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Identification and continuity of the distributions of burst-length and inter-spike-intervals in the stochastic Morris-Lecar neuron

Using the Morris-Lecar model neuron with a type II parameter set and K+ channel noise, we investigate the inter-spike interval distribution as increasing levels of applied current drive the model through a sub-critical Hopf bifurcation. Our goal was to provide a quantitative description of the distributions associated with spiking as a function of applied current. The model generates bursty spiking behavior with sequences of random numbers of spikes (bursts) separated by inter-burst intervals of random length. This kind of spiking behavior is found in many places in the nervous system, most notably, perhaps, in stuttering inhibitory interneurons in cortex. Here we show several practical and inviting aspects of this model, combining analysis of the stochastic dynamics of the model with estimation based on simulations. We show that the parameter of the exponential tail of the ISI distribution is in fact continuous over the entire range of plausible applied current, regardless of the bifurcations in the phase-portrait of the model. Further, we show that the spike sequence length, apparently studied for the first time here, has a geometric distribution whose associated parameter is continuous as a function of applied current over the entire input range. Hence this model is applicable over a much wider range of applied current than has been thought.