

***Implementation-Friendly Convolution Neural
Network For Sign Language Recognition Using Wi-Fi
CSI Data***

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Contents

- ❖ Introduction
- ❖ Problem Statement
- ❖ Broad Overview
- ❖ Sample CSI Data
- ❖ Pre-Processing
- ❖ Result Analysis
- ❖ Conclusion
- ❖ Future Directions
- ❖ References

Introduction

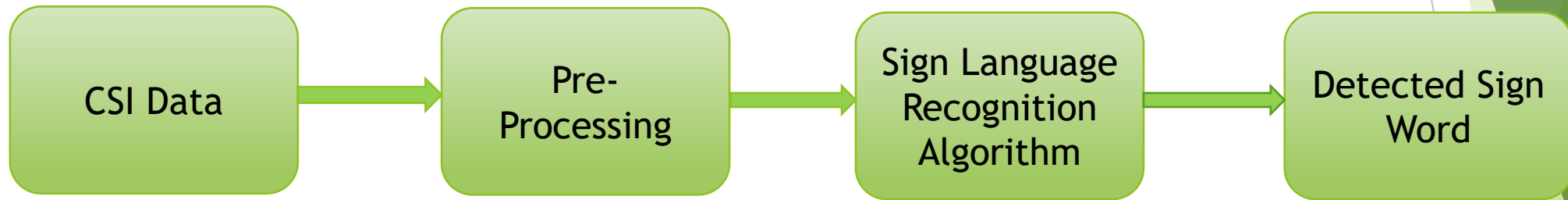
- ❑ Sign language is vital for deaf and hard of hearing individuals worldwide.
- ❑ Sign-Fi use Wi-Fi signals as a mode of communication for deaf community.
- ❑ The channel state information (CSI) collected from access points (APs) is employed for the purpose of detecting sign words.
- ❑ The ability to accurately recognize a wider range of sign words can be significantly enhanced.
- ❑ Can foster better communication and connectivity within the deaf community.



Problem Statement

- Accurate Real-Time Sign Language Detection
- Proper utilization of the CSI Data
- Privacy and Ethical Consideration
- Scalability and Adaptability
- Potential for Multimodal Integration
- Real World Deployment
- Promoting Inclusivity and Accessibility

Broad Overview



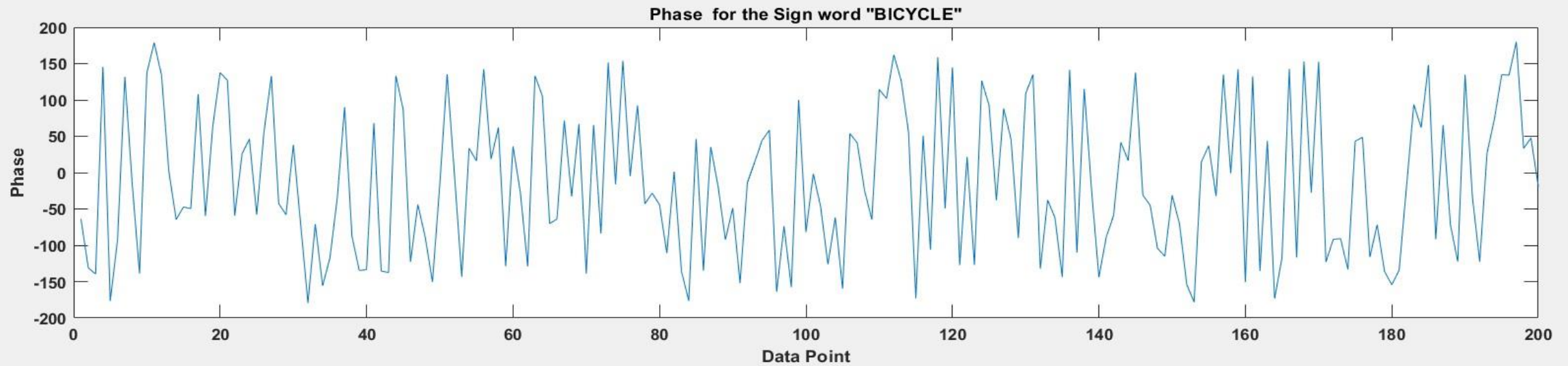
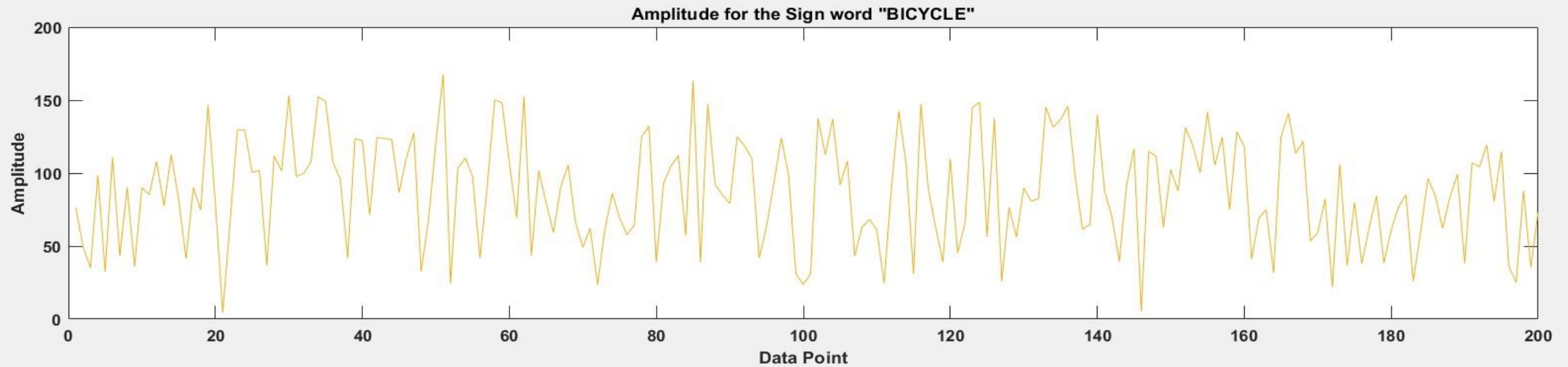
Broad Overview Contd.

CSI Data Arranged as (200,30,3,n) where,

- ▶ 200 is the number of data point.
- ▶ 30 is the number of sub-carrier.
- ▶ 3 is the number of antenna.
- ▶ n is the number of samples.

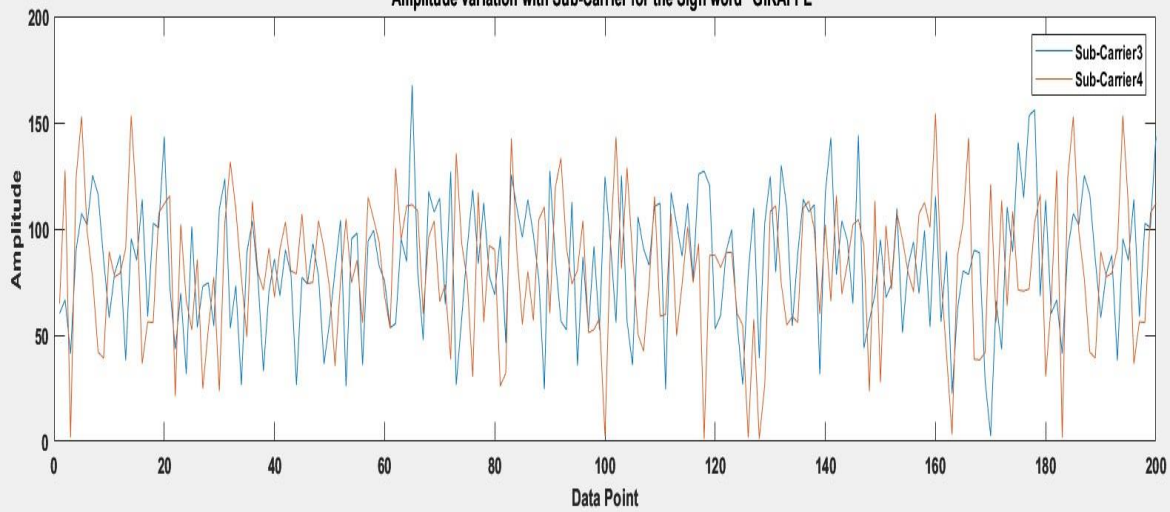
Dataset Name	Number of Samples	Number of Class
Lab_downlink	5520	276
Lab_uplink	5520	276
Home_uplink	2760	276
Home_downlink	2760	276
Lab_downlink	7500	150

Sample CSI Data

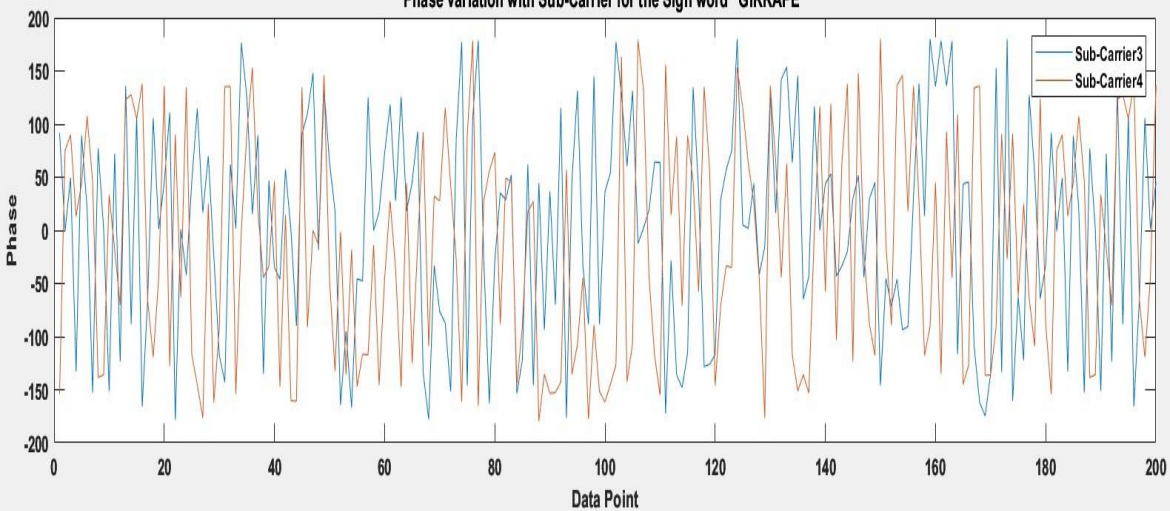


Sample CSI Data Contd.

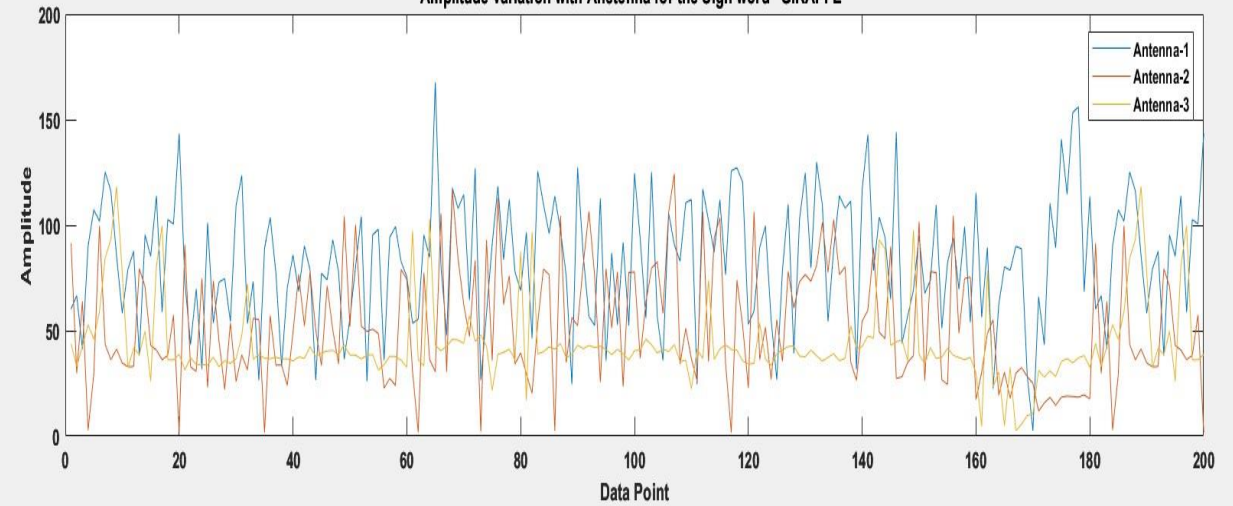
Amplitude variation with Sub-Carrier for the Sign word "GIRAFFE"



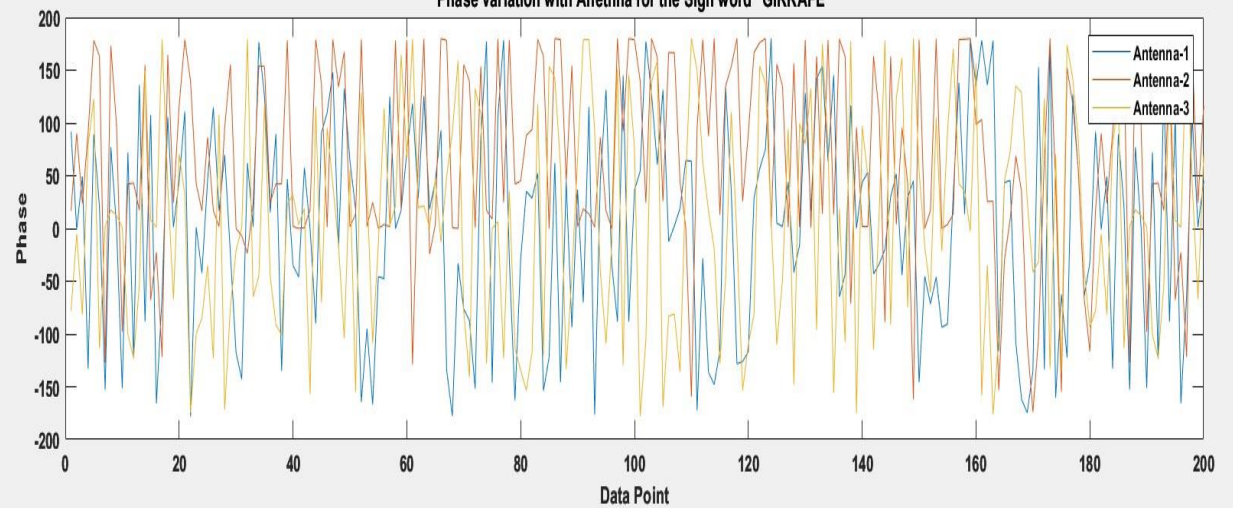
Phase variation with Sub-Carrier for the Sign word "GIRAFFE"



Amplitude variation with Antenna for the Sign word "GIRAFFE"



Phase variation with Antenna for the Sign word "GIRAFFE"



Pre-Processing

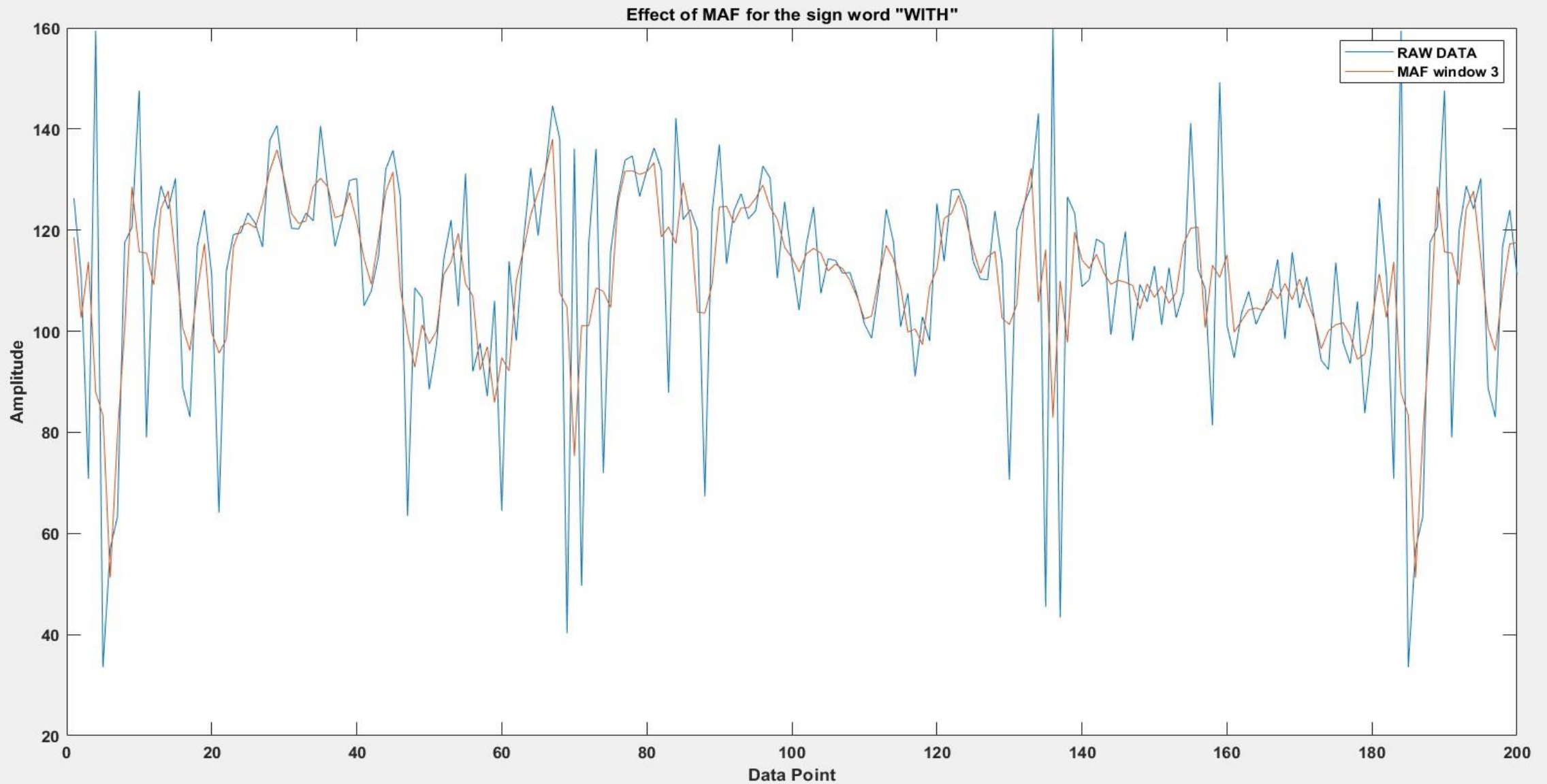
- ✓ Data Collection and Synchronization
- ✓ Noise Reduction and Filtering
- ✓ Feature Extraction
- ✓ Calibration and Normalization
- ✓ Dimensionality Reduction
- ✓ Data Augmentation

Amplitude Correction

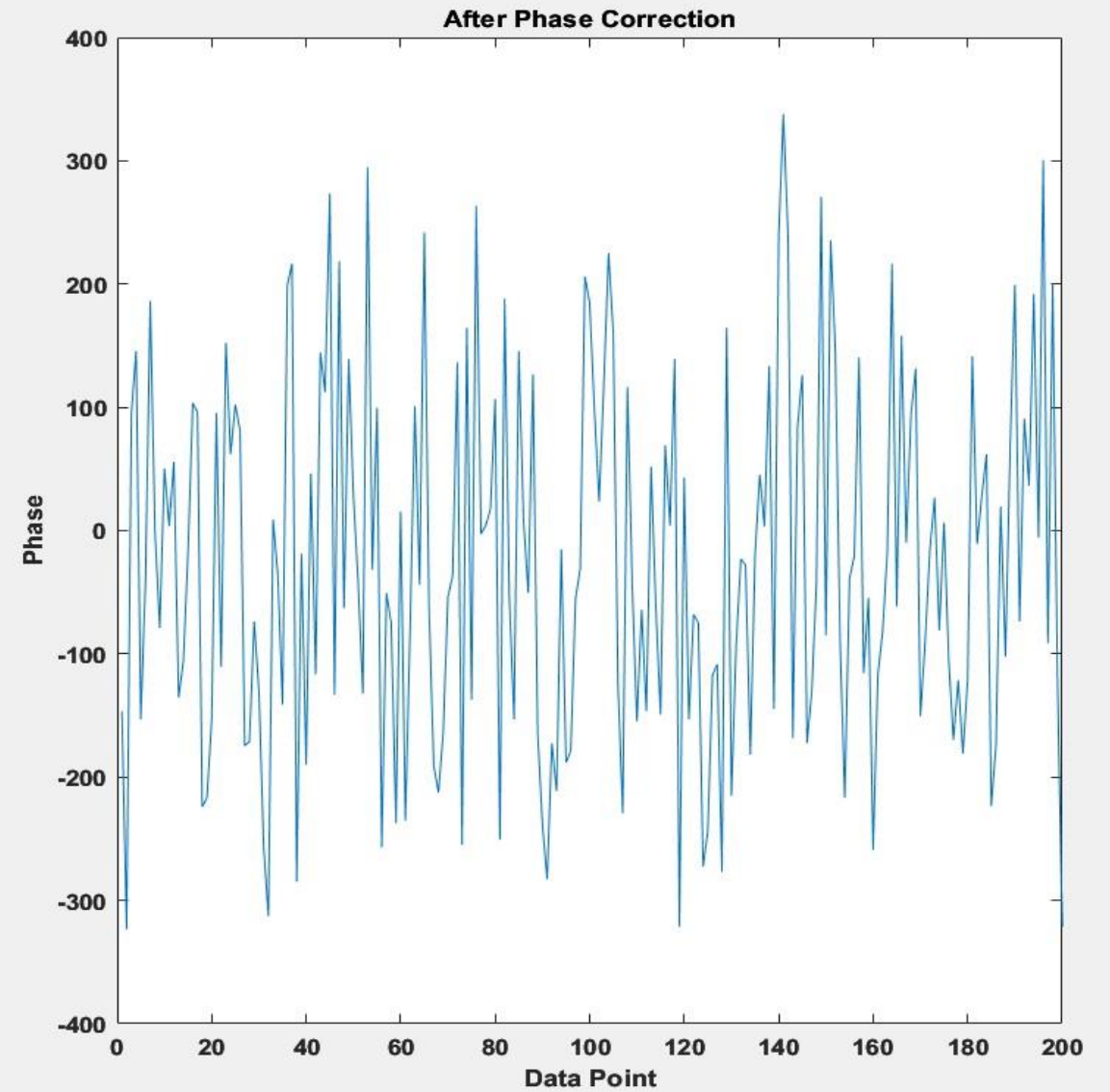
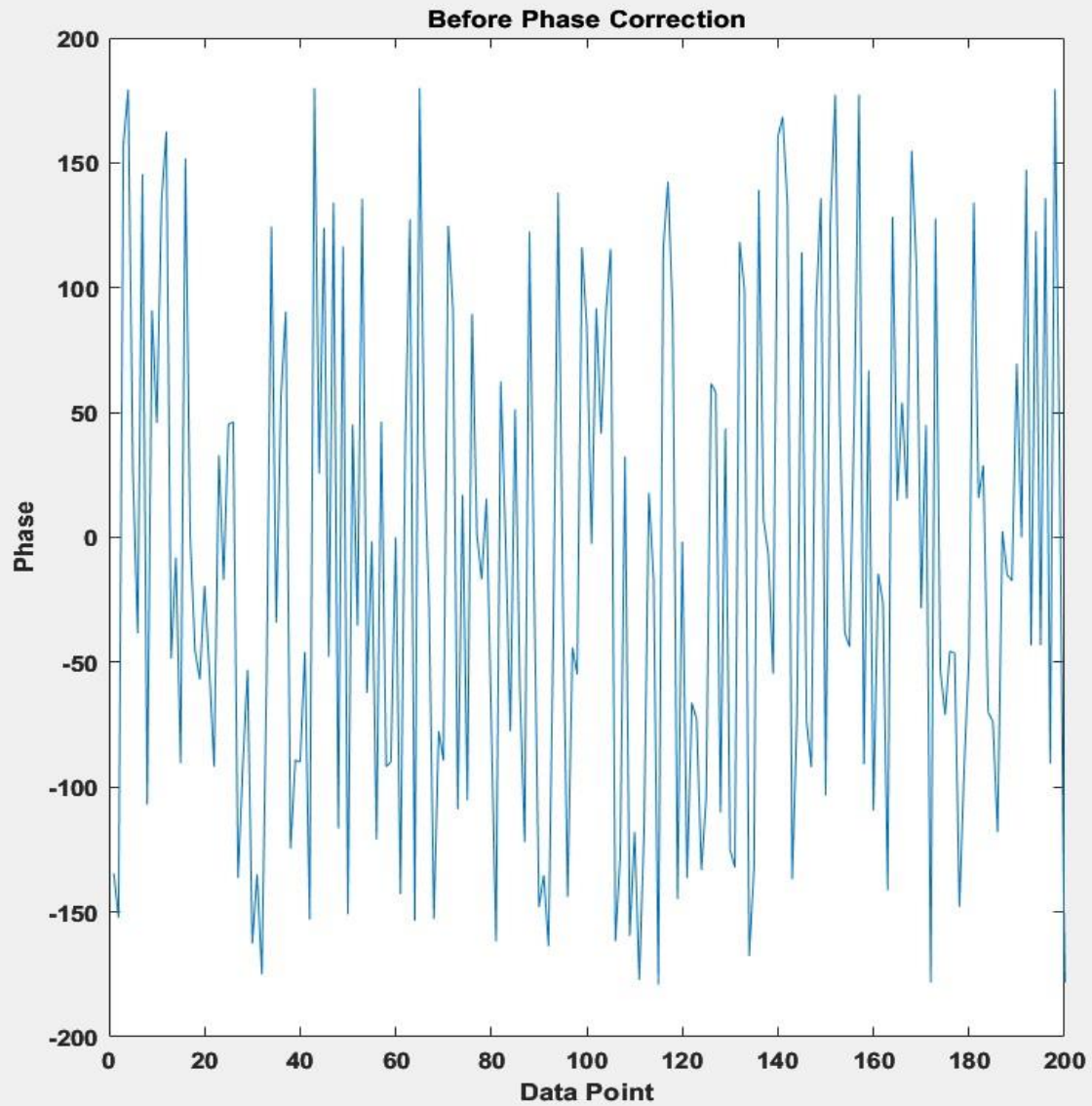
Phase Correction

Scaling

Pre-Processing Contd.



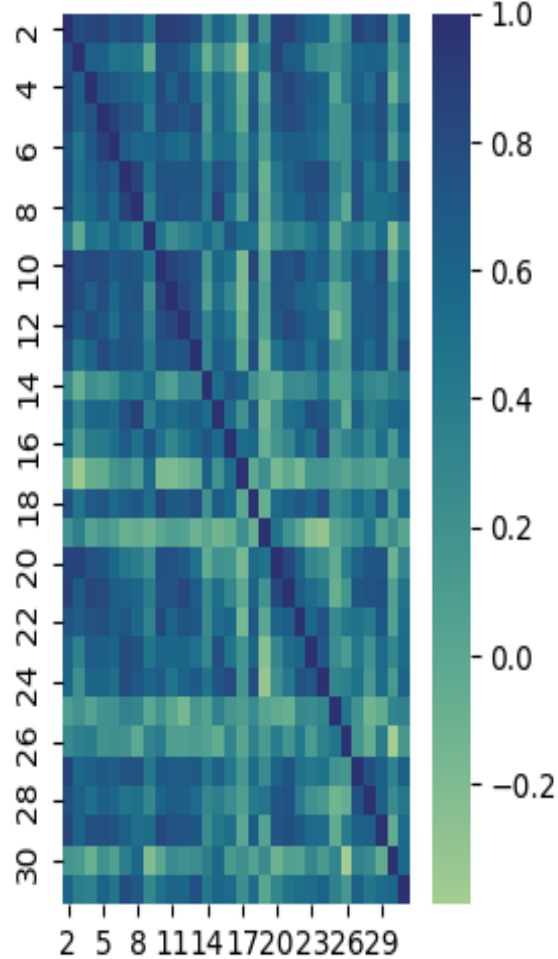
Pre-Processing Contd.



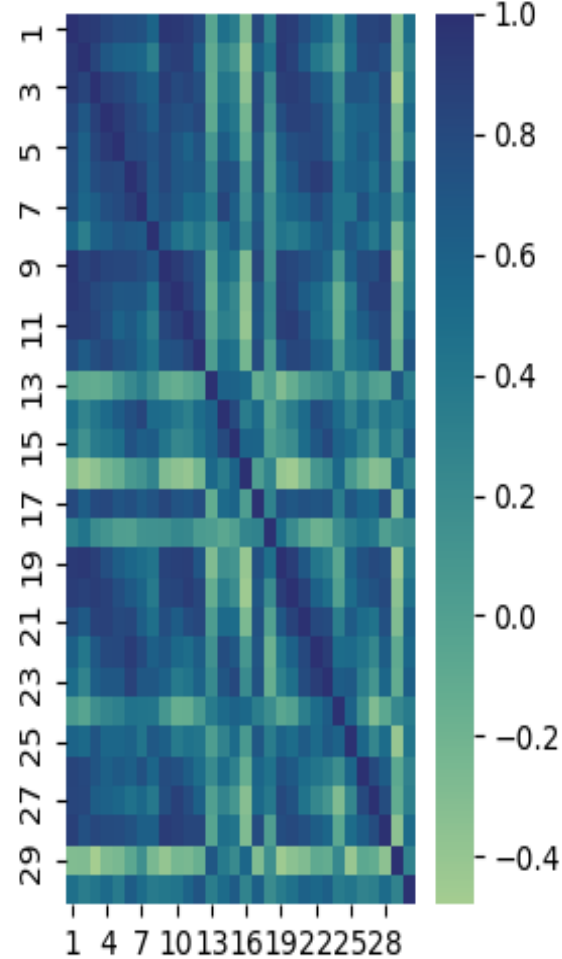
Pre-Processing Contd.

Correlation Coefficient Change with MAF

Before

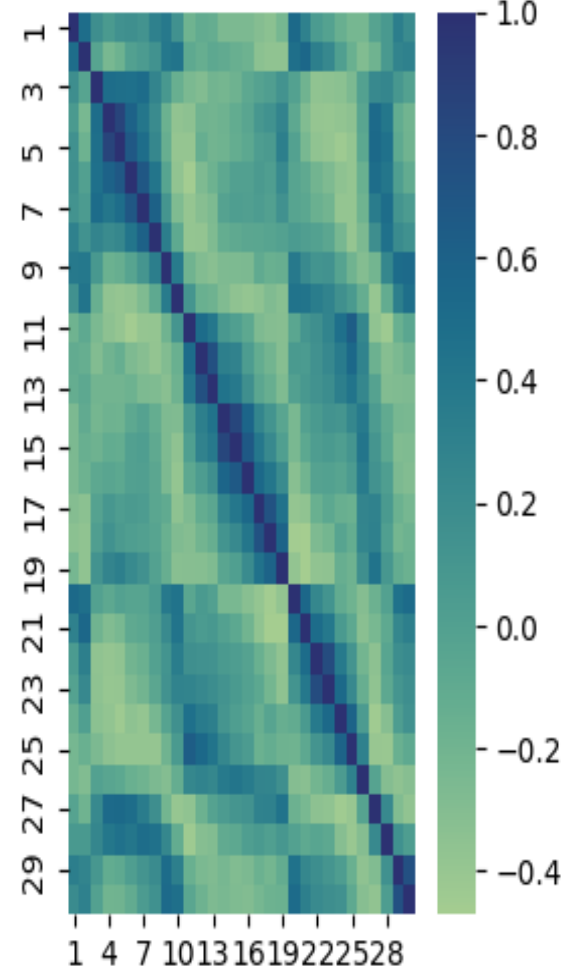


After

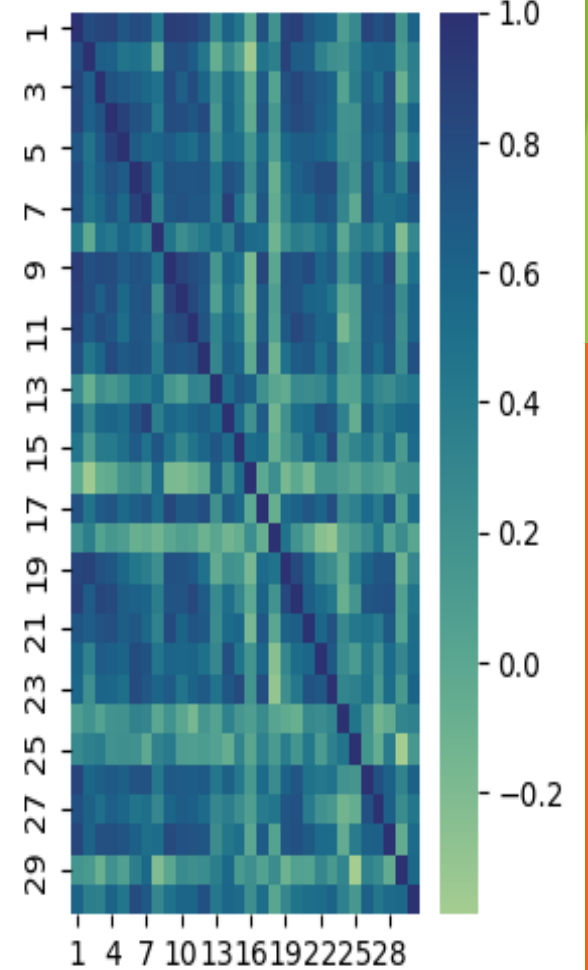


Correlation Coefficient Change with Phase Filtering

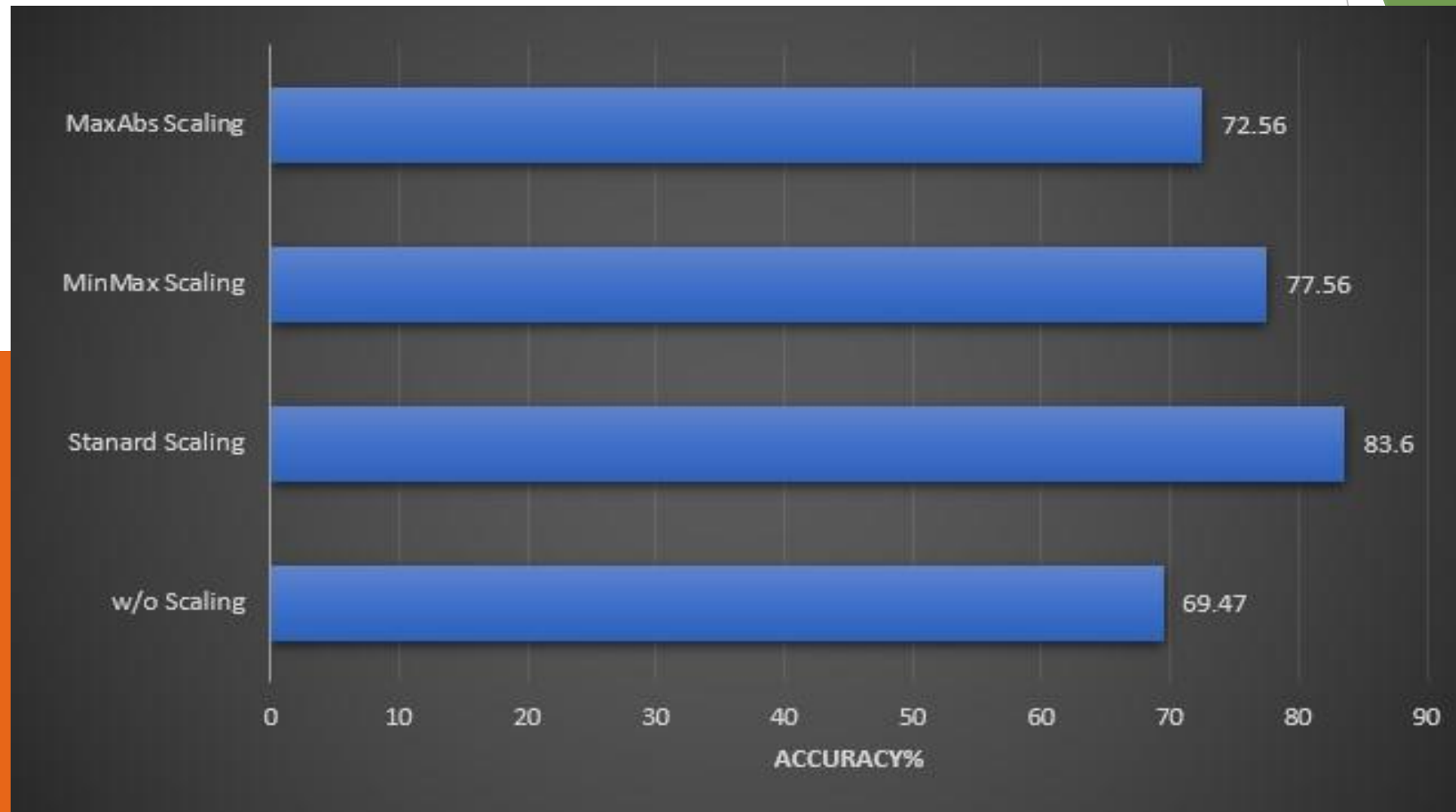
Before



After



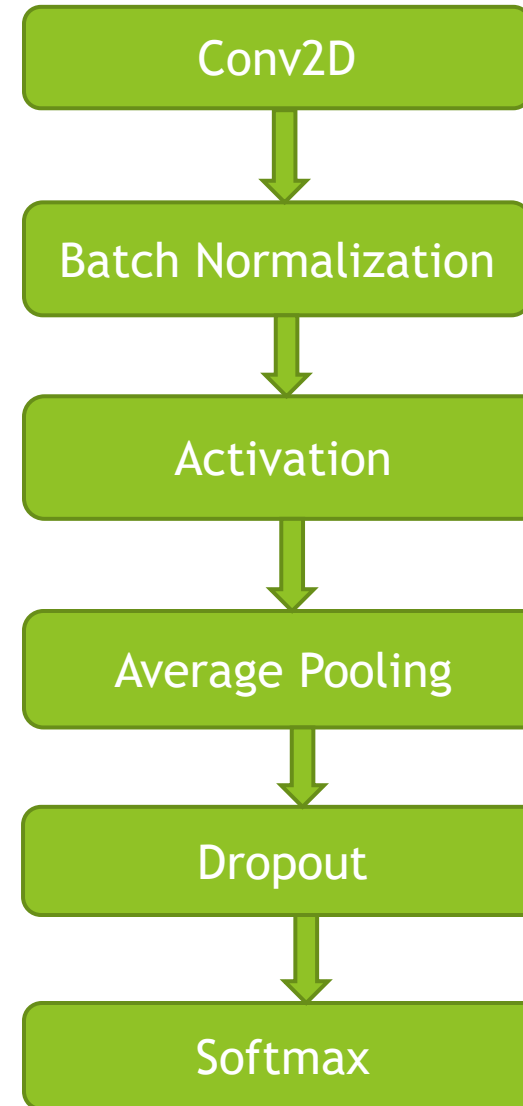
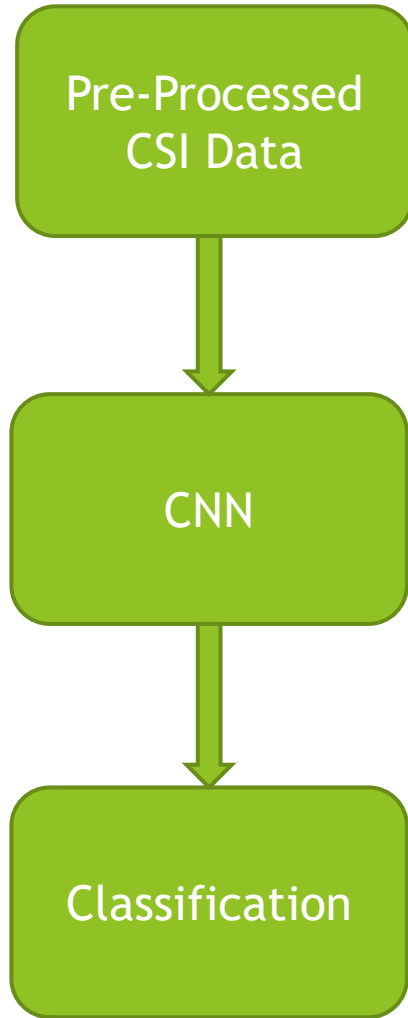
Pre-Processing Contd.



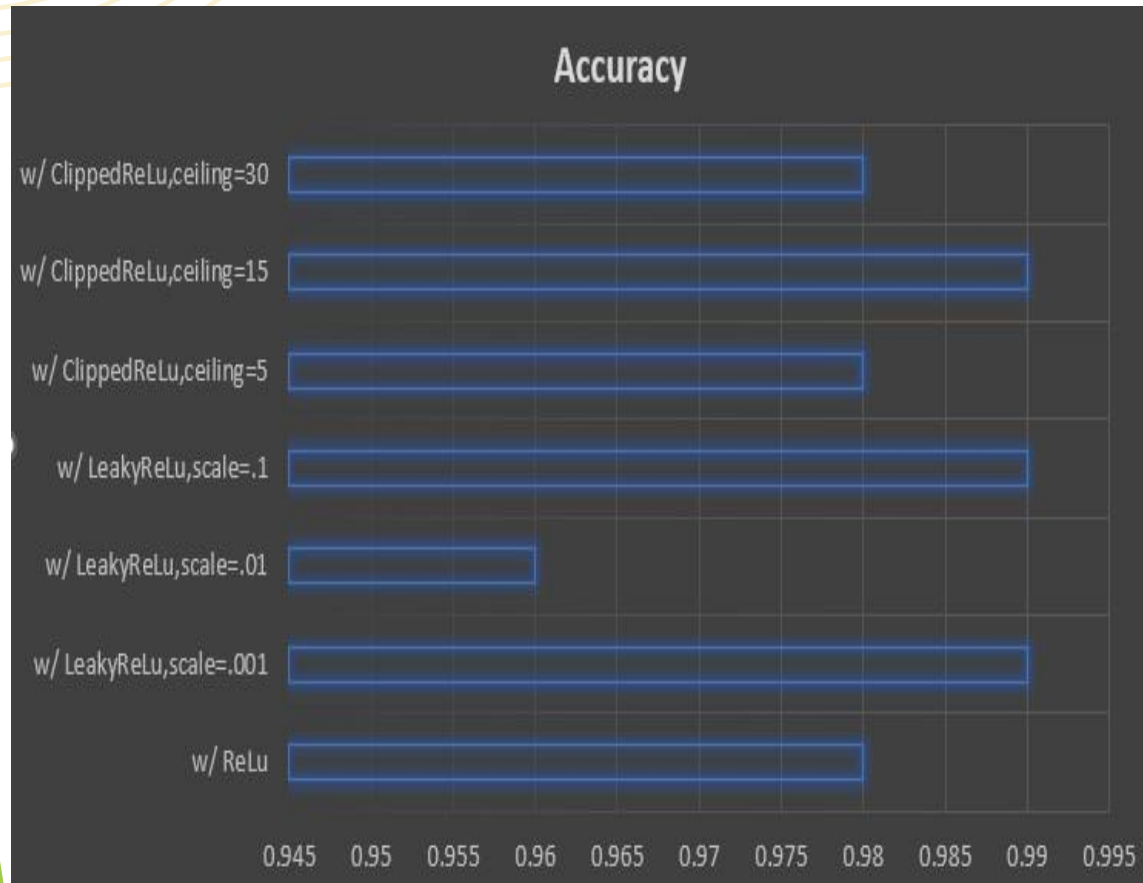
Result Analysis



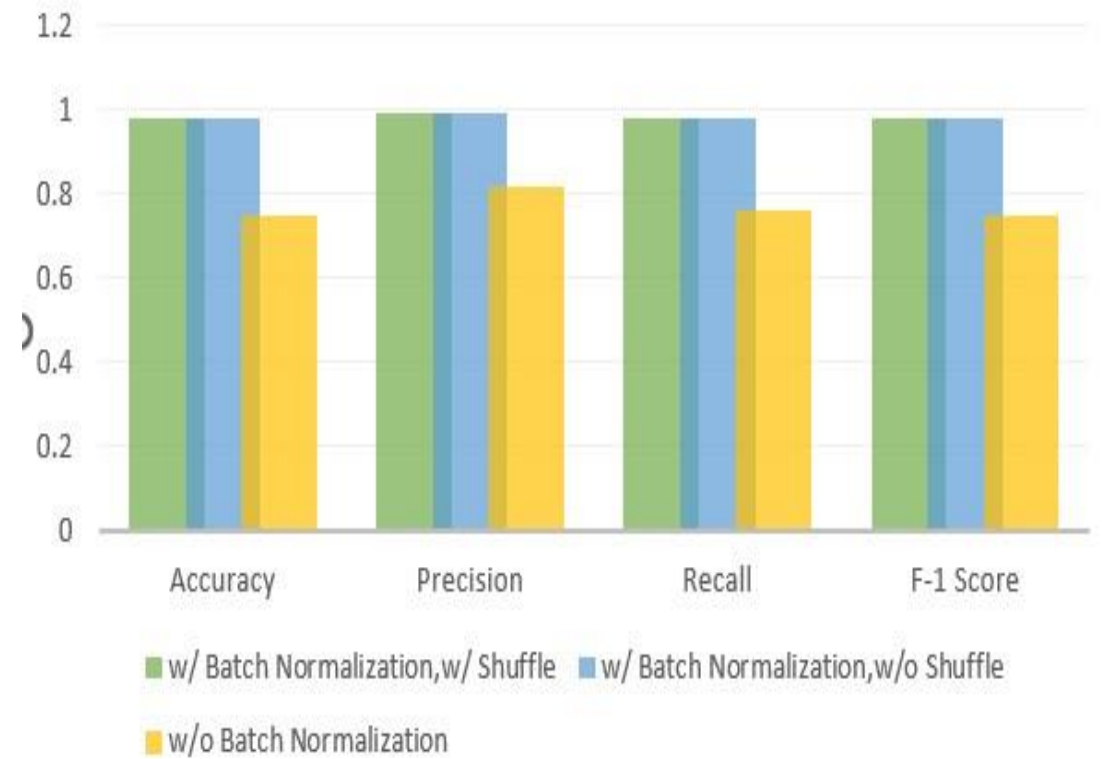
Result Analysis Contd.



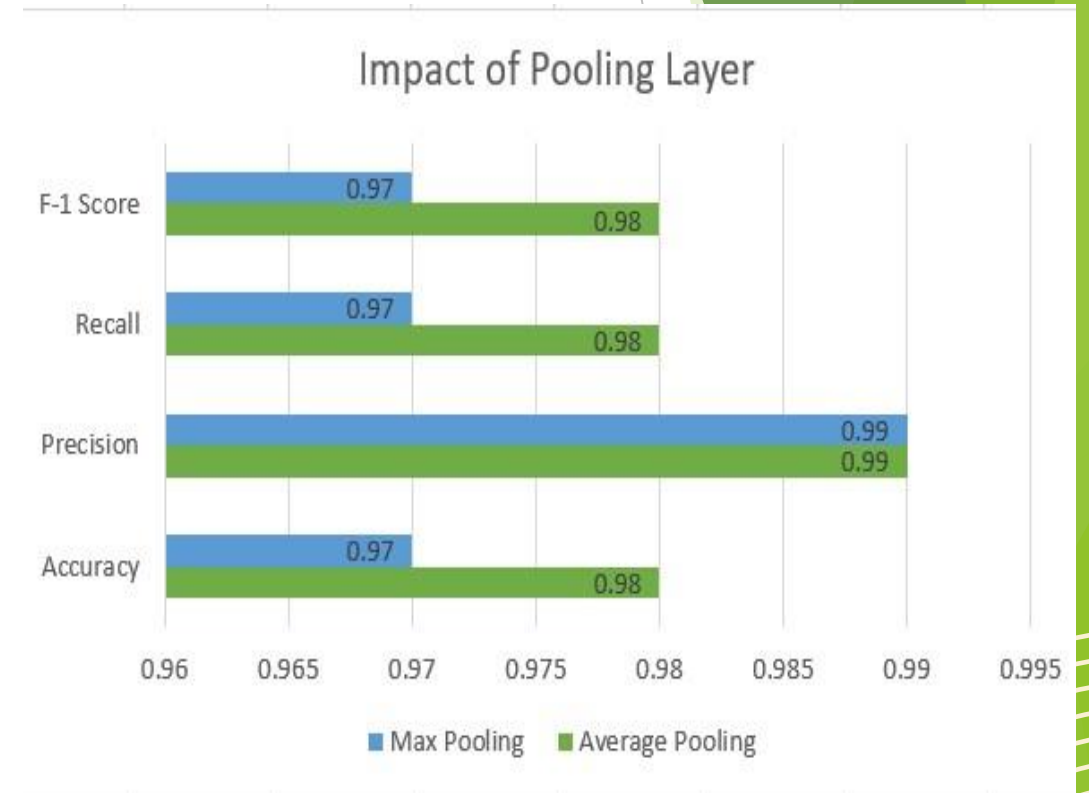
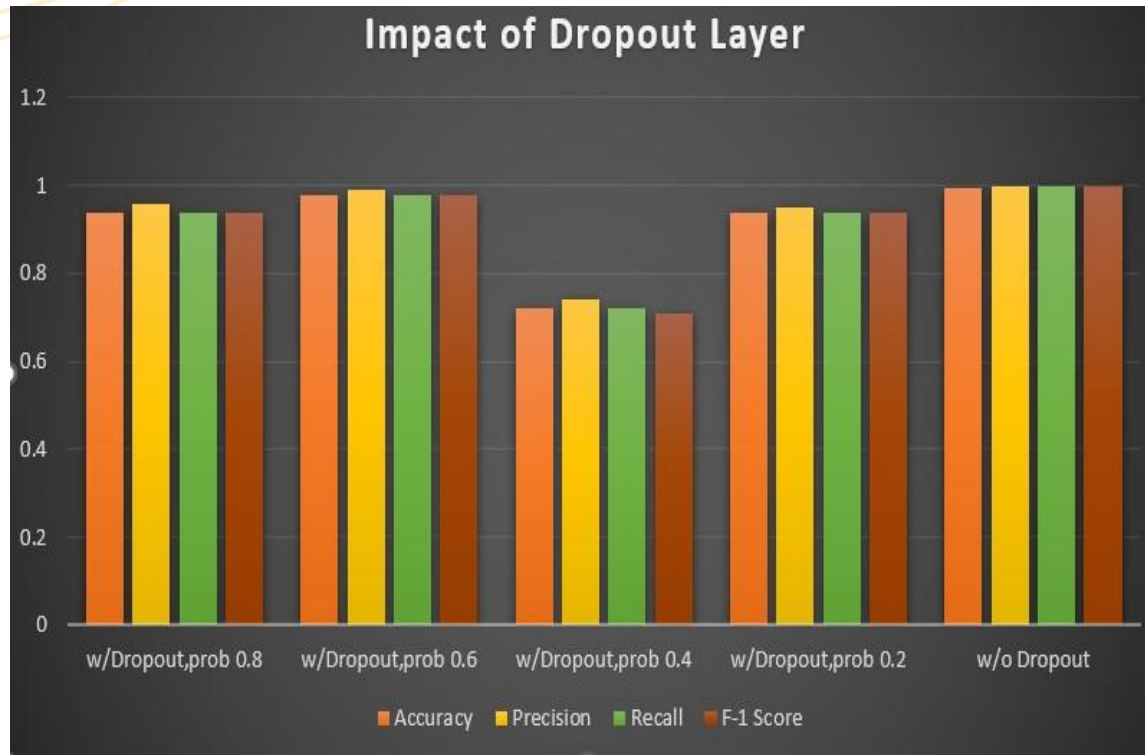
Result Analysis Contd.



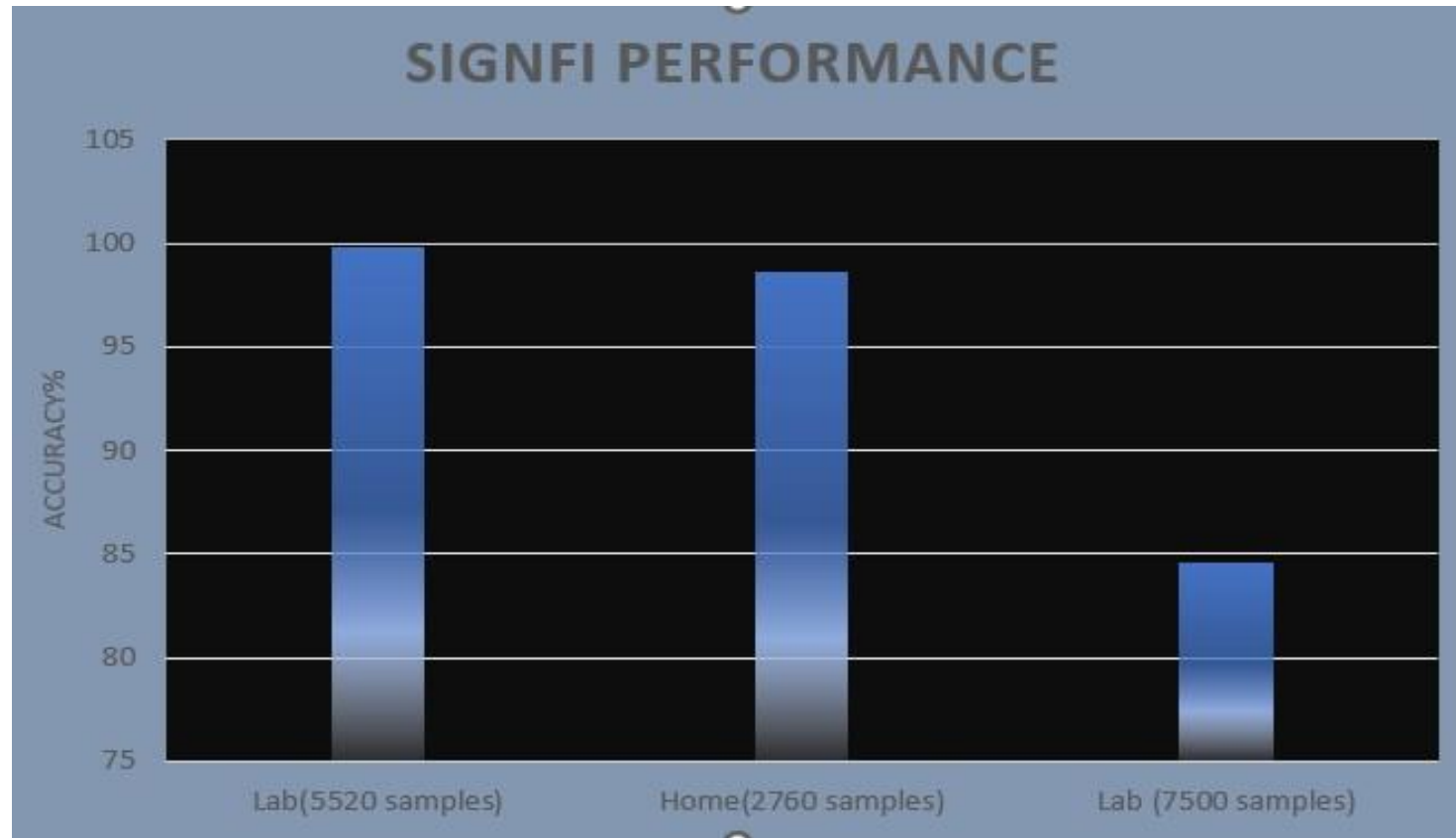
Impact of Batch Normalization



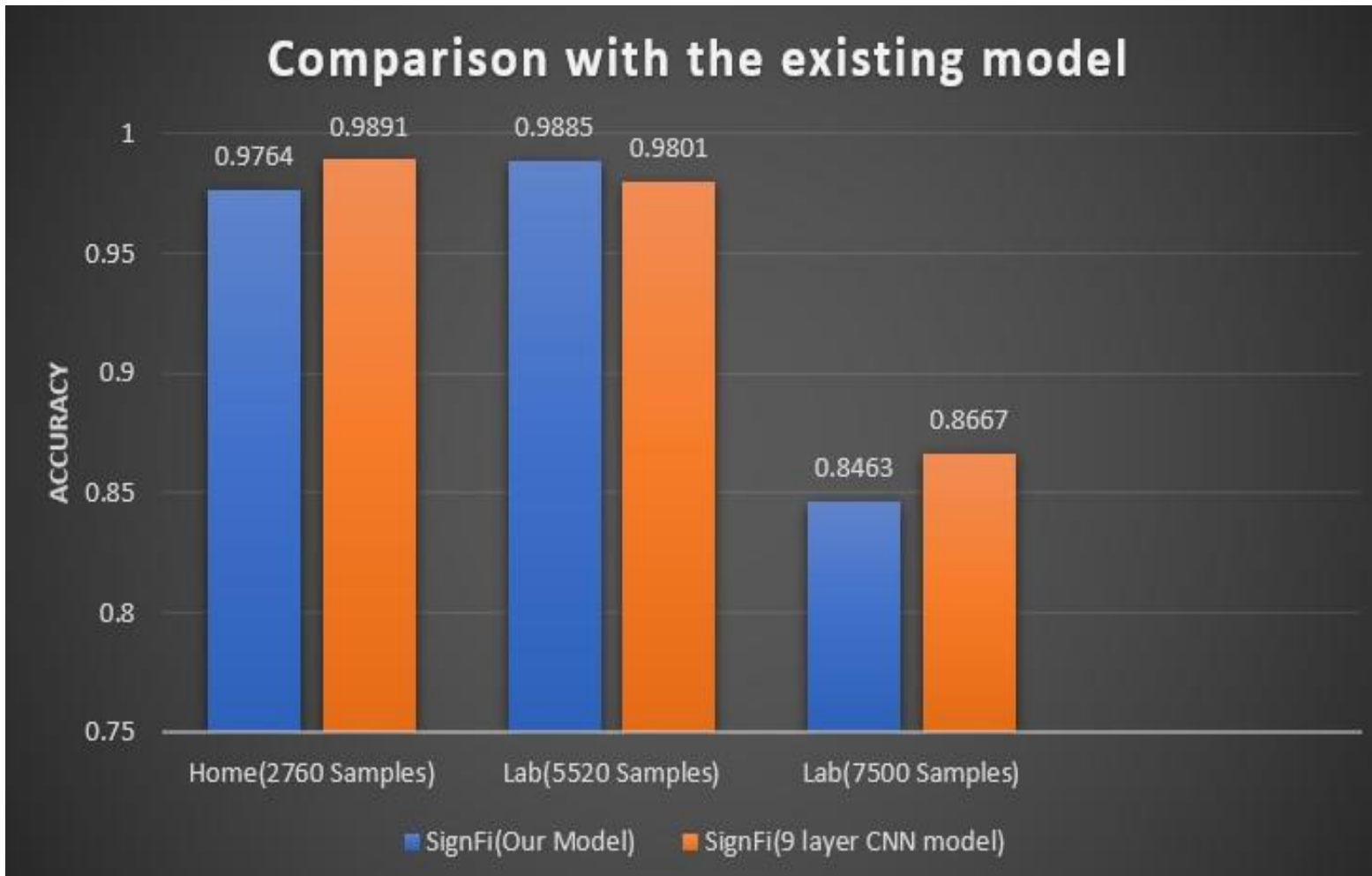
Result Analysis Contd.



Result Analysis Contd.



Result Analysis Contd.



Conclusion

SIMPLE MODEL

- Simplified processing technique
- Used 1 layer CNN model to get desired accuracy.


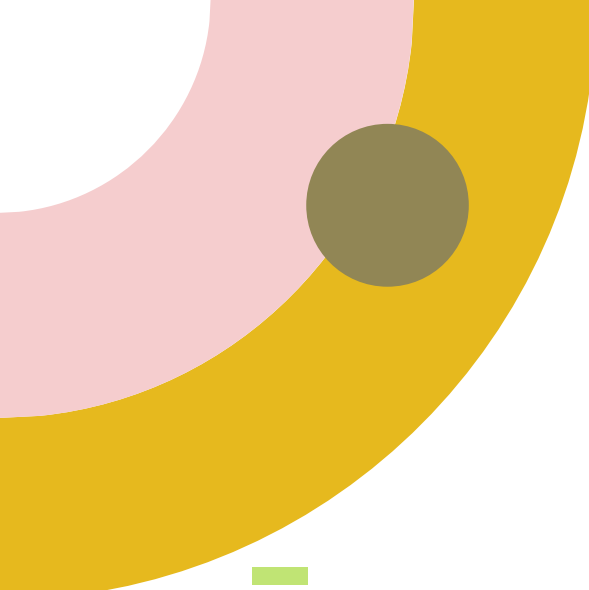
VARIATION OF ACCURACY

- Accuracy varies with user
- Falls to 84% for 5 person with each 1500 samples
- But performs better for less number of class.

HIGH QUALITY DATASET

- Well-curated, diverse and representative of target domain.
- Reliable and comprehensive information.

Future Directions



Improved
Accuracy and
Robustness

Integration with
NLP

Gesture
Recognition

Cross-lingual Sign
Language
Recognition

User Friendly
Interfaces



References

- ▶ Y. Ma, G. Zhou, S. Wang, H. Zhao, and W. Jung, “Signfi: Sign language recognition using wifi,” Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, vol. 2, no. 1, pp. 1-21, 2018.
- ▶ T. F. Sanam and H. Godrich, “Fuseloc: A cca based information fusion for indoor localization using csi phase and amplitude of wifi signals,” in ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing(ICASSP). IEEE, 2019, pp. 7565-7569.

THANK YOU

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