# Optimized Encoding of Sensation in Brain-Machine Interfaces

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## INTRODUCTION

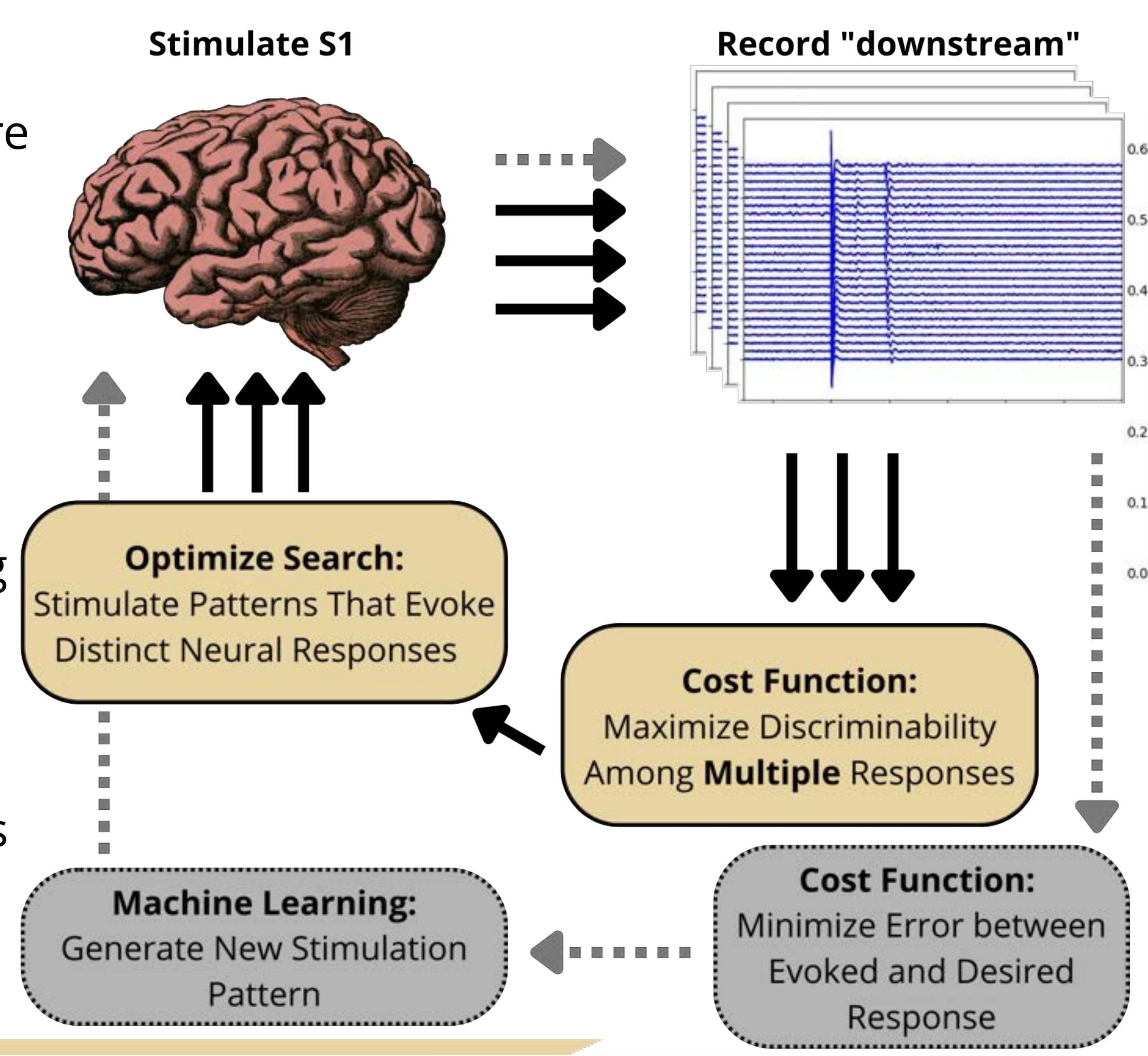
Sensory feedback in Brain-Machine Interfaces (BMI) currently rely on either *user-in-the-loop* calibration or *closed-loop algorithms* to *replicate desired neural responses* downstream of stimulation areas. However, both approaches are not practical or robust given time constraints in the clinic and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

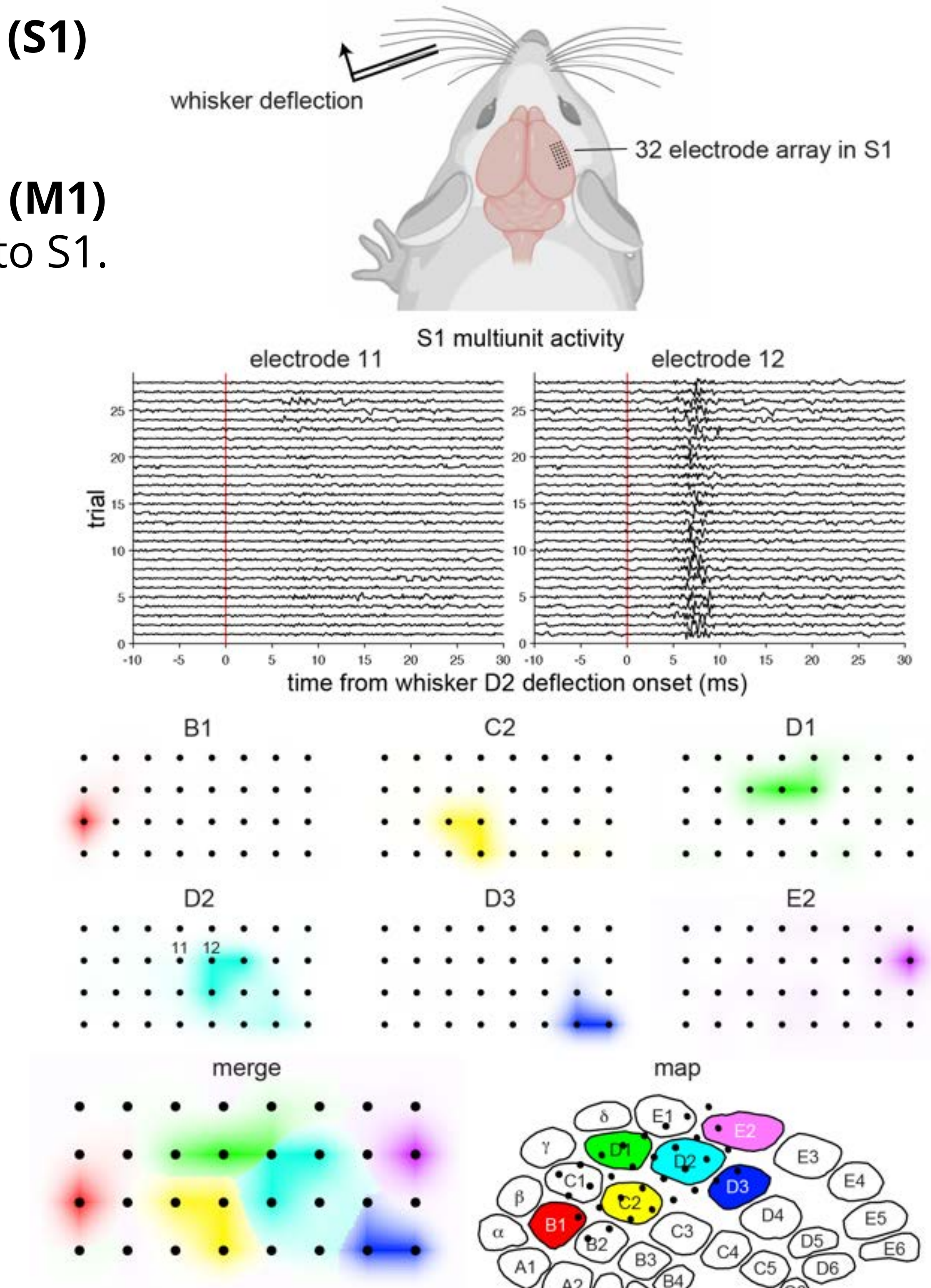


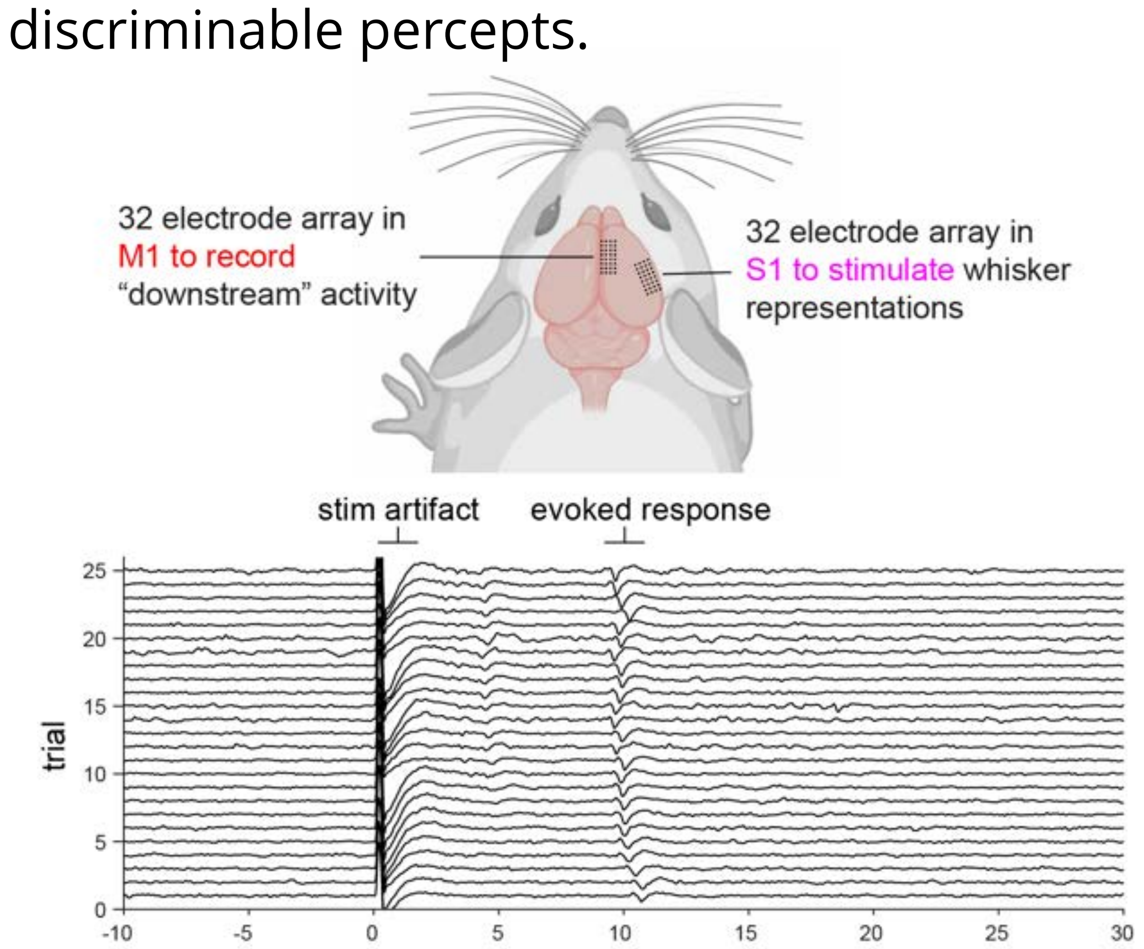

## EXPERIMENTAL DATA

**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.

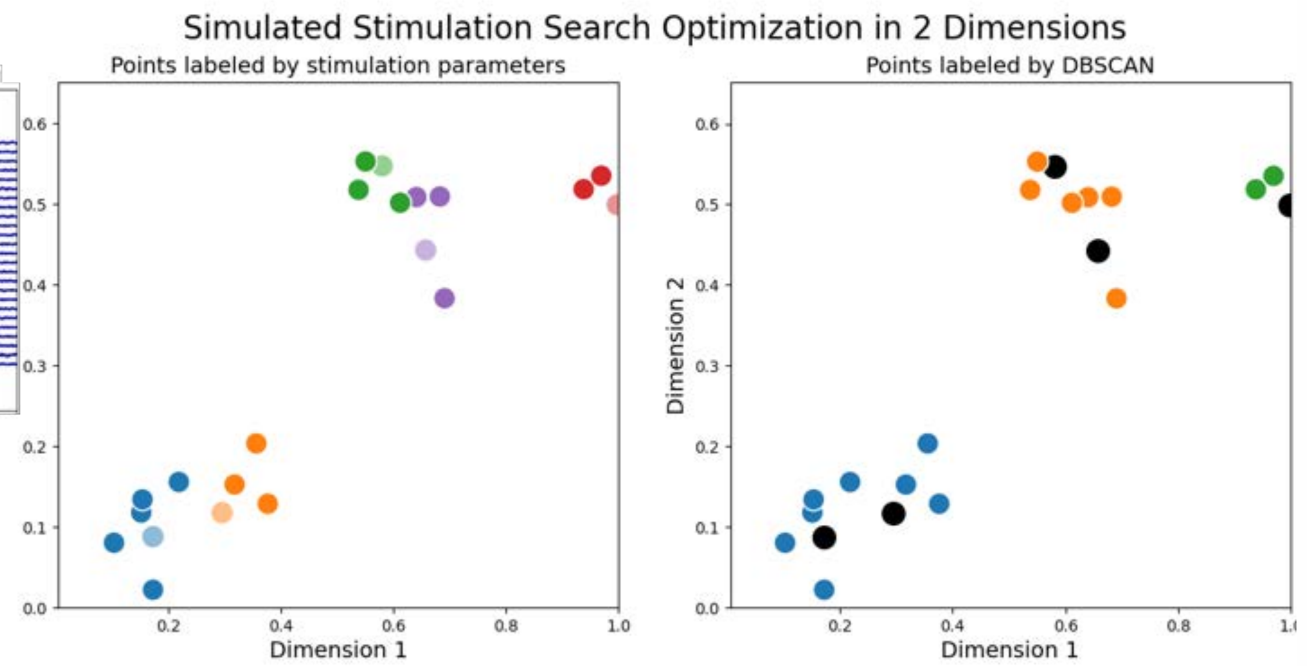
**Perceptual ground truth** determined by mapping whisker representations ("barrels") in S1. We safely assume stimulation of different barrels evokes discriminable percepts.

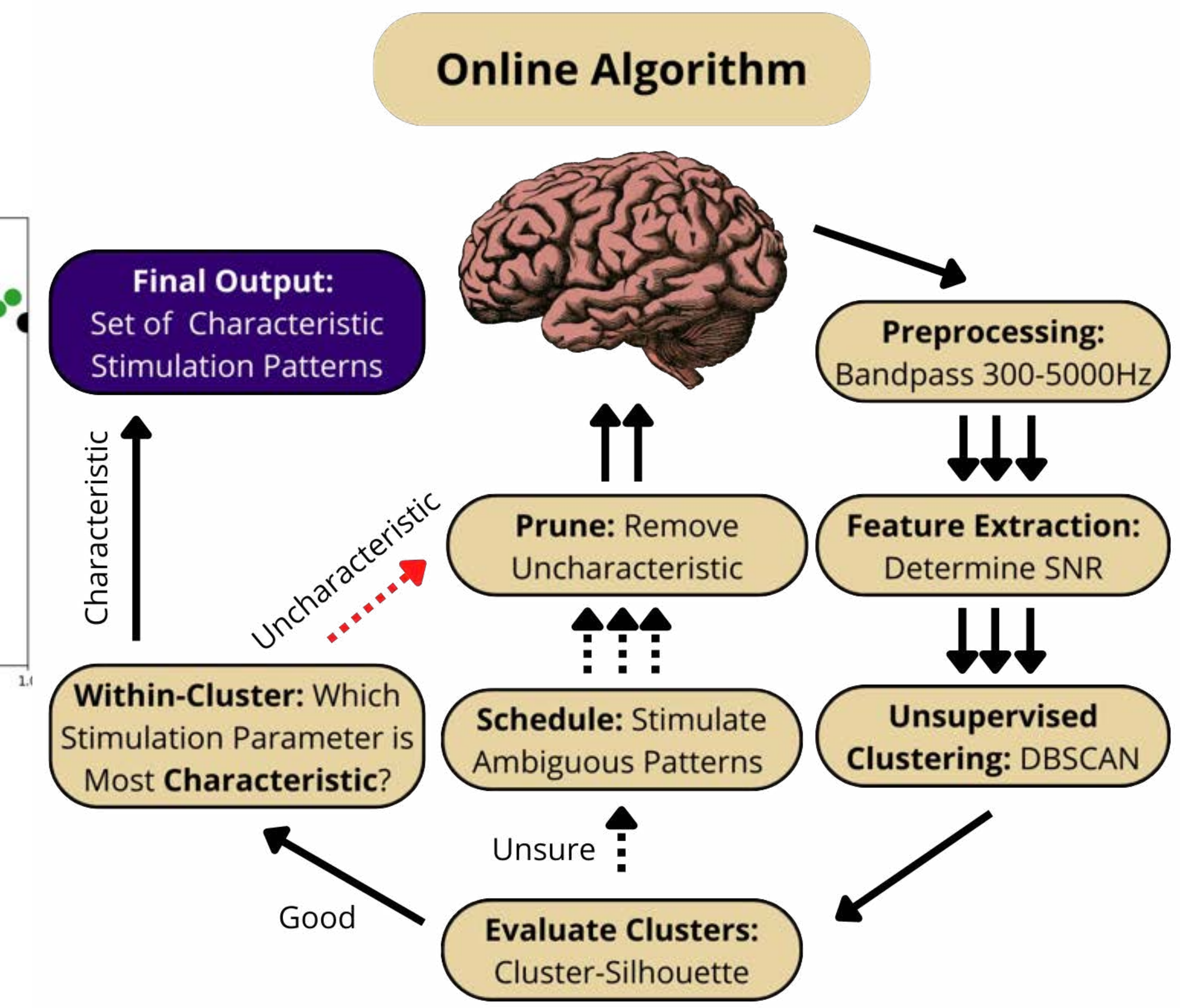



## OPTIMIZATION WORKFLOW

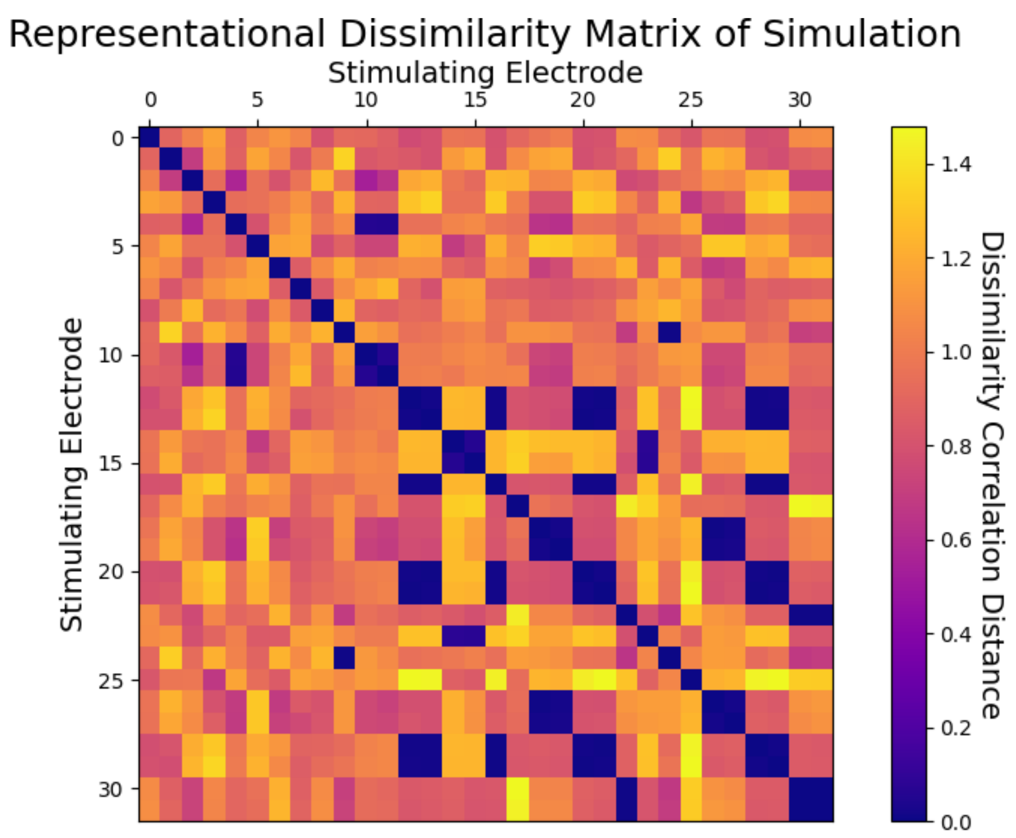
Simulated data to mimic the optimization workflow in two-dimensions.

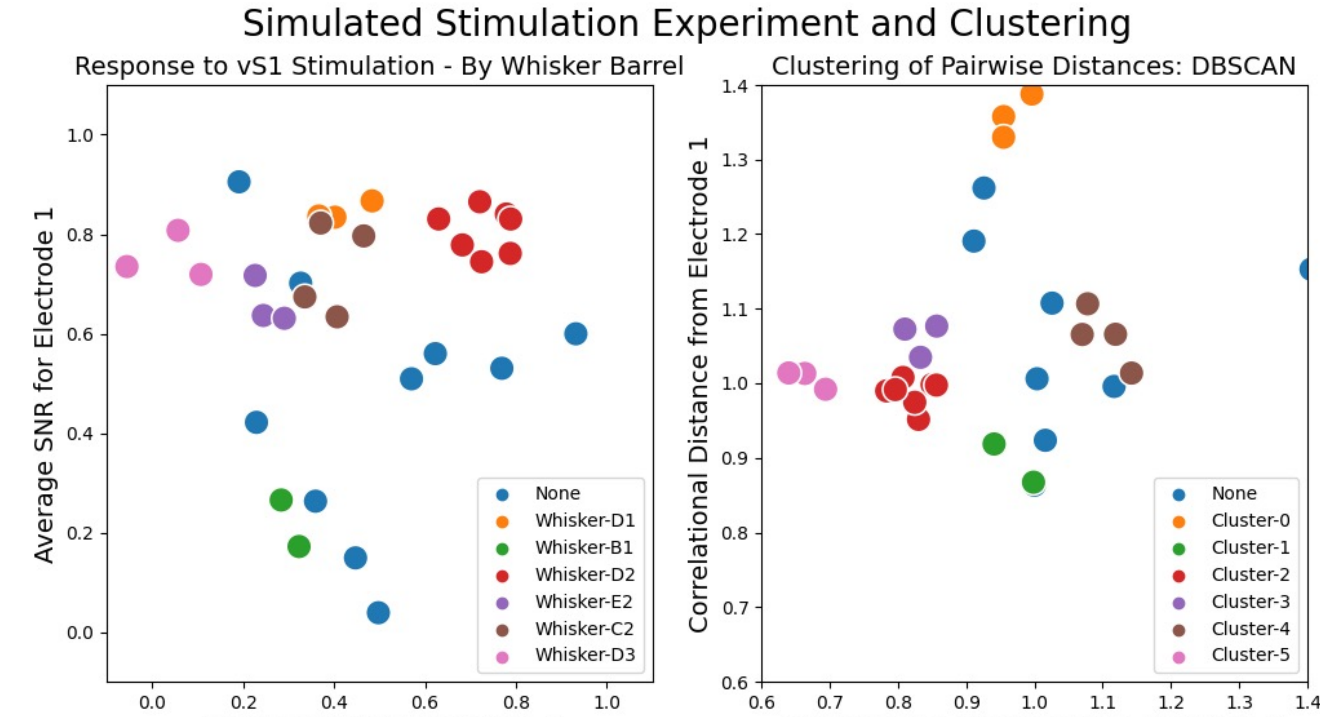



## DISSIMILARITY ANALYSIS

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.

## ACKNOWLEDGEMENTS

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