BioDiVinE: A Tool for Parallel Analysis of ODE Models

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Abstract

The use of model checking for the analysis of biological networks has attracted much attention recently. However, one of the practical limitations is the complexity of the model. Our work targets this issue by employing parallel on-the-fly LTL model checking.

1. Background

This work focuses on analysis of dynamic systems describing functionality of biological networks. In particular, the biological model is considered as a system of multi-affine ODEs. The continuous state space of the dynamic system is abstracted into a finite automaton by employing the rectangular abstraction method [3]. The analysis is performed on abstracted models. In particular, the abstracted state space reachable from given initial conditions (initial concentration of species) is automatically generated and analysed.

2. Related Work

This work considers the model in terms of chemical equations. The tool provides a graphical environment for visualization of the abstracted state space. The central feature of the tool is a bunch of algorithms for LTL model checking analysis.

3. BioDiVinE Tool Description

BIODIVINE tool considers the model in terms of chemical equations. The tool provides a user interface for specification of models as well as graphical environment for visualization of the abstracted state space. The central feature of the tool is a bunch of algorithms for LTL model checking analysis.

4. Experiments

We have performed several experiments with BioDiVinE [1] in order to show scaling of the algorithms when distributed on several cluster nodes. The following graph shows scaling of model checking conducted on a simple model of a reaction network representing a catalytic reaction scaled for different numbers of intermediate products. We have considered a property expressing the consumption and consequent reaccumulation of the enzyme.

\[ S + E \rightarrow E_S_1 \rightarrow E_S_2 \rightarrow \cdots \rightarrow E_S_k \rightarrow P + E \]

\[ E > 95 \land (E > 95) \land (E < 95) \land (E < 95) \land \text{End} \]

References

