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Dynamics and bifurcations of the adaptive exponential integrate-and-fire model. (English)

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Summary: Recently, several two-dimensional spiking neuron models have been introduced, with the aim of reproducing the diversity of electrophysiological features displayed by real neurons while keeping a simple model, for simulation and analysis purposes. Among these models, the adaptive integrate-and-fire model is physiologically relevant in that its parameters can be easily related to physiological quantities. The interaction of the differential equations with the reset results in a rich and complex dynamical structure. We relate the subthreshold features of the model to the dynamical properties of the differential system and the spike patterns to the properties of a Poincaré map defined by the sequence of spikes. We find a complex bifurcation structure which has a direct interpretation in terms of spike trains. For some parameter values, spike patterns are chaotic.

MSC:

92C20 Neural biology
92C05 Biophysics
37N25 Dynamical systems in biology
34C60 Qualitative investigation and simulation of ordinary differential equation models

Keywords:

integrate-and-fire; spiking neuron models; dynamical systems; bifurcations; chaos

Software:

Brian

Full Text: DOI

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