Epileptic Seizure Detection

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Epilepsy is a long-term disease in which the person is subject to recurrent and unprovoked seizures which happens due to unusual electrical activity in the brain. It is to be noted, if a person has seizures it does not necessarily mean he/she has epilepsy or epileptic seizure. Epilepsy is generally characterized by unpredictable seizures and can cause various health problems too. There are **65 Million** people around the world suffering from epilepsy and United States alone contributes to **3.4 Million** people which makes it a serious condition and unfortunately people also die from seizures [1].

Some of the tests to diagnose epilepsy are **Electroencephalogram (EEG)**, Computerized tomography (CT) scan, Magnetic resonance imaging (MRI), Functional MRI (fMRI), Positron Emission Tomography (PET) and Single-photon Emission Computerized Tomography (SPECT) and out of these tests the **EEG** is the most prevalent test for the diagnosis of an epileptic seizure [2]. **EEG** is done by placing small metal discs or electrodes to the scalp of the patient, the electrodes are glued to the scalp by a glue-like substance and thin wires are attached to the discs. **EEG** is able to evaluate the electrical activity inside the brain, as cells in the brain communicate via electrical impulses because of which **EEG** can aid in detecting problems in the electrical activity happening inside the brain. It does so by recording the brain wave patterns. Brainwaves are byproduct of electrical impulses produced in sync while the cells inside the brain are communicating with each other. The electrodes analyze the electrical impulses and send signals to the computer which are used by doctors for further analysis. Aberrations in the electrical activity inside the brain helps in assessing seizures and brain disorders.

Like any other clinical analysis **EEG** comes with problems too [3]. As diagnosis of epileptic seizures requires long-term recordings of the electrical activity happening inside the brain, for assessment by a doctor, which makes diagnosis of epileptic seizures time consuming and prone to human errors or even misdiagnosis especially for this big length of data. This project aims to solve this problem by applying **Statistical Machine Learning** to computationally detect Epileptic Seizure utilizing the **EEG** time series dataset [6], [7]. This can help health practitioner diagnose epileptic seizures at a much faster rate and with a better accuracy. This time series is a sample of 4097 data points. Each data point is the value of **EEG** recording at particular time in ASCII format. The sampling rate of the data was 173.61 Hz [6], [7]. For the purpose of detection of epileptic seizure, we will be applying Statistical and Machine Learning concepts like **Binary Classification** (seizure or non-seizure activity), **Clustering** and **Neural Networks**. We are planning to utilize **Support Vector Machine (SVM)** [4] as the core algorithm and further extend it to the use of **Recurrent Neural Network** [3].

References:

[1] Facts about Seizures and Epilepsy. (2017). Epilepsy Foundation. Retrieved 16 September 2017, from http://www.epilepsy.com/learn/about-epilepsy-basics/facts-about-seizures-and-epiepsy
[2] Epilepsy - Diagnosis - Mayo Clinic. (n.d.). Retrieved 16 September 2017 from http://www.mayoclinic.org/diseases-conditions/epilepsy/diagnosis-treatment/diagnosis/dxc-20117234
[3] Nigam VP, Graupe D (2004) A neural-network-based detection of epilepsy. Neurol. Res. 26: 55-60
[4] Ali Shoeb, John Guttag, "Application of Machine Learning to Epileptic Seizure Detection," Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, Massachusetts, 02139
[5] Paul Fergus, David Hignett, Abir Hussain, Dhiya Al-Jumeily, and Khaled Abdel-Aziz, "Automatic Epileptic Seizure Detection Using Scalp EEG and Advanced Artificial Intelligence Techniques," BioMed Research International, vol. 2015, Article ID 986736, 17 pages, 2015. doi:10.1155/2015/986736
[6] UCI Machine Learning Repository: Epileptic Seizure Recognition Data Set. (n.d.). Retrieved from http://archive.ics.uci.edu/ml/datasets/Epileptic+Seizure+Recognition
[7] Andrzejak RG, Lehnertz K, Rieke C, Mormann F, David P, Elger CE (2001) Indications of nonlinear deterministic and finite dimensional structures in time series of brain electrical activity: Dependence on recording region and brain state, Phys. Rev. E, 64, 061907