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Presentation Abstract

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Presentation Title: State decoding using hidden Markov models for continuous brain-machine interfaces

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Abstract: Brain-machine interfaces (BMIs) translate neural information into useful control signals. They aim to guide electronic systems such as computer cursors and robotic limbs. For continuously controlled systems, one of two methods has been employed to signal a stop or selection. The simplest method is to hover for a specified time over the desired target. An alternate approach is to predict the intended state and transmit a "click" signal, which can speed up selection rate. This state detection has been performed with an LDA (Kim et al., TNSRE 2011), and we hypothesize that a hideen Markov model (HMM) based solution could perform better. To investigate this possibility, we present a closed-loop HMM state classifier based off threshold crossings from intracortical multielectrode arrays implanted in motor cortices in monkeys. Additionally, an HMM-based approach provides the flexibility to craft states and transition probabilities to optimally tune parameters of the decoder to better suit the subject. By using an HMM classifier, additional states can be added to assist in successful BMI performance. The HMM made predictions off low-dimensional projections of the neural data (Kao et al., this volume) by assuming a multivariate Gaussian model over the observed neural trajectories. It was trained in a supervised fashion by tagging known segments of neural data within training trials. This state classifier was run in real-time in parallel with continuous cursor decoding controlled by the ReFIT-KF (Nuyujukian

et al, COSYNE 2012) and achieved less than 10% false positive rate and a bitrate of 6 bps (Monkey J). Similar to previous studies (Velliste et al., SFN 2010), the incorporation of an idle state reduces false positives during times when the monkey is not actively participating in the task. These states and their parameterization can have broad impact on the behavior of the decoder. Effects of the parameters explored here include the sensitivity of the click and ease of transitioning in and out of the idle state. Additional modelling assumptions can extend the utility of an HMM classifier as necessary. An HMM classifier, run in parallel with a continuous cursor decoder like the ReFIT-KF, can provide a flexible alternative to hold-time based decoders and can enable other features useful to practical BMI implementations.

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