Resampling techniques for the statistical investigation of neurophysiological data

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The uncertainties peculiar to neurophysiological experiments can often be at odds with classical statistical assumptions, such as that of identically distributed data, Poisson, or Gaussian distributions. Motivated in part by these concerns, resampling techniques are being employed with increasing frequency in neuroscience. Resampling involves the creation of surrogate data sets which are created from the original data set to reflect statistical hypotheses of interest. One then compares the surrogate data with the original data set to evaluate these hypotheses. Some familiar examples include trial shuffling, spike jittering, and bootstrapping from estimated models, but there are many possible, and practical, variations. Moreover, given that resampling is appropriate for a hypothesis testing problem, it is straightforward and automatic to extend the method to control for the effects of multiple hypothesis testing, which appears to be somewhat overlooked. Such controls are often important, for example, when the statistics of interest are indexed by continuous variables such as time or space. We argue that resampling can be particularly appropriate given the peculiarities of spike trains and illustrate these ideas in the context of several typical problems in multi-unit data analysis, such as i) establishing differences in time-varying firing rate statistics across populations of neurons and conditions, ii) separating the effects of firing rate from correlations, and iii) detecting monosynaptic interactions in a population of cell activity, as well as their variation as a function of time and/or space.

Acknowledgments
This work was supported by NIH (NS34994, MH54671), and an NSF postdoctoral fellowship in biological informatics.