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Transition and coexistence of periodic patterns in spiking neuron models of delayed recurrent inhibitory loops

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Abstract

We study the coexistence of multiple periodic solutions for a quadratic integrate-and-fire neuron model (QIF) of recurrent inhibitory loops, which incorporates two important biological features—the firing procedure and absolute refractoriness. We show that the interaction of the delay, the eedback and the refractoriness can generate three basic types of oscillations and these three basic oscillations can then be pinned together to form interesting coexisting periodic patterns. We derive general principles that determine whether a periodic pattern can and should occur and we apply such principles to some detailed case studies. In particular, we show how pattern transitions occur at certain critical time delays and how these transitions yield the coexistence of multiple pattern subsets in certain subintervals.