Parameter Estimation of Stochastic Models against Probabilistic Temporal Logic Behavioral Specifications

The inherent behavioral variability exhibited by stochastic systems makes it a challenging task for human experts to manually analyze them. Such systems can be translated into mathematical models so that they can be simulated and studied using various computational algorithms. However, the process of rendering stochastic systems into computational models introduces the presence of several unknown parameters. Determining the values of these parameters against known expert behavioral specifications has become a key challenge for designers of stochastic models.

The main contribution of this thesis is computing a quantitative tightness metric of model verification and employing it to guide a search algorithm to estimate all the unknown parameters present in a given stochastic model such that the model satisfies multiple probabilistic temporal logic behavioral specifications simultaneously; thus, generating a single parameter point against multiple specifications. The first step of the presented solution uses a larger mean hypothesis test based statistical model checking to estimate the parameters of the given stochastic model against a single probabilistic temporal logic behavioral specification and the second phase of this work extends it by using a multiple hypothesis testing based statistical model checking technique to estimate the parameters against multiple probabilistic specifications simultaneously.

The benchmarks studied, analyzed and experimented on in this study are two rule-based computational models of stochastic biochemical receptors, FcεRI and Tαε"cell. Experimental results demonstrate successful synthesis of the two models and estimate the values of all of their unknown properties against three probabilistic temporal logic behavioral specifications each. Further, our proposed algorithms have been implemented into tools and are being deployed as a publicly available cyber infrastructure.

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The public is welcome to attend.