

Hand Gesture Recognition using Random Forest Classifier

EE 277A

Fall-2019

Submitted by:

Mahrang Saeed

Shifa Shaikh

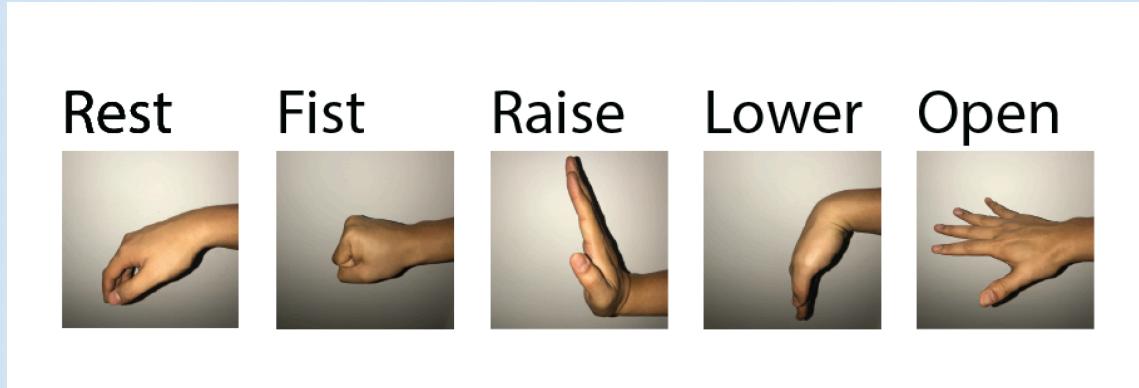
Submitted to:
Prof. Abbas Rahimi

What did we do?

- Raw data
- Pre-processing
- Hyper-parameters
- Training/Testing
- Performance improvement
- Results

Raw data

1/3



64 Electrodes

5 Gestures

5 seconds each

Subject 1, Session 1 (10 training + 10 testing trials)

Raw data

2/3

- Sampling rate : 1 kHz
- Time for each trial : 28 seconds
- Total samples in each trial : 28,000 samples

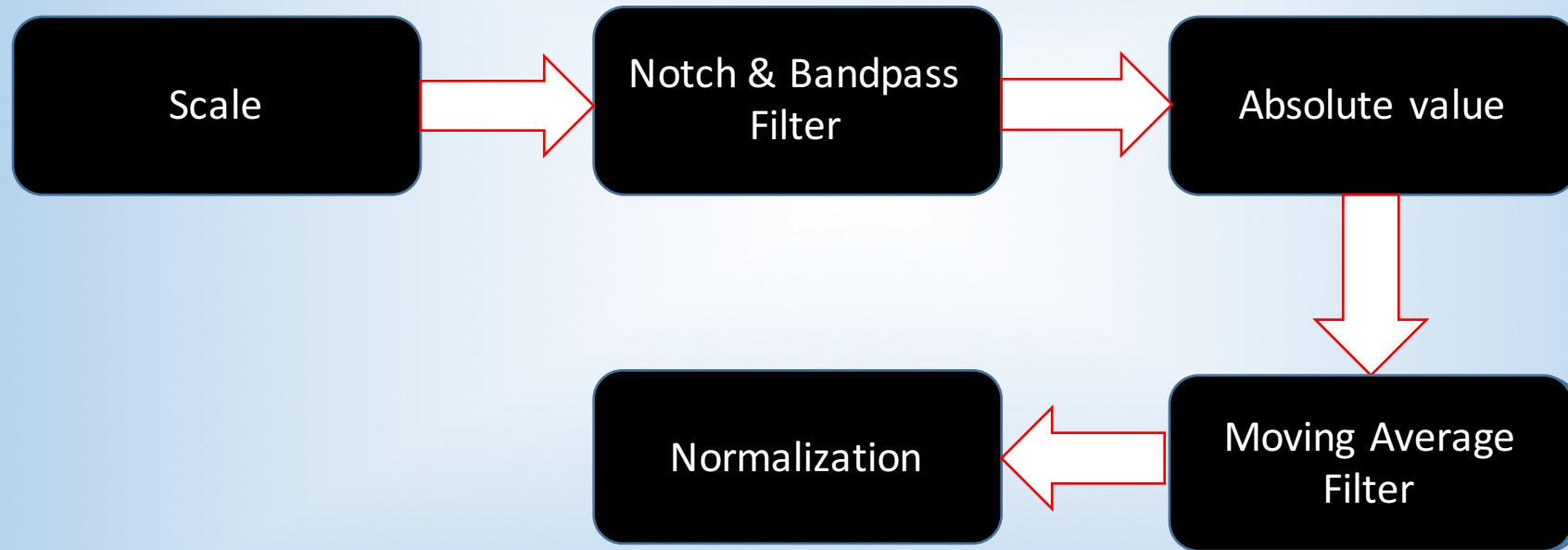
Before

- Time for each gesture: 5 seconds
- Samples in each trial: 28,000

After

- Used: middle 3 seconds
- Reduction to: 14,995 samples

Pre-processing



Pre-processing

Scale

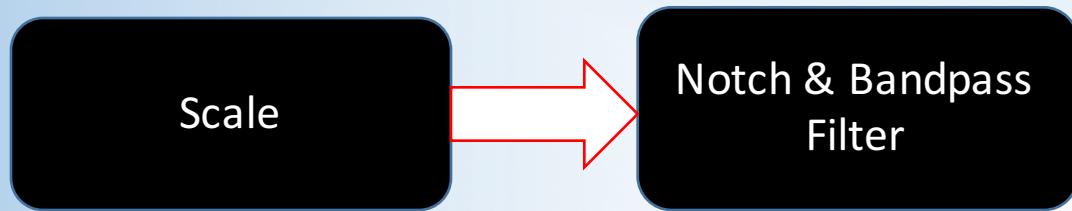
Pre-processing

Scale

Accuracy improvement:

Scaled the raw data by
factor of 10

Pre-processing



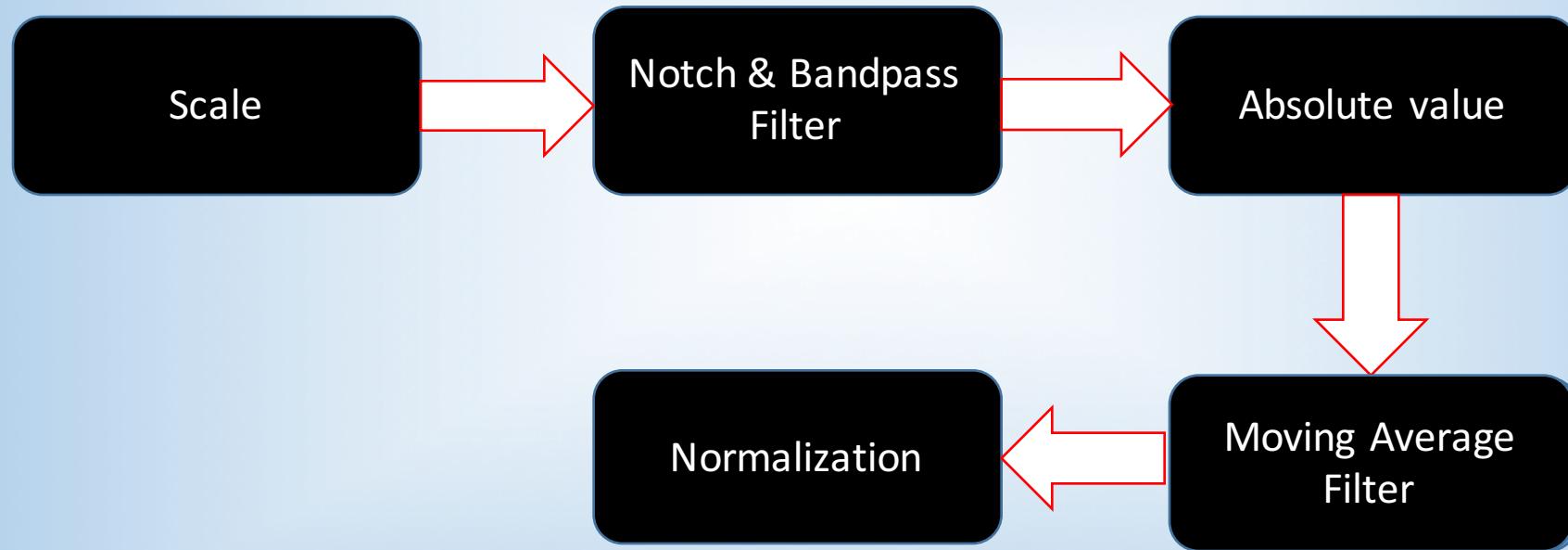
Pre-processing

Notch & Bandpass
Filter

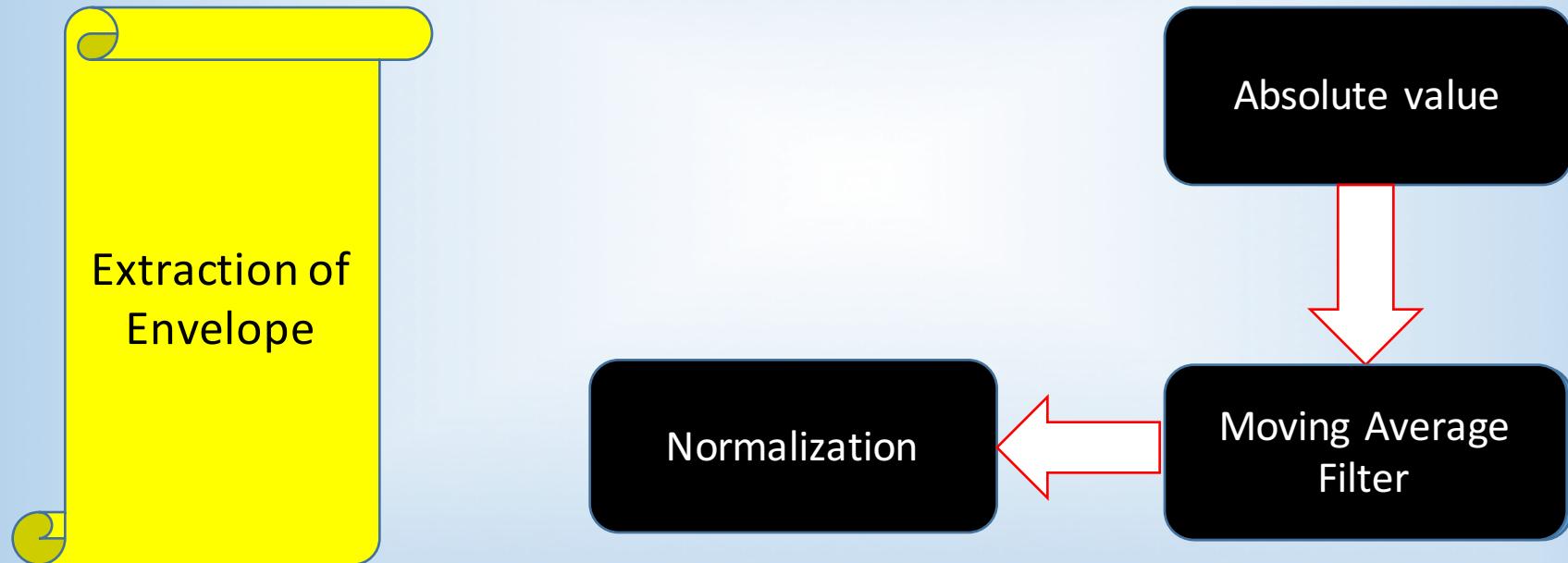
Notch filter:
Eliminates power line interference

Butterworth Band-pass filter:
Undesired frequency removal

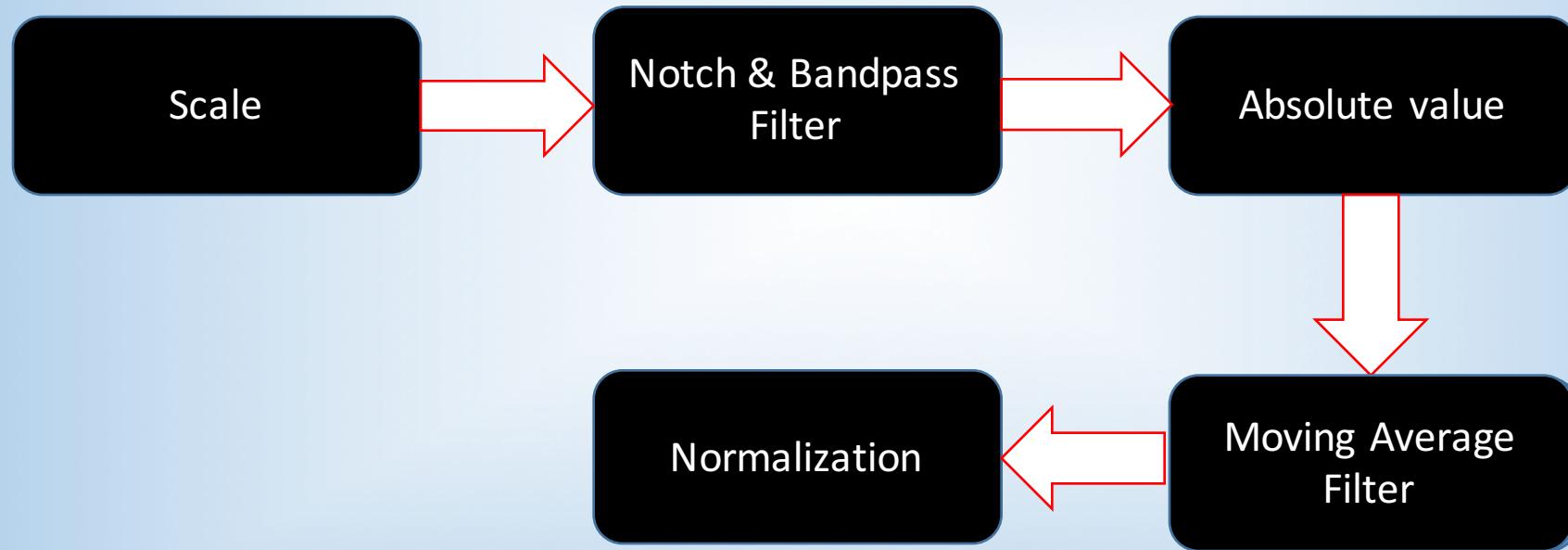
Pre-processing



Pre-processing



Pre-processing



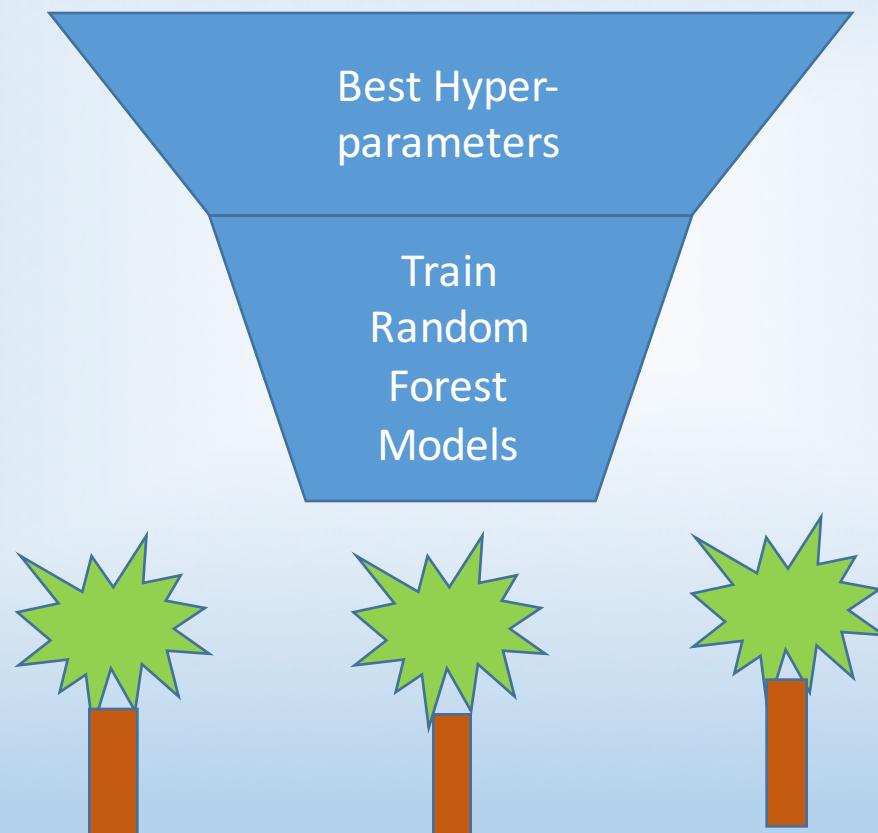
Hyper-parameters

GridSearchCV with 5-fold cross-validation



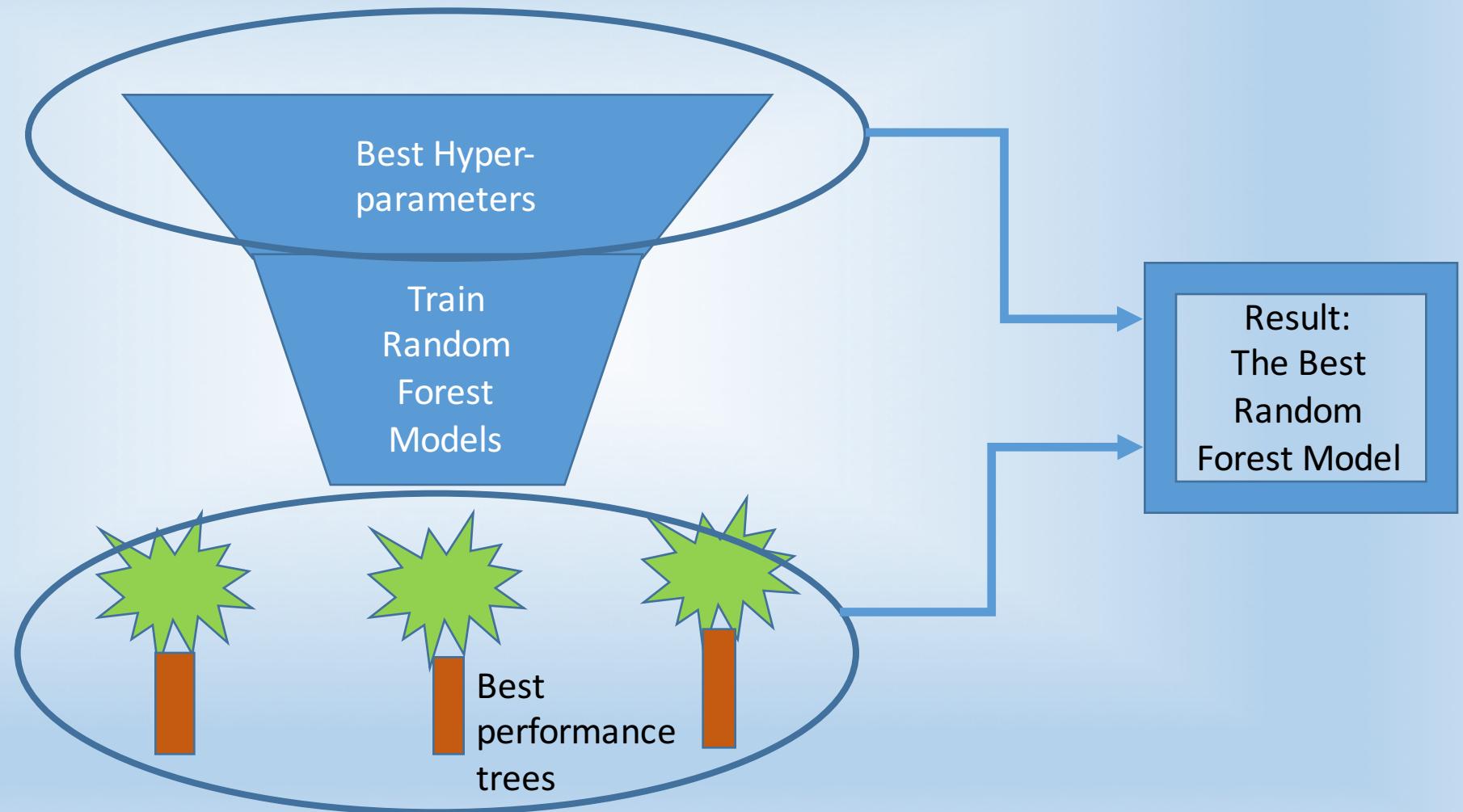
To get BEST hyper-parameters

Training/Testing



Generation of trees having
different performance

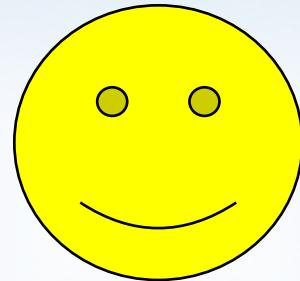
Training/Testing



Principal Components Analysis (PCA)

- Performs feature reduction
- Clusters correlated features into PC, Z
- PC are vectors comprised of features
- Each PC is perpendicular to another
- Model trained on PC instead of features

Performance Improved? Yes!



Use the Best Forest Model

+

Best Principal Components

Performance Improved? No!



Use the Best Forest Model
excluding
Principal Components

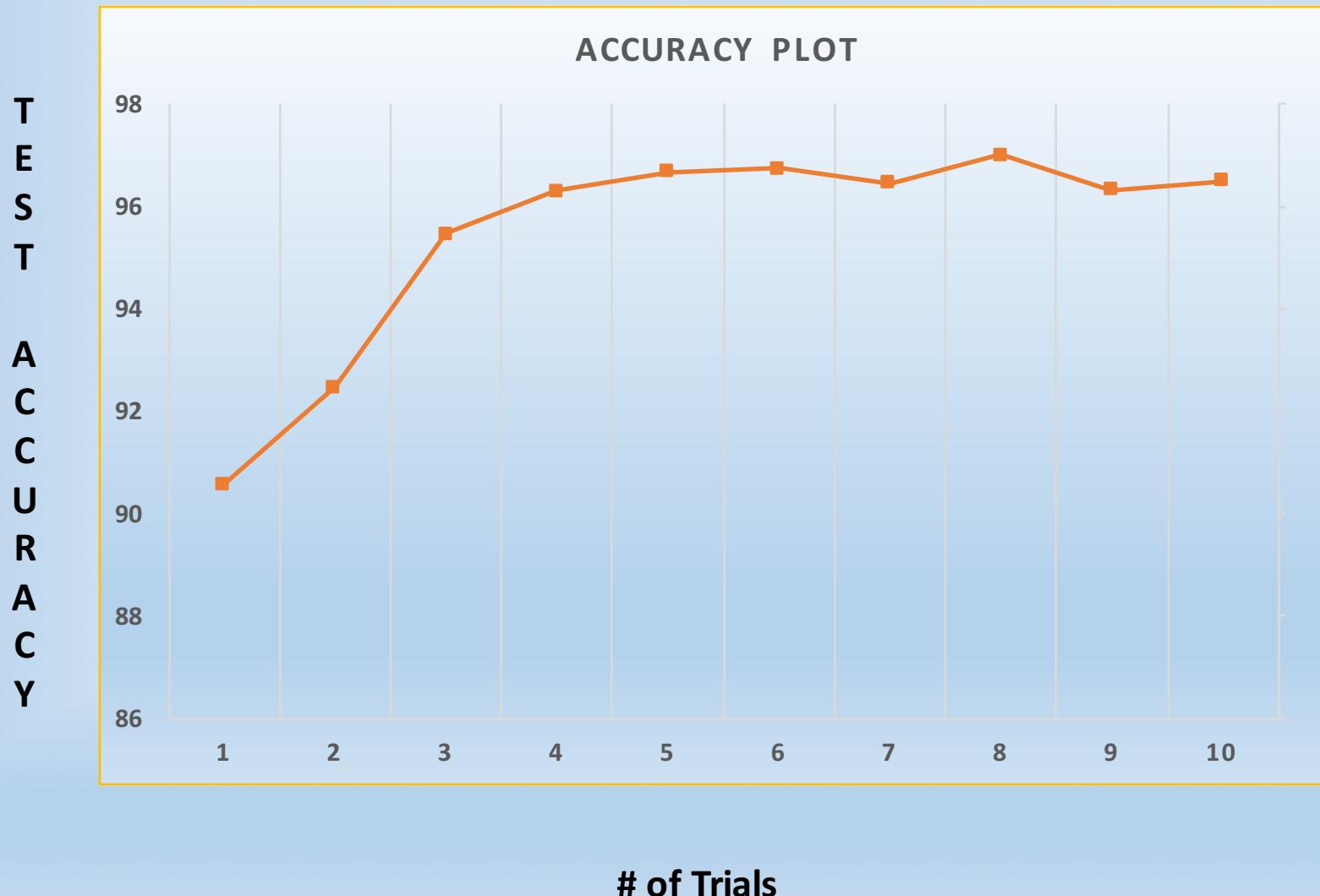
Results

1/6

| # of trials used | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| # of trees | 90 | 80 | 30 | 60 | 30 | 30 | 20 | 65 | 40 | 85 |
| Test accuracy before PCA | 85.80 | 92.46 | 95.47 | 96.30 | 96.67 | 96.73 | 96.45 | 97.00 | 96.14 | 96.48 |
| # of principle components | 8 | 40 | 8 | 28 | 32 | 32 | 32 | 64 | 40 | 40 |
| Test accuracy after PCA | 90.57 | 90.78 | 91.47 | 94.36 | 95.47 | 93.31 | 95.51 | 94.86 | 96.31 | 94.18 |
| Highest test accuracy | 90.57 | 92.46 | 95.47 | 96.30 | 96.67 | 96.73 | 96.45 | 97.00 | 96.31 | 96.48 |

Results

2/6



Results

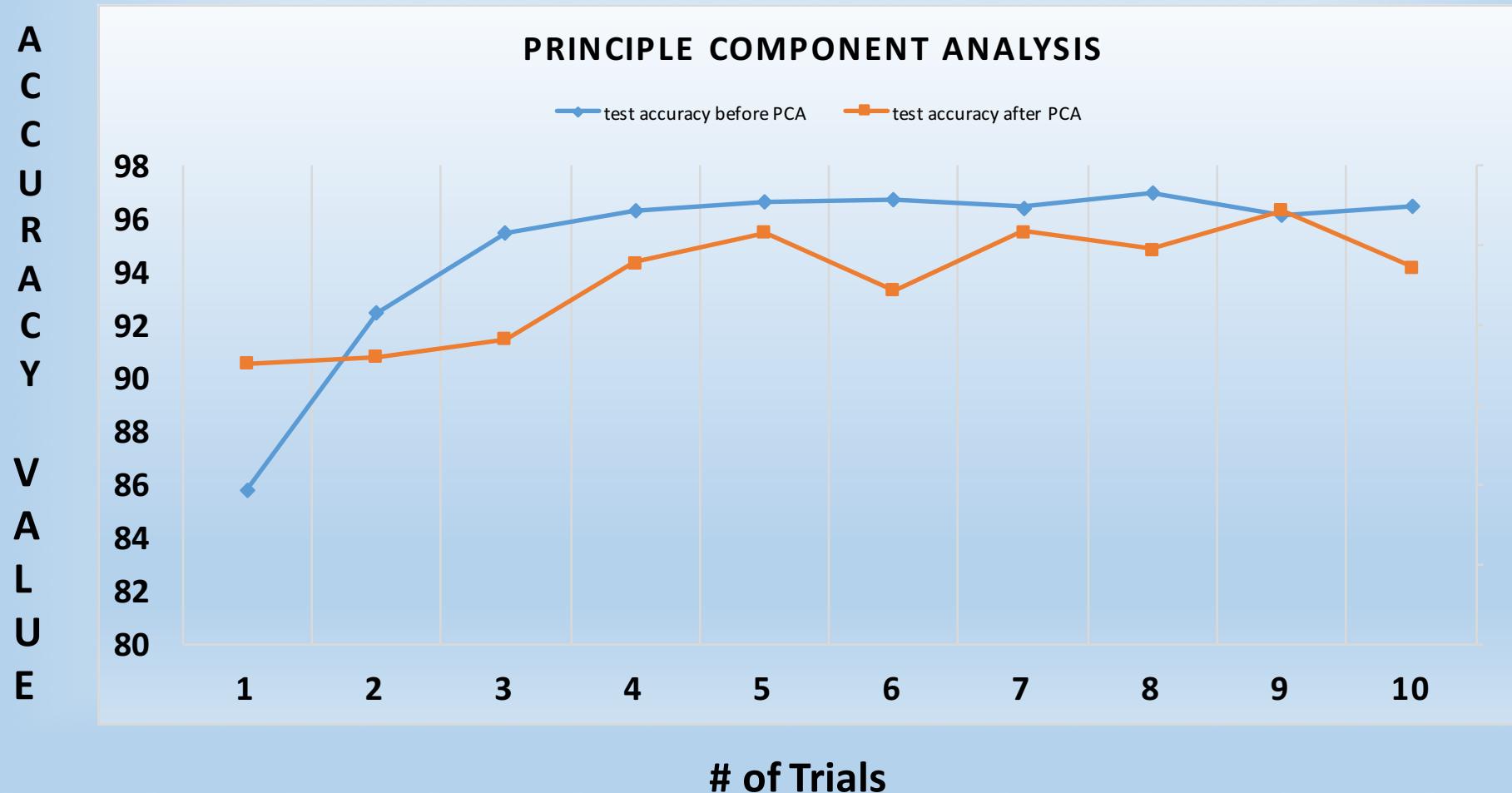
3/6

BEST PERFORMANCE

| # of trials used | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| # of trees | 90 | 80 | 30 | 60 | 30 | 30 | 20 | 65 | 40 | 85 |
| Test accuracy before PCA | 85.80 | 92.46 | 95.47 | 96.30 | 96.67 | 96.73 | 96.45 | 97.00 | 96.14 | 96.48 |
| # of principle components | 8 | 40 | 8 | 28 | 32 | 32 | 32 | 64 | 40 | 40 |
| Test accuracy after PCA | 90.57 | 90.78 | 91.47 | 94.36 | 95.47 | 93.31 | 95.51 | 94.86 | 96.31 | 94.18 |
| Highest test accuracy | 90.57 | 92.46 | 95.47 | 96.30 | 96.67 | 96.73 | 96.45 | 97.00 | 96.31 | 96.48 |

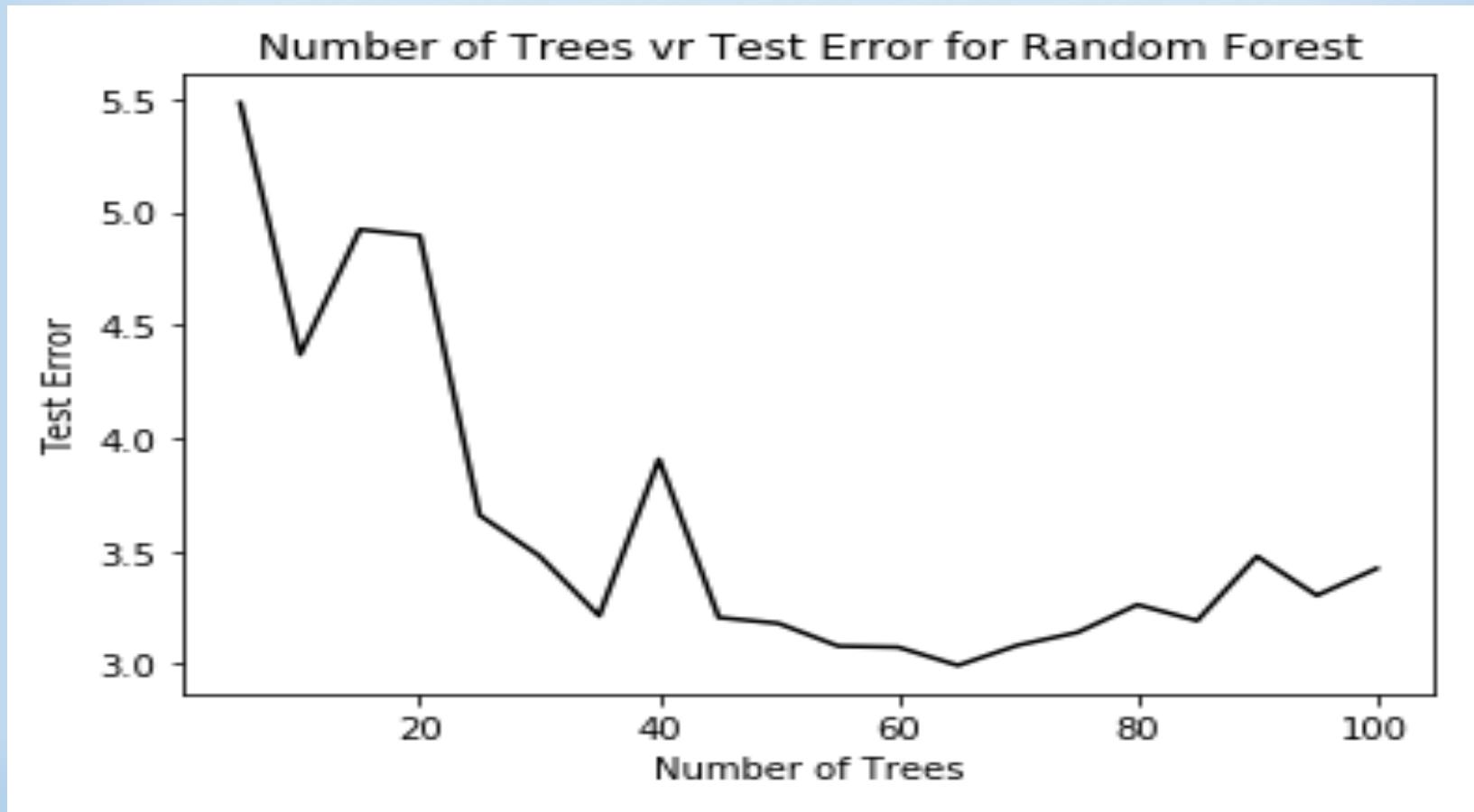
Results

4/6



Results

5/6



8 Trials

Random Forest Classifier

- Maximum Accuracy: 97.00%
- # trials= 8
- # samples/trial= 14,995

Hyper-Dimensional Classifier

- Maximum Accuracy: 96.64%
- # trials= 3
- # samples/trial= 5

Conclusion

Random Forest Classifier improves accuracy by 0.36% but requires larger training set than HD Classifier.

References

- An EMG Gesture Recognition System with Flexible High-Density Sensors and Brain-Inspired High-Dimensional Classifier by Ali Moin, Andy Zhou, Abbas Rahimi, Simone Benatti, Alisha Menon, Senam Tamakloe, Jonathan Ting, Natasha Yamamoto, Yasser Khan, Fred Burghardt, Luca Benini, Ana C. Arias, Jan M. Rabaey.
- Forests for randomized trees; scikit learn userguide.
- Random Forest wikipedia.com
- A One-Stop Shop for Principal Component Analysis by Matt Brems April 17, 2017.

Thank you for your precious
time!

Questions are always welcome