**Introduction**

**Description:**

Deep Learning (LSTM) based Seizure prediction using Scalp based EEG Readings.

**Rational & Gap Analysis**

**Functional Requirements**

**Business Rules**

The users must be able to use the product under proper licensed time durations only.

**Authentication**

Only an authorized neurologist must get an access to the system, thus proper authentication measures must be applied**.**

**Audit Tracking**

Proper logging mechanisms for convenient report generations and auditing should be established by the product.

**Ability to classify**

The algorithm must be able to classify the patients with appropriate preictal/non-preictal states as accurately as possible.

**Ability to Continuously Learn**

The algorithm must be able to learn from the historic data and keep on improving its accuracy.

**Non-Functional Requirements**

**Performance**

In our system, performance is given prime importance. Our system is based on real time event and the classification of data must be fast. The system should be able to handle multiple incoming data. Under these conditions, the performance should not hinder. Thus, the system should work under any environment and type of adversarial poisoning.

**Accuracy**

Accuracy is the most important part in our project. As the real time implementations of these problems are critical, the system should generate accurate outputs to measure accuracy, along with confusion matrix we will be using other performance measures that include precision recall.

**Reliability**

The system should be reliable so that the chances of getting an intruder into the system becomes less. Since every data in our system is unique, the number of false negatives should be less and also handled concept drift in the data with increase in time.

**Recoverability**

If the system fails, the system should be immediately restarted and should be connected to the database. The database should keep log of classified data and if new data is entered then system should classify it as early as possible.

**Applications**

Used is quantum chemistry, playing games, face identification, signal classification, 3D construction sequence recognition, medical diagnosis, controlling car, trajectory prediction, finance, trading, data mining, social network filtering and spam filtering. It is also used in diagnosis of cancer.

It is also used in geoscience, coastal engineering, cybersecurity and geomorphology.

It can also be used to simulate properties of quantum systems although it is still in research stage.

EEG, ECG analysis, designing prosthetics, speech classification, text to speech conversion, image compression, automated information services, braking vehicles, audio signal processing, anomaly detection, guidance system, weapons, electronics, manufacturing products etc.

**Hypothesis**

People suffering from epilepsy or also called seizure disorder, a disorder in which nerve cell activity in the brain is disturbed, causing seizures. These seizures do not have a fixed time they occur at random times causing great disturbance to emotional state and cognitive state of the mind. Their ability to work, social, economic situations come to a sudden halt. Having the option to foresee epileptic seizures will incredibly improve the personal satisfaction of individuals with epilepsy by either giving them an admonition of an approaching seizure so they can move to security or enacting an embedded seizure control gadget that can turn away seizures through medication conveyance or electrical incitement of the cerebrum. How might we arrange the stage epileptic seizures utilizing electrical accounts of mind action?

**Research Design &Methods**

**LSTM Model:**

* Gaussian Noise was added to improve generalization error which could be problem if not managed well. Adding noise for augmentation can prevent overfitting.
* Batch Normalization and Dropout were used to decrease the overfitting of the model.
* 60 neurons of lstm was used as it was 2/3rd of the number of input features.
* Adam optimizer was used instead of the classic stochastic gradient descent as it was especially designed for updating weights of deep neural networks. It is definitely more efficient.
* Dense layers were used to make a robust fully densely connected neural network.

**CNN:**

* Gaussian Noise was added to improve generalization error which could be problem if not managed well. Adding noise for augmentation can prevent overfitting.
* Batch Normalization and Dropout were used to decrease the overfitting of the model.
* Adam optimizer was used instead of the classic stochastic gradient descent as it was especially designed for updating weights of deep neural networks. It is definitely more efficient.
* The number of hidden convolution layers decrease gradually as the data passed across the network continually complexes. The number of neurons in the first layer is 24, the second has 16 and the third has 8.
* Dense layers were used to make a robust fully densely connected neural network.

**Preliminary work**

The data used here consists of 11500 patient’s data.

Each patient has been recorded of their scalp for about 178-time units and that’s why we see the columns of the data is in time series.

Below we’ll see the model decisions which were made for getting the desired accuracies.

**Expected Outcome**

In contrast to increasingly customary strategies for machine learning methods, deep learning classifiers are prepared through component adapting as opposed to task-explicit calculations. This means the machine would understand the patterns in the pictures as it is given instead of requiring the human administrator to characterize the examples which the machines should look for in the picture. The component learning system is utilized each day by the way we show a kid to perceive distinctive objects. Deep learning is a sort of AI that impersonates the neuron of the neural systems present in the human cerebrum. PC Vision Deep learning models are prepared on a lot of pictures a.k.a preparing information, to explain an undertaking. These deep learning models are for the most part utilized in the field of Computer Vision which permits a PC to see and picture as a human would. This kind of system is like the organic sensory system, with every hub going about as a neuron inside a bigger network. Thus, these models are a class of fake neural systems. This models’ calculations adapt dynamically about the picture as it experiences each neural system layer.

**Benefits to the society**

This world consists of 70 million people having PWE i.e., epilepsy and nearly 12 million PWE patients reside in India; which amounts to about a sixth of the world. The general pervasiveness (3.5-12.1 per 1,600 populace) which has a frequency (0.3-0.9 per 1,400 populaces for every year) information from ongoing examinations in India on all-inclusive community are similar to the paces of high-income nations regardless of checked varieties in populace attributes & information systems. Having a differential conveyance of PWE among different socio-demographic & monetary gatherings with higher rates detailed for the male, country populace, and low financial status. A changing example in the age-explicit event of epilepsy with prevalence towards the more established age bunch is seen due to sociodemographic and epidemiological progress. Neuro-infections, neuro-cysticercosis, and neurotrauma alongside birth wounds have risen as significant hazard factors for optional PWE. In spite of its shifted etiology, PWE are reasonable in outlook.

Programmed identification of epileptic seizures can impressively improve the patients' personal satisfaction.

**Cost Benefit Analysis**

16GB RAM (8GB works as well but not for the performance you may want and or expect)

Quad core Intel Core i7 Skylake or higher (Dual core is not the best for this kind of work, but manageable).

M.2 PCIe or regular PCIe SSD with at minimum 256GBs of storage, although having 512GB gives you the best performance. The performance of the system is directly proportional to the loading and saving of your application. (SATA III might hamper the system’s performance)

Premium graphics cards, so things with GTX 980 or 980Ms would be the best for a laptop, and 1080s or 1070s would be the best for the desktop setup. (try not to sacrifice too much here.

While a 980TI or a 970m may be cheaper, this as well is a critical part of the system, others you will notice a drastic drop in performance.

**Future Scope**

In contrast to increasingly customary strategies for machine learning methods, deep learning classifiers are prepared through component adapting as opposed to task-explicit calculations. This means the machine would understand the patterns in the pictures as it is given instead of requiring the human administrator to characterize the examples which the machines should look for in the picture.

The component learning system is utilized each day by the way we show a kid to perceive distinctive objects.

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**Limitations**

no pre-indicated limitations

**References**

M. D’Alessandro, R. Esteller, G. Vachtsevanos, A. Hinson, J. Echauz and B. Litt, ”Epileptic seizure prediction using hybrid feature selection over multiple intracranial EEG electrode contacts: a report of four patients, in” IEEE Transactions on Biomedical Engineering, vol. 50, no. 5, pp. 603-615, May 2003.

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