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Towards a realistic NNLIF model: excitatory-inhibitory populations with delay and refractory states

The Network of Noisy Leaky Integrate and Fire (NNLIF) model describes the behavior of a neural network at mesoscopic level. It is one of the simplest self-contained mean-field models considered for that purpose. Even so, as a starting point, it was necessary to disregard crucial phenomena in order to deal with the model. In this work we deal with the general NNLIF model without simplifications. It involves a network with two populations (excitatory and inhibitory), with transmission delays between the neurons and where the neurons remain in a refractory state for a certain time. We have studied the number of steady states in terms of the model parameters, the long time behaviour via the entropy method and Poincaré inequality, blow-up phenomena; and also explored numerically the importance of transmission delays between excitatory neurons to prevent blow-up and to give rise to synchronous solutions.