Optimized Encoding of Sensation in Brain-Machine Interfaces

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INTRODUCTION

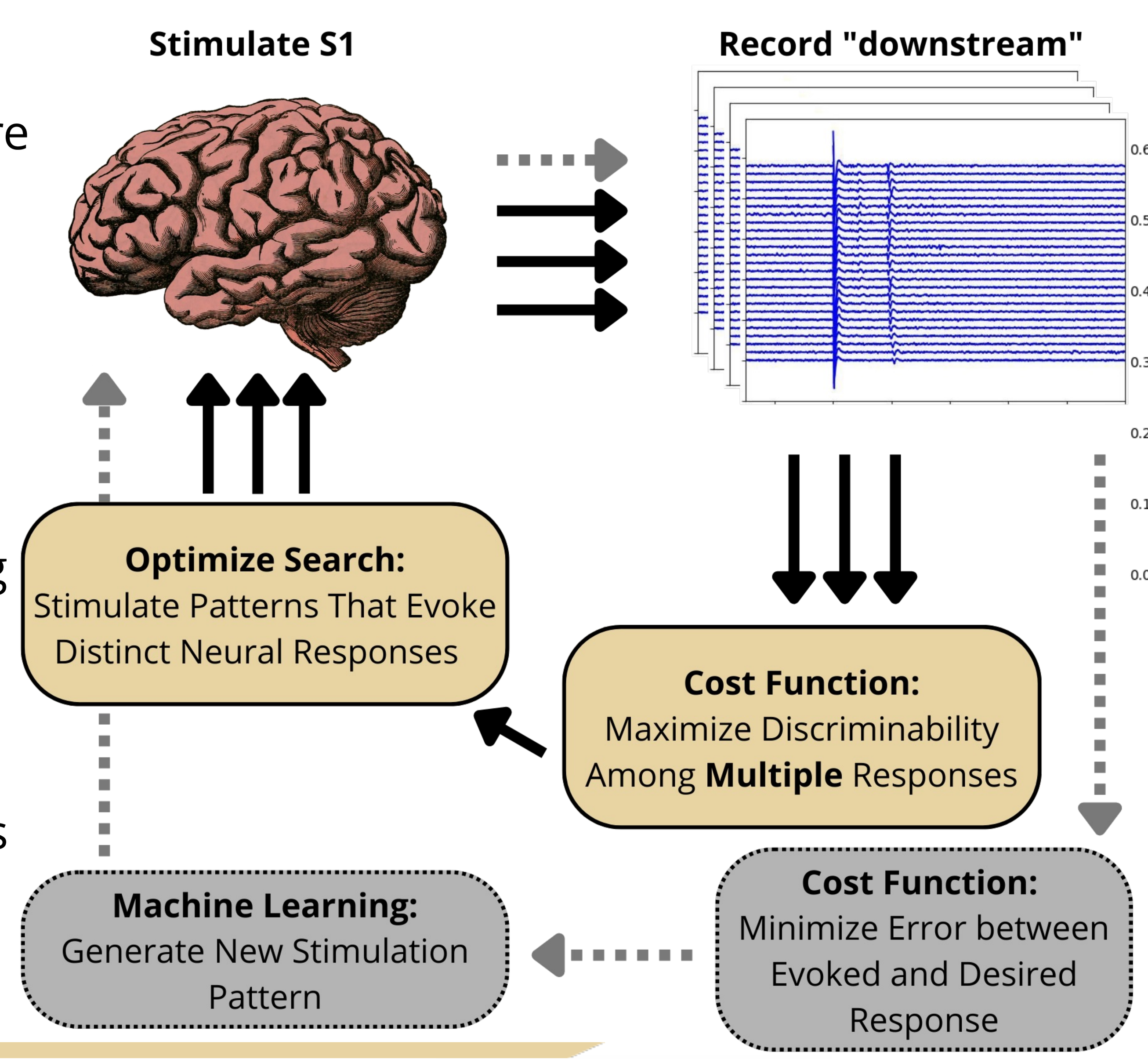
Sensory feedback in Brain-Machine Interfaces (BMI) currently rely on either *user-in-the-loop* calibration or *closed-loop algorithms* to *replicate desired neural responses* downstream of stimulation areas. However, both approaches are not practical or robust given time constraints in the clinic and variability in neural interfaces.

We propose an alternative algorithm that:

1) Quantifies the dissimilarity of downstream neural responses,
2) Schedules new applied stimulus patterns to efficiently identify clusters of patterns leading to similar responses.

The set of identified stimulus patterns would **maximize encoded information** under the assumption that discriminable neural responses lead to discriminable percepts.

Our Stimulation Parameter Search Algorithm
vs Previous Adaptive Closed-Loop Approaches

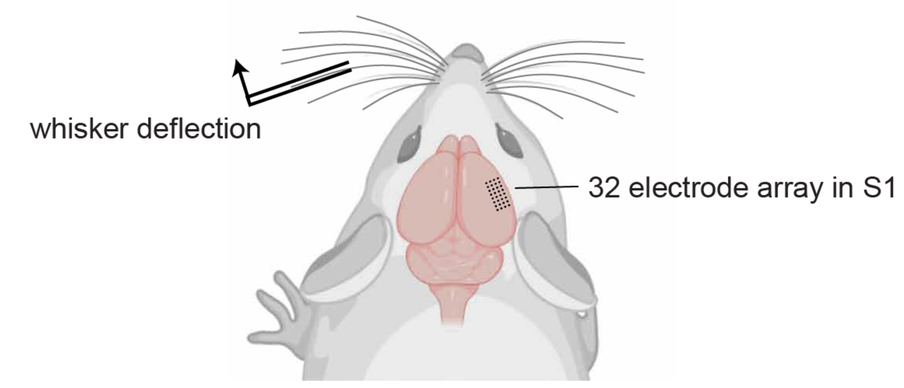


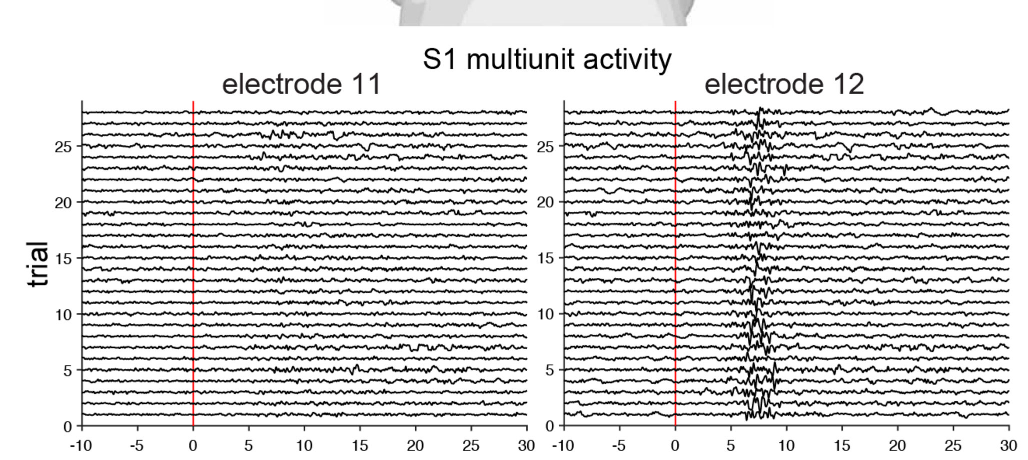
EXPERIMENTAL DATA

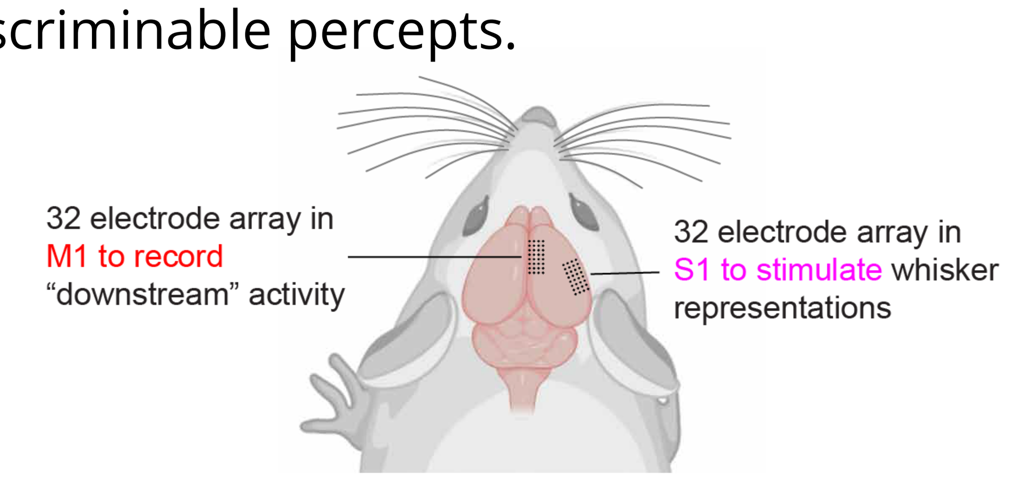
Electrical stim of whisker somatosensory cortex (S1) in anesthetized rats to encode sensations.

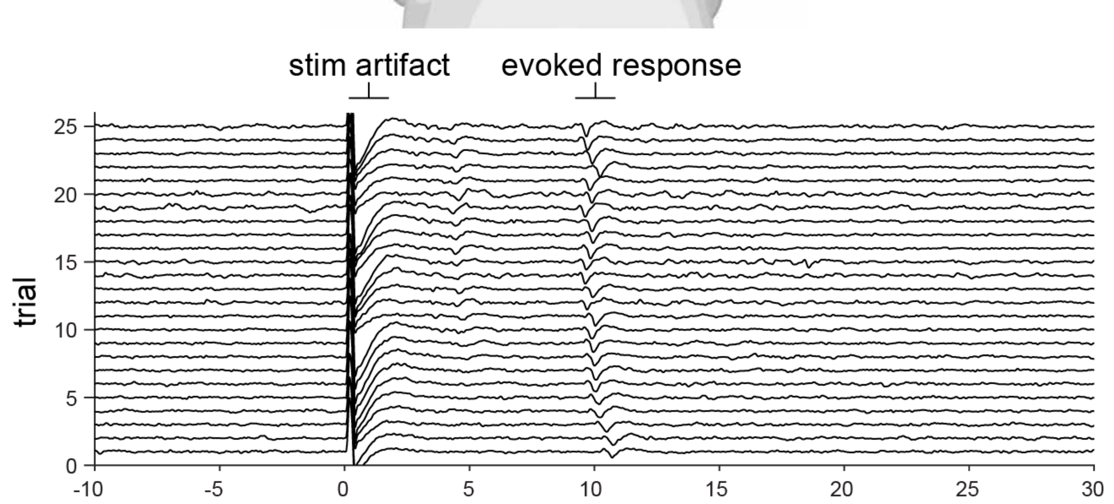
Downstream response recorded in motor cortex (M1) since often implanted in BMI and highly connected to S1.

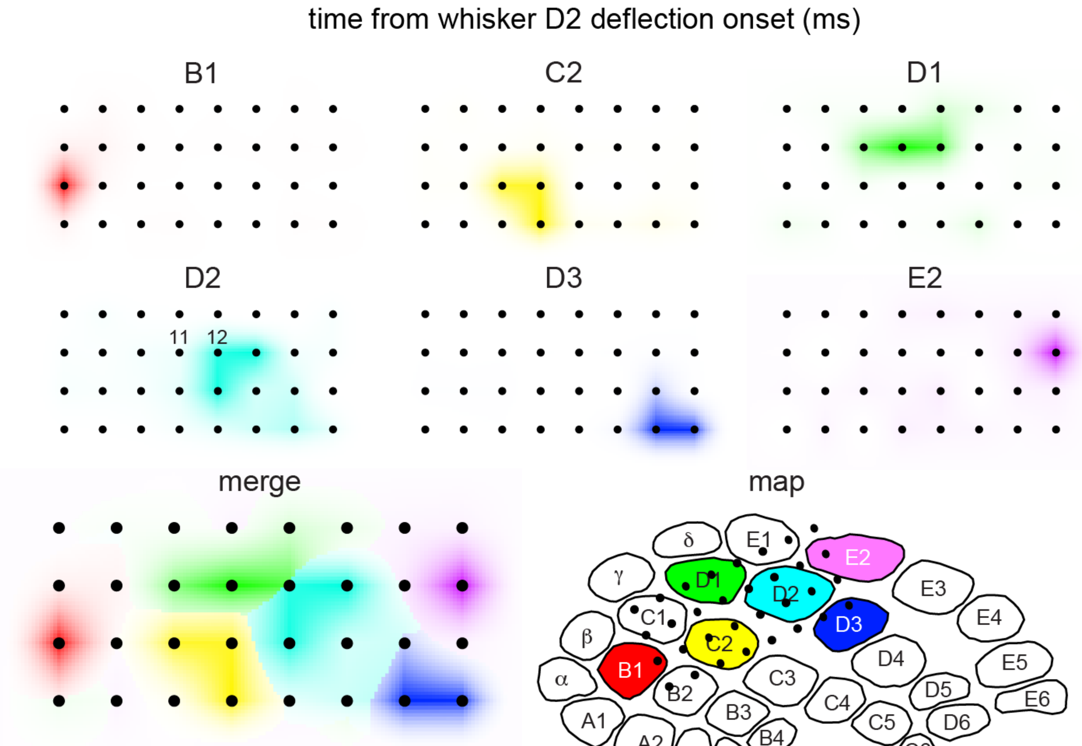
Perceptual ground truth determined by mapping whisker representations ("barrels") in S1. We safely assume stimulation of different barrels evokes discriminable percepts.





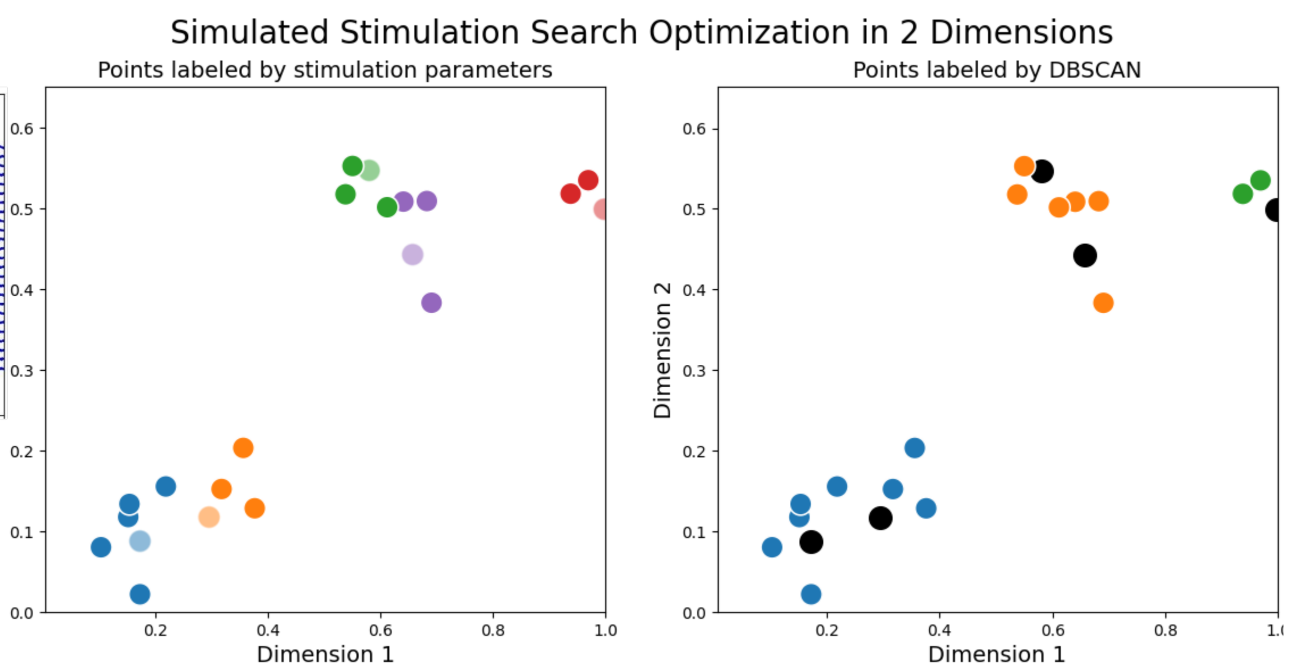


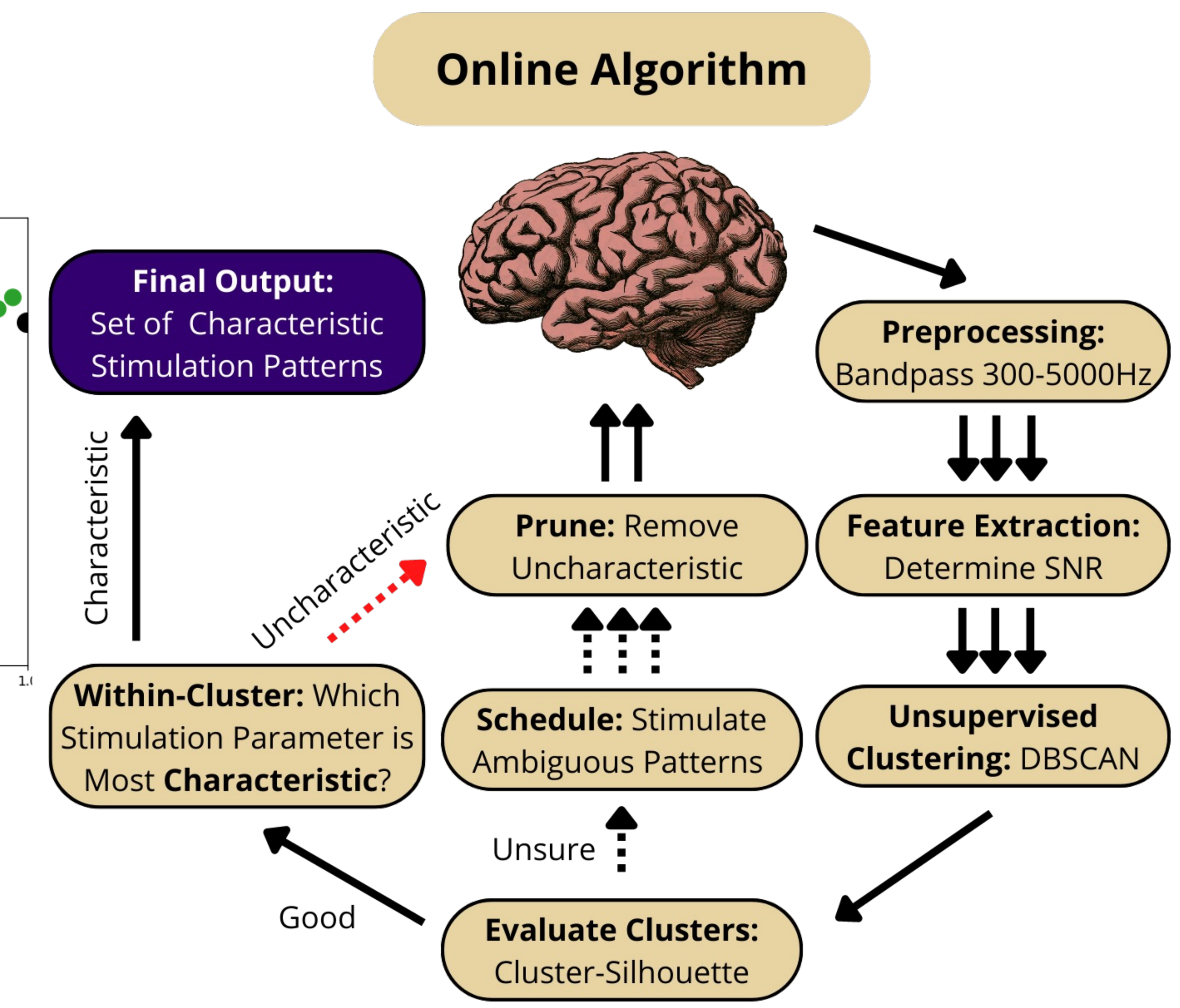




OPTIMIZATION WORKFLOW

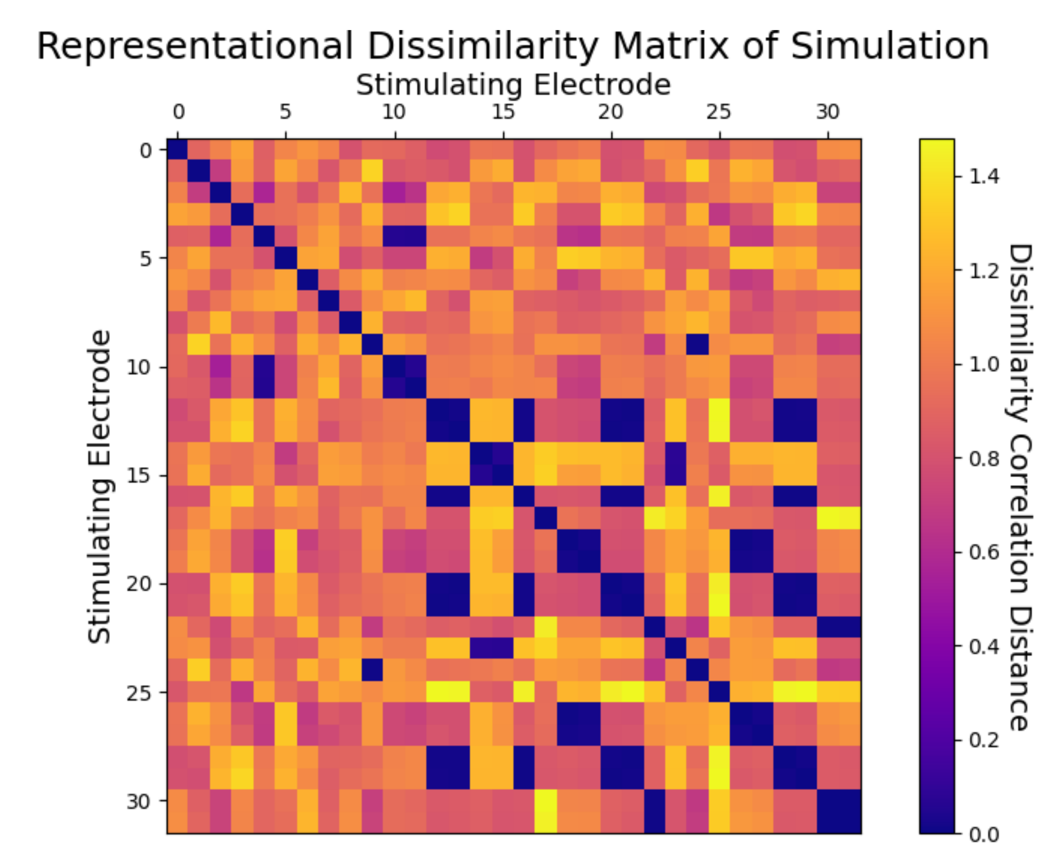
Simulated data to mimic the optimization workflow in two-dimensions.

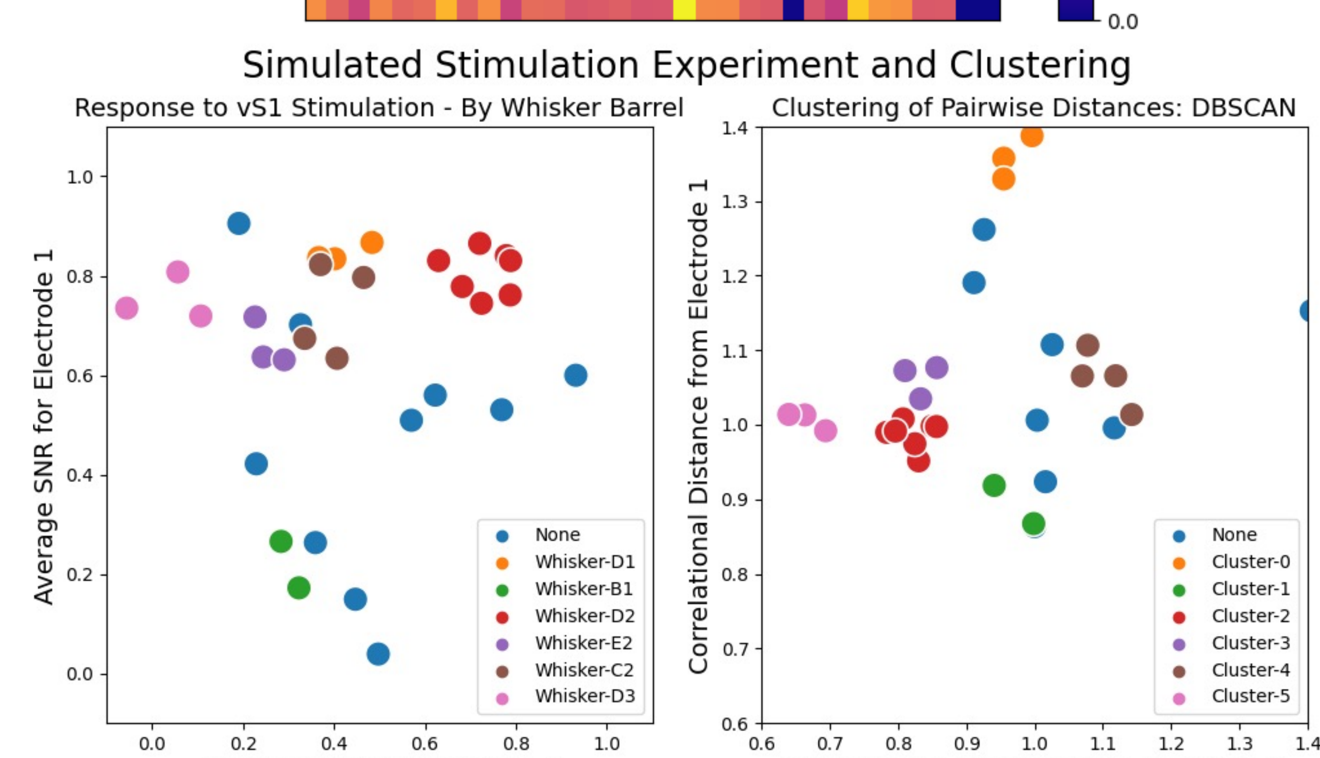




DISSIMILARITY ANALYSIS

To date, the whisker mapping and M1 recording are from different animals. Thus, created simulated M1 responses corresponding to the mapping data.





DISCUSSION

Next Steps: Algorithm to be implemented in real-time and validated and expanded upon a full vS1-vM1 and Whisker Mapping dataset. To further test perceptual discriminability, rats will be trained on a three-alternative forced choice (3AFC) "oddity" task to validate in behavioral experiments.

Algorithm: Future directions of the algorithm include different scheduling methods (Bayesian) and explicit mentioning of ***stimulation parameter nature*** to utilize parameter-specific features and/or physiological relevance.

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