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Poster title: On the emergence of stability and oscillation in a simple neuronal model

Abstract: In this project, we consider a discrete-time model of neuronal behavior involving a single postsynaptic neuron and multiple presynaptic neurons. This model combines a leaky integrate-and-fire model called the Spike Response model with the Galves-Locherbach model. In the combined model, the spiking activity of each neuron over time is described by a random process that takes binary values, and the probability that the postsynaptic neuron spikes at a given time interval is determined by its membrane potential, which in turn depends only on the portion of the neuron's history since the neuron last fired. Under the assumption that the activity of the presynaptic neurons forms a discrete-time Markov chain, and the spiking activity of the postsynaptic neuron evolves in reaction to but does not change the behavior of the presynaptic neurons, the random process describing the neuronal behavior is equivalent to the Markov chain of contexts, where the context at each time as a fraction of spiking history provides sufficient information to determine the postsynaptic membrane potential. Where a triggering pattern exists, i.e., existence of an input pattern that consistently yields a non-negligible probability of neuronal firing no matter what the context in which it occurs, the Markov chain of contexts has at least one recurrent class; all its recurrent classes are positive recurrent; starting from any transient state, the Markov chain of contexts visits a recurrent class eventually with probability one. As a result, by studying the Markov chain of contexts restricted to each recurrent class, we obtain the long-term convergence and oscillation behavior of the spiking activity in the neuronal model.