Research Project – Telecom Paris

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Students required: *1*

Quantitative Strategic 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 one in which failure is not an option. To address this problem, several methodologies have been proposed. Among these, model checking [1] has proven to be particularly useful. This approach provides a formal methodology to model systems, specify properties via temporal logics, and verify that a system satisfies a given specification.

Initially, applications of model checking focused on closed systems, whose behavior is entirely determined by their internal states. However, these techniques are often insufficient in practice, as most systems are open and interact continuously with other systems. To address this limitation, model checking has been extended to multi-agent systems, introducing temporal logics for 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 many real-world scenarios, static models are not sufficient, as the system structure may change over time. To address this, a temporal logic for dynamic multi-agent systems was introduced in [4], enabling the formal specification and verification of evolving models. Nonetheless, this approach does not consider quantitative aspects that are crucial in real-time and concurrent settings. A recent work [5] focuses specifically on these aspects, introducing probabilistic and continuous-time modeling to enable reasoning about performance and reliability in dynamic systems. It is important to note that these quantitative considerations ***are not related to strategies****, but concern only the underlying model itself. Integrating such quantitative features into dynamic multi-agent models is therefore essential to provide a more complete and realistic verification framework.*

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

1. *Analyze the state of the art in formal verification for multi-agent systems.*
2. *Extend the current approaches to incorporate quantitative aspects over strategies.*
3. *Provide a verification algorithm for the proposed quantitative approach.*
4. *Develop a module in the VITAMIN tool [6] capable of solving the verification problem for the new approach.*

Bibliography

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