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Development of novel mathematical methods based on deep learning and machine learning for epilepsy prediction from EEG signals with applications to automatic health monitoring

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Brain-Computer Interface (BCI) is a fairly fresh and developing field. Research on BCIs began in the 1970s at the University of California (UCLA). Although the history of BCIs started with Hans Berger's discovery of the electrical activity of the human brain and the development of Electroencephalography (EEG), furthermore, William Grey Walter developed an adjunct to EEG called EEG topography. This enjoyed a brief period of popularity in the 1980s and seemed especially promising for psychiatry. EEG as a non-invasive recording of electrical activity from the scalp has become one of the most useful tools for studying the cognitive processes and the physiology/pathology of the brain. The combined effect of fundamental results about neurocognitive processes and advancements in decoding mental states from ongoing brain signals has brought forth a whole range of potential neurotechnological applications. From an engineering point of view, the task of a BCI is to decode brain activity as reliably and as fast as possible. Clearly, the interface must identify neurophysiological activity that is associated with a subject's choices or decisions. I believe these points play an important roles in my PHD thesis, interpreting brain activity as quick as possible for biomedical usage mainly by EEG and fMRI. Pointedly, I believe BCIs attract more interest in near future with combination of new mathematical methods of dimensionality reduction and data compression specifically manifold learning and Compressed Sensing (CS) which is crucial for decreasing computational cost. For these reasons my research interests lie in its encouraging application in the traverse through these fields.

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