



Modeling, Simulation, and Verification of Stochastic Hybrid Systems: A computational approach

Derek Riley

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Formal modeling and analysis methods hold great promise to help further discovery and innovation for biochemical systems. This work uses Stochastic Hybrid Systems for modeling and analysis because they can formally capture the complex dynamics of a large class of biochemical systems. An advanced fixed step simulation technique is presented for SHS. Further, an adaptive time stepping simulation method for SHS is implemented to improve accuracy and efficiency. An exhaustive verification method for SHS based on dynamic programming is developed as a tool for analyzing reachability properties for the entire state space. Reachability analysis can also be performed using Monte Carlo methods, so Monte Carlo methods for SHS are implemented. Realistic case studies are used to demonstrate the modeling capabilities of SHS and the analysis methods. The case studies include models of sugar cataract development in the lens of a human eye, a commercial biodiesel production system, glycolysis, which is a cellular energy conversion mechanism found in every living cell, and the water and electrolyte balance system in humans.

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