

# Motor Imagery Classification

Kirtan Amitkumar Jha  
Naren Kalburgi Vishwanath

Introduction

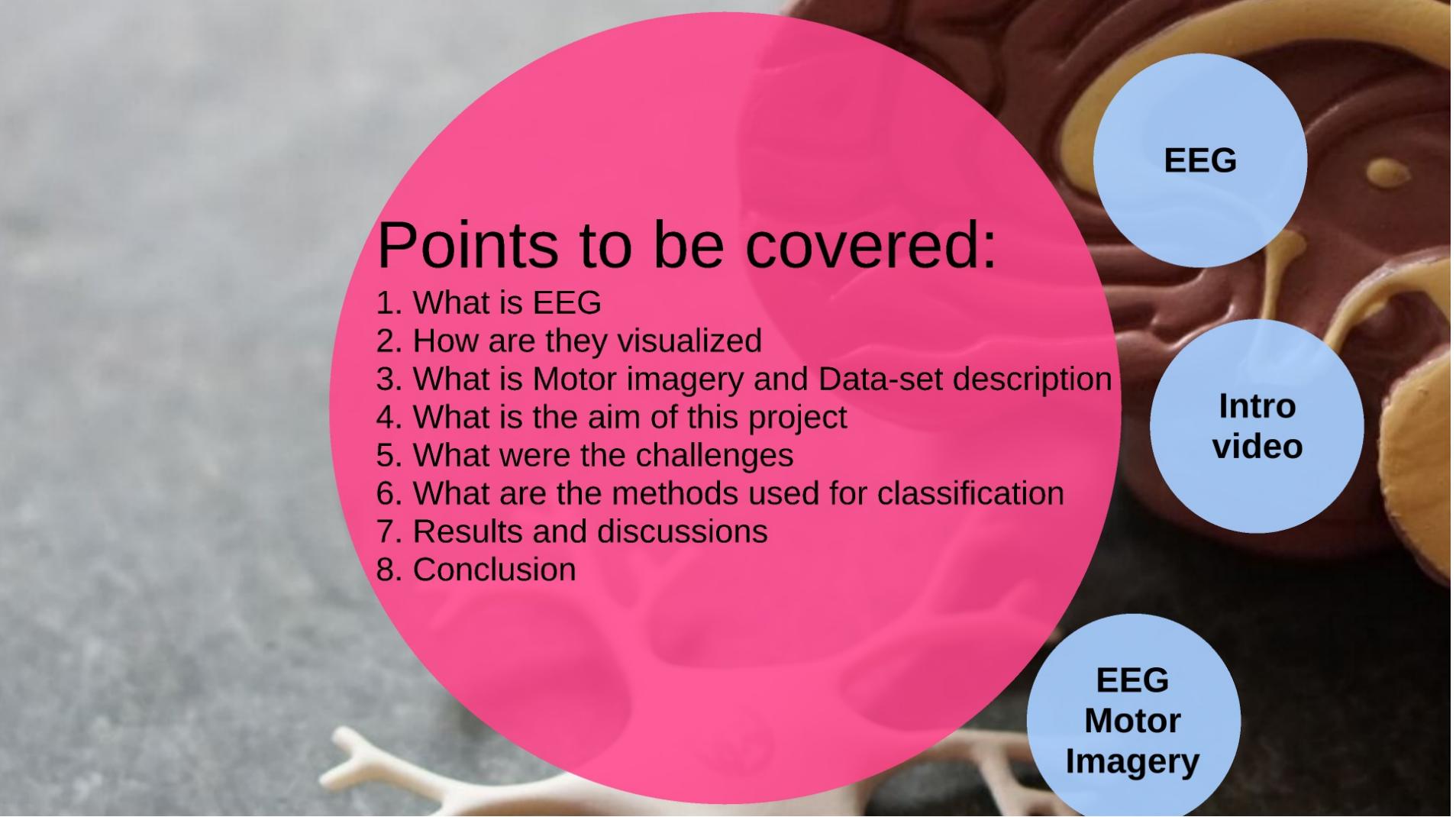
1 Data

2 Classifiers used

3 Results

4 Conclusion

19/05/2020



## Points to be covered:

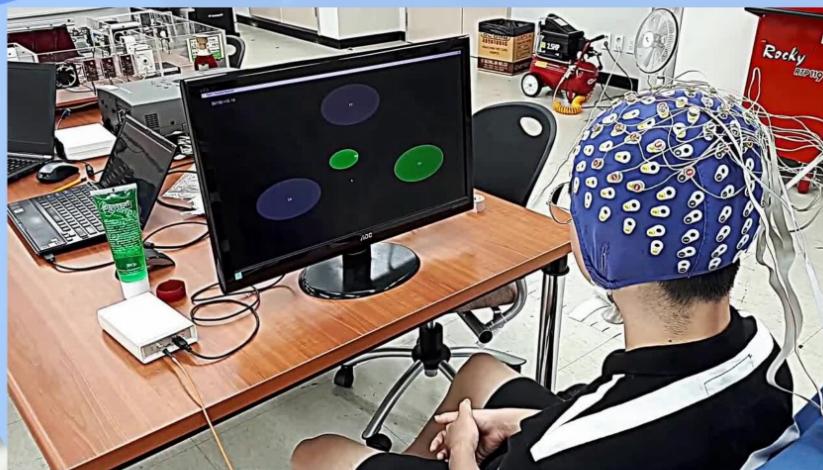
1. What is EEG
2. How are they visualized
3. What is Motor imagery and Data-set description
4. What is the aim of this project
5. What were the challenges
6. What are the methods used for classification
7. Results and discussions
8. Conclusion

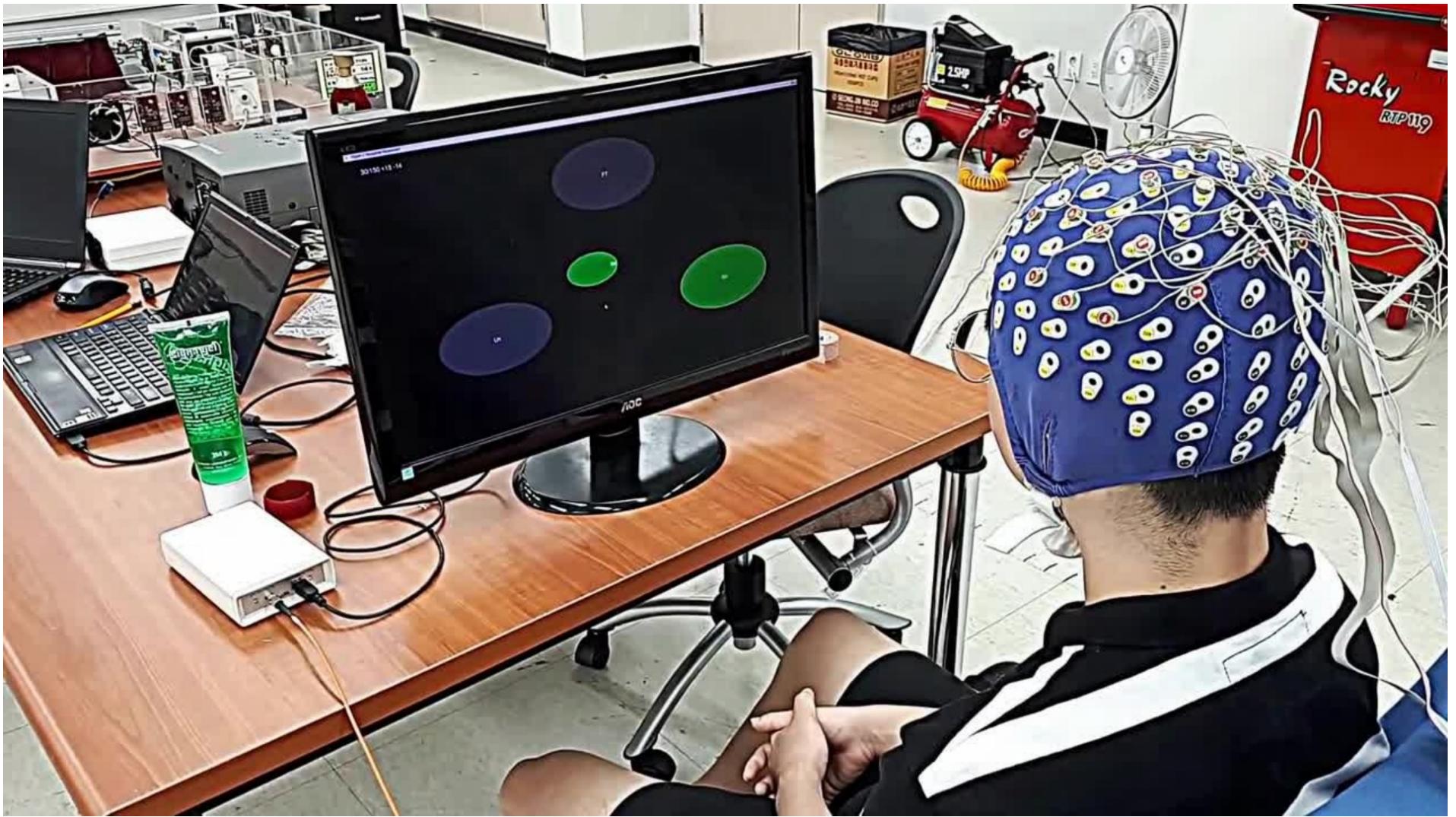
EEG

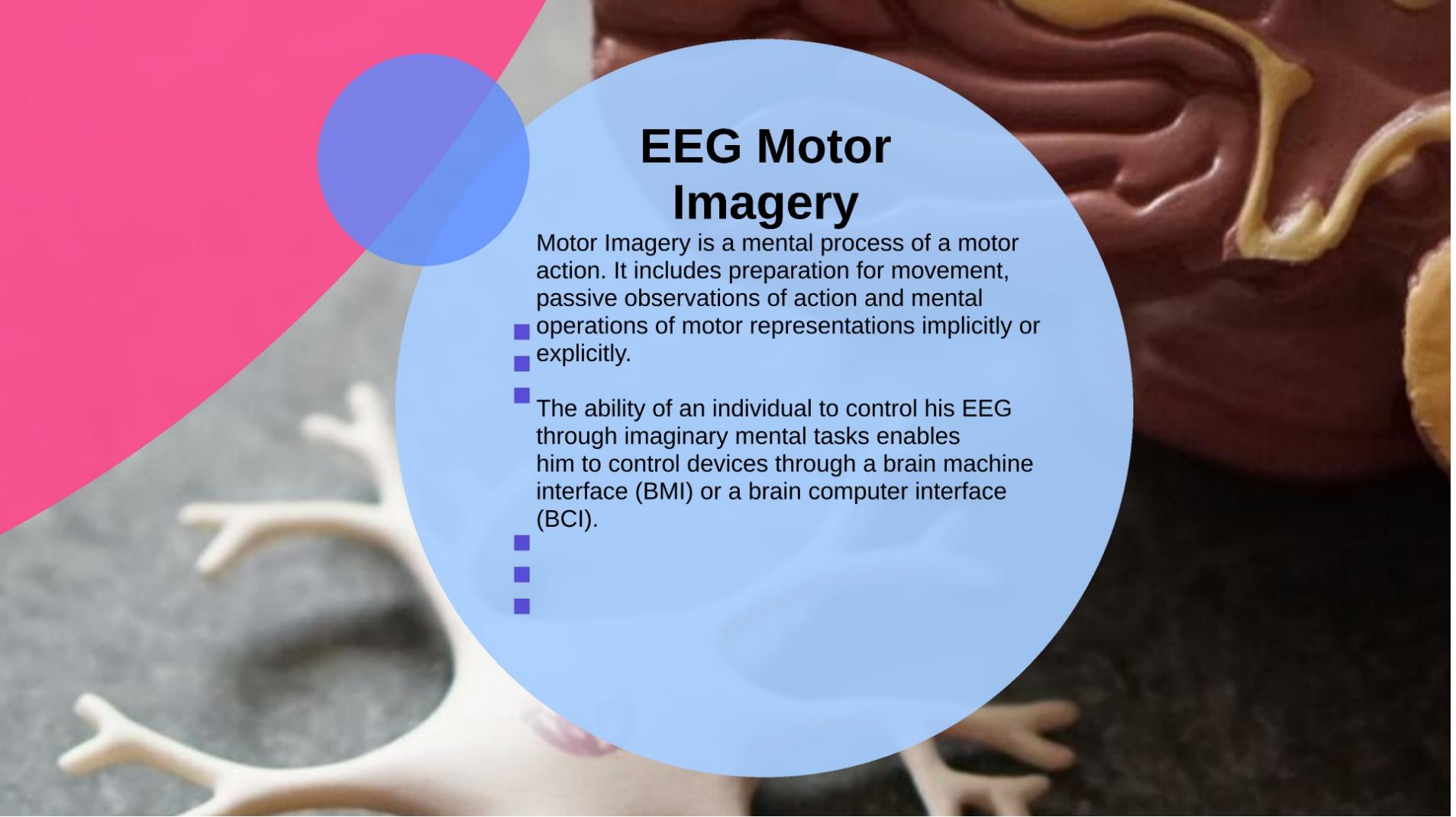
Intro  
video

EEG  
Motor  
Imagery

## EEG Motor Imagery







## EEG Motor Imagery

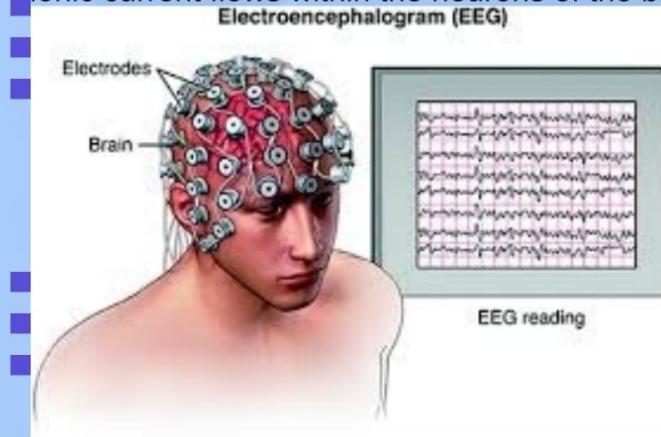
Motor Imagery is a mental process of a motor action. It includes preparation for movement, passive observations of action and mental operations of motor representations implicitly or explicitly.

- The ability of an individual to control his EEG through imaginary mental tasks enables him to control devices through a brain machine interface (BMI) or a brain computer interface (BCI).
- 
- 
-

## Electroencephalogram

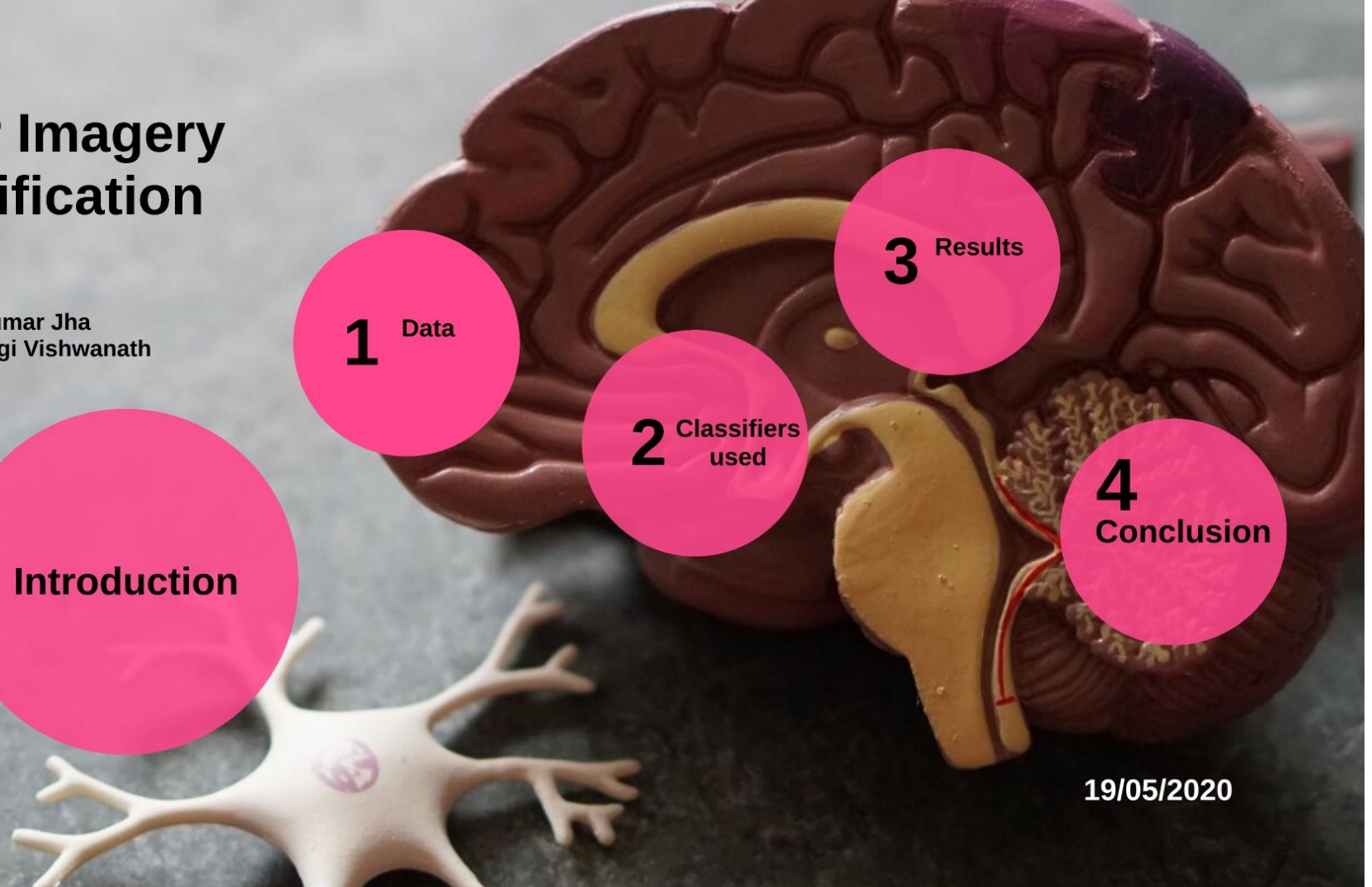
EEG is the recording of electrical activity along the scalp.

EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain.



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# Dataset info

Subjects,trials,Cha  
nnels

More Info

Pre-processing

Pre-processing

## General Info

### BCI Competition IV Dataset 2-A

number of subjects : 9

Dataset format: GDF

Number of classes: 4

Names: Left hand, Right hand, both feet and tongue

Number of trials/subject: 288

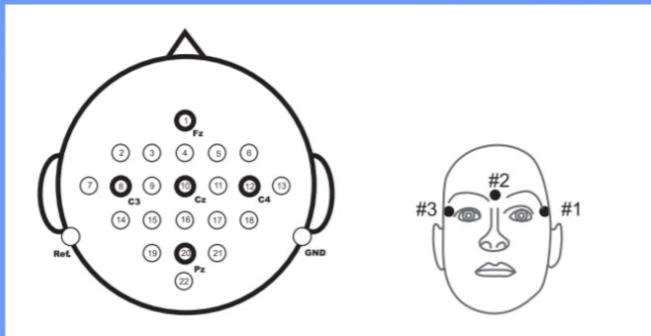
Number of channels: 25

## More information on Dataset

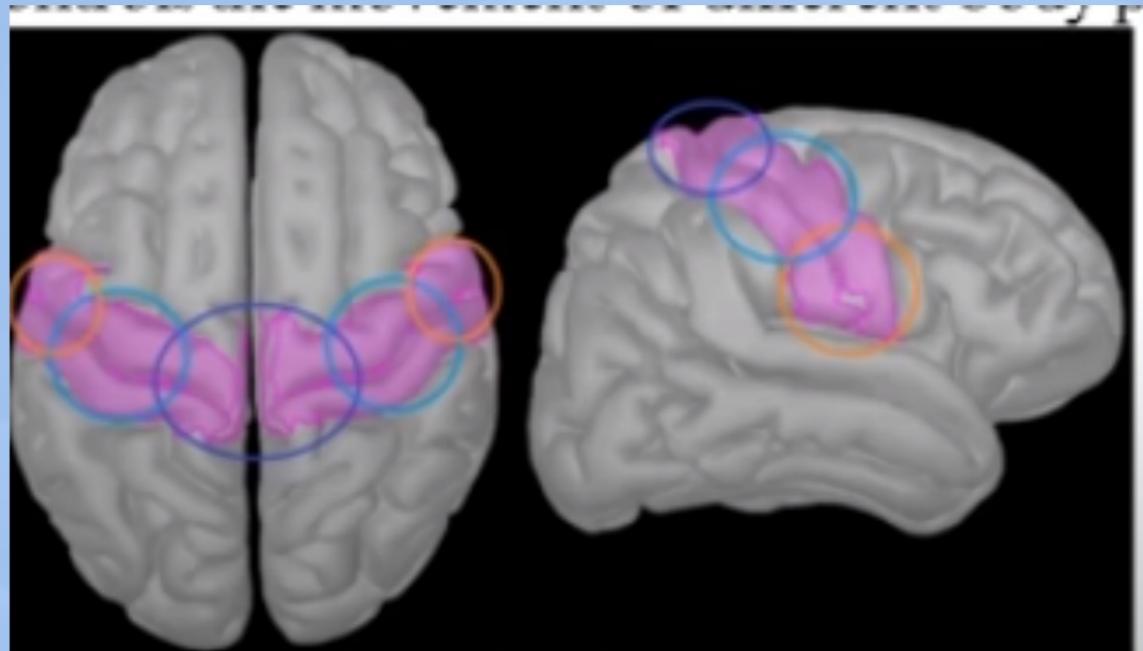
25 channels given

3 EoG channels

22 EEG Channels



## How to select the channels?



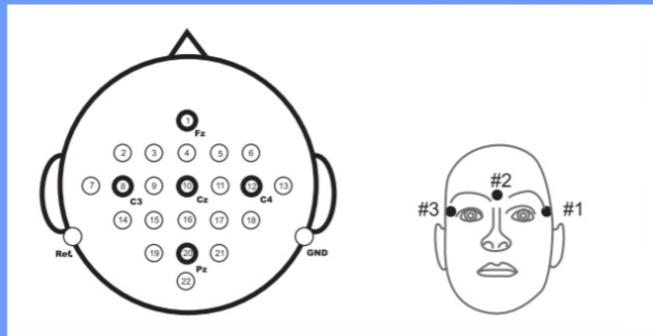
1. region above ears: controls face and tongue movements
2. region in pale blue color: controls hand movements
3. region in dark blue color: controls feet movement

## More information on Dataset

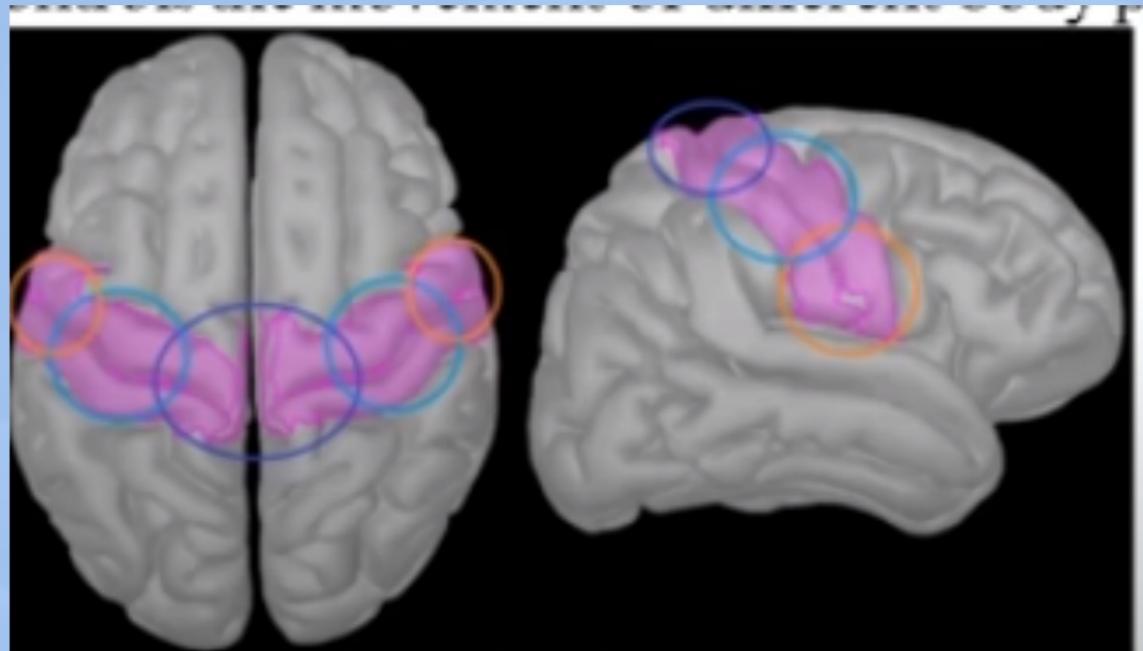
25 channels given

3 EoG channels

22 EEG Channels



## How to select the channels?



1. region above ears: controls face and tongue movements
2. region in pale blue color: controls hand movements
3. region in dark blue color: controls feet movement

# Minimal preprocessing done

#1

Applied bandpass  
filter  
7-30hz

Wavelet packet  
Decomposition

#2

#3

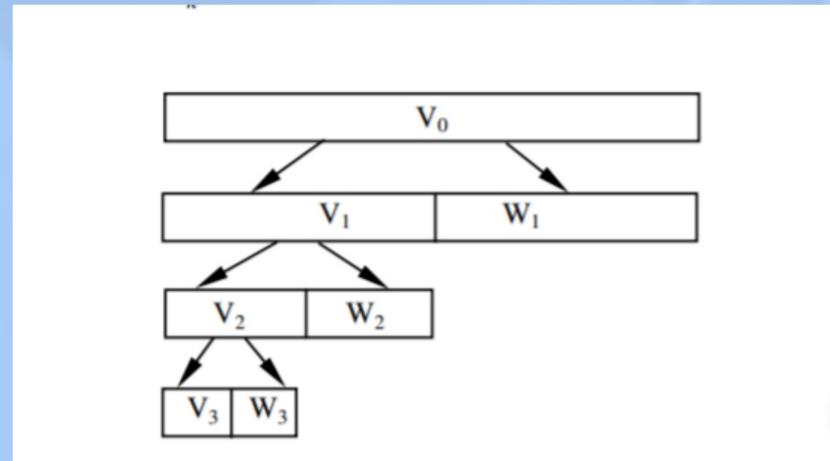
Split data into  
train and test  
data

# Preprocessing explained

## Bandpass filtering

## Wavelet Packet Decomposition

1. Motor related activities are associated with event related synchronization in alpha(8-13hz) and beta(14-30hz) waves
2. In WPD discrete time signal is passed through more and more filters



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**2** Classifiers  
used

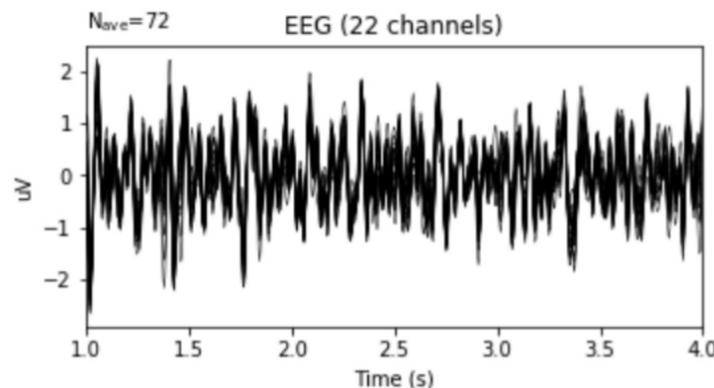
Epoch Average

Epoch Aver

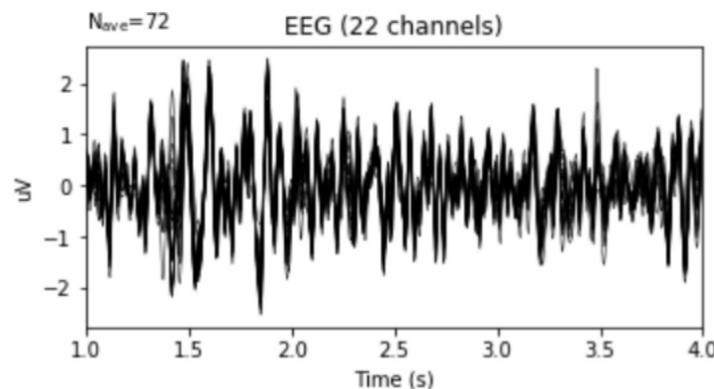
Classifiers

# Epoch Averages

<Evoked | 'left' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>

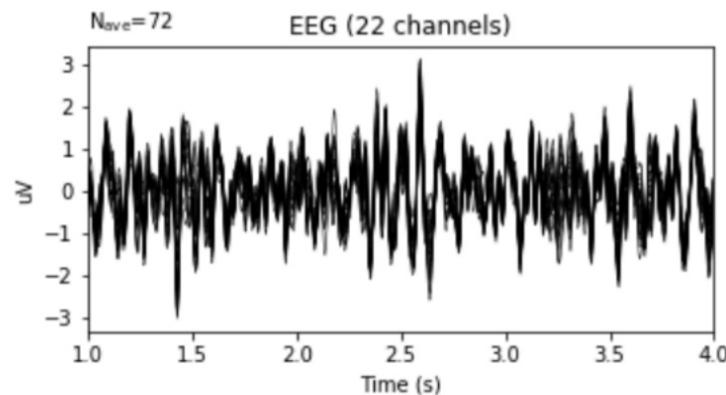


<Evoked | 'right' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>

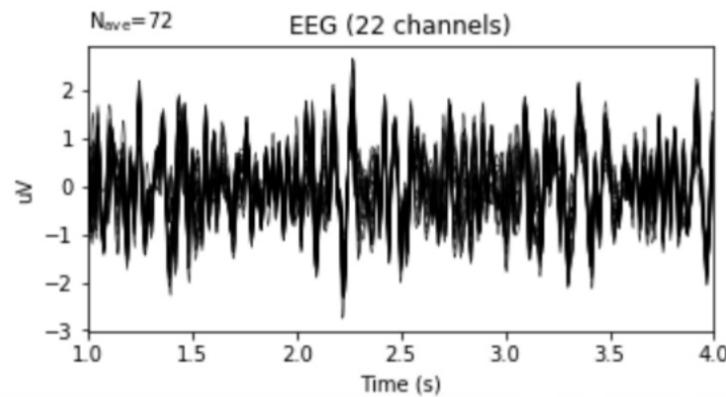


# Epoch average

```
<Evoked | 'foot' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>
```

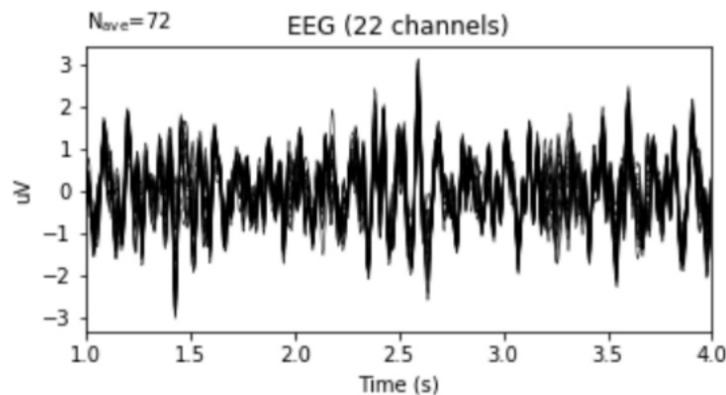


```
<Evoked | 'tongue' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>
```

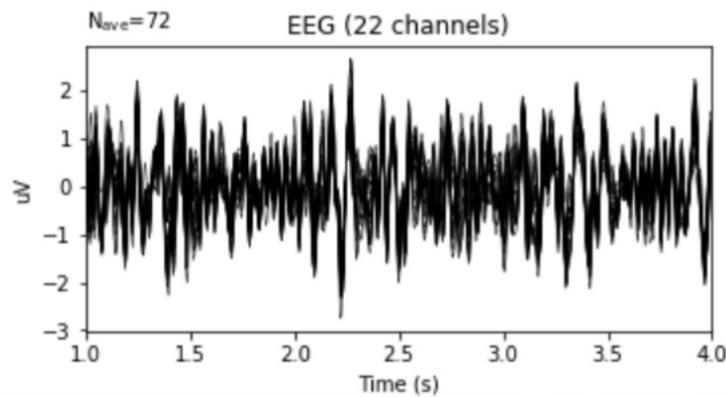


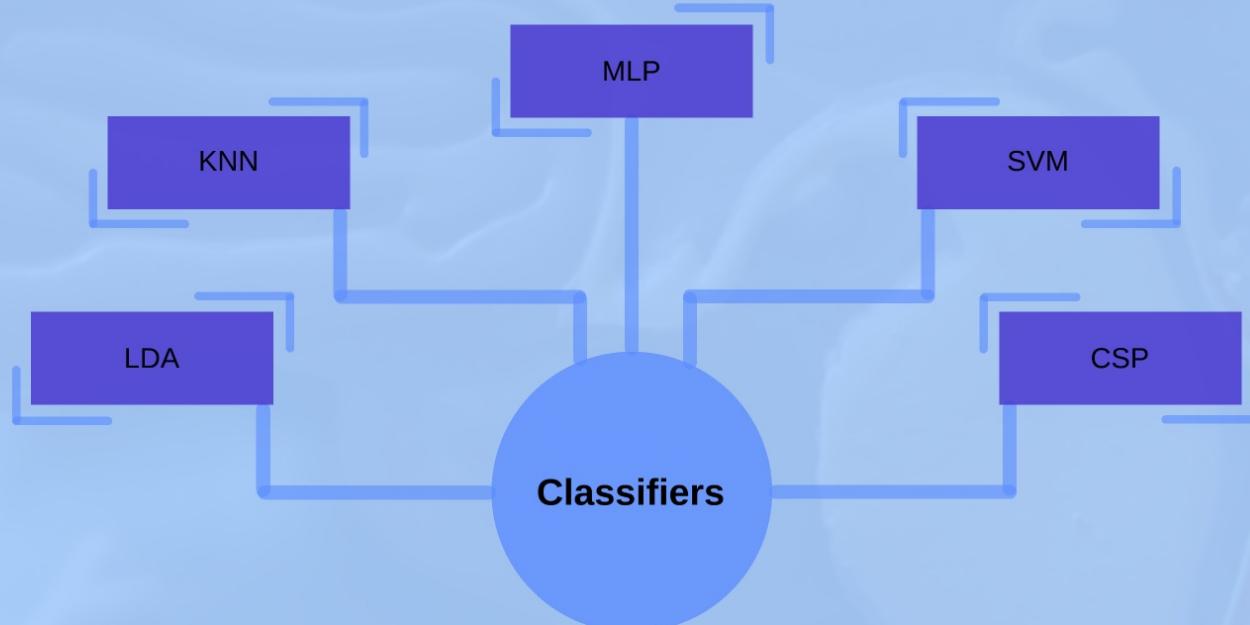
# Epoch average

<Evoked | 'foot' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>

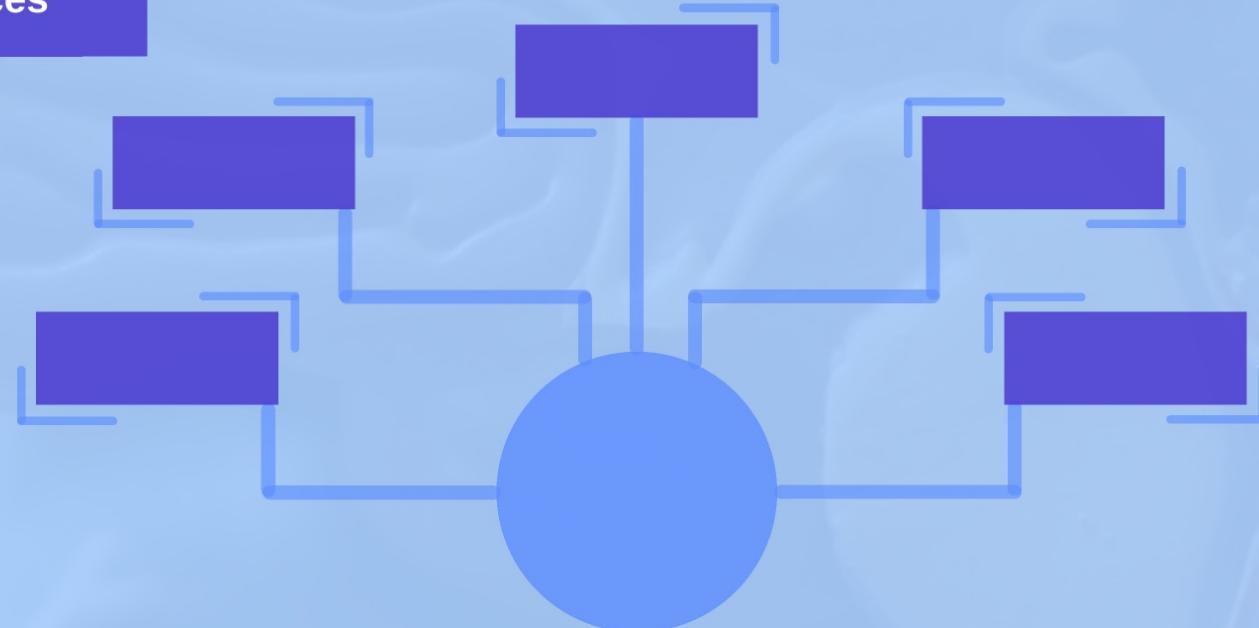


<Evoked | 'tongue' (average, N=72), [1, 4] sec, 22 ch, ~176 kB>



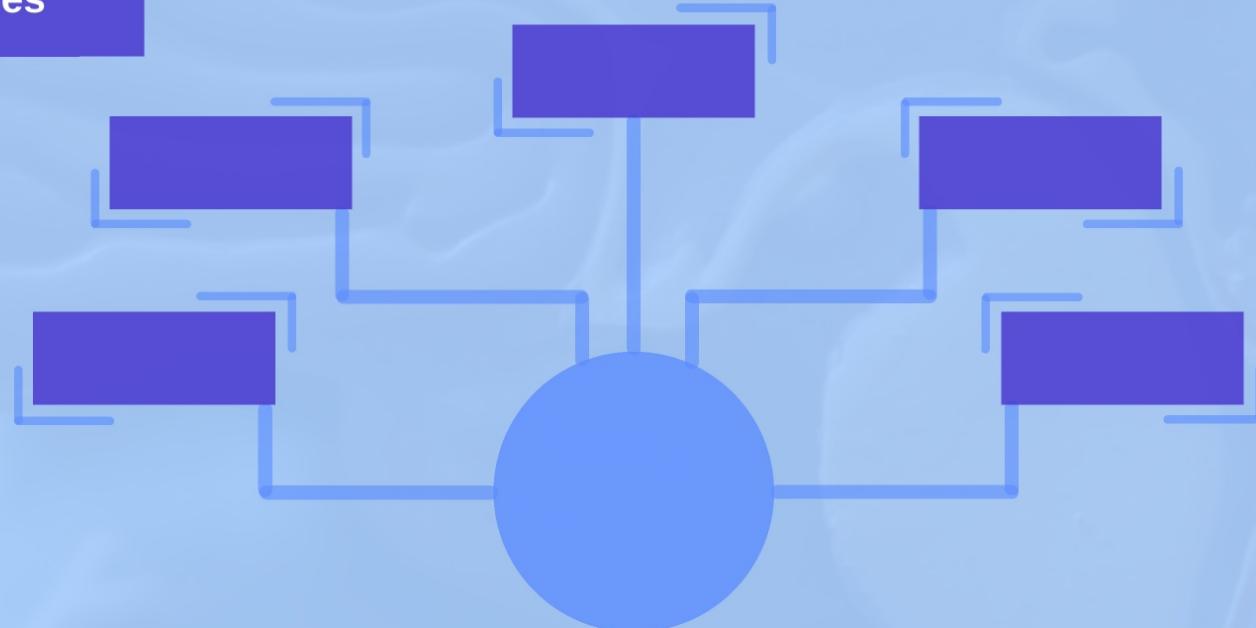


## Resources

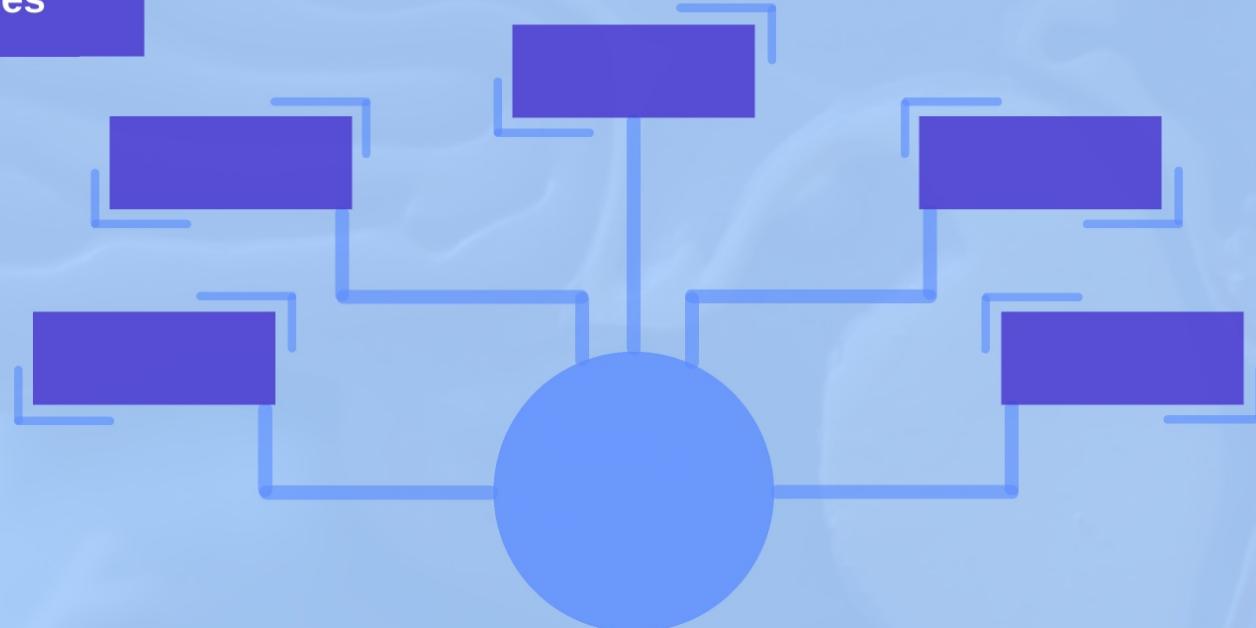


# **Classifiers used**

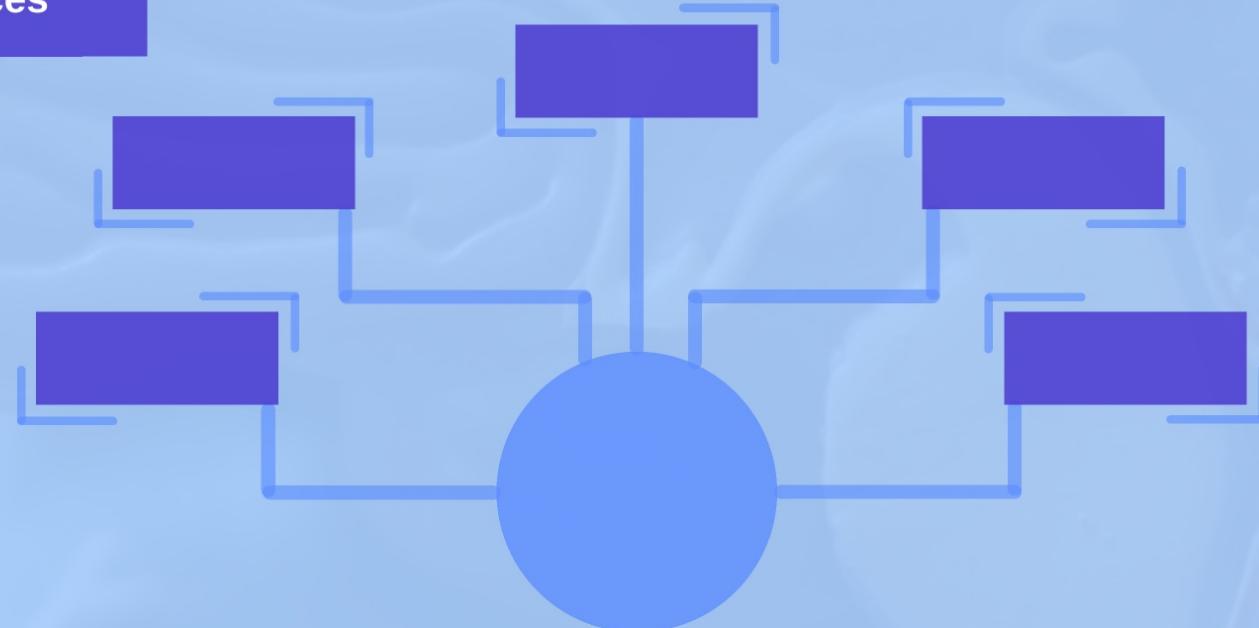
## Resources



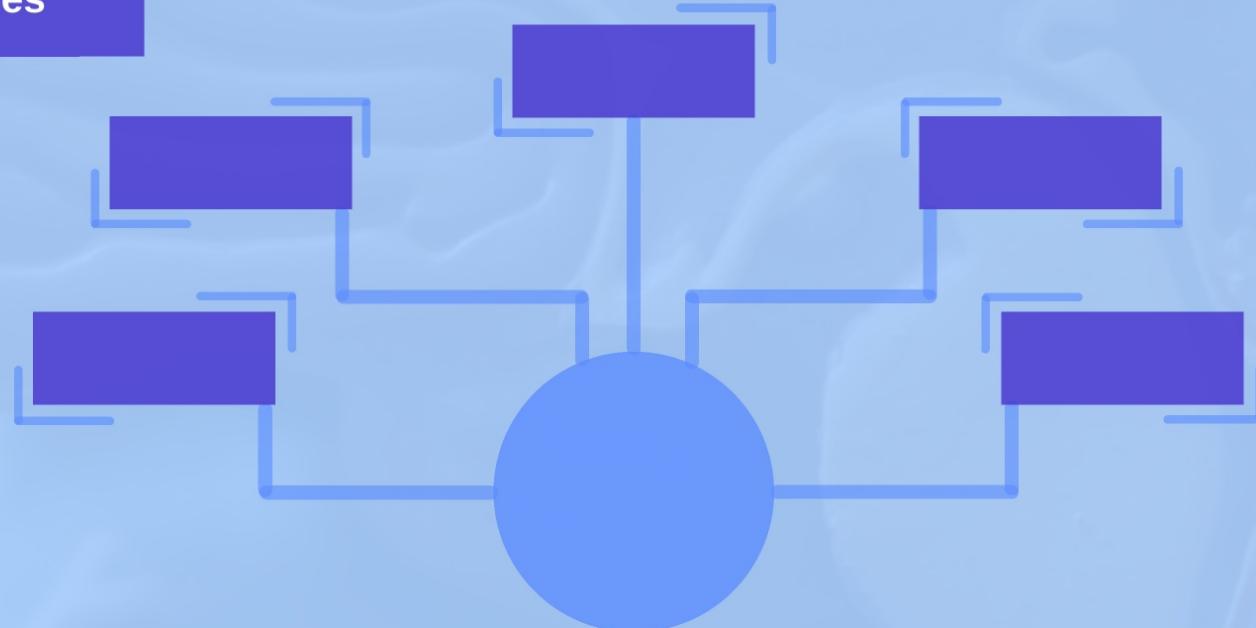
## Resources



## Resources



## Resources



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# 3 Results

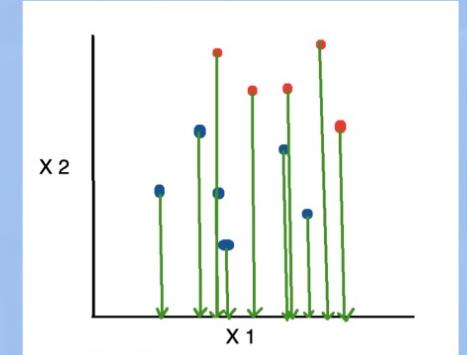
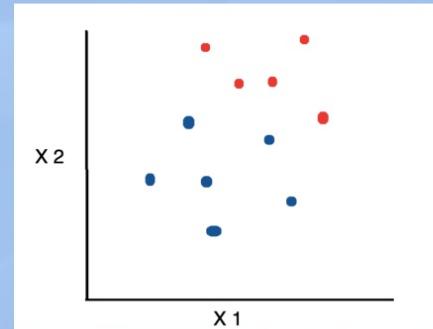
Classifiers

Classifiers

Final  
accuracies

# LDA

## Linear Discriminant Analysis



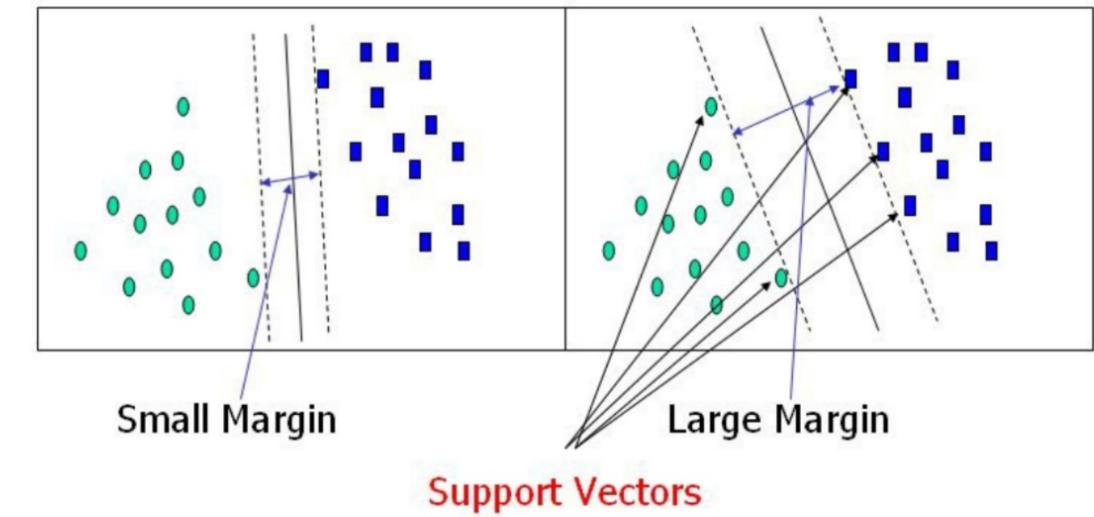
$$S_B = \sum_{i=1}^c N_i (\mathbf{m}_i - \mathbf{m})(\mathbf{m}_i - \mathbf{m})^T$$

where

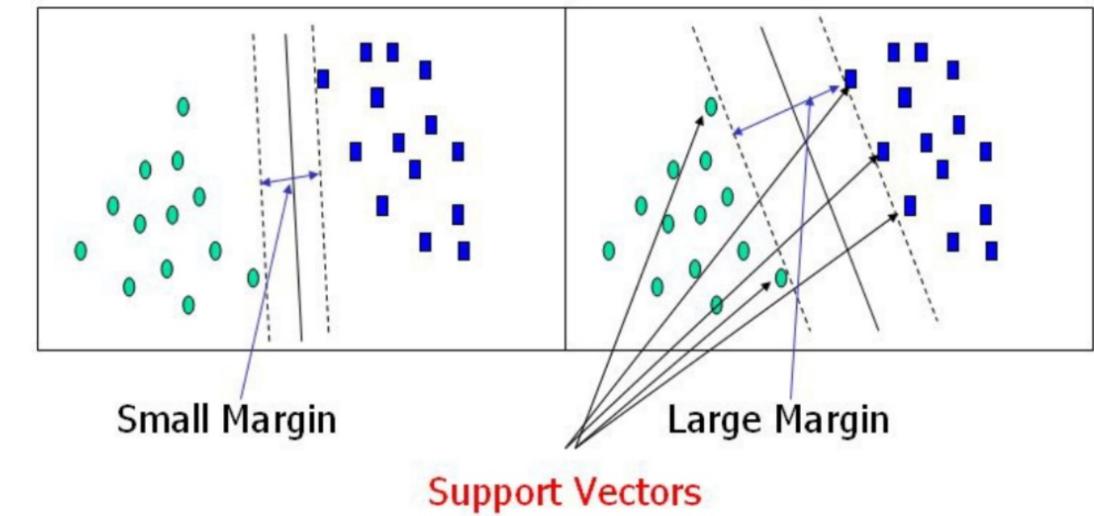
$$\mathbf{m}_i = \frac{1}{n_i} \sum_{\mathbf{x} \in D_i}^n \mathbf{x}_k$$

$$\mathbf{m} = \frac{1}{n} \sum_i^n \mathbf{x}_i$$

# SVM



# SVM

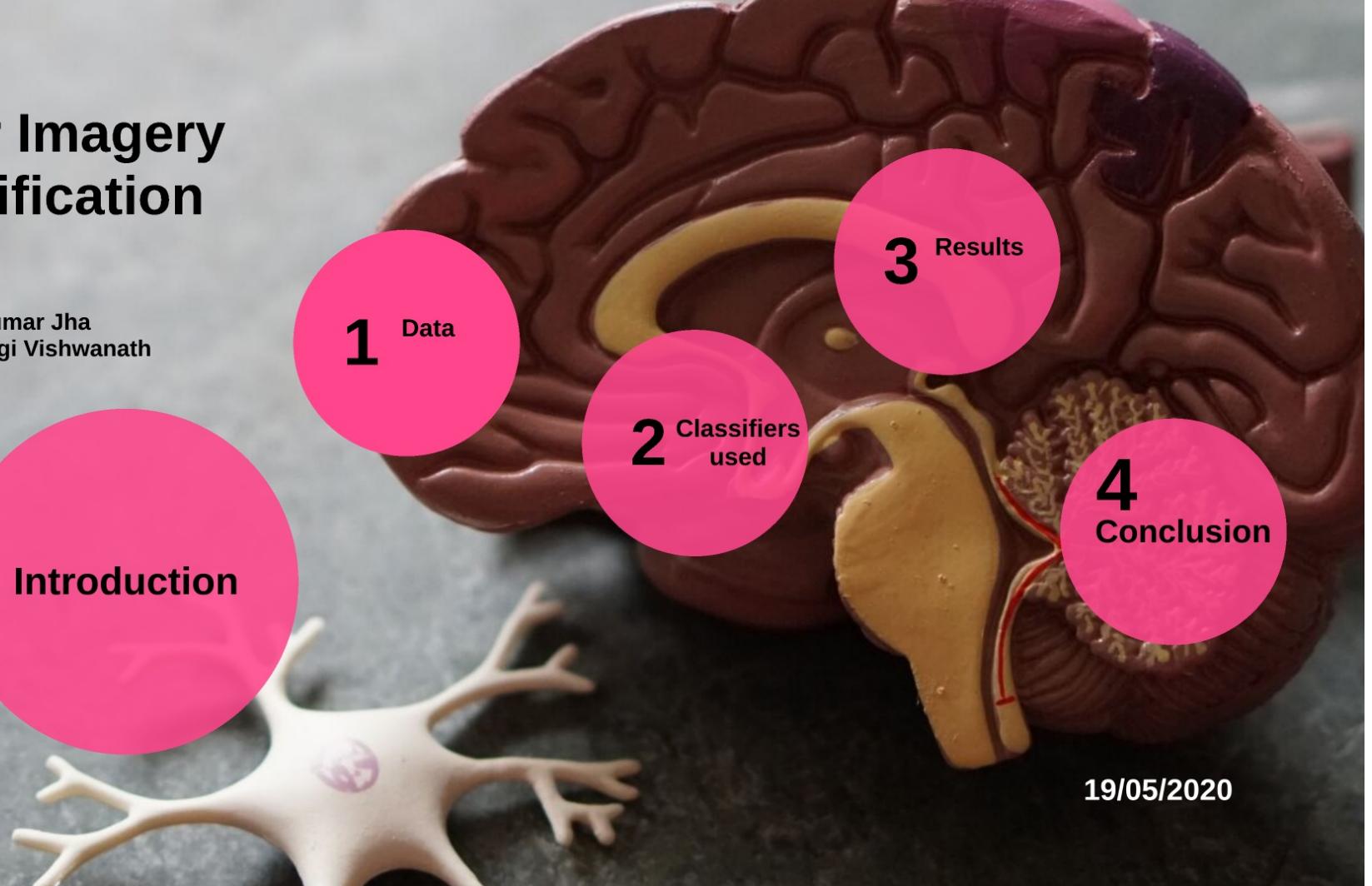


# Comparison of accuracies

Subject	LDA	KNN	MLP	SVM	CSP ( <u>Avg</u> )
Sub_01	65%	61%	61%	70%	68%
Sub_02	46%	43%	41%	48%	55%
Sub_03	74%	64%	68%	73%	82%
Sub_04	73%	59%	68%	66%	64%
Sub_05	37%	33%	33%	37%	46%
Sub_06	37%	32%	30%	35%	41%
Sub_07	68%	57%	54%	67%	73%
Sub_09	66%	60%	60%	66%	50%
Sub_08	75%	58%	64%	72%	66%

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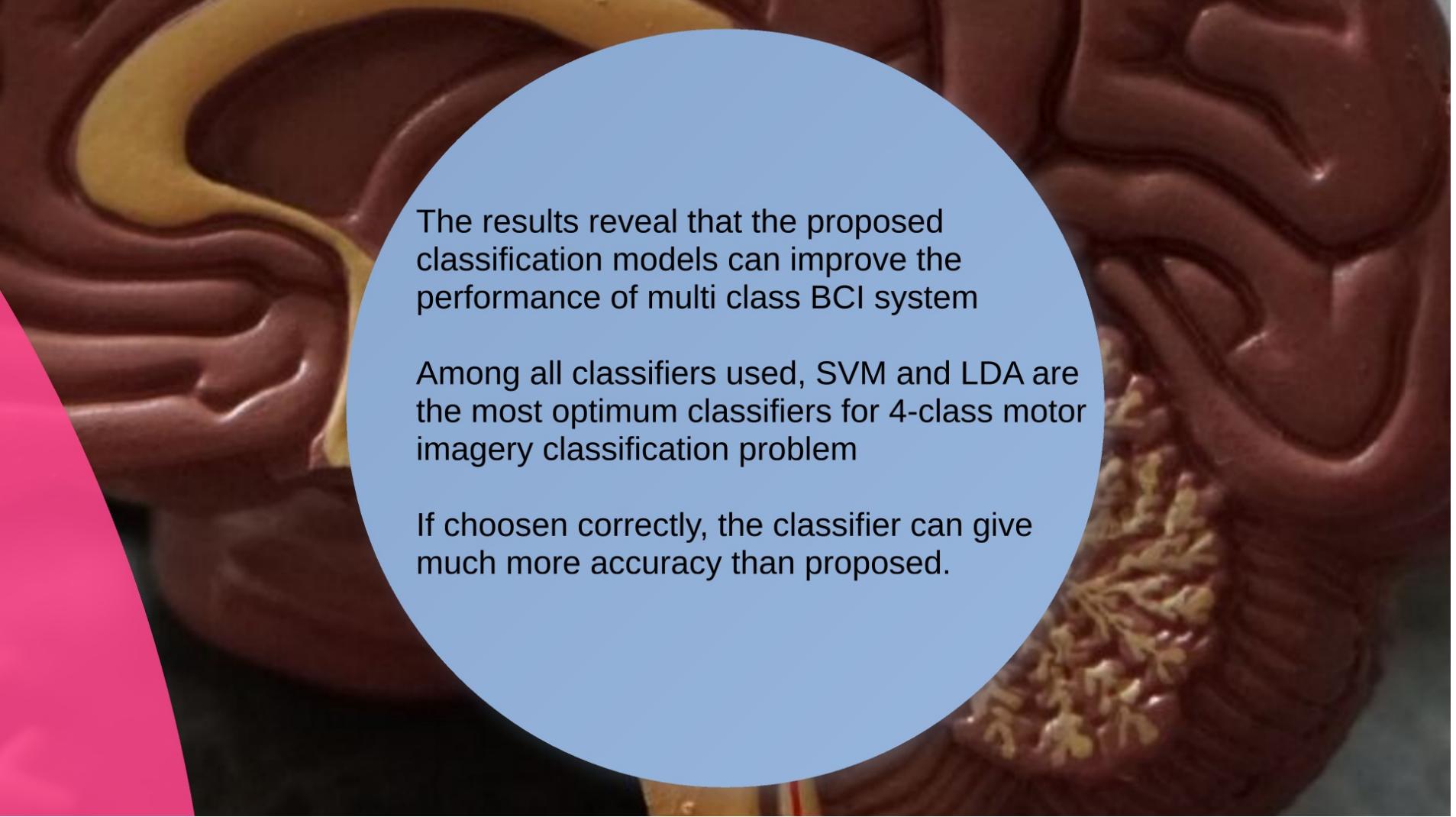
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# 4

## Results, conclusion and future scope

Conclusion



The results reveal that the proposed classification models can improve the performance of multi class BCI system

Among all classifiers used, SVM and LDA are the most optimum classifiers for 4-class motor imagery classification problem

If chosen correctly, the classifier can give much more accuracy than proposed.



THANK  
YOU

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