Skalenkaskaden in komplexen Systemen

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Quantification of coarse-graining error in overdamped/non-overdamped Langevin dynamics

Abstract:

Coarse-graining or dimension reduction is the procedure of approximating a large and complex system by a simpler and lower-dimensional one. A key feature that allows for such an approximation is a choice to consider only part of information by means of a coarse-graining map F that is strongly many-to-one. Assuming that the configuration of the full system is governed by a stochastic differential equation, for, say, a random variable X (representing for instance the position of particles in the system), Gyöngy postulated an ‛effective' evolution equation for the reduced (coarse-grained) variable F(X), which is again a stochastic differential equation with coefficients derived from the full one. This 'effective' equation is an approximation of the true evolution of F(X), and Legoll and Lelièvre showed in the case of one-dimensional coarse-graining maps F how to estimate the error of this approximation in the relative-entropy sense.

In this work we generalize this result in two ways: first, we extend the estimate to multidimensional maps F, and secondly, we also measure the error in the second-order Wasserstein distance. This second estimate is a weaker measure of the error, but also requires weaker conditions on the system.

This is joint work with A. Lamacz, M.H. Duong, A. Schlichting, and U. Sharma.