Joint PhD proposals

University of Ljubljana, Faculty of Medicine and **Katholieke Universiteit Leuven** offer **6 Joint PhD proposals.** Students, who are interested in Joint PhD between University of Ljubljana and KU Leuven are given the opportunity to visit KU Leuven's **Laboratory for Neuro- and Psychophysiology.** This offer includes **transportation and accommodation costs for a 10-day visit**, where students will be able to get familiar with the Lab's environment and will discuss further research collaboration and possible Joint PhD admission.

Please note: Cogdec project does not cover PhD scholarship or costs of any other collaboration that might emerge from this visit.

For additional information please go to project's page or send us an e-mail to cogdec@mf.uni-lj.si.

Topics:

Effects of confounds on EEG-based biomarkers of mild cognitive decline

Keywords: EEG, mild cognitive impairment, confounds

Abstract: According to the 2017 report of Global Voice of Dementia around 50 million patients worldwide are diagnosed with dementia of which Alzheimer's disease (AD) is the largest group. As pharmacological treatments of AD is still beyond reach, considerable effort is currently put into early detection with goal to postpone institutionalization. Currently there are few promising EEG signatures that could differentiate between healthy individuals and the ones with mild cognitive impairment (MCI), however it is still not clear how much of this differentiation can be attributed to the individual characteristics of the study participants. The proposed PhD will address this issue by charting the relationships between these candidate EEG signatures and a number of confounding factors that can influence the clinical manifestation of AD. This way, we can advance our stride towards the objective electrophysiological biomarker for early detection of cognitive decline.

Studying cognitive reserve with EEG in patients with mild cognitive impairment

Keywords: mild cognitive impairment, cognitive reserve, EEG

It has been shown that cognitive reserve (CR) can postpone the clinical manifestation of cognitive decline and maintain individual's normal functioning even in presence of certain degree of brain impairment. However, once individual exhausts his/her cognitive reserve and enters the stage of decompensation, the, patients present with a cognitive decline that in short time leads to dementia. The role of CR in mild cognitive impairment (MCI) and the value of its compensation mechanisms is less clear. The current PhD will investigate the role of CR in evolution of clinical and electrophysiological changes in patients with MCI and assess if the exhaustion of CR happens already in the stage of MCI or it lasts until patients enter the dementia stage.

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Using neural networks to uncover hidden relations in cognitive decline-related EEG data

Keywords: DNN, explainable AI

Abstract: Deep neural networks (DNNs) have witnessed modest successes in cognitive neuroscience as they offer only limited capabilities to account for prior knowledge. In recent years, the interest in explainable and interpretable AI has grown tremendously with a plethora of algorithms capable of explaining what the DNN has extracted from the data ("features"). This proposal aims at using first shallow neural networks, and in a later stage deep neural networks, to identify and gain insight into the relevance of extracted EEG features of patients suffering from cognitive decline.

Using functional connectivity brain networks as a biomarker of cognitive impairment.

Keywords; Source localization, biomarker, functional connectivity

Abstract: It has been shown that cognitive impairment coincides with changes in functional brain networks. However, due to restrictions in accuracy and fine-tuning of functional brain networks, the connection to cognitive impairment has only been done with static brain networks. With recent advances in source localization accuracy and sparsity, it has become possible to construct more accurate and finer functional connectivity brain networks. This PhD aims to build on these recent advances to gain insight into dynamic time-varying functional connectivity. In a second stage, these time-varying functional connectivity maps will be used to investigate the link to cognitive impairment.

Using Block Term Tensor Regression with source reconstructed EEG to investigate finger dexterity

Keywords; Source localization, BCI, Block term decomposition

Abstract: Tensor-based techniques, like Block Term Tensor Regression (BTTR) for Brain Computer Interfaces (BCIs) are believed to better account for the complex structure of brain signals compared to conventional techniques. Source localization from EEG is a notoriously difficult inverse problem but essential to identify the brain regions implicated in information processing at high temporal resolution. The aim of the PhD is to investigate the effect of source reconstruction on the performance of decoding finger movement using BTTR.

EEG-based biomarkers of early mild cognitive impairment

Keywords: MCI, biomarkers, machine learning, signal processing

Abstract: Faced with an ageing population, many western countries are witnessing an increased risk of their elder population to develop mild cognitive impairment (MCI), which eventually could develop into dementia. At this point, the used techniques to detect MCI are invasive, laborious, expensive or require skilled staffing, all of which renders them unsuitable for preemptive screening. This PhD will focus on machine learning and signal processing techniques, applied to public datasets of MCI and dementia patients and healthy controls, to arrive at an EEG-based biomarker with which the risk of MCI can be assessed.

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