Roberta Sirovich
Department of Mathematics, University of Torino
e-mail: roberta.sirovich@unito.it

About a modification of the firing time definition in stochastic leaky integrate–and–fire neuron models

The integrate-and-fire neuron model is one of the most widely used models for studies of neural coding [1,2]. It describes the membrane potential of a neuron in terms of the synaptic inputs and the injected current that it receives. An action potential (spike) is generated whenever the membrane potential crosses some threshold level from below. In integrate-and-fire models the form of an action potential is not described explicitly. Spikes are formal events fully characterized by a 'firing time' after which the membrane potential is reset and the process starts from scratch.

The observation of experimental intracellular recordings seems to suggest that the membrane potential may cross the threshold level several times before an action potential is detected [3]. We study a modified version of the leaky integrate-and-fire neuron model where a spike is generated whenever the membrane potential remains above the threshold level for a 'sufficiently' long time. Hence the firing time is not defined by an instantaneous crossing of the level, but depends on a longer history of fluctuations of the membrane potential. Comparisons with the dynamics exhibited in the classical models are presented.

References

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