Research Project – Telecom Paris

Supervisors: *Vadim MALVONE, Angelo FERRANDO*

Contact: *vadim.malvone@telecom-paris.fr, angelo.ferrando@unimore.it*

Keywords: *Runtime verification, Multi-agent systems, Strategic reasoning, Monitoring*

Students required: *1*

Runtime Assurance of Strategies in Multi-Agent Systems

Multi-agent systems consist of autonomous components that interact to achieve individual or collective objectives. In critical applications, it is important to ensure that these agents coordinate correctly and respect requirements involving safety and progress. Formal verification and strategic logics provide methods for reasoning about which objectives a group of agents can achieve through suitable strategies [1,2].

However, guarantees obtained before deployment do not necessarily ensure that agents will follow their prescribed strategies during execution. Deviations may arise from faults, unexpected circumstances, or decisions made using incomplete local knowledge. Runtime verification complements static analysis by observing system executions and checking them against formal requirements [3,4]. In multi-agent settings, it is particularly useful to reason about the actions of individual agents and their impact on collective objectives.

This internship will explore techniques for monitoring and assuring strategic behaviour in multi-agent systems. Potential directions include monitors for different representations of strategies, richer monitoring verdicts, connections between strategy compliance and temporal goals, or responses to detected deviations.

The aim of this project is divided in four macro steps:

1. Review the state of the art in runtime verification, multi-agent systems, and formal representations of strategies.

2. Select a monitoring problem and study how agent actions, system observations, and strategic objectives can be represented.

3. Investigate monitoring or runtime-assurance procedures, with attention to their expressiveness, guarantees, and limitations.

4. Implement a prototype or proof of concept and evaluate it on illustrative multi-agent scenarios.

Bibliography

[1] R. Alur, T. A. Henzinger, and O. Kupferman. Alternating-Time Temporal Logic. JACM, 49(5):672-713, 2002.

[2] W. Jamroga, V. Malvone, and A. Murano. Natural Strategic Ability. Artificial Intelligence, 277:103170, 2019.

[3] E. Bartocci, Y. Falcone, A. Francalanza, and G. Reger. Introduction to Runtime Verification. LNCS 10457, Springer, 2018.

[4] A. Bauer, M. Leucker, and C. Schallhart. Runtime Verification for LTL and TLTL. TOSEM, 20(4), 2011.