MSc in Computational Cognitive Neuroscience

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Deep Learning for EEG Time Series Forecasting

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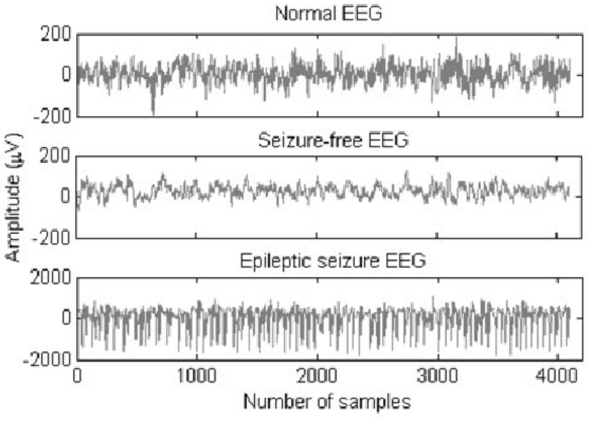
Introduction

Epilepsy is a group of neurological disorders, not a specific disease, characterized by a person having recurrent seizures. Epileptic seizures are characterized by a loss of consciousness due to unpredictable and sudden interruptions in brain function (Fisher et al.). As of 2015, there are around 40 million people with epilepsy and there are around 125,000 people that die as a result of epilepsy per year (Vos et al., 2016). Thus, reducing these deaths, mostly through surgery (resecting the part of the brain that causes seizures) or medication, and reducing seizures has been a research focus for many years. However, a growing area of research has been seizure prediction which may one day prevent injury. There is also a possibility that if prediction of seizures is possible, a device can be implanted which will administer medication or a treatment using electrical stimulation may possibly be developed. Hence, seizure prediction can be achieved by forecasting EEG.

Electroencephalography (EEG) is a non-invasive physiological test or monitoring method that records electrical brain activity (i.e. voltage potentials from in and around neurons) from the scalp. Scalp EEGs provide a measure of cortical function. During epileptic seizures, EEGs vary in comparison to a normal non-seizure EEG. Additionally, seizure activity maybe focal, only happening in certain brain areas, or generalized, which is more widespread.



Thus, due to these differences, EEG signals can be forecasted, and epileptic seizures predicted.

Aims

The aim of the project is to forecast EEG time series using a feedforward and convolutional neural network and assess which is more accurate in forecasting and predicting seizures.

Methods

Dataset

The dataset that will be used is EEG data from an open-source data set which was obtained from http://ieeg-swez.ethz.ch. The dataset includes data from 18 different participants with epilepsy and there are 1357 hours of EEG data (collected from 24 to 128 electrodes).

Procedure

An incremental multilayer perceptron feedforward neural network has been built in MATLAB with an input layer, a hidden layer and an output layer. The neural network employs a backpropagation algorithm, which is able to calculate the gradient of the error function with respect to the weights. A Kalman filter will also be applied to the network. This network has been built using the Mackay-Glass time series and it will then be applied to the EEG dataset.

A convolutional neural network will also be built using the Deep Learning Toolbox in MATLAB. The layers of this are yet to be determined.

Both of the neural networks will be used to forecast the EEG time series and they will be compared in terms of their ability to do so.

Results

There are not yet any results to report, but the results that will be obtained are time series EEG forecasts. It will be determined how far into the future EEG time series will be forecasted. Forecasts will also be compared to actual EEG data and the error for the forecast will be obtained.

References

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