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Cai, David; Tao, Louis; Rangan, Aaditya V.; McLaughlin, David W.

Kinetic theory for neuronal network dynamics. (English)

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In order to derive effective dynamics under a reduced representation of large-scale neural networks, the article is concerned with the development of representations for simulating more efficient the dynamics of large multi-layered networks. Starting with networks of conductance-based integrate-and-fire (I&F) neurons, a full kinetic description without introduction of new parameters is derived. After a brief description of the dynamics of conductance - based I&F neural networks, for the dynamics of a single I&F neuron with an infinitely fast conductance driven by a Poisson input spike train, an exact kinetic equation is proposed. Its properties are studied under a diffusion approximation. Then, for all-to-all coupled networks of excitatory neurons , using the so-called conditional variance closure, the kinetic equations are derived. Further, kinetic equations are extended to coupled networks of excitatory and inhibitory neurons. The developed kinetic models can be extended to multiple interacting coarse-grained spatial patches.

Claudia Simionescu-Badea (Wien)

Keywords : integrate and fire neural neurons; kinetic equation; Fokker-Planck equation; fluctuation; diffusion; coarse-grain

Classification :

∗82C31 Stochastic methods in time-dependent statistical mechanics
82C32 Neural nets
92B20 General theory of neural networks
92C20 Neural biology