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Presentation Abstract

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Abstract: The goal of motor and communication brain computer interfaces (BCI) is to determine a user's intent with high accuracy and speed. Such systems should take advantage of all signal sources to maximize performance. Current systems use neural spiking activity from cortical electrode arrays to decode intended behavior; however these implants also record local field potential (LFP), another information source (Hochberg et. al, 2006; Scherberger et. al, 2005). Many examples of LFP-based decoding extrapolate high channel count performance with recordings collected sequentially from different sites. Unfortunately, simultaneously recorded LFP channels are highly correlated and thus these extrapolations may be optimistic. BCI studies commonly use naïve Bayes (NB) decoding methods, which assume channels are independent given the intended behavior. The conditional independence assumption can be removed, but accurately estimating the full correlation matrix in a reasonable BCI training period is difficult, as the number of parameters grows as the square of the number of channels. However, the underlying correlation structure may be caused by the proximity of electrode site or may reflect a small set of unobserved variables, such as trial-by-trial cognitive and behavioral variation. By modeling hidden variables, we can account for correlated noise with fewer parameters. We propose a factor analysis (FA) based model to describe the correlation between LFP channels with a set of unobserved variables (or factors). This model was tested with data recorded from a 96-electrode array (CKI) implanted in dorsal premotor cortex of rhesus macaque H (and G). The data used for decoding are from the delay period of a center-out delayed reaching task to 1 of 8 targets. For each trial and channel, the power spectral density (PSD) from 10 to 50 Hz was calculated every 2 Hz using 250 ms of activity. Linear discriminant analysis was applied to each channel to find the best linear combination of PSD to discriminate between reach targets. The number of factors was chosen from 1 to 10 via cross-validation. The FA model consistently outperformed NB when decoding from 6 or more simultaneous LFP channels; with 96-channels, NB decoded 25% (25%) of trials correctly and FA decoded 39% (46%) of trials correctly. The FA model also improved performance when decoding from spike data, taking 89% (92%) performance to 94% (98%). If an NB model is used to fuse spike and LFP data, decoding performance degraded to 89% (87%); however with the FA model, performance is lifted back up to 95% (97%). The FA model better captures the underlying noise in both spike and LFP data, resulting in a significant boost in decoder performance.

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