Research Project

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Students required: *1*

Multi-Agent Reinforcement Learning for Obstruction Logic

Reinforcement Learning (RL) allows an agent to learn how to achieve a task in an unknown environment and it is widely used, for example, in robotics, control, and security.

Formal specifications have been widely used for describing complex tasks for RL, as they are expressive and provide the correctness guarantees (e.g., the RL algorithm will learn a policy that achieves the required task) that are necessary in security critical domains.

Such a problem has also been investigated for RL applied to multi-agent systems using Alternating-time Temporal Logic (ATL), as ATL expresses the strategic interactions among the agents [1]. However, ATL works in settings where the underlying model is static and cannot express strategy adaptation (e.g., an agent may have the power to disable another agent action). Strategy adaptation is important in cyber-security, where defenders can disable some actions when the system is under attack.

The main goal of the internship is to investigate the use of Obstruction Logic (OL) [2,3] to specify rewards for multi-agent systems when considering strategy adaptation. The main tasks are to design a transformation of an OL specification in a scalar reward signal that can be used directly by a RL algorithm (mainly theoretical works).

The project would enable the use of reinforcement learning algorithms to automatically learn defensive strategies for cyber-security and for cyber-physical systems while providing formal guarantees.

Bibliography

[1] Hahna, Moritz, et al. Multi-Agent Reinforcement Learning for Alternating-Time Logic.

[2] Catta, Leneutre, Malvone. Obstruction Logic: A Strategic Temporal Logic to Reason about Dynamic Game Models.

[3] Leneutre, Malvone, Ortiz. Probabilistic Obstruction Temporal Logic: a Probabilistic Logic to Reason about Dynamic Models.