

Model validation and verification

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In this tutorial we describe how model checking can be used in the Synthetic Biology development cycle to aid the construction and validation of models of biological systems, as well as to help guide the construction of the synthetic systems.

Model checking in this context is to "Formally check whether a model of a biological system does what we want", and involves the use of a computer programme to check whether a formal model of a biological system exhibits a desired behavioural property.

The things that can be done with model checking in the context of biological systems are:

- Model validation:
 - Show that your model of the pathway matches the lab data
- Model analysis:
 - In a collection of variants of a model (e.g., in silico gene knock-outs), which models show a certain interesting behavior?
- Model development:
 - If the model doesn't do what we want, change the model automatically until it does (parameters, structures,...)
- Model finding:
 - Given database of models, use model checking to query the database and find those models which exhibit a certain behaviour.
- Biosystem verification:
 - Does the constructed system do what we intended?

We illustrate this tutorial by reference to the simulative MC2 Model Checker which operates over properties written in Probabilistic Linear-time Temporal Logic with numerical constraints (PLTLc), and which can handle descriptions ranging from highly qualitative to fully quantitative.

We also introduce the concept of Model Engineering, which is a systematic approach for designing, constructing and analyzing computational models of biological systems, and takes some inspiration from efficient software engineering strategies.

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Some References

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