Estimation of Linear and Nonlinear Spatial Receptive Fields from Natural Images

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Abstract

Although visual cells are nonlinear, most methods for estimating receptive fields from input/output data assume linearity. Furthermore, most existing methods for estimating receptive fields use artificial stimuli. Estimating receptive fields from natural images is important, because cells are adapted to process natural images and responses to artificial stimuli may not yield good natural functional descriptions. Hence, a nonlinear model for visual cells and a method to estimate their parameters from natural images are needed. Here, we describe a method for estimating the parameters of a spatial Volterra model ([2]). The limited size of experimental data forbids direct estimation of the large number of parameters in spatial Volterra models. To reduce the dimensionality of the estimation, we expand their kernels in a low number of basis functions. We find the coefficients of these basis functions that best fit the data and we reconstruct kernels from these basis functions. The selection of the basis function is critical. Here, we use a statistical-learning algorithm to learn the basis functions from cell responses to natural images. We evaluate the method using well known nonlinear models of visual cells ([1]) and we show that the estimated kernels are good approximations of the true kernels.

References

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