Research Project – Telecom Paris

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Students required: *1*

Abstraction Methods for Scalable Strategy Synthesis

Autonomous and multi-agent systems interact with environments that are not fully under their control. To operate reliably, these systems must satisfy requirements such as safety, progress, and coordination. Formal methods provide techniques for expressing these requirements through temporal and strategic logics. In particular, strategy synthesis aims to construct a controller or policy that can enforce a desired behaviour despite the choices of the environment [1,2].

Unfortunately, synthesis and verification can become computationally expensive as the system and its specification grow. Abstraction techniques address this difficulty by replacing complex problems with simpler ones while preserving relevant information about the original requirements. Recent research has also suggested that the memory needed to implement a strategy can be used to guide the abstraction of temporal properties, opening several possibilities for scalable reasoning [3].

This internship will investigate formal techniques for improving the scalability of strategy synthesis and related verification problems. Possible directions include simplifying temporal specifications, exploiting restricted classes of strategies, studying abstraction and refinement procedures, or applying these ideas to multi-agent model checking.

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

1. Analyse the state of the art in strategy synthesis, temporal logics, and abstraction techniques for autonomous and multi-agent systems.

2. Identify an interesting family of specifications, strategies, or abstractions, and formulate a focused research question.

3. Investigate a formal approach for the selected problem, including its guarantees and limitations.

4. Develop a small prototype or experimental study, and assess the approach on representative examples.

Bibliography

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[3] A. Casares and P. Ohlmann. The Memory of ω-Regular and BC(Σ^0_2) Objectives. ICALP 2025.