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Title: Parkinson's Disease Brain States and Functional Connectivity

Parkinson's disease (PD) is a common neurodegenerative disorder characterized by cognitive degeneration and a specific motor symptomatology: bradykinesia, akinesia and hypokinesia. While these symptoms are consistent with a lesser than normal movement invigoration, it remains to be addressed whether they are consequence of a motor system weakening, or whether by contrast, its origin is more of a motivational nature. To answer this question, we performed an experiment with PD patients in which they performed movements and decisions between movements of different energetic cost and under different motivated conditions, both on and off medication. Electro-encephalographic (EEG) signals were recorded during these sessions. Our behavioural analyses showed that there are clear motivational factors involved in their symptomatology.

In this context, the goal of this project is to identify different mental states as a function of the aforementioned experimental factors; task engagement, perceived effort, ON/OFF medication. To this end, we will analyse the EEG datasets and will apply different machine learning techniques (logistic regression, k-means classifiers) to test whether these mental states may be identified (Gilson et al., 2016).

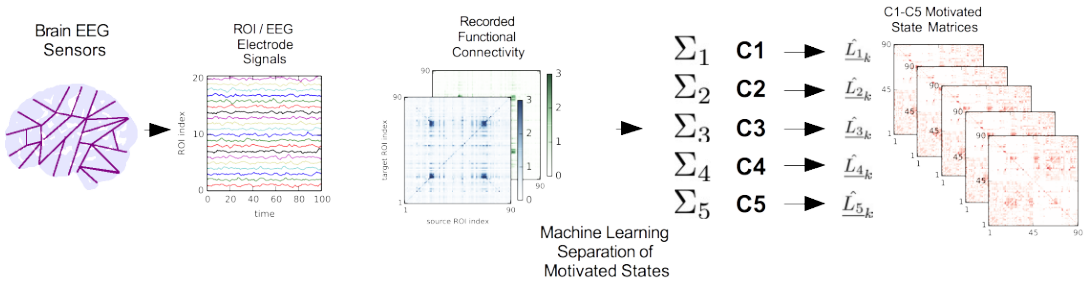

Figure 1 A. Schematic for the extraction of Functional and Effective Connectivity Metrics from EEG recordings during the different states Σ_i stands for the Effective Connectivity (EC) matrices to be extracted at regular time intervals, providing a dynamic signature of neural states related to each experimental condition (C1-C5).

Second, if we transform the EEG signals from sensory to source space (Hindriks et al., 2017), can we identify differences in functional/effective brain connectivity as a function of the same experimental factors/mental states?

In summary, the student's goal would be that of developing computational models of the brain, to identify and quantify differences of neural connectivity across brain areas as a function of the person's level of task engagement (motivated state). The student will also be at charge of the preparation of scientific manuscripts for publication and of presenting these results at scientific conferences.

References:

Gilson M, Moreno-Bote R, Ponce-Alvarez A, Ritter P, Deco G (2016) Estimation of Directed Effective Connectivity from fMRI Functional Connectivity Hints at Asymmetries of Cortical Connectome. PLoS Comput. Biol. 12

Hindriks R, Schmiedt J, Arsiwalla XD, Peter A, Verschure PFMJ, Fries P, Schmid MC, Deco G (2017) Linear distributed source modeling of local field potentials recorded with intra-cortical electrode arrays. PLOS ONE 12:e0187490