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Consistent estimation of complete neuronal connectivity in large neuronal populations using sparse "shotgun" neuronal activity sampling. (English) Zbl 1382.92070

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Summary: We investigate the properties of recently proposed "shotgun" sampling approach for the common inputs problem in the functional estimation of neuronal connectivity. We study the asymptotic correctness, the speed of convergence, and the data size requirements of such an approach. We show that the shotgun approach can be expected to allow the inference of complete connectivity matrix in large neuronal populations under some rather general conditions. However, we find that the posterior error of the shotgun connectivity estimator grows quickly with the size of unobserved neuronal populations, the square of average connectivity strength, and the square of observation sparseness. This implies that the shotgun connectivity estimation will require significantly larger amounts of neuronal activity data whenever the number of neurons in observed neuronal populations remains small. We present a numerical approach for solving the shotgun estimation problem in general settings and use it to demonstrate the shotgun connectivity inference in the examples of simulated synfire and weakly coupled cortical neuronal networks.

MSC:

92C20 Neural biology
62P10 Applications of statistics to biology and medical sciences; meta analysis
60J22 Computational methods in Markov chains

Keywords:

functional connectivity; neuronal circuit reconstruction; calcium imaging; neuronal population activity

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