Abstract View

ANALOG TO DIGITAL CONVERSION USING RECURRENT SPIKING NEURAL NETWORKS

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Networks of integrate-and-fire neurons with recurrent feedback can perform analog to digital conversion at a rate that is proportional to the size of the network (E.K.Ressler et al, 2004, Proc. SPIE Int. Soc. Opt. Eng. 5200, 91). The individual neurons are coordinated using feedback in a manner that suppresses noise and makes the output spike rate proportional to the level of the analog input signal without a predetermined progression of states or an explicit clock. We explored the possibility that cortical networks with strong excitatory and inhibitory loops and a range of latencies could also perform oversampling and noise shaping, which would allow the transmission of information with large bandwidths despite the slow and imprecise characteristics of individual neurons and synapses. Simulations using integrate-and-fire neurons in simple networks, first with global inhibitory feedback and then with both inhibitory and excitatory feedback, confirm the analytically predicted performance in terms of noise shaping and cell-to-cell spike train correlations previously reported. Input information was also preserved through cascades of single-layer networks. Similar simulations were performed using a recurrent network with Hodgkin-Huxley-like two-compartment models and a realistic noise environment. The model had 5,000 pyramidal and 1,250 inhibitory interneurons with local, sparse synaptic connections between all cell types.
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