Bayesian parameter synthesis for markov population model.

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Bayesian framework for parameter synthesis.

Model checking

Definition

Model checking is an automated technique that, given a finite-state model of a system and a formal property,systematically checks whether this property holds for (a given state in) that model

Since we are interested in probabilistic model checking, our models encompasses probabilistic behaviours.

Examples (Probabilistic models)

- ▶ Rational fucntion evaluation
- ▶ Statistical model checking

Properties

Properties are specified by temporal logics

Examples

- ▶ PCTL
- ▶ CSL
- ▶ LTL
- ▶ etc.

Statistical model checking

Statistical Model Checking (SMC) is a formal verification technique that combines simulation and statistical methods for the analysis of stochastic systems. [1] Statistical Model Checking verifies a system S property ϕ over a finite set of *traces*, acquired through simulating the system of concern S.

Advantages

▶ **Scalability**: avoid state space explosion issues.

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Given a model M of a system S and a temporal property ϕ. Let $p := Pr\{M \models \phi\}$ be the probability that the model M satisfies the property ϕ. [1]

Verification

- **Quantitative**: Estimate p
- **Qualitative**: Given a threshold θ, test the hypothesis $H :=$

Statistical model checking

> **Quantitative**
>
> Estimate $p := Pr\{M \models \phi\}$ wrt. precision δ and confidence level α

The estimation is described in detail in [**agha2018survey**]. We calculate $\hat{p}$ as an estimation of p such that

$$Pr\{|p - \hat{p}| < \delta\} = 1 - \alpha$$

$\hat{p}$ can be estimated using different bounds, such as Chernoff-Hoeffding bound [**hoeffding1963probability**], Okamoto bound [**okamoto1959some**] or Massart bound [**massart1990tight**]

Statistical model checking

Let $p := Pr\{M \models \phi\}$ and a threshold $\theta \in [0,1]$. Compare p and θ

The general approach is to do hypothesis test
[**younes2005verification**] given a confidential level α

- $H_0 : p >= \theta$
- $H_1 : p < \theta$

More details can be found at [**wald1945sequential**]

Case study

PRISM [**kwiatkowska2002prism**] is a model checking tool that support discrete event simulation and statistical model checking. For an example of how to use PRISM for statistical model checking please follow this link.