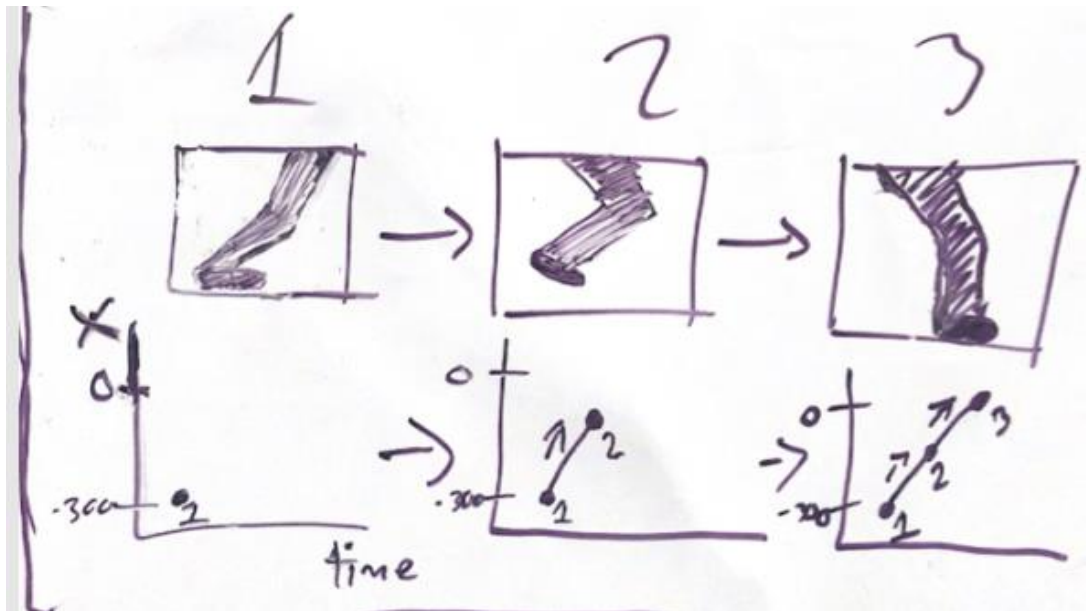Daniel Karkhut

Calculating Max Stride Length and Pace from Foot, Ankle, and Knee Data

Foot movement has an oscillatory behavior
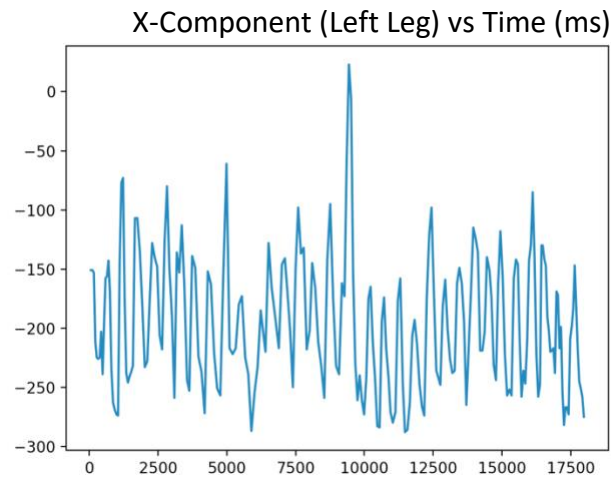
Idea:

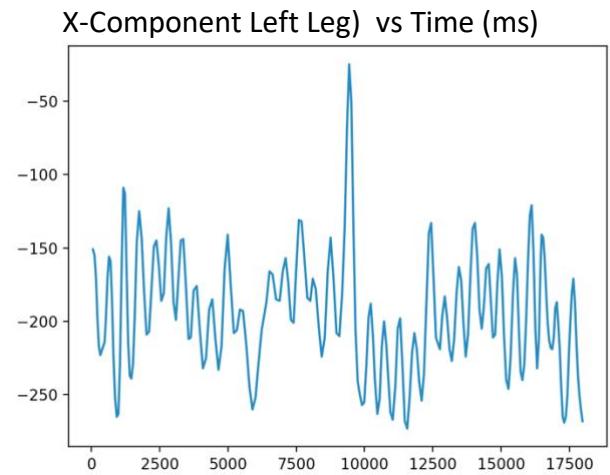*Use the peaks and troughs in the x components of the feet to measure each stride*

As the user moves, the x component will zigzag up and down, producing peaks and troughs.

First approach:

X-Component (Left Leg) vs Time (ms) → X-Component Left Leg) vs Time (ms)

```
peak = []
trough = []

for i in range(1, len(smooth_signal)-1):
    if (smooth_signal[i] > smooth_signal[i-1]) and ((smooth_signal[i] > smooth_signal[i+1])):
        peak.append(smooth_signal[i])
    if (smooth_signal[i] < smooth_signal[i-1]) and ((smooth_signal[i] < smooth_signal[i+1])):
        trough.append(smooth_signal[i])
```

1. Apply Gaussian Filter to smooth out the local peaks and troughs that crop up in the data.
2. Check whether each index is the local max/min between its two neighbors, save as peaks and troughs
3. Loop over all peaks and troughs and find distance between each one incrementally. eg.[distance = abs(peak[0] – trough[0])]
4. Use these distances and time to find max stride length and average pace

Problem: The gaussian blur dilutes a lot of the data which no longer has real recorded distances

Second approach:

Use Z-Score to calculate the number of peaks and troughs.

1. Estimate position of peaks and troughs using Z-Score produces square pattern (Bottom-Fig1)

    a. 1 == Peak Range
    b. -1 == Trough Range
    c. 0 == Stagnant

    d.   Fig1
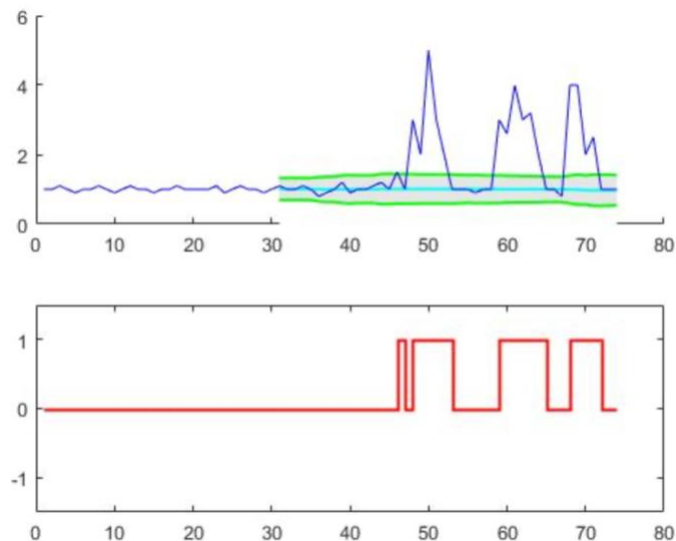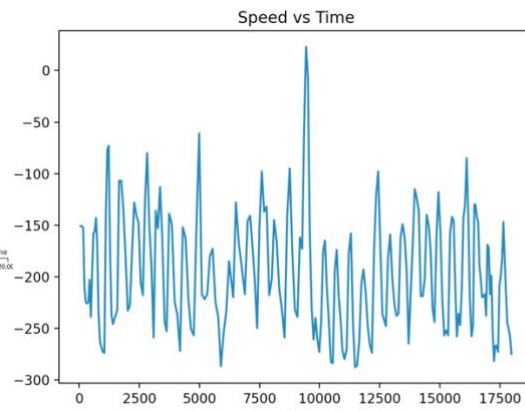
2. Find ranges when Z-Score is 1 and -1.
3. Search these ranges in the original signal (Top-Fig1) and find max/min point within this range
4. Save these max and mins as peaks and troughs, then apply same distance formula from first approach to find max stride length and average pace

```
Troughs Right: 33
Peaks Right: 15
Troughs Left: 30
Peaks Left: 30
_____Right Leg Report _____
Total Walk Length (mm): 1147
Total Elapsed Time (ms): 18037
Max Stride Length (mm): 152
Average Pace (mm/ms): 0.0635915063480623
_____Left Leg Report _____
Total Walk Length (mm): 3728
Total Elapsed Time (ms): 18037
Max Stride Length (mm): 296
Average Pace (mm/ms): 0.206686256029273
```

Results for left leg are good but results for right leg are not. Tracking data does not calculate the full stride of the right leg as it misses many peaks in detection. I believe this is due to the dynamic data present in the right leg x column of the data. The oscillating motion is better represented in FIG 3 but is less present in FIG 1. The settings can be tweaked to find more peaks and troughs.
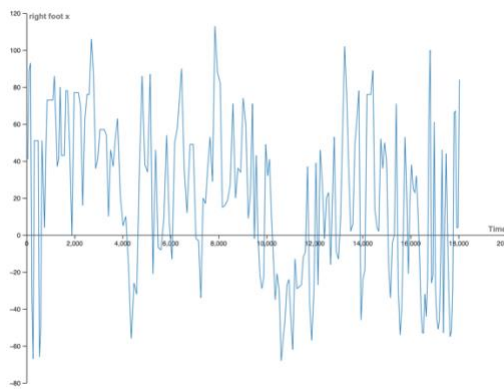
Stride data for right leg
FIG 2

Speed vs Time

Stride data for left leg
FIG 3