Is functional chaos in neural systems a pipedream?

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Abstract

It has become fashionable to report the existence of deterministic chaos in biophysical neuron models. Much of the time, the importance of this behavior is given as self-evident. Moreover, it is rarely transparent whether these studies actually investigate a chaotic behavior since a full mathematical analysis is not pursued. This report revisits two biophysical papers reporting chaotic bursting activity in neuron models, one an intrinsically bursting neuron [1] and the other a two cell anti-phasic half-center [2]. Using cycle-expansion techniques, we determine whether these models do in fact produce chaotic oscillations and how these oscillations come to be. We related these results back to biological mechanisms that may be responsible for the chaotic dynamics in biological neural systems. Finally, we investigate how likely chaos is to play a functional role in these simple neural circuits given the presence of large noise in the vast majority of biological systems.

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