MEMORY-INDUCED RESONANCE-LIKE SUPPRESSION OF SPIKE GENERATION IN A RESONATE-AND-FIRE NEURON MODEL

Romi Mankin

Sander Paekivi (presenting author)

School of Natural Sciences and Health, Tallinn University, Narva mnt 25
10120 Tallinn, Estonia
e-mail of presenting author: sander.paekivi@tlu.ee

The behaviour of a stochastic resonate-and-fire neuron model described by a generalized Langevin equation with a power-law-type memory kernel is presented. The effect of temporally correlated random activity of synaptic inputs, which arise from other neurons forming local and distant networks, was modelled as an additive fractional Gaussian noise. Using a first-passage-time formulation, exact expressions for the output interspike interval (ISI) density and for the survival probability (the probability that spikes are not generated) were derived and their dependence on input parameters, especially on the memory exponent, was analysed. In the case of the external noise, it is shown that at intermediate values of the memory exponent the survival probability is significantly enhanced in comparison with the case of strong and low memory, which causes a resonance-like suppression of the ISI distribution vs the memory exponent.

Moreover, an examination of the dependence of multi-modality in the ISI distribution on input parameters shows that there exists a critical memory exponent, α≈0.402, which marks dynamical transition in the behaviour of the system. The last phenomenon is illustrated by a phase diagram, shown in Figure 1, describing the emergence of three qualitatively different structures of ISI distribution. Similarities and differences between the behaviour of the model with internal and external noise are also discussed.

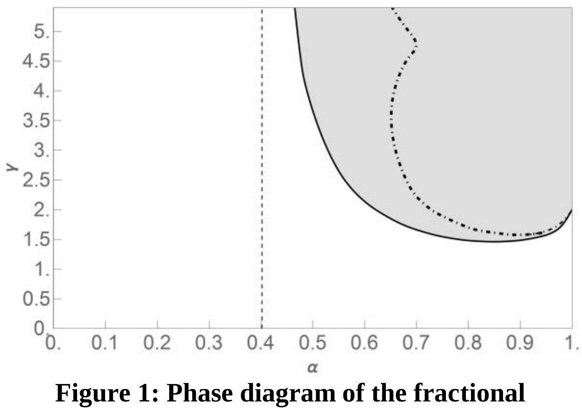

Figure 1: Phase diagram of the fractional oscillator.

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