Instructor :- Prof. Bakul Gohel

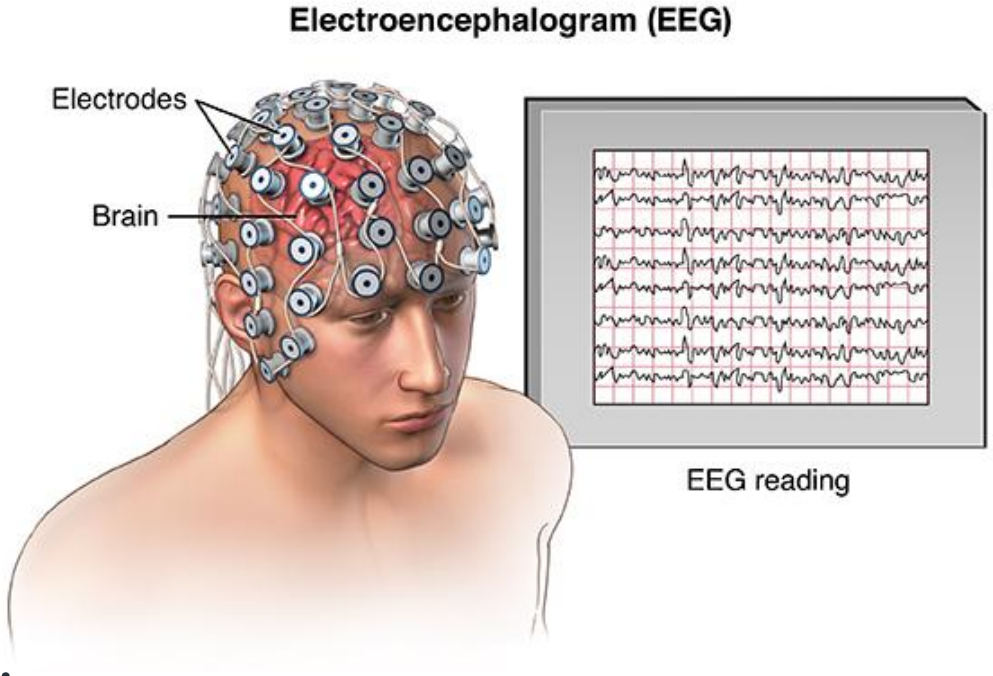
Classification using EEG data

*Looking **through** the brain*

Introduction

- Recognizing objects from different categories is of fundamental importance for survival.
- Electroencephalography , or EEG, records the electrical activity of brain.
- EEG signals - good temporal resolution, but a low spatial one.
- EEG scope in human computer interaction, psychology, and neurological sciences.

Dataset



- 10 - Subjects
- 5185 to 5188 - Trials per subject
- 124 - Electrodes or Channels
- 32 - Time Sample per trial
- 6 - Classes

Objective

- Classification using linear discriminant analysis.
- To study the linear separability
- Brain analysis with following binary classes
  - Human Face
  - Inanimate objects
- Effects of data augmentation on linear separability.
- Spatial and Temporal analysis of brain.

LDA

- Bayesian classifier
- Linear decision boundary
- Maximizes : $\frac{Between\ class\ variance}{Within\ class\ variance}$
- Gaussian density to each class
- Optimization technique : Eigen solver
- Shrinkage: Estimation of Covariance matrices

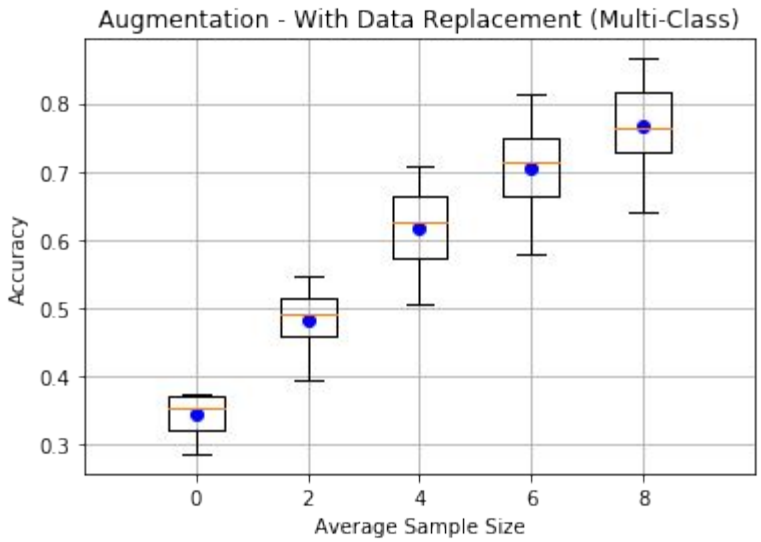
Data Augmentation

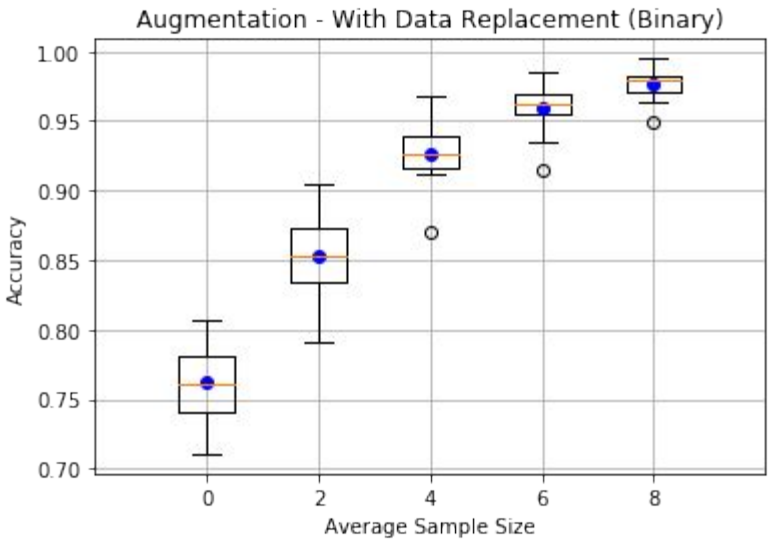
- New data points by averaging *n* number of data points, belonging to same class, randomly :-
  - With Replacement - Same number of samples
  - Without Replacement
- *n = [2, 4, 6, 8]*

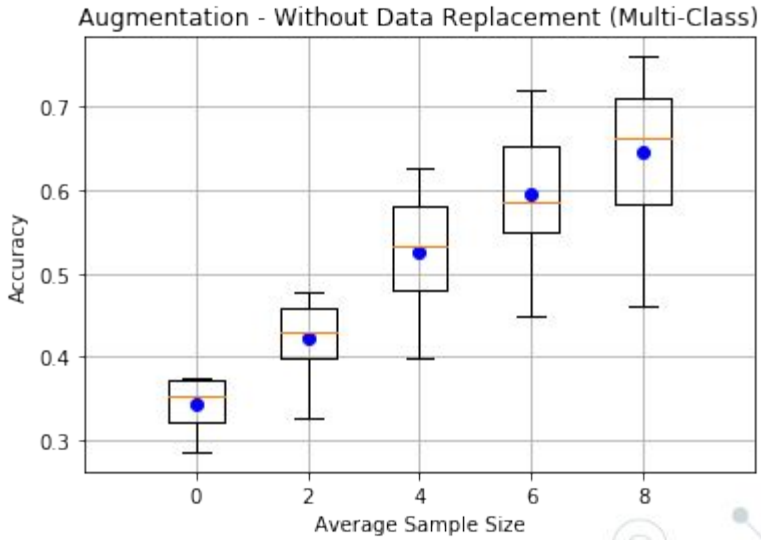
K-fold Cross Validation

K -> 5 , N -> 8

Result


Augmentation - With Data Replacement (Multi-Class)
Accuracy
Average Sample Size
0.3
0.4
0.5
0.6
0.7
0.8
0
2
4
6
8


Augmentation - With Data Replacement (Binary)
Accuracy
Average Sample Size
0.70
0.75
0.80
0.85
0.90
0.95
1.00
0
2
4
6
8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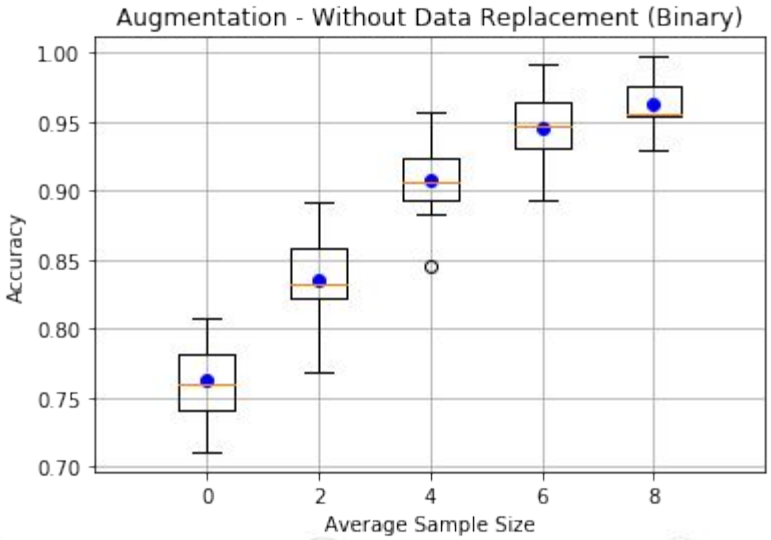
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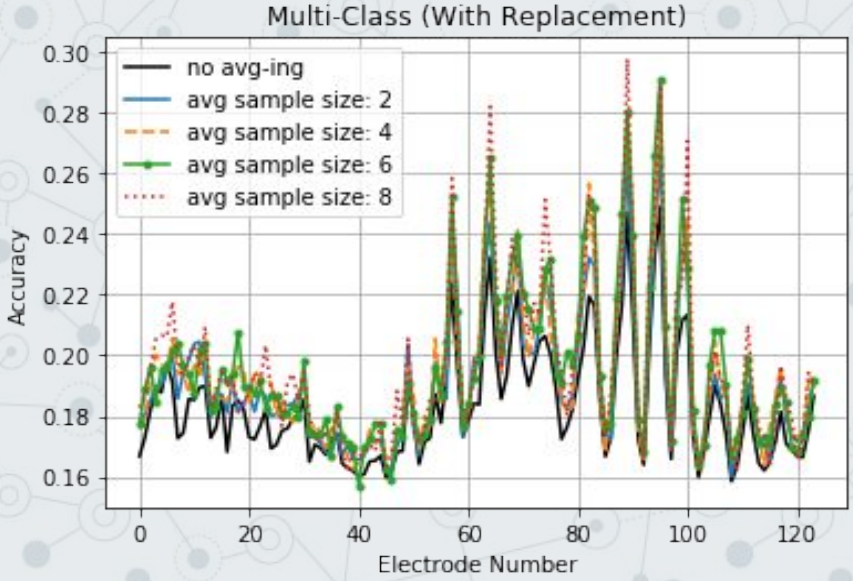
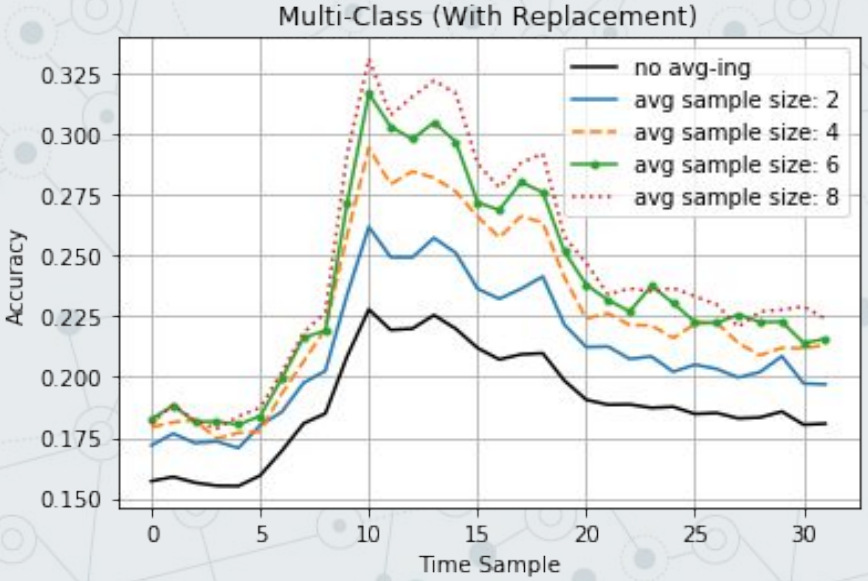

Multi-Class (With Replacement)
no avg-ing
avg sample size: 2
avg sample size: 4
avg sample size: 6
avg sample size: 8
Accuracy
Electrode Number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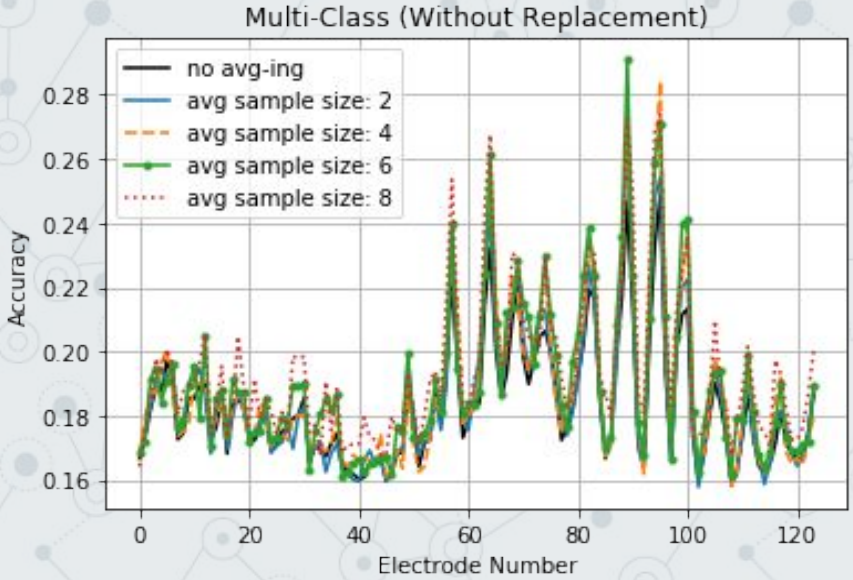
Accuracy
Time Sample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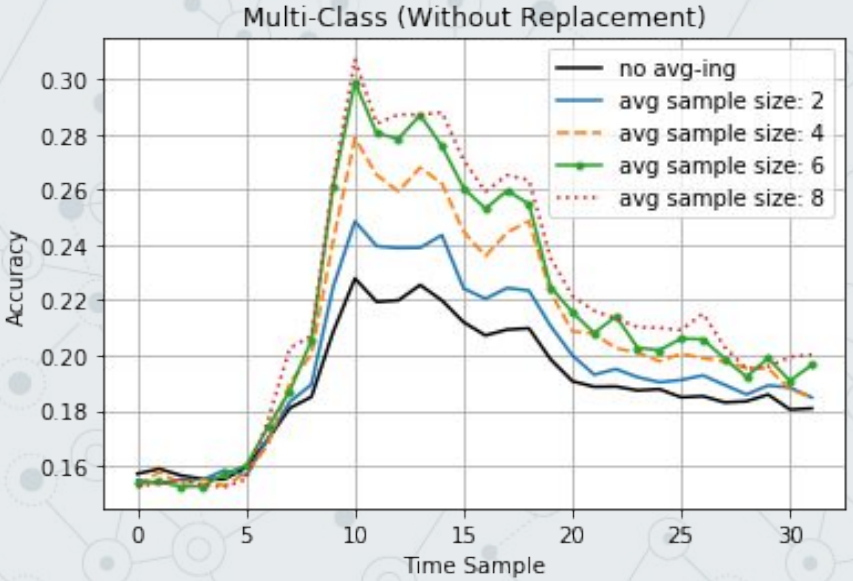
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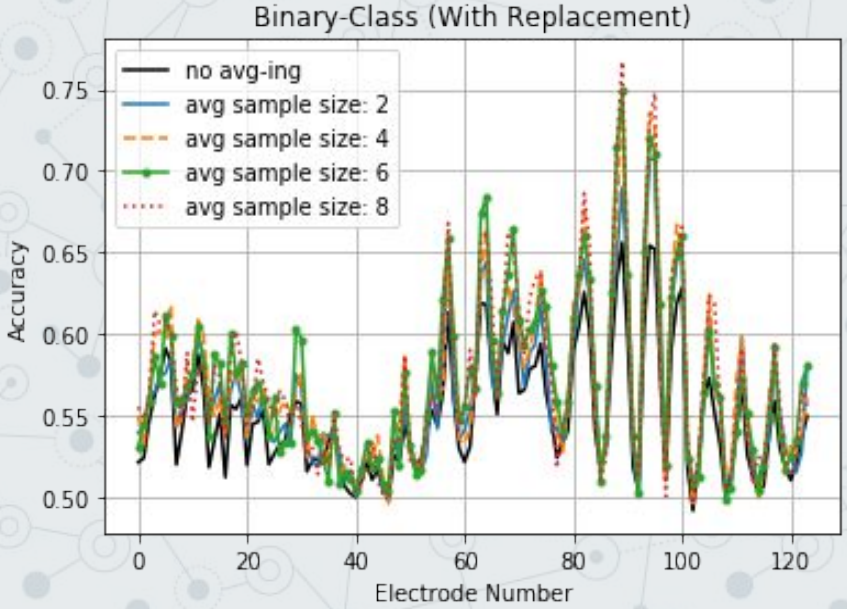
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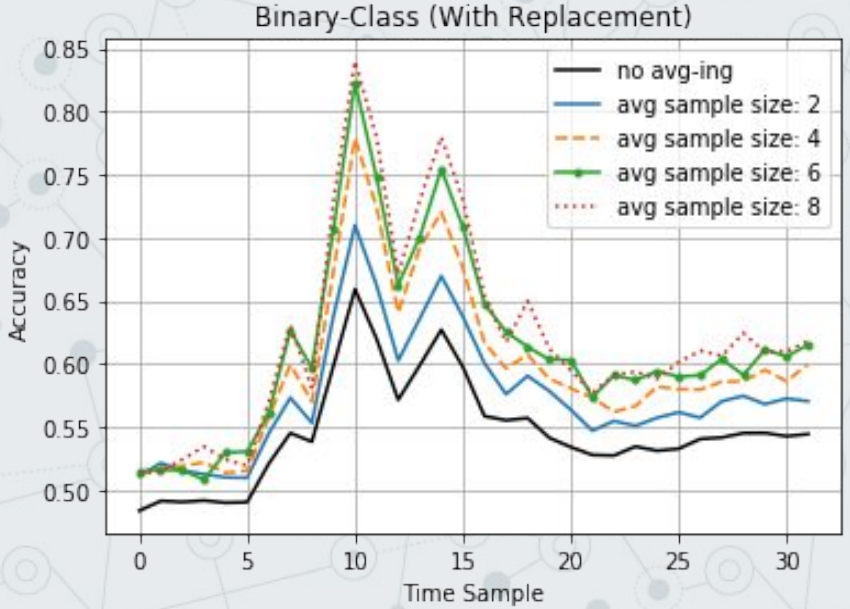
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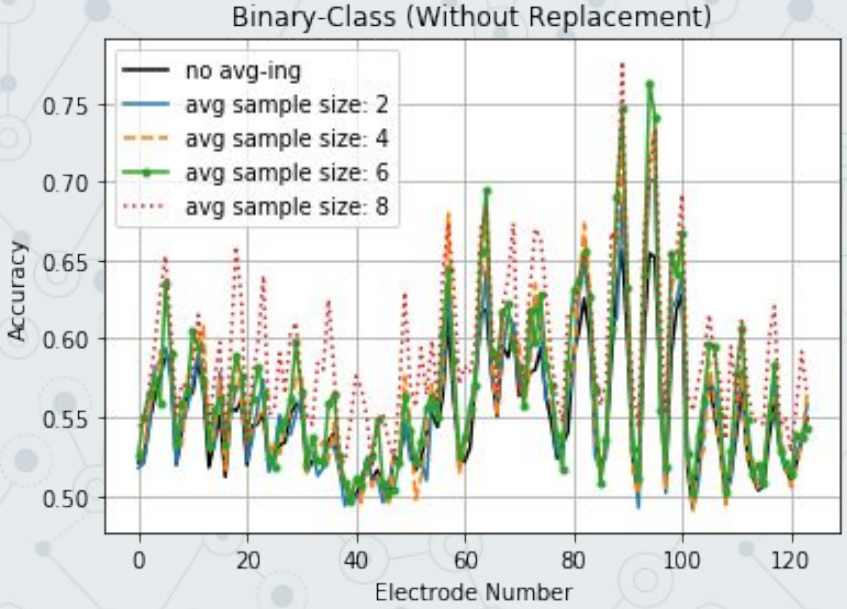
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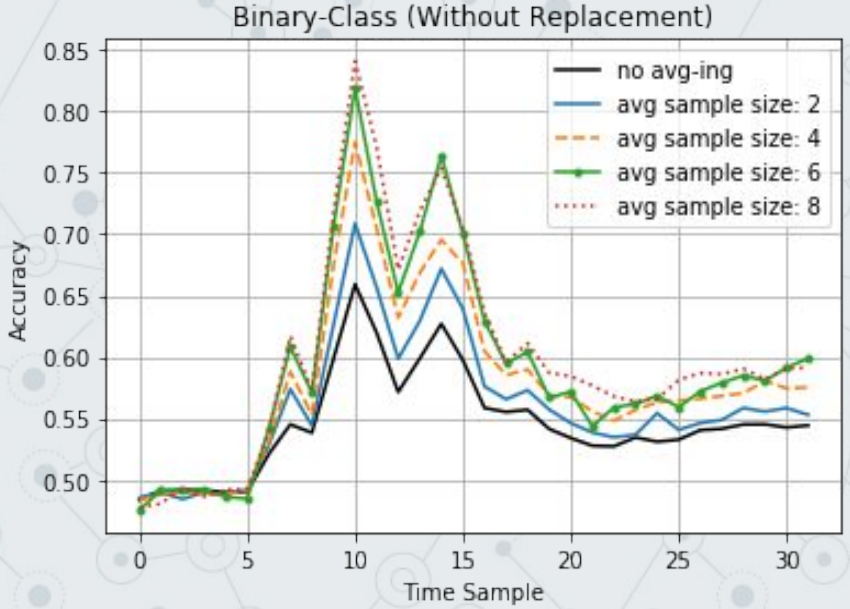
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Conclusion

- Brain differentiates human face and inanimate objects very distinctively.
- Specific region of visual recognition
- Specific time of brain response
- Augmentation effects
  - decreased SNR - more linear separability
  - Increased accuracy
- Stability of machine learning model is important

Thank you