**EEG-based Cognitive Workload Estimation using Deep Convolutional Neural Networks**

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Deep learning with convolutional neural networks (CNN) has revolutionized computer vision through end-to-end learning, by exploiting the hierarchical structure found in natural signals (as images) – out preforming state-of-the-art methods by large margin (from 26% error rate to 4% error rate on the ImageNet challenge in 4 years). However, one of the disadvantages of training CNN is that it usually requires large amounts of data, which do not necessarily exist in the context of other problems.

EEG decoding is one of these problems. EEG signal is a dynamic time series signal across multiple electrodes placed on the scalp. Due to the noninvasive nature of EEG signal collection, it has relatively low signal to noise ratio. Furthermore, due to the complexity of EEG data collection, the amounts of data are typically limited. Consequently, deep networks have had hard time competing with state-of-the-art methods for EEG decoding. The conventional approach to applying machine learning to EEG signal relies on hand crafted features extraction, designed by experts. These features reduce the dimensionality of the data and allow for learning with fewer examples.

In this project, we test whether deep CNN are a suitable method for estimating **cognitive workload** from raw EEG data (with minimal preprocessing). Cognitive workload refers to the relative load on our limited cognitive resources. Executing complex tasks results in high workload, which may affect decision making and lead to errors. Thus, EEG-based monitoring of workload has many potential applications from adapting the difficulty level of e-learning tools to monitoring drivers and pilots.

We relied on a previously published paper [1], which showed that recent advancements in deep learning (ELU, batch normalization, dropout and different training strategies) can improve deep CNN decoding performance for motor imagery classification tasks, making them a suitable method for brain computer interfaces based on motor imagery. The paper proposed as a future challenge to test whether these advancements in deep learning can be applied to additional EEG decoding tasks, such as cognitive workload estimation.

1. Schirrmeister RT, Springenberg JT, Fiederer LD, Glasstetter M, Eggensperger K, Tangermann M, Hutter F, Burgard W, Ball T. Deep learning with convolutional neural networks for EEG decoding and visualization. *Human brain mapping*. 2017 Nov;38(11):5391-420.