Research proposal: VASS games for resource-bounded logics

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Resource-bounded logics. Alternating-time temporal logics such as the logics ATL and ATL* [AHK02] extend the temporal logics CTL and CTL* respectively (see for instance [DGL16]), by interpreting the formulae on concurrent game structures, a sophisticated extension of labelled transition systems, and by allowing modalities to quantify over strategies for a given coalition of agents. The logic ATL has many extensions, some of them have models containing transitions that produce or consume resources, depending on the actions involved to fire transitions, see e.g. the resource-bounded logics in [ALNR14]. As shown in [ABLN15], having implicitly in the models counters (i.e. variables interpreted over the set of natural numbers) and the ability to quantify over strategies for a given coalition (i.e. for a set of agents) can easily lead to undecidability even though many logics have been introduced for which the model-checking problem is shown to be decidable, possibly with a very high worst-case complexity upper bound. Reasoning about resources happens to be quite similar to the analysis of runs of vector addition systems with states (a.k.a. VASS) and more specifically with games on VASS, see e.g. [BJK10], because of the very nature of strategy modalities.

Logics in AI and verification games. In the recent work [ABDL16], formal relationships have been established between model-checking problems for resource-bounded logics and decision problems for VASS so that new decidability results can be established for logical problems or new complexity characterisations can be inherited from problems on counter machines. Of course, this should not come as a real surprise because resource values and counter values are similar objects and logics based on concurrent game structures have inherently games in the semantics. Moreover, earlier works have already explored the connections with counter machines, either to obtain undecidability results or to get complexity lower bounds, see e.g. [ABLN15].

The objectives of the PhD thesis are to provide a complete map for model-checking bounded-resource logics based on VASS games.

References

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