**DEEP LEARNINGES APPROACHES FOR**

**AUTOMATIC ANALYSIS OF EEGS**

Meysam Golmohammadi1, Iyad Obeid1and Joseph Picone1

1 The Neural Engineering Data Consortium, Temple University, Philadelphia, Pennsylvania, USA

Abstract— Electroencephalograms (EEGs) are used in a broad range of health care institutions to monitor and record electrical activity in brain using electrodes placed on the scalp. EEGs are essential in diagnosis of clinical conditions such as epilepsy, depth of anesthesia, coma, encephalopathy, and brain death. Manual scanning and interpretation of EEGs is time-consuming since these recordings may last hours or days. It’s also an expensive process as it requires highly trained experts and neurologists to review and identify rare events in long data streams. Brain monitoring combined with automatic analysis of EEGs provides a clinical decision support tool that can reduce time to diagnosis in the reviewing of prolonged EEGs, and assist clinicians in real-time applications such as monitoring in neurological intensive care units.

Automatic analysis of clinical electroencephalograms is a challenging machine learning problem because the multichannel signal often has an extremely low signal to noise ratio. Events of interest such as seizures are easily confused with signal artifacts (e.g., eye movements) or benign variants (e.g., slowing). Commercially available systems suffer from unacceptably high false alarm rates. Deep learning algorithms that employ high dimensional models have not previously been effective due to the lack of big data resources. A significant big data resource, known as the TUH EEG Corpus, has recently become available creating a unique opportunity to evaluate high performance deep learning models that require large amounts of training data.

In this chapter, we introduce a variety of deep learning architectures for automatic interpretation of EEGs. Each of these architectures is a hybrid state-of-the-art system composed of one or more classes of neural networks including convolutional neural network (CNNs), long short-term memory networks (LSTM), gated recurrent units (GRUs), and residual neural network (ResNet). The Temple University EEG Corpus along with supplemental data corpora from Duke University and Emory University are used to train and evaluate the performance of these hybrid deep structures. Beside presenting these EEG classifiers and comparing them, this chapter discusses the issues involved in EEG classification and presents detailed preprocessing methods, feature extraction techniques, and performance metrics to address the mentioned issues. We demonstrate that the performance of these deep learning based systems is now approaching the threshold for clinical acceptance.