



# Identifying Hand Hygiene with Deep Neural Networks

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ADVISED BY DR. BOUTELL, DR. BAER, AND DR. GALLUZZI

# Introduction

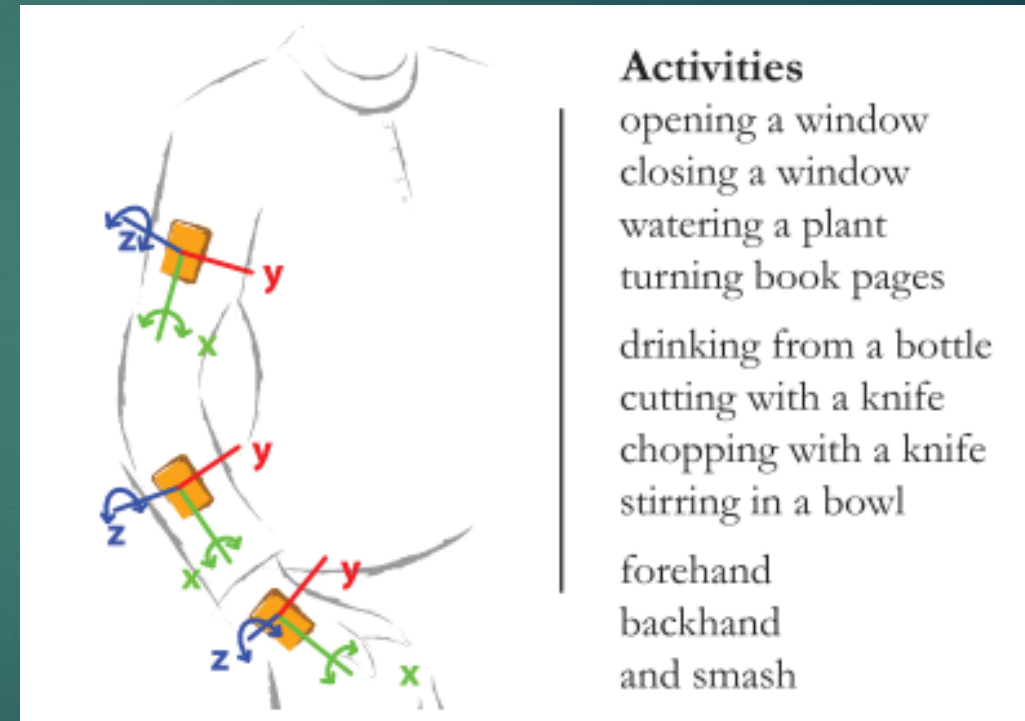
# Cleanliness Is Important in Healthcare

- Sterility
- Moments



# Hand Hygiene = Activity Recognition

- ▶ Gesture Recognition
- ▶ ASL (camera)

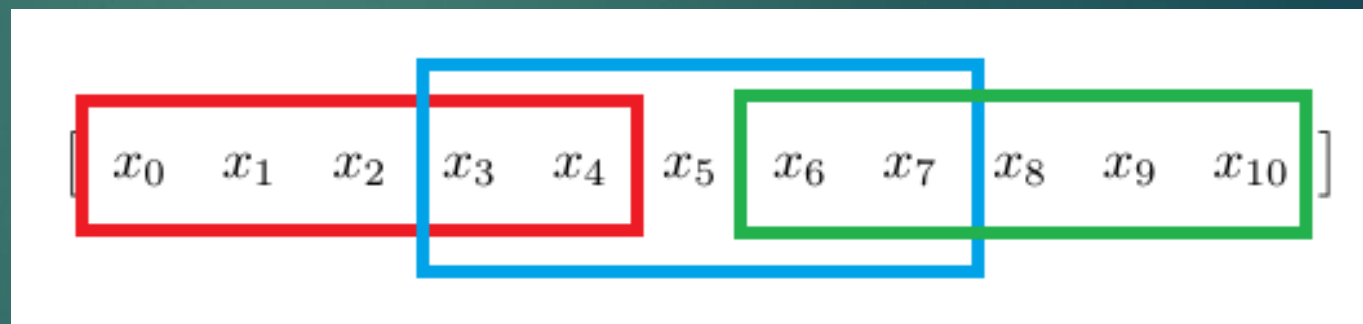


# Dr. Galluzzi Collected Data

- ▶ X,Y,Z accelerometer data

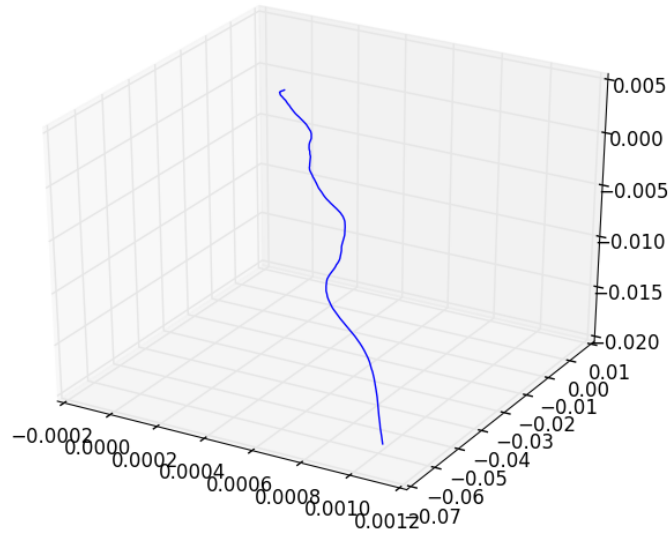
- ▶ 100 Hz

- ▶ Imbalanced

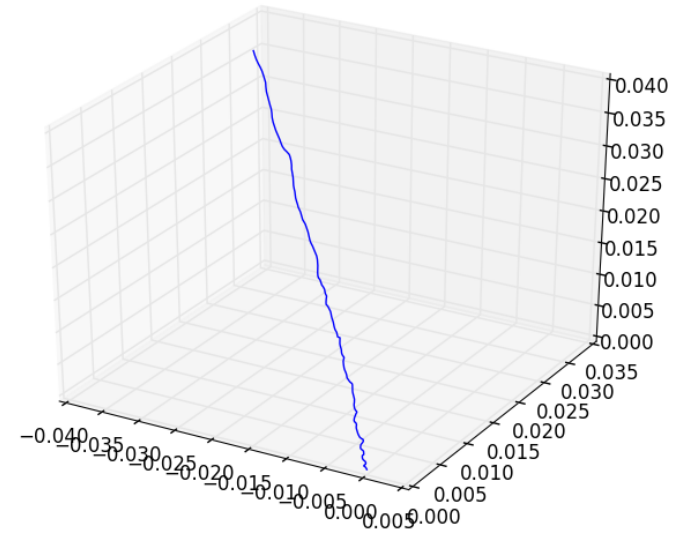


# The Data Was Not So Clear

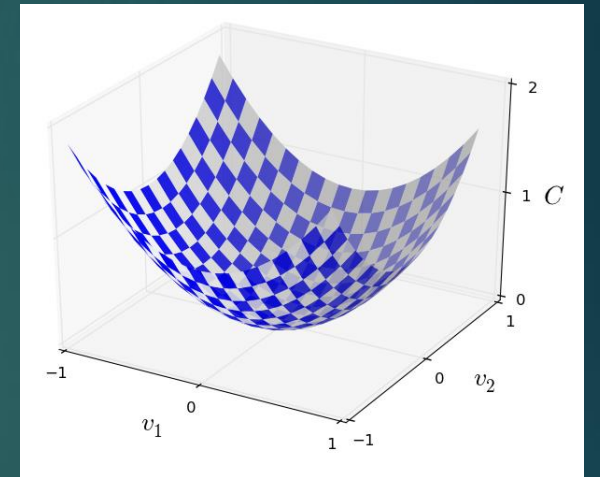
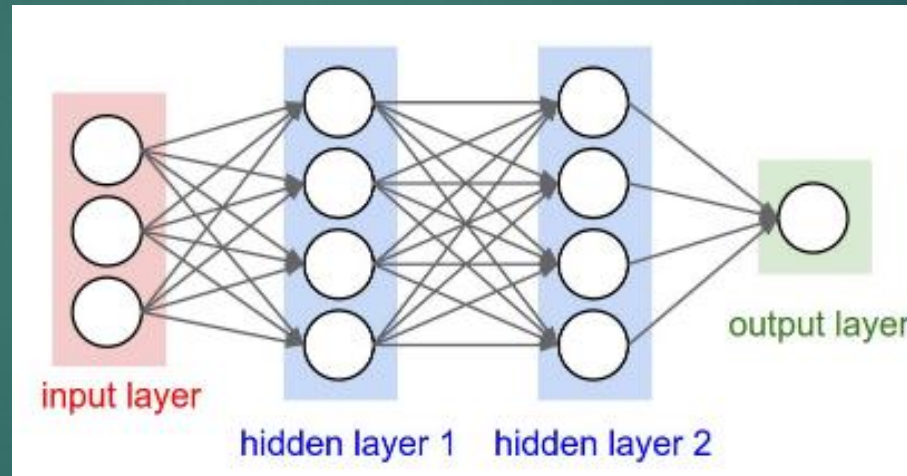
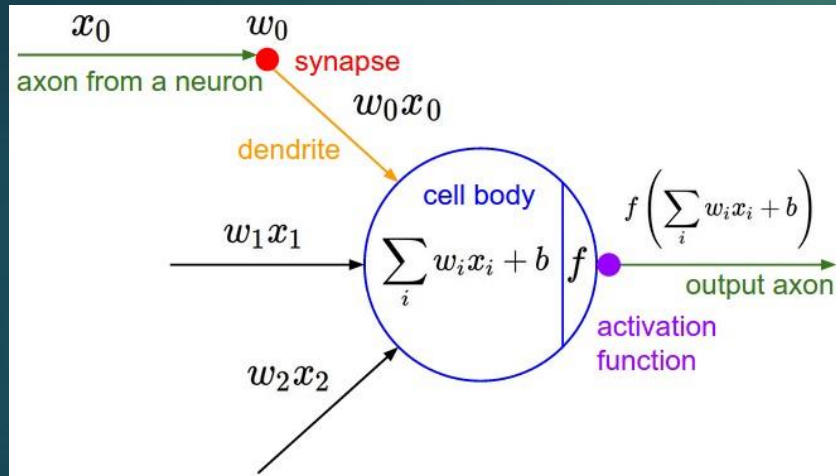
plot-200-49587l nhh




plot-200-52624r hh



# Deep Learning Simulates the Brain



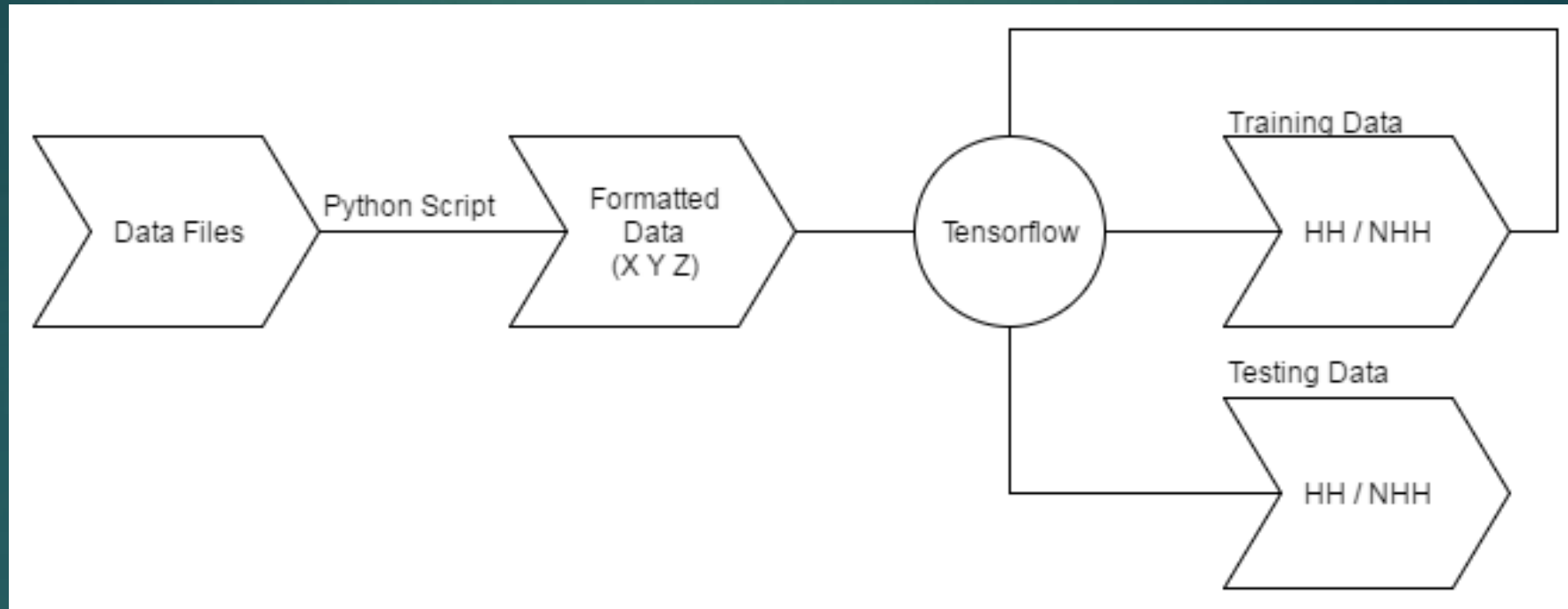




# Using Deep Networks to Classify Accelerometer Data as Hand Hygiene or Not

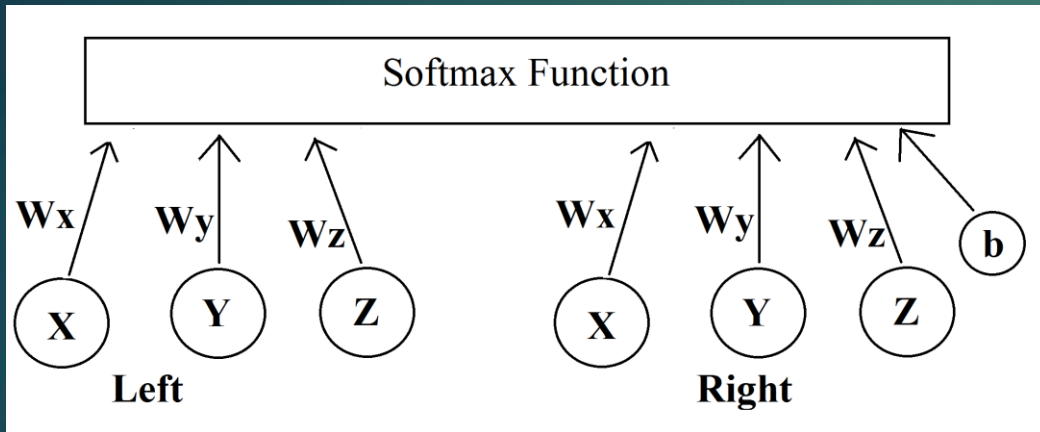


# The Foundation Was This Pipeline

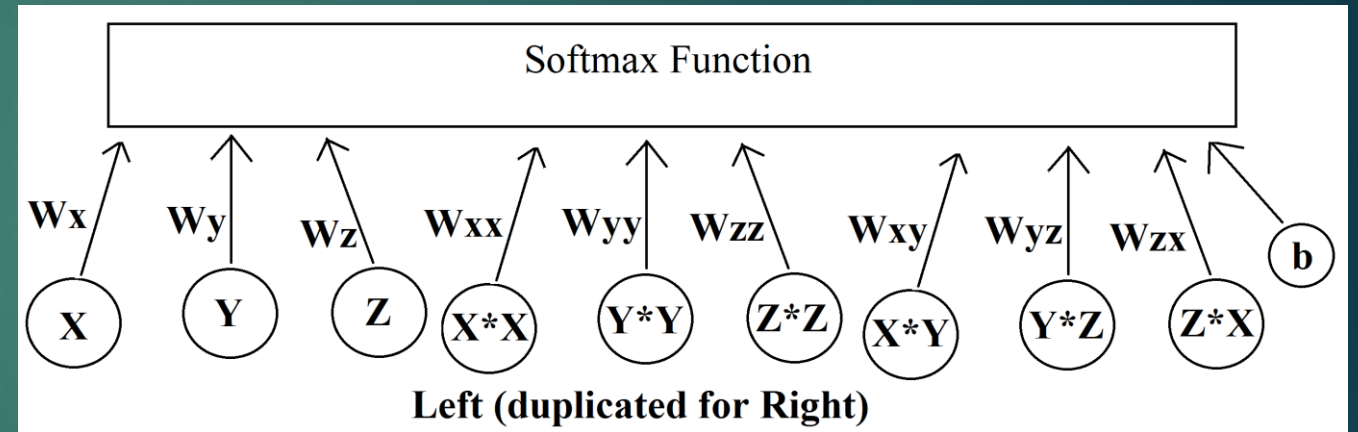


# Several Models Were Used - 1

Original



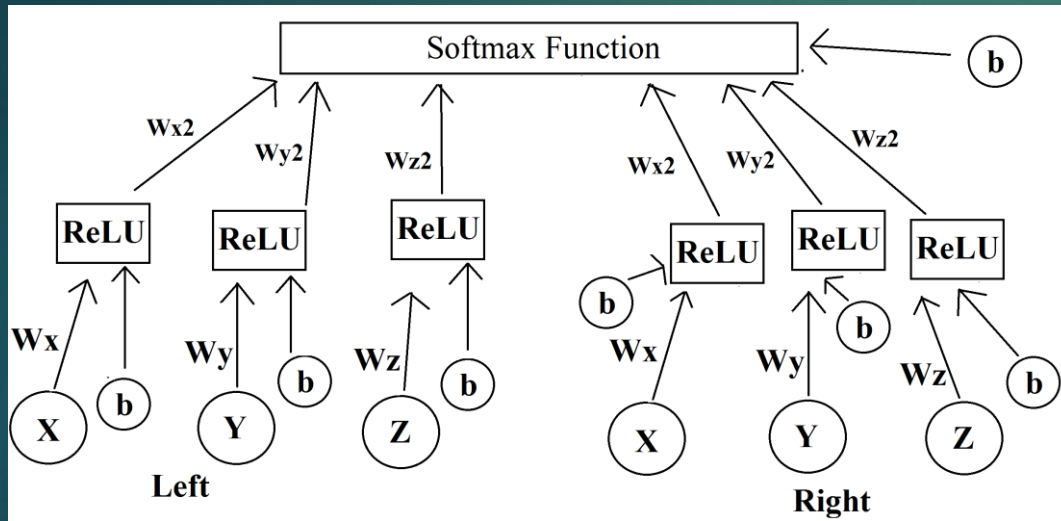
Complex



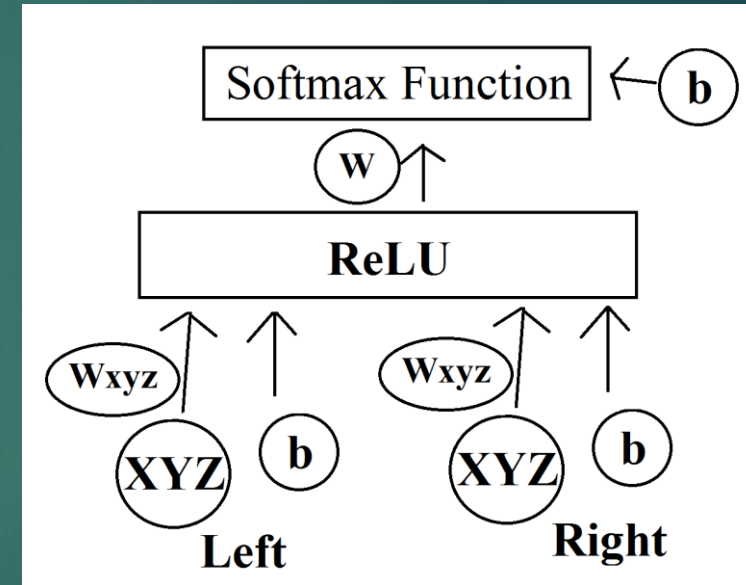
$$\begin{bmatrix} x_1 & x_2 & \dots & x_n \\ x_{n+1} & x_{n+2} & \dots & x_{2*n} \\ \vdots & & \ddots & \end{bmatrix}$$

# Several Models Were Used - 2

## Layered

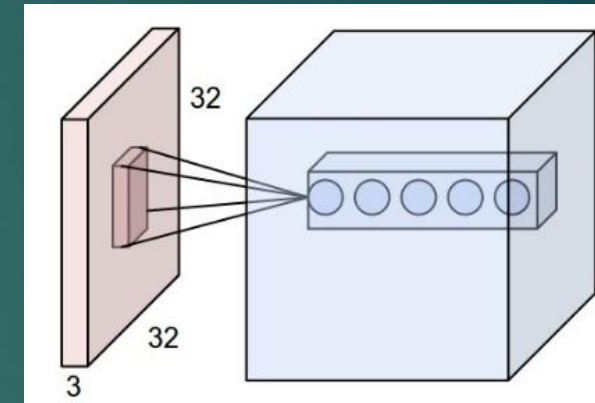
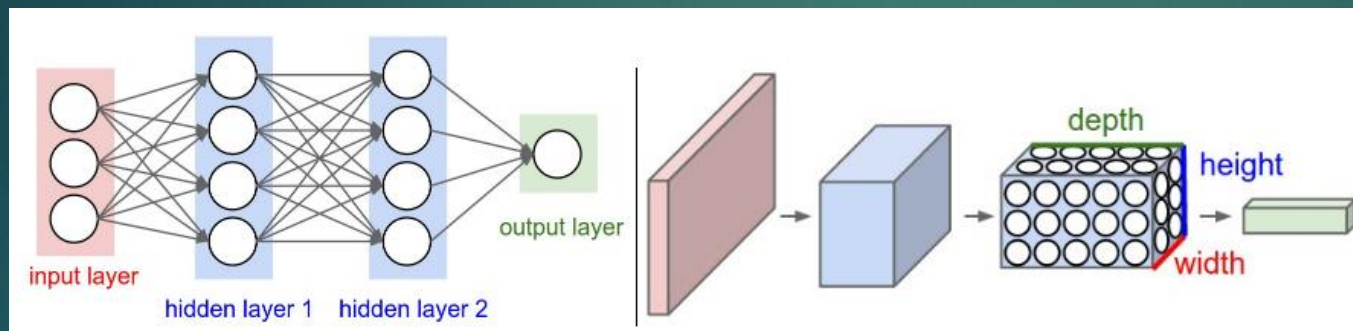


## XYZ



# Several Models Were Used - 3

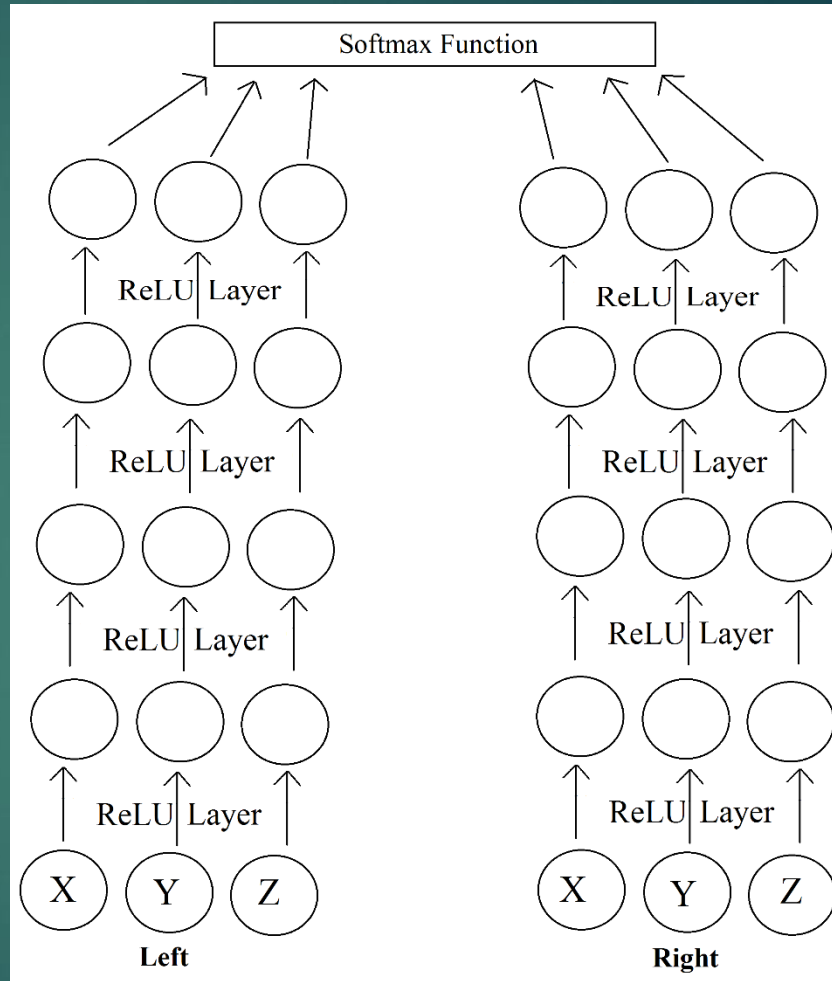
## Convolutional



$$\begin{bmatrix} x_0 & x_1 & x_2 & x_3 & \dots & x_{n-1} \\ x_n & x_{n+1} & x_{n+2} & x_{n+3} & \dots & x_{2*n-1} \\ x_{2*n} & x_{2*n+1} & x_{2*n+2} & x_{2*n+3} & \dots & x_{3*n-1} \\ \vdots & \vdots & \vdots & \vdots & \dots & \vdots \end{bmatrix}$$

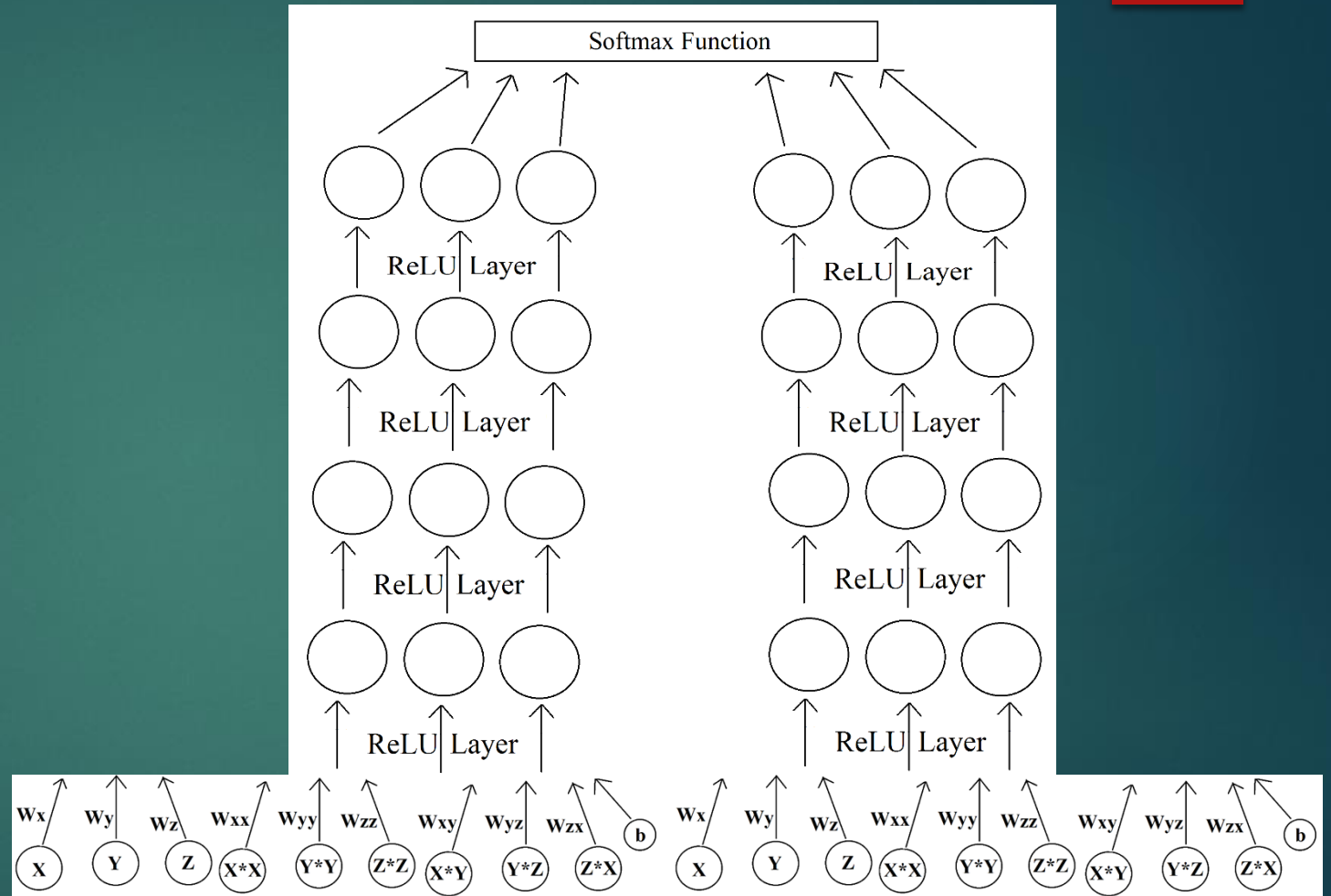
# Several Models Were Used - 4

- ▶ 5 Layered Model
- ▶ 5 Layered Complex



# Several Models Were Used - 4

- ▶ 5 Layered Model
- ▶ 5 Layered Complex



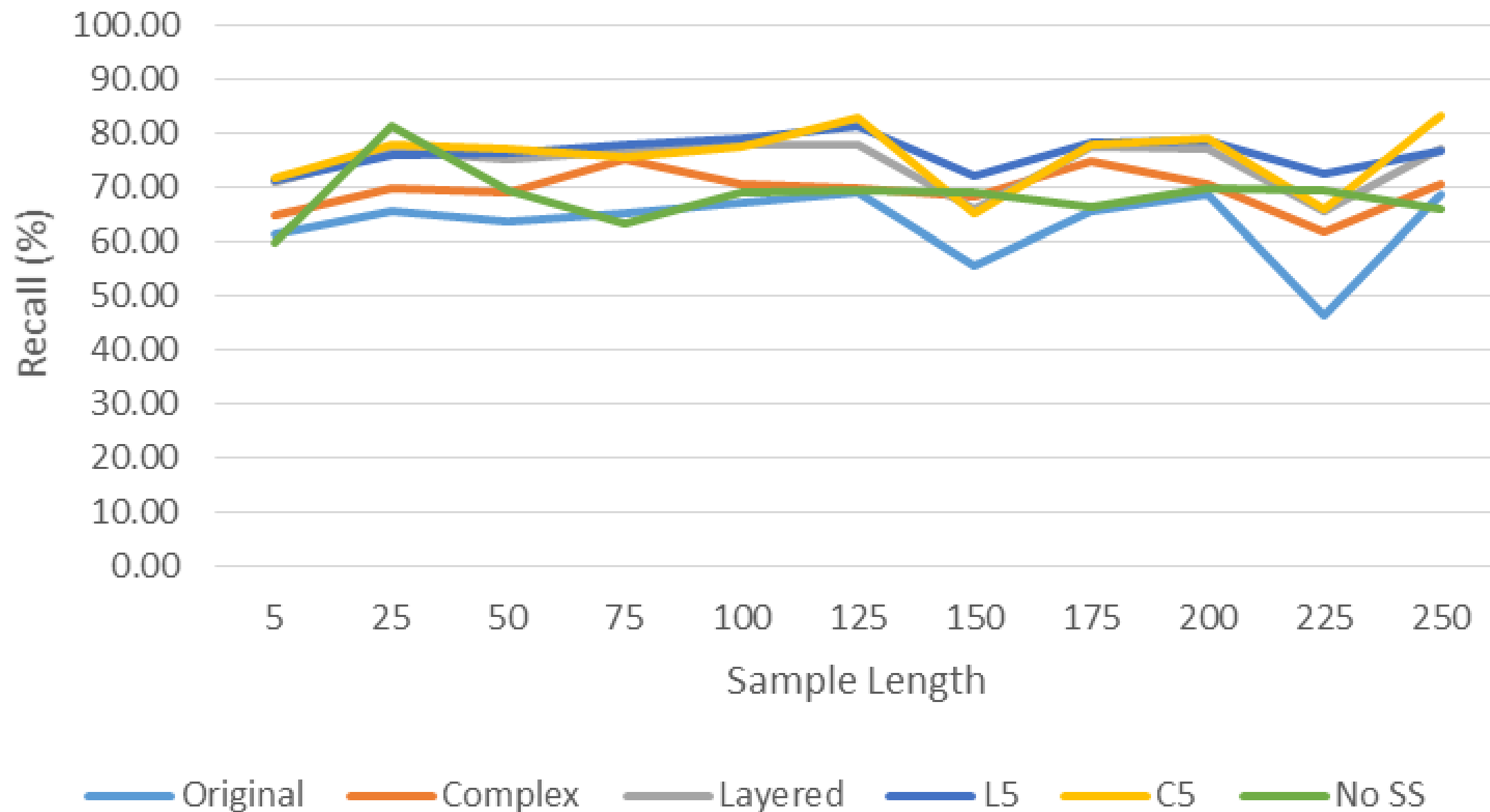
# Other Techniques Were Used

- ▶ L2 Regularization
- ▶ Early Stopping

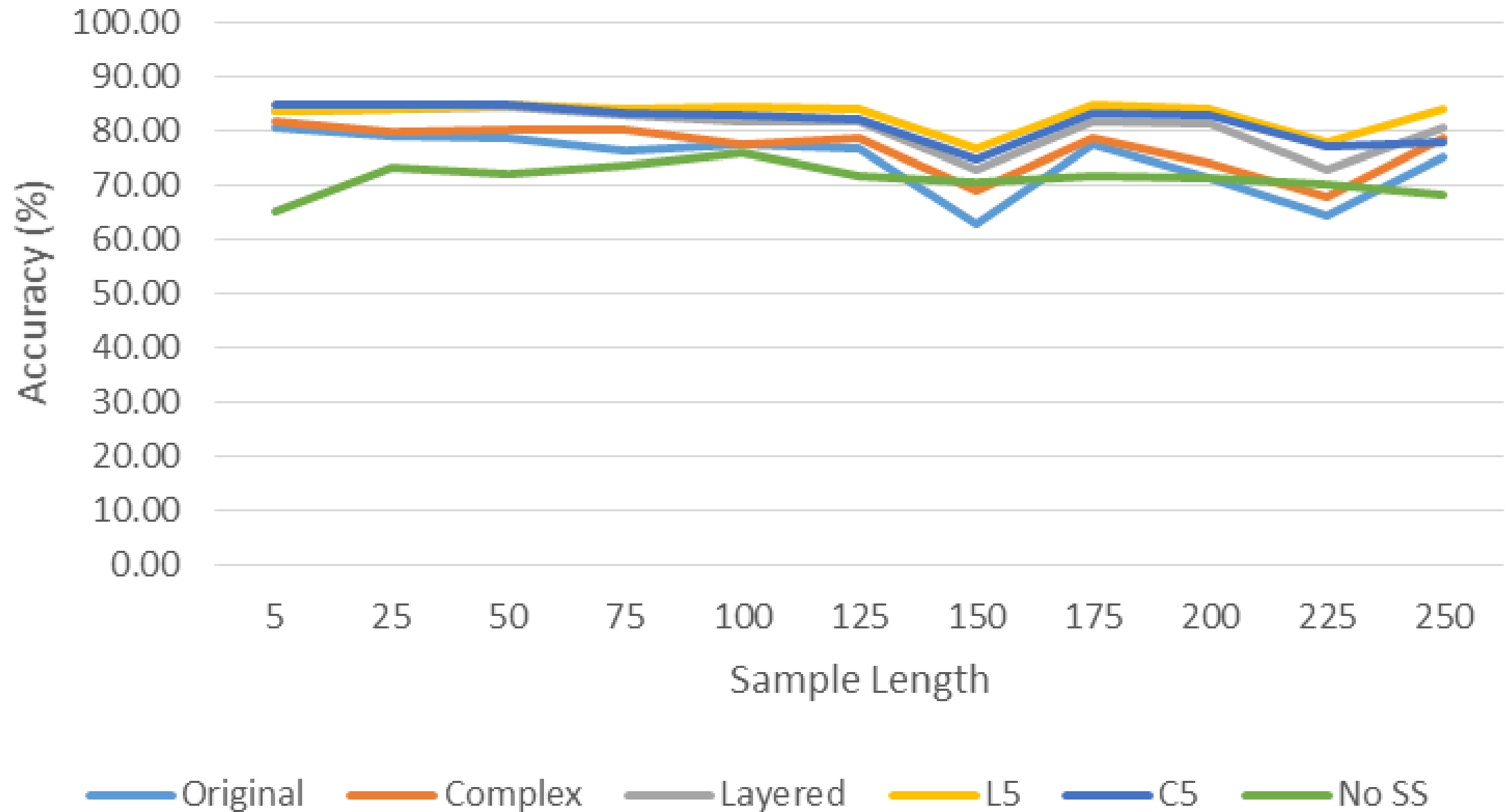


# Results

# Recall

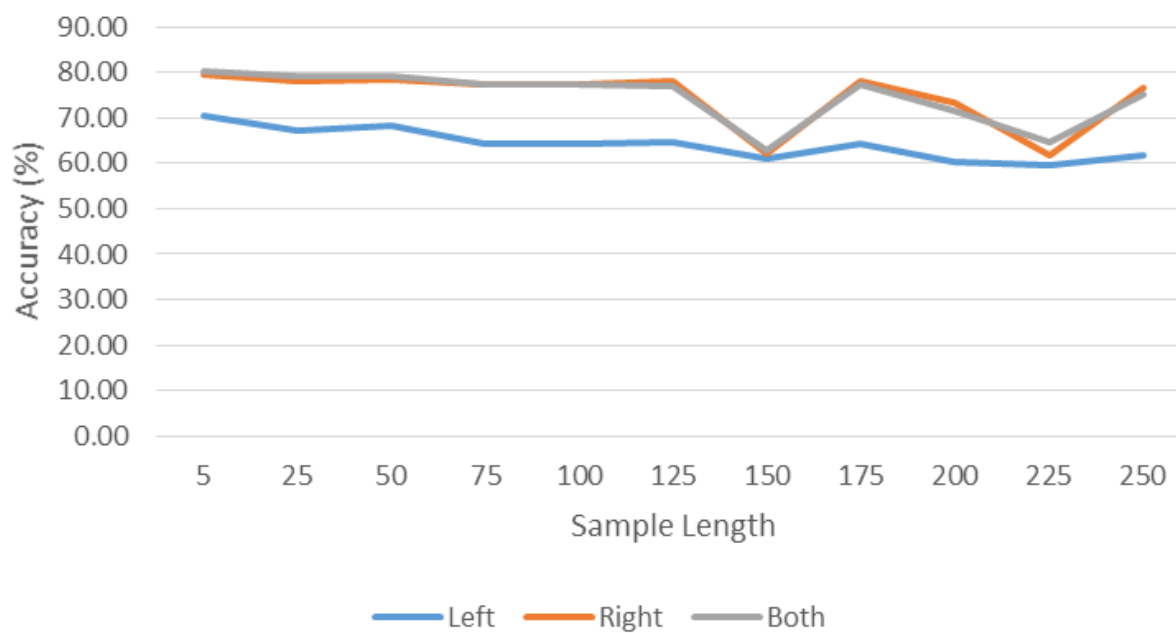


# Accuracy

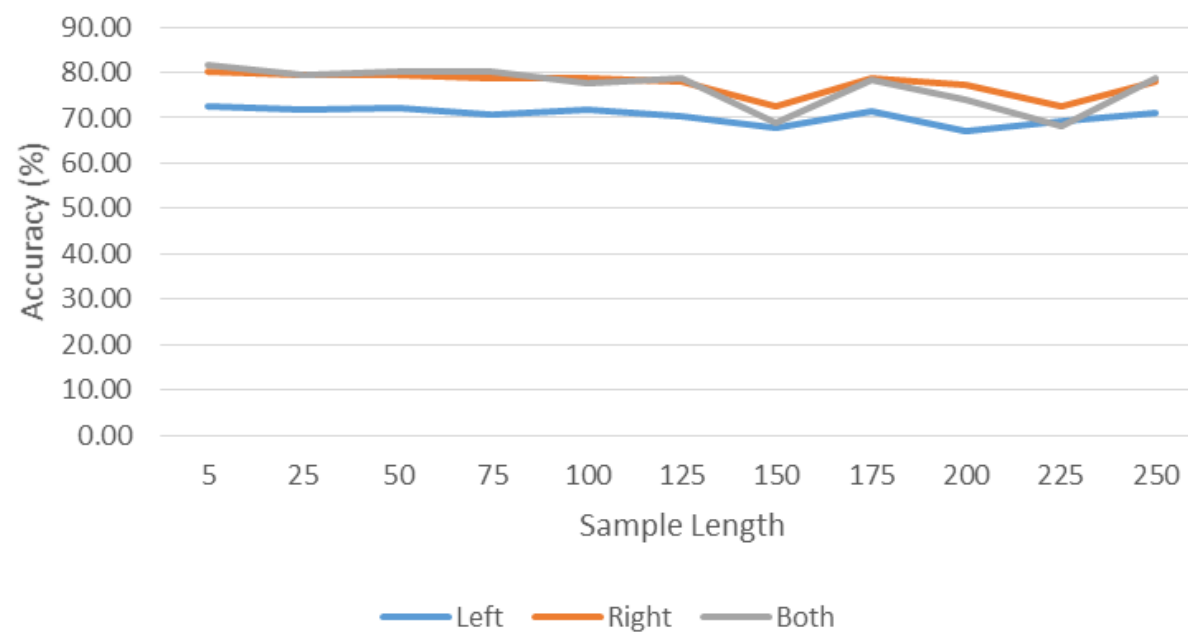


# Comparing Handedness

Original Model



Complex Model



# Discussion

# The Potential Impact May Be Limited

- ▶ Viability
- ▶ Cost
- ▶ Stations

# Future Work Is Wide Open

- ▶ Velocity / Relative Position
- ▶ Video
- ▶ Proper Technique



Questions?