Approximating Solutions of the Master Equation

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Abstract: The chemical master equation characterises time dependent probability distributions over a discrete space. In order to be able to solve the master equation for large reaction systems involving many different chemical species one needs to approximate the solution. In this talk we will review the chemical master equation, some simple examples and show how solutions can be approximated using aggregation and disaggregation.

The discussion of the approximation errors uses a signal processing framework where the error can be interpreted as the sum of a sampling and filtering errors. We provide some new approximation error bounds of piecewise constant, linear, and quadratic methods. The theoretical bounds which use a Fourier transform framework are confirmed by computational experiments for known solutions. In contrast to approximations over continuous domains the approximation over discrete sets contains the exact solution as a particular case rather than a limiting case. The "asymptotic" error rates are observed in a region which is between the exact solution and an approximation with a scale which is characteristic of the underlying function.

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