Research Project – Telecom Paris

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Quantitative Reasoning for Dynamic Models

The problem of assuring systems correctness is particularly felt in hardware and software design, especially in safety-critical scenarios. When we talk about a safety-critical system, we mean the one in which failure is not an option. To face this problem, several methodologies have been proposed. Amongst these, model checking [1] results to be very useful. This approach provides a formal-based methodology to model systems, to specify properties via temporal logics, and to verify that a system satisfies a given specification.

Notably, first applications of model checking just concerned closed systems, which are characterized by the fact that their behavior is completely determined by their internal states. Unfortunately, model checking techniques developed to handle closed systems turn out to be quite useless in practice, as most of the systems are open and are characterized by an ongoing interaction with other systems. To overcome this problem, model checking has been extended to multi-agent systems. In the latter context, temporal logics have been extended to temporal logics for the strategic reasoning such as Alternating-time Temporal Logic (ATL) [2], Strategy Logic (SL) [3], and their extensions.

When specifying properties for multi-agent systems, both ATL and SL assume that the model is static. However, in several multi-agent settings the models need to be dynamic, that is, they can change during the evolution of the MAS. A preliminary attempt to address this issue was presented in [4]; nonetheless, this approach does not account for several quantitative aspects that are crucial to ensure its use in real-time and concurrent contexts. Thus, further investigation is necessary to develop an optimal solution.

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

1. Analyze the state of the art in formal verification for multi-agent systems.

2. Extend the current state of the art with advanced approaches that can ensure the analysis of quantitative aspects that are crucial in real-time and concurrent contexts.

3. Provide a verification algorithm for the new proposed approach.

4. Develop a module in the VITAMIN tool [5] that can solve the verification problem for the new approach proposed.

Bibliography

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[5] A. Ferrando and V. Malvone: VITAMIN: A Compositional Framework for Model Checking of Multi-Agent Systems. CoRR abs/2403.02170 (2024).