Classication of Behavioral Decision using Pre-decision Neural Activity

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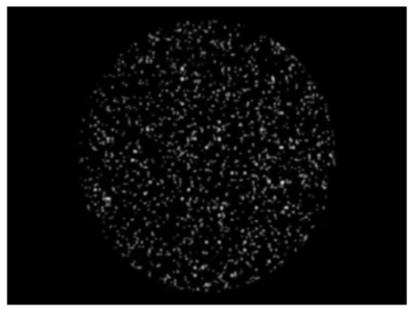
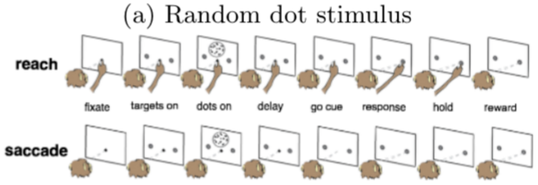
Abstract

Our project aims to use classification techniques to study decision making processes in macaque monkeys. We are working with the Newsome Lab in the Stanford School of Medicine, whose research agenda is to understand the neuronal processes that mediate visually guided behavior. To this end, they conduct parallel behavioral and physiological experiments in animals that are trained to perform selected perceptual or eye movement tasks. By recording the activity of cortical neurons during performance of such tasks, initial insights are gained into the relationship of neuronal activity to the animal behavioral responses. Our combination of behavioral, electrophysiological and computational techniques provides a realistic basis for neurophysiological investigation of cognitive functions such as perception, memory and motor planning. For our project, we use neural data from nuclei implicated in decision making to predict behavioral outcomes.

Experimental Design

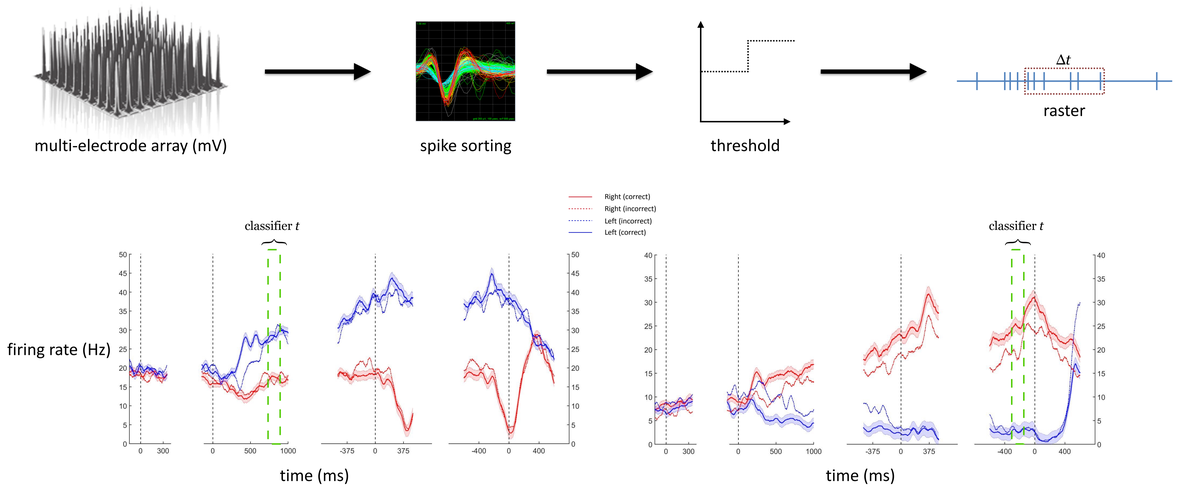


(a) Random dot stimulus



(b) Epochs for decision reporting by arm movement and eye saccades

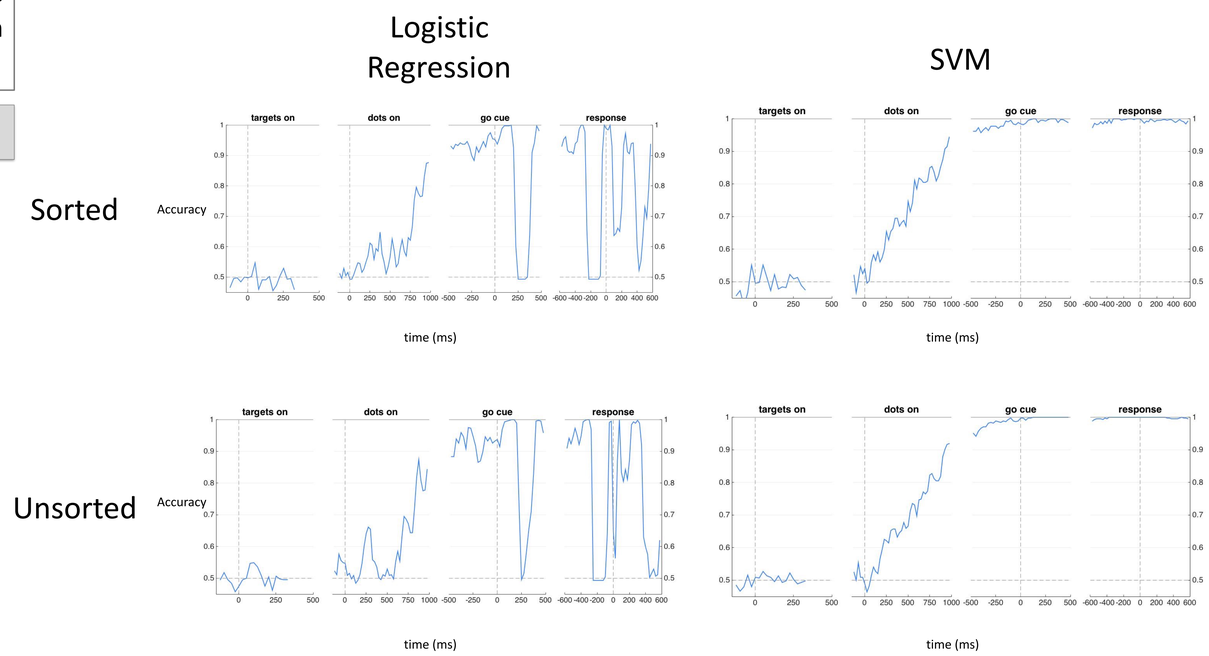
Our Data



$X_{ij}^{(t)}$ = sum of firing rates in bin t from unit j in trial i

Y_i = decision in trial i

Results



Conclusions

Summary of findings:

- Our models are able to predict the decision with high accuracy from the end of the dots epoch to the end of the trial.
- Our SVMs drastically outperformed logistic regression on both sorted and unsorted datasets.
- There was no significant difference within classifiers between using sorted and unsorted data, showing that classification on unsorted data can be reliably used in closed-loop experiments.

Discussion:

- In the logistic regression classifiers near the end of the "go cue" epoch, our prediction accuracy drops dramatically. This is likely because the regularization applied to logistic regression leads it to be very sensitive to the unstable neural dynamics during the final two epochs.
- We are currently working on extending our model to be able to predict the coherence of dot movement.
- We are also working on training a single classifier ofr each epoch rather than splitting the trial into separate time bins. This would reduce the computational complexity of predicting decisions in real time for closed-loop experiments.

References

1. Kiani, R., and M. N. Shadlen. "Representation of Confidence Associated with a Decision by Neurons in the Parietal Cortex." Science 324.5928 (2009): 759-64. Web.
2. Unpublished work from the Newsome Lab

Acknowledgments

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