Predicting Epileptic Seizures from Intracranial EEG Recordings

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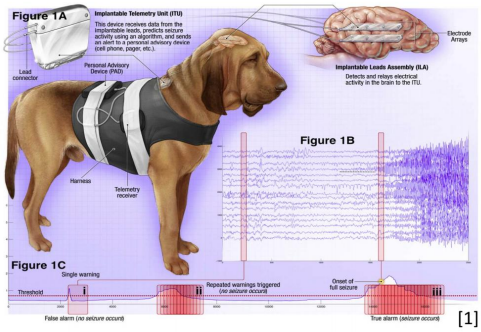
Predicting

Epileptic seizures are characterized by turbulent brain activity accompanied by bodily manifestations, and affect about 1% of the world's population. Given their unpredictable nature, seizures can be a source of major stress for victims who are affected by them. To tackle this issue, we have architected and trained both a CNN and a RNN (with LSTM) to predict oncoming seizures from 30 second readings of neural activity in dogs. The RNN achieved the best results, with an AUC of 73.3.

Data

Thirty-second voltage readings were sampled from 16 electrodes in a dog brain at 399.6 Hz. Each sample is a 16 by 11988 matrix classified as either preictal or interictal.

Training size: 1188
Test size: 132



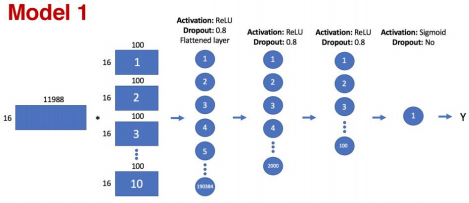
[1]

Features

There are 16 features, each a sequence of voltage readings from a different brain-implanted electrode in a dog.

Models

Model 1

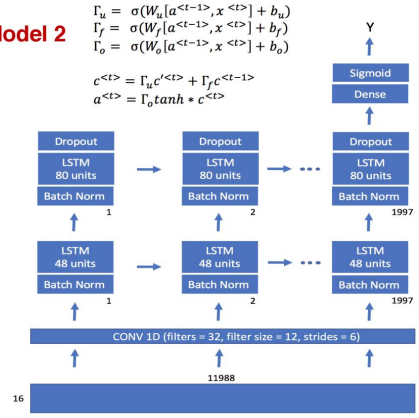


$$c'^{<t>} = \tanh(W_c[a^{<t-1>}, x^{<t>}] + b_c)$$

Model 2

$$\Gamma_u = \sigma(W_u[a^{<t-1>}, x^{<t>}] + b_u)$$
$$\Gamma_f = \sigma(W_f[a^{<t-1>}, x^{<t>}] + b_f)$$
$$\Gamma_o = \sigma(W_o[a^{<t-1>}, x^{<t>}] + b_o)$$

$$c^{<t>} = \Gamma_u c'^{<t>} + \Gamma_f c^{<t-1>}$$
$$a^{<t>} = \Gamma_o tanh * c^{<t>}$$



Results

	Training 1188 samples	Test 132 samples	AUC
Model 1	68.5%	62.9%	54.0
Model 1 (FFT)	79.1%	64.4%	54.5
Model 2	96.0%	69.7%	73.3
Model 2 (FFT)	100%	62.9%	63.8

Discussion

Model 2 was the one that performed best; however, there is still a lot of room for improvement given that the top Kaggle result had about an 84 AUC. We had a lot of issues with overfitting. We used both dropout and early stopping in our final model, but this was not enough to significantly decrease the training accuracy. We also had problems with the size of our data set, which was relatively small. This is mainly because we were using data from only a single dog to maintain consistency across electrode readings in input values.

Future

Further areas worth exploring include training the network with a larger data set, increasing the input values to more than 30 seconds, and training the network on human data. More elaborate data preprocessing methods, like spike sorting and a smoothing filter (such as a Gaussian kernel convolution) could also help to improve the results of our neural network.

References

[1] American Epilepsy Society Seizure Prediction Challenge | Kaggle. (2014, August 25). Retrieved June 08, 2018, from https://www.kaggle.com/c/seizure-prediction