EEG signal processing with machine learning

- Why do we use machine learning?

  We use it for machines to intelligently make decisions. The goal is to make machines' intelligence close to human intelligence.

- What is the method to make machines intelligent?

1. One method is to use lot of sensors and make decisions as per the sensor inputs, in a real time. For this method to work, we need real time supply of sensor data for the machine to work and make decisions
2. As the number of sensors increase, it becomes hard for a human mind to characterize the relationship between sensor inputs and expected output.
   For Example:

   We cannot write conditional statement like

   ```
   If (sensor1.data > 8 and sensor2.data > 16)
       Take Left Turn
   Else
       Take Right
   ```

   Things do not remain that simple. That time we use modelling technique to describe the relationship between input and output. For modelling the data, we use training and testing technique. We train the model with a sensor dataset which is representative of real life dataset. This training is done "offline". The accuracy of this model is then tested with test data. If the model is enough accurate it is used in real life scenario to predict the next action (output) from the input sensor data.

- What are the different types of Modelling?

1. Feature Based Modelling
   In this type of modelling, we extract certain features of the training data and train the model based on these features
   For Example: In case of EEG signals the "features" can be
   1. The amplitude and frequency of the signals
   2. Power spectrum of the EEG signals (alpha, beta, gamma, delta, theta)
   3. Signal Synchronization

2. Deep Learning Modelling
   In this type of modelling, we submit the entire training data to the model and the model itself figures out the features and trains itself.

- How do we validate the model and what are the different measures of accuracy of the model?

  In testing phase, we validate the model by predicting the model outcome of the "test data". The accuracy of the model is calculated using "confusion matrix".

- What are frequently used “feature based models”?
  - Linear Discriminant Analysis – LDA
  - Support Vector Machine – SVM
  - Multilayer Perceptron – MLP

- What are different “deep learning” (non-feature based) models?
  - Convolution Neural Network (CNN)
  - Long Short Term Memory (LSTM)
  - Recurrent Neural Network (RNN)

- Ensembles
  Ensembles consist of a combination of multiple models