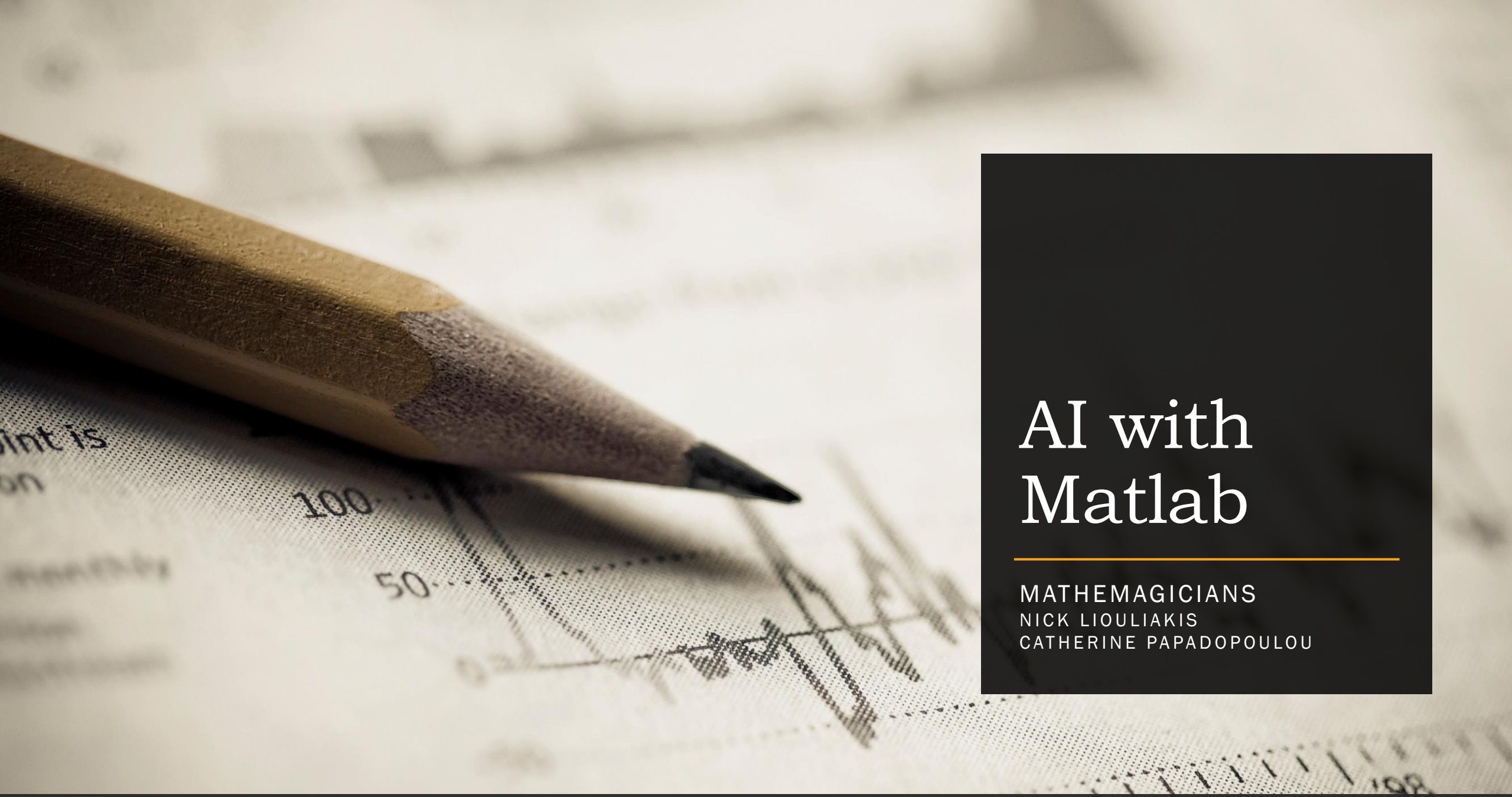

AI with Matlab

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The Problem

Create a fitness tracker based on data from sensors available on a smartphone.

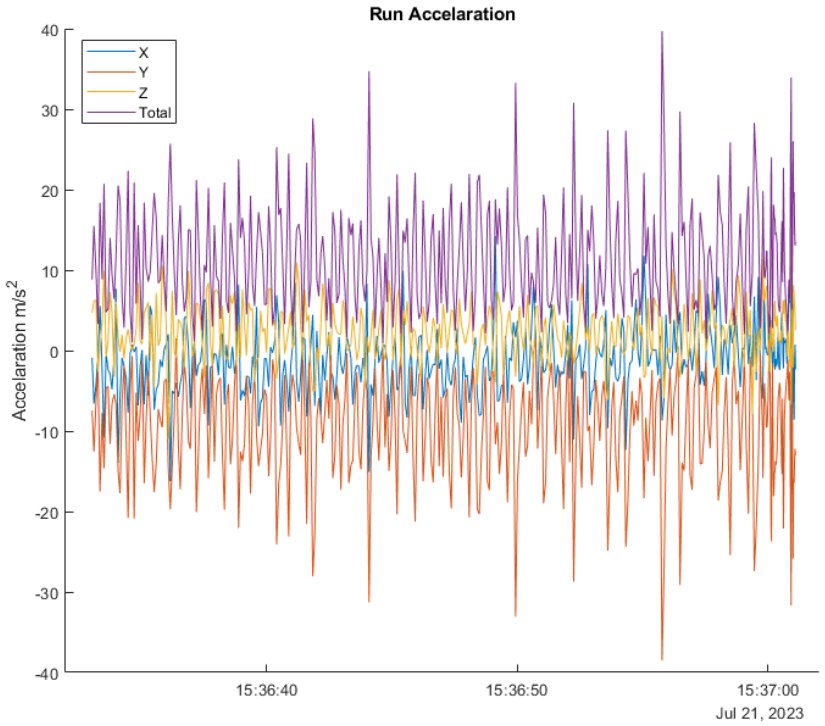
The available data were:

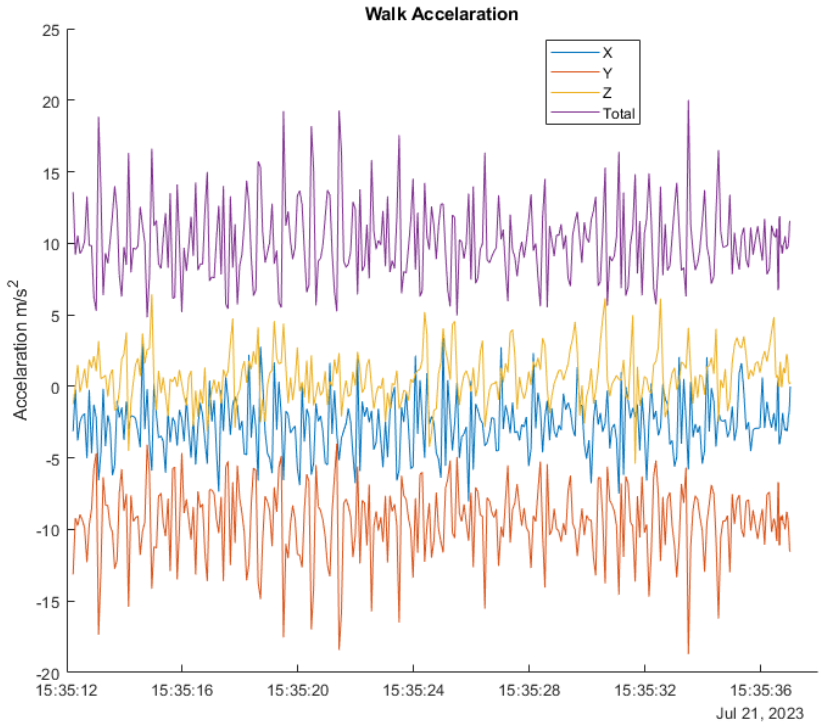
- Acceleration
- Orientation
- Angular Velocity
- Position

For our application, we used:

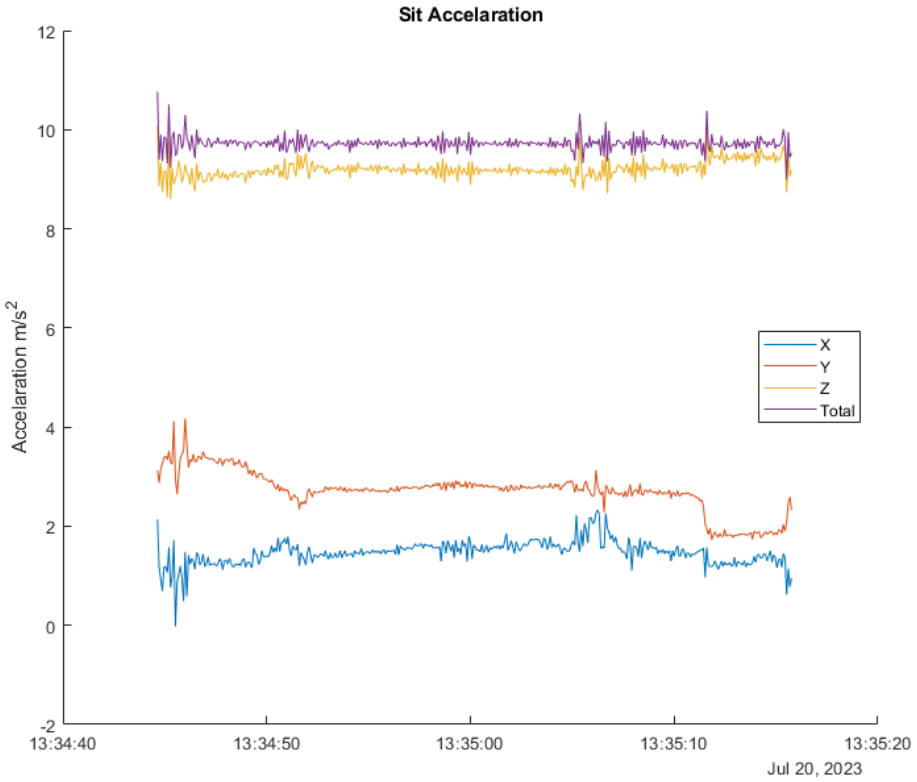
- Acceleration
- Position

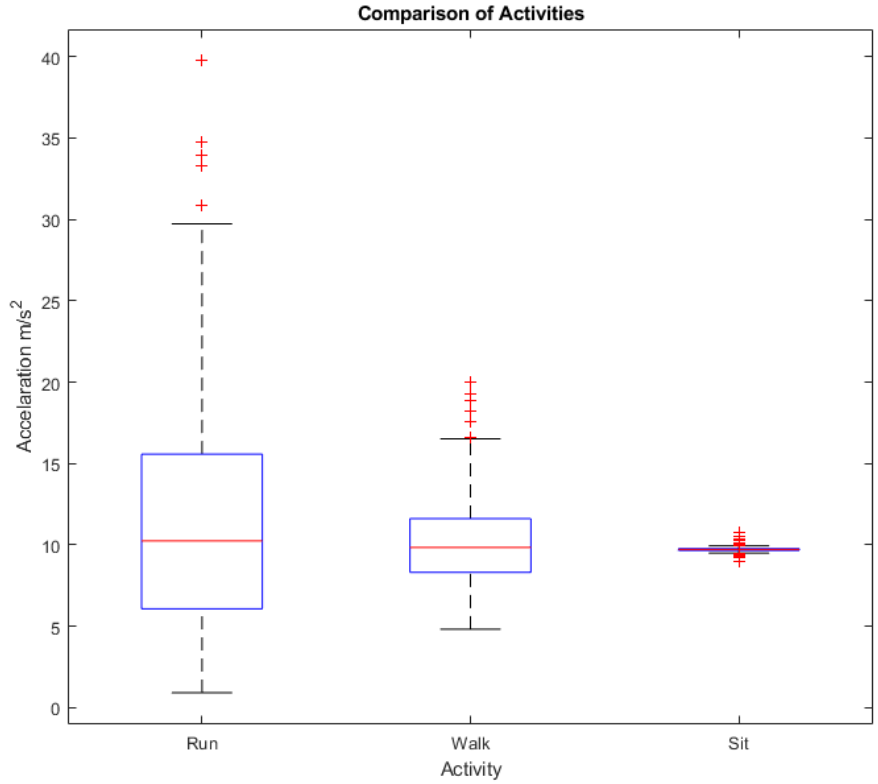
Exploratory data analysis and visualization





Exploratory data analysis and visualization





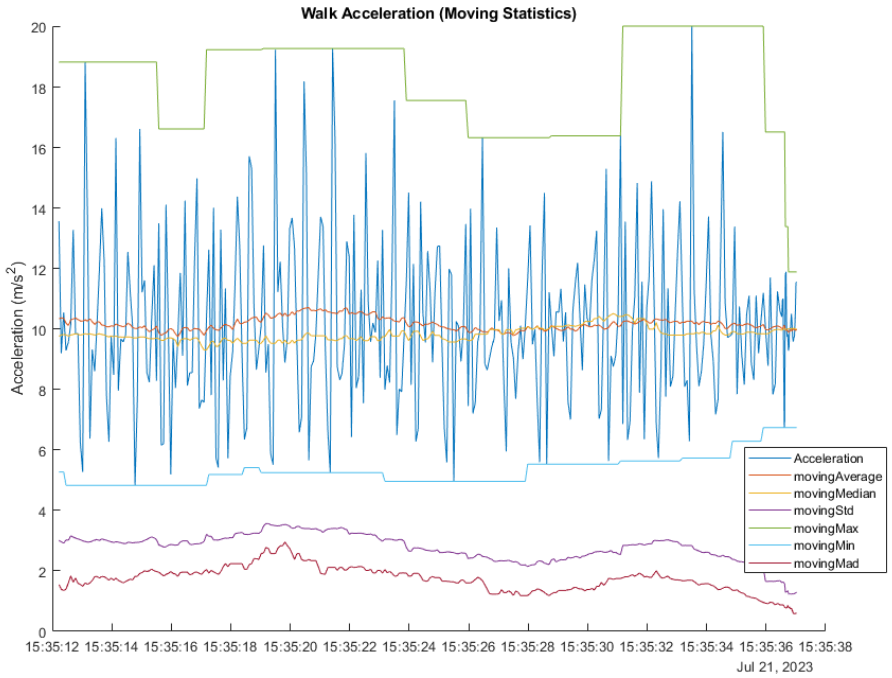
Data preprocessing

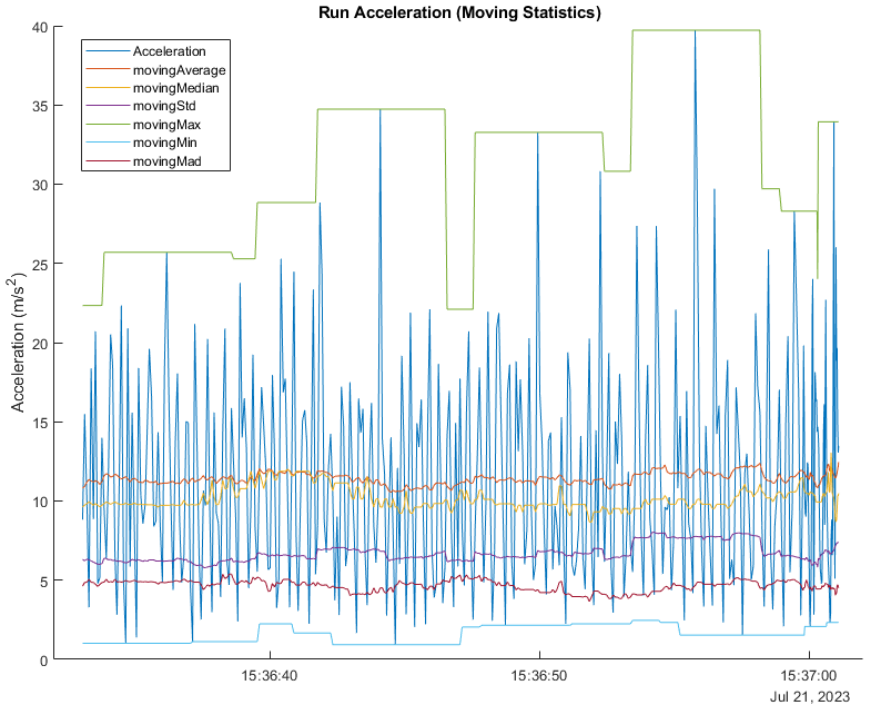
One of the main goals of our fitness tracker is to be able to distinguish whether the user was sitting, walking or running.

In to order to feed the data to the Classification Learner, the moving statistics are calculated. This is necessary in order to categorize the different time intervals.

Specifically, we used the following moving statistics with a moving window of 60 samples:

- Moving Average
- Moving Min
- Moving Max
- Moving Median
- Moving Standard Deviation
- Moving Median Absolute Deviation


Walk Acceleration (Moving Statistics)
Acceleration (m/s^2)
Acceleration
movingAverage
movingMedian
movingStd
movingMax
movingMin
movingMad
15:35:12 15:35:14 15:35:16 15:35:18 15:35:20 15:35:22 15:35:24 15:35:26 15:35:28 15:35:30 15:35:32 15:35:34 15:35:36 15:35:38
Jul 21, 2023


Run Acceleration (Moving Statistics)
Acceleration (m/s^2)
Acceleration
movingAverage
movingMedian
movingStd
movingMax
movingMin
movingMad
15:36:40
15:36:50
15:37:00
Jul 21, 2023


Sit Acceleration (Moving Statistics)
Acceleration (m/s^2)
Acceleration
movingAverage
movingMedian
movingStd
movingMax
movingMin
movingMad
13:34:40
13:34:50
13:35:00
13:35:10
13:35:20
Jul 20, 2023

Training the Model

For estimating whether the user is sitting, walking or running, we developed a Classification model.

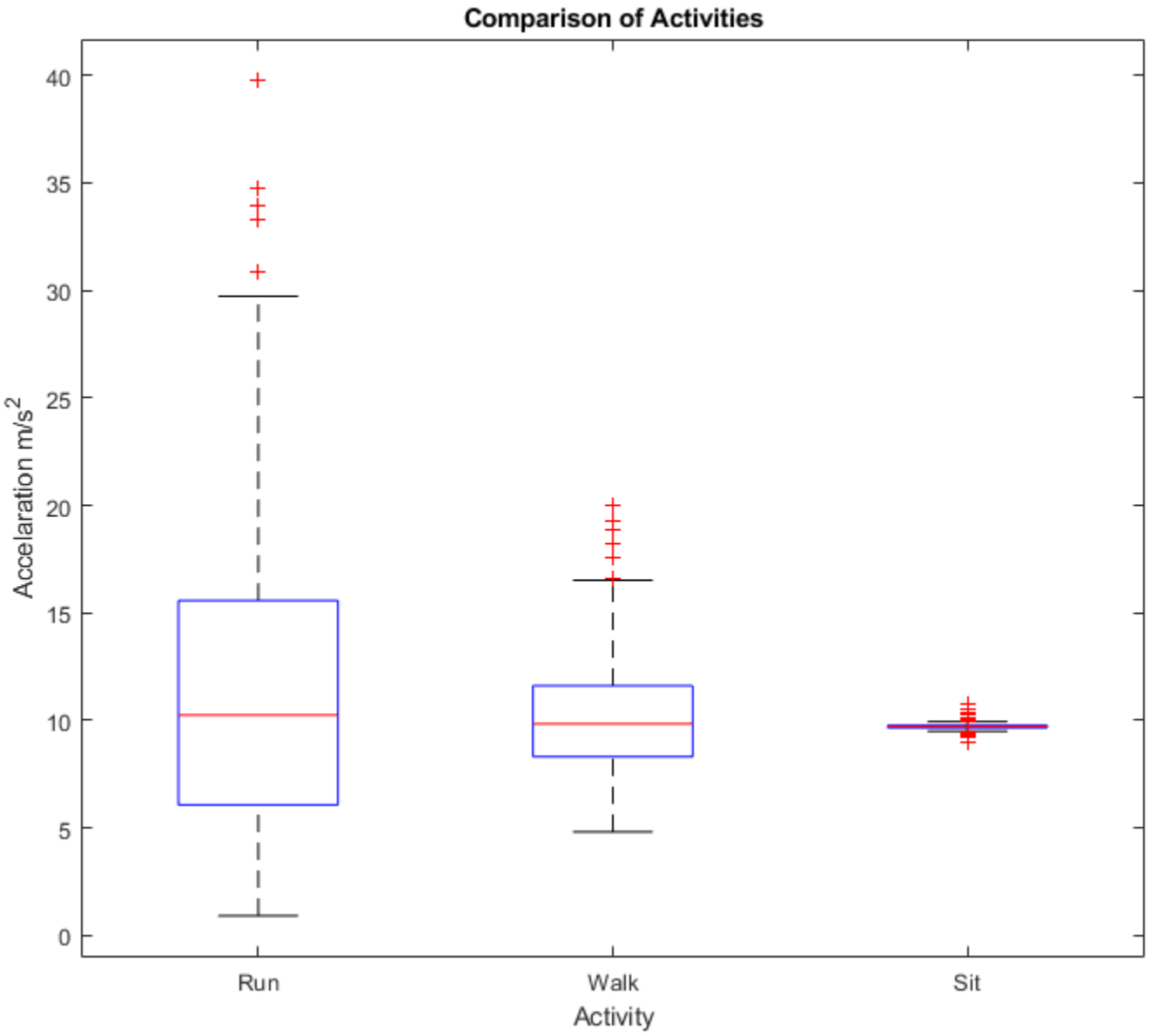
We tried all Quick-To-Train models. We used a test set and 10-fold cross-validation for validating all models.

Most of them had almost perfect accuracy for both testing and validation.

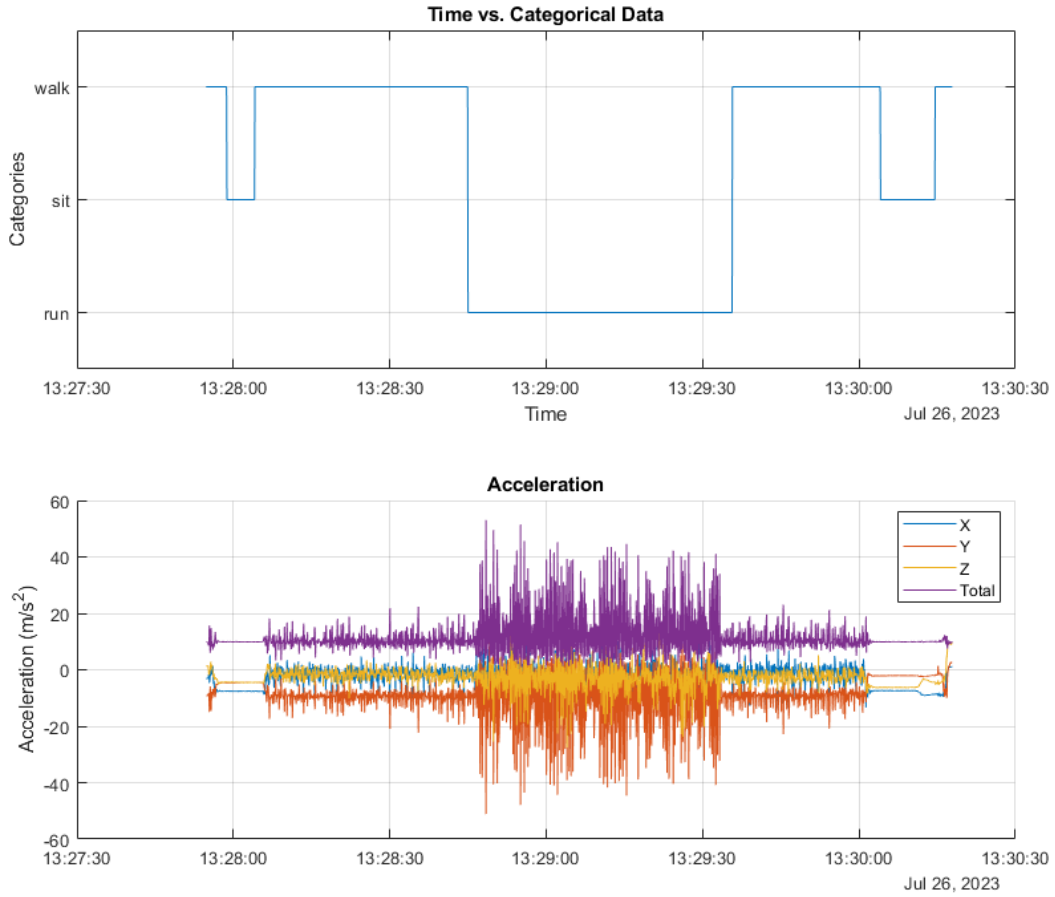
For training, we used both the provided datasets and datasets we recorded ourselves.

For the acceleration, after trial and error, we ended up calculating the magnitude of the acceleration vector first and then applying the moving statistics.

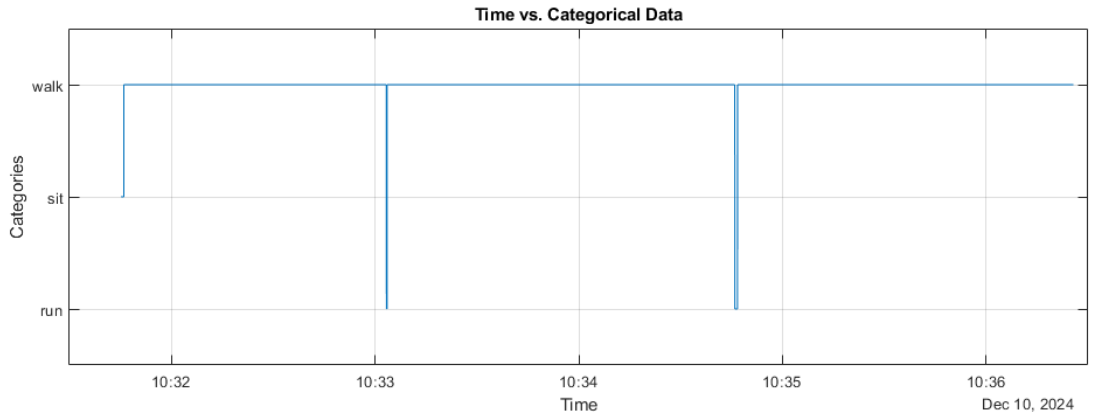
Important note: The accelerometer must record data with a frequency of 10 Hz.

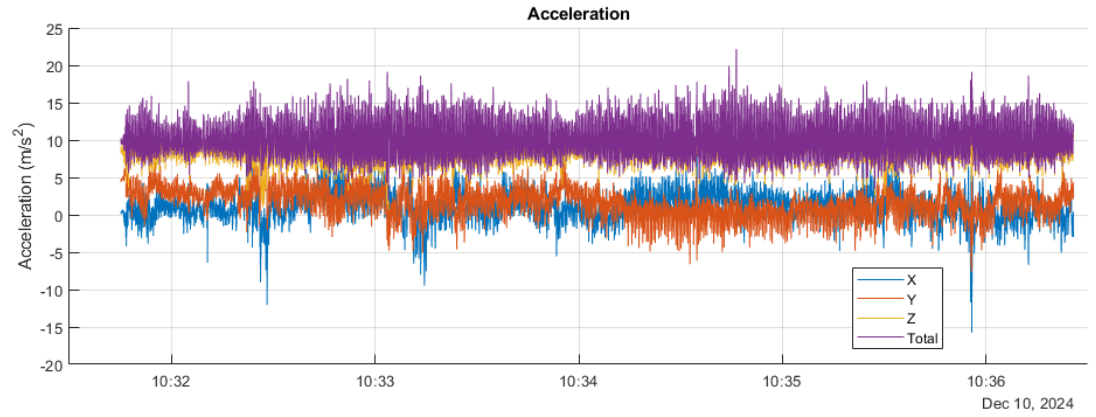

Comparison of Activities
Accelaration m/s2
40
35
30
25
20
15
10
5
0
Run
Walk
Sit
Activity

Results


Time vs. Categorical Data
walk
sit
run
Categories
13:27:30
13:28:00
13:28:30
13:29:00
13:29:30
13:30:00
13:30:30
Time
Jul 26, 2023
Acceleration
60
40
20
0
-20
-40
-60
Acceleration (m/s^2)
X
Y
Z
Total
13:27:30
13:28:00
13:28:30
13:29:00
13:29:30
13:30:00
13:30:30
Jul 26, 2023

Results


Time vs. Categorical Data
walk
sit
run
Categories
10:32
10:33
10:34
10:35
10:36
Time
Dec 10, 2024


Acceleration
25
20
15
10
5
0
-5
-10
-15
-20
Acceleration (m/s^2)
X
Y
Z
Total
10:32
10:33
10:34
10:35
10:36
Dec 10, 2024

Extra Features

We utilized the GPS data for calculating the distance travelled by the user.

In order to transform latitude and longitude measurements to distance, the World Geodetic System 1984 was used.

In addition, we created a plot that visualizes the route of the user on a map.