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Machine Learning Applications in Functional Neuroimaging Data (I)

Thursday, 14 June 2018 08:00 (30 minutes)

The overarching goal of my research is to improve methods for non-invasively mapping the spatial and temporal patterns of electrophysiological activity that underlies human brain function and dysfunction. My team at the Biosignal Lab studies brain electrophysiology with magneto- and electro-encephalography (M/EEG). These technologies provide spatially and temporally rich data about the changing magnetic fields and electric potentials resulting from synchronous neuronal activity, and how these signals change during perception and task performance. One approach that shows promise for studying M/EEG signal properties in this context is the use of pattern classification algorithms, or machine learning. We use machine learning to develop data-driven models that accurately classify between M/EEG data recorded at rest and data recorded during task performance. We look "under the hood"of effective models to understand what spatial and temporal patterns of the magnetic field and electric potential are driving accurate classification. This interpretation informs our understanding of the link between electrophysiology and information transfer in the human brain.

Much of the work that I will present focuses on small datasets (on the order of tens of human participants) acquired locally. I will show how machine learning allows us to determine which signals in which brain areas most strongly predict when a person is performing a task versus resting, and how these signals vary across a group. I will also present data to show how we are now using machine learning with large open-access datasets (on the order of hundreds of participants). In these larger datasets, we start to examine demographic shifts in task-related neuromagnetic activity and inter-subject variability. We also apply more complex (so-called "deep learning") pattern classification algorithms to explore brain electrophysiology in a way that has not been possible until recently.

Applying machine learning uncovers new ways to make predictions based on neuroimaging data. These predictions may be about what the person is doing, or the predictions could relate to how well the person is doing a task, if a person is unwell, or if their current course of treatment is likely to make them better. My research has the potential to inform the development of these predictive models.

Primary author: BARDOUILLE, Timothy (Dalhousie University)

Presenter: BARDOUILLE, Timothy (Dalhousie University)

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