How Much Information is Too Much?
Classification of Full Body Exercises using Machine Learning

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Objective

Successful automatic classification of the following back stretches. Participants move in the direction of the arrow, hold, then return to a neutral pose
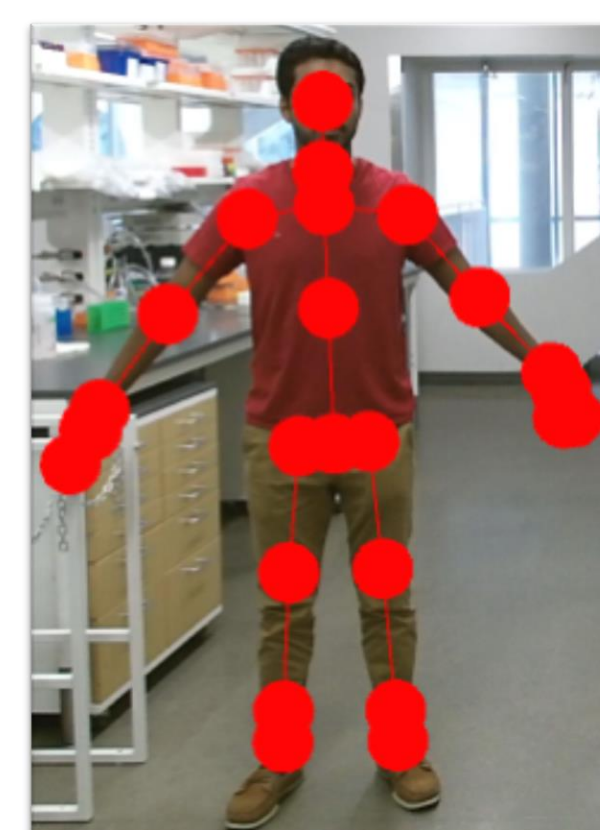
Mermaid Towel Seated

"Y" Sumo Wall

Via www.besthealthmag.ca/best-you/stretching/10-stretches-for-your-back/

Motivation

Most current classification models are built to isolate specific joints or body parts rather than full body exercises.
Instead of isolating position data, this model aims to classify full body exercises through velocity data and task segmentation
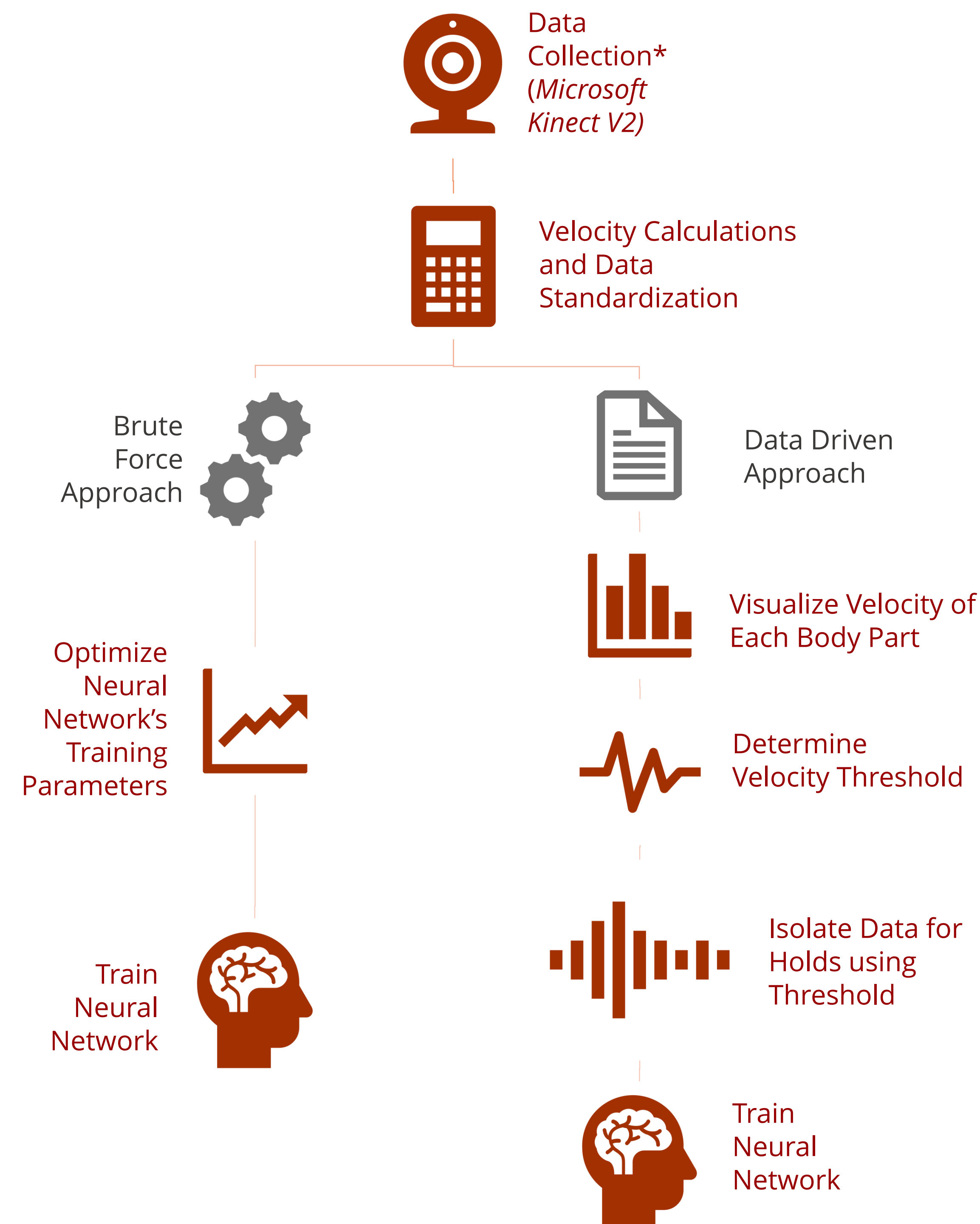
Methods

- Data Collected From the *Kinect V2* along the X, Y, and Z axes, down sampled to 30 FPS
- Origin at chest
- Data standardized using a Z score:
  - $z = \frac{x - \mu}{\sigma}$

Locations of the 25 joints tracked by the Kinect V2

Data Collection* (*Microsoft Kinect V2*)

Velocity Calculations and Data Standardization

Brute Force Approach

Data Driven Approach

Optimize Neural Network's Training Parameters

Visualize Velocity of Each Body Part

Determine Velocity Threshold

Train Neural Network

Isolate Data for Holds using Threshold

Train Neural Network

*Data was collected from 9 individuals ages 18-21 with 10 repetitions for each exercise. This database was randomly sampled into 100 examples with an equal distribution of exercises

Future Work

This experiment was only an introduction into the benefits of a data driven approach. By proving that there is valuable information stored within the velocity data, the team has paved the way for further research into creating a fully developed model capable of classifying these stretches in real time
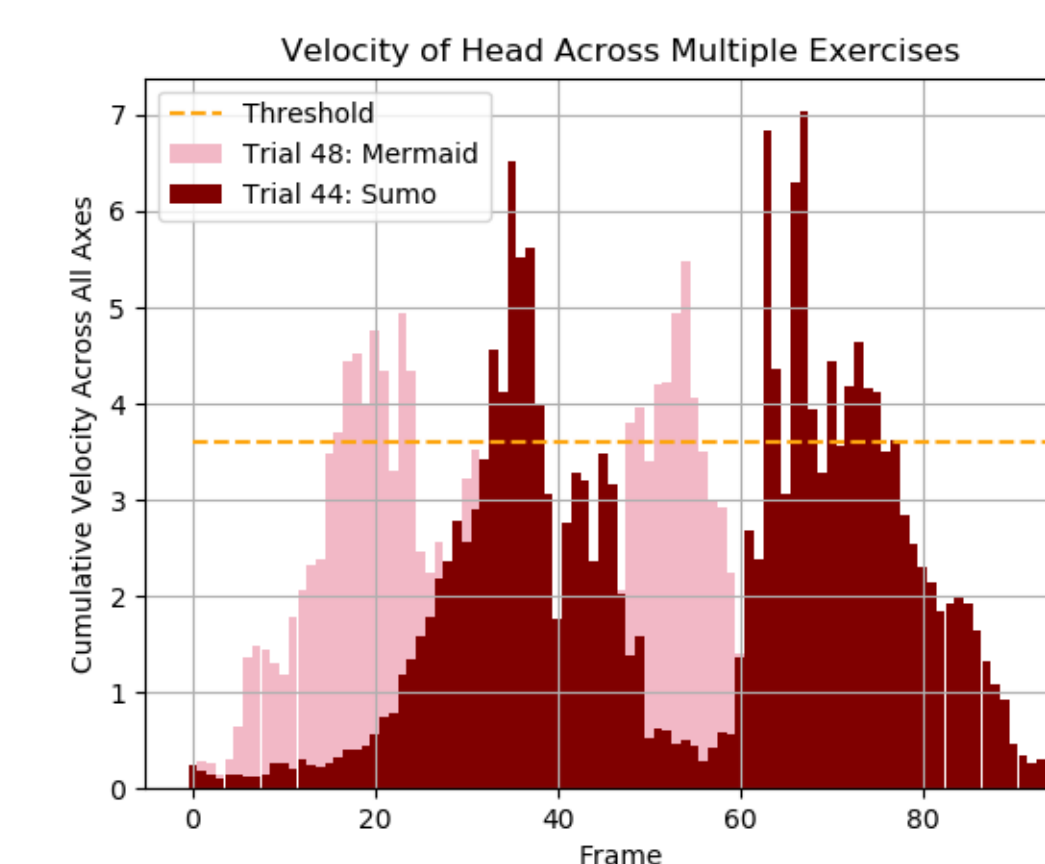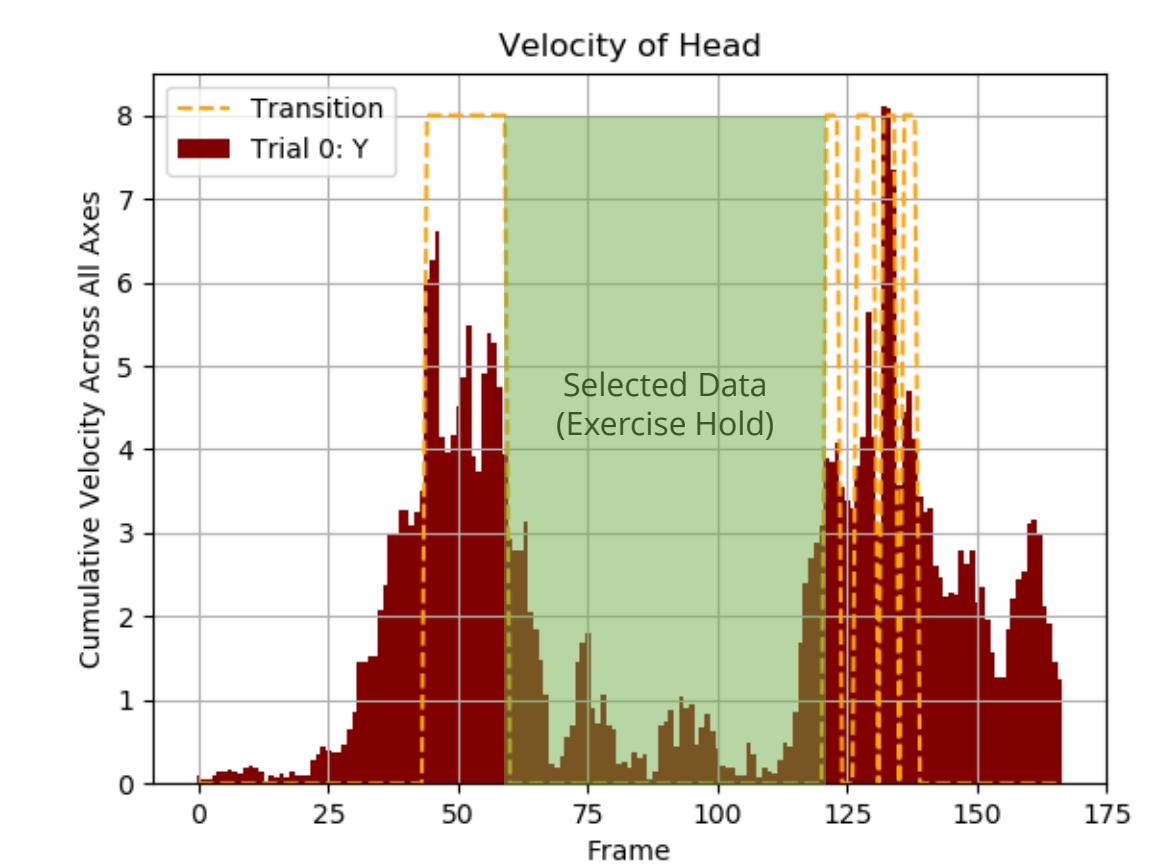
Results
Method 1:
Optimal Brute Force Model

- Learning Rate = 0.001
- Regularization = None
- Training Time = 1,000 Epochs
- Architecture = 30x30x30x30
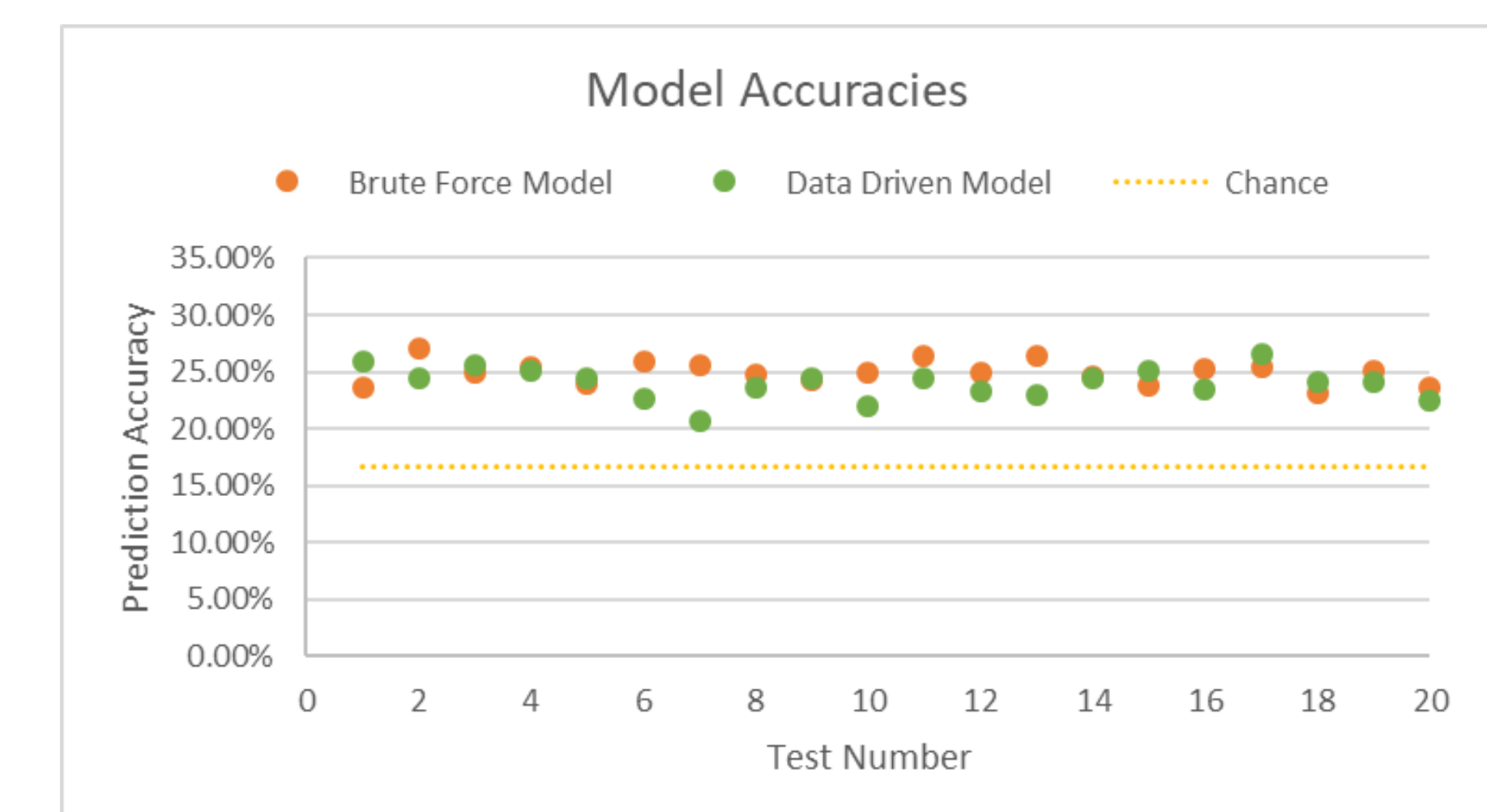- Activation Layer = ReLU

Method 2:

Plot of velocities used to determine an appropriate threshold between movements and holds.

When velocity exceeds threshold for more than 4 frames, mark it as a transition. The selected data is taken from the area between the two movements

Experimentally Determined Velocity Threshold = 3.6

Scatter Plot of Model Accuracies Vs. Chance

Conclusion

Although full body exercises provide large amounts of data, in order to create a usable model, the raw data collected must be trimmed and processed. Using the velocity data to differentiate between essential information provided a reliable way to achieve this. Even though surface level testing revealed the data driven approach had little to no impact on our model's performance, exploration into new architectures and preprocessing methods might show a more significant difference between the brute force and data driven approaches.