BMC Neuroscience

Poster presentation

Estimation of spectro-temporal receptive fields based on linear support vector machine classification

Arne F Meyer*[1], Max FK Happel[2], Frank W Ohl[2] and Jörn Anemüller[1]

Address: [1]Department of Physics, Carl-von-Ossietzky University, Oldenburg, DE, Germany and [2]Leibniz Institute for Neurobiology and Institute of Biology, Otto-von-Guericke University, Magdeburg, DE, Germany

Email: Arne F Meyer* - arne.f.meyer@uni-oldenburg.de

* Corresponding author

Introduction

The spectro-temporal receptive field (STRF) of a neuron is defined as the linear filter that, when convolved with the spectro-temporal representation of an arbitrary stimulus, gives a linear estimate of the evoked firing rate [1]. A common method for STRF estimation uses the spike-triggered average (STA) to compute the mean stimulus pattern preceding every spike.

Here, we present a method that not only considers stimulus patterns that evoke spikes but also those after which no spikes occur. This results in a binary classification problem. We show that the STRF model is equivalent to the structure of a linear support vector machine (SVM) and propose the use of SVMs for the estimation of the STRF. Based on this approach, we demonstrate that the obtained STRFs are a better predictor for spiking and non-spiking behavior of a neuron.

Methods and results

The SVM is trained using real spike data from anesthetized gerbils [2] and zebra finches [3]. The parts of the stimulus spectrogram preceding a spike are labeled as class 1, whereas the remaining (non spike-evoking) parts are labeled as class 0. We used 80% of the data for training and 20% for prediction. See figure 1

Discussion

In comparison to classic STA estimation, the method proposed here is characterized by a notably finer structure in the temporal evolution of spike rate prediction. In particular the non spike-eliciting time intervals are better captured by the novel approach. This behavior is likely a result of the learning procedure employed that is based on a binary classification paradigm with a linear classifier. The averaging approach of the STA results in smoother estimates for the neuronal receptive field (due to the temporal low-pass envelope characteristics of natural stimuli), consequently producing less-detailed spike rate predictions.

References

1. Theunissen FE, Sen K, Doupe AJ: **Spectral-temporal receptive fields of nonlinear auditory neurons obtained using natural sounds.** J Neurosci 2000, **20**:2315-2331.
2. Happel MFK, Müller SG, Anemüller J, Ohl FW: **Predictability of STRFs in auditory cortex neurons depends on stimulus class.** Interspeech 2008:670.
3. **STRFPAK Matlab Toolbox** [http://strfpak.berkeley.edu/]
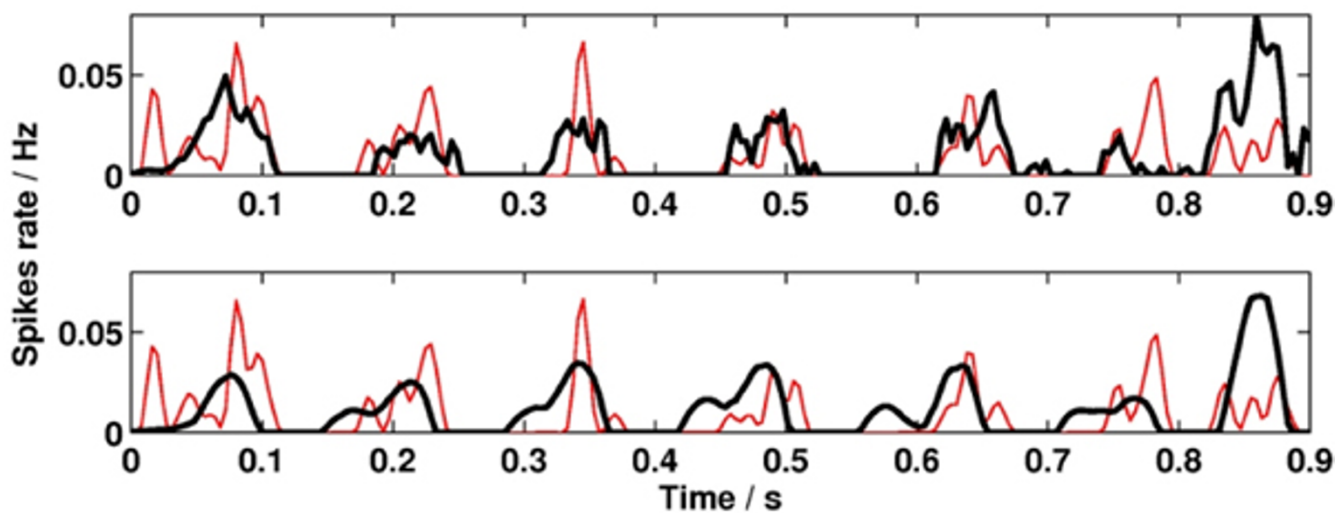
Figure 1
The predicted spike rate (bold black line) compared to the actual response smoothed with a Gaussian window of 20 ms (thin red line). The upper panel shows the result for the SVM-based method, the lower panel for the STA method. The mean coherence between actual and predicted rate is 0.23 for both methods.