008.

[2] Julian Gutierrez, Paul Harrenstein, and Michael Wooldridge. Iterated boolean games. *Information and Computation*, 242:53–79, 2015.

[3] Paul Harrenstein, Paolo Turrini, and Michael Wooldridge. Electric Boolean Games: Redistribution Schemes for Resource-Bounded Agents. In *AAMAS 2015*, pages 655–663. ACM, 2015.

[4] Martin J. Osborne and Ariel Rubinstein. *A Course in Game Theory.* The MIT Press, 1994.

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