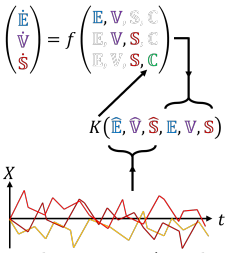
University of Stuttgart
Institute for Systems Theory and Automatic Control
Working Group Systems Theory in Systems Biology (Prof. Nicole Radde)

Master Thesis

Finding a Provably Stable Closure for the Method of Moments

Description:



Biochemical systems are typically governed by the Chemical Master Equation (CME), a very high-dimensional, linear ODE whose solution is the probability of observing the system in a specific state at a given time for all possible states and times. As the CME is only solvable for the smallest example systems, one often resorts to approximating its solution. One very powerful approach in this context is the method of moments. As the name indicates, it estimates not the full distribution but only its first stochastic moments. In order to do so, a second, smaller and nonlinear ODE system is derived that describes the time evolution of the desired moments. Unfortunately, the moment equations are not closed in the sense that moments of order m depend on moments of order $m+1$, which leads to an infinite hierarchy of dependencies. To still solve the system, on has to truncate this infinite hierarchy by heuristically choosing a moment of order m, thereby properly defining all lower order moments. However, as this truncation is based on heuristics, there is no guarantee that the resulting moment equations still represent the moments of the CME solution.
The goal of this project is to create a closure method that guarantees the method of moments to stay close to the true moments of the CME. To this end, few samples from the chemical master equation can be used as a reference trajectories. A promising first direction in literature is provided and even though the system at hand is motivated by biochemistry, this thesis is purely systems theoretical.

Prerequisites:

- Sound Mathematic Background
- Control Theory
- Basic Programming Skills (e.g. Python)

Supervisor:

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Keywords:

Nonlinear Systems
Provable Stability
Systems Theory

Thesis Aspects:

40% Literature
30% Implementation
30% Simulation

Language:

Deutsch/Englisch

Start:

Starting Now

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