A3: Shape Matching

Rahul Surti

Links

Cloning command:

```
git clone https://github.com/rahulsurti97/ubicomp.git
```

A3 Jupyter Notebook

(Assignment 3/signals/Projects/GestureRecognizer/GestureRecognizer-ShapeBased.ipynb)

Your algorithm design and evaluation process

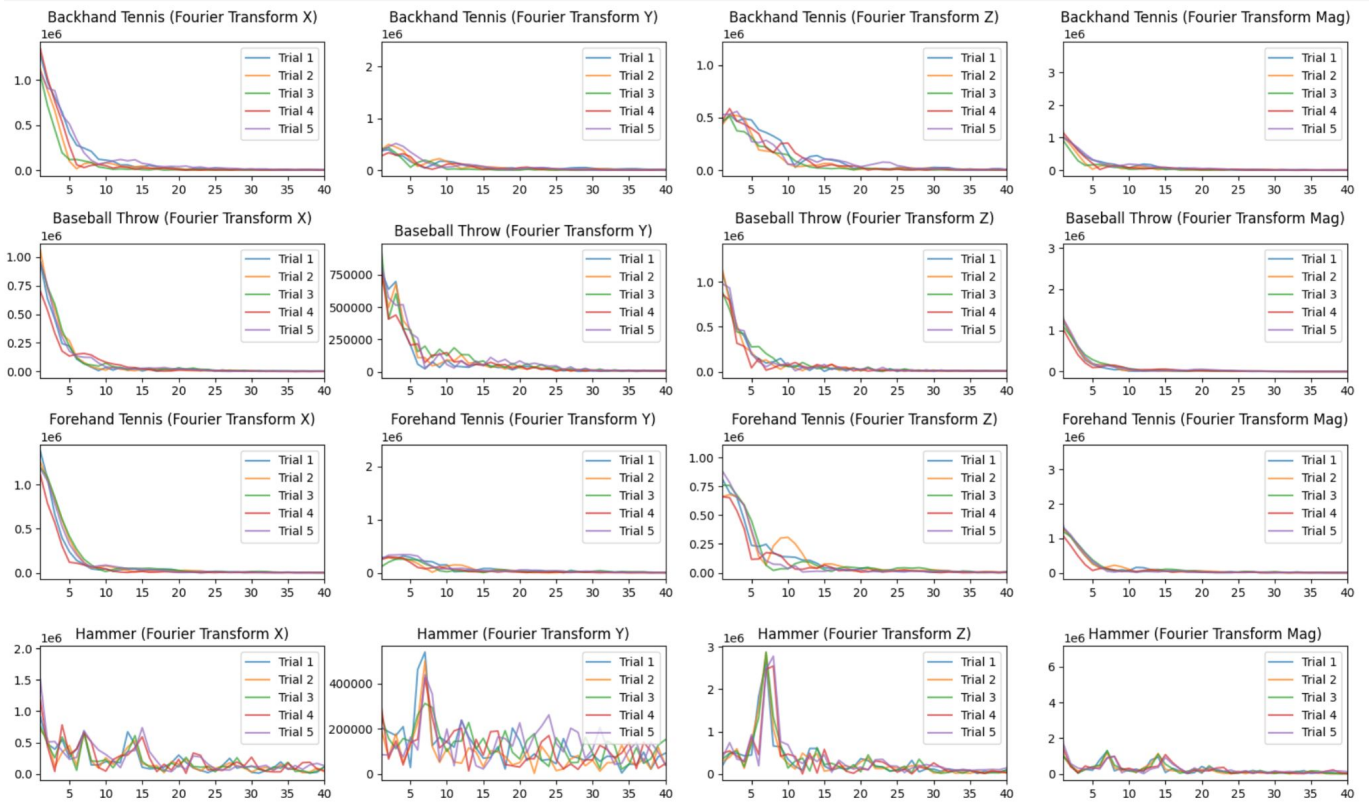
Given test trial and list of template trials, for each template trial signal:

1. Pad either signal to match
2. Calculate cross correlation between signals
3. Get the best correlation shift index
4. Shift template signal by calculated index
5. Mean fill the template signal
6. Calculate euclidean distance between signals
7. Append result into experiment result infrastructure

Your Visualizations

What visualizations did you make to aid analysis?

Example visualizations

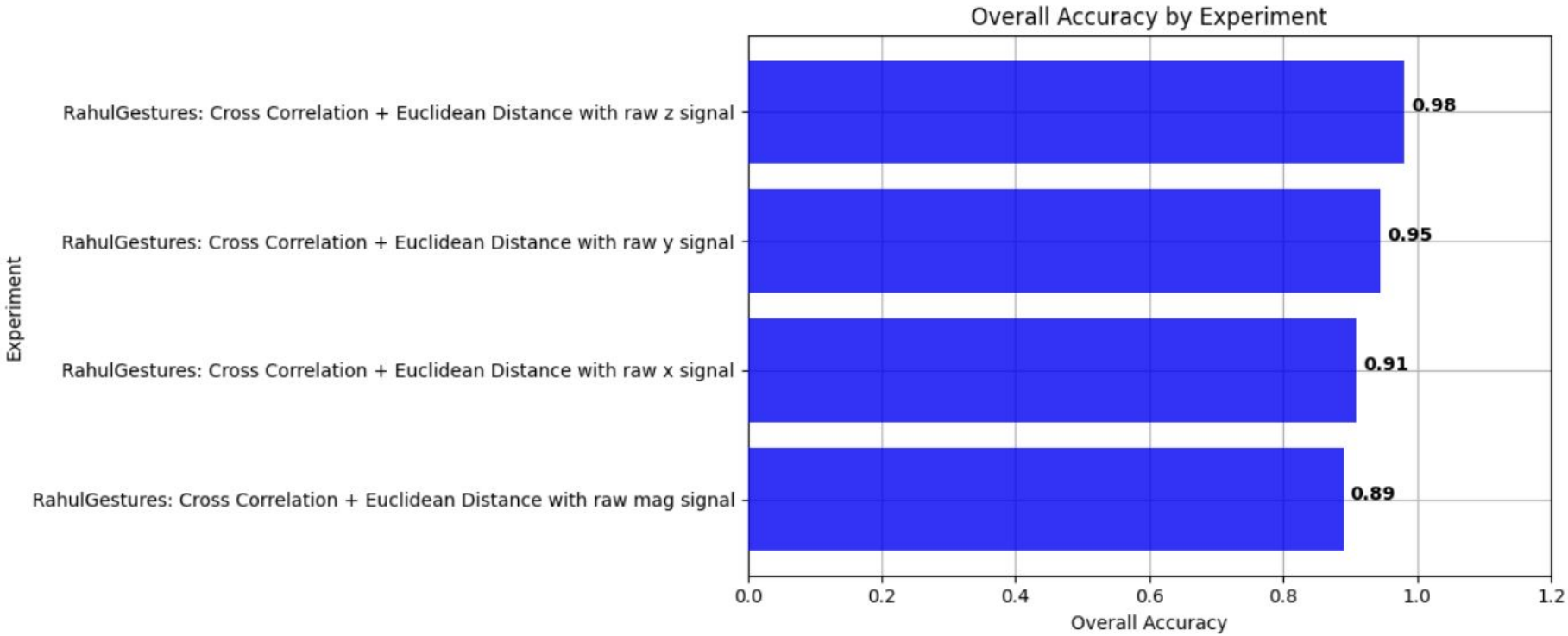


Here we have part of the fourier transforms for each component of all trials of the gesture signals. It was a good sanity check to ensure that all the trial data I collected was indeed recording what I intended, and to see the avg freq of each gesture

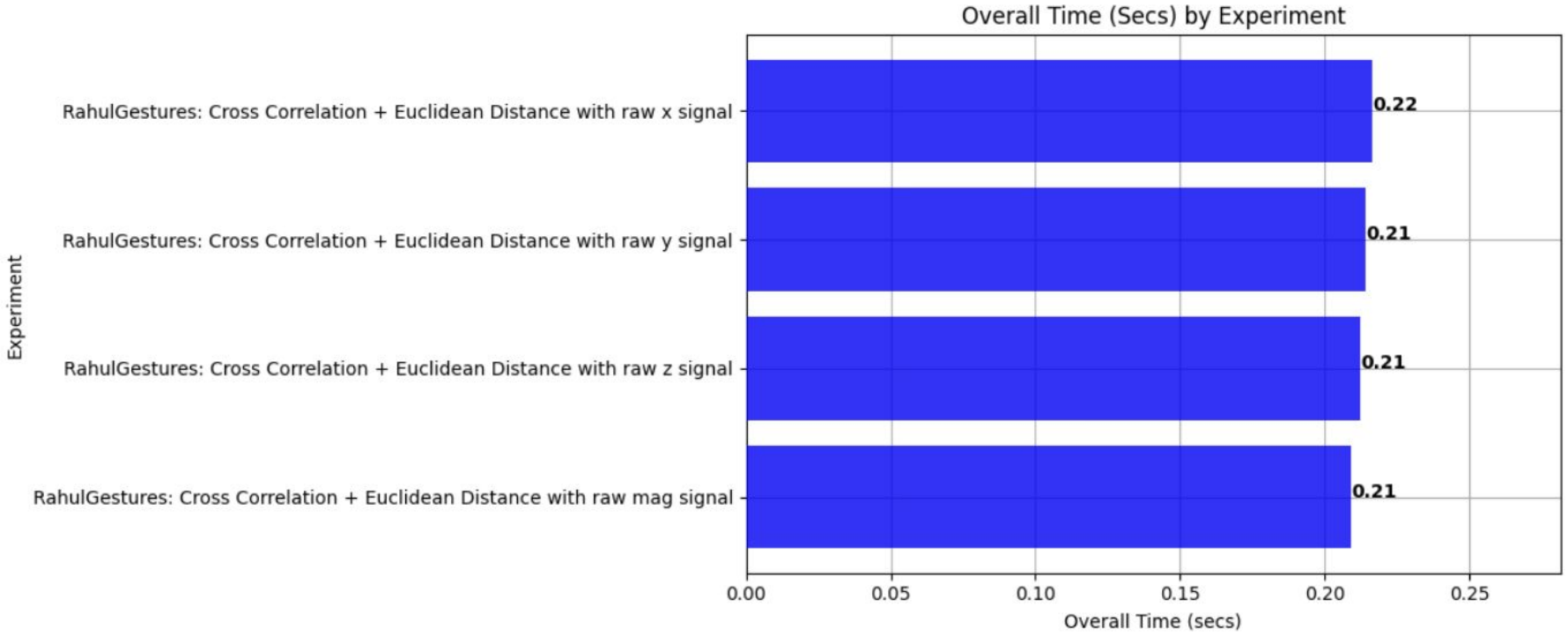
Your Gesture Results

Include graphs showing experiments and process

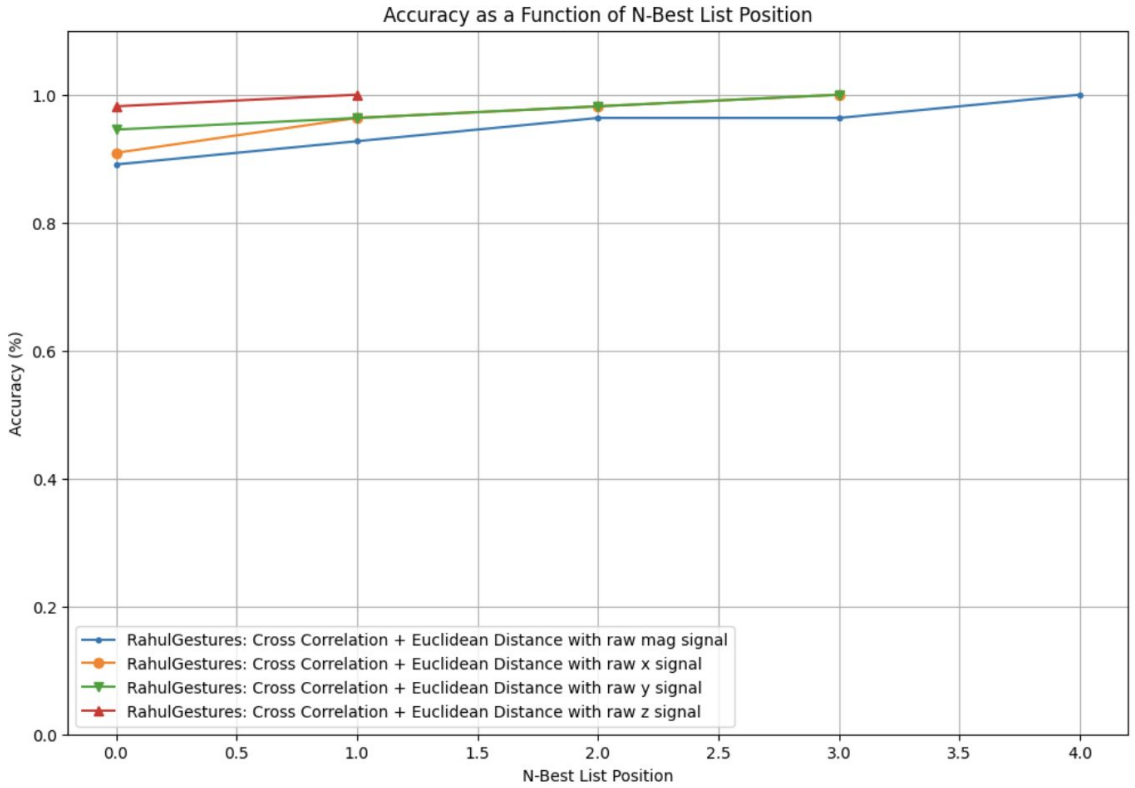
Overall **accuracy** by experiment



Overall **time** per experiment

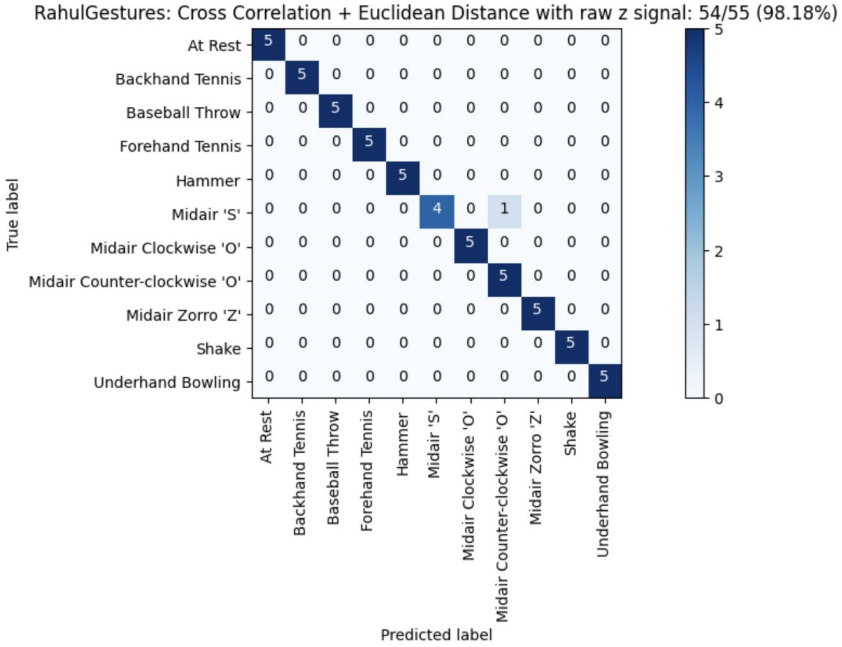


N-best list performance



Description of best-performing algorithm

The best results I achieved was cross correlation + euclidean distance on the raw z signal, with 98.18% accuracy. I was impressed with the cross correlation + euclidean distance approach as its accuracy was relatively high and the calculation speed was very fast (.004s/match), in contrast to the DWT approach I used in the midpoint. The DWT approach took significantly longer, but did achieve 100% accuracy in some cases.




```
Title: RahulGestures: Cross Correlation + Euclidean Distance with raw x signal: 50/55 (90.91%)
Optional arguments: {'verbose': False, 'signal_var_name': 'x'}
Took 0.216s for 55 comparisons (avg=0.004s per match)
```

Class Gesture Results

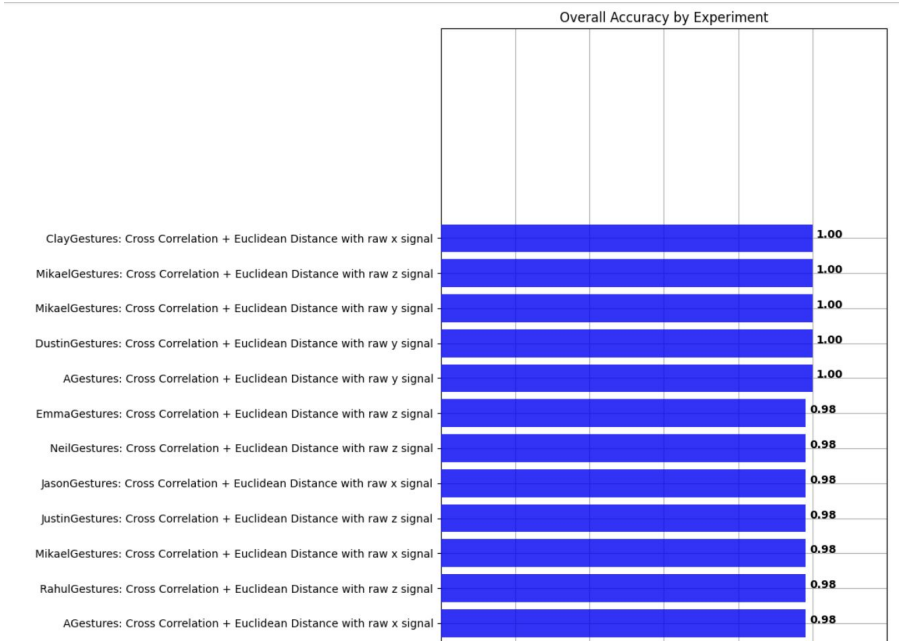
How well did your best algorithm perform on the class’ gesture set?

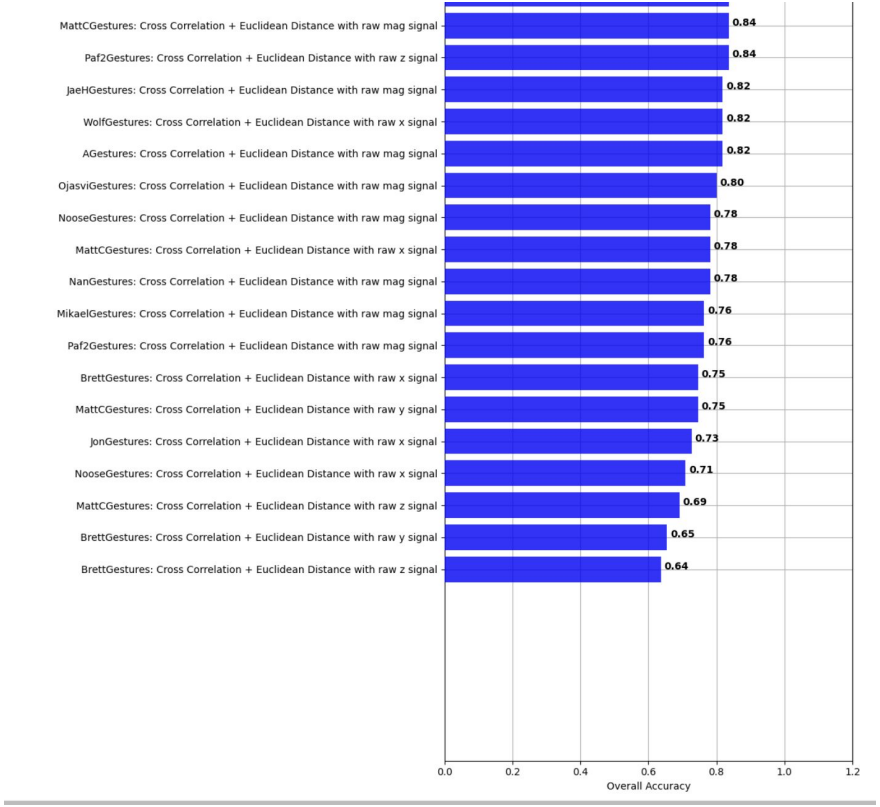
Overall accuracy across gesture sets with best alg

Avg accuracy: 90.2%
Stdev: 7.%

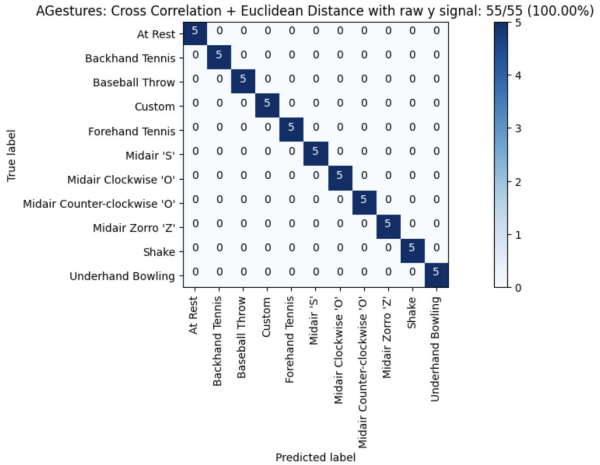
```
Average accuracy: 0.9016233766233767 Stdev=0.07596500667964219
```

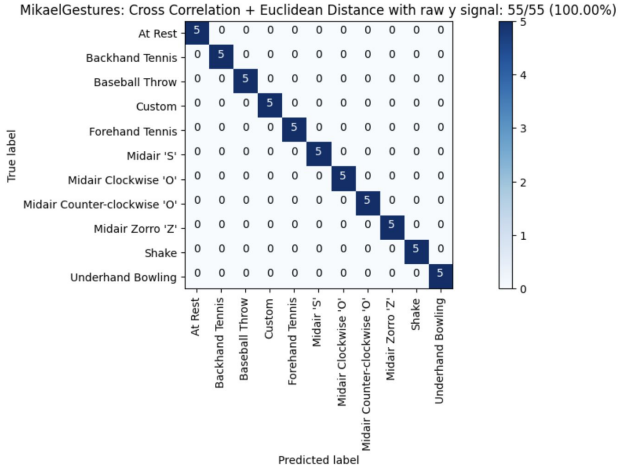
Accuracy per gesture set (best vs. worst)

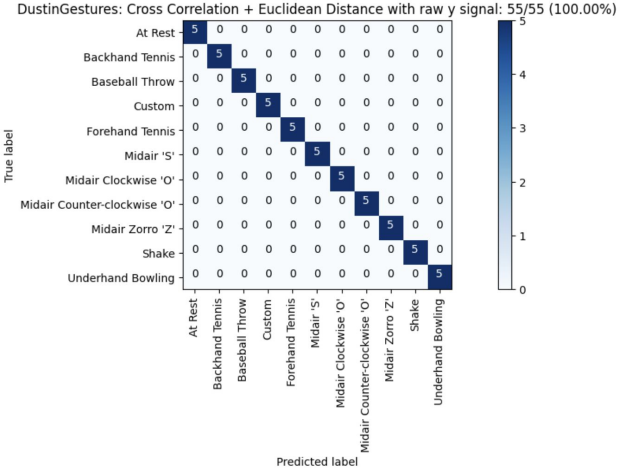




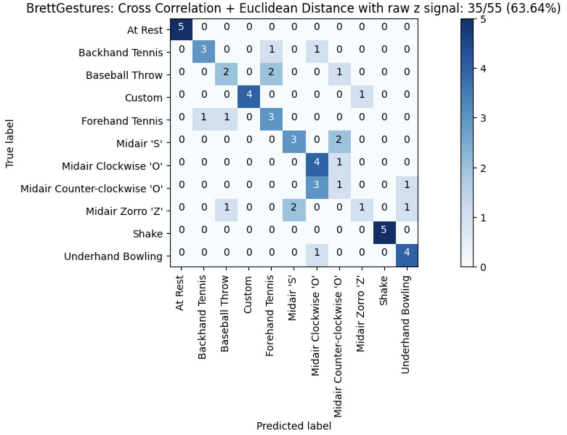
Confusion matrices of top performing gesture sets

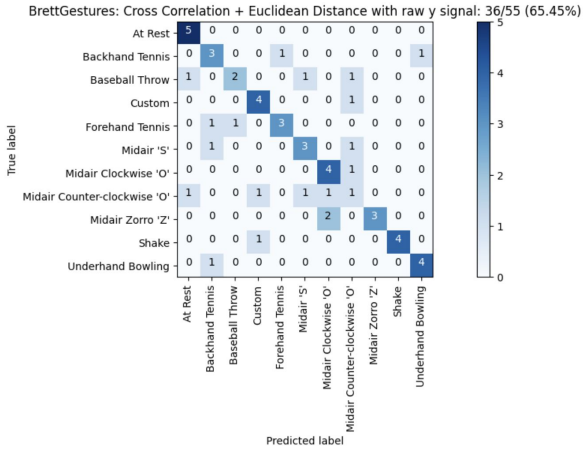


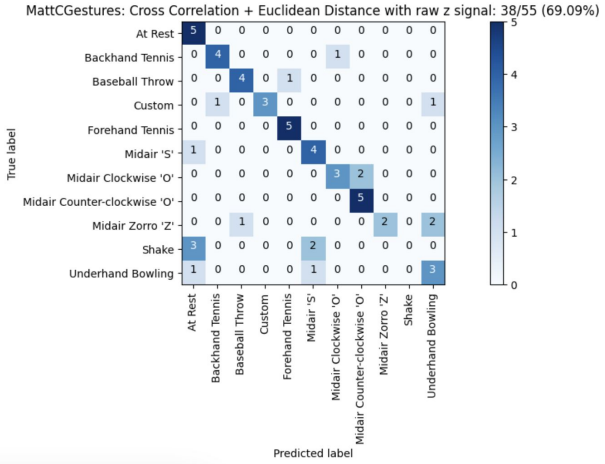




Confusion matrices of worst performing gesture sets







After exploring the data, I believe that these gesture sets performed worse because the orientation of the accelerometer was different than the training data

Enumerate key challenges/successes

What did you struggle with? Why?

Key challenges and successes

One challenge was wrapping my head around the testing/experiment framework. It is robust, and once I acclimated, managing many trials at once was easy. Another challenge that I found rewarding was implementing my own matching algorithms and seeing the performance of varying methods. Finally, a major success was implementing my own cross correlation shift value and calculating euclidean distance for my matching algorithm, and seeing the result was quite accurate and much faster than the dynamic time warping method.

Learning Reflection

What did you learn while completing this assignment?

Learning reflections

Key learnings:

- How to create shape matching algorithms
- How to plot data in an organized fashion for multiple data signals at once
- How k fold validation works
- How to use a experiment management framework