Formal Verification of Genetic Circuits*

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Abstract. Researchers are beginning to be able to engineer synthetic genetic circuits for a range of applications in the environmental, medical, and energy domains [1]. Crucial to the success of these efforts is the development of methods and tools to verify the correctness of these designs. This verification though is complicated by the fact that genetic circuit components are inherently noisy making their behavior asynchronous, analog, and stochastic in nature [2]. Therefore, rather than definite results, researchers are often interested in the probability of the system reaching a given state within a certain amount of time. Usually, this involves simulating the system to produce some time series data and analyzing this data to discern the state probabilities. However, as the complexity of models of genetic circuits grow, it becomes more difficult for researchers to reason about the different states by looking only at time series simulation results of the models. To address this problem, techniques from the formal verification community, such as stochastic model checking, can be leveraged [3, 4]. This tutorial will introduce the basic biology concepts needed to understand genetic circuits, as well as, the modeling and analysis techniques currently being employed. Finally, it will give insight into how formal verification techniques can be applied to genetic circuits.

References

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