

MACHINE LEARNING

Submission Assignment 02

von

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1. Data Preprocessing

1.1. Preprocessing - Missing values

Are there any missing values which need to be taken care of?

No, I did not find a sample that has missing values. This was done by counting the number of values that are not nan for each sample. Then I counted the number of nan values for the first values.

This means if the sample has 100 not nan values I took the first 100 values and counted the number of nan values. If the number of nan values in the first 100 values is 0, then there is no missing data in the sample.

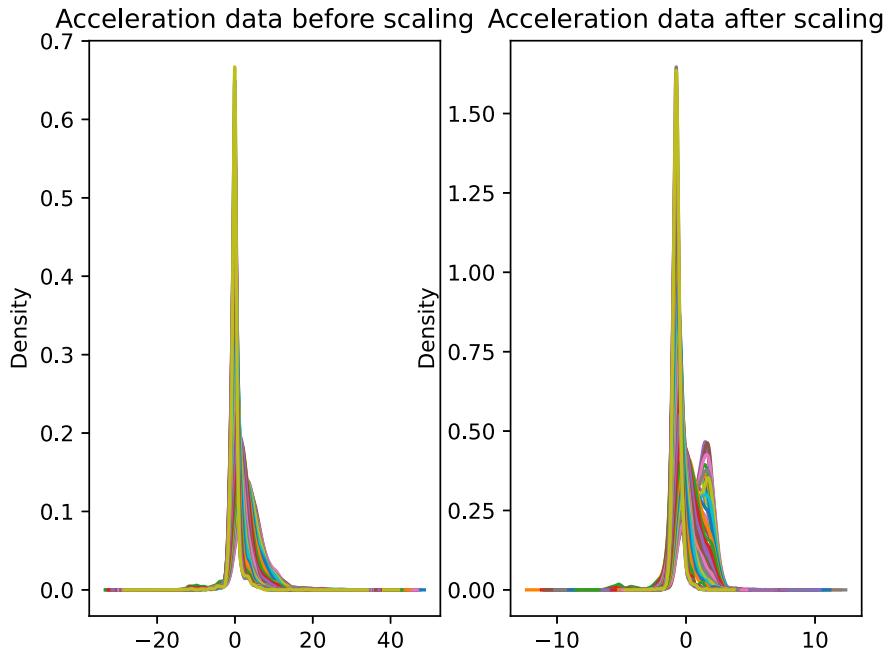
1.2. Preprocessing - Feature Reduction

To get an equal amount of acceleration values I interpolated the gesture data and took an equal amount of values for each sample. According to the description the sensor was recording with 100Hz and the max frequency that makes sense is 20Hz, this means 84.6 ($423/5$) values should be sufficient.

Therefore, I visualized the comparison of the interpolated data for each gesture and using 50, 100 and 200 values compared to the original data. As a result I decided to continue to work with only 50 values, because I think it still shows the mandatory information. The comparisons can be seen in Appendix Interpolations 3.1.

1.3. Preprocessing - Normalization

I decided to normalize the data using scaling. Figure 1 shows the distribution of the data before and after normalization. The normalization was done, because it helps the models to work with the data.



1.4. Preprocessing - Filtering

I decided to use filter to reduce the noise in the data, as suggested in the exercise hints. I tried the suggested filters (running mean, running median and savgol filter).

In my opinion the savgol filter preserves the trends of the gestures best, therefore I continued with the data that was filtered using the savgol filter. The comparisons can be seen in Appendix Filters 3.2. Regarding the windowsize I tried some sizes and ended up with 8, but I think including these plots here would be too much.

1.5. Preprocessing - Feature Addition

In the last exercise we already saw, that there is a correlation between the length of a sample and the gesture type. But, by processing the samples to get samples with equal lengths, we lost this information. Therefore, I added it manually as an extra feature, describing the original length of the recording.

2. Feature Extraction

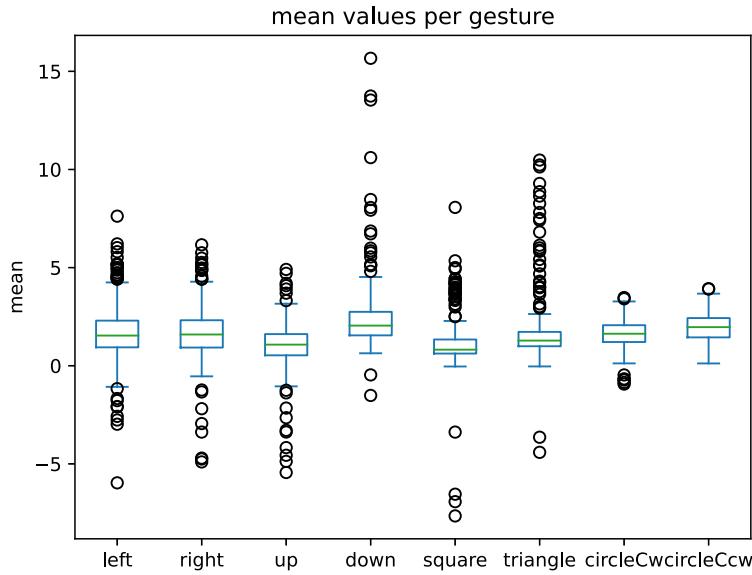
Yes I think it makes sense to derive more features besides the acceleration values, or at least try and look if there might be ones that make sense. I chose to extract the following features:

- mean
- median
- standard deviation
- min
- max
- innerquartile range
- median absolute deviation
- zero crossing rate
- median crossing rate
- number of maximas
- number of minimas
- 1st derivative of the acceleration values
- 2nd derivative of the acceleration values
- wavelet transformation
- frequency power
- frequency angle
- autocorrelation

Afterwards I selected the best features.....

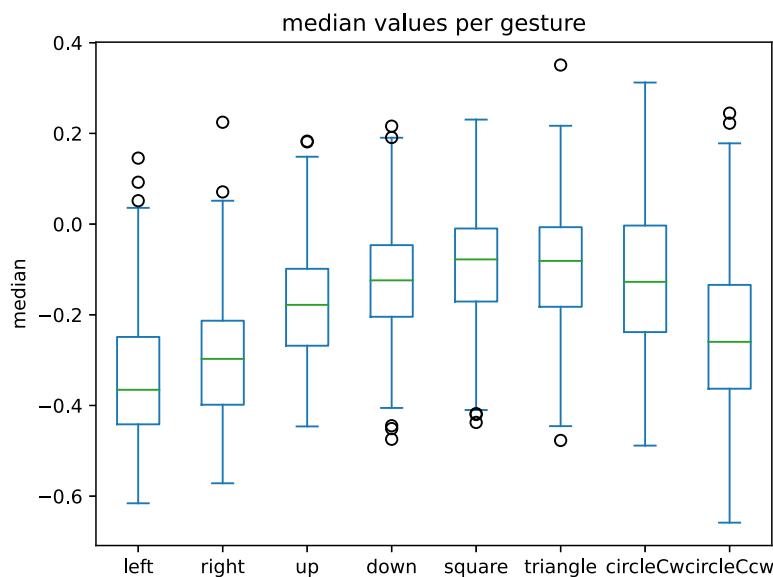
2.1. Feature Extraction - Mean

By normalizing the data during the preprocessing, the mean was “destroyed”, therefore I had to use the mean of the original data. In Figure 2 we can sense, that this value was calculated before preprocessing the data, especially looking on the amount of outliers.



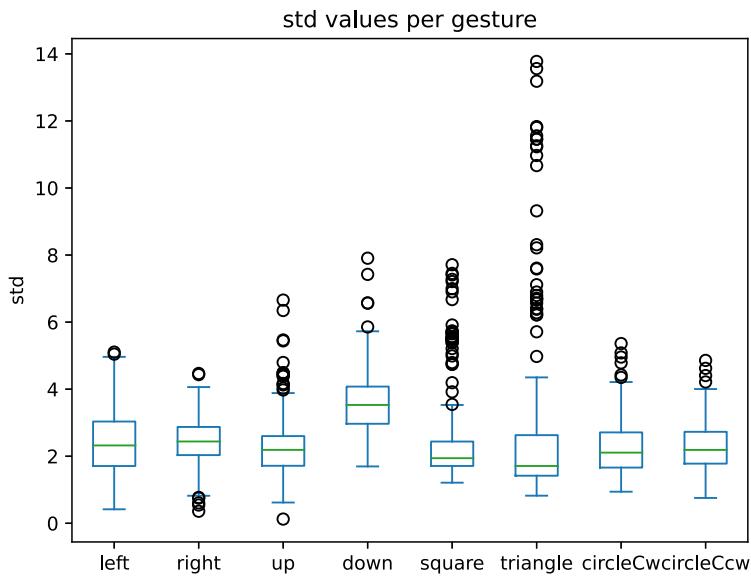
2.2. Feature Extraction - Median

The median could be taken from the preprocessed data in Figure 3 it looks like there is at least some correlation with the gesture types.



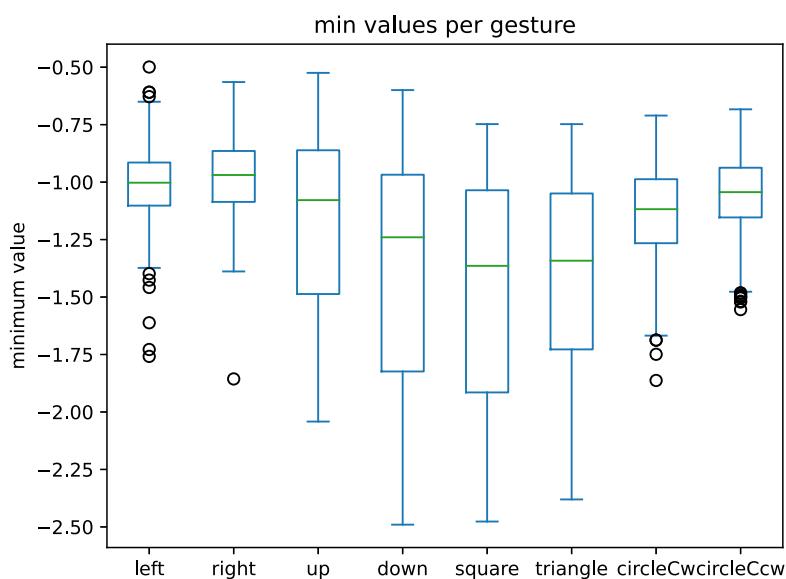
2.3. Feature Extraction - Standard Deviation

Same as with the mean, the std had to be taken from the original data. In Figure 4 we can see that the std is more robust compared to the mean in Figure 2, still there is a great amount of outliers.



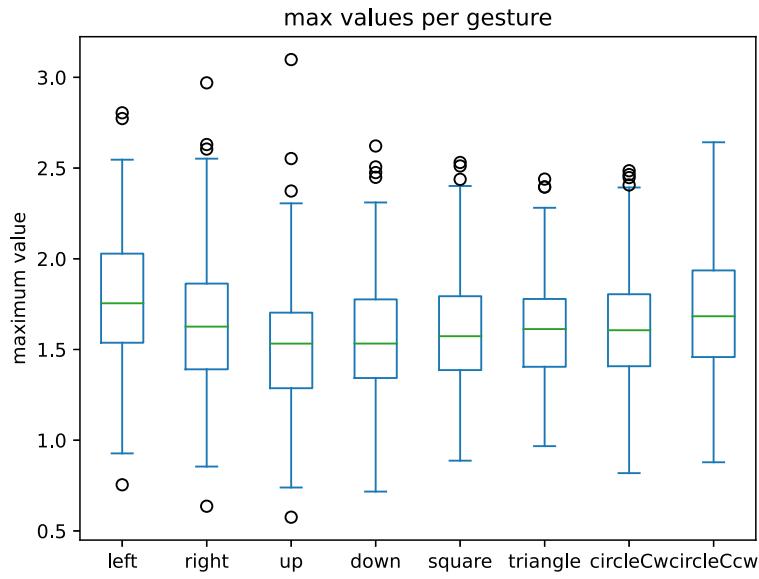
2.4. Feature Extraction - Min value

Figure 5 shows the correlation between the min value and the gesture types. It seems like there is at least some correlation, especially the gestures left and right and the circles have very high minimum values.



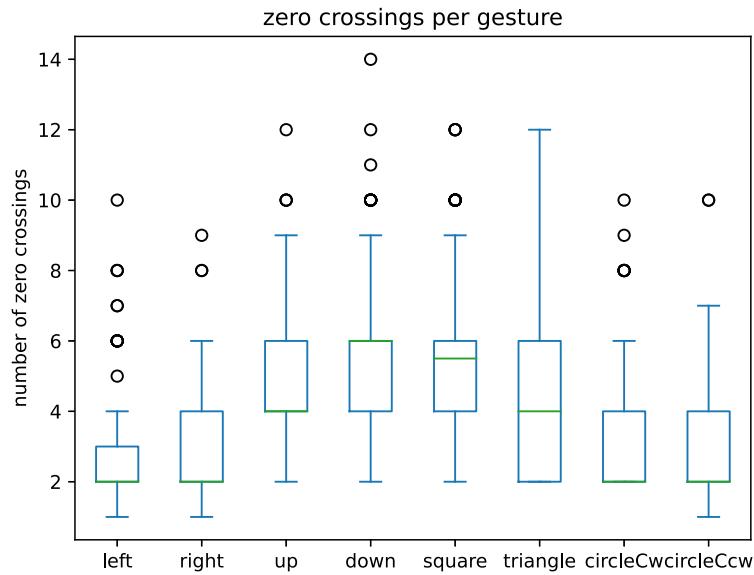
2.5. Feature Extraction - Max value

Figure 6 shows that the max value does not correlate very good with the gesture type.



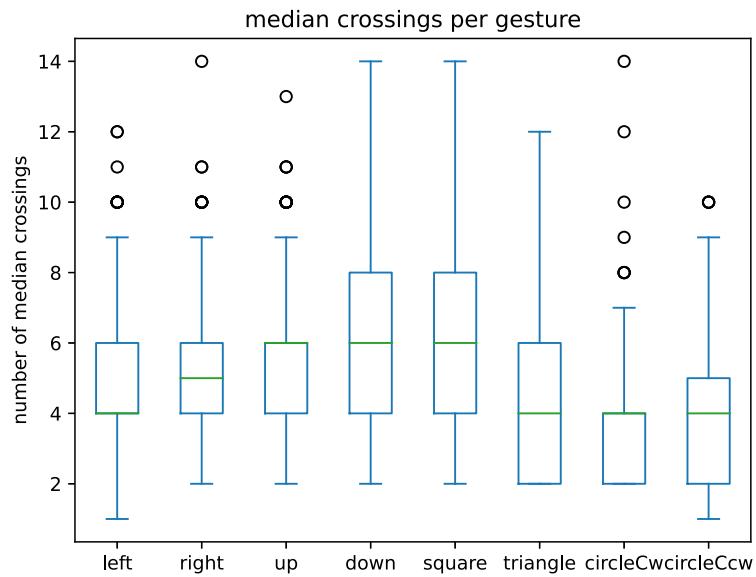
2.6. Feature Extraction - Zero Crossing Rate

Figure 7 shows the number of zero crossings per gesture, which looks like a potentially good feature.



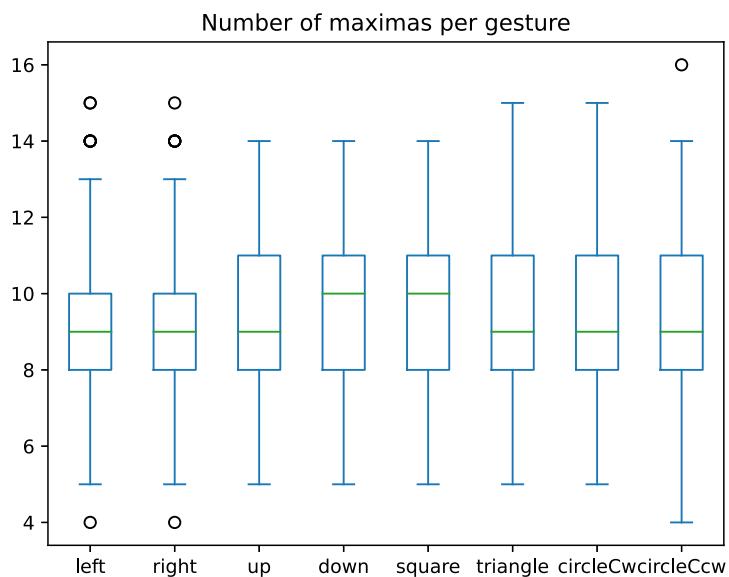
2.7. Feature Extraction - Median Crossing Rate

Figure 8 shows the number of median crossings per gesture, which does not look as promising compared to the zero crossing rate in Figure 7.



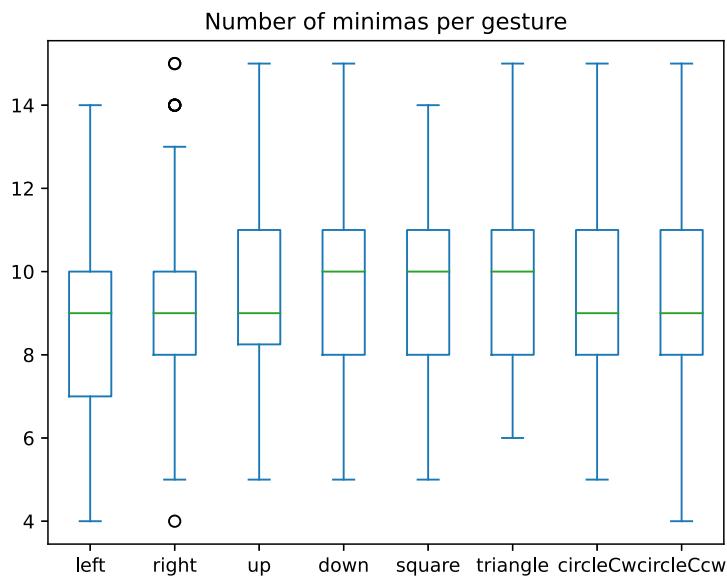
2.8. Feature Extraction - number of maximas

I calculated the number of maximas per gesture, because I thought this information would be a very good feature. But looking at Figure 9 we can see that this is not the case. Still I kept it and waited for the PCA, to tell us how good this feature is.



2.9. Feature Extraction - number of minimas

Same as with the maximas, we can see in Figure 10 that the number of minimas probably not a good feature.



2.10. Feature Extraction - 1st. derivative

plot by gesture?

2.11. Feature Extraction - 2nd. derivative

plot by gesture?

2.12. Feature Extraction - frequency transformation

dont know how to plot

2.13. Feature Extraction - autocorrelation function

dont know how to calculate

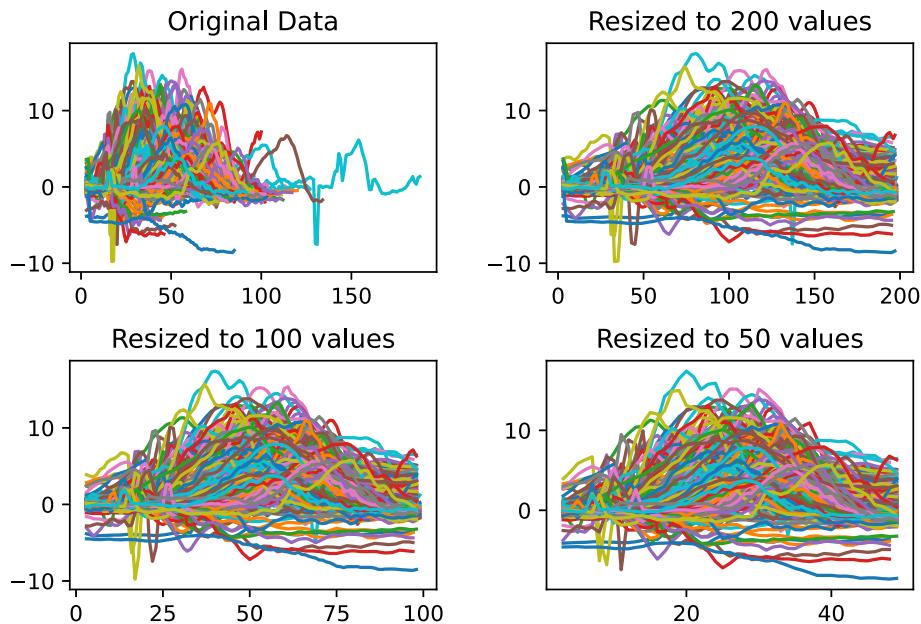
2.14. Feature Extraction - wavelets

dont understand

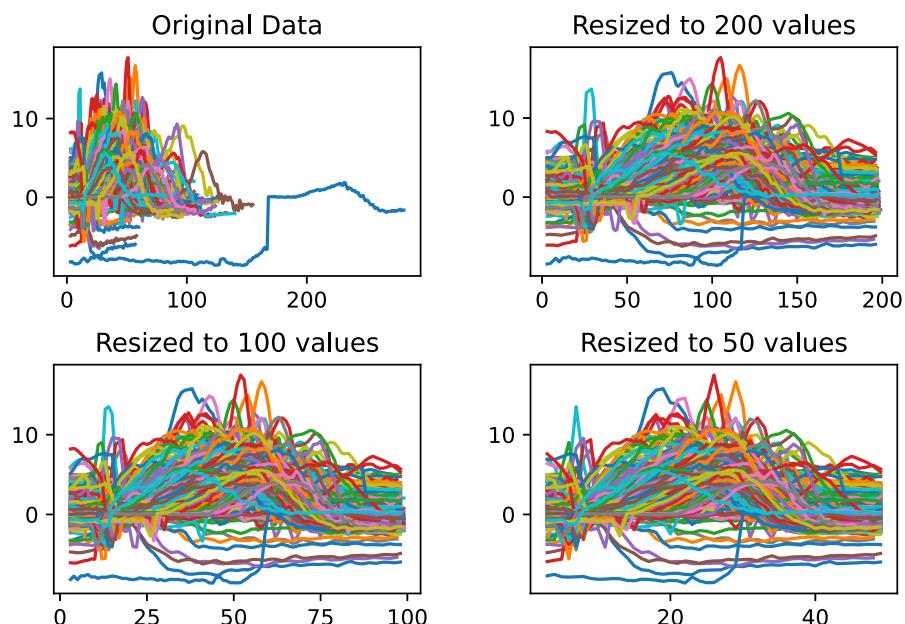
3. Appendix

3.1. Appendix Interpolations

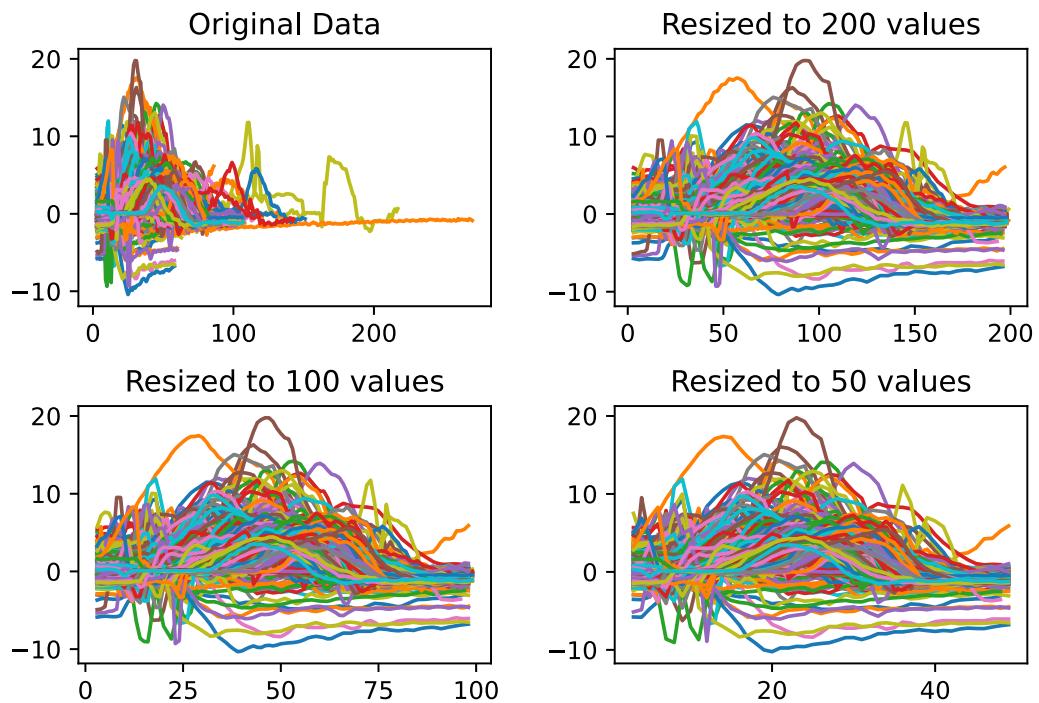
left gesture interpolation and resizing comparison



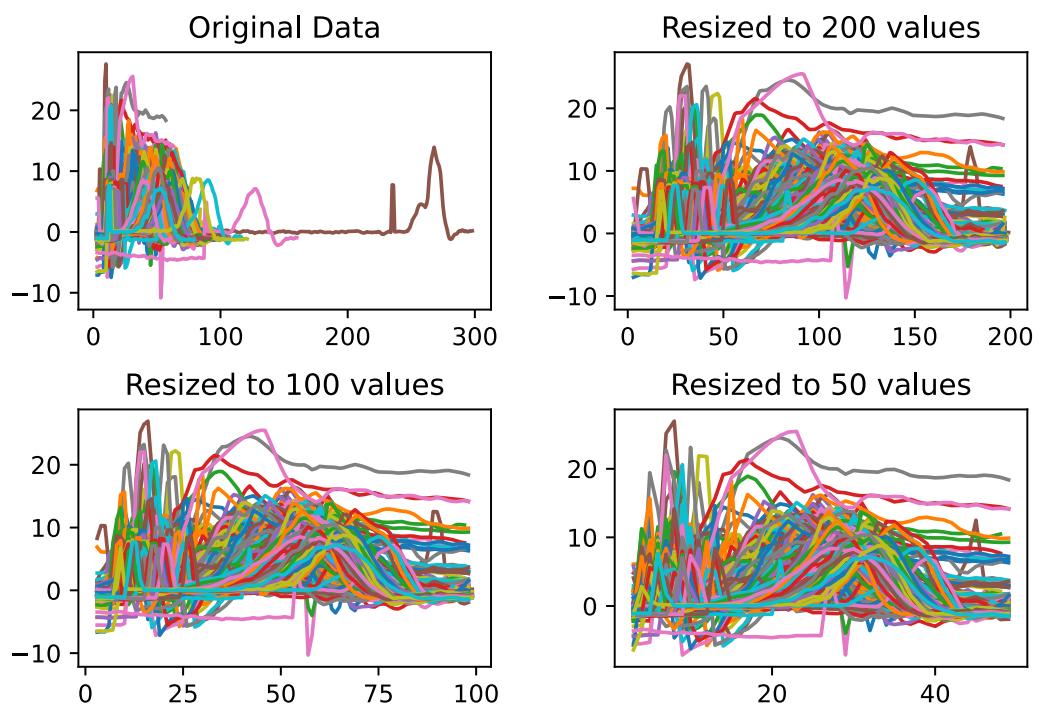
right gesture interpolation and resizing comparison



up gesture interpolation and resizing comparison



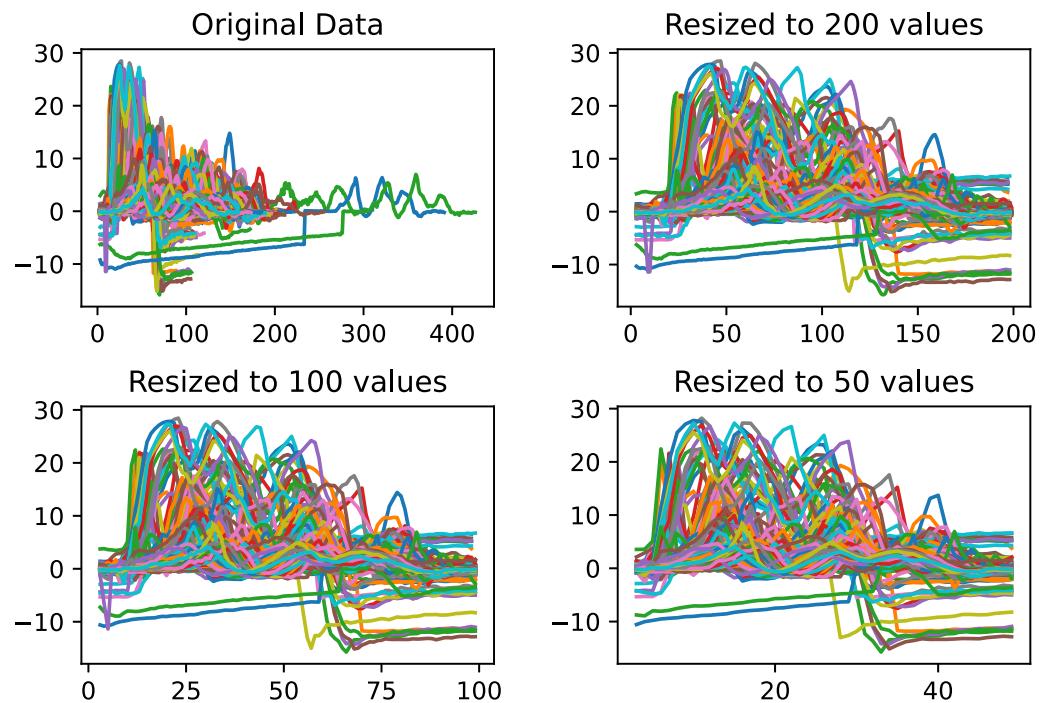
down gesture interpolation and resizing comparison



square gesture interpolation and resizing comparison



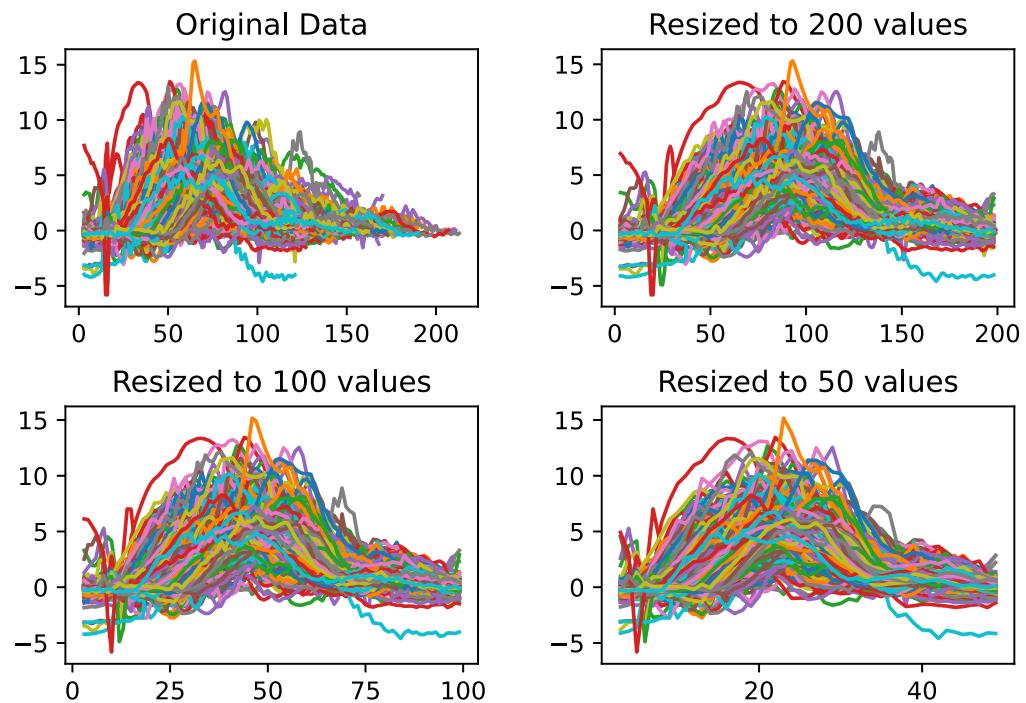
triangle gesture interpolation and resizing comparison



circleCw gesture interpolation and resizing comparison

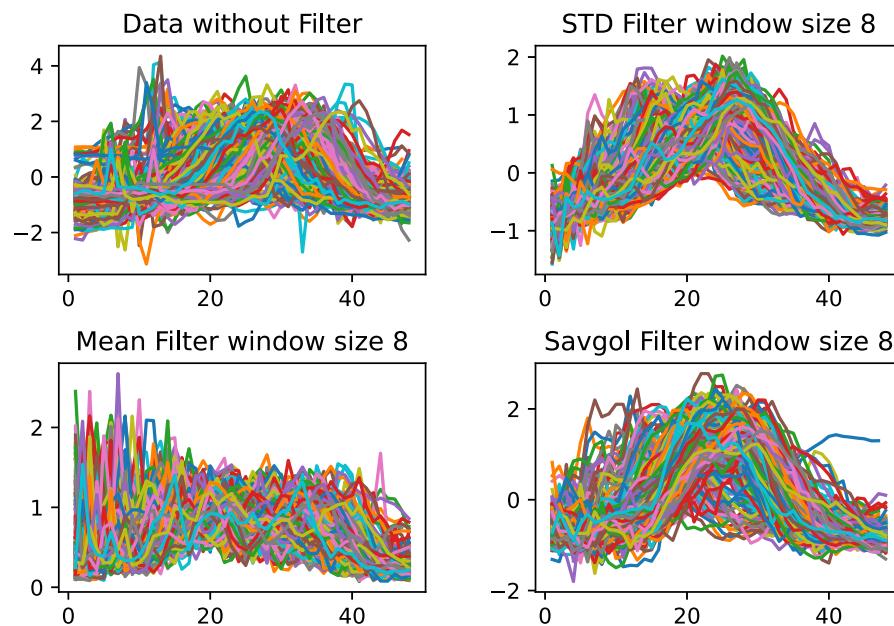


circleCcW gesture interpolation and resizing comparison

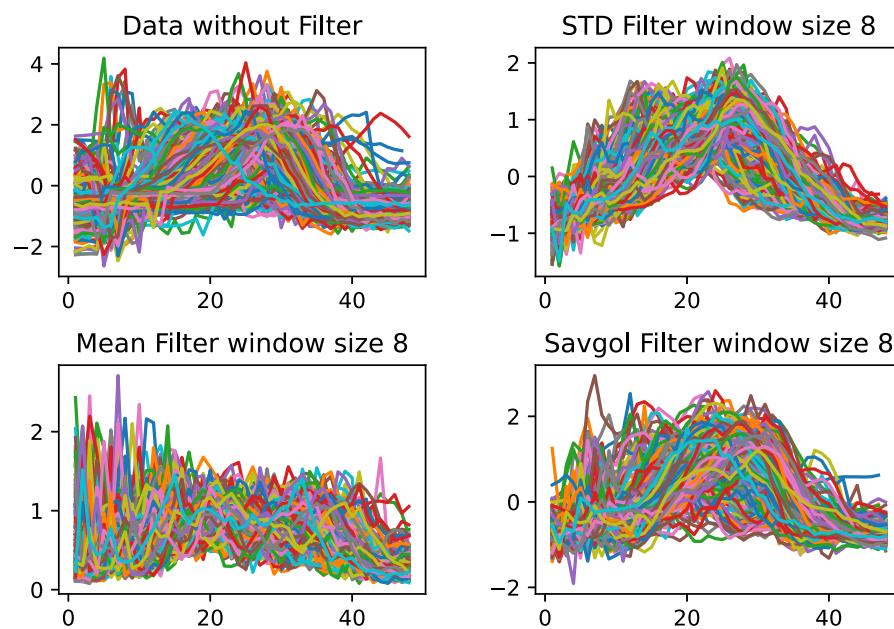


3.2. Appendix Filtering

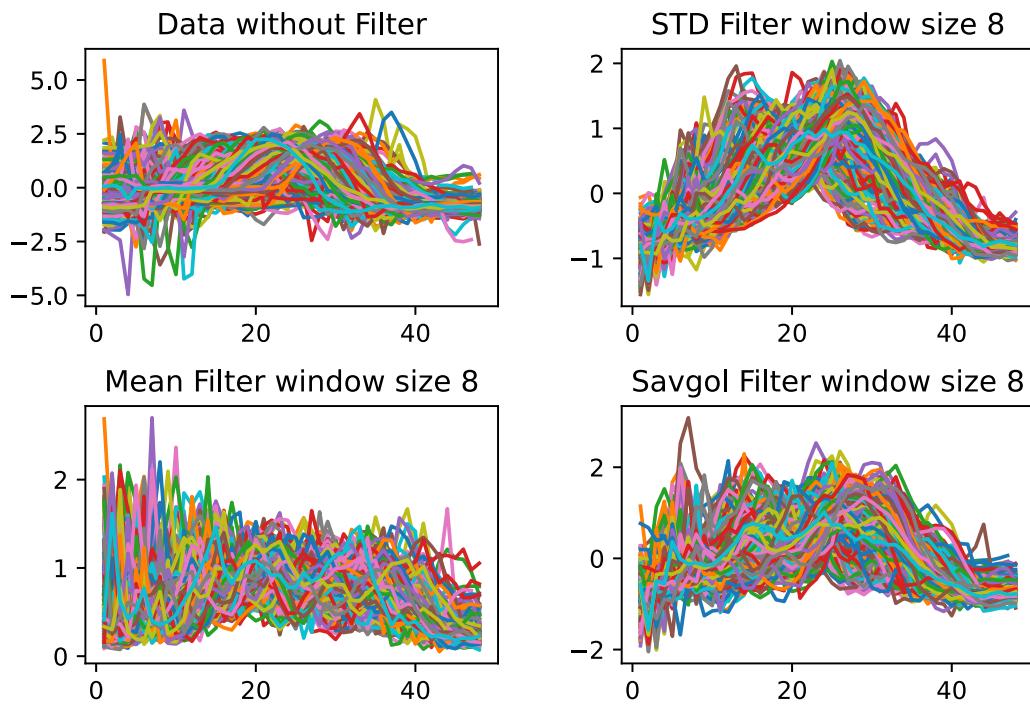
left gesture Filter comparison



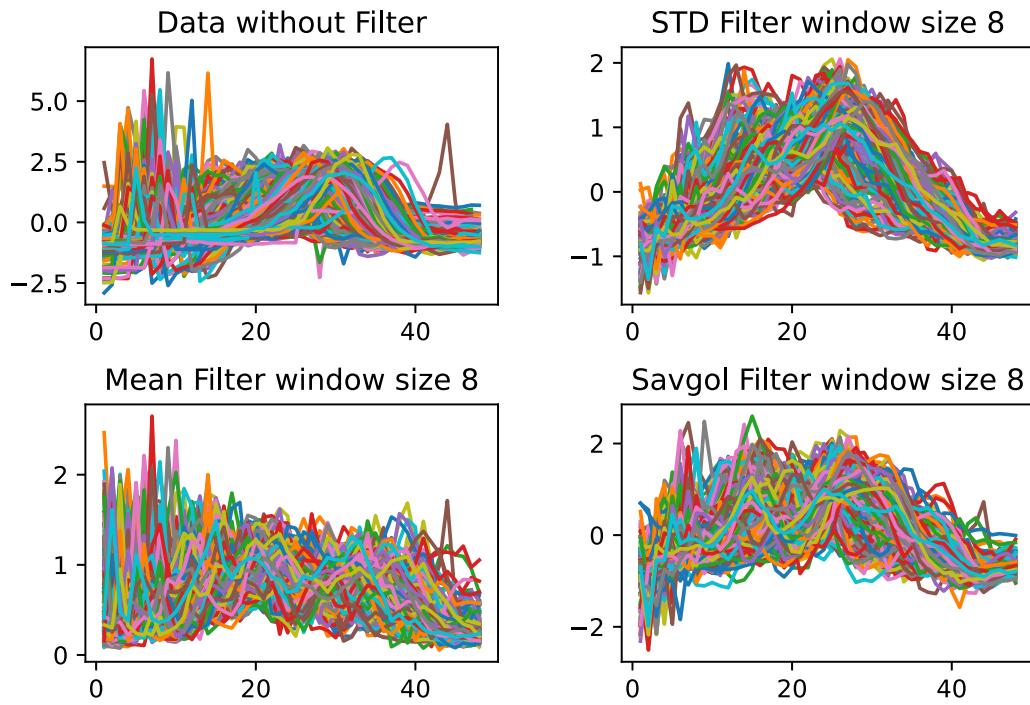
right gesture Filter comparison



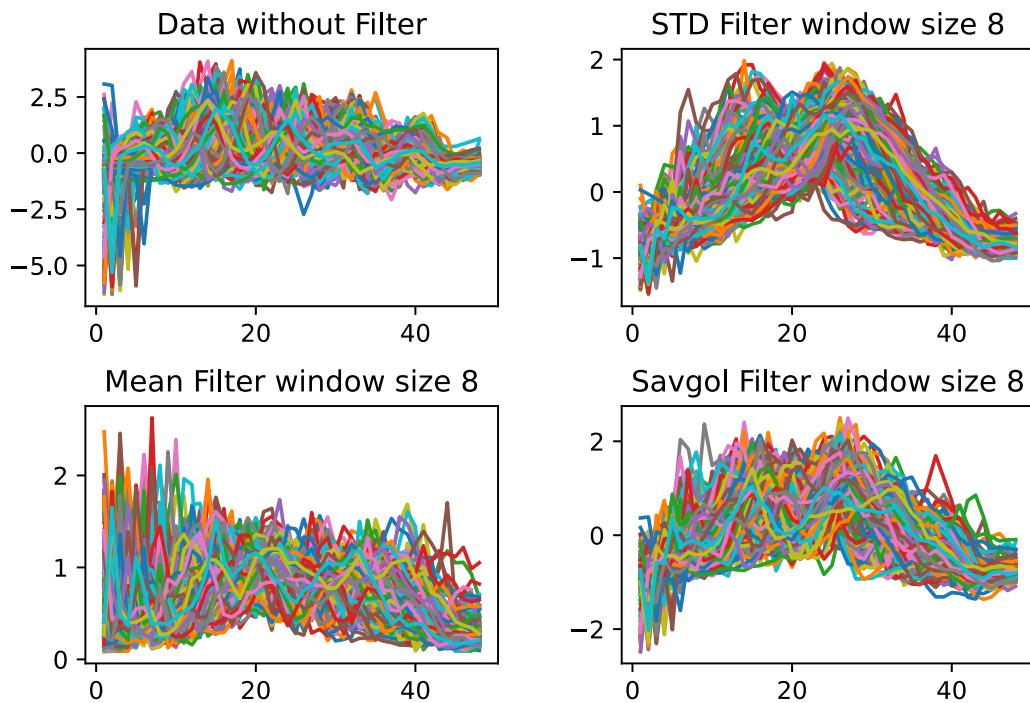
up gesture Filter comparison



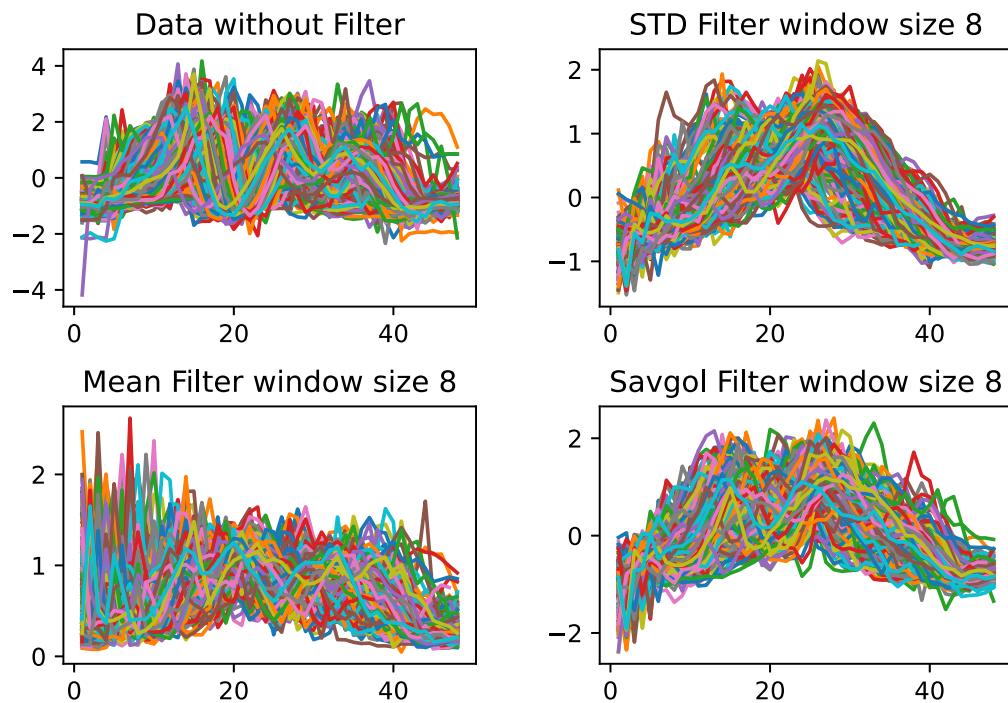
down gesture Filter comparison



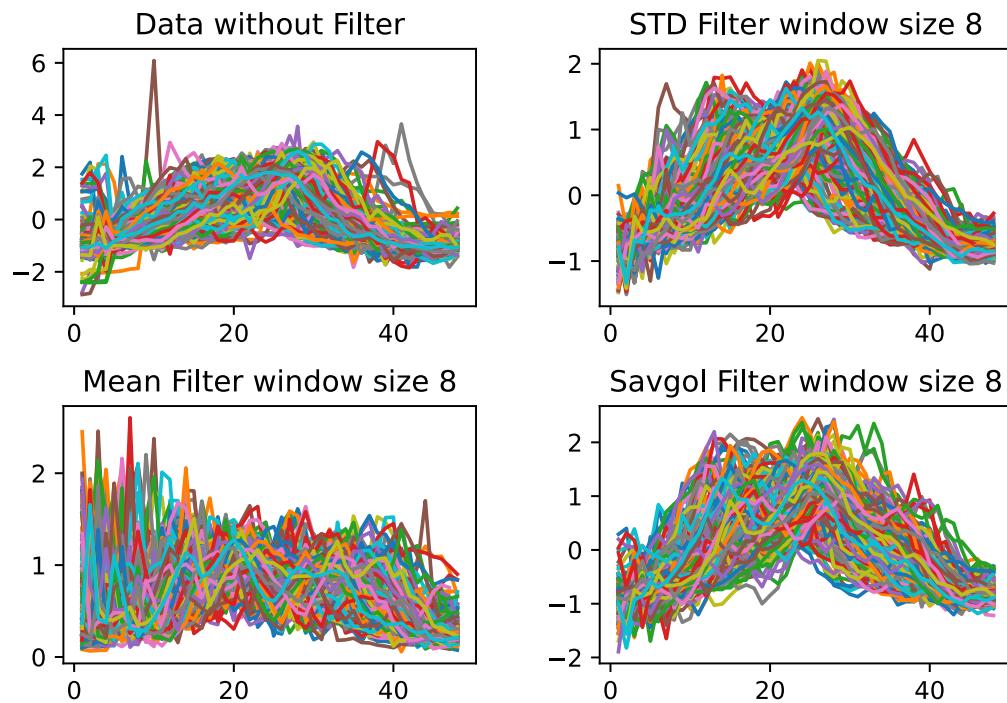
square gesture Filter comparison



triangle gesture Filter comparison



circleCw gesture Filter comparison



circleCcw gesture Filter comparison

