The Brainstorm Challenge

The Brainstorm Program at the Carney Institute for Brain Science is hosting its second Brainstorm Challenge starting January 16th, 2024. The Brainstorm Challenge consists of a 1-week data analysis workshop and a 3-week hackathon that allows students ranging from psychology to computer science to work on a unique clinical dataset and win up to $5,000 USD.

You will be provided with a rare dataset of stereoelectroencephalographic (SEEG) brain activity from up to 12 epileptic patients. The rarity of this data stems from the invasive nature of SEEG that allows for the direct measurement of brain activity. Typically, data is gathered non-invasively using techniques such as EEG, which indirectly measures the electrical activity of the brain at the scalp, and fMRI, which indirectly measures brain activity through changes in blood flow. Rather, SEEG directly measures the electrical activity of cortical and subcortical areas of the brain through the surgical implantation of electrodes directly into the brain of patients.

The patients participated in a memory task with multiple instances of recall while SEEG data were recorded. You will have the opportunity to analyze neural data from multiple brain regions simultaneously while patients watched short videos, as well as when patients were sleeping, to determine whether neural activity is related to their ability to remember aspects of the videos.

This valuable dataset provides the opportunity for multiple key challenges. One such challenge is to understand how the brain prioritizes information when people encode new memories (e.g., memories of video content). Prominent theories and findings from animal studies suggest that consolidating such memories involves the *replay* of neural patterns during sleep and rest (see Liu et al., 2019; van der Meer et al., 2020); however, there is little direct evidence of these mechanisms from humans. Confirming human replay during sleep can have great relevance for mental health disorders known to be associated with sleep disturbances, such as with anxiety and depression. As such, this challenge will allow us to study the basic mechanisms by which information gets stored and reactivated during sleep.

The first challenge would be to decode the neural underpinnings of the movie clips and apply this decoding to the same-day recall data and determine the degree of short-term consolidation. A second challenge would be to apply the decoded signals to the sleep data and determine instances of replay. Finally, a third challenge would be to determine the degree of long-term consolidation in the next-day recall data from the decoding of memories and/or of replay. Furthermore, these challenges could also investigate more specific information about the clips by constraining investigations to related neural loci—for example, one could decode the emotional valence of each clip by focusing on amygdala activity.

This is a rich dataset; however, and there are many other research questions that can be probed that do not relate to replay. For example, another challenge would be to determine the lateralization of the patients' seizures as brain regions impaired by epilepsy have been

connected to poorer memory consolidation than their healthy counterparts, and another challenge would be to identify different sleep stages using SEEG.

There are multiple prizes, totalling **$5,000 USD**, which will be awarded by a panel of judges to the best predictions and most interesting analyses.

Proposal Deadline: January 28th, 2024
Submission Deadline: February 11th, 2024.

Requirements

To take part in the Brainstorm Challenge you will need to be a student or employee at Brown University. The analysis will require an account on the computing cluster Oscar, which can be set up here. You MUST also sign a data sharing agreement PRIOR to participation and submit it to carney_brainstorm@brown.edu. We will email you this agreement closer to the event.

The Workshop

The Carney Institute offers an Advanced SEEG Analysis Workshop alongside this Data Challenge (Jan 16th - Jan 19th, 2024). This is a week of tutorials on how to conduct computational analyses of SEEG signals offered by world leaders on these topics. Some topics include preprocessing SEEG data, identifying sharp wave ripples, detecting replay, visual encoding and more! If you are interested in joining the workshop, you can indicate this in the Registration form.

Registration

Interested? Register here. Upon registration you will receive a video with a detailed description of the dataset and access to the data on Oscar.

The Challenge

There are in fact multiple challenges.
1. **Decode the movie clips being watched.**
2. **Detect instances of replay of the movie clips during sleep.**
3. **Determine the degree of long-term consolidation from the decoding of memories and/or of replay.**
4. **Determine the lateralization of the patients' seizures.**
5. **Identify different sleep stages using SEEG.**

We will have a panel of judges evaluate your submission. Awards will be based on predictive accuracy and with bonuses for interpretability.

A lecture from last year's challenge (with a different dataset) introducing Brainstorm and the idea behind this challenge can be found here.

A description from last year's challenge (with a different dataset) of how to do a prediction analysis can be found here.

Publication

The challenge is accompanied by the chance to publish successful submissions in collaboration with Dr. Wael Asaad.

Submission

You can submit your results via our [online form](#).

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References

Liu, Y., Dolan, R. J., Kurth-Nelson, Z., & Behrens, T. E. (2019). Human replay spontaneously reorganizes experience. *Cell, 178*(3), 640-652.

van der Meer, M. A., Kemere, C., & Diba, K. (2020). Progress and issues in second-order analysis of hippocampal replay. *Philosophical Transactions of the Royal Society B, 375*(1799), 20190238.