Ordinal analysis of spike correlations in the FitzHugh-Nagumo model with subthreshold periodic modulation

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In excitable systems the presence of noise can facilitate the detection of weak signals, which are encoded and transmitted in sequences of spikes. Here we investigate the correlations that are induced by an external subthreshold sinusoidal input, in the presence of white Gaussian noise [1]. To simulate the neuronal behavior, we use the FitzHugh-Nagumo (FHN) model, and to identify correlations in the timing of the output sequence of spikes, we apply the symbolic method of ordinal time-series analysis [2, 3] to the sequence of interspike intervals (ISIs). The external forcing signal is subthreshold and therefore, in the absence of noise the neuron only displays subthreshold oscillations. We show that the interplay of noise and subthreshold forcing results in a sequence of spikes with nonlinear correlations that depend on the forcing period, T, and on the noise strength, D. The probabilities of the ordinal patterns detect a resonance behavior with D and T: some patterns are more/less likely to occur in the ISI sequence depending on D and T.

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