**Epileptic Seizure Prediction**

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**Objective:**

To set up a deep learning prediction model by making use of existing EEG (Electro-encephalography) data of Epileptic Seizures to classify between pre-ictal and inter ictal periods, so as to set up alarms ahead of Epileptic Seizures which would allow the patient to take pre-emptive medication to reduce to effects and damages of the seizure or avoid the seizure entirely.

**Outcomes**:

* Machine Learning has been employed to classify raw EEG signal data into Pre-ictal and Inter-ictal periods.
* Classifier model is trained using CHB-MIT EEG Dataset. Classification is carried out on 5-minute intervals of 23-channel EEG signal collected using Brain-Computer Interface.
* When this model is fed real-time data, classification can be done in real-time so as to identify potential pre-ictal periods, allowing pre-emptive indication of an impending Epileptic seizure.
* This alarm would allow for medication to be taken ahead of an Epileptic Seizure to reduce the effects of the seizure or even avoid it completely

**Data used:**

The CHBMIT scalp EEG database was used for the training of the model. Recordings, grouped into 23 cases, were collected from 22 subjects (5 males, ages 3–22; and 17 females, ages 1.5–19). The raw EEG signals were sampled at 256 samples per second with 16-bit resolution. Most files contain 23 EEG signals.  The [International 10-20 system](http://www.bem.fi/book/13/13.htm#03) of EEG electrode positions and nomenclature was used for these recordings. There are 664 edf files included in this collection, which contain exactly one hour of digitized EEG signals, and 129 of those files contain one or more seizures. In all, these records include 198 seizures.

**Data Preprocessing:**

The edf files of patients with ID 1, 3, 7, 9, 10, 20, 21, 22 were loaded using pyedf library. The pre-ictal and inter ictal periods were separated and divided into 5-min intervals and stored as numpy arrays that could be directly fed to a Deep Convolutional Bi-LSTM model.

**Model:**

* (Conv2D, Max pooling , Batch Normalization) x3
* Flatten
* Bi –LSTM x2
* Dense x5

The model makes use of Convolutional layers to find spatial relationships and Bidirectional LSTM layers to find temporal relationships, to classify pre-ictal and inter-ictal periods.

**Observations:**

* The model makes use of raw EEG signals with minimal preprocessing, which allows EEG data captured by the brain-computer Interface to be fed directly to the model for classification, making it suitable for real time applications.
* Currently , the model trained using 8 patients has been able to classify well on data which is similar to training data ,but struggles on new patients. This would be attributed to the highly varying nature of EEG signals of different patients and the limited number of patients the model has been trained on, which has limited the capability of generalizing over different patients.
* Pre-emptive alarm is still being optimized.
* Training was initially done in local machine which seemed inadequate with respect to compute, and then it was switched to Google Colab, which also struggled to process and train using 8 patients data at a the same time, therefore making it difficult to add more patients data to the training of the model.

**Next Steps:**

* Increase in compute capability might prove favorable for training of present and additional data.
* Real time suitable data procurement of large capacities would be needed for proper generalization of model and subsequently adds on to the compute load.
* Improving the current methods for separation and division of pre ictal and inter ictal periods would allow more data to be processed easily.
* Adding steps to the current preprocessing flow such as FFTs, wavelet transform and other signal processing techniques, Capsule Networks and working on modifications and variations of the current model should be explored.