Neural Field Equations with Slowly Evolving Parameters

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Single-cell biophysical neural models are naturally written as systems of ordinary differential equations (ODEs) with time-scale separation, and this feature has a strong influence on their dynamical repertoire. A mathematical multiple time-scale theory for neural excitability, and for the generation of complex neural rhythms such as mixed mode oscillations or bursting, has been developed for single-cell models, but little is known at the level of neural populations, and for spatially-extended neural networks.

A major obstacle towards exploring time-scale separation in networks of neurons is the lack of a comprehensive Singular Perturbation Theory for spatially-extended models and infinite-dimensional dynamical systems. In this poster, we present progress in this direction, with specific applications in neural field models. We study neural field equations in which a (possibly large) number of parameters are varying on a slow time scale compared to neural activity. For these systems, we develop from scratch an analytical theory analogous to Fenichel Theory for ODEs.

We use a Lyapunov-Perron type approach, grounded in functional analytical methods, which can be adapted to other infinite-dimensional problems, such as Partial Differential Equations subject to slowly-varying parameters.

The poster gives an overview of the theory, and provides examples using neural field models available in the literature.

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