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Presentation Abstract

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Title:	Towards optimal estimates of neural firing rates from spike trains
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Abstract:	Neural signals present challenges to analytical efforts due to their noisy, spiking nature. Many studies of neuroscientific and neural prosthetic importance rely on a smoothed, denoised neural signal considered to be the spike train's underlying firing rate. Current techniques to find time-varying firing rates require ad hoc choices of parameters, offer no confidence intervals on their estimates, and can obscure potentially important single-trial variability. We present a new method, without these restrictions, for inferring estimates of firing rate functions underlying single or multiple neural spike trains. The method adapts Gaussian Process regression, a commonly used machine learning technique, to the problem of firing rate estimation. We tested the performance of this novel method using both simulated and experimentally gathered spike trains. Experimental data were recorded from areas M1 and PMd of a rhesus monkey performing a center-out reaching task. For both types of data (simulated and experimentally gathered), we found improvements over conventional estimators in terms of firing-rate estimation error (compared to the true underlying firing rate in simulated data, and compared to the trial-averaged firing rate in the experimentally gathered data). Our method outperforms standard Gaussian kernel smoothing (RMS

estimation error) by 17.1%, -3.4%, 7.3%, and 8.1% across four experimentally gathered neural data sets. Improvements in simulated data and improvements compared to spline-based smoothing methods are larger. This framework for firing rate estimation can also be extended to investigate firing rates across multiple, simultaneously recorded neurons and across multiple experimental trials, which may be useful in neural prosthetic decode applications and in studies for separating stimulus-driven neural activity from non-stimulus-driven (system-driven) neural activity.

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