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Presentation Abstract

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Presentation Title: Comparison of spike sorting and thresholding of voltage waveforms for brain machine interfaces

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Abstract: For intracortical neural prostheses, voltage signals are often sorted to separate out the activity of individual neurons. If these neurons contain independent information, this process increases the information that can be obtained. However, spike sorting requires high sampling rates and expensive computations. The overall performance gain may not be large if many electrodes are dominated by one action potential or contain units with similar tuning. Therefore, we quantified prosthetic performance when using threshold crossing events versus sorted action potentials.

We used data sets from 32 experimental sessions with one rhesus macaque, Monkey L (Chestek et al. JNE, 2011), implanted with a Utah array. Data were recorded while the monkey performed a center out reaching task with targets at seven different angles. Neural signals were either sorted into individual units by clustering the first four principal components of the waveforms using a mixture of gaussians (Sahani, 1999), or simply thresholded below a multiple of the root mean square voltage. We decoded the data using both a Naive Bayes classifier of reaching direction (1 of 7) and a linear regression to evaluate correlation

coefficient. Ten or 20-fold cross validation was performed.
We found the highest performance when placing a threshold at -4 to -4.5 x the rms voltage. Therefore, we set the threshold to -4.25. The correlation coefficient between predicted and actual hand position was R=0.94 for spike sorted data and R=0.92 for thresholded data. While this is only a small difference, it was reliable on individual days and statistically significant ($p<0.01$, t-test). Seven target classification also showed a small but reliably significant decline in average performance from 94% correct to 90% correct ($p<0.01$, t-test).
If we place two thresholds at -3 and -5.5 rms, correlation coefficients were better than those found with one threshold but still significantly different than spike sorted data ($p=0.01$, t-test). If we replaced thresholded units with spike sorted units in ranked order of how much performance they added on day one, 99% of the fully spike sorted correlation coefficient performance was reached on the remaining data sets after a few of the 96 electrodes were sorted. For prosthetics applications, these results imply that when thresholding is used instead of spike sorting, only a small amount of performance is lost in exchange for more stable recordings (Chestek et al. JNE 2011) and robust prosthetic performance (Gilja et al. NN 2012).

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MACAQUE

ELECTROPHYSIOLOGY

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