#16 Topic: Exact macroscopic description of network dynamics: can we trade spatial for temporal information?

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Abstract:

Many applications of complexity science and physics provide us with relatively simple microscopic (local) dynamical models. Our interest is however often in the more complicated macroscopic behavior, such as the time evolution of a few observables, an average over nodes, or a macroscopic stationary state. The bridge between the microscopic and macroscopic dynamics in arbitrary dynamical systems is highly non-trivial, and one often has to come up with semi-empirical parameterizations of the microscopic level, or additional assumptions to model the macroscopic system accurately.

In this project, we explore the possibility to model macroscopic dynamics exactly: the hope is that a local first order in time differential equation can be replaced by a higher order equation describing the macroscopic dynamics without introducing microscopic parameterizations. This could enable us to find macroscopic attractors without modeling microscopic dynamics, obtain microscopic spectral properties from macroscopic analysis, and explore the level of degeneracy that arises with coarse graining a dynamical system. So far we have derived formally how such an up-scaling can be established, and applied it to a simple 1-dimensional diffusion network as an example, where exact higher order macroscopic equations can be derived analytically at an arbitrary scale.