Abstract View

EXACT SOLUTIONS FOR THE NON-LEAKY INTEGRATE-AND-FIRE MODEL NEURON DRIVEN BY CORRELATED STOCHASTIC INPUTS.

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One way to understand the integration properties of a neuron driven by many synaptic inputs is to consider its total input as a stochastic variable with given statistical properties, and calculate the statistics of the response. Commonly, one assumes that the total input has a Gaussian distribution and that samples taken at different times are uncorrelated. Actual input currents, however, have a correlation time Tc, due to factors like synaptic time constants, synchrony in the input spikes or concerted oscillatory activity, which may change in a stimulus- or attention-dependent way, as observed in the somatosensory (Steinmetz et al., 2000) and visual (Fries et al., 2001) systems. To understand how the correlation time affects neural responses, we studied the firing times of an integrate-and-fire model neuron driven by binary inputs. The mean firing rate R and the coefficient of variation CV (a measure of spike train variability) were calculated analytically as functions of the mean, variance and correlation time of the inputs. We found that an increase in Tc typically increases both R and CV, but these effects depend differentially on the relative values of the input mean and variance: when the variance is large relative to the mean, R is highly sensitive to changes in Tc but CV is not; when the variance is relatively small the sensitivities are reversed. The behaviors obtained as Tc becomes large are also different: R saturates whereas CV diverges. The results agreed with simulations, and suggest that the spike train variability and firing rate of neurons may be strongly modulated through changes in the temporal correlations of the driving inputs.

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