Homework 4 Report

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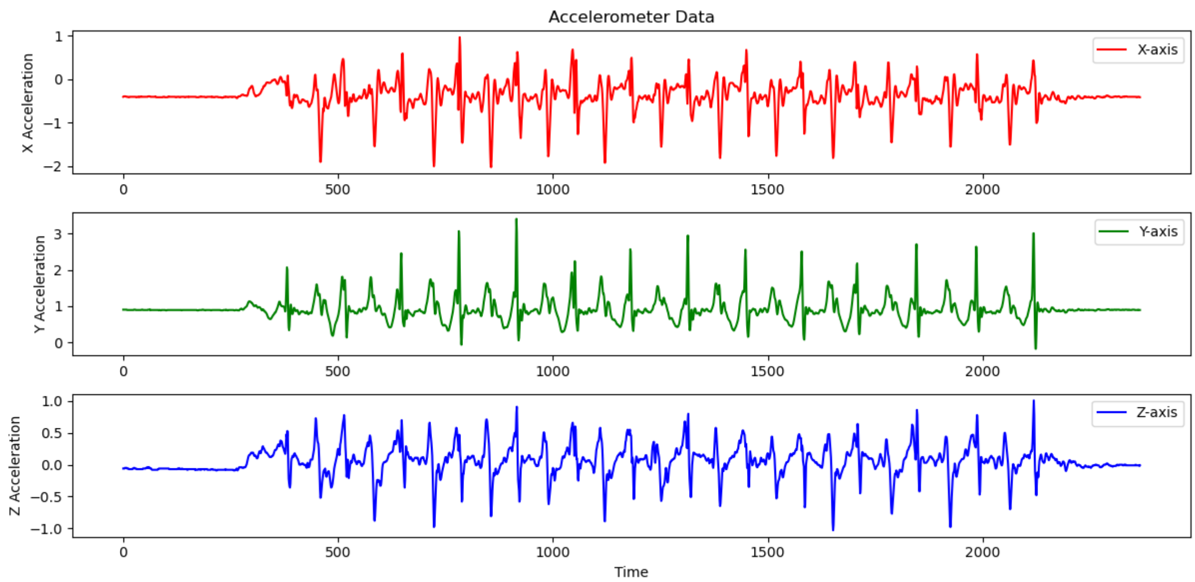
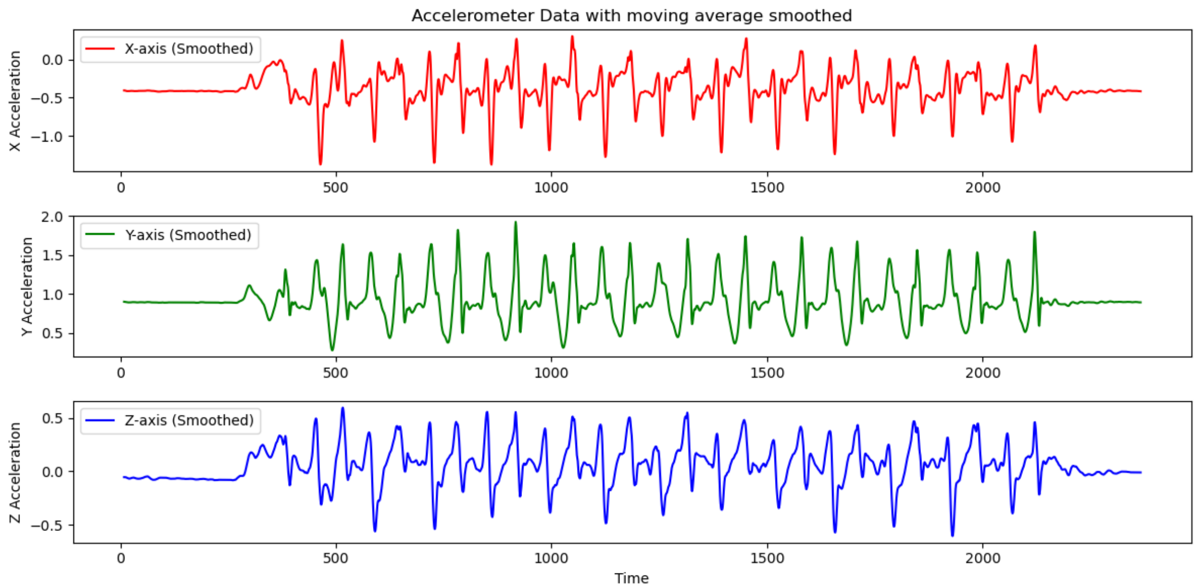
Part 1

Data processing

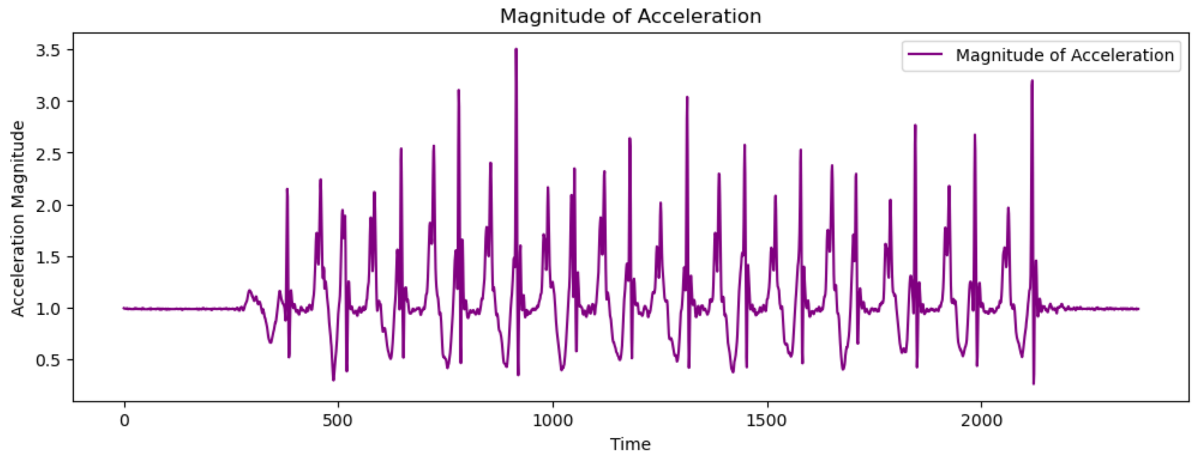


raw acceleration data

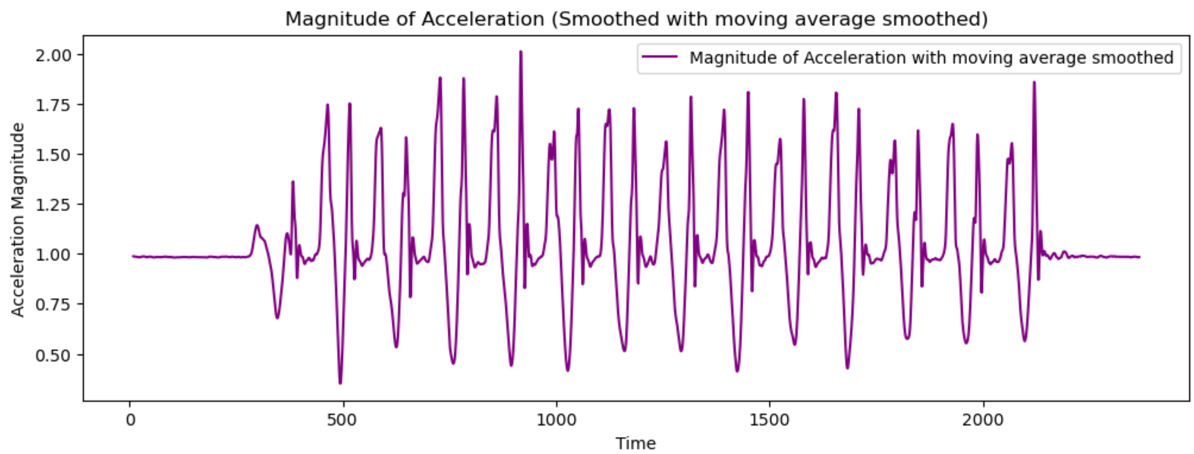


acceleration data with moving average smoothed

The top set shows the raw data, characterized by significant noise and variability across all axes. The bottom set shows the data after applying a moving average smoothing technique, which reduces noise and reveals clearer trends, making the data easier to interpret for further analysis.



raw acceleration magnitude



acceleration magnitude with moving average smoothed

Here shows two plots of acceleration magnitude over time. The top plot presents raw data with pronounced peaks, indicating rapid acceleration changes. The bottom plot applies a moving average to smooth the data, reducing peaks and clarifying trends.

Experiment

The thresholds I set according to the acceleration magnitude with moving average smoothed is:

- starting point: acceleration magnitude = `1.6`
- ending point: acceleration magnitude = `0.7`

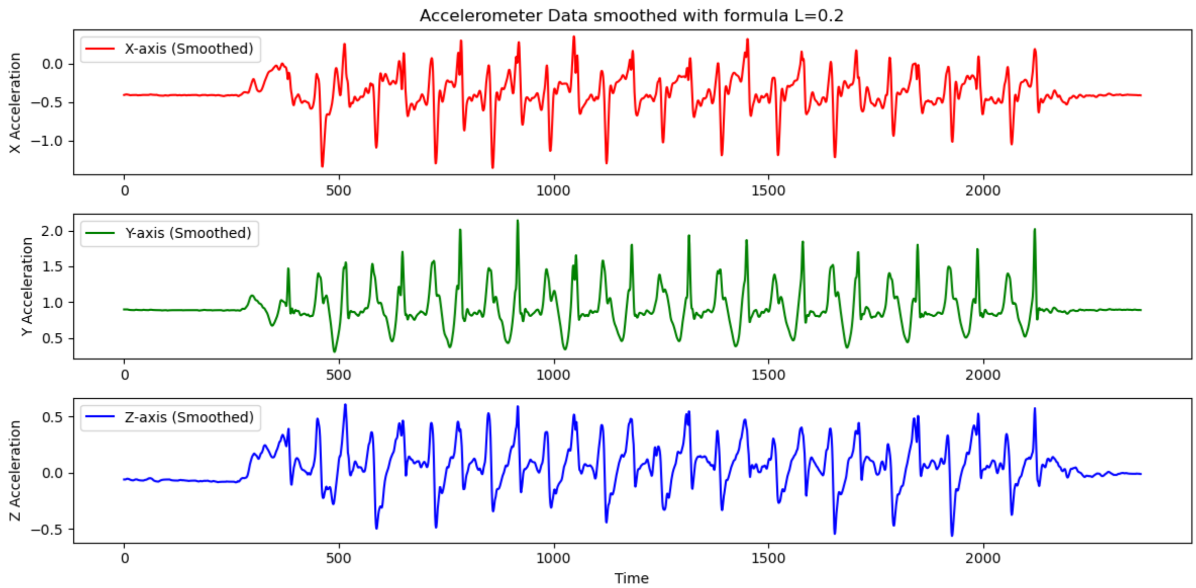
Using these thresholds to count the step(5 experiments)
Result:

real	counter
15	21
15	17
15	15
15	13
15	15

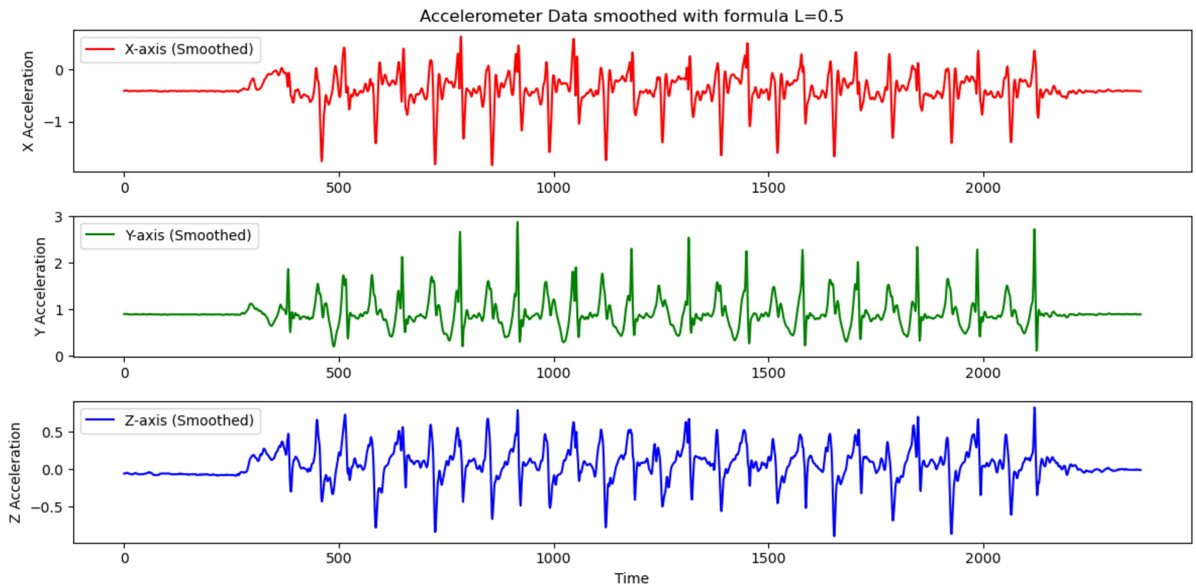
- The result above shows the selection of this set of thresholds yields relatively good results in step counting.

Part 2

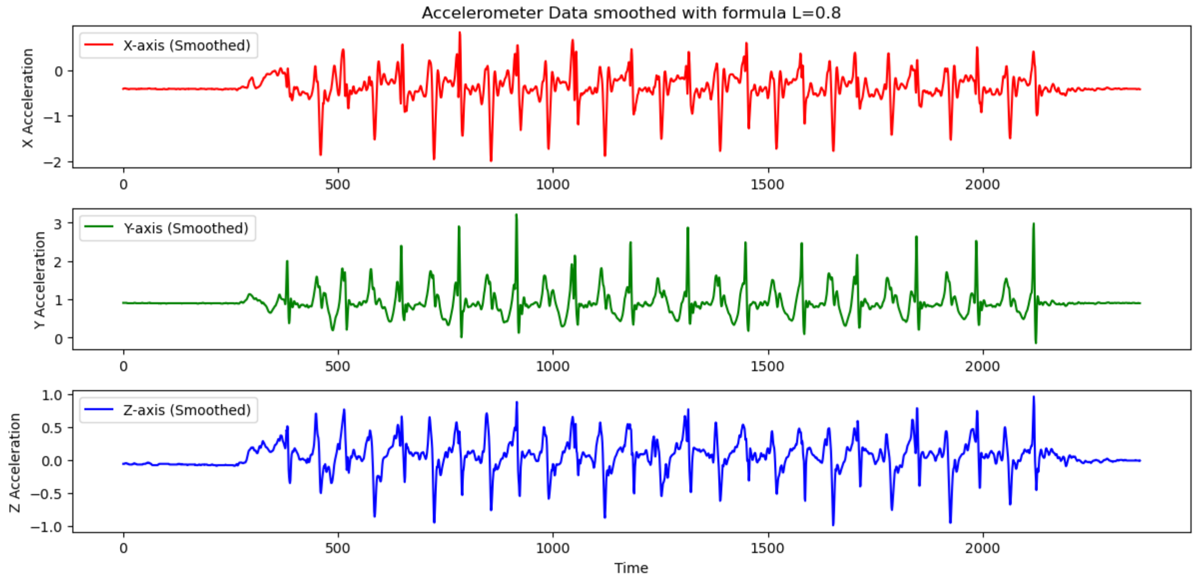
Data processing



acceleration data smoothed with formula (L=0.2)



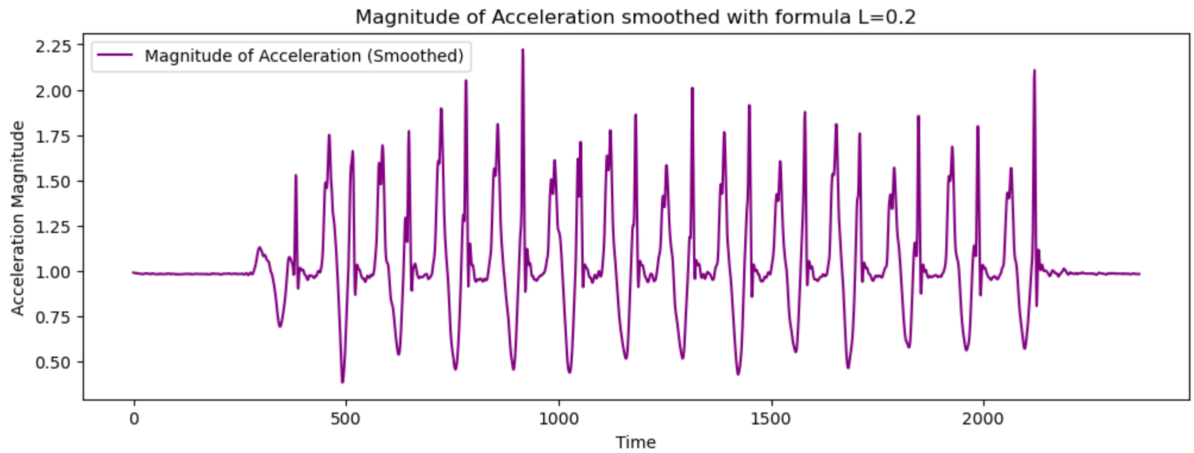
acceleration data smoothed with formula (L=0.5)



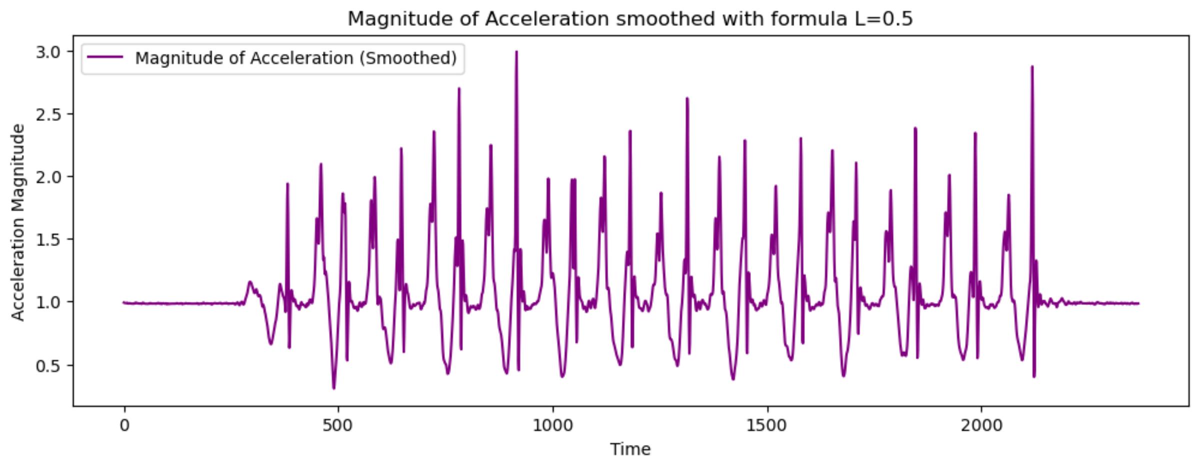
acceleration data smoothed with formula (L=0.8)

The three plots above show accelerometer data for X, Y, and Z axes, each smoothed using a different value of the smoothing factor L in the exponential moving average formula. The smoothing factor L determines the degree to which the algorithm weighs recent versus older observations.

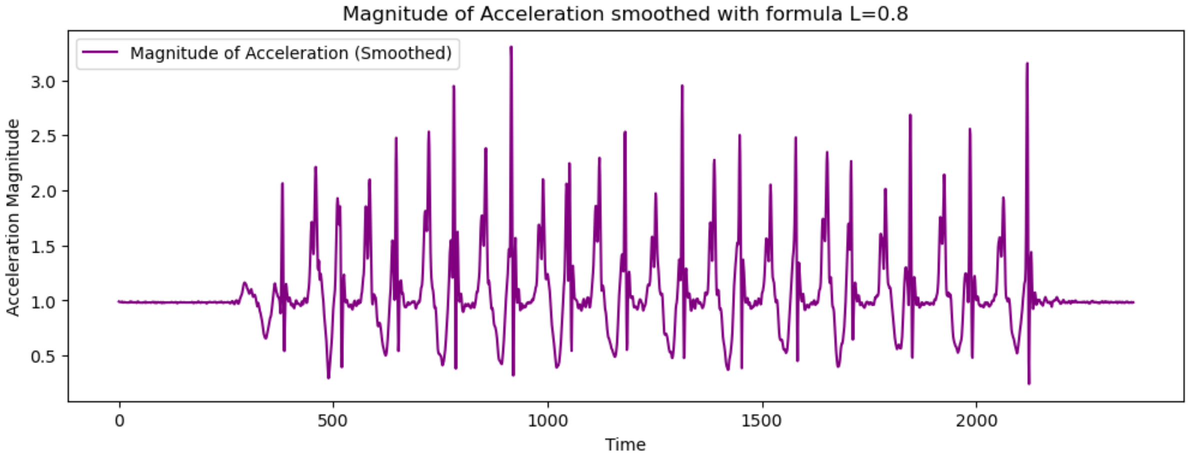
1. **L=0.5** yields moderate smoothing, retaining some data variability.
2. **L=0.8** provides minimal smoothing, preserving most of the original fluctuations.
3. **L=0.2** results in heavy smoothing, significantly reducing data variability.



acceleration magnitude smoothed with formula (L=0.2)



acceleration magnitude smoothed with formula (L=0.5)



acceleration magnitude smoothed with formula (L=0.8)

The three plots above compare the effects of different L values on the smoothing of acceleration magnitude:

1. **L=0.2**: Heavy smoothing with flattened peaks.
2. **L=0.5**: Moderate smoothing with noticeable but softened peaks.
3. **L=0.8**: Minimal smoothing, peaks closely resemble the raw data.

Lower L values produce smoother curves, while higher L values maintain more of the original data's variability.

Experiment

The thresholds I set according to the acceleration magnitude with 3 different smoothing are:

- L = 0.2
  - starting point: acceleration magnitude = `1.65`
  - ending point: acceleration magnitude = `0.6`
- step counting result (5 experiments):

real	counter
15	17
15	12
15	14
15	14
15	15

- L = 0.5
  - starting point: acceleration magnitude = `2`
  - ending point: acceleration magnitude = `0.5`
- step counting result(5 experiments):

real	counter
15	6
15	4
15	4
15	5
15	4

- L = 0.8
    - starting point: acceleration magnitude = `2.2`
    - ending point: acceleration magnitude = `0.5`
- step counting result(5 experiments):

real	counter
15	4
15	7
15	3
15	4
15	4

The results above indicate that the threshold selected with L=0.2 performs better in actual step counting. While thresholds are selected with L=0.5 or 0.8, due to weaker smoothing, they are relatively large, resulting in poorer performance in practical step counting and making it more challenging to detect steps.

Other Challenge

Attaching the sensor to different parts of the thigh may result in slightly different reading outcomes, which in turn could affect the selection of the threshold or the prediction of the counter.

Maybe using multiple sensors at different locations and combine the data to average out any discrepancies in readings from different thigh parts is a better option.