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APPLYING DEEP LEARNING ALGORITHMS ON SLEEP DATA

Abstract

Sleep is a vital physiological process that is necessary for both physical and mental health. Its importance is highlighted from the large number of research efforts that are ongoing regarding normal and pathological sleep related to specific diseases, such as neurodegeneration, depression, or extreme conditions, such as long term space flight. In most cases however the approaches used in utilizing and analyzing sleep data are commonly based on methodologies that rely on expert knowledge or multi-domain features extracted from electroencephalographic (EEG) recordings. These features in most cases are capable of providing insight into brain functions during sleep but are related to observations made by experts. It would therefore be interesting to use these features in order to extract meta-features or to use features extracted through deep learning algorithms directly from biological signal recordings, which may not be easily comprehensible by sleep experts, but may provide insight to complex or yet unobserved brain and other body system functions during sleep. This is possible since deep learning methodologies rely on computational approaches in determining new features and important attributes of biological signals, not restrained by the boundaries of human perception. In this paper we propose a set of methodologies that aim to combine and/or expand commonly used features derived from functional connectivity, oscillatory activity or brain network properties which will potentially assist in achieving more accurate and comprehensive sleep analysis. Such applications can be automatic sleep staging, body system interactions during sleep, detection of spindles, k-complexes, arousals and abnormal sleep periods as well as sleep patterns related to specific sleep disorders or diseases. All of the above can be vital in detecting, predicting and possibly counteracting abnormalities during sleep and may provide valuable tools in reducing or eliminating them. The development of such methodologies will also expand the pool of features used in sleep analysis providing a more complete, albeit possibly not fully understood, description of the sleeping human body and its functions. To sum up, our hypothesis is that the combination of deep learning methodologies and sleep data has the potential of enhancing sleep analysis and may be able to provide insight allowing increase in sleep quality and efficiency in human subjects. The proposed, novel machine learning approach was applied in longitudinal polysomnographic (PSG) data obtained from an ESA-funded, 6 head-down tilt, bed-rest study (60 days) performed in Cologne, Germany. It employed 23 healthy, young volunteers.