Doctoral School of Information and Biomedical Technologies
Polish Academy of Sciences (TIB PAN)

SUBJECT: Model Checking Parametric Timed Strategic Abilities

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DESCRIPTION

Autonomous agent systems provide a powerful paradigm for modelling and analyzing socio-technical systems. These systems are composed of networks of communicating agents that make autonomous decisions using AI techniques. Modelling strategic behavior in a real-time context is crucial for ensuring the safety and security of such systems. Current approaches—such as Asynchronous Multi-Agent Systems (AMAS) and timed automata—address strategic abilities and timing constraints, but typically in isolation. Moreover, most existing research focuses on uncertainty arising from the system's environment. However, uncertainty at design time should also be considered—for example, when the total number of agents or the duration of an event is not known in advance. In our experience, such uncertainty is more effectively captured by parametric models. This transforms the analysis into a synthesis problem, where the objective is to identify strategies that ensure critical system properties. Existing model-checking tools support the analysis of either multi-agent systems (e.g., MOCHA, MCK, MCMAS, STV) or (parametric) timed automata (e.g., IMITATOR, UPPAAL). However, these tools typically focus on specific system aspects in isolation and lack the capability to jointly address strategic behavior, timing, and uncertainty in an integrated framework.

PhD Objectives

The PhD project aims to overcome several limitations of current research by developing a flexible and unified framework for modeling and reasoning about autonomous agent systems. This includes the design of expressive logics and corresponding model-checking algorithms that can simultaneously handle agents' strategic behaviors, timing constraints, and design-time uncertainties. The ultimate objective is to provide a comprehensive approach that integrates these dimensions, enabling the verification and synthesis of strategies that ensure the correct functioning of complex agent-based systems.

PROFILE OF THE CANDIDATE:
A strong background in mathematical logic and theoretical computer science is required, as well as proficiency in programming languages such as C++, Java, or Python. A working knowledge of formal methods, verification techniques, and artificial intelligence is also expected. We seek candidates who demonstrate a proactive approach to addressing scientific challenges, along with strong communication skills and a high level of proficiency in both written and spoken English