# voltage vs. movement, take 1

us

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$T =$ number of time steps, $x$ is channels, $y$ is movement parameters. $l$ is the number of lags. lag should be between 60 and 150 msec, or so. $l$ can be about 10, so we add 9 different lags, ranging from 60 to 150 msec.

$x \in \mathcal{X} = \mathbb{R}_+^{96l \times T}$ $y \in \mathcal{Y} \subseteq \mathbb{R}^{k \times T}$, $k$ can include measured stuff, plus their derivatives

things to do:

up/down-sample both $x$ and $y$ at 10kHz.

1. unsupervised dimensionality reduction followed by regression: Reduce dimensionality of $x$ using sparse PCA, sparse-smooth PCA, sparse non-negative PCA. regress on $y_t$ on $x_{t-s}$, where $s$ is about 100 msec, linear, svr, MARS, GAM (generalized additive model). loss function is mse. concatenate trials by time. leave-some-out trials to estimate decoding accuracy. we can further classify into 8 choices after that if we want. can repeat with 1 to $95l$ dimensions

2. sparse CCA, free parameters: $\lambda_x$ (and perhaps $\lambda_y$), and $d$ (number of dimensions to keep). in theory, also include $L_2$ or structured penalty if code works (laplace penalty).

3. kalman filter: observed variable is $x$ concatenated with $y$. hidden state is $z$:

$$\dot{z} = Az \tag{1}$$
$$w = Cz \tag{2}$$

   sparse penalty on $C$, connectivity matrix, which is $96l + k \times 96l + k$.

4. mixed effects assuming we have 8-alternative forced choice