# Conditions for wave trains in spiking neural networks

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Spatiotemporal patterns such as traveling waves are frequently observed in recordings of neural activity. Previous studies have investigated the existence and uniqueness of different types of waves or bumps of activity using neural-field models [1], phenomenological coarse-grained descriptions of neural-network dynamics. But it remains unclear how these insights can be transferred to more biologically realistic networks of spiking neurons, where individual neurons fire irregularly.
Here, we employ mean-field theory [2] to reduce a microscopic model of leaky integrate-and-fire (LIF) neurons with distance-dependent connectivity to an effective neural-field model [3,4]. The dynamics in this neural-field model depends on the mean and the variance in the synaptic input, both determining the amplitude and the temporal structure of the resulting effective coupling kernel. For the neural-field model we employ linear stability analysis to derive conditions for the existence of spatial and temporal oscillations and wave trains, that is, temporally and spatially periodic traveling waves. Compatible with the architecture of cortical neural networks, wave trains emerge in two-population networks of excitatory and inhibitory neurons as a combination of delay-induced temporal oscillations and spatial oscillations due to distance-dependent connectivity profiles. We demonstrate quantitative agreement between predictions of the analytically tractable neural-field model, implemented in the toolbox LIF Meanfield Tools [5], and direct NEST simulations of both: networks of nonlinear rate-based units and networks of LIF neurons.

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