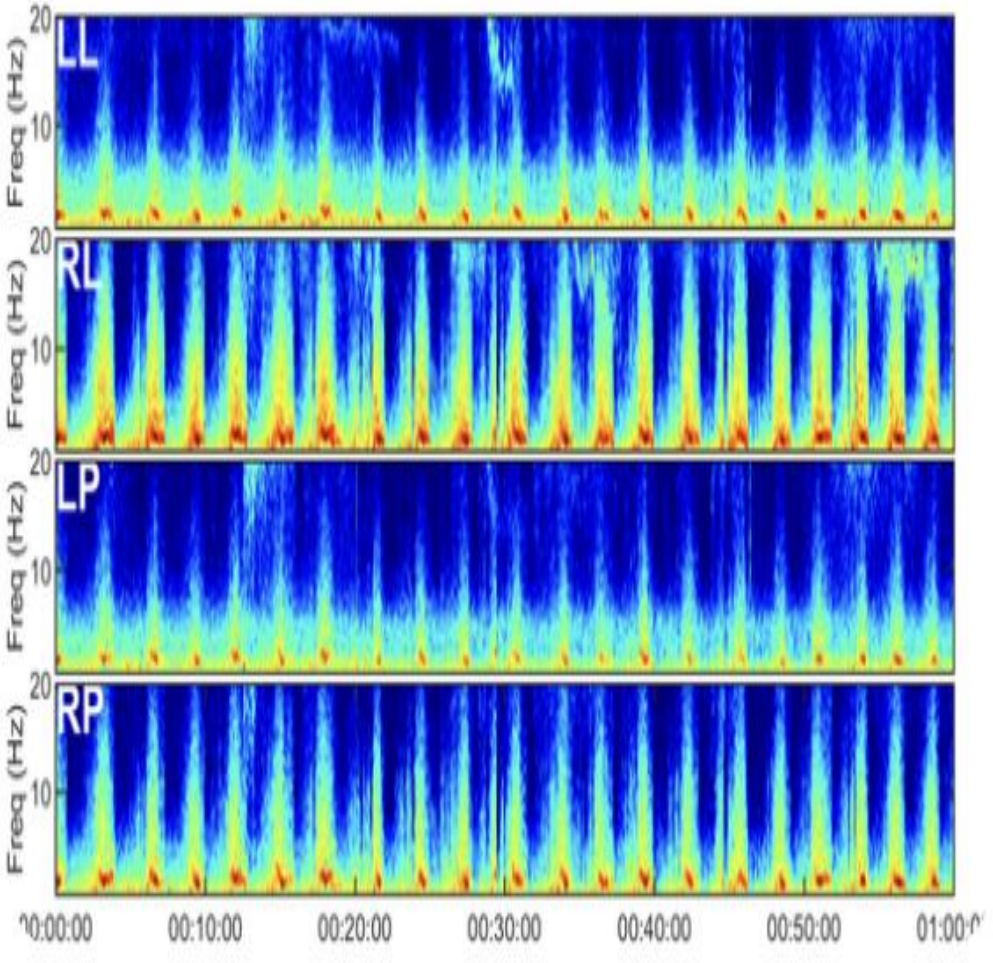
Harmful Brain Activity Classification

Kaung Myat Kyaw
&
Poopa Kaewbuapan



Overview

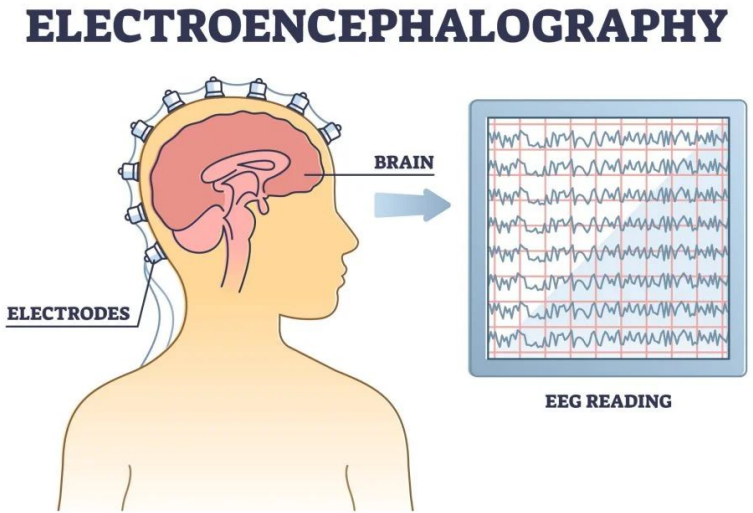
- Physicians use electroencephalography(EEG) on the critically ill patients to detect seizures and other types of brain activity that can cause brain damage.

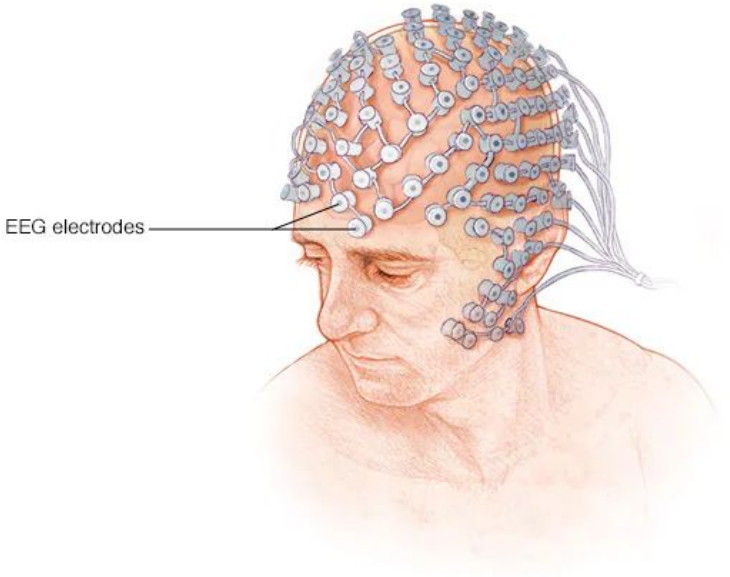
- Manual review of EEG recordings is time-consuming and, prone to fatigue-related errors, even when those reviewers are experts.

- The goal of the project is to automate EEG analysis to help doctors and brain researchers detect seizures and other types of brain activity that can cause brain damage

Electroencephalography (EEG)

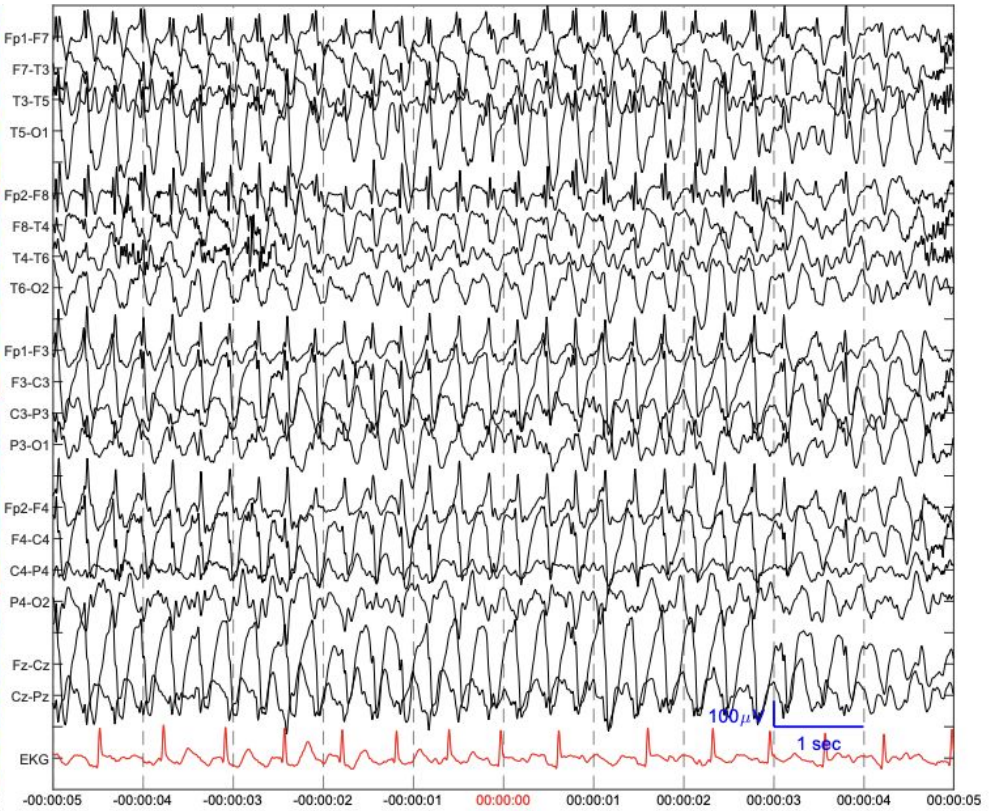
“A technique for the recording of electrical activity arising from the human brain”





What does EEG data look like?

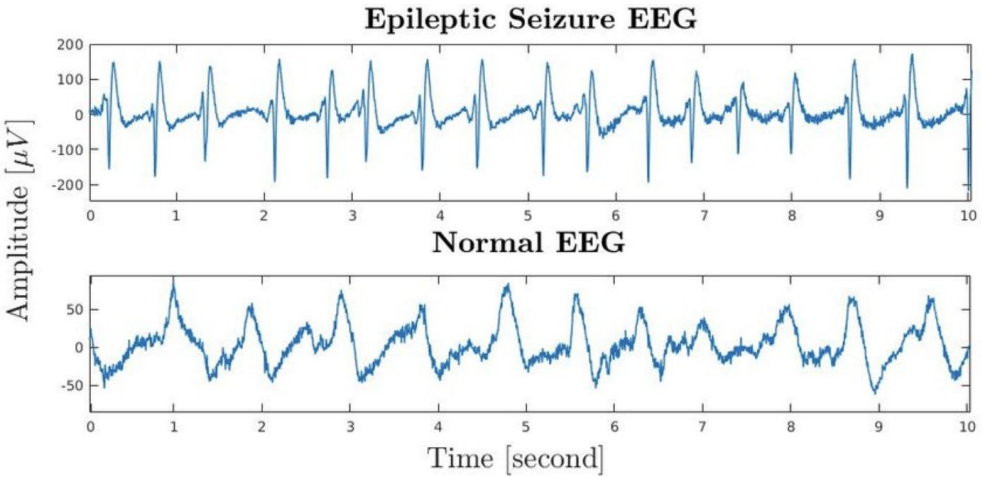
- The height of the waves (amplitude) shows how strong the signal is.
- The speed of the waves (frequency) tells you how fast the brain cells are firing



What can we learn from EEG data?

- Different types of brain activity have different wave patterns.

- Doctors use EEG to study conditions like epilepsy, where the brain's electrical activity is abnormal.

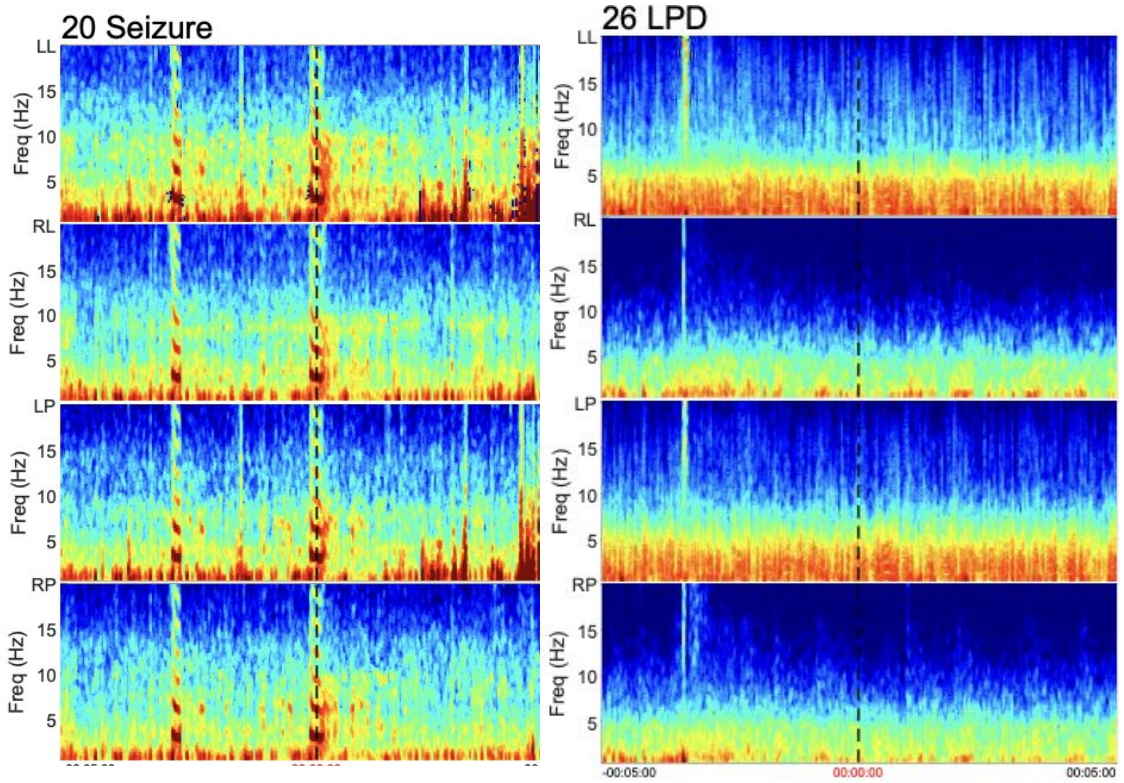


Espinosa, Natalia, Arthur Amorim, and Rudolf Huebner. "Feedforward Neural Network with Backpropagation for Epilepsy Seizure Detection."

Spectrograms: Brain waves in color! (Info Loss)

- Showing the different frequencies of brain waves like colors on a spectrum.

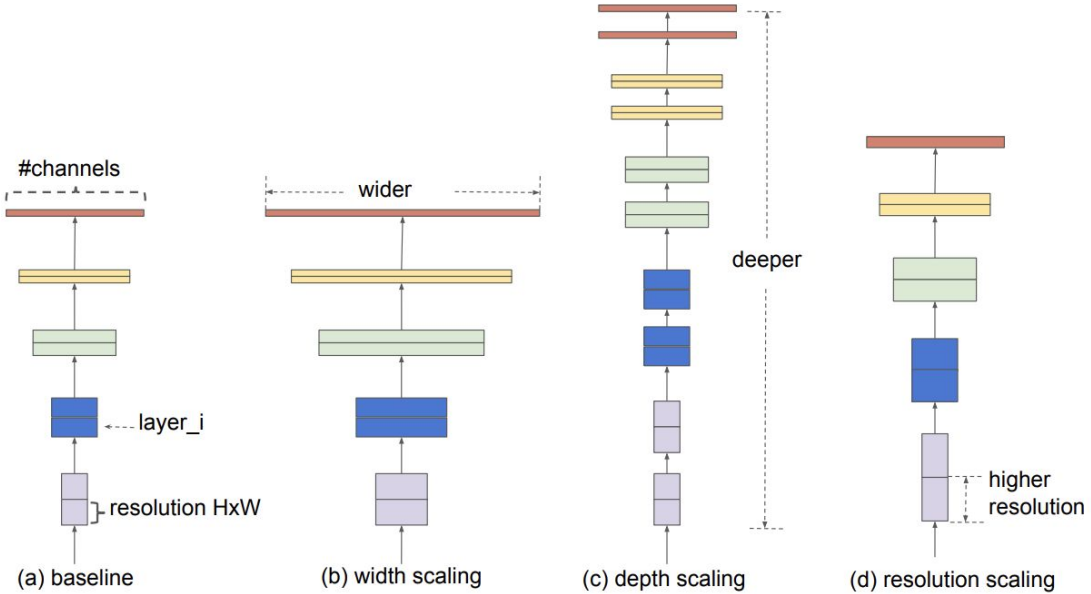
- This helps doctors see patterns and changes in brain activity more easily.



Convolutional Neural Networks Dilemma

- Convolutional Neural Networks (ConvNets) are commonly developed at a fixed resource budget, and then scaled up for better accuracy if more resources are available.

Wider?
Deeper?
Higher resolution?



Tan, Mingxing, and Quoc Le. "Efficientnet: Rethinking model scaling for convolutional neural networks." In *International conference on machine learning*, pp. 6105-6114. PMLR, 2019.

EfficientNet

- EfficientNet is a convolution
  compound scaling.
- Compound scaling method
  scales network width, depth

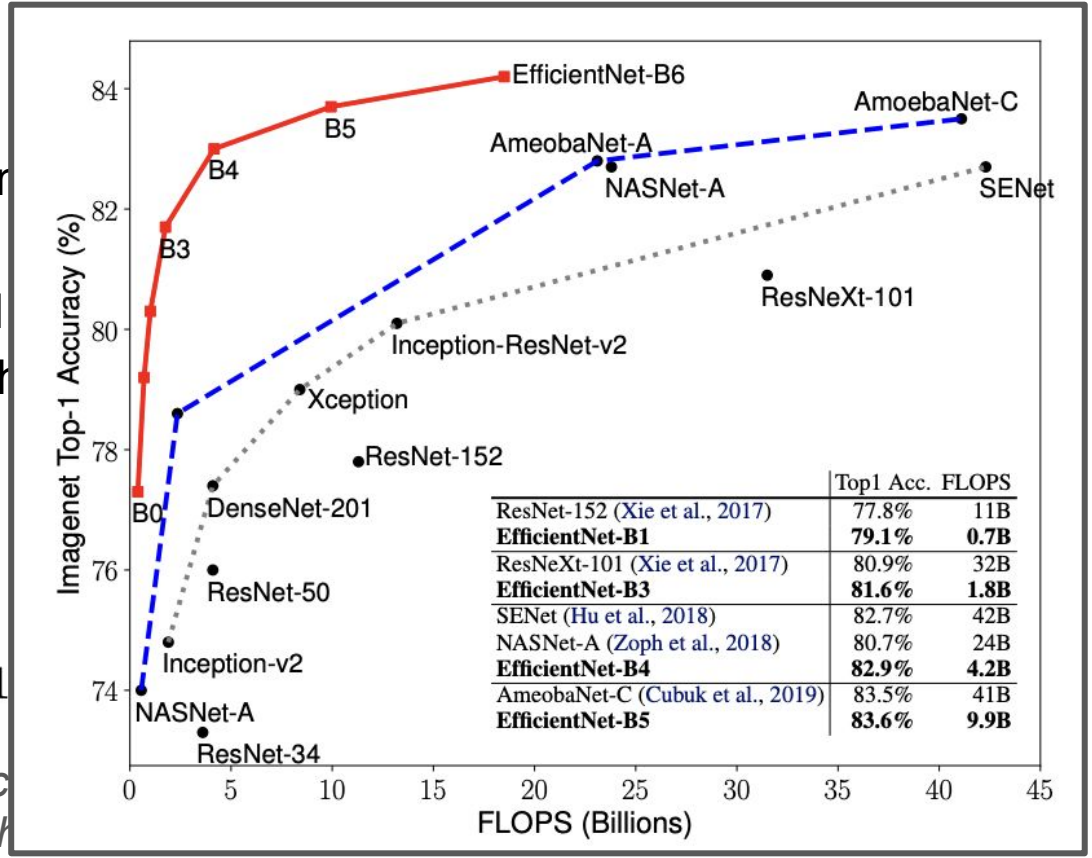
$$\text{depth: } d = \alpha^\phi$$

$$\text{width: } w = \beta^\phi$$

$$\text{resolution: } r = \gamma^\phi$$

$$\alpha \geq 1, \beta \geq 1, \gamma \geq 1$$

where α, β, γ are constants that c
determined by a small grid search



	Top1 Acc.	FLOPS
ResNet-152 (Xie et al., 2017)	77.8%	11B
EfficientNet-B1	**79.1%**	**0.7B**
ResNeXt-101 (Xie et al., 2017)	80.9%	32B
EfficientNet-B3	**81.6%**	**1.8B**
SENet (Hu et al., 2018)	82.7%	42B
NASNet-A (Zoph et al., 2018)	80.7%	24B
EfficientNet-B4	**82.9%**	**4.2B**
AmeobaNet-C (Cubuk et al., 2019)	83.5%	41B
EfficientNet-B5	**83.6%**	**9.9B**

Tan, Mingxing, and Quoc Le. "Efficientnet: Rethinking model scaling for convolutional neural networks." In *International conference on machine learning*, pp. 6105-6114. PMLR, 2019.

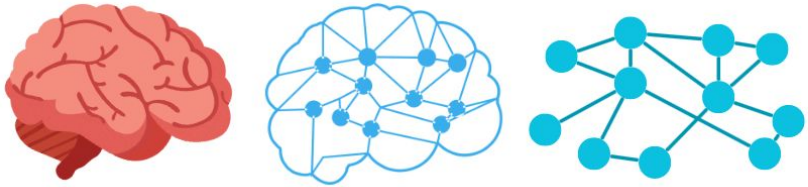
My Experiment Plan (Poopa)

- **Focusing on experimenting with only EEG waveform**

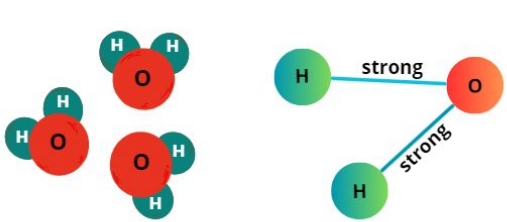
- Exploring possible model architectures that utilized spatiotemporal information in

  EEG waveform data

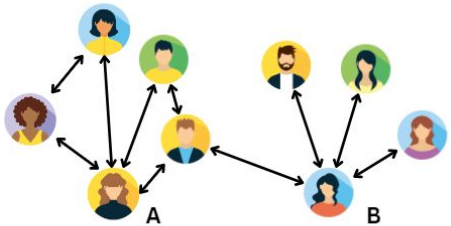
  - Graph Neural Network
  - 3D CNN



Brain networks



Chemical compounds



Social networks

Timeline (Poopa)

February - 1st Week of March:

- Experimenting the different input formats
  - Only EEG waveform
  - Both EEG and Spectrograms
- Data Augmentation on EEG waveform
- Trying different model architectures (3D CNN, GNN etc.)

March- 1st April (Competition End):

- Freezing the finalized model
- Ensembling with KM's Model

2nd April-May (Final Presentation):

- Continue training and validate performance of experimental Graph Neural Network model
- Evaluate GNN's CV score and find explanation of spatiotemporal info being utilized

Expected Challenges

- Inexperience in Graph Neural Network
  - Complicated formulation and learning rules
- Less to none prior works (Kaggle Notebook)
  - Custom implementation may be required