

# Hand Gesture Recognition using Random Forest Classifier

EE 277A

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Submitted by:

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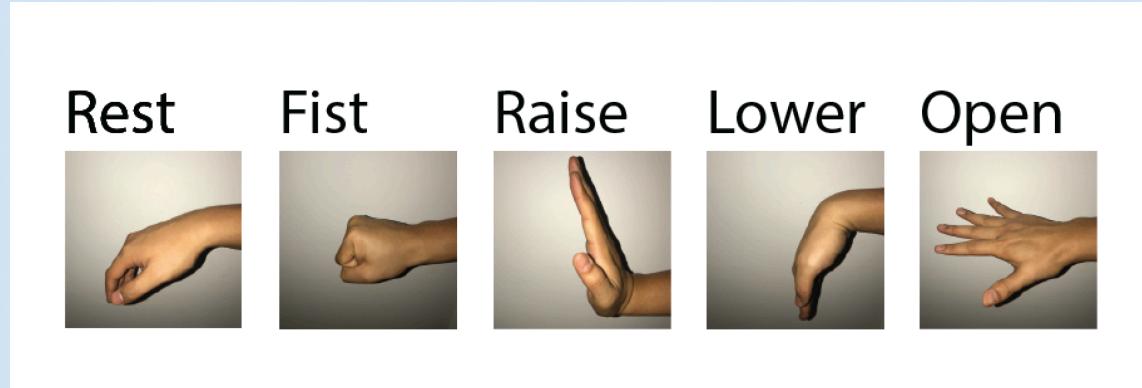
Submitted to:  
Prof. Abbas Rahimi

# What did we do?

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

# Raw data

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64 Electrodes

5 Gestures

5 seconds each

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

# Raw data

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

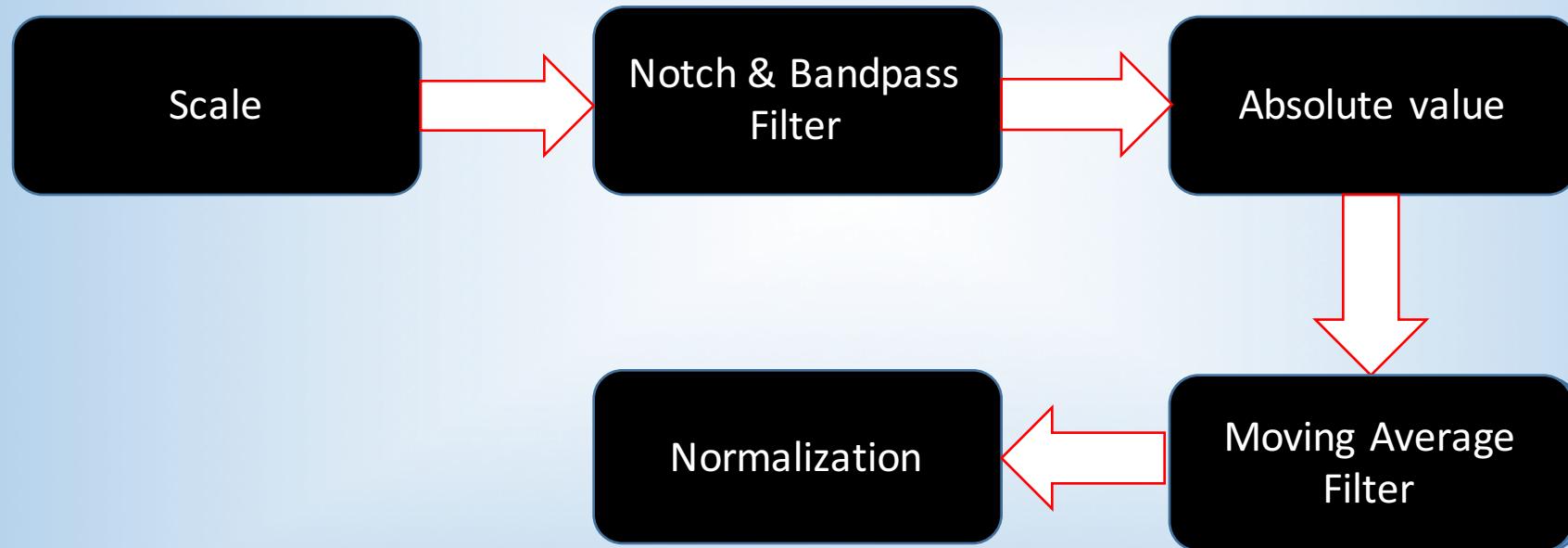
## Before

- 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

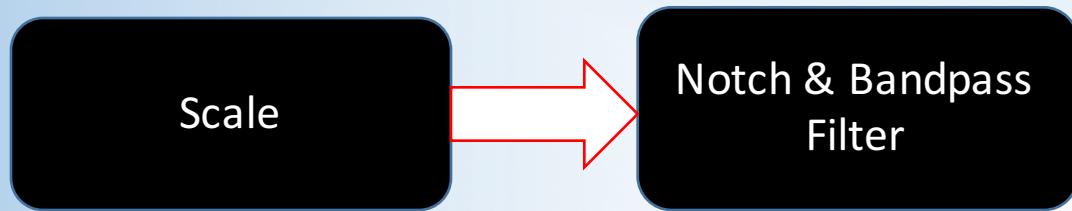
# Pre-processing

Scale

Accuracy improvement:

Scaled the raw data by  
factor of 10

# Pre-processing



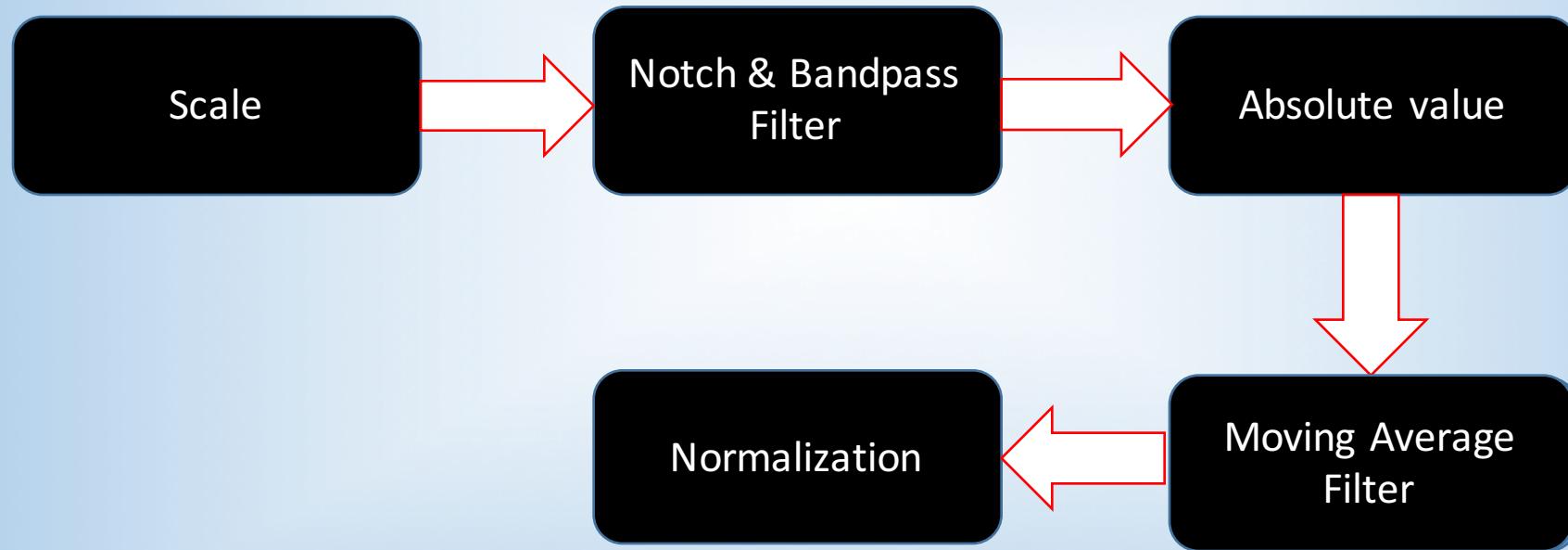
# Pre-processing

Notch & Bandpass  
Filter

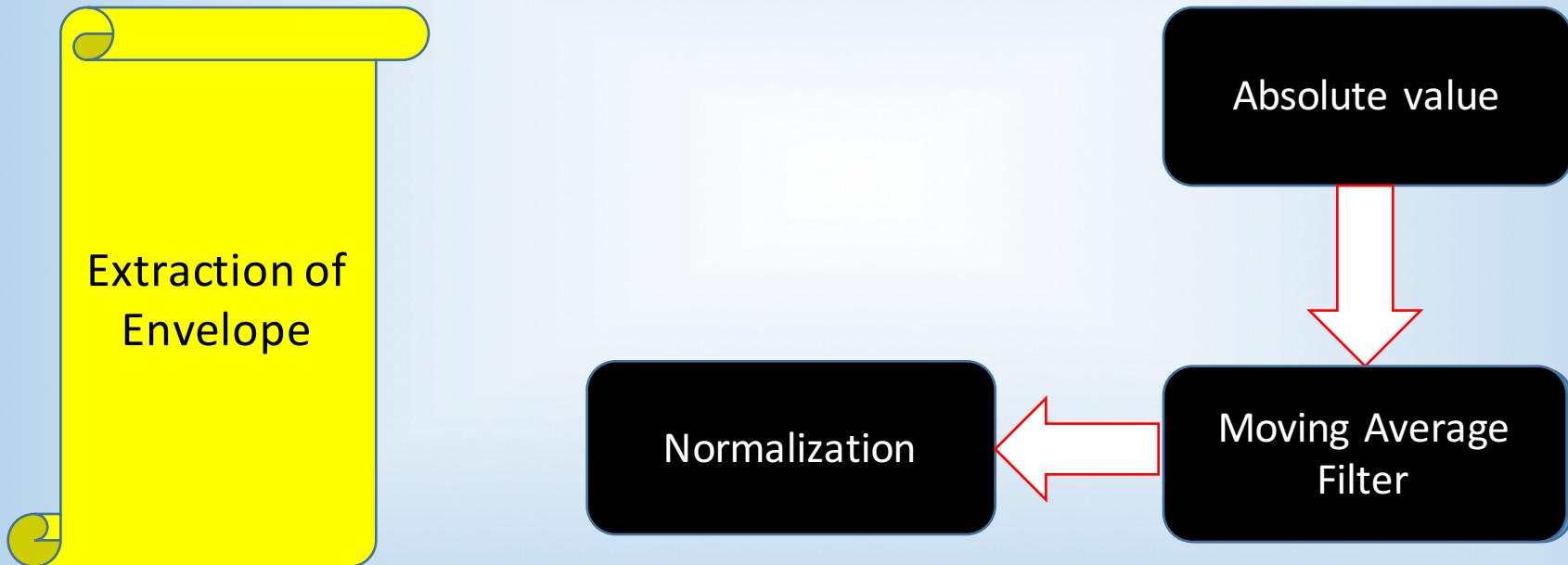
Notch filter:  
Eliminates power line interference

Butterworth Band-pass filter:  
Undesired frequency removal

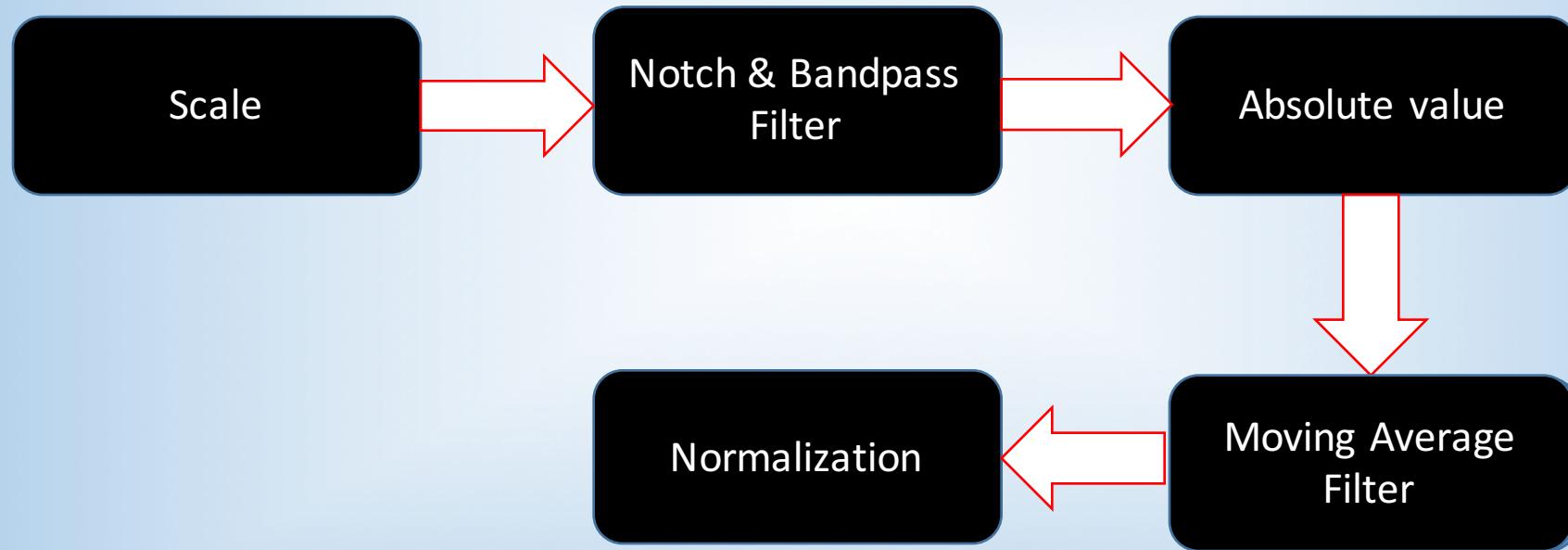
# Pre-processing



# Pre-processing



# Pre-processing



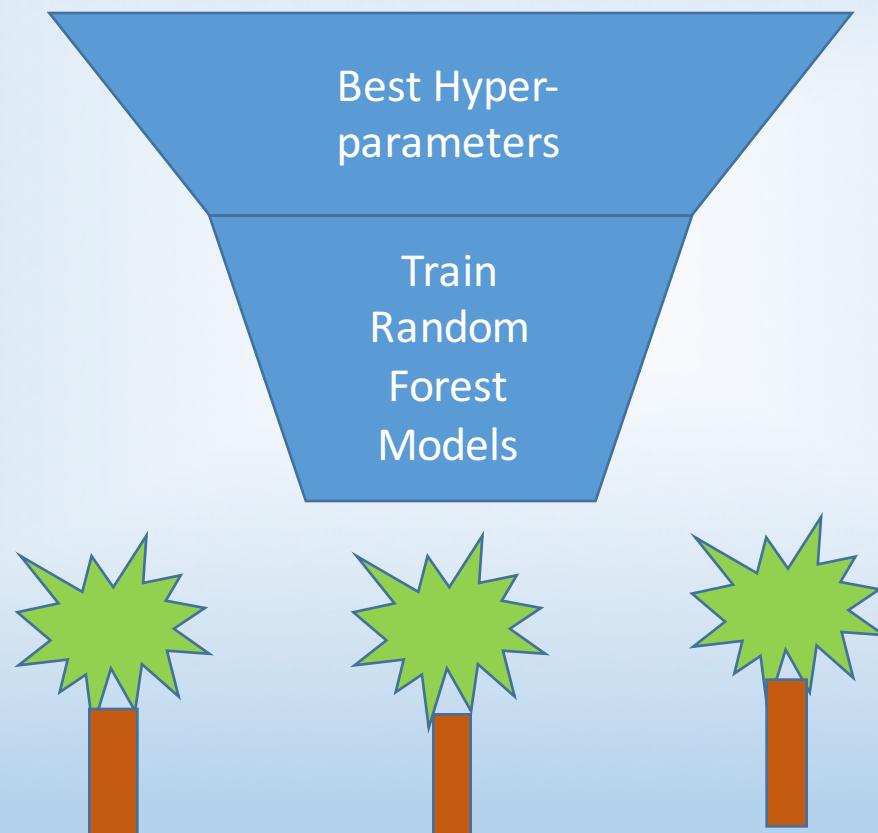
# Hyper-parameters

GridSearchCV with 5-fold cross-validation



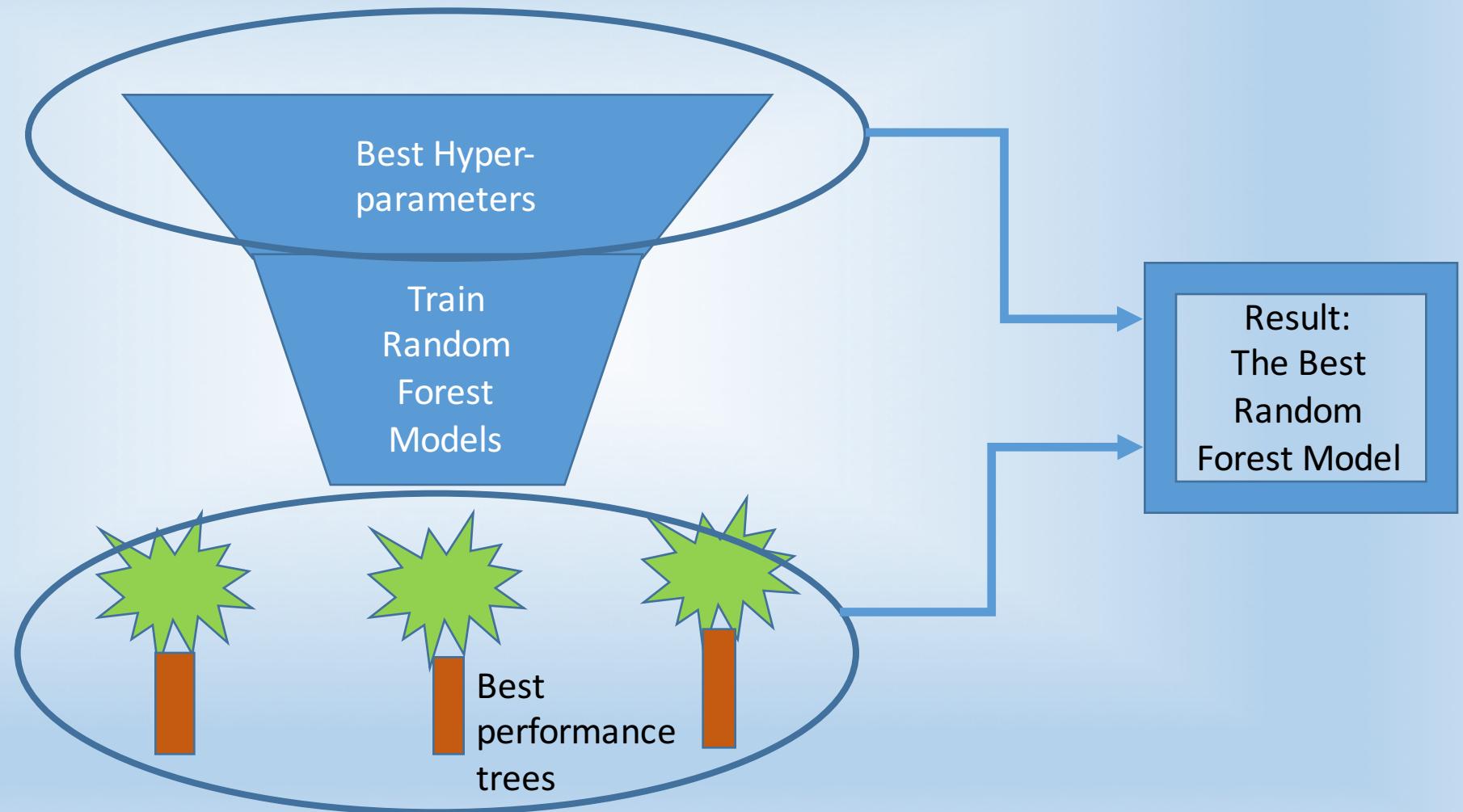
To get BEST hyper-parameters

# Training/Testing



Generation of trees having  
different performance

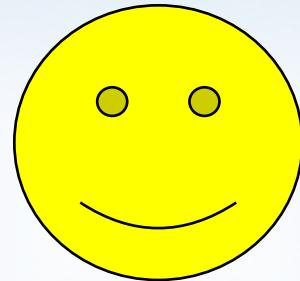
# Training/Testing



# 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!

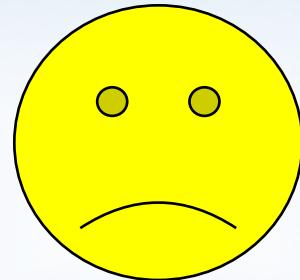


Use the Best Forest Model

+

Best Principal Components

# Performance Improved? No!



Use the Best Forest Model  
excluding  
Principal Components

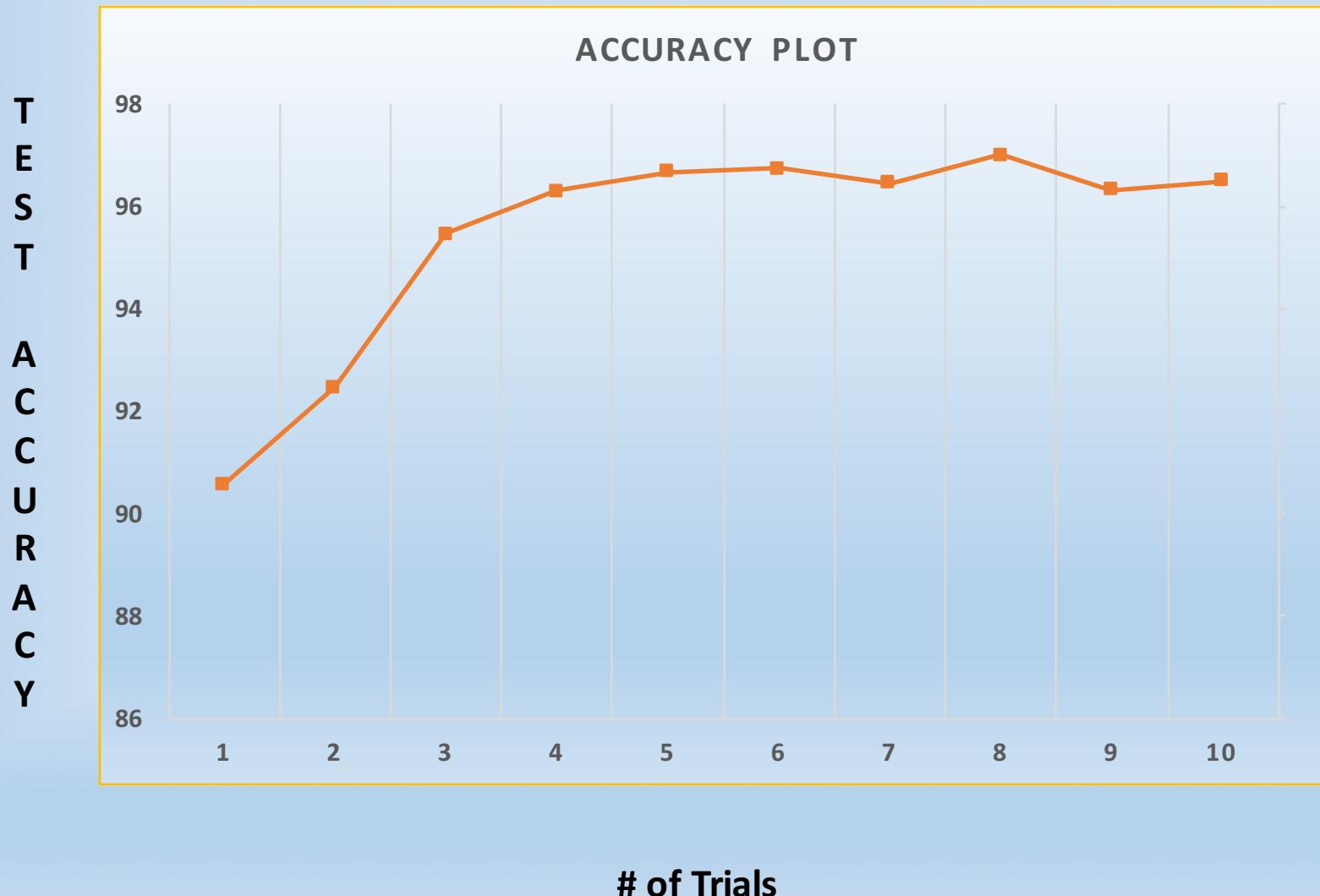
# Results

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# 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

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# Results

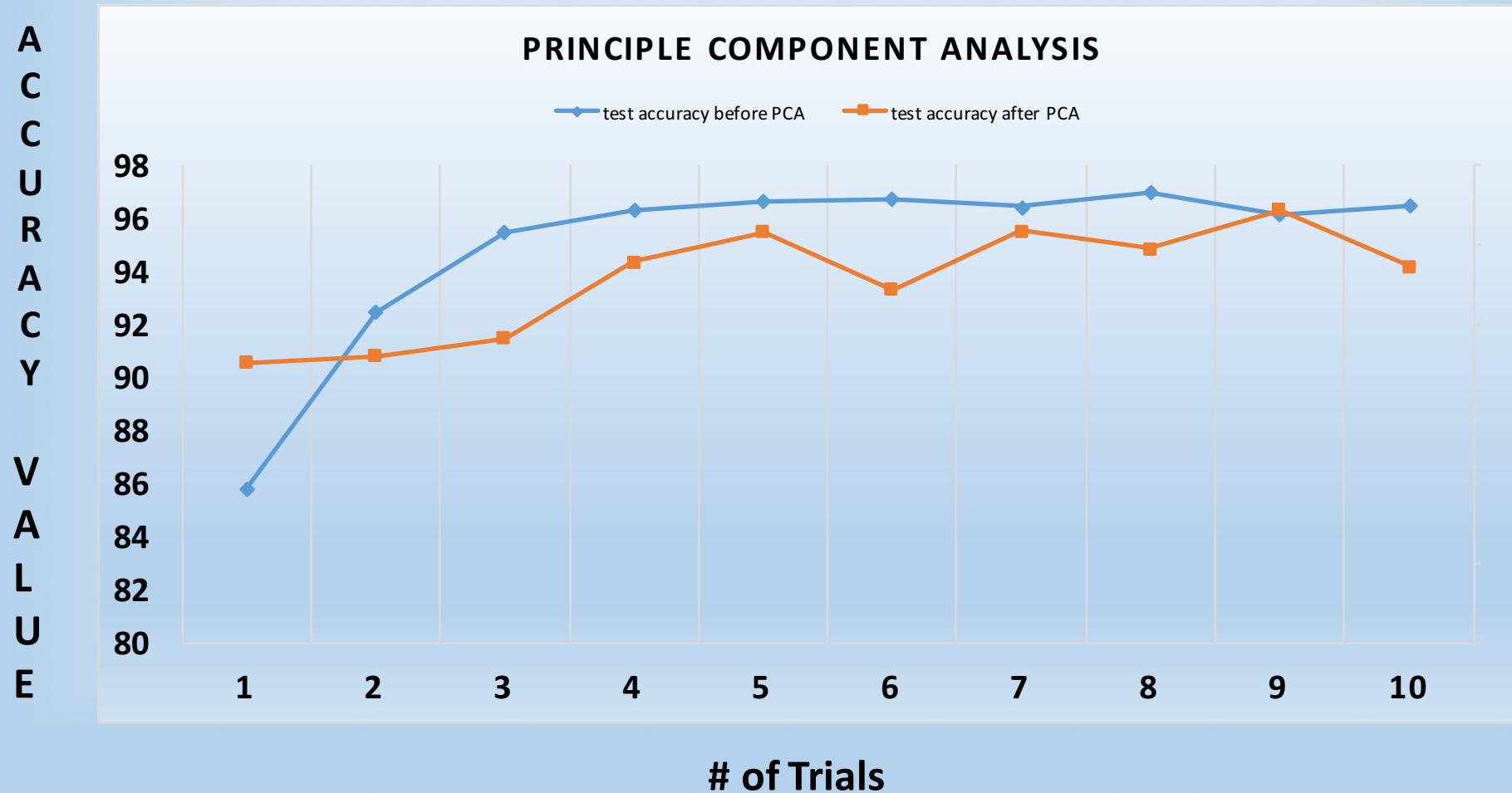
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## BEST PERFORMANCE

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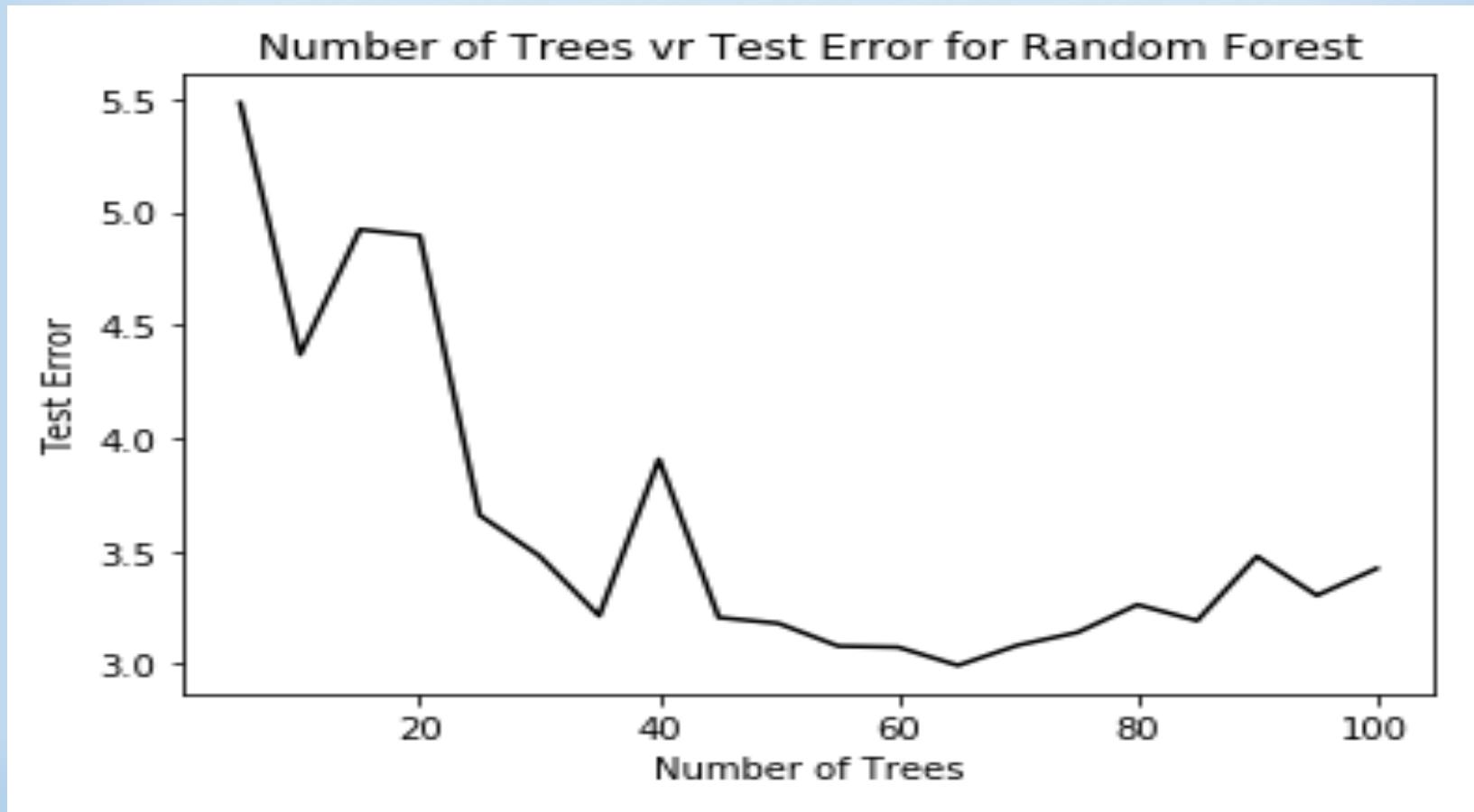
# Results

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# Results

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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.