First LDS analysis of Emmett' data

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1 Introduction

Here we use a Linear Dynamical System model (LDS)[1] to explore the low dimensional structure of Emmett's switching-task recordings (Thompson et al., 2024).

2 Methods

2.1 Data

We analyzed two minutes of continuous electrophysiological recordings starting at (electrophysiological) time 5512 from `EJT178_implant1 recording1_15032022`, and neurons 124 to 223 in the striatum.

2.2 LDS model

The LDS model estimates K latent variables, $x_0(t), \ldots, x_{K-1}(t)$. We concatenated the latent variables into a latent vector $\mathbf{x}(t)$:

$$\mathbf{x}(t) = \begin{bmatrix} x_0(t) \\ \vdots \\ x_{K-1}(t) \end{bmatrix} \tag{1}$$

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[1] https://github.com/joacorapela/ssm

The latents evolve in time following a first-order Markov process with additive Gaussian noise:

$$\mathbf{x}(t) = A\mathbf{x}(t-1) + \mathbf{v}(t) \quad \text{with } \mathbf{v}(t) \sim \mathcal{N}(0, Q) \tag{2}$$

The latent variables are combined linearly to approximate the firing rate of the recorded neurons (bin size 20 ms), $\mathbf{y}(t)$, with a constant offset, $\mathbf{a}$, and an additive noise, $\mathbf{w}(t)$.

$$\mathbf{y}(t) = \mathbf{a} + C\mathbf{x}(t) + \mathbf{w}(t) \quad \text{with } \mathbf{w}(t) \sim \mathcal{N}(0, R) \tag{3}$$

References

Thompson, E., Rollik, L., Waked, B., Mills, G., Kaur, J., Geva, B., Carrasco-Davis, R., George, T., Domine, C., Dorrell, W., et al. (2024). Replay of procedural experience is independent of the hippocampus. *bioRxiv*, pages 2024–06.